Group 6

FLYING CONTROLS

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Introduction

1. This Group contains descriptive and servicing information for the electrical equipment in the powered flying controls and associated systems, which comprise:-

(1) Powered flying controls
(2) Artificial feel controls
(3) Normal and emergency trim controls
(4) Air brake controls
(5) Parachute stream and jettison
(6) Auto-pilot power supplies

2. Component location illustrations are provided and theoretical circuit diagrams, for the more complex circuits, are to be found adjacent to the text covering circuit operation. Only the power supplies for the auto-pilot are described in this Group, details of this installation being contained in Chapter 2 of this Section.

3. A description of the powered flying controls system appears in Sect.3, Chap. 4 of this publi cation, and the information in this Group should be read in conjunction with that description. The following modifications are covered in this Group:-

Mod.258 To delete the group stopping circuit and switches and introduce group start push switches.

Mod.259 Improvements of safety trimmers circuit.

Mod.260 Further protection to safety of trimmer circuit.

Mod.289 To introduce warning device for artificial feel system.

Mod.296 To introduce type 10B relays in lieu of S2 and S3 in trimmer control circuit.

Mod.308 Further improvement of safety of trimmer circuit.

Mod.410 Introduction of Sunvic switch 601V in lieu of slugged relay W68M/1061/D2 in P.F.C. warning lights.

Mod.444 To change Western micro switches to Burgess Type V3 micro switches.

Mod.455 To introduce protective shrouds over switches in essential circuits.

Mod.486 To make parachute stream release unit more easily removable and introduce earthing strips for both stream and jettison units.

Mod.492 To introduce elevator unit, Type P113 with BP.Mod.P113/13 embodied.

Mod.493 To introduce rudder unit, Type P114 with BP.Mod.P114/20 embodied.

Mod.564 To introduce improvement to auto-pilot installation including roll error cut-out and remote indicator.

Mod.575 To introduce aileron power units, Type P112, with BP. Mod.P112/14 embodied.

Mod.588 To provide for pulse operation of the release and jettison slips and to fit contactors 5D/1840 and butt connectors 5D/1841 in lieu of contactor 5D/1933 in both slips.

Mod.593 To introduce time delay units to overcome surge of current when air brakes are being reversed.

Mod.692 To introduce switches to Mod. Elect C/179 standard.

Mod.697 To improve 112-volt generator system.

Mod.926 To prevent mal-operation of air brakes in the event of a failure of a rectifier associated with a delay unit.

Mod.928 To introduce Diamond H relays in lieu of P.O. Type in artificial feel units.

Mod.1312 To introduce motor Type C.7703, 5UD/6231, embodying Rotax Mod.6079.

Mod.1498 To prevent actuator failure due to motor burn-out caused by intermittent sticking of Diamond H relay contacts in A.F.U. electrical component boxes.

◀ Mod.1927 Introduction of locking circuit for artificial feel and feel relief actuators. ▶

POWERED FLYING CONTROLS

General

4. Because of the heavy aerodynamic loading on the flying control surfaces, considerable physical effort would be required in order to move them and so control the aircraft during flight. To overcome this, the surfaces are hydraulically operated, the hydraulic pumps being driven by electric motors. When the pilot moves his controls, a system of valves is operated resulting in hydraulic actuation of the appropriate control surface.

DESCRIPTION AND OPERATION

Control surfaces

5. As the aircraft has no tailplane, the elevators are fitted on the trailing edge of

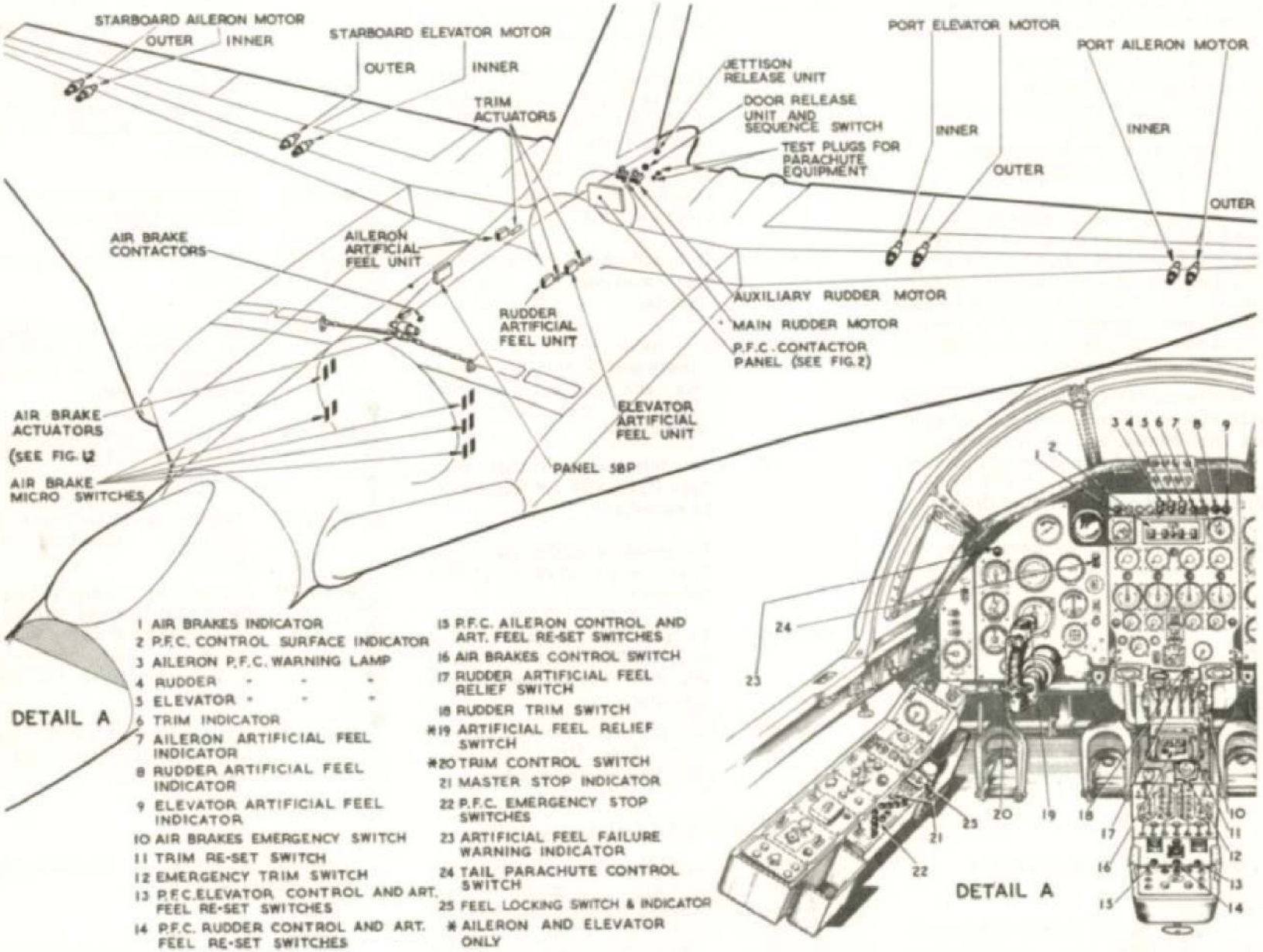

Fig. 1 Location of components
(*Mod. 1227*)

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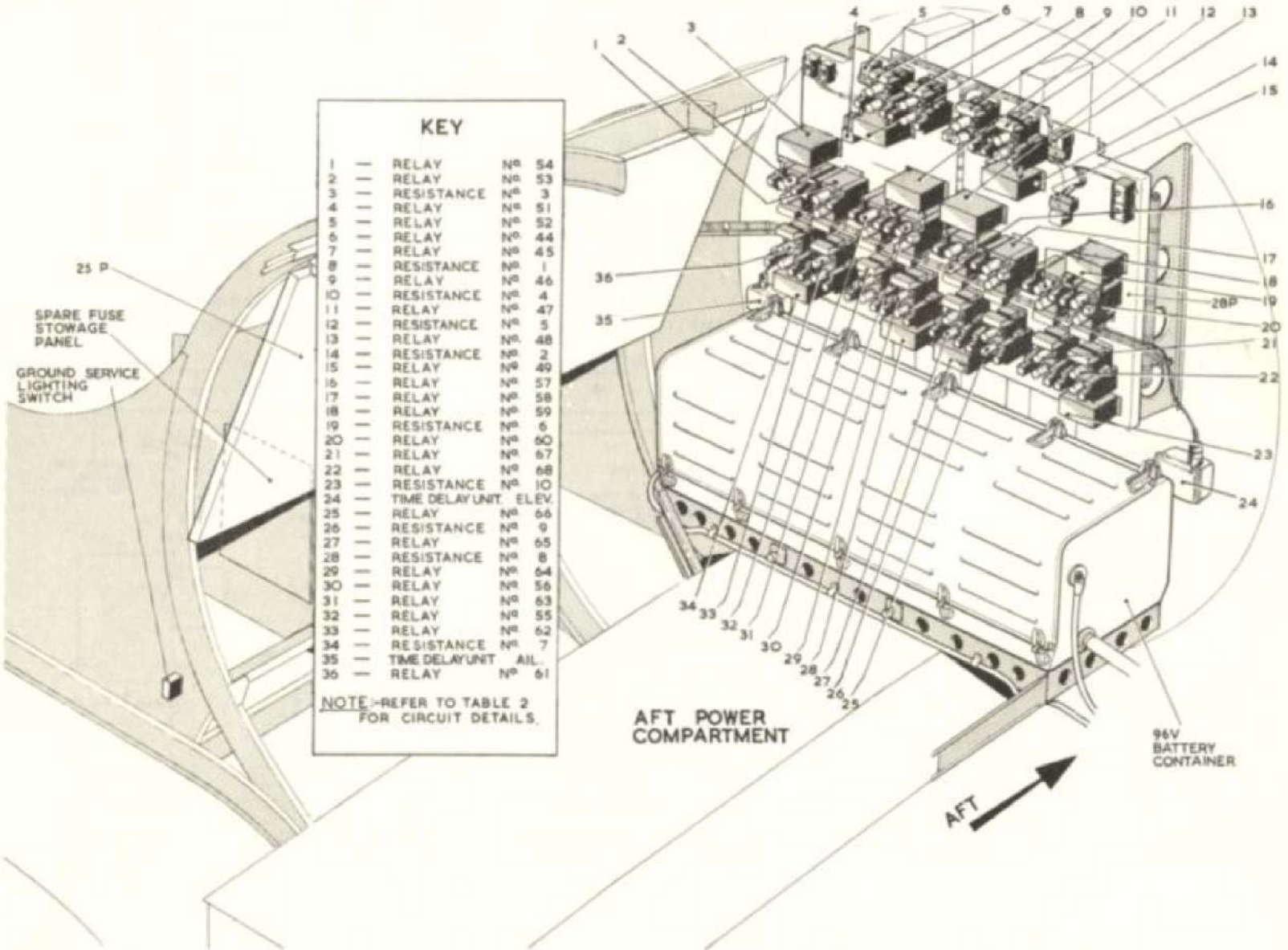

Fig. 2 P.F.C. contactor panel

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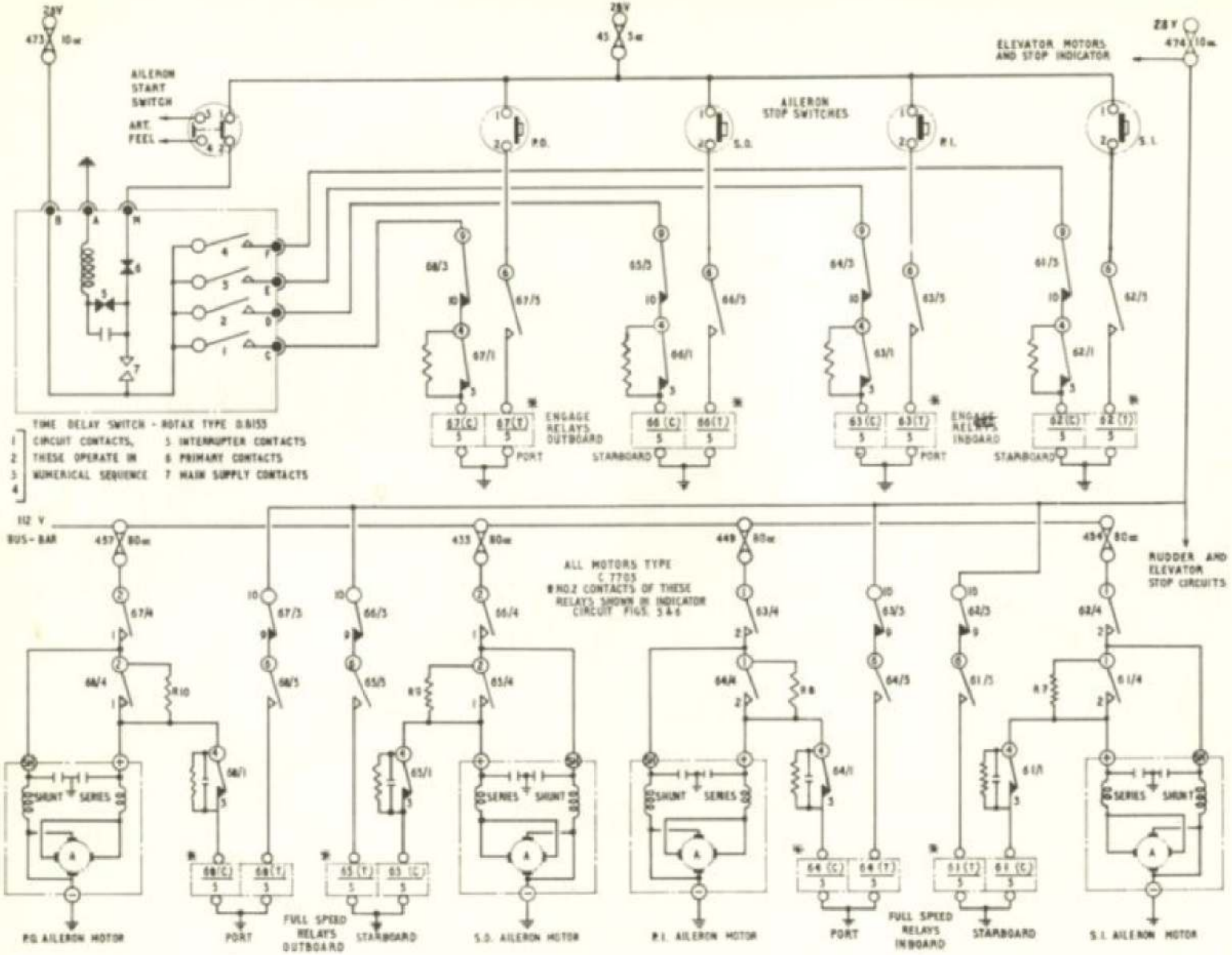

Fig. 3 Powered flying controls – aileron motors

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ADVANCE INFORMATION LEAFLET NO.12/59

Insert this leaflet in A.P.4505A, Vol.1, Book 2, Sect.5, Chap.1, Group 6, to face para.12

Para.15 ... ... Amend starting sequence to read:-

"1 Port outer
2 Starboard outer
3 Port inner
4 Starboard inner"

Delete last two sentences

Substitute the following:-

"Automatic sequential starting of the aileron and elevator motors following START selection is ensured by the operation of two time delay switches Rotax Type D8153. These are fitted one in each system and installed adjacent to panel 28P. Each switch also provides for the restarting of any of its associated motors regardless of unserviceability affecting the others. Since the two circuits are similar only the aileron circuit is described. The starting circuit for the rudder motors and the indicator circuits are described separately."

Para.16 ... ... Delete existing text.
Substitute the following:-

"The starting circuits for the motors will become operative when both 28-volt and 112-volt supplies are made available."

Para.17 ... ... Delete existing text.
Substitute the following:-

"Referring to fig.3 it will be seen that on depressing the aileron start switch a 28-volt d.c. supply is fed from fuse 45 on panel 2P to the input terminal M of the time delay circuit. Briefly, the time delay circuit causes the circuit contacts to close and open through a starting cycle in accordance with their numerical sequence. Each contact is closed for 3 seconds then a 1 second interval occurs before closure of the succeeding contact. On the closing of each contact a 28-volt energising supply will be fed from fuse 473 on panel 26P, via terminal B of the delay unit, to the close coil of its respective engage lay. Full technical details of the time delay switches are given in A.P.4343C, Vol.1, Book 2, Sect.3, Chap.107".

(continued overleaf)

(continued from overleaf)

Para.18 ... ... Delete existing text.
Substitute the following.

"18. On closure of the No.1 relay circuit contacts in the time delay unit the following circuit action takes place:-

(1) The 28-volt energising supply is connected via Pin C and normally closed relay contacts 68/3 and 67/1 to the close coil of the starboard inboard aileron motor engaging relay No.62(c).
(2) Closing of contacts 67/4 will connect the 112-volt supply from fuse 437 on panel 24P to the shunt field of the P.O. aileron motor.
(3) The circuit to the series field of the motor will be completed via the starting resistor R10.
(4) Opening of contacts 67/3 will interrupt the trip coil circuit of the full speed relay No.68.
(5) Closing of contacts 67/5 will prepare the trip coil circuit of relay 67.
(6) Opening of contacts 67/1 will insert an economy resistance in the close coil circuit of relay 67.
(7) Closing of contacts 67/2 (fig.5) will energise the P.F.C. stop indicator on the port console panel to show black."

Para.19 ... ... Delete existing text.
Substitute the following.

"19. The port outboard aileron motor is thus started up at a slow speed, and as the speed builds up, its current demand will grow progressively less, with the result that the voltage drop across R10 decreases. Thus the P.D. applied across the full speed relay close coil (68C) will correspondingly increase, with a P.D. of 75 volts across this coil, the relay will be energised, and the following circuit action will take place:-

(1) The starting resistance R10 will be short-circuited by the closing of contacts 68/4 and full line voltage is thus applied to the armature of the motor and the motor will run at full speed.
(2) Opening of contacts 68/1 will insert an economy resistance in the close coil circuit of relay 68.
(3) Closing of contacts 68/5 will prepare the trip coil of relay 68.
(4) Opening of contacts 68/3 will interrupt the supply to the close coil of the engaging relay 67.
(5) Closing of relay contacts 62 (fig.5) in series with the No.2 contacts of the three remaining high speed relays, as they close, will connect a 28-volt energising supply from fuse 470 on panel 26P, to the coil of the aileron warning relay No.52.
(6) Opening of the normally closed relay contacts 52/1 will interrupt the supply, also from fuse 470, to the warning indicator. The lamp is thus extinguished to show that a satisfactory starting cycle has been completed."

Para.20 ... ... Delete first sentence
Substitute the following:-

"The foregoing circuit operation will be repeated for the remaining aileron motors as their main supply contacts are operated, and via their respective relays as follows:-

Contacts No.2 via pin D - Starboard outboard
Contacts No.3 via pin E - Port inboard
Contacts No.4 via pin F - Port outboard

and will also apply to the elevator motors via the appropriate fuses, start switch and relays."

(continued overleaf)

Notes

(1) The information contained in this leaflet will be incorporated by normal amendment list action in due course.

(2) If, after receipt of this leaflet, an amendment list with a prior date and conflicting information is received, the information in the leaflet is to take precedence.

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the wings, alongside the ailerons, and, as each surface is duplicated, there are four sections to each trailing edge; the two outboard sections are ailerons, the two inboard are elevators.

6. The rudder is made up of one section only. Its control is duplicated, however, there being two independent hydraulic pumps. Normally, both pumps are in operation, but, if the main one fails, either electrically or hydraulically, the auxiliary unit will automatically take over rudder operation. The procedure for airborne failure is covered in para.29.

P.F.C. units

7. Ten electro-hydraulic Powered Flying Control (P.F.C.) units are fitted; they are:-

P.O.aileron unit P.I.aileron unit S.O.aileron unit S.I.aileron unit	Boulton Paul, Type P112
P.O.elevator unit P.I.elevator unit S.O.elevator unit S.I.elevator unit	Boulton Paul, Type P113
Rudder main unit Rudder aux. unit	Boulton Paul, Type P114

Each unit is driven by a compound-wound 112-volt motor, Type C7703. The motors are controlled from the 28-volt d.c. system. The pump units are described in A.P.4603C D and E, Vol.1, and the motors in A.P.4343D, Vol.1, Book 4.

◀ *NOTE . . .*
When Mod.1312 is embodied these motors embody Rotax Mod.6079.

Control switches

8. Three double-pole, push-switches, Type B, mounted on the centre console in the pilot's compartment, are labelled START AND ART.FEEL RESET and, additionally, AILERON RUDDER and ELEVATOR, respectively. One pole of each switch controls the starting of its associated group of P.F.C. motors and the other engagement of the corresponding artificial feel system.

9. A further ten push-switches, Type B, fitted to a panel attached to the port console, are labelled P.F.C. STOP SWITCHES. They are arranged in plan view to correspond with the position of their associated motors on the aircraft and bear the titles of the control surface which they serve, i.e., AILERON, ELEVATOR and RUDDER.

Indicators

10. A control surface position indicator is installed on the pilot's centre instrument panel 1P. Three red warning lamps, Type B labelled AILERON, ELEVATOR, RUDDER, are fitted adjacent to the position indicator and, when illuminated, indicate the failure of any of the P.F.C. units in the associated system. An electro-magnetic indicator, Type B2, installed on the P.F.C. stop switch panel attached to the port console 6P, is labelled P.F.C. STOP and is de-energized to give a white display only when all the P.F.C. units are stationary. The operation of the indicators and warning circuit is described in para.25 to 41.

Supplies

11. Heavy-duty supplies for the P.F.C. motors are obtained from the 112-volt bus-bars in panels 24 and 25P. The control circuits and indicators are fed from the 28-volt supply via fuses on 3P and 26P. The control relays and heavy-duty contactors are fitted to the P.F.C. contactor panel 28P (fig.2) at the aft end of the power compartment in the rear fuselage. The latched contactors in the P.F.C. circuits have been given relay numbers for identification purposes, and are referred to as relays in the text and routing charts of this Group. Relay types, their numbers and functions, are given in Table 2. Descriptive and servicing details of the relays appear in A.P.4343C, Vol.1, Book 2.

Circuit operation

12. Each group of pump units is controlled by its associated start push-switch on the centre console. The aileron and elevator motors are started in the following automatic sequence:-

(1) Port outboard
(2) Starboard outboard
(3) Port inboard
(4) Starboard inboard

Automatic sequential starting is brought about by the operation of two time delay switches, Type D8153, fitted one in each system and installed adjacent to panel 28P. Each switch also provides for the restarting of any of its associated motors even if the others are unserviceable. Since the two circuits are similar, only the aileron circuit is described; the circuit for the rudder motors is described separately. The starting circuits for the motors will become operative when both 28-volt and 112-volt supplies are made available. Details of the time delay switch are given in A.P.4343C, Vol.1, Book 2.

Starting the aileron units

13. When the aileron start switch (fig.3) is pressed, a 28V d.c. supply from fuse 45 on panel 3P is fed to pin M of the time delay switch. Within the switch, contacts 1 to 4 operate in numerical sequence; each contact closes for three seconds and then opens, there follows a 1-second delay before closure of the succeeding contact. As each contact closes, a 28V supply is fed from fuse 473 on panel 26P to pin B on the switch, through the closed contact and thence to one coil of the associated engage relay. The following operating sequence therefore applies to each aileron unit circuit in turn.

14. On closure of the No.1 contacts in the time delay unit.

(1) A 28-volt energizing supply is connected via pin C and normally-closed relay contacts 68/3 and 67/1 to the close coil of the port outboard aileron motor engaging relay 67/C.

(2) Closing of contacts 67/4 connects the 112-volt supply from fuse 437 on panel 24P to the shunt field of the port outboard aileron motor.

(3) The circuit to the series field of the motor is completed via the starting resistor R.10.

(4) Opening of contacts 67/3 interrupts the trip coil circuit of the full speed relay 68.

(5) Closing of contacts 67/5 prepares the trip coil circuit of relay 67.

(6) Opening of contacts 67/1 inserts an economy resistance in the close coil circuit of relay 67.

(7) Closing of contacts 67/2 (fig.5) energizes the P.F.C. stop indicator on the port console panel to show black.

15. The port outboard aileron motor thus starts and, as the speed builds up, its current demand grows less; the voltage drop across R.10 thus decreases and the P.D. applied across the full speed relay close coil 68C will correspondingly increase and, when it reaches 75 volts, the relay will be energized. The following circuit action then takes place:-

(1) Starting resistance R.10 is short-circuited by the closing of contacts 68/4 allowing full line voltage to be applied to the armature of the motor which then runs at full speed.

(2) Opening of contacts 68/1 inserts an economy resistance in the close coil circuit of relay 68.

(3) Closing of contacts 68/5 prepare the trip coil of relay 68.

(4) Opening of contacts 68/3 interrupt the supply to the close coil of the engaging relay 67.

(5) Closing of relay contacts 68/2 (fig.5), in series with contacts 2 of the three remaining high speed relays, connects a 28-volt energizing supply from fuse 470 on panel 26P, to the coil of the aileron warning relay 52.

(6) Operation of the lock valve micro switch (fig.5) as the pressure rises, interrupts the energizing supply to relay 437, relays 438, 439 and 440 being similarly de-energized by the operation, in turn, of their respective micro switches.

(7) Opening of normally-closed contacts 52/1 and the parallel contacts 437/1, 438/1, 439/1 and 440/1 (fig. 5) disconnects the supplies to the warning lamp. The lamp will thus be extinguished to show that a satisfactory starting cycle has been completed in respect of all the aileron units.

Stopping individual aileron units

16. As the stop circuits of the four units are identical (fig.3) the following description is, in its general terms, applicable to all units.

17. On depressing the port outboard stop button, a 28-volt d.c. supply from fuse 45 is connected, via relay contacts 67/5, to the trip coil of relay 67 and the following circuit action results:-

(1) Opening of relay contacts 67/4 disconnects the 112-volt d.c. supply from the motor, causing it to stop.

*(2) Opening of contacts 67/2 (fig.5) disconnects the supply, in respect of this motor, from fuse 474 to the stop indicator.

(3) Closing of relay contacts 67/3 connects a 28-volt d.c. supply from fuse 474 to the trip coil of relay 68.

(4) Opening of relay contacts 68/2 (fig. 5) interrupts the energizing supply to the coil of the aileron warning relay 52.

(5) Closing of relay contacts 52/1 (fig. 5) connects a supply from fuse 470 to the aileron warning lamp which lights indicating a failure in the system.

(6) Operation of the lock valve micro switch (fig.5) as the pressure falls energizes indicator relay 437.

(7) Closing of relay contacts 437/1 (fig.5) completes the parallel supply to the warning lamp.

* The stop indicator (fig.5) is only de-energized when all motors, including those for rudder control, are switched off; it then shows white.

18. If for any reason the incorrect stop button is depressed, resulting in the stoppage of a serviceable aileron motor, the motor can be re-started by operation of the start switch. This will cause the time delay switch to function through its starting cycle, and operation of the correct button will then stop the P.F.C. unit which has failed.

Starting the rudder units

19. The main and auxiliary rudder motors (fig.4) are started simultaneously. On depressing the start switch on the centre console, a 28-volt supply is fed from fuse 45 on panel 3P to energize the coil of start relay 48 on panel 28P. The following action will then take place in respect of both motors though the relay numbers quoted apply only to the main motor.

(1) Closing of relay contacts 48/1 connects a 28-volt supply from fuse 475 on panel 26P, via normally-closed relay contacts 44/3 and 45/1, to the close coil of the main engage relay 45C.

(2) Closing of contacts 45/4 connects a 112-volt supply from fuse 434 on panel 24P to the shunt field.

(3) The circuit to the series field of the motor is completed via starting resistance R.1.

(4) Opening of contacts 45/3 interrupts the trip coil circuit of the full speed relay 44.

(5) Closing of contacts 45/5 prepares the trip coil circuit of relay 45.

(6) Opening of contacts 45/1 inserts an economy resistance in the close coil circuit of relay 45.

(7) Closing of contacts 45/2 (fig.5) energizes the P.F.C. stop indicator on the port console panel to show black.

20. The main rudder motor thus starts and, as the speed builds up, its current demand grows progressively less so that the voltage drop across R.1 decreases. Thus, the P.D. applied across the full speed relay close coil 44C correspondingly increases and when its value reaches 75-volts the relay is energized and the following circuit actions occur:-

(1) Starting resistor R.1 is short-circuited by the closing of contacts 44/4 and full line voltage is applied to the armature of the motor which runs at full speed.

(2) Opening of contacts 44/1 inserts an economy resistor in the close coil circuit of relay 44.

(3) Closing of contacts 44/5 prepares the trip coil of relay 44.

(4) Opening of contacts 44/3 interrupts the supply to the close coil of the engaging relay 45.

(5) Closing of relay contacts 44/2 (fig.5) in series with contacts 2 of the auxiliary motor high speed relay 47 connects an energizing supply from fuse 473 on panel 26P to the coil of the rudder warning relay No. 49.

(6) Operation of the associated pressure switch and the lock valve micro switch (fig.5), as the pressure rises, de-energizes the warning relays 432 and 431.

(7) Opening of normally-closed contacts 49/1 and the parallel contacts 432/1 and 431/1 (fig.5) then disconnects the supply to the warning lamp which is extinguished to show that a satisfactory starting cycle has been completed in respect of both units.

Stopping individual rudder units

21. Under no circumstances should the rudder main unit be stopped in flight other than in compliance with the procedure in para. 29. Referring again to fig.4, the stop circuits of the two units are similar and the following description consequently applies to them both, though the relay numbers, etc., quoted apply only to auxiliary stop circuit.

22. On depressing the auxiliary unit stop button, a supply is connected from fuse 45, via relay contacts 46/5, to energize the trip coil of relay 46 and the following circuit actions result:-

(1) Opening of relay contacts 46/4 disconnects the 112-volt d.c. supply from fuse 453 to the motor, causing it to stop.

(2) Opening of relay contacts 46/2 (fig.5) disconnects the supply, in respect of this motor, from fuse 474 to the stop indicator.

(3) Closing of contacts 46/3 connects a 28-volt d.c. energizing supply from fuse 475, via relay contacts 47/5, to the trip coil of relay 47.

(4) Opening of relay contacts 47/2 (fig.5) interrupts the supply to the coil of rudder warning relay 49.

(5) Closing of relay contacts 49/1 (fig.5) connects a supply from fuse 472 to the warning lamp which lights to indicate a failure in the system.

(6) Operation of the pressure switch (fig.5), as the pressure falls, energizes indicator relay 431.

(7) Closing of relay contacts 431/1 (fig.5) completes the parallel supply to the warning lamp.

23. From the circuit description at para.19 to 22 it will be seen that the

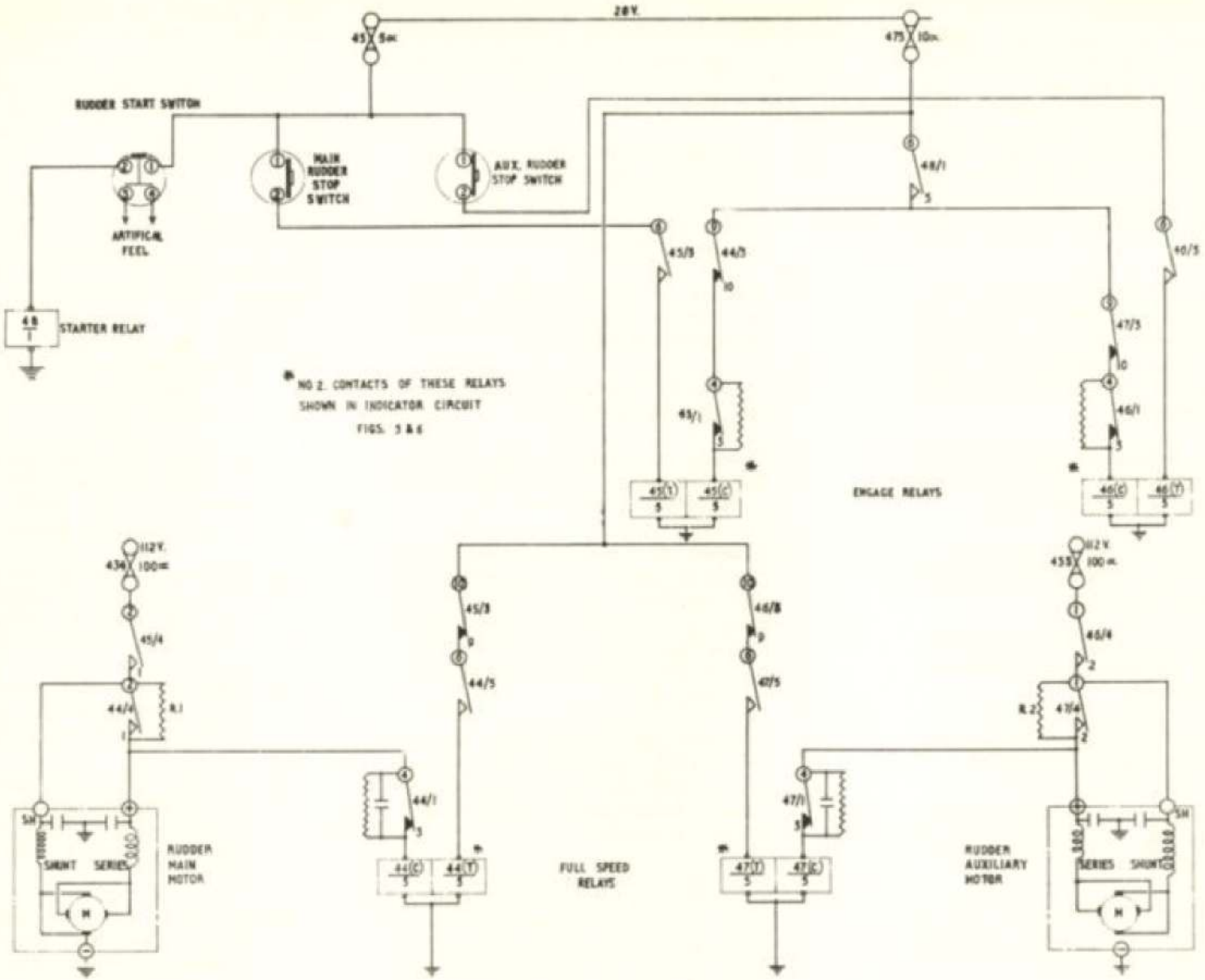

Fig. 4 Powered flying controls - rudder motors

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Volume 1, Book 2

AIR MINISTRY

VULCAN B Mk.1 (AND ASSOCIATED ROLE) AIRCRAFT

ADVANCE INFORMATION LEAFLET NO.14/59

Insert this leaflet in A.P.4505A, Vol.1, Book 2, Sect.5, Chap.1, Group 6, to face para.21

Para.21 ... ... Delete the existing text. **Remove and destroy A.L.L. No.9/58**
Substitute the following:-

"21. In the event of a failure of say, the port outboard aileron unit, the aileron warning indicator on the pilots' centre panel will be illuminated. Observation of the control surface position indicator would show which section of the control surface had failed. The appropriate individual stop button on the port console for the port outboard aileron motor should then be depressed to isolate the faulty P.F.C. unit. If for any reason the incorrect stop button is depressed, resulting in the stoppage of one of the aileron motors not subject to failure, this can be restarted by operation of the start switch. Such operation will cause the time delay switch to function through its starting cycle and operation of the correct button will then stop the P.F.C. unit which has failed."

Para.22 ... ... Delete existing text.
Substitute the following:-

"22. Operation of the port outboard aileron motor stop button connects a 28-volt supply from fuse 45, via relay contacts 67/5 to the trip coil of relay 67. The following action then takes place:-

(1) Opening of relay contacts 67/4 will disconnect the 112-volt supply from the motor, causing it to stop.
(2) Opening of contacts 67/2 (fig.5) will disconnect the supply, in respect of this motor, from fuse 474 to the stop indicator.
(3) Closing of relay contacts 67/3 will connect the 28-volt supply from fuse 45 to the trip coil of relay 68.
(4) Opening of relay contacts 68/2 (fig.5) will interrupt the energising supply to the coil of the aileron warning relay No.52.
(5) Closing of relay contacts 52/1 will connect a supply from fuse 470 on panel 26P to the aileron warning indicator and this will be illuminated to show a motor failure in the system.

The above stop action applies to all the aileron and elevator motors via their respective relays. The stop indicator (fig.5) is only de-energised when all motors including those for rudder control are switched off, it then shows white."

Paras.22(a) to 22(d) Take in new paras.22(a) to 22(d) as follows:-

"Starting main and auxiliary rudder motors
22(a). Referring to fig.4 it will be seen that the main and auxiliary rudder motors are started simultaneously. On depressing the start switch on the centre console a 28-volt energising supply is fed from fuse 45 on panel 3P to the coil of the start relay No.48 on panel 28P. The following action will then take place:-

(continued overleaf)

(continued from overleaf)

(1) Closing of relay contacts 48/1 will connect a 28-volt supply from fuse 475 on panel 26P as follows:-

(a) Via normally closed relay contacts 44/3 and 45/1 to the close coil of the main motor engage relay No.45C.
(b) Via normally closed relay contacts 47/3 and 46/1 to the close coil of the auxiliary motor engage relay No.46C.

(2) In the case of the main motor, closing of contacts 45/4 will connect a 112-volt supply from fuse 434 on panel 24P to the shunt field.
(3) The circuit to the series field of the motor will be completed via the starting resistance R1.
(4) Opening of contacts 45/3 will interrupt the trip coil circuit of the full speed relay 44.
(5) Closing of contacts 45/5 will prepare the trip coil circuit of relay 45.
(6) Opening of contacts 45/1 will insert an economy resistance in the close coil circuit of relay 45.
(7) Closing of contacts 45/2 (fig.5) will energise the P.F.C. indicator on the port console panel."

22(b). The main rudder motor is thus started up at slow speed, and as the speed builds up, its current demand will grow progressively less, with the result that the voltage drop across R1 decreases. Thus the P.D. applied across the full speed relay close coil 44(c), will correspondingly increase. With a P.D. of 75 volts across this coil, the relay will be energised, and the following circuit action will take place:-

(1) The starting resistor R1 will be short-circuited by the closing of contacts 44/4 and full line voltage is thus applied to the armature of the motor and the motor will run at full speed.
(2) Opening of contacts 44/1 will insert an economy resistor in the close coil circuit of relay 44.
(3) Closing of contacts 44/5 will prepare the trip coil of relay 44.
(4) Opening of contacts 44/3 will interrupt the supply to the close coil of the engaging relay 45.
(5) Closing of relay contacts 44/2 (fig.5) in series with the No.2 contacts of the auxiliary motor high speed relay No.47 will connect an energising supply from fuse 472, on panel 26P to the coil of the rudder warning relay No.49.
(6) Opening of normally closed relay contacts 49/1 will disconnect the 28-volt supply to the rudder warning indicator. The lamp will thus be extinguished to show a satisfactory start of both motors.

The foregoing circuit operation for starting will have been occurring simultaneously for the auxiliary rudder motor but via its respective relays.

Stopping main or auxiliary rudder motors

22(c). Referring again to fig.4 it will be seen that depressing the main rudder motor stop button connects an energising supply from fuse 45, via relay contacts 45/5, to the trip coil of relay 45. The following action then takes place:-

(1) Opening of relay contacts 45/4 disconnects the 112-volt d.c. supply to the motor causing it to stop.
(2) Opening of relay contacts 45/2 will disconnect the energising supply in respect of this motor from fuse 474 on panel 26 to the stop indicator.
(3) Closing of contacts 45/3 will connect a 28-volt energising supply from fuse 475 on 26P, via relay contacts 44/5 to the trip coil of relay 44.
(4) Opening of relay contacts 44/2 (fig.5) will interrupt the supply to the coil of the rudder warning relay No.49.
(5) Closing of relay contacts 49/1 will connect the supply from fuse 472 on panel 26P to the rudder warning indicator and this will be illuminated to show a motor failure in the system.

The above circuit operation applies also to the auxiliary motor via its respective stop button and relays."

(continued overleaf)

"22(d). From the circuit descriptions contained in paras.22(a), (b) and (c) it will be seen that the control system for the P.F.C. main and auxiliary rudder units provides the following facilities:-

(1) Simultaneous starting on depression of a common start button.
(2) Independent stopping on depression of their respective stop buttons.
(3) In the event of air borne failure of either unit and inadvertent depression of the incorrect stop button, the serviceable unit can be restarted regardless of the unserviceability of the other."

Para.23 ... ... Amend second sentence to read as follows:-

"This action will trip relay No.45 and the main rudder motor will be stopped as described at para.22(c).

Fig.4 overleaf

Notes

(1) The information contained in this leaflet will be incorporated by normal amendment list action in due course.

(2) If, after receipt of this leaflet, an amendment list with a prior date and conflicting information is received, the information in the leaflet is to take precedence.

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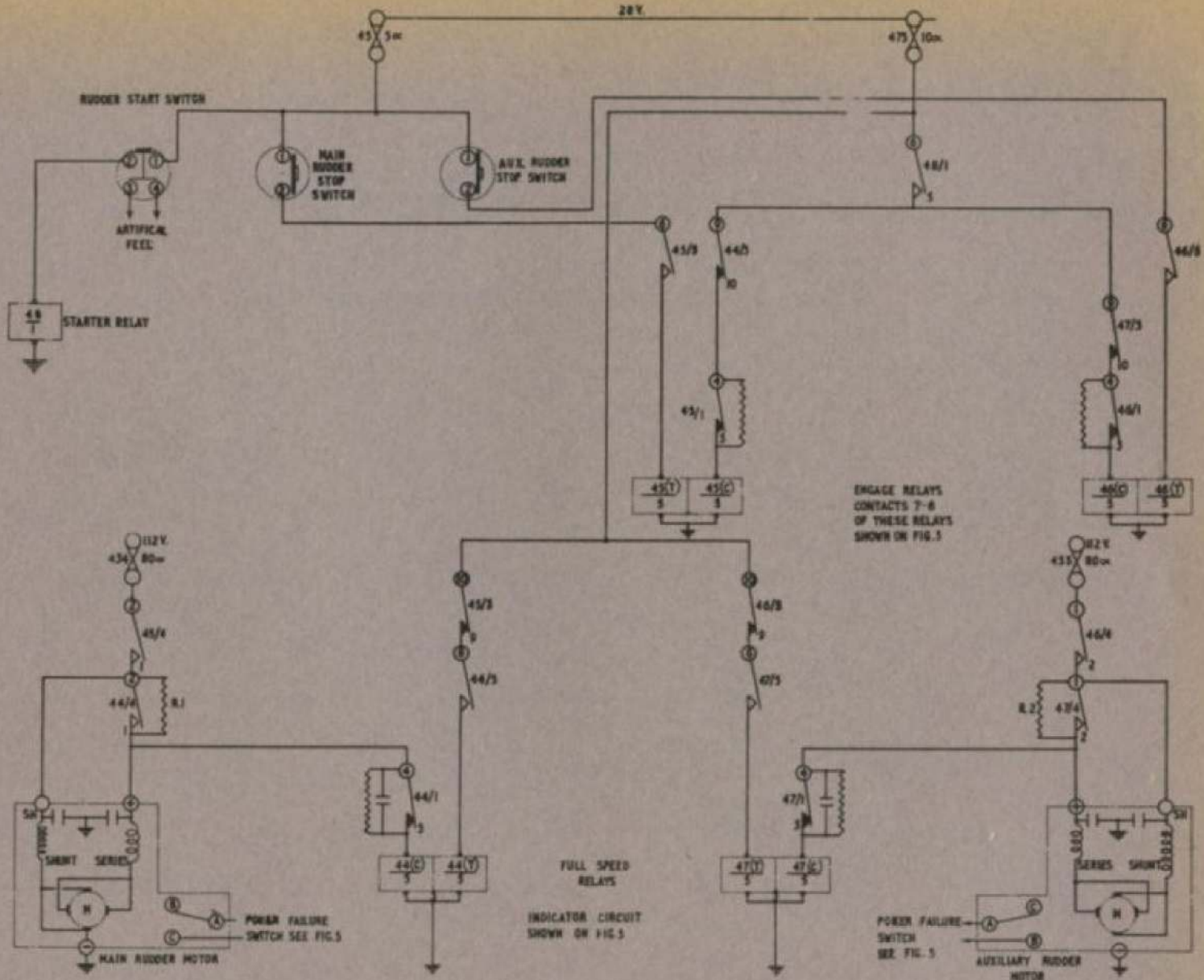

FIG. 4 POWERED FLYING CONTROLS - RUDDER MOTORS (C)

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control system for the rudder main and auxiliary P.F.C. units provides the following facilities:-

(1) Simultaneous starting on depression of a common start button.

(2) Independent stopping on depression of the appropriate stop button.

(3) In the event of an airborne failure of either unit, and in compliance with para.29, restarting of the serviceable unit notwithstanding the unserviceability of the other.

Switching off after use

24. As the P.F.C. contactor relays are of the latched type, the engage relays will remain in the engaged position until the associated stop switch has been operated. It is essential therefore that, after flight or ground test use, ALL the stop switches are operated until the stop indicator shows white. This applies also after ground tests of the artificial feel units which are controlled by the P.F.C. start switches. If this instruction is not complied with damage or injury may be caused by the P.F.C. units which will start automatically if a 112-volt d.c. supply is subsequently connected to the aircraft.

Failure warning system

25. The three separate indication systems provided for the powered flying controls are as follows:-

(1) A control surface position indicator.

(2) A magnetic indicator to show when all the P.F.C. units are stationary.

(3) Three warning lamps to show when any of the P.F.C. units is subject to failure.

The magnetic indicator circuit is controlled by contacts of the engage relays. The warning lamp circuits are controlled by contacts of the high speed relays and also by pressure and micro switches which are integral parts of the P.F.C. units. The function of these switches is described in A.P.4603C, D and E, Vol.1.

Control surface position indicator

26. An indicator on the pilots' centre instrument panel shows the position of all the control surfaces simultaneously. It enables the pilots to check that the controls are operating correctly and in the right direction. Two datum lines, one vertical and one horizontal, are fixed in the centre of the face of the instrument and represent a view of the aircraft looking forward from the tail end. Indication is provided by nine fluorescent arms which move across the datum lines and simulate the control surfaces. Each indicator arm is controlled by a position transmitter operated by a particular flying control surface. Descriptive and servicing information for the control surface position indicator installation is contained in Chap.2, Group 2, of this Section.

Warning lamps

27. The three warning lamps indicate failure in their respective systems as follows:-

(1) On starting the motors, the lamps will remain alight as a result of:-

(a) Incomplete operation of any of the full speed relays and non-closure of its No.2 contacts.

(b) Mechanical failure of any lock valve due to seizure.

(2) Whilst the motors are operating, the lamps will light as a result of:-

(a) Loss of pressure due to failure in the electrical supply, motor or pump unit. In the elevator and aileron systems this will cause operation of the respective lock valve micro switch. In the rudder system, the appropriate pressure switch will be operated.

(b) In the rudder system only, failure of either servo valve, due to seizure of its associated lever mechanism, will cause operation of the respective micro switch.

Aileron or elevator failure

28. As the warning lamps indicate the failure of any of the four units in their respective systems, it is necessary to identify which unit has failed. When either lamp is illuminated therefore, the simultaneous manipulation of the controls and observation of the control surface position indicator will confirm which surface is not responding. Depressing the appropriate stop button will then switch off the unserviceable unit. It should be noted that, in the event of a failure, the aileron or elevator surface affected will in time return to the trailing position.

Rudder failure

29. As it is unlikely that both the rudder units will fail simultaneously, when the warning lamp is illuminated to indicate a failure, manipulation of the controls and observation of the control surface position indicator will give evidence of continuing powered operation. In flight, therefore, in order to establish which unit has failed, the following procedure should be employed and rigidly adhered to at all times:-

(1) Stop the auxiliary unit and verify whether satisfactory powered operation continues.

(a) If this is the case the auxiliary unit should be left inoperative.

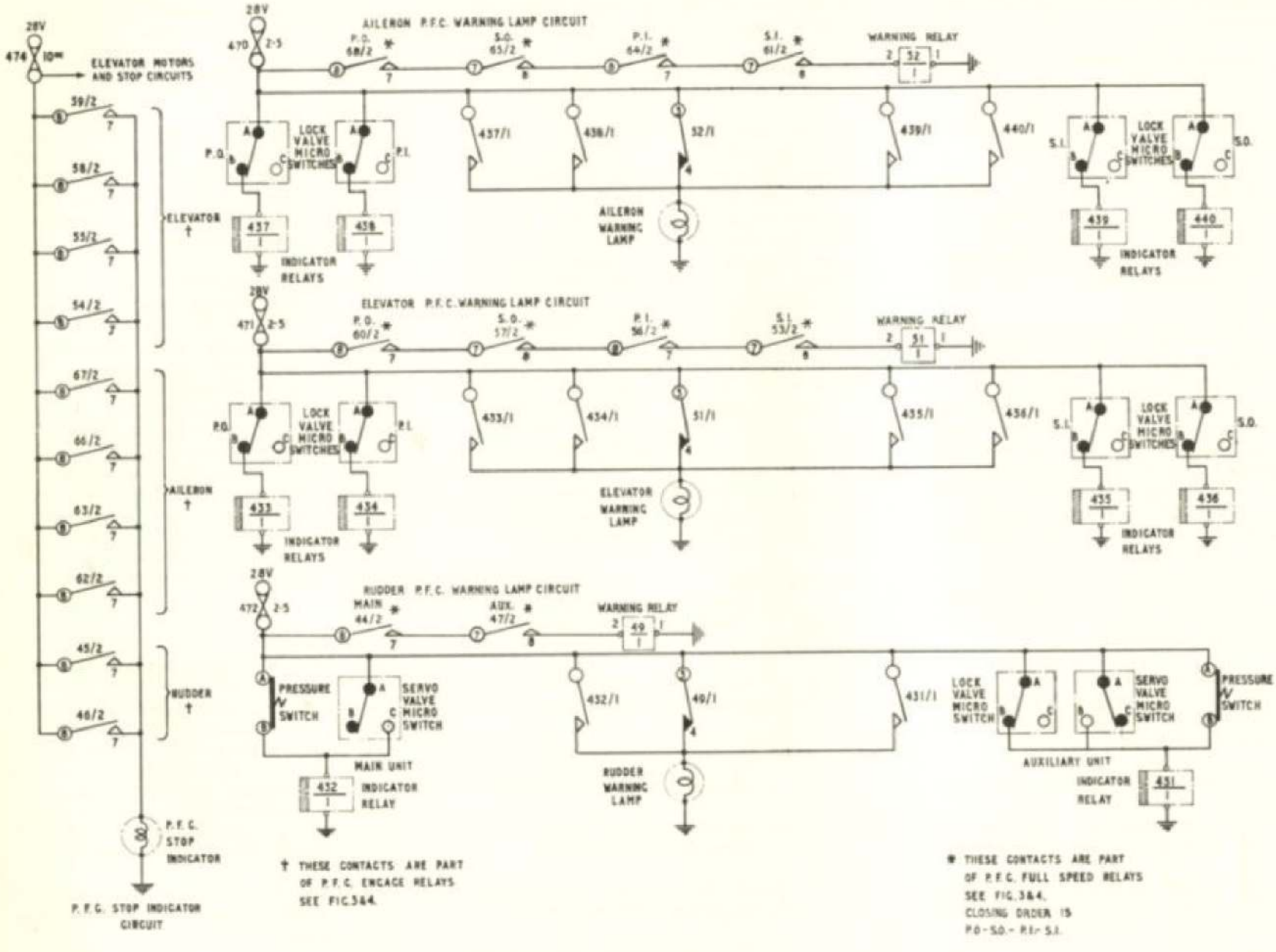

Fig. 5 P.F.C. Indicators (pre Mod. 410)

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(b) If this is not the case, the auxiliary unit should be restarted by operation of the common start button.

(2) When it is necessary to restart the auxiliary unit and satisfactory powered operation is restored, the defective main unit should be stopped.

Circuit operation

30. On aircraft where Mod.410 is embodied, the slugged relays previously employed in the P.F.C. warning lamp circuits are replaced by time delay switches, Type 601V. They overcome any tendency of the warning lights to flicker when their associated control surfaces are being subjected to rapid movement. These switches are supplied with the timing resistor attached and calibrated to the required delay. These resistors, therefore, are not interchangeable without recalibration and should not be detached from the associated switch. Pre- and post-Mod.410 texts and illustrations are provided. Full details of the time delay switch will be found in A.P.4343C, Vol.1, Book 2.

Pre-Mod.410

31. Referring first to the Pre-Mod.410 P.F.C. warning lamp circuits at fig.5, the three circuits, aileron, elevator and rudder, are basically the same. Although the rudder lock valve is operated by the pressure of either the main or auxiliary unit, its micro switch is included in the circuit of the auxiliary unit indicator relay. The rudder units are additionally provided with separate pressure switches and servo-valve operated micro switches. The following description relates to the aileron circuit but applies generally to the elevator and rudder circuits, though there are additional switches in the rudder system.

32. When a supply is made available at fuse 470 with no pump units operating, the following circuit actions occur:-

(1) A supply is connected from fuse 470, via normally-closed contacts 52/1 of the warning relay, to light the lamp.

(2) A supply from fuse 470, via contacts A-B of the lock valve micro switches, energizes indicator relays 437, 438, 439 and 440. In the rudder auxiliary unit circuit, the indicator relay is energized via the pressure switch and lock valve micro switch, which are in parallel; for the rudder main unit, however, the supply passes only through the associated pressure switch.

(3) Closing of relay contacts 437/1, 438/1, 439/1 and 440/1 also connects a supply from fuse 470 to the warning lamp.

33. When the P.F.C. units are started the following circuit action occurs:-

(1) A supply is connected from fuse 470 via the high speed relay contacts 68/2, 65/2, 64/2 and 61/2, when they close, to energize the warning relay 52.

(2) Opening of contacts 52/1 breaks one of the parallel feeds to the warning lamp.

(3) The resulting rise in pressure causes the operation of the lock valve micro switches to select contacts A-C, disconnecting the supply to their respective indicator relays 437, 438, 439 and 440, which will be de-energized. With rudder units, the rise in pressure will also operate the pressure switches to de-energize the indicator relays.

(4) Opening of relay contacts 437/1, 438/1, 439/1 and 440/1 disconnects all remaining feeds to the warning lamp, which is thus extinguished.

NOTE...
The warning lamp will only be extinguished by the circuit action at both (2) and (4); it will thus indicate that a satisfactory starting cycle has been completed in respect of all the associated P.F.C. units. If any of the lock valves fail due to seizure, the lamp will remain alight, a supply being fed to it through the associated relay contacts, as at para.32 (2) and (3).

34. Should a failure of the 112-volt d.c. supply, the motor or the pump occur, for example of the port outboard unit, the following circuit action will take place:-

(1) The resulting fall in pressure will cause operation of the lock valve micro switch, selecting contacts A-B and thus connecting a supply from fuse 470 to energize relay 437.

(2) Closing of contacts 437/1 will connect a supply from fuse 470 to the warning lamp which will light to indicate a failure.

Post-Mod.410

35. Referring now to the Post-Mod.410 indicator circuits (fig.6), the slugged relays which were operated by the individual pump units have been replaced by one hot wire vacuum switch, Type 601V, in each system. Although these switches function in the warning lamp circuits under all conditions, they are effective only under conditions of failure. On starting the aileron and elevator systems, the lamps will be extinguished only when the last unit in the sequence has created

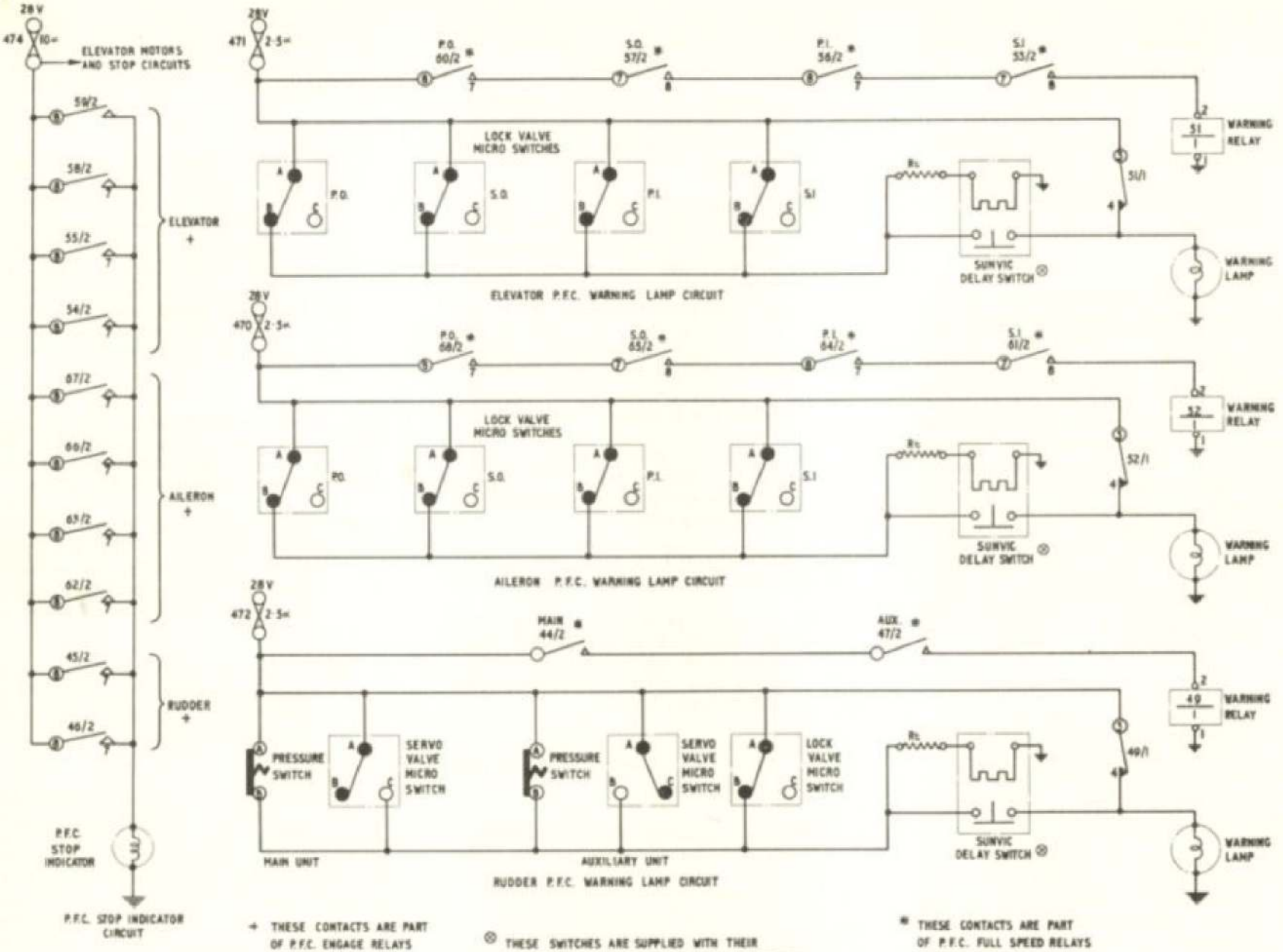

Fig. 6 P.F.C. indicators (post Mod 410)

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sufficient pressure to operate its lock-valve. This will occur approximately 15 seconds after depressing the start switch. The rudder lamp will be extinguished within 3 seconds of depressing the start switch. On depressing the stop buttons, the lamps will light simultaneously with depression of the first switch operated for each system. On the occurrence of a failure, the warning lamp of the system involved with light approximately 12 seconds after the pressure has decreased sufficiently to cause operation of the lock valve. The following description relates to the aileron warning lamp circuit, but applies generally to the elevator and rudder circuits though there are additional switches in the rudder circuit.

36. When a supply is made available at fuse 470 with no pump units running, the following circuit actions occur:-

(1) A supply is connected from fuse 470, via normally-closed contacts 52/1 of the warning relay, to light the lamp.

(2) A supply from fuse 470, via contacts A-B of the lock valve micro switches, energizes the time delay switch. In the rudder auxiliary unit circuit, the time delay switch is energized also via the pressure switch and lock valve micro switch, in parallel; for the rudder main unit, however, the feed is via the pressure switch only.

(3) The delayed closing of the time delay switch contacts connects an additional parallel feed from fuse 470 to the lamp.

37. When the P.F.C. units have started, the following circuit actions occur:-

(1) A supply is connected from fuse 470 via the high-speed relay contacts 68/2, 65/2, 64/2 and 61/2, as they close, to energize warning relay 52.

(2) Opening of contacts 52/1 disconnects the supply to the warning lamp.

(3) The resulting rise in pressure will cause the operation of the lock valve micro switches to select contacts A-C, disconnecting the supply to the time switch and its contacts, In the rudder units system, the pressure switches will be similarly operated.

(4) The warning lamp is thus extinguished indicating to the pilots that a satisfactory starting cycle has been completed in respect of all the associated P.F.C. units.

38. Should a failure of the 112-volt d.c. supply, the motor or the pump occur, for example of the port outboard unit, the following circuit actions will occur:-

(1) The resulting fall in pressure will cause operation of the lock valve micro switch, selecting contacts A-B and thus connecting a supply from fuse 470 to the time delay switch.

(2) The delayed closing of the delay switch contacts will further connect the supply at (1) to the lamp which will light to indicate a failure.

Servo valve micro switches

39. The rudder main and auxiliary units each have a micro switch fitted adjacent to, and mechanically-operated by, the servo valve mechanism, Referring to fig.5 and 6, under normal working conditions the contacts of both switches are open-circuited, but, whereas the switch for the main unit is decompressed, that for the auxiliary unit is compressed.

40. Should either valve fail due to siezure or defect in its lever mechanism, the following circuit action will occur:-

(1) Operation of the respective micro switch will connect a supply from fuse 472 via contacts A-B or A-C to energize the coil of the associated indicator relay (Pre-Mod.410) or the time delay switch (Post-Mod.410).

(2) Closing of the relay or time delay switch contacts will further connect the supply from 472 to light the warning lamp.

Stop indicator

41. Referring to fig.5 and 6, when a supply is made available at fuse 474, the indicator will remain de-energized until the closing of contacts 2 of any of the engage relays. These contacts will close as the engage relays of the associated P.F.C. units are operated during the starting cycle for each system. The indicator will be energized therefore to give a black display by the operation of the first engage relay selected. The indicator will continue to be energized until operation of the appropriate stop switches has stopped all the P.F.C. units. When this happens, the opening of all the No.2 contacts, will de-energize the indicator to give a white display.

ARTIFICIAL FEEL

General

42. The artificial feel system simulates aerodynamic loading on the pilot's flying controls by introducing a restriction to

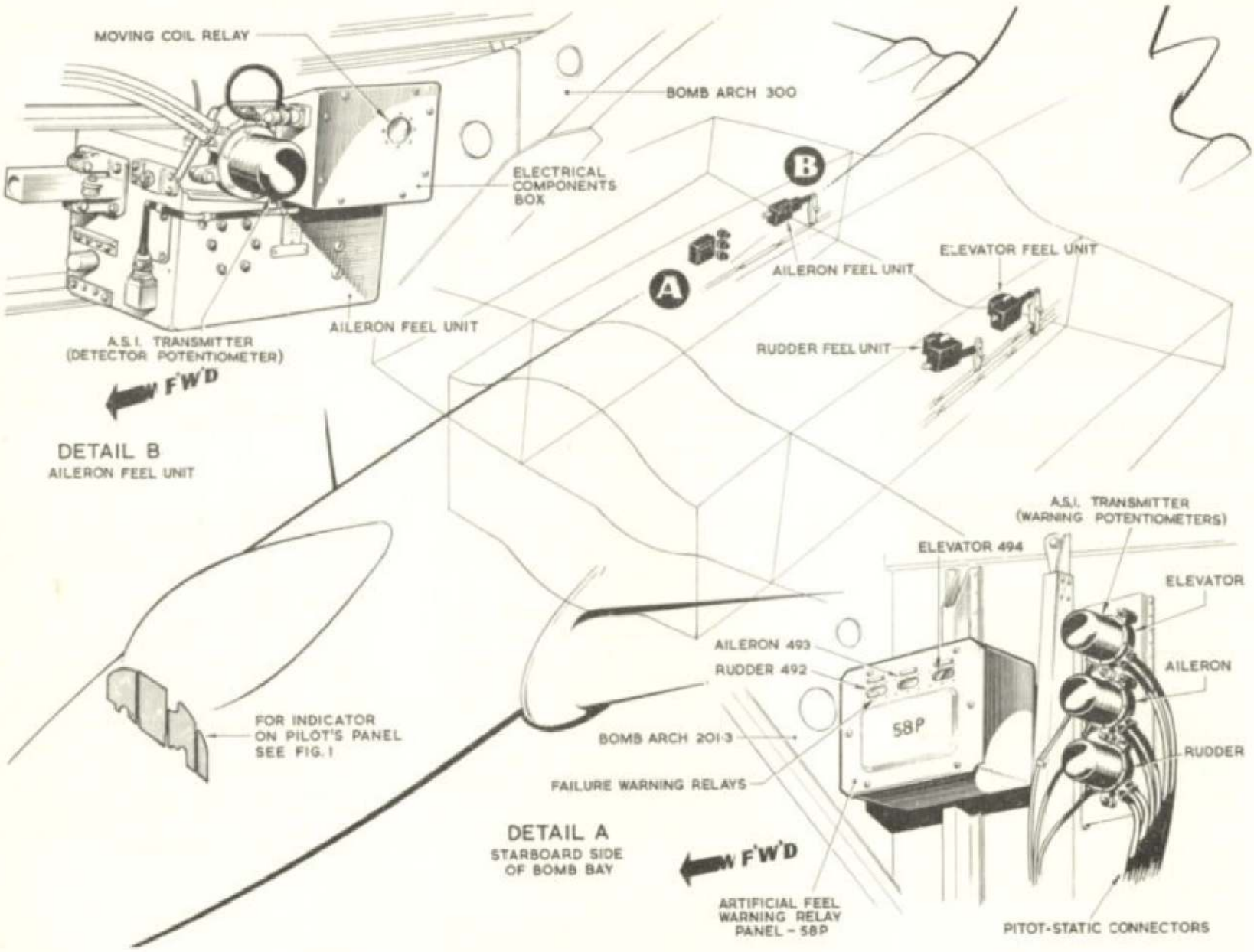

Fig.7 Artificial feel units

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movement of the controls which is variable under three conditions, as follows:-

(1) *Artificial feel*
In the case of elevators and rudder this provides variation of the restricting force in direct relation to air speed. In the case of ailerons it provides variation of the maximum angle which can be applied in inverse relation to air speed.

(2) *Artificial feel reduction*
This condition applies only to elevators and provides reduction of the restriction in the "track" and "glide" phases of an autopilot-controlled approach to land, with alighting gear extended.

(3) *Artificial feel relief*
In the case of elevators and rudder this provides reduction of the restriction to a fixed minimum. In the case of ailerons, it permits full aileron angle to be applied. (The difference in operation between elevator and rudder units on the one hand and aileron units on the other at (1) and (3) above is accommodated by the mechanical components. The basic electrical system is common to all three, the conditions at (2) being obtained by the relay-controlled insertion of additional resistors in the elevator control and warning circuits. Because of the circuit arrangement of the three systems, should feel relief not be previously selected, disconnection and subsequent reconnection of their supplies will cause the relief actuators to automatically run to the retract, or relief, position. Operation of the P.F.C./artificial feel start switches will then cause the relief actuators to run to the extend, or feel engaged, position.)

43. The mechanical operation of the artificial feel system is described fully in Section 3, Chapter 4 of this publication, and the electrical operation of the system, with a brief outline of the mechanical controls is dealt with in the following paragraphs.

44. By means of suitable mechanical linkages, any movement of the pilots' controls causes a lever to act against the resistance of a spring box. A slot in the lever accommodates a movable fulcrum, movement of which gives variations in the lever ratio. Any variations in air speed cause the fulcrum to move so that, at low air speed, a large movement of the pilots' controls results in a small movement in the spring box. At high air speed, a small movement of the pilots' controls results in a large movement in the spring box. When artificial feel relief is required, the fulcrum is moved to a fixed position where the spring box compression is small.

Actuators
45. The fulcrum point is moved by two linear actuators, one for the variable position the other for the fixed position. The actuators employed to vary the restriction are Rotax, Type A.0117, whilst those for the feel relief position are Rotax, Type A.0904. Descriptive details of both will be found in A.P.4343D, Vol.1, Book 3.

Control switches
46. The artificial feel systems are engaged simultaneously with the starting of their respective group of P.F.C. units. This is effected on depression of the double-pole push-switches, as described in para.8. Two push-switches are fitted, one to each pilots' control column handle, and serve to cut out normal artificial feel on the aileron and elevator systems. A further push-switch, for rudder feel relief, is mounted on the pilots' fuel gauge panel panel 2P and suitably labelled.

Micro switches
47. There are two micro switches in each of the three systems. One controls the supplies to the feel control and warning circuits, and is manipulated to connect these supplies by the relief actuator in its extended, or feel engaged, position. The other micro switch functions as an external limit switch in the retract field circuit of the relief actuator. It is manipulated to disconnect the supply to the retract field by the fulcrum lever mechanism when it reaches the feel relief position. On Aircraft where Mod.444 is embodied the type of switch fitted in both cases is changed to Burgess Type V3.

Feel units
48. The artificial feel units are installed in the bomb bay of the aircraft. The elevator and rudder units are on the port side and the aileron unit on the starboard side. The actuators, spring box, micro switches and the follow-up potentiometer are contained within the boxes. A component box, containing the moving coil relay, its associated P.O. type relays and the suppressor and trim resistors is fitted to each feel unit. The detector potentiometer is mounted adjacent to the components box. The indicator relays, warning potentiometer, rectifiers and trim resistances are fitted to the artificial feel relay panel 58P in the bomb bay. The various components are illustrated in fig.7.

Indicators
49. Three magnetic indicators, Type B2, are installed on the pilots' centre instrument panel and labelled ARTIFICIAL FEEL; AILERON, RUDDER and ELEVATOR. These indicators give warning of a failure in the feel control circuit of their associated system. A further magnetic indicator, Type B2, is installed on the 1st pilot's instrument panel adjacent to the A.S.I. It is labelled ARTIFICIAL FEEL FAILURE and gives

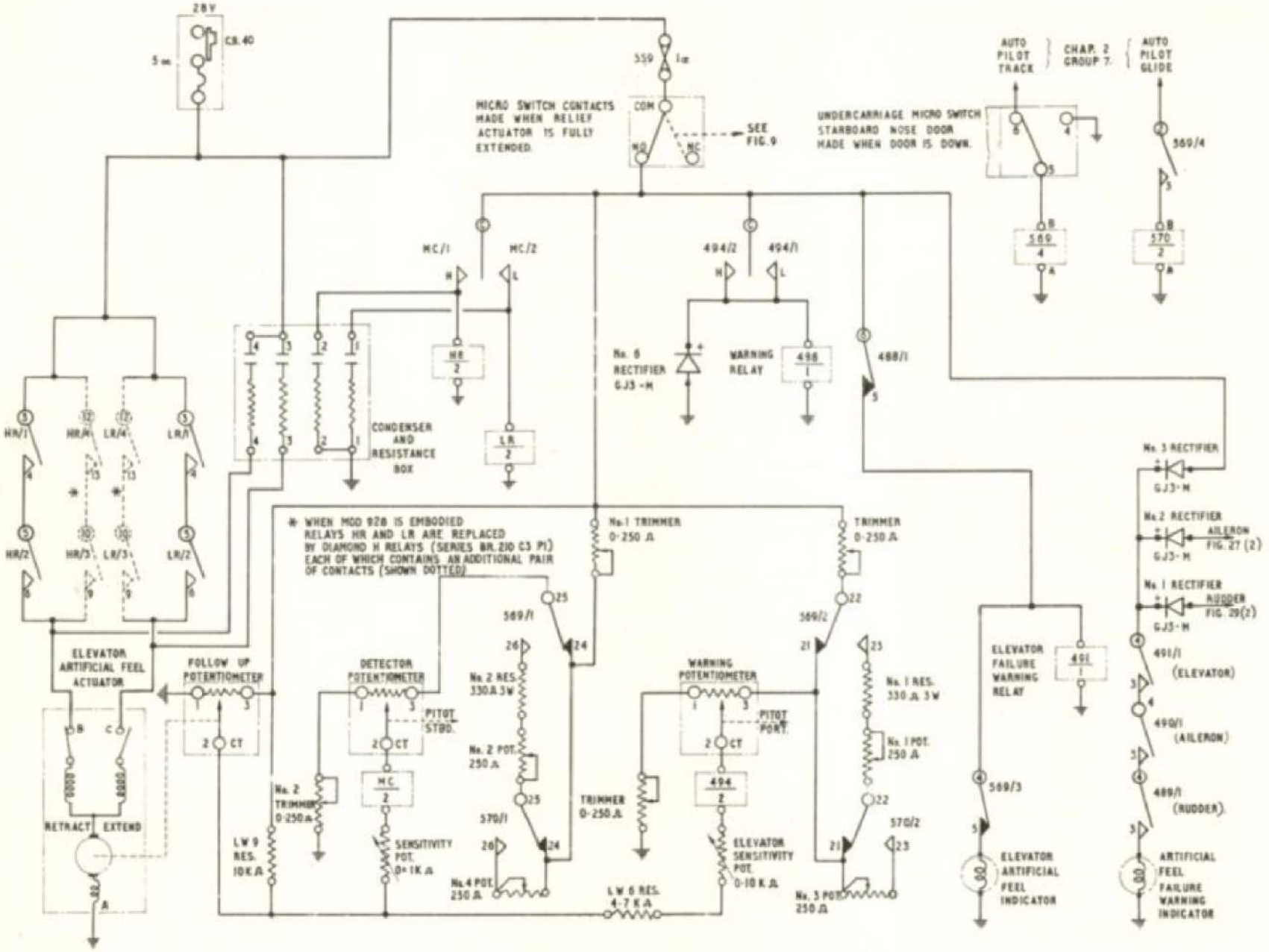

Fig. 8 Artificial feel system control (pre. Mod. 1498, pre. and post Mod 928)

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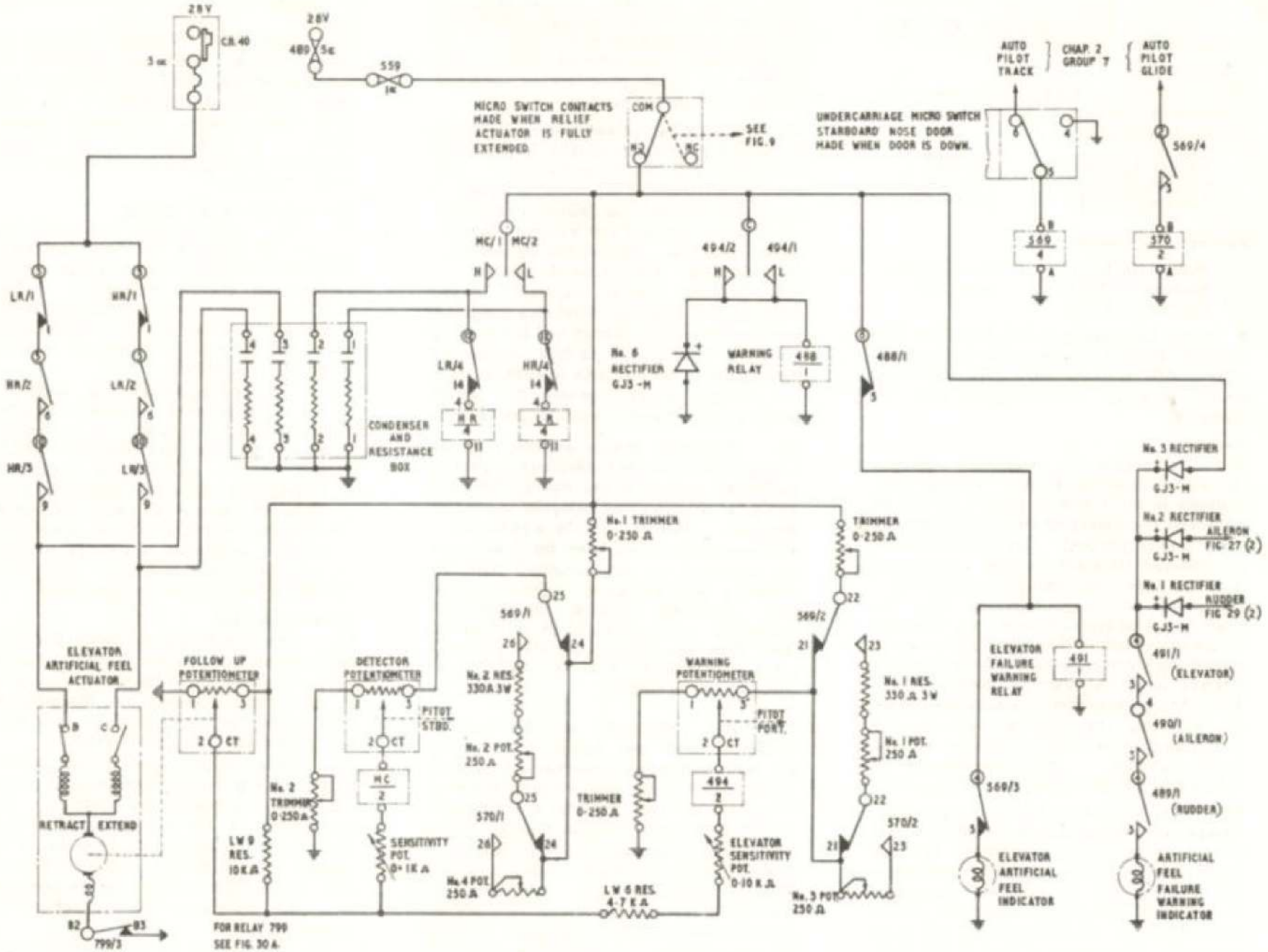

Fig. 8A Artificial feel system control (post Mod. 928 and 1498)

(◄Mod 1927►)

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warning of a failure in any of the three systems. The indicators and warning system are described in para.70 to 74.

Supplies

50. 28-volt d.c. supplies are fed to the artificial feel system as follows:-

Feel control circuits:-

Rudder (C.B.39)	Mounted
Elevator (C.B.40)	adjacent to
Aileron (C.B.41)	panel 15P

Feel relief actuators:-

Rudder (C.B.17)	Mounted on
Elevator (C.B.18)	panel 4P
Aileron (C.B.17)	

A 28-volt d.c. supply is fed from fuse 183 on panel 4P to the coils of the feel-engage relays, also on panel 4P. The relays are No.110 (rudder), 111 (Elevator) and 102 (aileron).

Control

51. To obtain the necessary changes in the mechanism fulcrum setting with changes in air speed, a control system is employed consisting of two potentiometers connected in parallel. One potentiometer is mounted adjacent to the components box, its wiper arm being connected to a diaphragm which is operated from the starboard pitot-static system. Any changes in air speed cause the wiper arm to move around the potentiometer which is therefore referred to as the detector potentiometer. The other potentiometer is mounted inside the feel unit; its wiper arm is connected to the mechanism and is movable relative to the fulcrum. This potentiometer is referred to as the follow-up potentiometer.

52. The wiper arms of the two potentiometers are interconnected through the coil of a sensitive moving coil relay, the coil being energized whenever the potentiometer wiper arms are at different potentials (i.e., out of balance). Movement of the contact arm to the left or right will complete the coil circuit of one of two P.O. type relays the contacts of which control supplies to the field circuits of a split field series actuator. Operation of the actuator will set a new fulcrum position for the ratio lever and move the wiper arm of the follow-up potentiometer until a new position of equal potential is obtained between both potentiometers.

53. A warning potentiometer, operated by the port-pitot static system, is connected in parallel with the control circuit. The moving coil relay of the warning circuit is connected between the follow-up potentiometer wiper arm and the warning potentiometer wiper arm. Any electrical failure of the artificial feel control system, or out-of-balance due to 'runaway' of the actuator, sets up an out-of-balance condition between the control circuit and the warning circuit. This action, in turn, causes the moving coil relay contacts to operate, and, via control relays, operate the failure warning indicator on the pilots' panel.

54. The servo torque permitted by the spring strut cut-out is inadequate to provide sufficient control power during the track and glide phases of an autopilot controlled approach. This is offset by a reduction of elevator artificial feel when track and glide are engaged on the autopilot with the alighting gear extended. The amount of bias provided extends the autopilot authority, corresponding to a minimum feel, from the normal 80 kts. (nominal) I.A.S. to 130-140 kts. in TRACK and 160-165 kts. in GLIDE.

55. The reductions in the elevator artificial feel are brought about by the relay-controlled insertion of resistors in the circuit of the detector potentiometer. Selection of track inserts a series-connected fixed and variable resistor whilst subsequent selection of glide inserts a further series connected variable resistor. Similar resistors are simultaneously inserted in the warning circuit thus adjusting the overall relative resistance between the two circuits. It should be noted that the supply, controlling operation of the track and glide relays, is fed via contacts of the starboard nose door down micro switch.

56. When the feel relief actuators are caused to run from the extended, or feel-engaged, position to the retract or feel relief position, the fulcrums in the ratio lever arms reach a position of minimum force. In this position the minimum restriction is imposed on movement of the pilots' controls.

Feel and feel relief locking

56A. The introduction of Mod.1927 enables all artificial feel and feel relief actuators to be locked in any predetermined position by manual selection. This facility is used to prevent the possibility of actuator runaway to a low speed value when the aircraft is flying at high air speed and low altitude.

56B. The locking circuit is controlled by a 2-positioned switch, labelled NORMAL-LOCK, located on a bracket attached to the port console (fig.1). Control of the actuators is maintained by interrupting the earth returns via the contacts of relays 798 and 799, which are energised when the switch is selected to LOCK. Indication of locking is given by a press-to-test indicator, Page Type C500B7, fitted adjacent to the switch.

Circuit operation

57. The circuit (fig.9) shows the relay and actuator limit switch contact positions which result when the 28-volt d.c. supplies to the circuit breakers are disconnected after normal use, i.e. provided feel relief has not been previously selected.

58. When these supplies are disconnected, the relief actuator remains in the extended, or feel-engaged position. The interruption of the hold-in supplies from the circuit breakers to the coils of the engage relays 102, 111, and 110, however, has caused these relays to be de-energized and the following circuit action has occurred:-

(1) Opening of relay contacts 102/2, 111/2 and 110/2 has isolated the extend field circuits from the

circuit breakers.

(2) Closing of the normally-closed relay contacts 102/1, 111/1 and 110/1 has connected the retract field circuits to the circuit breakers.

59. As the 28-volt d.c. supplies are now reconnected to the actuators, the following circuit action occurs:-

(1) A supply is connected from the circuit breakers via normally-closed relay contacts 102/1, 111/1 and 110/1, via the limit switches to the actuator retract fields. This causes the three actuators to run to the retract, or relief, position. The external limit switch will be operated by the lever mechanism to disconnect the supply to the retract field thus stopping the motor at the relief position.

(2) As the relief actuator leaves the extend, or feel-engaged, position:-

(a) The micro switch controlling the supplies to the control and warning circuits will operate to disconnect these supplies. This will cause the master and individual magnetic indicators to show a white display indicating relief.

(b) Movement of the relief actuator from the extend position will also cause the operation of the internal limit switch in the extend field circuit to close its contacts.

The three circuits are now in the feel-relieved condition and at readiness for selection of artificial feel reset at the P.F.C. control switches.

Feel engaged

60. The following description relates to the elevator system but applies, in principle, also to the aileron and rudder systems.

61. Referring again to fig.9, momentary depression of the elevator P.F.C. start/artificial feel switch will connect a 28-volt d.c. supply from fuse 183, to energize the coil of the engage relay 111 and the following circuit action will result:-

(1) Opening of contacts 111/1 will isolate the retract field actuator from the supply at CB.18.

(2) Closing of contacts 111/2 will:-

(a) Connect a 'hold-in' supply from CB.18 via the limiting resistor and normally-closed relay contacts 126/2 to the coil of relay 111.

(b) Connect a supply from CB.18 to the extend field of the relief actuator which will run until this supply is disconnected by operation of the internal limit switch.

62. Referring to fig.8, the elevator artificial feel control and warning circuits are now set to operate with a supply from circuit breaker 40, fed via contacts COM-NO of the micro switch. The artificial feel indicator will now be energized to show black via normally-closed relay contacts 488/1 and 569/3. For the aileron and rudder feel indicators there is only one set of relay contacts employed. The failure warning relay 491 will also be energized, and closing of relay contacts 491/1 in series with the warning relay contacts of the aileron and rudder circuit, when they close, will energize the warning indicator to show black. The energizing supply to the indicator is fed from the elevator, aileron and rudder warning circuits via their respective rectifiers. When the aircraft is stationary, i.e. no air speed, the centre contacts of the moving coil relay MC/2 in the control circuit will be in the centre neutral position.

63. As the aircraft begins to gain speed, the wiper arm of the detector potentiometer will be moved around the resistance to a new position. This action will set an 'out-of-balance' in the control circuit network, causing current flow through the coil of the moving coil relay. This action will cause the contact arm of the moving coil relay to move to the H position and the control relay HR/2 will be energized. Operation of the series contacts HR/1 and HR/2 will connect a supply from circuit breaker 40 to the retract field of the elevator artificial feel actuator. Operation of the actuator will cause the ratio lever fulcrum to be moved, this in tum producing an increase in the restriction being applied to the pilot's elevator control.

64. At the same time, the wiper arm of the follow-up potentiometer will be moved by the actuator and, when a position of balance is reached between the two potentiometers, no current will flow through the moving coil relay. The moving coil will then revert to its central neutral position, and the supply to the control actuator will be cut off. The feel or resistance to flying control movement is thus increased progressively with increased air speed until the I.A.S. reaches approx. 412 knots, in the case of the aileron, and 460 knots for elevator and rudder, beyond which the artificial feel conditions will remain constant.

65. Reduction of air speed will again upset the balance between the two potentiometers, causing a current flow through the moving coil relay in the opposite direction. This will cause the contacts to be made C-L and the control relay LR/2 will be energized. Operation of contacts LR/1 and LR/2 to close will energize the extend field of the control actuator, thus causing a reduction in the feel applied to the pilot's elevator control. The actuator movement will again be interrupted when the follow-

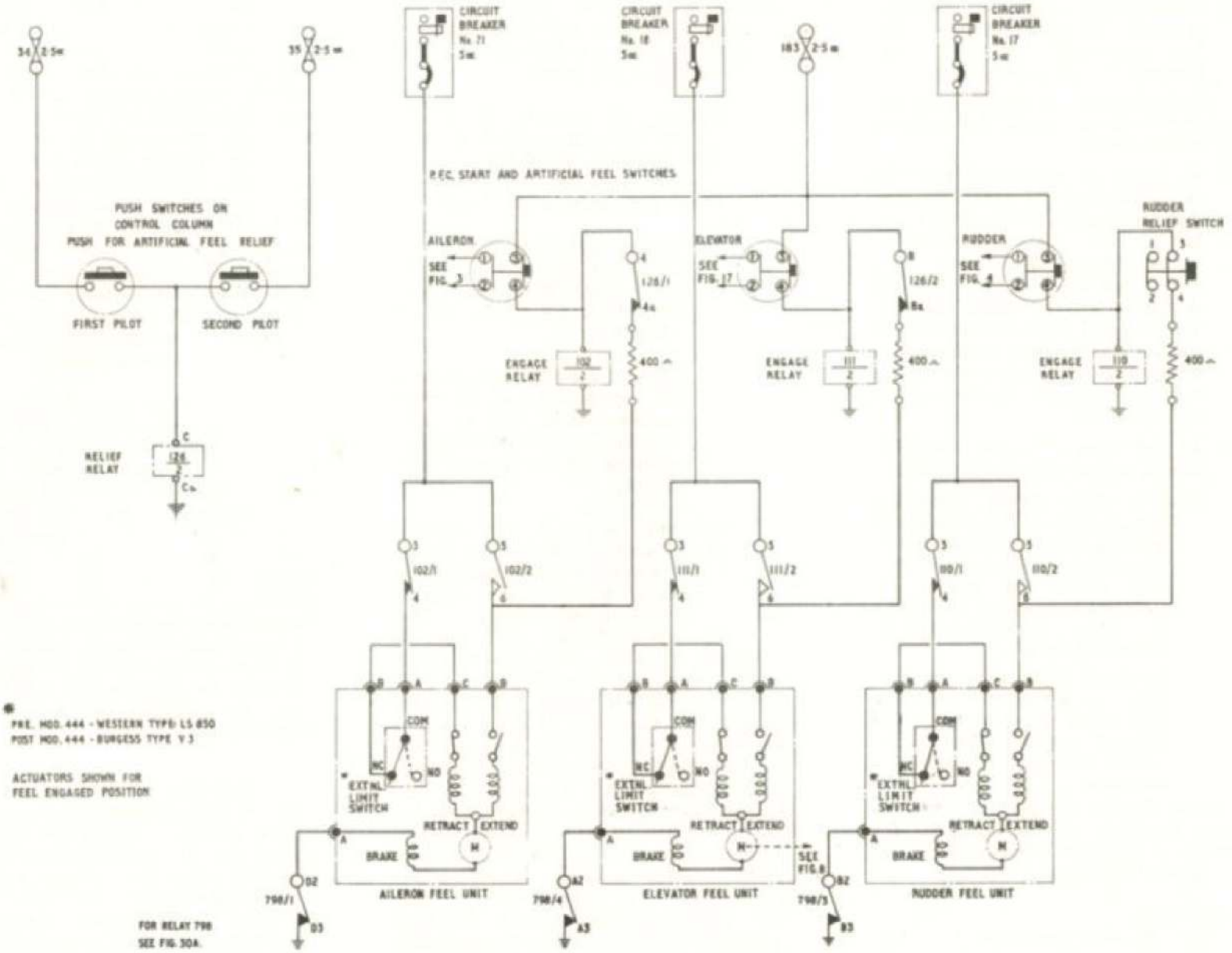

Fig. 9 Artificial feel relief
(← Mod 1927 →)

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up potentiometer reaches the same potential as the detector potentiometer. Any variation between the upper and lower I.A.S. cut-off limits will thus result in automatic adjustment of the artificial feel.

Feel reduction

66. The following description applies to the elevator system only. The track circuit (fig.8) controls relay 569, via the nose-wheel door down micro switch. The glide circuit controls relay 570, via contacts of relay 569. Engagement of track on the autopilot with the alighting gear extended, will energize the coil of relay 569, via contacts 5-6 of micro switch ND, and the following circuit action will take place:-

(1) Closing of contacts 569/4 will prepare the circuit for glide engagement.

(2) Changeover of contacts 569/1 will insert No.2 resistance and No.2 potentiometer in the detector circuit, thus causing an out-of-balance which, in turn, causes the actuator to reduce the artificial feel.

(3) Similarly, changeover of contacts 569/2 will insert No.1 resistance and No.1 potentiometer in the warning circuit. This maintains a state of balance with the control circuit, so that the feel failure indicator will not be operated.

(4) Opening of contacts 569/3 will isolate the artificial feel indicator from the supply, and the indicator will be de-energized to give a white display, thus warning the pilot that feel conditions have changed in the elevator system.

67. Engagement of glide on the autopilot will connect a supply via contacts 569/4 to energize relay 570, and the following circuit action will take place.

(1) Changeover of contact 570/1 will insert No.4 potentiometer in the detector circuit thus causing further reduction in the artificial feel.

(2) Similarly, changeover of contact 570/2 will insert No.3 potentiometer in the warning circuit, further maintaining of the state of balance with the control circuit so that the failure indicator will not be operated.

Feel relief

68. The following description relates to the elevator system but applies in principle also to the aileron system. Circuit operation for rudder feel relief is similar except that operation of the normally-closed contacts of the relief switch replaces that of the cut-out relay.

69. Referring to fig.9, on momentarily depressing either the 1st or 2nd pilot's feel relief switches a supply will be connected from fuse 34 or 35, as appropriate, to energize the coil of the cut-out relay 126. The following circuit action will then take place:-

(1) Opening of relay contacts 126/2 will interrupt the hold-in supply from CB.118 via relay 111/2 to the coil of relay 111.

(2) Opening of relay contacts 111/2 will isolate the extend field of the relief actuator from the supply at CB.18.

(3) Closing of relay contacts 111/1 will connect a supply from CB.18 to the retract field of the actuator which will run until the supply is cut-off by the action of the external limit switch.

(4) Initial movement of the relief actuator from the extend position will operate the micro switch (fig. 8) to interrupt the supply to the normal feel circuit.

(5) The elevator feel indicator will thus be de-energized to show white. The simultaneous de-energizing of warning relay 491 will cause the opening of relay contacts 491/1 and the feel failure indicator will also be de-energized to give a white display.

Mod.928

69A. When Mod.928 is embodied the P.O. relays which control the movement of the feel actuators are replaced by diamond H relays, series BR-210.C3 P1. The circuit operation of the control relays before and after the embodiment of Mod.928 is similar, except that at the post Mod. state an additional pair of contacts has been connected in each supply circuit of the actuator fields. The appropriate routing charts refer and fig.8 shows the elevator circuit at the pre and post Mod. states.

Mod.1498

69B. When Mod.1498 has been embodied the control relays are interlocked and a separate supply is connected to the artificial feel units. The control relay circuit operation at the post Mod. state differs from that at the pre Mod. state, and for this reason a brief description follows. For ease of explanation the low relay only will be considered, as the operation of the high relay is similar. Referring to fig.8A it can be seen that when the low relay is energised (para.65), contacts LR/1 and 4 will open to isolate the high relay and its associated contacts in the actuator retract field. Contacts LR/2 and 3 will close and connect a supply to the actuator extend field. When the low relay is de-energized (para.65) its contacts return to their normal positions to reconnect the circuit for further operation.

◀ *Feel and feel relief locking*

69C. Should the control switch for the feel and feel relief locking circuits be selected to LOCK (fig.30A), supplies from fuses 93 and 94 will be fed via the respective contacts of the switch to energise relays 799 and 798. The earth returns for the feel and feel relief actuators, which are completed via the normally closed contacts of the relays will then be broken, and the actuators will stop in the selected position. At ▶

the same time the indicator will be bit from fuse 94 via the series contacts C1-C2 of the relays.

Indicator and warning system

70. The magnetic indicator, installed in the 1st pilot's instrument panel, functions as a master indicator and will be de-energized to show white if any of the three artificial feel system fails. The three similar indicators installed on the pilots' centre panel show white if there is a failure in their associated systems, i.e., elevators, ailerons, or rudder. Selection of artificial feel relief will cause indications similar to those for a failure in a particular system.

71. Selection of the track and glide channels during an autopilot controlled approach to land with the nose door down, will cause the elevator indicator to show white whereas the master indicator will remain energized to show black. The resultant combined display will therefore indicate to the pilots that feel reduction only has taken place and not a failure in the system. For this purpose, although the circuits of the three feel control indicators are basically the same, that for the elevators also includes the normally-closed relay contacts 569/3. Relay 569 is energized to open those contacts when track is selected during an autopilot controlled landing approach with the alighting gear extended, the elevator indicator will then be de-energized to show white.

Circuit operation

72. The following description is given for the elevator warning circuit but applies also to the aileron and rudder circuits via their respective supplies and relays.

73. The warning potentiometer (fig.8) is connected to the control circuit in such a manner, that, with the artificial feel circuit working correctly, all three potentiometers will remain in balance and, during normal operation:-

(1) The feel control indicator will be energized to show black by a supply from circuit breaker 40, via fuse 559, the external limit switch contacts of the relief actuator, and normally closed relay contacts 488/1 and 569/3.

(2) The failure warning indicator will be energized to show black by a supply from the artificial feel circuit breakers via failure warning relay contacts 491/1 (elevator), 490/1 (aileron) and 489/1 (rudder).

NOTE . . .

The three failure warning relays will be energized to close these contacts only whilst their associated systems are operating correctly.

74. Should a fault develop in the feel detector circuit, the three potentiometers will become out of balance and,

(1) A current will flow through the coil of moving coil relay 494 (MC) causing its contacts to operate H-C or L-C, according to the direction of the current flow.

(2) This action will energize relay 488 and contacts 488/1 will operate to open, thus de-energizing the artificial feel indicator.

(3) At the same time, relay 491 will be de-energized, and operation of contacts 491/1 will interrupt the supply to the failure warning indicator.

(4) Both indicators will now show white.

NORMAL AND EMERGENCY TRIM

75. The aircraft trim is adjusted by varying the length of the control runs between the pilots' controls and the artificial feel units. Normally, the zero-feel position is pre-set to centralise the cockpit controls with the control surfaces in their neutral position.

76. By extending or retracting the control run lengths, the pilots' controls take up a new position of zero feel and their movement causes the P.F.C. units to reposition the flying control surfaces. Linear actuators in the control runs bring this about. With the elevators, extension and retraction of the control run lengths cause nose down and nose up trimming, respectively. With the ailerons and rudder, extension and retraction of the control run lengths cause trim to starboard and port, respectively.

Components and controls

77. Three two-motor linear actuators, in the Rotax, Type A1702/3/6 series, are used in the trim control circuits. The motors drive a common extension shaft through a differential gearbox. One motor of each pair is controlled, in the case of the aileron and elevator, by two-axis control switches fitted, one on each pilot's control handle. The rudder trim actuator is controlled by two single-pole switches, Type D5403, mounted together and fitted to the fuel contents panel 2P. These switches are spring-returned to the central off position, and the method of mounting allows simultaneous operation of both toggles. A description of the actuators will be found in A.P.4343D, Vol.1, Book 3.

78. The other three motors are selected by a three-axis emergency control switch, Type TS.101 Mk.14, positioned at the forward end of the centre console below the throttle pedestal. This circuit can only be operated whilst the push-button in the centre of the switch knob is kept depressed.

79. The normal and emergency trim

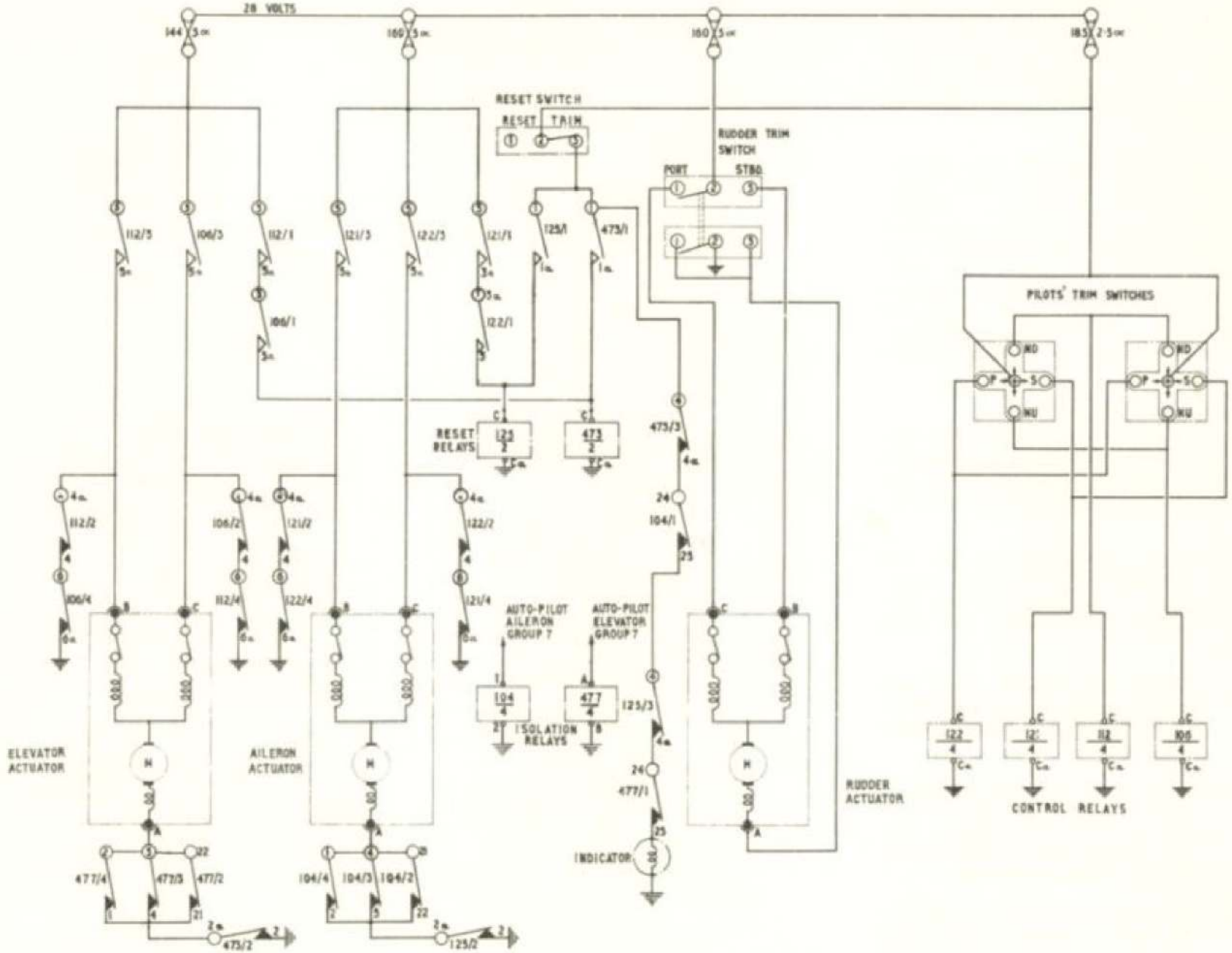

Fig 10 Normal trim controls

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circuits prevent runaway of the actuators, due to 'stray positives' in the supply lines to the motors, by the use of relays, the contacts of which earth the supply lines until the control switches are operated. The relays are located in the port fuse and relay panel 4P.

80. A magnetic indicator, Type B2 on the pilots' panel, is energized black during all trimming operations. Should a fault develop in the aileron or elevator circuits, which necessitates opposite trim selection to that causing the fault, reset relay action will de-energize the indicator to present a white image, thus warning the pilots that reset action is necessary. This action is described in detail in para. 85.

Circuit operation

81. The circuit operation for trim control described in the following paragraphs should be read in conjunction with the theoretical circuit diagrams (fig.10 and 11).

Normal

82. When the first pilot's elevator trim switch is held to NU, a 28-volt supply from fuse 185 will energize relay 106, and the following circuit action will take place:-

(1) Closing of contacts 106/3 will connect a supply from fuse 144 to the retract field of the normal motor of the actuator.

(2) At the same time, the opening of contacts 106/2 and 106/4 will disconnect the earths from the motor supply lines, and the actuator will run to retract the shaft.

(3) When the actuator has retracted to the required position, the switch can be released to the centre neutral position, de-energizing relay 106, and the actuator motor.

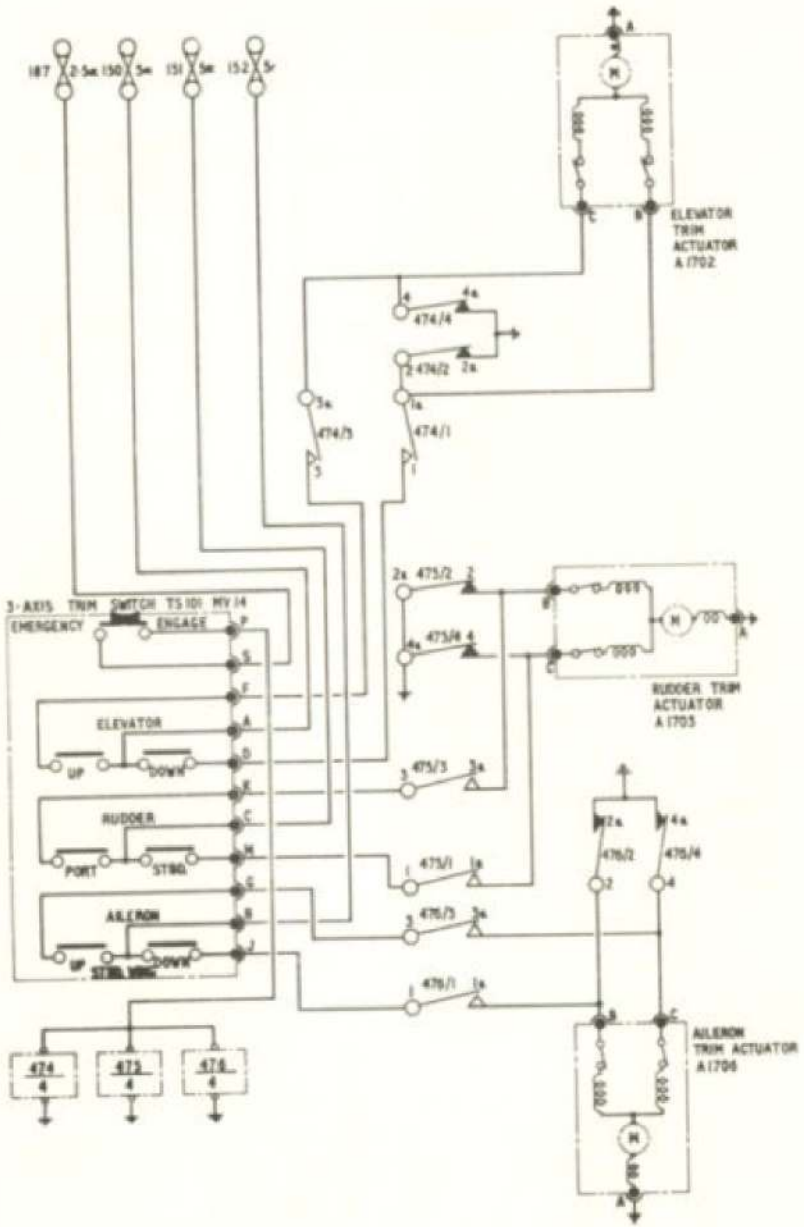

Fig.11 Emergency trim controls

83. Movement of the trim switch toggle to the ND position will energise relay 122, and the extend field of the actuator motor will be energized by a similar circuit action to that described for the NU selection in the previous paragraph. Operation of the aileron trim circuit is similar to that of the elevator circuit.

84. Rudder normal trim is controlled by the two 3-position switches on panel 2P. Operation of both switches to either port or starboard positions will run the actuator in the required direction to retract or extend the actuator ram. Note that the control switch in the positive line controls the supply, and the switch in the negative line connects the actuator negative line to earth.

Reset

85. Should a fault develop in either pilot's trim switches, or in the control relays 106, 112, 121 or 122, causing, for example, ND trim, the following circuit action will take place:-

(1) The faulty ND trim circuit will energize relay 112 causing trim action.

(2) Selection of opposite sense (NU) by the pilot will energize relay 106, so connecting a supply from fuse 144, via contacts 112/1 and 106/1, to energize relay 473.

(3) Closing of contacts 473/1 will form a hold-in circuit for the relay, via the reset switch.

(4) Opening of contacts 473/2 will isolate the elevator trim actuator motor from its normal earth return path.

(5) Opening of contacts 473/3 will de-energize the trim indicator, and the white display will warn the pilots that the circuit is isolated.

86. The circuit will remain isolated until the reset switch is momentarily held to the reset position. This action will interrupt the hold-in circuit to the reset relay 473, and return the circuit to normal, the indicator being de-energized to show black. If the fault is not correct by the operation of the reset switch, then the faulty trim system can still be operated by using the emergency trim switch. If both pilots inadvertently select opposite trim sense simultaneously on the aileron or elevator circuits, a similar circuit action will occur as that outlined for a faulty circuit.

Emergency

87. When the push-button in the knob of the emergency trim switch (fig.11) is pressed, relays 474, 475 and 476 will be energized. Operation of the normally-closed contacts of these relays will disconnect the protective earths from the motor supply lines, and operation of the normally-open relay contacts will connect the motor supply lines to the 3-axis switch contacts.

88. Movement of the trim switch in the required sense will then cause the actuator to run and select the appropriate trim. It should be noted that the normal emergency trim circuits may be operated together in the same sense, and twice the trim rate will result. Ground tests for the trim circuits appear in para.156 to 161.

Normal trim isolation

89. With the engagement of the aileron and elevator channels of the autopilot the normal trim system becomes isolated; trimming is then carried out by use of the emergency trim circuit. Isolation of the aileron and elevator trim system is effected by relays 104 and 447, the circuit operation being as follows-

90. The coils of relays 104 and 447 (fig.10) are connected respectively to the aileron and elevator channels of the autopilot circuit. If the elevator channel on the autopilot is selected, relay 477 will be energized. Opening of contacts 477/1 will de-energize the indicator to show white thus advising the pilot that normal trim is not available. Opening of contacts 477/2, 3 and 4 will disconnect the negative return of the normal elevator trim actuator, rendering it inoperative.

91. A similar sequence of operations will take place in the aileron normal trim circuit when the aileron channel of the autopilot is engaged. It should be noted that, on disengagement of either or both channels, the associated normal trim control will be restored due to de-energizing of relays 104 and/or 477.

AIR BRAKES

General

92. The air brakes take the form of rectangular flaps secured to movable drag posts which, in the retracted position, fit into and form part of the upper and lower main plane surfaces. Mod.593, embodied concurrently with Mod.38, introduces two time delay units, one into the coil circuits of each contactor. These units delay connection of the field supplies to the actuator motors when a selection of movement is made at the control switches. The delay is necessary to allow sufficient time for the motor brakes to function when the direction of movement is being rapidly reversed during flight refuelling operation.

93. Although the controls and the resultant positioning of the air brakes remain unchanged, the circuit operation before and after embodiment of Mod.593 varies; the two variants are dealt with separately in the text and illustrations. A description of the time delay unit is given in para.100. The mechanical aspect of the air brake system is described in Sect.3, Chap.4 of this publication.

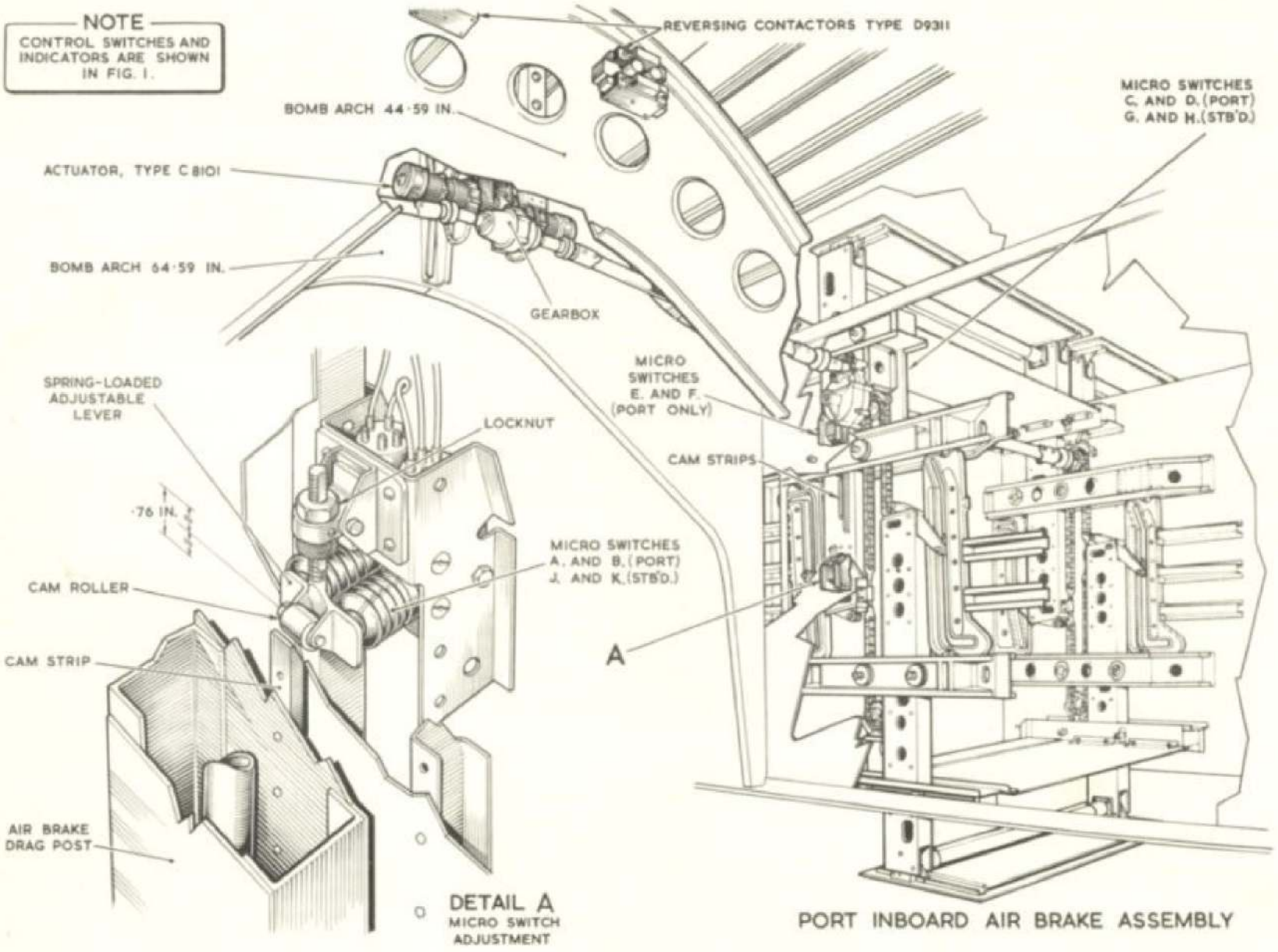

Fig. 12 Air brakes components

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94. The air brakes can be moved outwards from the mainplane to any of three positions, namely:-

Medium drag - Where the drag posts are partially extended and the flaps are at 35 deg.

High drag - Where the drag posts are almost fully extended and the flaps are at 55 deg.

High drag - Where the drag posts are fully extended and the flaps are at 80 deg. (alighting gear DOWN only).

Components and controls

95. A 112-volt d.c. actuator, Type C8101, containing two compound-wound motors, operates the air brakes. The motors have solenoid-operated brakes which are released whenever the motors are switched on. Reversing contactors, Type D9311, enable the motors to be rotated in either direction. Both motors operate simultaneously to extend the air brakes to any drag position and both operate simultaneously to retract the air brakes except where IN is selected; in this case only one motor operates, the other being available as a stand-by. Changeover to the stand-by motor is controlled by the emergency switch. A description of the actuator is in A.P.4343D, Vol.1 Book 3, and of the contactor in A.P.4343C, Vol.1, Book 2.

96. The motors are installed in the bomb bay (fig.12) and drive, through reduction gearing, shafts, extending to port and starboard. The shaft is fitted with sprockets which carry endless chains, an idler sprocket being fitted in each chain system. Two connector blocks are fitted, one in each half of the chain so that, on movement of the chain, one connector block moves up and the other down. The connector blocks are secured to the drag posts. The heavy-duty reversing contactors are mounted near the motors.

Control switches

97. The motors are controlled by two linked, single-pole, three-position switches, on the throttle box pedestal in the pilots' compartment, labelled IN-MEDIUM DRAG-HIGH DRAG. To operate the switches the press-button in the centre of the link-bar must be depressed. Ten micro switches, operated by cams and rollers on the drag posts, limit movement of the air brakes to the selected position.

Emergency switch

98. A double-pole switch, labelled NORMAL-EMERGENCY, is adjacent to the main control switches. Setting this switch to EMERGENCY causes changeover to the stand-by motor, should a failure occur during retract movement of the air brakes, after selection of IN on the main control switches.

Test switch

99. A test switch for the air brakes circuit, fitted in the nose wheel bay, permits ground testing of the 55 deg. HIGH DRAG position.

Time delay units

100. After embodiment of Mod.593, two time delay units, Avro Type 1/V9303 (fig. 15) are installed adjacent to their associated contactors in the bomb bay. The units give a delay of 0.25 second with an input voltage range of 24 to 28-volts d.c.; their operation is described in para.110. Being sealed, no adjustment of the time delay units is possible, defective units being replaced by serviceable items. A testing device is under development for checking the delay time and further information will be issued later.

Warning indicator

101. A magnetic indicator, Type B1838Y, fitted to the pilots' instrument panel, gives warning that the air brakes are operating. The indicator will be energized to show black when the air brakes are IN.

Circuit operation (pre Mod.593 and 926)

102. The circuit operation described in the following paragraphs applies to fig.14 and 34, i.e. prior to the addition of the time delay units and associated resistors.

In to medium drag

103. Operation of the mechanically-linked control switches on the throttle pedestal from the IN to the MEDIUM DRAG position will cause the air brakes to be driven by both motors to the selected position by the following circuit action:-

(1) 28-volt supply from fuses 97 and 181 will be fed via the control switches and micro switches E, F, C and D to the extend coils of the reversing contactors A and B.

(2) Operation of the reversing contactors will connect 112-volt supplies to each of the air brake motors, and the air brakes will commence to move to the MEDIUM DRAG (35 deg.) position.

(3) As the air brakes leave the IN position, micro switches A and B will operate to make contacts 5-4; micro switches J and K will operate to make contacts 2-1, and the warning indicator will be de-energized.

(4) As the air brakes move to the MEDIUM DRAG position, micro switch F will be operated, causing its contact positions to change 2-1, 5-4, thus the supply to the reversing contactors will be cut off and the motors will stop.

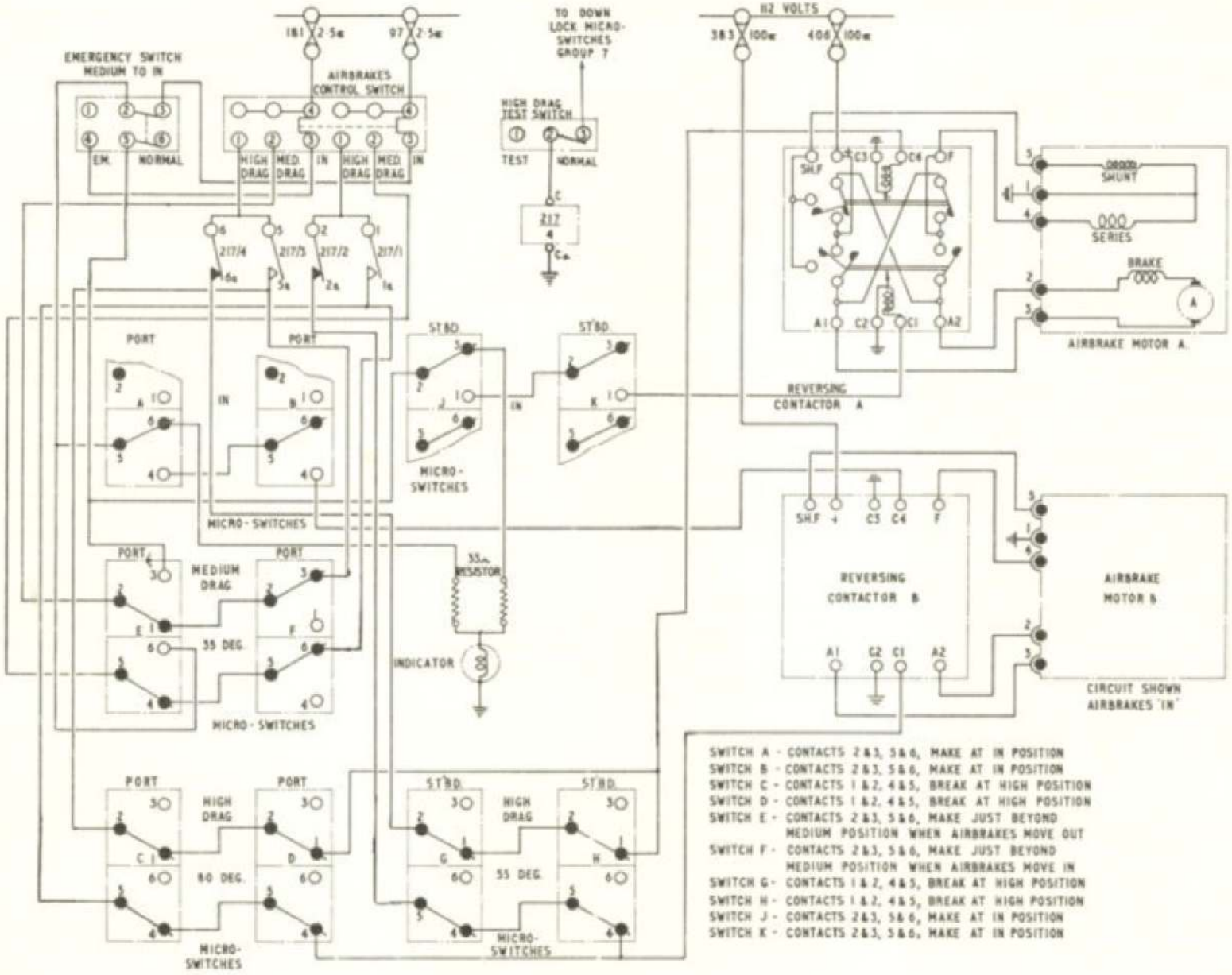

Fig. 13 Air brakes control (pre. Mod. 593 and 926)

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Medium drag to high drag (55 deg.)

104. Operation of the control switches from the MEDIUM DRAG to the HIGH DRAG position will cause the air brakes to be driven by both motors to the selected position by the following circuit action:-

(1) 28-volt supply from fuses 97 and 181 will be fed via the control switches, normally-closed relay contacts 217/2 and 217/4 to micro switches G and H, and thence to the coils of the reversing contactors A and B. The air brake motors will thus be energized and the air brakes will commence to move to the HIGH DRAG (55 deg.) position.

(2) As the air brakes commence to move, micro switch E will operate, causing its contacts to change 2-3, 5-6. This action will prepare the circuit for retraction selection.

(3) As the air brakes reach the HIGH DRAG position, micro switches G and H will operate to make contacts 2-3 and 5-6, and the supply to the reversing contactor extend coils will be interrupted. This action will cause the air brakes to stop at the HIGH DRAG position.

High drag (80 deg.)

105. During landing operations, when the air brakes are selected at HIGH DRAG, and with the alighting gear locked down, the air brakes will extend to the 80 deg. flap position to give full braking facilities for landing. This condition is achieved by the inclusion of relay 217 in the alighting gear circuit. When the alighting gear is locked down, relay 217 will be energized, opening contacts 217/2 and 217/4 and closing contacts 217/1 and 217/3. The following circuit action will now take place:-

(1) Opening of contacts 217/2 and 217/4 will isolate the supplies to micro switches G and H.

(2) Closing of contacts 217/1 and 217/3 will connect the 28-volt supplies from the control switches to the micro switches C and D.

(3) The reversing contactor extend coils will be energized and the air brake motors will operate to drive the air brakes to the HIGH DRAG (80 deg.) position.

High drag to medium

106. Operation of the control switches from the HIGH DRAG to the MEDIUM DRAG position will cause the air brakes to be retracted to the selected position and the following circuit action will take place:-

(1) 28-volt supply from fuses 97 and 181 will be fed via the control switches to micro switch E, contacts 2-3 and 5-6, then to micro switches A and B, J and K and to the retract coils of the reversing contactors A and B.

(2) Operation of the reversing contactors will cause both air brake motors to drive the air brakes to the MEDIUM DRAG position.

(3) As the air brakes leave the HIGH DRAG position, micro switches G and H will return to their normal contact position, and the circuit will be prepared for any extend selection.

(4) Just before the air brakes reach the MEDIUM DRAG position, micro switch F will revert to its normal contact position and, as the air brakes reach the medium drag position, micro switch E will operate to make contacts 2-1, 5-4, causing the reversing coils to be de-energized, and the air brakes will stop at the MEDIUM DRAG position.

Medium drag to in

107. Selection from MEDIUM DRAG to IN on the control switches will cause the air brakes to be moved to the fully retracted position by one motor only. The following circuit action will take place:-

(1) A supply from fuse 97 will be fed via the control switches and the emergency switch contacts 2-3 to micro switches A and B. These switches will be made 5-4 and thus the retract coil of the reversing contactor B will be energized.

(2) This action will cause the B air brake motor to rotate and retract the air brakes to the IN position.

(3) As the air brakes reach the IN position, micro switches, A, B, J and K will revert to their normal contact position, and the air brake indicator on the pilots' panel will be energized.

◀ **Circuit operation (post-Mod.593 and 926)** ▶

108. Except for the functioning of the time delay units, introduced by Mod.593, the actuator circuit operation before and after its embodiment is the same. The following paragraphs describe the variation in circuit operation caused by the addition of the time delay units.

109. When the control switch or emergency switch (fig.14) is operated to extend or retract the air brakes, the 28-volt d.c. supply will be connected to the corresponding contactor coils or coil, as applicable,

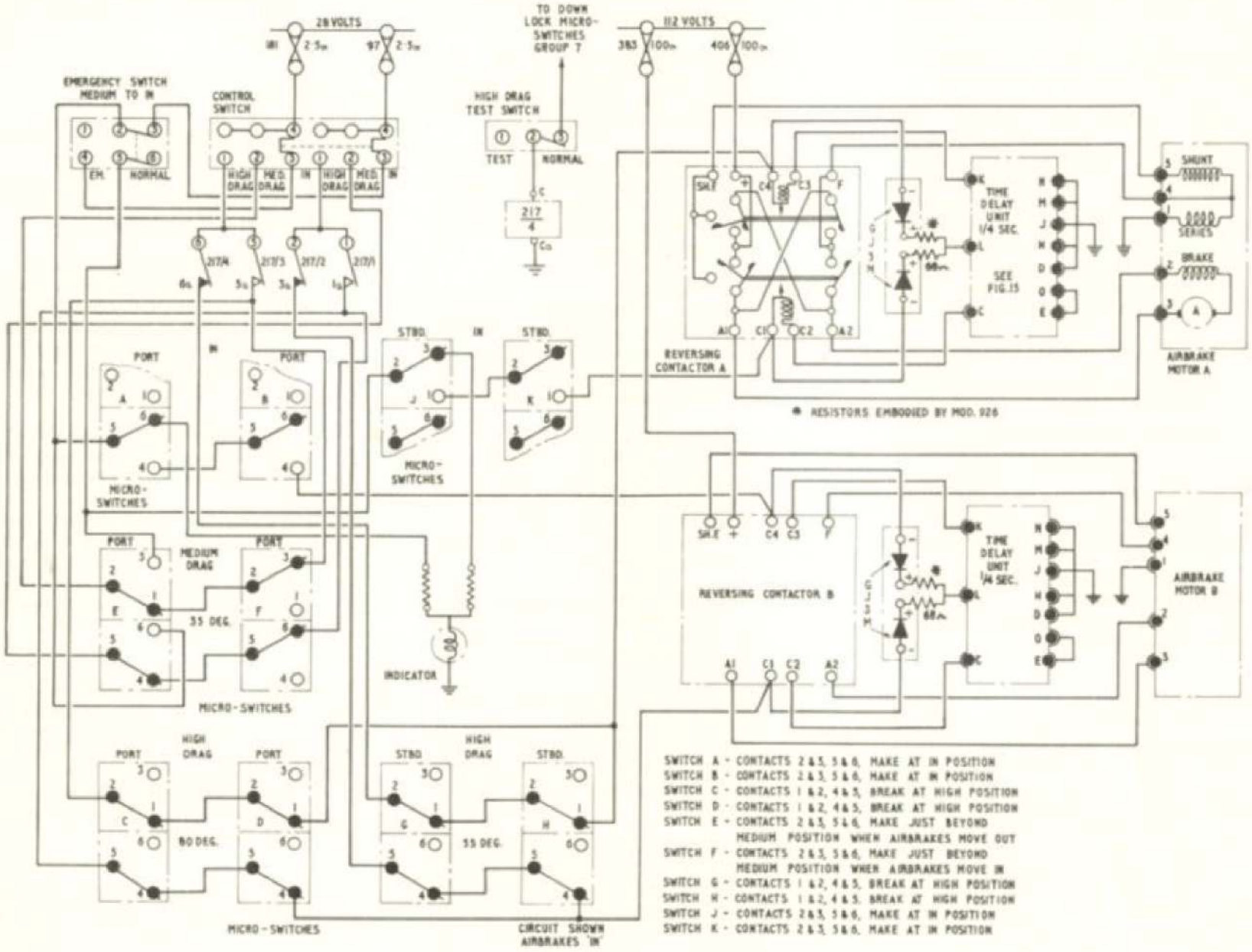

Fig. 14 Air brakes control (post. Mod. 593 and 926)

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via the same sequence of micro switch contacts as for the pre-Mod.593 circuit. These supplies, however, are also connected via rectifiers to the input terminal L of the associated delay unit and the earth ends of the contactor coils to terminals K and C of the same unit. The contactor coils will not therefore be energized, and further circuit action will be delayed until the time circuit has functioned and allowed the delay unit relay to operate.

Time delay circuit

110. When a 28-volt d.c. supply is connected to terminal L of the time delay unit (fig.15), it will be applied across the series circuit formed by resistor R1 and the two 9-volt reference diodes D1 and D2. The stabilized 18 volts developed across the diodes will commence to charge the capacitors C1 and C2 via resistors R2 and R3 which provide the required time constant. When the voltage across the capacitors rises above 9 volts, diode D3 will conduct causing base to emitter current to flow in transistor T. This in turn causes current flow in the circuit formed by the coil of the relay and the collector, with the result that the coil becomes sufficiently energized to operate the contacts. Resistor R4 provides a shunt path for the current in the coil circuit. The closing of contacts 5-6 completes a hold-in circuit for the relay coil and the closing of contacts 10-9 short-circuit capacitors C1 and C2, discharging them in readiness for subsequent operation. The closing of contacts 3-2 and 12-13 connect terminals C and K to earth.

111. Connection of terminals C and K to earth (fig.14) completes the circuits of the contactor coils. The contactor will then operate, subsequent operations in the circuit depending upon which coil has been selected.

◀ 111A. The two resistors connected in series between the rectifiers serve to prevent a mal-function taking place should a rectifier fail. Considering a rectifier failure without the resistors in circuit, a supply could be fed to the reversing contactor coil controlling the direction of movement opposite to that selected. With the resistors in circuit, however, the subsequent drop in voltage prevents the opposite contactor coil being energized in the event of such failure occurring.

Emergency operation

112. Should air brake motor B fail, the brakes can be retracted to IN from MEDIUM DRAG by placing the EMERGENCY/NORMAL switch on the throttle box pedestal to EMERGENCY. This action will connect a supply from fuse 181, via the control switch, terminals 4-5 on the emergency switch, to micro switches J and K. This will cause the retract coil of reversing contactor A to be energized, and motor A will return the air brakes to the IN position.

TAIL PARACHUTE

▶ **General**

113. A tail parachute provides additional braking should it be required during landing. The parachute is stored in a compartment in the rear fuselage and is released to the stream, or braking position by the opening of the compartment doors. This operation is controlled by the pilot, who can also jettison the parachute when sufficient additional braking has been

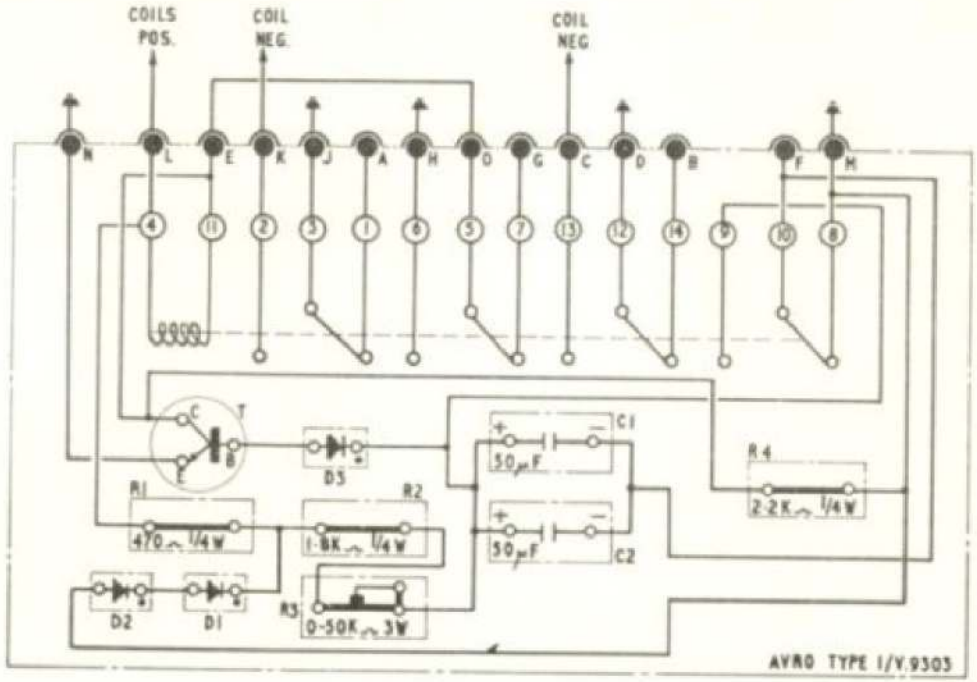

Fig.15 Time delay unit

ettected. The circuit also provides for the automatic jettison of the parachute should the doors inadvertently open. Both the stream and jettison circuits have a supply cut-off relay, the operation of which is controlled by an associated resistor/capacitor timing circuit. The cut-off facility disconnects the supplies to the coils of the electro-magnetic release units should icing conditions affect the stream or jettison mechanisms. A description of the mechanical aspect of the installation is given in Sect.3, Chap.13, of this publication.

Components and controls

114. Two electro-magnetic release units No.1 (Ref.No.11A/3669) are fitted, one for door release (stream) and the other for jettison. A relay, Type 34, connects the supplies to the release units. Two relays Type 9B, two resistors (200 ohms, 3w) and two capacitors (140 mf, 30v) form the supply cut-out circuits. Two test plugs in the rear fuselage, one in each circuit, facilitate servicing. The circuit is controlled by a switch, Type D5406, fitted to the pilots' instrument panel 1P and labelled STREAM and OFF & JETTISON. After Mod.455, this switch is shrouded to prevent ingress of moisture. After Mod.692, the type of switch is changed to Ref.No.5CW/6429.

Circuit operation

115. With the control switch at OFF (fig.16) both ends of the coil of relay 261 are earthed. This prevents operation of the installation by a supply other than via the switch. When preparing the installation for use, the door release unit must be cocked before the jettison release unit.

Stream

116. If a supply is available at fuse 31 and the control switch is set to STREAM,

(1) Relay 261 is energized.

(2) Opening of the normally-closed relay contacts 261/2 disconnects the jettison circuit from fuse 490.

(3) Closing of relay contacts 261/1 connects a supply from fuse 490, via normally-closed relay contacts 632/1, to energize the coil of the stream release unit.

(4) Operation of the stream release unit:-

(a) Opens the compartment door, thus releasing the parachute to the stream or braking position.

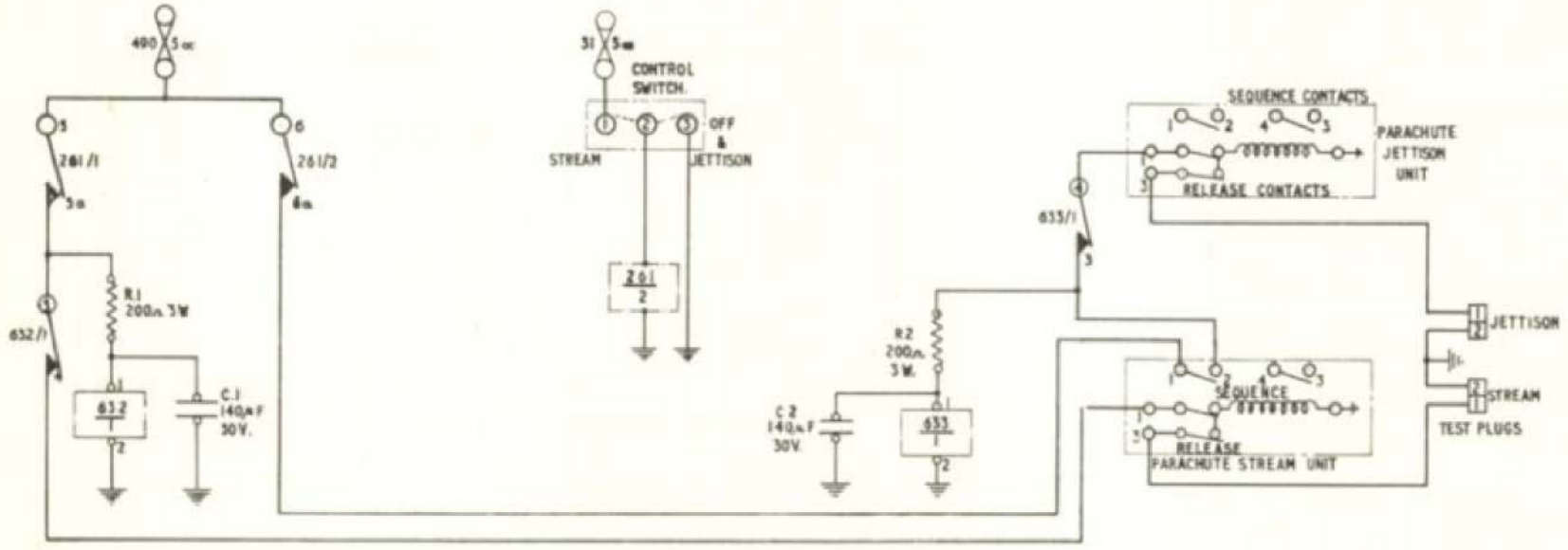

Fig.16 Tail parachute circuit

(b) Operates the sequence switch to close contacts 1-2 thus placing the jettison circuit at readiness for use.

Jettison

117. When the aircraft has slowed sufficiently, the control switch is returned to OFF/JETTISON. Thus:-

(1) Relay 261 is de-energized.

(2) Opening of relay contacts 261/1 disconnects the supply from fuse 490 to the stream release unit.

(3) Closing of contacts 261/2 will connect a supply, from fuse 490, via contacts 1-2 of the stream unit sequence switch and normally-closed contacts 633/1, to energize the coil of the jettison release unit.

(4) Operation of the jettison release will detach the parachute from the aircraft.

Supply cut-off relays

118. The closing of relay contacts 261/1 (para.116 (3)) also connects a supply from fuse 490, via resistor R1 and capacitor C1 to the coil of the cut-off relay 632. If the stream release unit fails to operate as at (4), due, for example, to ice affecting the mechanism, the following circuit action will result:-

(1) After an interval, capacitor C1 becomes sufficiently charged to energize relay 632.

(2) Opening of normally-closed contacts 632/1 disconnects the supply from fuse 490 to the coil of the stream release unit thus preventing overload damage.

(3) To reconnect the stream release unit circuit, relay 632 must be de-energized by momentarily returning the control switch to OFF. The following actions then take place.

(4) Relay 261 is de-energized.

(5) Opening of contacts 261/1 disconnects the supply from fuse 490 to the timing circuit; capacitor C1 discharges via the coil of relay 632 is left de-energized.

(6) Closing of relay contacts 632/1 prepares the stream circuit for subsequent selection of STREAM.

(7) Re-selection of STREAM will cause repetition of the circuit action at para.116 (1), (2) and (3), possibly resulting in that at (4).

119. Referring now to the description of the jettison circuit at para.117, if the operation of the release unit at sub-para.4 does not take place, due to ice affecting the mechanism, a similar circuit action will result as that for the stream unit (para.118), but with the following variations:-

(1) The cut-out circuit consists of resistor R2, capacitor C2 and relay 633.

(2) In order to allow discharge of the capacitor C2, momentary disconnection of the supply from fuse 490 to the timing circuit is effected by setting the control switch to STREAM. This is necessary as relay 261 has to be energized by a supply from fuse 31 in order to open the normally-closed relay contacts 261/2.

Automatic jettison

120. If the stowage compartment doors open inadvertently, the mechanical operation of the stream release unit will cause closure of the contacts 1 and 2 on the sequence switch. The following circuit action will then result:-

(1) Closing of contacts 1-2 will complete a supply from fuse 490 via normally closed relay contacts 261/2 and 633/1 to energize the coil of the jettison release unit.

(2) Operation of the jettison release unit will detach the parachute from the aircraft.

AUTO PILOT SUPPLIES

General

121. The Mk.10 auto-pilot installation automatically controls the flying control surfaces; the complete installation is described in Chapter 2 of this Section but details of the d.c. and a.c. supplies are contained in the following paragraphs.

Supplies

122. Under normal operating conditions, 115-volt, 400 c/s, 3-phase a.c. supplies for the auto-pilot installations are obtained from No.4 inverter (Type 153). If No.4 inverter fails, a stand-by supply is available from No.2 inverter (Type 350). D.C. supply to the auto-pilot installation is fed from fuse 213 and the circuit is so arranged that the d.c. supply to the auto-pilot amplifier is always connected last, and, in the event of an a.c. failure, the d.c. supply is automatically interrupted.

Circuit operation

Normal

123. The control switch for No.4 inverter is situated on the a.c. control panel at the navigation station. Setting the control switch to ON will energize relay 386 with a supply from fuse 233. Closing of contacts 386/1 will connect a 112-volt d.c. supply to the motor section of No.4 inverter via the resistance of the inverter starting relay STR4. As the speed of the inverter increases, the voltage drop across the starting resistance will decrease until the voltage applied to the coil of the

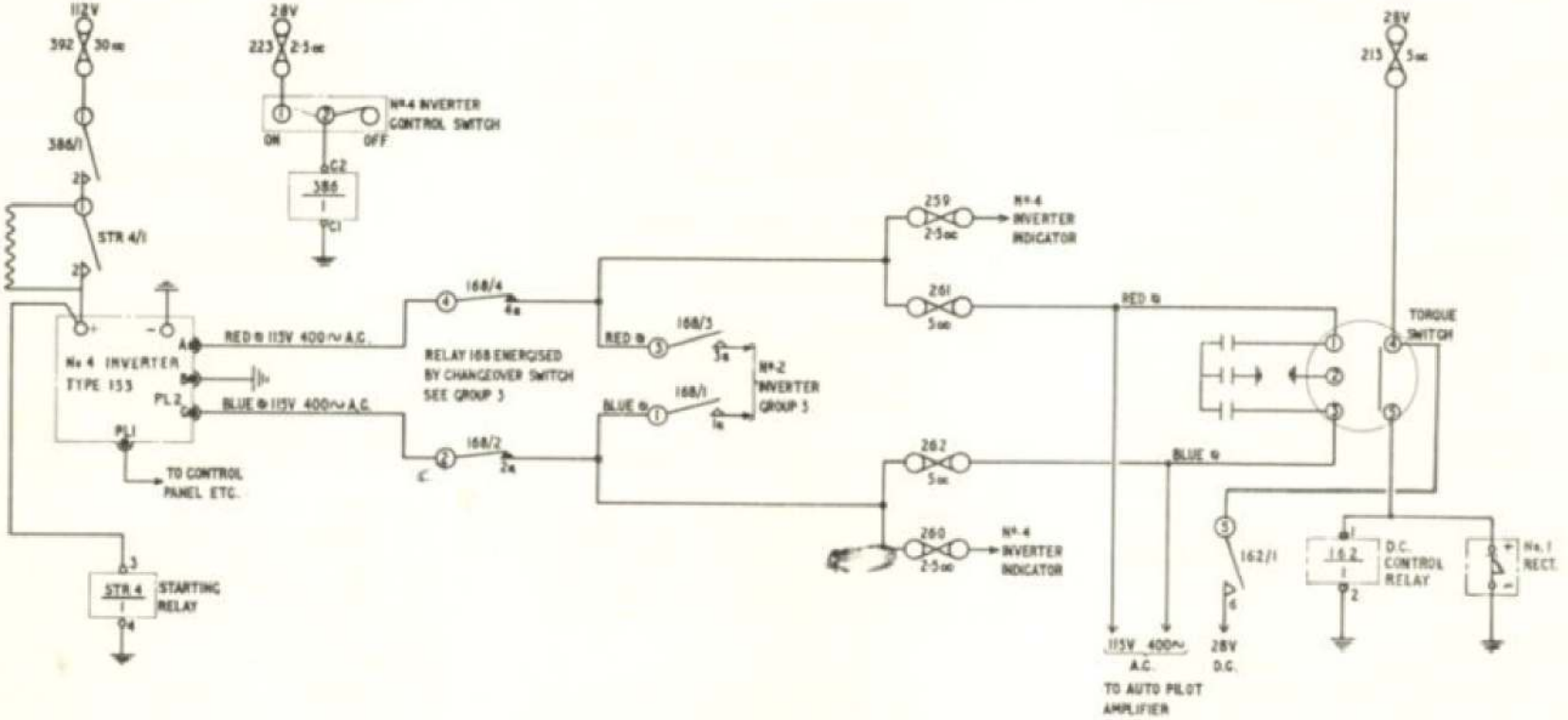

Fig.17 Supplies for auto-pilot

starting relay is high enough to energize the coil and close contacts STR4/1. At this stage, full input voltage will be fed to the inverter motor, and the inverter will operate at full speed.

124. Meanwhile, on the output side of the inverter, a 3-phase a.c. supply will be fed to the auto-pilot amplifier and, when the inverter output is at its correct operating value, the torque switch will operate to close its contacts 4-5. This will connect a 28-volt d.c. supply from fuse 214 to energize the d.c. control relay No.162, operation of contacts 162/1 connecting the d.c. supply to the auto-pilot amplifier. Should the inverter output fall below its correct operating range, the torque switch contacts will open and the d.c. supply to the auto-pilot installation will be interrupted. Indication that the inverter output is normal is given by two neon indicators on the a.c. control panel.

Emergency

125. If No.4 inverter fails, the auto-pilot load can be switched to the No.2 inverter by holding the EMERGENCY CHANGE-OVER switch on the a.c. control panel to the No.4 position. This action will energize relay 168, and operation of its contacts will disconnect the No.4 inverter from the auto-pilot installation and connect the No.2 inverter to the system. A theoretical circuit diagram for the auto-pilot supplies is contained in fig.17. Descriptive information and servicing details for the a.c. supplies and distribution will be found in Group 3.

General

126. Due to the nature of the flying controls systems, it is essential that there is the closest co-operation between airframe, electrical and instrument trades during servicing and inspection operations. This will minimise the repetition of functional checks and calibration tests.

127. The following paragraphs contain servicing information for the electrical portion of the flying controls system, servicing details for the mechanical side of the system are given in Book 1, Sect.3, Chap.4 of this publication. Setting-up instructions for the control surface position indicator and its associated transmitters are contained in Sect.5, Chap.2, Group 2 of this book.

POWERED FLYING CONTROLS

128. The wiring to the P.F.C. motors and control gear should be examined periodically for general security and cleanliness. Particular attention should be given to the heavy-duty cables between the contactors and the P.F.C. units, to ensure that the connections are tight and the cable insulation is free from damage.

P.F.C. motors

129. Servicing of the P.F.C. units whilst they are installed in the aircraft consists of inspection for security of attachment, signs of brush wear and functional testing of the individual motors, using the miscellaneous systems test console as described in A.P.4343V, Vol.1, Sect.4. Servicing details for the pump units and motors, when detached from the aircraft, will be found in A.P.4603C, D, or E and A.P.4343D, respectively.

130. Functional checks on the P.F.C. units can be carried out prior to flying, in the following manner:-

SERVICING

(1) Ensure that 112-volt and 28-volt external supplies are connected to the aircraft.

(2) Check that the aileron, elevator and rudder P.F.C. red warning lamps, on the pilots' centre instrument panel, light and that the STOP indicator on the port console (6P) shows white.

(3) With the airframe fitter, ensure that the flying control surfaces on the wings and rudder are clear of any obstruction (ladders, trestles, etc.).

(4) Start the aileron, elevator, and rudder P.F.C. units in turn by pressing the appropriate start switches on the centre retractable panel. Check for operation of the warning lamps as at para.35; the correct starting sequences for the aileron and elevator units is as follows:-

Port outboard
Starboard outboard
Port inboard
Starboard inboard

Check that the rudder units start simultaneously.

NOTE . . .
The P.F.C. stop indicator will be energized to show black on the starting of the first motor selected.

131. The powered flying controls can now be operated by the airframe fitter, and checked for freedom of movement, correct sense, etc., as laid down in Book 1, Sect. 3, Chap.4, of this publication. During this check, the operation of the rudder auxiliary unit should be proved by pressing the main rudder unit STOP switch on 6P, and ensuring that the rudder controls are still operating. Test procedure for the control surface indicator is contained in Sect.5, Chap.2, Group 2 of this book.

132. When the airframe fitter has completed the functional checks, the P.F.C. units should be stopped by pressing, in turn, each of the STOP switches on the P.F.C. stop switch panel which forms part of the port console 6P. The red warning lamps on the pilots' centre instrument panel should then light and, when the last unit is stopped, the stop indicator should be de-energized to show white.

P.F.C. contactors

133. These units, fitted to the P.F.C. contactor panel 28P in the aft power compartment, comprise engage contactors, Type 14A, No.2, and full-speed contactors, Type 14A, No.3. The contactors should be examined periodically for signs of physical damage. If a unit is suspect, it should be removed from the panel and bench tested in accordance with the instructions contained in A.P.4343C, Vol.1, Book 2.

Time delay switches

134. Servicing details for the time delay switches, Type D8153, will be found in A.P.4343C, Vol.1, Book 2.

ARTIFICIAL FEEL

WARNING . . .
Operation of the P.F.C. start switches to connect 28-volt d.c. supplies to the feel systems for ground testing will simultaneously energize the latched relays of the P.F.C. units engage circuits. Subsequent connection of a 112-volt d.c. supply to

the aircraft system could cause the starting load of all ten P.F.C. units to be imposed on the system simultaneously, resulting in possible damage to the associated equipment and injury to servicing personnel. For this reason it is essential that, immediately after operation of the P.F.C. start switches, the corresponding P.F.C. unit stop switches should be operated to cause a white display at the P.F.C. stop indicator. It is advisable that an additional check be made at the conclusion of ground testing operations.

135. The artificial feel units are adjusted and the micro-switches set by the contractor prior to their installation in the aircraft. The units are supplied as sealed items and the seals must not be broken. If an artificial feel unit becomes unserviceable it must be returned to an authorised depot for repair and a serviceable replacement fitted in the aircraft. The method of checking the calibration of the elevator servo authority in the 'track' and 'glide' phases is given in Book 3, Sect.5, Chap.2, Group 8 of this publication.

NOTE

The autopilot installation must be switched OFF before carrying out tests on the artificial feel system.

136. To assist in the early detection of possible faults in the artificial feel system, a series of tests are laid down in Book 1, Sect.3, Chap.4 of this publication. These tests will be carried out by the airframe tradesman but, as electrical supplies will be necessary to run the P.F.C. units and the tests require the use of a portable manometer, electrical and instrument tradesmen will be required during the tests.

Test set, Type U.1390

136A. A test set, Ref.No.26DC/95217, enables the artificial feel units to be bench tested. The test set can also be used to carry out the balance and differential tests detailed in paras.138 to 140. Full details of the test set and the methods of using it will be found in Book 3, Sect.5, Chap.2, Group 8 of this publication.

Failure warning system

137. Setting-up and calibration tests have to be made on the failure warning portion of the artificial feel system. These tests, contained in the following paragraphs, must be carried out whenever an artificial feel unit is changed, or any of the components in 58P are changed.

NOTE 1 . . .

Damage to the capsules of the air speed potentiometers can be caused by application of pressures in excess of 500 knots. This can occur as a result of a sticking valve on the ground test apparatus. Such damage usually causes the 'cut-in' and 'cut-out' limits of the system to vary from the required setting.

NOTE 2 . . .

Experience shows that, for setting-up operations, the graduated scales of the micro-ammeter relays in the warning system do not provide a sufficiently accurate zero current indication. For this reason, a reliable centre-zero micro-ammeter, graduated to 100 micro-amp., should be connected in series with the coil of the relay being adjusted. The zero current indication of this instrument should then be used for the setting-up adjustments.

NOTE 3 . . .

Particular care is necessary when adjusting the aileron warning circuit. The operating range for the feel system is 312 to 412 knots, whereas the air speed potentiometers function from 295 to 425 knots. Consequently, at 295 knots or below there will be a 17-knot differential and at 425 knots and above there will be a 13-knot differential. As both differentials are inherent in the system there is no alternative but to take them into account when adjusting the aileron warning system. It is for this reason also that, when feel is engaged up to approximately cut-in air speed, the micro-ammeter relay of the aileron feel unit will normally register at the low end of the graduated scale and above cut-out air speed at the high end. This condition, however, will not cause any further circuit action as the internal limit switches of the feel actuator are adjusted to prevent further movement.

NOTE 4 . . .

The ideal setting for the warning system is at an air speed differential of 25 knots above and below that at which a fault occurs and every effort should be made to approach as closely as possible to this figure. The differential should not in any case be allowed to exceed 35 knots. In some instances, the decreasing and increasing differentials resulting from a setting at a particular reference speed may be found to differ. This is of no consequence provided they both fall within the limits of 25 to 35 knots; the important consideration is that the warning system should not be affected by flight conditions. Very rapid application of the rudder, elevator, or aileron can cause a blink at the magnetic indicator but this does not indicate failure.

Setting-up procedure

138. The air speeds given at Table 1 are intended for use as guidance during setting-up operations only; they are not intended to be used as inspection speeds, the warning system being required to function correctly at all speeds. The setting-up procedure for balancing the warning circuit with the feel unit circuit requires that the reference air speed should

be approached from not less than 50 knots below its own value. The initial setting and checking procedure for the differential requires that the reference air speed should be approached from not less than 50 knots above and below its own value. This is necessary to verify both increasing and decreasing air speed differentials. Having engaged artificial feel, the figures in Table 1 should be used with the following instructions.

Balance

139.

(1) Set the sensitivity potentiometer, the low-speed and the high-speed trimmers of the warning system to their approximate mid-positions.

(2) Apply simulated air speed to the feel unit and to the warning system and increase to the low figure.

(3) Adjust the low-speed trimmer of the warning system for zero current indication on the micro-ammeter (Note 2).

(4) Increase the air speed in both systems to the high figure.

(5) Adjust the high-speed trimmer for zero-current indication on the micro-ammeter.

(6) Reduce air speed in both systems to at least 50 knots below the low figure and increase again to the low figure.

(7) Re-check adjustment of low-speed trimmer for zero current in the micro-ammeter.

(8) Repeat as in (4), (5), (6) and (7) until balance is approximately correct at both high and low speeds.

Differentials

140.

(1) From not less than 50 knots below the mid figure increase the air speed in both systems to the mid figure.

(2) Keeping the feel unit air speed constant, introduce a 25-knot differential by carefully raising the warning air speed.

(3) Adjust the sensitivity potentiometer of the warning system until the magnetic indicators are de-energized to give a white display. It may be necessary to slightly increase the air speed differential to bring this about. Note the air speed differential at which it occurs.

(4) Increase the air speed in both systems to not less than 50 knots above mid-speed, then decrease the air speed in both the mid figure.

(5) Keeping the feel unit air speed constant, further decrease the warning system air speed until the magnetic indicator shows white and note at what differential this occurs.

(6) Compare the high and low differentials, these should fall within the limits of 25 to 35 knots.

(7) Re-check the balance as in para.139 (4), (5), (6), and (7) adjusting if necessary. If adjustment is necessary, repeat as in para.140 (1) to (6).

(8) Increase and decrease air speed between 0 and 460 knots at a rate of approximately 500 knots per minute. No warning signal should be given during this test. If a signal is given, slight trimmer adjustment is required.

Checking differentials

141. In the rudder and elevator systems, a check of the decreasing and increasing differentials may be made using as a reference the low and high air speeds, respectively. As the range of the aileron system is limited, such a check is not necessary.

Fault finding

142. Having synchronised the warning circuit in accordance with the foregoing procedure, the feel systems should not require much attention.

Table 1

Setting speeds (knots) for artificial feel systems
(See para.138)

A.F.U.	Cut-in (approx.)	Low	Mid	High	Cut-out (approx.)
Rudder	130	170	295	400	450
Elevator	80	120	270	400	460
Aileron	312	337	362	400	412

143. The feel unit and its associated electrical components box are to be serviced by the manufacturers only. The following information however, may be of use in checking the overall feel systems for correct functioning.

Micro switch settings

144. The two micro switches in each system are correctly adjusted on initial assembly of the feel unit. The Burgess Type V3 micro switches, fitted post-Mod.444, should require little attention and their initial adjustment should not change sufficiently to cause malfunctioning.

145. The correct functioning of these switches can be checked, however, as follows.

(1) Connect a 28-volt d.c. ground supply to the aircraft; the short, high-pitched hum of the relief actuators as they move automatically to the relief positions will be heard.

(2) Check that the master and individual circuit magnetic indicators are de-energized to show white.

(3) Check that the pointers of the micro-ammeter relays on the feel unit and warning system are all indicating neutral.

(4) Engage artificial feel for the respective system to be checked. The short, high-pitched hum of the relief actuator moving from the relief to the feel-engaged position will be heard.

(5) Check that only the magnetic indicator for the system selected is energized to give a black display.

(6) Check that the pointers of the micro-ammeter relays in the feel unit and the warning systems move from the neutral position. In the case of the aileron system, movement will be to the low end of the graduated scale on the feel unit instrument and slightly off neutral on the warning instrument. For the elevator and rudder systems, movement will be to slightly off neutral on both instruments.

146. For air speeds up to the cut-in speed for the control surface, the travel of the relief actuator between the relief and engage positions is very short. The reason is that, up to the cut-in speed, the lever mechanism will be in the position of minimum restriction of movement due to air speed variation. The feel actuator will have been stopped at that point by the opening of its extend-field limit switch. The mechanism will therefore have only a short travel left to the position of fixed minimum restriction of movement, i.e., not subject to air speed variation, or feel relieved. The external limit switch in the retract field circuit of the relief actuator is set so that the motor will stop at this point.

147. With feel engaged in the elevator and rudder system, increasing air speed up to the cut-in speed will cause no variation in the indications or circuit operation. In the aileron system, however, as air speed increases through the range 300 to 310 knots, the pointer of the feel unit micro-ammeter relay will move away from the low position and the low contacts may be heard to open. The pointer will read neutral at approximately 310 knots, thereafter indication and circuit operation within the limit speeds will be similar to those of the other two systems.

148. On increasing air speed beyond cut-out, but not in excess of 500 knots, the micro-ammeter relays of the rudder and aileron feel units will indicate at the high end of their scales. In the rudder system this is due to the setting of the lever mechanism; corresponding adjustment of the internal limit switch of the feel actuator prevents further movement. For adjustment of the aileron system, see Note 3, which precedes para.138.

Operating indications

149. During the few seconds in which the feel unit attains its final adjustment to an air speed setting, a loud ticking sound will be heard. This is caused by operation of relays and the actuator brakes and is quite in order. When the load is put on the feel unit by the pilot operating his controls, the feel unit will be heard to operate and when the pilot releases this load, operation of the unit will again be heard; the sound is caused by the feel unit maintaining its air speed setting whilst being loaded and unloaded.

Warning system-58P

150. The warning system compares the potential of the follow-up potentiometer in the feel unit with that of the air speed potentiometer in the warning circuit. If the feel unit is working correctly, at any given air speed the potentials of both the air speed and follow-up potentiometers will be the same as that of the air speed potentiometer in the warning circuit. If there is an electrical fault in the feel unit, the unit will either:-

(1) Remain stationary and not respond to air speed variation.

(2) Set itself to a speed condition above or below the actual air speed.

(3) Operate to the high-speed condition and remain there.

(4) Operate to the low-speed condition and remain there.

151. The effect will depend on the nature

of the fault. For any of these faults, the warning system will indicate within 30 knots of the fault occurring. For this purpose the warning system has to be very sensitive and it is so sensitive that it may indicate a feel unit failure when none exists. This is generally caused by incorrect setting of the warning panel trimmers which should really be balanced but, according to the characteristics of the air speed transmitters, may have to be biased slightly. This is more fully explained in para.137.

152. If a warning indicator flickers during flight, the warning system should be fully checked and tested in accordance with para.139 and 140, before the feel unit is regarded as unserviceable. If the warning panel micro-relay is very close to making a contact either on the low or high positions when tested on the ground, it may well be that in flight such factors as change in pressure or temperature, vibration, pipe leaks, yaw, etc., may cause a contact to be made. The warning panel trimmers should be reset to avoid this though it is appreciated that this may be difficult and that success largely depends upon the experience of the operator. Sometimes air speed transmitters are damaged or develop faults during use which affect the functioning of the feel unit or warning system.

Air speed potentiometers

153. The potentiometers consist of:-

(1) A capsule which expands when pressure from the pitot head is fed to it.

(2) A coil across which 28-volts is applied.

(3) A wiper arm which is moved across the coil by the expansion of the capsule.

The potential on the wiper arm varies, therefore, with air speed. If a wiper arm does not respond smoothly to variations in air speed, a fault indication may be shown. The fault may be either in the feel unit or on 58P. Another fault which can develop is that the wiper arm may lose contact with the coil at some point in its travel. If the feel unit potentiometer is at fault then this will be indicated to the pilot. If one end of the coil breaks, or if a lead to the coil breaks the feel rate moves to either a maximum or minimum depending upon which end of the coil is affected. The pilot will of course receive warning.

Follow-up potentiometer

154. The follow-up potentiometer consists of a single coil and a wiper arm operated mechanically by a cam in the feel unit. The faults which normally occur are very similar to those in the air speed potentiometers.

(1) Breaking of coil or lead to coil, causing maximum or minimum feel rate.

(2) Bad contact of wiper coil causing hunting.

(3) Wiper arm losing contact with coil; in this case the feel rate remains constant at the speed at which the fault occurred.

If the motion of the follow-up potentiometer becomes excessively stiff, the feel unit will respond correctly to increasing air speed but, when speed is reduced, the feel will run down to the minimum feel position and will remain there until the speed at which the fault occurred is exceeded.

Post office relays

155. The main cause of fault in these relays is burning of the points. As the points are wired in series, a defect in one pair will cause a failure with the result that the feel rate cannot be increased or decreased, depending upon which relay has failed.

TRIM SYSTEM

156. Little servicing is required on the normal and emergency trim controls, apart from routine checks of the wiring and switches for general security and cleanliness.

Actuators

157. The two-motor linear actuators of the Rotax A1702/5/6 series should be serviced in accordance with the instructions contained in A.P.4343. Vol.1, Sect.17, Chap.2, App.11. The travel settings for the actuators are given in Book 1, Sect.3, Chap.4, fig.8 of this publication.

Trim switches

158. The normal aileron and elevator trim control switches, fitted on the pilots' control handles, should be checked for correct operation during the trim system functional test (para.159). No servicing is permissible on the switches, and an unserviceable switch should be removed and replaced by one which is serviceable and of the correct type. The normal rudder trim switch, located on the fuel gauge panel (2P), should also be checked for correct operation (para.159). The emergency trim switch, Type TS104 Mk.14, should be checked for correct operation in each axis during the trim system functional check (para.159). Any suspect switch should be replaced by a serviceable item of the correct type.

Functional checks

159. A functional check of the normal and emergency trim systems should be carried out preferably at the same time as the P.F.C. units are checked (para.130). The checks must be done in conjunction with an

airframe tradesman so that the sense and range checks laid down in Book 1, Sect.3, Chap.4 of this publication can be done at the same time.

The procedure is as follows:-

(1) Start the powered flying control units, as described in para.130.

(2) Select normal aileron trim, using the first pilot's trim switch, and check for correct operation and travel.

(3) Select normal elevator trim, using the first pilot's trim switch, and check for correct operation and travel.

(4) Repeat (2) and (3) using the second pilot's trim switch.

(5) Simultaneously select opposite aileron sense on each pilot's trim switch (i.e., first pilot port, second pilot starboard). Check that the system becomes inoperative and that the trim indicator has changed over to show white.

(6) Hold the trim/reset switch to RESET momentarily; check that the indicator now shows black and that the aileron trim system is again operative.

160. The rudder trim system should be checked by operating the two rudder trim switches on the fuel gauge panel 2P. The two switches must be operated together; operation of one switch will have no effect.

161. The emergency trim circuits should be checked by moving the emergency trim switch knob to each position in turn, with the centre button depressed, and the trim controls checked for correct sense and operation. If selection is made without the centre button depressed the system should not operate.

NOTE...

After any functional checks on the trim controls the system must always be left with the surface trimmed to neutral.

AIR BRAKES

162. The wiring of the air brakes circuit should be checked periodically for general security and signs of chafing, particular attention being paid to the heavy connectors on the contactors and motors.

Functional checks

WARNING (1)...

Do not operate the air brakes if the access doors at the forward end of the bomb doors are in the fully open position.

WARNING (2)...

Air brakes must be operated by hand and not with the electrical motor if the brakes on either side of the motor are disconnected from it, or if any of the micro switches are isolated or disconnected.

163. Functional checks for the air brakes, which should be carried out in conjunction with the airframe tradesman, are contained in Book 1, Sect.3, Chap.4 of this publication. It is important that the air brake motors should not be run continuously for more than 3 minutes, after which a 45 minute cooling period must be observed. To safeguard against inadvertent operation of the control switches during servicing operations, a locking pin, Avro Part No.1/U1678 should be inserted through the locating holes in the switch guard to lock the switch toggles.

Reversing contactors

164. These units, Type D9311, should be inspected periodically for undue arcing and burning of the main contacts. Further servicing information on the reversing contactors will be found in A.P.4343C, Vol.1, Book 2.

Actuator

165. In situ servicing of the air brake actuator is limited to a check for security and brush wear. Further information will be found in A.P.4343D, Vol.1, Book 3.

Micro switch settings

166. The micro switches which control the air brakes are operated by spring-return levers to which are attached cam rollers (fig.12). The rollers are operated by cam strips affixed to the drag posts of the airbrake mechanism. The micro switch assemblies are adjusted on initial fitment so that the switch contacts will operate and disconnect the supplies to the actuator motor at a point where the mechanism has not quite completed its full travel. This occurs during extension and during retraction of the airbrakes and allows for override in the mechanism's travel. The override may vary with use and the position of the rollers relative to the mechanism travel is therefore made variable by inclusion of an adjustable securing bolt. Re-adjustment of the roller positions can be carried out using the air brakes test set, Avro, Type 1U1339. The test set provides a means of inching the mechanism to any position in its travel so that the correct operation of the appropriate micro switch contacts can be checked and the roller position adjusted accordingly. Technical details and operating instructions for the test set, Type 1U1339, will be promulgated in A.P.4343V in due course.

Time delay units

167. The Avro time delay units, Type 1/V9303, are supplied as sealed items. Servicing of these, when defective, therefore consists of replacement of a serviceable item and return of the faulty unit to the manufacturer.

TAIL PARACHUTE

168. Little servicing is required for the tail parachute controls. The stream and jettison E.M. release units should be checked for continuity when cocked, using the two test points provided. When cocking the release units, the stream unit must always be cocked first.

REMOVAL AND INSTALLATION

General

169. When major items of equipment have to be removed from the aircraft, the correct ground equipment for the job must be used. When more than one man is necessary for the removal or assembly of a particular piece of equipment, no attempt should be made to carry out the task single-handed.

170. Removing equipment in the flying controls systems presents no serious difficulties. Points to be borne in mind are:-

(1) Before removing electrical items, ensure that the circuit is electrically "safe".

(2) Always tape up and stow all disconnected cables.

(3) When re-making cable connections, check with the appropriate routing chart for correct terminal numbers and cable references.

P.F.C. units

171. Removal and assembly instructions for the P.F.C. units are given in detail, with illustrations, in Book 1, Sect.3, of this publication. The electrical tradesman will be required to disconnect the associated wiring.

Start switches

172. Access to the connections at the back of the P.F.C. START push-switches on the retractable centre control is obtained by removing the auto-pilot switch panel from 5P. The connections to the P.F.C. START switches will then be accessible.

Stop switches

173. Access to the connections of the P.F.C. STOP switches on the panel attached to the port console 6P is gained by releasing the screws securing the panel to the console. The panel can then be tilted.

Contactor panel

174. The P.F.C. contactor panel (28P), located in the aft power compartment, should not have to be removed. Should it be necessary, however, to remove any of the contactors, the servicing platform sections (Ref. No. 26DC/95153 and 26DC/95152) must be fitted to the floor of the compartment. The contactor can then be removed by disconnecting the wiring, and releasing the bolts securing the contactors to the panel face.

Artificial feel units

175. Removal of the artificial feel units is covered in Book 1, Sect.3, Chap.4 of this publication. Removal of the master transmitter potentiometers and access to the relays in 58P (fig.7) presents no difficulties.

Trim actuators

176. Removal of the trim actuators presents no serious difficulties. The actuators must be re-set in accordance with the figures contained in Book 1, Sect.3, Chap.4 of this publication before they are assembled in the control runs.

Trim switches

177. The recommended procedure for the replacement of a trim switch on either pilot's control handle is as follows:-

(1) Ensure that the trim circuit is electrically "safe".

(2) Remove the two csk/hd. screws securing the trim switch to the handle.

(3) Gently pull the switch out, until the terminals are accessible.

(4) Disconnect the cables from the switch, and remove the switch.

When the replacement switch has been connected to the cables and refitted in the control handle, the trim system should be check-functioned as laid down in para. 159.

Air brakes

178. Access to the air brakes, for micro switch adjustment and inspection, is gained via the access panels in the forward section of the bomb bay and the access panels in the engine air intakes. No difficulty should be met with when removing the air brake motors, and this task should be carried out in conjunction with the airframe tradesman.

Table 2

P.F.C. relays and contactors

Relay No.	Type	Function
44	14A, No.3	Rudder main full-speed relay
45	14A, No.2	Rudder main engage relay
46	14A, No.2	Rudder auxiliary engage relay
47	14A, No.3	Rudder auxiliary full-speed relay
48	Q1	Rudder start relay
49	Q3	Rudder warning relay
51	Q3	Elevator warning relay
52	Q3	Aileron warning relay
53	14A, No.3	S.I. elevator full-speed relay
54	14A, No.2	S.I. elevator engage relay
55	14A, No.2	P.I. elevator engage relay
56	14A, No.3	P.I. elevator full-speed relay
57	14A, No.3	S.O. elevator full-speed relay
58	14A, No.2	S.I. elevator engage relay
59	14A, No.2	P.O. elevator engage relay
60	14A, No.3	P.O. elevator full-speed relay
61	14A, No.3	S.I. aileron full-speed relay
62	14A, No.2	S.I. aileron engage relay
63	14A, No.2	P.I. aileron engage relay
64	14A, No.3	P.I. aileron full-speed relay
65	14A, No.3	S.O. aileron full-speed relay
66	14A, No.2	S.O. aileron engage relay
67	14A, No.2	P.O. aileron engage relay
68	14A, No.3	P.O. aileron full-speed relay
Pre-Mod. 416 only: 431	W68M10610/2	Rudder main indicator relay
Pre-Mod. 416 only: 432	W68M10610/2	Rudder auxiliary indicator relay
Pre-Mod. 416 only: 433	W68M10610/2	P.O. elevator indicator relay
Pre-Mod. 416 only: 434	W68M10610/2	P.I. elevator indicator relay
Pre-Mod. 416 only: 435	W68M10610/2	S.I. elevator indicator relay
Pre-Mod. 416 only: 436	W68M10610/2	S.O. elevator indicator relay
Pre-Mod. 416 only: 437	W68M10610/2	P.O. aileron indicator relay
Pre-Mod. 416 only: 438	1068M10610/2	P.I. aileron indicator relay
Pre-Mod. 416 only: 439	1068M10610/2	S.I. aileron indicator relay
Pre-Mod. 416 only: 440	1068M10610/2	S.O. aileron indicator relay

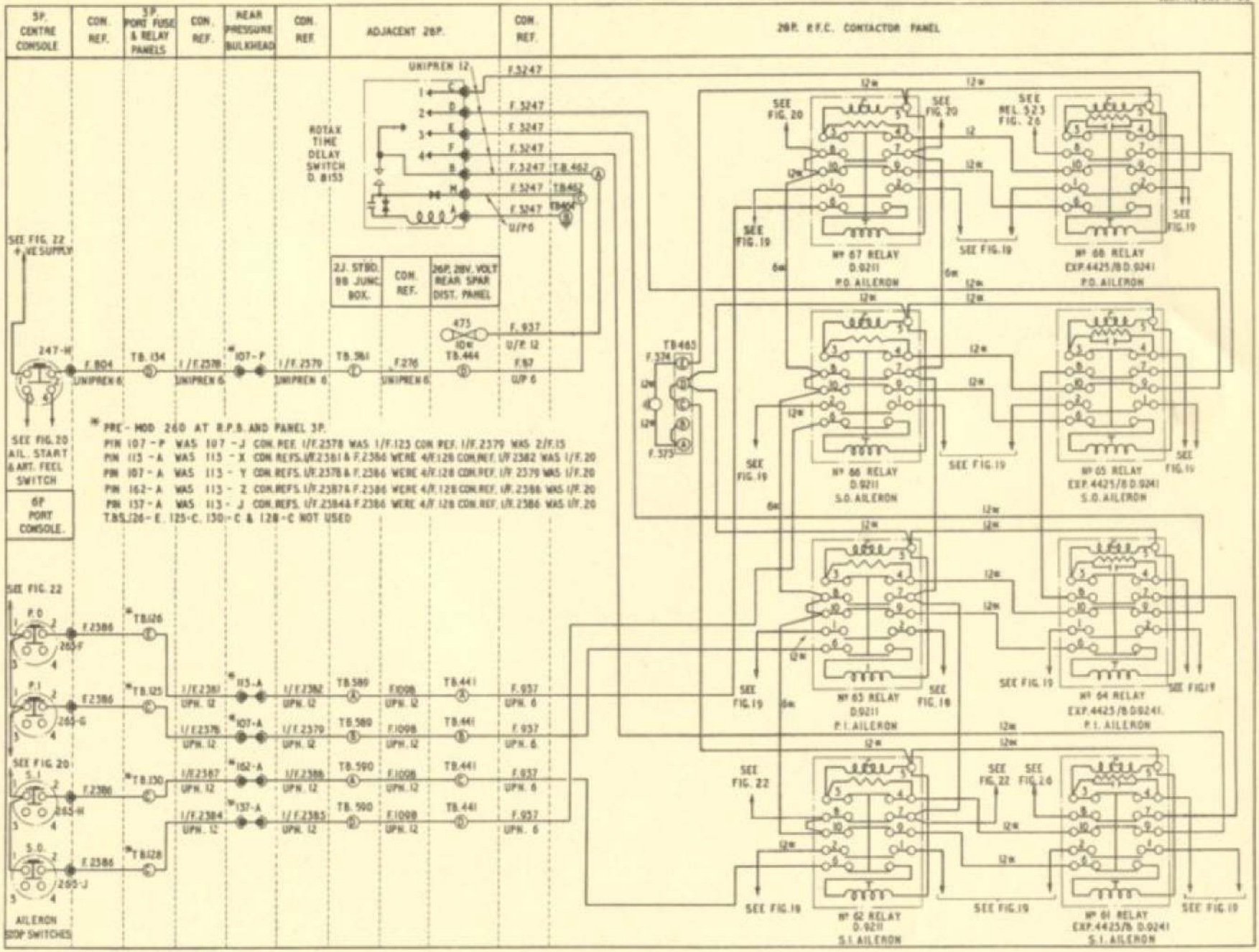

FIG. 18 28 VOLT P.F.C. AILERON CONTROLS(C).

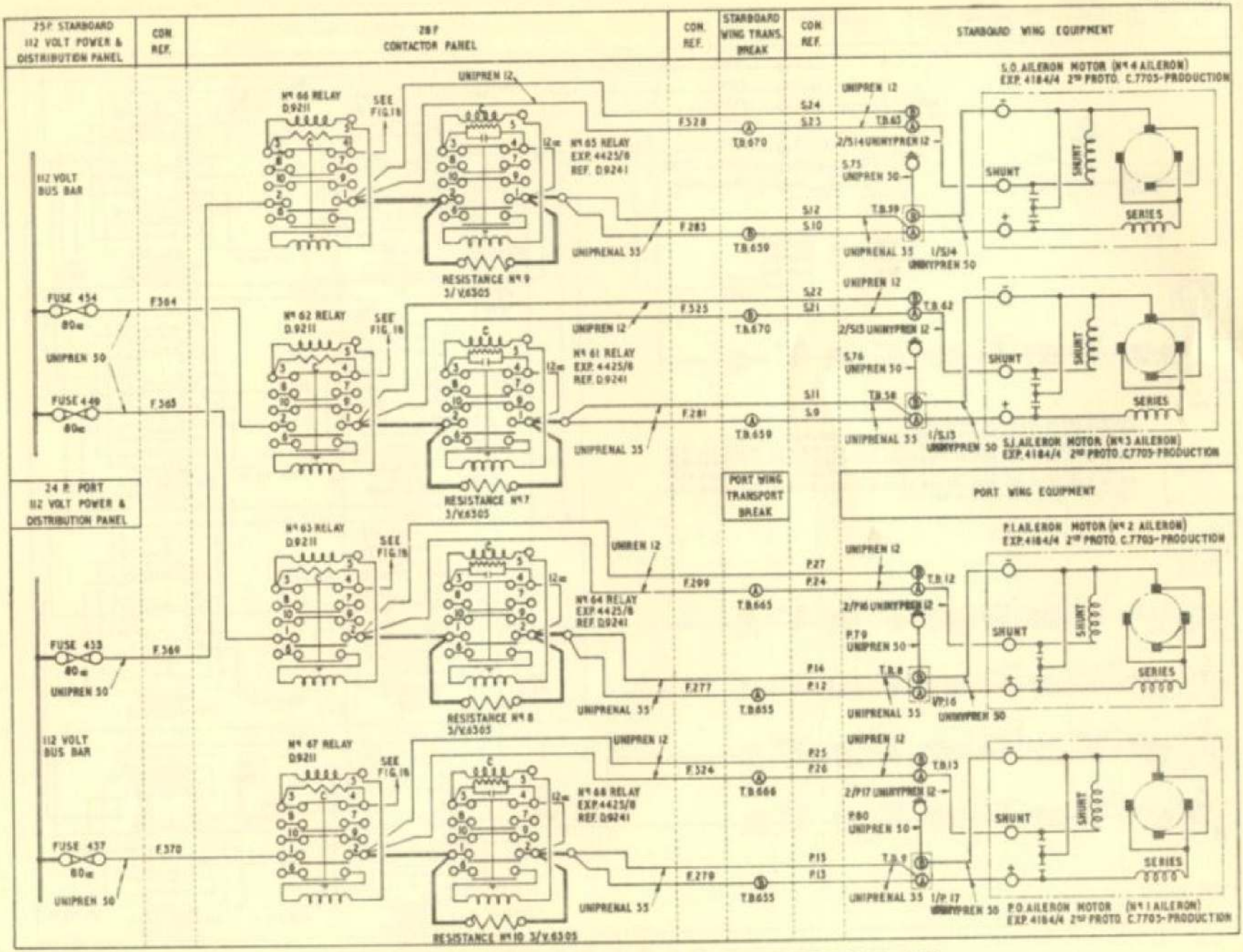

FIG. 19 112 VOLT P.F.C. AILERON CONTROLS. (C)

PP8617 458635 8318 12.59 631 C&P Gp. 934 (9)

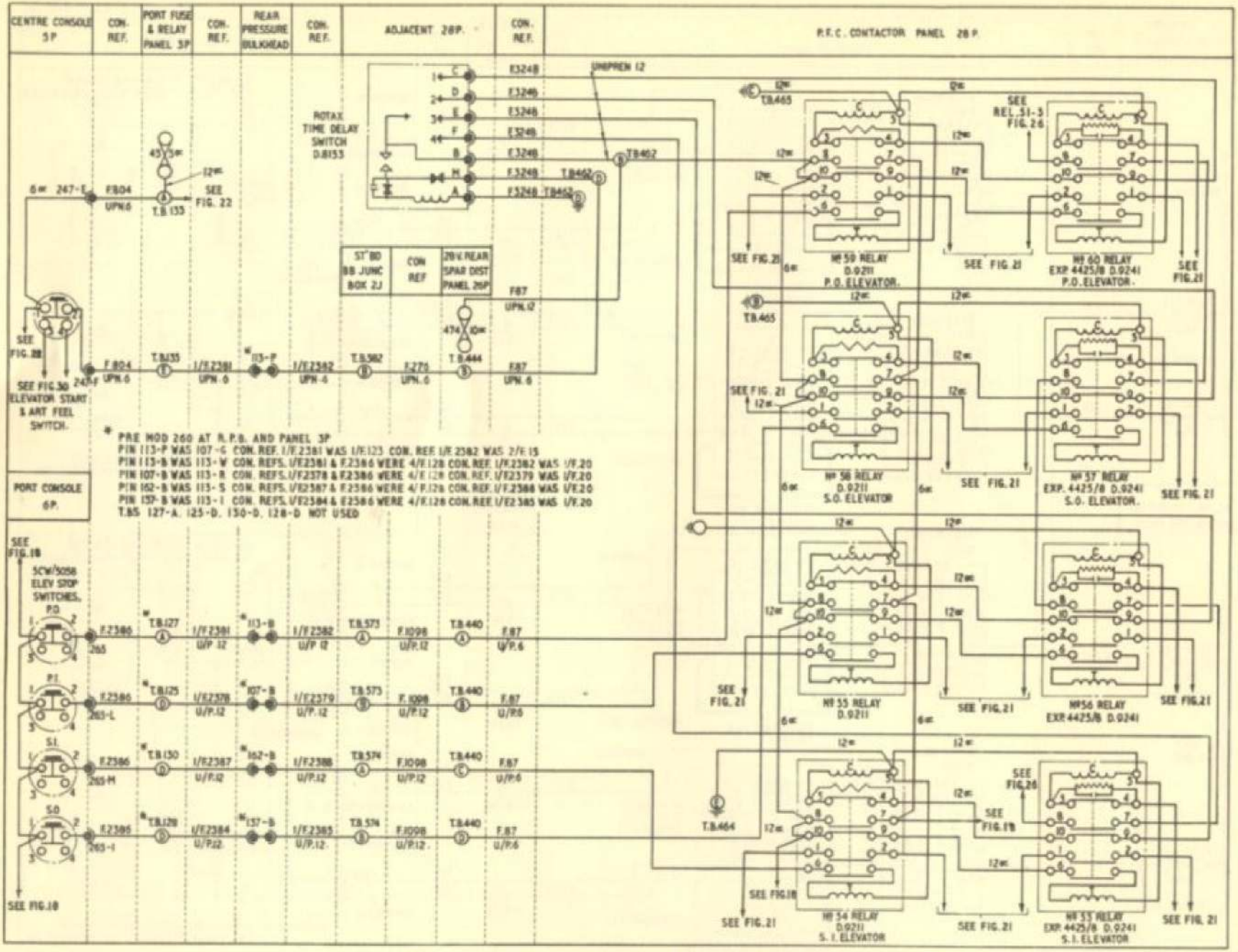

FIG.20 28 VOLT P. F. C. ELEVATOR CONTROLS (C)

A.L.45 SEP./59

RESTRICTED

February, 1959

AIR MINISTRY

Air Publication 4505A
Volume 1, Book 2

VULCAN B Mk.1 (AND ASSOCIATED ROLE) AIRCRAFT

ADVANCE INFORMATION LEAFLET NO.23/59

Insert this leaflet in A.P.4505A, Vol.1, Book 2, Sect.5, Chap.1, Group 6, to face AIL.22/59

Fig.22 overleaf

Notes

(1) The information contained in this leaflet will be incorporated by normal amendment list action in due course.

(2) If, after receipt of this leaflet, an amendment list with a prior date and conflicting information is received, the information in the leaflet is to take precedence.

ENGINEER

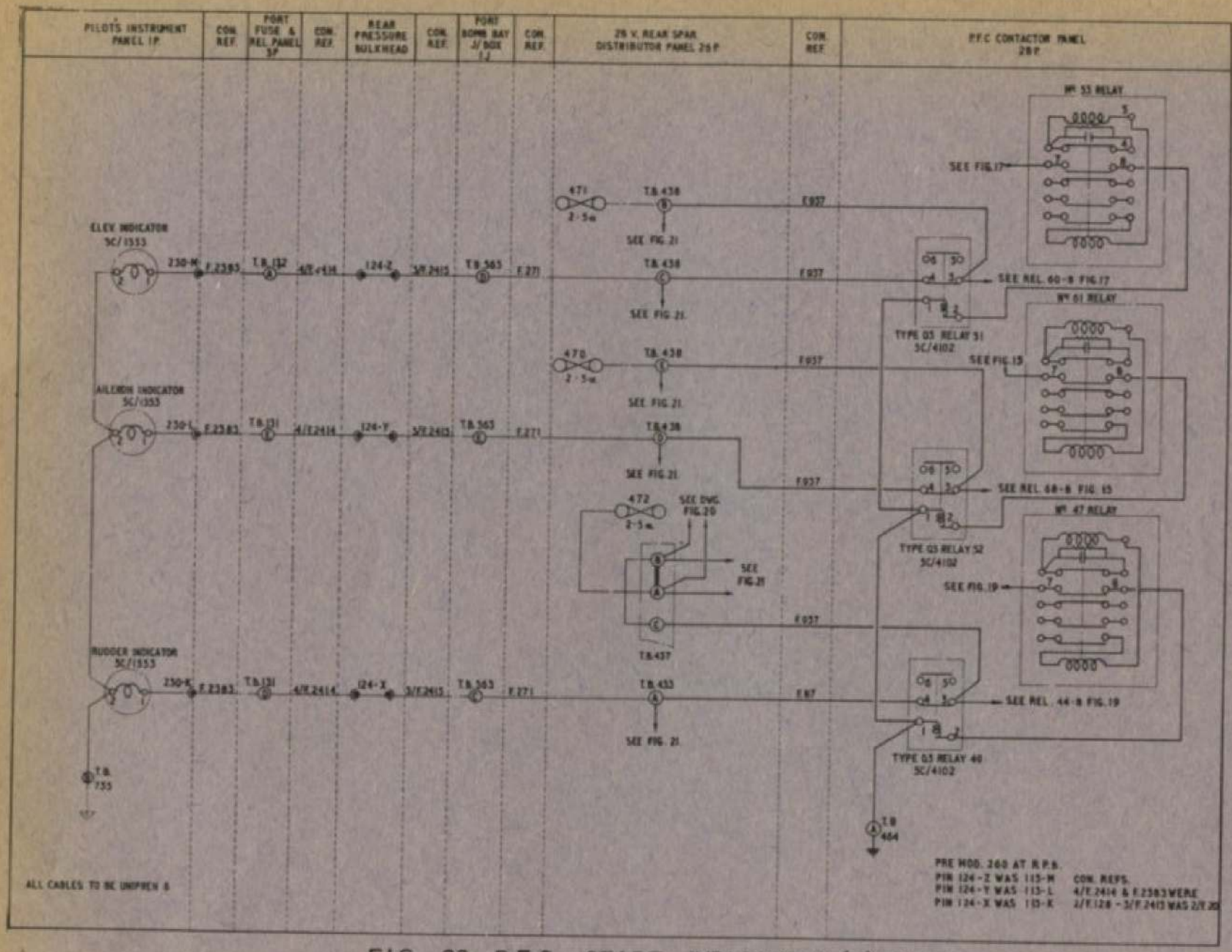

FIG. 22 P.F.C. START INDICATORS (C) PRE & POST MOD. 260

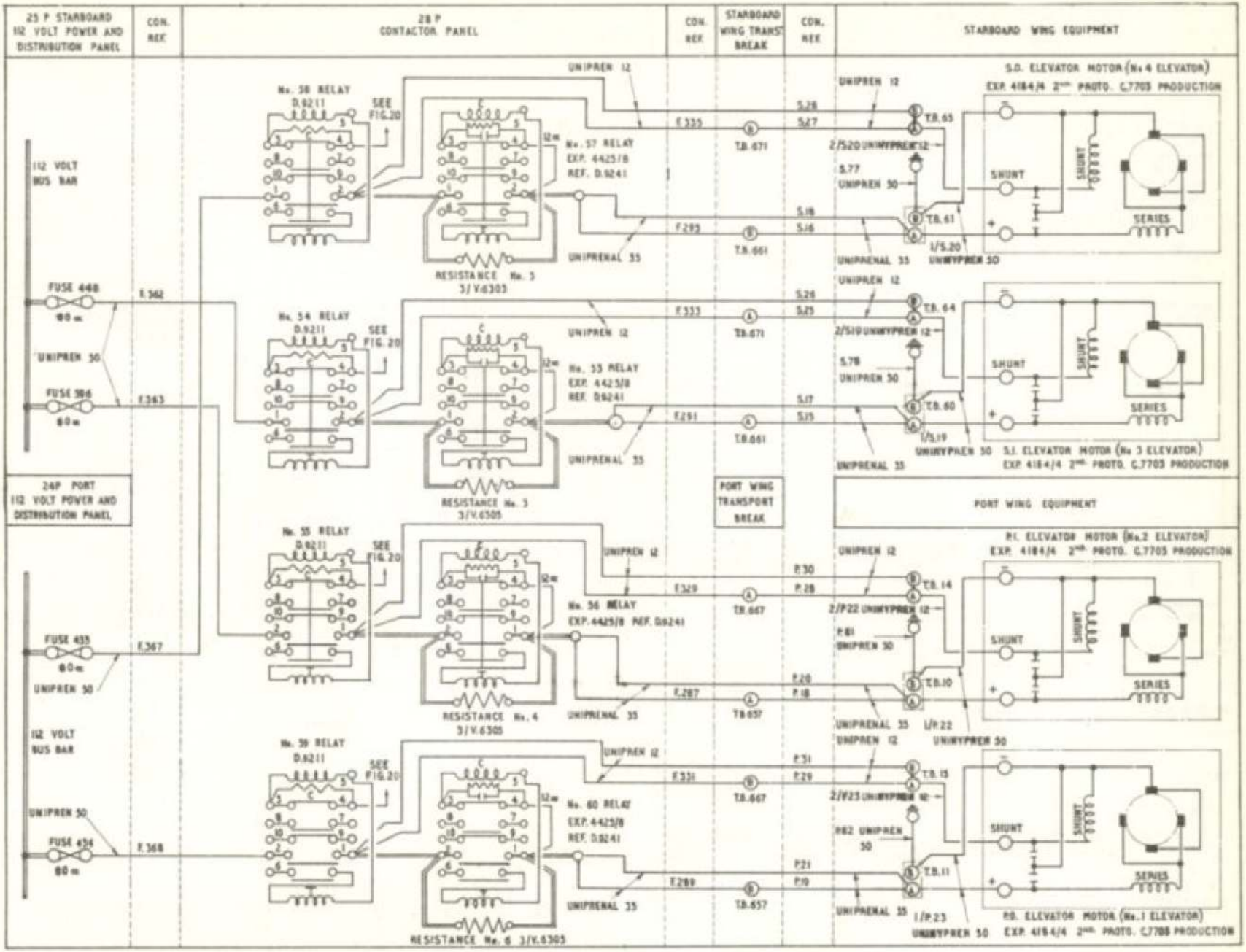

Fig. 21 112-volt P.F.C. elevator controls

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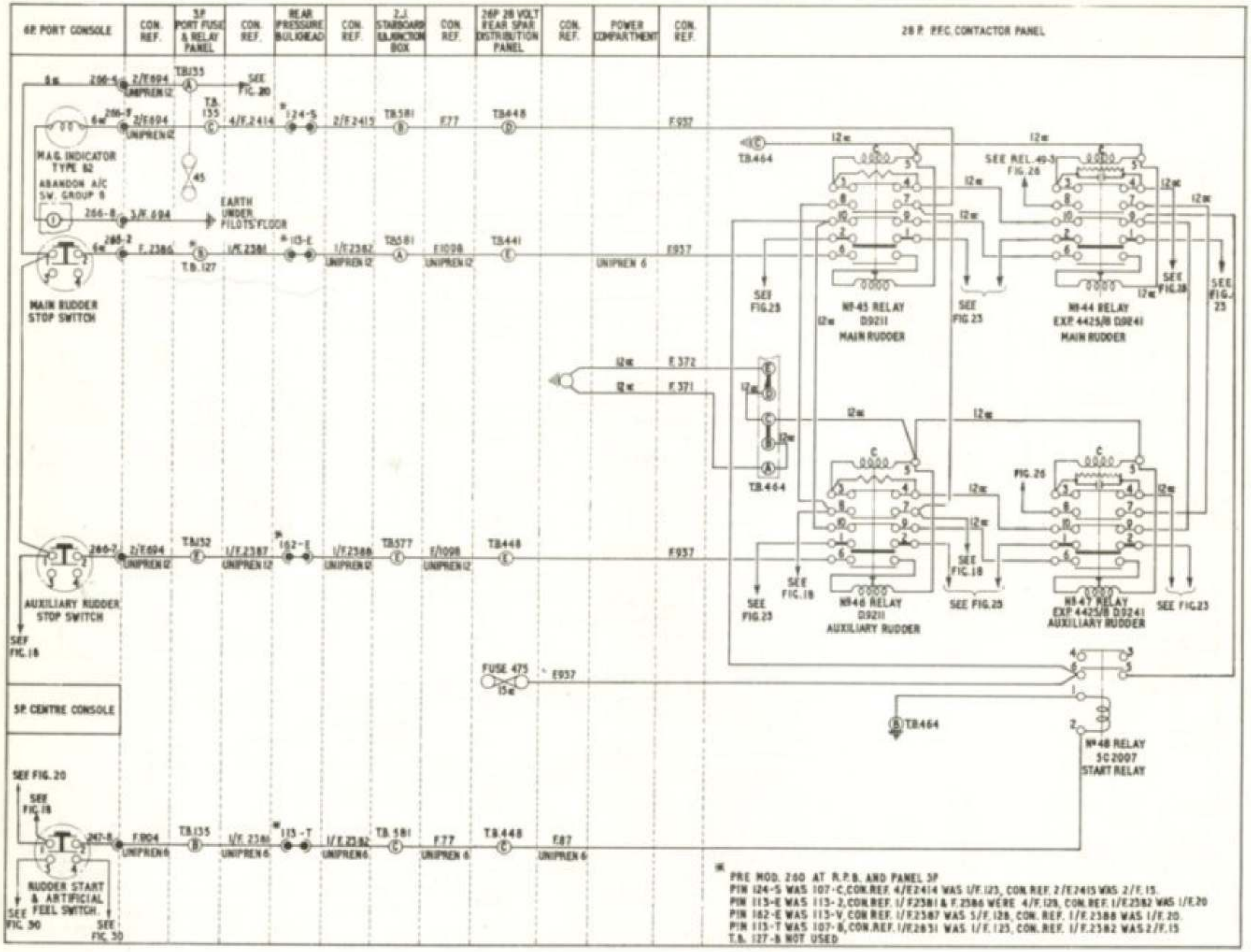

Fig. 22 28-volt P.F.C. rudder controls

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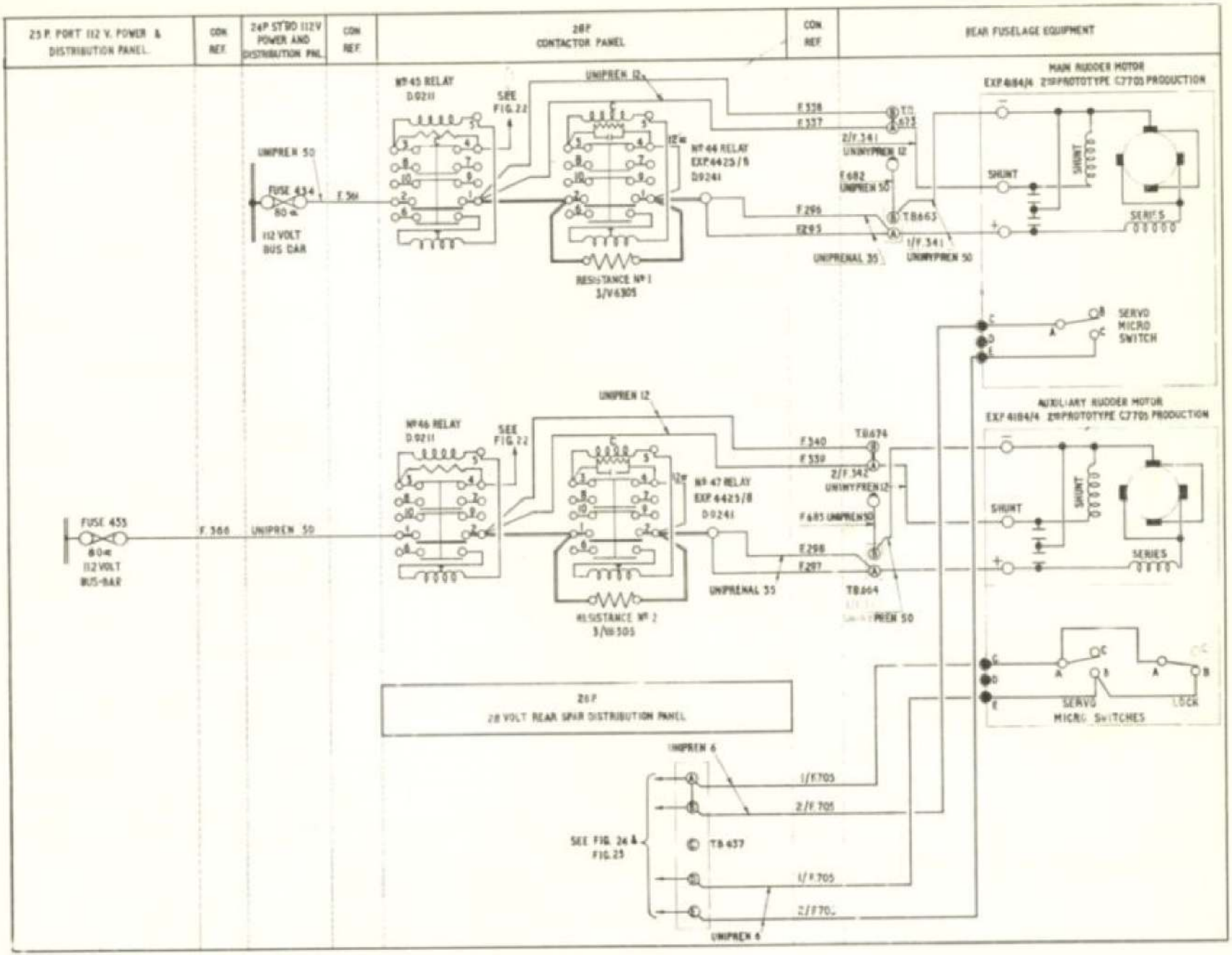

Fig. 23 112-volt P.F.C. rudder controls

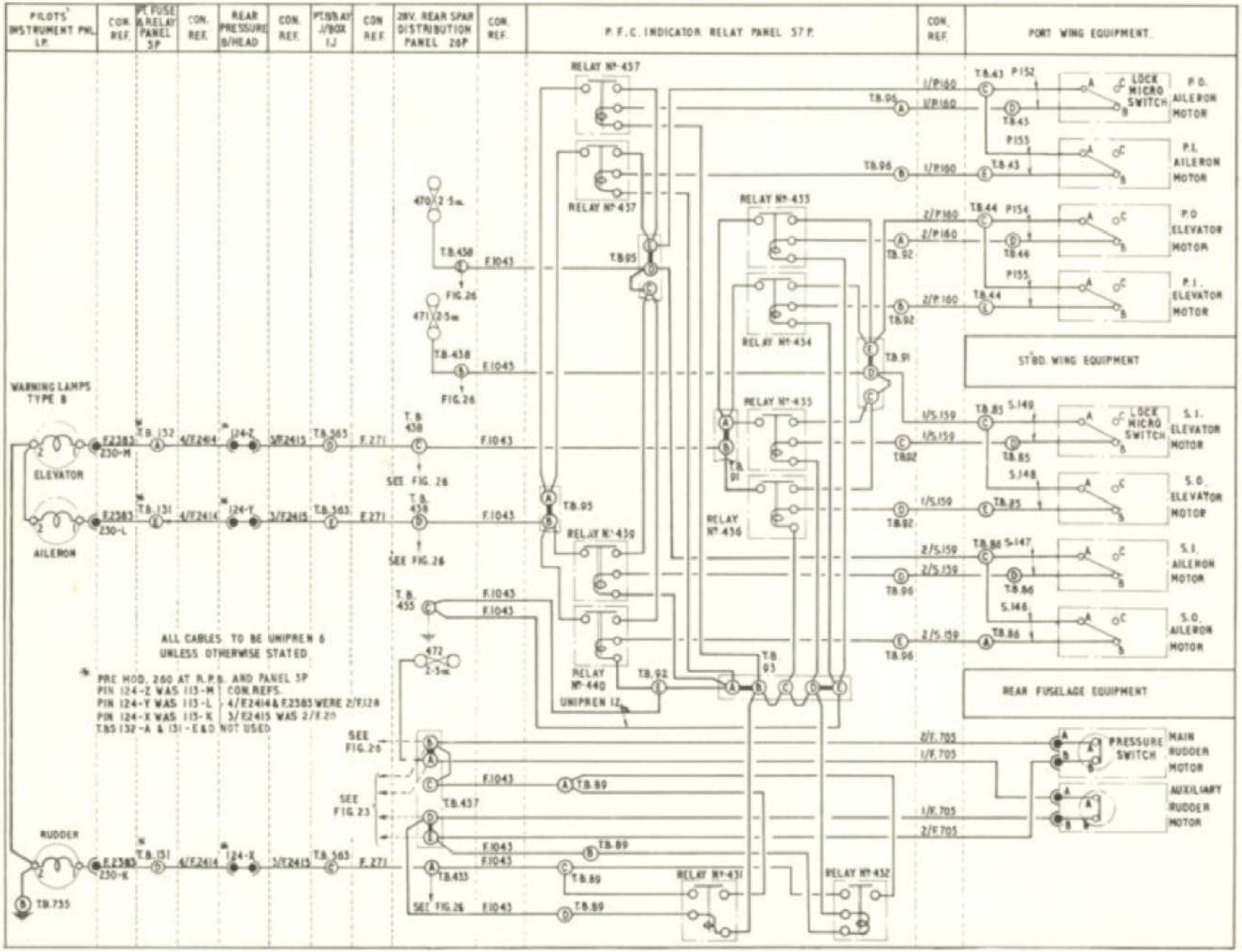

Fig. 24 Indicators for aileron elevator and rudder motors (pre. Mod. 410)

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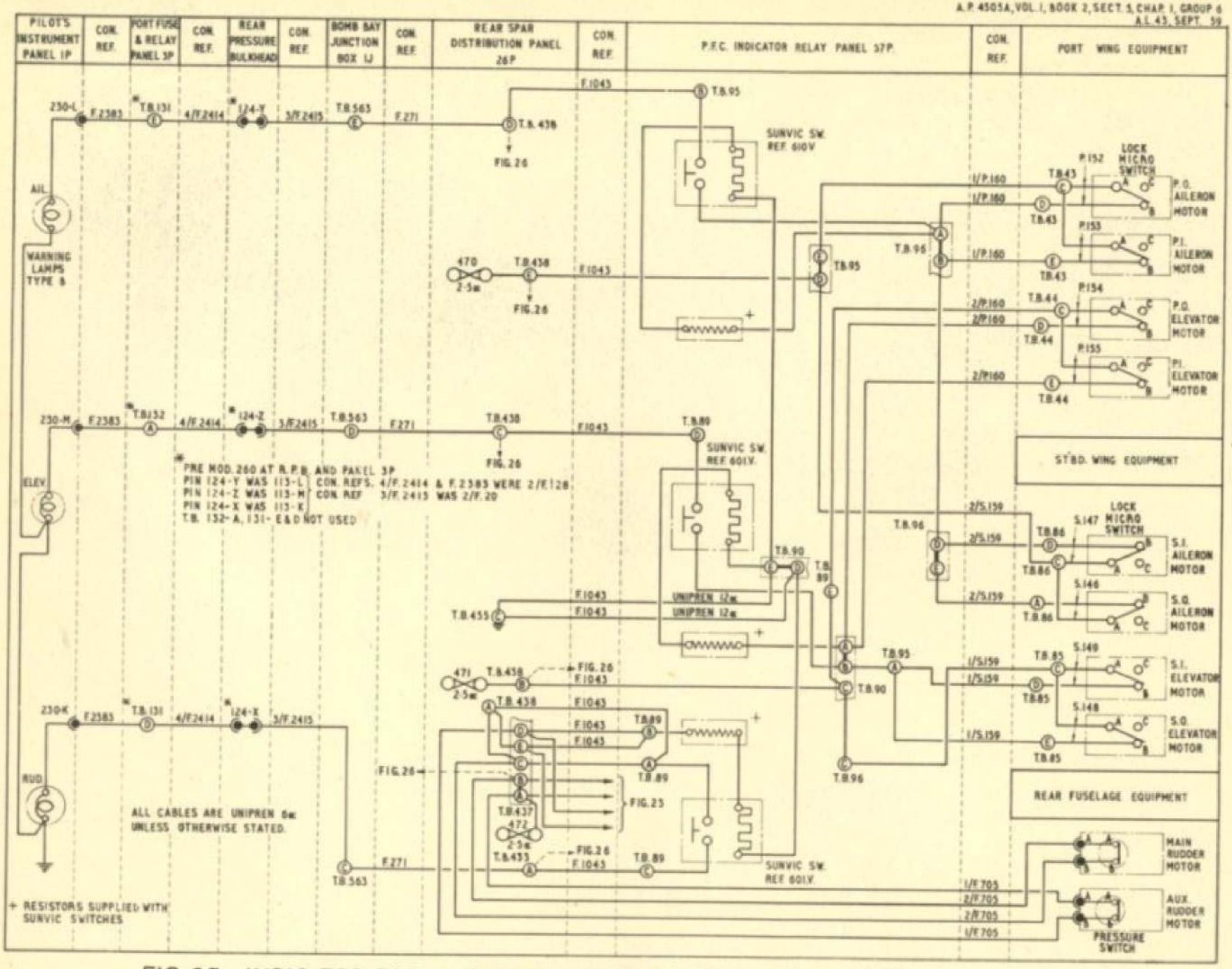

FIG. 25 INDICATOR FOR AILERON, ELEVATOR AND RUDDER MOTORS(C) (POST MOD. 410)

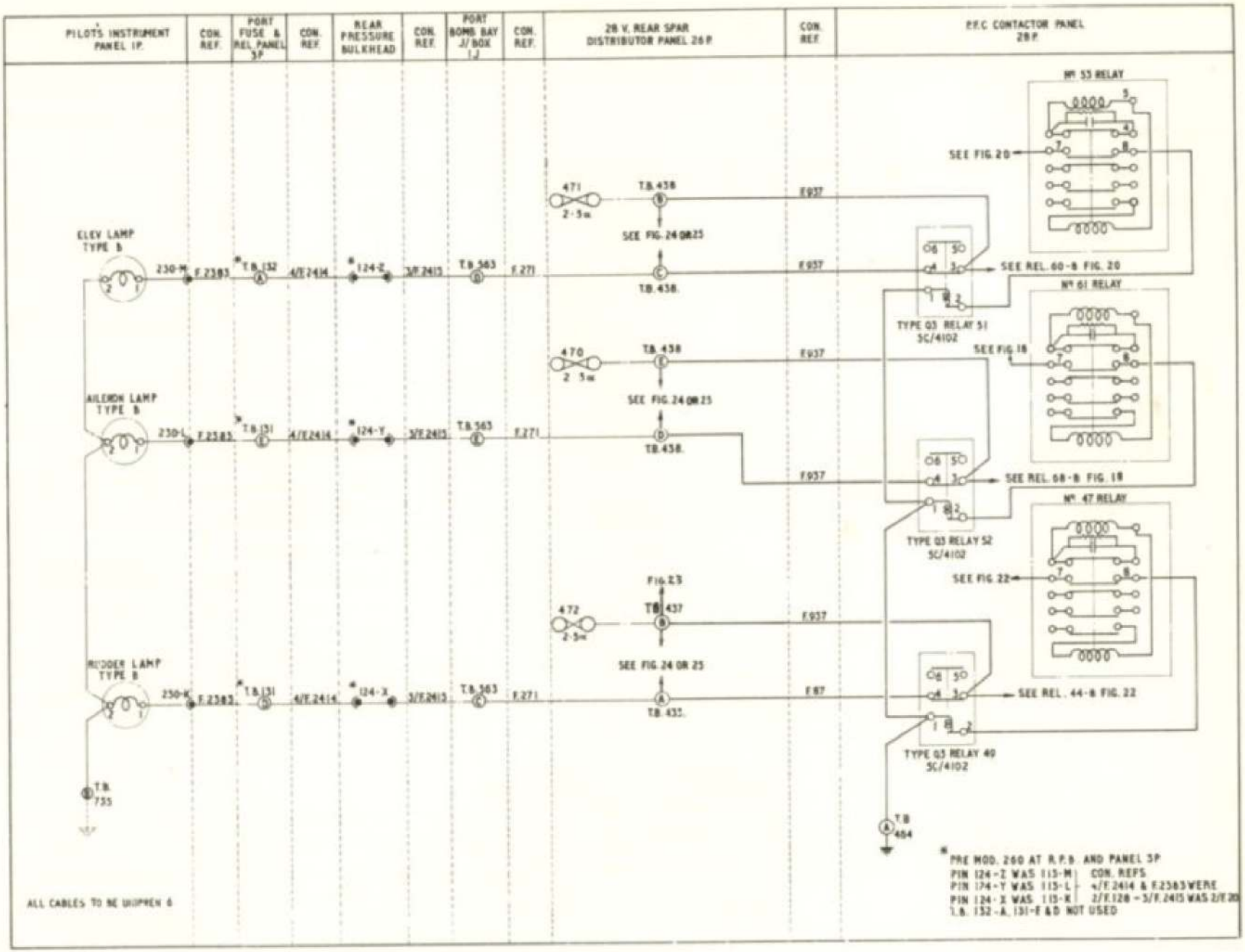

Fig. 26 P.F.C start indicators

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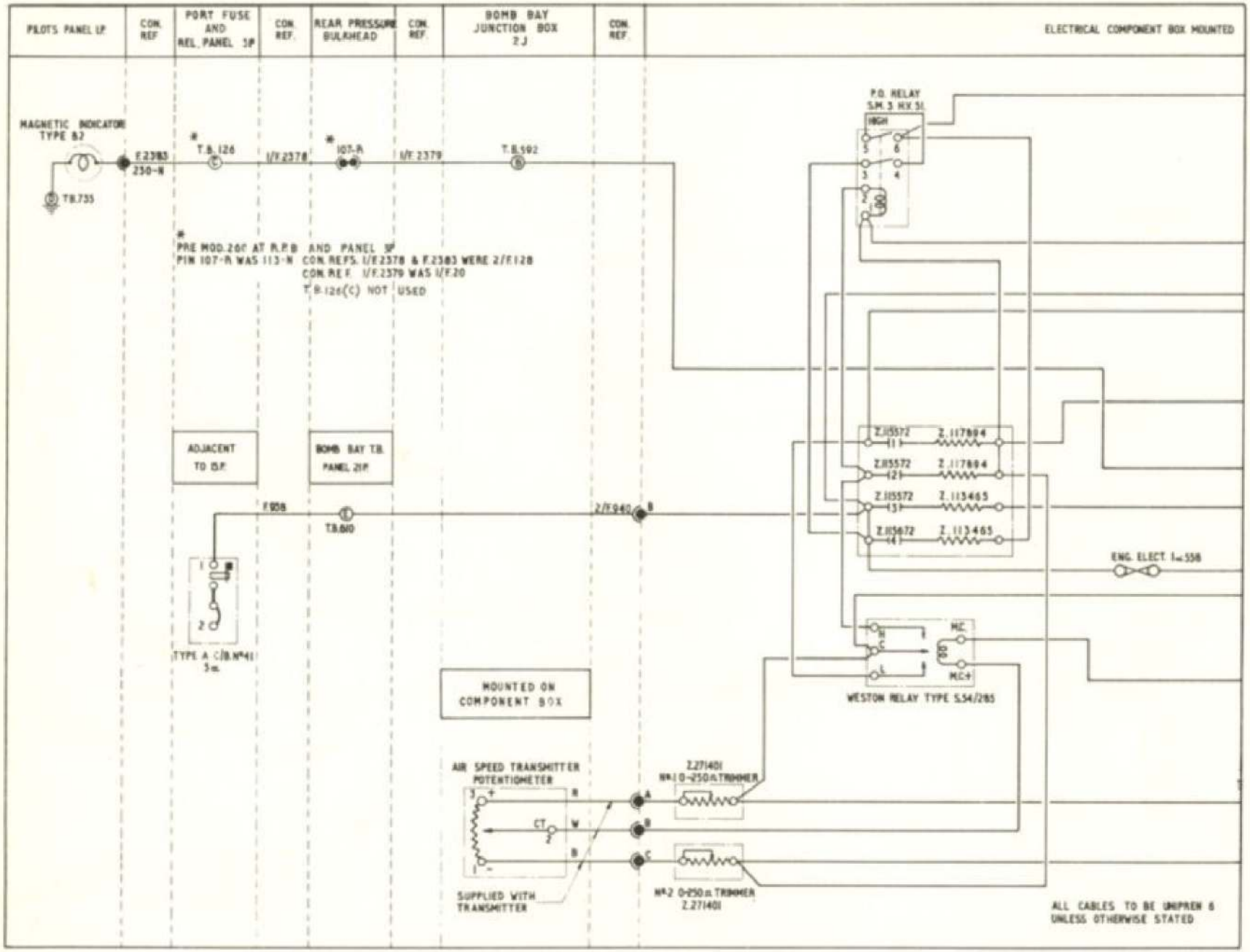

Fig. 27 (1) Aileron artificial feel (pre. Mod. 928 and 1498)

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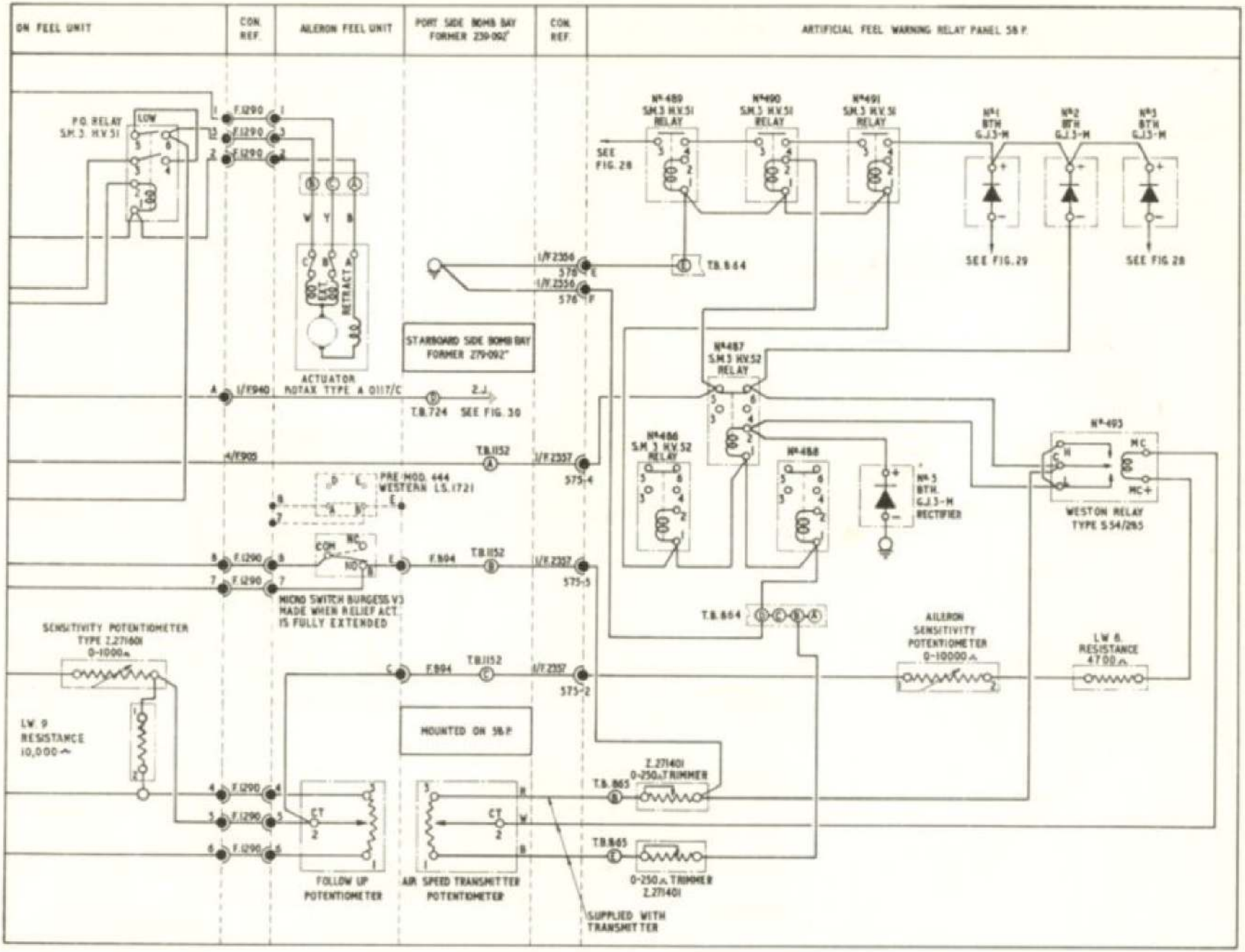

Fig. 27 (2) Aileron artificial feel (pre. Mod. 928 and 1498)

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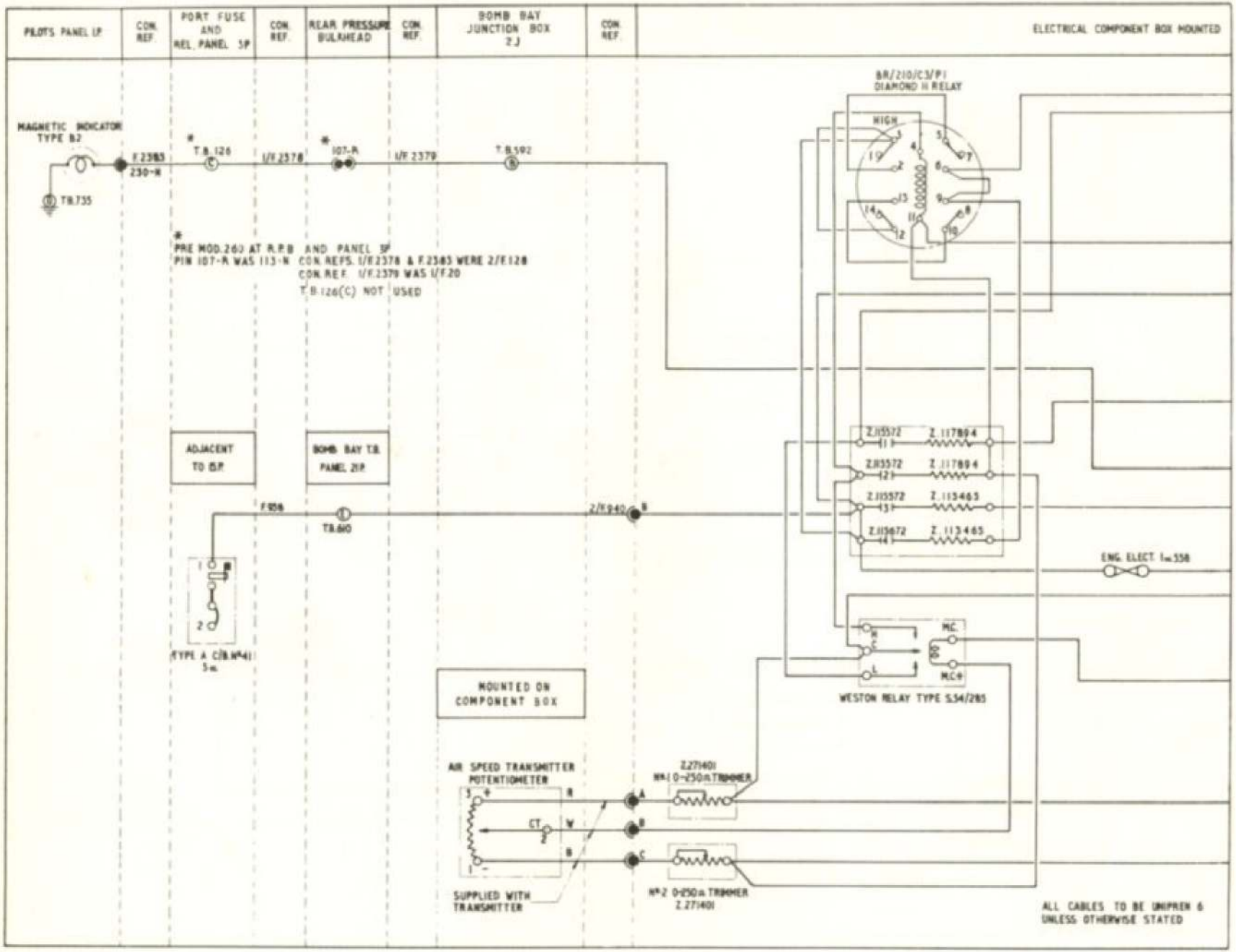

Fig. 27A (1) Aileron artificial feel (pre Mod. 1498, post Mod. 928)

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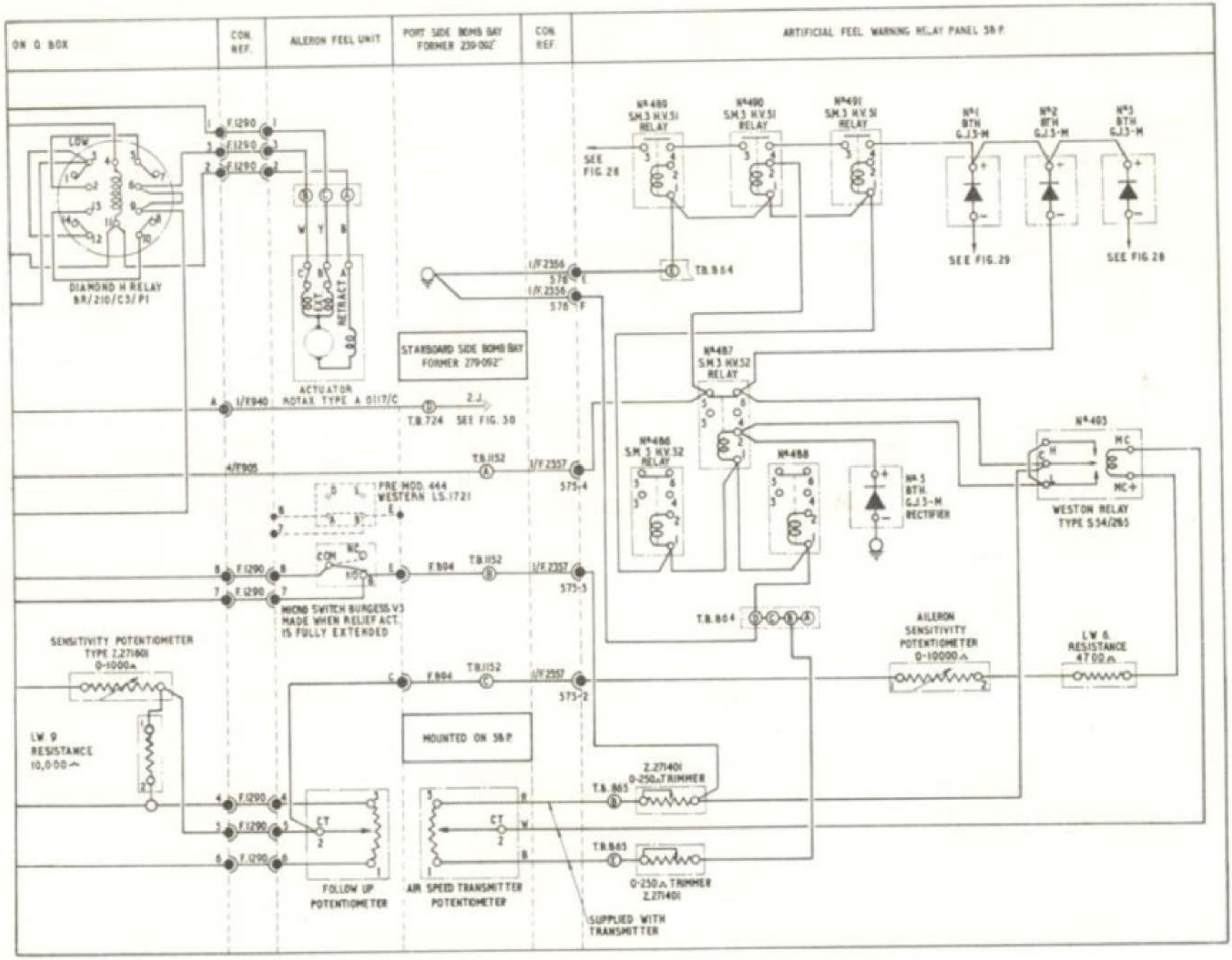

Fig. 27A (2) Aileron artificial feel (pre Mod. 1498, post Mod. 928)

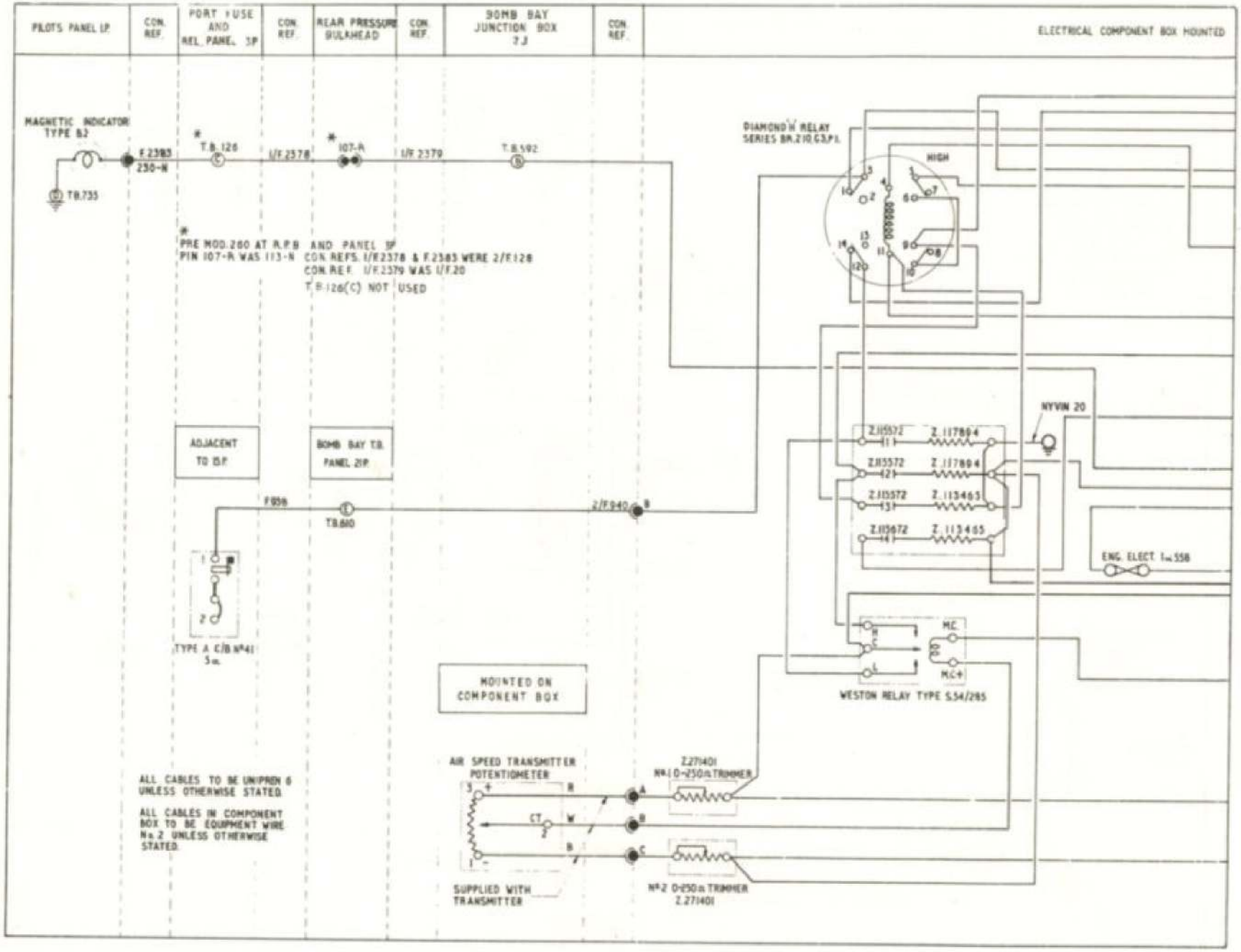

Fig. 27B (1) Aileron artificial feel (post Mod. 928 and 1498)

(◄ Mod. 1927 ►)

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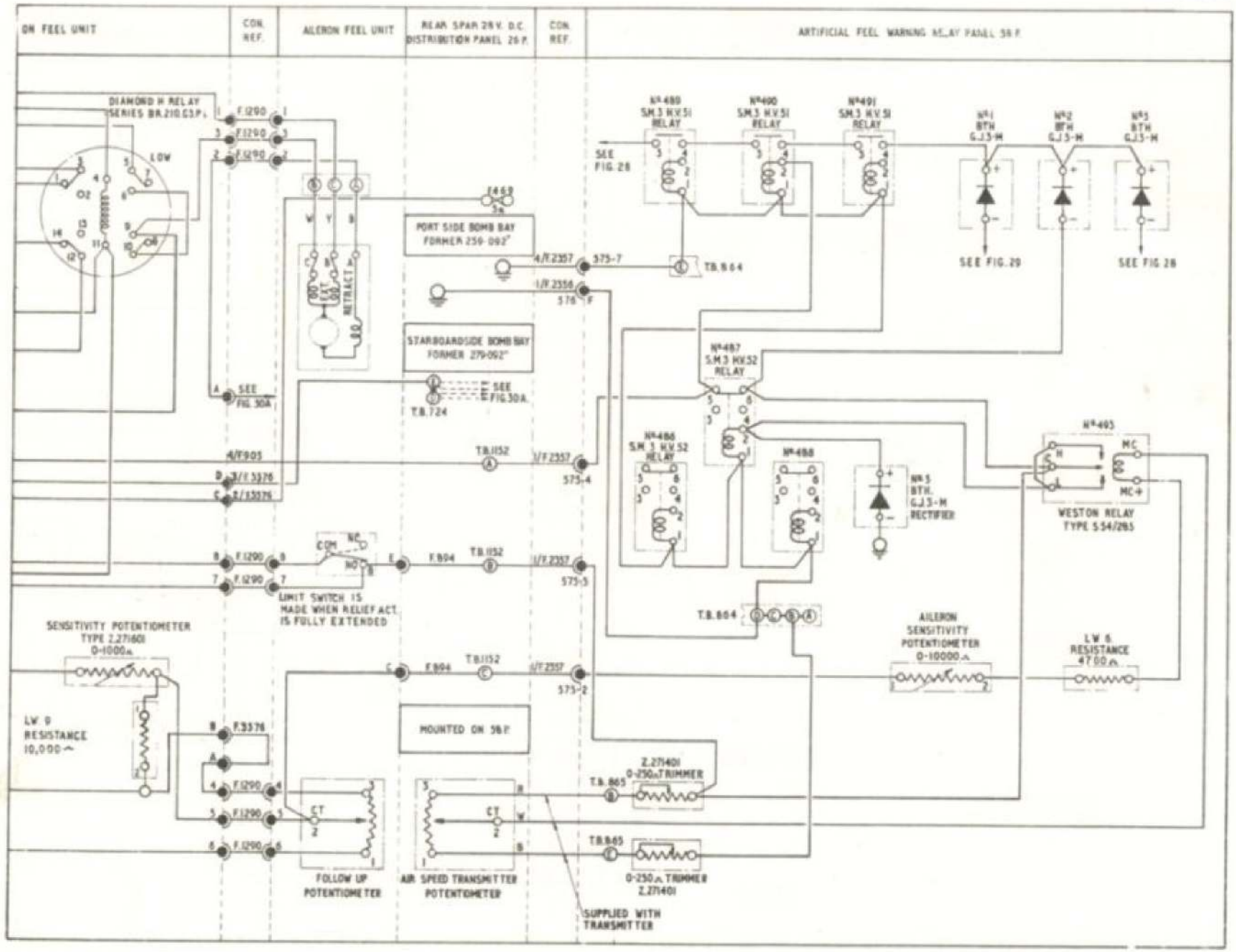

Fig. 27B (2) Aileron artificial feel { post Mod. 928 and 1498 (← Mod. 1927 →) }

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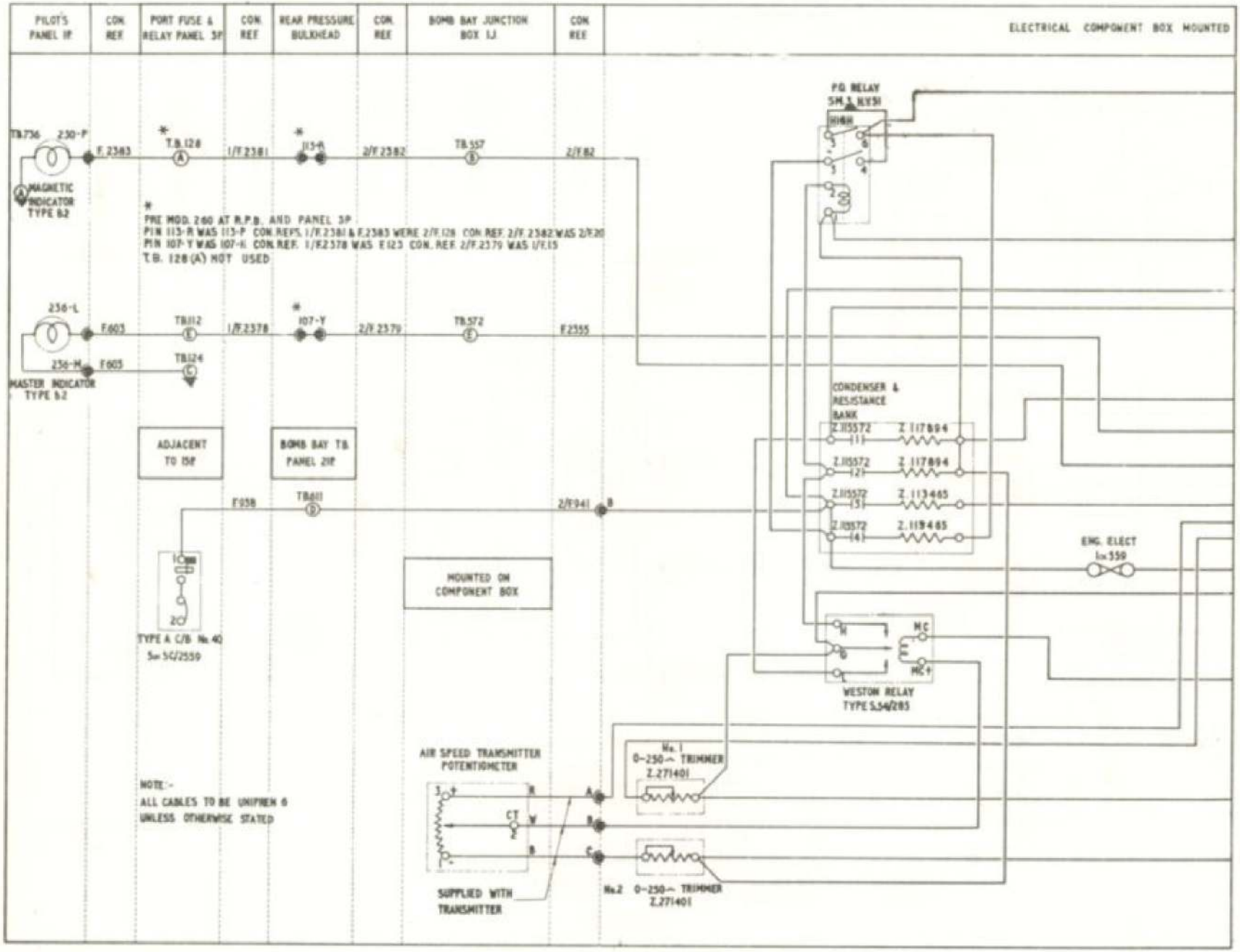

Fig. 28 (1) Elevator artificial feel (pre. Mod. 928 and 1498)

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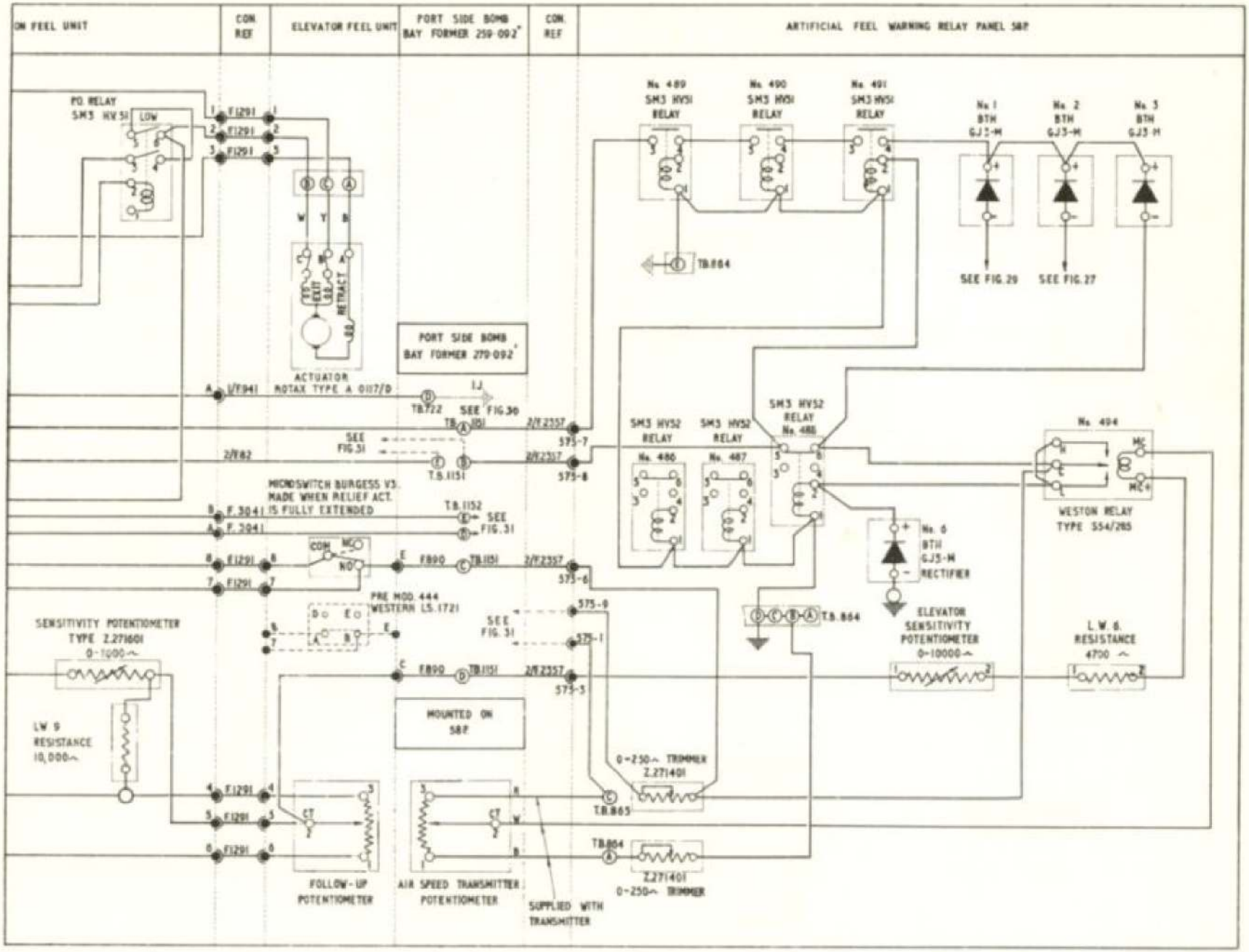

Fig. 28 (2) Elevator artificial feel (pre Mod. 928 and 1498)

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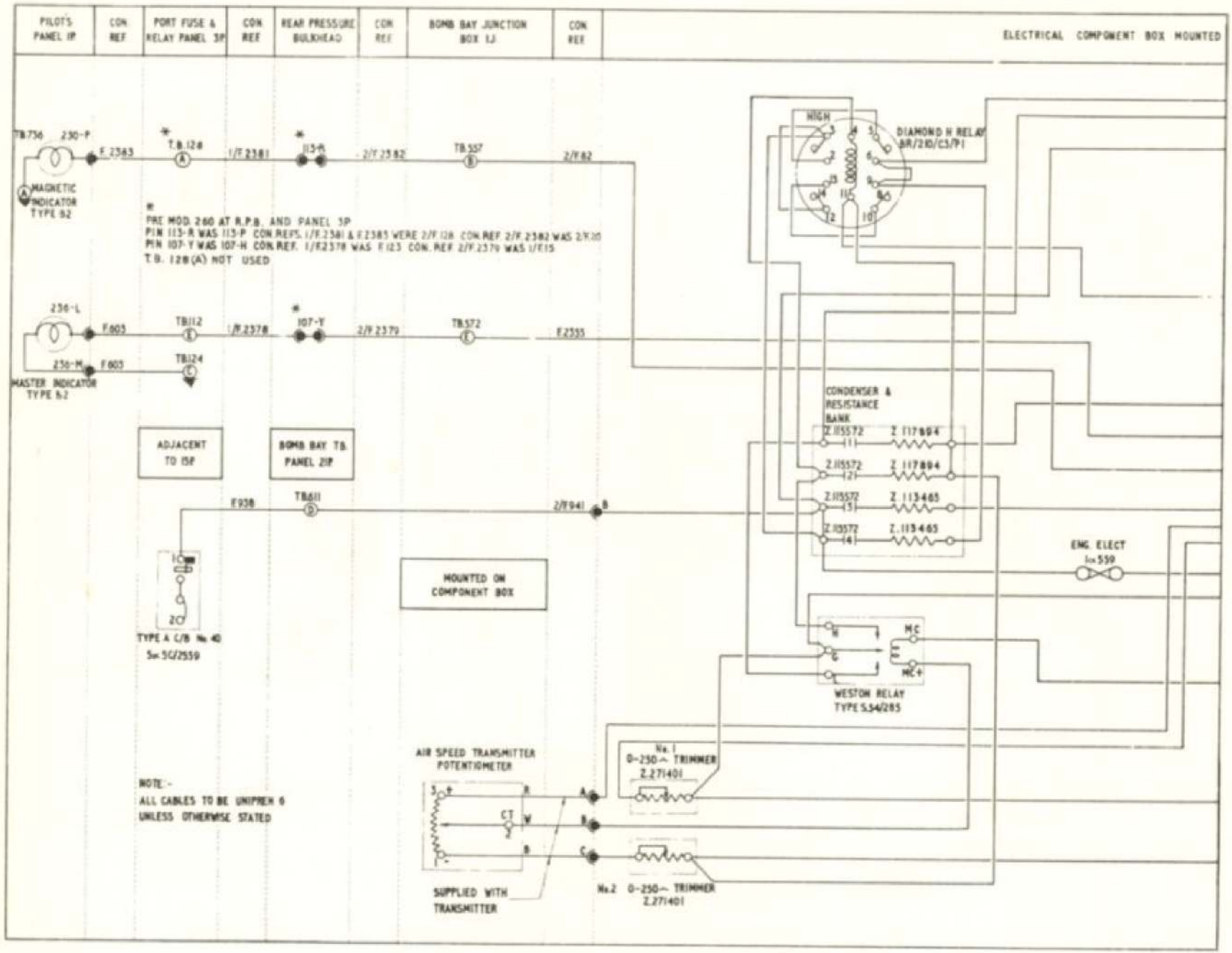

Fig. 28A (1) Elevator artificial feel (pre Mod.1498, post Mod. 928)

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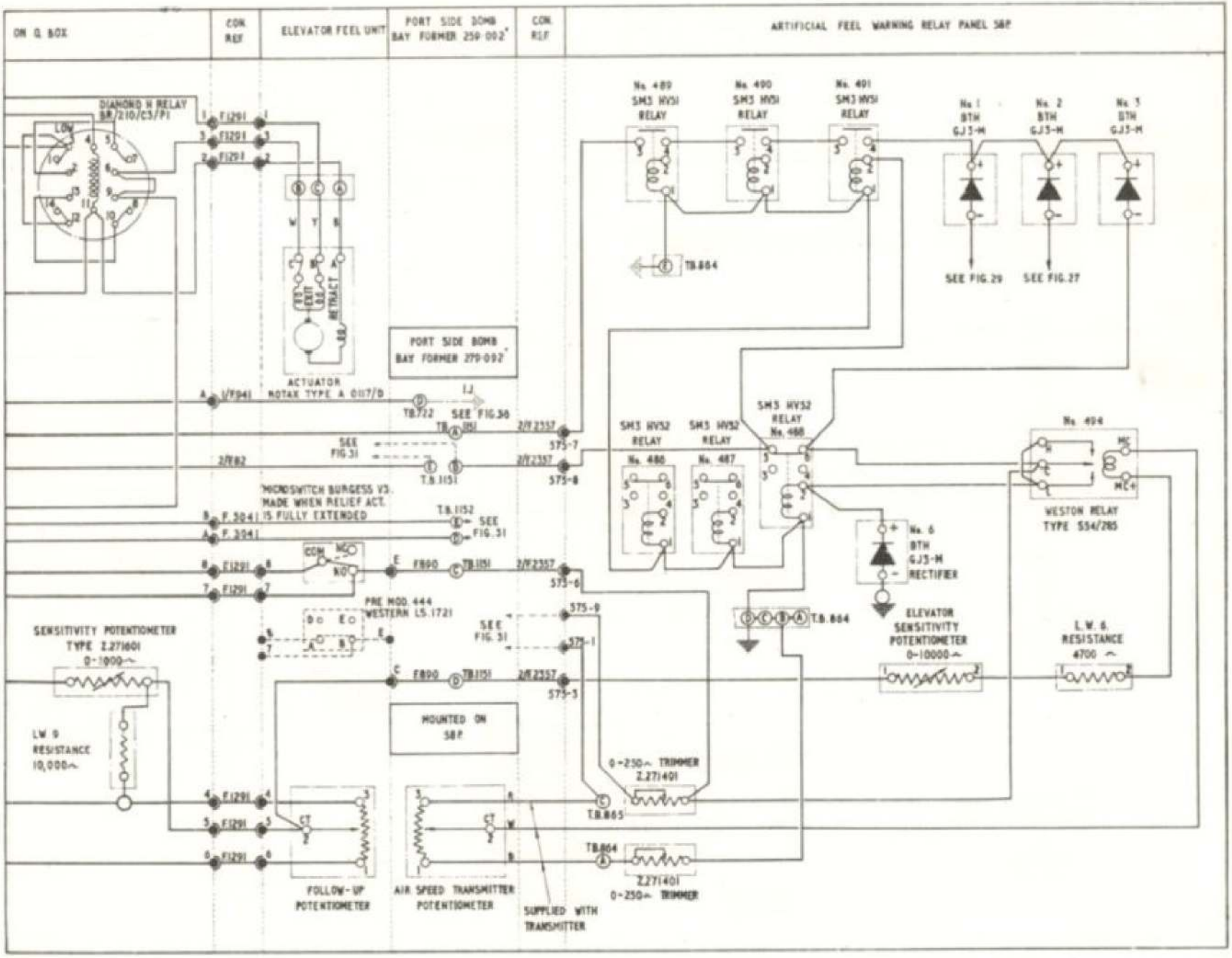

Fig. 28A(2) Elevator artificial feel (pre Mod. 1498, post Mod. 928)

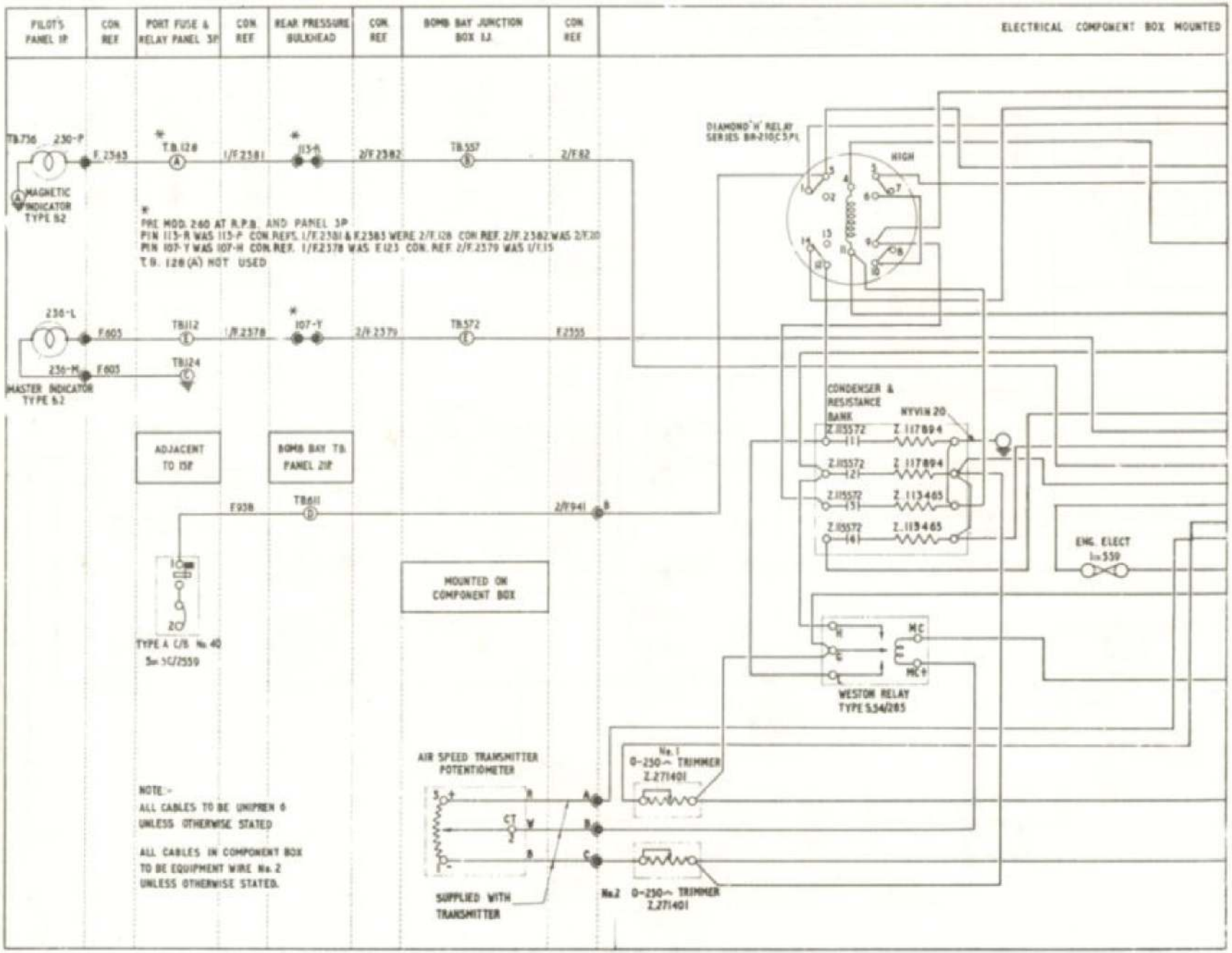

Fig. 28B (1) Elevator artificial feel (post Mod. 928 and 1498)
(◄Mod. 1927►)

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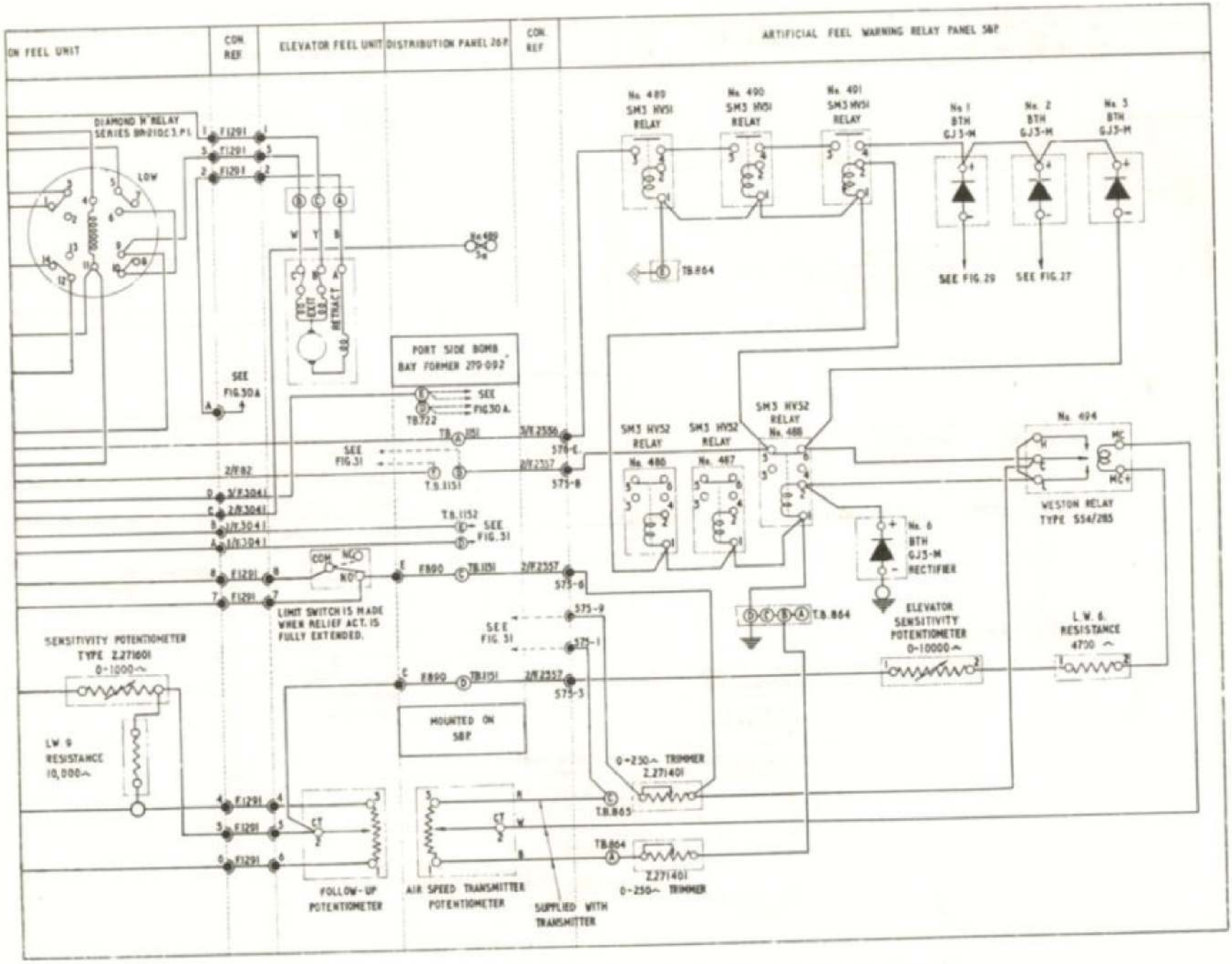

Fig. 28B (2) Elevator artificial feel (post Mod. 928 and 1498)
(◄ Mod. 1927 ►)

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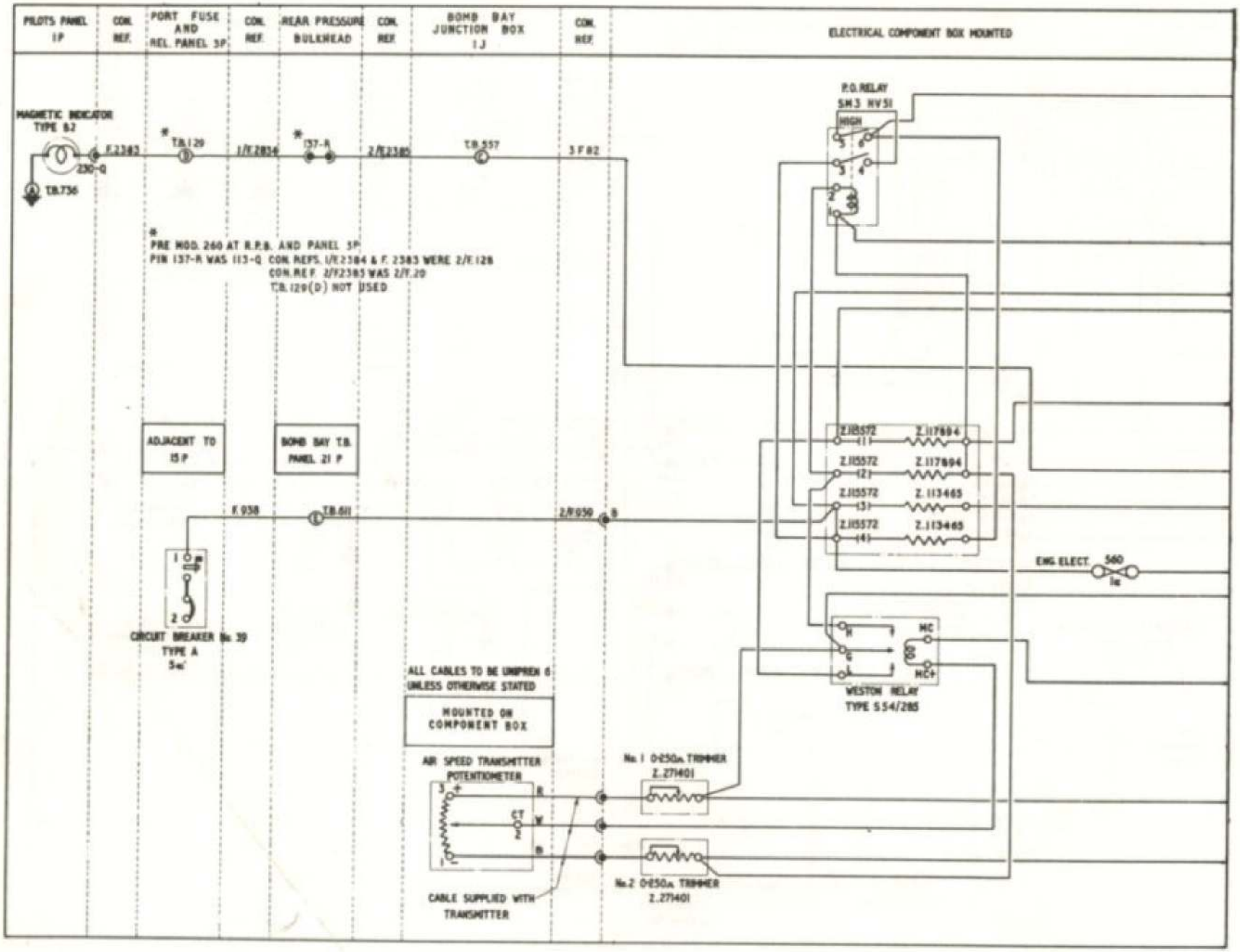

Fig. 29 (1) Rudder artificial feel (pre. Mod. 928 and 1498)

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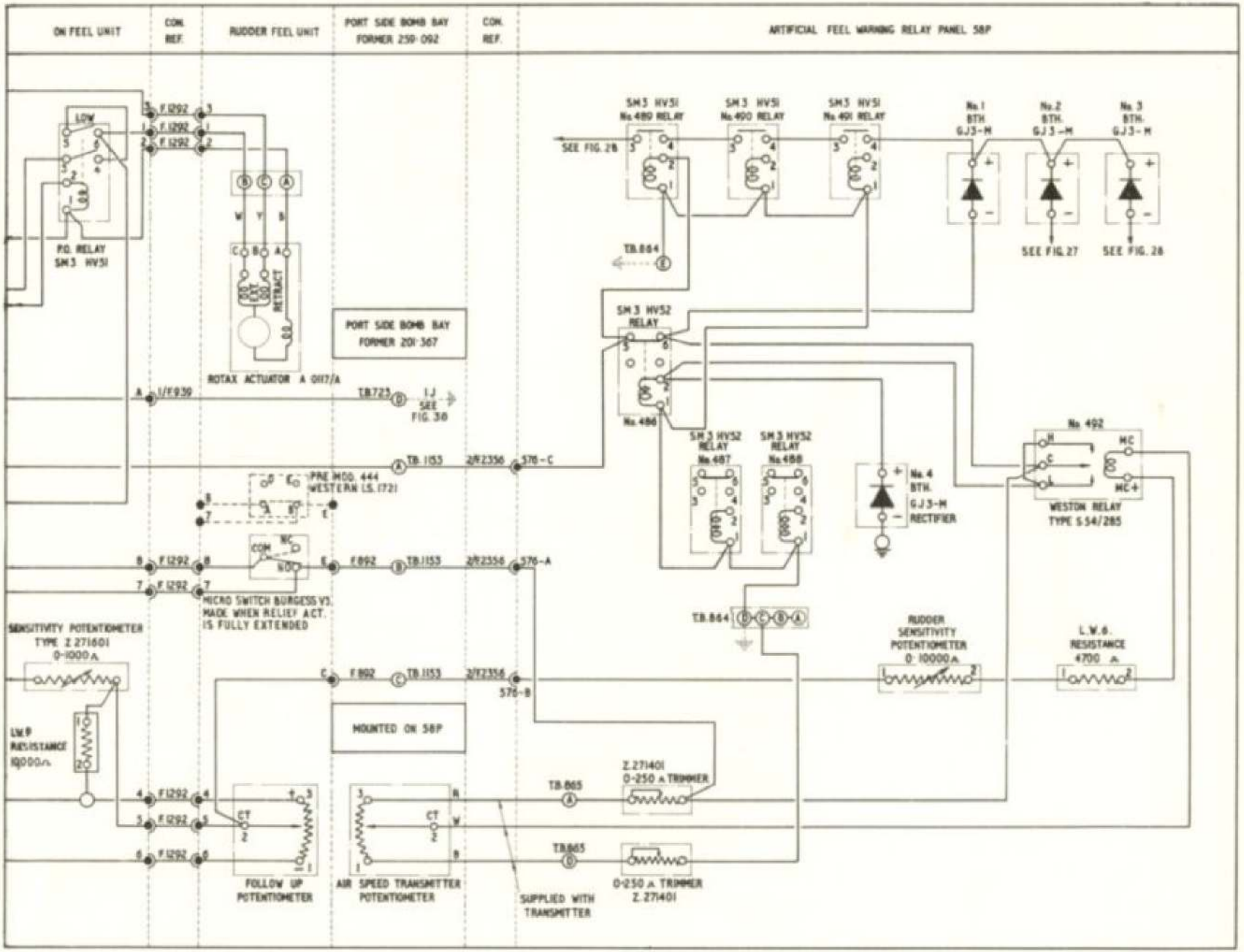

Fig. 29 (2) Rudder artificial feel (pre. Mod. 928 and 1498)

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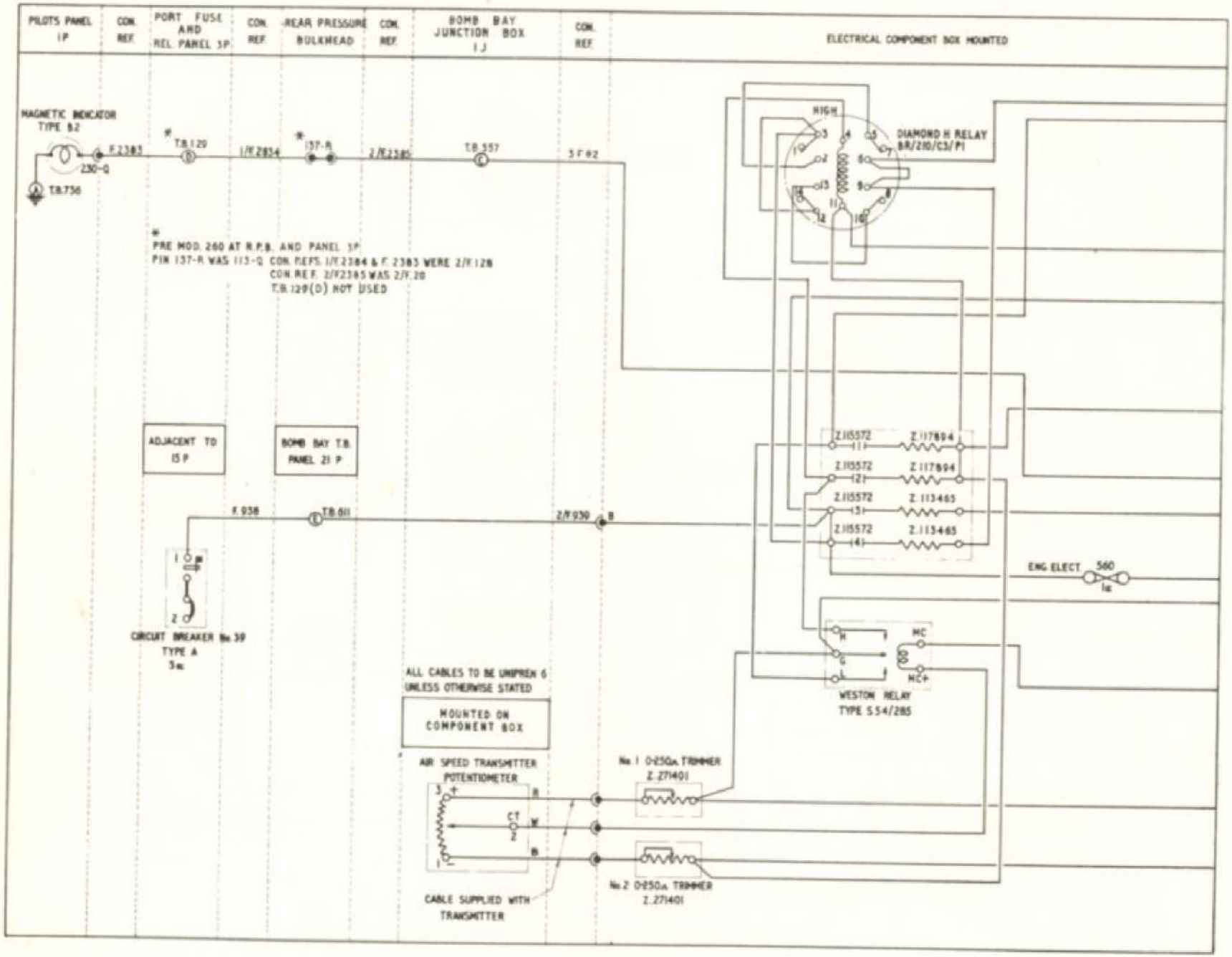

Fig. 29A (1) Rudder artificial feel (pre Mod.1498, post Mod.928)

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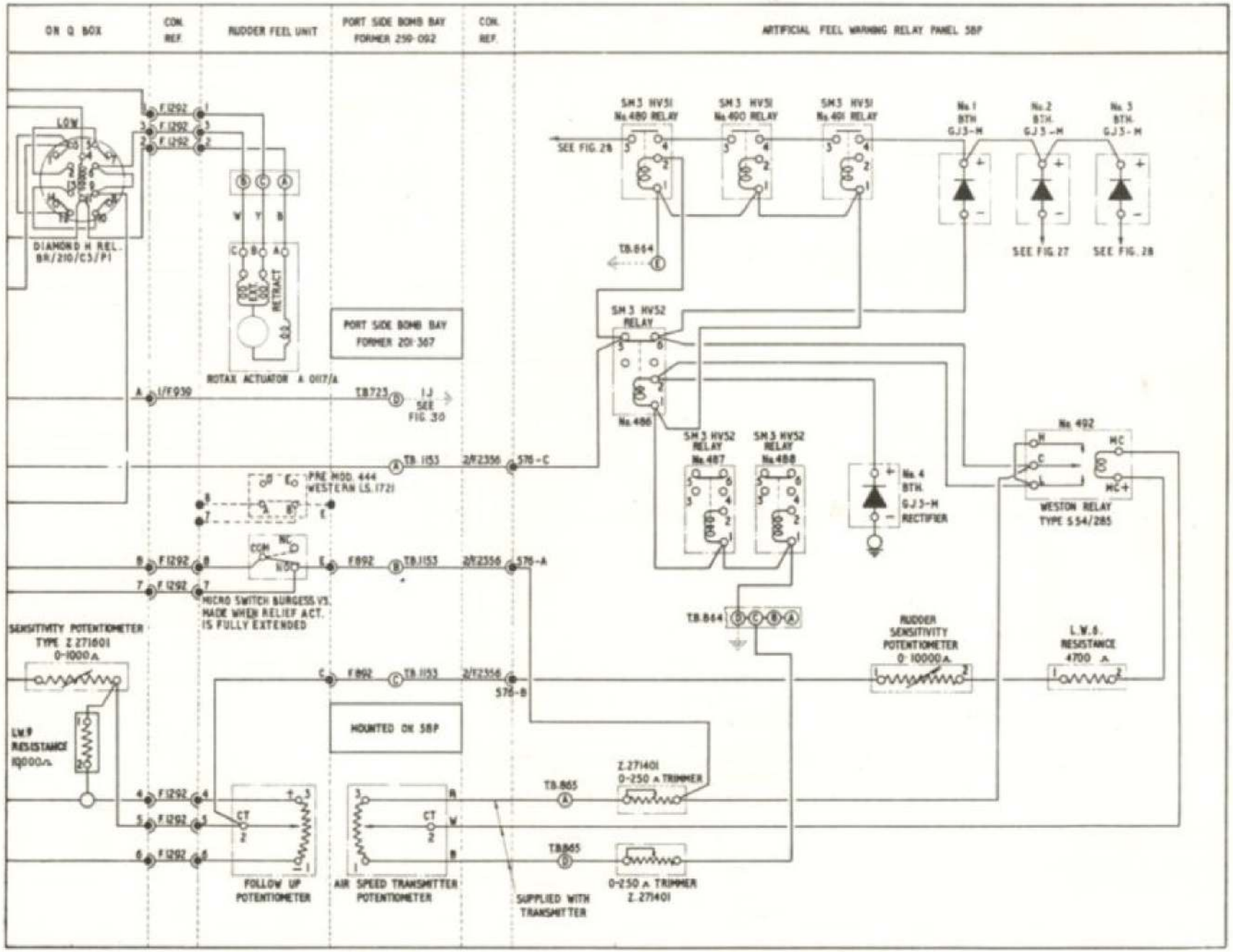

Fig. 29A (2) Rudder artificial feel (pre Mod 1498, post Mod 928)

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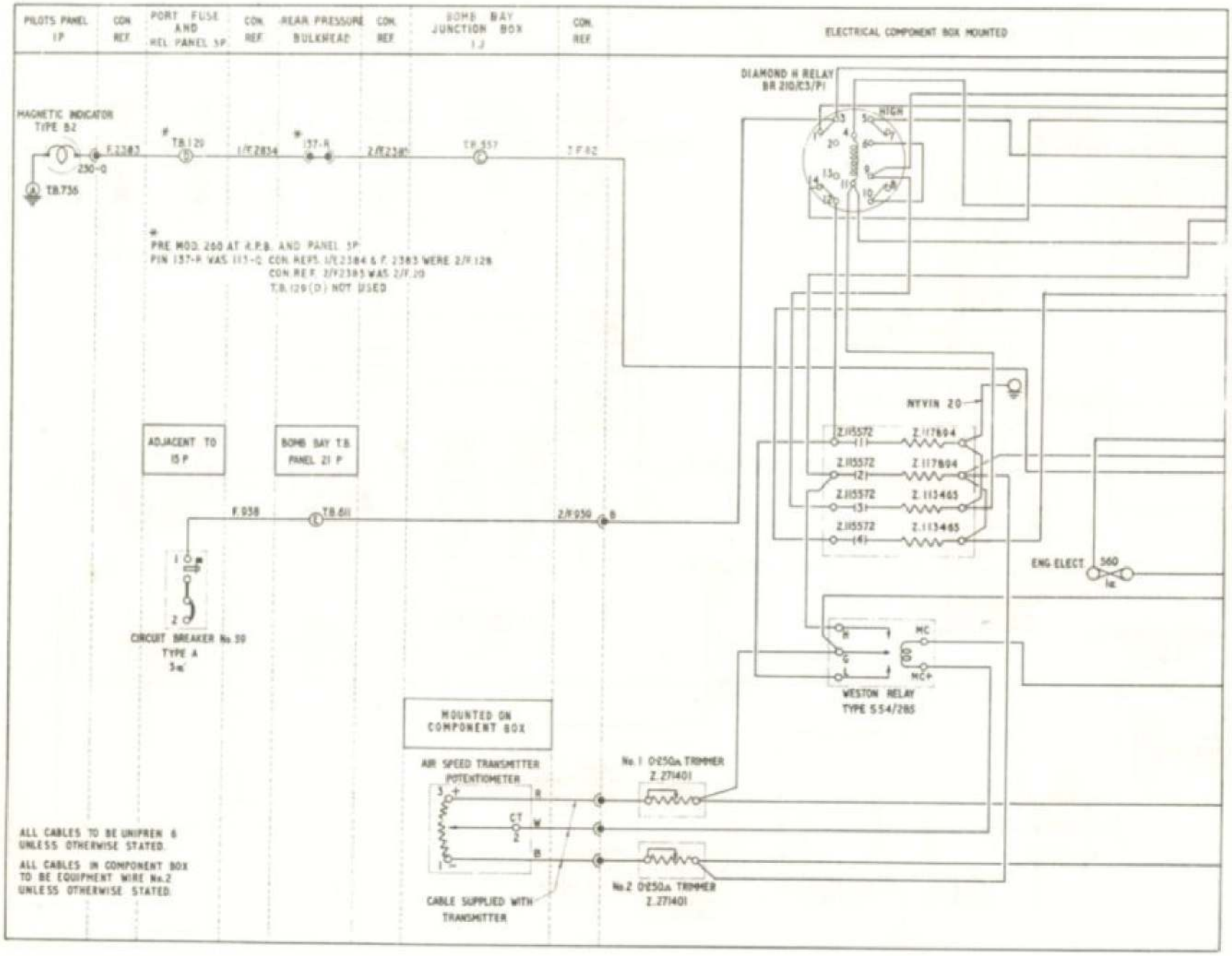

Fig. 29B (1) Rudder artificial feel (post Mod. 928 and 1498)

(◄ Mod. 1927 ►)

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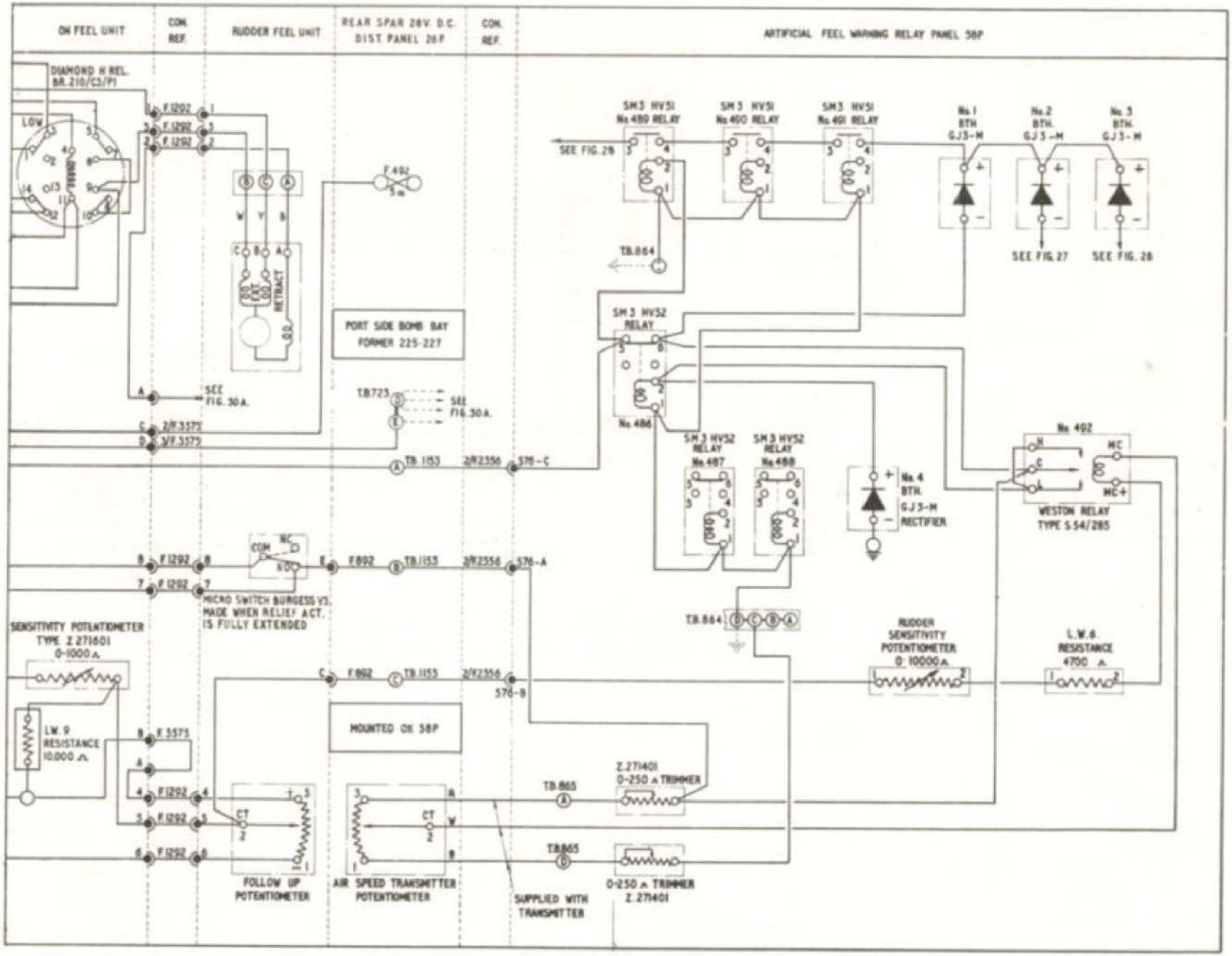

Fig. 29B (2) Rudder artificial feel (post Mod. 928 and 1498)
(◄Mod. 1927►)

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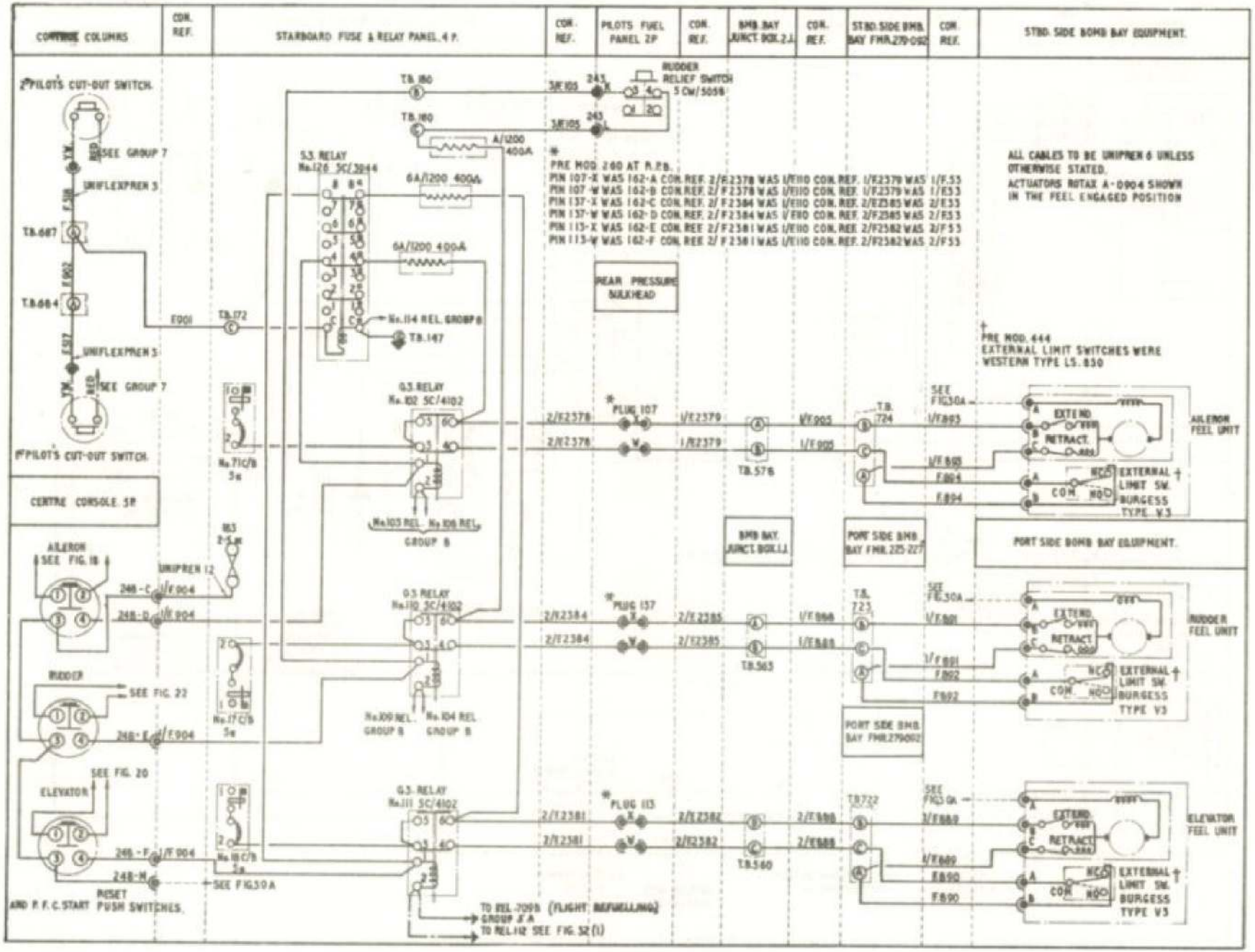

Fig. 30 Artificial feel relief

(◄Mod 1927►)

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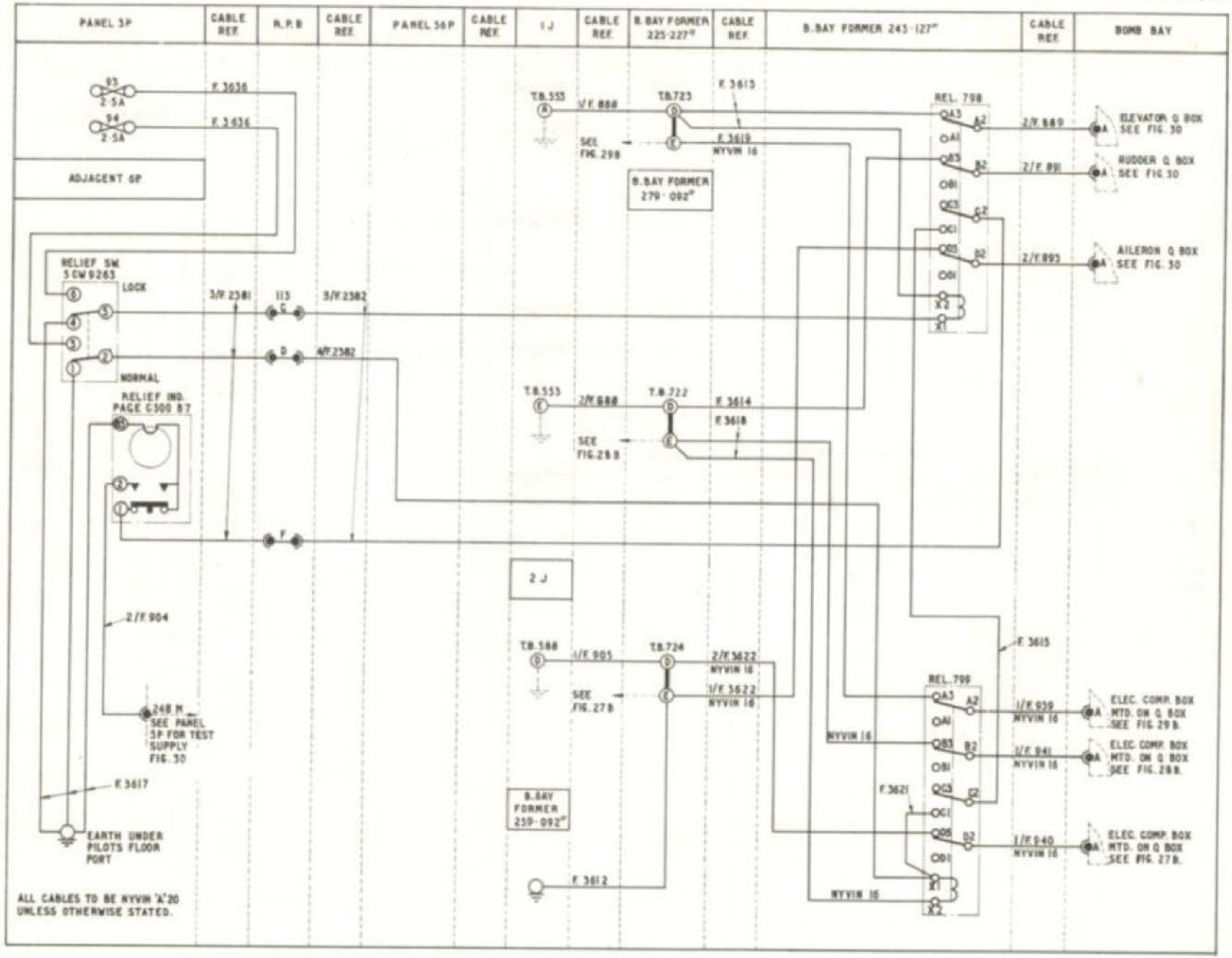

Fig. 30A Artificial feel and feel relief locking.

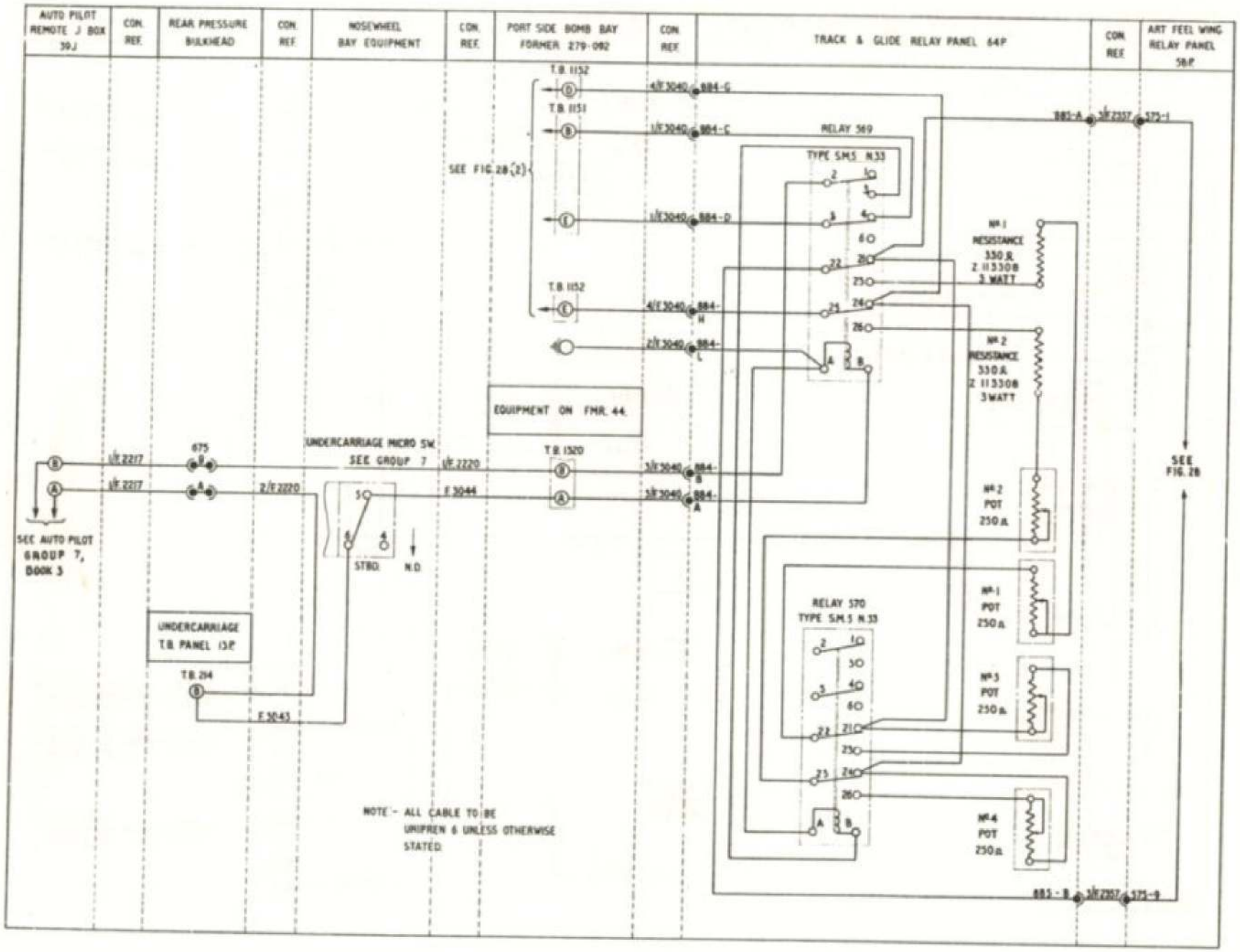

Fig.31 Artificial feel relief with track and glide

(◄ Correction to refs ►)

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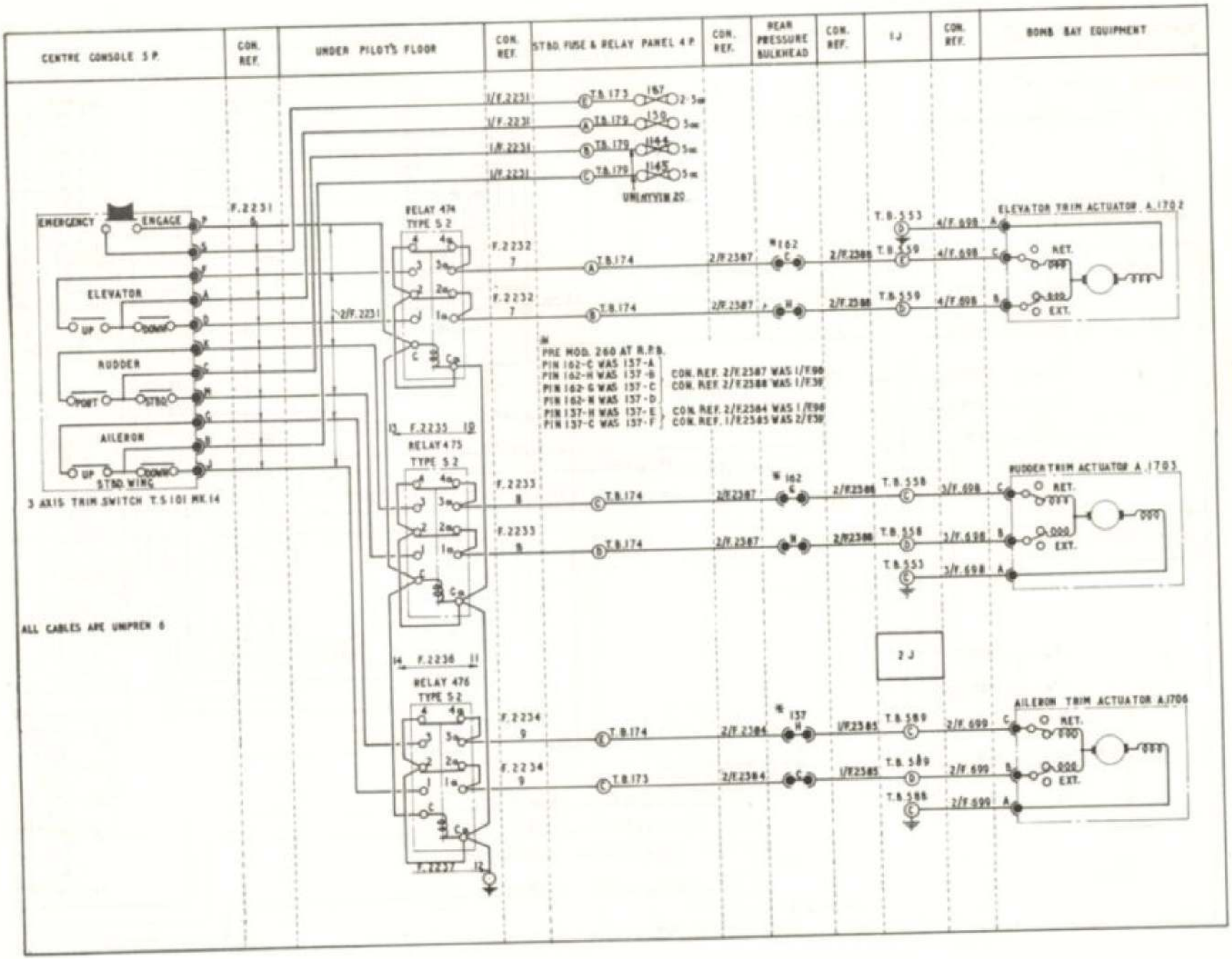

Fig. 32 Emergency trim controls

RESTRICTED

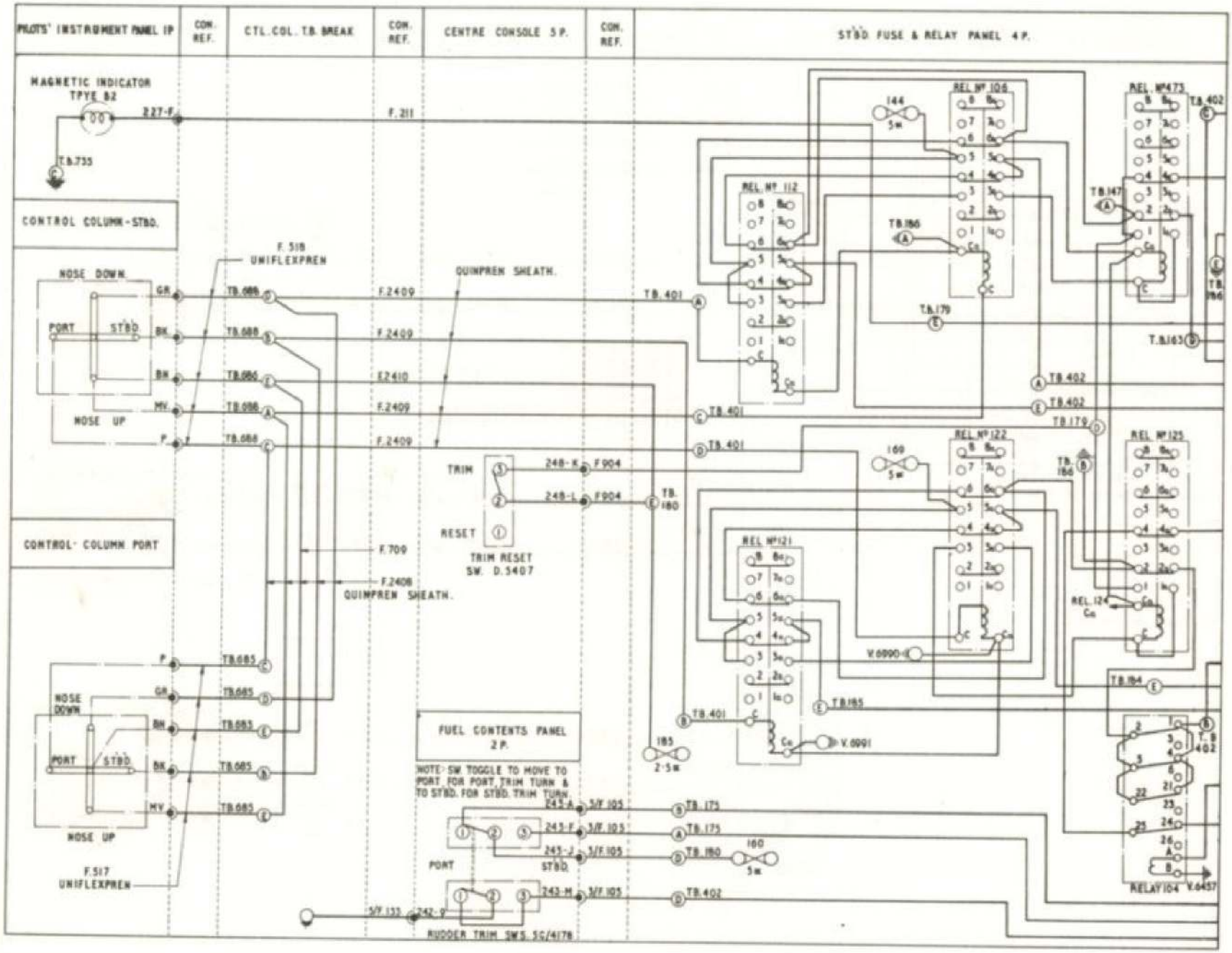

Fig. 33 (1) Normal trim controls

RESTRICTED

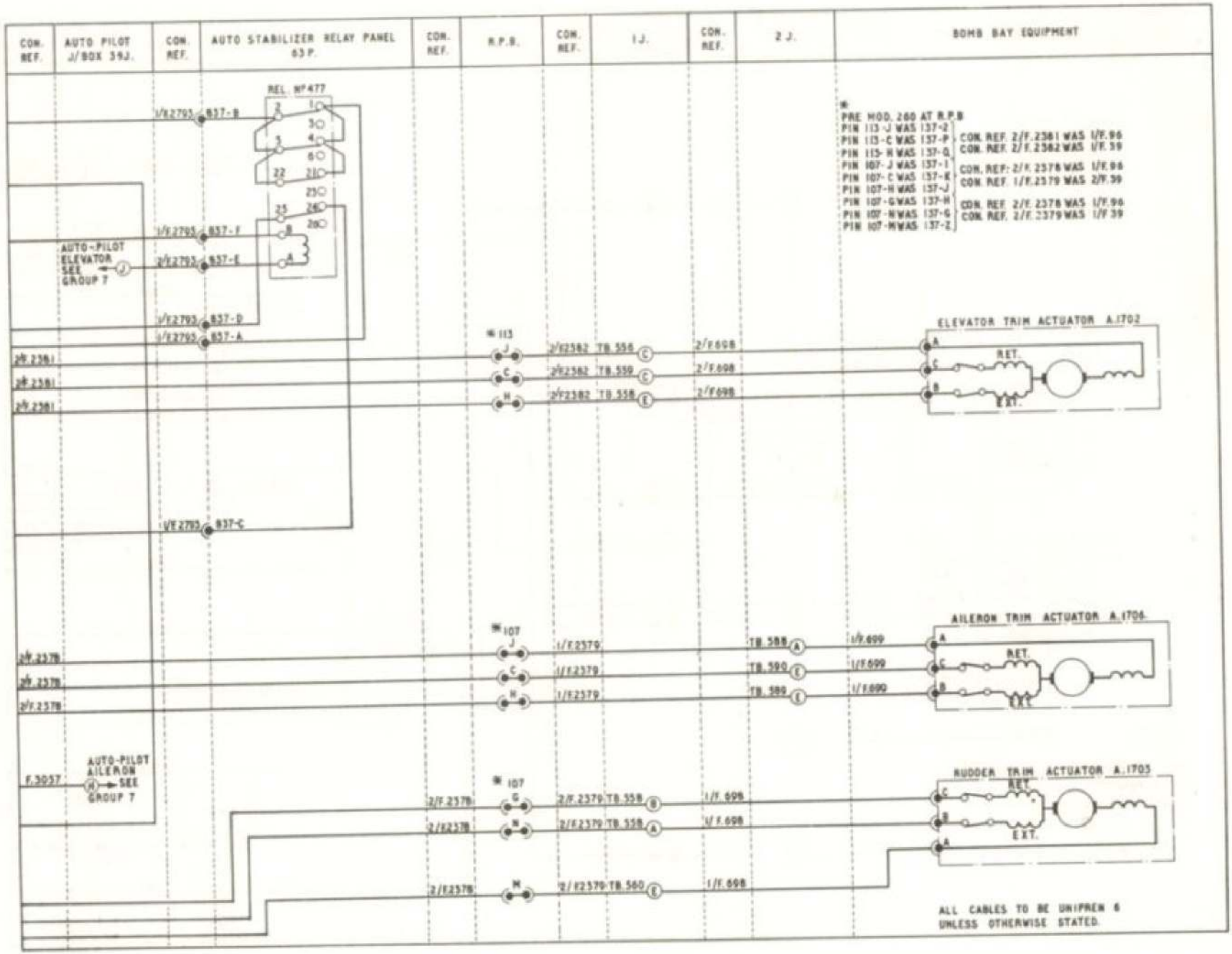

Fig.33 (2) Normal trim controls

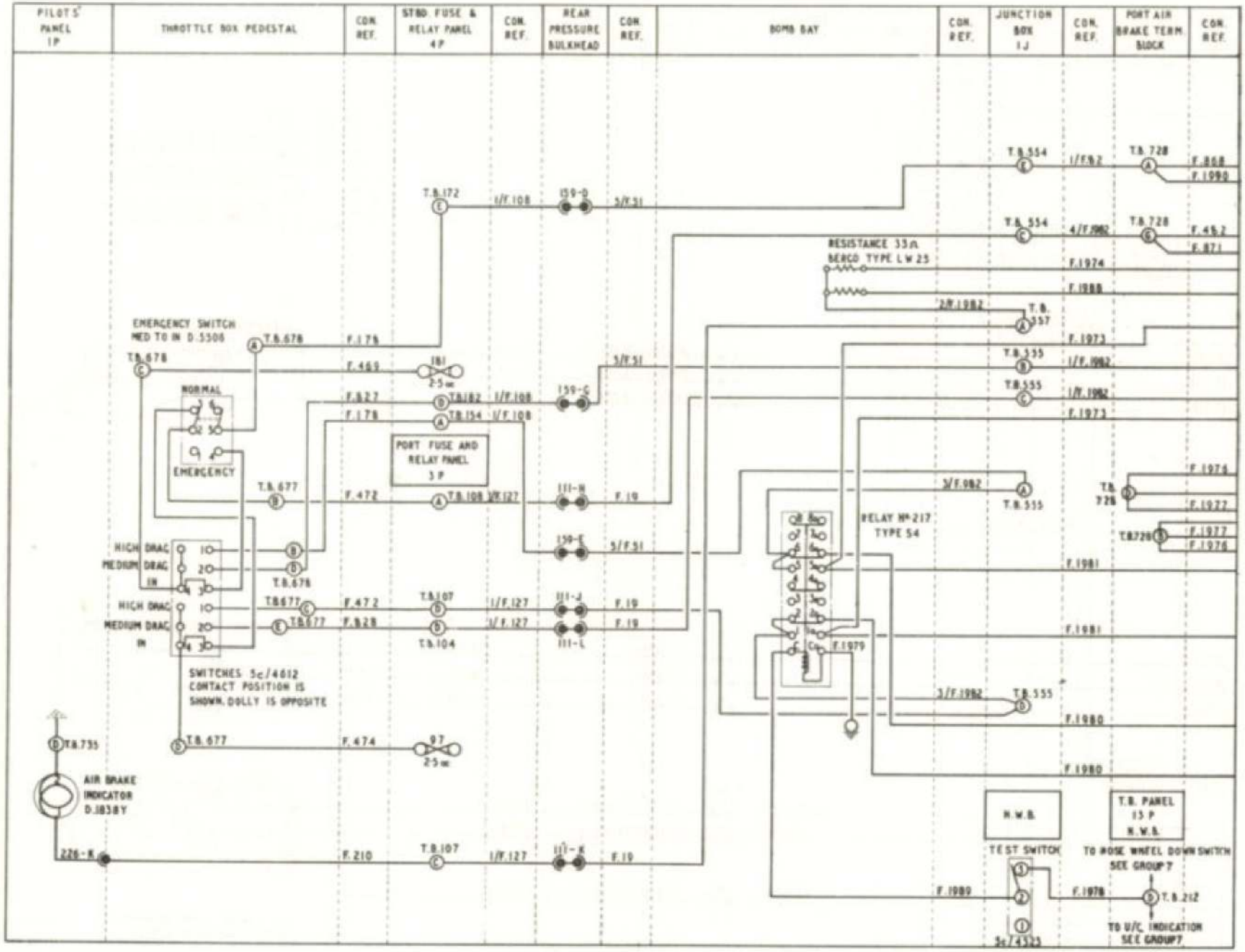

Fig. 34 (1) Air brakes controls (pre. Mod. 593 and 926)

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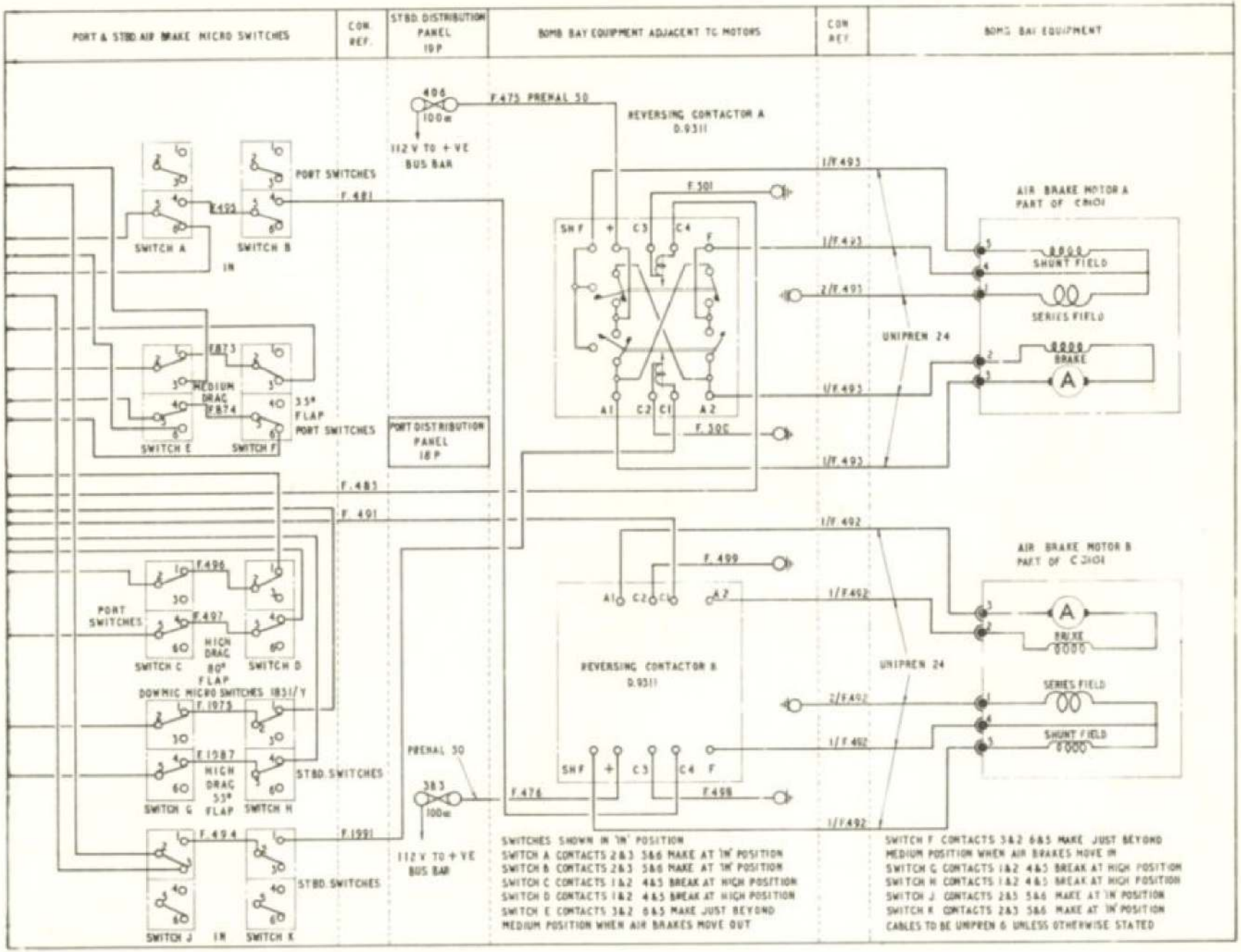

Fig. 34 (2) Air brakes controls (pre. Mod. 593 and 926)

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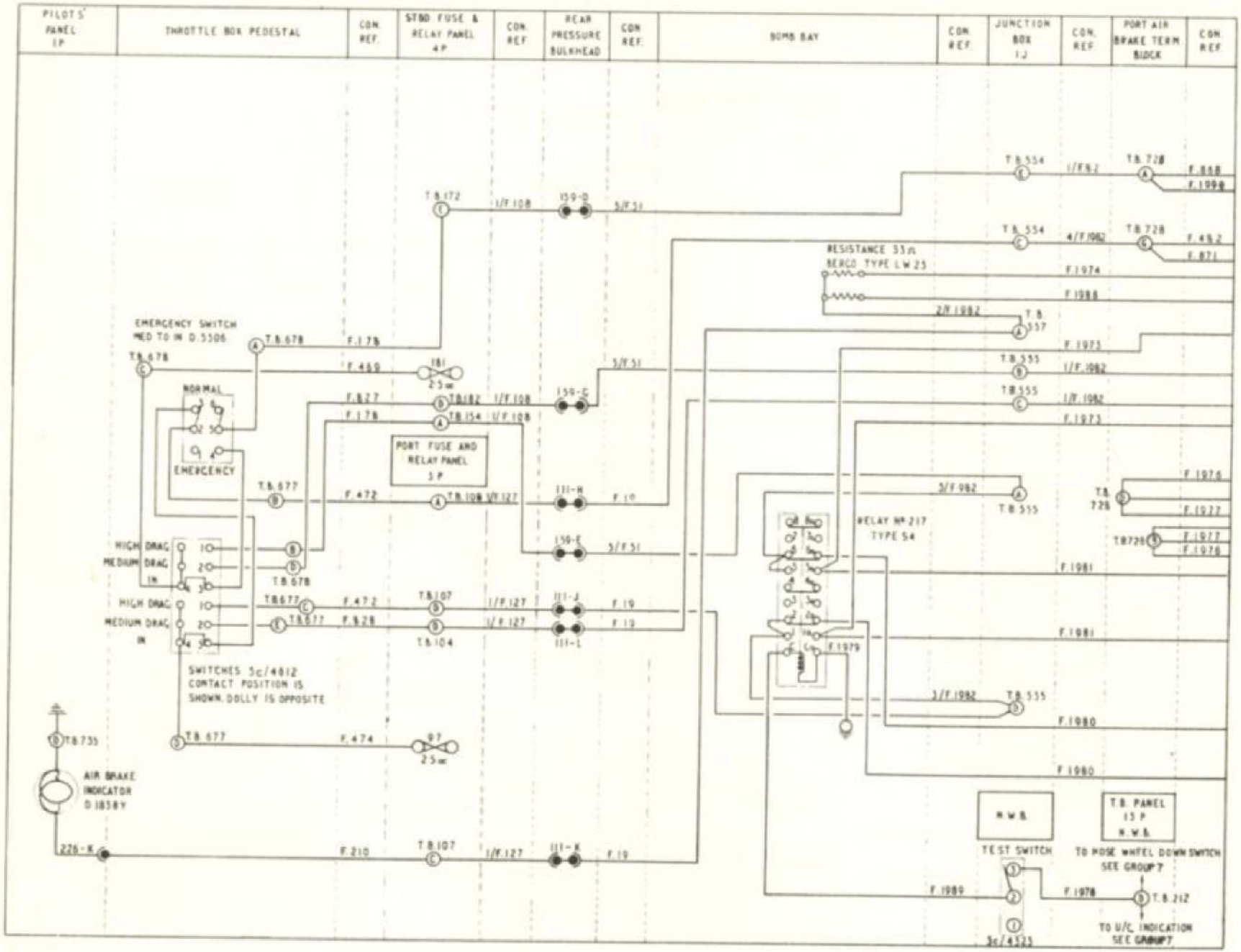

Fig. 35.(1) Air brakes controls (post Mod. 593 and 926)

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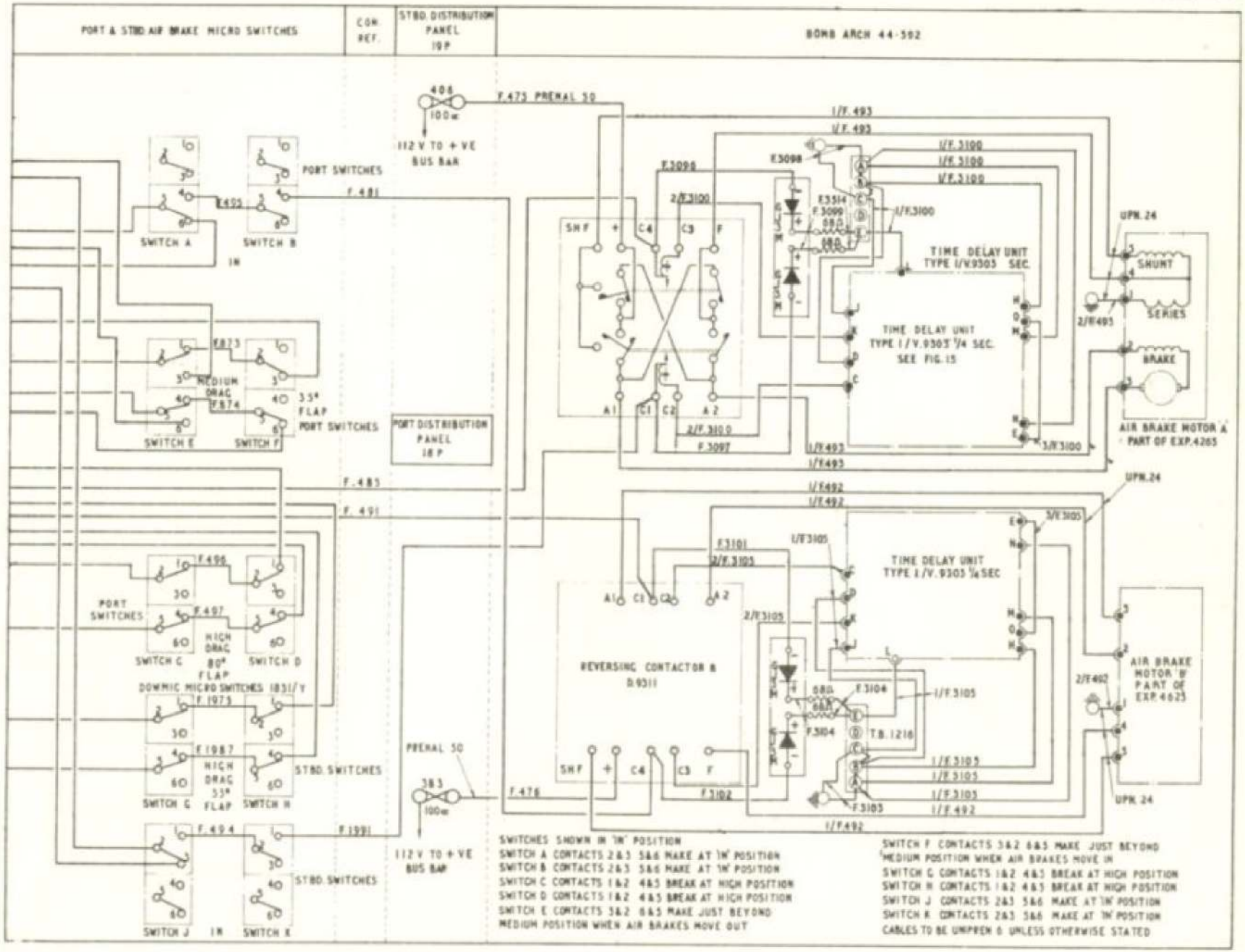

Fig. 35 (2) Air brakes controls (post Mod. 593 and 926)

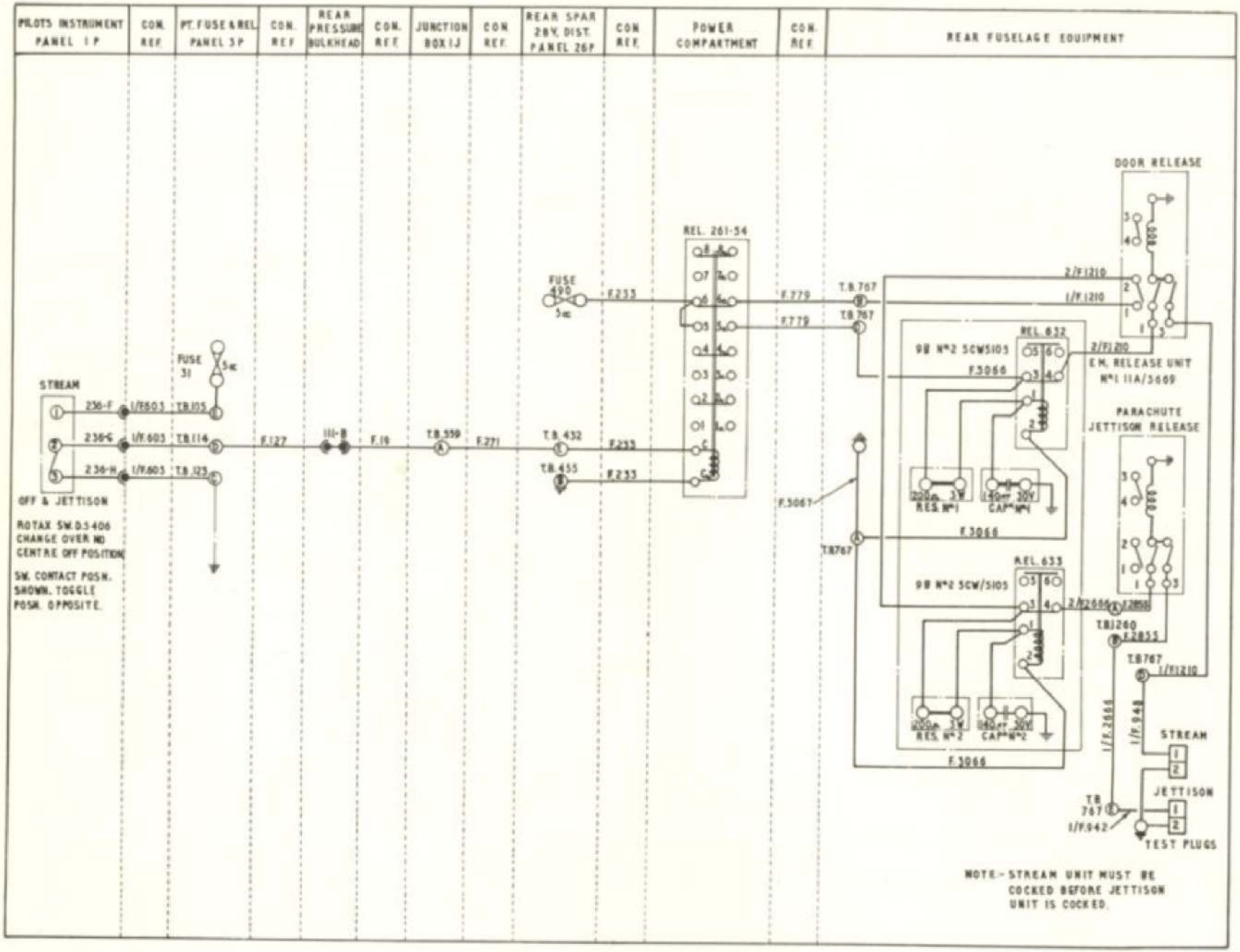

Fig. 36. Parachute stream and jettison