GROUP D.2

ELEVATOR AND AILERON POWER CONTROLS AND HYDRAULIC PRESSURE INDICATOR (CODE PE, PA AND HP)

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Equipment employed

1. The major components employed in the elevator and aileron power controls and hydraulic pressure indicator circuits are quoted below, together with the appropriate Air Publications to which reference should be made for a detailed description and the necessary servicing required to maintain them in an efficient condition.

Elevator and aileron power controls Pre.Mod.686 and 687

Aileron control valve, Type C.5702Y, Mk.A Elevator control valve, Type C.5702Y, Mk.C	A.P.1803D, Vol.1, Book 3, Sect. 8
Control switches, Rotax, Type D.10002	A.P.4343C, Vol.1, Book 1, Sect. 1
Micro-switches, Type 1A, and Type C.1831Y, Mk.2 (Modified to HAWKER Part No.F.230401)	A.P.4343B, Vol.1, Book 1, Sect. 2
Indicators, Type B.2	A.P.4343E, Vol.1, Sect.18
Switches, push button, Type A	A.P.4343C, Vol.1, Book 1, Sect. 1
Standby batteries, 12 volt, 4 amp.hr.	A.P.4343A, Vol.1, Sect.11

Elevator and aileron power controls Post.Mod.686 and 687

◀ Aileron control valve, Type C.5702Y, Mk.A or 08808Y-B0.6 ▶ ◀ Elevator control valve, Type C.5702Y,Mk.C or 08808Y-B.0.7 ▶	A.P.1803D, Vol.1, Book 3, Sect. 8
◀ Power control switch, D.P./C.O. Type XD.789 No.4 ▶	A.P.4343C, Vol.1, Book 1, Sect. 1
Pressure switches, Type T.P.5566	A.P.1275A, Vol.1, Sect.11
Indicators Type B.2	A.P.4343E, Vol.1, Sect.18

Hydraulic pressure audio warning and indicator

Lamp, Type B	A.P.4343E, Vol.1, Sect.18
Pressure switch Type T.P.5555	A.P.1275A, Vol.1, Sect.11
Relay, Type Q, No.3	A.P.4343C, Vol.1, Book 2, Sect. 3
Audio warning cut-out switch, single-pole, change-over, spring return one side (Ref. No.5CW/5829)	A.P.4343C, Vol.1, Book 1, Sect. 1

DESCRIPTION

Elevator and aileron power controls

Pre.Mod.686 and 687

2. The electrical circuits for the elevator and aileron power-operated controls incorporate a special "fail safe" feature as described in paragraph 10. The controls consist of two spring-return, 3-position ON/OFF selector switches, one of which is mounted on the centre instrument panel to control the elevator electro-hydraulic selector valve and the other, located on the port instrument panel, to control the aileron selector valve.

Electro-hydraulic valves

3. The elevator selector valve is located between frames 54 and 55 in the rear fuselage lower fin structure. The aileron selector valve is mounted on the front spar in the starboard wheel bay. These valves control the supply of hydraulic power to the elevator booster jack and release unit, located between frames 52 and 55 in the rear fuselage lower fin structure, and to the aileron booster jacks and release units, located one in each outer wing.

Control indicators

4. Two magnetic indicators, located one on the port instrument panel and the other on the centre instrument panel, are provided to indicate when the elevator and aileron booster jacks are disengaged, due either to operation of the selector switches or to a hydraulic or electrical failure. These indicators, which are separately fused, are controlled by micro-switches operated by the release units on each booster jack.

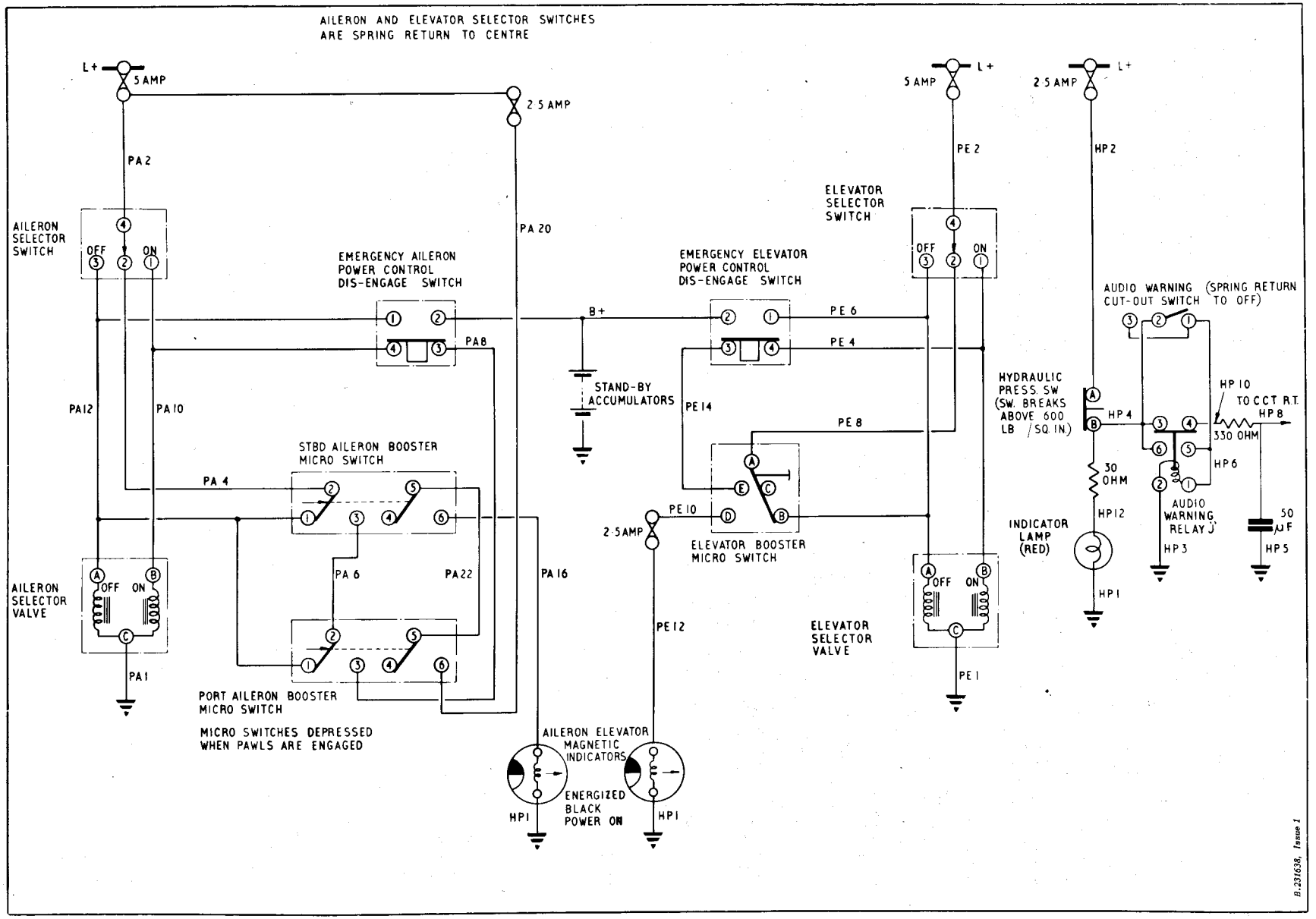

Fig. 1 Elevator and aileron power controls and hydraulic indicator (theoretical) Pre-Mod. 686 and 687

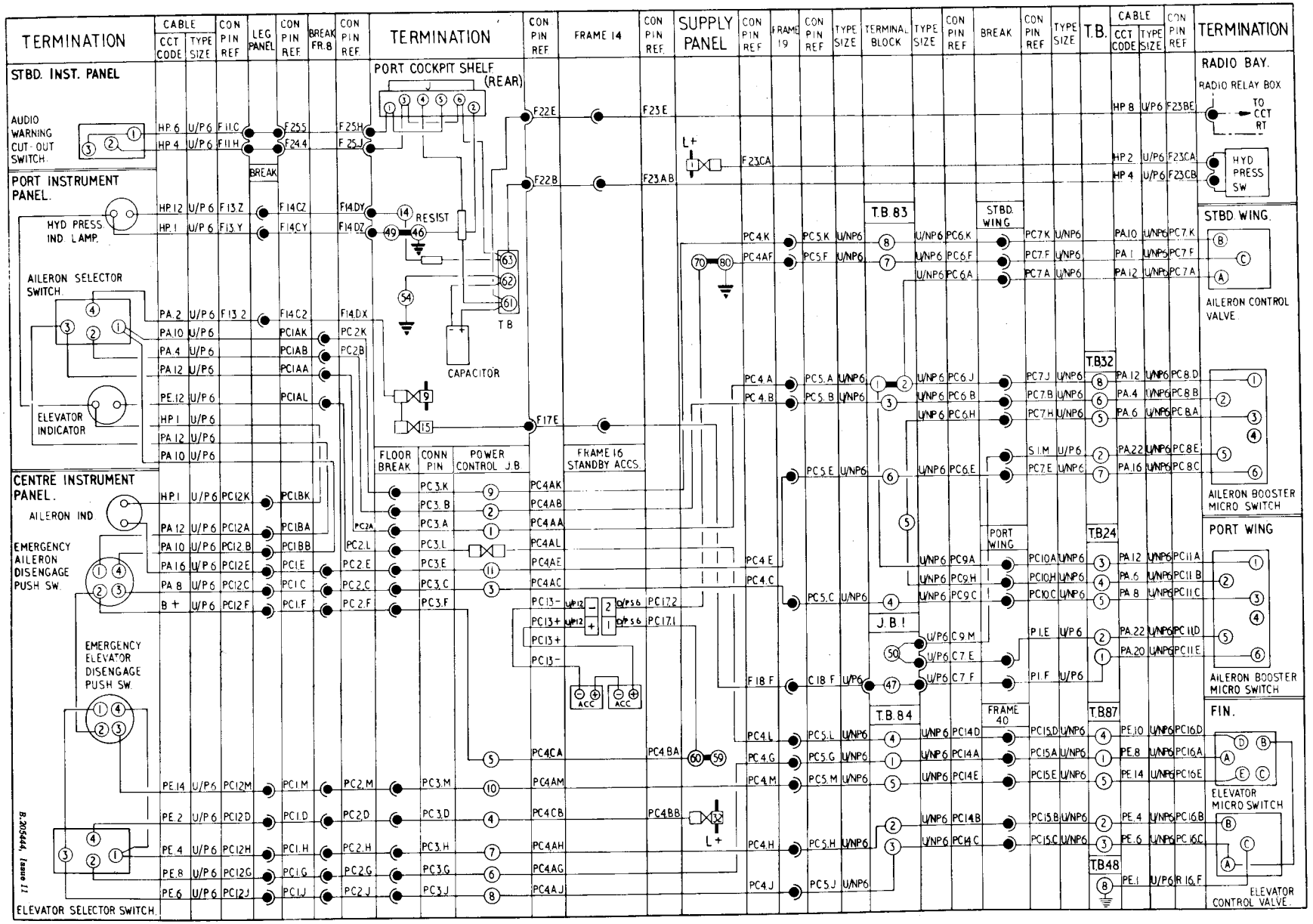

Fig.2 Elevator and aileron power controls and hydraulic indicator (routing) Pre-Mod.686 and 687

T.P.(E) 8009

RESTRICTED

Emergency disengage

5. In addition to the two selector switches, two emergency power control disengage push-switches are also provided on the centre instrument panel for use in conjunction with two, series connected, standby batteries *(Group B.1)* when it is required to disengage the power controls after electrical system failure. For a full description of the elevator and aileron power controls, reference should be made to Section 3, Chapter 4, of this volume.

Operation

Power on

6. As the operation of the elevator and aileron power control electrical circuits are similar, only the function of the aileron circuit will be described. When the aileron selector switch is held in the ON position, current will be fed through the switch and energize the ON solenoid of the aileron electro-hydraulic selector valve. When this solenoid is energized, it allows the hydraulic supply pressure to move the slide valve within the selector in such a direction as to supply hydraulic pressure to the aileron booster jack servo valves and release units.

7. As the control column is moved from side to side, to engage the pawls of the release units with the booster jack rams, the booster unit micro-switches will be operated. This allows a power supply to be fed via the ON/OFF switch, which must still be held in the ON position, through the normally closed contacts of the emergency aileron power control disengage push-switch, and via contacts 3 and 2 of the micro-switches, to the centre contact of the aileron selector switch. Contacts 5 and 6 of each micro-switch are wired in series and a supply is fed through these closed contacts to the aileron magnetic indicator which when energized shows BLACK indicating both pawls engaged. The selector switch may now be released and allowed to return to the centre position under the spring return action.

8. Current will now pass across contacts 4 and 2 of the switch to the micro-switches and through them to the normally closed contacts of the emergency aileron disengage switch to maintain the ON solenoid of the aileron selector valve in an energized state throughout flight.

9. Hydraulic power is now engaged and movement of the control column will open one of two orifices in the servo valves. The orifice which is opened depends upon the direction in which the control column is moved. Hydraulic pressure will then be directed to one side of the booster jack rams and this pressure will move the booster jack bodies. These, being in connection with the ailerons will move the ailerons in the required direction.

Fail safe

10. When the selector switch is in the centre, that is in the safe position, the electro-hydraulic selector valve is maintained in the energized state by a feed from the centre contact of the selector switch, through contacts 2 and 3 of the two micro-switches and the emergency disengage push-switch. The magnetic indicator is also maintained in the energized state by a feed, via contacts 5 and 6 of the series connected micro switches. This forms the fail safe feature of the circuit, for example, should the port release unit pawl disengage from the booster jack ram, for any reason, its micro-switch will operate to break the supplies to the ON solenoid of the selector valve and the magnetic indicator. A supply to the OFF solenoid will then be made via contacts 1 and 2 of the micro switch, causing the starboard release units pawl to disengage immediately from its booster jack ram and operate its micro-switch. Current is now fed to the OFF solenoid of the selector valve across contacts 2 and 1 of the starboard micro-switch so by-passing the port micro-switch.

11. A similar series of operations takes place should the starboard release units pawl disengage first. It will be seen, therefore, that this safety feature renders it impossible for only one pawl to engage or a false anchorage to occur.

Emergency disengage

5. In addition to the two selector switches, two emergency power control disengage push-switches are also provided on the centre instrument panel for use in conjunction with two, series connected, standby batteries *(Group B.1)* when it is required to disengage the power controls after electrical system failure. For a full description of the elevator and aileron power controls, reference should be made to Section 3, Chapter 4, of this volume.

Operation

Power on

6. As the operation of the elevator and aileron power control electrical circuits are similar, only the function of the aileron circuit will be described. When the aileron selector switch is held in the ON position, current will be fed through the switch and energize the ON solenoid of the aileron electro-hydraulic selector valve. When this solenoid is energized, it allows the hydraulic supply pressure to move the slide valve within the selector in such a direction as to supply hydraulic pressure to the aileron booster jack servo valves and release units.

7. As the control column is moved from side to side, to engage the pawls of the release units with the booster jack rams, the booster unit micro-switches will be operated. This allows a power supply to be fed via the ON/OFF switch, which must still be held in the ON position, through the normally closed contacts of the emergency aileron power control disengage push-switch, and via contacts 3 and 2 of the micro-switches, to the centre contact of the aileron selector switch. Contacts 5 and 6 of each micro-switch are wired in series and a supply is fed through these closed contacts to the aileron magnetic indicator which when energized shows BLACK indicating both pawls engaged. The selector switch may now be released and allowed to return to the centre position under the spring return action.

8. Current will now pass across contacts 4 and 2 of the switch to the micro-switches and through them to the normally closed contacts of the emergency aileron disengage switch to maintain the ON solenoid of the aileron selector valve in an energized state throughout flight.

9. Hydraulic power is now engaged and movement of the control column will open one of two orifices in the servo valves. The orifice which is opened depends upon the direction in which the control column is moved. Hydraulic pressure will then be directed to one side of the booster jack rams and this pressure will move the booster jack bodies. These, being in connection with the ailerons will move the ailerons in the required direction.

Fail safe

10. When the selector switch is in the centre, that is in the safe position, the electro-hydraulic selector valve is maintained in the energized state by a feed from the centre contact of the selector switch, through contacts 2 and 3 of the two micro-switches and the emergency disengage push-switch. The magnetic indicator is also maintained in the energized state by a feed, via contacts 5 and 6 of the series connected micro switches. This forms the fail safe feature of the circuit, for example, should the port release unit pawl disengage from the booster jack ram, for any reason, its micro-switch will operate to break the supplies to the ON solenoid of the selector valve and the magnetic indicator. A supply to the OFF solenoid will then be made via contacts 1 and 2 of the micro switch, causing the starboard release units pawl to disengage immediately from its booster jack ram and operate its micro-switch. Current is now fed to the OFF solenoid of the selector valve across contacts 2 and 1 of the starboard micro-switch so by-passing the port micro-switch.

11. A similar series of operations takes place should the starboard release units pawl disengage first. It will be seen, therefore, that this safety feature renders it impossible for only one pawl to engage or a false anchorage to occur.

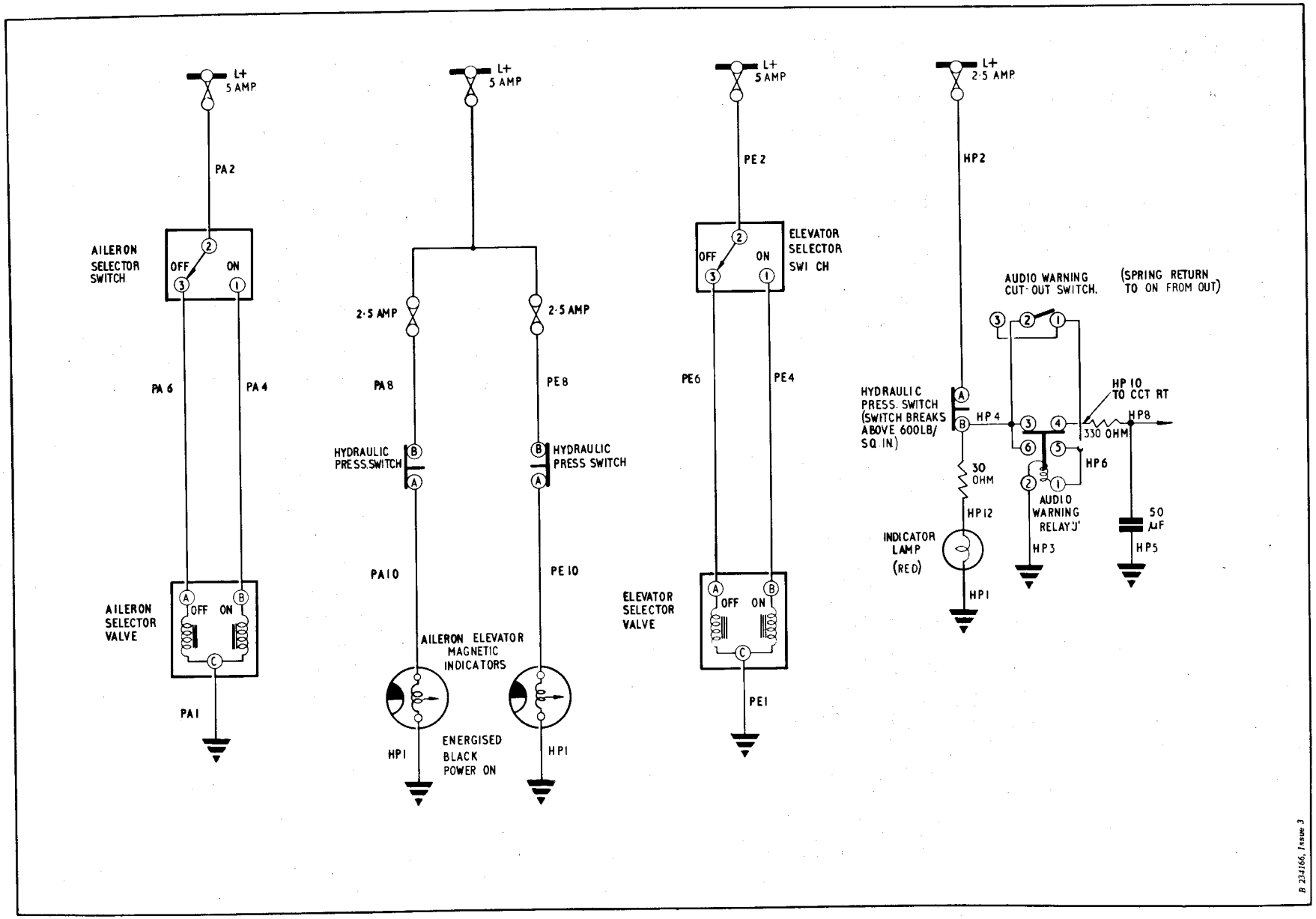

Fig.3 Elevator and aileron power controls and hydraulic indicator (theoretical) Post Mod.686 and 687

RESTRICTED

Power off

12. When the aileron selector switch is held in the OFF position, current will be fed through the switch and energize the OFF solenoid of the aileron electro-hydraulic selector valve. When the OFF solenoid is energized, it allows the hydraulic supply pressure to move the slide valve within the selector in such a direction as to cut off the hydraulic pressure to the booster jack servo valves and release units. The slide valve movement also allows the pressure in these units to flow back into the return line. As the pressure in the release units discharges into the return line, the release unit pawls disengage from the booster jack rams.

13. While disengaging, the release units operate the micro switches, which in turn de-energize the aileron magnetic indicator, thus indicating that the power is disengaged and manual effort alone must be used to move the ailerons. When the power controls have disengaged, the selector switch may be released and allowed to return to the centre, safe position. The OFF solenoid will be maintained in the energized state by a feed from the centre contact of the switch, through contacts 2 and 1 of the starboard micro-switch which are made while the release units are disengaged.

Hydraulic failure

14. In the event of hydraulic failure, the hydraulic pressure indicator lamp will illuminate and the audio warning system operate to indicate that only a limited number of power operations of the controls are available from the hydraulic accumulator in the system. When the accumulator is exhausted, the booster jacks will be automatically disengaged and the release units will operate the micro-switches to de-energize the ON solenoid of the electro-hydraulic selector valve and the magnetic indicator. At the same time, to prevent hydraulic pressure from being trapped in the booster jacks, the OFF solenoid of the selector valve will be energized. This is achieved by a feed from the centre contact of the selector switch, through the contacts of the starboard release unit micro switch, which are made when the release unit is disengaged from the booster jack ram.

Electrical failure

15. In the event of an electrical failure, the normal selector switch will be ineffective and both the solenoids of the electro-hydraulic selector valve and the magnetic indicator will be de-energized. In these circumstances it will be impossible to disengage the power controls by use of the normal selector switch. Pressing the emergency power control disengaged push-switch will, however, bring the standby batteries into circuit and energize the OFF solenoid of the selector valve. The power controls now disengage, in a manner similar to that described in para.10. When the power controls have disengaged, the disengage push-switch may be released, as the selector valve will remain in the OFF position automatically once this condition is selected.

Note . . .

The operation of the emergency disengage push-switches must NOT be tested at any time other than during a ground function check as the control circuit fuse usually blows due to a back feed through the standby batteries.

Post Mod.686 and 687

General

16. On aircraft with Mod.686 and 687 embodied, the elevator and aileron power control systems employ booster units which are permanently engaged. Hydraulic power may, be selected, on or off, with the control column in any position, by the operation of selector switches which control electro-hydraulic selector valves in each system. Magnetic indicators controlled by hydraulic pressure switches are also provided to show when the hydraulic pressure is applied to the boosters.

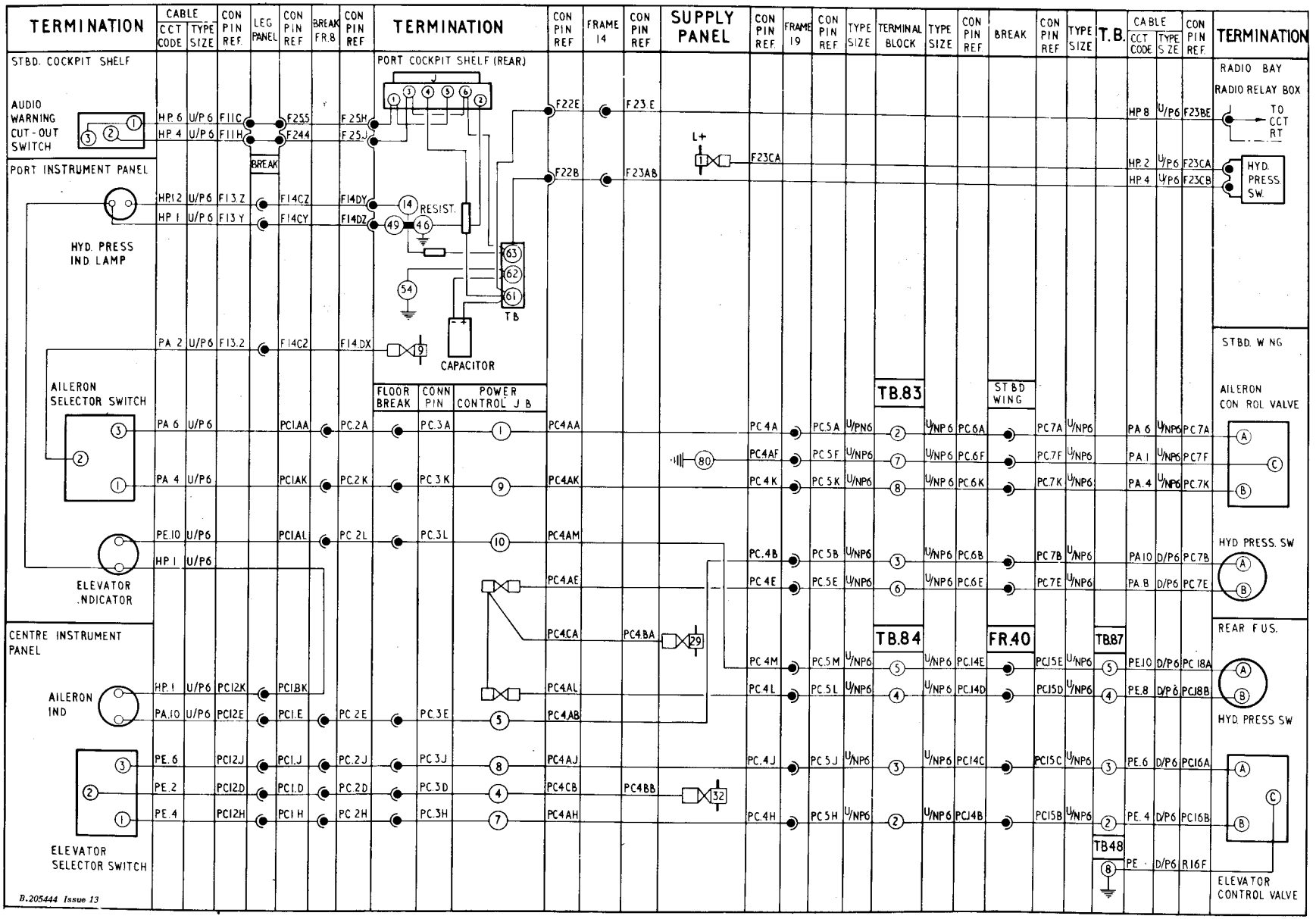

Fig.4 Elevator and aileron power controls and hydraulic indicator (routing) Post Mod.686 and 687

T.P (E) 8011

RESTRICTED

17. The electrical circuits for the elevator and aileron power operated controls consist of two 2-position ON-OFF selector switches, one of which is mounted on the centre instrument panel to control the elevator electro-hydraulic selector valve and the other, located on the port instrument panel, to control the aileron selector valve.

18. The elevator selector valve is located between frames 54 and 55 in the rear fuselage lower fin structure, and the aileron selector valve is mounted on the front spar in the wheel bay. These valves control the supply of hydraulic power to the elevator booster jack, located between frames 52 and 55 in the rear fuselage lower fin structure, and to the aileron booster jacks located in each outer wing.

19. Two magnetic indicators, located one on the port instrument panel and the other on the centre instrument panel, are provided to indicate when hydraulic pressure is applied to the elevator and aileron booster units. These indicators, which are seperately fused, show BLACK when the hydraulic pressure supplied to the boosters is greater than 600 lbs.per sq.in., and WHITE when the pressure drops below this figure. The indicators are controlled by two hydraulic pressure switches, the aileron switch being located between interspar ribs E and F in the starboard wing and the elevator switch is situated just forward of frame 54, below the tailplane in the fin structure.

Operation

20. Once reference has been made to the theoretical diagrams given in fig.3 of this group, the operations of these systems will be obvious.

◀ Manual reversion on ground (Post Mod. 895)

21. On aircrafts (Post Mods 686 and 687) the controls are normally left in power operation after shutdown. If the oil pressure in the accumulator is sufficient, reversion to manual control can be achieved by use of the handpump. If the oil pressure in the accumulator is insufficient, reversion to manual operation can be achieved by operating the push button incorporated in each of the elevator and aileron electro-hydraulic valves while using the handpump. ▶

Hydraulic pressure failure indicators

22. Indication of failure in the hydraulic system is given, when the hydraulic pressure drops below 600 lbs. per sq.in. The warning is given by a lamp situated on the port instrument panel and by an aural warning interconnection with the V.H.F. installation.

23. These warning devices are controlled by a hydraulic pressure switch located in the hydraulic pipe-line on the port side of the gun pack bay. The supply to the aural warning circuit is taken through relay J situated on the underside of the cabin port shelf.

24. Provision is made to prevent the warning devices operating and causing annoyance due to transient pressure drops while the hydraulic services are functioning normally. This is achieved through resistance and capacity delay networks provided in the supply lines of the warning devices.

Audio warning cut-out

25. Relay J may be energized to cut-out the aural warning by the operation of a audio warning cut-out switch located on the starboard instrument panel. Once relay J has been energized it is held locked-on by a circuit through its own contacts. The audio warning cut-out switch is marked OUT and OFF and is of the single pole, centre off type, with a spring return to centre from the OUT position.

Operation

26. The hydraulic pressure warning lamp and audio warning interconnection receive their electrical supply from the aircrafts main supply through a fuse to contact A of the hydraulic pressure switch, the contacts of which close when the hydraulic pressure drops below 600 lbs. per sq.in. The closing of the switch allows the current to pass across contacts A and B. From contact B the supply passes to the pressure warning lamp through a delay resistance. Another supply from contact B is fed across contacts 3 and 4 of the de-energized relay J and thus to the aural warning relay in the V.H.F. installation, via the resistance and capacitor delay network.

27 Terminal 2 of the audio warning cut-out switch and contact 6 of relay J also receive current when the pressure switch contacts are closed. When the cut-out switch is held in the 'OUT' position, current flows across its contacts 2 and 1 to the coil of relay J which is energized and makes contacts 5 and 6, so completing the relay hold-on circuit. The cut-out switch, which, may then be released, will return to its centre position due to the spring return action. Relay J will, however, remain energized until the hydraulic pressure increases sufficiently to open the contacts of the pressure switch, thus extinguishing the warning lamp and de-energizing relay J by isolating its hold-on circuit.

28. Aural warning may be permanently cut-out by placing the cut-out switch in the 'OFF' position thus closing contacts 3 and 2 of the switch. This side of the switch has no spring return to the centre position. Current will therefore flow to energize relay J continuously until the cut-out switch is manually replaced to its centre position.

SERVICING

General

29. For general servicing of the electrical system as a whole, reference should be made to Group A.1 of this chapter. Apart from keeping all the components clean and carrying out the normal routine tests of security and serviceability, the only other servicing necessary is the electrical tests of the electro-hydraulic selector valves as described in the appropriate Air Publication quoted in paragraph 1.

REMOVAL AND ASSEMBLY

General

30. Once access has been obtained, the removal of the electrical components forming the elevator and aileron power controls and hydraulic pressure indicator circuits, should present no unusual difficulties. The location and access to all the components is indicated in Group A.3 of this chapter.