Group 3 POWER CONTROLS

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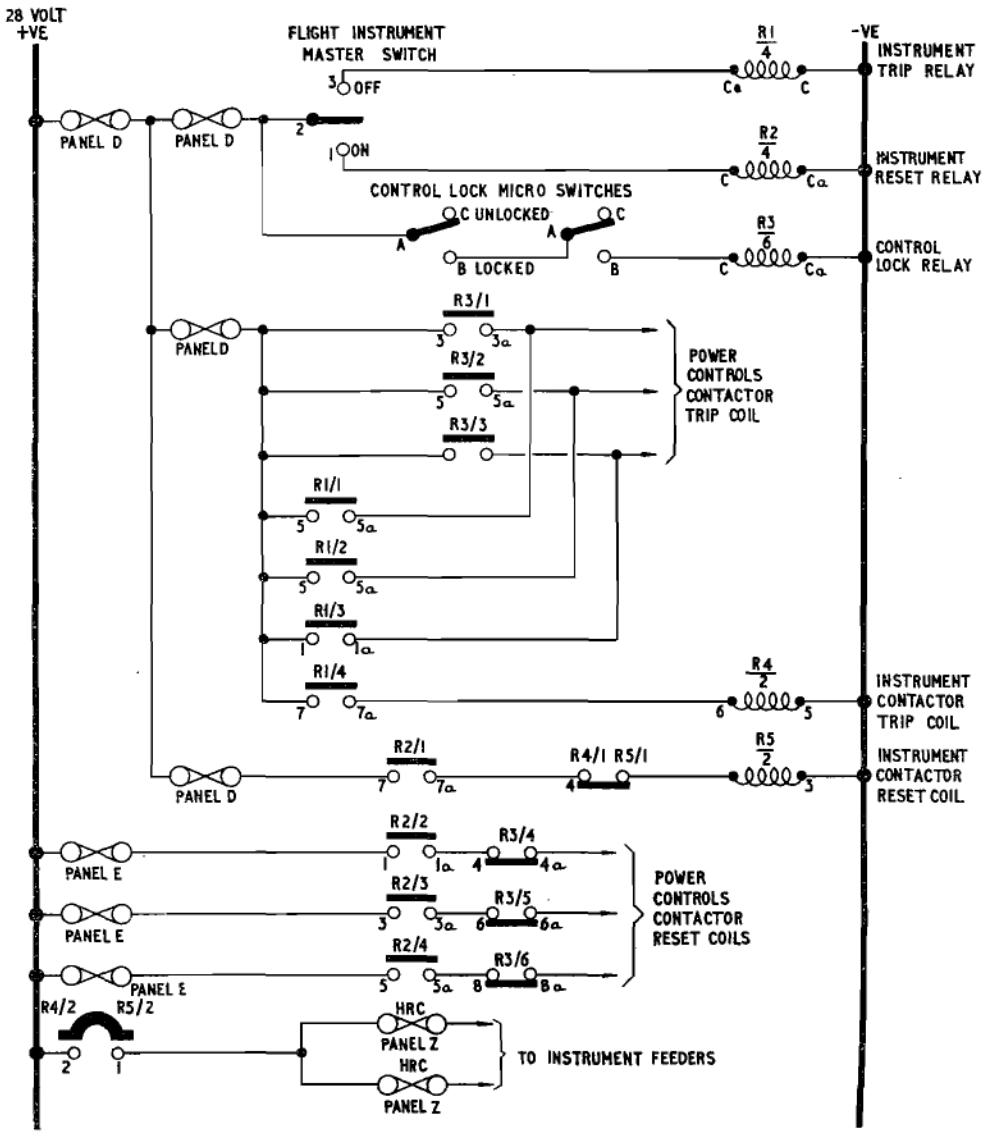

Fig. 1. Power controls master control (pre-Mod. 2089)

Warning . . .

Voltages in excess of 100 *volts a.c. or d.c. can be dangerous under certain circumstances. Personnel should, therefore, ensure that the electrical system is electrically safe before any servicing is attempted. Where it is essential that tests or adjustments are to be made with the electrical power switched on, the greatest care must be exercised.*

DESCRIPTION & OPERATION

Note . . .

The power controls should not be started up if the outside air temperature is below —26 deg. C.

Introduction

1. Information on the lay-out and interpretation of the schematic wiring diagrams can be obtained from the General Information Group contained immediately after Section 5 marker card. Also to be found in the General Information Group are all the general modifications applicable to all aircraft.

Master control

2. The four electric motor-driven pumps for the power control units are controlled by the control lock lever on the control pedestal and are interlocked with the instrument master switch.

Pre-Mod. 2089 (*fig.* 1)

3. When the switch is placed in the ON position it connects a supply from the starboard fuse panel D, to the operating coil of the reset relay, R2, Type S4, mounted behind the power panel Z. This relay connects (R2/2, 3, 4) supplies from port fuse panel E to the contacts R3/4, 5, 6 of the control lock relay, Type S4, also mounted behind panel Z. The control lock relay, R3, is operated by two micro switches in series, mounted in the control pedestal, which are in turn operated by cams incorporated in the controls locking mechanism.

4. If the controls locking lever on the control pedestal is in the unlocked position, the supply from the reset relay will be connected (R3/4, 5, 6) to the reset coils of the power controls motor contactors; if the controls lock lever is in the locked position, the original supply from panel Z will be connected (R3/1, 2, 3) via another fuse on panel D to the trip coils of the motor contactors; thus preventing the motors and therefore the power units, from being operated until the controls are unlocked.

5. When the switch is placed to the OFF position, the supply from panel D is connected to the operating coil of the trip relay, R1, which operates (R1/1-4) and connects a further supply from panel D to the trip coils of the motor contactors, thus stopping the power units.

6. If the controls lock lever is placed to the LOCKED position before the flight instrument master switch is placed to the OFF position, the controls lock relay, R3, is operated by the micro switches and the power units are stopped before the locks are engaged.

7. The flight instrument master switch, as well as controlling the power controls, also controls the flight instrument supply contactor mounted on the face of panel Z. R4, R5 are supplied through the reset and trip relays, R2 and R1 respectively. When selected to OFF, the supply is fed through contacts on the trip relay to trip the instrument supply contactor.

Post Mod. 2089 (*fig.* 2)

8. The power control motors are interlocked electrically with the flight instrument master switch and the control locking system. The power controls are started up by moving the control lock lever to UNLOCK and then selecting the flight instrument master switch to ON. The flight instrument master switch is spring returned to the centre position so that the associated reset relay will be energized only when the switch is held at ON; the contacts of the reset relay will, therefore, provide only a pulse to energize the reset coils of the power control contactors. If the instrument master switch is selected ON before the controls are unlocked, it will have to be re-selected ON to start up the power controls.

◀ **9.** To shut down the power controls the contactor units must be tripped by operating the four trip switches on the port coaming

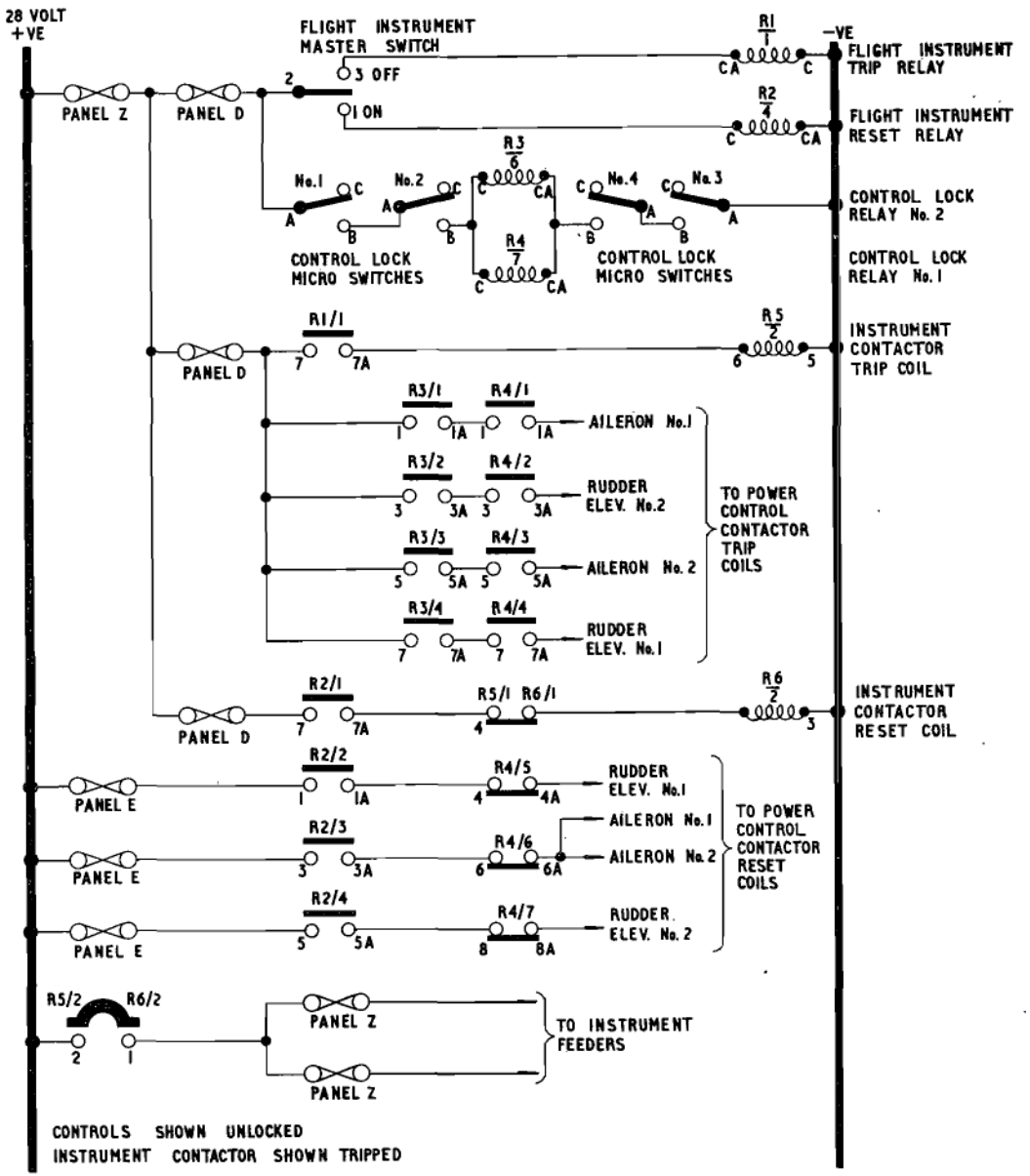

Fig. 2. Power controls master control (post Mod. 2089)

panel. A period of not less than 30 secs. must be allowed to elapse before the control lock lever is moved to lock; individual units may be tripped, in the event of failure or testing, by using the appropriate trip switch. Selecting the flight instrument master switch to OFF does not trip the power control contactors

WARNING . . .

The controls must never be locked while there is pressure in the power controls system otherwise damage may result. One of the following methods of locking the controls must be used:—

(1) Offset all the controls, then pull back on the locking lever fully thus tripping the power control motors. As soon as all the power failure warning lamps light centralize the controls making small movements around the central position until the locks engage. In gusty conditions, as the hydraulic pressure drops and the controls revert to manual, some difficulty may be felt in holding the controls and the following method will probably prove easier.

(2) Offset all the controls, then trip all the power control motors by operating the four trip push buttons on the port coaming panel. When all warning lamps light pull back the locking lever and centralize the controls making small movements around the central position until the locks engage. This latter method ensures that all hydraulic pressure has been dissipated before the locking pins are operated. ▶

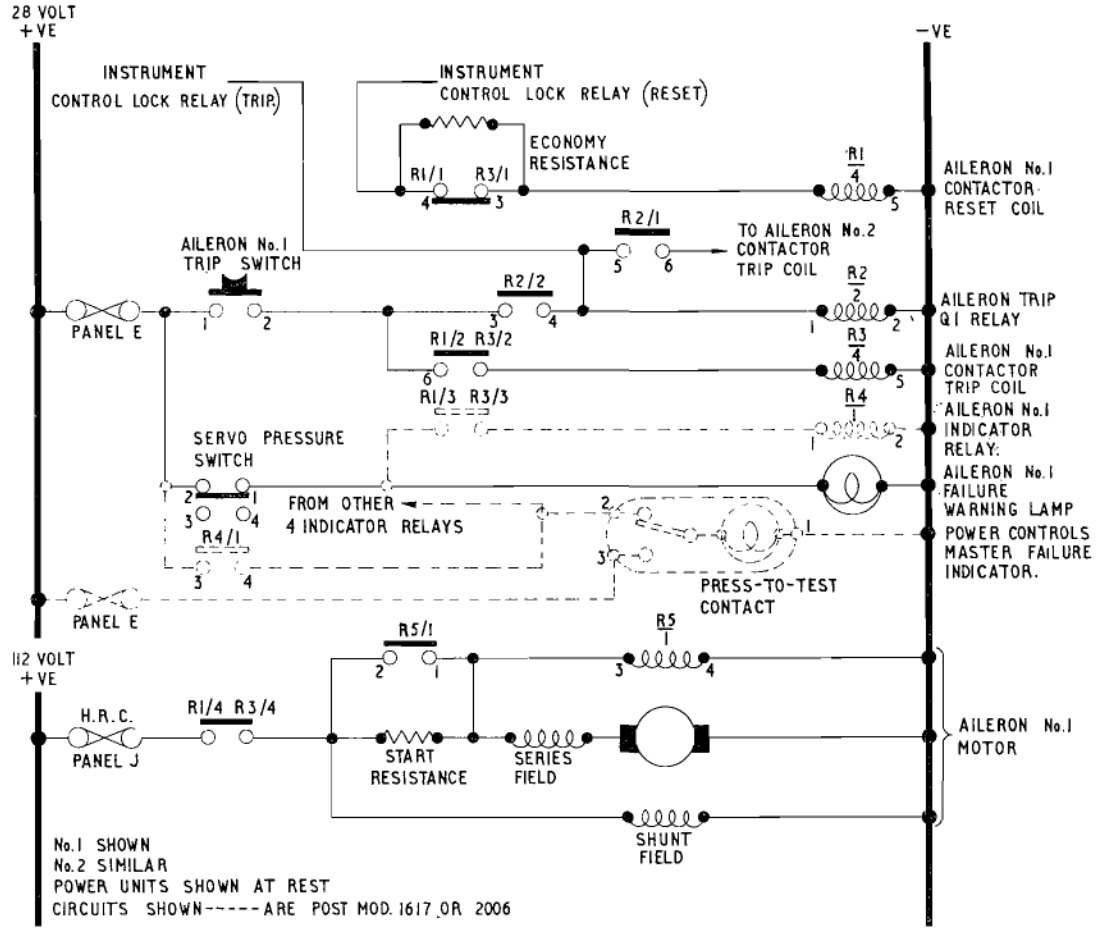

Fig. 3. Aileron power control (pre Mod. 2089)

10. When the control lock lever is moved to UNLOCK, four micro switch contacts are broken; Nos. 1 and 2 in series are in the positive feed to, and Nos. 3 and 4 in series are in the negative return from, the parallel connected coils of the control lock relays R3 and R4, Type S4, mounted behind panel Z. The relays are thus de-energized, their contacts R3/1-4 and R4/1-4 opening in the supply circuits to the power control contactor trip coils; contacts R4/5-7 of the control lock relay No. 1 are closed to prepare the supply circuits to the power control contactor reset coils.

11. When the flight instrument master switch is selected ON, a supply from panel Z is connected via a fuse on panel D to the coil R2 of the flight instrument reset relay, Type S4, mounted behind panel Z. This relay is energized so long as the switch is held at ON to close its contacts R2/2-4 to connect separate supplies from panel E through the contacts of the duplicate control lock relay to the power control contactor reset coils.

12. When the control lock lever is selected to LOCK, the four associated micro switches are operated to make on their contacts A-B and the control lock relays R3 and R4 are energized by a supply from panel Z, via a fuse on panel D. Contacts R4/5-7 of the No. 1 control lock relay open in the supply circuit to the power control contactor reset coils and contacts R3/1-4 and R4/1-4 of the control lock relays close to connect the

supply from panel Z, via a further fuse on panel D, to the power control contactor trip coils.

13. The flight instrument master switch also controls the flight instrument supply contactor R5, R6 via the reset and trip relays R2 and R1 respectively (*See Chapter* 6).

Note . . .

The two control lock relays are mounted behind panel Z in the same vertical plane, but they are arranged so that the direction of pull of one relay is opposite to that of the other. This is important as it ensures that fault conditions or 'g' forces applied to the relays in flight do not have the same effect on both relays with resultant tripping of the power controls.

(*continued overleaf*)

Master failure indicator (Mod. 1617 or 2006) (*fig.* 3)

14. Mod. 1617 introduces a master failure warning lamp on the port blind flying panel. This lamp comes on when any of the four servo unit hydraulic pressures fail, after which reference should be made to the individual indicators on the port coaming panel and the pump motor for the faulty unit tripped out. The indicator lamp has press-to-test contacts for testing the filament. Mod. 2006 has been raised to introduce this indicator retrospectively.

15. A circuit has been added to each motor pump system. The supply after passing through the servo pressure switches, is taken through auxiliary contacts 7-8 of the main contactor (closed when the contactor is made) to the coil R4 of a Type Q1 indicator relay on panel J, and thence to earth. If the servo pressure fails, the pressure switches will close and the relay R4 will be energized at the same time as the respective failure warning lamp on the port coaming panel comes on. The relay closes its contacts R4/1 to connect the servo pressure switch supply to the master failure indicator lamp.

16. The output side (terminal 4) of the four indicator relays R4 are parallelled to feed the master indicator lamp, so that, if any one unit fails, the indicator lamp will light.

17. The relays allow the master indicator to be used again after one unit has been tripped. When a unit fails and the relative trip switch is operated, contact 7-8 of the main contactor will open, to de-energize the indicator relay R4, and the indicator will go out. The relative warning lamp on the port coaming panel will remain on.

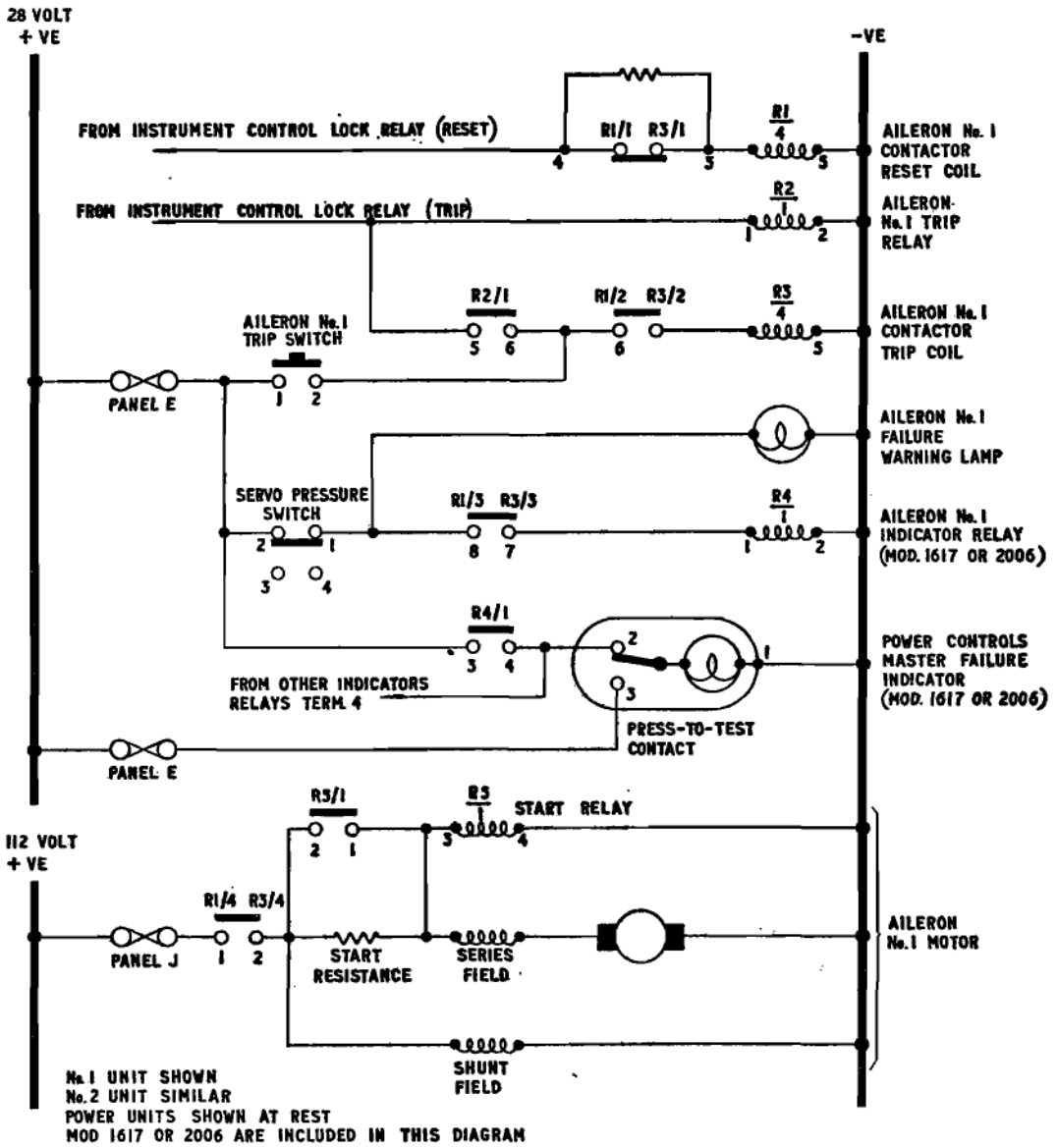

Fig. 4. Aileron power control (post Mod. 2089)

18. In addition, the indicator relay provides a differentiation between a servo pressure failure and a contactor tripping due to other causes. In the first instance both lamps will come on, in the latter instance only the relative warning lamp will come on. This is because the contactor auxiliary contacts 7-8 will break the circuit to the master indicator lamp; the relative lamp will come on because a contactor tripping will stop the pump motor and the servo pressure will fall.

19. The master indicator has press-to-test contacts so that when the face of the indicator is pressed, a supply from panel E will be connected to the indicator filament. The supply is broken when the indicator face is released.

Note . . .

The press-to-test contacts provide a means of testing the filament only.

Aileron units

20. The electro-hydraulic power unit used to control the ailerons, consists of duplicated electric motor-driven pumps and hydraulic generators feeding a single ram built into a single casing mounted on the rear face of the rear spar to the port side. The motors are controlled by the flight instrument master switch via the trip, reset and control lock relays as described above. The two motors are each controlled by an identical system, the following description applies to one motor only.

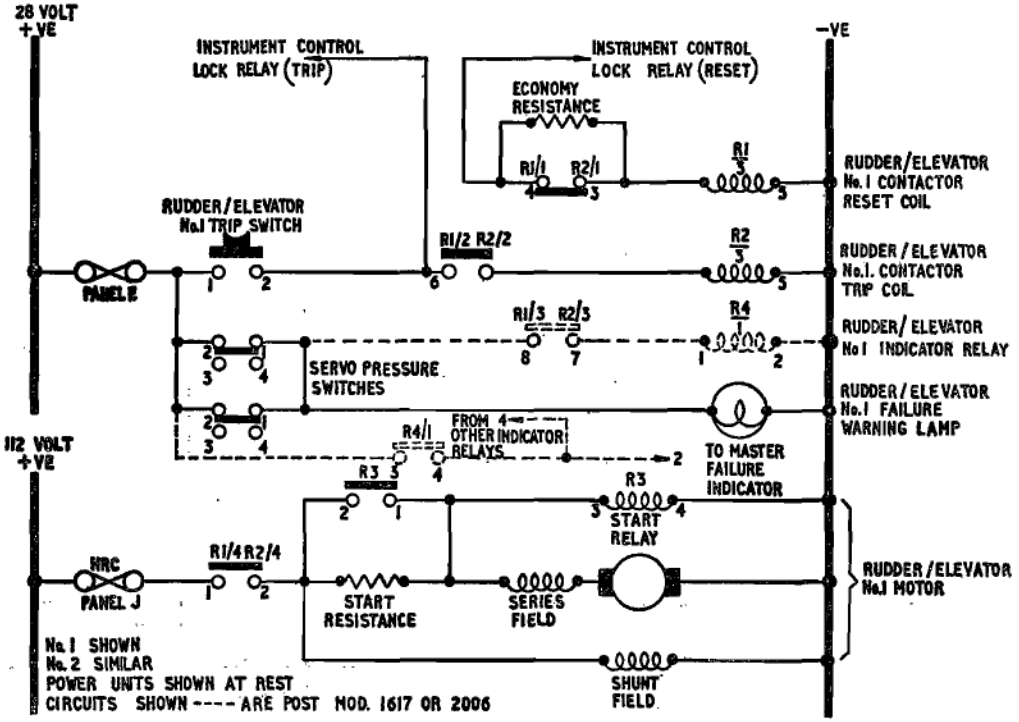

Fig. 5. Rudder/elevator power control

21. When the flight instrument master switch is placed in the ON position, the reset relay is operated, to connect a supply via the control lock relay (which is closed if the controls are unlocked) to the reset coil, R1, via its closed trip contacts, R1/1, of the motor contactor, which is mounted on power panel J. This connects (R1/4) a 112-volt d.c. supply from the 112-volt bus-bar to the motor armature via a resistance in the starter resistance unit (mounted just above the power unit). When sufficient back e.m.f. has been built up by the increasing speed of the motor, the starter unit relay R5 is energized and short circuits (R5/1) the resistance and allows the motor to attain its operating speed on full voltage.

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Pre-Mod. 2089 *(fig.* 3)

22. To stop the motors, the flight instrument master switch is placed in the OFF position which energizes the control lock relay to connect a supply to the operating coil of a Type Q1 relay, R2 on panel J. The relay then closes and connects (R2/1-2) the supply to the trip coils, R3, of the contractors for both motors, via their closed reset contacts, R3/2.

Post Mod. 2089 *(fig.* 4)

23. To stop the motors, the control lock lever is placed to LOCK. The associated micro switches are closed to energize the control lock relays which connect a supply from panel D to the aileron motor trip relays R2, Type Q1, on panel J. These relays operate to connect R2/1, the same supply to the coils of the respective aileron motor contactor trip coils R3 via their auxiliary contacts R3/2.

Indicators

24. A separate supply is taken from a fuse on the port fuse panel E, via a pressure switch built into each power unit, to a red indicator lamp on the port coaming panel. In the event of a hydraulic pressure failure the pressure switch closes thus lighting the lamp. There is a covered push-switch above each warning lamp, which when pressed, connects the warning lamp supply to the trip coil, R3, of the appropriate motor contactor thus disconnecting the motor from its supply.

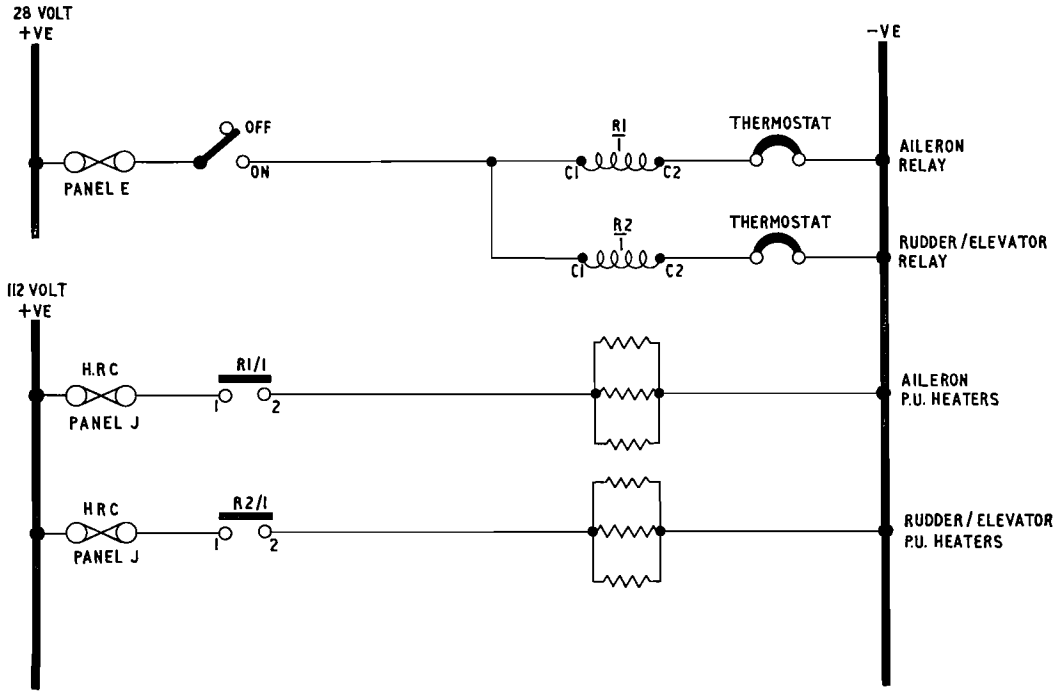

Fig. 6. Power control unit heaters (pre-Mod. 1626 only)

Rudder and elevator units *(fig.* 5)

25. The electro-hydraulic power unit used to control the rudder and elevators, consists of duplicated electric motor-driven pumps and hydraulic generators feeding two rams, one for elevators and one for rudder, built into a single casing mounted in the rear fuselage on the starboard side, just above the rear servicing hatch. The motors are controlled as described for the aileron unit except that when the units are shut down the trip supply to the trip coils R2, of the contactors is taken directly and NOT via a Type Q1 relay.

26. A similar hydraulic pressure failure scheme is employed except that there are two pressure switches to each pump — generator unit. The two switches in each unit are in parallel, each set being in series with a warning lamp on the port coaming panel and being fed from the port fuse panel E. In the event of hydraulic failure in either unit the appropriate warning lamp will be lit, and the covered push-switch above it, when pressed, will disconnect the affected pump motor from its supply.

Power unit heaters (Pre-Mod. 1626 only) (*fig.* 6)

Note . . .

Mod. 1626 *deletes the provision of heaters for the power control units.*

27. Heaters are built into the aileron and rudder-elevator power control units and are controlled by a switch on the rear face of the port console. A supply of 28 volts is taken to the switch from the port fuse panel E. When the switch is placed to the ON position it connects the supply to two single-pole contactors, one on each of the aileron and rudder-elevator starter panels. These contactors connect their respective power unit heaters to separate 112-volt d.c. supplies from the power panel J. Also built into each power unit is a thermostat, which is connected in series with the operating coil of its respective contactor, so that the hydraulic fluid is maintained at a constant temperature.

Feel unit control (*fig.* 7)

28. An artificial feel unit is used in conjunction with the aileron, rudder and elevator power controls. The feel units for the rudder and ailerons are adjustable to relieve the pilot of rudder pedal and handwheel loads. The adjustment is effected by means of electric actuators in the feel unit mechanism. The feels units are to be found in the rear fuselage, the rudder unit actuator is on the starboard side near its feel unit cylinder and the aileron unit actuator is further forward on the port side and remote from its feel unit cylinder.

29. The actuators are controlled by a trim switch on the control pedestal, sideways movement trimming the aileron feel units and rotary movement trimming the rudder feel unit. Two supplies from the port fuse panel E, are taken to the switch from which the supplies are taken to the two actuators via panel V. Actuator positions are as follows :—

Port wing up, aileron actuator retracted.
Rudder to starboard, rudder actuator extended.

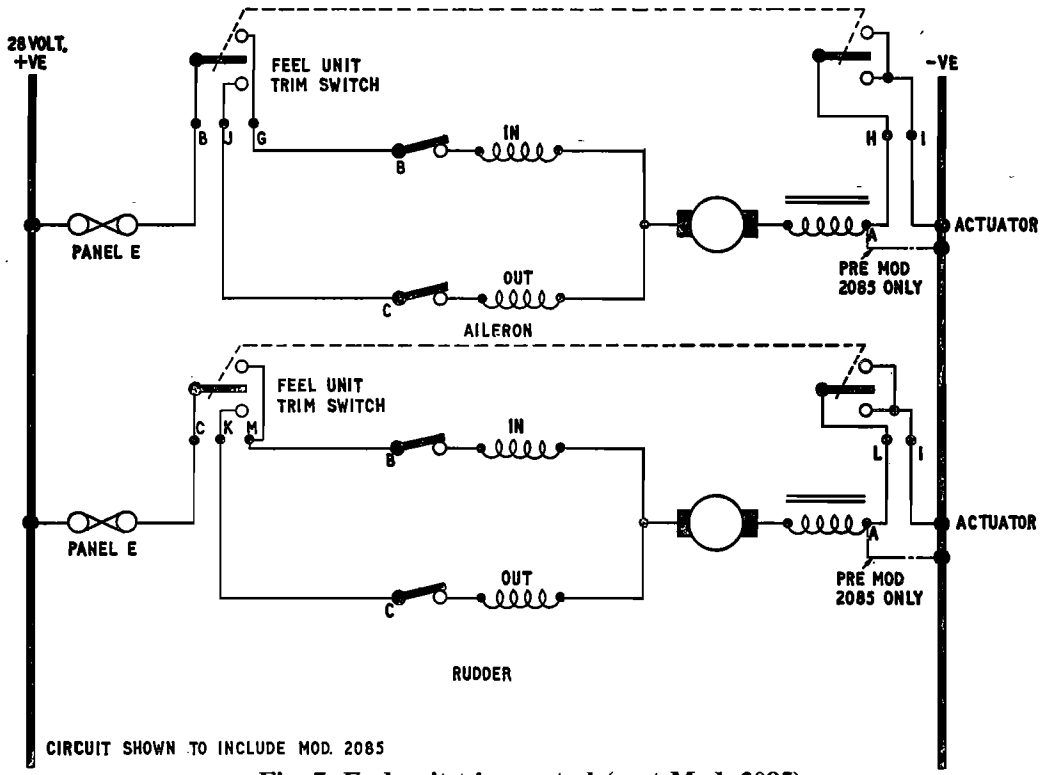

Fig. 7. Feel unit trim control (post Mod. 2085)

Note . . .

To minimize the chance of inadvertent operation of the actuator due to fault conditions, Mod. 2085 *has been introduced. This provides negative as well as positive switching at the trim switch. When the trimming switch is operated, both positive and negative connections are made to the actuator.*

Feel unit heaters (*fig.* 8)

30. The three feel unit cylinders are enclosed in electrically heated muffs each controlled automatically by a built-in thermostat. The supply is from a fuse on panel Z. Further information on these muffs is contained in A.P.4343E, Vol. 1, Sect. 11.

SERVICING

Note . . .

To safeguard against possible overheating of the power controls motors whilst being serviced, it is essential that the motors are not operated continuously for periods of more than 1 hour. A further period of 1 hour must elapse before the motors are again operated.

Introduction

31. The General Information Group, contained in Book 2 immediately after Section 5 marker card, gives a detailed description of the general tests to be applied to all aircraft circuits and the procedure to be adopted when servicing special circuits.

Power controls

32. (1) Check all circuit fuses and connect 28-volt and 112-volt d.c. supplies to the external supply connections. The four power control motor failure warning lamps should now be on.

(2) Operate the control lock lever to unlock the controls.

(3) Place the flight instrument master switch to ON.

(4) Check that the four warning lamps go out and that the power controls motors are operating.

(5) Trip each motor in turn and see that the respective warning lamp comes on.

(6) Select the flight instrument master switch to ON and check that the indicating lamps go out and motor operates.

(7) Operate the controls lock lever to lock the controls and see that the four indicating lamps come on.

(8) Operate the control lock lever to unlock the controls.

(9) Select the flight instrument master switch to ON and check that the indicating lamps go out and the motors operate.

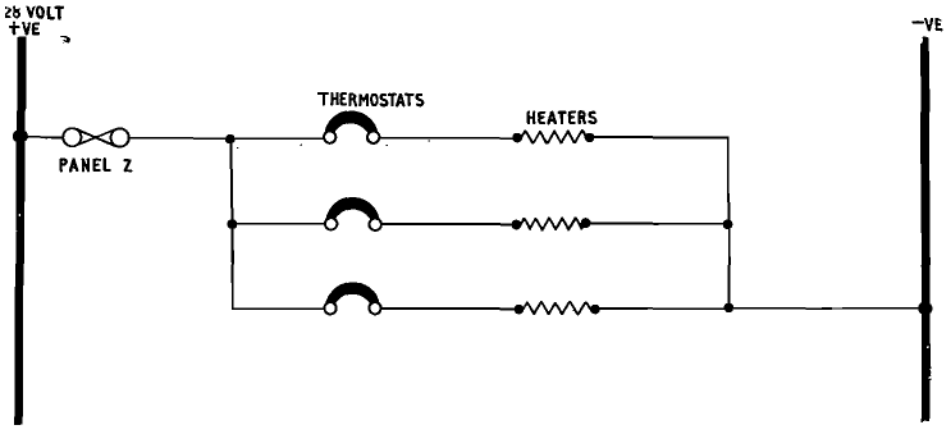

Fig. 8. Feel unit heaters

(10) Select the flight instrument master switch to OFF and check that the indicating lamps come on.

Note . . .

Post Mod. 2089 operations 8 to 10 do not apply. The power controls motors can only be tripped by operating the controls lock lever to lock the controls.

Master indicator

33. (1) Check the circuit fuses and connect a 28-volt d.c. supply to the external connection. The four power control motors failure warning lamps should be on.

(2) Operate the controls lock lever to unlock the controls.

(3) Switch ON the flight instrument master switch. The four power control motors failure warning lamps should stay on and the master indicator warning lamp should come on.

(4) Trip each contactor in turn and note that when the last contactor is tripped the master indicator warning lamp goes out, but the four power control motors warning lamps stay on. Repeat using all combinations of the four trip push buttons.

Periodic checks on power control motors

34. It is essential that a periodic check is carried out on the commutators of the motors.

(1) Remove the commutator end cover.

(2) Check that the commutator is clean and free from pitting.

(3) Check that there is no excessive play between the brushes and their holders.

(4) Check length of brushes. MIN. permissible length 0.6 in.

Fuel unit control

35. (1) Check the circuit fuses and connect a 28-volt d.c. supply to the external connection.

(2) Move the trim switch sideways and check that the aileron feel actuator operates.

(3) Operate the trim switch in a rotary direction and check that the rudder feel actuator operates.

Feel unit heaters

36. (1) Check the circuit fuses and connect a 28-volt d.c. supply to the external connection.

(2) Connect a 28-volt test lamp in series with the earth connection.

(3) Bridge out each thermostat in turn and see that the lamp comes on and goes out when the bridge is removed.

(4) Disconnect the lamp and reconnect the earth lead.

Note . . .

For further details refer to A.P.4343E, Vol. 1, Sect. 11.

Power unit heaters (pre-Mod. 1626 only)

37. (1) Connect C2 on aileron heater relay and rudder/elevator heater relay to earth.

(2) Connect a 112-volt test lamp in series with the heater earth connections.

(3) Check the circuit fuses and connect 28-volt and 112-volt d.c. supplies to the external connections.

(4) Switch ON the power unit heaters switch and check that all the lamps light.

(5) Remove all the earth connections previously made. Disconnect test lamps and replace all heater earths.

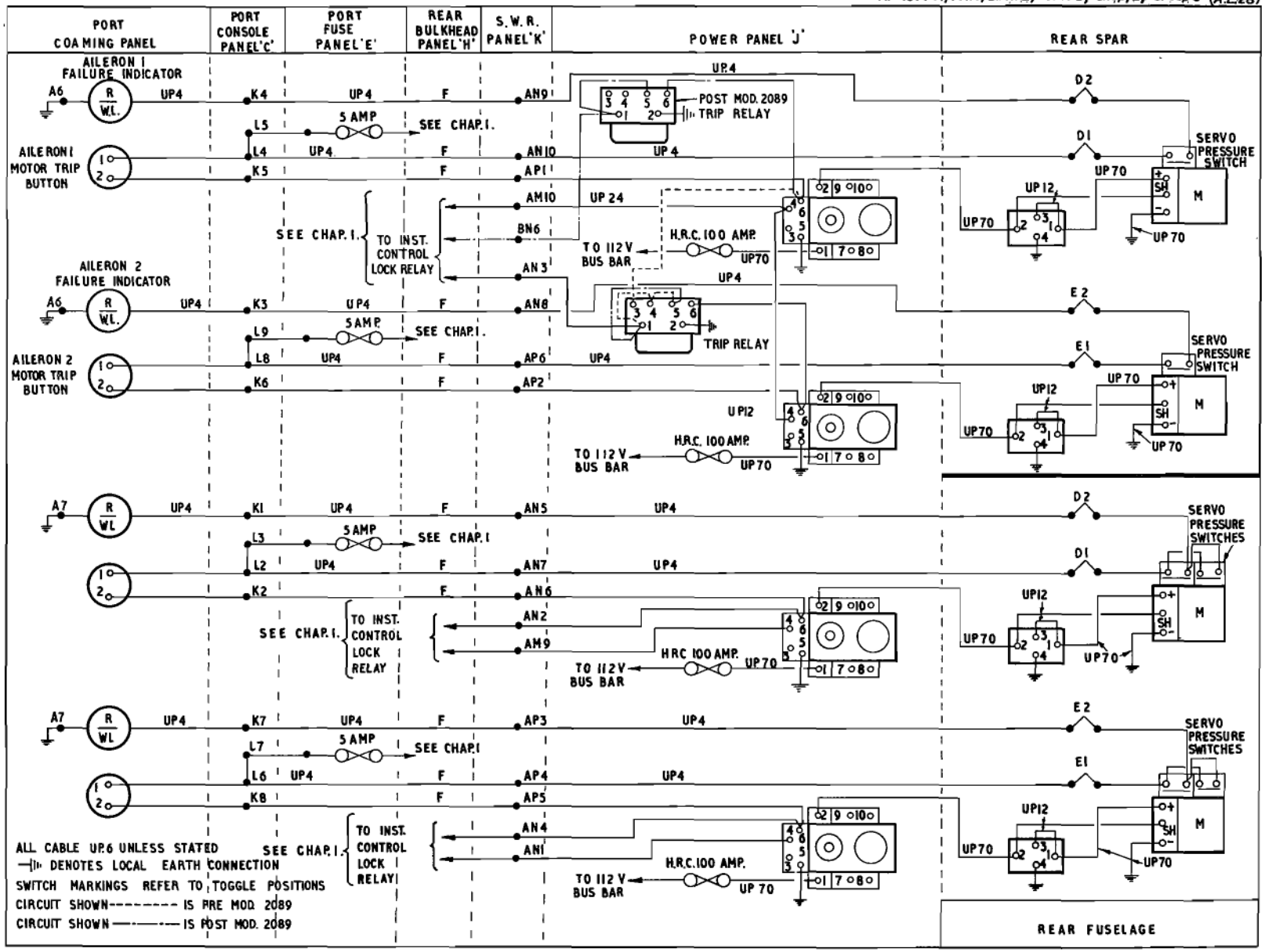

Fig. 9. Power controls (pre. Mods. 1617 or 2006)

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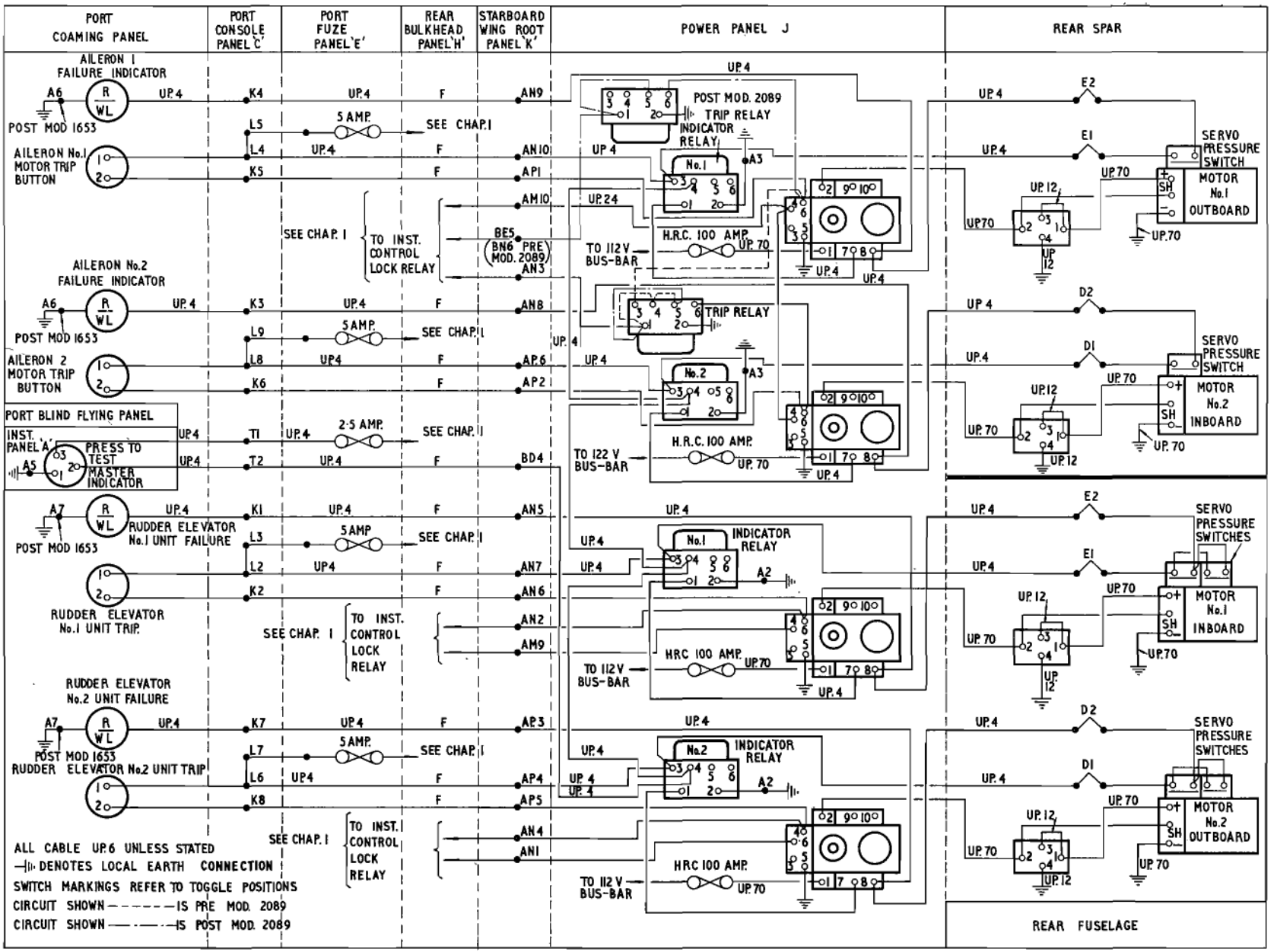

Fig. 10. Power controls (post Mod 1617 or 2006)

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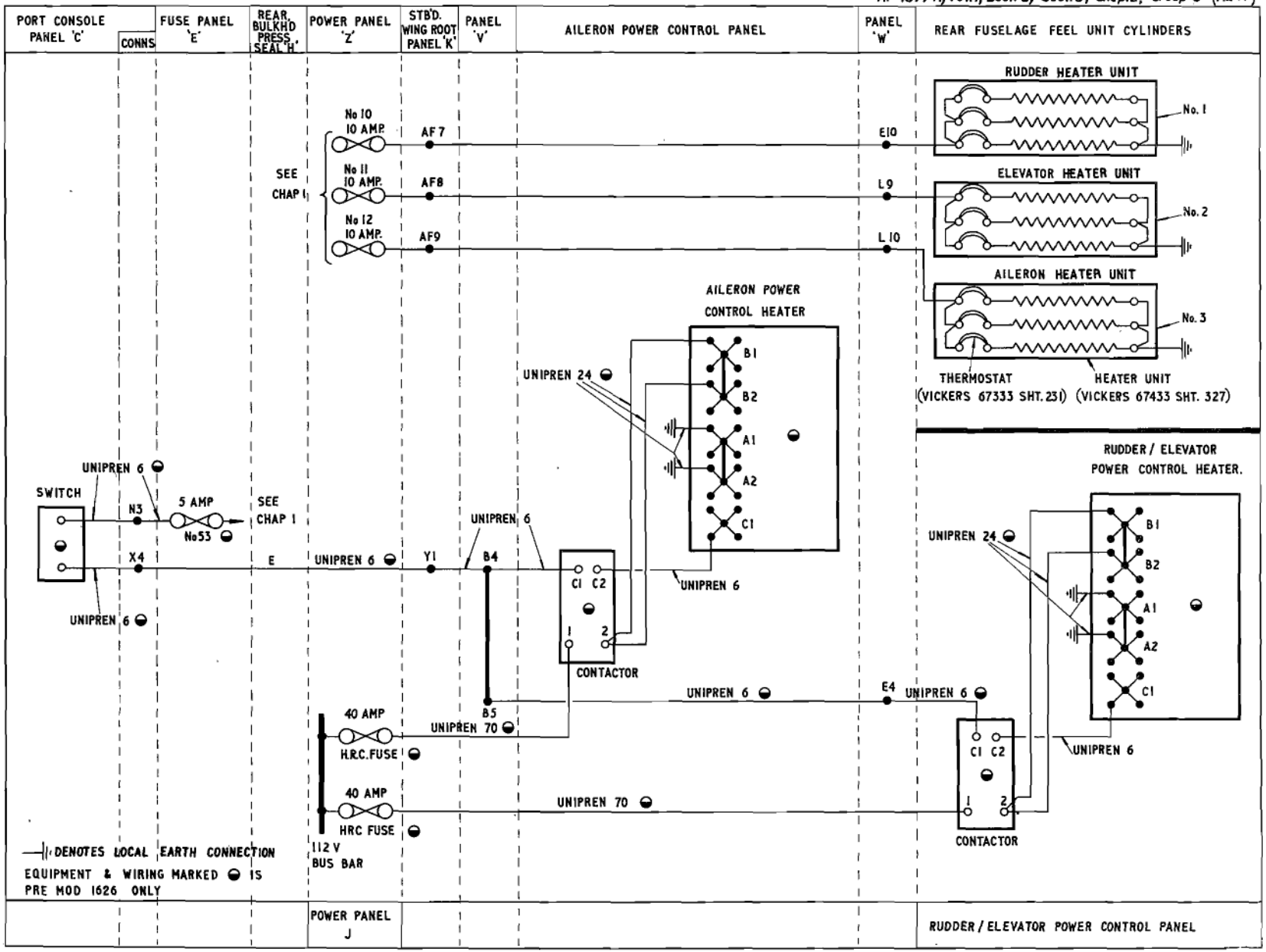

Fig. 11. Power control and feel unit heaters

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67436 SHT. 180-E

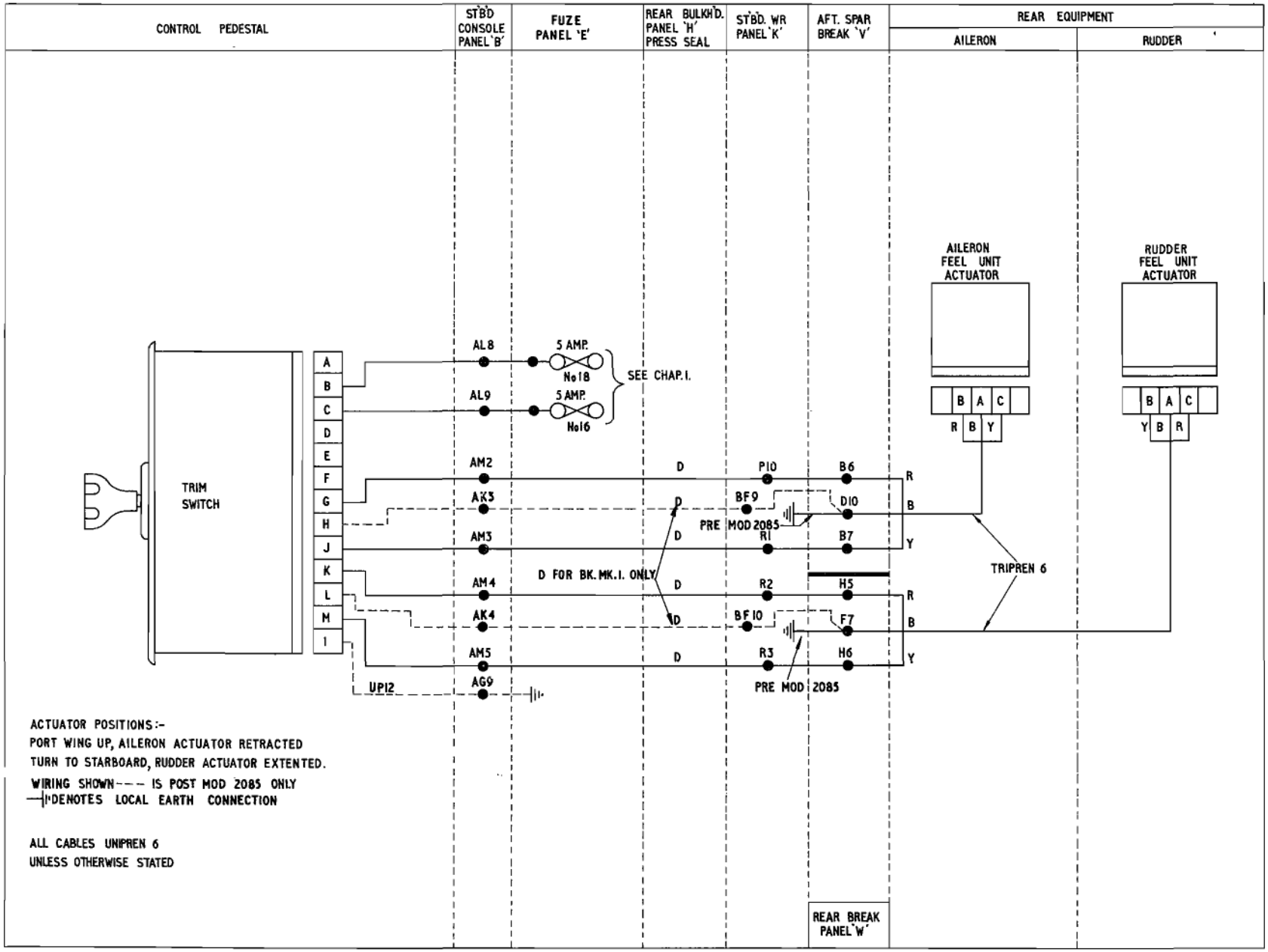

Fig. 12. Feel unit control

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Appendix 1

FEEL UNIT HEATERS (Mod. 3058)

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Feel unit heaters (post Mod. 3058) ... 1
◀Alterations to fig. 11 (post Mod. 3058) 2▶

Introduction

1. Three feel unit cylinders are enclosed in electrically heated muffs, each controlled automatically by a built-in thermostat. They are supplied from fuses in panel E, and in the event of an emergency, such as loss of generated power, can be individually switched 'ON' or 'OFF' by guarded switches fitted on the port console rear door. Due to the increase of load at panel E, the pilots port feeder No. 1 H.R.C. fuse on panel Z is uprated to 100 amps. Figs. 1 and 2 of this appendix show the wiring changes. For further information on the muffs refer to A.P. 4303Z, Vol. 1, Sect. 11, Chap. 1.

Servicing

2. (1) Check the circuit fuses and connect a 28-volt d.c. supply to the external connection.

(2) Connect a 28-volt test lamp in series with the earth connection.

(3) Switch ON the relevant switch and bridge each thermostat in turn and ensure that the light comes on and goes out when the bridge is removed or when the switch is put to the 'OFF' position.

(4) Disconnect the lamp and reconnect the earth lead.

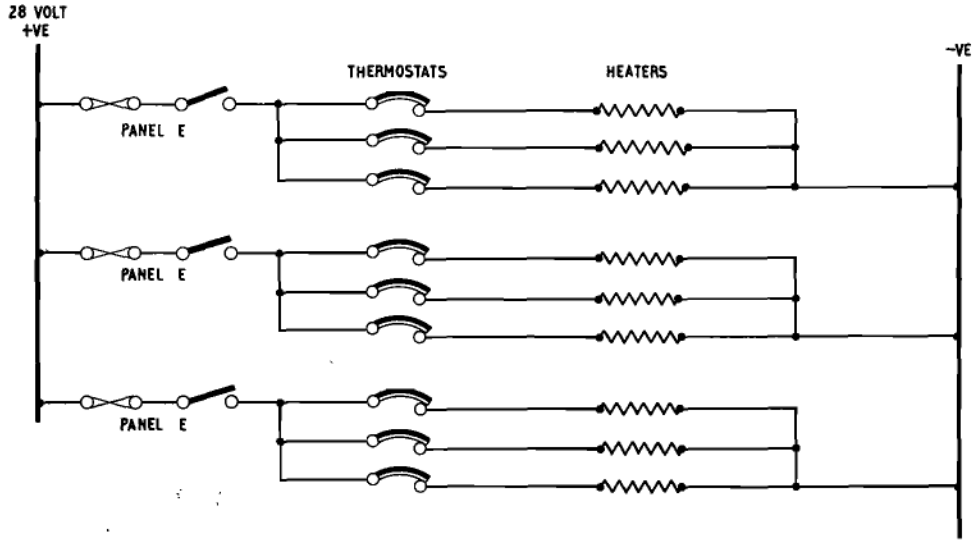

Fig.1. Feel unit heaters (post Mod. 3058)

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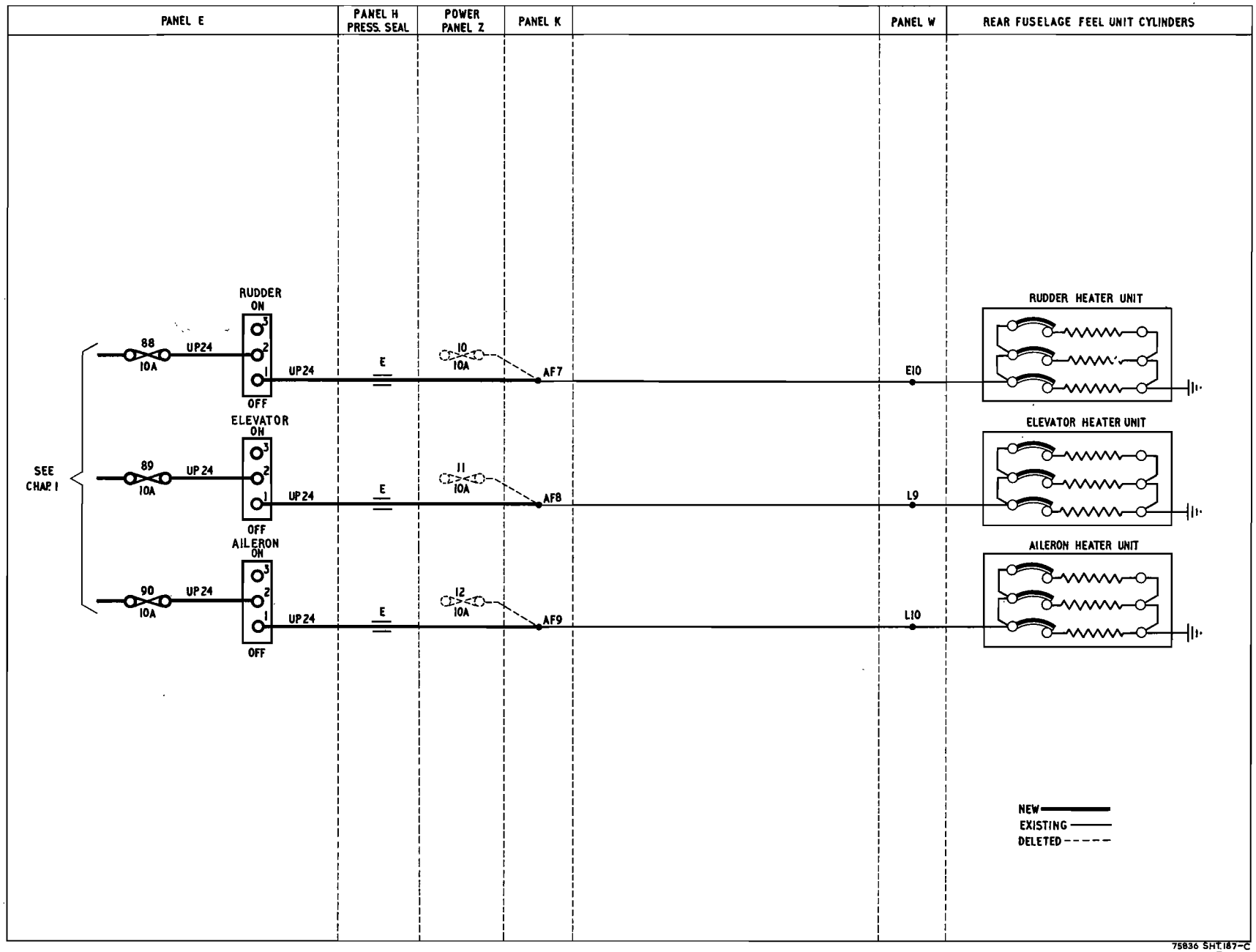

Fig.2 Alteration to Fig.11 (post Mod. 3058)

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