

## Group 6 ALIGHTING GEAR

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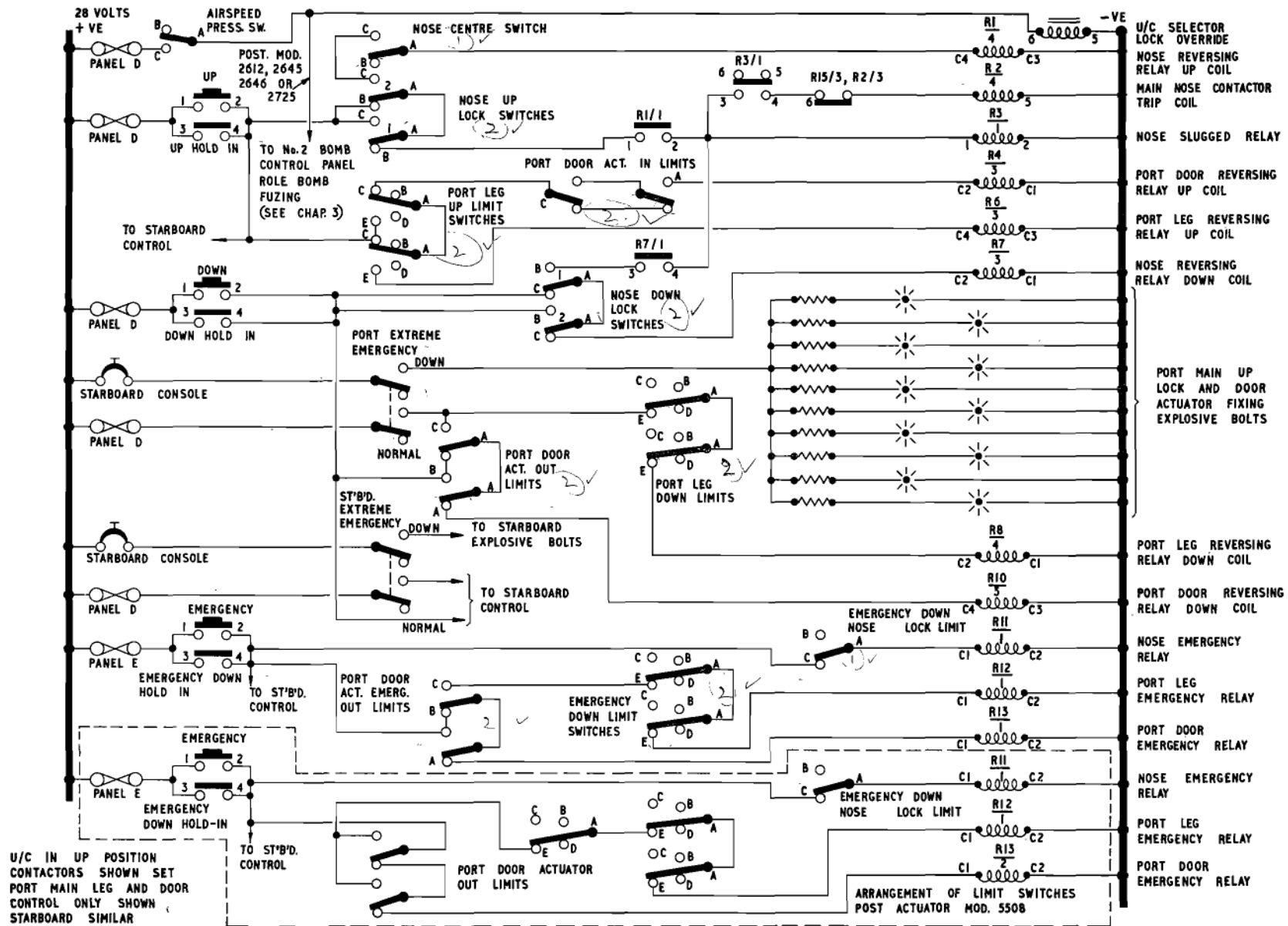


Fig. 1. Alighting gear control (1)

**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 AND OPERATION****Introduction**

1. Information and interpretation of the lay-out of the schematic wiring diagrams and descriptions of the general modifications applicable to all Valiant aircraft, can be obtained from the General Information group contained immediately after Section 5 marker card.

**GENERAL INFORMATION**

2. The main wheel units, outer doors and nosewheel, are operated by electric actuators which are controlled by three push-switches, mounted next to one another, in a switch unit on the control pedestal. These switches, which have hold-in contacts are labelled UP, DOWN and EMERGENCY. The switch unit embodies an interlock mechanism ensuring that when one switch is depressed, the remaining two are automatically released. The switch unit also contains a lock to prevent operation of the UP button when the aircraft is standing on the ground. The lock is released either by a solenoid, which is energized via the air speed pressure switch when the aircraft has attained a speed of 80-85 knots, or by rotating the UP button through 90 deg. before operating it.

3. Once a push-switch has been depressed, circuit operation is entirely automatic, the main wheel door actuators working before, or after, the main leg actuators, according to whether the alighting gear is moving up or down. A form of rheostatic braking is employed on the main wheel units to control the rate of descent when lowering them. A clutch slip detecting device is used on the main and nosewheel main motors, which

trips out the relative supply contactor in the event of too much slipping of the driving clutch.

4. The EMERGENCY push-switch enables the alighting gear to be lowered, but not raised, by the actuator emergency motors in the event of failure of either the main motors or the main motor control circuits. The port and starboard EXTREME EMERGENCY guarded 2-way, 2-position switches, mounted on the starboard console and labelled NORMAL-DOWN, detonate their respective mainwheel uplock and door actuator attachment explosive fixing bolts, at the same time connecting the 112-volt supplies to the mainwheel actuator main motors via their respective reversing relays. The EXTREME EMERGENCY switches are used only in the event of failure of the mainwheel uplock mechanism.

**◀4A. Electrical detonators No. 108.**

(1) The detonators must not be handled during removal or replacement, but should be held by the lead ends, which should be twisted together as a safety precaution.

(2) When fitting the detonator to the explosive bolt, the label around the detonator must be removed. It is important that this is done otherwise the detonator can stick inside the bolt resulting in failure to operate.

(3) Further details on removal and replacement of detonators are contained in Sect. 3, Chap. 1.▶

5. Should the condition arise where the complete alighting gear fails to lower under

normal or emergency control, the main wheels only can be lowered by the extreme emergency operation and the aircraft will have to be landed on the mainwheels and the tail skid, which consists of a reinforced plate under the fuselage to the rear of the bomb bay air deflector.

**CIRCUIT OPERATION****Normal down (fig. 1 to 3)**

6. Assume that the alighting gear is retracted. When the DOWN push-switch is depressed, a supply from the starboard fuse panel D is connected through the nosewheel down lock limit switches 1 and 2 to the 'down' coil of the nosewheel reversing relay R7, fig. 1, mounted in the nosewheel, in the nosewheel bay roof.

7. This supply is also connected through the port and starboard main wheel door actuator 'out' limit switches, to the 'down' coils of the port and starboard mainwheel door reversing relays, R10 (fig. 1), on their respective alighting gear control panels. The reversing relays operate; contacts R7/2-3-4 (fig. 3) operate to connect a 112-volt supply from panel J via R15/2, R2/2 of the nosewheel main contactor mounted in the nosewheel bay roof (pre-Mod. 786) or on power panel J (Post Mod. 786) to the nosewheel actuator main motor and its series connected brake solenoid.

8. The port and starboard door relays R10 operate contacts R10/1-2-3 (fig. 2) to connect 112-volt supplies from panel J via contacts R16/3 R17/3 of the port and starboard main contactors on their alighting

gear control panels through fuses to their respective actuator main motors and their series connected brake solenoids. The door and nosewheel actuator main motors will now start, their brakes being released simultaneously with the motors starting.

9. Resistances across the motor armatures of the door and nosewheel motors ensure that the brake solenoids remain energized

when the weight of the doors and nosewheel reduce their motor armature currents below the hold-in value for the brake solenoids. A clutch slip device on the nosewheel main motor trips out the main contactor after ten complete revolutions of clutch slip (para. 22).

10. The actuators will continue to operate until the limits of their travel are reached

when the doors and nosewheel will be in their down positions. The actuator, door and nosewheel limit switches (fig. 1) will then be operated. The nosewheel uplock limit switches 1 and 2 set the circuit for raising the nosewheel; the nosewheel downlock limit switches 1 and 2 disconnect the supply to the reversing relay down coil R7, which, in turn, disconnects the 112-volt

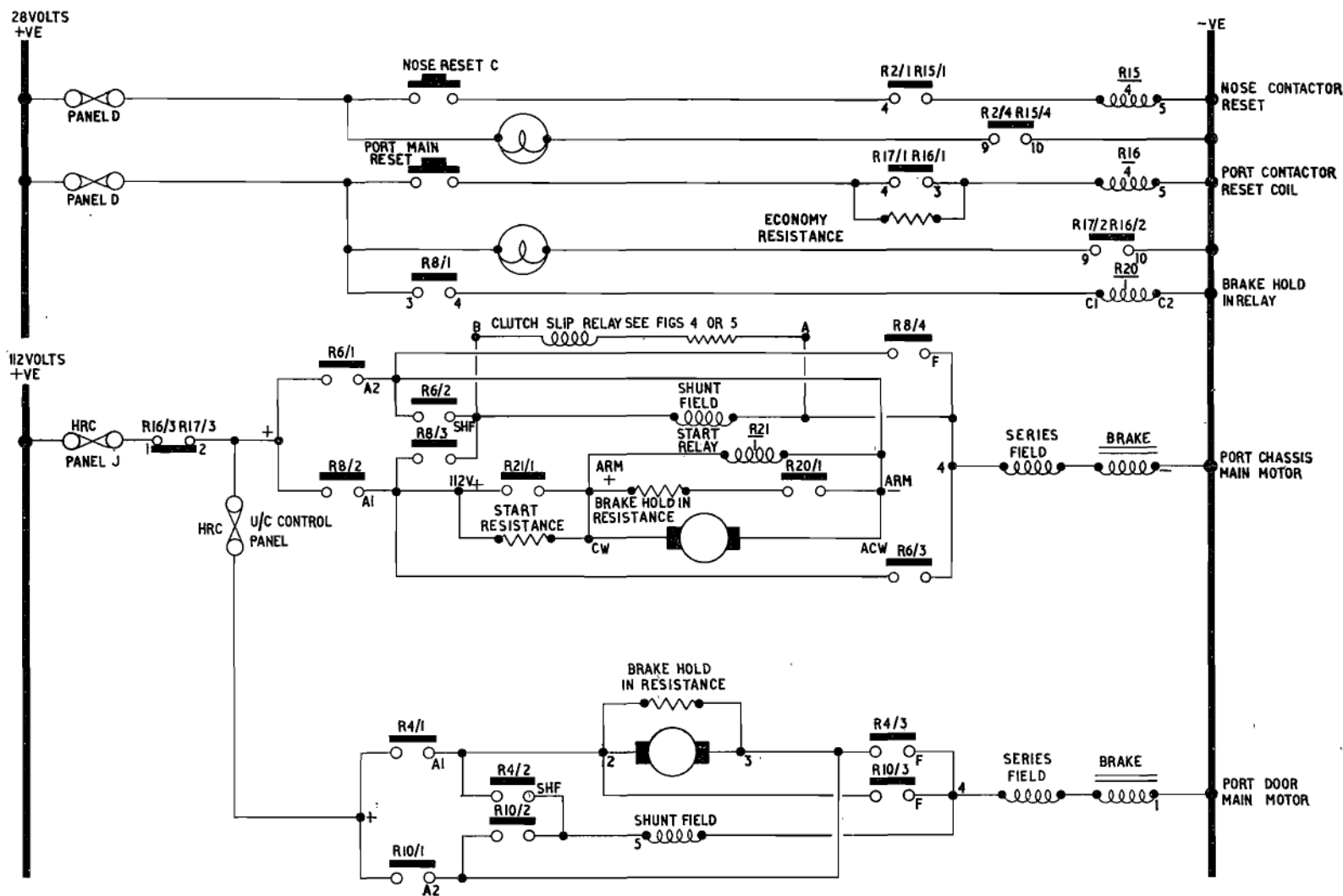


Fig. 2. Alighting gear control (2)

RESTRICTED

supply to the nosewheel motor and applies the brakes.

**11.** The nosewheel downlock limit switches 1 and 2 also connect the supply to the operating coil of a slugged relay R3 (*fig. 1*). mounted in the nosewheel bay roof, via contacts R7/1 of the nosewheel reversing

relay, so that, if the reversing relay should weld in, the slugged relay would become energized from the original supply. After a delay of about  $\frac{1}{2}$  sec. the slugged relay would connect (R3/1) the same supply to the trip coil R2 of the nosewheel main contactor, thus disconnecting (R2/2) (*fig. 3*) the 112-volt supply to the nosewheel motor.

**12.** The door actuator in limit switches set the circuit for raising the doors. The door actuator out limit switches disconnect the supply to the door reversing relays R10 (*fig. 1*), which in turn, disconnect (R10/1-3) (*fig. 2*) the 112-volt supplies to the door

(continued overleaf)

motors and apply the brakes. The door actuator out limit switches (fig. 1) also connect the supply, from the down push-switch, through the mainwheel down lock limit switches to the 'down' coils of the port and starboard motor reversing relays R8, mounted on their respective alighting gear control panels.

13. When the mainwheel reversing relays operate (fig. 2), the 112-volt supplies, which supplied the door motors, are connected (R8/2-4) to the main wheel actuator main motors. They also connect (R8/1) a supply, from panel D, to the operating coil of the brake hold in relay R20, in the starter relay box. This operates (R20/1) to connect the brake hold-in resistance across the motor armature. The motors start to operate, their brakes being released simultaneously with the motors starting. The motors have starting resistances controlled by relays across the armatures.

14. As the motors accelerate, their armature back e.m.f.'s increase, which on reaching 75 volts, energize the coils of the starting relays R21 (fig. 2). The starting relays operate (R21/1) to short-circuit the starting resistances in the armature circuits, so allowing the motors to run on full voltage. The weight of the undercarriage reduces the load on the motors and eventually drives the motors at above their normal speed thus producing a reverse current which is dissipated in the brake hold-in resistance. Thus a form of rheostatic braking is applied to the motors to control the 'free fall' speed of the main undercarriages.

15. As the undercarriage nears its down position, the free fall force on the actuator motors, decreases, resulting in reduction of the armature speed and therefore, reverse current, the load on the motors being gradually increased. The motors will then drive the undercarriages home into the downlocks. The down lock limit switches

will operate (fig. 1) to disconnect the supply to the mainwheel motor reversing relays R8, which in turn, disconnect the 112-volt supplies to the motors and brakes. The motors will then stop and the brakes will be applied. The alighting gear is now in the down position.

panel D, is connected through the nosewheel uplock limit switches 1 and 2 and the nosewheel centre micro switch to the 'up' coil of the nosewheel reversing relay R1. This supply is also connected via the mainwheel uplock limit switches to the 'up' coil of the mainwheel motor reversing relays R6.

Note. . .

The nose undercarriage cannot be raised if the nosewheel is off centre, but the main undercarriage can.

**Normal up**

16. When the UP push-switch is depressed (fig. 1) a supply from the starboard fuse

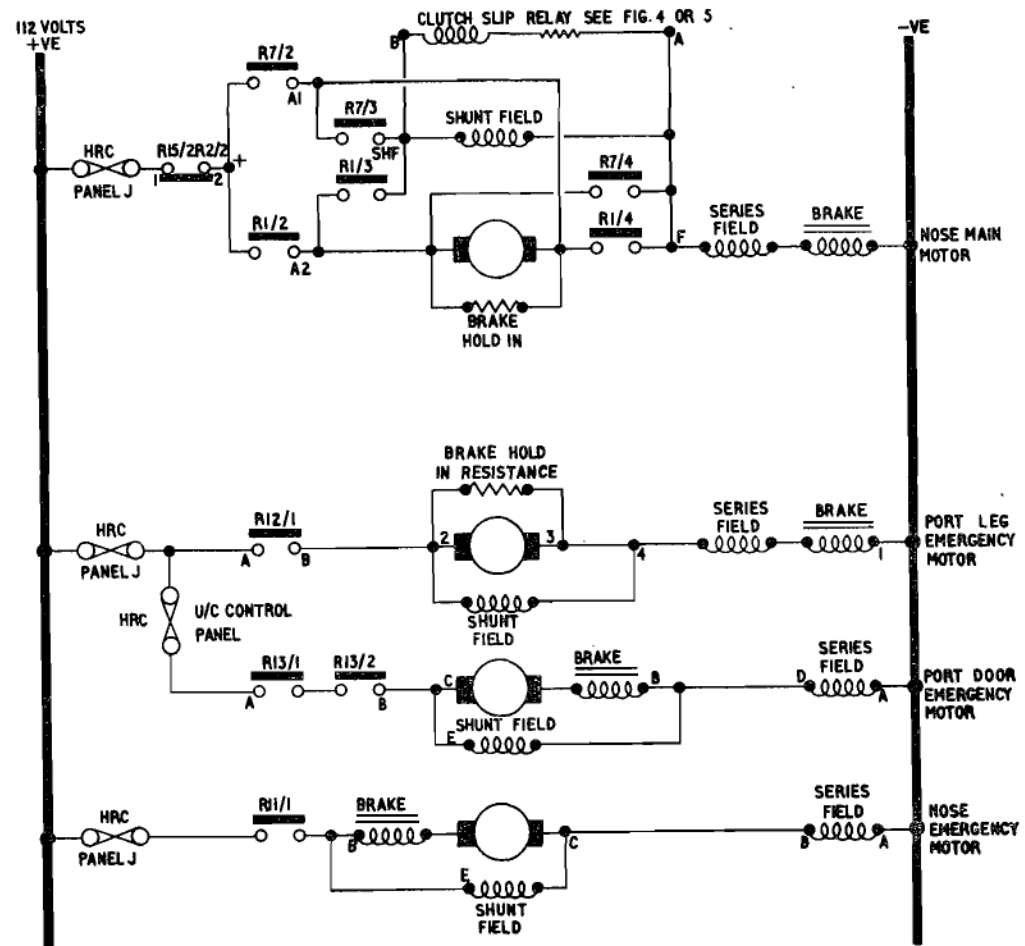


Fig. 3. Alighting gear control (3)

17. The nosewheel relay connects (R1/2-3 (fig. 3) a 112-volt supply from the nosewheel main contactor to the nosewheel actuator main motor and its series connected brake solenoid. The mainwheel relays (R6/1-3) (fig. 2) connect 112-volt supplies from the mainwheel main contactors to the mainwheel actuator main motors and their series-connected brake solenoids. The mainwheel motors have starting resistances in series with their armatures. These resistances are controlled by relays, whose coils are across the armatures so that when the armature back e.m.f.'s reach 75 volts due to increasing speeds of the motors, the relays are energized and the starting resistances are short-circuited. The motors on the actuators will now start, their brakes being released simultaneously with the motors starting.

18. The actuators will continue to operate until the limits of their travel are reached when the main and nose undercarriages will be fully retracted. The nose and main limit switches will be operated. The nosewheel downlock limit switches 1 and 2 (fig. 1) set the circuit for lowering the undercarriage and the uplock limit switches 1 and 2 disconnect the supply to the nosewheel reversing relay 'up' coil R1, thus disconnecting (R1/2-3) the motor from its supply and applying the brake.

19. The nosewheel uplock limit switches 1 and 2 (fig. 1) also connect the circuits to the slugged relay R3, via contacts R1/1 of the nosewheel reversing relay so that, if the reversing relay should weld in, the slugged relay would operate (R3/1), after about ½ sec., to energize the trip coil of the nosewheel main contactor R2 and so trip the 112-volt supply to the motor.

20. The mainwheel down limit switches (fig. 1) set the circuit for lowering the undercarriages and the up limit switches disconnect the supply from the motor reversing relays R6. These in turn disconnect (R6/1-3) (fig. 2) the motors from their 112-volt supplies and apply the brakes. The mainwheel up limit switches (fig. 1) connect the

supply, from the up switch, through the mainwheel door 'actuator in' limit switches, to the 'up' coils of the door reversing relays R4.

21. These reversing relays operate (R4/1-3) (fig. 2) to connect the 112-volt supply from the mainwheel main contactors (R16/3, R17/3) via the fuses to the mainwheel door actuator main motors and their series

connected brakes. The actuators operate to raise the doors until the limits of their travel are reached, when the door actuator limit switches will operate. The door 'actuator in' limit switches (fig. 1) disconnect the supplies to the door reversing relays R4, which in turn disconnect (R4/1-3) the 112-volt supplies to the motors and apply the brakes. The door actuator out limit switches set the circuits to lower the doors.

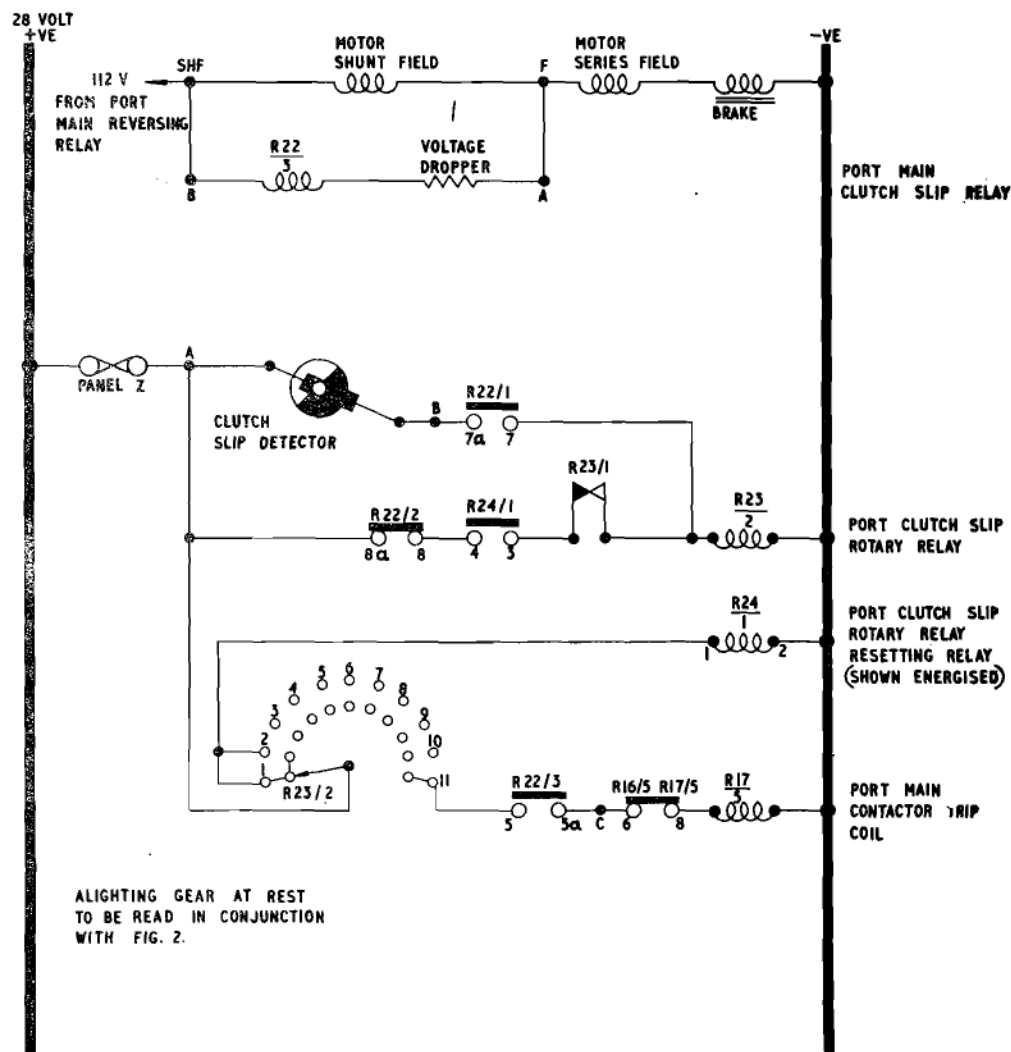


Fig. 4. Clutch slip protection (pre-mod. 2017)

**Clutch slip** (fig. 4 - 5)

22. Each of the main and nose under-carriage actuator main motors employs a clutch slip protective device. On the end of each motor shaft are two slip rings, one

attached to the motor shaft and one attached to the driven side of the clutch; one of these rings is 180 deg. conducting and 180 deg. insulating. When the clutch is slipping the rings will move relative to one another.

**Note. . .**

*It should be appreciated that the clutch slip device may come to rest with the two slip rings in the contacting condition. With no*

(Continued overleaf)

slip on the clutch the slip rings will be rotating together and passing current to the rotary relay coil. The rotary relay will not, however, inch round until slip occurs, the current being interrupted and re-connected as the rings make and break contact. On aircraft pre-Mod. 2017 careful inspection of the rotary relay coil should be made at frequent intervals as the coil tends to be overloaded by a continuous supply on it when the rings are making contact and rotating together.

Pre-Mod. 2017 (fig. 4)

23. As the above motor systems are identical the port undercarriage system only is described below. A supply from panel Z, is fed to the main motor slip ring and also to the rotary relay contacts, R23/2. The second slip ring is connected, via contacts R22/1 of the clutch slip relay, to the coil of the clutch slip rotary relay R23. The clutch slip relay R22 is energized through a voltage dropping resistance whenever the main motor reversing relay is operated for either up or down conditions.

24. For every complete revolution (360 deg.) of the clutch slip, the clutch slip rotary relay R23 will be energized once and each time the relay is energized it pulls its contacts, R23/2, to its next contact. After 10 full revolutions of clutch slip the rotary relay will have moved to its contact 11 to connect its supply through contacts R22/3 of the clutch slip relay to the main motor contactor trip coil R17 via its auxiliary contacts R17/5.

25. When the contactor trips, the supply to the clutch slip relay R22 is interrupted, its contacts returning to normal. In this condition the 28-volt slip ring supply is connected (R22/2), via contacts R24/1 of the clutch slip rotary relay reset relay, closed when the rotary relay left its contact 2, to make-and-break contacts R23/1 of the rotary relay and thence to the rotary relay coil. The coil is energized, thus breaking its contacts R23/1 and moving its contacts R23/2 a further step. As contacts R23/1

break they de-energize the coil and allow these contacts to reset.

26. This inching is continued until the rotary relay contacts R23/2 have returned to position 1, when the supply is connected to the reset relay R24 which operates to open (R24/1) the line to the rotary relay coil. So the rotary relay is reset. The contactor may be reset by pushing the relative contactor reset push-switch. The undercarriage must now be actuated by the emergency system.

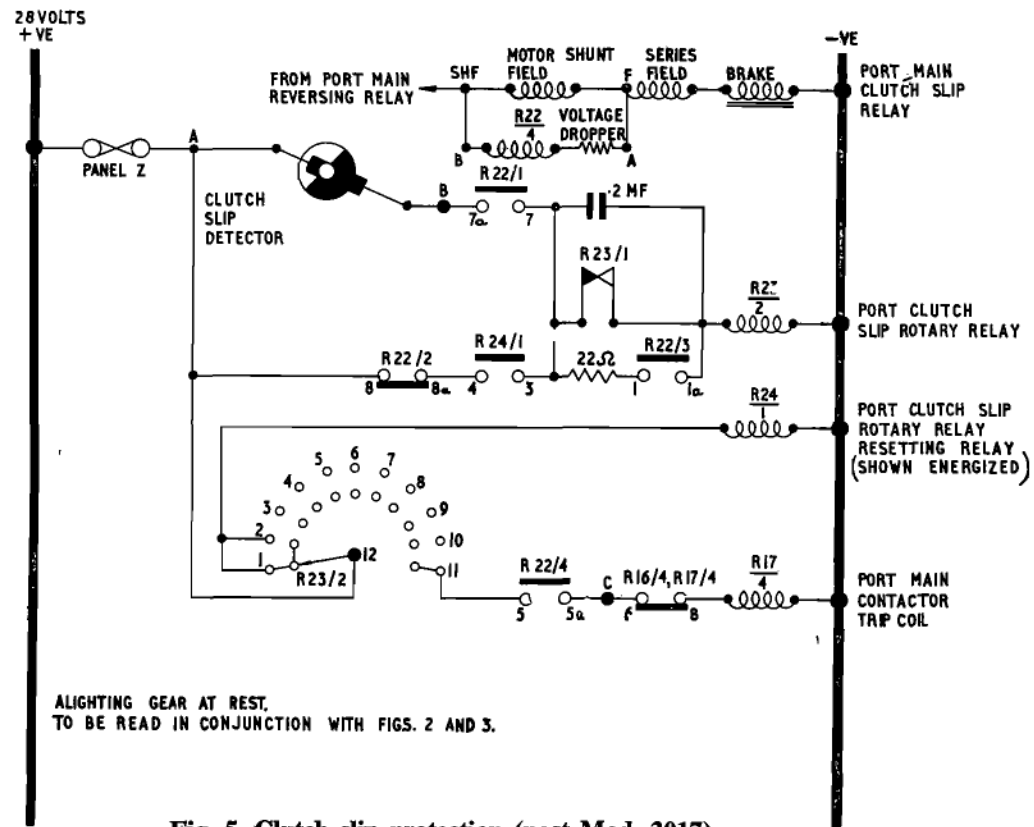
**Note...**

If the undercarriage completes its travel with the clutch slipping not more than ten

revolutions but more than two, the rotary relay will reset to position 1 in a similar manner to that described in paras. 25 and 26. This is because the clutch slip relay R22 will have been de-energized on completion of actuator travel (instead of due to the main contactor being tripped) and its contact R22/2 thereby closed to complete the coil (R23) circuit via contact R24/1 of the resetting relay (closed when the rotary relay R23/2 left position 2).

Post Mod. 2017 (fig. 5)

27. As the systems on each undercarriage are identical, the port undercarriage system only is described. A supply from panel Z,



ALIGNING GEAR AT REST.  
TO BE READ IN CONJUNCTION WITH FIGS. 2 AND 3.

Fig. 5. Clutch slip protection (post Mod. 2017)

is fed to the main motor slip ring and also to the rotary relay stepping contacts R23/2. The second slip ring is connected, via contact R22/1 of the clutch slip relay and the interrupter contact R23/1 of the rotary relay, to the coil R23 of the rotary relay. The clutch slip relay R22 is energized through a voltage dropping resistance whenever the main motor reversing relay is operated for either up or down conditions.

**28.** If the slip rings are in the contacting condition and there is no clutch slip, then the supply will be applied continuously to the coil of the rotary relay R23 for the period of retraction or lowering (approx. 13 secs.). In order not to overload the coil under this condition, a 22-ohm economy resistance is connected in series with the coil via contact R22/3 of the clutch slip relay when the rotary relay interrupter contact R23/1 opens on receipt of the first pulse and the stepping contact R23/2 will be moved round one step.

**29.** For every complete revolution (360 deg.) of clutch slip, the clutch slip rotary relay is energized to pull its contact R23/2 round one step. After 10 full revolutions of clutch slip, the rotary relay will have moved to its contact 11 to connect its supply through contacts R22/4 of the clutch slip relay to the main motor trip coil R17 via its auxiliary contacts R17/5.

**30.** When the contactor trips, the supply to the clutch slip relay R22 is interrupted, its contacts returning to normal. In this condition, the slip ring supply is connected (R22/2) via contact R24/1 of the rotary relay reset relay, closed when the rotary relay contact R23/2 left step 2, to the interrupter contact R23/1 of the rotary relay and thence to the rotary relay coil R23. The coil is energized thus breaking its contact R23/1 and moving its contact R23/2 round one step. As the interrupter contacts R23/1 break, the rotary coil is de-energized and the contacts re-set. The economy resistance is not in circuit under this resetting condition since the clutch slip relay contact R22/3 is open. A 0.2mF condenser is connected across the interrupted contacts R23/1.

**31.** This inching is continued until the rotary relay contact R23/2 has returned to position 1, when the supply is connected to the reset relay R24 which operates to open (R24/1) the circuit to the rotary relay coil. The rotary relay is now reset.

◀ **31A.** The main contactor may be reset by depressing the relative contactor reset-push-switch on the starboard console. The undercarriage may then be lowered by using the emergency system.

**Note . . .**

*If the undercarriage completes its travel with the clutch slipping not more than ten revolutions but more than two, the rotary relay will reset to position 1 in a similar manner to that described in paras. 30 and 31. This is because the clutch slip relay R22 will have been de-energized on completion of actuator travel (instead of due to the main contactor being tripped) and its contact R22/2 thereby closed to complete the coil (R23) circuit via contact R24/1 of the resetting relay (closed when the rotary relay R23/2 left positions 2).*

*When no undercarriage selection is made (fig. 4 or 5)*

**32.** Frequently on connecting or switching on power to the aircraft's 28-volt system the rotary relay for any of the undercarriages can be heard to notch round. This is quite normal and can be considered as a side effect of the clutch slip protection system as explained in the following paragraphs.

**32A.** Whether the clutch slip device is at rest with the slip rings in the contacting condition or not, the rotary relay will be stepped round one position each time the 28-volt system on the aircraft is made 'live'. When the bus-bar is 'dead' the resetting relay R24 will be un-energized and its contact R24/1 closed, thus, when the bus-bar is made 'live' this closed contact R24/1 will allow the rotary relay R23 to be energized simultaneously with the resetting relay R24 and in consequence its contact R23/2 will notch round to position 2. The next time the bus-bar is made 'live' the contact R23/2 will be similarly notched round to position 3.

**32B.** At position 3, the resetting relay R24 will be de-energized and the supply from panel Z via R22/2 will be connected by contact R24/1 through the interrupter contacts R23/1 to the rotary relay coil R23. Since the clutch slip relay R22 is un-energized, due to the undercarriage not being operated, the rotary relay will continue to notch round its contact R23/2 until position 1 is again reached and R24 re-energized; the undercarriage main contactor R17 will not be tripped when the contact passes position 11 as the clutch slip relay contact R22/3 (Fig. 4) or R22/4 (Fig. 5) will be open. ▶

**Emergency**

**33.** The emergency circuit can only be used to lower the alighting gear. When the EMERGENCY push-switch is depressed (fig. 1) a supply from the port fuse panel E is connected through the emergency down nosewheel uplock limit switches to the operating coil of the nosewheel emergency relay R11 which is mounted in the nose-wheel bay roof. The supply is also connected through the port and starboard mainwheel door actuator emergency out limit switches, to the operating coils of the mainwheel door emergency relays, R13, mounted on their respective alighting gear control panels.

**34.** The emergency relays operate (R11/1, R13/1) (fig. 3) to connect 112-volt supplies from panel J to the nosewheel and mainwheel door emergency motors and their series connected brake solenoids. The supplies to the mainwheel door emergency motors are fused branches of the supplies to the mainwheel emergency motors, the fuses being mounted on the alighting gear control panels. The motors will now start to lower the nosewheel and the mainwheel doors. The brakes are released simultaneously with the motors starting. The motors will continue to operate until the actuators reach the limits of their travel, when the nosewheel and mainwheel doors will be in the down position, and the limit switches will be operated.

35. The normal limit switches will be operated as for normal conditions. The nosewheel emergency down uplock limit switch (*fig. 1*) disconnects the supply to the nosewheel emergency relay R11, which, in turn, disconnects (R11/1) (*fig. 3*) the 112-volt supply to the nosewheel emergency motor and applies the brake.

36. The mainwheel door actuator emergency out limit switches (*fig. 1*) disconnect the supply to the door emergency relays R13, which, in turn, disconnect (R13/1) (*fig. 3*) the 112-volt supply to the door emergency motors and apply the brakes. At the same time, the door actuator emergency out limit switches (*fig. 1*) connect the supply, from the downlock emergency limit switches, to the operating coils of the mainwheel emergency relays R12, mounted on their respective alighting gear control panels.

37. These relays operate to connect (R12/1) (*fig. 3*) 112-volt supplies from panel J to the mainwheel actuator emergency motors and their series connected brake solenoids. The motors start to lower the main undercarriages, the brakes being released simultaneously with the motors starting. Resistances across the motor armatures ensure that the brake solenoids remain energized when the weight of the falling undercarriage reduces the armature current to below the hold-in value for the brake.

38. When the actuators reach the limits of their travel, the main undercarriage will be in the down position and the limit switches will be operated. The normal limit switches will be operated as described for normal operation. The mainwheel downlock emergency limit switches (*fig. 1*) will disconnect the supply to the mainwheel emergency relays R12, which, in turn, disconnect (R12/1) (*fig. 3*) the 112-volt supply to the

mainwheel emergency motors and apply the brakes.

39. In the event of mechanical failure of the uplock or undercarriage mechanism, the extreme emergency circuit will have to be brought into operation. The circuits to port and starboard are separate but identical and the following description applies to one circuit only.

#### **Extreme emergency**

40. When an EXTREME EMERGENCY switch is placed in its DOWN position, a supply from the feed side of a fuse on the starboard fuse panel D, via a circuit breaker (*fig. 1*) mounted on the rear face of the starboard console, is connected to the mainwheel door actuator to the door. There is a resistance in series with each bolt so that the current is limited in the event of a bolt welding in. *(Continued overleaf)*

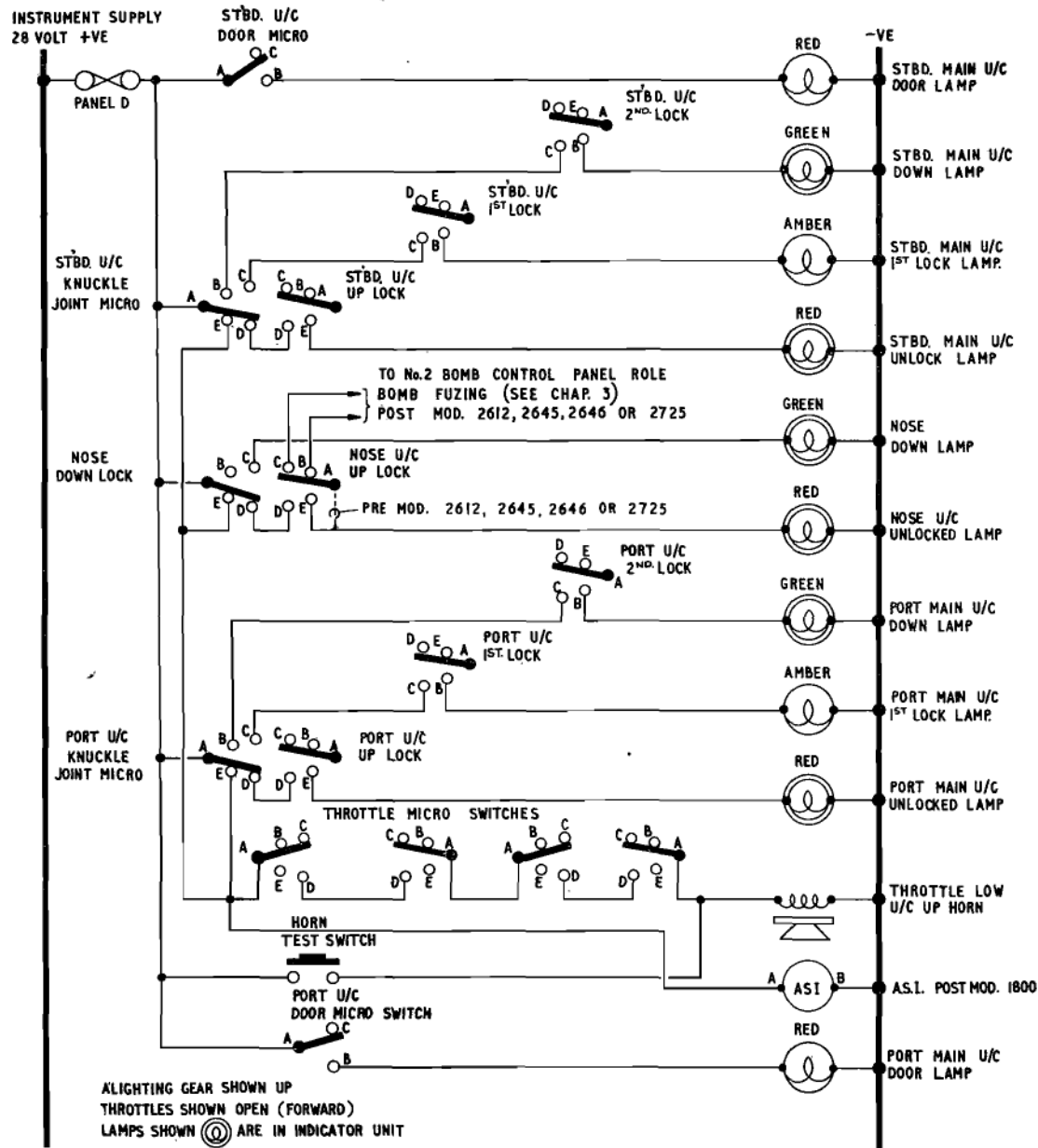


Fig. 6. Alighting gear indication and warning (pre-mods. 2257 and 2118)

41. At the same time another supply, from the starboard fuse panel D, is connected through the mainwheel down limit switches to the 'down' coil of the mainwheel motor reversing relay (R8) which operates as described for the normal lowering operation as described for the alighting gear.

42. When the explosive bolts have been detonated, the door will drop under its own weight but the undercarriage will be driven down as in normal operation, rheostatic braking being applied.

#### ALIGHTING GEAR INDICATION

Pre-Mod. 2257 (fig. 6)

Note. . .

Mod. 2202 introduces Type 'C' Mk. 2 Dowty "Downmic" limit switches in lieu of micro switches Ref. No. 5CW/4638 for the port and starboard door indicating lamps.

43. An indicator on the pilot's instrument centre panel, shows whether the alighting gear is locked up, locked down or unlocked. The indicator consists of six lamps, three of these are green to indicate that the alighting gear units are locked down, and the other three are red to indicate that the alighting gear units are unlocked. When no lamps are lit the alighting gear units are locked in the up position. The three green lamps and the three red lamps give individual indication of the state of each undercarriage.

44. In the event of failure of a lamp filament, duplicate lamps can be brought into service by a switch on the indicator. A screen is fitted to the indicator to cover the lamps when flying at night.

45. The lamps of the indicator are operated by eight micro switches, one at each uplock, one at each of the main undercarriage 2nd downlocks, one on the nose undercarriage downlock, and one on each of the main undercarriage side stay knuckle joints. A micro switch at each downlock 1st lock is

connected to an amber lamp on the pilots' instrument centre panel. The system is supplied from the starboard fuse panel D, and becomes operative when the flight instrument master switch is closed.

46. When the alighting gear is locked down, the supply is connected by the port and starboard main undercarriage knuckle joint micro switches to four parallel circuits. Two of these circuits feed the port and starboard main undercarriage 1st downlock amber lamps, through their respective 1st lock micro switches. The other two circuits feed the port and starboard main undercarriage down green lamps in the indicator, through their respective 2nd down-lock micro-switches. At the same time the supply is connected through the nose undercarriage down-lock to the nose down green lamp in the indicator. Thus indication is given to show that all the down locks are home.

47. When the alighting gear is raised, the 1st and 2nd downlocks are first withdrawn. As the locks are withdrawn, their micro switches operate to disconnect the supplies to the port and starboard, 1st lock and main undercarriage down lamps. As the alighting gear is raised, the main undercarriage knuckle joints 'break' thus operating the knuckle joint micro switches, which now connect the supply to the port and starboard main undercarriage unlocked red lamps in the indicator. At the same time the nose undercarriage downlock micro switch is operated, which disconnects the supply to the nose down lamp and reconnects it to the nose unlocked red lamp in the indicator. Thus indication is given that all the locks are 'broken'.

48. As the alighting gear reaches its up position, the uplocks will be operated. The nose, port and starboard undercarriage uplock micro switches will then be operated to disconnect the supplies to their respective red lamps. Thus indication is given that all the uplocks are locked.

49. The position of the port and starboard main undercarriage doors, is indicated by

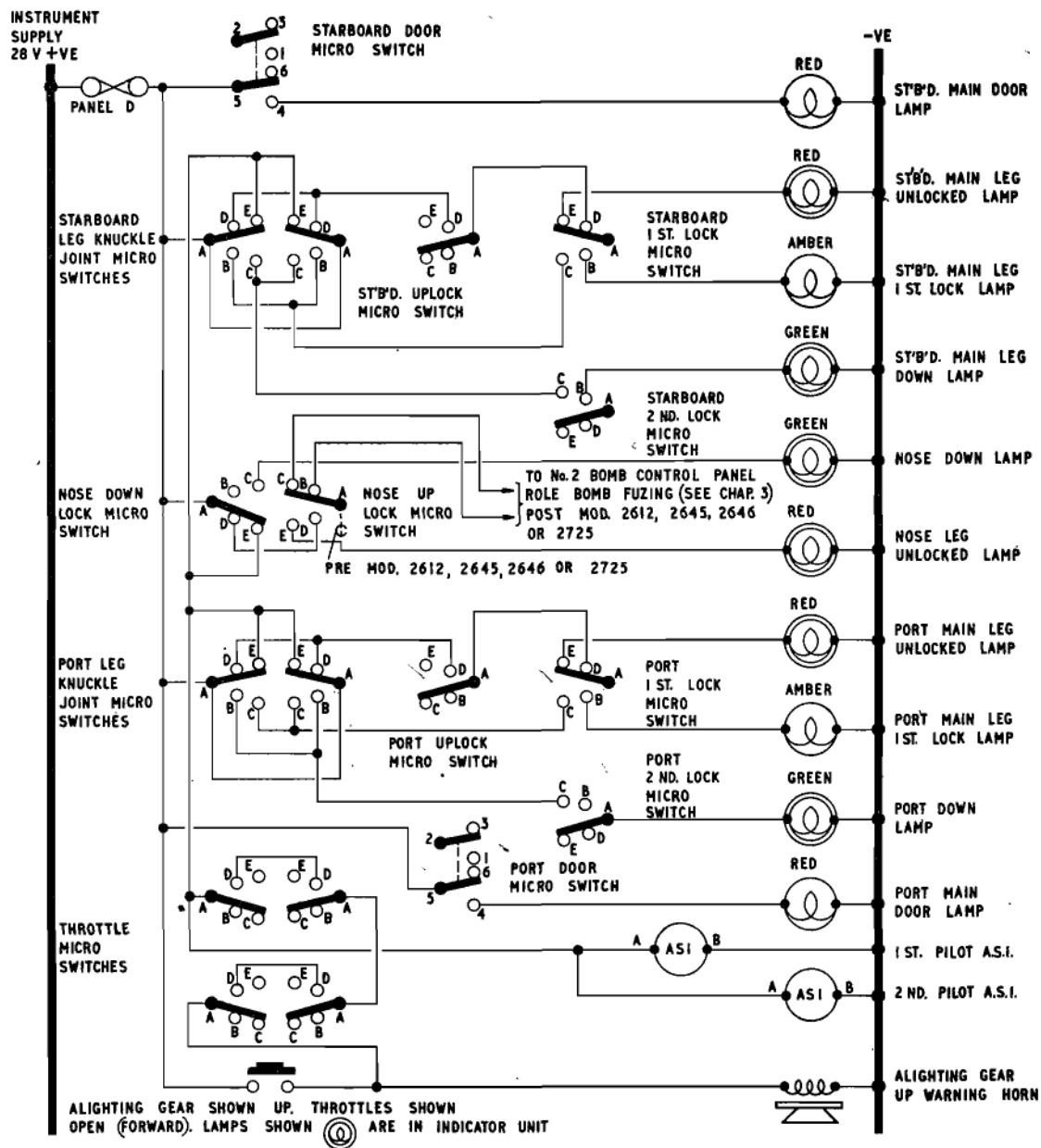


Fig. 7. Alighting gear indication and warning horn (post mods. 2118, 2257 and 2202)

two red lamps mounted, on the starboard coaming panel. The lamps are controlled by micro switches mounted in the door up stops. When the doors are open the lamps are lit. The supply is the same as that which feeds the alighting gear indicator circuits. Micro switch positions for these conditions are given below.

**Post Mod. 2257 (fig. 7)**

50. Mod. 2257 introduces two extra micro switches (Ref. No. 5CW/4639), mounted one on each of the port and starboard undercarriage knuckle joints. These micro switches are connected in parallel with the original knuckle joint micro switches. This modification also revised the circuit to provide additional switching, through the 1st lock micro switches, for the port and starboard undercarriage red unlocked indicator lamps. Operating sequence and function of the micro switches is the same as pre-Mod. 2257. Warning horn and A.S.I. circuits are not applicable to this modification.

51.

**MICRO—SWITCH POSITIONS**

	Main downlock 1st lock	Main downlock 2nd lock	Nose downlock	Knuckle joints	All Uplocks	Main door stop
Alighting gear locked down	A.B.C.	A.B.C.	A.B.C.	A.B.C.	A.D.E.	A.B. (Pre-Mod. 2202) 5—4 (Post Mod. 2202)
Alighting gear going up or down, but unlocked	A.D.E.	A.D.E.	A.D.E.	A.D.E.	A.D.E.	A.B. (Pre-Mod. 2202) 5—4 (Post Mod. 2202)
Alighting gear locked up	A.D.E.	A.D.E.	A.D.E.	A.D.E.	A.B.C.	A.C. (Pre-Mod. 2202) 5—6 (Post Mod. 2202)

**WARNING HORN (fig. 6 — 7)**

52. The alighting gear and throttles are interlocked, so that, if the throttles should be closed beyond a pre-determined position whilst the alighting gear is in any position other than locked down, a horn mounted on the pilot's floor forward beam, will be energized. The horn will be de-energized as soon as the alighting gear is locked down.

53. The supply, that feeds the alighting gear horn circuit, is obtained through the main undercarriage knuckle joint and the nose undercarriage down lock micro switches, when they are in their undercarriage not locked down positions. From these micro switches the supply is taken via four micro switches, connected in series, to the horn and hence to the negative line. These four micro switches are fitted one to each throttle control rod at the base of the control pedestal, and are operated as the throttles are pulled back (closed) beyond a pre-set position. Thus, if the alighting gear is not locked down and the throttles are closed, the supply is connected

to the horn which becomes energized, giving audible warning of the fact.

54. There is a push-switch mounted on the starboard console which when depressed connects the supply directly to the horn. This is for test purposes only.

**THROTTLE MICRO SWITCH POSITIONS**

55. Throttles open           A.B.C.  
Throttles closed           A.D.E.

**Note. . .**

Post Mod. 1800 the Air Speed Indicator on the 1st pilot's blind flying panel is replaced by a Type KAB/1401K (Ref. No. 6A/4380) 50/490 knots instrument. This is supplied via the main undercarriage knuckle and nose downlock micro switches only when the undercarriage is raised. When the aircraft speed falls below a predetermined speed, with the undercarriage up, a 'flag' starts to oscillate across the face of the instrument. Mod. 2118 introduces a similar system at the 2nd pilot's position.

**NOSEWHEEL STEERING AND MAINWHEEL BRAKES AND PUMP CONTROL (fig. 8)**

56. Nosewheel steering and mainwheel braking is effected by two hydraulic services, 1 and 2, operating in conjunction with one another. Pressure in each service is supplied by an electric motor driven pump. The two pumps, mounted in the starboard service bay, are controlled independently by a pressure switch in each service and by micro switches operated by the nosewheel downlock. As the pump motor circuits are identical one only will be described. The instrument master switch must be ON.

**Note. . .**

Post Mod. 1710, the nosewheel steering panel comprising the pump contactors and their start units are mounted forward and above Z panel on the starboard side of the fuselage.

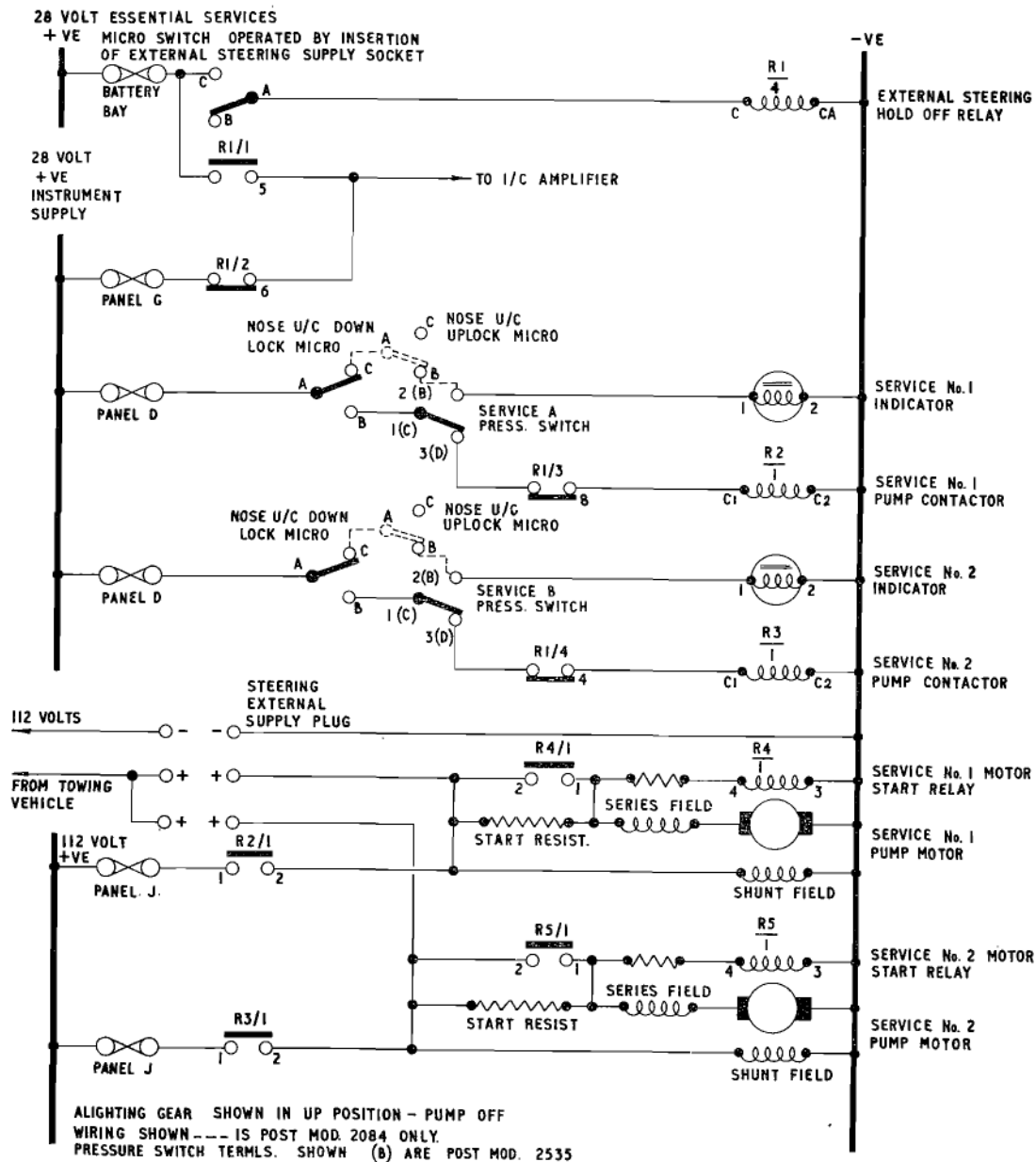


Fig. 8. Nosewheel steering and mainwheel brake pump control

57. When the undercarriage is lowered the nosewheel downlock operates a micro switch, which connects a supply from a fuse on the starboard fuse panel D, to the live side of the pressure switch for the associated service. The pressure switches are mounted on a panel near the pumps. The pressure switch closes when the hydraulic pressure in the service falls to 1,900 lbs. sq. in. and opens when the pressure reaches, 2,300 lb. sq. in.

Post Mod. 2084.

58. When the undercarriage is lowered, the uplock micro switch breaks the circuit to the pump running magnetic indicator which is thus de-energized to read ON. The downlock micro switch connects its supply from panel D to the pressure switch. The pressure switch closes when the hydraulic pressure in the service falls below 1,900 lb./sq. in. and opens when the pressure reaches 2,300 lb./sq. in.

59. When the pressure switch is in the closed position, the supply is connected, via contacts R1/3 on the hold off relay, Type S4, mounted in the nosewheel bay on the nosewheel retraction panel, to the operating coil of the pump motor contactor R2, mounted on the nosewheel steering panel, and thence to the negative line. The contactor closes R2/1 to connect a 112-volt supply, from a H.R.C. fuse on power panel J, to the starter resistance unit, also mounted on the nosewheel steering panel, and to the shunt field of the motor. From the starter resistance unit, the supply is taken to the motor armature and series field and thence to the negative line.

59A. Various modifications introduce improved pressure switches as follows:

- Pre-Mod. 1695 — Vickers A5308 Sht. 1
- Post Mod. 1695 — Vickers A5738 Sht. 1
- Post Mod. 2535 — Teddington FPH/A/6

60. The starter resistance unit consists of a resistance, which is in series with the motor armature, and a relay R4. The

relay coil R4 is connected in series with another resistance, the two being connected in parallel with the motor armature and series field. When the back e.m.f. of the motor builds-up to 80 volts due to increasing speed, the relay operates R4/1 short-circuiting the starting resistance and allowing the motor to operate on full voltage.

#### Indicators (fig. 7)

**61.** A magnetic indicator, pre-Mod. 1613, mounted on the port coaming panel, is de-energized to show WHITE when the motor is running and energized BLACK when the motor is not. Each indicator is operated by its respective service pressure switch; the indicator operates only when the undercarriage is down.

**62.** Post Mod. 1613, the indicators are of the ON/OFF type (C.5165Y Mk. 23) in lieu of the black/white type (Ref. No. 5CZ/4362). Each indicator is operated by its respective service pressure switch, so that, when the pressure has built up suffi-

#### Introduction

**66.** The General Information Group, contained in Book 2 immediately after Section 5 marker page, 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.

#### Note. . .

*Setting instructions for all micro switches are given in the relative chapters of Book 1 Section 3.*

#### GROUND OPERATIONAL LIMITS

**67.** To prevent damaging the alighting gear motors by overheating whilst they are being serviced on the ground, it is essential

ciently to trip the pump, the indicator will be energized to read OFF.

**63.** Mod. 2084 introduces a micro switch on the nose uplock connected in series with that on the downlock so that they will both be made when the undercarriage is raised to keep the indicator energized to read BLACK in flight. This Mod. also introduces magnetic black and white indicators. Ref. No. 5CZ/5074 in lieu of Ref. No. 5CZ/4362 and C5165Y Mk. 23.

#### Towing

**64.** When it is required to tow the aircraft, electrical power is required to build up the hydraulic pressure for the brakes and steering. The power supply is obtained externally at 112-volts from the towing vehicle, by inserting its socket into the 112-volt external supply plug which is mounted at the front end of the starboard wall of the nosewheel bay, and which is provided especially for this purpose. The plug has two positive pins, one for each pump motor, and one common negative pin. When the external supply socket is inserted the two

positive pins are connected together and the two pumps are fed in parallel. The contactors, nosewheel downlock micro switches and pressure switches are not in circuit, when the external supply is used, the 112-volt supply being connected directly to the pump motors and their starter units.

**65.** As the external supply socket is inserted, it operates a micro switch, which connects a supply from the essential services bus-bar, via a fuse on the 24-volt battery control panel, to the operating coil of the hold-off relay R1, mounted on the nose undercarriage relay panel. This relay operates (R1/3-4) to isolate the normal 24-volt system from the motor control circuits, so that if the system should be energized whilst the steering and brake pumps external supply is connected, the pump motor contactors R2, R3, cannot be operated, thus preventing a feedback of 112-volt from the towing vehicle to the aircraft 112-volt system. The hold-off relay also connects (R1/1) the 28-volt essential services supply to the aircraft intercomm. system.

## SERVICING

that the motors are not operated for periods in excess of those given below:

#### Main and nose undercarriage and undercarriage doors

A series of five cycles with five minutes interval between each cycle.  
30 minutes between series.

#### Emergency motor

Three operations with a thirty minutes interval after every third operation.

## ALIGHTING GEAR INDICATIONS

#### Pre-Mod. 2257

**68.** (1) Check the circuit fuse and connect a 28-volt d.c. supply to the external connection.

(2) Select the flight instrument master switch to ON. Check that the three green indicator lamps and the two amber lamps are on. Check that the two red door indicating lamps are on.

(3) Operate the duplicate filament switch on the indicator and check that the other lamps come on. Test the horn by pressing the test push.

(4) Check that the indicator night screen operates correctly.

(5) Pull the throttles back (closed). The horn should not sound whilst the alighting gear is locked down.

(6) Operate the port and starboard door micro switches and check that their respective indicating lamps go off.

- (7) Operate the starboard 1st lock micro switch and check that the starboard amber indicating lamp goes off.
- (8) Operate the starboard 2nd lock micro switch and check that the starboard green indicator lamp goes off.
- (9) Operate the starboard knuckle joint micro switch. Check that the starboard red indicator lamp comes on and the starboard green and amber indicating lamps go off. Check that the warning horn sounds.
- (10) Open and close each throttle in turn. Check that the horn stops sounding when each throttle is open.
- (11) Repeat the above procedure for the port undercarriage.
- (12) Operate the nose undercarriage down lock micro switch. Check that the green nose indicator lamp goes off and the red lamp comes on. Check that the warning horn sounds.
- (13) Return all switches to OFF.

#### Post Mod. 2257

69. Mod. 2257 alters the circuit wiring for the port and starboard red indicator lamps. The procedure for functioning the indicator system is the same as for pre-Mod. 2257 except that, to operate the port and starboard main undercarriage unlocked red indicator lamps, the knuckle joint and 1st lock micro switches must be operated simultaneously.

#### ALIGHTING GEAR

##### WARNING. . .

*Detonators (Sub-para. 14) must not be handled during removal or replacement they must only be held by their connecting wires.*

*Detonators should be renewed at the periods laid down in the current Servicing Schedules for this class of equipment.*

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

- (2) Reset all contactors that are tripped.
- (3) Check that the nose undercarriage is in the central position.
- (4) Rotate and depress the UP push switch. Check that the indicator lamps sequence is correct and that the time between fully locked down and fully locked up correspond with the times given in para. 72.
- (5) Press the alighting gear DOWN push switch. Check that the indicator lamps sequence is correct and that the time between fully locked up and fully locked down positions correspond with the times given in para. 72.
- (6) Select the alighting gear UP.
- (7) Press the EMERGENCY DOWN push switch. Check that the time between fully locked up and fully locked down positions correspond with the times given in para. 72.

#### Note. . .

*Immediately after lowering the main undercarriage using the emergency system:*

- (a) *Remove the arc chutes from the main undercarriage emergency and door emergency contactors.*
- (b) *Check that the contacts have not welded together and that the contact arms are not interlocked.*

- (8) Disconnect the nose undercarriage main actuator.

- (9) Connect a 28-volt test lamp between terminal C4 of the nose undercarriage main reversing relay and earth.
- (10) Disconnect the port and starboard main actuators.
- (11) Press the undercarriage UP push switch and check that the test lamp lights.
- (12) Operate the nosewheel central micro switch to break the circuit and check that the test lamp goes out.
- (13) Reconnect the port, starboard and nose main undercarriage actuators.
- (14) Disconnect all uplock and door actuator fixing explosive bolts. Connect 28-volt test lamps between each supply and earth. Secure the lamps so that movement of the undercarriage will not damage them.
- (15) Disconnect the undercarriage door actuators.
- (16) Raise the undercarriages using the UP push switch.
- (17) Select DOWN with the extreme emergency switches. Check that the test lamps come on and the port and starboard undercarriages operate.
- (18) Return the extreme emergency switches to NORMAL.
- (19) Lower the nose undercarriage by using the normal down push switch.
- (20) Remove all test lamps. Reconnect the uplock and door fixing explosive bolts. Reconnect the door actuators.
- (21) Rotate the UP push switch to its normal position.

#### 71.

#### ALIGHTING GEAR LAMPS INDICATION SEQUENCE

Alighting gear locked up and throttles closed.

Alighting gear travelling up or down and throttles closed.

Alighting gear fully locked down and throttles closed.

Warning horn sounds and door red lamps are on.

Warning horn sounds.

Door red lamps are on and nose, port and starboard red indicator lamps are on.

Nose, port and starboard green lamps are on.

**AVERAGE TIMES FOR  
OPERATIONS ON THE GROUND**

**72. Main undercarriage and undercarriage doors.**

Normal up	12±3	seconds
Normal down	13±3	seconds
Emergency down	35±5	seconds

**Main undercarriage**

Normal up	8±2	seconds
-----------	-----	---------

**Main undercarriage doors**

Normal down	4±2	seconds
Emergency down	12±3	seconds

**Nose undercarriage**

Normal up	11±3	seconds
Normal down	8±3	seconds

**CLUTCH SLIP RELAY**

**73. (1)** Disconnect the main undercarriage doors actuators.

(2) Unfix the nose undercarriage doors.

(3) Connect a micro switch across pins A and B of the main undercarriage actuator two pin socket.

(4) As the undercarriage moves up, operate the micro switch to make and break the circuit. On the tenth operation of the micro switch the undercarriage will stop.

(5) Check that the contactor tripped warning lamp comes on.

(6) Press the main contactor reset push and note that the lamp goes out and the undercarriage completes its operation to the fully up position.

(7) Repeat the above procedure for the undercarriage down operation.

(8) Carry out the above procedure for both the main and the nose undercarriages.

(9) Reconnect the actuators two pin sockets.

(10) Reconnect the undercarriage doors actuators.

(Continued overleaf)

**NOSE UNDERCARRIAGE  
SLUGGED RELAY**

74. (1) Disconnect the undercarriage actuator.
- (2) Rotate and depress the UP push switch.
- (3) Bridge terminals A and B on No. 1 uplock micro switches and check that the main contactor tripped warning lamp comes on.
- (4) Remove the bridge and reset the main contactor noting that the lamp goes out.
- (5) Select alighting gear DOWN.
- (6) Bridge terminals A and B on No. 1 downlock micro switches and check that the main contactor tripped warning lamp comes on.
- (7) Remove the bridge and reset the main contactor noting that the lamp goes out.
- (8) Reconnect the undercarriage actuator.
- (9) Rotate the UP push switch to its normal position.

**Control indications**

- |                   |   |               |
|-------------------|---|---------------|
| 76. Pre-Mod. 1613 | } | Pumps running |
|                   |   | Pumps off     |
| Post Mod. 1613    | } | Pumps running |
|                   |   | Pumps off     |
| Post Mod. 2084    | } | Pumps running |
|                   |   | Pumps off     |

**NOSEWHEEL STEERING AND  
MAINWHEEL BRAKES PUMP**

**Control**

75. (1) Check the circuit fuses and connect 28-volt and 112-volt d.c. supplies to the external connections.
- (2) Select ON with the flight instrument master switch.
- (3) Operate the nosewheel steering control and check that the nosewheel operates in the correct direction and that the indicators read correctly.
- (4) Switch to OFF the flight instrument master switch and remove the external supplies.
- (5) Connect a 112-volt d.c. supply to the nosewheel steering external supply plug.
- (6) Operate the nosewheel steering control and check that the nosewheel operates in the correct direction and that the indicators read correctly.

- De-energized WHITE
- Energized BLACK
- De-energized ON
- Energized OFF
- De-energized WHITE
- Energized BLACK

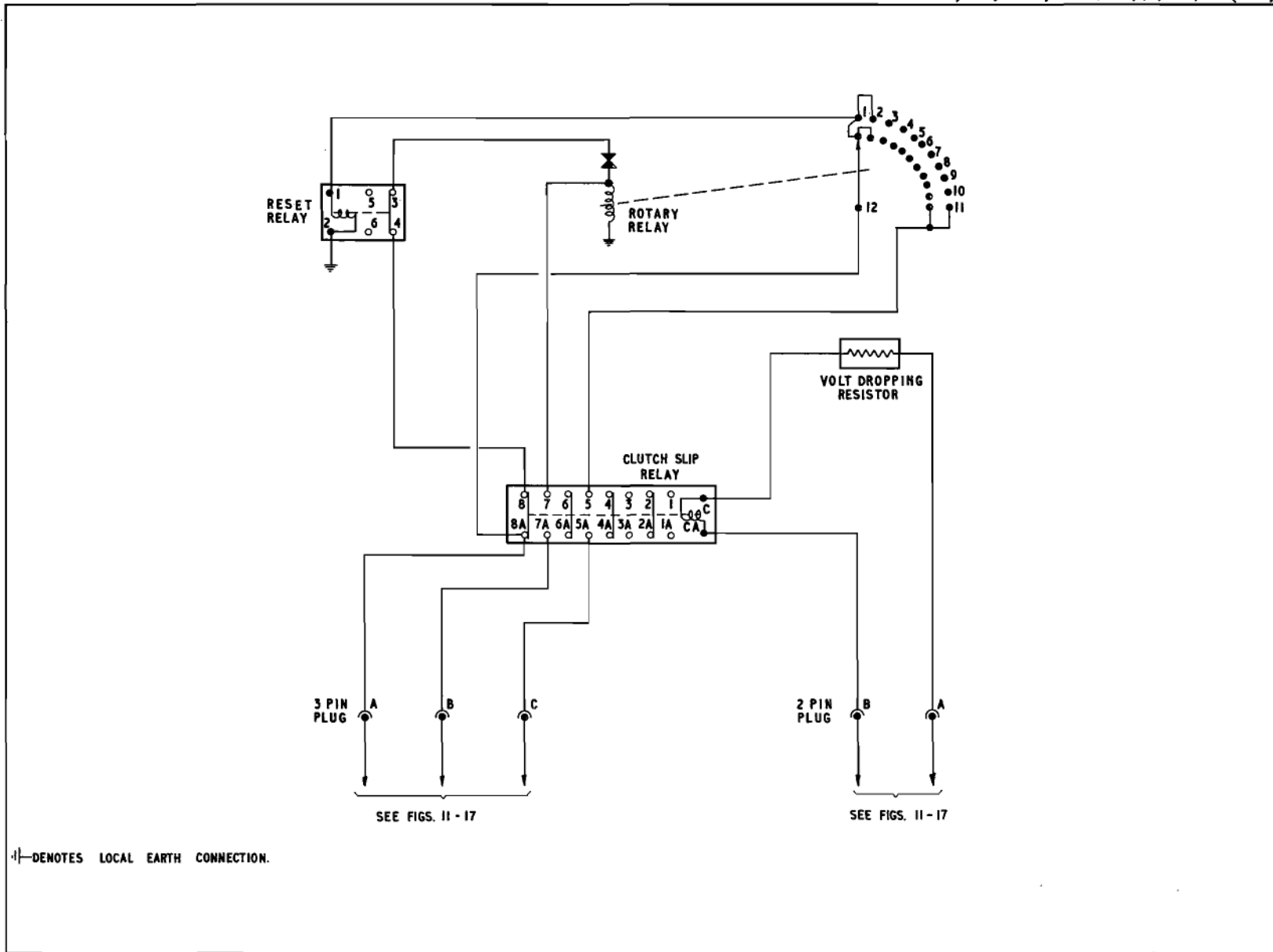


Fig. 9. Clutch slip relay box. (pre Mod. 2017)  
RESTRICTED

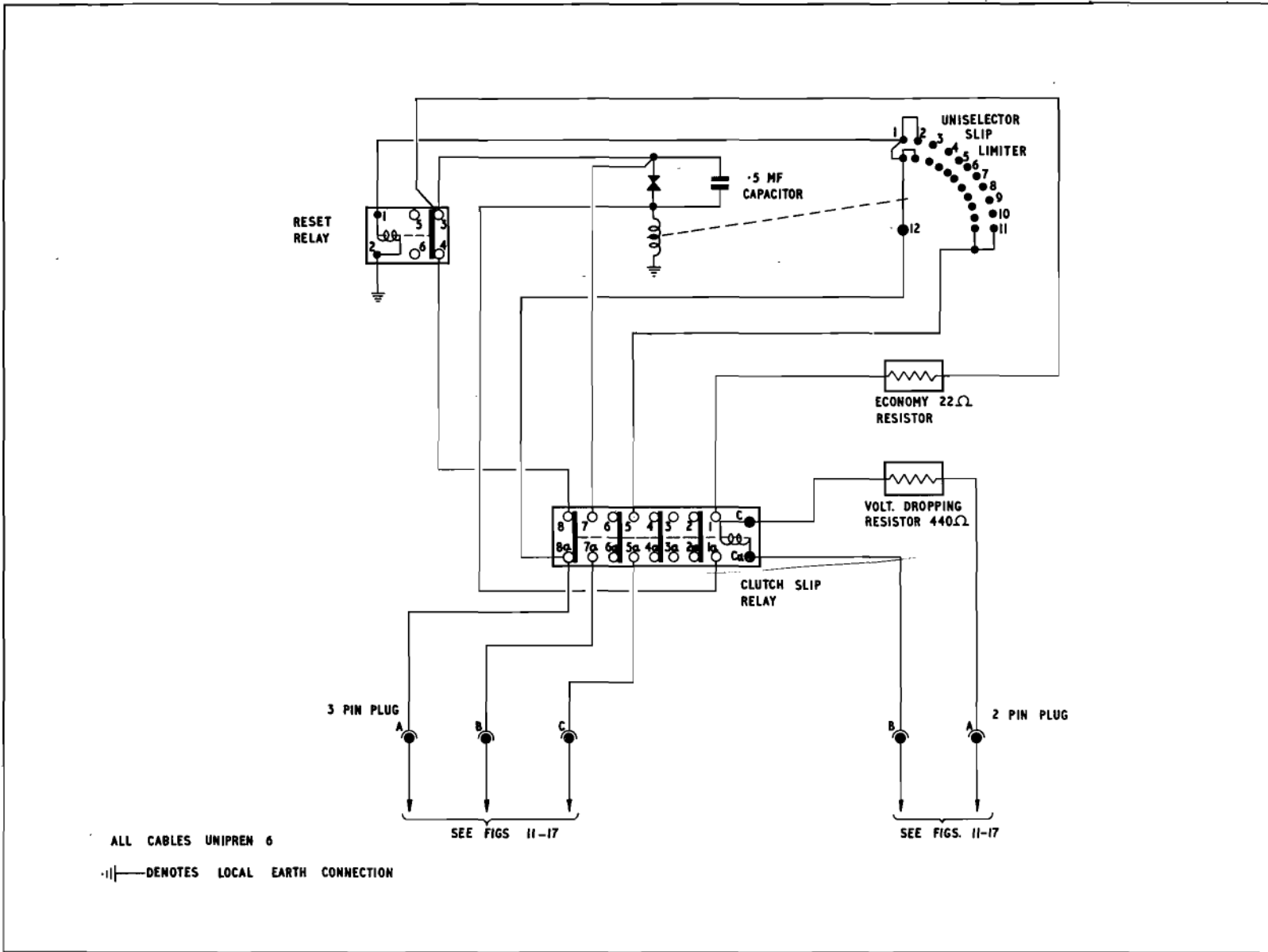


Fig. 10. Clutch slip relay box (post Mod. 2017)  
RESTRICTED

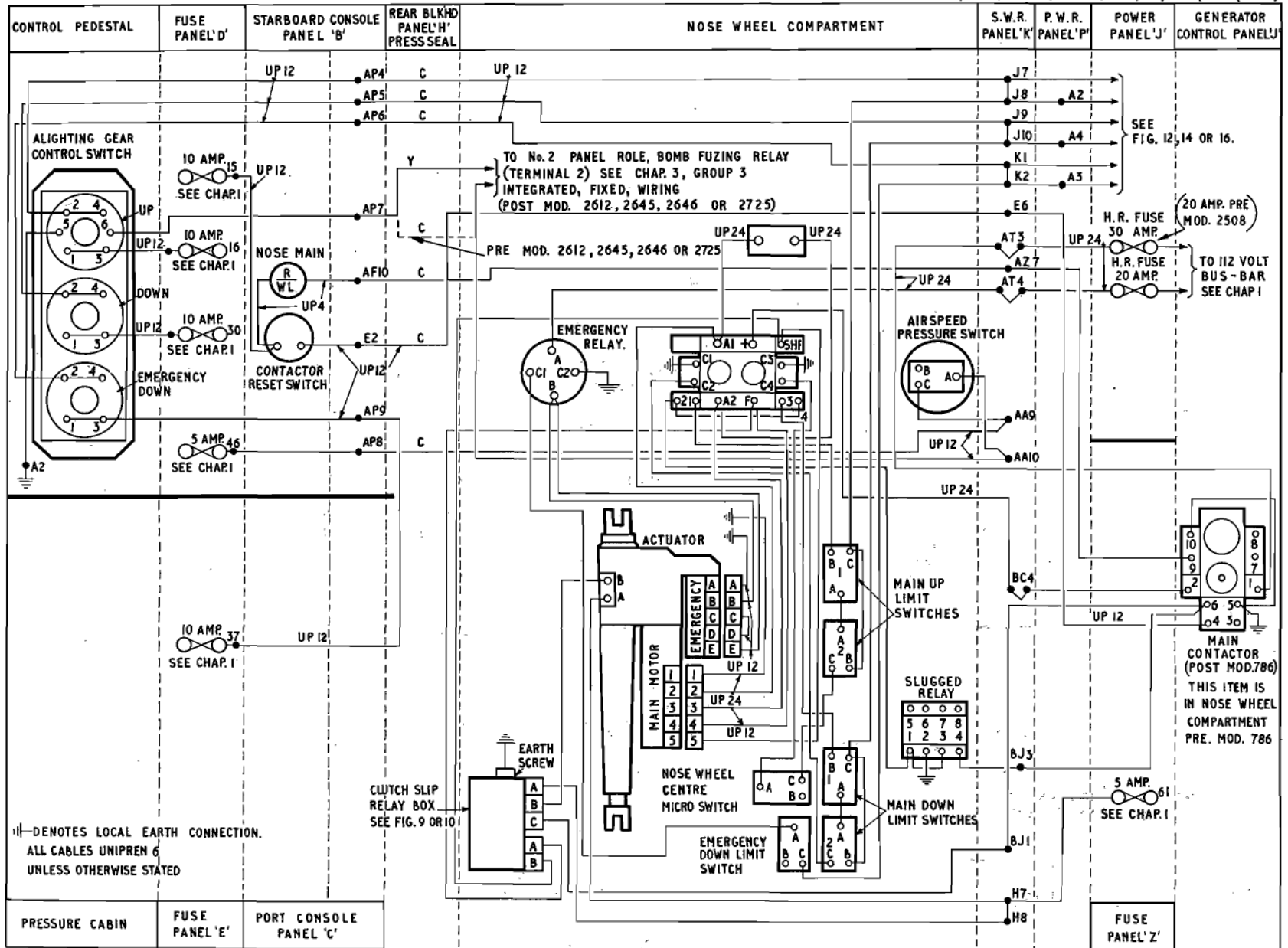


Fig. 11. Alighting gear actuation nose RESTRICTED



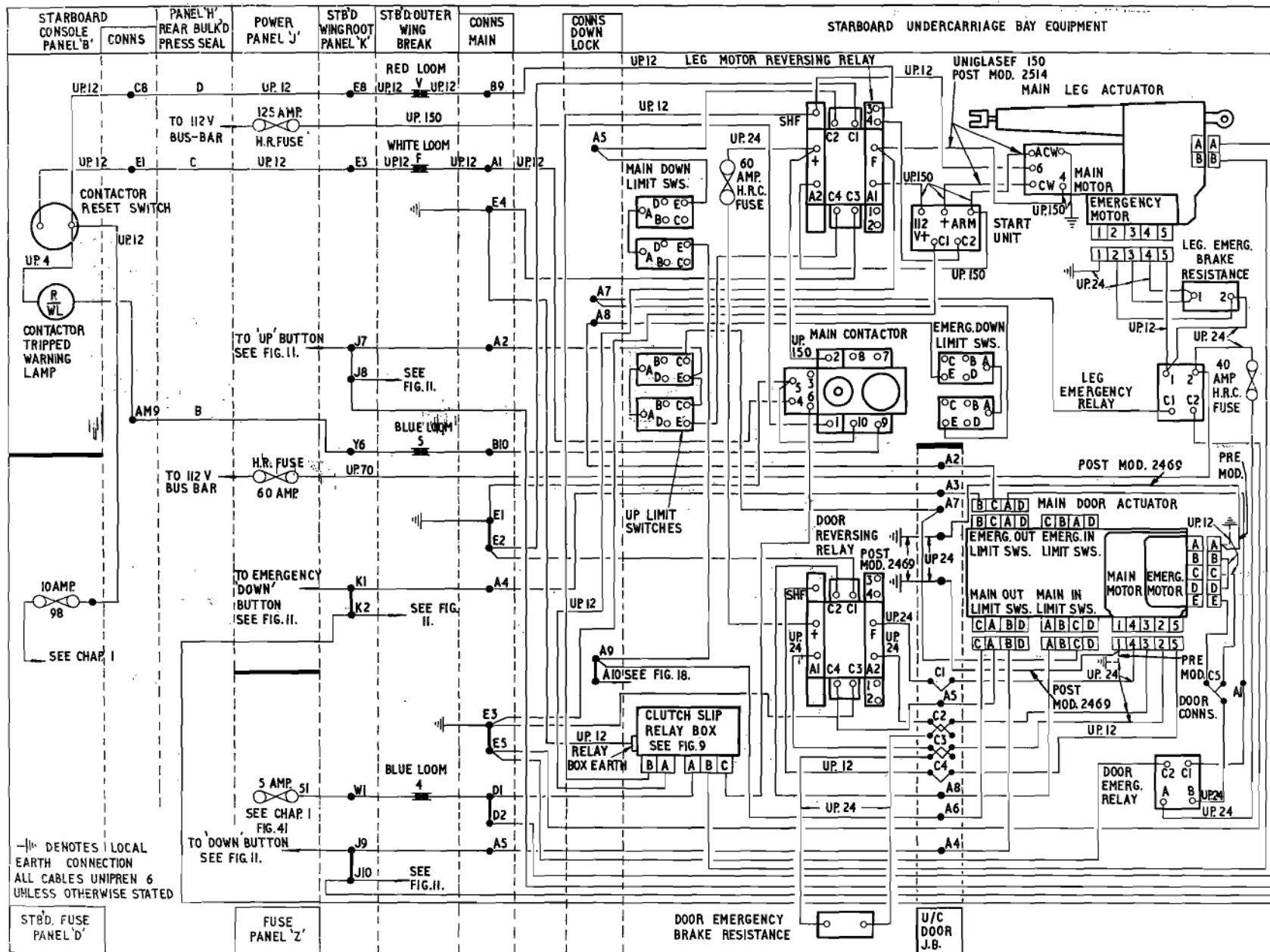


Fig.13.(1) Alighting gear actuation main (post Mod.1835)

RESTRICTED

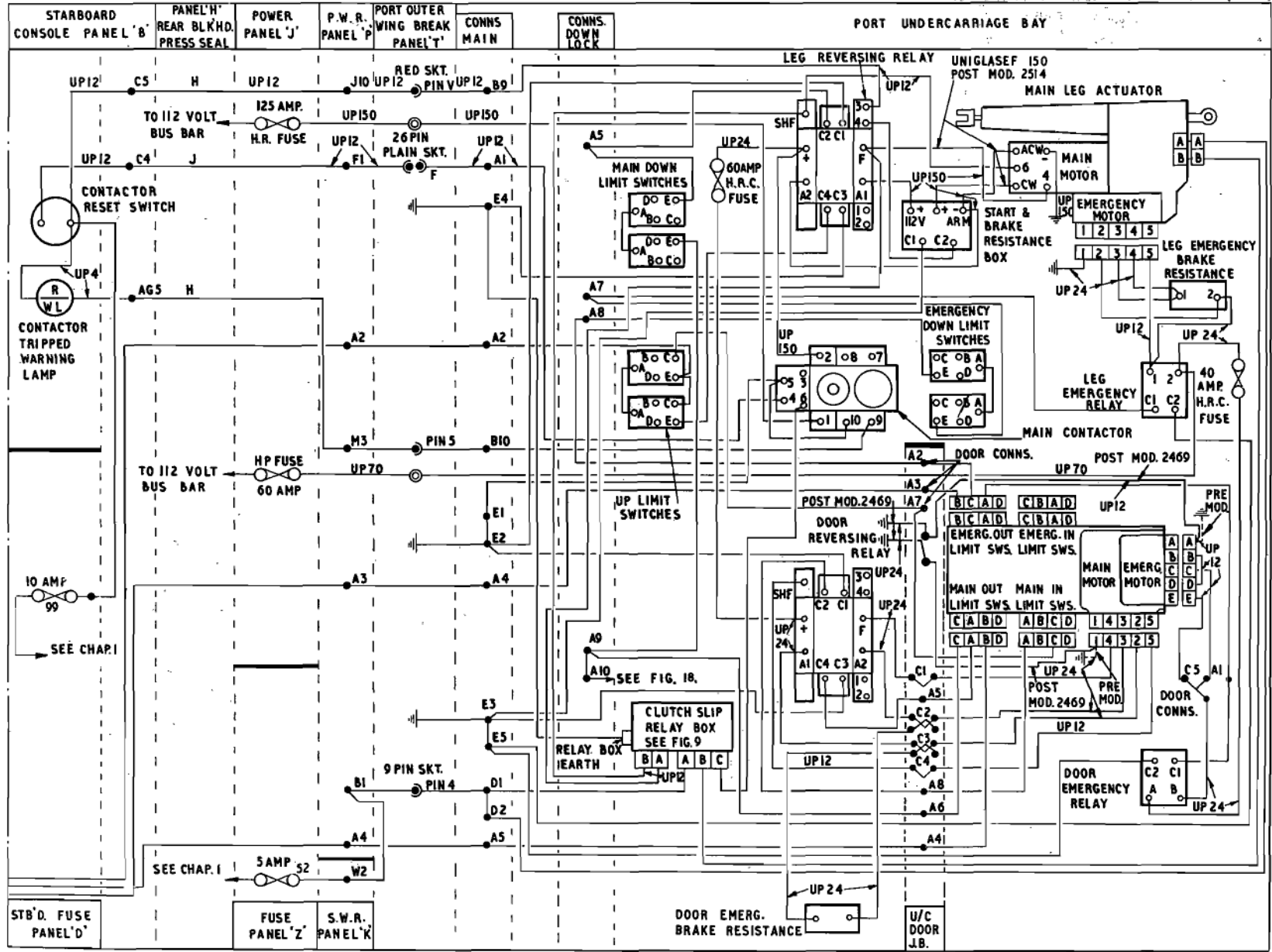


Fig. 12(2) Alighting gear actuation main (post Mod 1775)  
RESTRICTED pre Mod 1835 or 1785)

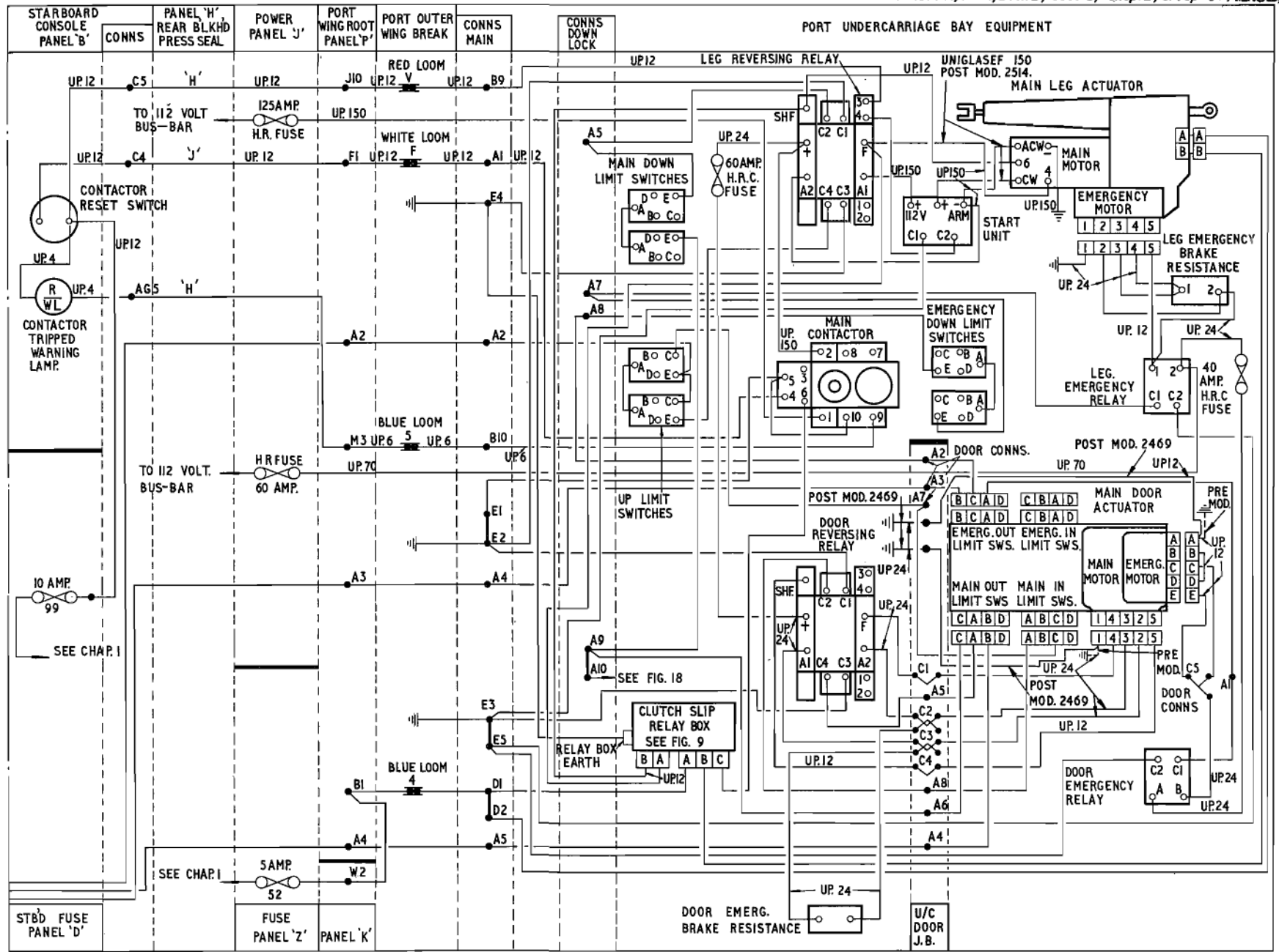


Fig.13.(2) Alighting gear actuation main (post Mod.1835)  
 RESTRICTED



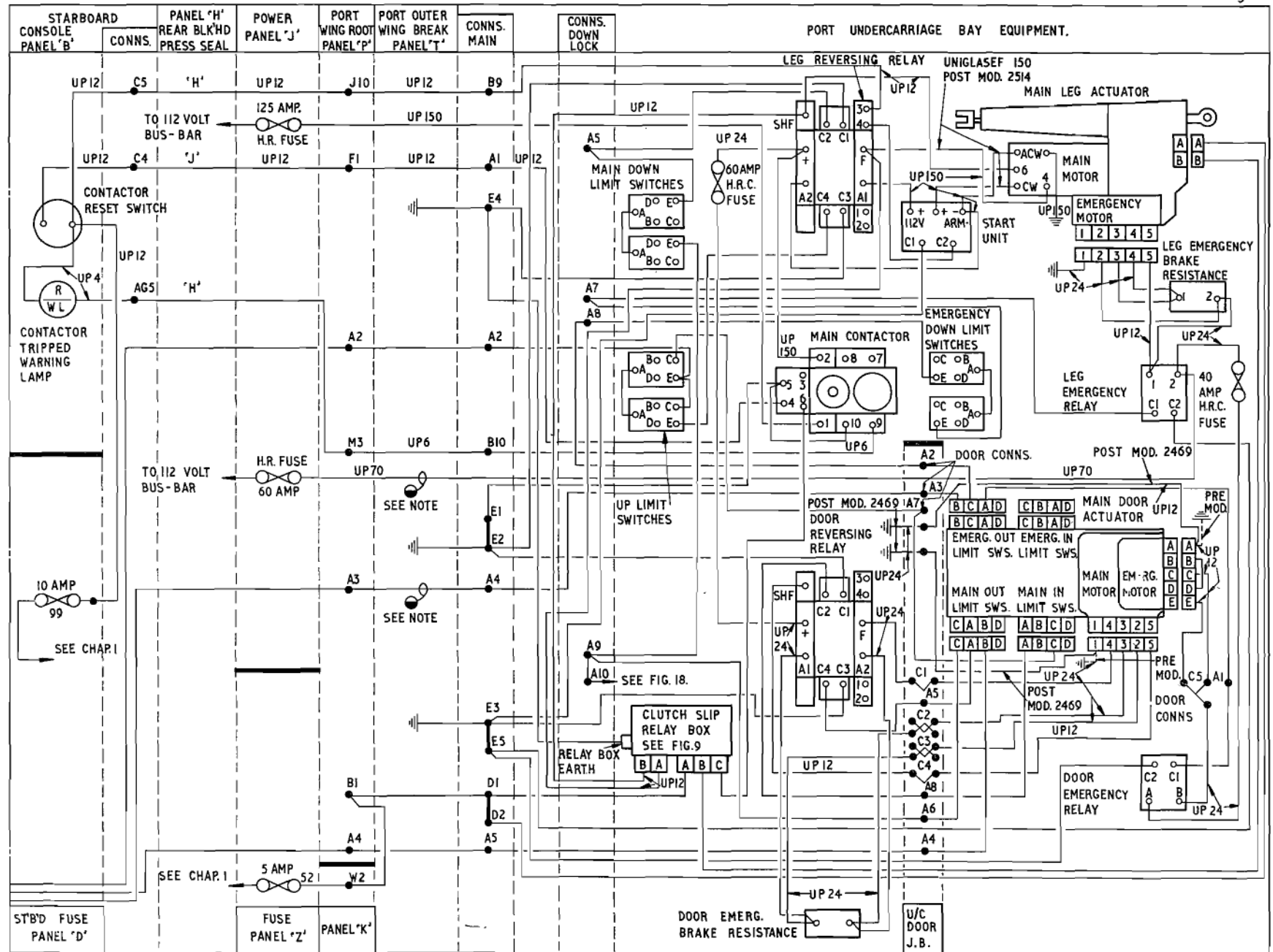


Fig. 14.(2) Alighting gear actuation main (post Mod 1785)

RESTRICTED

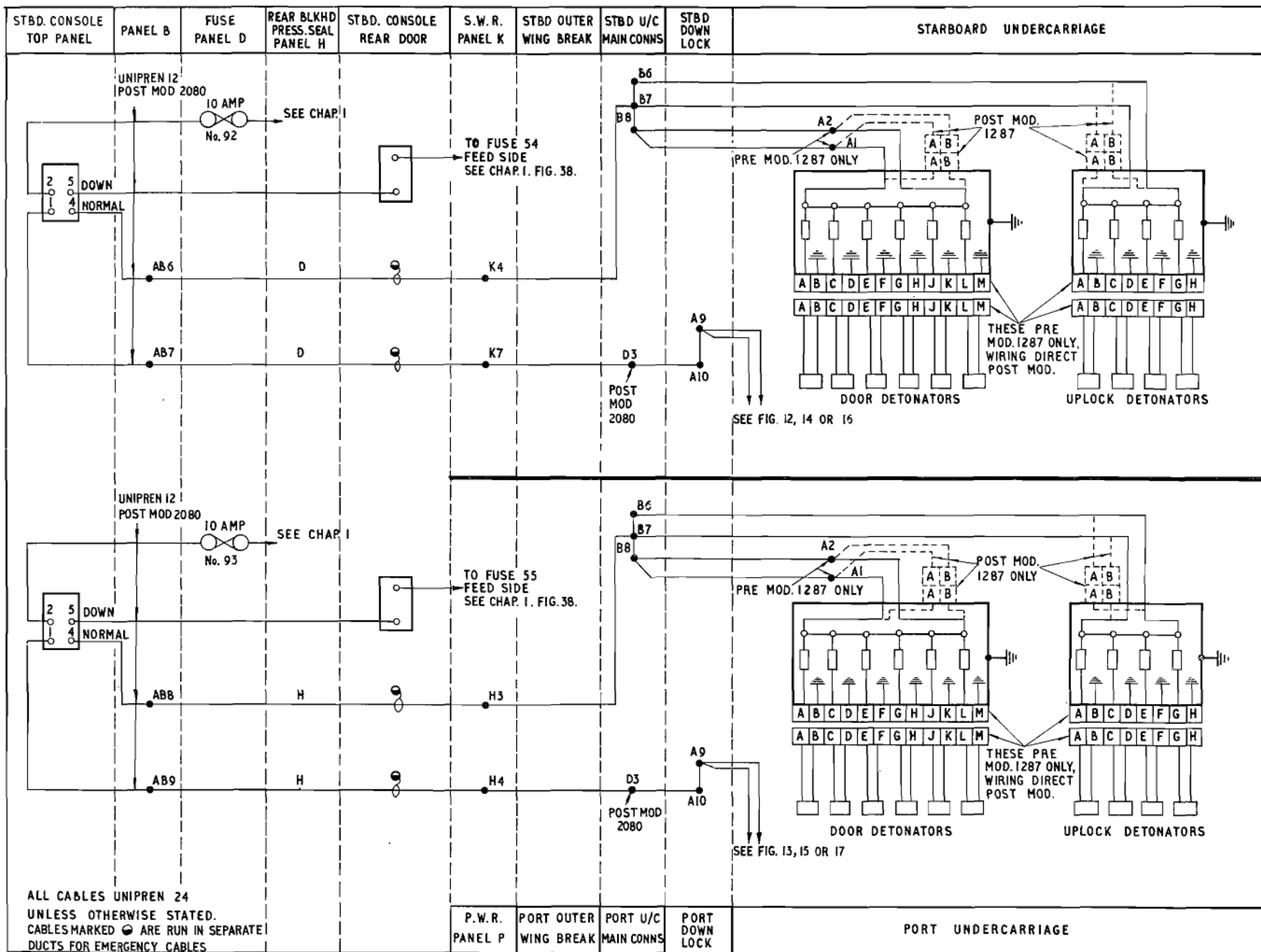


Fig. 15. Extreme emergency alighting gear control (post Mod 1775).  
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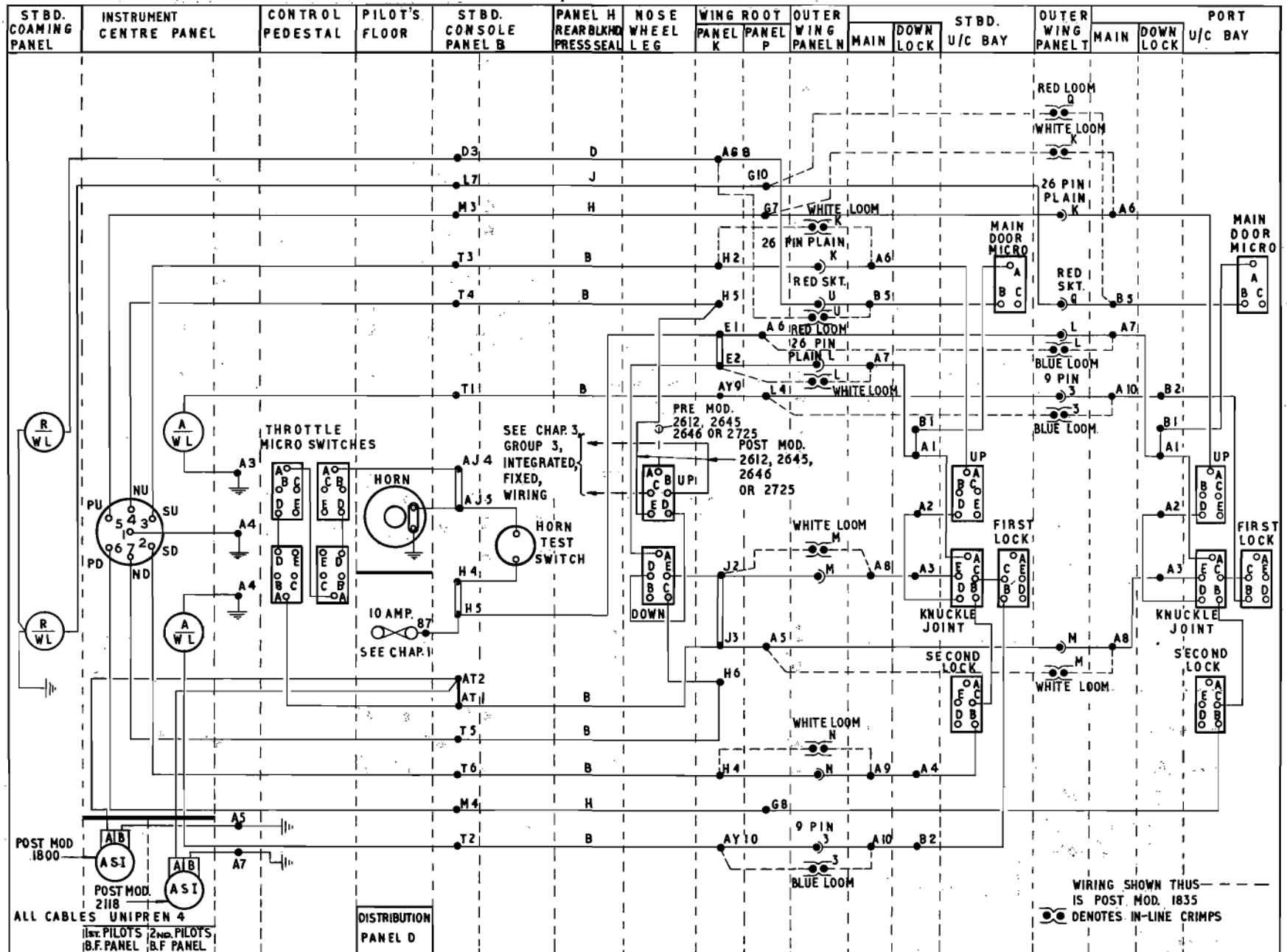


Fig. 16. Alighting gear indicator lamps (pre Mod. 1785)

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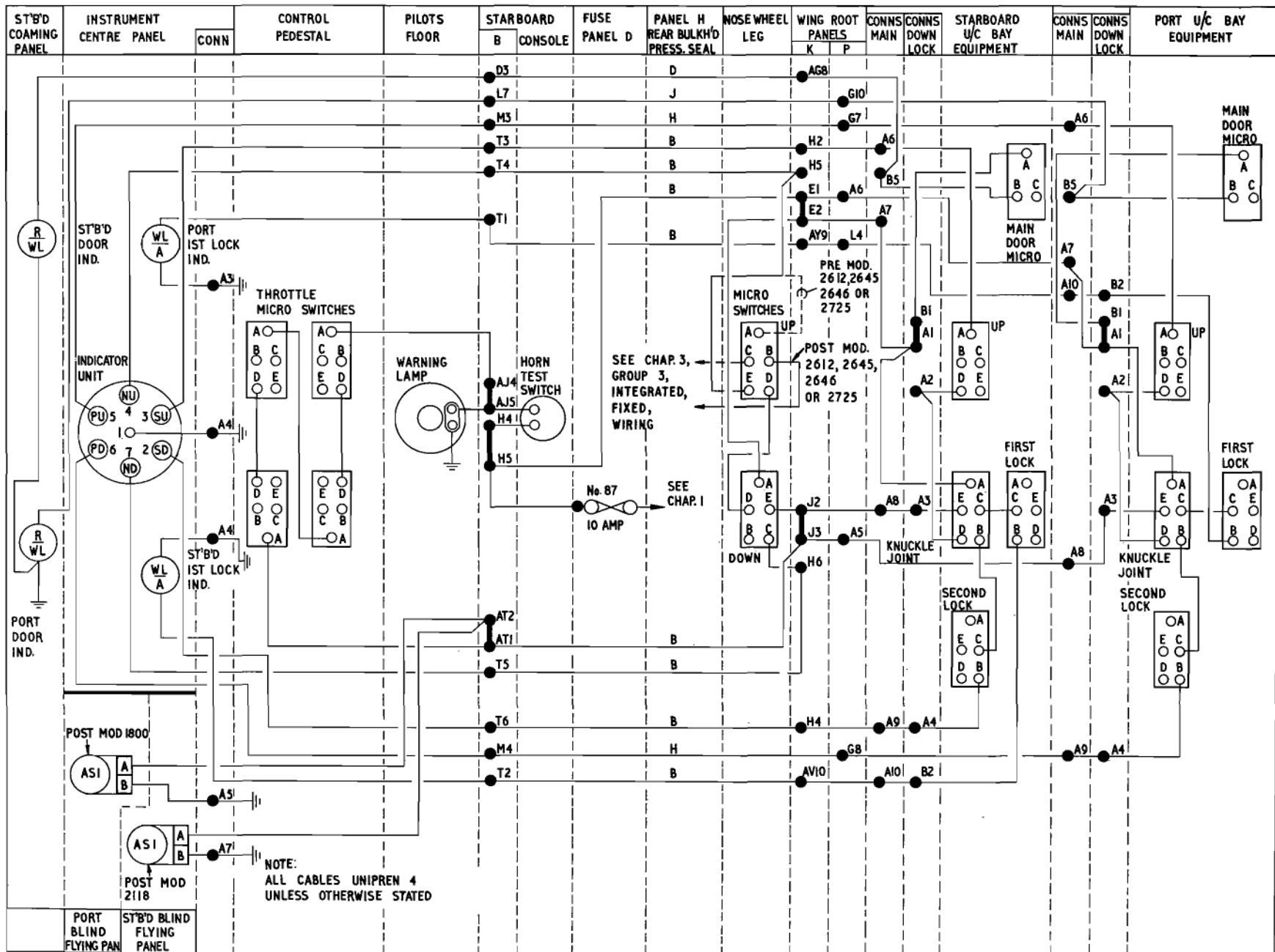


Fig. 17. Alighting gear indicator lamps (post Mod. 1785, pre Mod. 2257)

**RESTRICTED**

70636 SHT.611-A, FOR MOD.2612 etc.  
 75836 SHT.110 D  
 75836 SHT.178 C

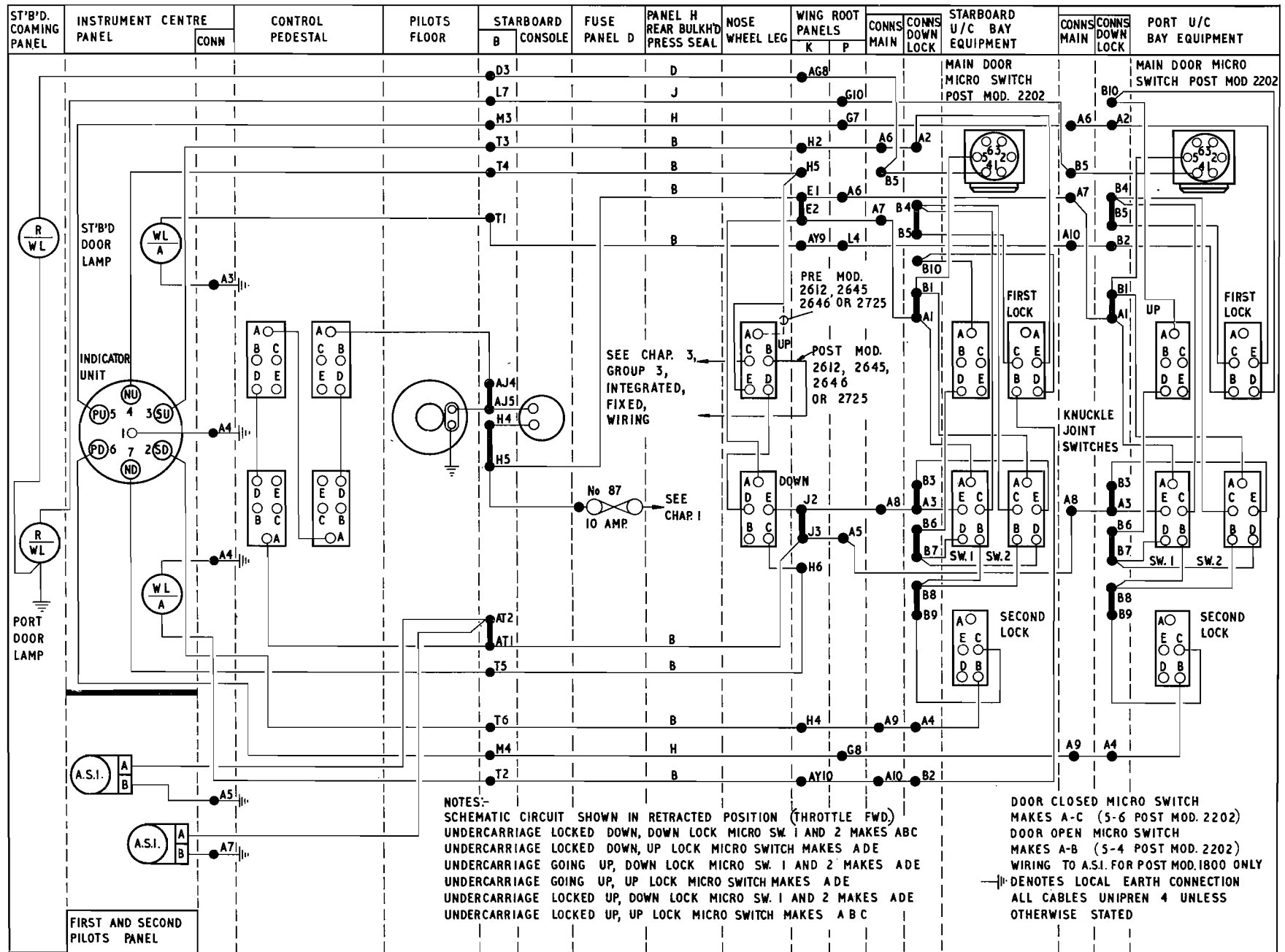


Fig. 18. Alighting gear indicator lamps (post Mod. 2257)

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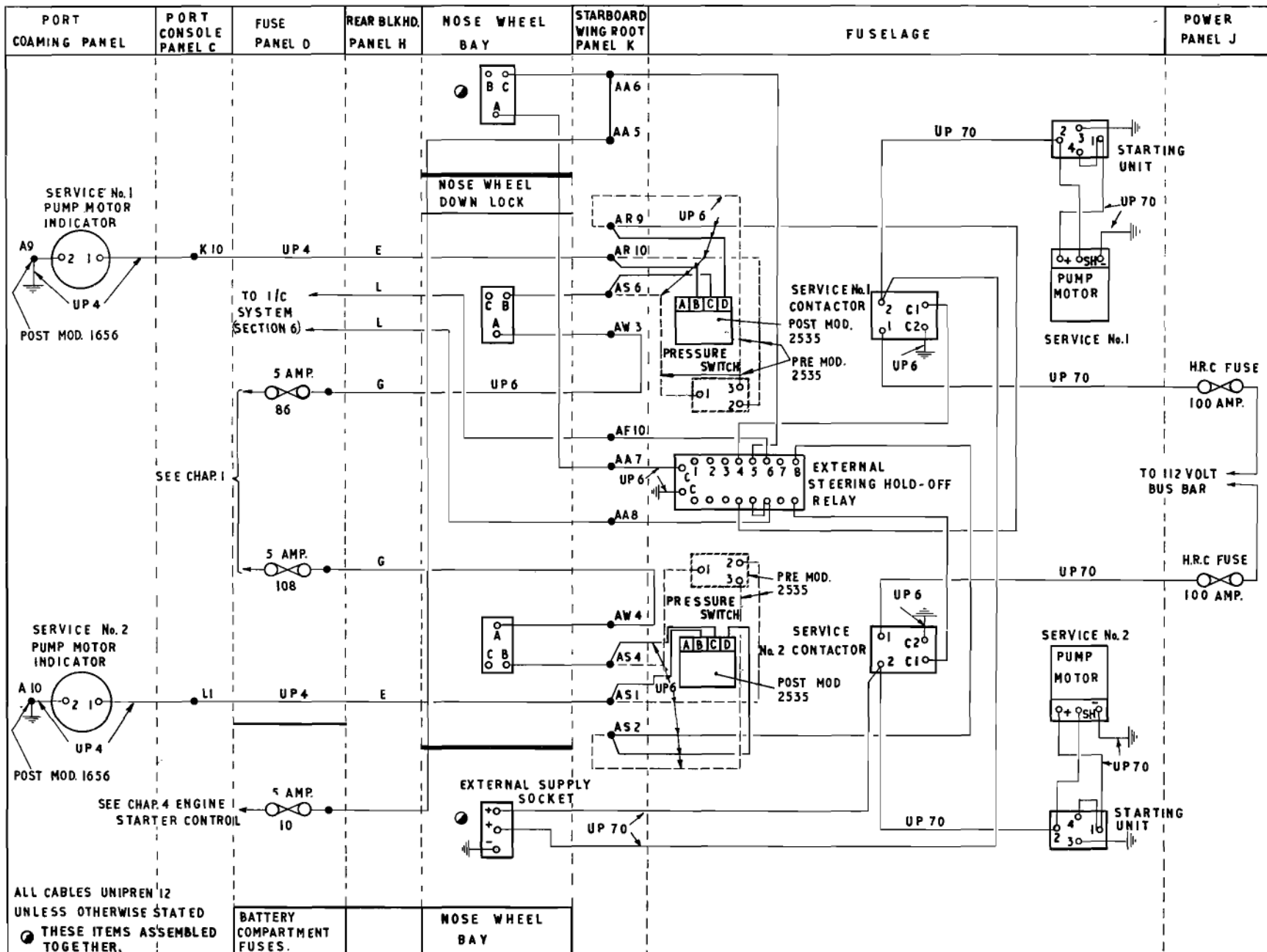


Fig. 19. Nose wheel steering and main wheel brakes pump control (pre Mod 2084)

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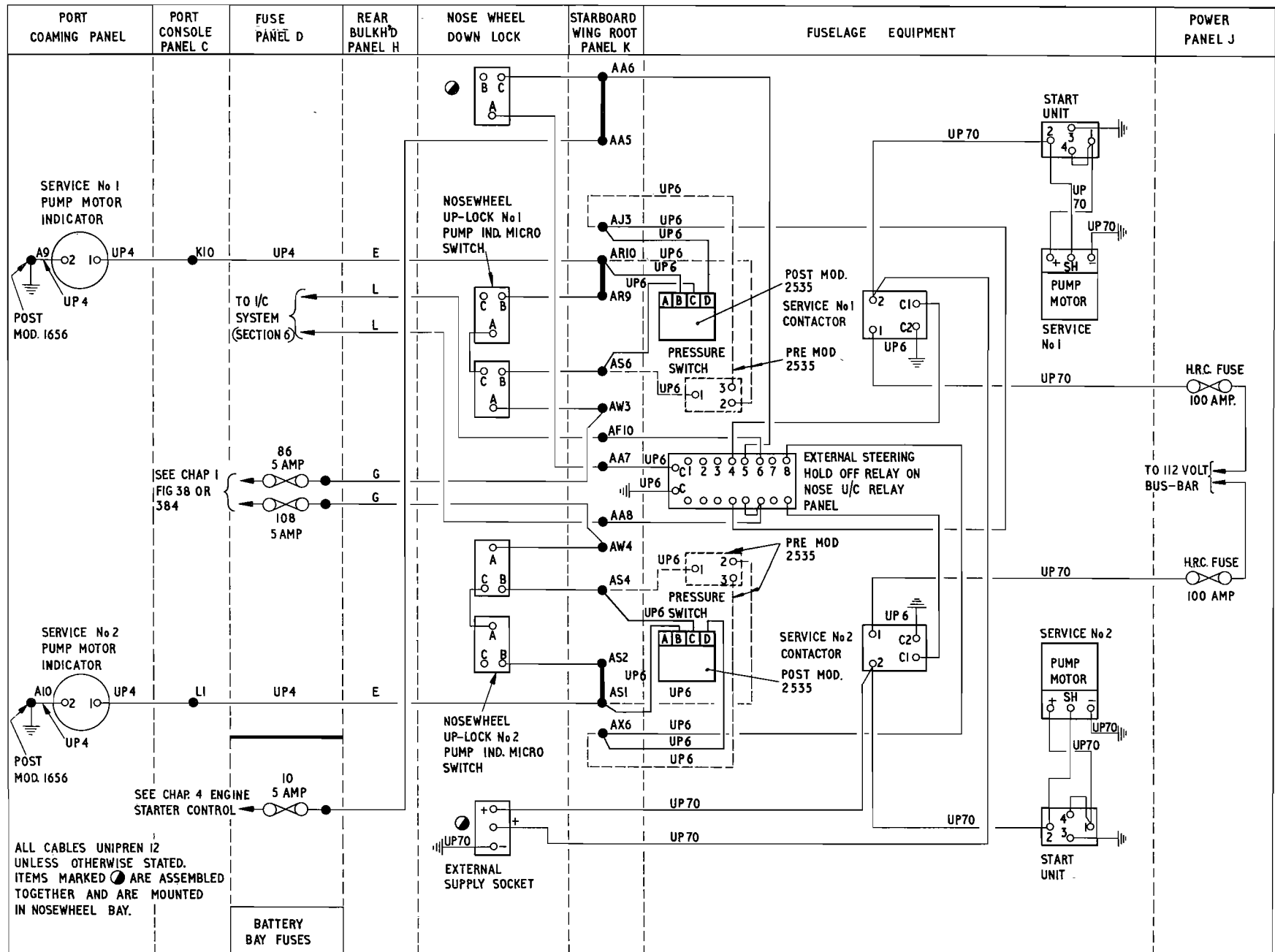


Fig. 20. Nosewheel steering and main wheel brakes pump control (post Mod. 2084)

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