

Chapter 6

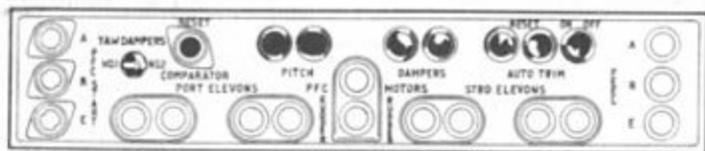
AUTOCONTROLS

(Completely revised)

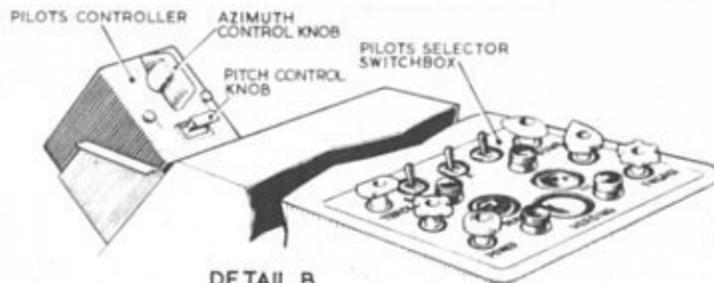
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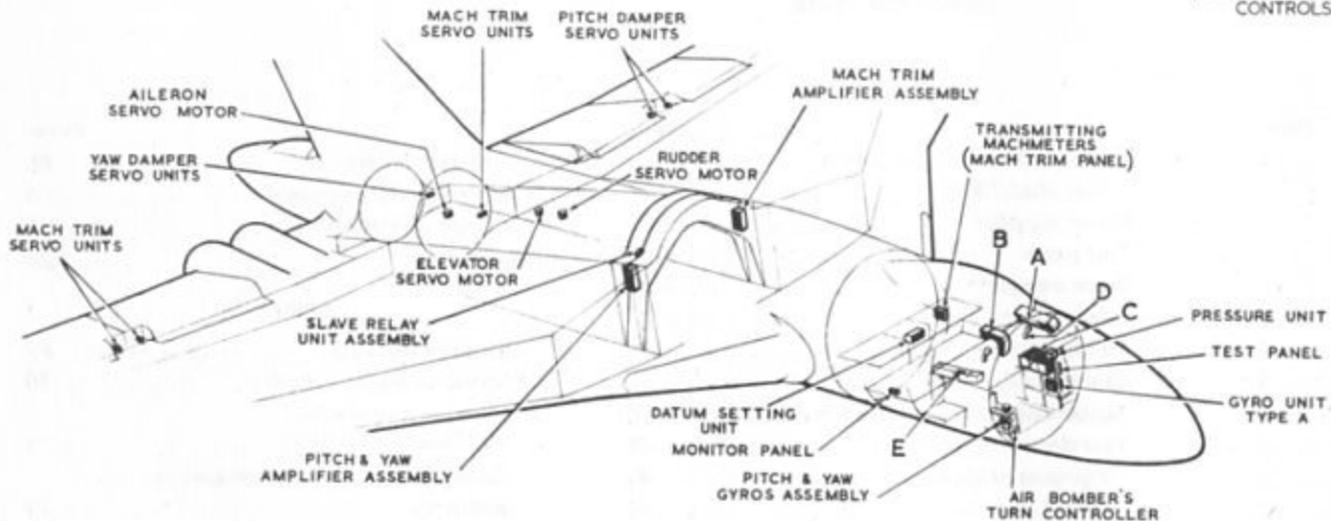
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DETAIL A
AUTOSTABILIZATION CONTROLS ON P.F.C. PANEL
PORT CONSOLE

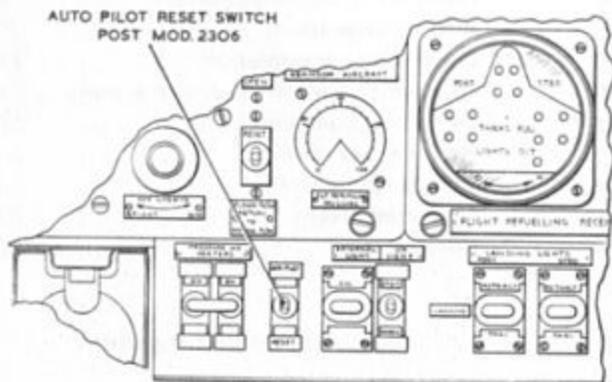


DETAIL B
AUTO PILOT MK.10A
CONTROLS

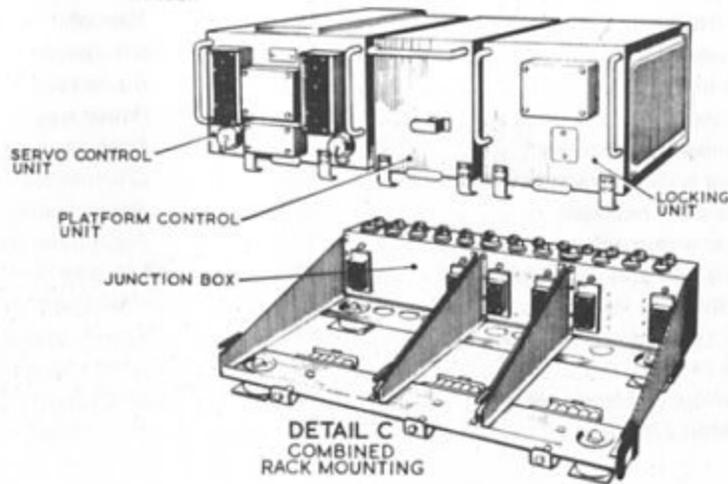


DETAIL D

INSTINCTIVE CUT-OUT SWITCH
ON PILOTS COLUMN



DETAIL E
STARBOARD CONSOLE PANEL 7P



DETAIL C
COMBINED
RACK MOUNTING

Fig. 1 Location of autocontrols

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Introduction

1. This chapter contains descriptive and servicing information on the autopilot Mk.10A and the autostabilization systems. The various units comprising the systems are described, together with details of their location and the necessary power supplies. The autopilot Mk.10B, which is basically the same as the Mk.10A, is dealt with in App.1. The flying controls are dealt with in Sect.7, Chap.10 and also in Sect.3, Chap.4. A complete description of the autopilot Mk.10A will be found in A.P.112C-0802-1, whilst the autostabilization system is described in A.P.112C-2400-1.

AUTOPILOT MK.10A

3. The Mk.10A autopilot is provided in the aircraft to relieve the human pilot of much of

Routing charts for both systems are provided at the end of the text.

2. The following modifications are incorporated in the chapter:-

- Mod.1073 - Improvements to Mk.10A autopilot
- Mod.1320 - To introduce rapid engine start
- Mod.2082 - To prevent back feed from the autopilot to the bomb release

system in the event of an autopilot fault.

Mod.2306 - To introduce a RESET switch to ensure that the 28-volt d.c., supply is isolated whenever the instinctive cut-out switches are operated

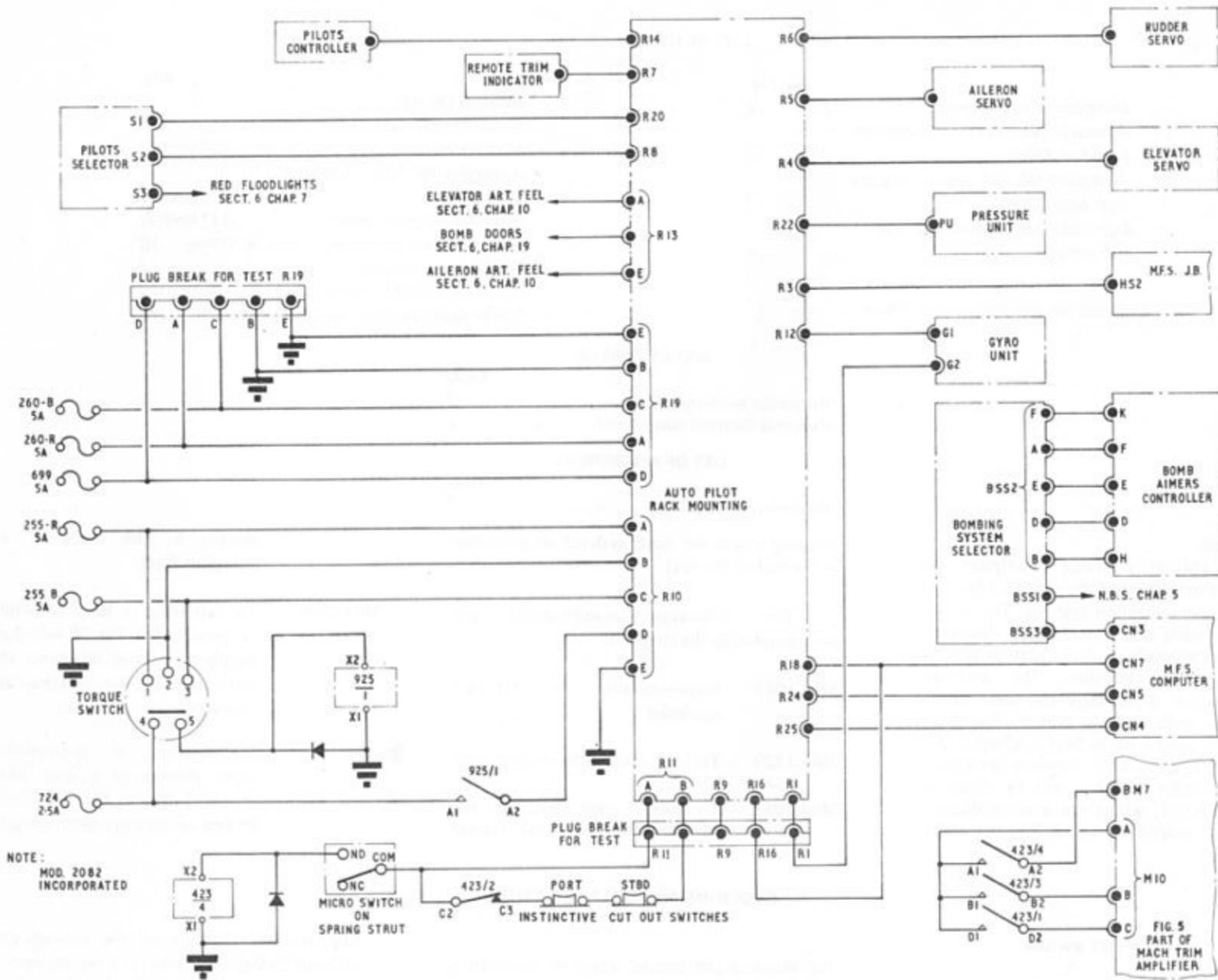
► Mod.2432 - Introduction of re-identified servo motors to a zero lified standard (Smiths Mod.AP/E225) in lieu of existing servo motors. ◀

DESCRIPTION AND OPERATION

the physical and mental strain to which he is subjected when controlling high speed bomber aircraft during long flights. The autopilot

improves the stability of the aircraft under difficult flying conditions. The system operates on the 'rate-rate' principle and will stabilize an aircraft in each of the pitch, roll and yaw axes.

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NOTE:
MOD. 2082
INCORPORATED

Fig. 2 Autopilot Mk. IOA circuit diagram - Pre. Mod. 2306

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4. In addition to the above functions the autopilot may be used by the human pilot to change an aircraft's heading or attitude, maintain a constant altitude or indicated airspeed, turn on to and maintain a pre-selected heading or make fully automatic approaches to an airfield equipped with I.L.S. During bombing runs the autopilot may also be used to manoeuvre the aircraft in response to signals from the N.B.S. Mk.1A or from a turn controller by the air bomber.

5. Bombing, heading and radio information is passed to the system via the Military Flight System (M.F.S.) with which the autopilot is integrated. Details of the M.F.S. will be found in Chap.7, and details of the N.B.S. in Chap.5 of this section.

6. Most of the autopilot units are mounted on a special rack mounting under the first pilot's floor (fig.1). Other units are individually mounted nearby. The controller, selector and cut-out switches are installed at the pilots' station whilst the servo motors are mounted in the bomb bay and aft power compartment. Table 1 gives a complete list of the units together with their type and reference numbers.

Gyro unit

7. The gyro unit is mounted at the port side of the aircraft under the first pilot's floor and contains the three disturbance detecting rate gyros. Also mounted on the gyro platform is the pitch monitor and a mercury switch, both of which respond to displacement of the aircraft in the pitch axis. The mercury switch maintains the gyro platform level when the autopilot is switched on, but disengaged.

Servo control unit

8. The servo control unit contains the three servo control channel amplifiers (rudder, aileron and elevator) and the roll error cut-out amplifier. The unit is mounted in the special rack mounting below the first pilot's floor.

Platform control unit

9. This unit is mounted alongside the servo control unit in the special rack mounting under the first pilot's floor. The unit contains the pitch and bank platform amplifiers, the pitch integrator amplifier and the pitch datum unit.

Locking unit

10. The locking unit houses the signal amplifiers for control in azimuth (localizer, heading and bombing signals) and pitch (glide path signals) along with the amplifiers for the altitude and airspeed lock system. The unit is mounted alongside the platform control unit in the special rack.

NOTE . . .

Strong interference with the I.L.S. signal will be experienced if this unit is fitted without its associated gearing pad.

Rack mounting and junction box

11. The rack mounting which carries the locking unit, platform control unit and servo control unit is so constructed that the backplate is formed by a junction box. The junction box carries six Cannon plugs to which the three units connect. Twenty-five miniature Mk.4 connectors are provided on the junction box for connection to the other units of the autopilot system.

Pressure unit

12. The pressure unit is mounted just forward of, and slightly above the special rack mounting under the first pilot's floor. The unit contains the altitude and airspeed detectors and their associated chaser motors. The unit is fed with a pressure and static supply from the port pitot-static system and provides signals for the airspeed and altitude locks.

Servomotors

13. The three servomotors which operate the control surfaces are mounted in the bomb bay and aft power compartment (fig.1). The aileron servomotor, Type C, is mounted between the rear spar and the front fin support on the forward bulkhead of the aft power compartment. The rudder servomotor, Type C, is mounted on the port side of the bomb bay between stations 259.092A and 243.127A. The elevator servomotor, Type A, is on the port side of the bomb bay between stations 321.936A and 343.387A.

14. Each servomotor unit contains a three-phase motor, an a.c. tacho-generator, and electro-magnetic clutch, and a reduction gear train which terminates in an external output pinion. The electro-magnetic clutch enables the servomotor to be disengaged from the aircraft's control surfaces when necessary and is operated by a switch on the pilot's selector switch box. The reduction gearing is housed in the mountings on which the servomotors are installed.

Pilot's selector

15. The pilot's selector switch box is mounted on the retractable centre console (fig.1). Mounted on the face of the box are the

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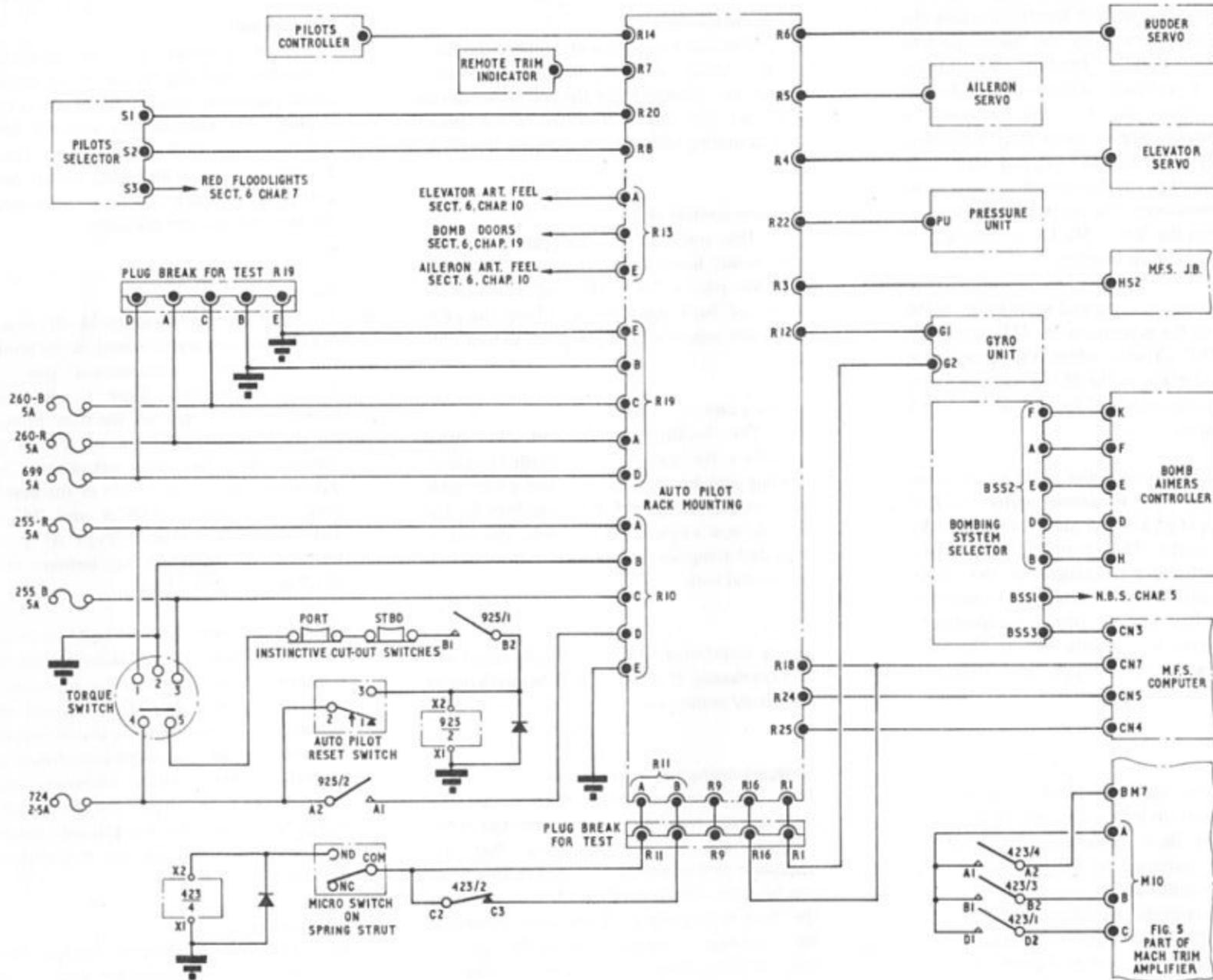


Fig. 3 Autopilot Mk. IOA circuit diagram - Post Mod. 2306

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power supplies switch, the track and glide selector switches, the three control switches for the electro-magnetic clutches, the bomb, altitude and airspeed lock selector switches, and the engagement switch.

Pilot's controller

16. The pilot's controller is mounted at the forward end of the retractable centre console and takes the form of a knob which may be rotated clockwise or anti-clockwise to bank the aircraft up to 40 deg. starboard or port. The central position is located by a detent, but the knob is not springloaded and will remain at any desired setting until it is restored manually to the centre position.

Pitch control

17. Immediately below the control knob on the pilot's controller is a small lever, spring-loaded to the centre position which is moved forward to make the aircraft dive and aft to make the aircraft climb. Slow and fast control rates are provided, the lever also being spring-loaded at each half travel position to indicate the changeover from one rate to another.

Air bomber's controller

18. A second azimuth controller is provided in the system to enable the air bomber to control the aircraft when the visual bomb-sight is being used. The controller is mounted at the starboard side of the prone bomb aimers position and will only operate when VISUAL is selected on the bombing system selector switch.

Bombing system selector switch unit

19. The bombing system selector switch unit

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is mounted on a bracket which projects from the front face of the navigator's table at the navigator bomber's station. The unit consists of a two-position switch marked BLIND-VISUAL and a rotary switch marked N.B.C. GEARING. Depending upon the position of the two-position switch, signals are fed to the autopilot from either the bomb aimer's controller or the N.B.C.

Remote trim indicator

20. A remote trim indicator, Type B, is fitted on the first pilot's panel. This indicator is in the form of a pointer moving within a miniature outline of the aircraft and indicates a pitch trim of the aircraft whenever the autopilot is in use.

Safety arrangements

21. In emergency conditions the autopilot may be immediately dis-engaged by means of the instinctive cut-out switches fitted on each pilot's column. In addition to these switches a roll error cut-out is embodied in the system to dis-engage the autopilot should a 'runaway' occur in the roll axis. The autopilot may also be dis-engaged by the action of a spring strut operating between the elevator servo motor and the control rods at former 321.936. The spring strut is pre-loaded to operate a microswitch when subjected to a load in excess of 78 lb. in either direction.

Circuit operation, Pre. Mod. 2306

22. The spring strut microswitch is connected in series with the two instinctive cut-out switches and relay 423 (fig.2). Operation of either instinctive cut-out switch will open circuit the supply from plug R11, pole A to plug R11, pole B on the autopilot rack mounting and the autopilot will be

dis-engaged. Operation of the spring strut microswitch will connect a supply from plug R11, pole A to energize relay 423. Contacts 423/2 will open resulting in the autopilot being dis-engaged. Contacts 423/1, 423/3 and 423/4 close, to permit spurious negative and positive G signals to be fed into the mach trim comparator circuits. This will result in the immediate locking of the mach trim servo and at the same time a misalignment signal will be presented on the mach trim indicator.

Autopilot reset switch

23. On aircraft Post Mod.2306 an AUTOPILOT - RESET switch, spring-loaded to the central position, is fitted on panel 7P at the second pilot's position (fig.1). Prior to the operation of the switch, the d.c. supply is isolated from the autopilot. The switch also ensures that the d.c. supplies are isolated from the autopilot whenever the instinctive cut-out switches are operated. In order to re-engage the autopilot it will be necessary to operate the RESET switch, pull on the POWER switch, and after a period of 60 seconds, when the ready indicator shows white, pull the ENGAGE switch.

Circuit operation, Post Mod.2306

24. When RESET is selected, a 28-volt d.c. supply is fed from fuse 724 via contacts 2 and 3 of the autopilot reset switch to energize relay 925 (fig.3). Contacts 925/1 close providing a hold-on circuit for relay 925 via the torque switch contacts 4 and 5 and the two instinctive cut-out switches. Contacts 925/2 close connecting the d.c. supply from fuse 724 to the autopilot rack mounting junction box. If either the torque switch operates (para.27), or the instinctive cut-out switches are pressed, the autopilot will be dis-engaged and the hold-on supply for relay 925 will be broken,

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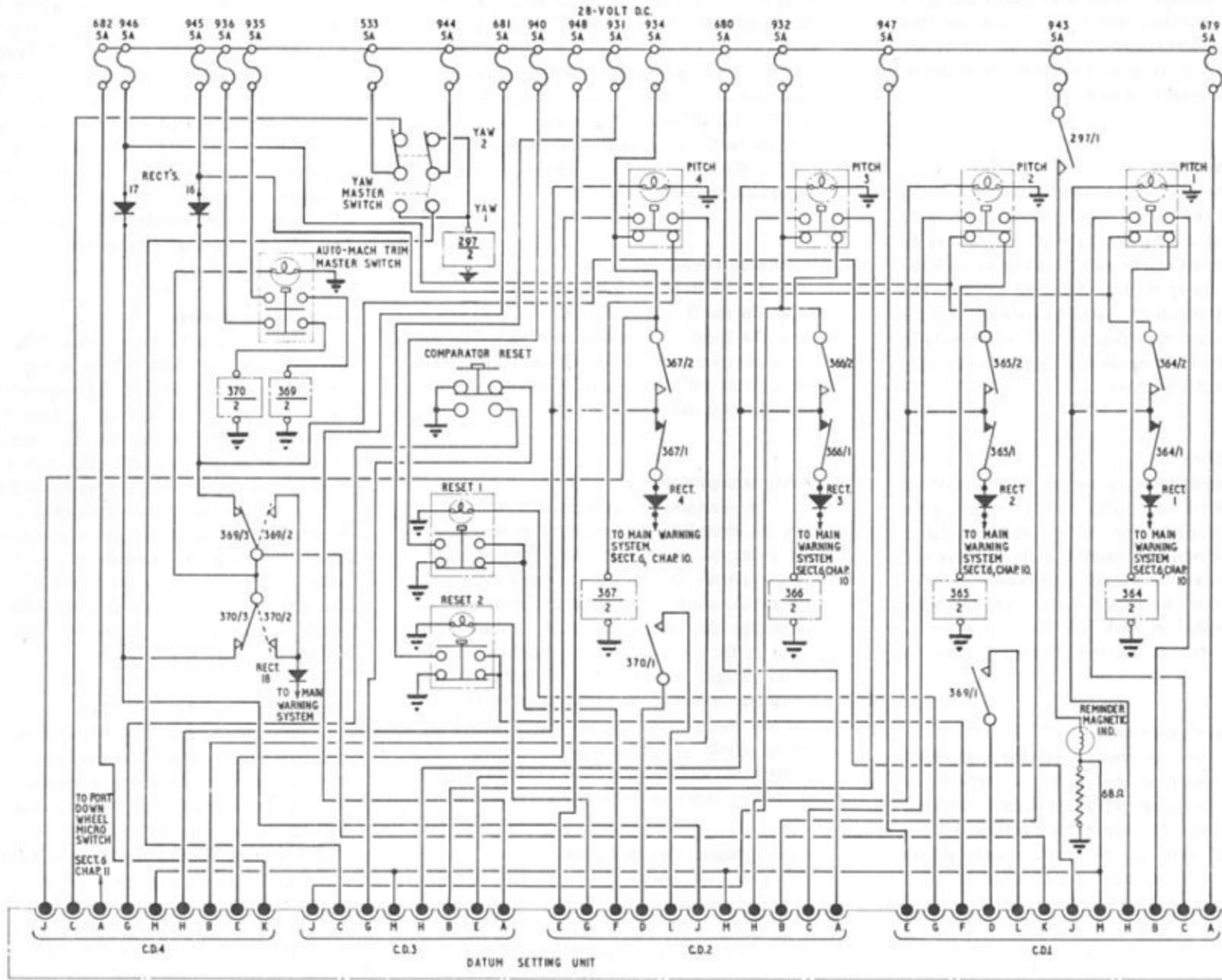


Fig. 4 Autostabilization switching and indication

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de-energizing the relay and isolating the d.c. supply. In order to re-engage the autopilot, the RESET switch must first be operated (para.23). Operation of the spring strut microswitch will connect a supply from plug R11, pole A to energize relay 423. Contact 423/2 will open, resulting in the autopilot being dis-engaged. Contacts 423/1, 423/4 will close to permit spurious negative and positive G signals to be fed to the mach trim comparator circuits, locking the mach trim servo, and feeding a misalignment signal to the mach trim indicator. It should be noted that the operation of the spring strut microswitch does not result in the d.c. supplies being isolated from the autopilot and the autopilot can be re-engaged by pulling the ENGAGE switch.

Torque switch

25. A torque switch, Type B1 is mounted at the starboard side of the aircraft under the crew's floor adjacent to panel 24P. The switch is connected across the 115-volt, 3-phase a.c. supply to plug R10 in the rack mounting junction box, and controls the d.c. supply to pole D of the same plug. The switch consists of a three-phase motor which operates to close a pair of contacts when the a.c. supply to the motor is within the prescribed limits. A fault in the a.c. supply lines will cause the contacts to open isolating the d.c. supply.

Operation of torque switch - Pre.Mod.2306

26. Providing the a.c. supply, to plug R10, and the torque switch is within the prescribed limits, the torque switch motor will run, and the contacts will close. A 28-volt d.c. supply from fuse 724 in panel 48P is fed via the closed torque switch contacts 4 and 5, to energize relay 925 (fig.2). Contacts 925/1 will close connecting the supply from fuse 724 to plug

R10, pole D of the rack mounting junction box. Should a fault develop in the a.c. supply, the torque switch contacts 4 and 5 will open and relay 925 will be de-energized. Contacts 925/1 will open isolating the d.c. supply from the equipment.

Operation of torque switch - Post Mod.2306

27. Providing the a.c. supply to plug R10 is within the prescribed limits, the torque switch contacts 4 and 5 will close. With the autopilot reset switch set to RESET, a 28-volt d.c. supply is fed from fuse 724 via the reset switch contacts 2 and 3 to energize relay 925 (fig.3). Contacts 925/2 close, connecting the d.c. supply from fuse 724 to plug R10, pole D. Contacts 925/1 close providing a hold-on supply for relay 925 via the closed torque switch contacts 4 and 5 and the instinctive cut-out switches. Should a fault develop in the a.c. supply, the torque switch contacts will open, breaking the hold-on supply for relay 925, thus isolating the d.c. supply from the equipment (para.24).

Power supplies

28. The autopilot is provided with 115-volt, 3-phase 400 Hz a.c. from fuses 255R and B in panel 24P, and fuses 260R and B in panel 25P, and 28-volt d.c. from fuses 699 and 724 in panel 48P. The supplies are fed to a junction box on the special rack mounting under the first pilot's floor, where they are distributed to the various units via Cannon plugs and Mk.4 connectors (fig.2 or 3). For further details of the a.c. supplies to panels 24P and 25P refer to Sect.6, Chap.4 of this publication.

Test panel

29. A test panel, containing five test sockets,

is fitted at the forward member of the crate under the first pilot's floor (fig.1). The sockets enable the a.c. and d.c. supplies, connected to the autopilot via the rack mounting to be monitored during servicing periods. The test sockets are labelled from top to bottom A.P. - R.M.11, A.P. - R.M.19, A.P. SUPPLY TEST, A.P. - R.M.16 and A.P. - R.M.1.

Track and glide

30. When the aircraft is making an I.L.S. approach under autopilot control the elevator angles demanded by the autopilot are in excess of those allowed by the spring strut authority. This is particularly so in rough weather and thereby constitutes an unacceptable nuisance.

31. To overcome this, provision has been made for the spring strut authority to be increased during an I.L.S. approach. This is achieved by reducing the artificial feel forces when the M.F.S. selector switch has been set to G.P., and the autopilot TRACK switch pulled ON. Further details of the artificial feel system will be found in Sect.6, Chap.10 of this publication.

32. An indication that partial feel relief is operative is provided by the artificial feel magnetic indicator on the pilots' centre panel which changes from a black to a white indication. The elevator feel lamp however will not light (Sect.6, Chap.10). A failure in the elevator circuit when partial feel relief is operative will be indicated in the normal manner by the main warning system. To prevent the possibility of an out-of-trim release, or autopilot mal-function the maximum speed for selecting G.P. on the M.F.S. navigational selector switch is 180 knots I.A.S.

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Aileron channel

33. The rate of roll in the event of autopilot mal-function at high altitudes is too great for the roll error cut-out. Consequently it has been necessary to restrict the aileron authority when the autopilot aileron channel is engaged. This is accomplished by moving the aileron A.F.U. stops to the high speed position when the aileron channel is engaged. This condition will be indicated by the artificial feel magnetic indicator changing from a black to a white indication. At the commencement of an I.L.S. approach, when G.P. is selected on the M.F.S. selector navigational switch and TRACK is selected on the autopilot, the aileron stops will move to allow 6 deg. of aileron movement.

Bomb door compensation

34. Provision has been made in the autopilot, and in the aircraft wiring for compensating elevator angle signals to be applied to the autopilot whenever the bomb doors are being opened. These signals will correct the aircraft's trim so that steady flight is maintained. The E adjustment, which controls this setting is mounted below a perspex panel in the servo control unit. Further details will be found in A.P.112C-0802-1.

Gearing pads

35. The servo control unit and the locking unit each have a gearing pad plugged into their front faces. These pads enable the parameters of the autopilot system to be made compatible with the aerodynamic characteristics of the aircraft. Further details are contained in Table 1.

NOTE . . .

Strong interference with the I.L.S. signal will be experienced if this unit is fitted without its associated gearing pad.

AUTOSTABILIZATION AND MACH TRIM SYSTEMS

36. Under certain flight conditions it has been found that aircraft tend to oscillate about the yaw, roll and pitch axes. This tendency is particularly undesirable when an aircraft is being manoeuvred on to a target. The autostabilization system is designed to combat this tendency by first detecting the oscillations and then suppressing them by suitable movement of the control surfaces.

37. The autostabilization system embraces two separate systems, the yaw damper system, operating in the yaw axis, and the pitch damper system, operating in the pitch axis. In addition to being separate from each other, each system operates through a number of separately wired channels. The yaw damper system has two such channels and the pitch damper system has four. All channels pass through the datum setting unit under the navigator's table which acts as a central servicing point. A similar type of system, which employs signals from a modified machmeter assembly, is fitted to correct the inherent nose-down tendency of the aircraft when flying at speeds in excess of a certain mach number. This system is called Mach Trim and will be described in the later paragraphs of this chapter. A detailed description of all the system will be found in A.P.112C-2400-1. Table 2 gives a complete list of all the units employed in the autostabilization system together with their individual part and reference numbers.

Yaw damper system

38. Each channel of this two channel system is completely separate from the other and

consists of the following units:-

- Rate gyro unit
- Airspeed monitor unit
- Datum setting unit
- Amplifier unit
- Slave relay unit
- Servo unit

39. Yaw movement of the aircraft is detected by the rate gyro. The gyro produces a signal which is first passed to the airspeed monitor, and then on to the amplifier, via the datum setting unit. The output from the amplifier is fed to the slave relay unit, which passes the signal to the servo unit for subsequent operation of the control surfaces.

Equipment location

40. The yaw gyro assembly is mounted under the second pilot's floor between formers 358 and 372. The unit is mounted at a slight angle to the horizontal to pick up some component of rolling rate in addition to the yawing rate. The monitor assembly, height switches and the speed and height monitoring units are mounted on a panel fitted under the aft-end of the crew's floor between formers 232 and 268.

41. The datum setting unit, through which all channels pass, is fitted on the centre line of the aircraft, under the navigator's table. The pitch and yaw amplifier assembly is fitted on the starboard side of the bomb bay at bomb arch 44.592. Adjacent to the amplifier assembly is the slave relay assembly. The yaw servo unit is mounted in the rudder control rod circuit at former 428, and forms an extensible link which operates through a differential lever linkage. For details of location of all units refer to fig.1.

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Power supplies

42. The system is supplied with 115-volt, 3-phase 400 Hz a.c. and 28-volt d.c. direct to plugs PY 7 and PY 8 on the pitch and yaw amplifier (fig.13). The supply sources and channels served are as follows:-

PY 7	115-volt, 3-phase 400 Hz a.c. from fuses 314R and B in panel 28P and 28-volt d.c. from fuse 821 in panel 19P.	} Yaw channel 1
PY 8	115-volt, 3-phase 400 Hz a.c. from fuses 313R and B in panel 28P and 28-volt d.c. from fuse 820 in panel 19P.	

Reference to para.49 will show that these supplies also serve pitch channels 3 and 4, distribution taking place within the amplifier assembly.

43. These direct supplies ensure that the system is stable and ready for use when required. The system will not function however until the d.c. circuit is completed via the yaw channel selector switch. For details of the 3 kVA transformer which provides the a.c. supplies, reference should be made to Sect.6, Chap.4. Details of the change-over circuit for use in the event of a transformer failure will be found in the same chapter.

Yaw channel selector switch

44. This switch, mounted on the port console (fig.1) is a double-pole, change-over type, with a centre off position, labelled YAW 1 - YAW 2. The switch enables either of the two yaw channels to be selected and also acts as a master switch for the yaw damper system.

The switch is supplied with 28-volt d.c. from fuse 533 in the starboard fuse and relay panel 4P and fuse 944 in the port fuse and relay panel 3P (fig.4).

45. With the switch selected to YAW 1, a d.c. supply is fed from fuse 533 to energize relay 297 and a supply from fuse 944 is fed to plug CD 3, pole C of the datum setting unit to complete the circuit for yaw channel 1. Contacts 297/1 close connecting a 28-volt d.c. supply from fuse 943 in panel 3P to a magnetic reminder indicator fitted at the pilots' instrument panel 1P. The indicator will not be energized however, due to feedback from the pitch and mach trim systems. The feedback will be eliminated and the indicator will change from a white to a black indication when all three systems are switched on and functioning correctly. A similar sequence of operations will take place when the switch is selected to YAW 2. In this switch position, relay 297 is energized from fuse 944 and a supply from fuse 533 is fed to plug CD 4, pole C of the datum setting unit. Yaw channel 2 will thus be brought into operation.

Pitch damper system

46. The pitch damper system is similar to the yaw damper system in many respects and much of the equipment is located adjacent to, or integrated with, the yaw damper units. The main difference is that the pitch damper system has four independent channels operating simultaneously, any three of which will, together, meet the requirements of the system. A single channel failure will not cause noticeable deterioration in the system and it is possible for two channels to fail without serious effect on aircraft stability.

47. The detection, amplification and signal

path for each channel follows the same sequence as that given for the yaw damper system in para.39, with only one exception, the monitoring stage. The pitch system monitoring depends upon height and powered monitors which modify the gyro signal as it passes first to the datum setting unit and then to the amplifier.

Equipment location

48. The pitch gyro assembly is mounted under the second pilot's floor adjacent to the yaw gyro assembly, while the datum setting unit, is mounted under the navigator's table. The pitch amplifiers and comparator are mounted on the same assembly as the yaw amplifiers at bomb arch 44.592. Mounted adjacent to the amplifier are the slave relays for both the pitch and yaw systems. The four servo units are fitted to form a mechanical feedback link on each of the power control units for the two inner pairs of elevons.

Power supplies

49. The system is supplied with 115-volt, 3-phase 400 Hz a.c. and 28-volt d.c. direct to each pitch channel via plugs PY 5, PY 6, PY 7 and PY 8 on the pitch and yaw amplifier assembly (fig.13). The plugs and their various supplies and services are as follows:-

PY 5	115-volt, 3-phase 400 Hz a.c. from fuses 288R and B in panel 27P and 28-volt d.c. from fuse 834 in panel 19P.	} Pitch channel 1
PY 6	115-volt, 3-phase 400 Hz a.c. from fuses 287R and B in panel 27P and 28-volt d.c. from fuse 833 in panel 19P.	

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PY 7 115-volt, 3-phase 400 Hz
a.c. from fuses 314R and
B in panel 28P and
28-volt d.c. from fuse
821 in panel 19P. } Pitch
channel 3

PY 8 115-volt, 3-phase 400 Hz
a.c. from fuses 313R and
B in panel 28P and
28-volt d.c. from fuse
820 in panel 19P. } Pitch
channel 4

As in the case of the yaw damper system, these direct supplies ensure that the pitch system is stable and ready for use when required. The system will not function however, until the d.c. circuit is completed via the pitch channel selector switches (para.51).

50. The a.c. supplies are fed from the starboard 3 kVA transformer. In the event of a transformer failure provision is made for switching the load to the other 3 kVA transformer. For further details of the transformers and switching refer to Sect.6, Chap.4.

Pitch channel selector switches

51. Four push-pull type selector switches are mounted on the port console (fig.1). Each switch controls one channel and incorporates a warning lamp in the switch head. The system is switched on by operating the channel switches to the full-out position, thus completing the individual channel circuits from the datum setting unit (fig.4). The system is prevented from operating in this condition by the height switches which act as a further control in the system and limit its functioning to altitudes above 20,000 ft. The height switches are mounted in the monitor assembly underneath the crew's floor between formers 232 and 238.

Channel failure warning

52. Failure of any one of the four pitch channels will provide the pilots' with two warning indications:-

- (1) The two amber MAIN WARNING lamps at the top of the pilots' centre panel will light (Sect.6, Chap.10).
- (2) The lamp in the head of the control switch for the channel affected will light.

The lamps are operated by the pitch comparator, which compares the positions of all four servo feedbacks and indicates misalignment of any channel.

53. Assuming that a failure has occurred in pitch channel 1, reference to fig.4 will show that the misalignment signal is fed from the datum setting unit plug CD 1, pole H, to the lamp in the head of the associated selector switch. The lamp will light giving an indication of channel 1 failure. The signal is also fed via the normally closed relay contacts 364/1 and rectifier 1 to the main warning system (Sect.6, Chap.10). The main warning lamps will light giving a further indication of a pitch channel failure.

Reset facility

54. To ensure that the main warning system is clear and available for indication of further failures, a reset facility is incorporated in the system. The reset circuit is controlled by pressing the illuminated head of the selector switch for the channel that has failed. Before pressing the individual channel lamp, the system should first be proved faulty by pressing the comparator reset push switch on the port console, providing the system is

functioning correctly the warning signal will be cancelled.

55. In the case of a pitch channel 1 failure, pressing the head of the switch will isolate the faulty channel circuit and connect a supply from fuse 945, in the port fuse and relay panel 3P, via the closed pitch channel 1 switch contacts to energize relay 364 (fig.4). Relay contacts 364/1 will open isolating the supply to the main warning system. Relay contacts 364/2 will close connecting a supply from fuse 945 to the pitch channel 1 warning lamp. The lamp will light, providing a permanent reminder that the channel has failed.

56. Operation of the reset facility for pitch channels 2, 3 and 4 is similar to that described for channel 1, the supplies being fed from fuses 946, 932 and 934 respectively. Failure of a second channel will be indicated in a similar manner providing the main warning system has been reset by pressing the illuminated channel switch. In the remote event of a third channel failure all four channel lamps will be lit together.

Pitch servo heaters

57. The four pitch servo units are provided with internal heaters to prevent the units freezing during flight. The supply to the heaters is controlled by a relay in the pitch and yaw rack, supplies being fed to the heaters when the relays are de-energized. The relays are operated by the landing gear circuit, (Sect.6, Chap.11). When the aircraft is on the ground, a 28-volt supply is fed from fuse 619 in panel 3P, via the port main wheel down-lock micro switch to energize the relays and disconnect the supplies to the heaters. Retraction of the landing gear will break the supply to de-energize the relays and thus connect the supplies to the heaters.

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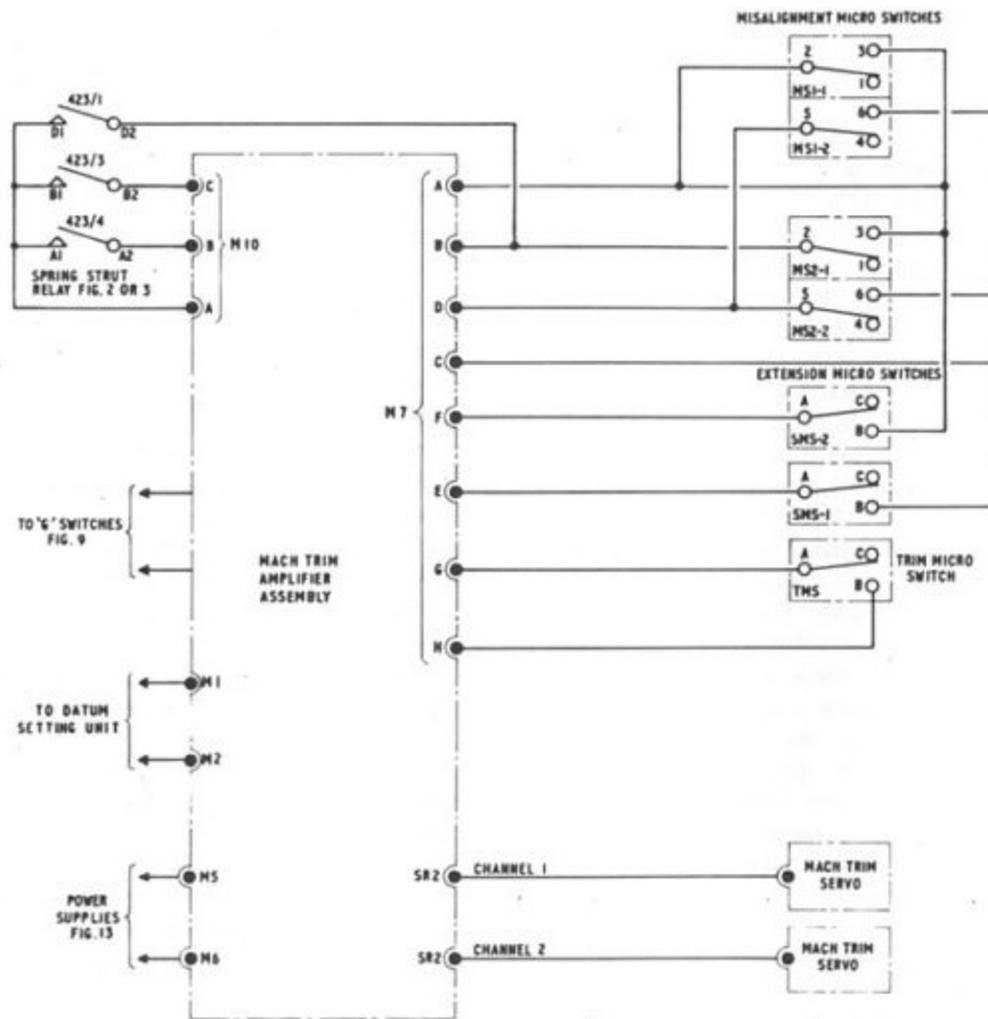


Fig.5 Mach trim safety circuits

Mach trim system

58. The mach trim system is fitted in the aircraft to correct the inherent nose-down tendency of the aircraft when flying at speeds in excess of a certain mach number (para.37). This is achieved by replacing the gyro signals with signals from a unit sensitive to mach number.

59. The unit consists of two transmitting machmeters whose output is passed to the main amplifier units, via the datum setting unit. The amplifier output is fed, via slave relay units, to the servo units. These units are mounted on the power bay forward bulkhead and coupled into the elevon control rod circuit through a differential linkage.

Equipment location

60. The mach trim panel is mounted at the port side of the aircraft, under the crew's floor, between formers 218 and 232 (fig.1). The panel contains the transmitting machmeter unit, the unit being connected to the pitot-static supply from both the port and starboard pitot-static systems (Sect.7, Chap.1). The datum setting unit is fitted on the centre-line of the aircraft, under the navigator's table (para.41). The mach trim amplifier assembly containing the slave relay units and comparators is fitted at bomb arch 44.592 on the port side of the bomb bay. The two accelerometers incorporated in the system are mounted side by side on top of the amplifier assembly. Five microswitches are mounted on the mach trim servo assembly at the rear spar. These switches operate extension reminders and also provide a circuit to the failure warning systems when misalignment occurs between the two servo units.

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Power supplies

61. The system is supplied with 115-volt, 3-phase 400 Hz a.c. and 28-volt d.c. direct to plugs M5 and M6 on the mach trim amplifier assembly (fig.13). The supply sources and channels served are as follows:-

M5	115-volt, 3-phase 400 Hz a.c. from fuses 312R and B in panel 28P and 28-volt d.c. from fuse 825 in panel 19P.	} Channel 1
M6	115-volt, 3-phase 400 Hz a.c. from fuses 286R and B in panel 27P and 28-volt d.c. from fuse 827 in panel 19P.	

These direct supplies ensure that the system is stable and ready for use when required. The system will not function however, until the d.c. circuits are completed via the mach trim selector switch. The d.c. supplies to the switch control circuits are all fed from fuses in panel 3P. For details of the 3 kVA transformer which provides the a.c. supplies, refer to Sect.6, Chap.4. Details of the change-over circuit for use in the event of a transformer failure will be found in the same chapter.

Control switches

62. Three push-pull type switches labelled AUTO TRIM are mounted in a row on the pilots' console (fig.1). Each switch incorporates an amber warning lamp in the switch head. The first two switches labelled RESET are spring-loaded to the out position. When the switches are pushed in a supply is connected to the mach trim servos to bring them back to their fully retracted position. The warning lamps fitted in these switches will light whenever the relevant channel servo is

extended. The third switch labelled ON-OFF, is the mach trim master switch, which, when moved to the ON (pulled out position) completes the circuit for both channels. The warning lamp in the switch head will light when the switch is selected to OFF (pushed in position), or when a misalignment is detected in either servo.

Mach trim switching

63. Reference to fig.4 will show that with the switch in the OFF position (pushed in), 28-volt d.c. supplies are fed from fuse 945, via rectifier No.16 and the normally closed relay contacts 369/3 and from fuse 946 via rectifier No.17 and the normally closed relay contacts 370/3 to light the warning lamp in the switch head. With the switch in the ON position (pulled out), a supply from fuse 935 is fed via the switch contacts 1-1 to energize relay 369, and a supply from fuse 936 is fed via switch contacts 2-2 to energize relay 370. Contacts 369/3 and 370/3 will open, isolating the supply to the warning lamp. Contacts 369/1 and 370/1 will close, completing the circuits for both mach trim channels. Contacts 369/2 and 370/2 close, preparing a circuit to the main warning systems in the event of a servo misalignment. As in the case of the pitch dampers the mach trim system is fitted with height switches to prevent the system being used below altitudes of 20,000 ft.

Failure warning indication

64. Should a misalignment occur in either servo, this will be detected by the microswitches on the servo assembly and a supply will be fed from plug CD 1, pole K on the datum setting unit, to the lamp in the head of the mach trim master switch. The lamp will light to give a warning of servo misalignment.

The same supply is also fed via the closed relay contacts 369/2 and 370/2 (para.63) and rectifier No.18 to light the MAIN WARNING lamps at the top of the pilots' centre panel (Sect.6, Chap.10). Following such an indication, the system may be reset by depressing the channel RESET switches (para.62) and then the COMPARATOR-RESET switch on the pilot's console. When a mach trim lock-out has occurred, due to excessive loading of the control system, the mach trim system must be switched off before re-setting and switching on again.

Accelerometers

65. Runaway protection is provided by two accelerometers which, at pre-determined increments of normal acceleration, prevent further movement of either servo in the direction of the applied 'g'. Provided that the comparator circuit gives no indication of misalignment between the two channels, the servos will be re-energized when 'g' is reduced. If, however, misalignment is present when 'g' is applied, then the accelerometer relays will remain energized. The system may be reset by depressing the comparator reset switch. This should not be attempted until the aircraft's speed has been reduced, the mach trim switched off and the servos reset to their retracted position by means of the channel reset switches. Provision has also been made for lock out of the mach trim system by the action of a spring strut fitted in the elevator control circuit. Details of the spring strut are given in para.21.

Fault reminder indicator

66. In addition to the warning indications previously outlined for the pitch damper and mach trim systems, a magnetic indicator

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labelled AUTO STABILIZER is fitted on the pilots centre panel 1P, to provide a permanent reminder to the pilots of a fault in one of the systems. The indicator will show a black indication when all systems are functioning correctly, and a white indication when a fault has occurred in the pitch damper or mach trim channels. The indicator will show white if either of the mach trim servos is extended whilst the aircraft is flying at an altitude below

General

68. As the instrument, electrical and mechanical components of the auto-controls system are so closely integrated, it is essential that complete co-operation be maintained between the various tradesmen concerned. Such co-operation will prevent wasteful duplication of ground tests and at the same time ensure that a high degree of serviceability is maintained in the systems.

AUTOPILOT MK.10A

69. The fixed components of the autopilot system require little servicing, apart from a periodical check on the connectors and cables for security, cleanliness and signs of damage. Details of functional ground checks for the autopilot Mk.10A and ground test procedures for the artificial feel system and bomb door compensating unit are provided in the following paragraphs. These instructions should be read in conjunction with A.P.112C-0802-1. A test socket is provided adjacent to the rack mounting, which enables the supplies at plug R19 to be tested when necessary.

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that at which the height switches operate (20,000 ft.).

Circuit operation

67. With all stabilization systems switched on and functioning correctly, a 28-volt d.c. supply is fed from either fuse 533 or 944, depending upon the position of the yaw channel selector switch (para.44), to energize relay 297 (fig.4). Contacts 297/1 close, connecting a supply from fuse 943 in panel 3P

via the magnetic indicator and a 68 ohm dropping resistor to earth. The indicator will be energized to show a black indication. In the event of a failure in the pitch damper or mach trim channels, a supply will be fed from pole M of either plug CD1, CD2, CD3 or CD4 (depending upon the channel that has failed) on the datum setting unit, to back off the supply to the indicator. This will result in the indicator being de-energized to show white.

SERVICING

Functional ground checks

70. These checks are performed without the use of test equipment, and should be carried out at the periods laid down in A.P.101B-1902-4. Carry out the functional ground checks as laid down in A.P.112C-0802-1. Before proceeding with these checks carry out the following:-

- (1) Remove fuse 612 in panel 3P (this is to prevent unnecessary operation of the aileron A.F.U., since the unit would move to its high speed position upon engagement of the aileron channel).
- (2) Ensure that the 200-volt a.c. and 28-volt d.c. ground supplies are available and connected.
- (3) Ensure that the flying controls are free from obstruction.
- (4) Switch on the 3 kVA transformers, by means of the two switches on the secondary supplies control panel 50P, at the A.E.O's station.

- (5) Switch on the mach trim pitch and yaw systems.
- (6) Check the flying controls for freedom of movement.
- (7) Pull out the retractable centre console to locate the autopilot control switches.

NOTE...

- (1) If the aircraft is not laterally level when carrying out the ground checks, 'drift' will be present on the rudder controls when the autopilot is engaged. Rudder movement will be to starboard when the starboard wing is low, and vice versa.
- (2) On aircraft Post Mod.2306, the autopilot RESET switch must first be operated before operating the autopilot POWER switch. Subsequent dis-engagement of the

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autopilot by the operation of the instinctive cut-out switches will result in the 28-volt d.c. supply being isolated and the ENGAGE and POWER switches being released. In order to re-engage the autopilot it will be necessary to first operate the RESET switch. During normal autopilot operation, it will be more convenient to dis-engage the autopilot by pushing the ENGAGE switch off, so as to avoid the delay before re-engagement. In fault conditions or whenever the system is not required the system should be dis-engaged by operating either of the instinctive cut-out switches in order to isolate the d.c. supply to the system.

Ground test procedure

Artificial feel system

71. The initial setting-up procedure for the artificial feel system will be found in Sect.6, Chap.10, of this publication. The following paragraphs contain the necessary instructions for setting up and testing the aileron and elevator feel system on autopilot control. The following equipment is required for these tests.

- (1) Pitot pressure simulator rig.
- (2) Suitable ohmmeter.
- (3) Two-foot rule.

Calibration of elevator servomotor authority

72. When the autopilot is used for auto-controlled I.L.S. approach, the authority of the elevator servo is increased by reducing the level of the artificial feel forces. The elevator feel warning circuit is biased correspondingly, so that only the centre instrument panel 'FEEL' indicator gives indication of this change. The following test procedure checks the elevator servo authority in both normal and approach conditions.

- (1) Remove fuse 612 in panel 3P, to prevent unnecessary operation of the aileron A.F.U.
- (2) Disconnect the pitot piping from the elevator feel unit airspeed transmitter, on the port side of the bomb bay and the associated pitot pipe from the elevator feel warning transmitter, on the starboard side of the bomb bay. Connect a pitot pressure simulator rig to both transmitters simultaneously.

NOTE...

It is important to connect the rig to both transmitters simultaneously to prevent unbalancing the system.

- (3) Ensure that the 200-volt a.c., and 28-volt d.c. ground supplies are connected.
- (4) Switch ON the two 3 kVA transformers at panel 50P, A.E.O's station.

- (5) Ensure that the flying controls are free from obstruction.
- (6) Check that the autopilot is dis-engaged and then trim the elevator into line with the inboard fixed trailing edge.
- (7) Engage the autopilot and then trim the elevators until the remote trim indicator indicates zero load. Refer to note 7 (a). Pull the pitch control backward to the 'slow rate' position until the autopilot is dis-engaged by the operation of the spring strut cut-out. Measure the maximum deflection of the elevators between 'zero load' and 'cut-out'. Refer to note 7 (b).

NOTES...

- (a) *It is important that when trimming the servomotor to zero load, the final movement of the pitch control must be in the same sense in which it is required to move the elevators in the tests which follow.*
- (b) *When the autopilot is dis-engaged by the operation of the spring strut, the elevators will return to their trimmed position at high speed dictated by the recovery of the artificial feel unit. Care, must therefore be taken when measuring the deflection of the elevators.*

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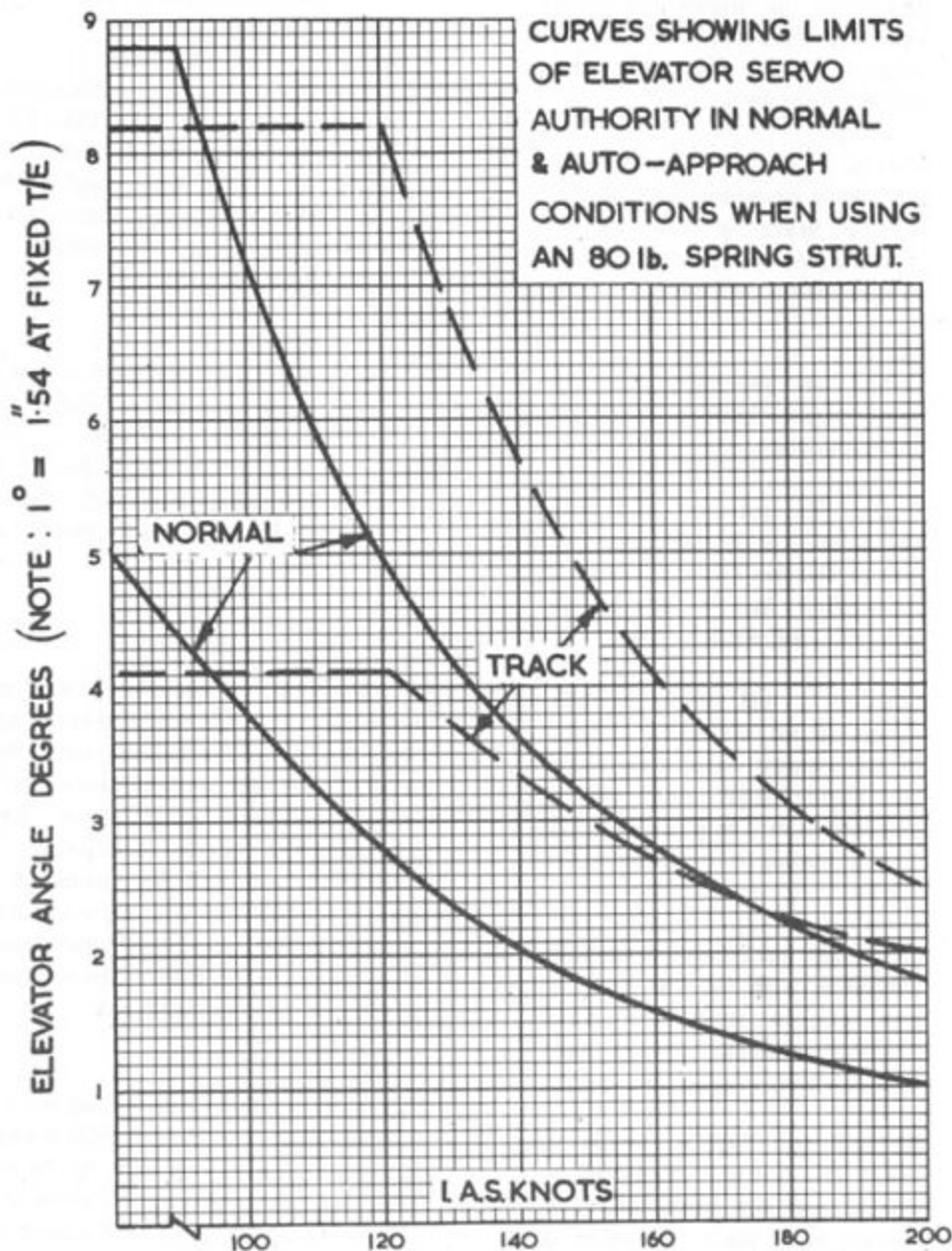


Fig.6 Graph for elevator control limits

- (8) Slowly increase the airspeed in the pitot pressure rig and (by listening at the A.F.U. for the first operation of the actuator) note the speed at which the elevator A.F.U. cuts-in. Refer this speed to the elevator movements measured at sub-para (7) (i.e., record the servo authority at A.F.U. 'cut-in' speed).
- (9) Repeat the test in sub-para.(7) at simulated airspeeds of 120, 160 and 200 knots, taking care always to approach target-speed from below. Record the elevator movements and associated airspeeds.
- (10) Decrease the airspeed to zero and repeat the tests in sub-para.(7) and (8) with the pitch control pushed forward to the 'slow rate' position.
- (11) Check, and set if necessary, the resistance values at potentiometers No.3 and 2 in panel 83P to 200 ohms.
- (12) Switch the M.F.S. selector to LOC and G.P. engage the autopilot and pull 'ON' the TRACK switch. Repeat the test in sub-para.(7) to (10) at simulated airspeeds of 160, 180 and 200 knots.

NOTE...

Artificial feel failure warnings arising during these checks may be ignored. Refer to para.74 for feel warning circuit balance checks.

- (13) Check that all the readings obtained in the above tests lie between the appropriate curves on the graph for elevator control limits fig.6.

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73. If readings obtained from para.72 (7) to 72 (10) do not lie within the appropriate tolerances the fault lies either in the spring strut breakout load or in the artificial feel system. To determine where the fault is located proceed as follows:-

- (1) The spring strut breakout load may be checked with a spring balance. The load to operate the microswitch should be $80 \text{ lb} \pm 2 \text{ lb}$.
- (2) If above check shows no fault in the strut, then the control circuit components should be checked for excessive friction. It is essential that the breakout force at the control column does not exceed 9 lb.
- (3) If the fault still persists, then the artificial feel system must be recalibrated and appropriate remedial action taken (refer to Sect.3, Chap.4 of this publication).
- (4) With satisfactory results from tests (para.72 (7) to 72 (10)) and if the results from tests outlined in para.72 (12) do not lie within the appropriate range, then the amount of artificial feel bias may be adjusted at potentiometer 1 in panel 83P.

Elevator feel warning balance

74. The procedure for setting-up the elevator feel warning balance system is as follows:-

- (1) Switch OUT the aileron channel and replace fuse 612 in panel 3P.

- (2) Simulate an airspeed of 200 knots approx. at the elevator feel and warning transmitters, then adjust airspeed until the relay dial on the feel unit reads zero.
- (3) Check that all feel failure indications are normal and test the failure warning circuit by depressing the elevator test switch on panel 66P (bomb bay).

NOTE...

Setting up procedure for this circuit is given in Sect.6, Chap.10, of this publication.

- (4) Engage the autopilot and with M.F.S. selector at 'LOC and GP', pull to ON the TRACK switch. It is possible that a feel failure indication will result.
- (5) Whether a feel failure warning occurs or not, check the position of the elevator warning relay dial in panel 66P and adjust potentiometer 2 in panel 83P until a zero reading is obtained at the relay.
- (6) Check that feel failure warnings are cancelled, with the exception of the centre instrument panel magnetic indicator which must remain white.
- (7) Depress the TRACK switch to OFF. The feel unit must reset to normal and the white indication reverts to a black indication in approximately 2 seconds.

- (8) Lock the adjustments on potentiometer 2 and 3 in panel 83P.
- (9) Dis-engage the autopilot, reduce to zero (at not more than 20 knots per second) the simulated airspeed at the feel system and disconnect the simulator. Reconnect and make good the aircraft A.S.I. piping circuit.

NOTE...

Whenever any part of the pitot static system is disturbed, the instructions laid down in A.P.1275A, Vol.2, Part 2, leaflet A9, and A.P.3158, 2nd Edn., Vol.2, Leaflet B42 must be carried out.

Aileron range check

75. Selection of aileron channel engaged causes the A.F.U. to restrict aileron angle to ± 5 deg; the aileron feel failure warning circuit is inhibited, but the reminder indicator on the centre instrument panel shows white to indicate the above conditions. During Auto-I.L.S. approach the permitted aileron angle is increased to ± 6 deg. with the same warning circuit conditions prevailing. The following procedure governs the setting-up and checking of these arrangements.

NOTE...

This interconnection ensures that the A.F.U. is exercised each time the autopilot is engaged or dis-engaged. Up to this stage of the tests this effect has been prevented by removal of fuse 612, or by switching out the aileron channel, but from this point, the frequency of engage or

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dis-engage switching should be minimised to prevent needless wear and tear on the A.F.U. In any case a time of 10 seconds should be allowed to elapse between engagement and dis-engagement.

- (1) With the autopilot dis-engaged check that the elevons are trimmed in line with the inboard fixed trailing edge.
- (2) In panel 83P, check that the total resistance between relay 702 (terminal 2) and plug 892 (terminal E) is set at 795 ohms. Reset if necessary at potentiometer No.1
- (3) With the aileron channel switched OUT, engage the autopilot and check that the feel indicator on the centre instrument panel shows black.
- (4) Switch IN the aileron channel and ensure that:-
 - (a) The indicator shows white, but no main warning occurs.
 - (b) The aileron A.F.U. has moved to its high speed condition (i.e., stop clearance reduced to 0.4 in. approx.).
- (5) Move the turn control a small amount clockwise and measure the maximum control surface movement. This should be between 4.5 deg. and 5 deg. (i.e. between 7 in. and 7.7 in. at the fixed trailing edge). If, these movements are not

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correct the feel system is at fault and reference should be made to Sect.3, Chap.4 of this publication for remedial action. Re-centre the turn control.

NOTE...

If the turn control is held over for any length of time the autopilot may dis-engage via the roll error cut-out. Should this occur 10 seconds must be allowed before re-engagement takes place.

- (6) With the M.F.S. selector at LOC and GP, pull to ON the TRACK switch. The A.F.U. stops should open out by approximately 0.08 in.
- (7) Move the compass setting knob a small amount clockwise and measure the resulting control surface movement. This should be between 6 deg. and 6.5 deg. (i.e. between 9.4 in. and 10.1 in. at the fixed trailing edge) and is adjustable at potentiometer No.1 in panel 83P.
- (8) Repeat (7) above with anti-clockwise movement of the compass setting knob.
- (9) Lock the adjustment on potentiometer No.1
- (10) Dis-engage the autopilot. Stop the P.F.C. motors using the individual stop switches. Switch off the two 3 kVA transformers. Disconnect the ground supplies.

Bomb door compensation

76. To offset the nose down pitch error, due to the extra drag caused by the opening of the bomb doors whilst in flight, compensating signals are provided by the autopilot and fed to the elevator servo channel to provide automatic trim during the operation. The following tests check this function with the aircraft on the ground.

NOTE...

During this test procedure it is necessary to operate the bomb doors, therefore a hydraulic rig will be required. Ensure that the bomb doors are unobstructed and cleared for operation.

- (1) At the servo control unit, remove the perspex panel for the bomb door compensation adjustments. Ensure that all settings are at zero.
- (2) Ensure that the 200-volt a.c. and 28-volt ground supplies are connected and switched on.
- (3) Switch on the 3 kVA transformers by means of the two switches on panel 50P.
- (4) Engage the autopilot and check that the aircraft controls remain stationary. Pull the BOMB switch on the pilot's selector.
- (5) Open the bomb doors and whilst the doors are in motion, check that no control movement exists.
- (6) Close the bomb doors.
- (7) At the servo control unit, set and lock the E adjustment at -5.

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- (8) Open the bomb doors and check that a slow elevator up movement occurs whilst the bomb doors are in motion, and the elevator movement ceases when the bomb doors are fully open.
- (9) Close the bomb doors and dis-engage the autopilot.
- (10) Push OFF the autopilot power switch and disconnect all test equipment used making good all connections broken down for testing.

77. On completion of the calibration checks above, switch 'off' in turn, the M.F.S. and powered flying controls. Disconnect the ground supplies and ensure that the flying controls have freedom of movement in all directions.

AUTOSTABILIZATION AND MACH TRIM SYSTEMS

78. Apart from periodical checks of the wiring and connectors, little in the way of servicing is required in the installation. During the checks, all wiring and connectors should be examined for signs of damage and general security. The fixed components should also be examined for security and signs of damage.

79. Detailed instructions for servicing the autostabilization systems will be found in A.P.112C-2400-1 where instructions on the use of the No.1 test set, Type 1170, Ref.No. 6C/2113, will be found. No test equipment is required for functioning checks on the systems as built-in test facilities are provided in the

datum setting unit. These facilities take the form of a number of switches which are fitted underneath the front flap of the unit. There are eleven switches in all; four of these, S1A, S2A, S3A and S4A, are used to override the altitude switches, which would normally prevent operation of the systems at ground level, four are used for pitch damper tests, S1B, S2B, S3B and S4B, two others for mach trim tests, S5B and S6B, and the remaining one for yaw damper tests, S7B. For more thorough checks on the mach trim system it will be necessary to employ suitable test equipment in order to simulate conditions of altitude, airspeed and mach number. Instructions for connecting the equipment to the pitot-static system, together with the necessary calibration figures, will be found in A.P.112C-2400-1.

Functional ground check

80. The checks that follow are to be carried out at the periods laid down in A.P.101B-1902-4. No special equipment is required for the checks other than a magnet to operate the accelerometers, and the necessary ground power supplies. Proceed as follows:-

- (1) Ensure that the 200-volt a.c. and 28-volt d.c. ground supplies are connected.
- (2) Switch ON the two 3 kVA transformers at panel 40P, A.E.O's station.
- (3) Ensure that the flying controls are free from obstruction.

81. Open the front flap of the datum setting unit and ensure that the test switches are set as follows:-

- (1) The four pitch damper switches S1B, S2B, S3B and S4B are at the mid-position.
- (2) The two mach trim switches S5B and S6B are at the mid-position.
- (3) The yaw damper switch S7B is in the mid-position.
- (4) The four altitude override switches S1A, S2A, S3A and S4A are operated to the down position.

82. Inspect the P.F.C. control panel on the port console to ensure that the following lamps are lit:-

- (1) The warning lamps contained in the P.F.C. switches.
- (2) The four warning lamps contained in the pitch damper switches.
- (3) The warning lamp contained in the mach trim switch.
- (4) The main warning lamps on the pilots' centre panel.

83. Switch on all the P.F.C. motors and check that all the P.F.C. warning lamps and main warning lamps go out. With the motors running, set the controls to neutral, then pull the four pitch damper switches to ON. Check that the pitch warning lamps go out.

NOTE . . .

If any pitch damper warning lamp remains lit, operate the comparator re-set switch on the P.F.C. control panel.

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84. Set the yaw damper switch to YAW 1 and pull to ON the mach trim switch. Check that the following indications of correct functioning are given.

- (1) Mach trim switch: warning lamp goes out.
- (2) Mach trim re-set switches: warning lamps out.
- (3) Magnetic indicator on pilots' centre panel: shows black.

NOTE...

If any lamp remains lit, press the mach trim re-set switches for a period of not more than 15 sec.

Pitch damper checks

85. Using the pitch damper test switches, S1B, S2B, S3B and S4B, in the datum setting unit, carry out the following checks:-

- (1) Operate switch S1B to the down position. Ensure that No.3 elevon moves down and then returns to the neutral position.
- (2) Return switch S1B to its original position. Ensure that No.3 elevon moves up, then returns to the neutral position.
- (3) Repeat operations (1) and (2) with switches S2B, S3B and S4B. Ensure that No.4, 5 and 6 elevons respectively move in a similar manner.

NOTE...

If, during the tests, a warning indication is given by any of the

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pitch damper switches, the comparator re-set switch should be operated.

Yaw damper checks

86. Using switch S7B, in the datum setting unit, carry out the following checks:-

- (1) Operate switch S7B to the down position. Ensure that the rudder moves to port and then returns to the neutral position. (The return period may take up to 15 secs).
- (2) Return switch S7B to its original position and ensure that the rudder moves to starboard and then returns to the neutral position.
- (3) Set the yaw damper switch on the P.F.C. control panel to YAW 2 and repeat operations (1) and (2).

Mach trim checks

87. Using switches S5B and S6B in the datum setting unit, carry out the following checks:-

- (1) Operate switch S5B to the down position and check that the following indications are given:-
 - (a) Mach trim No.1 re-set switch: warning lamp is lit.
 - (b) The elevons move up.
 - (c) Mach trim switch: warning lamp is lit.
 - (d) Main warning system: lamps are lit.

- (e) Magnetic indicator on the pilots' centre panel: shows white.

- (2) Return switch S5B to its original position immediately the main warning lamps light. Ensure that the indications given in 1(a) to (e) are cancelled, i.e., warning lamps out, magnetic indicator showing black and elevons at neutral.
- (3) Repeat (1) and (2) using switch S6B.

88. Set the four altitude override switches S1A, S2A, S3A and S4A to their original position. Operate switches S1B, S2B, S3B, S4B and S5B and S6B, first to the down position and then back to their original position. Ensure that the elevons remain at neutral.

89. Push the four pitch damper switches, the mach trim switch, and each of the P.F.C. switches to OFF, in turn. Check that the switch warning lamps light in each instance. Set the yaw damper switch to the mid-position. Switch off the two 3 kVA transformers and disconnect the power supplies.

Gyro rotation

90. Check the gyros of the pitch and yaw damper systems for correct rotation. Direction of rotation can be most readily detected when the gyros are just starting up, or in the final stage of running down. Direction of rotation should be anti-clockwise when viewed from the open end.

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REMOVAL AND INSTALLATION

General

91. The components which form the autopilot and autostabilization systems are readily accessible and no special removal instructions are required. Removal of the servo units will normally be carried out by the airframe tradesmen, providing that the electrical services to the unit have been

previously disconnected. All disconnected cables should be protected and stowed on the adjacent aircraft structure. Before removing the servo unit the flying controls should be locked in the position as described in Sect.3, Chap.4 of this publication where full instructions for removing the units will be found.

WARNING . . .

The bolts securing the microswitch bracket to the mach trim servo units should be torque loaded to 16-20 lb/in² whenever refitment of the microswitch bracket to the servo unit is made, otherwise severe distortion of the bracket leading to possible jamming of the servo unit action may be experienced.

TABLE 1

▶ Autopilot Mk.10A equipment ◀

Equipment	Type	Ref. No.	No. off
Pilots' selector	A	6T/1623	1
▶ Pilots' controller	A	6TB/4545187	1
Bomb aimer's controller	A	6TB/4545256	1 ◀
Gyro unit	B	6T/1648	1
Servo control unit	A	6T/1615	1
Platform control unit	A	6T/1616	1
Locking unit	A	6T/1617	1
▶ Rack mounting	A	6TB/4545409	1 ◀
Junction box	A	6T/1621	1
Pressure unit	A	6T/1614	1
▶ Pressure unit (post Mod.1160)	B	6TB/4545466	1
Pressure unit mounting	A	6TB/402	1
Servo motor	A	6TB/6402607	1
Servo motor	C	6TB/6402611	2 ◀
Servo motor mounting	A	6T/232	3
Bombing system selector	A	6T/1613	1
▶ Remote trim indicator	B	6TB/4545448	1 ◀
Gearing pad (servo control unit)	-	6T/1618	1
Sense pad (servo control unit)	-	6T/1620	1
Gearing pad (locking unit)	-	6T/1619	1

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TABLE 2
Autostabilization equipment

Equipment	Part No.	Ref.No.	No. off	
▶ Amplifier unit	869	6S/4551509	4	Pitch Gyro Assembly Part No.866
Gyro unit	868	6S/4551508	4	
Mounting	867	6S/4551661	1	
Amplifier unit	869	6S/4551509	2	Yaw Gyro Assembly Part No.872
Gyro unit	868	6S/4551508	2	
Mounting	873	6S/4551510	1	
Pitch amplifier	890	6S/4551516	4	Pitch and Yaw Amplifier Assembly Part No.1223
Pitch comparator	884	6S/4551515	2	
Yaw amplifier	892	6S/4551517	2	
Mounting	1224	6S/4551514	1	
Slave relay unit	899	6S/4551522	6	Pitch and Yaw Slave Relay Assembly Part No.897
Mounting	898	6S/4551662	1	
Pitch servomotor	894	6S/4551519	4	
Yaw servomotor	895	6S/4551520	1	
Mach trim servomotor	1350	6S/4551521	2	
Datum setting unit	1352	6S/4551529	1	
Monitor panel	1357	6S/Vulcan 1	1	
Transmitting mach unit tray		6S/Vulcan 2	1	For A/C with 301 series engines
		6S/Vulcan 3	1	For A/C with 201 series engines
Amplifier unit	1004	6S/4551523	2	Mach trim Amplifier Assembly Part No.1353
Comparator	1355	6S/4551524	2	
Slave relay unit	1009	6S/4551528	2	
Accelerometer		6S/266	2	

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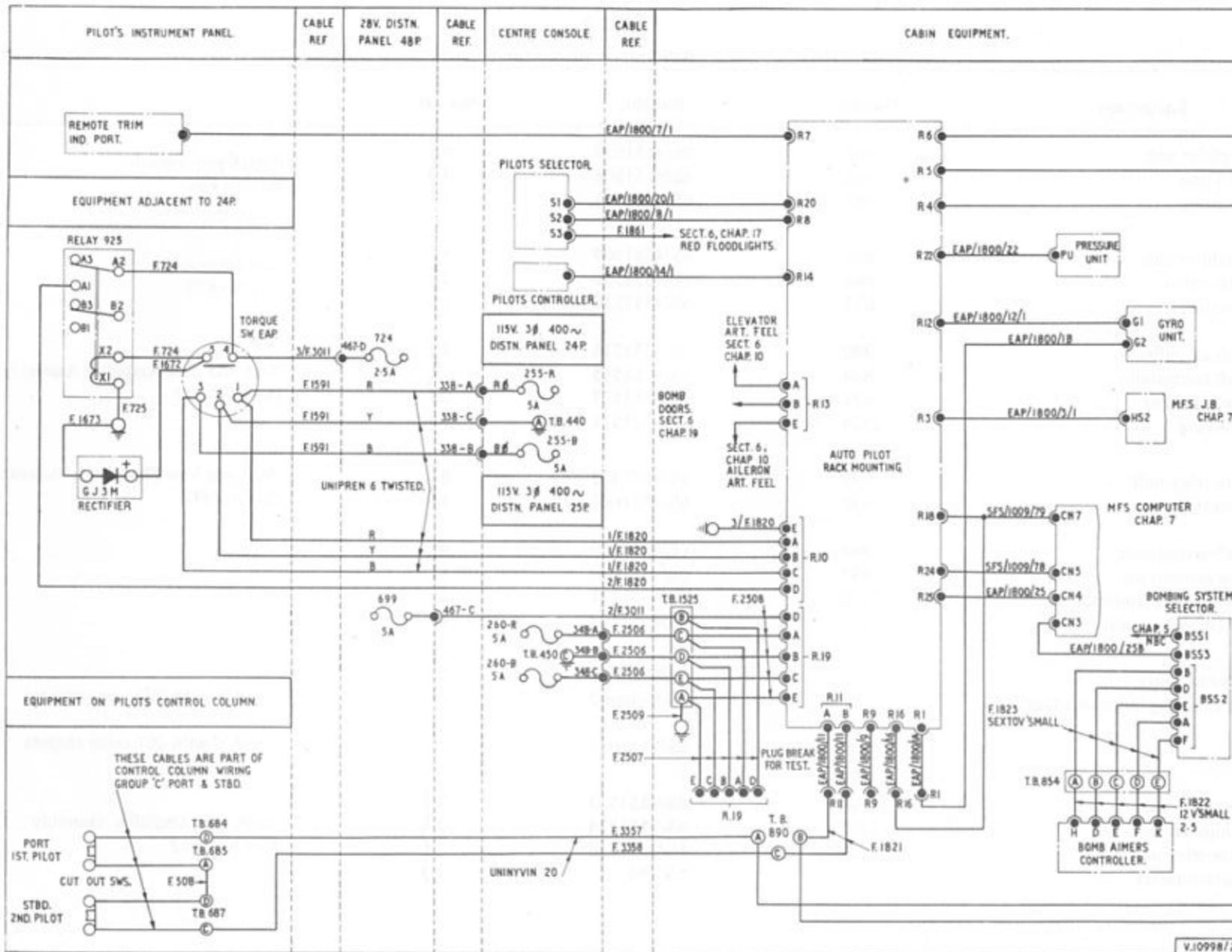


Fig. 7 (i) Autopilot Mk. 10A - Pre. Mod. 2306

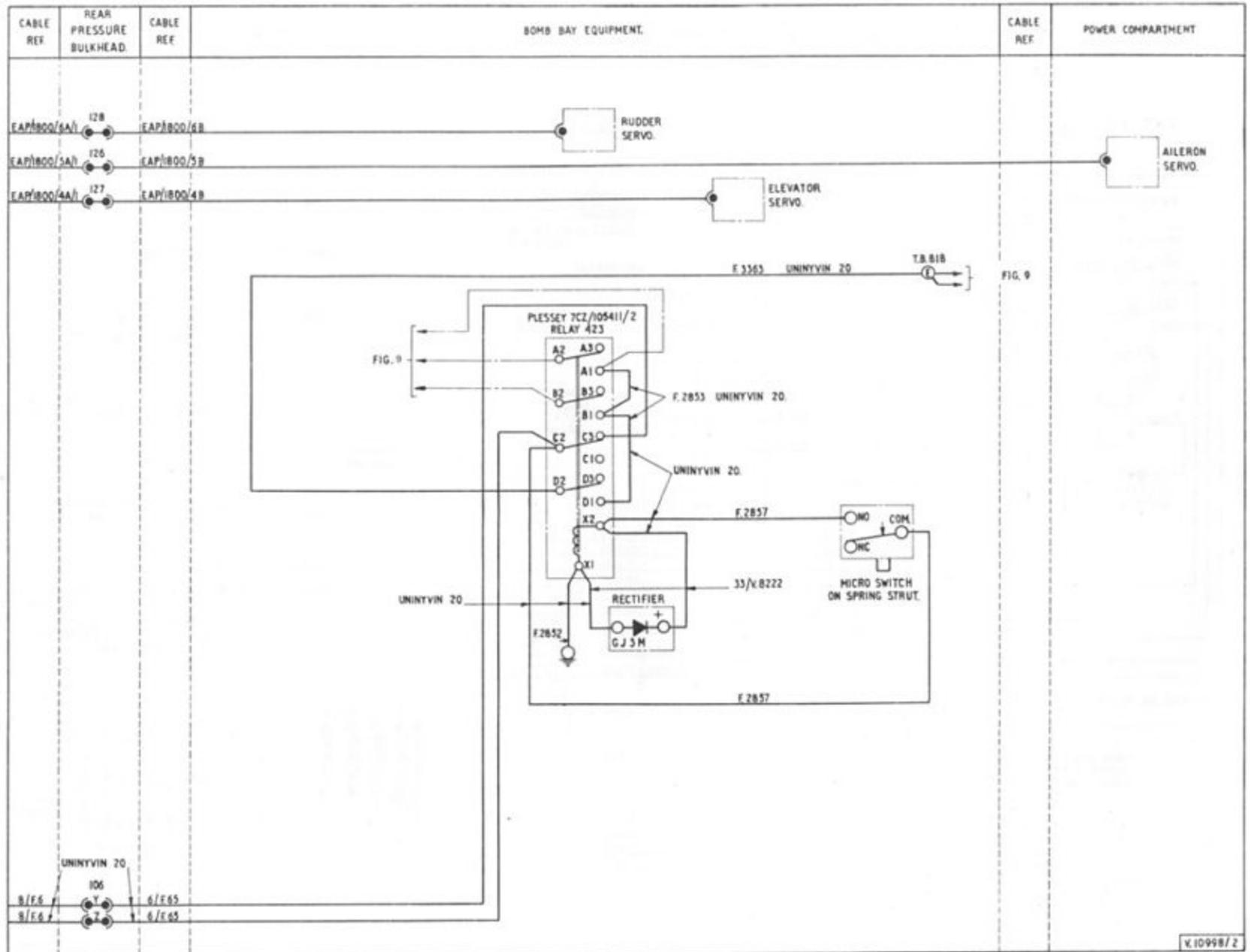


Fig. 7 (2) Autopilot Mk.10A - Pre. Mod. 2306

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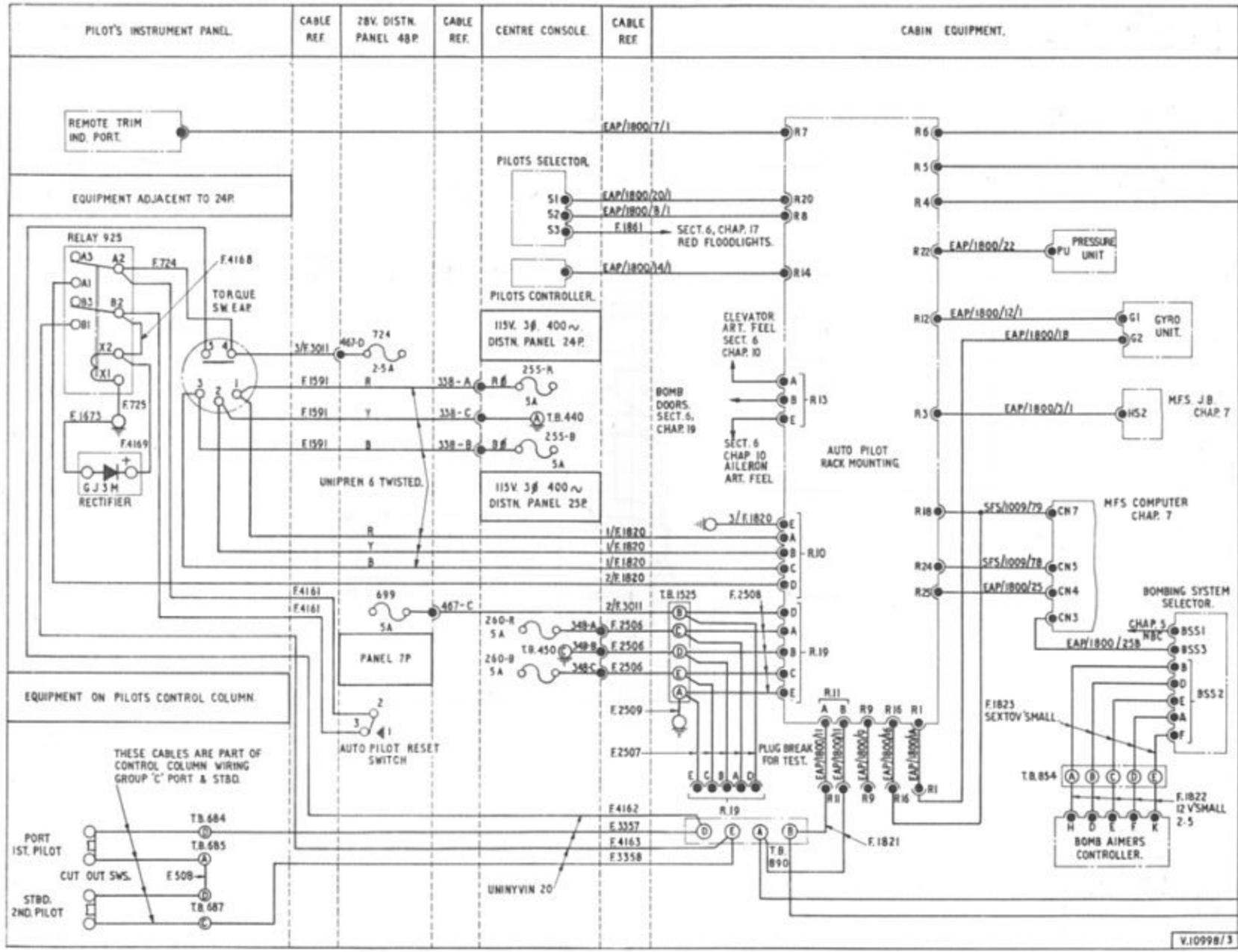
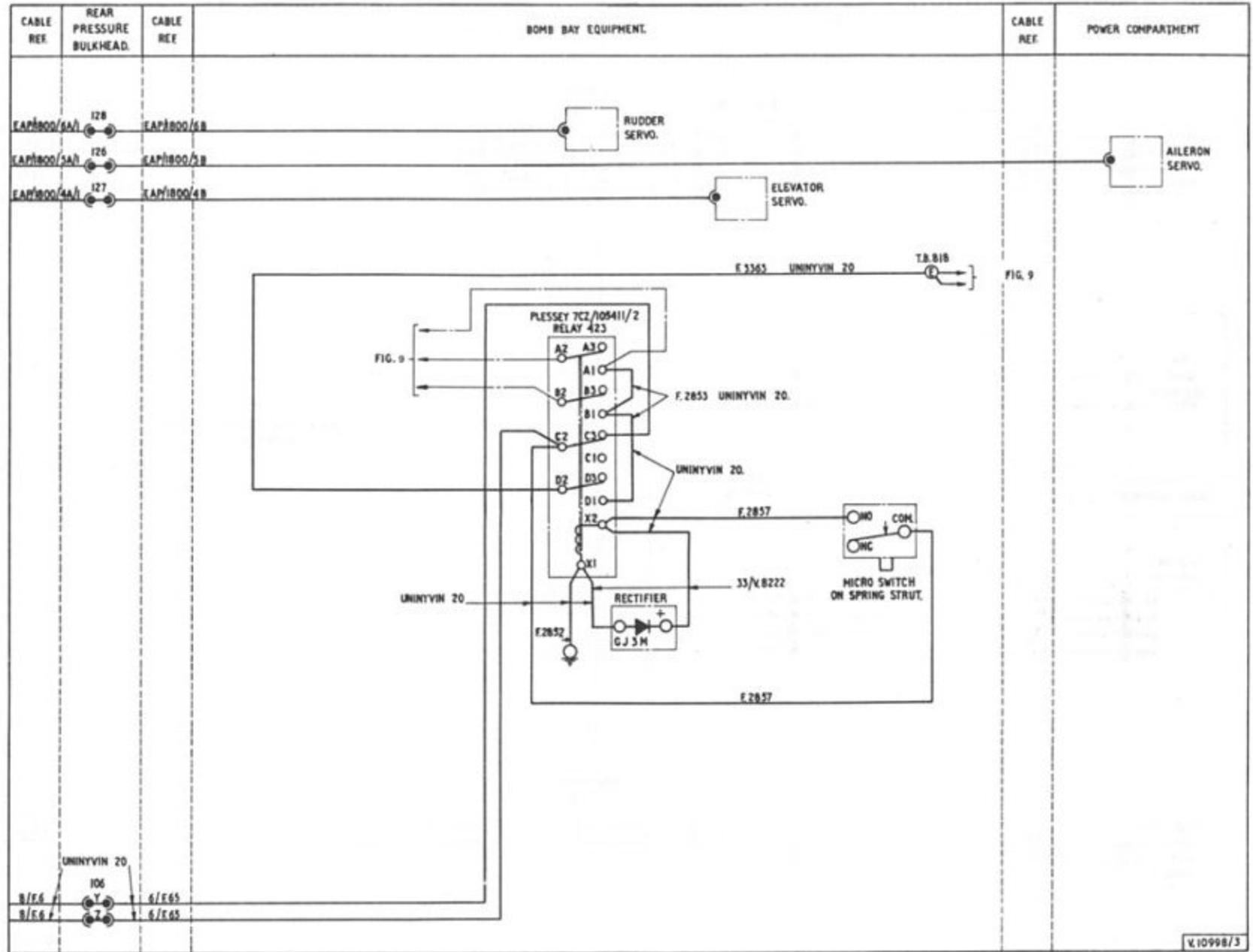
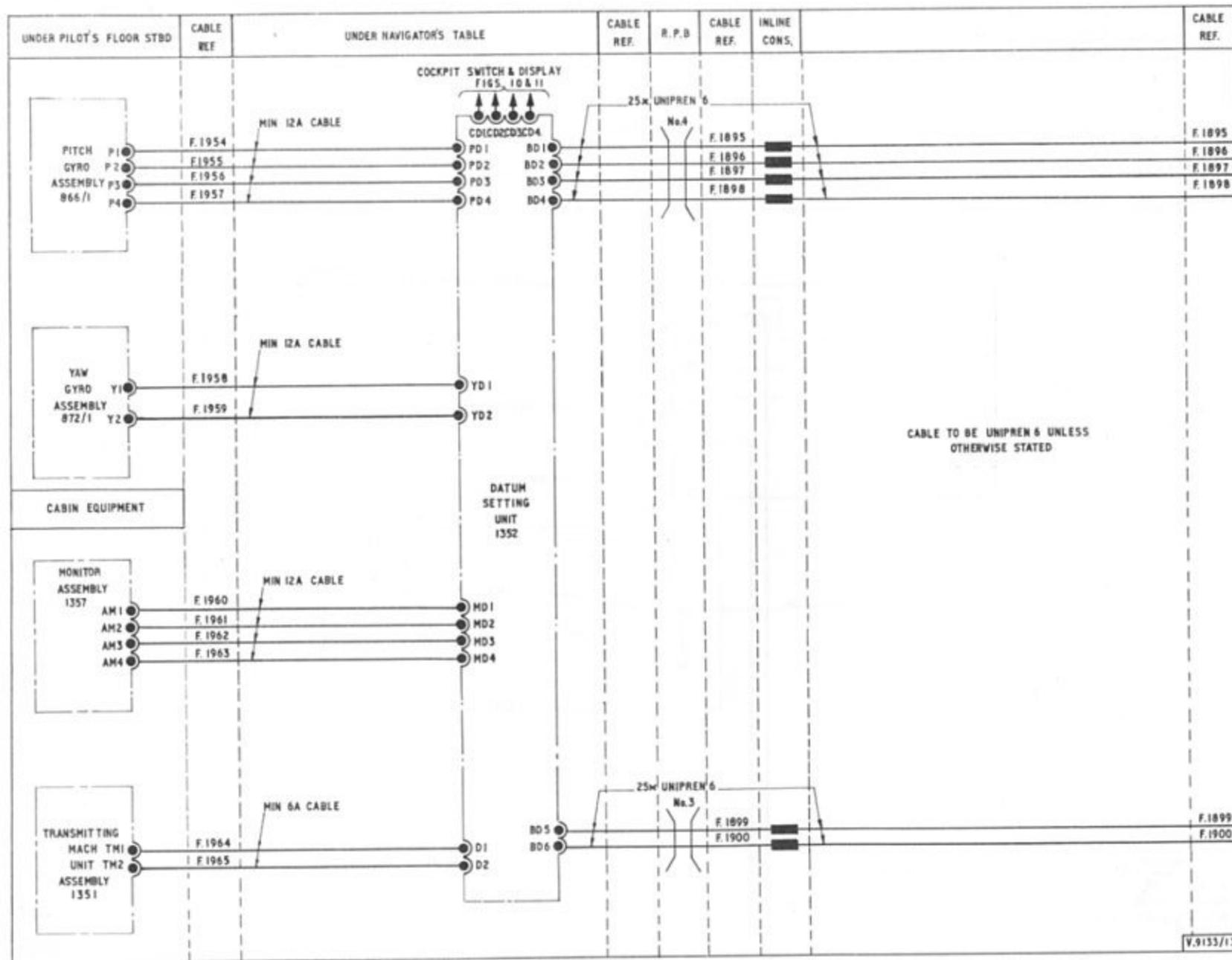


Fig. 8 (i) Autopilot Mk.10A - Post Mod. 2306



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V.9133/13

Fig. 9 (1) Autostabilization systems

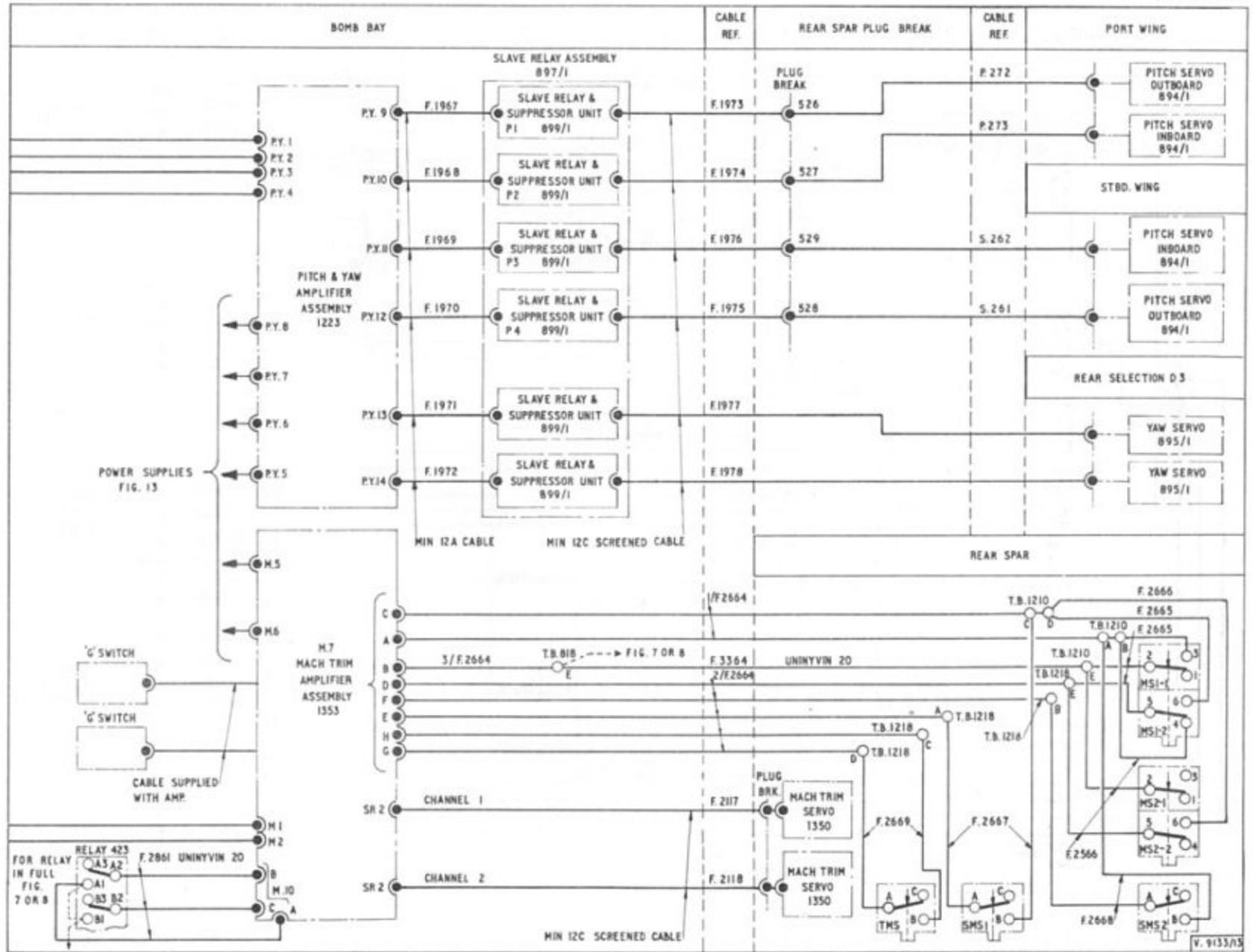


Fig. 9 (2) Autostabilization systems

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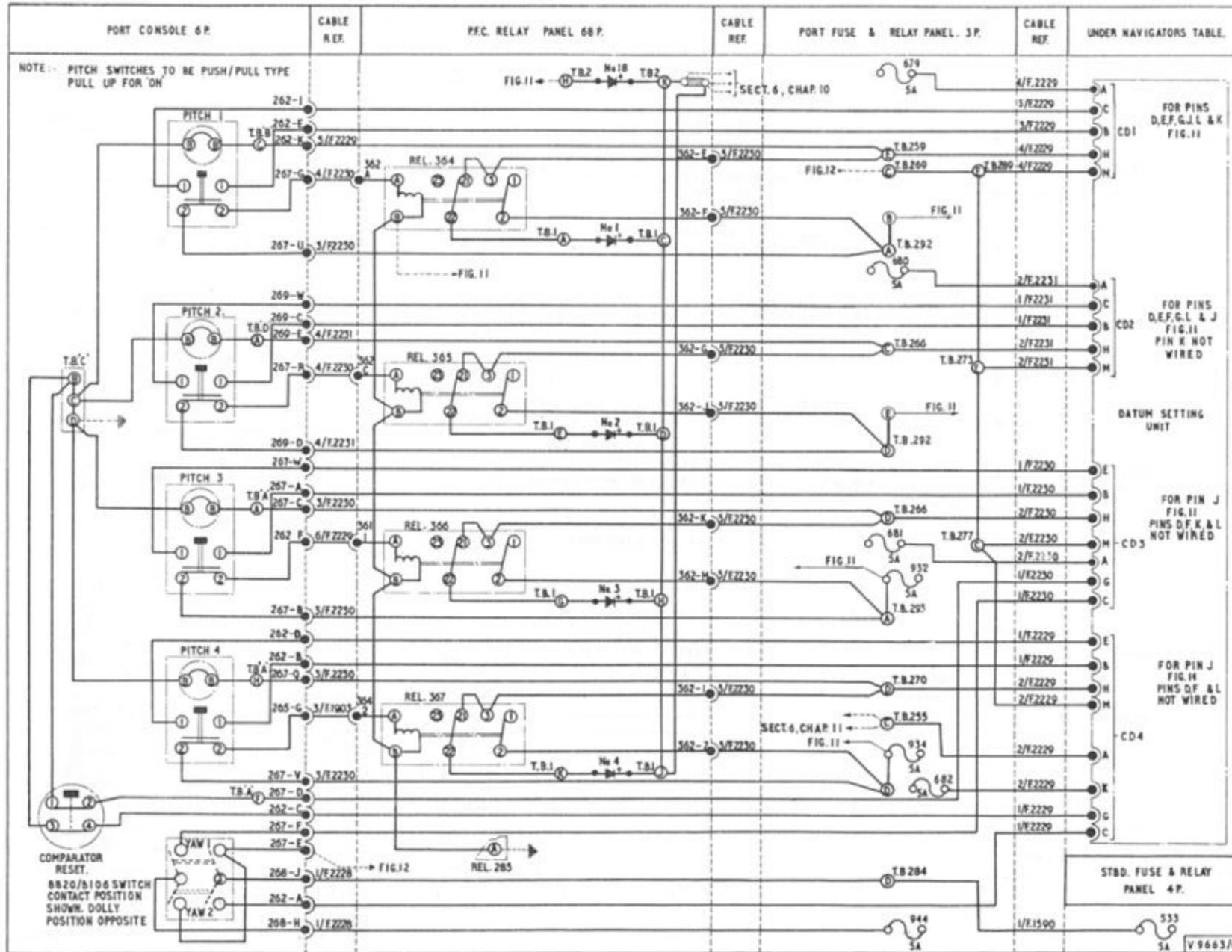


Fig. 10 Pitch and yaw comparator reset switching

Appendix 1
AUTOPILOT MK.10B

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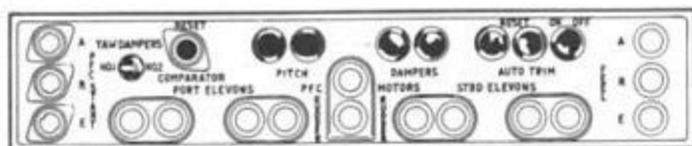
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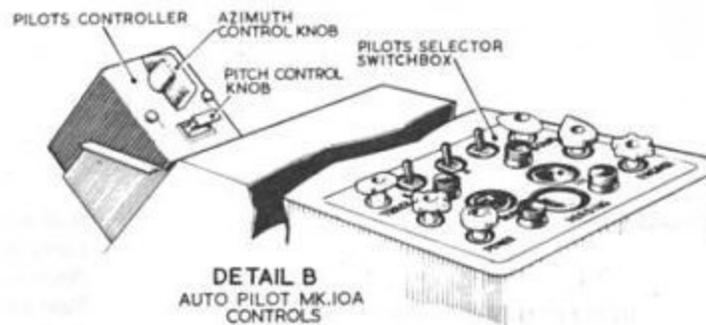
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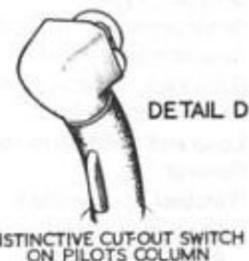
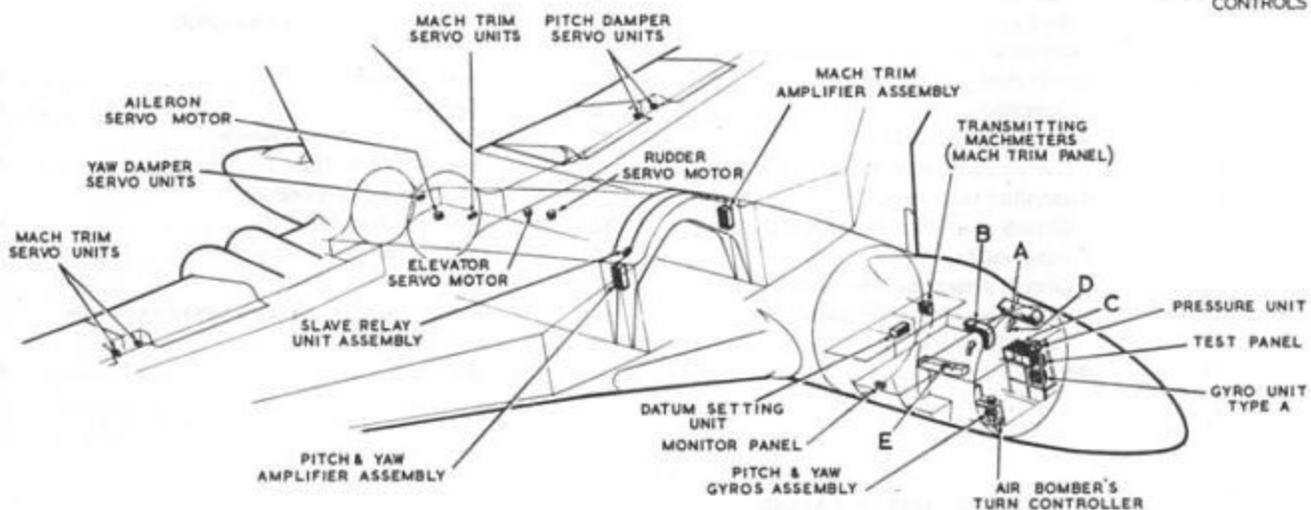
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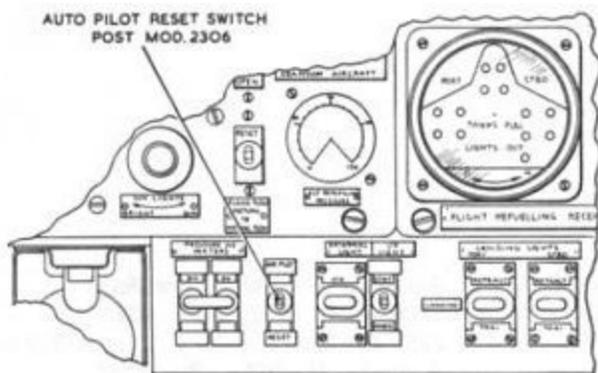
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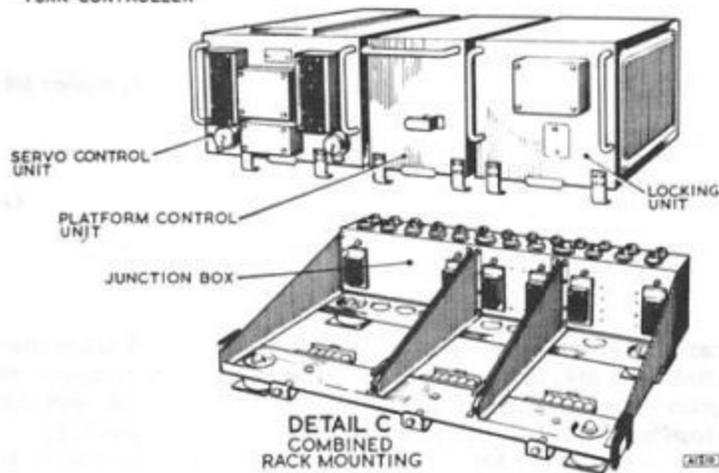
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Fig. 1 Location of autocontrols

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Introduction

1. This appendix contains descriptive and servicing information for the Autopilot Mk.10B, formerly fitted to aircraft equipped with the automatic landing system. With the incorporation of Mod.2263, which deletes the automatic landing facility, the function of the autopilot Mk.10B is the same as that for the Autopilot Mk.10A, and this appendix should be read in conjunction with the main chapter. A complete description of the Autopilot Mk.10B system will be found in A.P.112C-0800-1A.

2. The system is integrated with the aircraft flying controls and autostabilization controls, for further details reference should be made to the main chapter.

3. Illustrations showing the location of components are provided, together with an equipment table. The appropriate routing charts will be found at the end of the text.

4. The following modifications are incorporated:-

Mod. 980 - To make provision for the leader cable loop aerial auto-landing instruments and auto-throttle installation. (This Mod. superseded by Mod.2263).

Mod.1204 - To introduce the leader cable installation, autopilot Mk.10B, the auto-throttle installation and auto-landing instruments, to complete the auto-landing

installation. (This Mod. superseded by Mod.2263).

Mod.1232 - To introduce a test point to simulate bomb doors open and opening positions.

Mod.1512 - To introduce relay, Type 4190 GD in lieu of Type 4190 HD, in servo control unit. (complementary to Smiths Mod. AP/E.156).

Mod.1545 - To introduce pilots' control handle, Type A.C. 61320, in lieu of Type AC.14256, which contains an instinctive cut-out switch requiring a conscious action.

Mod.1581 - To bring the autoland installation up to the interim release standard by allowing the autopilot Mk.10B to be used with the autoland facility disconnected, and also ensuring that all a.c. supplies for the autopilot Mk.10B are derived from the same source. (This Mod. superseded by Mod.2263).

Mod.1856 - This Mod. supersedes Mod.1581 and permits full operation of the autopilot Mk.10B with the autoland facility to the C.A. release standard. (This Mod. superseded by Mod.2263).

Mod.2082 - To prevent an electrical backfeed to the bomb release system in the event of an autopilot failure.

Mod.2149 - To introduce junction box, Type H (6TB2294) in lieu of junction box Type F (6TB1988) (Mod. AP/E/198. To fit failure warning indicator for radio altimeter to aircraft with Mod.200 embodied.

Mod.2263 - To remove autoland Leader cable and auto-throttle facility from aircraft fitted with Mk.10B autopilot.

Mod.2272 - Changes to the bomb door indication circuit to achieve satisfactory operation of the autopilot when Mod.200 is removed from the aircraft.

Mod.2305 - To introduce an autopilot reset switch to ensure that the d.c. supply is isolated from the autopilot whenever either of the instinctive cut-out switches are operated.

Mod.2409 - To introduce Mk.10B auto-pilot equipment on aircraft not having Mod.360 embodied.

► Mod.2432 - Introduction of re-identified servo motors to a sero lifed standard (Smiths Mod.AP/E225) in lieu of existing servo motors. ◀

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DESCRIPTION AND OPERATION

General

5. The Autopilot Mk.10B is a development of the Autopilot Mk.10A and provides the same facilities with the addition of 'long' and 'short' term stabilization in the roll, pitch and yaw axes. As a detailed description of the autopilot Mk.10A is provided in the main chapter, this appendix will only contain information on those facilities which are not provided by the Mk.10A.

6. The units comprising the Mk.10B are similar to those which comprise the Mk.10A. Reference to Table 1 will show that the items marked with an asterisk are fitted only in the Mk.10B installation. The unmarked items of Table 1 are fitted in both the Mk.10A and 10B systems. The marked items only are described in this appendix.

Control and unit location

7. Most of the units are contained in the combined rack assembly located under the first pilot's floor (fig.1). Other units are mounted individually nearby. The controller, selector and cut-out switches are installed at the pilots' station, whilst the servo-motors are fitted in the bomb bay and aft power compartment.

Selector, Type C

8. The selector switch box Type C is mounted on the aft end of the retractable centre console (fig.1). In addition to the switches detailed in the main chapter, the selector fitted in the Mk.10B installation contains a two-position switch labelled A/L PRIME, the switch positions being labelled L/CABLE and LOC. In this installation the switch is no longer used.

Servo control unit, Type D

9. The servo control unit, Type D, contains four high gain amplifiers, one each for the aileron, elevator and rudder channels, and one for the roll error cut-out circuit. When Mod.1512 is embodied, the servo-control unit embodies Smith's Mod.A.P./E156.

Junction box, Type F

10. The junction box, Type F, is an integral part of the combined rack assembly which contains the platform control, the servo control and the locking units. The junction box carries six Cannon plugs, to which the above three units connect, and 25 miniature Mk.4 connectors which serve to connect the units to the other components comprising the installation. When fitted in the Mk.10B system, the interior of the junction box is re-wired to accommodate the three modified units. In this installation, the locking unit is not used.

Gyro unit, Type A or B

11. The gyro unit, Type A or B, mounted on the port side of the aircraft, under the first pilot's floor (fig.1), contains the three 'short term' disturbance detecting gyros. Also mounted on the platform is the 'long term' pitch monitor and a mercury switch, both of which respond to aircraft displacement in the pitch axis. The mercury switch is also used to keep the platform level when the autopilot is switched on but disconnected.

Servo-motors

12. The servo-motors, described in the main chapter, are mounted in the bomb bay and aft power compartment (fig.1). Each servo-motor contains an integrally coupled a.c.

tacho-generator which produces a signal, proportional in amplitude, to the rate of control surface application. The elevator and aileron servo-motors, Type A and C respectively, are used in both the Mk.10A and Mk.10B installations, the rudder servo-motor however, is changed from a Type C to a Type B in this installation.

LONG AND SHORT TERM STABILIZATION

General

13. Short term stabilization in the roll, pitch and yaw channels is provided by three 'rate-of-turn-signalling' gyroscopes. Long term stabilization in the pitch and yaw channels is provided by two monitors of the 'signalling pendulum' type. Long term stabilization in the roll axis is derived from the M.F.S. compass system.

14. The rate gyro and monitor signals are shaped and amplified to operate the electric servo-motors which in turn actuate the three aircraft control surfaces. The three rate gyros are mounted on a platform which can be rotated in the pitch and roll axis to produce aircraft manoeuvres with respect to these axes.

15. The principle of 'aileron steering' is employed to control the aircraft in azimuth. In this method, the heading of the aircraft is controlled by the application of aileron only. The rudder is used solely to damp short period yaw instability, and, for the longer term, to suppress side slip.

Principle of operation

Short term stabilization

16. Short term stabilization in the roll, pitch

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and yaw axes is provided by a combination of the rate gyro signals (para.11), and the tachogenerator signals (para.12), being added together and amplified to drive the servo-motors.

17. The gyro signal is shaped (as described in para.19) and added to the tach-generator signal, their algebraic sum being fed to the appropriate servo amplifier (para.9). In such a system it is arranged that the two signals are of opposite polarities and therefore tend to balance each other out. Consequently, when the two signals are added together, the resultant signal is proportional to the rate of change of aircraft attitude. The signal is amplified to drive the servo-motors which apply control surface movement at the same rate, but in opposite direction, to the aircraft change of attitude.

18. Should the aircraft deviate from the desired flight path the control surfaces are made to operate to bring the aircraft back on the original flight path. The control surface angle progressively diminishes as the aircraft error is corrected, and reduces to neutral when the recovery is complete.

Roll and pitch axis

19. In the roll and pitch axis the gyro signals are 'shaped' by having part of their signals passed through a passive differentiating network, the resultant derivative being added to the original signal. Shaping of the gyro signals provide enhanced short period damping.

20. In the yaw channel, the whole of the signal is passed through a differentiating amplifier and only the derivative is used to control the rudder.

Roll and yaw axis

21. Signals from the roll and yaw axis gyros are added algebraically and fed to the roll servo channel. In the event of a yaw disturbance, aileron control surface is applied, at a rate proportional to the aircraft rate of yaw, and the aircraft commences to roll. The roll gyro senses the roll and produces a signal proportional to this rate of roll.

22. The roll and yaw gyro signals are of opposite polarities and tend to cancel each other out. In consequence, the aileron angle commences to move progressively and comes to rest when the two signals are equal, i.e., no derivative. At this point, the bank angle of the aircraft is equal to the yaw disturbance and the control surface is neutral.

23. Side slip now occurs and the directional stability of the aircraft (aided to some extent by the action of the rudder channel) gives rise to a yawing movement which brings the aircraft back on to its original heading. This results in aileron surface movement which takes off the aircraft bank angle. As the aircraft commences to roll off the bank, the aileron angle is progressively reduced until the aircraft is re-established on its original heading, when the aileron angle is reduced to zero.

Long term stabilization

24. Long term stabilization is derived, in the pitch and yaw axis, from signalling pendulum type monitors, and in the roll axis, from the M.F.S. compass system. The monitors are described in the main chapter and the M.F.S. compass system in Chap.7 of this publication.

Pitch axis

25. The pitch axis monitor is mounted on the gyro platform (para.11), longitudinal to

the aircraft line of flight. The monitor provides signals which are proportional in amplitude to the aircraft's pitch attitude relative to the plane of the earth over which the aircraft is flying. The signal is shaped (para.19), and fed to the elevator amplifier in the servo control unit, where it is amplified to drive the servo-motor. In this channel a rate of elevator movement is applied, which is proportional to the rate of change of pitch attitude. This elevator movement acts to reduce the pitch deviation to zero, when the elevator angle is neutral.

Yaw axis

26. The yaw axis monitor, which is located under the second pilot's floor between formers 358 and 372, is mounted across the aircraft line of flight. The monitor provides signals, proportional in amplitude to the aircraft deviation from a plane which is vertical to the plane of the earth and longitudinal relative to the true track. This signal is fed unshaped to the rudder channel servo amplifier where it is amplified to drive the servo-motor. In this channel the rate of applied rudder is proportional to the rate of side slip and the rudder movement acts to reduce the side slip to zero.

Roll axis

27. Gradual deviation from the aircraft magnetic heading is detected by the M.F.S. compass monitor (Chap.7) which produces a signal proportional to the deviation. The signal is shaped and fed into the aileron channel servo amplifier where it is amplified to drive the servo-motor. The resultant aileron movement causes the aircraft to bank, and thereby turn it back on to its original heading.

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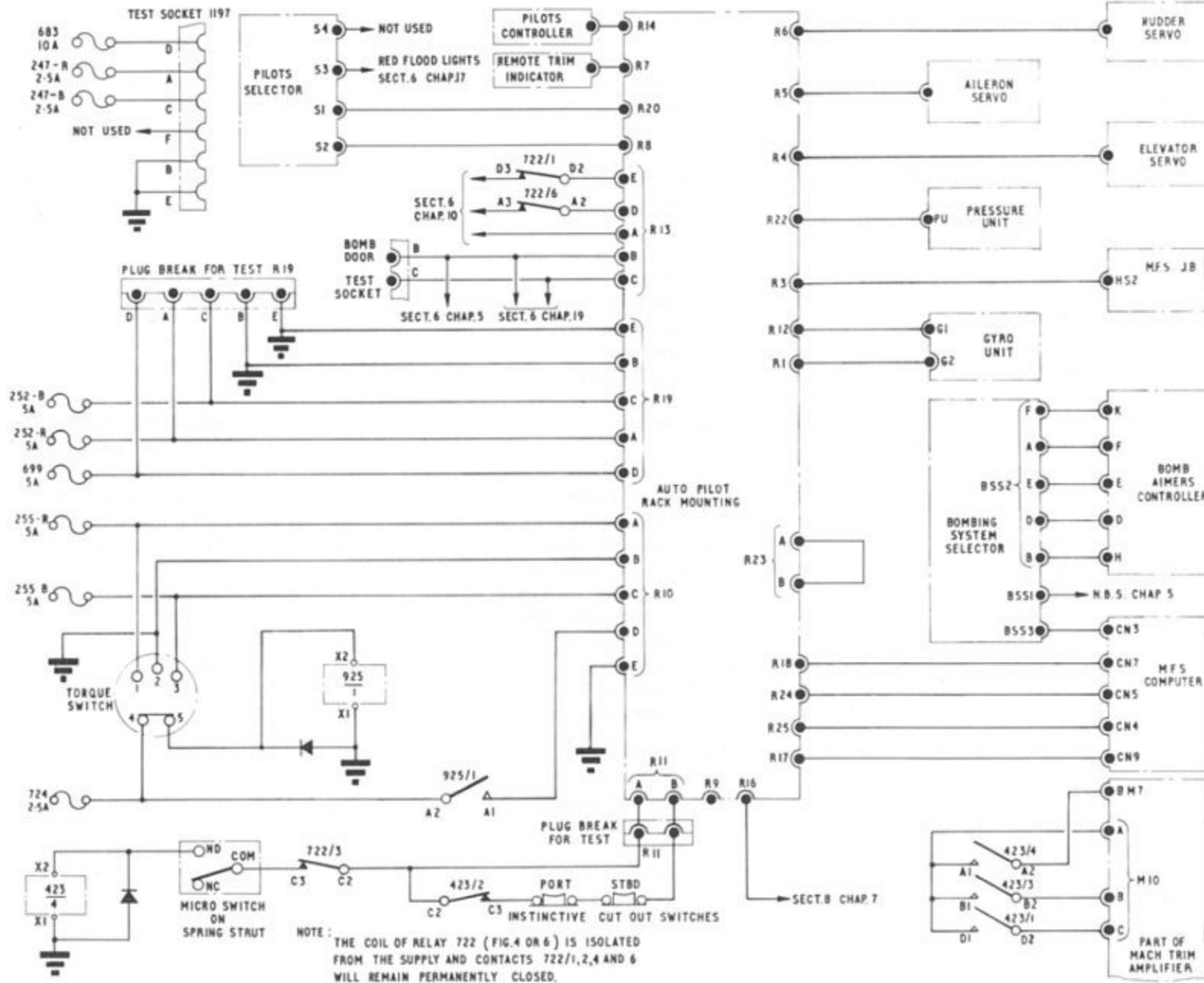


Fig.2 Autopilot Mk.IOB circuit diagram - Pre. Mod. 2305

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Control of bombing manoeuvres

28. The aircraft can be guided along a pre-determined track for a bombing run, by signals from either the bomb aimer's controller or the N.B.C., operating through the autopilot. Bank angle and rate of turn are proportional to signal amplitude. Further details of the bombing manoeuvres are contained in the main chapter.

Bomb door compensation

29. Opening the bomb doors causes extra drag on the aircraft fuselage resulting in a nose-down pitch error. Provision has been made in the autopilot and aircraft wiring for compensating signals to be applied to the elevator servo channel, and also disconnection of the pitch monitor, which results in elevator movement. This movement corrects the aircraft trim so that steady flight is maintained. Compensation is not applied once the doors are fully open or whilst they are closing. A test socket labelled BOMB DOOR TEST, is fitted on the autopilot test panel (para.41), and is used to inject signals into the autopilot to simulate the opening and fully opened positions of the bomb doors during servicing periods.

Operation

30. As the bomb doors begin to open, a 28-volt d.c. supply is fed from fuse 480 via the bomb door closed microswitches (Sect.6, Chap.19) to plug R13, pole C of the autopilot junction box (fig. 2 or 3). This supply is used to inhibit the compensating signals applied to the elevator channel. When the bomb doors are fully open, a 28-volt d.c. supply is fed from fuse 481 via the bomb door open microswitches (Sect.6, Chap.19) to plug R13,

pole B of the autopilot junction box. This supply is used to reset the system. On aircraft Post Mod. 1173 the supply to plug R13 is fed from fuse 486 (Sect.6, Chap.19).

Safety arrangements

31. For information on the safety arrangements refer to the main chapter.

Circuit operation Pre. Mod.2305

32. The spring strut microswitch is connected in series with the two instinctive cut-out switches and relay 423 (fig.2). Operation of either cut-out switch will open circuit the supply from plug R11, pole A, to plug R11, pole B on the autopilot rack mounting, resulting in the autopilot being disengaged. Operation of the spring strut microswitch will connect a supply from plug R11, pole A via the permanently closed relay contacts 722/3 to energize relay 423. Contacts 423/2 will open resulting in the autopilot being disengaged. Contacts 423/1, 423/3 and 423/4 close, to permit spurious negative and positive G signals to be fed into the mach trim comparator circuits (refer to main chapter). This will result in the immediate locking of the mach trim servo and at the same time a misalignment signal will be presented on the mach trim indicator.

Autopilot reset switch

33. On aircraft Post Mod.2305 an AUTOPILOT-RESET switch, spring loaded to the central position, is fitted on panel 7P at the second pilot's position (fig.1). Prior to the operation of the switch, the d.c. supply is isolated from the autopilot. This switch also ensures that the d.c. supplies are isolated from the autopilot whenever the instinctive cut-out

switches are operated. In order to re-engage the autopilot it will be necessary to first operate the RESET switch, pull on the POWER switch and after a period of 60 seconds, when the ready indicator shows white, pull the ENGAGE switch.

Circuit operation Post Mod.2305

34. When RESET is selected, a 28-volt d.c. supply is fed from fuse 724 via contacts 2 and 3 of the autopilot reset switch to energize relay 925 (fig.3). Contacts 925/1 close providing a hold-on circuit for relay 925 via the torque switch contacts 4 and 5 and the two instinctive cut-out switches. Contacts 925/2 close, connecting the d.c. supply from fuse 724 to the autopilot rack mounting junction box. If either the torque switch operates or the instinctive cut-out switches are pressed, the autopilot will be disengaged and the hold-on supply for relay 925 will be broken, disengaging the relay and isolating the d.c. supply. In order to re-engage the autopilot, the RESET switch must first be operated (para.33).

35. Operation of the spring strut microswitch will connect a supply from plug R11, pole A via the permanently closed relay contacts 722/3 to energize relay 423. Contacts 423/2 will open resulting in the autopilot being disengaged. Contacts 423/1, 423/3 and 423/4 will close to permit spurious negative and positive G signals to be fed to the mach trim comparator circuits, locking the mach trim servo and feeding a misalignment signal to the mach trim indicator. It should be noted that the operation of the spring strut microswitch does not result in the d.c. supplies being isolated from the autopilot and the autopilot can be re-engaged by pulling the ENGAGE button.

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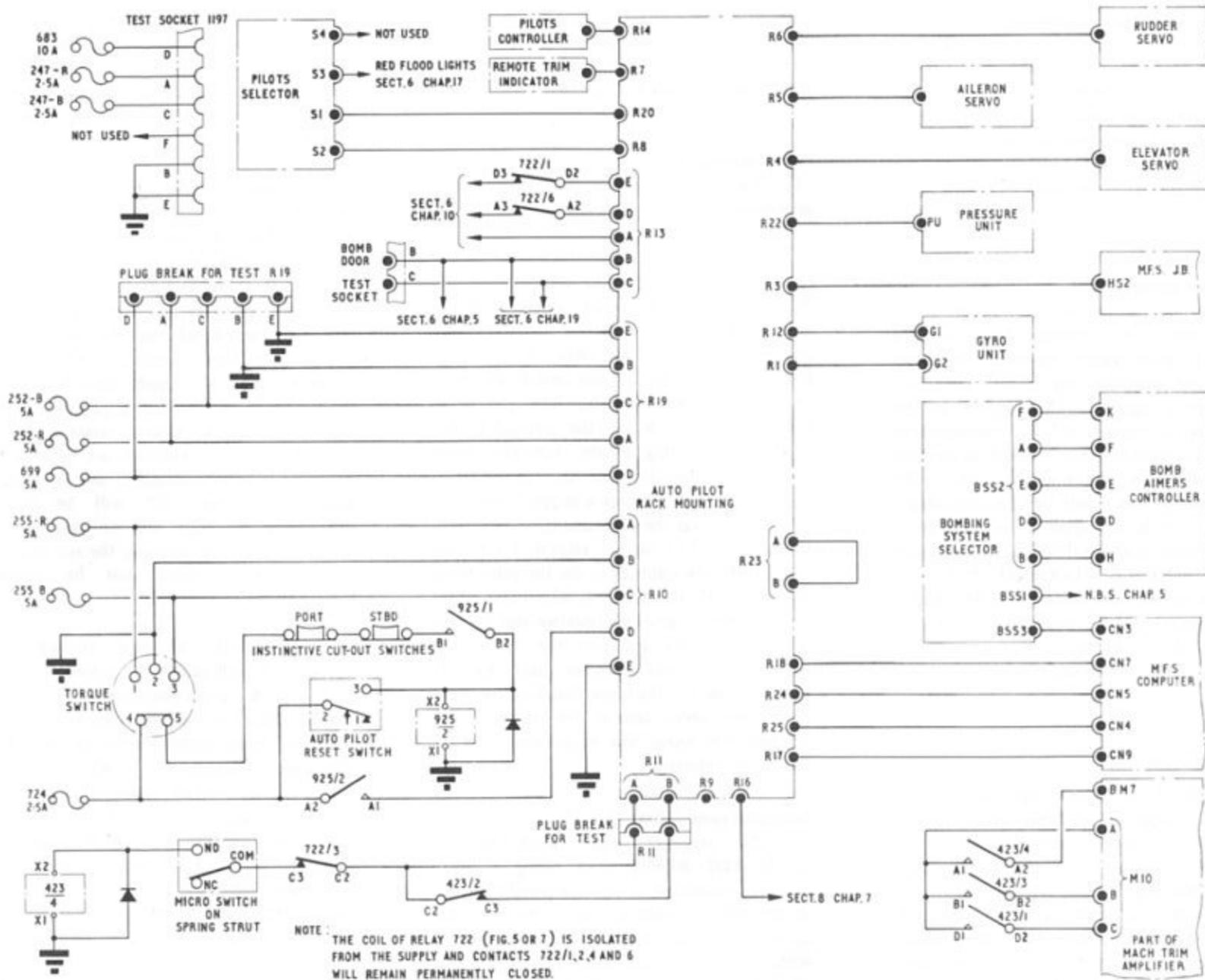


Fig. 3 Autopilot Mk.IOB circuit diagram - Post Mod. 2305

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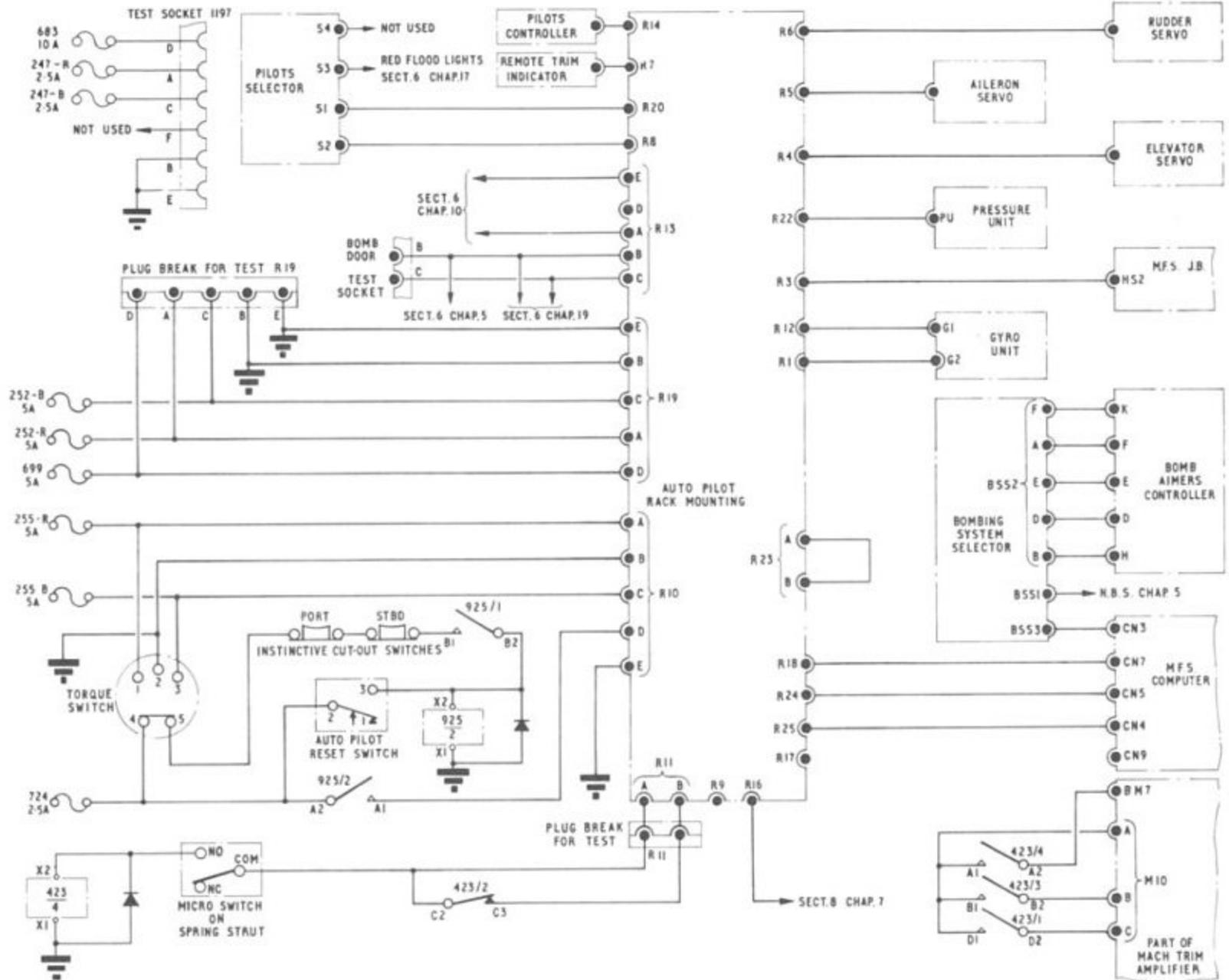


Fig. 3A Autopilot Mk. IOB circuit diagram - Post Mod. 2409

Torque switch

36. For information on the torque switch refer to the main chapter.

Circuit operation Pre. Mod.2305

37. Providing the a.c. supply to plug R10 and the torque switch is within the prescribed limits, the torque switch motor will run and the switch contacts will be closed (fig.2). A 28-volt d.c. supply from fuse 724 in panel 48P is fed via the closed torque switch contacts 4 and 5 to energize relay 925. Contacts 925/1 will close connecting the supply from fuse 724 to plug R10, pole D of the rack mounting junction box. Should a fault develop in the a.c. supply, the torque switch contacts 4 and 5 will open and relay 925 will be de-energized. Contacts 925/1 will open isolating the d.c. supply from the equipment.

Operation of torque switch - Post Mod.2305

38. Providing the a.c. supply to plug R10 is within the prescribed limits, the torque switch contacts 4 and 5 will be closed. With the autopilot reset switch set to RESET, a 28-volt d.c. supply is fed from fuse 724 via the reset switch contacts 2 and 3 to energize relay 925 (fig.3). Contacts 925/2 close connecting the d.c. supply from fuse 724 to plug R10, pole D

Precautions

42. Servicing personnel are reminded that a.c. or d.c. voltages in excess of 100-volt can be dangerous to the extent of causing personal injury, fatal or otherwise. It is essential that the closest attention be given to servicing instructions where matters of safety are concerned, and that maximum co-operation be maintained between trades concerned in servicing operations.

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on the rack mounting junction box. Contacts 925/1 close providing a hold-on supply for relay 925 via the closed torque switch contacts 4 and 5 and the instinctive cut-out switches. Should a fault develop in the a.c. supply the torque switch contacts will open, breaking the hold-on supply for relay 925 and isolating the d.c. supply from the equipment.

Artificial feel system

39. Details of the artificial feel system are contained in Sect.6, Chap.10 of this publication. For information on partial feel relief, during an I.L.S. approach under autopilot control, refer to the main autopilot chapter.

Power supplies

40. The autopilot is provided with 115-volt, 3-phase, 400 Hz a.c. from fuses 255 R and B and fuses 252 R and B in panel 24P, and 28-volt d.c. from fuses 699 and 724 in panel 48P. The supplies are fed to a junction box on the special rack mounting, under the pilots' floor, where they are distributed to the various units via Cannon plugs and Mk.4 connectors (fig.2 or 3). For further details of the a.c.

SERVICING**General**

43. The fixed components of the autopilot system require little servicing apart from a periodical check on the connectors and cables for security, cleanliness and signs of damage.

Functional ground checks - autopilot Mk.10B

44. These checks are performed without the use of test equipment, and should be carried

supplies to panel 24P refer to Sect.6, Chap.4 of this publication.

Test panel

41. A test panel, fitted with five test sockets, is located on the forward member of the crate situated under the first pilot's floor. The panel test sockets are labelled as follows:-

A.P. - RM11	- Used to check the autopilot cut-out circuits.
A.P. - RM19	- Used to check the a.c. and d.c. supplies connected to plug R19 on the autopilot rack mounting.
A.P. BOMB DOOR TEST	- Described in para.29.
TEST SOCKET 1196	- Not used.
TEST SOCKET 1197	- Used to connect a.c. and d.c. supplies to test equipment from a.c. fuses 247R and B in panel 24P and d.c. fuse 683 in panel 3P. (fig.2 or 3).

out daily or at the periods laid down in A.P. 101B-1902-4. Carry out the functional ground checks as laid down in A.P. 112C-6800-1. Before proceeding with the checks carry out the following:-

- (1) Remove fuse 612 in panel 3P (this is done to prevent unnecessary operation of the aileron A.F.U., since the unit would move to its

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high speed position upon engagement of the aileron channel).

- (2) Ensure that the 200-volt a.c. and 28-volt d.c. ground supplies are available and connected.
- (3) Ensure that the flying controls are free from obstruction.
- (4) Switch on the 3KVA transformers, by means of the two switches on the secondary supplies control panel SOP, at the A.E.O's station.
- (5) Switch on the mach trim, pitch and yaw systems.
- (6) Check the flying controls for freedom of movement.
- (7) Pull up the retractable centre console to locate the autopilot control switches.

NOTES...

- (1) *If the aircraft is not laterally level when carrying out the ground checks 'drift' will be present on the rudder controls when the autopilot is engaged. Rudder movement will be to starboard when the starboard wing is low, and vice versa.*
- (2) *On aircraft Post Mod.2305, the RESET switch must first be operated before operating the POWER switch. Subsequent disengagement of the autopilot by the operation of the instinctive cut-out switches will result in the 28-volt d.c. supply being isolated and the ENGAGE and POWER push-switches being released. In order to re-engage the autopilot it will be necessary to first operate the RESET switch. During normal autopilot operation, it will be more convenient to disengage the autopilot by pushing the ENGAGE*

switch to off, so as to avoid the delay before re-engagement. In fault conditions, or whenever the system is not required, the system should be disengaged by operating either of the instinctive cut-out switches in order to isolate the d.c. supply to the system.

Ground test procedure - artificial feel system

45. The initial setting-up procedure for the artificial feel system will be found in Sect.6, Chap.10 of this publication. Instructions for setting up and testing the aileron and elevator feel system on autopilot control, are contained in the main autopilot chapter.

Bomb door compensation

46. Functional checks on the bomb door compensating signals, when the autopilot is engaged, are contained in the main autopilot chapter.

REMOVAL AND INSTALLATION

General

47. Removal of the components which comprise the autopilot Mk.10B, is straightforward, therefore no special instructions are required. Should any unit be removed, all loose connectors should be

secured to the adjacent aircraft structure to prevent damage. The servo units will normally be removed by the airframe tradesmen providing that the electrical connectors to the units have been disconnected. Before removing

the servo units, the flying controls should be locked in the positions detailed in Sect.3, Chap.4 of this publication, where detailed instructions for removing the units will be found.

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TABLE 1

Autopilot Mk.10B equipment

Equipment	Type	Ref. No.	No. off
* Pilot's selector	C	6TB/2466	1
▶ Pilot's controller	A	6TB/4545187	1
Bomb aimer's controller	A	6TB/4545256	1
Remote trim indicator	B	6TB/4545448	1
Gyro unit	A or B	6TB/201	1
		or	
		6TB/4545426	
* Servo control unit	D	6TB/4545610	1 ◀
* Gearing pad No.1 (S.C.U.)	M	6TB/1955	1
* Gearing pad No.2 (S.C.U.)	M	6TB/1956	1
▶ * Sense pad (S.C.U.)	J	6TB/1841	1
* Platform control unit	B	6TB/1680	1 ◀
* Gearing pad No.1 (L.U.)	M	6TB/1986	1
* Gearing pad No.2 (L.U.)	M	6TB/1987	1
* Junction box (Mod.2149)	F (H)	6TB/1988 (6TB/2294)	1
▶ Rack mounting	A	6TB/4545409	1
Pressure unit	B	6TB/4545466	1
Mounting (Multiplex)	A	6TB/402	1
Servomotor	A (Elevator)	6TB/6402607	1
* Servomotor	B (Rudder)	6TB/6402609	1
Servomotor	C (Aileron)	6TB/6402611	1
Mounting (servomotor)	A	6TB/4545192	3
Locking unit	F	6TB/4545646	1 ◀

NOTE . . .

Items marked thus * are fitted only in the autopilot Mk.10B installation. Refer to para.6.

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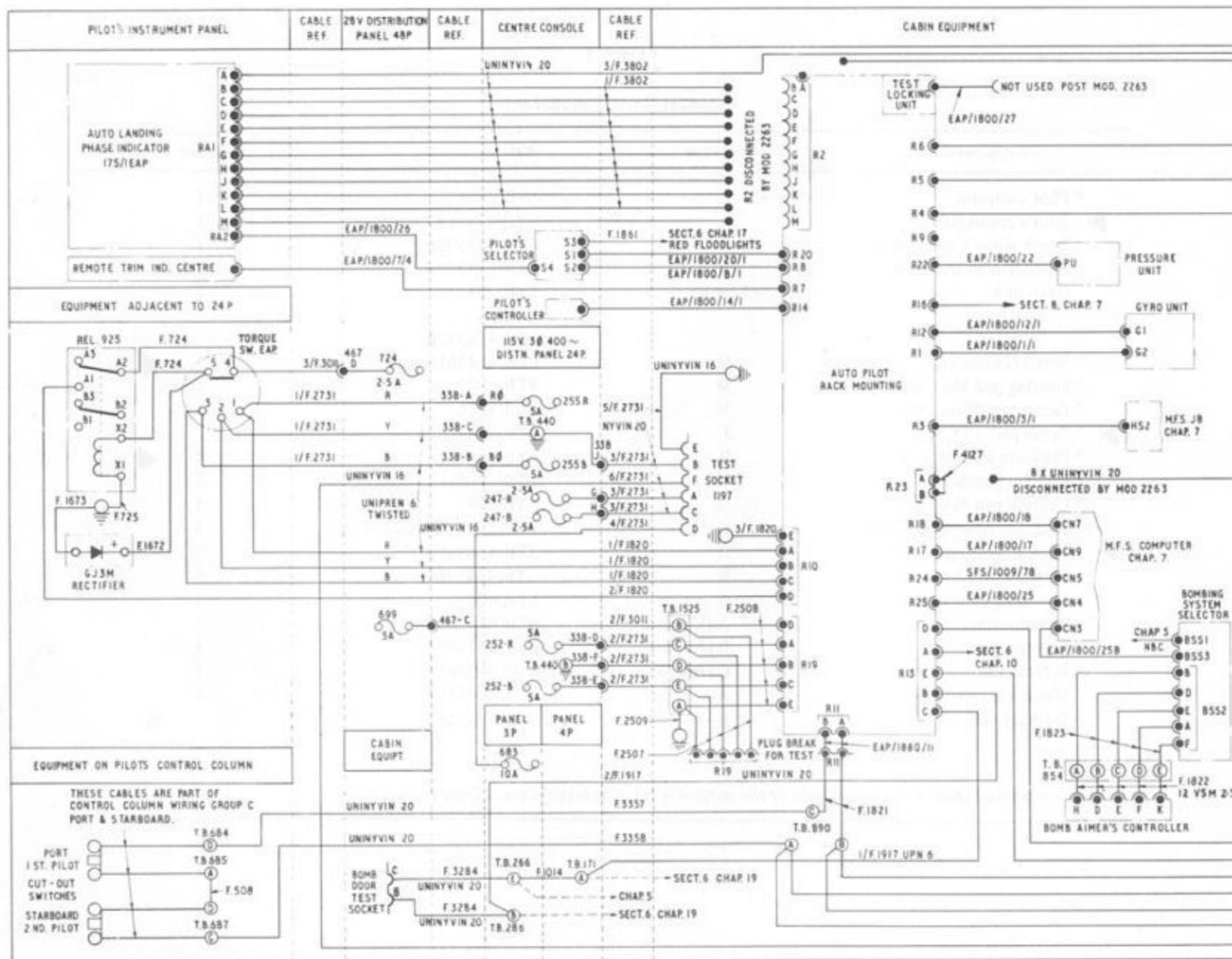


Fig.4 (1) Autopilot Mk.10B - Pre. Mod. 748 and 2305, Post Mod. 2082 and 2263

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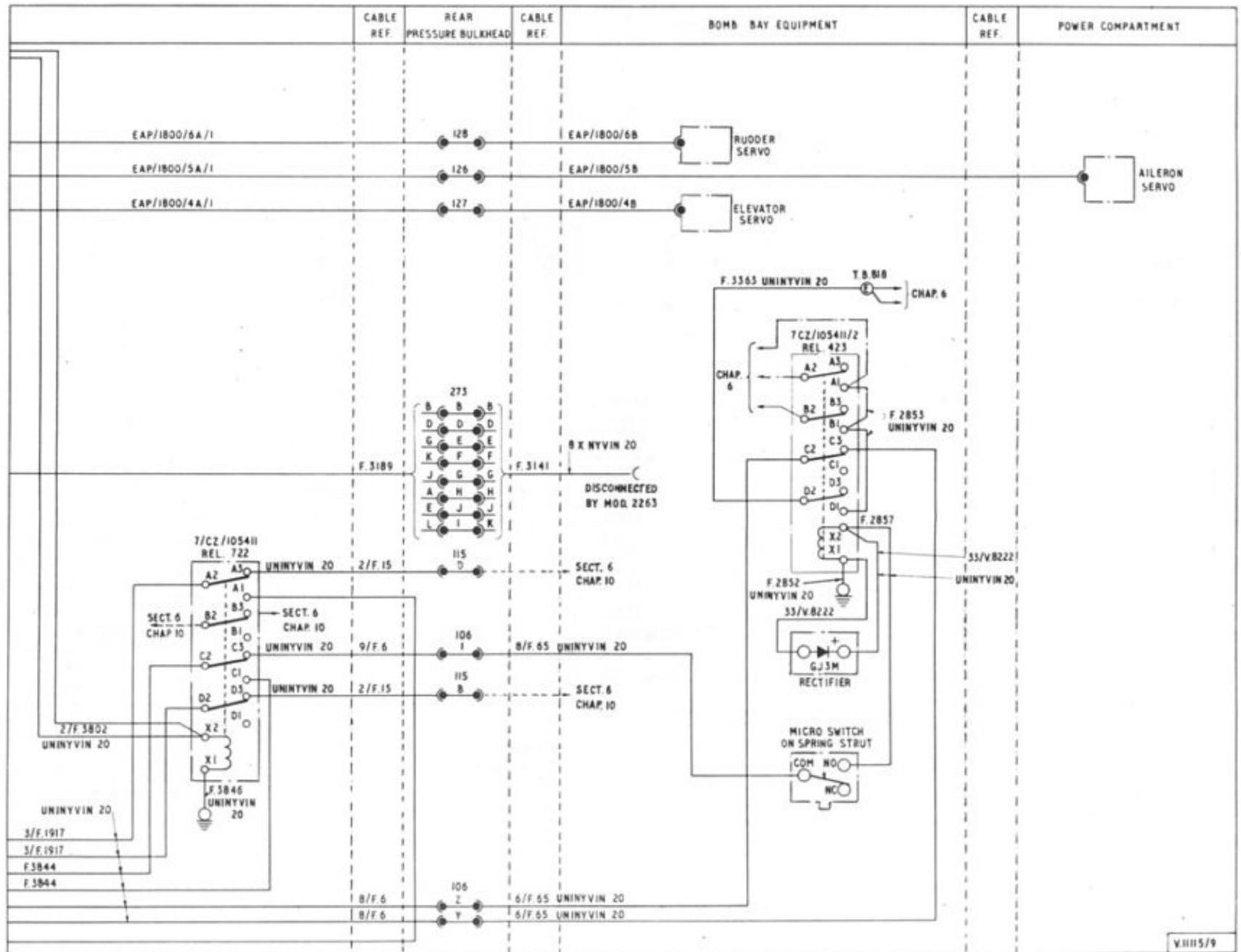


Fig.4 (2) Autopilot Mk.10B - Pre. Mod. 748 and 2305, Post Mod. 2082 and 2263

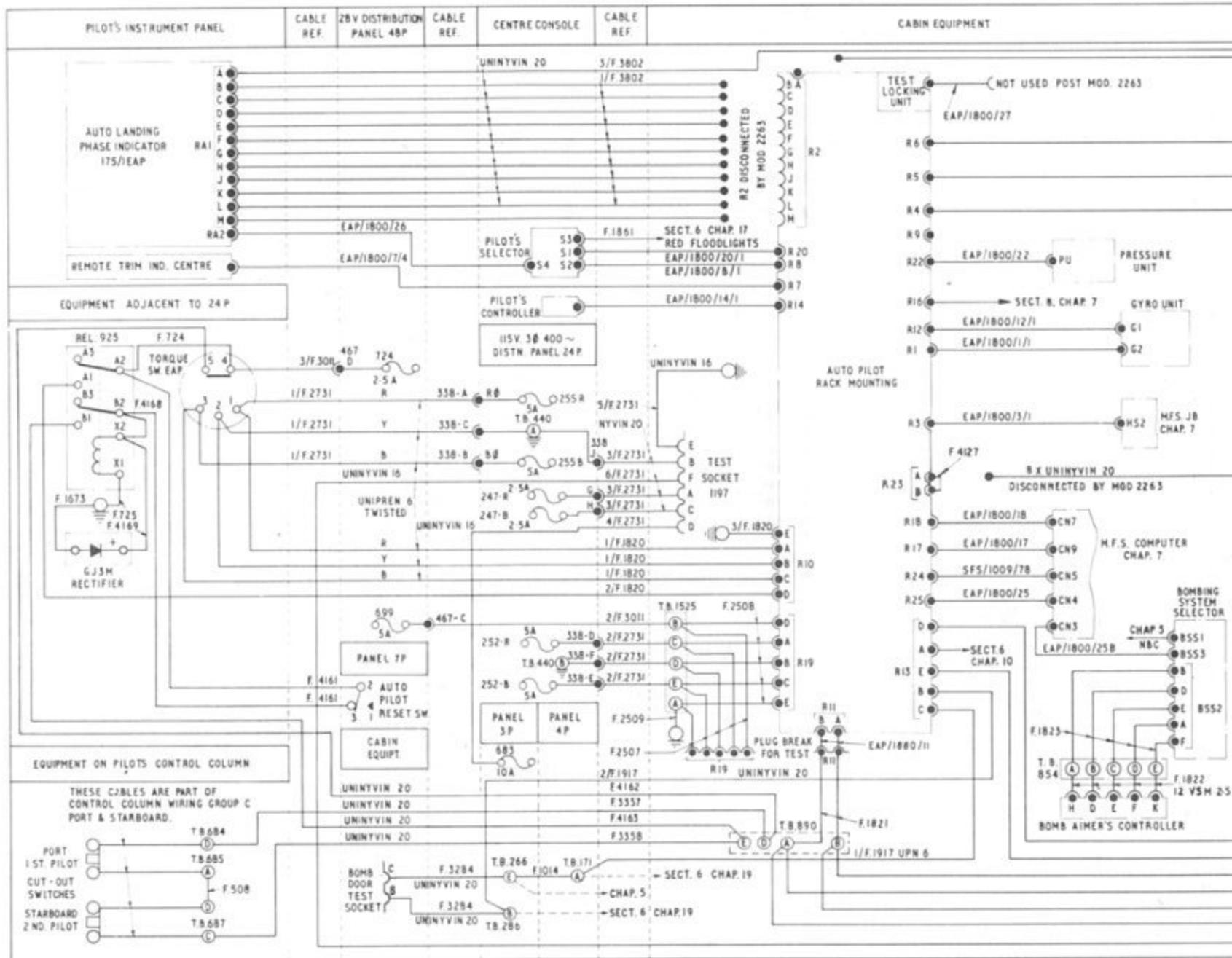


Fig.5 (1) Autopilot Mk.10B - Pre. Mod. 748. Post Mod. 2082, 2263 and 2305

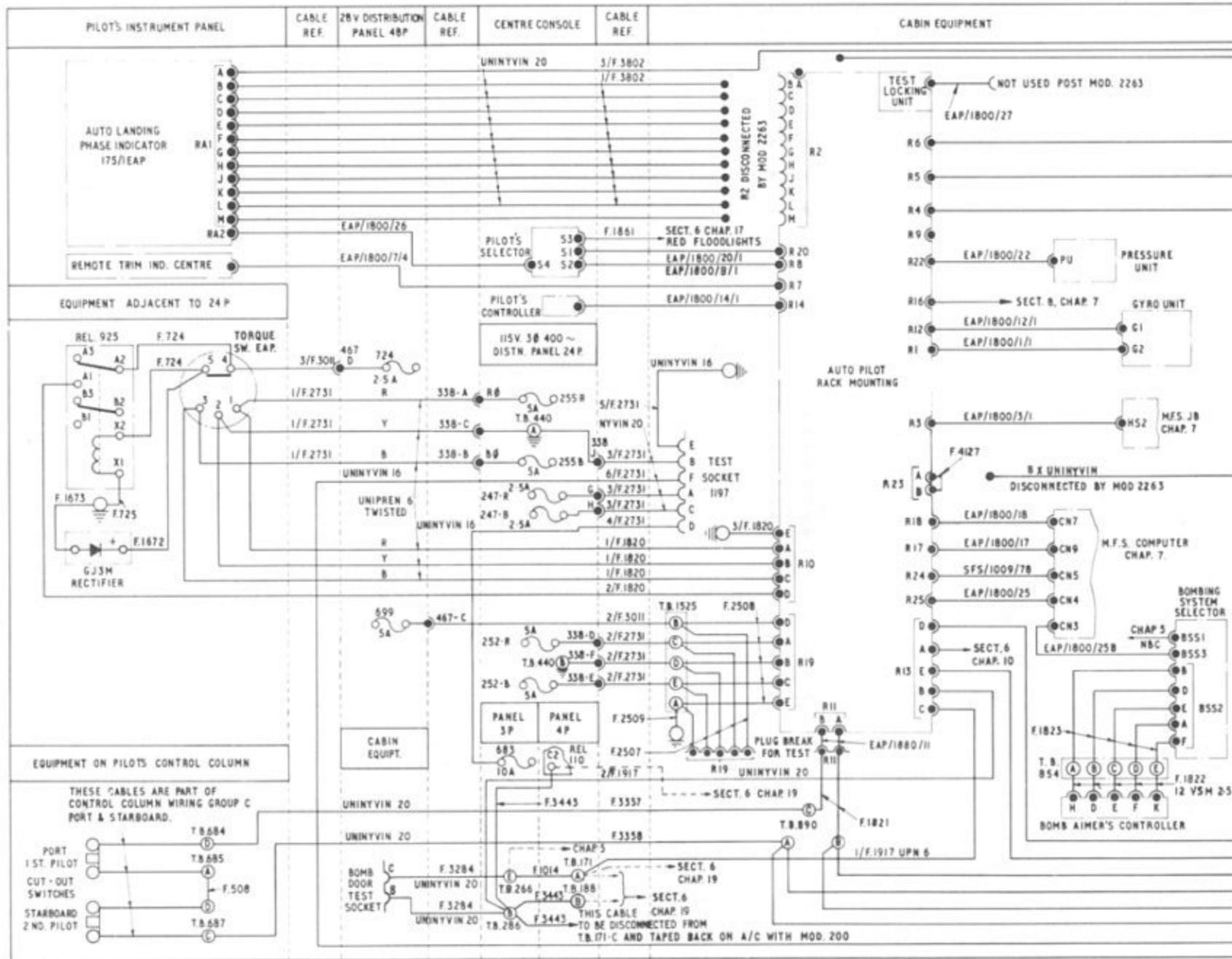


Fig. 6 (1) Autopilot Mk.10B - Pre. Mod. 2305, Post. Mod. 748, 2082, 2263 and 2272

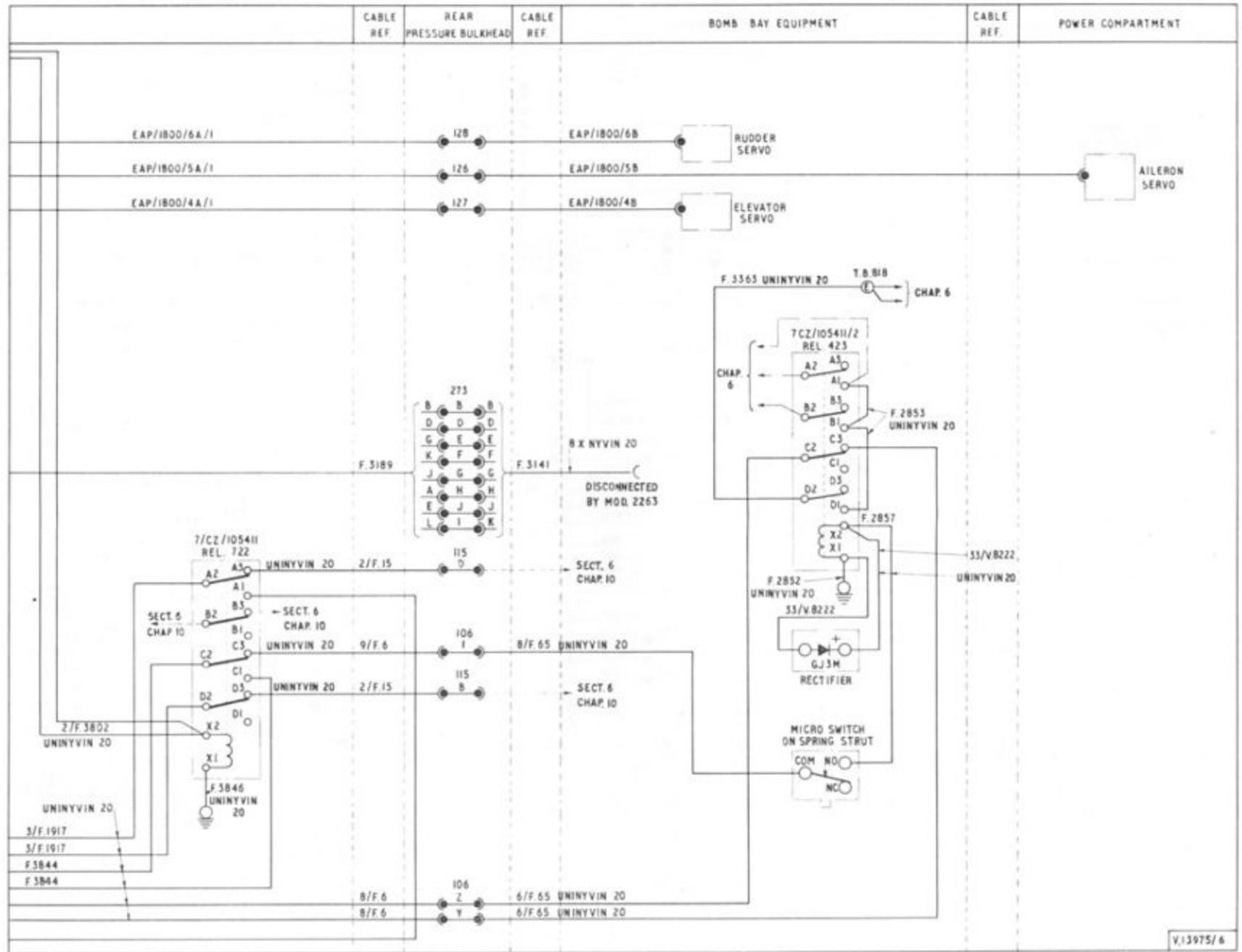


Fig.6 (2) Autopilot Mk.10B - Pre. Mod. 2305, Post. Mod. 748, 2082, 2263 and 2272

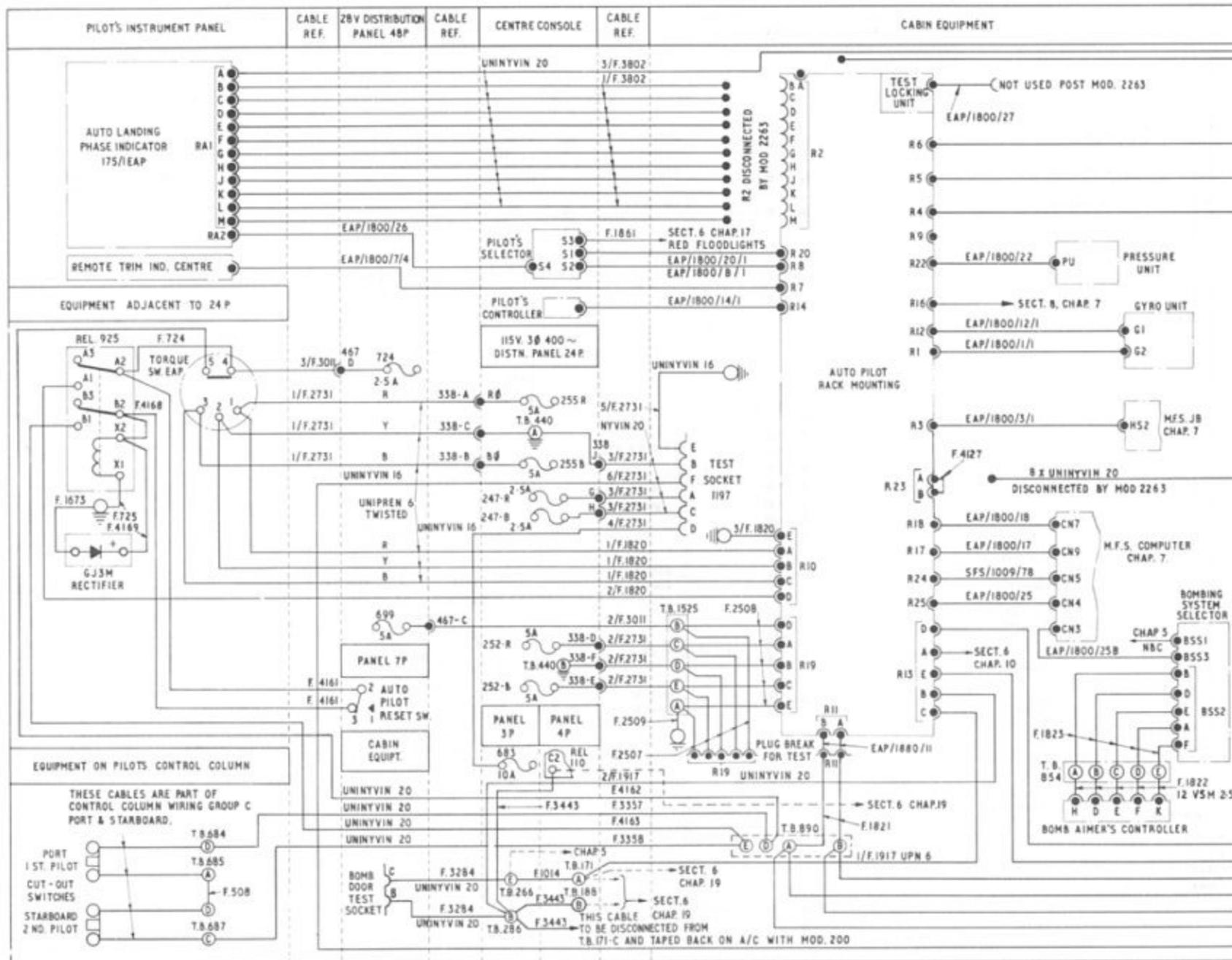


Fig.7 (i) Autopilot Mk.10B - Post Mod. 748, 2082, 2263, 2272 and 2305

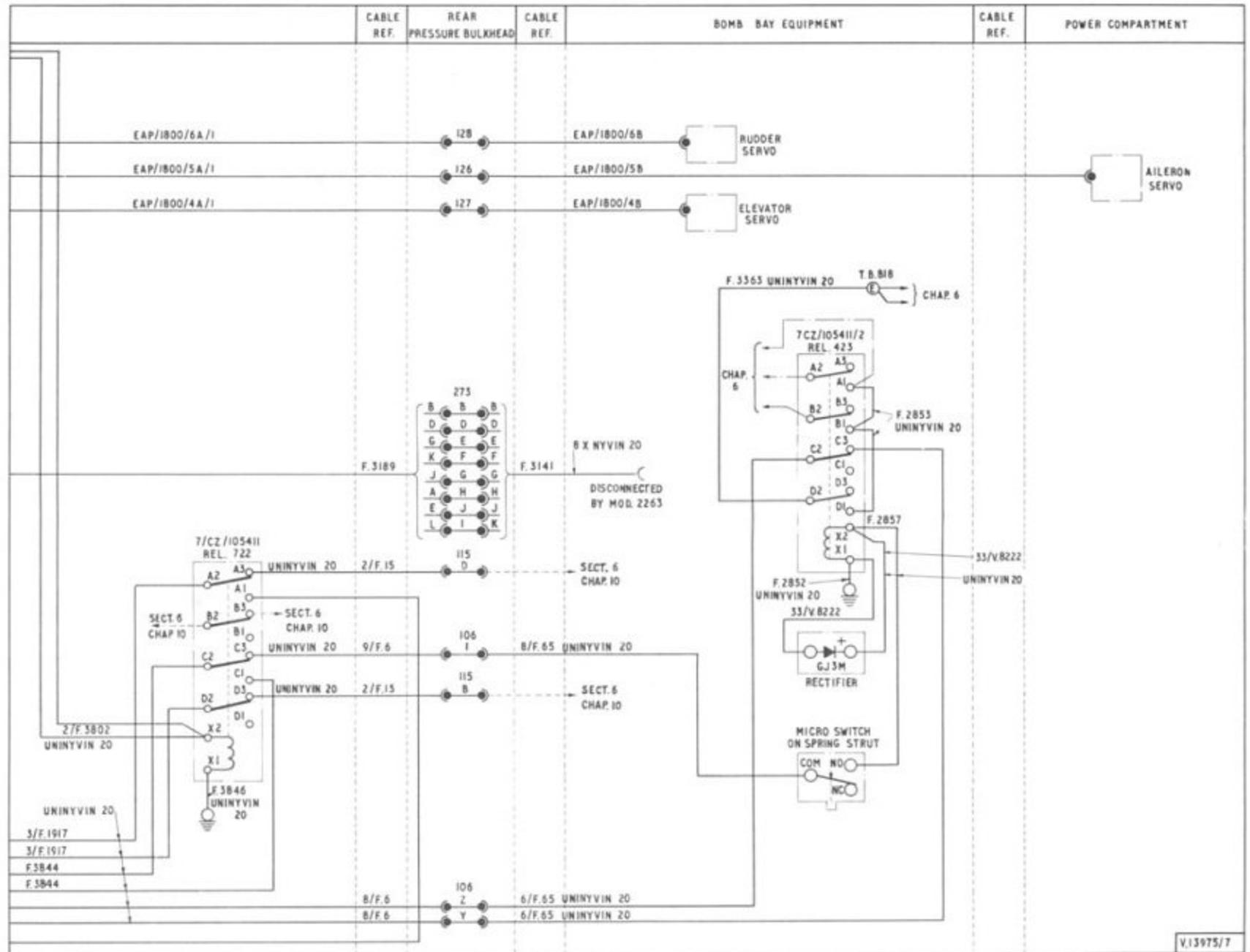
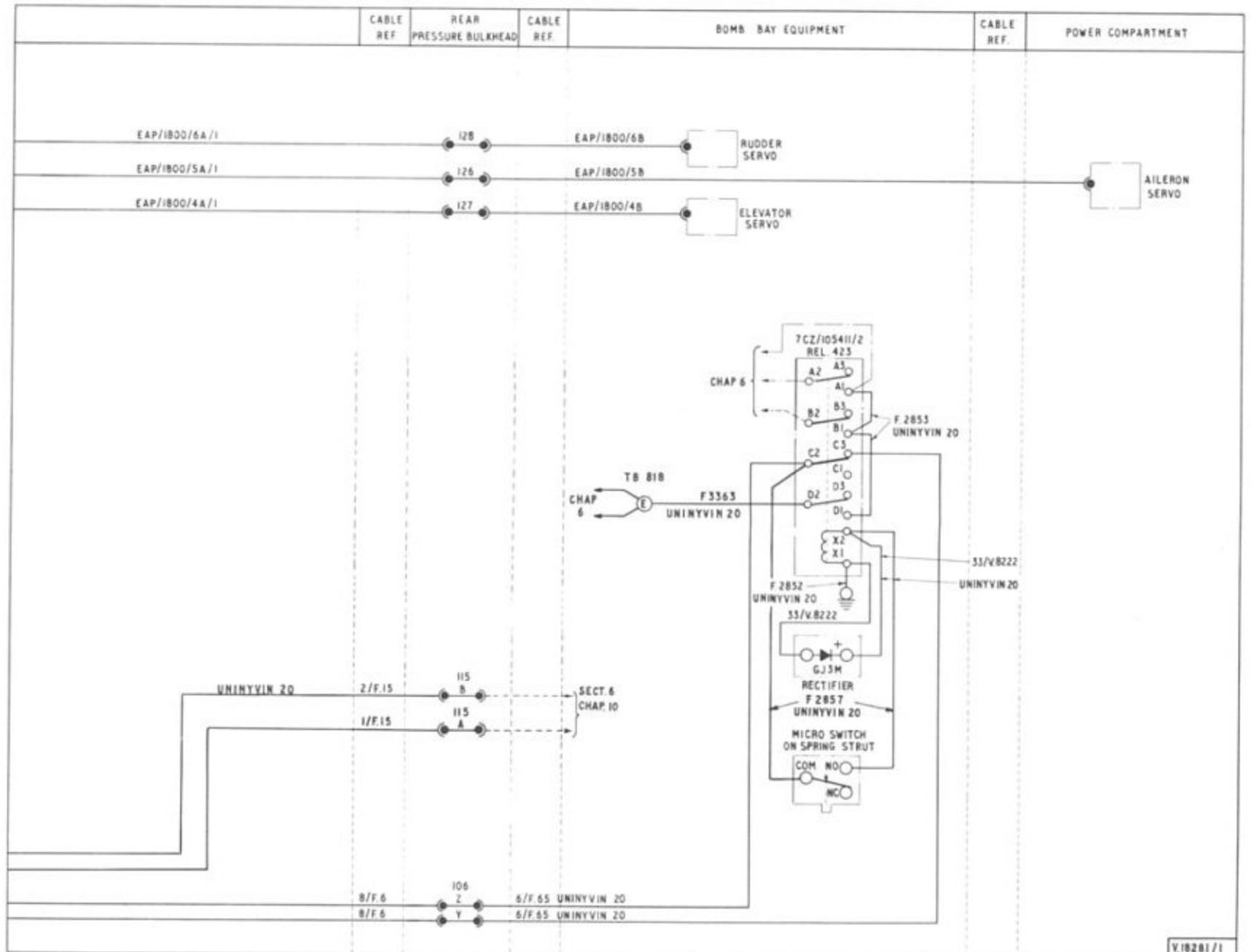


Fig.7 (2) Autopilot Mk.10B - Post Mod. 748, 2082, 2263, 2272 and 2305



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Fig 8 (2) Autopilot Mk. IOB - Post Mod. 2409



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