Group 7
AUTO CONTROLS

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* *To be issued later*

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Introduction

1. This group deals with the installation and general functioning of the following systems:-

Automatic pilot Mk.10 (with Mod.564)

Autostabilizer and mach trim controls

Zero reader and flight director (Mod. 353).

Location illustrations are provided adjacent to the text covering the particular system, and routing charts are provided at the end of the text. Brief details only are given for the power supplies to the various systems, and reference should be made to Sect.5, Chap.1, Groups 2 or 2A and 3 or 3A for full information on the aircraft d.c. and a.c. supply systems.

DESCRIPTION AND OPERATION

AUTOMATIC PILOT

2. Automatic control of the aircraft in flight is catered for by the automatic pilot Mk.10 installation. The main purpose of the installation is to relieve the human pilot of a great deal of the physical and mental fatigue of controlling the aircraft. The human pilot can manoeuvre the aircraft through the autopilot system and, even though the system may be engaged or disengaged in complete safety at any time (within certain limits), it need not be disengaged to change the aircraft's heading or altitude.

3. The approach to an airfield equipped with I.L.S. can be made automatically by coupling the aircraft's I.L.S. receivers to the autopilot system. In addition, the aircraft in flight can also be manoeuvred through the autopilot in response to signals from the N.B.S. and other systems.

4. The bulk of the controlling equipment is situated under the pilot's floor on the port side of the cabin and the pilot's control switches are fitted on the retractable centre console (5P). A complete description of the automatic pilot Mk.10, with illustrations and operating instructions is provided in A.P.1469E, Vol.1. The full range of components, together with the individual Mk. number is given in Table 1.

Control switches

5. The control switches required to use the autopilot in all its functions are fitted on the centre console (5P), and consist of a switch unit, Type A and a pilot's controller. Two cutout switches are provided, one on each control column for emergency disengagement of the autopilot should it be necessary for the human pilot to regain instant control of the aircraft.

6. Further automatic controls and safety switching when using the autopilot have been introduced by Mod.564, these consist of:-

(1) Engagement of the rudder channel on the autopilot automatically isolates the yaw damper system.

(2) Engagement of the aileron channel on the autopilot isolates the normal trim controls.

(3) Engagement of the elevator channel on the autopilot isolates the normal trim controls.

(4) A spring strut, operating a micro-switch is introduced between the elevator servo motor and the control circuit; when a rod force of 78 lb. is exceeded the micro switch operates, and isolates the auto-mach trim system and the autopilot.

(5) Engagement of TRACK on the autopilot automatically reduces the amount of artificial feel on the elevators. Engagement of GLIDE on the autopilot, further reduces the amount of artificial feel on the elevators.

Full details of these controls are dealt with under the heading 'Safety switching'.

Indicating instruments

7. The trim of the aircraft in pitch is indicated by a remote trim indicator fitted on the first pilot's instrument panel.

8. A heading selector is fitted on the pilot's centre panel and operated by the G.4.B compass. The desired aircraft heading can be set by the knob on the front of the instrument.

Servomotors

9. The servomotors which produce the necessary torques to operate the ailerons, elevators and rudder are mechanically linked to the flying control rods. The aileron servomotor is mounted in the aft power compartment, the elevator servomotor is mounted in the bomb bay adjacent to the elevator artificial feel unit; the rudder servomotor is fitted on the port side of the bomb bay adjacent to the rudder artificial feel unit.

Cabin equipment

10. Installed below the pilots' floor between formers 344 and 372 are the control units of the installation. These are listed as follows:-

Gyro unit
Amplifier unit
Bomb coupling unit
Condenser unit
Automatic approach coupling unit
Roll error cutout
Junction box 39J

The units are positioned to take up the minimum amount of space and at the same time be easily accessible.

11. The gyro unit is mounted on a shelf behind the amplifier in the direction of the line of flight, i.e. with the plug and socket connections facing aft. The three mounting feet at the base of the gyro unit are bolted to the shelf, and adjustment for the lateral level can be made by raising or lowering the locknuts on the bolt securing the starboard mounting foot. A spirit level inside the gyro unit gives indication of the correct attitude and is visible through the perspex dome of the assembly.

12. Triangular-shaped mounting plates are provided for the amplifier and coupling units. Each plate is equipped with three studs which are designed to locate in the keyhole attachment slots at the back of the units. The condenser unit is bolted to a bracket immediately behind the amplifier.

Link setting cards

13. The selector panels at the front of the amplifier unit and the approach coupling unit consist of chains of fixed resistors which can be selected to enable the parameters of the system to be varied according to the requirements of different aircraft types. The system is preset appropriate to the aircraft type by selector links which are fitted in certain positions on the preselector panel of each unit. To ensure that the links are correctly set, a link setting card is fitted over the panel. The link setting card is drilled with holes in a suitable position to suit the particular aircraft. When the links have been inserted according to the setting on the card, a transparent plastic cover is fitted to hold the links in position. One link setting card is required for the amplifier, three for the approach coupling unit, and one for the bombing coupling unit. These cards are supplied under Stores Reference numbers, for the Vulcan aircraft as follows:-

Amplifier - Link setting card, Ref.No. 6T/425.

Approach coupling unit - Approach section Link setting card, Ref.No.6T/444.
Height section - Link setting card, Ref. No.6T/445. Heading (KN3 pres.) - Link setting card, Ref.No.6T/446.

Bombing coupling unit - Link setting card, Ref.No.6T/449. (Pre.Mod.1426)
Ref.No.6T/1815 (Post Mod.1426)

14. Connections to the automatic approach coupling unit are made from the G.4.B compass junction box underneath the navigator's table. The coupling unit is also connected to the static line of the starboard pitot-static system.

15. A junction box, designated J.B.39, is interposed in the cable between the amplifier socket J.5 and the switch unit S2. This junction box, which is mounted adjacent to the amplifier forms the distribution point to the various safety switching circuits outlined in para.6.

Power supplies

16. The a.c. and d.c. power supplies for the autopilot are fed from the a.c. supplies panel (11P) to the amplifier unit under the pilots' floor. Three-phase a.c. at 115-volts 400 cycles is supplied from fuses 261 and 262. The 28-volt d.c. supply is fed from fuse 213.
28-volt d.c. supply is fed from fuse 213.

17. The a.c. power for the system is generated by the No.4 (Type 153) inverter, which is situated on the starboard side of the crew's floor. An illustration of the inverter with its associated control panel, Type 19, is contained in Chap.1, Group 3.

18. The operation of the No.4 inverter is controlled by a 2-position on-off switch on the a.c. control panel at the navigator's station. A torque switch is provided in the output circuit and is fitted within the a.c. supplies panel (11P). The torque switch (No.2 in the panel) will operate to connect the d.c. supply to the amplifier when the inverter output is in the required frequency ranges. Similarly, the switch contacts will open to break the d.c. supply should the a.c. supply fall below the normal operating value. Indication that the inverter output is normal is given by two neon indicators adjacent to the control switch. Both a.c. and d.c. supplies to the autopilot can be checked for correct operating value from a test socket provided above the amplifier mounting.

19. In the event of a failure of the No.4 inverter, the load can be transferred to the No.2 inverter by operating the EMERGENCY CHANGEOVER switch on the a.c. control panel. A full description of the autopilot a.c. and d.c. supplies, including a theoretical circuit diagram is contained in Chap.1, Group 6.

Control switching and safety provisions

20. As stated in para.6, certain safety circuits are introduced on the system by Mod.564. The following paragraphs deal with these safety circuits, and a theoretical circuit diagram, fig.2, is provided which should be read in conjunction with the circuit operations.

Yaw damper isolation

21. As adequate yaw damping is provided by the autopilot installation, and the matching of the autopilot to the aircraft yaw damper system is not practicable, the circuit is arranged so that with engagement of the rudder channel of the autopilot, the aircraft yaw damper system is automatically isolated.

22. This is effected by the action of an isolation relay (No.12), the contacts

of which are interposed in the yaw damper switching circuit. Referring to the theoretical circuit diagram (fig.2), it will be seen that the coil of relay 12 is connected to terminal G of J.B.39, and will be energised when the autopilot rudder channel is engaged. Operation of contacts 12/1 and 12/2 to open will isolate the yaw damper system from the aircraft supply.

Normal trim isolation

23. With the engagement of the aileron and elevator channels of the autopilot, the normal trim system is isolated, and trimming is carried out using the emergency trim circuit. This is to prevent the possibility of trimmer actuator 'runaway' when the autopilot is engaged. Isolation of the aileron and elevator trim system is brought about by the use of two trim isolation relays, No.104 and 477, the circuit action for which is given in the following paragraphs.

24. Referring to fig.2, it will be seen that the coils of relay 104 and 477 are connected to the respective aileron and elevator channels

(Continued overleaf)

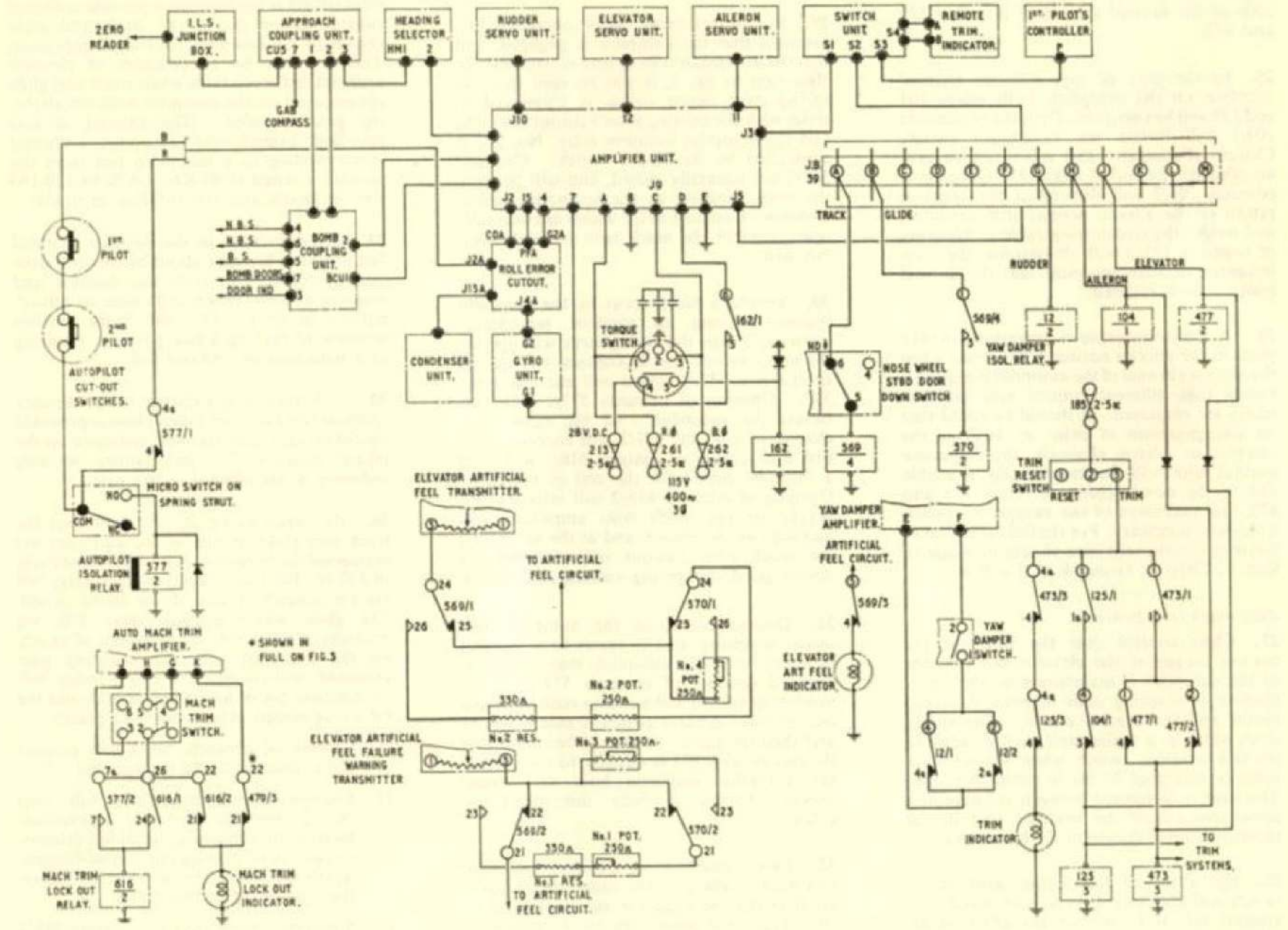

Fig. 2. Autopilot switching controls

of the autopilot circuit via terminals H and J of J.B.39, and the supply from these two terminals is also connected by rectifiers to the coils of the normal trim hold off relay 125 and 473.

25. In the case of say, elevator channel selection on the autopilot, both relays 104 and 125 will be energised. Opening of contacts 104/1 will isolate the TRIM/RESET switch. Closure of contacts 125/1 will therefore have no effect on the coil of relay 125. Opening of contacts 125/2 will disconnect the negative return of the aileron normal trim actuator, and render the circuit inoperable. Opening of contacts 125/3 will de-energise the trim indicator to warn the pilot that the normal trim circuit is isolated.

26. A similar sequence of operation will take place in the aileron normal trim circuit when the aileron channel of the autopilot is engaged, except that different control and isolation relays are employed. It should be noted that on disengagement of either or both of the elevator or aileron channels, the respective normal trim will be immediately available due to the de-energising of relays 125 and 473, and operation of the TRIM/RESET switch will not be necessary. For the full operation of the trim circuit, reference should be made to Sect. 5, Chap. 1, Group 6 of this Book.

Auto mach trim lock-out

27. Close control over the value of the cut-out torque of the elevator servo motor of the autopilot is maintained by the introduction of a spring strut between the servo motor and the control circuit. The spring strut which is a sealed unit, is preloaded to operate a micro switch when subject to a force in excess of 78 lbs in either direction. The strut is connected between the autopilot servo motor and the trimmer unit in the elevator control system in the bomb bay.

28. Operation of the spring strut micro switch will also lock out the auto mach trim system; this is to restrict the effect of an auto mach trim runaway when autopilot is engaged. A magnetic indicator, fitted adjacent to the first pilot's machmeter indicates when the auto mach trim power supply is cut off.

29. For the following circuit operation it is assumed that the autopilot is engaged, and that the automach trim system is switched on. Referring to fig. 2, it will be seen that the spring strut micro switch is connected in series with the existing pilot's cutout switches, and the autopilot isolation relay, No. 577 is controlled by the micro switch. Contacts 577/1 are normally closed, and will perform the same function as the instinctive cutout switches. Contacts 577/2 which are normally open, control the mach trim lockout relay, No. 616.

30. Should a fault occur in the autopilot system, causing an elevator servomotor 'runaway', then the spring strut will operate the micro switch, and its contacts will change to COM-NO. This action will energise relay 577. Opening of contacts 577/1 will then isolate the autopilot. At the same time, closure of contacts 577/2 will energise relay 616, and closure of contacts 616/1 will form a 'hold-in' circuit for the coil of the relay. Opening of contacts 616/2 will interrupt the supply to the mach trim amplifier, thus locking out the system, and at the same time the mach trim lockout indicator will be de-energised, thus giving warning to the pilot.

31. Disengagement of the autopilot will cause the spring strut to revert to its normal position, and the autopilot may again be engaged (closure of contacts 577/1). The mach trim system will however remain locked out until the control switch is placed to OFF and then ON again. It should be noted that the coil of relay 577 is slugged, to ensure that the autopilot magnetic hold on engage selector button is fully disengaged on cutouts.

32. Fault conditions in the automach trim servomotor will give the same circuit operation as that outlined for autopilot in para. 29. Thus, the pilot can, by a process of elimination, successfully isolate the faulty system.

Track and glide selection

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

34. The reductions in the elevator artificial feel force are brought about by the introduction of resistors in both the detector and warning circuits, which will cause an out-of-balance to exist. This will cause the feel actuator to take up a new position, resulting in a reduction of artificial feel.

35. Indication that a change in the elevator artificial feel force has taken place is provided via the elevator feel magnetic indicator on the pilots' panel. The feel failure warning indicator is not affected in this case.

36. Reference to fig. 2, will show that the track and glide circuits of the autopilot are connected to terminals A and B respectively of J.B.39. The track circuit controls relay 569 via the nosewheel door down micro switch. The glide circuit controls relay 570, via contacts of relay 569. Engagement of TRACK on the autopilot with the alighting gear extended, will energise the coil of relay 569, via contacts 5-6 of micro switch ND, and the following circuit action will take place:—

(1) Closure of contacts 569/4 will prepare the circuit for GLIDE engagement.

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

(3) Similarly, changeover of contacts 569/2 will insert No. 1 resistance and No. 1 potentiometer in the elevator artificial

feel warning master circuit, thus maintaining correct differential to the detector circuit, so that the feel failure indicator will not operate.

(4) Contacts 569/3 will open to de-energise the elevator artificial feel indicator and warn the pilot that feel conditions have changed.

37. Engagement of GLIDE on the autopilot will connect a supply from J.B.39 terminal B, via contacts 569/4 to energise relay 570, and the following circuit action will take place.

(1) Changeover of contacts 570/1 will insert No.4 potentiometer in the elevator artificial feel detector circuit, thus causing an extra reduction in the amount of artificial feel force.

(2) Changeover of contacts 570/2 will insert No.3 potentiometer in the elevator artificial feel warning master circuit maintaining the correct differential with the detector circuit so that the failure warning circuit will not operate.

For full details of the artificial feel circuit, reference should be made to Sect. 5, Chap.1, Group 6, of this Book.

AUTOSTABILIZER AND MACH TRIM CONTROLS

38. Under certain flight conditions, aircraft tend to oscillate about the yaw, roll and pitch axes with very little damping. This tendency is undesirable when manoeuvring the aircraft on to a target. The function of the auto-stabilizer and mach trim systems is to detect and suppress these oscillations, by actuating the appropriate flying control.

39. The autostabilizer equipment operates in two axes, a yaw damping device in the rudder control run, and a pitch damping device in the elevator flying control feed back linkages. In addition, equipment for automatically trimming the aircraft in the fore and aft axis is installed.

40. The system for yaw and pitch correction consists of a rate gyroscope which detects the oscillation and relays a signal to an amplifier, to operate a servo-motor connected to the appropriate flying control. This control is moved in the opposite direction to the oscillation thus suppressing it. A modified system, using an a.c. inductive pick-off in place of the gyro, is used for detection and correction of 'nose-down' trim above a certain Mach number. This equipment is called Auto-Mach trim.

41. These systems are described in detail in A.P.1469S, Vol.1, Sect.4, and further information on the location and layout of the systems on the aircraft are included in the following paragraphs.

42. The autostabilizer system operating in pitch, yaw and auto-mach trim, uses separate controls, and any one may be operating without the others. However, when the autopilot is in use, certain safety devices are brought into use, as follows:-

(1) Engagement of the rudder channel on the autopilot automatically isolates the yaw damper system.

(2) The auto mach trim system will be isolated should the rod force on the elevators exceed 78 lbs. This is effected by a spring strut and micro switch assembly in the elevator control system.

Control switches

43. The control switches for the three sections of the system are fitted to the retractable centre console (5P). Three switches are provided as follows:-

Yaw damper control switch	ON-OFF
Pitch stabilizer control switch	ON-OFF
Auto mach trim control switch	ON-RESET

In addition, an altitude switch, located in the bomb bay adjacent to the pitch damper stabilizer amplifier isolates the pitch damper and auto mach trim systems at altitudes below 20,000 ft.

Yaw damper

44. The equipment for correcting yaw oscillations consists of the following:-

- Amplifier unit
- Slave relay unit
- Phase advance unit
- Monitor unit
- Gyro unit
- Servomotor

The bulk of the controlling equipment is fitted to a mounting tray on the port side of the cabin below the crews floor. Stowage adaptors are provided for the pitot-static tubes when the air speed monitor is removed.

45. The gyro is fitted to a special mounting bracket which ensures that the gyro orientation is correct. The mounting bracket is attached to the fuselage adjacent to the navigator's table. The servomotor is located in the rear fuselage adjacent to former 428, and is connected in series with the rudder control run to the rudder P.F.C. The servomotor is an essential part of the control run, which means that if the servomotor is removed, the rudder control run is unserviceable.

Power supplies

46. Three phase a.c. at 115 volts, 400 c/s for the yaw damper system is fed from No.3 rotary inverter in the nosewheel bay. Supply fuses are situated in panel 22P in the bomb bay and are as follows:-

Fuse 247	2·5 amp.	red phase
Fuse 248	2·5 amp.	blue phase
Earth	-	white phase

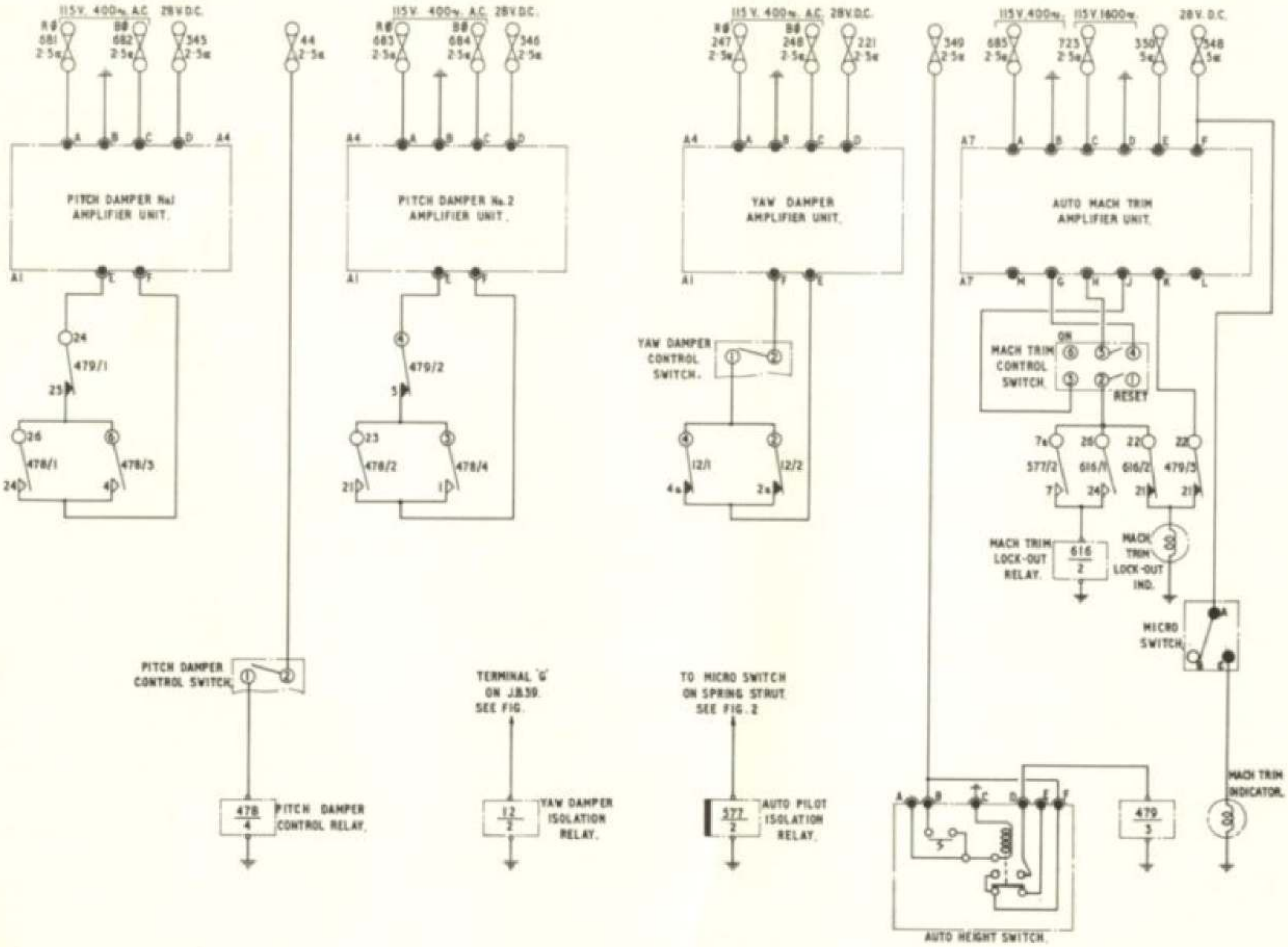

Fig. 3 Autostabilizer power supplies

47. Referring to the theoretical circuit diagram, fig.3, it will be seen that the a.c. supply is fed direct to the yaw damper amplifier, so that whenever the No.3 inverter is operating, the yaw damper will have an a.c. supply. This arrangement ensures that the gyro is running and the automatic controls stable and ready for operation when required. Should a failure of the No.3 rotary inverter occur, operation of the a.c. supplies changeover switch will enable the load to be transferred to the No.2 inverter, this circuit is described fully in Group 3, Chap.1 of this Section.

48. 28 volt d.c. supply, fed via fuse 221 in 22P, is connected direct to the yaw damper amplifier, but the system cannot be brought into use until the control switch is operated. It will be seen (fig.3), that the normally closed contacts 12/1 and 12/2 of the yaw damper isolation relay are interposed in the d.c. switch feed to the amplifier. Should the rudder channel on the autopilot be engaged, relay 12 will be energised, contacts 12/1 and 12/2 open, and the yaw damper system isolated.

Pitch stabilizer

49. The pitch stabilizing system operates in a similar manner to the yaw system, except that no provision is made for monitoring. The system comprises two separate installations, one for the port outer elevator and the other for the starboard outer elevator. A master switch in the form of an auto height switch is installed to prevent operation of the circuit at an altitude below 20,000 ft.

50. The bulk of the equipment is installed in the bomb bay on a mounting tray, and consists of:-

- Amplifier units (2)
- Gyro units (2)
- Phase advance units (2)
- Slave relays (2)

The mounting tray is fitted to the starboard side of the bomb bay between formers 44 and 64. The auto-height switch, which is connected to the starboard pitot-static system, is installed on the front face of former 44 in the bomb bay.

51. The servomotors form part of the feedback lever mechanism in the elevator P.F.C. units. Should one of the elevator outer P.F.C. units fail, the servomotor will become inoperative, and the pitch system should be switched off.

52. On aircraft where Mod.458 is embodied, the pitch stabilizer servomotors are equipped with thermostatically controlled heaters to prevent the servomotors icing up at high altitudes. The contacts of the thermostats, type T, Mk.3 are set close at temperatures of zero degrees C and below.

Power supplies

53. A.C. power supplies to the pitch stabilizer system, at 115 volts 3-phase 400 c/s is fed from the No.3 inverter in the nosewheel bay, via supply fuses in the bomb bay. Supply fuses are as follows:-

Port pitch stabilizer

Fuse 681	2.5 amp.	red phase
Fuse 682	2.5 amp.	blue phase
Earth	-	white phase

Starboard pitch stabilizer

Fuse 683	2.5 amp.	red phase
Fuse 684	2.5 amp.	blue phase
Earth	-	white phase

54. Referring to the theoretical circuit diagram, fig.3, it will be seen that the a.c. supply is fed direct to the pitch damper stabilizer amplifiers. This arrangement ensures that the gyros are running and the automatic controls stable and ready for operation when required. Emergency changeover action in the event of the No.3 inverter is the same as that for the yaw damper (para.47).

55. 28-volt d.c. supply to the systems is fed direct to the amplifiers, but the system cannot be brought into use until the control switch is placed to ON. Note that the supply is switched via the contacts of relay 478. In addition, the system is inoperative at altitudes below 20,000 ft. The coil of relay 479 is connected to the supply via the auto height switch, so that relay 479 will be energised while the aircraft is operating below 20,000 ft. At altitudes above this height the contacts of the auto height switch will operate to energise its built-in relay, thus isolating the supply to relay 479. This will cause contacts 479/1 and 479/2 to revert to their normally closed position and allow the pitch stabilizer to be brought into use. Note that contacts 479/3 are employed in the auto-mach trim circuit.

Auto mach trim

56. This automatic trimmer system is installed in the aircraft to counteract an inherent tendency to dive with increase in mach. number.

57. The bulk of the auto mach trim equipment is installed on the starboard side of the bomb bay on a suitable mounting tray between formers 44 and 64. This equipment consists of:-

- Amplifier unit
- Pre-amplifier unit
- Slave relay unit
- Altitude monitor
- Auto gain unit (removed after Mod. 1036)
- Auto control unit (fitted after Mod. 1036)
- Auto accelerometer

An auto-height unit, which is connected to the static line of the starboard pitot-static system is installed in the bomb bay adjacent to the auto mach trim equipment mounting tray.

58. The auto mach unit (which is a modified Mk.3A machmeter), is installed in the crew's cabin below the floor, and

is connected to the port pitot-static system. The servomotor is installed in series with the elevator control run in the bomb bay.

59. No gyro unit is fitted in the automach trim system. A variable a.c. signal from the automach unit is applied to a full wave rectifier. The output of the rectifier is mixed with a further signal from the auto height unit. The resultant composite output signal (being a function of height and mach number) is then passed to the pre-amplifier, the windings of which are arranged to give a push-pull output. The gain is further stepped up by the amplifier which operates a centre stable Carpenter relay, in a direction according to the sense of the input in the magnetic amplifier coils.

60. Operating in conjunction with the Carpenter relay are a slave relay and an auto accelerometer, to energise the servomotor. As the servomotor lead screw is extended, a micro switch is functioned to operate an indicator on the pilots' centre instrument panel to indicate that trim other than that controlled by the pilot is being applied to the elevator flying controls.

61. Safety measures to lock out the automach trim system in the event of a fault in the automach trim servo motor or the autopilot servomotor are included, the circuit operation which is described in para. 26.

Power supplies

62. A.C. power for the automach trim system, at 115-volts, single-phase, 400 and 1600 c/s is fed from the No.3 inverter in the nosewheel bay, via supply fuses in 22P in the bomb bay. Supply fuses are as follows:-

Circuit operation

14. Reference to fig.4 and 5 and the

◀ Fuse 685	2.5 amp.	115 volt 400 c/s single phase
Fuse 723	2.5 amp.	115 volt 1600 c/s single phase ▶

63. Referring to the theoretical circuit diagram, fig.3, it will be seen that the a.c. supply is fed direct to the auto mach trim amplifier unit. This arrangement ensures that the automatic control is stable and ready for operation when required. Emergency changeover action in the event of a failure of the No.3 inverter is the same as that for the yaw damper (para.47).

64. 28-volt d.c. supplies via fuses 348 and 350 in 16P are fed direct to the mach trim amplifier, but the system cannot be brought into use until the control switch is operated. In addition the system is inoperative at altitudes below 20,000 ft. by the action of the auto-height switch. Referring to fig.3, it will be seen that the coil of relay 479 will be energised whilst the aircraft is operating below 20,000 ft. Contacts 479/3 which are interposed in the switch feed line (terminals J and K on plug A7 of the amplifier and switch contacts 2-3 on the control switch), will be open, thus isolating the supply line. At altitudes above 20,000 ft., the auto-height switch will operate to de-energise relay 479, and contacts 479/3 will revert to the closed position, thus switching on the mach, trim system.

ZERO READER AND FLIGHT DIRECTOR

65. On aircraft where Mod.353 has been embodied, a zero reader and flight director system is installed. This equipment is a flight aid which correlates attitude, heading, altitude and radio approach information, and presents this information on an indicator at the pilots' panel. A full description of the system, along with the testing and servicing information is given in A.P.1275A, Vol.1, Sect.9, Chap.1.

Equipment location

66. The major portions of the equipment for the system is installed in the cabin below the pilots' floor; these items of equipment consist of:-

Flight computor
Junction box, type B
Junction box, 34J

The indicators and control switches are installed on both the first and second pilot's panels as follows:-

1st pilot's panel
Combined course selector and control unit
Flight director indicator

2nd pilot's panel
Flight director indicator
Horizon gyro Mk.1

67. The flight computor is attached to a suitable mounting rack and back plate assembly below the first pilot's floor. The mounting rack is secured on resilient mountings on the floor structure below the first pilots station, with the carrying handle of the computor facing aft for accessibility. The junction box, designated 34J, which forms the linkage point for the I.L.S. and approach coupling unit, is installed behind the flight computor. The junction box, Type B, which forms the distribution point for the system, is attached to suitable brackets above the flight computor. Note that the computor is connected to the static line of the starboard pitot-static system via suitable flexible piping. A stowage block for the pipe line is provided on the mounting rack.

68. The combined course selector and control panel, which is installed on the top inboard portion of the first pilots' panel, enables the pilot to select the desired flight path. The unit has four controls which are electrically interlocked. Details of these controls are:-

(1) Main selector switch
(2) Test button
(3) Altitude switch
(4) Pitch control

Immediately below the control panel, is located the flight director indicator, which provides flight path indications to the pilot.

69. A duplicate flight director indicator is installed on the second pilot's panel, and adjacent to the director indicator is a horizon gyro unit, Mk.1.

Flight computor				
Fuse 734	2·5 amp.	red phase A	}	115 v. 3 ph. 400 c/s
Fuse 610	2·5 amp.	blue phase C	}	
Earth	-	white phase B	}	
Fuse 735	2·5 amp.	-		28 v. d.c.
Junction box Type B				
Fuse 257	2·5 amp.	red phase A	}	115 v. ph. 400 c/s
Fuse 258	2·5 amp.	blue phase C	}	
Earth	-	white phase B	}	
Fuse 733	2·5 amp.			28 v. d.c.

Power supplies

70. A.C. supply at 115 volts 3-phase 400 c/s, and d.c. supply at 28 volts, are fed from fuses in 11P as follows:-

71. The 115 volt 3-phase 400 c/s supply is fed from the No.3 (Type 350) inverter in the nosewheel bay. This inverter is switched on automatically with engine starting, and in the event of a failure of supply, the load is automatically transferred to No.2 inverter. Full details of the switching and control of the inverter supplies will be found in Book 1, Chap.1, Group 3A.

General

72. Due to the operation of the electrical and mechanical controls of the auto control systems being so closely allied, it is essential that co-operation of the highest order is maintained between the instrument, electrical and mechanical trades. This will ensure that a high degree of serviceability is maintained, and also obviate unnecessary repetition of function tests etc., during servicing periods.

73. Servicing and test functioning covering the general operation of the systems is contained in the following paragraphs, reference should be made to Sect.5, Chap.1, for the electrical portion of the powered flying controls, and to Book 1, Sect.3, Chap.4 for the mechanical portion of the powered flying controls.

AUTOMATIC PILOT

74. Little servicing is required on the fixed installation of the autopilot system, apart from a periodical check on the connectors and cables for security, cleanliness, and signs of damage. Pre-flight and ground testing of the complete installation is contained in the following paragraphs, and these should be read in conjunction with the information contained in A.P.1469E, Vol.1, Sect.4, 5 and 6.

SERVICING

Pre-flight functional ground checks

75. The following pre-flight functional ground checks should be carried out daily, or at the periods laid down in A.P.4505A, Vol.4. Proceed as follows:-

(1) Ensure that the flying control surfaces are clear of any obstructions.

(2) Plug in the 112-volt and 28-volt ground supplies to their respective external sockets.

(3) Switch on the autopilot power supplies, and start up the powered flying controls. Switch on the yaw damper and mach trim systems. Ensure that the mach trim magnetic indicator (adjacent to the machmeter) is presenting a black image.

(4) Pull the POWER switch on the autopilot switch unit (on). Note that after approx. 1 minute, the READY indicator should be visible, indicating that the autopilot is ready to be engaged.

(5) Check that all three channel switches on the switch unit are in the IN position, and pull the ENGAGE switch to ON. The IN flag should appear and the READY flag disappear, but check that each servo-motor has engaged by pressing against all three manual controls in turn in each direction.

76. Select each channel switch OUT in turn, and note that:-

(1) The READY flag appears in addition to the IN flag.

(2) The respective channel becomes disengaged, but the other two remain firm.

(3) Upon re-engagement the READY flag disappears.

(4) With all three channels 'out' the READY flag appears, the IN flag disappears, and the ENGAGE switch moves to 'off'.

77. With the autopilot fully engaged, check that the following actions result in disengagement of all three controls, disappearance of the IN flag and appearance of the READY flag and release of the ENGAGE switch to the 'off' position.

(1) Operating the pilots' instinctive cutout switch.

(2) Displacing the turn control fully in either direction.

(3) Applying a steadily increasing

manual force (26 lb. approx.) in either direction to the elevator control. Check in this case that the mach trim indicator presents a white image. Reset the mach trim system by placing the mach trim switch to OFF and then ON, and ensure that the indicator now presents a black image.

78. With the autopilot fully engaged, check the following:-

(1) That elevator and aileron normal trim is inoperative.

(2) That the yaw damper is inoperative. This may be carried out by applying a firm thumb pressure in an athwartships direction to the yaw gyro mounting, and ensuring that no rudder movement results.

(3) Displace the turn control to the left and check that the control column moves to port accompanied by a slow left rudder movement. Displace the turn control to the right, and check that the control column moves to starboard accompanied by a slow right rudder movement.

NOTE...

Since a roll error cutout is fitted, this test may result in total disengagement of the autopilot para.77 (2). The required result should, however, be obtained satisfactorily before cut-out if only slow movement of the turn control is used. The control column will not necessarily return to its neutral position.

(4) Move the pitch control fully forward and check that forward movement of the control column results. Repeat the last with rearward movement of the pitch control and check that rearward movement of the control column results. Note that only small movements of the control column are required to satisfy this test. Large movements will cause the autopilot to become totally disengaged.

(5) Manually apply light forward pressure on the control column, and check that the remote trim indicator presents a nose heavy reading. Repeat this test by pulling lightly on the control column, and check that the trim indicator presents a tail heavy reading.

79. Disengage the autopilot, and ensure that:-

(1) The normal trim system for elevators and ailerons is again operative.

(2) The yaw damper system is again operative.

80. With the autopilot fully engaged, pull the ALTITUDE switch on, and check the following:-

(1) That the ALTITUDE switch is held in the ON position, and no control column movement results.

(2) Check that the pitch control is inoperative in both climb and dive directions on slow rate positions (first pressure).

(3) Push the pitch control to the full DIVE position, the ALTITUDE switch should release to OFF.

(4) Re-engage the ALTITUDE switch, and repeat (3) using the full CLIMB condition, and check that that ALTITUDE switch is again released to OFF.

(5) Re-engage the ALTITUDE switch, and select the elevator channel switch OUT, the ALTITUDE switch should again release to OFF.

81. Re-engage the auto-pilot, select G4B gyro to port on the compass control panel and check that the heading selector and gyro compass unit readings agree to within ± 1 deg. Then proceed with the following checks:-

(1) Using the synchronising control, increase the gyro unit reading by 15 deg. The reading on the heading selector should increase accordingly, and the control column commence to move slowly to port.

(2) Decrease the gyro compass reading by 30 deg. The heading selector reading should decrease accordingly, and the control column should commence to move slowly to starboard.

(3) Turn the synchronizing control slowly in the appropriate direction until the control column ceases to move. Disengage the aileron channel on the autopilot.

(4) Alter the gyro compass heading by 10 deg. in either direction. Re-engage the aileron channel. The control column should remain stationary.

(5) Disengage the aileron channel, synchronise the gyro compass with the heading selector, and re-engage the aileron channel.

82. Press the pilots' instinctive cutout switch, the autopilot should be totally disengaged, i.e., the READY flag should reappear, the IN flag disappear, the ENGAGE switch release to OFF, and the controls become free.

83. Keeping the instinctive cutout switch pressed, pull on the ENGAGE switch. Check that the ENGAGE switch does not hold ON and that the controls remain free. Release the ENGAGE switch and then the instinctive cutout switch.

84. At the conclusion of the foregoing checks, switch off all systems previously switched on, and stop the system inverters.

Ground test procedure

85. The ground test procedure outlined in the ensuing paragraphs should be carried out:-

(1) At the periods stated in A.P.4505A, Vol. 4.

(2) Following the report of a defect, and,

(3) After a unit of the autopilot or a cable has been changed.

86. The ground test procedure is intended primarily for use on initial installations, and in this case, the aircraft will be jacked level for setting up purposes. For periodic checks, it is not essential that the aircraft is jacked up level, and effects resulting from the aircraft not being level are noted in the appropriate paragraphs.

87. It should be borne in mind that an immediate loss of control datum will result if a manual control is run to its stops under operation of the manoeuvring controls of the autopilot. Although such a loss may be readily redeemed by disengaging the appropriate autopilot channel and then re-engaging it after centralizing the control, care must be taken to avoid such practices, otherwise unnecessary wear and tear will inevitably occur to the servomotor and control run linkages.

88. Note also that 'drift' in a channel will cause loss of control datum. In such instances, the magnitude of loss will be directly proportional to the duration of engagement of the autopilot. Wherever possible, this point has been taken into account in the instructions on test procedure.

89. As stated in para. 27, the elevator control is fitted with a spring-loaded strut between the autopilot servomotor output arm and the aircraft control run. At a predetermined load, in either direction, this excess torque cutout will 'collapse' and operate a micro switch to cause immediate total disengagement of the autopilot. It should be noted that it is not within the confines of the autopilot test procedure to check the operating load of the excess torque cutout. This should be ascertained on the bench using appropriate test gear at the intervals laid down in A.P.4505A, Vol. 4. A guide to its serviceability in this respect, however, may be obtained by using a spring balance on the control column and applying a force of $26{\cdot}5 \pm 2$ lb. Further details of this test are given in para. 123 (4).

90. It is essential that a two-man crew be employed to carry out the test procedure detailed. In order to co-ordinate all aspects of the test procedure, it is recommended that one man is stationed in the pilot's seat, and the other at the test equipment. Note also that the powered flying controls must be operative for all checks, and both 28-volt d.c. and 112-volt d.c. external ground supplies must be used.

Testing requirements

91. The requirements for testing the autopilot installation are as follows:—

(1) 112-volt and 28-volt d.c. external supply truck.

(2) Test set No. 1 (*Ref.* 6C/1200) (described in A.P.1469E, Vol. 1, Sect. 4, Chap. 1).

(3) Leak tester (*Ref.* 6C/849) (described in A.P.1275A, Vol. 1, Sect. 6, Chap. 31).

Link setting cards

92. Open the flap-doors of the amplifier, the approach coupling unit, and the bomb coupling unit. Check that the links of each selector panel are set in compliance with the authorative settings for the Vulcan aircraft, or, when available, that all link setting cards are in position and that the switches on the bombing coupling unit are set in accordance with the instructions on the link setting card. Close the flap doors.

Connections to test set No. 1

93. Remove the following cable connectors from the autopilot:—

(1) Plug J1, amplifier (location, facing front of unit—right hand end plate, nearest connector bottom row).

(2) Socket J4, amplifier (location, facing front of unit—right hand endplate, nearest connector second row from top).

(3) Socket CU5, coupling unit (location, facing front of unit—right-hand endplate, nearest connector bottom row).

(4) Socket BCU6, bombing coupling unit (location, facing front of unit—left-hand endplate, centre connector top row).

(5) Plug J2, amplifier (location, facing front of unit—right-hand endplate, smallest connector top row).

94. Connect the cables of the test set No. 1 to the autopilot as follows:—

(1) Socket J4U, cable "G2T-J4U" (TE.6242) to J4, amplifier.

(2) Coupler plug G2U, cable "J4T-G2U" (TE.6137) to J4 connector removed from amplifier (see para. 93 (2) above).

(3) Socket "CU5U", adaptor cable "CU5-UT-CU5U" (TE.7422) fitted to cable "CU5T-CU5U" (TE.6238) to CU5, coupling unit.

(4) Socket "BCU6U", cable "BCU6T-BCU6U" (TE.6241) to BCU6, bombing coupling unit.

(5) Plug TEST A, cable "TEST A" (TE.6246) to TEST A, amplifier (location, facing front of unit—right-hand endplate, nearest top connector, fitted with blanking cap).

(6) Plug TEST B, cable "TEST B" (TE.6247) to TEST B, amplifier (location, facing front of unit—left-hand endplate, nearest bottom connector, fitted with blanking cap).

(7) Plug SUPPLY, cable "SUPPLY" (TE. 6239) to power supply test point.

(8) Plug J2U, cable "J2T-J2U" (TE.6189) to J2, amplifier.

(9) Check that the opposite ends of all the above-mentioned cables are connected to their appropriate points on test set No. 1.

95. Connect a leak tester into the aircraft's static system from which the autopilot coupling unit operates, in order to simulate altitude pressure changes. Set the control knob of the leak tester to RELEASE.

Initial control settings

96. Set the test set controls to the following positions:—

A.C. TEST SELECTOR	A.C. VOLTS (AB, BC, or CA)
D.C. TEST SELECTOR	OFF
RUDDER BALANCE control	Centre of travel
I.L.S. control	Centre of travel
BCU. PORT/STBD. switch	STBD.
BCU. HIGH/LOW switch	LOW
BAL. IND. SENSITIVITY switch	LOW
R. GYRO switch	IN
A. GYRO switch	IN
E. GYRO switch	IN
SLIP MON switch	IN
PITCH MON switch	IN
TURN DEMAND switch	IN
GROUND TEST RELAY switch	"Off"
5° switch	"Off"

Note . . .

Switches QUAD. NEUT., PHASE SEQUENCE, MON. TEST and A.P. CUT-OUT are biased to "off".

97. The control positions given in para. 96 are the "normal" settings referred to in the text that follows.

Precautions

98. Before starting the tests, ensure that:—

(1) The aircraft controls are free and unobstructed.

(2) Both 112-volt and 28-volt d.c. external supplies are connected to the aircraft.

(3) Ensure that the aircraft is jacked level (essential only for setting-up gyro unit).

(4) That the autopilot gyro unit is adjusted to lateral level (see spirit level mounted on the aft side of gyro unit outer gymbal ring).

Power supply checks

99. Switch on the autopilot inverter No. 4 and carry out the following checks in the *sequence given*:—

(1) With the D.C. TEST SELECTOR at OFF, the d.c. voltmeter should read 27·5 ± 1 V.

(2) With the A.C. TEST SELECTOR at A.C. VOLTS-AC, BC and CA in turn, the a.c. voltmeter should read 115 ± 5 volts in each instance.

(3) The FREQUENCY meter should read 400 ± 20 c/s.

(4) With the PHASE SEQUENCE switch pressed the BRIGHT and DIM lamps should glow brightly and dimly as indicated.

Autopilot checks

100. (1) Check that the channel switches "R", "A" and "E" are set to IN (switch unit).

(2) Check that the turn control (switch unit) is in the detent position.

Power switch hold-on, and delay relay action

101. Pull "on" autopilot POWER switch (switch unit), and check that the switch holds "on". Start a time check. The READY flag (switch unit) should appear 60 ± 30 secs. after the POWER switch was held "on".

Power supply capacity

102. Repeat the checks given in para. 99 (1), (2) and (3) to check for consistency.

Power supply phase voltages

103. Depress the QUAD. NEUT. switch, set the A.C. TEST SELECTOR to AB, BC and CA in turn, and check that the a.c. voltmeter reads 66·5 ± 7 V. in each instance. Release the switch.

Blower motor operation

104. Check that the amplifier unit blow motor is forcing air out of the circular filter on the right hand endplate of the unit.

Note . . .

The blower motor operation is controlled by a thermostat switch. This will switch the motor off if the temperature within the unit is 0 deg. or lower, and on again when the unit has warmed to approximately 10 deg. C.

Autopilot engagement

105. (1) Centralise the manual controls and pull the ENGAGE switch "on" (switch unit). The ENGAGE switch should hold "on". The IN flag should appear and the READY flag disappear (switch unit). The COMPASS CLUTCH SUPPLY lamp should light.

(2) Check that the servomotor clutches have engaged by pressing lightly against all three manual controls in turn in each direction.

Note . . .

Throughout the following text, the phrase "engage the autopilot" will be used irrespective of channel switch selection and implies "pull the ENGAGE switch "on".

Autopilot disengagement circuit

106. Press the autopilot's cut-out switch (test set) and release. The READY flag should appear, the IN flag disappear, the ENGAGE switch release to "off", and the controls become free. The COMPASS CLUTCH SUPPLY lamp should go out.

Note . . .

Throughout the following text, the phrase "disengage the autopilot" will be used and implies that the autopilot "cut-out" switch on the test set should be pressed.

Channel switch operation

107. Centralise the manual controls. Engage the autopilot and:—

(1) For each channel switch in turn, check that selection OUT frees the associated control and causes the READY flag to appear in addition to the IN flag and that re-selection IN restores the previous condition.

Note . . .

In the case of the A channel switch only, also check that the COMPASS CLUTCH SUPPLY *lamp goes out on selection* OUT, *and lights again on re-selection* IN.

(2) Select all three channel switches OUT. The READY flag should appear, the IN flag disappear, the ENGAGE switch release to OFF and the controls become free. Select all three channel switches IN. Pull "on" the ENGAGE switch and the previous conditions should prevail.

Channel balance—preliminary check

108. Push the ENGAGE switch "off". Open the flap-door on the amplifier unit for access to the channel balancers, R, A, E and C. Set the BAL. IND. SENSITIVITY switch to HIGH.

109. Balance the channels as detailed below. In each instance, slowly adjust the associated balancer on the amplifier unit in the appropriate direction to obtain a "minimum" or "null" reading on the a.c. voltmeter (less than 10 V).

(1) *Rudder.* Set the R. GYRO switch to OUT, the SLIP. MON. switch to OUT, and the A.C. TEST SELECTOR to CHANNEL BALANCE R. The a.c. voltmeter now indicates the rudder servomotor control voltage. Adjust the rudder balancer, R.

(2) *Elevator.* Set the PITCH MON. switch to OUT, the GROUND TEST RELAY switch to ON, and the A.C. TEST SELECTOR to CHANNEL BALANCE E. (The a.c. voltmeter now indicates the elevator servo-motor control voltage). Adjust the elevator balance, E.

(3) *Aileron.* Set the R. GYRO switch to IN, and the A.C. TEST SELECTOR to CHANNEL BALANCE A. (The a.c. voltmeter now indicates the aileron servomotor control voltage). Then (proceeding only in the sequence given) set the 5° switch to ON, and adjust the aileron balancer, A. Set the 5° switch to OFF, and adjust the cross feed balancer, C.

110. Close the flap-door on the amplifier unit and return the test set controls to "normal" (*para.* 96 *refers*).

Note . . .

Unless the aircraft is absolutely level laterally, there will be a continuous slow rudder movement—right rudder if the starboard wing is low and left rudder if the port wing is low—when the autopilot is subsequently engaged after the test detailed in para. 109. *This condition may be verified by reference to the gyro unit cross-level bubble. The effect is due to the resultant sideslip monitor signal. Its possible nuisance value during subsequent tests on the rudder channel is removed by the nature of the test methods employed.*

111. Switch on the compass system and synchronize the monitored compass gyro unit.

1 deg. and 5 deg. bank circuits, turn control and gyro bank platform operation, roll gyro and turn demand cross feed signals—aileron channel

112. (1) Select the TURN DEMAND switch to OUT, and the D.C. TEST SELECTOR to LOC. (The d.c. voltmeter now indicates bank platform displacement. The voltmeter should read 20 ± 2V). Engage the autopilot.

(2) Select the A CHANNEL switch OUT, and manually rotate the control column fully anti-clockwise from the central position. Select A CHANNEL switch IN.

(3) Displace the turn control (pilots' control) *just out of detent* to the right. The COMPASS CLUTCH SUPPLY lamp should be out, the control column should rotate clockwise a proportional amount, and the D.C. voltmeter reading should increase.

Note . . .

If the turn control has been displaced as required, the increase in voltmeter reading should be not greater than 2 *V.*

(4) Set the TURN DEMAND switch, to IN, and the control column should commence rotating slowly and continuously clockwise. Increase the displacement of the turn control to approximately position 10 to the right. The control column should again rotate clockwise a proportional amount and then remain stationary.

(5) Select the A CHANNEL switch OUT. The d.c. voltmeter reading should return to 20 ± 2 V. Centralise the turn control.

(6) Set the TURN DEMAND switch to OUT, and repeat sub-paras. (2), (3), (4) and (5) with the control column initially rotated fully clockwise and the turn control displaced to the left. Similar but opposite sense control column rotation and voltmeter excursion should result.

(7) Disengage the autopilot. Centralise the manual controls and select the A CHANNEL switch IN. Return the test set controls to "normal" (*para.* 96 *refers*).

Turn control safety circuit—aileron channel

113. (1) With the autopilot disengaged, displace the turn control from detent in one direction.

(2) Engage the autopilot and check that the turn control is inoperative until it has first been returned to detent position.

(3) Repeat sub-paras. (1) and (2) with the turn control displaced in the opposite direction.

(4) Select the A CHANNEL switch OUT and centralise both turn control and control wheel.

Preselect turn operation and turn control override—roll error cut-out operation—aileron channel

114. (1) Set the TURN DEMAND switch OUT and select the A CHANNEL switch IN.

(2) Set the heading selector pointer 5 deg. clockwise from the datum mark, by depressing and rotating the course setting knob at the bottom right-hand corner of the instrument. No control column movement should result from this operation.

(3) Press the "alter heading" button at the top left-hand corner of the heading selector for at least two seconds and then release. The COMPASS CLUTCH SUPPLY lamp should be out, and the control wheel should rotate clockwise approximately 5 deg.

(4) Slowly reset the heading selector pointer to read 5 deg. anti-clockwise from the datum mark. The control column should rotate anti-clockwise to its nominal central position and the COMPASS CLUTCH SUPPLY lamp then light.

(5) Displace the heading selector pointer either clockwise or anti-clockwise from the datum mark. No control column movement should occur.

(6) Repeat sub-paras. (2) to (5) inclusive with the heading selector pointer displaced in opposite directions. Similar but opposite sense control column response and COMPASS CLUTCH SUPPLY lamp indications should result.

(7) Select the A CHANNEL switch OUT, and centralise the control column.

(8) Repeat sub-paras. (1), (2) and (3). Displace the turn control just out of detent to the left. The control column should respond to this action, rotating anti-clockwise.

(9) Displace the heading selector pointer either clockwise or anti-clockwise from the datum mark. No control column movement should result. Centralise the turn control.

(10) Set the A. GYRO switch to OUT, and the D.C. TEST SELECTOR to LOC. (The d.c. voltmeter now indicates bank platform displacement. The voltmeter should read 20 ± 2V).

(11) Set the heading selector pointer to read at least 120 deg. clockwise from the datum mark.

(12) Press the ALTER HEADING button on the heading selector for at least two seconds and then release. The d.c. voltmeter reading should increase to not more than 32 ± 2V.

(13) Reset the heading selector pointer to read at least 120 deg. anti-clockwise from the datum mark.

(14) Wait for the d.c. voltmeter reading to return to 20 ± 2V and then press the ALTER HEADING button on the heading selector again. The d.c. voltmeter reading should decrease to not less than 8 ± 1V.

(15) Disengage the autopilot. Remove the test set cable connector "J2U" from J2 on the amplifier unit, and reconnect the autopilot cable to J2 plug. Engage the autopilot.

(16) Set the heading selector pointer to read at least 90 deg. clockwise from the datum mark. Press the ALTER HEADING button on the heading selector for at least two seconds and then release. The d.c. voltmeter reading should increase to not more than 26 ± 2V, the ENGAGE switch should automatically release to "off" as the "maximum" reading is reached (i.e. as the autopilot becomes fully disengaged), and the d.c. voltmeter reading should then return to 20 ± 2V.

(17) Reset the heading selector pointer to read at least 90 deg. anti-clockwise from the datum mark. Engage the autopilot and press the ALTER HEADING button again. The d.c. voltmeter reading should decrease to not less than 14 ± 2V, and similar complete disengagement of the autopilot occur as in sub-para. (16).

(18) Remove the autopilot cable connector J2 from the amplifier unit, and reconnect the test set cable "J2U".

(19) Disengage the autopilot and centralise the manual controls. Return test set controls to "normal" (*para. 96 refers*).

Yaw gyro cross feed signal—aileron channel
Turn demand and sideslip monitor signals—rudder channel

115. (1) Set the following switches on the test set:—

GROUND TEST RELAY switch	to ON
A. GYRO switch	to OUT
SLIP MON. switch	to OUT
PITCH MON. switch	to OUT
TURN DEMAND switch	to OUT

Then with the autopilot disengaged, operate the pitch control (pilot's control) *fully forward* for at least 25 seconds, and then release the control.

(2) Engage the autopilot. Displace the turn control approximately 10 deg. to the right and initially note the rudder pedals. They should "kick" to the right on displacement of the turn control, and the control column should rotate clockwise a proportional amount. Select the R and A channel switches "out". Centralise the turn control, control column and rudder pedals.

(3) Select the R and A channel switches IN, and repeat sub-para. (2) above with the turn control displaced to the left. Similar but opposite sense rudder pedal and control column movements should result.

(4) Set the GROUND TEST RELAY switch to OUT, the R. GYRO switch to OUT, and the TURN DEMAND switch to IN. Select the R and A channel switches IN, and then the E channel switch OUT.

(5) Displace the turn control fully to the right and note the rudder pedals. Rudder movement to the right should occur and then cease. Ignore any control column movement.

(6) Select the A channel switch OUT, centralise the control column and then reselect this channel switch IN. Select the R channel switch OUT, centralise the rudder pedals and then reselect this channel switch IN.

(7) Repeat sub-para. (5) with the turn control displaced to the left. Similar but opposite sense rudder movement should result.

(8) Set the SLIP. MON. switch to IN, and press the MON. TEST switch. Continuous rudder movement to the right should occur. Release the MON. TEST switch.

(9) Disengage the autopilot. Centralise the rudder panels and control wheel if necessary. Select the E channel switch IN, and return the test set controls to "normal" (*para. 96 refers*).

Pitch control and gyro pitch platform operation, pitch gyro and pitch monitor signals—elevator channel

116. (1) Set the D.C. TEST SELECTOR to P.P.W./GLIDE. (D.C. voltmeter now indicates pitch platform displacement). With the autopilot disengaged, the d.c. voltmeter pointer should be slowly oscillating approximately $\pm \frac{1}{2}$V about a reading of 25 $\pm$ 3V.

(2) Centralise the control column. Engage the autopilot. The d.c. voltmeter pointer should steady and read 25 $\pm$ 3V. The control column should be stationary, but if movement does exist this should be very slow.

(3) Set the PITCH MON. switch to OUT, and push the pitch control (control unit) forward to the "slow rate" position (first pressure). The d.c. voltmeter reading should decrease slowly, and the control column should move forward slowly. Push the pitch control further forward to the "fast rate" position (second pressure). The d.c. voltmeter reading should decrease faster, and the control column should move forward faster. Release the pitch control. The d.c. voltmeter reading should steady, and the control column movement should cease.

(4) Set the PITCH MON. switch to IN. The control column should commence moving continuously forward.

(5) Disengage the autopilot. The d.c. voltmeter pointer should return to and oscillate, as before, about a reading of 25 $\pm$ 3V (*sub-para.* (1)).

(6) Repeat sub-paras. (2) and (5) inclusive for opposite pitch control action. Similar but opposite sense control column movements and voltmeter excursions should result.

(7) Return the test set controls to "normal" (*para. 96 refers*).

Height lock operation, height chaser and integrator circuits—elevator channel

117. (1) Set the PITCH MON. switch to OUT, and the D.C. TEST SELECTOR to P.P.W./GLIDE. (The d.c. voltmeter now indicates pitch platform displacement). Centralise the control column and engage the autopilot. The d.c. voltmeter should read 25 $\pm$ 3V. Note the actual reading.

(2) Engage height lock by pulling ON the ALT. switch (control unit). The switch should hold ON. No control column movement should result from this action, and the d.c. voltmeter reading should not change.

Note . . .

On engaging height lock, a small "kick" of the d.c. voltmeter pointer may be observed, but any resultant change in reading from that initially noted in sub-para. (1) *should not be greater than $\frac{1}{2}$V.*

(3) Check that the pitch control is inoperative in either direction *on the 'slow rate' positions.*

(4) Push the pitch control fully forward to the 'fast rate' position. The ALT. switch should automatically release to OFF. Release the pitch control. Re-engage height lock and repeat this test for opposite pitch control action.

(5) Re-engage height lock, and select the E channel switch OUT. The ALT. switch should automatically release to OFF.

(6) Pull the control column to the fully-back position, and select E channel switch IN. Re-engage height lock, and note the d.c. voltmeter reading.

(7) Increase the pressure in the aircraft's static system by an amount equivalent to a height increase of approximately 500 ft. The d.c. voltmeter reading should decrease a proportional amount and then continue to decrease very slowly. The control column should move forward a proportional amount followed by a very slow continuous movement in the same sense.

Note . . .

The initial movement of the control column should be clearly observed. The ensuing slow movement, however, will not normally be noticeable. Provided, therefore, that the d.c. voltmeter reading behaves as detailed, the test may be concluded as satisfactory without further delay.

(8) Return the pressure in the static system to atmospheric. The control column should move backward, and the d.c. voltmeter reading should return towards that initially noted in sub-para. (6), and remain appreciably steady.

Note . . .

The difference between the final d.c. voltmeter reading obtained in this test and that initially noted in sub-para. (6) will be directly proportional to the time in which the slow change in sub-para. (7) has been allowed to occur.

(9) Select the E channel switch OUT. Wait at least 15 seconds (or until d.c. voltmeter pointer returns to and "oscillates" about its initial reading (*sub-para.* (1)) before proceeding as detailed in the following paragraph.

(10) Push the control column fully forward, and select the E channel switch IN. Re-engage height lock, and note the d.c. voltmeter reading.

(11) Repeat (7), (8) and (9) for a similar increase of pressure in the static system. Similar but opposite sense control column movements and voltmeter excursions should result.

(12) Centralise the control column, and select the E channel switch IN. With the height lock disengaged, increase the pressure in the static system by an amount equivalent to a height decrease of approximately 500 ft. Wait at least 60 seconds and then repeat sub-para. (2) when the results should conform.

(13) Push the ALT. switch OFF. Return the pressure in the static system to atmospheric. Wait at least 60 seconds and then repeat sub-para. (2) when the results should conform.

(14) Disengage the autopilot and return the test set controls to "normal" (*para.* 96 *refers*).

I.L.S. radio coupling circuits—track and glide phases—aileron and elevator channel control conditions. Aileron servomotor tacho generator crossfeed and sideslip monitor signals—rudder channel

118. (1) Select the following switches on the test set:—

R. GYRO switch	to OUT
SLIP. MON. switch	to OUT
PITCH MON. switch	to OUT
TURN DEMAND switch	to OUT

Set the heading selector pointer to the datum mark as accurately as possible. Centralise the manual controls, and engage the autopilot. The COMPASS CLUTCH SUPPLY lamp should light.

(2) Pull the TRACK switch ON (switch unit). The TRACK switch should hold ON and no appreciable control wheel movement should result. The COMPASS CLUTCH SUPPLY lamp should go out. Check that the turn control is inoperative in both directions, and then return the control to detent.

(3) Set the heading selector pointer to the following approximate displacements from the datum mark; 5 deg. clockwise 5 deg. anti-clockwise, and 0 deg. The control column should follow throughout the cycle such that its rotation is clockwise for clockwise movement of the pointer, and vice versa. Rudder movement should occur whilst the control column is in motion—to the right for clockwise and to the left for anti-clockwise control column rotation.

(4) Set the SLIP MON. switch to IN, and depress the MON. TEST switch. Continuous rudder movement to the right should occur. Release the MON. TEST switch, and select the R channel switch OUT.

(5) Set the D.C. TEST SELECTOR to LOC. (The d.c. voltmeter now indicates bank platform displacement).

(6) Rotate the I.L.S. control a small amount clockwise from the "normal" setting (i.e. centre of travel; para. 96 refers) to simulate left radio signal demand. The control column should be driven anti-clockwise in sympathy, and the d.c. voltmeter reading should decrease accordingly. Rotate I.L.S. control a small amount anti-clockwise from the normal setting to simulate radio signal demand. The control column should be driven clockwise in sympathy, and the d.c. voltmeter reading should increase accordingly.

(7) Select the A channel switch OUT. The TRACK switch should remain ON, and the d.c. voltmeter reading should return to 20 ± 2V.

(8) Set the A. GYRO switch to OUT and return the I.L.S. control to the "normal" setting. Centralise the control column, and select the A channel switch IN.

(9) Set the heading selector pointer 10 deg. clockwise from the datum mark, and the TURN DEMAND switch to IN. The control column should commence rotating continuously clockwise. Set the TURN DEMAND switch to OUT, and the control column rotation should cease.

(10) Repeat sub-para. (9) with the heading selector pointer displaced 10 deg. anti-clockwise from the datum mark. Similar but opposite sense control column rotation should occur.

(11) Set the heading selector pointer at least 40 deg. clockwise from the datum mark. The d.c. voltmeter reading should increase to not greater than 32 ± 2V.

(12) Reset the heading selector pointer at least 40 deg. anti-clockwise from the datum mark. The d.c. voltmeter reading should decrease to not less than 8 ± 1V. Return the heading selector pointer to the datum mark.

(13) Select the E channel switch OUT, and pull the control column to the fully-back position. Select the E channel switch IN.

(14) Push the pitch control fully forward. The control column should move forward. Release the pitch control. The control column movement should cease. Set the PITCH MON. switch to IN, and the control column should commence moving continuously forward. Set the PITCH MON. switch OUT, and the control column movement should cease.

(15) Select the E channel switch OUT. Locate the control column halfway between the central and back stop positions, and select the E channel switch IN.

(16) Engage height lock. The ALT. switch should hold ON. Pull the GLIDE switch ON (control unit), and the switch should hold ON. The ALT. switch should automatically release to OFF. The control column should move forward a fixed amount. Check that the pitch control is inoperative in both directions.

(17) Note the d.c. voltmeter reading. This should be approximately 20 ± 2V. Set the heading selector pointer at least 20 deg. clockwise from the datum mark. The d.c. voltmeter reading should increase to not greater than 25 ± 2V.

(18) Reset the heading selector pointer at least 20 deg. anti-clockwise from the datum mark. The d.c. voltmeter reading should increase to not less than 15 ± 2V. Reset the heading selector pointer to the datum mark.

(19) Repeat sub-para. (17) and (18) rotating the I.L.S. control knob fully anti-clockwise and clockwise respectively in lieu of the heading selector pointer displacements quoted. Similar d.c. voltmeter excursions should result. Return the I.L.S. control to "normal" setting (i.e. centre of travel, para. 96 refers).

(20) Set the D.C. TEST SELECTOR to P.P.W./GLIDE. (The d.c. voltmeter now indicates pitch platform displacement).

(21) Note the d.c. voltmeter reading. Rotate the I.L.S. control fully anti-clockwise from the "normal" setting to simulate up radio signal demand. The d.c. voltmeter reading should increase a proportional amount and then continue to increase very slowly. The control column should move backward a proportional amount and then continue moving back very slowly.

Note . . .

The initial control column movement should be clearly observed but the ensuing slow movement may not be noticeable. Provided, therefore, the d.c. voltmeter reading behaves as detailed, the test may be concluded as satisfactory without further delay.

(22) Return the I.L.S. control to the "normal" setting. The control column should move forward a proportional amount and the d.c. voltmeter reading should return towards that initially noted in sub-para. (21) and then remain appreciably steady.

Note . . .

The difference between the final d.c. voltmeter reading obtained in this test and that initially noted in sub-para. (21) will be directly proportional to the time in which the slow change in sub-para. (21) has been allowed to occur.

(23) Repeat sub-para. (21) for clockwise displacement of the I.L.S. control to simulate down radio signal demand. Similar but opposite sense control column movements and voltmeter excursions should result. Select the E channel switch OUT. Both the TRACK and GLIDE switches should remain ON. The d.c. voltmeter pointer should return and oscillate about a reading of 25 ± 3V. Return the I.L.S. control to the "normal" setting. The d.c. voltmeter reading should initially increase slightly and the pointer then return to an oscillate about a reading of 25 ± 3V.

(24) Push the TRACK switch OFF. The GLIDE switch should automatically release to "off".

(25) Select the E channel IN, and pull the GLIDE switch ON. This switch should NOT hold ON, and no control column movement should result from this action. Release the GLIDE switch.

(26) Pull the TRACK and GLIDE switches ON in the sequence stated. Disengage the autopilot. The TRACK, GLIDE and ENGAGE switches should automatically release to OFF. Return the test set controls to "normal" (*para. 96 refers*).

Bombing coupling circuit operation—track phase override—aileron channel

119. (1) Set the following switches on the test set:—

R. GYRO switch	OUT
SLIP MON. switch	OUT
PITCH MON. switch	OUT
TURN DEMAND switch	OUT
D.C. TEST SELECTOR	N.B.C.
B.C.U. PORT/STBD. switch	PORT
B.C.U. HIGH/LOW switch	LOW

(The d.c. voltmeter now indicates bank platform displacement). Rotate the I.L.S. control *fully anti-clockwise*, and centralise the control column.

(2) Select the A channel switch IN only and engage the autopilot. The COMPASS CLUTCH SUPPLY lamp should light. Pull the BOMB switch "on" (switch unit). No appreciable control column movement should result, and the COMPASS CLUTCH SUPPLY lamp should go out. Check that the turn control is inoperative in both directions.

(3) Rotate the I.L.S. control clockwise. The control column should be driven anti-clockwise and the d.c. voltmeter reading decrease. Rotate the I.L.S. control fully anti-clockwise. The control column should return to a nominal central position.

(4) Push the BOMB switch OFF. Rotate the I.L.S. control *fully clockwise* and set the B.C.U. PORT/STBD. switch to STBD. Pull the BOMB switch ON.

(5) Rotate the I.L.S. control anti-clockwise. The control column should be driven clockwise and the d.c. voltmeter reading increase. Rotate the I.L.S. control fully clockwise. The control column should return to a nominal central position.

Note . . .

If it is required to measure the bank platform angle against input to the autopilot, this may be done by reading the input volts on a high impedance monitor voltmeter (at least 1,000 *ohms per volt) plugged into the* B.C.U. MON. *socket by means of test cable* "B.C.U. MON." (*TE*.6248) *and the platform displacement on the d.c. voltmeter* (1 *volt equals* 2 *deg.*), *whilst the checks given in sub-paras.* (3), (4) *and* (5) *are being carried out. Unplug the monitor voltmeter following the completion of the tests.*

(6) Set the A. GYRO switch to OUT, and the B.C.U. HIGH/LOW switch to HIGH. Rotate the I.L.S. control fully anti-clockwise. The d.c. voltmeter reading should increase to not greater than 32 ± 2V. Set the TURN DEMAND switch to IN. The control column should commence rotating slowly and continuously clockwise. Set the TURN DEMAND switch to OUT. The control column motion should cease.

(7) Set the B.C.U. PORT/STBD. switch to PORT, and rotate the I.L.S. control fully clockwise. The d.c. voltmeter reading should decrease to not less than 8 ± 1V. Set the TURN DEMAND switch to IN. The control column should commence rotating slowly and continuously anti-clockwise. Set the TURN DEMAND switch to OUT. The control column motion should cease.

(8) Ensure that the heading selector pointer is aligned to the datum mark. Pull the TRACK switch ON. The d.c. voltmeter reading should return to 20 ± 2V. Set the A. GYRO switch to IN, and the heading selector pointer to the following approximate displacements from datum mark:—5 deg. clockwise, 5 deg. anti-clockwise, 0 deg. The control column should follow throughout the cycle so that the rotation is clockwise for clockwise movement of the pointer, and vice versa.

(9) Depress the autopilot cut-out switch. The TRACK, BOMB and ENGAGE switches should automatically release to OFF. Return the test set controls to "normal" (*para.* 96 *refers*).

Channel balance—check for final adjustment

120. Carry out the tests as detailed in para. 108 and 109.

121. (1) Remove all the test set cables from the autopilot amplifier, automatic approach and bombing coupling units, power supply test point and to J4 cable connector.

(2) Reconnect the following cable connectors to the autopilot:—

Socket J4, amplifier unit

Plug J2, amplifier unit (if necessary)

Socket CU5, automatic approach coupling unit

Socket BCU6, bombing coupling unit

Note . . .

Do NOT *reconnect plug J*1, *amplifier unit (compass monitor) until so instructed in the ensuing text.*

Channel balance—final check

122. The following procedure is necessary to obtain the accurate balance required to ensure the best results from the autopilot. For this a channel balance test cable, constructed as detailed in Appendix 1, must be used.

(1) Connect the TEST A and TEST B plugs of the channel balance test cable respectively to TEST A and TEST B on the amplifier unit.

(2) Select all three channel switches IN, centralise the manual controls, and engage the autopilot.

(3) Balance each channel of the autopilot as detailed below:—

Elevator. Note either the remote trim indicator or the control unit trim indicator. If "drift" is present the pointer will slowly deflect in either a NOSE HEAVY or TAIL HEAVY direction. Select the E channel switch OUT, "inch" the elevator balancer (E) in the appropriate direction (see note), re-select this channel switch IN and again note the trim indicator. Repeat this procedure until adjustment of the elevator balance (E) results in the turn indicator pointer being stationary at centre-scale for at least 15 secs.

Note . . .

Elevator balancer (E). Clockwise rotation from zero will produce nose-heavy trim-indicator movement or backward movement of the control column, and vice versa.

Rudder. Check for any continuous slow movement of the rudder pedals over a period of half a minute. "Inch" the rudder balancer (R) in the appropriate direction (see note) until any movement existing on the rudder pedals ceases. If the movement has not been arrested until the rudder pedals are well de-centralised, disengage the channel, centralise the controls, and, after re-engaging, repeat the above procedure until the required conditions are attained with the pedals virtually central.

Note . . .

Rudder balancer (R). Clockwise rotation from zero will produce right rudder movement, and vice versa.

Aileron. Proceed in the following sequence only:—

With the test cable TEST B plug connected to TEST B, amplifier unit, check for any continuous slow movement of the control column over a period of one minute.

"Inch" the aileron balancer (A) in the appropriate direction (see note) until any movement on the control column ceases. If movement has not been arrested until the control column is well de-centralised, disengage the channel, centralise the control, and, after re-engaging, repeat the above procedure until the required conditions are attained with the control column virtually central. Remove the test cable TEST B plug from the amplifier unit. Repeat the above procedure using the cross-feed balancer (C).

NOTE...
Aileron (A) and cross-feed (C) balancers. Clockwise rotation from zero will produce anti-clockwise control column movement and vice versa. The turning flight performance of the autopilot is very dependent on the accurate setting of these balancers. Particular care and attention should, therefore, be taken in their adjustment.

(4) Disengage the autopilot. Remove the test cable TEST A plug from the amplifier unit, and replace the blanking caps on the connector points TEST A and TEST B, amplifier unit. Note the readings of the balancers for record purposes, and close the flap-door of the amplifier unit.

Brief functional check of the autopilot
Operation of the trim indicators
Operation of the excess torque cut-out - (elevator channel)
Operation of interlocks with normal trim system, autostabilisation system and artificial feel

123.(1) Centralise the manual controls, and check that the R, A and E channel switches are IN. Engage the autopilot.

(2) Check that the turn control is operative in both directions, and then return it to detent.

NOTE...
Use small or slow displacement, otherwise disengagement will result via the roll error cut-out.

(3) Gently exert a steadily increasing forward pressure on the control column. The remote trim indicator (if fitted) and the control unit turn indicator should deflect in a NOSE HEAVY direction. Check that a momentary increase in the applied manual force to the control column results in the ENGAGE switch automatically releasing to OFF, and in total disengagement of the autopilot. Re-engage the autopilot and repeat this test for backward applied pressure in the control column. The trim indicator should deflect in a TAIL HEAVY direction and similar disengagement of the auto-pilot result.

NOTE...
The spring strut cut-out fitted as part of the elevator servomotor-aircraft control linkages is designed to "collapse" and automatically disengage the autopilot when loaded to 78 lb. ± 2 lb. This 78 lb. using the direct gearing conversion factor, is equivalent to a stick force of 17·5 lb. Allowing a nominal figure of 9 lb. for control column break-out force, a load of 26·5 lb. ± 2 lb. applied at the control column should "collapse" the strut and disengage the autopilot.

(4) Re-engage the autopilot and carry out a similar test to that detailed in sub-para.(3) on the rudder pedals in both directions. Total disengagement of the autopilot should similarly occur.

(5) Re-engage the autopilot and check that the pitch control is operative on the 'fast rate' position in both directions. Disengage the autopilot.

Heading selector and compass monitor operation and alignment - aileron channel

124.(1) Set the first pilot's gyro compass indicator to COMPASS on the control panel. Replace plug J1 (compass monitor) on the amplifier unit. Centralise the manual controls, and engage the autopilot. Check that the heading selector and first pilot's compass gyro readings agree to within ± 1 deg.

(2) By means of the caging knob increase the compass gyro readings by 20 deg. The heading selector dial reading should increase accordingly. The control column should commence to rotate anti-clockwise. Decrease the compass gyro reading by 20 deg. The heading selector dial reading should decrease accordingly. The control column should commence to rotate slowly clockwise. Turn the caging knob slowly in the appropriate direction until the control wheel rotation ceases. Select the A channel switch OUT.

(3) Alter the compass gyro reading by 10 deg. in either direction, and select the A channel switch IN. The control column should remain

NORMAL

CUT-IN SPEED :- __________

TABLE 1

I. A. S. (KNOTS)	ELEVATOR	
	UP	DOWN
CUT-IN		
120		
160		
200		

TRACK

CUT-IN SPEED:- __________

TABLE 2

I. A. S. (KNOTS)	ELEVATOR	
	UP	DOWN
CUT-IN		
160		
180		
200		

GLIDE

CUT-IN SPEED:- __________

TABLE 3

I. A. S. (KNOTS)	ELEVATOR	
	UP	DOWN
CUT-IN		
160		
180		
200		

THESE CURVES SHOW TOLERANCES FOR AUTOPILOT ELEVATOR SERVO AUTHORITY FOR USE IN CALIBRATION OF FEEL RELIEF PROVISION WITH 'TRACK' AND 'GLIDE' SELECTED

(NOTE:- ELEVATORS MUST BE OPERATED FROM AUTOPILOT PITCH CONTROL DURING THESE TESTS)

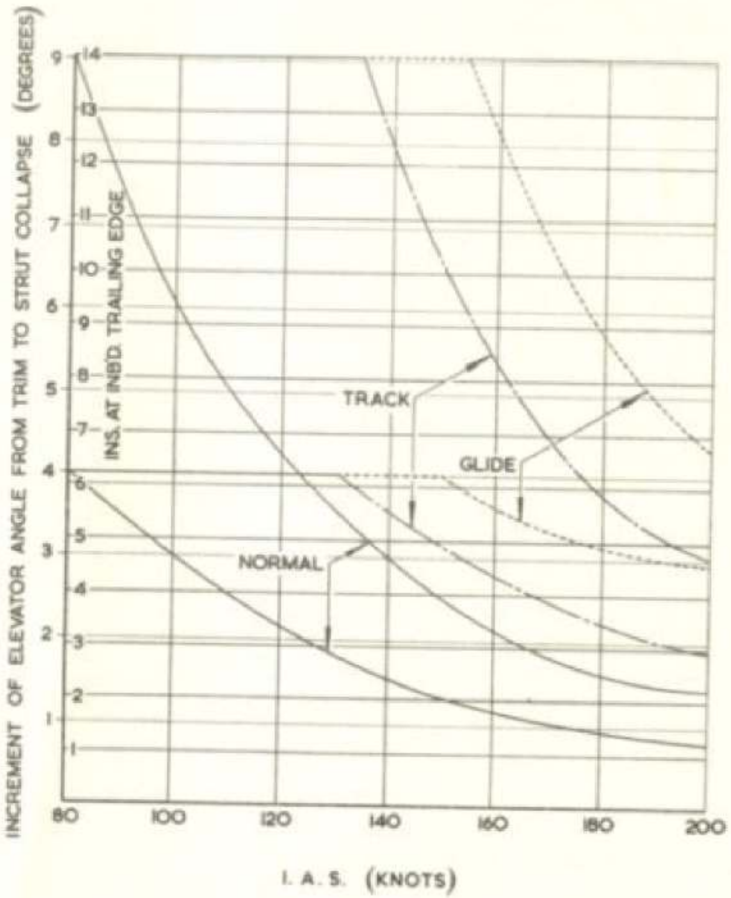

Fig. 4 Elevator calibration – track and glide

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stationary. Select the A channel switch OUT, and synchronise the first pilot's gyro compass indicator. Select the A channel switch IN.

Autopilot disengagement - pilot's 'cutout' and safety circuit. Power supply torque switch operation

125.(1) Press the first pilot's instinctive cutout (trigger switch in the hand-grip of the control column), and release. The autopilot should become totally disengaged, i.e., the READY flag should appear, the IN flag disappear, the ENGAGE switch release to OFF, and the aircraft controls become free. Re-engage, and repeat this test using the second pilot's cutout switch.

(2) Re-engage the autopilot, then hold the first pilot's cutout switch in its depressed state. At the same time, pull the ENGAGE switch ON. The ENGAGE switch should not hold ON, and the aircraft controls should remain free. Release the ENGAGE switch and then the cutout switch.

(3) Re-engage the auto-pilot, and switch the auto mach trim system off. Ensure that the mach trim indicator, adjacent to the mach-meter on the first pilot's panel, is presenting a white image.

(4) Switch the auto mach trim system ON, ensure that the mach trim indicator shows a black image. Push the control column forward (care should be taken not to accidentally operate the instinctive cutout switch); with a stick load of 26 lb. approx., the autopilot and the auto mach trim system should both be disengaged (White image on mach trim indicator).

(5) Re-engage the autopilot, the mach trim indicator should continue to present a white image.

(6) Reset the auto mach trim system by switching to OFF, and then ON. The magnetic indicator should now present a black image.

(7) Repeat (4), using a 'pull' instead of a push force.

(8) With the autopilot disengaged, check that both the elevator and aileron normal trim systems are operative. Engage the aileron channel on the autopilot, check that the aileron normal trim is not operative. Disengage the aileron channel, and check that aileron normal trim is again available.

(9) Repeat (8), with the elevator channel and the normal trim switch.

(10) With the autopilot disengaged, ensure that the yaw damper system is operative. (This may be carried out by applying a firm thumb pressure in either a port or starboard direction to the yaw damper mounting, checking that rudder movement results).

(11) Engage the rudder channel on the autopilot, and check that the yaw damper is inoperative. Disengage the autopilot, and re-check that the yaw damper is again operative.

Calibration of elevator servo authority in track and glide phases

126. For this final checking stage it will be necessary to increase the operating crew to three men, stationed one in the first pilot's seat, one in the bomb bay, and one at the trailing edge of the inboard elevator. The following additional test equipment will be required:-

(1) A pitot pressure simulator rig equipped with sufficient piping to operate simultaneously two instruments 12 ft. apart.

(2) A suitable 2 foot rule.

(3) Ground intercom. facilities with three head sets.

127. Disconnect the pitot supply line from the elevator artificial feel airspeed transmitter on the port side of the bomb bay, and disconnect the pitot supply pipe from the elevator artificial feel failure warning transmitter. Connect up a simulator rig to both transmitters simultaneously. Ensure that both pitot head covers have been removed.

128. With the autopilot disengaged, trim the elevators into line with the inboard fixed trailing edge.

129. Note that in the following tests, the deflection of the elevator under autopilot control is to be measured. Great care must be exercised during these measurements, due to the operation of the spring strut when maximum elevator

deflection is reached. At this point, the autopilot will be automatically disengaged, and the elevators will return to their trim position at a speed dictated by the recovery artificial feel unit. For the calibration of the elevator servo authority, proceed as follows:-

(1) Engage the autopilot, trim to zero servo load, and then operate the pitch control at a low rate in the nose up sense until the autopilot becomes disengaged by the operation of the spring strut cutout. Measure the maximum deflection of the elevators between zero load and disengagement.

NOTE...

It is important that when trimming the servomotor to zero load, the final movement of the pitch control must be towards the direction in which it is required to move the elevators in the succeeding test.

(2) Slowly increase the airspeed on the pitot pressure rig, and check the cut-in speed of the elevator artificial feel unit (by listening at the feel unit for the first operation of the actuator). This cut-in speed should be referred to the maximum deflection and tabulated as shown in table 1, fig.4.

(3) Increase the airspeed to 120 Kts., and repeat (1); record the maximum elevator deflection.

(4) Repeat (3) at airspeeds of 160, 180 and 200 Kts.

(5) Decrease the airspeed to zero, and repeat tests (1), (3) and (4), using nose down operation of the pitch control.

(6) Re-engage the autopilot and engage TRACK. Repeat (2), (3), (4) and (5), using the airspeed values given in table 2, fig.4.

(7) Place the GLIDE ANGLE switch in the approach coupling unit to the TEST position and reduce the airspeed to zero. Re-engage the autopilot and trim the elevator servo to zero load by means of the pitch control. Engage TRACK and slowly push the pitch control forward, until the trim indicator shows elevators almost fully out of trim, then select GLIDE and release the pitch control. The autopilot will continue to run until the spring strut collapses, at which point the elevator movement should be measured.

(8) With TRACK and GLIDE selected, slowly increase the airspeed and check the cut in speed of the elevator A.F.U. as in (2). The cut in speed should be referred to the maximum deflection measured as in (7) above and tabulated as shown in fig.4.

(9) Increase the airspeed to 160 knots, repeat (7) recording maximum deflection.

(10) Repeat (9) at airspeeds of 180 and 200 knots.

(11) Using the method described in (7), but with nose up movement of the pitch control, repeat (8), (9) and (10) for elevator up movement.

The readings obtained in all the tests (1) to (11) should be proved and compared with the curves in fig.4, which shows the the maximum and minimum permissible values.

130. The elevator authority in track phase is adjustable at potentiometer No.2 in the relay panel 64P; any adjustment at these points will also affect the glide phase. It is important therefore that any adjustment necessary in track be finalized before completing the adjustment in the glide phase at potentiometer No.4. In general, however, the trend shown by the normal calibration should be maintained, i.e., if normal authority is towards the high side of the tolerances, then track and glide phases should similarly be maintained towards the high side. Any adjustment carried out at No.2 and 4 potentiometers should be followed by balancing adjustments to the artificial feel warning system at potentiometers No.1 and 3. After final adjustments, lock all the potentiometers, and proceed as follows:-

(1) Re-engage the autopilot and select TRACK. The elevator artificial feel failure indicator should show a white image and the feel failure warning indicator (adjacent to the first pilot's airspeed indicator) should present a black image.

(2) Select GLIDE on the autopilot control unit and the indicator conditions outlined in (1) should not change.

(3) Depress the TRACK selector, the GLIDE selector should automatically return to OFF, and the elevator artificial feel failure indicator should present a black image.

(4) Disengage the autopilot, and depress the POWER switch to OFF. Ensure that the READY and ENGAGE indicator flags disappear.

(5) Ensure that the airspeed simulation rig is at zero pressure, disconnect the rig, and reconnect the aircraft

pitot piping, making certain that the joints are leak-proof.

(6) Exercise the flying controls in all directions and check for freedom of movement.

At the conclusion of the foregoing tests, switch off the autopilot inverter, and switch off the powered flying controls.

AUTOSTABILIZER AND MACH TRIM CONTROLS

131. Full instructions for servicing and setting-up the autostabiliser and mach trim controls will be found in A.P.1469S, Vol.1, Sect.4, Chap.2.

ZERO READER

132. Full instructions for servicing and setting-up the zero reader installation will be found in A.P.1275A, Vol.1, Sect.9, Chap.1.

REMOVAL AND ASSEMBLY

General

133. The removal and assembly of equipment described in this group is reasonably straightforward and no special instructions are required. However, before removing equipment which connects into the flying control runs reference should be made to Book 1, Sect.3, Chap.4 of this publication.

Table 1

Schedule of equipment

Automatic Pilot Mk.10

Unit	Type	Ref.No.	No.off
Switch unit	A	6T/213	1
Pilots' controller	A	6T/214	1
Heading selector	A	6T/216	1
Remote trim indicator	A	6T/218	1
Gyro unit	A	6T/201	1
Amplifier unit	A	6T/204	1
Automatic approach coupling unit	B	6T/346	1
Bombing coupling unit	A	6T/217	1
Roll error cutout	A	6T/401	1
Mounting tray for roll error cutout	A	6T/402	1
Condenser unit	A	6T/212	1
Servomotor (20 lb. ft.) rudder	C	6T/307	1
Servomotor (20 lb. ft.) aileron	C	6T/307	1
Servomotor (40 lb. ft.) elevator	A	6T/202	1
Servomotor mountings	A	6T/232	3
Link setting card - amplifier	-	6T/425	1
Link setting card - approach section	-	6T/444	1
Link setting card - height section	-	6T/445	1
Link setting card - preselect turn	-	6T/446	1
Link setting card - bombing coupling unit	-	6T/449 Prior to Mod.1426	1
Link setting card - bombing coupling unit	-	6T/1815 Post Mod. 1426	1

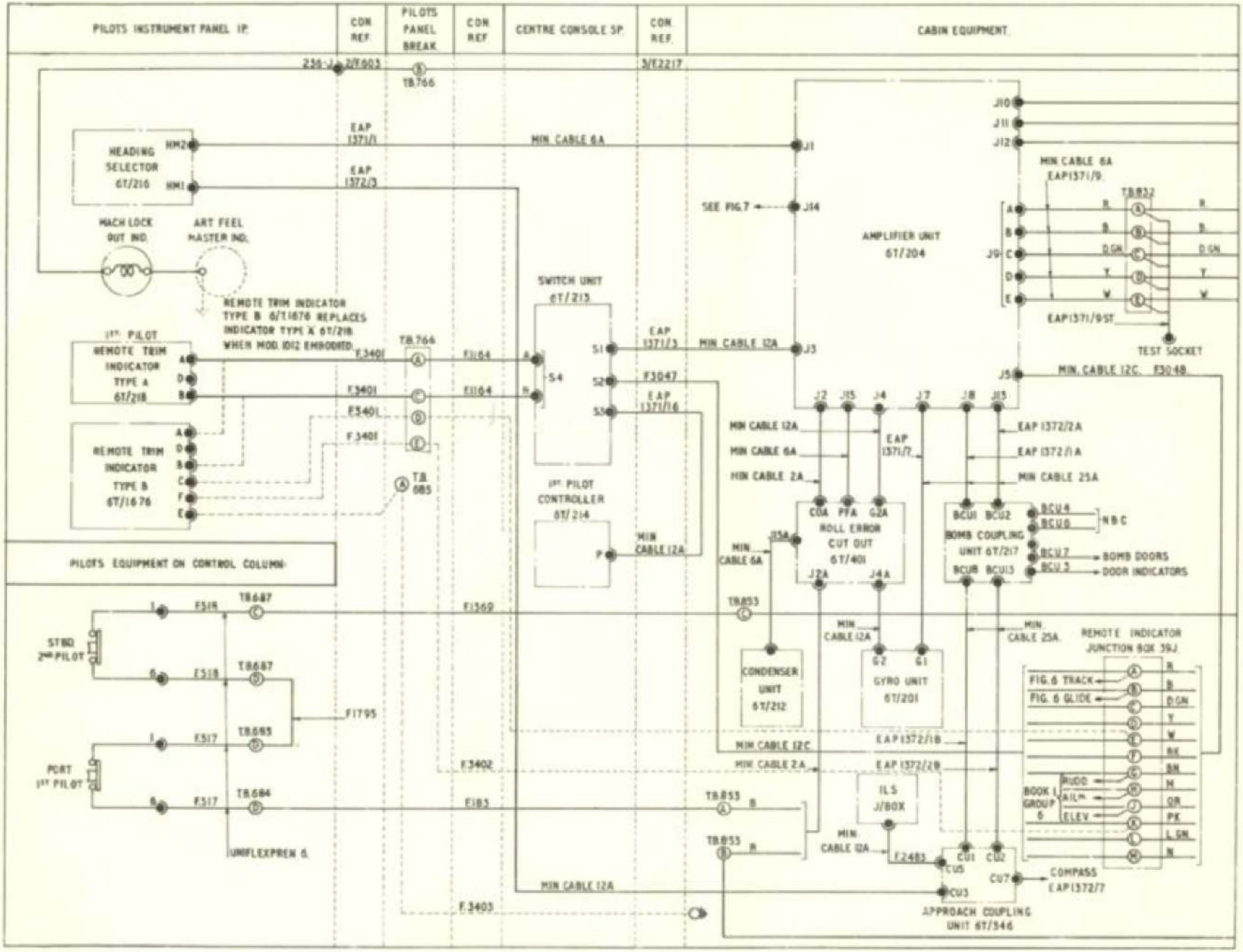

Fig.5 (1) Autopilot Mk.10

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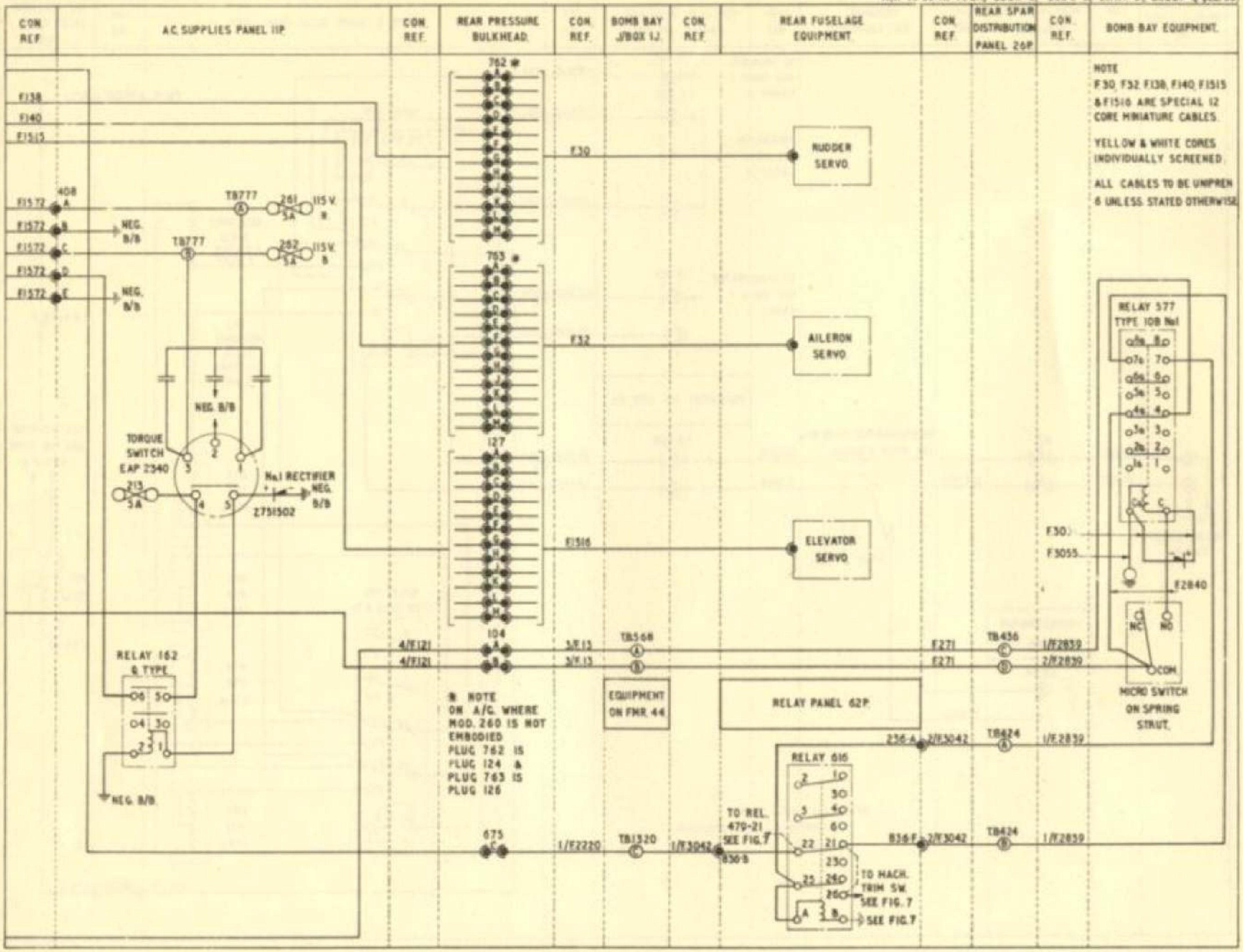

FIG. 5 (2) AUTO PILOT MK. 10

(A.L. 35 OCT. 58)

PP8464 345682 8133 12 58 506 C&P Gp. 924 (4)

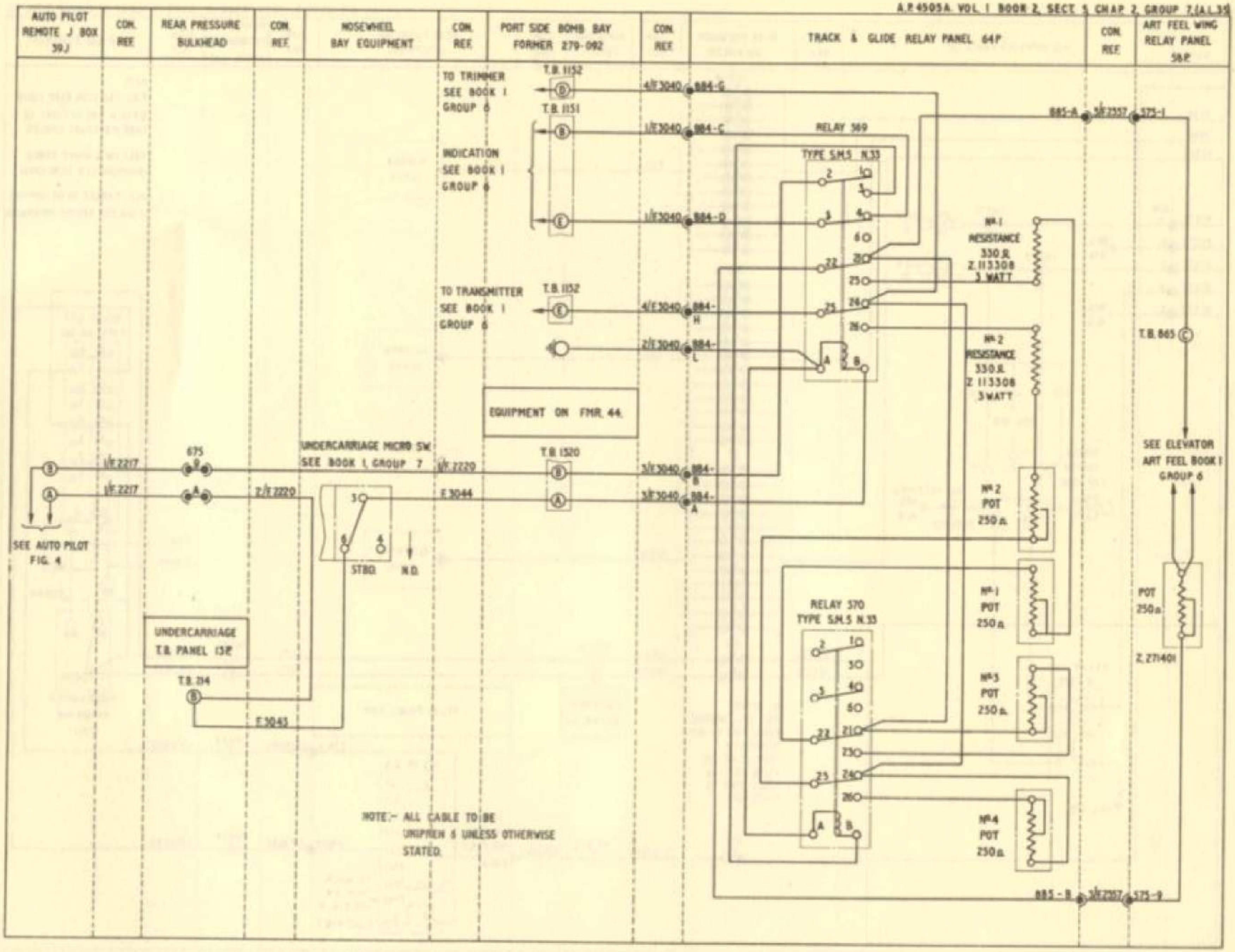

FIG. 6 FEEL RELIEF WITH TRACK AND GLIDE

(A.L. 35 OCT. 58)

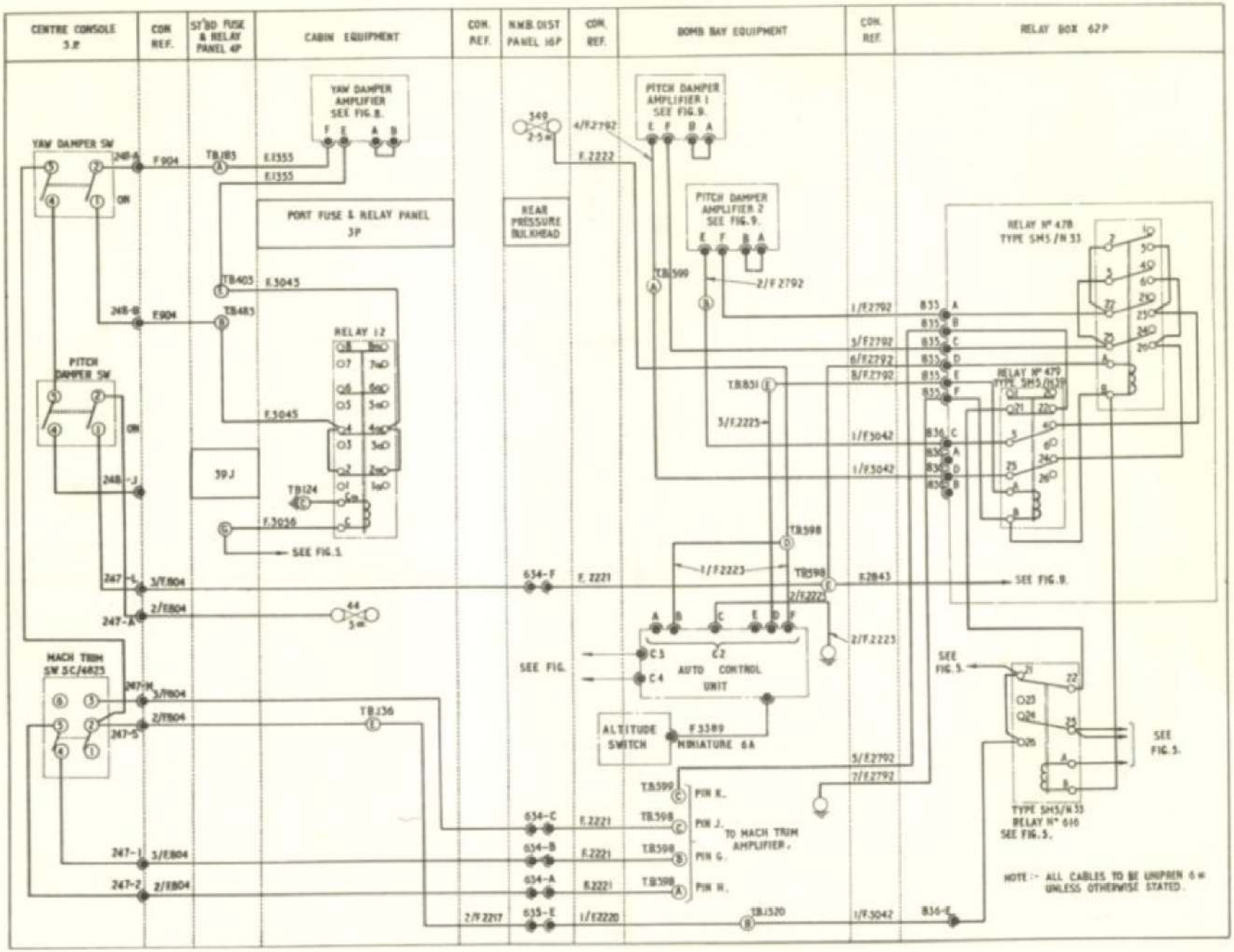

Fig.7 Autostabilizer Switching

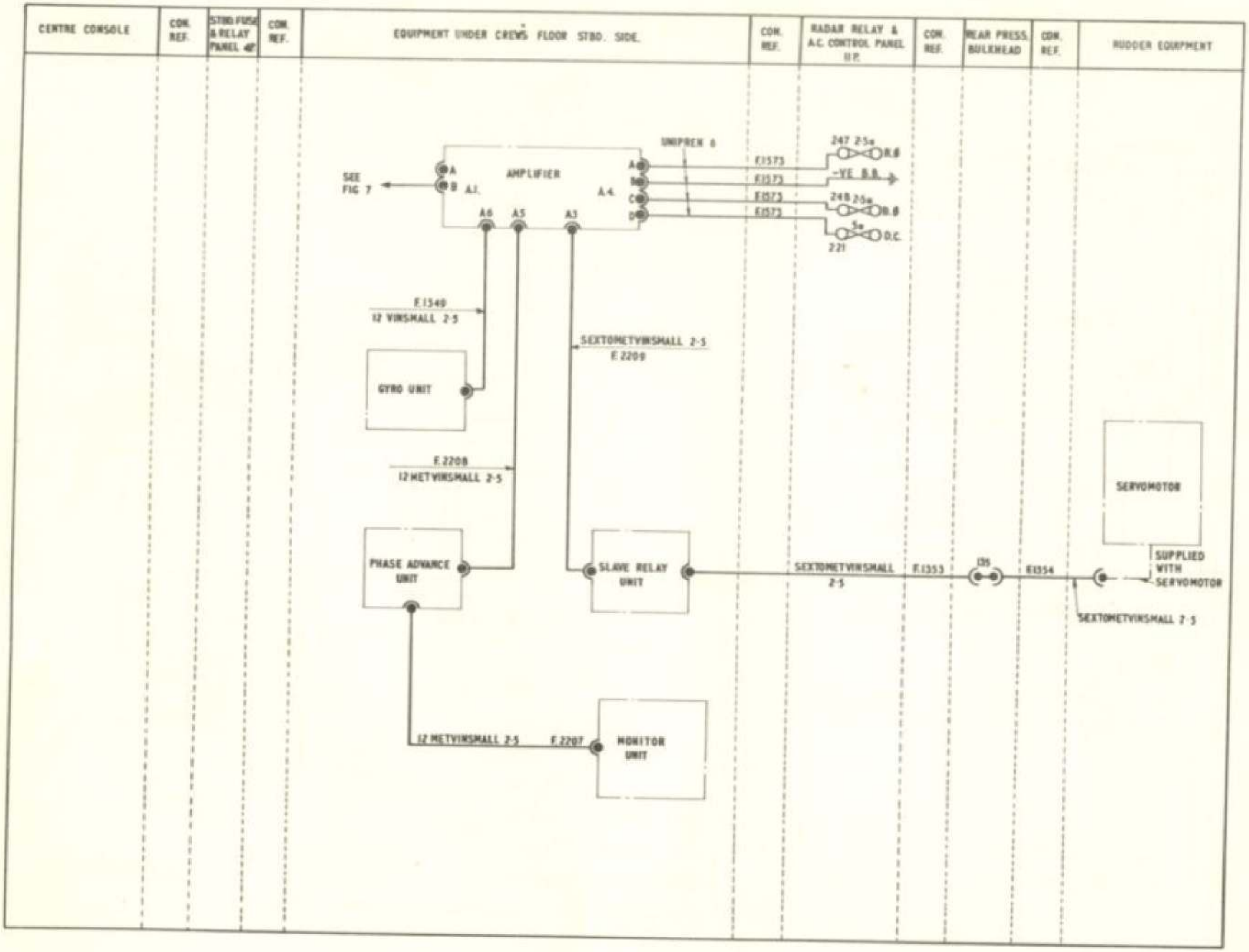

Fig.8 Yaw Damper

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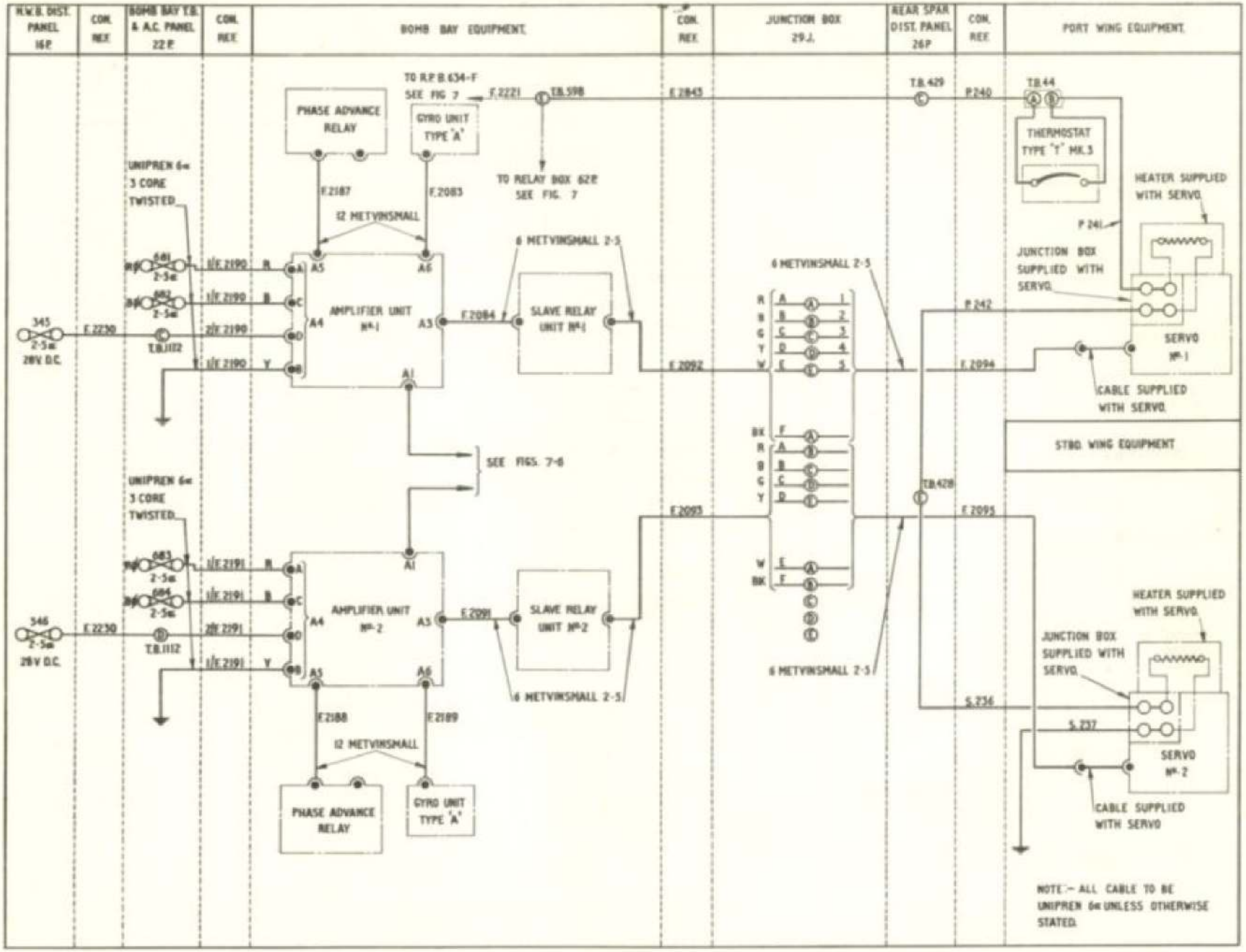

Fig.9 Pitch Stabilizer

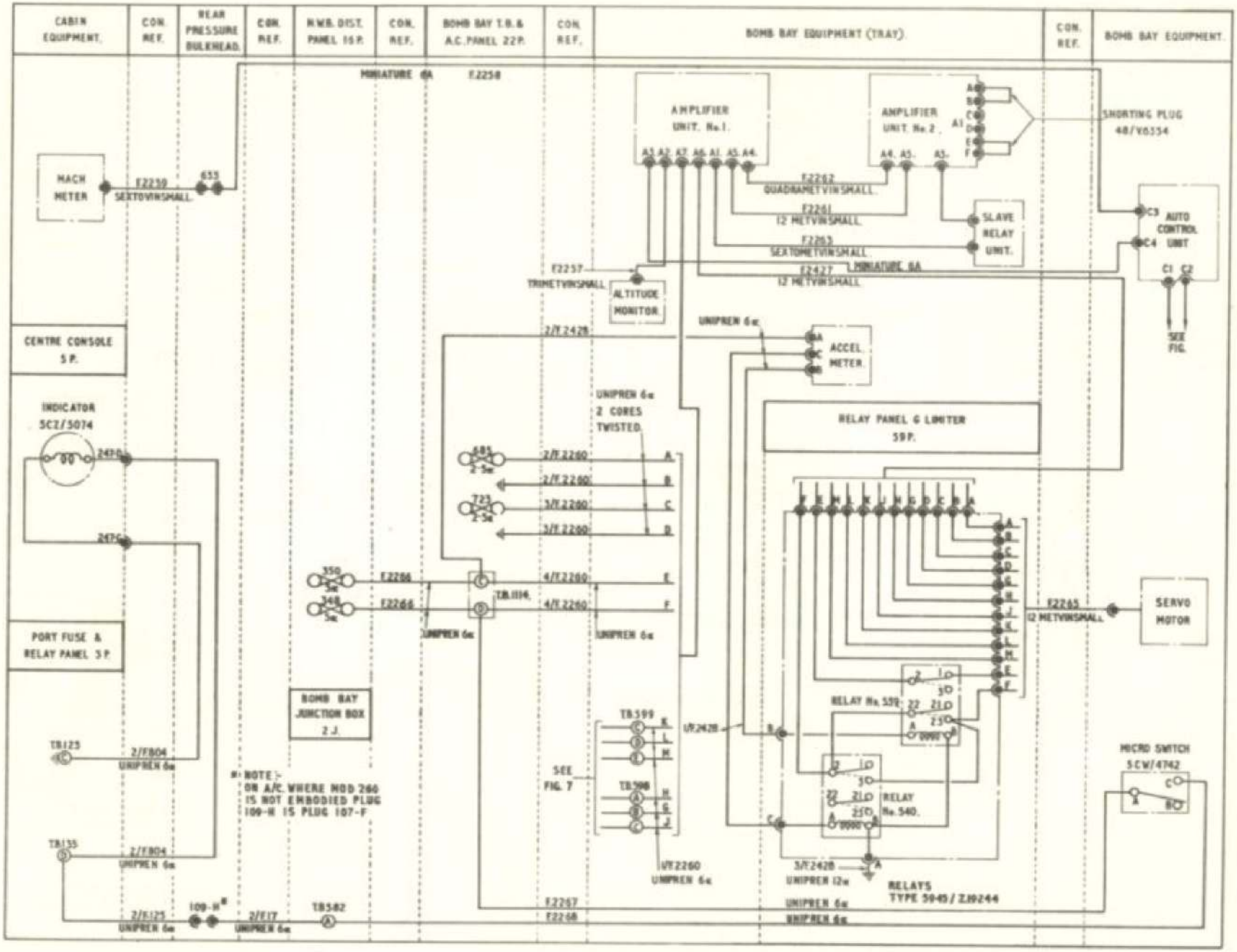

Fig. 10 Auto Mach Trim

RESTRICTED

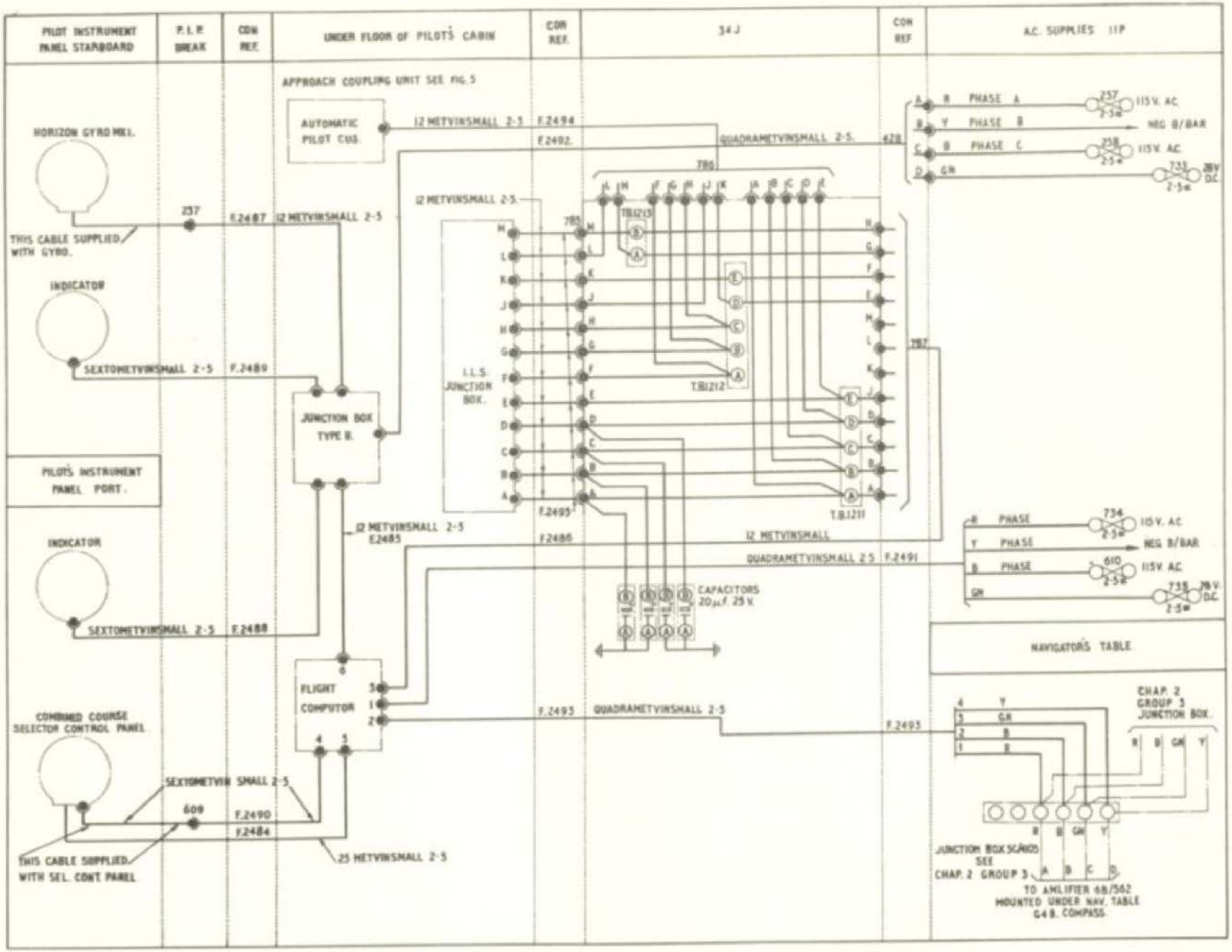

Fig.11 Zero Reader