Chapter 16

(This chapter supersedes that issued with A.L. Nos. 158, 163 and 179)

COMPASSES, GYRO-MAGNETIC, Mk. 4B

LIST OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF APPENDICES

Introduction

1. The construction and the method of operation of the Mk. 4B gyro-magnetic compass are described in this chapter. Test procedure and routine servicing instructions are also included.

2. The compass is an aircraft flight instrument which combines the functions of the directional gyro and the magnetic compass and, in so doing, combines the particular advantages of each. The indications shown by the compass are stabilized by means of a gyro, and synchronized with the earth's magnetic field by a remote detector unit and a monitoring system, so that a steady and accurate directional reference is always obtained. As a result of gyro stabilization, northerly turning error and other errors common to magnetic compasses are greatly reduced, and the effect of the monitoring system is to eliminate the slow inherent drift of the gyro.

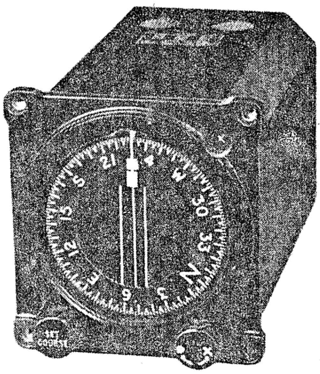
3. Separate indicators are provided for the pilot and for the navigator, but if required, an additional indicator may be fitted for the use of the second pilot. The compass also includes a power repeater system for operating compass repeaters and for controlling in azimuth such equipments as automatic pilots, the ground position indicator, radio compass and radar equipment. A synchronous transmission system is also available and a separate signal system is incorporated for monitoring the automatic pilot, Mk. 9.

4. By means of a control on the navigator's indicator, magnetic variation can be set into the compass so that all indicators and monitored equipment are automatically corrected to the true heading of the aircraft.

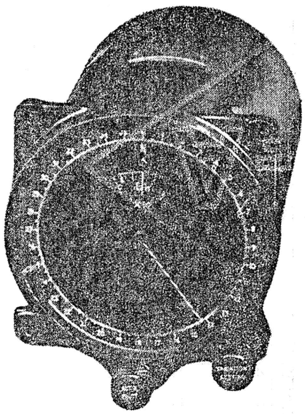
GENERAL DESCRIPTION

General

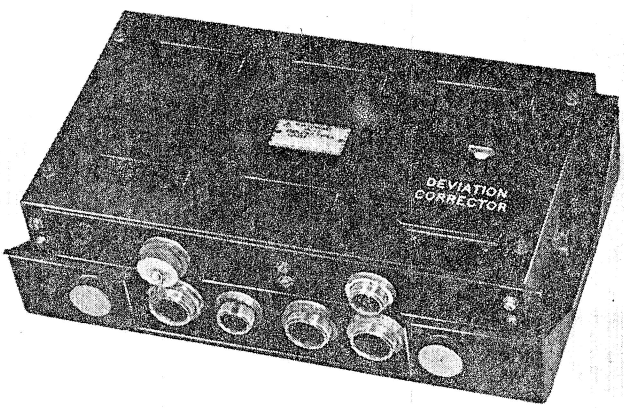
5. The Mk. 4B compass consists of the five separate units shown in fig. 1. An additional gyro unit for the second pilot can be installed if required. Each of the five units comprising the compass is separately described in this chapter and to facilitate a clear understanding of the relative functions of each unit and of the system as a whole, a simplified schematic diagram of the compass is given in fig. 2.



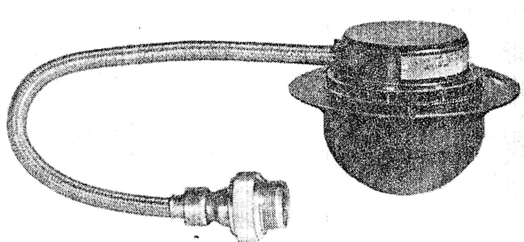
GYRO UNIT



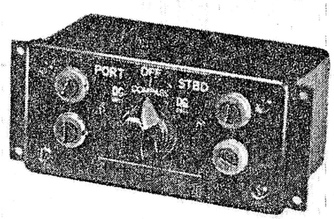
MASTER INDICATOR



AMPLIFIER AND MOUNTING TRAY



DETECTOR UNIT



CONTROL PANEL

Fig. 1. Compass, gyro-magnetic, Mk. 4B

Detector unit

6. The detector unit (Stores Ref. 6B/1993) a sectional view of which is given in fig. 3, senses the direction of the earth's magnetic field and provides signals for monitoring the the compass. It comprises a pendulous sensitive element and an electro-magnetic deviation compensator.

7. The sensitive element of the detector unit, known as the flux valve, is free to swing up to 25 deg. in pitch and roll, but is fixed to the aircraft in azimuth. In construction the flux valve resembles a wheel with three spokes spaced 120 deg. apart. The rim is divided between the spokes so that each section of the rim forms a flux collector horn for its respective spoke. By referring to the schematic diagram, fig. 4, which shows the general arrangement, it will be seen that a pick-off coil is wound around each spoke and an exciter coil is wound around the hub which forms a central core. The axis of the exciter coil is at right angles to the axes of the pick-off coils.

8. Referring to fig. 3, the detector unit and compensator assembly is provided with a mounting flange which is marked FORE and AFT. When the unit is installed, it must be aligned with the fore and aft axis of the aircraft, so that the axes of the pick-off coils are horizontal and that of the exciter coil is vertical.

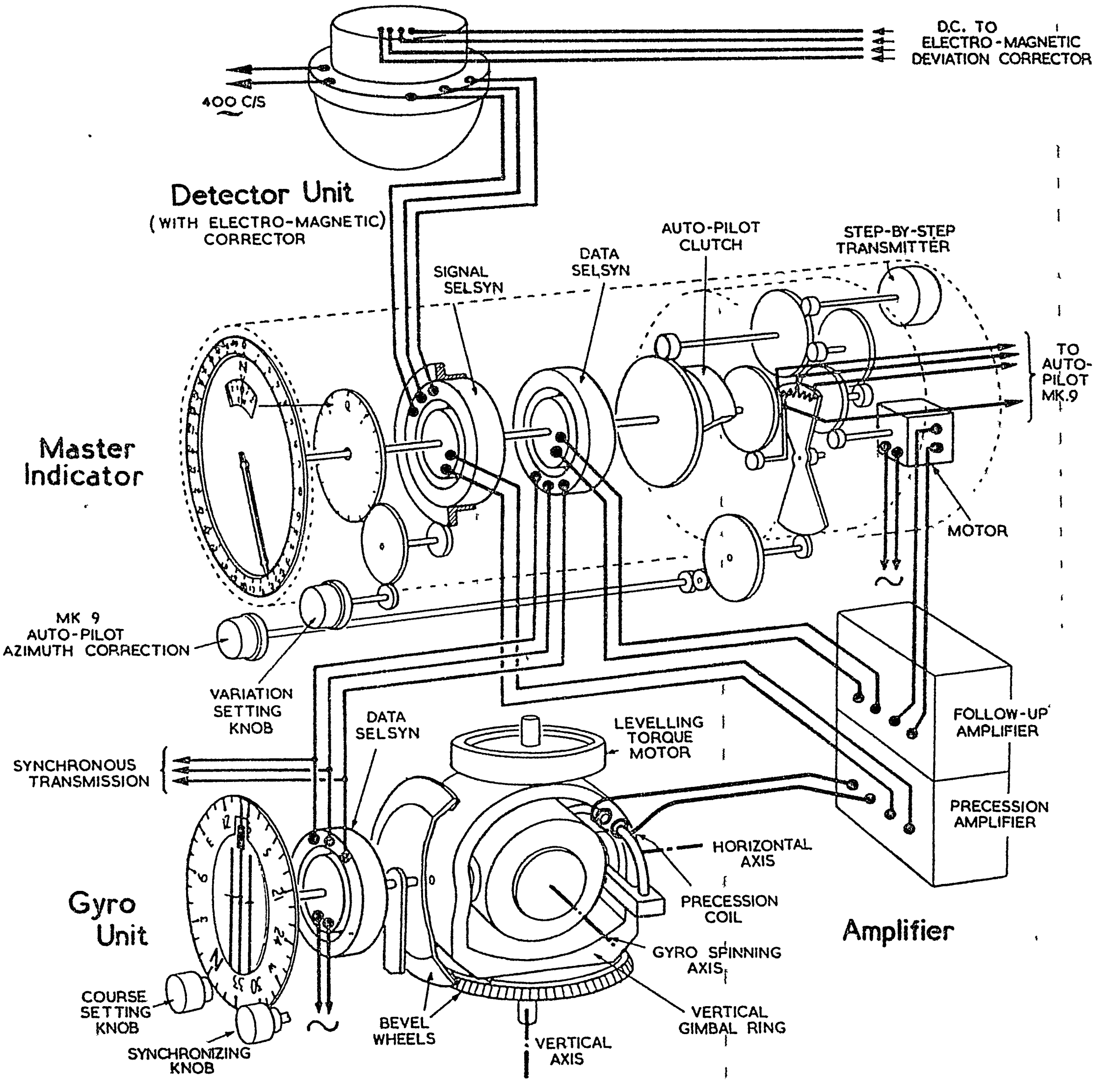


Fig. 2. Schematic diagram of gyro magnetic compass, Mk. 4B

9. The exciter coil is supplied with 400 c/s, single-phase a.c. to produce a flux sufficient to saturate each spoke. The horizontal component of the earth's magnetic field, however, also affects the magnetization of the spokes and as a result of the interaction between the two fields, alternating signals are induced in each of the pick-off coils, the amplitude of the signals being proportional to the component of the earth's field in line with each particular spoke. Fig. 5 shows schematically, the relation between the heading of the aircraft and the flux in the spokes caused by the earth's field.

Note . . .

A detailed explanation of the operation of the flux valve and a description of the selsyn transmission system (used extensively in the Mk. 4B compass) are given in Section 3, Chapter 14 of this publication.

Deviation compensator

10. The deviation compensator, shown in fig. 3, is mounted in a housing secured to the top of the detector unit from which it must not be removed. It consists of four mumetal cores around each of which is wound a coil supported on a bakelite former. Two of the

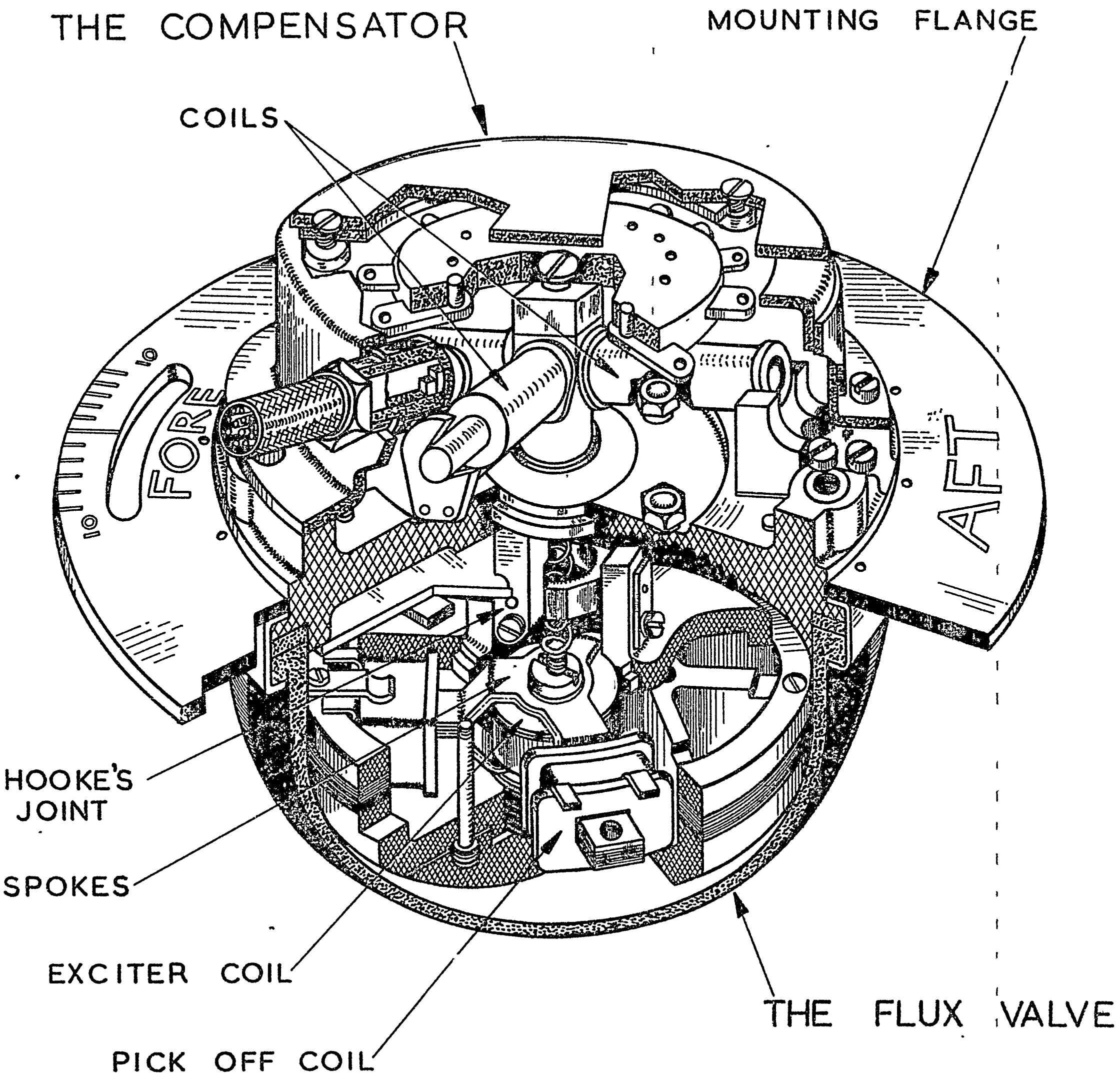


Fig. 3. Detector unit, sectional view

(A.L. 225, Feb. 54)

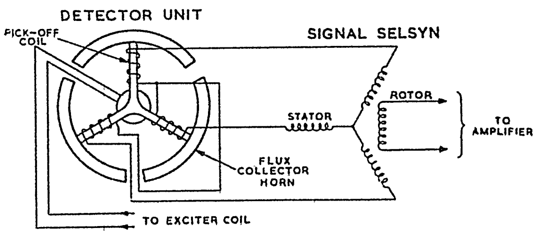


Fig. 4. Flux valve and selsyn system

cores are mounted in, or parallel to, the fore and aft axis of the aircraft, and two athwartships. The coils are supplied from a stabilized d.c. source and the current through them is adjusted by two calibrated potentiometers so that the resultant magnetic field neutralizes the local magnetic interference.

Master indicator

11. The master indicator, Type A (Stores R. f. 6B/1996) is shown in fig. 6 and 7. The main shaft, which carries the pointer and the rotors of the signal and data selsyns, is driven through gears by a small two-phase motor. One phase of this motor is continuously energized, the control phase being supplied with power from the follow-up amplifier.

12. The master indicator is maintained in synchronism with the gyro unit by a signal transmission system, and to enable the navigator to verify that the gyro unit is correctly synchronized, an indicating device in the form of a small flag marked with a dot and a cross is provided. The flag is visible through a small aperture immediately below the N calibration mark on the indicator dial and is operated by a small electro-magnetic relay connected in series with the annunciator coil in the gyro unit.

13. The lubber line, which registers against the variation scale, is not fixed to the indicator case but can be moved, within limits, to the left or to the right by means of a compass adjusting key. The key fits over the end of the shaft accessible through a hole on the left of the indicator case (*Chapter* 14, *fig*. 6). This adjustment is used to make final small corrections for coefficient A.

14. A course setting device, consisting of a rotatable ring and a perspex cursor is included to enable the navigator to note any divergence from the selected course. The ring should be turned until the cursor indicates the selected course and if the master indicator point is not then in alignment with the cursor it is apparent to the navigator that the aircraft is being flown "off course".

15. Provision is also made for setting in magnetic variation by means of the VARIATION SETTING control located at the bottom right-hand corner of the bezel. By means of this control the master indicator, gyro unit and any monitored equipment which may be in use can be made to indicate the heading of the aircraft relative to true North instead of Magnetic North. A locking ring may be fitted to the master indicator variation setting knob, to prevent inadvertent operation, in aircraft where the variation setting control is not required.

16. An AUTO-PILOT control, located directly beneath the bezel, is provided specifically for use with the automatic pilot, Mk. 9, and permits the navigator to make fine adjustments to the course within limits of $\pm$ 4 deg. in $\frac{1}{2}$ deg. steps.

Gyro unit, Type A

17. The gyro unit, Type A (Stores Ref. 6B/1992) a sectional view of which is given in fig. 8, is essentially an electrically driven directional gyro and can be used as such if required. It incorporates a gyroscopic movement, a data selsyn assembly compass card, annunciator, course setting, and synchronizing controls.

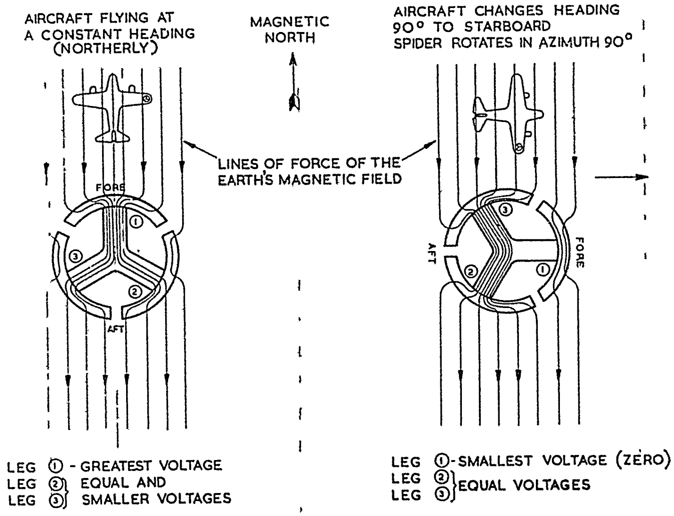


Fig. 5. Operation of flux valve, schematic diagram

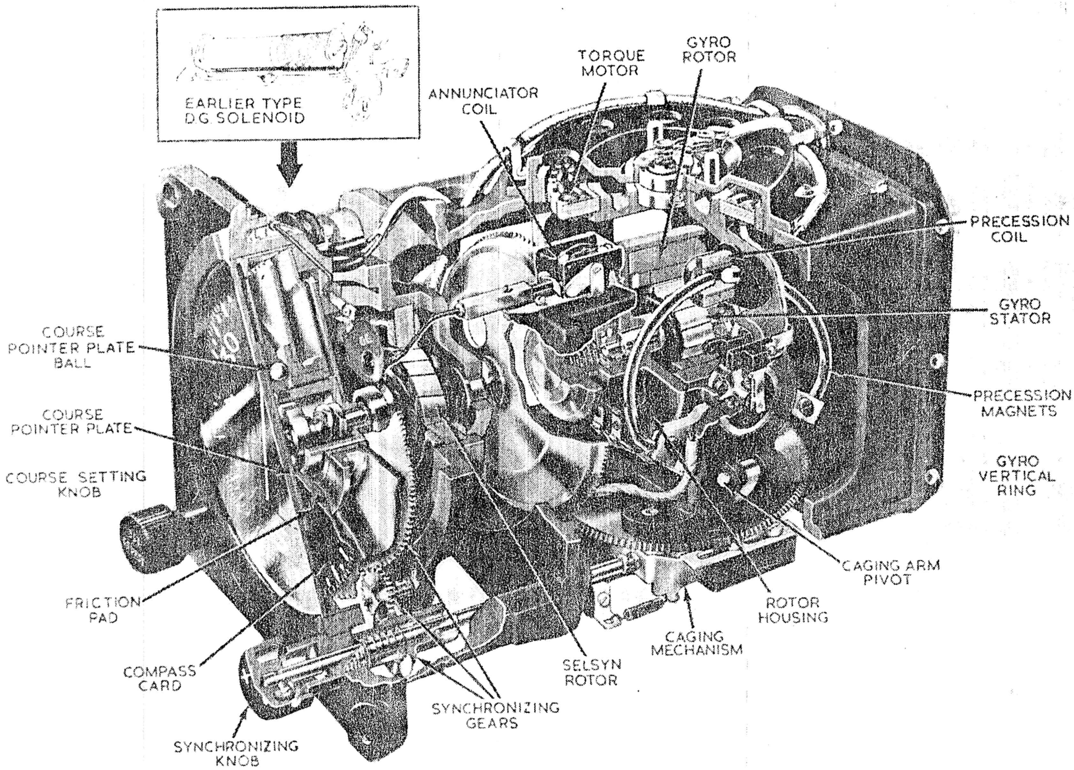


Fig. 8. Gyro unit, sectional view

18. The gyro movement comprises an electrically-driven rotor which spins about a horizontal axis. The rotor is carried in a housing which is pivoted in a vertical gimbal ring about a horizontal axis at right angles to the rotor axis. The vertical gimbal ring is free to move about its vertical axis.

19. The compass card in the gyro unit is mounted at one end of the data selsyn rotor shaft. The other end of a shaft carries a bevel gear in mesh with a second bevel gear which is secured to the base of the vertical gimbal ring. Thus, any movement of the gyro assembly in azimuth will cause the rotor of the data selsyn and the compass card to rotate.

Gyro drift

20. Gyroscopic inertia maintains the spin axis of the gyro rotor in a fixed position irrespective of the movements of the aircraft, but all gyros have an inherent tendency to drift due to such causes as the rotation of the earth and low-level friction.

21. Any drift in azimuth, however, causes the rotor of the data transmitter selsyn in the gyro unit to move in relation to its stator and a signal is transmitted via the data selsyn in the master indicator, to the follow-up amplifier. The follow-up motor is thus energized and the rotor of the signal selsyn moves out of alignment with the stator field.

22. A signal is passed from the signal selsyn to the precession amplifier thus energizing the precession coil which exerts a torque about the horizontal axis causing the gyro to precess about the vertical axis back to its original position. As a result, the shaft carrying the compass card rotates until the rotor and the stator of the signal selsyn in the master indicator are re-aligned, the precession signal is cancelled, and the compass card indicates the magnetic heading of the aircraft.

Corrective torque

23. The arrangement of the Mk. 4B compass provides for a corrective torque to be applied

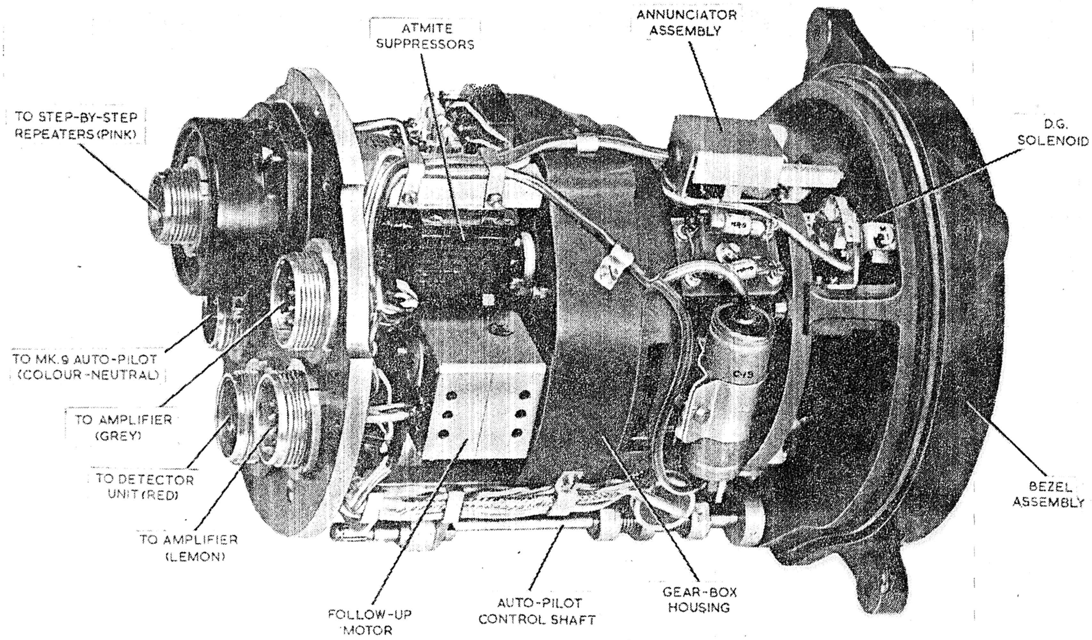


Fig. 6. Master indicator, Type A, G.-M. compass, Mk. 4B, view showing back plate and connections

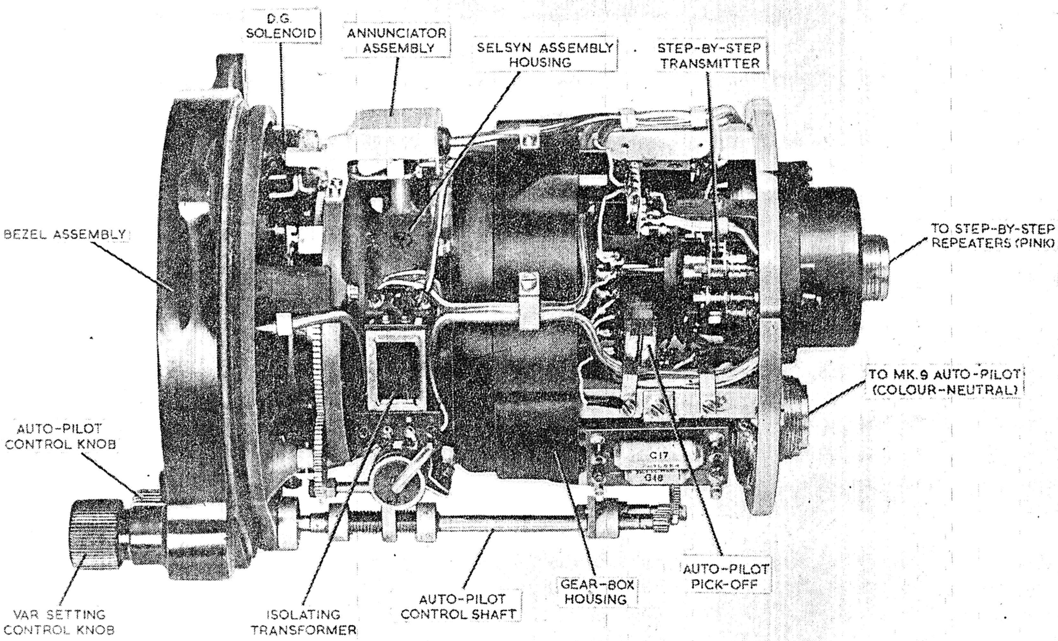


Fig. 7. Master indicator, Type A, G.-M. compass, Mk. 4B, view showing variation setting mechanism

(A.L. 225, Feb. 54)

immediately the gyro commences to drift, and the sensitivity is such that the compass card is continuously synchronized with the direction of the earth's magnetic field.

Behaviour in turns

24. When the aircraft turns, the compass card, data selsyn rotor and the vertically mounted bevel gear on the rotor shaft move around the gyro-stabilized vertical gimbal ring, causing the shaft to rotate about its own axis and altering the position of the data selsyn rotor relative to its stator. The resulting misalignment signal from the data selsyn in the master indicator starts the follow-up motor, and the course pointer thus follows the movement of the compass card.

25. The signal selsyn rotor in the master indicator is mounted on the same shaft as the course pointer and will have rotated with it, but since the signals from the detector unit, which has turned with the aircraft, have progressively altered to correspond with the new heading, the electrical alignment between the rotor and stator of the signal selsyn is maintained. During turns, therefore, the compass card and the course pointer remain in synchronism and continuously indicate the aircraft heading.

Annunciator

26. The annunciator facilitates the initial synchronization of the gyro unit and provides a constant visual indication enabling the pilot to verify whether or not synchronism is maintained. It consists of a small flag mounted on a pivoted staff operated by an electro-magnetic relay, and marked with a dot and a cross visible through the annunciator window at the front top right-hand corner of the gyro unit. The annunciator relay in the master indicator is connected in series with the relay in the gyro unit.

Use as a directional gyro

27. For certain flight operations it may be desirable to use the compass as a directional gyro. Provision is therefore made for removing the monitoring of the detector unit by means of the selector switch located on the control panel which should be turned to COMPASS OFF.

Note . . .

When the gyro unit is functioning as a directional gyro, an indicating flag marked D.G. *is moved in front of the annunciator flag and, on master indicators with serial numbers from 464 upwards, a similar indication is shown.*

Amplifier unit

28. The amplifier unit (Stores Ref. 6B/1994) shown in fig. 9, comprises two separate amplifiers, the precession amplifier and the follow-up amplifier, fitted in one rectangular case, see also fig. 28. Two fuses are provided to protect the amplifiers. The unit also incorporates the two calibrated potentiometers and a d.c. voltage stabilizing circuit (referred to in para. 10), for the deviation compensator in the detector unit. A jack socket is provided so that an external centre-zero voltmeter can be plugged in when testing the compass.

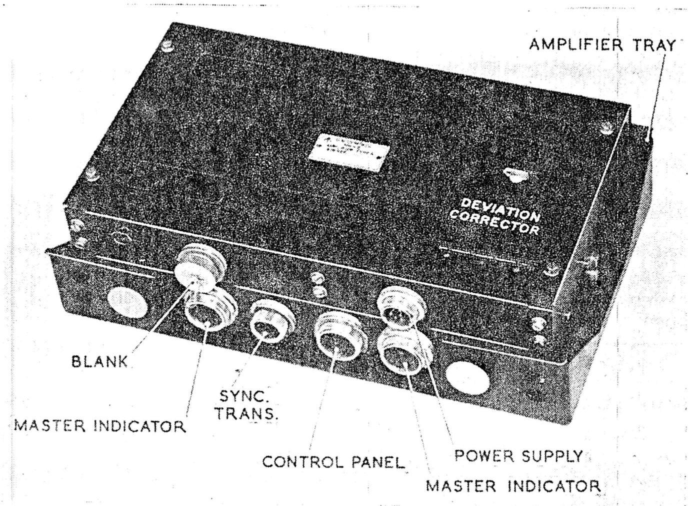


Fig. 9. Amplifier, Type A and mounting tray

29. The precession amplifier comprises a two-stage valve amplifier and a phase-discrimination rectifier circuit. The follow-up amplifier consists of a two-stage a.c. valve amplifier with a transductor output circuit. A detailed circuit description of each amplifier is given in para. 122 to 130 and 131 to 147, respectively.

Control panel

30. The control panel (Stores Ref. 6B/408) shown in fig. 10, is used to control the monitoring signals to the gyro unit.

It consists of a rectangular metal box which carries a selector switch, four fuses, one 12-pin plug and two 12-pin sockets. On the particular unit illustrated in fig. 1, three switch positions can be seen, PORT COMPASS, STBD., COMPASS and COMPASS OFF. The selector switch indicating plate, however, can be reversed so that on installations where only one gyro unit is installed two switch positions only, GYRO COMPASS and COMPASS OFF are available, (*fig.* 10). The control panel can be used for rail or bulkhead mounting by altering the position of the receptacles.

31. On single gyro unit installations the master indicator is always synchronized with the gyro unit, whether it is functioning as a compass or as a directional gyro. On installations where two gyro units are installed, the master indicator is synchronized with whichever gyro unit is functioning as a compass, or with the port gyro unit if both units are functioning as directional gyros.

Note . . .

The control panel is usually installed in a position where it is accessible to the pilot, but on single gyro installations provision is made for installing the panel wherever convenient and effecting the control of the monitoring signals by a separate two-way switch.

Power requirements and weights

32. The power supplies required for the Mk. 4B compass are as follows:—

(1) 115 volts, 400 cycles, 3-phase a.c.

(2) 28 volts d.c.

The a.c. power consumption, when one gyro unit only is used, is approximately 75 watts. An additional gyro unit for the second pilot necessitates an increase of 20 watts.

The d.c. power consumption is less than 3·5 watts, but if repeaters are fitted this consumption is increased by 10 watts for each additional repeater.

BASIC OPERATION PRINCIPLES

General

34. The basis of the Mk. 4B compass is the gyroscope. The gyro rotor is mounted in the gyro unit so that it possesses freedom about three axes; a horizontal spin axis, a second horizontal axis at right angles to the spin axis, and a vertical axis. The rotor spins at approximately 23,000 r.p.m.

35. All practical applications of the gyroscope are based upon two fundamental characteristics, gyroscopic inertia and precession. Gyroscopic inertia tends to maintain the spin axis of the gyro in a fixed attitude irrespective of the movements of the aircraft. Precession is the angular change in direction of the axis of rotation. In the Mk. 4B compass the property of inertia is used to stabilize the indications of the compass and the tendency to drift is overcome by a monitoring system which utilizes the signals from a remote detector unit to synchronize the card with the earth's magnetic field. Fig. 5 shows in schematic form, the relationship between the magnetic heading of the aircraft and the signals from the detector unit.

Monitoring and follow-up systems

36. Referring to the schematic diagram of the Mk. 4B compass, fig. 2, and the functional

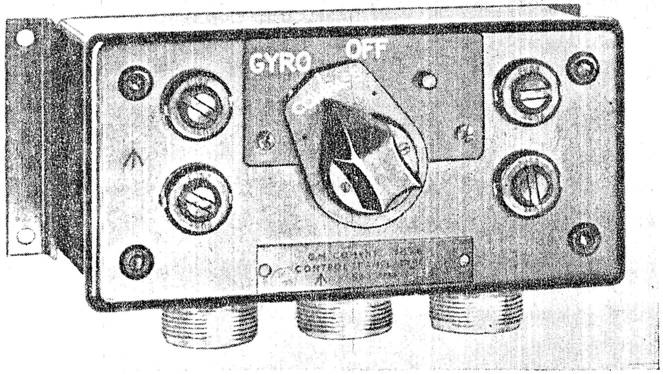


Fig. 10. Control panel, bulkhead mounting

33. The Stores Reference numbers and the approximate weights, excluding cabling, of each unit comprising the Mk. 4B compass are as follows—

	Stores Ref. No.	*Description*	*Weight*	
◄	6B/1993	Detector unit, Type A	1 lb. 10 ozs.	►
	6B/1992	Gyro unit	6 lb. 0 ozs.	
◄	6B/1996	Master indicator, Type A	6 lb. 9 ozs.	►
◄	6B/1994	Amplifier unit, Type A	10 lb. 11 ozs.	►
	6B/437	Amplifier mounting tray	— 11 ozs.	
	6B/408	Control panel	1 lb. 5 ozs.	

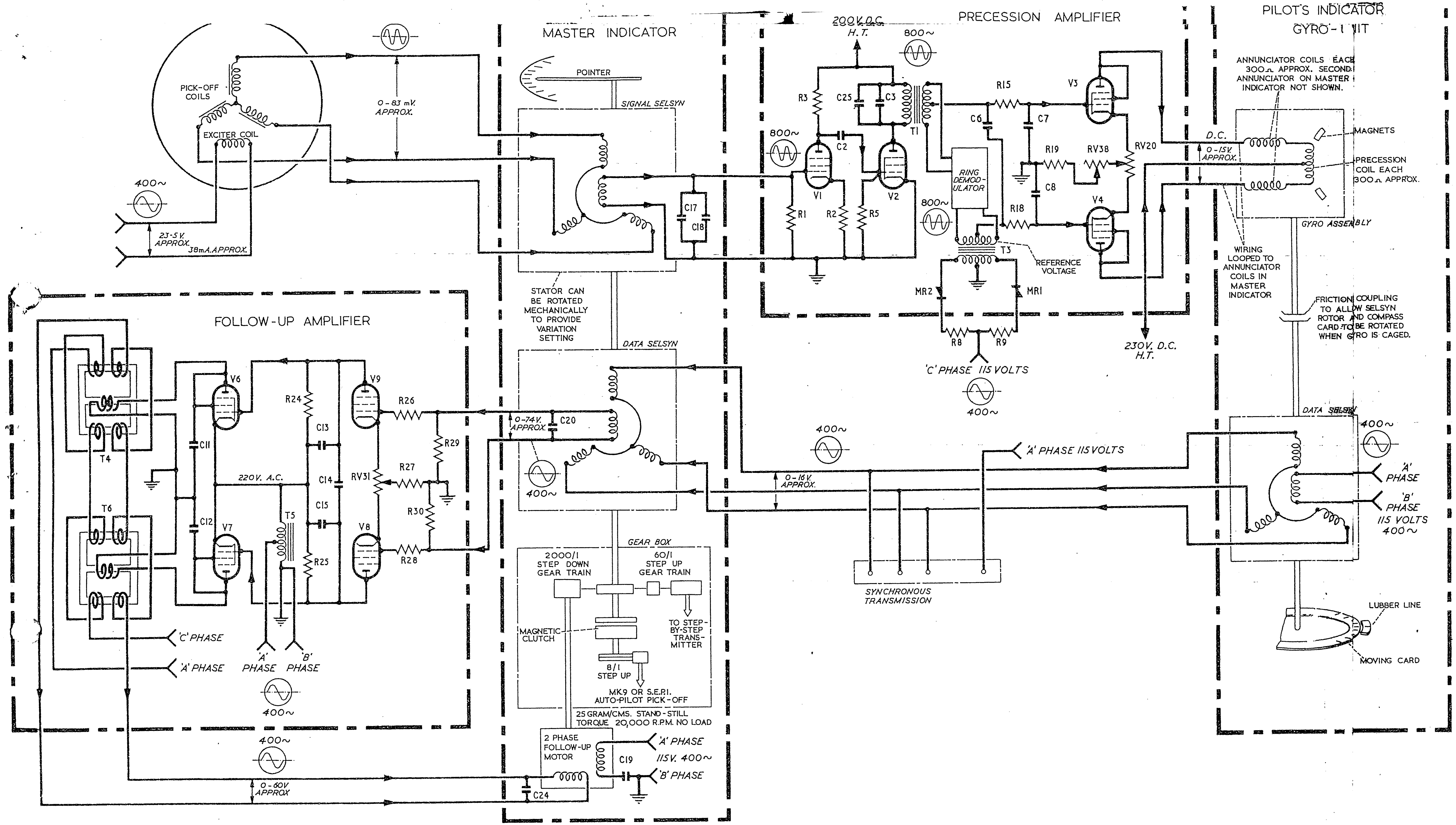


Fig.11 Functional diagram, G-M Compass Mk.4B, Type A equipment Fig.11

RESTRICTED

PP7401 72851/5955 3/54 675

diagram, fig. 11, it will be seen that two amplifiers are incorporated. These amplifiers are quite independent of each other and differ widely in their electrical characteristics but, for convenience, are mounted in the same chassis.

37. The signal selsyn in the master indicator, the precession amplifier and the precession circuit in the gyro unit constitute the monitoring system by means of which the card is synchronized with the earth's magnetic field. The data selsyn in the master indicator, the follow-up amplifier and the data selsyn in the gyro unit, comprise the follow-up system which maintains synchronism between the master indicator and the gyro unit.

Operation

38. The detector unit originates alternating electrical signals which vary in amplitude and sign according to the magnetic heading of the aircraft. These signals are fed to the stator of the signal selsyn in the master indicator, thus establishing a magnetic field in the stator. It will be seen from the illustration that the rotor of the signal selsyn is mounted on the same shaft as the course pointer and rotates with it. During manufacture, however, the pointer indication is correlated with the angular position of the rotor relative to its stator so that, provided the rotor is aligned with the vector of its stator field, a correct indication of the heading of the aircraft is always given.

39. If, during flight, the pointer does not indicate the heading of the aircraft, the rotor is out of alignment with the vector of the magnetic field set up in its stator by the signals from the detector unit, i.e., it will be off null. An error signal, proportional to the degree of misalignment, is therefore induced in the rotor.

40. This signal is fed to the precession amplifier where it is amplified, phase-detected, rectified and is then applied in d.c. form to the precession circuit of the gyro. The coil, thus energized, exerts a torque causing the gyro to precess in azimuth.

41. The precession of the gyro is transmitted through bevel gears to the shaft which carries the compass card and the rotor of the data selsyn assembly. The rotor is energized by single-phase a.c. and its stator is connected to the stator of a similar data selsyn in the master indicator. The movement of the rotor caused by the precession of the gyro, therefore, alters the magnetic fields induced in both stators and as a result, the rotor of the master indicator data selsyn passes a signal to the follow-up amplifier.

42. After power amplification by the follow-up amplifier, the signal is fed to the follow-up motor on the master indicator causing it to turn the selsyn rotor shaft and re-align the rotors of the signal and the data selsyns to the null position.

43. This misalignment signals throughout the monitoring and the follow-up systems cease when the rotors and stators are at null, and at this point the gyro unit and the master indicator are synchronized with each other and with the directional reference supplied by the detector unit. Both units therefore indicate the magnetic heading of the aircraft.

Note . . .
In the explanation given in para. 38 to 43 inclusive, it has been assumed that the magnetic variation control referred to in para. 15 is set to zero. If, however, the correct variation has been set in, the true heading of the aircraft will be shown by the gyro unit and the master indicator and transmitted to the compass repeaters and monitored equipment.

INSTRUCTIONS FOR USE

General

44. In the subsequent paragraphs the adjustments necessary to synchronize the gyro unit and to set and alter course when in flight have been allocated specifically to the pilot and the navigator. Fig. 12 and fig. 13 show the presentation of the gyro unit and the master indicator respectively.

Procedure before flight

Variation setting

45. NAVIGATOR. Set in local variation on the scale by pushing in and turning the VARIATION SETTING control knob until the correct variation is read against the lubber line.

Note . . .
It is most important that the navigator should verify that both the lamps in the compensator

(A.L. 225, Feb. 54)

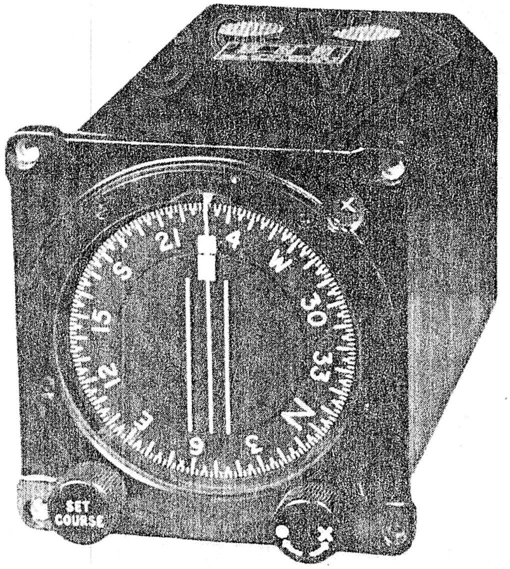


Fig. 12. Presentation of gyro unit

circuit are alight, since the failure of either lamp will cause the value of the current flowing through the compensator coil to alter, thus introducing compass errors. The lamps are visible through small holes on the front of the amplifier case.

Synchronizing the gyro unit

46. (1) PILOT. Note the indication shown in the annunciator window of the gyro unit. If D.G. shows, turn the selector switch on the control panel to COMPASS.

Note . . .

This instruction is applicable only to installations with one gyro unit. In some installations, however, the control panel is mounted remotely and control is effected by a separate selector switch. Where two gyro units are fitted, the selector switch should be turned to PORT *or* STARBOARD *according to which unit is to be synchronized.*

(2) Press in the synchronizing knob and turn it in the direction marked on the knob as indicated by dot (·) or cross(+), shown in the annunciator window (i.e., dot: clockwise, cross: counter-clockwise), until the indication changes to the opposite sign; then turn the knob slowly back until the annunciator window is cleared, or a dot and a cross appear alternately.

(3) NAVIGATOR. Navigators should check that the annunciator flag in the master indicator shows the same sign as that shown on the gyro unit.

Setting course

47. (1) PILOT. Press in and turn the SET COURSE knob until the course pointer is aligned with the desired heading.

(2) NAVIGATOR. Set the index line on the cursor to the desired heading.

Procedure during flight

Altering course

48. (1) PILOT. Press in and turn SET COURSE knob until the course pointer is aligned with the designed heading.

(2) NAVIGATOR. Set the index line on the master indicator cursor to the same heading as the course pointer on the gyro unit.

(3) PILOT. Fly the aircraft so that the course pointer is aligned with the lubber line and maintain course by keeping the course-pointer rectangle aligned with the aircraft heading rectangle.

Setting variation

49. (1) NAVIGATOR. Reset the VARIATION SETTING as required to compensate for changes which occur during flight.

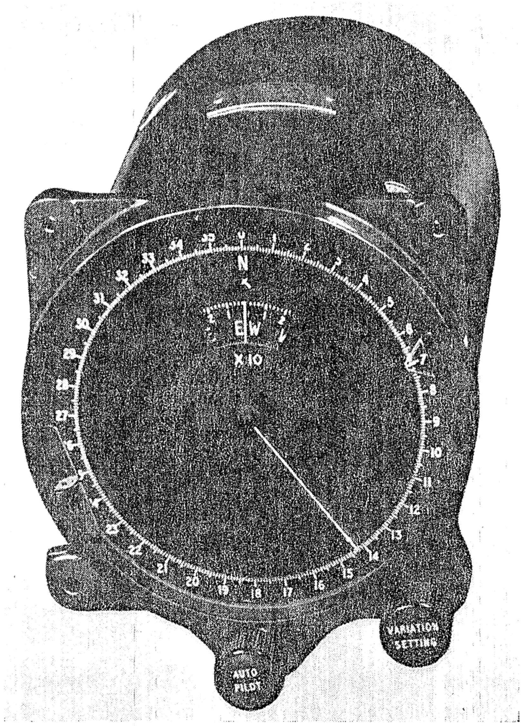


Fig. 13. Presentation of master indicator, Type A

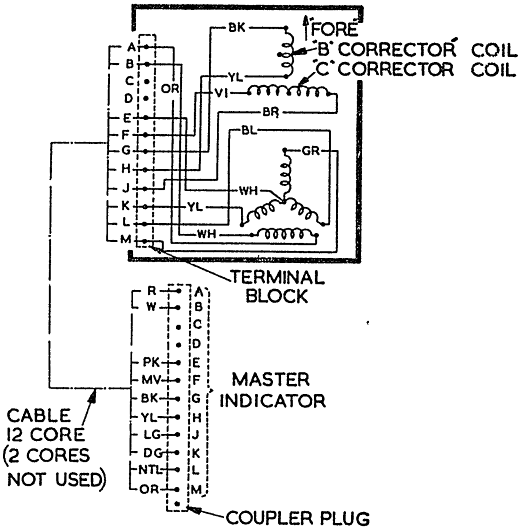


Fig. 14. Circuit diagram, detector unit

50. The information given in the following sub-para. should be memorised by pilots and navigators.

(1) The gyro unit, the master indicator and any other apparatus which is coupled to the Mk. 4B compass will be monitored to the true heading of the aircraft when the correct variation is set in.

(2) If, for any reason, a large change in variation must be set in, such as would occur when changing to a grid navigation system during flight, the monitoring system will re-synchronize the gyro unit automatically at an approximate rate of 2 deg. per min. This time lag can, however, be reduced by re-synchronizing the gyro unit manually (*para.* 46). The master indicator is at all times in synchronism with the gyro unit.

(3) The operating limits which, if exceeded, necessitate re-synchronization of the gyro unit, are $\pm$ 84 deg. in pitch or roll. There is complete freedom in azimuth.

Re-synchronizing the gyro unit

51. (1) PILOT. Proceed as described in para. 46. It will not be necessary to re-synchronize the gyro unit unless the operating limits have been exceeded, the control panel selector switch has been operated, or a large change in variation has been set in by the navigator.

Automatic flight

52. NAVIGATOR. When the aircraft is under the control of the Mk. 9 automatic pilot which is being monitored by the Mk. 4B compass, the navigator can make corrections to the course being flown up to a maximum of 4 deg. to port or starboard in $\frac{1}{2}$ deg. steps.

Using the gyro unit as a directional gyro

53. When the selector switch on the control panel is turned to OFF, the monitoring signals from the detector unit cease to affect the gyro unit which then functions as a directional gyro. The indication D.G. is displayed in the annunciator windows on the gyro unit and on the master indicator, see note following para. 27.

54. On installations where there are two gyro units fitted, i.e., on the pilot's and the second pilot's instrument panels, one gyro unit is normally used as a compass and the other as a directional gyro. Either or both gyros can, however, be used as directional gyros by operating the selector switch on the control panel as follows:—

(1) Switch to STARBOARD: port gyro unit functions as a directional gyro only.

(2) Switch to PORT: starboard gyro unit functions as a directional gyro only.

(3) Switch to OFF: both gyro units function as directional gyros.

Note . . .

If either or both gyro units have been used as directional gyros, it is essential to re-synchronize the unit that is switched to COMPASS.

55. As previously stated, the master indicator is always synchronized with the gyro unit whether it is functioning as a compass or as a directional gyro. When two gyro units are installed, however, the master indicator is synchronized with whichever gyro unit is functioning as a compass; or with the port gyro unit if both units are functioning as directional gyros.

Flight characteristics

Annunciators

56. Under normal flight conditions in piston-engined aircraft, the dot and cross will be displayed alternately in the annunciator windows on the gyro unit and the master indicator. This is caused by the flux valve in the detector unit moving about its neutral position due to vibration and air turbulence and is quite consistent with satisfactory operation.

57. On jet-propelled aircraft, however, the dot and cross will alternate at a slower rate and may be only partially visible as the annunciator flag reaches the extremities due to the absence of vibration and the stable straight flight path of high speed aircraft.

58. Unless aerobatics have been carried out or the operating limits of the gyro specified in para. 50 have been exceeded, the gyro will not normally require re-synchronization during flight.

Gyro topple

59. The mechanical limits of the gyro in pitch and roll are ± 85 deg. If these limits are exceeded during flight the gyro must be re-synchronized as described in para. 46.

Turn error

60. A small indicated error may be introduced after a prolonged turn but will be monitored out after two or three minutes flight on a straight and level course. This would be indicated by the annunciator. If desired, the error may be removed immediately by means of the synchronizing knob. For certain manœuvres it may be desirable to switch to D.G., returning to COMPASS when on a straight and level course, and re-synchronizing.

Stopping

61. The Mk. 4B compass should not be switched off in flight or when taxying, but should be left running until the aircraft is stationery at its base. Switch off the main compass switch and not at the control panel. Switching to COMPASS OFF on the control panel switches off the monitoring signals only and leaves the gyro unit functioning as a directional gyro (*para.* 53).

Compass calibration

62. The Mk. 4B compass should be calibrated when it is installed in an aircraft and thereafter at frequent intervals. The procedure is given in Section 3, Chapter 14, Appendix 3 of this publication.

63. During compass calibration all equipment should be in the stowage position as in flight. Owing to the change in conditions causing deviation which may occur only in flight, it may be found desirable to carry out compass calibration when airborne, in place of or as a check on the ground calibration.

GENERAL OPERATION AND DETAILED DESCRIPTION

Detector unit

64. As previously stated in the note following para. 9 of this chapter, a detailed description and mathematical analysis of the theory of operation of the detector unit is given in Section 13, Chapter 14, of this manual which should be referred to if further information is required.

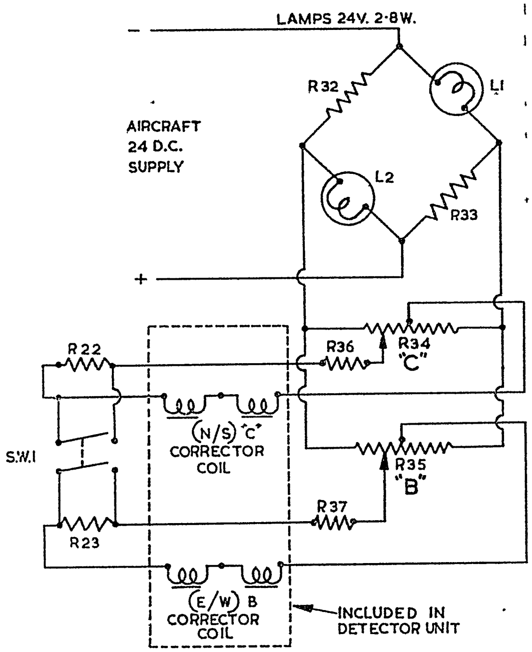


Fig. 15. Electrical compensator circuit

65. In the description given hereafter the physical construction of the unit is described and a general explanation of its operation is given. It should be noted that since the detector unit is hermetically sealed, should any fault develop, the complete unit must be renewed.

66. A sectional view of the detector unit and the deviation compensator is shown in fig. 3 and a circuit diagram is given in fig. 14. The mounting flange is engraved FORE and AFT and the unit, when installed, must be in alignment with the fore and aft axis of the aircraft. One of the three screw slots in the flange is engraved up to 10 deg. on each side of the zero index mark to serve as a reference when installing the unit in an aircraft or when correcting coefficient A (*para.* 8). The electrical connections to the detector unit and to the compensator coils are made via a 12-pin coupler plug attached to the detector unit by twelve inches of free lead.

Flux valve

67. The sensitive element of the detector unit, known as a flux valve, is pendulously mounted and is free to move up to a maximum of 25 deg. in pitch and roll but is fixed to the aircraft in azimuth. It is composed of a series of laminations of a special nickel alloy having a high magnetic permeability and low hysteresis; it takes the form of a wheel with three spokes spaced 120 deg. apart. The wheel is divided around its periphery into three parts, each of which forms a flux collector horn for the spoke attached to it.

68. Each spoke consists of two members, separated by insulating material, which extend outwards from the central hub to the rim. A pick-off coil is wound around both members of each spoke, and the central hub forms a core around which an exciter coil is wound. The detector unit is installed so that the axes of the pick-off coils are horizontal and axis of the exciter coil vertical.

69. The exciter coil is energized from a 400 c/s single-phase a.c. supply of approximately 23 volts, sufficient to produce a flux to saturate the spokes. The polarity at each end of the core is thus alternately North and South, and therefore at any instant the flux in the top members of each spoke is in the opposite direction to that in the lower members so that the net flux cutting the pick-off coils is zero.

70. The earth's magnetic field, however, also affects each of the spokes to an extent depending upon the degree of its alignment with the direction of the earth's field and, as a result of the periodic magnetic saturation caused by the excitation current, alternating signals at twice the excitation frequency i.e., 800 c/s are induced in the pick-off coils. The amplitude and phase of the signal in each pick-off coil is proportional to the component of the earth's magnetic field in line with the spoke which forms its core.

71. Referring to fig. 4, it will be seen that the pick-off coils are star-connected to the stator of the signal selsyn in the master indicator and, therefore, the magnetic field produced in the stator by the flux valve signals has a vector directly related to the direction of the earth's magnetic field. As mentioned in para. 67, the detector unit is fixed to the aircraft in azimuth and the signals originated by the flux valve will vary according to the magnetic heading of the aircraft as shown in schematic form in fig. 5.

72. As only the horizontal component of the earth's field is of value for obtaining a directional reference, it is desirable that the sensitive element of the detector unit should, as far as possible, maintain a horizontal position irrespective of the movement of the aircraft. Accordingly, the flux valve is suspended pendulously from a Hooke's joint which permits freedom of movement about the roll and pitch axes. In order to damp down oscillation, the assembly is enclosed in a plastic bowl partially filled with oil.

73. In turbulent air conditions, the element tends to oscillate slightly about its neutral position and issue fluctuating signals. The gyro unit integrates and stabilizes these signals, and as a result the compass card continuously provides accurate and dead beat indications irrespective of the oscillatory motion of the sensitive element.

Deviation compensator

74. The general arrangement of the compensator is shown in fig. 3. It comprises four mumetal cores around each of which is wound a coil supported on a bakelite former. Two of the cores are mounted in the fore and aft axis of the aircraft and two athwartships. The compensating coils are connected via two centre-tapped potentiometers in the corrector control box, to a source of approximately 8 volts obtained from a voltage stabilizing network connected across the aircraft d.c. supply as shown in fig. 15.

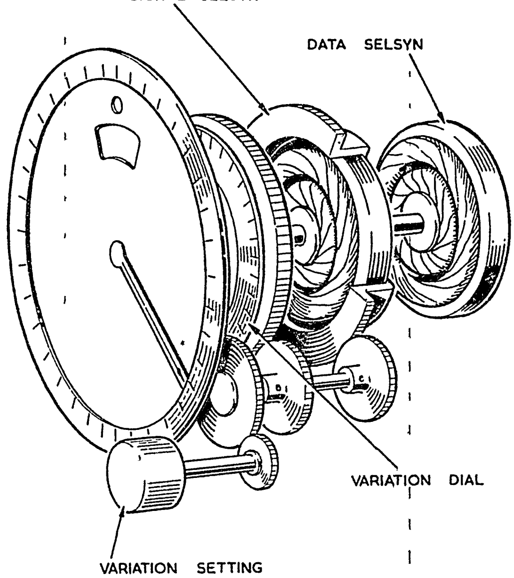


Fig. 16. Selsyn assembly

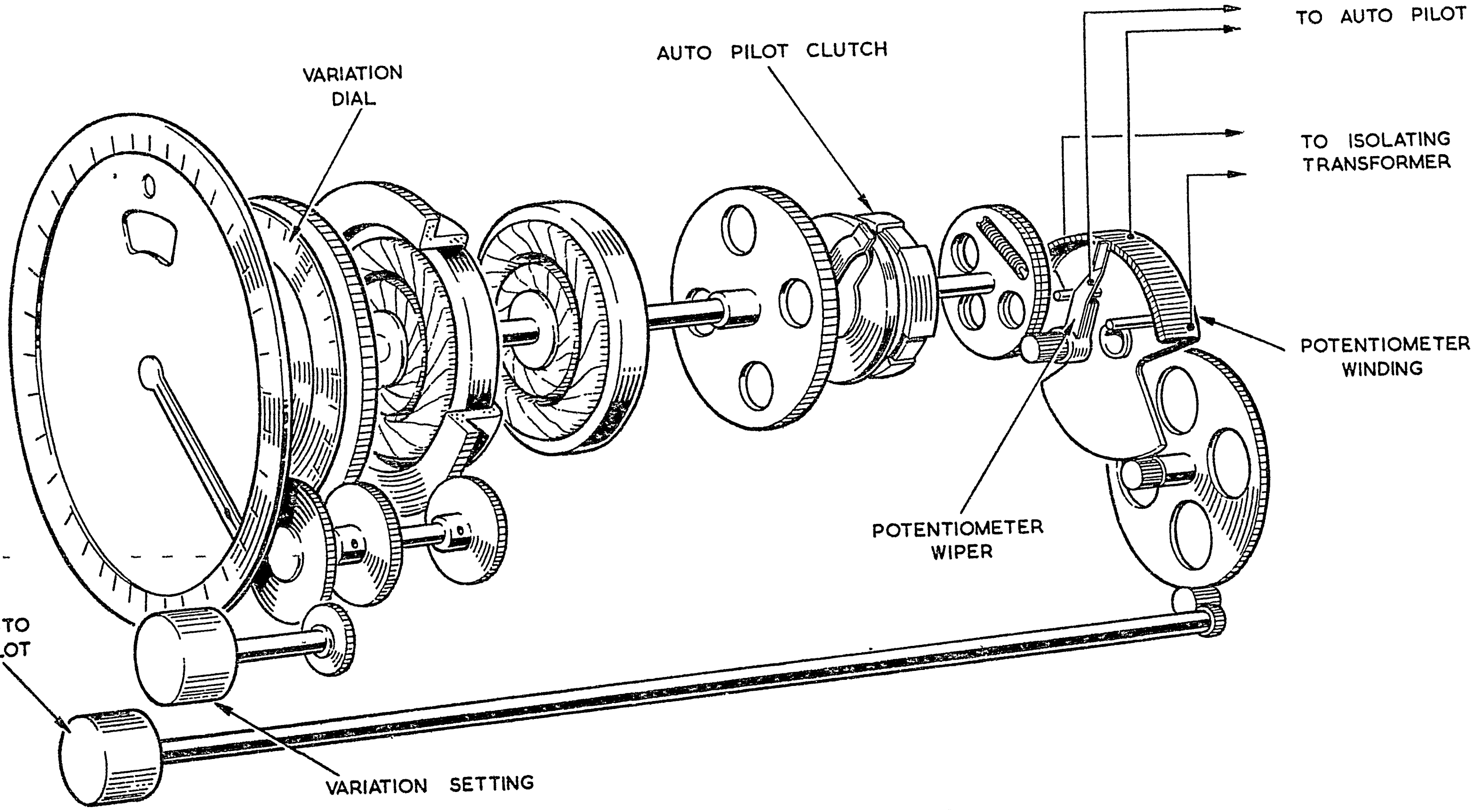


Fig. 17. Automatic pilot pick-off assembly

75. When no current is flowing in the coils the compensator is magnetically inert. By adjusting each potentiometer appropriately, however, the polarity and field strength of each pair of coils can be regulated so that the the resultant field produced by the coils neutralises the local magnetic interference. The potentiometers are mounted in the corrector control box and are provided with calibrated scales. By means of a toggle switch, either of two ranges can be selected. The scales are calibrated 15 deg. —0—15 deg., 3 deg. —0—3 deg. in terms of coefficients B and C. The electrical connections to the compensator are made via the 12-pin plug through which the connections to the detector unit are taken.

Master indicator, Type A

General construction

76. The master indicator which is shown in fig. 6 and 7, is intended for panel mounting and is provided with three integral lugs as fixing points. It consists of three principal assemblies; the bezel assembly, the selsyn assembly, and the gear box assembly, which are bolted together and form a rigid unit. The complete indicator is enclosed by a protecting cover which fits into a sealing gasket behind the bezel, and is secured to the back plate by four screws. The cover is provided with two breathers which are covered by tropicalized felt held in position by circlips. The drains are located at the bottom of the cover. Fig. 16 and 21 show, in schematic form, the various assemblies and associated circuits comprising the master indicator.

Bezel assembly

77. This assembly comprises the course setter, glass, dial, lubber line adjustment, variation setting scale, VARIATION SETTING and AUTO PILOT control knobs and actuating mechanism. The assembly also includes the the front bearing for the selsyn rotor shaft.

78. The course setter comprises a rotatable snap ring which carries a small perspex cursor. The bezel is recessed in front of the glass and the ring is retained in the groove by its own snap action and can be turned so that the cursor is aligned with any required course. The glass is retained in position by a corrugated spring ring.

79. The dial is secured to the bezel by three screws and its scale is engraved from 0 deg. to 360 deg. in one degree markings. The centre part of the dial is recessed so that the tip of the course pointer lies flush with the scale, thus eliminating parallax error. Two windows are provided in the upper half of the dial, a circular one for the annunciator flag or D.G. indicator, and a curved rectangular aperture for the variation scale.

80. The lubber line which is visible in the same aperture as the variation scale, is mounted at one end of a thin metal strip which is brushed to the centre of the rear face of the dial. The other end of the strip is slotted to receive the actuating pin projecting from a small tapped steel block which travels on a threaded shaft. The shaft is supported in plain bearings in the lower part of the bezel casting and its outer end is of square section. A hole in the side of the bezel gives access to the outer end of the shaft which can be adjusted by means of a special adjusting key.

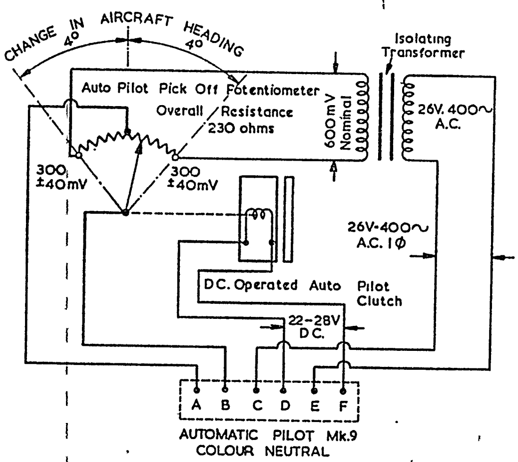


Fig. 18. Automatic pilot pick-off circuit

81. When the key is turned the tapped block travels along the shaft and the strip carrying the lubber line pivots about its centre, causing the lubber line to move to the left or to the right over the variation scale, depending on which way the key is turned. This adjustment is provided so that coefficient A can be compensated for during compass calibration without altering the position of the detector unit.

82. Variation can be set in by means of the VARIATION SETTING control knob. When this knob is pushed in and turned, a gear on the shaft extending from the knob engages with a train of gears which rotate the stator of the signal selsyn and also the variation scale.

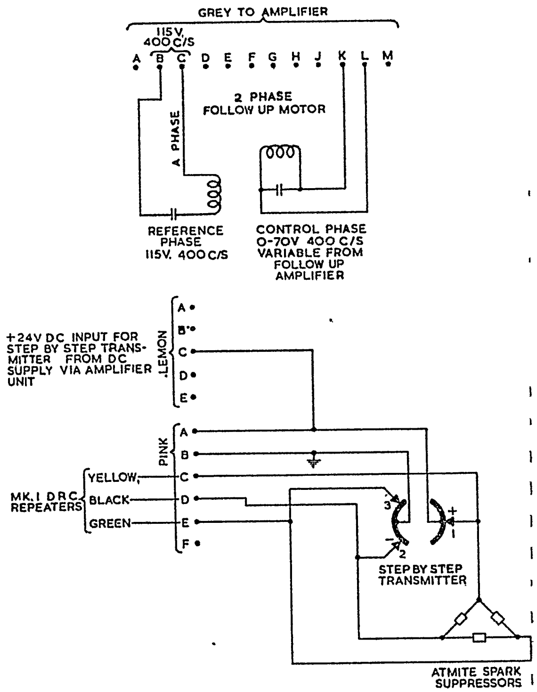


Fig. 20. Follow-up and step-by-step transmission system

83. The signals from the detector unit are fed to the stator of the signal selsyn via brush contacts on the back of the bezel assembly which establish contact with slip rings on the stator. Thus if the stator is rotated, the vector of the stator field will move, and a signal will be transmitted by its rotor to the precession amplifier. By appropriately adjusting the angular position of the stator relative to its rotor, the local magnetic variation can be set into the compass so that true indications are shown by the master indicator, gyro unit and any repeaters which may be included in the installation.

Selsyn assembly

84. This assembly is bolted to three mounting bosses which project from the back of the bezel casting. It incorporates the rear bearing for the rotor shaft, two selsyns, three slip ring assemblies, an interference shield and the course pointer.

85. The data selsyn stator is fixed to the selsyn assembly casting but the signal selsyn stator is mounted in a plain bearing and can be rotated through 360 deg. by means of the VARIATION SETTING control as shown in fig. 16 (*para.* 82 *and* 83).

86. A gear and a slip ring assembly is bolted to the signal selsyn stator, the gear engaging with the variation correction gear train operated by the control knob.

Brushes attached to the bezel casting contact a slip ring assembly on the signal stator and transmit the signals from the detector unit to the stator windings.

87. The rear end of the rotor shaft projects into the gear box and carries a spring-loaded circular plate which forms part of an electro-magnetic clutch. The clutch is energized when the auto-pilot switch is operated and the movement of the rotor shaft is then transmitted via the clutch to a gear train which operates the brush contact arm on the auto-pilot pick-off potentiometer. Stops are provided so that this contact arm is prevented from travelling beyond prescribed limits. A schematic circuit diagram of the pick-off connections is shown in fig. 18.

88. The follow-up motor is a two-phase squirrel-cage induction motor and is mounted on the outside of the gear box assembly. One phase is continuously energized from the 115 volt a.c. supply and the control phase is energized by the output of the follow-up amplifier. The rotor turns at a maximum speed of 11,880 r.p.m.: the transmission ratio at the rotor shaft is 1980 : 1 (max. speed 6 r.p.m.) and at the transmitter it is 33 : 1 (max. speed 360 r.p.m.). The rotor shaft is fitted with a friction damping device to minimize any tendency to hunt. Fig. 19 shows the follow-up motor and gear train and fig. 20 shows the circuit connections to the follow-up motor and step-by-step transmitter.

Annunciator

89. The annunciator is mounted on the selsyn casting and consists of a small flag marked with a dot and a cross. The flag is carried at one end of a pivoted staff, on the other end of which is mounted a small permanent magnet which swings between two coils wound on soft iron pole pieces.

90. The coils are connected in series with the annunciator coils in the gyro unit. If the

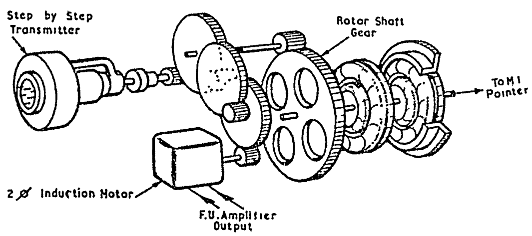


Fig. 19. Follow-up mechanism

gyro unit is not synchronized with the detector unit and the annunciator coils in both units (i.e., master indicator and gyro unit) are energized, the magnetic field produced re-acts with the small magnet on the end of the annunciator arm causing it to move either the dot or the cross into the annunciator window. The particular indication shown will depend upon the direction in which the gyro is precessing, and will persist until synchronism is regained. Fig. 21 shows the annunciator and selsyn connections in the master indicator.

91. Under normal flight conditions in piston-engined aircraft, the dot and the cross will appear alternately in the annunciator window due to the flux valve in the detector unit moving about its neutral position. The movement is caused through vibration effect and air turbulences affecting the aircraft. In jet-propelled aircraft, however, the flag will alternately show a dot and a cross at a slower rate. Such a condition is quite normal and is due to the absence of vibration and to the stable straight flight path of this type of aircraft.

92. When the gyro is precessing, either a dot or a cross will be displayed continuously, the particular indication shown depending on the direction of precession. If the dot or the cross is continuously displayed under normal straight flight conditions the gyro should be re-synchronized as described in para. 46.

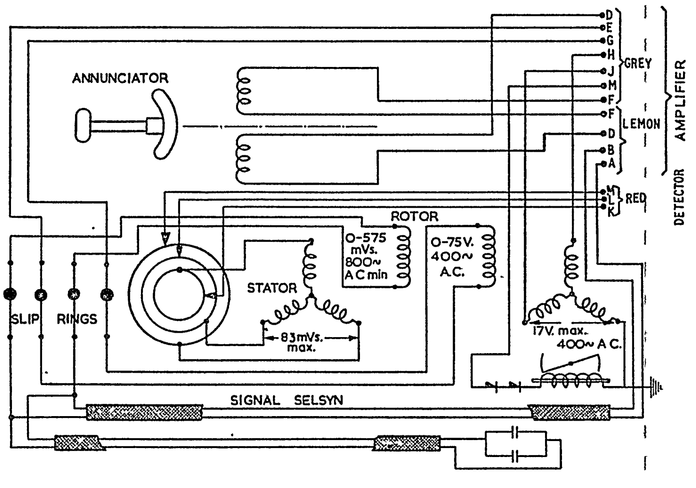


Fig. 21. Annunciator and selsyn connections

93. When the compass is switched to D.G. and is functioning as a directional gyro, an electro-magnetic relay is energized in the gyro unit causing a small flag marked D.G. to move in front of the annunciator flag and mask its indications. A similar relay fitted in the later series of master indicators is also energized by the operation of the selector switch and operates in the same manner, so that a D.G. indication is displayed in the annunciator windows of both indicators. This device is fitted to all master indicators with serial numbers from 464 upwards.

Automatic pilot control

94. The automatic pilot control shaft, operated by the AUTOMATIC PILOT control knob is fitted with a clicker mechanism which operates once during each complete revolution of the shaft. Limit stops are fitted which prevent the shaft from being turned more than eight revolutions in each direction. Each revolution of the shaft is equivalent to an alteration in aircraft heading of $\frac{1}{2}$ deg., and thus a maximum correction of 4 deg. to port or to starboard can be made.

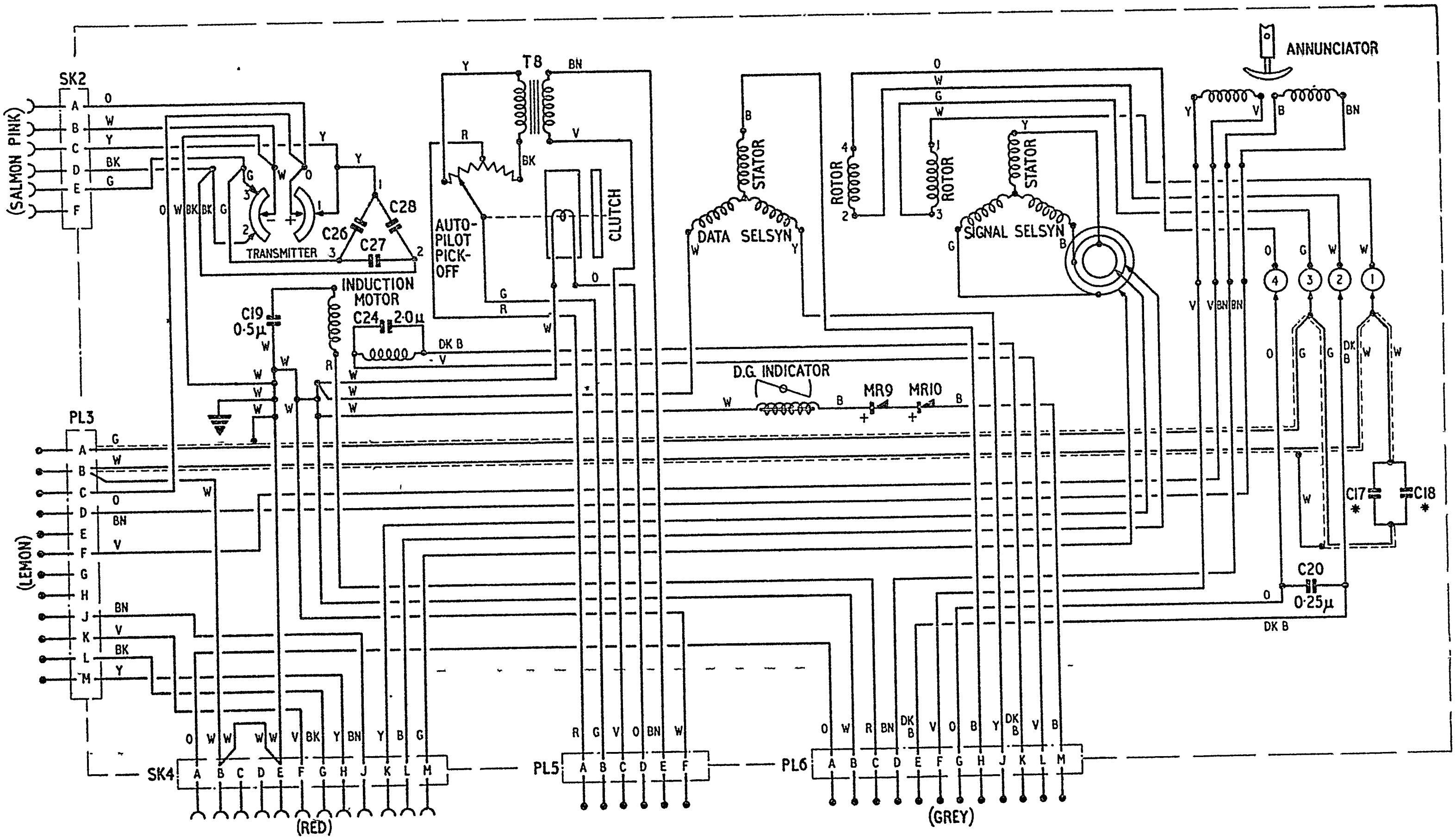
95. A spur gear on the end of the control shaft engages with an intermediate gear train which is in mesh with a quadrant gear. The quadrant gear is bolted to the pick-off potentiometer and thus, when the control knob is turned, the potentiometer rotates and the position of the brush contact relative to the centre tap on the potentiometer is altered as shown in fig. 16. A signal is therefore transmitted to the auto-pilot and a change of course results.

Note . . .

The pick-off incorporated in the master indicator of the Mk. 4B compass is designed specifically for use with the automatic pilot Mk. 9.

Gyro unit

96. This unit, a sectional view of which is given in fig. 8, can conveniently be considered to consist of three main assemblies: the gyro assembly, the selsyn bezel assembly and the chassis. The gyro assembly is fitted in the chassis which is bolted to the selsyn bezel assembly. The complete unit



ABBREVIATIONS OF COLOURS

R	RED	G	GREEN	O	ORANGE
W	WHITE	Y	YELLOW	V	VIOLET
B	BLUE	BK	BLACK	DK B	DARK BLUE
		BN	BROWN		

* C17 AND C18 SELECTED ON TEST FROM 0·005μ, 0·01μ, 0·02μ, 0·05μ

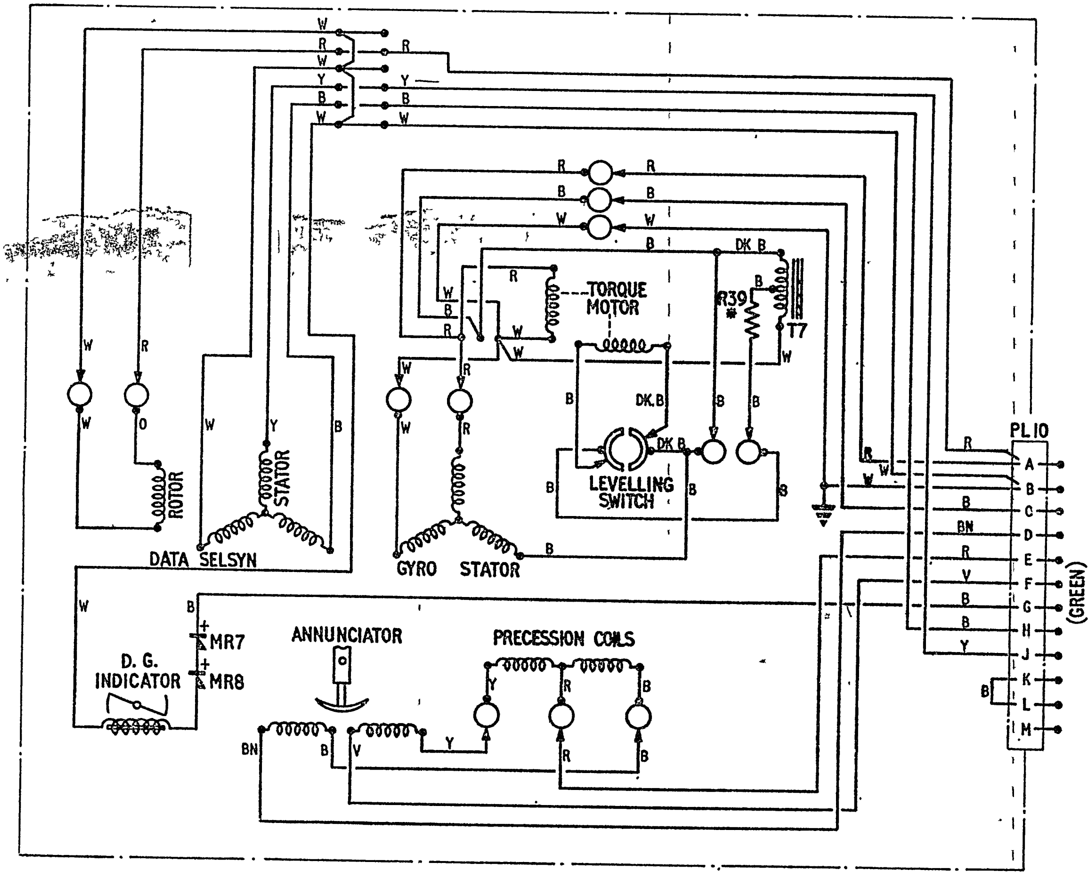
Fig. 22. Circuit diagram, master indicator

is enclosed by a metal cover, which fits into a neoprene sealing gasket behind the bezel casting and is secured, together with the back plate, by four screws. Two breathers covered with tropicalized felt are provided on the top surface at the rear of the cover.

Gyro assembly

97. The gyro is a 3-phase squirrel-cage induction motor, the rotor of which spins at approximately 23,000 r.p.m. The rotor is of mild steel and is of cup cross-section with a central shaft. Its interior is sleeved with a cylindrical insert of aluminium alloy centrifugally cast about a laminated iron core, and forms the squirrel-cage armature of the motor.

98. The rotor housing is a light alloy casting, one end of which is spanned across its diameter by a bridge-piece which carries one bearing for the rotor shaft. This is a ball type bearing, the balls being housed in a plastic cage. The other end of the rotor housing carries the stator windings of the motor which are supported by the stator tube surrounding the rotor shaft. The rotor shaft projects through the rotor housing and is carried in a ball race which is fitted in a brass cup in the rotor housing end plate. The brass cup is spring-loaded inwards by a coil



ABBREVIATIONS OF COLOURS			
R	RED	BN	BROWN
W	WHITE	O	ORANGE
B	BLUE	V	VIOLET
Y	YELLOW	DK B	DARK BLUE

* R39 SELECTED ON TEST FROM 60 Ω, 85 Ω, 110 Ω, 150 Ω

Fig. 23. Circuit diagram, gyro unit, Type A

spring between the cup and the bearing cover plate in order to provide automatic compensation for temperature variations.

99. The inner gimbal ring has two bearing pivots on its outside at right angles to the rotor axis which fit into ball races on the vertical gimbal ring. The bearing pivots are insulated, and extend through the vertical gimbal ring to serve as commutators for light spring contacts through which the electrical connections to the gyro stator are made. The circuit diagram of the gyro unit is given in fig. 23.

Erection mechanism

100. A torque motor is used to maintain the gyro spin axis horizontal. The stator of this motor is mounted on the top of the vertical gimbal ring whilst the squirrel-cage rotor is secured to the gyro assembly

101. If the gyro spin axis tends to depart from its position at right angles to the vertical ring axis, an electrical contact is made via the levelling switch. This switch is in the form of a two-segment commutator and two diametrically opposed brushes. The two segments of the commutator are continuously energized at approximately 2 volts a.c. from phases A and B via a small auto-transformer mounted on the vertical ring.

102. Two brushes are mounted on the vertical ring and are connected to the control winding of the torque motor stator so that when the gyro rotor axis tilts from the horizontal the commutator rotates, establishing contact with the brushes on the vertical ring, and causing the torque motor to be energized. The rotating field induced in the stator reacts with the rotor which is mounted on the gyro unit chassis to produce a torque which causes the gyro to precess about its horizontal axis until its spin axis is again at right angles to the vertical axis.

Precession

103. The compass indication is monitored to the magnetic meridian by precessing the gyro in azimuth by a d.c. signal applied to the precession coil on the vertical gimbal ring.

104. By referring to fig. 8, it will be seen that the rotor housing has attached to it two curved permanent magnets which pass through the precession coil. Signals from the precession amplifier energize this coil and the magnetic field thus produced, reacts with the permanent magnets so as to cause the gyro vertical ring to precess in the direction necessary to restore the alignment of the compass card with the magnetic heading of the aircraft.

105. Electrical connection to the precession coil is made via three brushes which contact three slip rings on the bottom pivot of the vertical gimbal ring. A large bevel gear is mounted horizontally on the base of the vertical gimbal ring and engages with a second vertically-mounted bevel gear on the selsyn rotor shaft which also carries the compass card. Any movement of the gyro in azimuth is, therefore, transmitted to the compass card by the bevel gears.

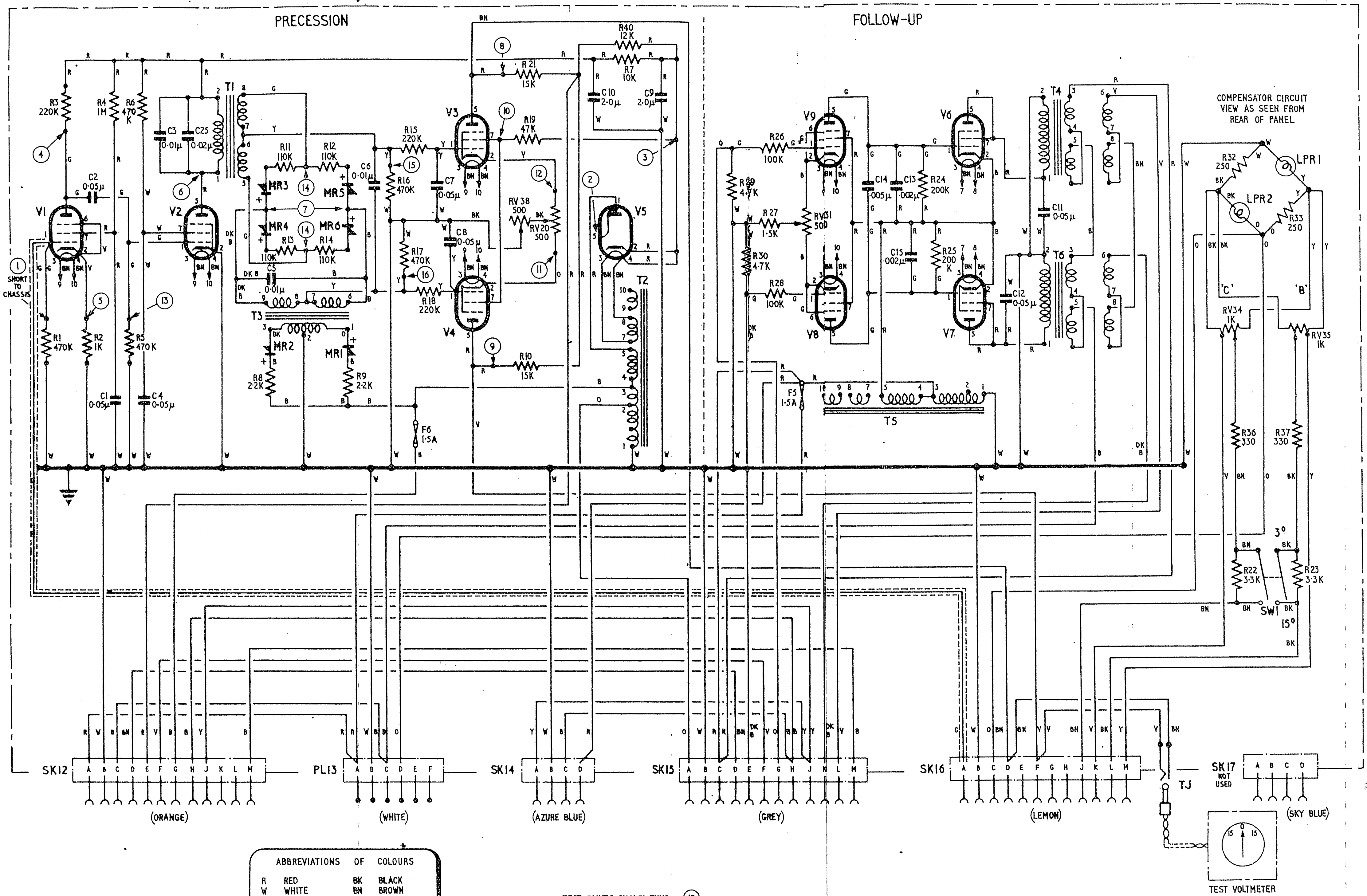
106. The caging mechanism on the gyro consists of two alloy rings situated below the horizontal bevel gear at the base of the gyro vertical ring. The upper ring carries three tapered cam projections which engage with three corresponding slots in the lower ring.

107. When the synchronizing control knob is pushed in, the lower plate is rotated slightly, and the cams, moving up the slots, cause the upper plate to lift, locking the bevel gear so that it cannot rotate. At the same time, a caging arm is raised by the upward movement of the ring so as to level and cage the rotor housing, thus preventing the gyro from precessing and toppling while the compass is being synchronized.

Selsyn and bezel assembly

108. This assembly consists of two castings one forming the gyro unit and face and carrying the bezel glass, dial, synchronizing control knob and annunciator window. The assembly also incorporates the operating mechanism for the synchronizing and SET COURSE controls, an annunciator, an auto-transformer, and the shaft which carries the course pointer, compass card, data selsyn rotor and the vertical bevel gear.

109. The lubber line is marked at the top of the bezel and is also engraved and painted on the bezel glass. The aircraft heading rectangle and two parallell grid lines are painted on the glass to assist the pilot in maintaining an accurate course. The course pointer and a matching reference in the form of a rectangle, are marked on a circular metal plate which is friction loaded to the compass card by an annular friction pad. The compass card is engraved from 0 deg. to 360 deg. Fluorescent paint is used throughout for all markings.



ABBREVIATIONS	OF	COLOURS	
R	RED	BK	BLACK
W	WHITE	BN	BROWN
B	BLUE	O	ORANGE
G	GREEN	V	VIOLET
Y	YELLOW	DK B	DARK BLUE

TEST POINTS SHOWN THUS:- (13)

Fig. 24 Circuit Test diagram, amplifier Type A Fig. 24

SET COURSE control

110. This control is operated by a knob located at the bottom left-hand corner of the instrument face. When the SET COURSE knob is pressed in, the course pointer plate is lifted slightly off the friction pad. A gear on the shaft extending from the SET COURSE knob is constantly in mesh with a second gear carried on a sleeve fitted to the selsyn assembly casting. As the knob is turned, this sleeve rotates three ball bearings which project through apertures in the compass card mounting and bear on the course pointer plate causing it to rotate. When the SET COURSE knob is released, contact between the course pointer plate and the friction pad is restored and the course pointer is again friction loaded to the compass card.

Synchronizing control

111. This control is operated by a knob, marked with a dot and cross and direction arrows. It is situated at the bottom right-hand corner of the bezel. When the knob is pushed in and turned, a train of gears is operated which rotates the selsyn rotor and the compass card. Since the horizontal bevel gear on the vertical ring of the gyro is now locked (*para.* 107), a slipping clutch assembly is interposed between the vertical bevel gear and the shaft carrying the compass card, so that when the knob is turned, the card and the selsyn rotor can be rotated relative to the selsyn stator. By means of this control, the rotor can be quickly aligned with the vector of the stator magnetic field produced by the detector unit signals, thus synchronizing the compass card indication with the magnetic heading of the aircraft.

Chassis

112. The chassis is bolted to the selsyn assembly casting and carries the bearings for the vertical gimbal ring, the slip ring brushes for the a.c. supply, the annunciator and the back cover plate.

Annunciator

113. This device is included in the gyro unit to provide a constant indication which enables the pilot to verify whether or not the compass is synchronized with the earth's magnetic field. It consists of a small flag marked with a dot and cross, which is visible through a window in the top right-hand corner of the bezel. The flag is carried at one end of a pivoted staff, on the other end of which is mounted a small permanent magnet which swings between two coils wound around soft iron pole-pieces. The coils are connected in series with the annunciator coils in the master indicator and, together with the precession coil, are energized by the amplified signals from the detector unit.

114. In piston-engined aircraft the flag will move from side to side and the dot and the cross will alternately be visible. In jet-propelled aircraft, however, the alternations will be slower and the dot or cross may be only partially visible. When the gyro is precessing, either the dot or the cross will be continuously displayed, the particular indication shown depending on the direction of precession. These indications are characteristic and have already been explained in the description given of the annunciator in the master indicator (*para.* 89 *to* 93).

115. When the selector switch is in the OFF position a coil, mounted on the back of the bezel assembly, is energized and causes a small flag marked D.G. to be moved in front of the annunciator flag. An electro-magnetic indicator in the master indicator is also energized and a similar indication is shown in the annunciator window of that instrument (*para.* 93).

Cover

116. The gyro unit is enclosed in an alloy cover which fits into a neoprene sealing gasket at the back of the bezel. Two circular breather apertures covered with tropicalized felt are provided on the front top surface of the cover and two drains on the bottom surface. The cover is secured to the chassis by eight screws which also pass through the back plate.

Back plate

117. The alloy plate which closes the back of the cover is secured in place as described in para. 116 and carries a 12-pin plug for connection to the control panel.

Precession amplifier *(fig. 28)*

General

118. The precession amplifier is employed to amplify and rectify the monitoring signals, relayed from the detector unit by the signal selsyn in the master indicator before they are applied to the precession coil on the gyro.

119. Although this amplifier is contained in the same case as the follow-up amplifier it is electrically a completely separate unit. It comprises four amplifying valves, a half-wave rectifying valve for H.T. supplies and a phase-discriminating rectifier circuit.

120. A d.c. voltage stabilizing circuit and two calibrated centre-tapped potentiometers for adjusting the current to the electro-magnet deviation compensator (*para.* 10) are also incorporated and a jack socket is provided for an external voltmeter used when calibrating the compass.

121. The case in which both amplifiers are contained is secured to a mounting bracket by four bolts which pass through anti-vibration mountings on the bracket and screw into four tapped bosses. The plug and socket connections are as shown in Table 1.

125. A reference a.c. voltage is also applied to the demodulator circuit from the secondary winding of T3. The frequency of the reference voltage is the same as that of the signal input, i.e., 800–c/s, and is obtained by the circuit arrangement of the primary winding of T3 and the action of the two rectifiers MR1 and MR2.

126. The amplitude of the reference voltage is arranged to be large in comparison with the signal voltage but is prevented from overloading the rectifiers when they are conducting by the resistors R11 to R14 which are included for this purpose.

TABLE 1

Plug and socket connections

Type	Colour Code	Connection
12-way socket	Light grey	To master indicator
12-way socket	Orange	To control panel
4-way socket	Azure blue	To equipment requiring synchronous transmission
12-way socket	Lemon	To master indicator
6-way plug	White	To power supplies

Circuit description

122. Referring to the precession amplifier test circuit diagram included in fig. 24 it will be seen that the signal input is applied via a screened load, directly to the control grid of V1 which functions as an amplifier. Cathode bias for this valve is obtained from the voltage drop across R2; R3 is the load resistor connecting the anode of V1 to the H.T. line. After amplification, the signals are fed via the condenser C2 to the control grid of V2 which also functions as an amplifier in the same manner as V1.

123. The anode circuit of V2 includes the primary winding of the transformer T1 and in order to filter out any remaining harmonics of the signal frequency (800–c/s), the condensers C3 and C25 are connected in parallel across the winding to form a tuned circuit.

124. The amplified signals are then applied via the secondary winding of T1 to a ring demodulator circuit consisting of the four metal rectifiers MR3–MR6 and the resistors R11–R14.

127. The ring demodulator functions as a phase sensitive circuit by means of which a d.c. voltage is obtained from the centre-taps on the secondaries of T1 and T3, the magnitude and direction of this voltage varying in accordance with the amplitude and sign (relative to the reference voltage) of the signal input. A detailed description of the operation of this part of the amplifier circuit is given in para. 131 to 139 inclusive.

128. After demodulation, the rectified half-cycles are smoothed by C6 and are then fed via the resistors R15 and R18 to the control grids of V3 and V4 where they are power amplified and applied in d.c. form to the precession coil on the gyro unit.

129. With the signal input earthed the outputs of V3 and V4 should be equal. Cathode bias to these valves is controlled by the adjustment of the pre-set resistor R38, and their outputs are balanced by suitably adjusting R20. All amplifier valve heaters are connected in parallel to the heater winding on

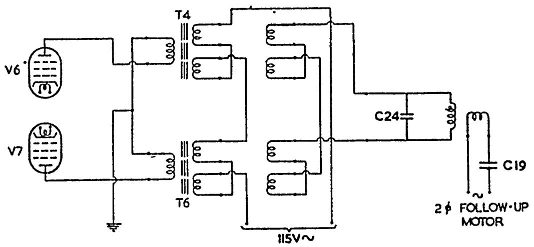


Fig. 25. Simplified diagram, transductor output

the power transformer T2, and the requisite h.t. supplies are obtained from the cathode of the rectifier valve V5.

Ring demodulator circuit

130. This part of the amplifier circuit can be considered to function as a double-pole change-over switch whereby the amplified alternating signals originated by the flux valve are converted into rectified half-cycles of a.c.

Follow-up amplifier (*fig. 28*)

General

131. The follow-up amplifier is employed to provide a suitable a.c. power output, related in amplitude and sign to the signal input, which is used to energize the control winding of the follow-up motor and so maintain synchronism between the master indicator and the gyro unit.

132. The amplifier incorporates four valves forming a two-stage a.c. amplifier followed by a transductor output. Transductors, sometimes referred to as magnetic amplifiers are, essentially, saturable reactors of special design and are used in pairs. They are reliable in operation and in the follow-up amplifier they have been preferred to the large output valves which would otherwise have been required. A description of their mode of operation is given in para. 141 to 147.

Circuit description

133. By referring to the follow-up amplifier circuit diagram included in fig. 24, it can be seen that the amplifier comprises two stages of push-pull amplification, both of which are supplied with an alternating H.T. voltage of the same frequency and phase as the a.c. supply to the data selsyn in the master indicator.

134. The rotor winding of the data selsyn is connected to the input of the amplifier, and under no signal conditions, the valves V8 and V9 which comprise the first stage of amplification, carry equal pulse of anode current during the positive half-cycles of the h.t. supply; thus their anode potentials are always equal.

135. The anodes of V8 and V9 are connected directly to the control grids of V6 and V7 respectively, which comprise the second stage of amplification. The anodes of V6 and V7 are also supplied with an alternating H.T. voltage obtained from the common H.T. transformer T5, but the phase opposite to that supplied to V8 and V9. Hence, equal pulses of anode currents are carried by V6 and V7 but, due to the difference in the polarity of the h.t. supply, only when V8 and V9 are non-conducting.

136. The condensers C13, C14 and C15 form the coupling between the first and second stages of amplification, and during the periods when V8 and V9 are conducting, C15 and C13 store a proportion of the anode voltage of these valves. This voltage is applied to the control grids of V6 and V7 during the next half-cycle thus bringing V6 and V7 to near cut-off point.

137. When an a.c. signal of one polarity is applied to the control grids of V8 and V9 from the data selsyn, the pulses of anode current through V9 increase since the control grid and the anode are positive at the same time.

138. Similarly, the pulses of anode current through V8 decrease since when its anode is positive and the valve is conducting, its control grid is driven negative. A differential voltage therefore exists between the anodes of V8 and V9 which is stored in C14 and then applied to the control grids of V6 and V7.

139. During the next half-cycle, when V6 and V7 are conducting, the voltage applied from C14 causes V6 to be driven further towards cut-off, whilst V7 carries current pulses of increased magnitude. Similarly, a signal input to V8 and V9 of the opposite polarity results by exactly the same process in current pulses of increased magnitude in V6, whilst V7 is driven towards cut-off point.

140. The signal windings of the transductors T4 and T6 are connected in the anode circuits of V6 and V7 and in this manner the pulses of anode current through these valves are made to control the transductor output. The condensers C11 and C12 are included in the circuit to provide smoothing so that the anode current flow is sensibly constant.

Transductors

141. As stated in para. 132, transductors are saturable reactors. They are employed in the follow-up amplifier to provide a suitable power output which is related in magnitude and sign to the direct current input, and is used to energize the control winding of the follow-up motor.

142. The transductor consists essentially of a three-legged laminated iron core of high permeability around which three separate coils are wound. The centre leg carries the input, or signal, coil and each of the outer legs carries an inner a.c. coil on top of which an outer a.c. coil is wound. The windings of the inner and the outer a.c. coils are divided and their ends are connected as shown in fig. 25.

Operation

143. Referring to the simplified circuit diagram of the transductor output (*fig.* 25) it will be seen that the anode current of V6 and V7 flows through the signal coils of the transductors T4 and T6 respectively.

The inner a.c. coils on each transductor are connected in series and supplied with 115 volt, 400 c/s a.c. and therefore, since the transductors are identical in design, the voltages across each coil are equal and opposite (*para.* 142).

144. When a signal reaches the amplifier input causing a current of increased magnitude in the anode circuit of V6, the increase in current through the signal coil of T4 will cause the core to become saturated. The impedance of T4 will therefore be reduced and the voltage across its inner a.c. coils will be decreased. The voltage across the inner a.c. coil of T6 will, however, be increased since V7 is driven towards cut-off.

145. Since the inner and the outer a.c. coils each have the same number of turns, the voltages induced in the outer a.c. coils of T4 and T6 are equal at any instant to the voltages across the inner a.c. coils. The outer a.c. coils, however, are connected so that their voltages are in opposition and therefore the output voltage is equal to the difference between the voltages appearing across the inner a.c. windings of T4 and T6.

146. The sign of the output voltage will, therefore, depend upon which of the transductors is saturated and the magnitude of the voltage will depend upon the amplitude of the signal input to the amplifier.

147. The output from the transductors is fed directly to the control winding of the two-phase follow-up motor in the master indicator, the condenser C24 being connected across the winding to improve the power factor. The reference of this phase motor is continuously energized from a single-phase a.c. supply and the follow-up amplifier output supplies the controlling phase. Thus, the direction of rotation of its rotor is directly related to the polarity of the signal input. The value of components used in the precession and follow-up amplifiers are given in Table 2.

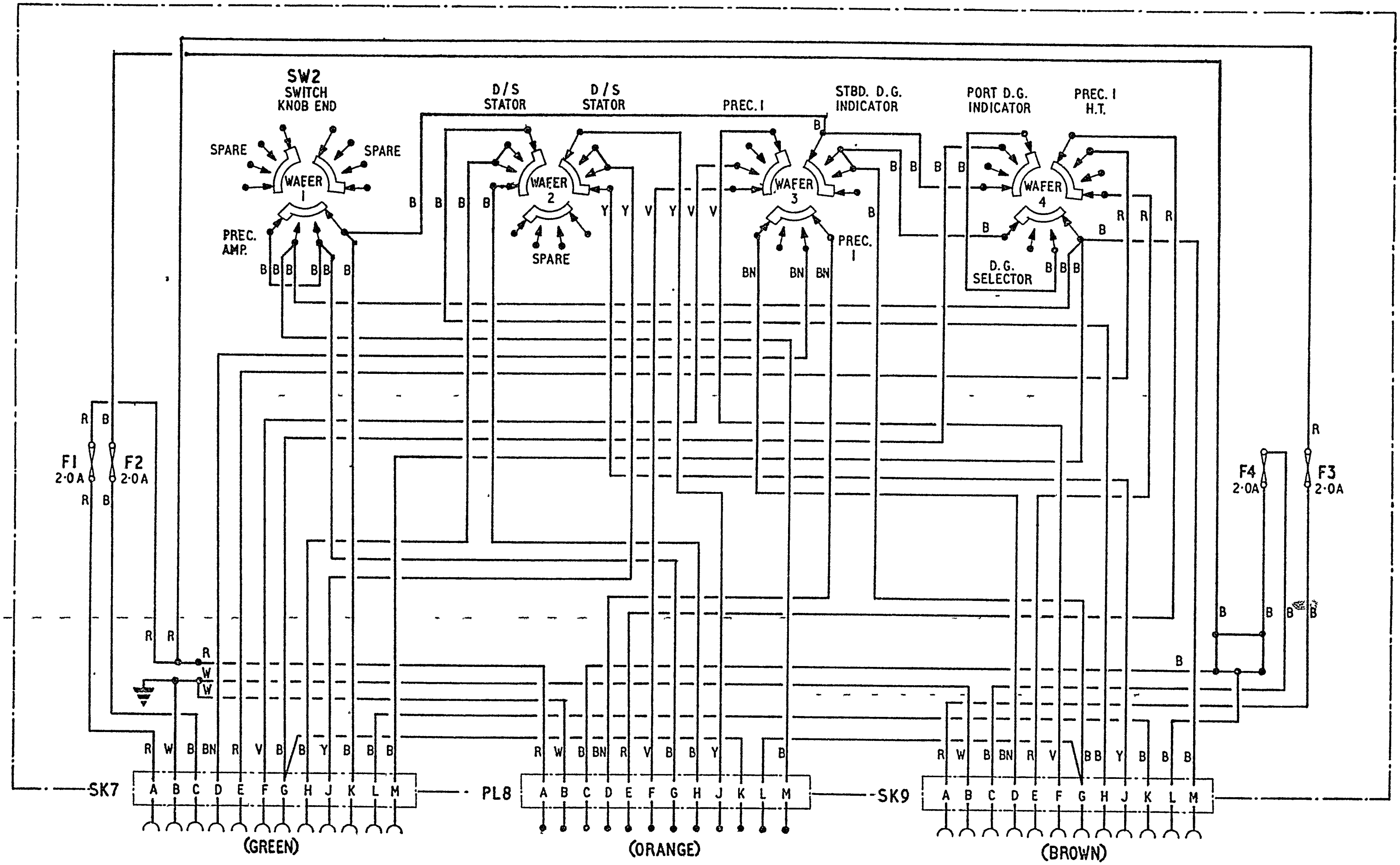
Voltage stabilizing circuit

148. The current which energizes the coils of the deviation compensator described in para. 10, is obtained from the aircraft d.c. supply. The supply voltage, however, is not entirely steady but fluctuates between 24 and 28 volts and it is, therefore, necessary to provide an adequate degree of stabilization to ensure that the current in the compensator coils remains reasonably constant irrespective of voltage fluctuations.

149. In the Mk. 4B compass, the stabilizing circuit and the potentiometers for adjusting the current in the compensator coils are included in the amplifier unit. A small hinged flap at the bottom right-hand corner of the amplifier case gives access to the two potentiometer spindles which can be adjusted by means of a compass adjusting key (Stores Ref. 6E/337).

150. A toggle switch, immediately beneath the potentiometer spindles, enables either of two calibration ranges (3 deg.—3 deg. or 15 deg. —0—15 deg.) to be selected, and a jack socket at the bottom left-hand end of the amplifier case is provided so that a 15—0—15 voltmeter can be plugged in when calibrating the compass.

151. The stabilizing circuit is included in fig. 15 from which it will be seen that the Lamps L1 and L2 and the resisters R32 and R33 form a bridge network connected across the aircraft d.c. supply. The lamp filaments have a high temperature resistance coefficient and thus the effective resistance of each lamp increases or decreases considerably for a small rise or fall in voltage. By utilizing this characteristic and selecting suitable circuit constants for a bridge circuit, a reasonably steady output voltage can be obtained with input voltages varying between 20 and 30 volts.



ABBREVIATIONS OF COLOURS			
R	RED	Y	YELLOW
W	WHITE	BN	BROWN
B	BLUE	V	VIOLET

Fig. 26. Circuit diagram, control panel

TABLE 2

Components used in amplifier

Ref.	Capacitors	Ref.	Resistors
C1	0·05 M.F. Metalmite	R1	470K $\frac{1}{4}$W Erie 9
C2	0·05 M.F. Metalmite	R2	1K. $\frac{1}{4}$W Erie 9
C3	0·01 M.F. Metalmite	R3	220K. $\frac{1}{4}$W Erie 9
C4	0·05 M.F. Metalmite	R4	1M. $\frac{1}{4}$W Erie 9
C5	0·01 M.F. Metalmite	R5	470K. $\frac{1}{4}$W Erie 9
C6	0·01 M.F. Metalmite	R6	470K. $\frac{1}{4}$W Erie 9
C7	0·05 M.F. Metalmite	R7	10K. $\frac{1}{4}$W Erie 9
C8	0·05 M.F. Metalmite	R8	2·2K. Berco L.W.9 W.
C9	2 M.F. Micropack	R9	2·2K. Berco L.W. 9 W.
C10	2 M.F. Micropack	R11	110K. Welwyn A 3622 $\frac{1}{4}$W.
C11	0·05 M.F. Metalmite	R12	110K. Welwyn A 3622 $\frac{1}{4}$W.
C12	0·05 M.F. Metalmite	R13	110K. Welwyn A 3622 $\frac{1}{4}$W.
C13	0·002 M.F. Metalmite	R14	110K. Welwyn A 3622 $\frac{1}{4}$W.
C14	0·005 M.F. Metalmite	R15	220K. $\frac{1}{4}$W Erie 9
C15	0·002 M.F. Metalmite	R16	470K. $\frac{1}{4}$W Erie 9
C16	0·1 M.F. Metalmite	R17	470K. $\frac{1}{4}$W Erie 9
C17	Metalmite (value determined on test)	R18	220K. $\frac{1}{4}$W Erie 9
		R19	680 $\frac{1}{2}$W Erie 8
		R20	500 Colvern Potr.
C18	Metalmite (value determined on test)	R21	15K. $\frac{1}{4}$W Erie 9
C19	0·5 M.F. Metal pack	R22	3·3K
		R23	3·3K
		R24	200K. $\frac{1}{2}$W Erie 8
		R25	200K. $\frac{1}{2}$W Erie 8
		R26	100K. $\frac{1}{4}$W Erie 9
C24	2 M.F. Dubilier paper type	R27	1·5K. $\frac{1}{4}$W Erie 9
C25	0·02 M.F. Metalmite	R28	100K. $\frac{1}{4}$W Erie 9
C26	Atmite suppressor	R29	4·7K. $\frac{1}{2}$W Erie 8
C27	Atmite suppressor	R30	4·7K. $\frac{1}{2}$W Erie 8
C28	Atmite suppressor	R31	500 Colvern Potr.
		R32	250 Welwyn $4\frac{1}{2}$W.
		R33	250 Welwyn $4\frac{1}{2}$W.
		R34	1000 (CT.) Colvern Potr.
		R35	1000 (CT.) Colvern Potr.
		R36	330 ohm. $\frac{3}{4}$W.
		R37	330 ohm. $\frac{3}{4}$W.
		R38	500 Colvern Potr.

Ref.	Switches	Ref.	Lamps
S.W.1	2 pole ON-OFF	L1	24V. 2·8W.
S.W.2	N.S.F. Type "M.H.C."	L2	24V. 2·8W.

Ref.	Transformers	Ref.	Fuses
T1	Transformer (Interstage)	F1	Cartridge fuse 1·5 amp.
T2	Transformer (Power)	F2	Cartridge fuse 1·5 amp.
T3	Transformer (Ref. volt)	F3	Cartridge fuse 1·5 amp.
T4	Transductor	F4	Cartridge fuse 1·5 amp.
T5	Power transformer	F5	Cartridge fuse 1·5 amp.
T6	Transductor	F6	Cartridge fuse 1·5 amp.

TABLE 2 — continued

Ref.	Metal rectifiers	Ref.	Valves
M.R.1	S.T.C. 25R	V1	C.V.138 (E.F.91)
M.R.2	S.T.C. 25R	V2	C.V.136 (E.L.91)
M.R.3	S.T.C. M43T	V3	C.V.136 (E.L.91)
M.R.4	S.T.C. M43T	V4	C.V.136 (E.L.91)
M.R.5	S.T.C. M43T	V5	C.V.135 (E.Y.91)
M.R.6	S.T.C. M43T	V6	C.V.136 (E.L.91)
M.R.7	Germainium	V7	C.V.136 (E.L.91)
M.R.8	Germainium	V8	C.V.138 (E.F.91)
M.R.9	Germainium	V9	C.V.138 (E.F.91)
M.R.10	Germainium		

152. The calibrated centre-tapped potentiometers R34 and R35, which control the current in the compensator coils, are connected across this source and thus the current is maintained at a steady value. The two-way change-over switch SW1 and the resistors R22 and R23 provide a means of altering the range of correction in relation to the degree of adjustment of the potentiometers to suit the requirements on any particular installation. With the switch open, the range is 3 deg. —0 deg.—3 deg., and with it closed it is 15 deg.—0 deg.—15 deg.

153. It is most important that the same type of lamp is always used in the stabilizing circuit otherwise the voltage stabilization will not be effective. Should either lamp fail, it should be replaced by 24V lamp (Stores Ref. 5L/X951230).

Control panel

154. The control panel shown in fig. 10 is used to control the monitoring signals to the gyro unit. It consists of a rectangular box which carries a 3-way selector switch, four fuses, one 12-pin plug and two 12-way sockets.

155. The selector switch indicating plate is reversible, one side being engraved to suit single gyro unit installations and the other to suit installations where an additional gyro unit is fitted for use by the second pilot. The indicating plate is provided with a stop so that on single gyro unit installations only two switch positions can be used:—

(1) GYRO COMPASS. The gyro unit is monitored by the detector unit and functions as a compass.

(2) COMPASS OFF. The gyro unit is unmonitored and functions as a directional gyro. A D.G. indication is shown in the annunciator windows of the gyro unit and the master indicator.

The master indicator is synchronized with the gyro unit in either switch positions.

156. On installations where two gyro units are fitted, three switch positions are available:

(1) PORT COMPASS. The port gyro unit functions as a compass, the starboard as a directional gyro.

(2) STARBOARD COMPASS. The starboard gyro functions as a compass, the port as a directional gyro.

(3) COMPASS OFF. Both gyro units function as directional gyros.

The master indicator is synchronized with whichever gyro unit is acting as a compass, or with the port gyro unit when both units are functioning as directional gyros.

157. The control panel is usually mounted in the cockpit in a position accessible to the pilot, but if this is impracticable owing to limitation of cockpit space in small aircraft, it can be mounted on a bulkhead or at any other convenient point. In such instances the selector switch is turned to COMPASS or PORT COMPASS and wire-locked in this position. Remote control is effected by means of a 2-way switch in the pilot's cockpit which is connected to the control panel by a special connector. A circuit diagram of the control panel is given in fig. 26.

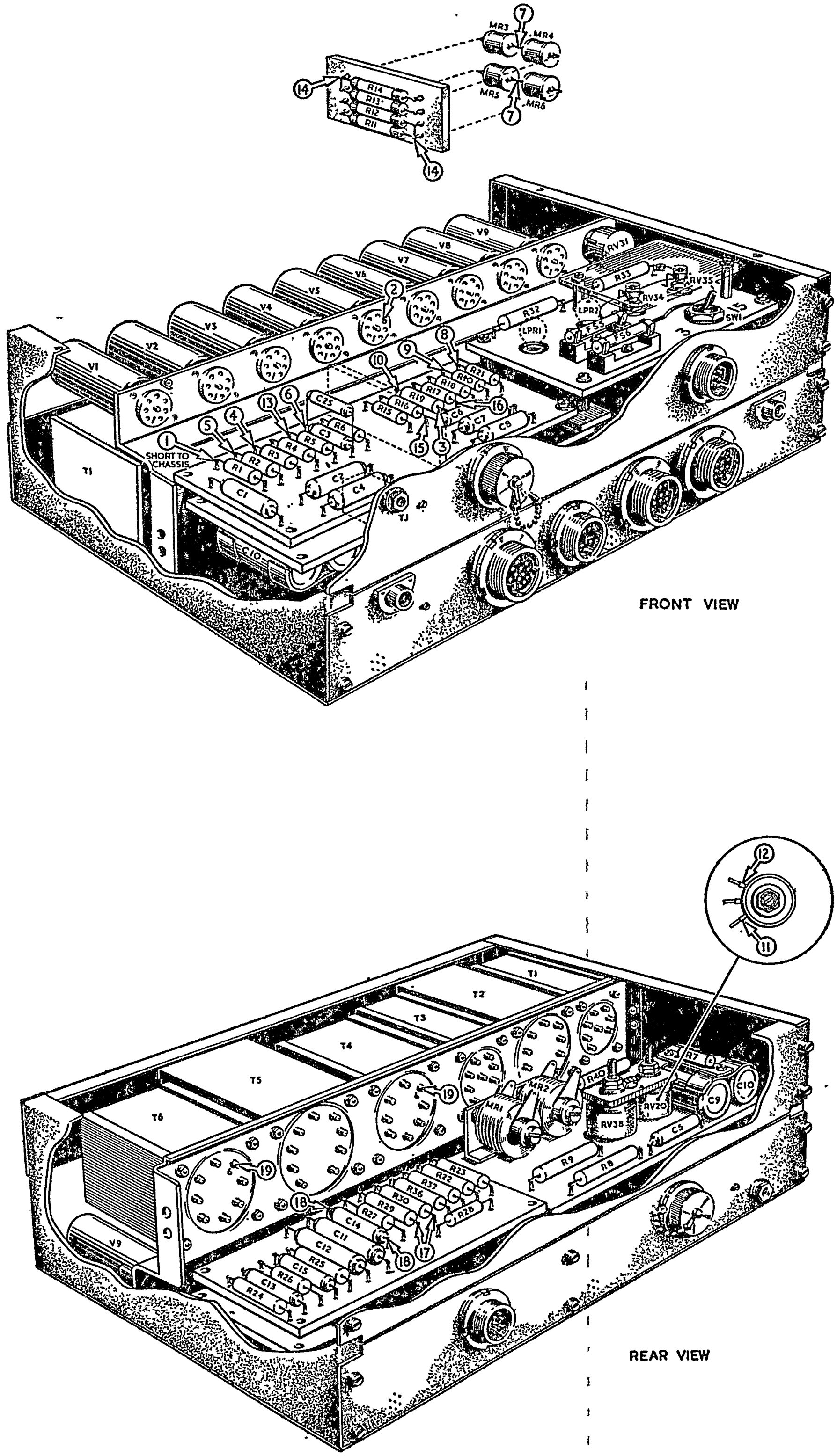


Fig. 28. Amplifier, component layout diagram

RESTRICTED

SERVICING

General

158. The storage requirements, pre-flight serviceability checks, inspection periods and routine servicing are described in the subsequent paragraphs.

Storage

159. All the equipment comprising the Mk. 4B compass is generally supplied in airtight tropicalized, preservative packs and does not require any attention for periods not exceeding twelve months. If the equipment is not contained in preservative packs, the gyro unit must be exercised for 15 minutes every three months on a roll, pitch and yaw table. After 12 months storage the bearings in the gyro unit require re-lubrication but this must only be carried out at authorised Repair Depots.

Pre-flight serviceability check

160. When the compass is installed in an aircraft, each unit of the equipment must be inspected and a serviceability check made before the aircraft takes off. The inspection and check must be made only by authorised personnel. A diagram showing the inter-unit connectors is given in fig. 27.

Mounting and connectors

161. (1) Check the security of the gyro unit and the master indicator mountings. Ensure that all other units comprising the compass are securely fixed.

(2) Check the security of all plugs and socket connections on the inter-unit connector harness.

Bezel glasses

162. The glass on the gyro unit and on the master indicator must be cleaned and examined for cracks. Should it become necessary to remove an instrument glass, extreme care must be taken to avoid touching the inner surface as this is coated with an anti-condensation compound which is adversely affected by the slightest trace of grease. If required, the inner surface of the glass can be lightly dusted with a perfectly clean rag which is free from fluff.

Luminous markings

163. Inspect all luminous markings for discolouration or chipping.

Functional test

Installations with one gyro unit

164. (1) Switch on the a.c. and d.c. power supplies to the compass and allow the equipment to run for not less than two minutes. Check that the compensator circuit indicator lamps in the amplifier light.

(2) Turn the selector switch on the control panel to GYRO COMPASS: verify that the dot or a cross is shown in the annunciator window of the gyro unit and that a similar indication is shown by the annunciator in the master indicator.

(3) Synchronize the gyro unit (*para.* 46) and note the compass card heading against the lubber line.

(4) Set the compass card 10 deg. off the indicated heading by means of the synchronizing control and note the time taken for it to return to the original heading within ± 0·5 deg. The time taken should not exceed five minutes. Check that the master indicator pointer follows the compass card and agrees within ± 1 deg.

(5) Turn the selector switch to COMPASS OFF and verify that D.G. is shown in the annunciator window on the gyro unit and on the master indicator.

(6) Alter the heading shown by the compass card by means of the synchronizing control and check that the master indicator pointer follows the movement of the card and agrees within ± 1 deg.

Installation with two gyro units

165. (1) Turn the selector switch on the control panel to PORT COMPASS; verify that a dot or a cross appears in the annunciator window of the port gyro unit and that a similar indication is shown by the flag indicator in the master indicator. The annunciator in the starboard gyro unit should show D.G.

(2) Synchronize the port gyro unit (*para.* 46) and note the heading shown against the lubber line.

(3) Set the compass card on the port gyro unit 10 deg. off the indicated heading by means of the synchronizing control and note the time taken for it to return to the original heading within ± 0·5 deg. The time taken should not exceed 5 minutes. Check that the master indicator pointer follows the compass card on the port gyro unit and agrees within ± 1 deg.

(4) Turn the selector switch to STARBOARD COMPASS and repeat the procedure described in sub-para. (2) and (3) using the starboard gyro unit (*para.* 164).

(5) Turn the selector switch to COMPASS OFF and verify that D.G. is shown in the annunciator windows of both gyro units and the master indicator (see para. 93 if applicable to the unit).

(6) Alter the heading shown by the compass card on the port gyro by means of the synchronizing control and check that the master indicator pointer follows the movement of the card and agrees within ± 1 deg.

Note . . .

If an artificially high rate of turn is introduced by rotating the compass card rapidly, the master indicator pointer will oscillate about the new heading several times before settling. This effect is characteristic and is quite consistent with satisfactory operation.

Compass calibration

166. The calibration of the Mk. 4B compass installation must be checked at periodic intervals in conformity with regulations governing the use of this equipment. Instructions concerning the method of carrying out the calibration check are given in Chapter 14, Appendix 3 of this publication.

Routine checks

167. The security of all connector terminations, mountings, and in particular the four mounting screws on the amplifier tray must be checked in accordance with the current Servicing Schedule.

Lubrication

168. All bearings and moving parts are lubricated during assembly and require no further lubrication until next overhaul.

Overhaul

169. Overhaul periods are laid down in A.P.3158, Vol. 2, Leaflet B11. Further details of overhaul procedure will be given in A.P.1275B, Vol. 2, Part 3, Sect. 3, Chap. 16 as soon as information is available.

Repairs and fault tracing

170. Repairs or renewal of faulty components in the precession or follow-up amplifiers can be made by qualified Instrument (Nav.) tradesmen. To assist in the identification of various components an exploded view of the precession and follow-up amplifiers is given in fig. 28 in which each item is annotated in accordance with its circuit reference.

171. A circuit diagram of the precession and follow-up amplifiers is given in fig. 24. In this diagram various accessible check points are indicated by numbered arrow heads, arranged so that the voltage or current in different parts of the circuits can be measured under static or dynamic conditions.

172. The voltage between any two appropriate check points should correspond to that shown in Tables 3 and 4 which specify the correct values. The values of the electrical supplies at other points in the circuits are given in fig. 24.

173. As a general aid to the location of faults throughout the compass installation a list of symptoms typical of certain faults, their probable cause and the remedy is given in Table 5 at the end of this chapter.

TABLE 3

Reference keys to circuit test points

Test under dynamic conditions with input to V1 control grid short circuited, see para. 172

Test between	Volts approximately	Remarks
4 and Earth	60 volts d.c.	V1 anode volts
5 and Earth	0·7 volts d.c.	V1 cathode bias
6 and Earth	200 volts d.c.	V2 anode volts
7 and 7	80 volts a.c.	Reference a.c. voltage
8 and Earth	85-105 volts d.c.	V3 anode volts
9 and Earth	85-105 volts d.c.	V4 anode volts
3 and Earth	225 volts d.c.	V5 cathode volts
2 and Earth	200 volts a.c.	a.c. volts at V5 anode

P24364 478782/3443 3/55 6250 C & P Gp. 1

TABLE 4

Reference keys to circuit test points

Test under static conditions with 12·5 mV. 800 c/s a.c. signal input to control grid V1. Phase difference between injected signal and reference voltage across C5 must be 0 deg.

Test	Volts approx.	Remarks
13	Grid V2 to earth	500 mV a.c.
14	Voltage across T1	45 V a.c.
15	Differential voltage input to V3	2·5 V d.c.
16	Differential voltage input to V4	2·5 V d.c.

Note . . .

Further information in respect of tests will be given in A.P.1275B, Vol. 2, Part 3, Chap. 16 as soon as information is available.

TABLE 5

Fault finding

Symptom	Possible cause	Action
Instrument fails to start	(1) Failure of power supply	Check power supply at amplifier. Supply should be 3-phase 115 volt ± 11% (104–126 volts), 400 cycles ± 5% (380–420 c/s), phase rotation A-B-C with B phase earthed
	(2) Defective fuse in control panel	Renew fuse
	(3) Faulty connections	Check continuity of cables and correct fitting of plugs and sockets. Test for short circuits, open circuits, and shorts to earth
	(4) Faulty gyro unit	Check continuity of 3-phase circuits on pins A, B and C of 12-pin plug at rear of unit A-B 40 ohms } approx. B-C 50 ohms } A-C 50 ohms } Replace unit if faulty
Gyro precesses and annunciator indicates CROSS or DOT continuously: Master indicator pointer follows compass card movement	(1) V3, V4 defective in precession amplifier	Renew defective valve
	(2) Defective circuit in precession section of amplifier	Remove amplifier for repair

Symptom	Possible cause	Action
Gyro precesses and annunciator indicators CROSS or DOT continuously: Master indicator pointer does not move	(1) Faulty connections between amplifier and master indicator (2) Fault in follow-up section of amplifier (3) Fault in master indicator	Check continuity of cables and connectors. If connections are satisfactory, disconnect from master indicator the socket colour-coded grey. Connect B and C pins of the fixed plug to the A and B phases of 115-volt 400 c/s supply (B pin to B phase and C pin to A phase) and connect K and L pins to a variable voltage 400 c/s a.c. supply not exceeding 40 volts, obtained from A and B phases. Switch on the supply, and the master indicator pointer should start rotating. Reverse K and L connections, and pointer should rotate in opposite direction. If it rotates in both directions, the fault is in the follow-up section of the amplifier. If it does not rotate, the fault is in the master indicator follow-up circuit. Remove amplifier or master indicator for repair.
	(4) Fuse F5 blown	Clear fault and replace fuse.
Gyro precesses and annunciator indicates CROSS or DOT: master indicator pointer moves intermittently in one direction only, irrespective of direction of movement of compass card	Faulty valve (V8 or V9) in follow-up amplifier	Renew valve
Gyro precesses and annunciator indicates CROSS or DOT: master indicator pointer moves continuously in one direction only	(1) Faulty valve (V6 or V7) in follow-up amplifier	Renew valve
	(2) Fault in transductors in amplifier	Remove amplifier for repair
Gyro precesses and annunciator indicates CROSS or DOT: master indicator pointer settles on an approximate heading of 0 deg., 60 deg., 120 deg., 180 deg., 240 deg., or 300 deg., irrespective of compass card heading	Short circuit in data selsyn stator circuit	Check continuity of data selsyn stator circuit, starting at pins G and H of the fixed plug colour-coded grey on the master indicator and following through the amplifier and control panel to pins G and H of the plug on the gyro unit

TABLE 5 — *continued*

Symptom	Possible cause	Action
Gyro precess and annunciator indicates CROSS or DOT. Master indicator pointer settles on an approximate heading of 30 deg., 90 deg., 150 deg., 210 deg., 270 deg., or 330 deg., irrespective of compass card heading	Open circuit in data selsyn stator circuit	Check continuity of data selsyn stator circuit
When synchronized gyro unit has 180 deg. error	Reversed connections between master indicator and amplifier	Check continuity between grey colour-coded 12-pin plug or master indicator and grey colour-coded socket on amplifier
When synchronized gyro unit indication is correct, master indicator has 180 deg. error	Incorrect phase rotation of the power supply	Check phase rotation which must be A-B-C with B phase earthed
When synchronized both gyro unit and master indicator have 120 deg. error	(1) Faulty signal lead connections between detector unit and master indicator	Check continuity between the 12-pin coupler plug (signal red) on the detector unit and the 12-pin socket (signal red) on the master indicator
	(2) Fault in detector unit	Check continuity with flux valve continuity tester *Note.—On no account use a d.c. continuity tester for this check*
	(3) Fault in master indicator	If connections are correct and detector unit passes the continuity test, check the master indicator and remove for repair if necessary
When synchronized both gyro unit and master indicator have a small error from the correct heading which varies with aircraft heading	(1) No deviation correction of detector unit due to failure of d.c. supply to compass	Check d.c. supply from aircraft distribution board and continuity of cables and connectors between detectors unit, master indicator and amplifier
	(2) Faulty compensator on detector unit	Remove detector unit for repair

Symptom	Possible cause	Action
When synchronized, both gyro unit and master indicator have a small error (maximum 9 deg.) which remains constant irrespective of aircraft heading	Deviation corrector control lamp unserviceable	Replace both lamps (Stores Ref. No. 5L/1928) (*para*. 161)
Compass cannot be synchronized; compass card and course pointer wander erratically; when the compass card is rotated by means of the synchronizing knob the course pointer will only follow-up the movement in one direction	(1) Faulty valve in follow-up amplifier	Check valves V6, V7, V8, and V9 and fit new if necessary (*fig*. 24)
	(2) Open circuit in follow-up amplifier	Check continuity with the aid of the wiring and component layout drawing (*fig*. 24)
	(3) Fuse F5 blown	Clear fault and fit new fuse
Annunciator indicates null over 360 deg. rotation of compass card; no precession	(1) Fault in connections between units	Check continuity of connection between detector unit and master indicator (*signal red*), master indicator and amplifier (*lemon*), amplifier and control panel (*orange*), control panel and gyro unit (*brilliant green*)
	(2) Fault in amplifier	Check with aid of fig. 24
	(3) No excitation current	Check a.c. supply to detector unit
	(4) Fault in detector unit excitation coil	Check continuity with a.c. continuity tester
	(5) Fuse F6 blown	Check fault and fit new fuse
Annunciator sluggish in operation	(1) Derated valve in precession amplifier	Check valve V1 to V5, and fit new as may be necessary
	(2) Incorrect power supply	Check power supply. The supply must be 115 volts ± 11% (104–126 volts). 400 ± 20 cycle a.c. with phase rotation A-B-C and B phase earthed
	(3) Improper shielding of detector unit cable	Check continuity of earth shield

TABLE 5—*continued*

Symptom	Possible cause	Action
Course pointer movement sluggish	(4) Open circuit in connections between detector unit and master indicator	Check continuity of plugs and sockets colour-coded signal red
	(5) Fault in detector unit	Check continuity with flux valve continuity tester. *Note.—On no account use a d.c. continuity tester*
	(1) Derated valve in follow-up amplifier	Check valves V6 to V9, and fit new as may be necessary
	(2) Faulty phase-changing condenser in follow-up amplifier	Check C14 (*fig.* 24)
	(3) Faulty follow-up motor or faulty gear train in master indicator	Remove master indicator for repair of motor
Automatic pilot. No signal on rotation of auto-pilot knob	(1) Circuit not energized from auto-pilot	Check output from auto-pilot
	(2) Open circuit in master indicator auto-pilot pick-off circuit	Remove master indicator for repair
Signal one side only	Partial open circuit in potentiometer winding of master indicator auto-pilot pick-off	Remove master indicator for repair
Jumpy or intermittent signal	Poor contact between wiper and potentiometer winding, or short circuits in winding	Remove master indicator for repair
Step by step transmitter. Loss of synchronization between compass repeaters and transmitter	(1) Insufficient pressure on brushes, or dirty commutator	Remove transmitter for cleaning and adjustment
	(2) Short or open circuit in transmitter	Remove transmitter for repair
Compass repeaters do not operate	(1) No supply to transmitter	Check d.c. supply (*fig.* 2)
	(2) Faulty transmitter	Remove transmitter for repair

Storage

4. The equipment comprising the Mk. 4B compass is contained in airtight tropicalized preservative packs, and providing that the pack is intact, requires no attention for a considerable period. Details concerning treatment of equipment in storage and the life of such equipment will be found in A.P.830, Vol. 2 and A.P.3158 respectively.

TESTS

Preliminary inspection

5. All units comprising the compass must be carefully examined for signs of damage or deterioration before testing.

Bezel glasses

6. Clean and examine for marks. Should it be necessary to remove the bezel and glass assembly, extreme care must be taken to avoid touching the inner surface as it is coated with an anti-condensation film which is adversely affected by the slightest trace of grease. If necessary, the inner surface of the glass may be lightly dusted with a perfectly clean cloth which is free from fluff. When replacing the bezel assembly, ensure that the longest of the five securing screws is fitted in the "6 o'clock" screw hole.

Fluorescent markings

7. Inspect the markings for discolouration and verify that the fluorescent compound has not flaked off at any point.

Electrical tests

8. The following electrical tests should be carried out.

(1) Measure the resistance between pins D and E and E and F on the gyro unit GREEN plug. The ◀ resistance should be between 600 and 750 ohms in each instance for Type A gyro unit, or between 900 and 1000 ohms resistance for Types B and C gyro units. ▶

(2) Measure the resistance between pin D on the GREY plug and pin D on the YELLOW plug, and between pins F on the similarly coloured plugs on the master indicator. The resistance should be between 300 and 400 ohms in each instance.

Serviceability test

9. Although the standard serviceability test for the installations incorporating two gyro units is similar to that for single gyro unit installations, the description given hereafter will refer in general to the former and additional paragraphs will be added, where applicable, to cover the latter. The test comprises six separate checks which should be carried out in the following sequence:—

(1) Starting test for gyro units.
(2) Drift test for gyro units.
(3) Functioning check using the compass test set.
(4) Monitoring system test and functional check of master indicator.
(5) Functional test of deviation compensator.
(6) Compass repeater test.

Starting test

10. Equipment with two gyro units. Each gyro unit must be given a starting test with the a.c. supply voltage reduced to 90 volts. The gyro rotors must be stationary at the commencement of the test and should start to rotate and accelerate up to speed immediately the power is switched on, see note after para. 2 (b). The test should be carried out as follows:—

(1) Mount the gyro units on the gyro test table and connect to the 115 volts 400 c/s, 3-phase a.c. supply.
(2) Switch on the gyros and allow them to run up to full speed. Then by means of the voltage control provided on the test table, reduce the supply voltage to 90 volts.
(3) Switch off the power supply and allow the gyros to come to rest.
(4) Switch on the reduced a.c. supply to the gyro units and verify that each gyro rotor commences to rotate immediately and accelerates to full speed. A distinct whine, rising in pitch, should be audible as the rotors accelerate.
(5) Switch off the a.c. supply.

Exercising period

11. Before commencing the following tests each gyro must be exercised whilst running on full voltage (115 volts ± 11·5 volts, 3 phase, 400 c/s ± 20 c/s) as follows:—

APPENDIX 1

STANDARD SERVICEABILITY TEST (S.G.50)

for

COMPASS, GYRO-MAGNETIC MK. 4B

Introduction

1. The tests described in this Appendix must be applied to the Mk. 4B gyro-magnetic compass immediately before it is installed in an aircraft, and at any time that the serviceability of the compass installation is suspect. The tests must also be applied during re-inspection periods at Maintenance Units and should be carried out in the sequence in which they are described.

Conditions of test

2. The following conditions of test must be observed at all times and tolerances specified for any particular test should not be exceeded.

(1) All tests must be carried out at normal room temperature, i.e., between 10 deg.—25 deg. C

(2) When in use during any of the tests the detector unit must be placed in a locality where magnetic interference is a minimum.

(3) The power supplies used during the tests must comply with the requirements specified below. This should be checked with a compass test set.

(a) The a.c. supply must be 115 volts $\pm$ 11·5 volts 3-phase, 400 c/s $\pm$ 20 c/s, 3-phase, but if possible it should be 115 $\pm$ 5 volts, 400 $\pm$ 5 c/s. Phase rotation must be 'A'—'B'—'C' with 'B' phase earthed.

(b) The d.c. supply must be steady at 24 volts.

Note.—It is important to ensure that the phase rotation is correct; reversed phase rotation will cause excessive gyro drift. After switching on the a.c. supply to a gyro unit verify at once that the gyro rotor commences to rotate and accelerates up to full speed. If the gyro rotor does not start up at once, SWITCH OFF the power supply IMMEDIATELY. If one phase is open-circuited, failure to switch off at once will cause serious damage to the gyro unit.

Warning.—Under no circumstances must a d.c. continuity tester be used for checking the detector unit circuits.

(4) The standard Mk. 4B bench test harness must be used for inter-unit connections. Details of the connectors are given in fig. 1.

(5) Except where otherwise specified, all tests must be carried out with the full voltages applied, but provision must be made for reducing the a.c. voltage during the gyro starting test.

TEST EQUIPMENT

3. The test instruments and other equipment listed below are required for the tests

(1) Frequency meter (Stores Ref. 5Q/154).

(2) Gyro test table Mk. 4 (Stores Ref. 6C/790).

(3) Avometer Type D (Stores Ref. 10S/10610).

(4) Compass test set (Stores Ref. 6C/848).

(5) Detector unit support bracket or turn table (local manufacture).

(6) Stop-watch (Stores Ref. 6E/287).

(7) Test bench harness (Stores Ref. 6C/803).

Note.—For instructions concerning the use of compass test set (item 4) reference should be made to A.P.1275A, Vol. 1, Sect. 6, Chap. 28.

Storage

4. The equipment comprising the Mk. 4B compass is contained in airtight tropicalized preservative packs, and providing that the pack is intact, requires no attention for a considerable period. Details concerning treatment of equipment in storage and the life of such equipment will be found in A.P.830, Vol. 2 and A.P.3158 respectively.

TESTS

Preliminary inspection

5. All units comprising the compass must be carefully examined for signs of damage or deterioration before testing.

Bezel glasses

6. Clean and examine for marks. Should it be necessary to remove the bezel and glass assembly, extreme care must be taken to avoid touching the inner surface as it is coated with an anti-condensation film which is adversely affected by the slightest trace of grease. If necessary, the inner surface of the glass may be lightly dusted with a perfectly clean cloth which is free from fluff. When replacing the bezel assembly, ensure that the longest of the five securing screws is fitted in the "6 o'clock" screw hole.

Fluorescent markings

7. Inspect the markings for discolouration and verify that the fluorescent compound has not flaked off at any point.

Electrical tests

8. The following electrical tests should be carried out.

(1) Measure the resistance between pins D and E and E and F on the gyro unit GREEN plug. The ◄ resistance should be between 600 and 750 ohms in each instance for Type A gyro unit, or between 900 and 1000 ohms resistance for Types B and C gyro units. ►

(2) Measure the resistance between pin D on the GREY plug and pin D on the YELLOW plug, and between pins F on the similarly coloured plugs on the master indicator. The resistance should be between 300 and 400 ohms in each instance.

Serviceability test

9. Although the standard serviceability test for the installations incorporating two gyro units is similar to that for single gyro unit installations, the description given hereafter will refer in general to the former and additional paragraphs will be added, where applicable, to cover the latter. The test comprises six separate checks which should be carried out in the following sequence:—

(1) Starting test for gyro units.
(2) Drift test for gyro units.
(3) Functioning check using the compass test set.
(4) Monitoring system test and functional check of master indicator.
(5) Functional test of deviation compensator.
(6) Compass repeater test.

Starting test

10. Equipment with two gyro units. Each gyro unit must be given a starting test with the a.c. supply voltage reduced to 90 volts. The gyro rotors must be stationary at the commencement of the test and should start to rotate and accelerate up to speed immediately the power is switched on, see note after para. 2 (b). The test should be carried out as follows:—

(1) Mount the gyro units on the gyro test table and connect to the 115 volts 400 c/s, 3-phase a.c. supply.

(2) Switch on the gyros and allow them to run up to full speed. Then by means of the voltage control provided on the test table, reduce the supply voltage to 90 volts.

(3) Switch off the power supply and allow the gyros to come to rest.

(4) Switch on the reduced a.c. supply to the gyro units and verify that each gyro rotor commences to rotate immediately and accelerates to full speed. A distinct whine, rising in pitch, should be audible as the rotors accelerate.

(5) Switch off the a.c. supply.

Exercising period

11. Before commencing the following tests each gyro must be exercised whilst running on full voltage (115 volts ± 11.5 volts, 3-phase, 400 c/s ± 20 c/s) as follows:—

This leaf issued with A. L. No.226, March, 1954

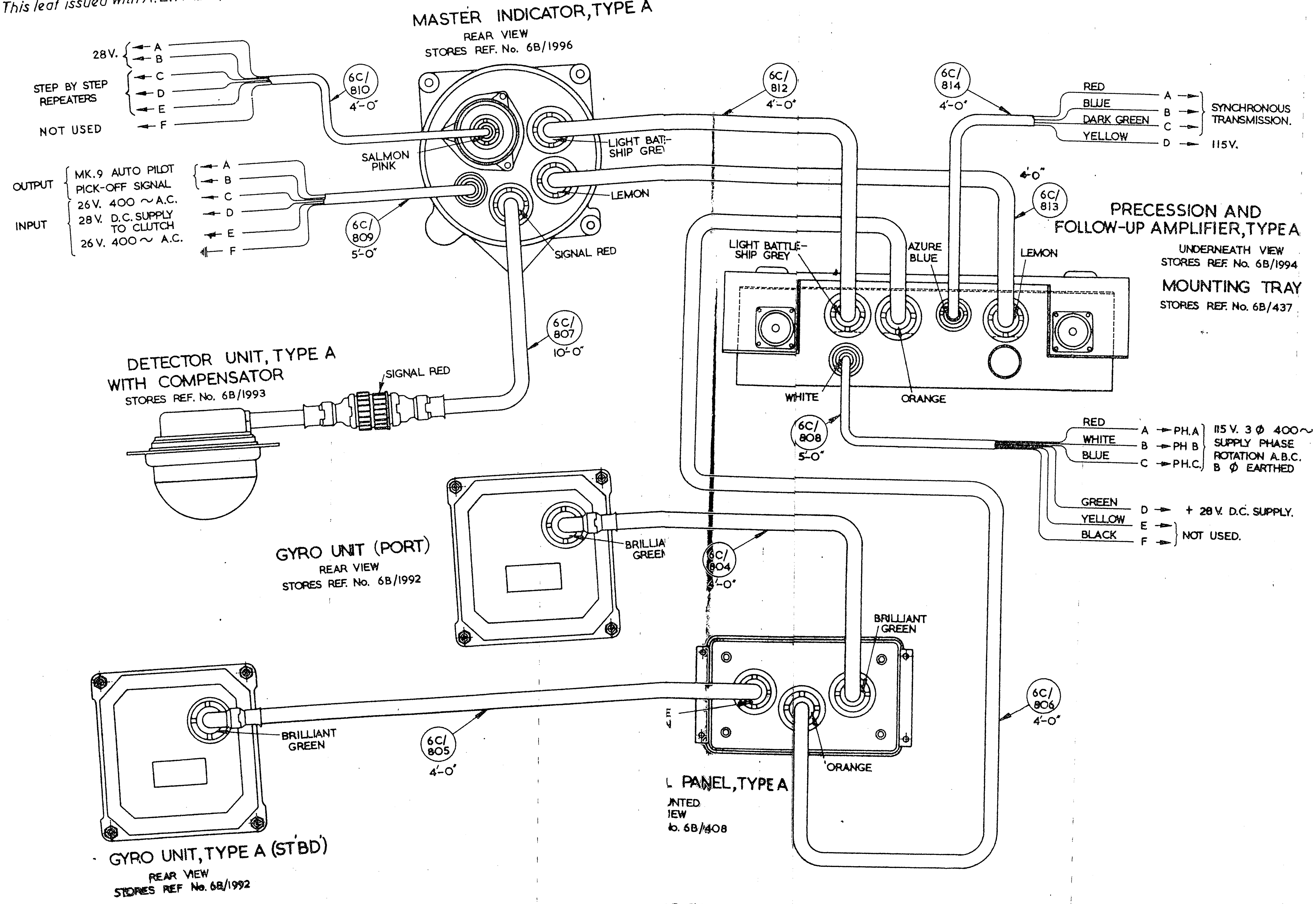


FIG. 1

DIAGRAM OF BENCH TEST HAFCOMPASS, GYRO-MAGNETIC, Mk.4B

RESCTED

FIG. 1

PP7427 434604/4273 4/54 6750 C&P Gp. 959 (4)

(1) Mount both gyro units on a roll, pitch and yaw table which has been adjusted to originate $\pm 7\frac{1}{2}$ deg. movements about the horizontal at a rate of 6 to 10 movements per minute.

(2) Set the roll, pitch and yaw table in motion. Connect the gyro to a proved 115 volts 400 c/s supply and switch on.

(3) Allow the gyros to run for a period of not less than 20 minutes during which the direction of movement of the table should be reversed at intervals of approximately one minute. No readings are to be recorded.

(4) Stop the roll, pitch and yaw table.

Drift test for gyro units

12. The following procedure should be followed when setting the Mk. 4B compass to the cardinal points during the drift test:—

(1) Level the roll, pitch and yaw table.

(2) The gyro should still be running after exercising.

(3) Push in the synchronizing control knobs on the port and on the starboard gyro units to cage and level the gyro rotors. Turn the control knobs until the compass card on each gyro unit indicates North. Release the control knobs.

(4) Set the roll, pitch and yaw table in motion. After ten minutes running time, stop and level the table and note the drift shown by the compass cards on the port and on the starboard gyro units.

(5) Turn the roll, pitch and yaw table until the gyro reads 90 deg.; push in the synchronizing control knobs on the port and on the starboard gyro units to cage and level the rotors. Release the control knobs.

Note.—The required rotation of the outer gimbal cannot be achieved by using the caging knob on the instrument itself. This action merely holds the gyro in a fixed position and rotates the card with respect to the outer gimbal.

(6) Set the roll, pitch and yaw table in motion. After ten minutes running time, level the table and note the drift shown by the compass cards on the port and on the starboard gyro units.

(7) The procedure described in sub-para. (5) and (6) must be repeated successively on compass headings of 180 deg. and 270 deg. noting the drift of each gyro unit at the completion of each ten minute running period.

(8) Switch off the gyro units. Stop and level the roll, pitch and yaw table.

Types A and B

(9) The drift on any one of the four headings should not exceed $2\frac{1}{2}$ deg. for any 10 minute period, with the exception that a drift of 3 deg. on any one heading is acceptable provided that the total drift (ignoring the signs) does not exceed 10 deg. The test figures shown in the following table are typical examples.

TABLE 1

Example	Heading 0	90	180	270	Total drift	Remarks
1	$+2\frac{1}{2}°$	$+2\frac{1}{2}°$	0°	1°	6°	Acceptable
2	$+2\frac{1}{2}°$	$+2\frac{1}{2}°$	$-2\frac{1}{2}°$	$-3°$	$10\frac{1}{2}°$	Reject: excessive total
3	$+2\frac{1}{2}°$	$+2\frac{1}{2}°$	$+3°$	$+2°$	10°	Acceptable

Note.—These figures are applicable only if the gyro unit is tested at the latitude for which it was calibrated by the manufacturer. When tested at another latitude the observed results must first be corrected before applying the above criteria. Reference should be made to para. 15 for the method of correction.

13. If the drift exceeds the permissible maximum on any heading a repeat check should be made, but if the result is still unsatisfactory the gyro unit must be considered unserviceable.

14. The useful property of a gyroscope is the tendency of its spin axis to retain its direction in space unchanged. If a perfectly balanced compass gyro unit were to be set down at, say, the North pole of the earth, the gyro spin axis would retain a fixed direction in space while the outer framework

would be carried round with the earth as the latter rotated about its own axis. To an observer, who would of course move with the earth, it would appear that the gyro spin axis was precessing steadily in azimuth at 1 revolution in 24 hours, i.e., at 15° per hour. Again, if the gyro unit is at the equator there will be no change in azimuth of the spin axis, although in general it will tend to move in the vertical plane. Hence, since the earth is the normal basis of reference, a gyro unit will show an apparent drift in azimuth depending on its position on the earth's surface. This apparent drift will vary from zero at the equator to 15° an hour at the poles, the law actually being:—

$$\text{apparent drift} = 15 \times \text{sine latitude deg./hour}$$

For the compass gyro unit this apparent drift will be negative in the Northern Hemisphere, positive in the Southern.

The manufacturer calibrates the gyro units to have zero observed drift at a particular latitude, 51°N for type A units, 21°N for type B (units may be calibrated for other latitudes under special circumstances). Hence, if a gyro unit is checked for drift at a latitude other than that for which it was calibrated, allowance must be made for this effect of the earth's rotation.

15. It should now be evident that if a gyro unit, Type A, has been calibrated to have zero observed drift at latitude 51°N, in reality it has been given a real drift of $+15$ sine 51° i.e., $+ 11\frac{1}{2}°$ an hour to counteract the effect of earth's rotation of $-11\frac{1}{2}°$ an hour, so that its observed drift at 51°N is $+11\frac{1}{2} - 15$ sine $51° = 0$.

If now this gyro is tested at some other latitude N° north, the observed drift will be:—

$$+11\tfrac{1}{2}° - 15 \sin N \text{ degrees an hour.}$$

(If tested at S° south latitude, the observed drift will of course be $+11\frac{1}{2}° + 15 \sin S$ degrees an hour.) This amount, taking due account of sign, must therefore be subtracted from all observations of drift made at latitude N° north, before applying the test laid down in para. 12. sub.-para. (6).

Note.—For details of errors over intervals of 10 degrees between the equator and 70 degrees north, reference should be made to Table 2.

16. Using the compass test set carry out the following electrical functioning tests:—

(1) Check the functioning of the precession section of the amplifier unit

(2) Check the exciter current taken by the detector unit.

Note.—It has been found that the original type of relay used to actuate the D.G. indicator in the gyro unit may adversely affect the drift rate of the instrument, when energized. Under modification Inst. B/40, this relay is being replaced in production by a more satisfactory type, but many gyro units already in service are fitted with the original type. If a gyro unit is run on the gyro test table when connected into a complete compass system, for measurement of the drift rate, the D.G. relay will be energized. If excessive drift rates are found, the instrument must not be rejected until the test has been repeated under the following conditions. Disconnect the connecting cable from the gyro, and apply 3-phase power at 115 v.— 400 c/s to pins A, B and C of the gyro unit plug (pin B is earthed). Repeat the drift tests as described in para. 12; the drift should not exceed that given in para. 12, sub-para. (9).

17. Using the compass test set, carry out the following tests:—

(1) Check the functioning of the precession section of amplifier unit.

(2) Check the functioning of the follow-up section of amplifier unit.

(3) Check the exciter current taken by detector unit.

(4) Check the functioning of the auto-pilot pick-off unit.

Monitoring system test and functional check of the master indicator

18. The gyro units and the master indicator must be connected to a proved 400 cycle a.c. supply and to a steady 24-volt d.c. supply. The detector unit should be mounted horizontally on a detector unit turntable or other suitable rigid fixture which must be placed so that it is in a position where magnetic interference is at a minimum.

19. The separate units comprising the compass should be interconnected by means of the bench test harness and the extension lead of the centre-zero voltmeter in the compass test set (Stores Ref. 6C/848) should be plugged into the jack socket on the amplifier.

20. The complete equipment should be connected to a proved a.c. supply (*para.* 2) and the monitoring system checked as follows:—

(1) Switch on the a.c. supply to the compass. Verify that the gyros start and continue to run up, and that the phase rotation is correct, and leave the equipment running for approximately 20 minutes.

(2) Turn the compass selector switch on the control panel to PORT COMPASS or to GYRO COMPASS if only one gyro unit is used.

(3) Check the voltages on the follow-up motor in the master indicator by means of the compass test set.

(4) Push in and turn the port gyro unit synchronizing control knob in the direction indicated by the annunciator and verify that the annunciator changes signs as the voltmeter pointer passes through zero.

(5) Synchronize the port gyro unit by adjusting the synchronizing control knob until the voltmeter pointer reads zero and the annunciator is central, i.e., in the null position.

(6) Verify that the heading shown by the compass card on the port gyro unit and that shown by the master indicator agree to within $\pm$ 1 deg.

(7) Using the synchronizing control, offset the port gyro compass card 7 deg. to one side of the established null position. Verify that the master indicator pointer follows the movement of the card and agrees within $\pm$ 1 deg. Note the time taken for the gyro to precess from 5 deg. to within $\frac{1}{2}$ deg. of zero, or until the centre-zero volt-meter reads not more than $2\frac{1}{2}$ volts.

(8) Offset the port compass card 7 deg. to the other side of the null point and again note the time taken for the gyro to precess from 5 deg. to within $\frac{1}{2}$ deg. of zero or until the centre-zero voltmeter reads not more than 2 volts.

(9) Turn the compass selector switch to STARBOARD COMPASS and, using the starboard gyro unit, repeat the test described in the preceeding sub-para.

(10) The time taken in each of the above checks should not exceed 5 minutes.

Note.—If an artificially high rate of turn is introduced by rotating the compass card rapidly, the master indicator pointer will oscillate about the new heading before settling. This is a characteristic effect, common to all master indicators, and is quite consistent with satisfactory operation.

D.G. indicator test

21. Turn the compass selector switch to OFF and verify that D.G. is shown in the annunciator windows of each gyro unit and in the master switch indicator.

Note.—Master indicators with serial numbers up to No. 463 inclusive are not fitted with the D.G. indicating device. It is, therefore, important to check the serial number of the master indicator when applying this test.

Equipments with one gyro unit

22. These should be tested in a similar manner to that described in para. 13 to 17 inclusive. With the selector switch at GYRO COMPASS a dot or a cross should be shown in the annunciator window of the gyro unit and the same indication should be shown on the master indicator. With the selector switch OFF, D.G. should be shown in the annunciator windows of the gyro unit and the master indicator.

Compensator lamps

23. It is important to check that both the compensator lamps light up when the d.c. supply is switched on. If either lamp has failed it should be replaced by a new lamp (Stores Ref. 5L/X951230).

Functional test of deviation compensator

(1) Mount the detector unit on a detector turntable.

(2) Interconnect all the separate units comprising the compass by means of the bench test harness and connect the equipment to a proved 115-volt, 400 c/s, 3-phase a.c. supply, and to a steady 24-volt d.c. supply.

(3) Open the flap in the amplifier cover and, using a compass adjusting key (Stores Ref. 6E/337) turn the B and C corrector controls in the compensator circuit to zero.

24. Turn the selector switch on the control panel to PORT COMPASS (or GYRO COMPASS if only one gyro unit is used) and proceed as follows:—

(1) Switch on the a.c. and the d.c. supplies and verify that the gyro rotors start to rotate and accelerate to full speed. If either gyro rotor fails to start immediately, switch OFF the a.c. supply at once. Allow the equipment to run for not less than two minutes.

(2) Turn the detector unit in azimuth until the port gyro unit compass card, when synchronized correctly, shows a North heading.

(3) Turn the C (North-South) corrector control so that its dial reads +14. Verify that a cross is shown in the annunciator windows of the port gyro unit and the master indicator.

(4) Synchronize the port gyro by means of the synchronizing control knob and verify that the annunciator shows a null i.e., mid-way between the dot and the cross signs, when the compass card heading is between 12 deg. and 18 deg.

(5) Turn the C corrector control to −15 and verify that a dot is shown in the annunciator windows of the port gyro unit and the master indicator. Repeat the procedure described in (4) and verify that the annunciator shows a null when the compass card heading is between 342 deg. and 348 deg. Return the C corrector control to zero.

(6) Turn the detector unit 90 deg. in azimuth so that the port gyro unit compass card, when synchronized, shows an East heading.

(7) Turn the B (East-West) corrector control so that its dial reads +15. Verify that a cross is shown in the annunciator window of the port gyro unit and the master indicator.

(8) Synchronize the port gyro and verify that the annunciator shows a null when the compass card heading is between 102 deg. and 108 deg.

(9) Turn the B corrector control so that its dial reads −15 and verify that a dot is shown in the annunciator windows of the port gyro unit and the master indicator.

(10) Repeat the procedure described in (8) and verify that the annunciator shows a null when the compass card heading is between 72 deg. and 78 deg.

Compass repeater test

25. Using the bench test harness, interconnect all units comprising the compass and connect it to the proved 115 volt 400 c/s a.c. and to the 24 volts d.c. supplies. Connect a standard Mk. 1 D.R.C. repeater (Stores Ref. 6B/742) to the six-way connector, (colour coded SALMON-PINK) at the rear of the master indicator. The connections to the D.R.C. repeater should be as shown in fig. 1.

D.R.C. Repeater		6-pin connector on Mk.1
Blue	to	C
Green	to	D
Red	to	E

(1) Switch on the a.c. and the d.c. supplies and turn the compass selector switch to PORT COMPASS.

(2) Bring the repeater reading into agreement with that of the master indicator by means of the compass corrector key.

(3) Rotate the port gyro unit compass card through 180 deg. by means of the synchronizing control knob at a rate not exceeding 12 deg. per second and verify that the repeater remains in synchronism within ± deg. of the master indicator heading. This test should be repeated twice in each direction and the average error should not exceed the limits specified.

TABLE 2

Latitude	Apparent drift	Manufacturer's Setting	GYRO UNIT, TYPE A Total drift in 10 min.		GYRO UNIT, TYPE B Total drift in 10 min.	
			Add.	Subtract	Add.	Subtract
0°	0°	+11½°/hr.		2°		10°
10°N	2½°	TYPE A		1½°		½°
21°N	5½°			1°		0°
30°N	7½°	+5½°/hr.		½°	0°	
40°N	9½°	TYPE B		½°	½°	
51°N	11½°			0°	1°	
60°N	13°		0°		1°	
70°N	14°		½°		1½°	
		(See para. 15)				

P23346 434603/4272 6/54 6750 C & P Gp. 1

Appendix 2

TYPE B EQUIPMENT

1. In order to improve the performance of the Mk. 4B compass when used in association with certain other equipment which will be introduced into the Services, certain modifications are being made to the master indicator, gyro, and amplifier units. To assist in identification of these modified units they have been designated Type B equipment, and given new Stores Reference Numbers.

Master indicator Type B 6B/634
Gyro unit Type B 6B/561
Amplifier unit Type B 6B/562

Details of these changes are given in the following paragraphs.

Master indicator, Type B

2. The Type B indicator differs from the Type A indicator in the variation dial presentation and the auto-pilot pick-off.

The aperture through which the variation dial is visible has been modified and it is located in the 9 o'clock position. This has enabled all the figures to be included in the scale numbering, and the caption "X10" used on the Type A scale to be eliminated. The scale has also been sub-divided into 1 deg. intervals, a finer lubber mark has been provided, and the scale markings are now black on a white dial.

The facility for trimming the course held by the auto-pilot has been deleted from the Type B unit. This has resulted in the elimination of the knob and associated mechanism at the bottom of the instrument. The range of the pick-off potentiometer has also been increased from $\pm$ 4 deg. to $\pm$ 10 deg., although the total monitoring signal for full misalignment remains unaltered at 300mV.

Gyro unit, Type B

3. The main changes are in the bevel gear linking the card to the vertical gimbal ring, and in the introduction of an a.c. precession system.

In the Mk. 4B Compass, synchronous transmission of heading information is obtained from a transmitter mounted behind the card of the gyro unit. This is coupled to the vertical gimbal ring by the large bevel gear. In order to maintain a sufficiently low level of friction in this system, it is necessary to give a tolerance of $\frac{1}{4}$ deg. backlash in the bevel gear. In certain associated equipments it is desired to make use of the azimuth stabilization provided by the compass gyro unit. For this application the presence of $\frac{1}{4}$ deg. backlash in the transmission is very undesirable. In the Type B gyro unit, the simple bevel wheels are replaced by wheels the main drive of which is taken by friction surfaces, a portion of tooth being retained to eliminate the possibility of cumulative slip.

As with the Mk 4F compass, trouble is sometimes occasioned by interference caused at the emergency compass by the permanent magnets used for the d.c, precession system of the Type A gyro unit. This has been largely eliminated in the Type B unit by the introduction of an a.c. precession system not requiring permanent magnets.

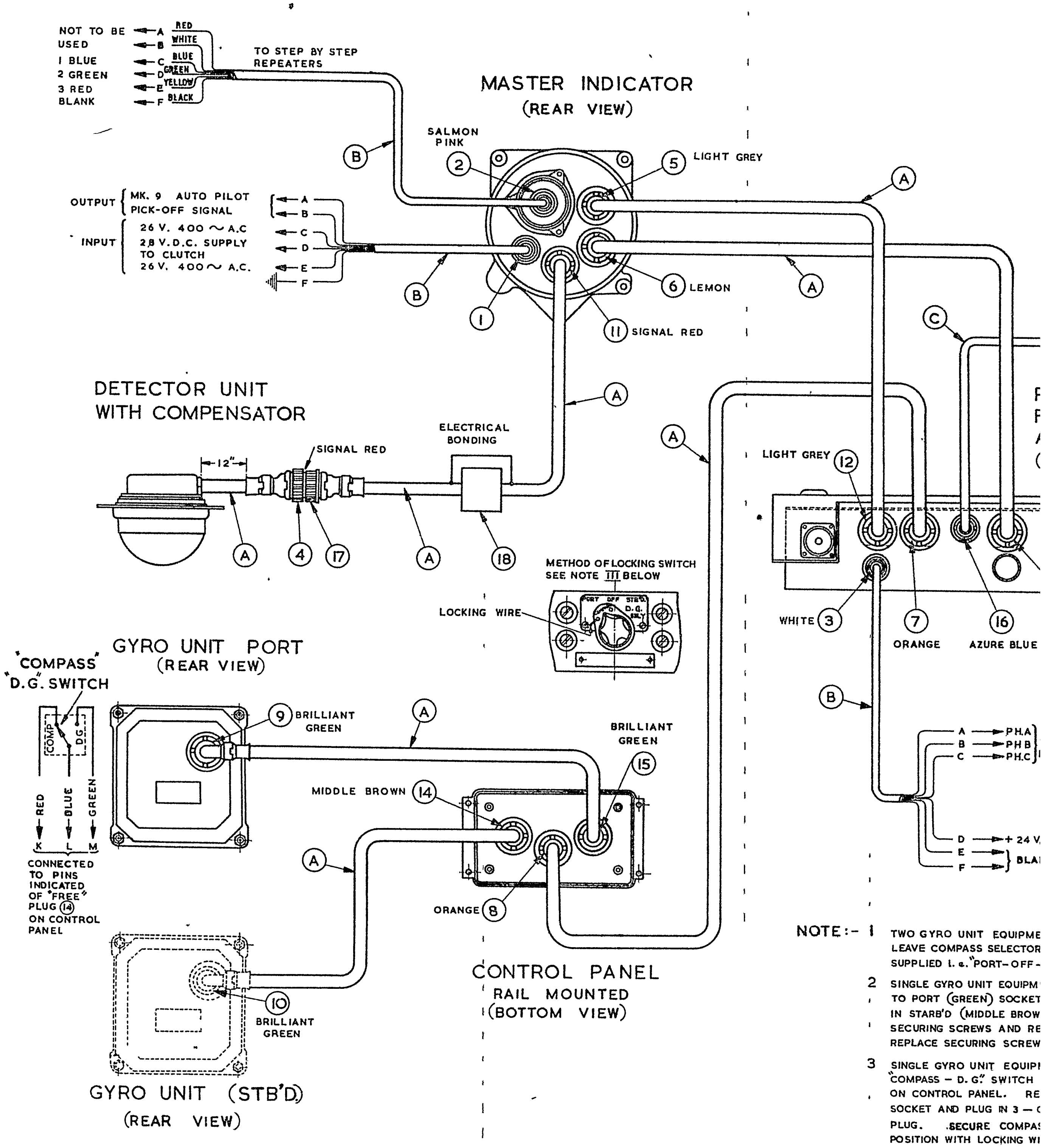
On the gyro cover, the position of the breather vents which were originally on the top surface have been moved to the sides to avoid the possibility of water percolating through the felt and dripping down on to the actual gyro assembly.

Amplifier unit, Type B

4. The rectifier valve Type CV.135 has been replaced by the CV.493. Since the latter is physically larger than the CV.135, it cannot be used in the Type A amplifier. The Type B unit has been designed to accommodate the CV.493. By suitable cross-connection of the valve-holder, it has been possible to arrange that the CV.135 can still be used in the Type B amplifier. A relay has also been included to enable the compass monitoring to be interrupted by the application of a 28V signal. This facility is sometimes required when it is necessary to reduce compass errors during turns. Finally, to assist the task of the designers of auto-pilots in obtaining heading stabilization from the compass, the monitoring characteristic has been brought under closer control by the introduction of negative feed-back. This has the further useful result that the amplifier is rendered more independent of valve characteristics and voltage variations.

P23230 72850/5954 5/54 6750 C & P Gp. 1

This leaf issued with A. L. No. 225, Feb.. 1954



NOTE:- 1 TWO GYRO UNIT EQUIPME LEAVE COMPASS SELECTOR SUPPLIED i. e. "PORT-OFF-

2 SINGLE GYRO UNIT EQUIPM TO PORT (GREEN) SOCKET IN STARB'D (MIDDLE BROW SECURING SCREWS AND RE REPLACE SECURING SCREW

3 SINGLE GYRO UNIT EQUIPI "COMPASS – D. G." SWITCH ON CONTROL PANEL. RE SOCKET AND PLUG IN 3 – C PLUG. SECURE COMPAS POSITION WITH LOCKING WI

FIG. 27 INTER-UNIT CONNECTOR DIAGRAM AND DE

RES

DETAILS OF PLUGS, SOCKETS & COUPLER PLUG ATTACHED TO CABLE ENDS

No. OF WAYS	DESIG-NATION	COUPLER PLUG BODY ASS'D.	SOCKET BODY ASS'D	PLUG BODY ASS'D.	OUTLET GASKET	OUTLET & NUT ASS'D	SEALING RING	INNER FERRULE	OUTER FERRULE
6	1		Z.560542		Z. 970058	Z. 970062	Z. 970088	Z. 970078	Z. 970077
6	2			Z.560360	Z. 970058	Z. 970062	Z. 970088	Z. 970078	Z. 970077
6	3		Z.560120		Z. 970058	Z. 970062	Z. 970088	Z. 970078	Z. 970077
12	4	Z. 560470			Z. 970059	Z. 970065	Z. 970091	Z. 970084	Z. 970083
12	5		Z. 560184		Z. 970059	Z. 970065	Z. 970091	Z. 970084	Z. 970083
12	6		Z. 560182		Z. 970059	Z. 970065	Z. 970091	Z. 970084	Z. 970083
12	7			Z.560363	Z. 970059	Z. 970065	Z. 970091	Z. 970084	Z. 970083
12	8		Z. 560181		Z. 970059	Z. 970065	Z. 970091	Z. 970084	Z. 970083
12	9		Z 560185		Z. 970059	Z. 970072	Z. 970091	Z. 970084	Z. 970083
12	10		Z. 560185		Z. 970059	Z. 970072	Z. 970091	Z. 970084	Z. 970083
12	11			Z.560360	Z. 970059	Z. 970065	Z. 970091	Z. 970084	Z. 970083
12	12			Z.560360	Z. 970059	Z. 970065	Z. 970091	Z. 970084	Z. 970083
12	13			Z.560362	Z. 970059	Z. 970065	Z. 970091	Z 970084	Z. 970083
12	14			Z.560361	Z. 970059	Z. 970065	Z. 970091	Z. 970084	Z. 970083
12	15			Z.560365	Z. 970059	Z. 970065	Z. 970091	Z. 970084	Z. 970083
4	16			Z.560290	Z. 970058	Z. 970062	Z. 970088	Z. 970078	Z. 970077
12	17		Z. 560180		Z. 970059	Z. 970065	Z. 970091	Z. 970084	Z. 970083
—	18	WING ROOT, TRANSPORT OR PRESSURE BULKHEAD JUNCTION BOX							
—	A	12 CORE VINMETSMALL CABLE							
—	B	6 CORE VINMETSMALL CABLE							
—	C	4 CORE VINMETSMALL CABLE							
—	D	3 CORE VINMETSMALL CABLE							

ONOUS
ON
&
)
NTING TRAY
-Y
).C.

OVE WITH STARBD GYRO DOTTED.
PLATE ON CONTROL PANEL AS

L ACCESSIBLE):- CONNECT GYRO UNIT
.. INSERT SHORTING PLUG
VE INDICATOR PLATE
IAT "GYRO-OFF" IS SHOWN.

NEL INACCESSIBLE):- SEPARATE
GYRO UNIT TO PORT (GREEN) SOCKET
JG FROM STBD. (MIDDLE BROWN)
FROM S. P D T. SWITCH USING REDUCER
CH IN PORT

OF PLUGS, SOCKETS AND COUPLER PLUG FIG. 27

ED