Chapter 15

COMPASSES, GYRO-MAGNETIC, Mk. 4F

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Introduction

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

2. The Mk. 4F compass is an aircraft flight instrument which combines the functions of the directional gyro and the magnetic compass. It is intended primarily for use in aircraft in which the pilot is also the navigator.

3. The indications shown by the compass are stabilized by the 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.

4. 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.

GENERAL DESCRIPTION

General

5. The Mk. 4F Compass, shown in fig. 1, consists of four units each of which is separately described in this chapter. Reference should be made to the simplified schematic diagram (*fig.* 2) which will facilitate a clear understanding of the relative function of each unit and of the system as a whole.

Detector unit

6. This unit, a sectional view of which is shown in fig. 3, comprises a pendulous sensitive element and an electro-magnetic deviation compensator. It is provided with

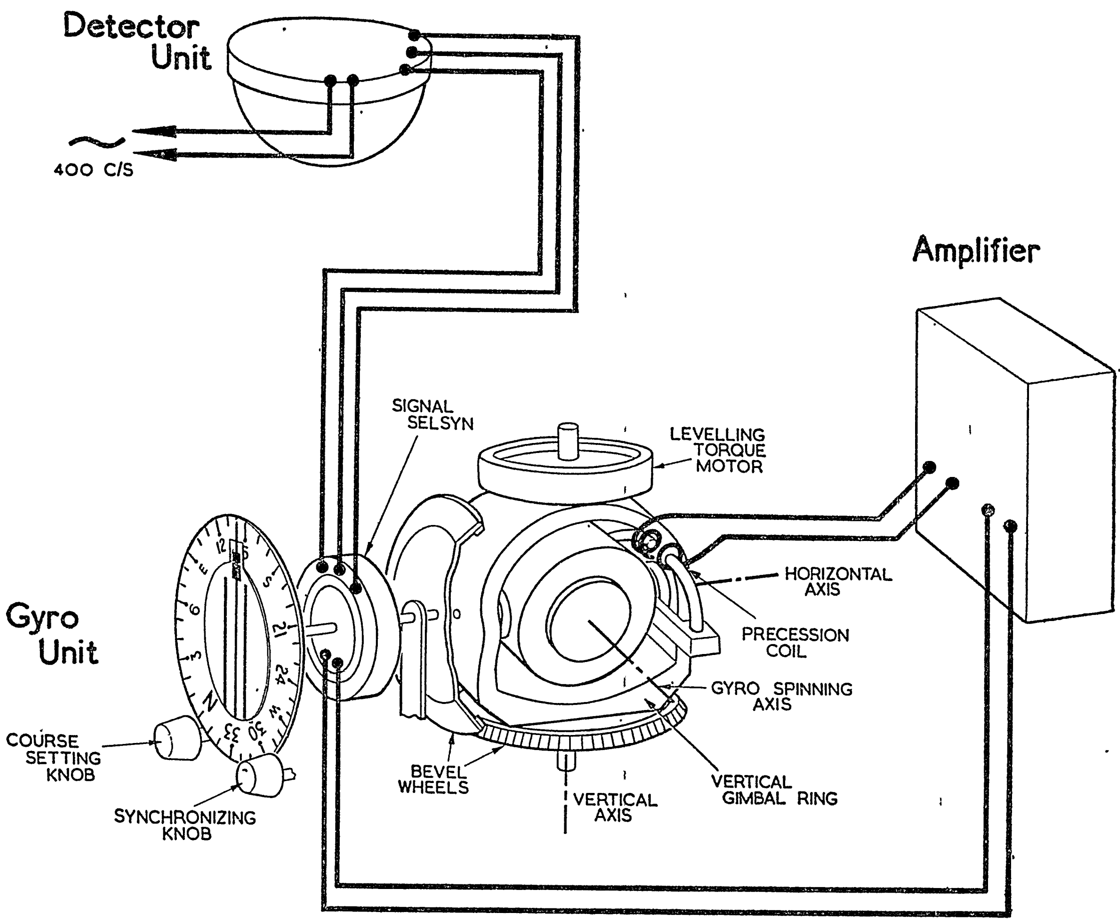

Fig. 2. Schematic diagram of gyro-magnetic compass, Mk. 4F (gyro unit, Type A)

a mounting flange which is engraved FORE and AFT and when installed must be in alignment with the fore and aft axis of the aircraft.

7. The pendulous element, known as a flux valve, is free to swing up to a maximum of 25 deg. in pitch and roll, but is fixed to the aircraft in azimuth. In construction the element 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.

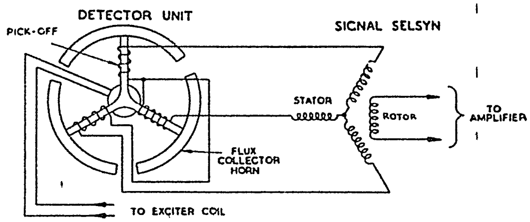

Fig. 4. Flux valve and selsyn connections

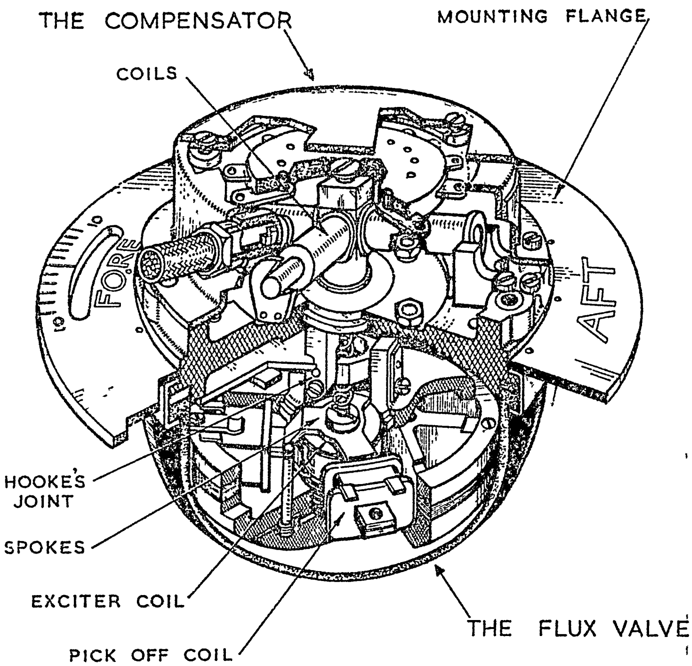

Fig. 3. Detector unit and compensator assembly

8. Referring to the schematic diagram (*fig.* 4), it will be seen that an exciter coil is wound around the central core and a pick-off coil is wound around each spoke. The axis of the exciter coil is vertical and is at right angles to the axes of the pick-off coils which are horizontal.

9. The exciter coil is supplied with 400 c/s single-phase a.c. sufficient to induce a strong magnetic flux in each spoke. 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 magnetic field in line with each spoke (*fig.* 5).

10. Since the pick-off coils are star-connected to the stator winding of the signal selsyn in the gyro unit, the magnetic field produced in the stator has a vector directly related to the direction of the earth's magnetic field.

Note . . .

A detailed technical explanation of the operation of the flux valve, and a description of the selsyn transmission system used in the Mk. 4F compass are given in Chapter 14 of this section.

Gyro unit

11. This unit, a sectional view of which is given in fig. 6, is essentially an electrically driven directional gyro and can be used as such if required. It includes a gyroscopic movement, a signal selsyn assembly, compass card, annunciator, course setting and synchronizing controls.

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

13. Referring to fig. 2, it will be seen that the compass card is mounted at one end of the signal selsyn rotor shaft and that the other end of the shaft carries a bevel gear. This gear engages with a second bevel gear mounted in a horizontal plane and secured to the base of the vertical gimbal ring. Thus, any movement of the gyro assembly in azimuth will cause the selsyn rotor and the compass card to rotate.

14. Gyroscopic inertia maintains the spin axis of the gyro in a fixed position irrespective of the movements of the aircraft, but all gyros have an inherent tendency to drift due

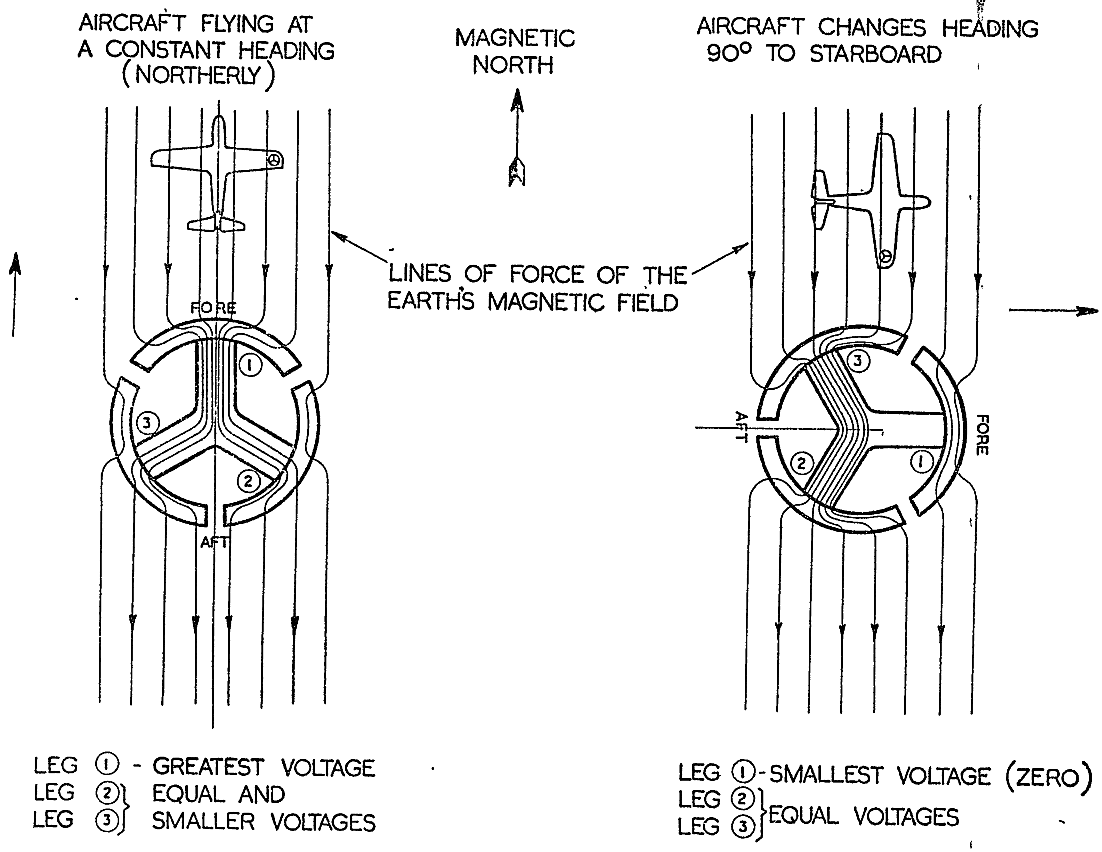

Fig. 5. Operation of flux valve

to such causes as the rotation of the earth and to low level friction. In the Mk. 4F compass, however, this tendency is immediately corrected as follows.

Gyro drift

15. Any drift of the gyro in azimuth will cause the rotor of the signal selsyn to move out of alignment with the vector of its stator field and, as a result, alternating signals will be induced in the rotor winding.

16. These alternating signals, which are related in amplitude and phase to those transmitted by the flux valve, are passed to the amplifier where they are amplified phase-detected and rectified, and are then applied in d.c. form to the precession circuit in the gyro unit.

17. According to the direction of movement of the selsyn rotor relative to its stator, the gyro precession coil is energized in the correct sense to exert a torque about the horizontal axis, thus causing the gyro to precess about the vertical axis back to its original position.

18. As a result, the shaft carrying the rotor and the compass card rotates until the rotor is re-aligned with its stator field. The precession signal is then cancelled and the compass card indicates the magnetic heading of the aircraft.

Immediate correction

19. The arrangement of the Mk. 4F compass provides for the corrective torque to be applied 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

20. When the aircraft turns, the compass card, the signal selsyn rotor and the vertically mounted bevel gear on the rotor shaft move

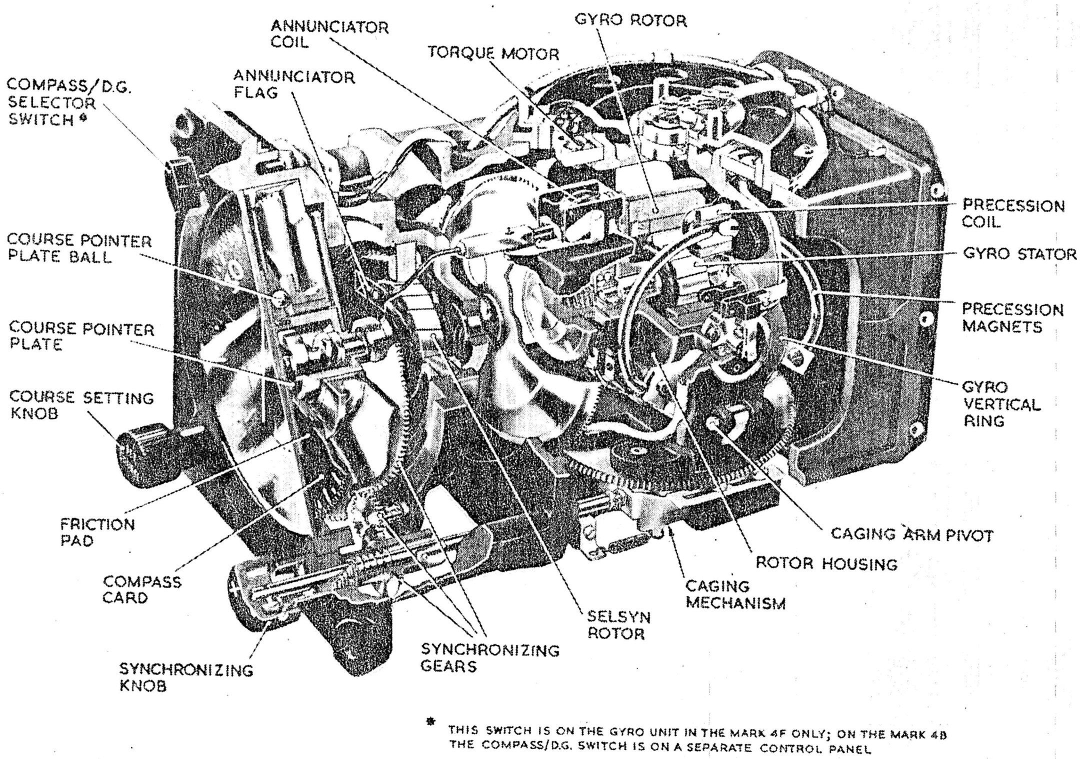

Fig. 6. Sectional view of gyro unit

around the gyro-stabilized vertical gimbal ring causing the rotor shaft to turn. Although the position of the selsyn rotor relative to the stator is now altered, the detector unit has also turned with the aircraft, its signals altering to correspond with the new heading, thus maintaining the alignment between the rotor and the vector of the stator magnetic field.

Annunciator

21. The annunciator provides a constant visual indication enabling the pilot to verify whether or not the compass is synchronized. It also facilitates the initial synchronization of the gyro unit (*para.* 25). It consists of a small flag marked with a dot and cross mounted on a pivoted shaft. The flag is visible through the annunciator window at the front top right-hand corner of the gyro unit.

Use as a directional gyro

22. For certain flight operations it may be desirable to use the gyro unit as a directional gyro. For this reason provision is made for switching off the monitoring by the detector unit by means of the D.G. compass selector switch located at the top left-hand corner of the gyro unit instrument face.

Principal details of the installation

23. The various units which comprise the Mk. 4F compass are shown in fig. 1 and a diagram showing the inter-unit connections is given in fig. 7. The total weight of a complete installation is approximately 15 lbs. excluding cable harness.

Note . . .

The mouldings in the plugs and sockets may be set to any one of six positions. Unless the appropriate plug is used for a particular socket, connection cannot be made (*Table* 1).

24. The power supplies required are 115 volts, 400-cycle, 3-phase a.c. and 28-volts d.c. The a.c. consumption is approximately 50 watts and the d.c. less than $3\frac{1}{2}$ watts. Phase rotation of the 3-phase a.c. supply should be A–B–C with phase B earthed.

TABLE 1

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

No. OF WAYS	DESIGNATION	COUPLER PLUG BODY ASS'D	SOCKET BODY ASS'D	PLUG BODY ASS'D	OUTLET GASKET	OUTLET AND NUT ASS'D	SEALING RING	INNER FERRULE	OUTER FERRULE
6	(1)		Z560120		Z970058	Z970062	Z970088	Z970078	Z970077
6	(2)		Z560521		"	Z970069	Z970088	Z970078	Z970077
6	(3)			Z560300	"	Z970062	Z970088	Z970078	Z970077
12	(4)		Z560181		Z970059	Z970072	Z970091	Z970084	Z970083
6	(5)		Z560522		Z970058	Z970062	Z970088	Z970078	Z970077
12	(6)	Z560470			Z970059	Z970065	Z970091	Z970084	Z970083
12	(7)			Z560360	Z970059	Z970065	Z970091	Z970084	Z970083
12	(8)			Z560361	Z970058	Z970065	Z970091	Z970084	Z970083
6	(9)			Z560301	Z970058	Z970062	Z970088	Z970078	Z970077
12	(10)		Z560180		Z970059	Z970065	Z970091	Z970084	Z970083
	(11)	NOT USED							
—	(12)	WING ROOT TRANSPORT OR PRESSURE BULKHEAD JUNCTION BOX							
—	(A)	12 CORE VINMETSMALL CABLE 5E/2881							
—	(B)	6 CORE VINMETSMALL CABLE 5E/2879							

INSTRUCTIONS FOR USE

Procedure before flight

Synchronizing the gyro unit

25. The following check should be made immediately before flight:—

(1) Switch on the power supply to the compass and allow a period of not less than one minute for the amplifier to warm up.

Note . . .

Check that the gyro is running by depressing and turning the SET COURSE *control knob. If the compass card rotates with the course pointer the gyro is not running and power should be switched off immediately to avoid possible serious damage to the gyro unit.*

(2) Verify that both lamps in the corrector control box light up when the supply is switched on.

Note . . .

It is most important that both the compensator lamps in the corrector control box are functioning when the compass is in use. The failure of either one or both of the lamps will cause the value of the current in the compensator coils to alter and thus introduce compass errors which may well be of a serious order. Should either lamp fail it should be replaced by a 24V, 2·8W lamp (Stores Ref. 5L/X951230).

(3) Note whether the dot or cross appears in the annunciator window. If D.G. shows, turn the compass D.G. switch clockwise until the D.G. flag disappears and either a dot or a cross is shown.

(4) Push in the synchronizing control knob and turn it in accordance with the indication shown in the window and the arrows on the knob (i.e., dot: clockwise, cross: counter-clockwise), until the indication changes to the opposite sign: then turn it back slowly until the indicator shows midway between the dot and the cross. The gyro unit is now synchronized and the magnetic heading of the aircraft is indicated by the compass card against the lubber line.

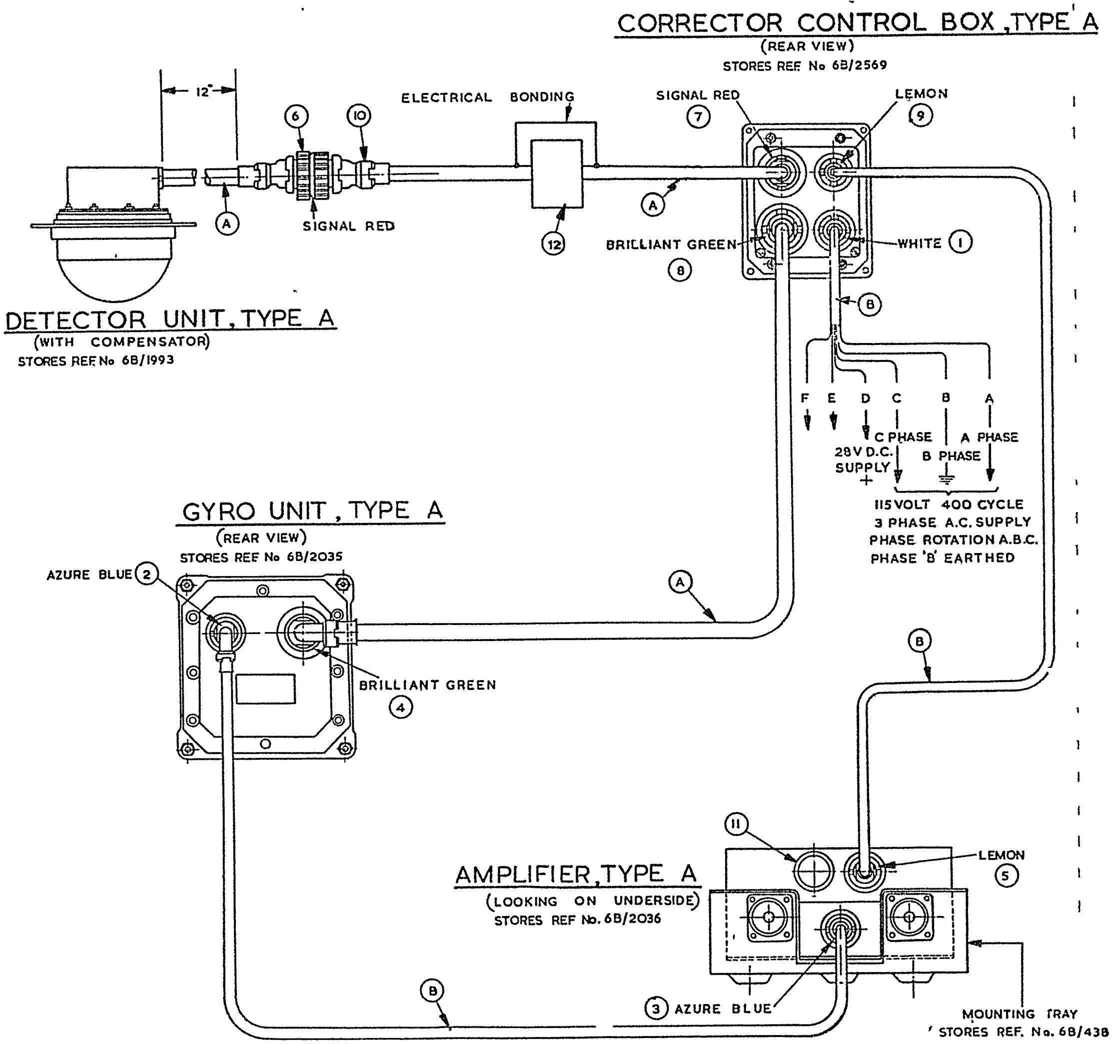

Fig. 7. Installation diagram showing inter-unit connections

Course setting

26. Press in the SET COURSE control knob and turn it until the course pointer is aligned with the required heading on the compass card. Release the knob.

Operation during flight

Synchronizing the gyro unit

27. Under normal flight conditions in piston-engined aircraft the gyro unit is maintained in synchronism with the earth's magnetic field, and the dot and the cross are displayed alternately in the annunciator window due to the pendulous element in the detector unit moving about its neutral position. Such a condition is quite consistent with satisfactory operation and is due to the vibration of the aircraft and to air turbulence.

28. In high-speed jet propelled aircraft, however, the annunciator flag will move more slowly from side to side and the dot or cross may not be fully displayed. This characteristic is quite normal and is due to the absence of vibration and to the stable straight flight of this type of aircraft.

Gyro topple

29. If aerobatics are carried out or any other manœuvres are executed during which the mechanical limits of the gyro unit are exceeded (± 85 deg. in pitch or roll), the gyro should be resynchronized as described in para. 25.

Maintaining course

30. Fly the aircraft so that the course pointer rectangle is kept aligned with the aircraft heading rectangle. The parallel lines on the bezel glass used in conjunction with the course pointer, will also assist in maintaining course.

Altering course

31. Push in the SET COURSE control knob and turn it until the course pointer is aligned with the selected heading on the compass card. Release the knob and turn the aircraft until the course pointer is aligned with the lubber line.

Using the gyro unit as a directional gyro

32. If required, monitoring from the detector unit can be discontinued and the gyro unit will then function as a directional gyro.

(1) Turn the compass D.G. switch counter-clockwise and verify that D.G. is shown in the annunciator window.

(2) Compare the aircraft heading shown on the gyro unit with that shown by the magnetic compass and reset the gyro to the compass by means of the synchronizing control.

Note . . .

When the compass D.G. *switch is returned to compass the gyro must be resynchronized.*

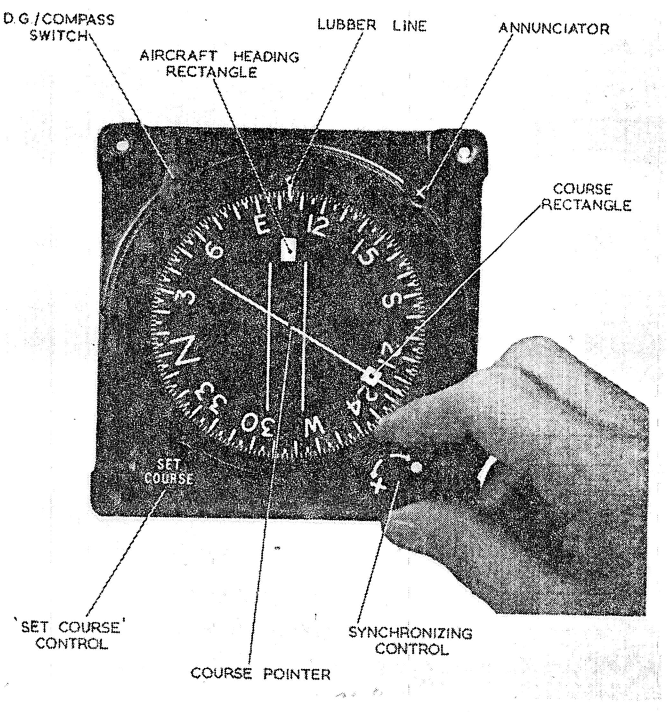

Fig. 8. Presentation of gyro unit

Flight characteristics

Annunciator

33. Under normal flight conditions, the annunciator provides a continuous visual indication which enables the pilot to verify that the compass is being monitored by signals from the detector unit.

Turn error

34. After a prolonged turn a small indicated error may be introduced but will not be of a serious order and will be completely removed after two to three minutes flight on a straight and level course.

Stopping

35. The Mk. 4F compass should not be switched off in flight or when taxying but should be left running until the aircraft is stationary.

Compass calibration

36. The gyro magnetic compass should be calibrated after it has been installed in an aircraft and calibration checks should be made subsequently in accordance with the appropriate Servicing Schedule.

37. During calibration all equipment should be in storage position as in flight, and if possible the aircraft should be supported in the normal flight attitude. Owing to the change in the conditions affecting compass deviation which occur in flight, it may be desirable to carry out a calibration check when airborne, either in place of, or to verify the accuracy of the "ground" calibration. This is described in Section 3, Chapter 14, Appendix 3, of this publication.

DETAILED DESCRIPTION

Detector unit

38. As previously stated in the note following para. 10 of this chapter, a detailed description and a mathematical analysis of the theory of operation of the detector unit is given in Section 3, Chapter 14 of this publication which should be referred to for further information if required.

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

40. A sectional view of the detector unit and the deviation compensator is shown in fig. 3. The detector unit mounting flange is engraved FORE and AFT and the unit must be secured in alignment with the fore and aft axis of the aircraft. One of the three screw slots in the flange is engraved throughout 10 deg. on each side of the zero index mark to serve as a reference when correcting coefficient A. 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. The circuit diagram of the detector unit is shown in fig. 9.

Flux valve

41. The sensitive element of the detector unit, known as a flux valve, is pendulously mounted and is free to move in pitch and roll through an angle not exceeding 25 deg. in a vertical plane, 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 and 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.

42. Each spoke consists of two legs, one above the other, extending outwards from the central hub. A pick-off coil is wound around both legs of each spoke and the central hub forms a core around which the exciter coil is wound. The axis of the exciter coil is vertical and the pick-off coils are wound with their axis horizontal. A schematic diagram of the flux valve showing the manner in which the pick-off and exciter coils are connected is given in fig. 4.

43. The exciter coil is fed with a 23-volt (approx.) 400 c/s single phase a.c. supply sufficient to induce a strong magnetic flux in each spoke and collector horn.

44. An 800 c/s a.c. signal is induced in the pick-off coils, the amplitude of the signal being proportional to the component of the earth's magnetic field in line with each particular spoke.

45. These signals from the flux valve are fed to the stator of a signal selsyn assembly in the gyro unit of the Mk. 4F Compass as shown in fig. 2, with the result that the magnetic field in the stator has a vector directly related to the direction of the earth's magnetic field.

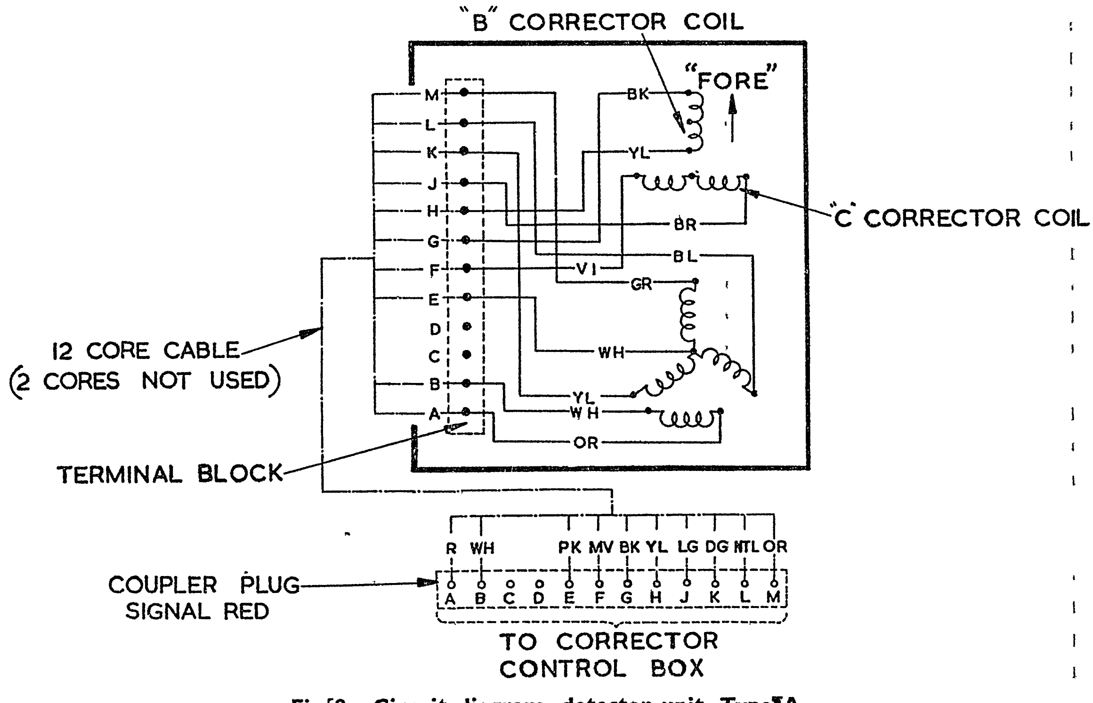

Fig. 9. Circuit diagram, detector unit, Type A

Flux valve mounting

46. The earth's magnetic field at any point on its surface, except at the magnetic poles or at the magnetic equator, can be resolved into two components, one horizontal and the other vertical. As only the horizontal component is of value for obtaining directional references, it is desirable that the sensitive element of the detector unit should, as far as possible, maintain a horizontal attitude, irrespective of the movement of the aircraft.

47. Accordingly, the flux valve is suspended pendulously from a universal joint which permits freedom of movement about the roll and pitch axes up to a maximum of 25 deg. in a vertical plane. In order to damp down oscillation, the assembly is enclosed in a plastic bowl which is partially filled with oil.

48. In turbulent air conditions, the element tends to oscillate continuously and issue fluctuating signals. The gyro unit integrates and stabilizes these signals, and as a result the compass card gives accurate, dead-beat indications continuously, irrespective of the oscillatory motion of the sensitive element.

Deviation compensator

49. The detector unit must be mounted in a wing tip or at some point on the aircraft where vibration effects and local magnetic interference are at a minimum.

50. Since local magnetic interference is rarely, if ever, negligible, an adjustable electro-magnetic deviation compensator is provided by means of which errors due to B and C coefficients can be neutralized. The compensator coil assembly is mounted on top of the detector unit during manufacture and must not be removed from this position.

51. 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.

52. The compensating coils are connected via two centre-tapped potentiometers in the corrector control box to an 8 volt (approx.) d.c. source obtained from a voltage stabilizing network connected across the aircraft d.c. supply.

53. 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 field produced by the coils neutralizes the local magnetic interference.

54. The potentiometers are mounted in the corrector control box and are provided with scales calibrated in terms of coefficients B and C over a range from +15 deg. —0—15 deg.

55. The electrical connections to the compensator are made via the 12-pin coupler plug through which the connections to the detector unit are taken.

Gyro unit

56. The gyro unit, a sectional view of which is given in fig. 6, may conveniently be considered to consist of three assemblies; the gyro, the selsyn-bezel and the chassis. The complete unit is enclosed by an anodized aluminium alloy cover case, one end of which fits into a sealing gasket behind the front casting. The cover case is secured to the rear plate by eight steel screws. The circuit diagrams of the gyro units, Type A and B, are shown in fig. 10 and 11 respectively.

Gyro rotor

57. 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 constructed of mild steel and is of cup cross-section and carries 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.

58. 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 housing carries the stator windings which are supported on the stator tube which surrounds the rotor shaft.

59. The other end of the rotor shaft projects through the 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 coiled spring between the brass cup and the bearing cover plate in order to provide automatic compensation for temperature variations.

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29		RESISTORS
11	12	CONDENSERS
S.1		MISCELLANEOUS

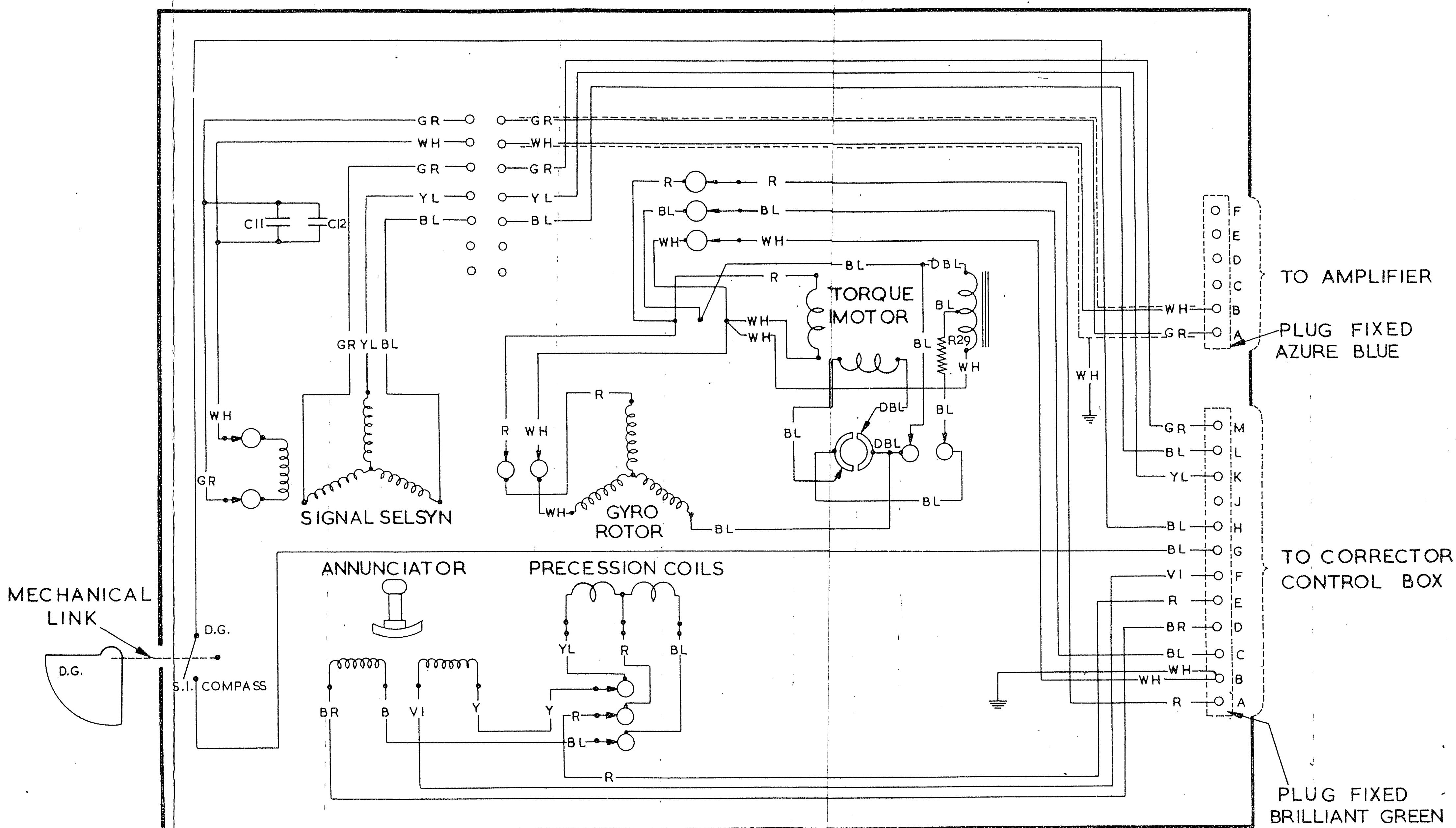

Fig.10 Gyro unit Type A, circuit diagram Fig.10

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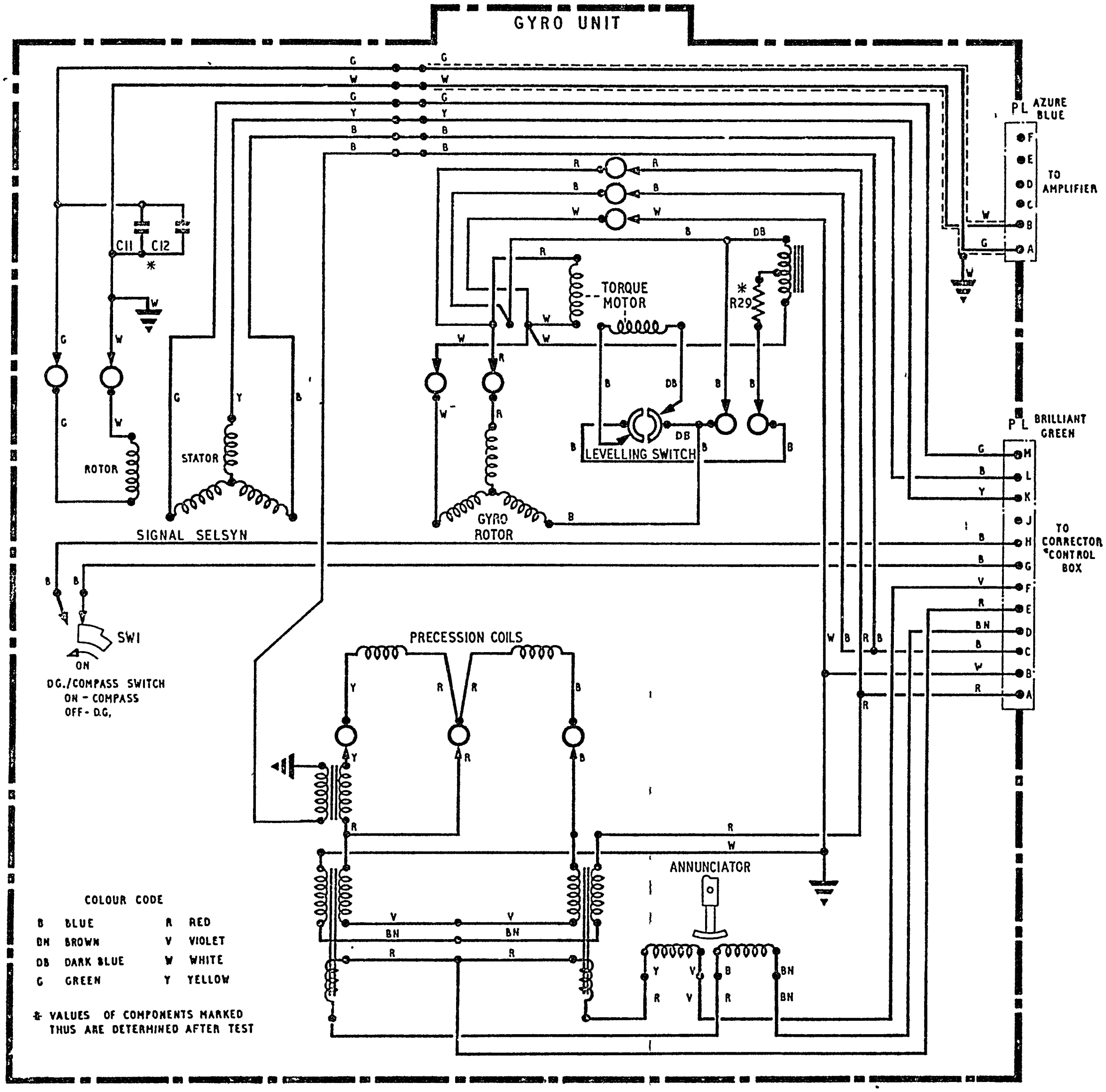

Fig. 11. Circuit diagram, gyro unit, Type B

Selsyn-bezel assembly

71. Two castings bolted together form the chassis of this assembly. The front part carries the compass card, bezel glass, synchronizing knob, SET COURSE knob, compass D.G. switch and annunciator window. It also incorporates the shaft carrying the course pointer, selsyn rotor and vertical bevel gear together with the operating mechanism for the synchronizing and SET COURSE controls.

Presentation

72. The form of presentation is shown in fig. 8. Two parallel grid lines and the aircraft heading rectangle are engraved and painted on the bezel glass. The lubber line is marked in a similar manner on the instrument case and also on the glass. The course pointer consists of a circular metal plate marked with a luminous pointer and a matching reference in the form of a rectangle. It is friction loaded to the compass card by means of an annular pad.

Set course control

73. This control is operated by a knob located at the bottom left-hand corner of the instrument face. When the SET COURSE

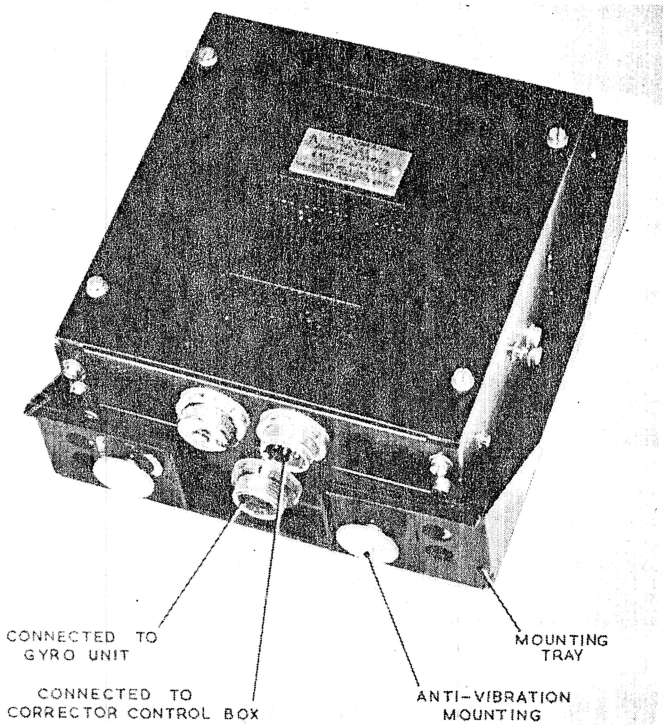

Fig. 12. Amplifier, Type A

knob is pressed in, the course pointer plate is lifted slightly off the friction pad. A gear on the shaft of 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 turn the course pointer plate. When the SET COURSE knob is released, contact with the friction pad is restored, and the course pointer is again friction loaded to the compass card.

74. When the gyro is synchronized, the magnetic heading of the aircraft is always indicated by the lubber line against the compass card. To set a new course, the SET COURSE control should be pushed in and rotated until the selected course is indicated by the course pointer against the compass card. To fly on the new course the pilot should turn the aircraft until the aircraft heading rectangle is aligned with the matching reference rectangle on the course pointer plate. The grid lines on the glass assist in maintaining an accurate course.

Synchronizing control

75. This control is operated by a control knob marked with a dot, a cross, and direction arrows. It is situated at the bottom right-hand corner of the instrument face. 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 locked (*para.* 70), a slipping clutch assembly is interposed between the vertical bevel gear and the compass card shaft, so that the card and the selsyn rotor can rotate relative to the selsyn stator.

76. By using this control the rotor can be quickly aligned with the vector of the stator magnetic field caused by the detector unit signal, thus synchronizing the compass card indication with the magnetic heading of the aircraft.

Chassis

77. The chassis is bolted to the bezel casting and carries the bearings for the vertical gimbal ring, the slip ring brushes for the a.c. supply the squirrel cage rotor of the levelling torque motor, the annunciator, and the back cover plate which carries a 6-pin and a 12-pin plug.

Annunciator

78. 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.

79. It consists of a small flag, marked with a dot and a cross, which is visible through a small window in the top right-hand corner of the bezel casting. 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.

80. The coils are connected in series with the precession circuit and are energized by the amplified d.c. signals.

81. If the gyro unit is not synchronized with the detector unit, the selsyn rotor is out of synchronism with its stator field and a

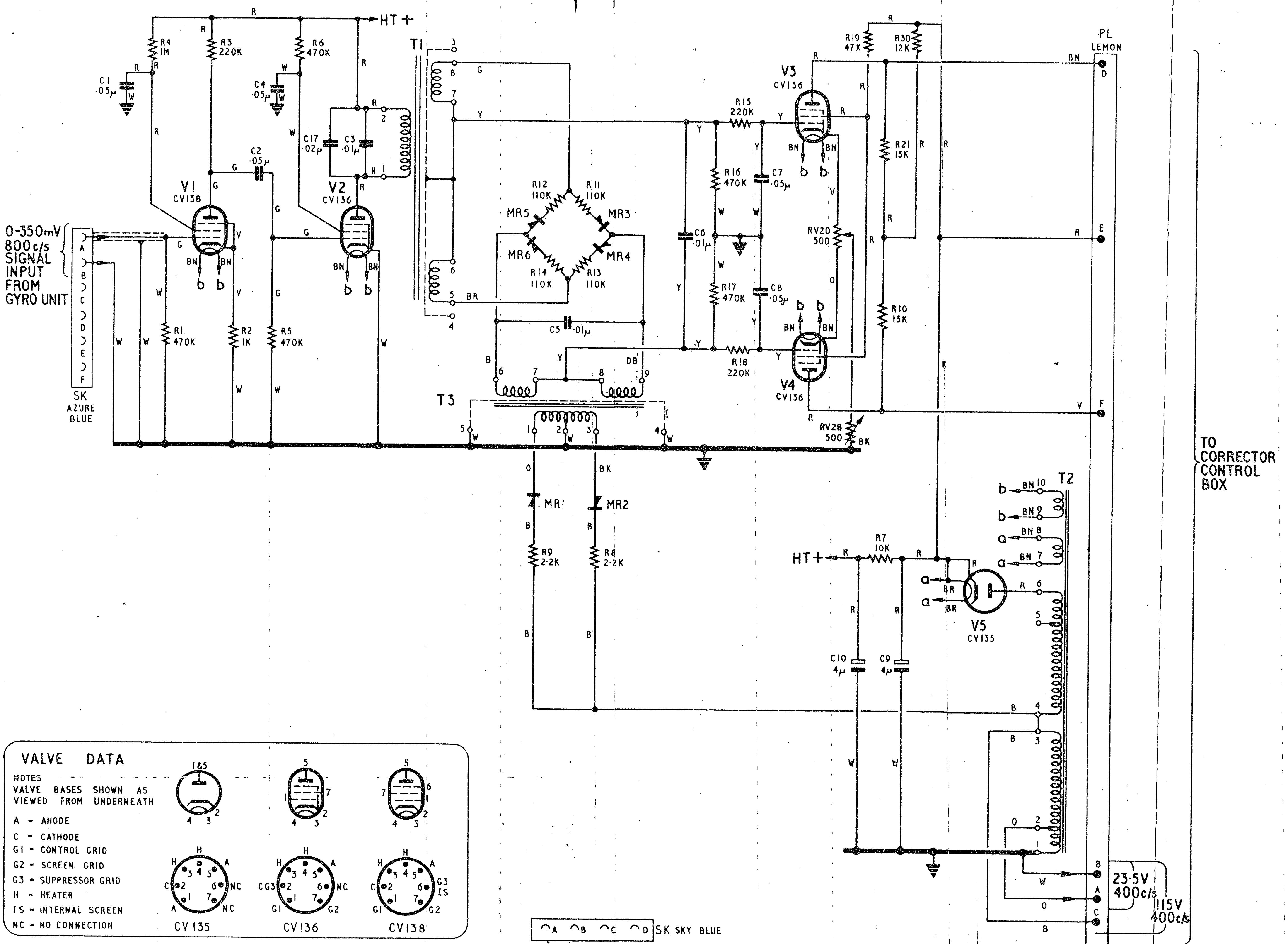

Fig. 13 — Amplifier Type A, circuit diagram — Fig. 13

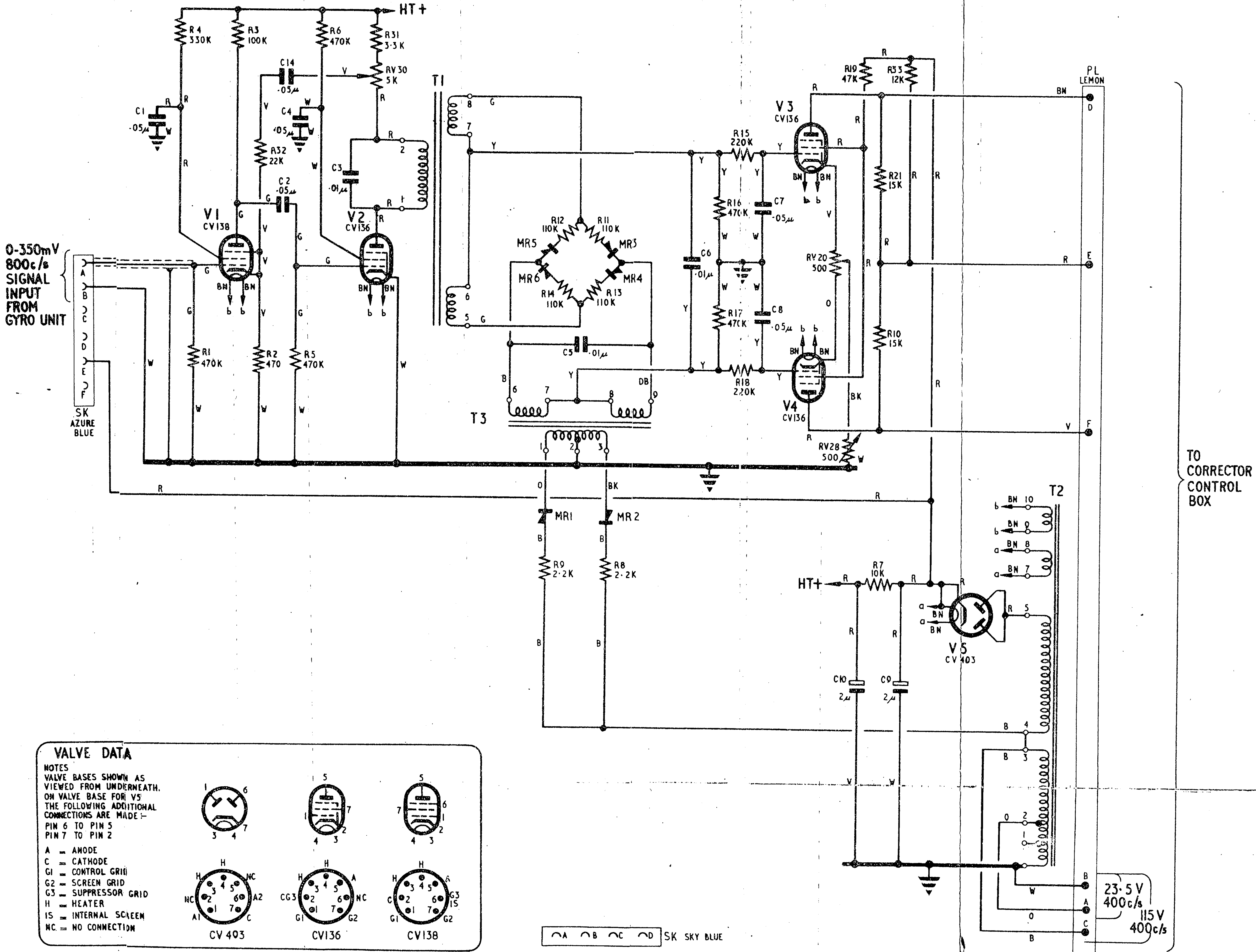

Fig. 14 Circuit diagram, Amplifier, Type B

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signal is passed to the amplifier. The amplified and rectified signal is fed to the precession circuit and to the annunciator coils. The magnetic field induced in the latter reacts with the small permanent magnet at the end of the staff causing it to swing to one side and to move either the dot or cross into the annunciator window. The particular indication shown depends upon the direction in which the gyro is precessing and will persist until synchronization is regained.

82. Under normal flight conditions, in piston-engined aircraft, the flag will alternate between the dot and cross due to the sensitive element of the flux valve in the detector unit moving about its neutral position. This movement is caused through vibration and any air turbulence affecting the aircraft. In jet-propelled aircraft, however, the flag may not alternate dot and cross or will do so at a very slow rate. Such a condition is quite normal and is due to the absence of vibration and stable straight flight path of this type of aircraft.

83. When the gyro is precessing either a dot or a cross will be displayed depending on the direction of precessing. Should the annunciator flag remain completely stationary under normal straight flight conditions in either type of aircraft the compass D.G. switch should be turned to D.G. and the gyro unit used as a directional gyro.

84. The compass D.G. control knob situated at the front top left-hand corner of the gyro unit operates a switch which disconnects the unit from the monitoring circuit and also moves a D.G. indicator flag into the annunciator window.

Cover

85. The cover is made of anodized alloy sheet and fits the bezel casting over a neoprene sealing washer. Two circular breather apertures are provided on the upper surfaces of the cover and two on the bottom.

The apertures are covered with tropicalized felt held in position by two circlips secured to the cover by duralumin rivets. The cover is secured in position by eight steel screws through the back plate.

Back plate

86. The alloy plate which forms the back carries a 12-pin plug, colour coded bright green, through which electrical connections are taken to the corrector control box. A six-pin plug, colour coded azure blue, enables connection to be made to the precession amplifier; clips are provided for retaining cables and some small components. The plate itself is secured to the rear of the chassis by four steel screws.

Precession amplifier

Function

87. The function of this unit, shown in fig. 12, is to amplify and rectify the monitoring signals from the detector unit before they are applied in d.c. form to the precession circuit on the gyro.

Circuit description

88. By referring to the amplifier circuit diagram included in fig. 13, it will be seen that the signals from the detector unit are applied via a screened lead from the gyro unit socket directly to the control grid of V1 which functions as an amplifier. Cathode bias is provided by the voltage drop across R2. The load resistor R3 connects the anode of V1 to the H.T. line. After amplification in the normal manner the signals are fed to the control grid of V2 via the condenser C2.

89. The valve V2 functions in the same way as V1 but includes the primary winding of the transformer T1 in its anode circuit.

90. It should be noted here that, although the signals transmitted by the detector unit consist principally of 800 c/s a.c., other harmonics are present to a small extent. For this reason the two condensers C3 and C17 are connected in parallel across the primary winding of T1 thus forming a tuned circuit which filters out any remaining harmonics.

91. After further amplification by V2 the signals are 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.

92. A reference a.c. voltage is also applied to the demodulator circuit from the secondary winding of the transformer T3. The frequency of the reference voltage is the same as that of the flux valve signals, i.e. 800 c/s, and is obtained by the circuit arrangement of the centre-tapped primary winding of T3 and the action of the two rectifiers MR1 and MR2.

Note . . .

The amplitude of the reference voltage is arranged to be large in comparison with the signal voltage and hence R11 to R14 are included to avoid overloading the rectifiers when they are conducting.

93. 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 flux valve signals. A detailed description of the operation of this circuit is given in para. 96 to 103.

94. The d.c. signals are fed via the resistors R15 and R18 to the control grids of V3 and V4. After power amplification at this stage the signals are applied to the precession circuit in the gyro unit.

95. With the signal input earthed the outputs of V3 and V4 should be equal. Grid bias to these valves is controlled by the adjustment of the preset resistor R28 and their outputs are balanced by suitably adjusting R20. All amplifier valve heaters are connected in parallel to the heater winding on the power transformer T2, the requisite d.c. h.t. supplies being obtained from the cathode of the rectifier valve V5.

Ring demodulator

96. This part of the amplifier circuit can be considered to function as a double-pole changeover switch whereby the amplified alternating signals originating from the flux valve are converted into rectified half cycles of a.c. Referring to fig. 13, it will be seen that the rectified a.c. is smoothed by C6 and the network consisting of R15, R18, C7 and C8, and is applied to the control grids of V3 and V4.

97. In order to understand clearly the principle of operation of the ring demodulator circuit, it must first be appreciated that although the metal rectifiers MR.3–MR.6 offer a very low resistance to an applied voltage of one polarity, their resistance to an applied voltage of the opposite polarity is very high. Also, to simplify description, it is convenient to consider that the currents in the demodulator circuit due to the reference voltage and to the signal voltage respectively, are separate currents in the same circuit.

98. The reference voltage from T3 is arranged to be considerably greater than the maximum amplitude of the signal voltage from T1 and therefore, its polarity determines which of the rectifiers is conducting. The resistors R11 to R14 are included in the circuit to limit the current and to avoid short-circuiting the secondary of T3.

99. Consider the effect of a half-cycle of signal voltage from T1. This voltage will have the same frequency as the reference voltage but may be of the same or opposite sign. If the signal voltage fed to the demodulator is in phase with the reference voltage, then the polarities across each half of the secondary winding of T1 will be as shown.

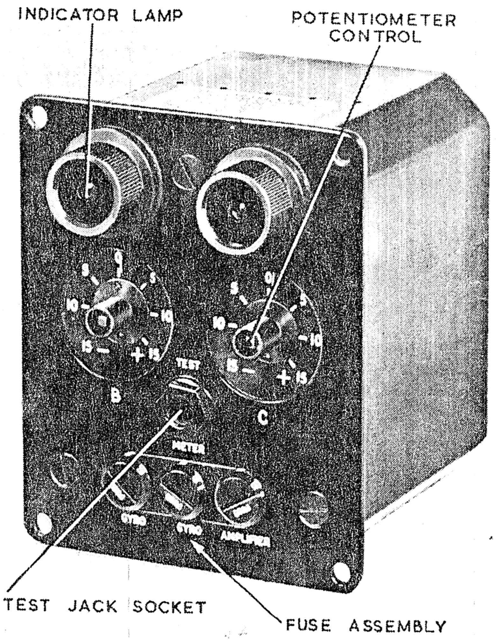


Fig. 15. Corrector control box

100. Under such conditions it can be assumed that MR3 and MR5 are open to small currents in either direction due to the signal voltage from T1, whilst MR4 and MR6 are closed. Current will therefore flow from the positive end of T1 through MR5 and MR3, via both halves of T3 to its centre tap, and thence through R17 and R16 back to the centre tap of T1.

101. Since the junction of R16 and R17 is taken to earth, the voltage developed across these resistors due to the signal, causes the control grids of V4 and V3 to become positive and negative respectively.

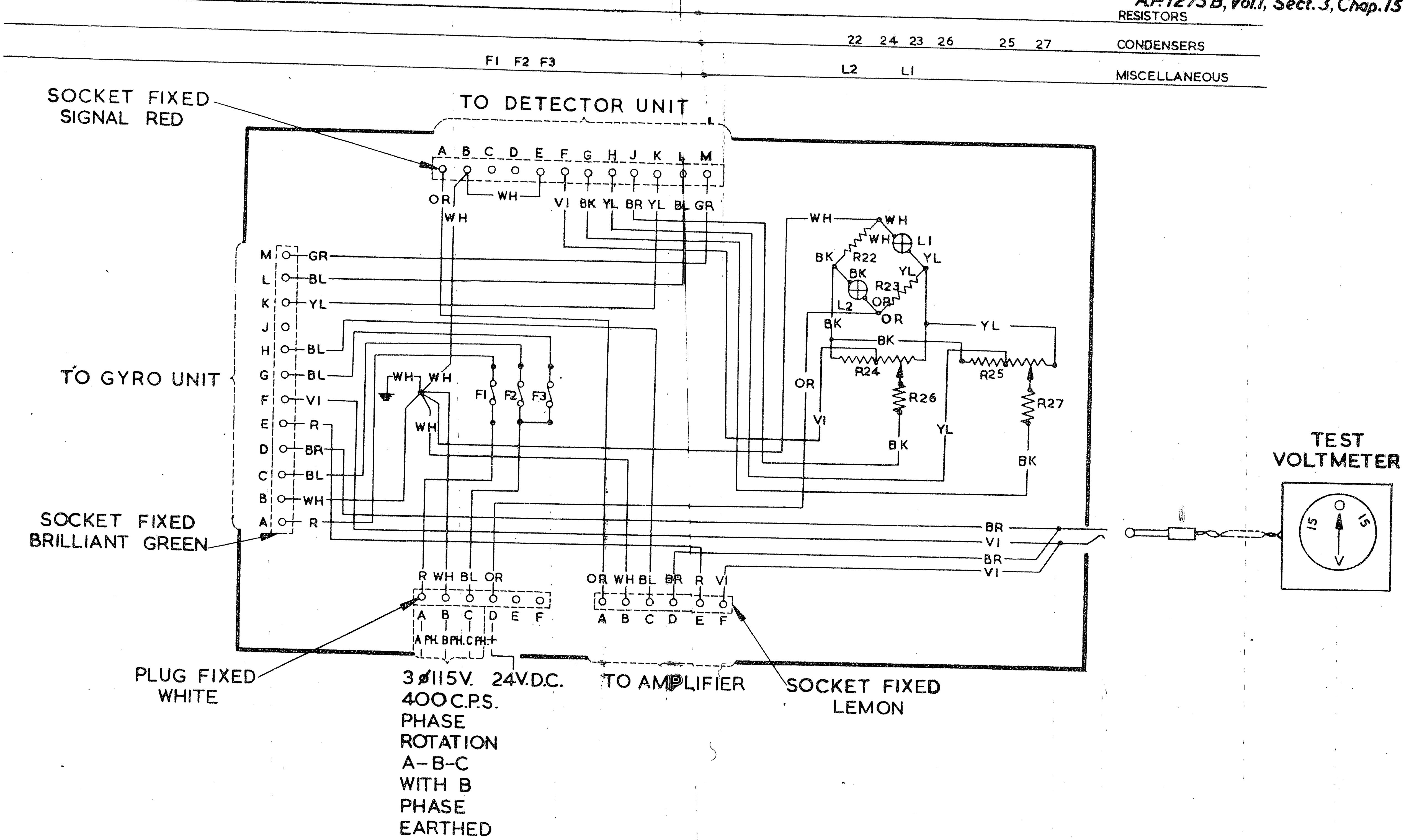


Fig. 16

Corrector control box Type A, circuit diagram

Fig. 16

RESTRICTED

102. During the next half cycle of the reference voltage, MR4 and MR6 will be open and MR5 and MR3 will be closed to signal currents, but if the sign of the signal voltage is reversed, the current through the load resistors R16 and R17 will be in the same direction as before.

103. It follows, therefore, that if the signal voltage is of opposite sign to the reference voltage the current through the load resistors R16 and R17 will be reversed. Thus, the control grids of V3 and V4 will simultaneously become positive and negative with respect to each other and to earth, the polarity at each grid being dependent upon the phase of the signal voltage with respect to the reference voltage.

Note . . .

When the Type A amplifier was produced, the appropriate "preferred" rectifier valve was the C.V.135. This has since been declared obsolete and its replacement is the CV.403. This is a larger valve and cannot be used in the Type A unit. In the Type B unit the valve-holder sub-chassis has been altered to accommodate the CV.493. It has also been possible to inter-connect the CV.493 holder sockets so that the CV.135 can still be used, if necessary.

The gain of the Type A amplifier has proved to be unnecessarily high. In the Type B unit negative feed-back has been introduced to control the gain and at the same time to render the amplifier less sensitive to valve changes and voltage variation. See Fig. 14.

Type A, Stores Ref. 6B/2036
Type B, Stores Ref. 6B/635

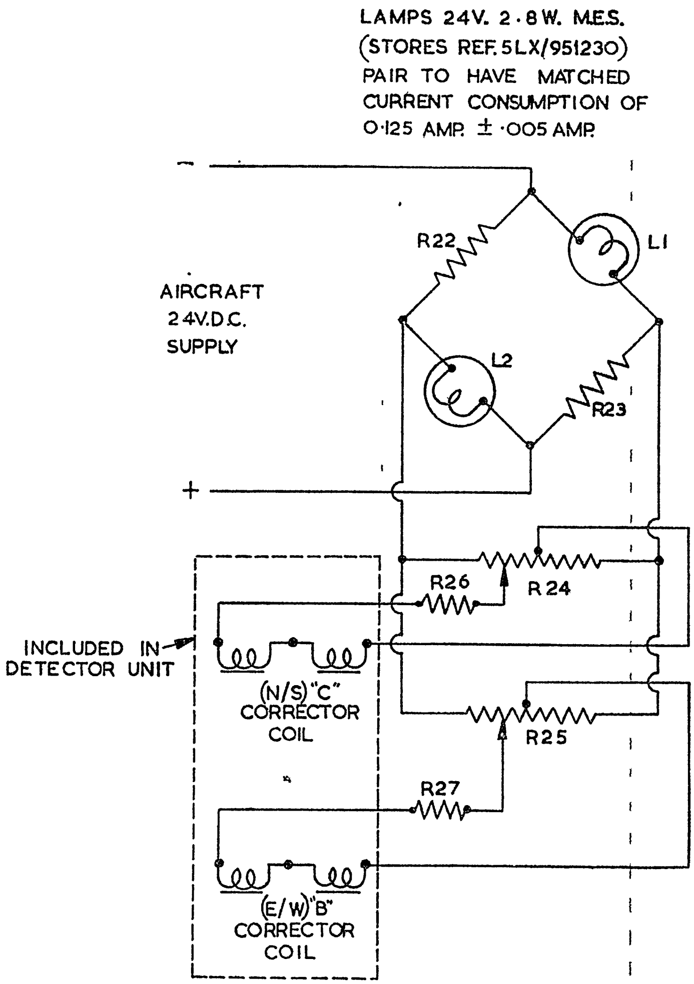


Fig. 17. Electrical compensator circuit

Corrector control box

104. The corrector control box (Stores Ref. 6B/2569) shown in fig. 15, contains the preset controls for adjusting the current through the compensator coils in the detector unit and also incorporates two shrouded indicator lamps, two centre-tapped calibrated potentiometers, a test jack socket and a fuse assembly. Fuses 1 and 2 serve the gyro unit and fuse 3 protects the amplifier.

105. The jack socket and compensator lamp shrouds are mounted on the front panel, suitable apertures being provided through which the potentiometer controls and indicator lamps project.

106. Behind the front panel a Paxolin panel is supported on a distance post and a bakelite moulding secured to the front panel by three B.A. screws. Three spring-loaded fuses are carried inside the bakelite moulding and are accessible from the front by removing the cover caps which retain them in position. The potentiometer sub-assembly and all other remaining components with the exception of the

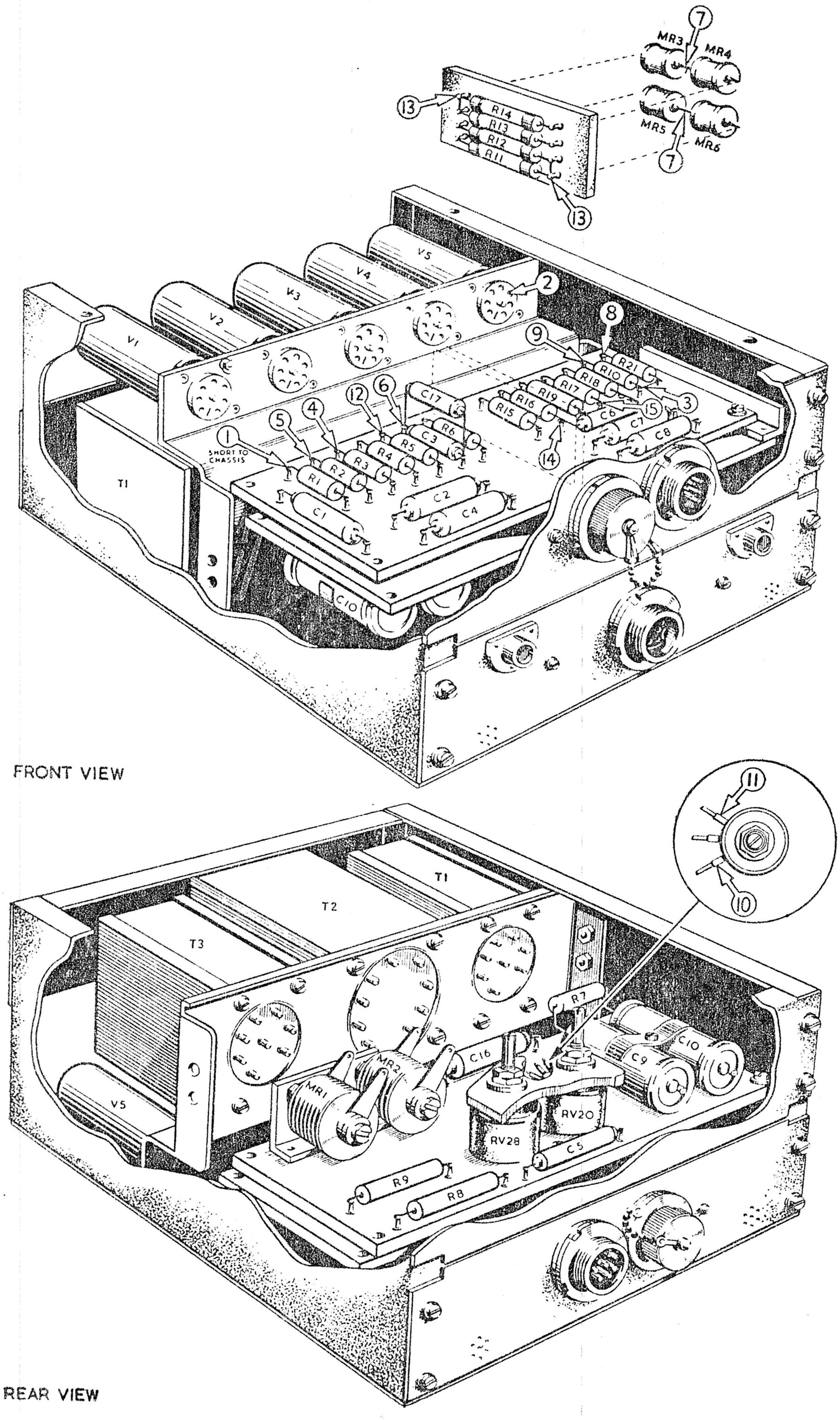


Fig. 18. Amplifier, Type A, layout of components

power plug and sockets are mounted on the Paxolin panel. The circuit diagram of the corrector box is shown in fig. 16.

Back plate

107. The back plate is supported on three distance pieces extending from the rear of the Paxolin panel and secured by three 2 B.A. screws. On it are mounted one 6-pin plug, one 6-pin socket and two 12-pin sockets for connecting the power supply leads to the detector unit, amplifier and gyro unit. The plug and sockets are colour coded and should be connected as shown in Table 2.

TABLE 2

Corrector control box connections

Description	Colour Code	Connect to
6-pin plug	White	115 volt, 400 c/s, 3-phase a.c. and 28-volt d.c. power supply
6-pin socket	Lemon yellow	6-pin plug (lemon yellow) on amplifier
12-pin socket	Signal red	12-pin coupler plug (signal red) attached to detector unit
12-pin socket	Brilliant green	12-pin plug (brilliant green) on gyro unit

Electrical compensator circuit

108. As stated in para. 52, the current flowing in the compensator coils in the detector unit is obtained from the aircraft d.c. electrical supply and is adjusted by means of the two calibrated potentiometers in the corrector control box.

109. The voltage of the aircraft d.c. supply is not entirely steady but fluctuates from 24 to 28 volts approximately. It is therefore necessary to provide an adequate degree of stabilization in order that the magnetizing current in the compensator coils will remain constant under conditions of supply variation.

110. The internal connections of the control box and also the connections to the electromagnetic compensator in the detector unit are shown in fig. 17, from which it will be seen that the lamps L1 and L2 and the resistors R22 and R23 are connected to form a bridge network.

111. The lamp filaments, however, have a high resistance/temperature coefficient and therefore the effective resistance of each lamp will depend upon its filament temperature and will increase or decrease considerably with small increases or decreases of voltage. By utilizing this characteristic and suitably arranging the circuit constants of the bridge circuit a reasonably constant output voltage is obtained.

112. The calibrated potentiometers R24 and R25 are connected in parallel across this source and the current through the compensator coils is thus maintained at a steady value.

113. It is important that only lamps, Stores Ref. 5L/X951230, are used in the corrector control box. Should either lamp fail, it must be replaced by the correct lamp, as the retention of a burnt-out lamp may lead to appreciable compass errors.

Potentiometer adjustment

114. The ends of the potentiometer spindles are of square cross-section and project through two calibrated perspex scales on the front panel. The potentiometers are calibrated from +15 deg. through 0 deg. to −15 deg. in accordance with the scale markings and can be adjusted when calibrating the Mk. 4F Compass by means of an adjusting key (Stores Ref. 6E/337) which fits over the spindle ends.

115. The jack socket, referred to in para. 105, is included so that a 15 —0 —15 d.c. voltmeter can be plugged in during calibration. A duralumin cover fits over the back plate and encloses the corrector box assemblies. The cover is secured to the back plate by four 8 B.A. screws.

SERVICING

General

116. The information given in the subsequent paragraphs is provided as an interim measure, pending the issue of the appropriate Bay Servicing Schedule, which will be issued in A.P.1275B, Vol. 4.

Pre-flight serviceability test

117. When the compass is installed in an aircraft, 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.

Mountings

118. Check the security of the gyro unit on the instrument panel and verify that all other units comprising the compass are securely fixed to their mountings.

Bezel glass

119. Clean and examine the glass for cracks. Should it be necessary to remove the glass, extreme care must be taken not to touch the inner surface as this is coated with an anti-condensation compound which is affected by the slightest trace of grease. If necessary the inner surface can be lightly dusted with a perfectly clean cloth which is free from fluff.

Fluorescence or luminous markings

120. Inspect markings for discolouration or chipping.

Functional check

121. (1) Switch on the a.c. and d.c. power supplies to the compass and allow a period of two minutes for the amplifier to warm up and the gyro to attain full speed.

(2) Operate the compass D.G. switch and verify that, when the switch is turned counter-clockwise, D.G. appears in the annunciator window.

OVERHAUL

122. The repair of any defects revealed during fault tracing or periodic inspections, which necessitate the readjustment of the unit concerned must only be undertaken at a fully equipped repair unit. Instructions concerning the overhaul of the Mk. 4F compass are given in A.P.1275B, Vol. 2, Chapter 15.

Repairs and fault tracing

123. Repairs to faulty, or the fitting of new components, in precession amplifiers can be made by qualified radio mechanics. To assist in the identification of various components, an exploded view of the amplifier is given in fig. 18 in which each item is annotated to correspond with its circuit reference.

124. A separate circuit diagram of the amplifier, Type A, is given in fig. 19. In this diagram various check points are indicated by numbered arrows arranged so that the voltage or current in various parts of the circuit can be measured.

125. The correct values of voltage or current between any two appropriate check points are shown in Table 5. The values of the electrical supplies at other points in the circuit are specified on the diagram and in Table 3.

TABLE 3

Component, amplifier

RESISTORS		RESISTORS	
No.	Description	No.	Description
R. 1	470k ERIE 9¼ watt	R. 14	110k WELWYN A3622 ¼ watt
2	1k ERIE 9¼ watt	15	220k WELWYN A3622 ¼ watt
3	220k ERIE 9¼ watt	16	470k WELWYN A3622 ¼ watt
4	1M ohms ERIE ¼ watt	17	470k WELWYN A3622 ¼ watt
5	470k ERIE ¼ watt	18	220k WELWYN A3622 ¼ watt
6	470k ERIE ¼ watt	19	680 ohms ½ W
7	10k ERIE ¼ watt	20	500 ohms COLVERN Potr.
8	2·2k BERCO LW 9 watt	21	15k ¼ W ERIE 9
9	2·2k BERCO LW 9 watt	28	500 ohms IW Colvern
10	15k BERCO LW 9 watt		TRANSFORMERS
11	110k WELWYN A3622 ¼ watt	T.1	Transformers
12	110k WELWYN A3622 ¼ watt	T.2	Transformers
13	110k WELWYN A3622 ¼ watt	T.3	Transformers

TABLE 3—*cont.*

CAPACITORS

No.	Description
C. 1	0·05 μf METALMITE 350 V.D.C.
2	0·05 μf METALMITE 350 V.D.C.
3	0·01 μf METALMITE 350 V.D.C.
4	0·05 μf METALMITE 350 V.D.C.
5	0·01 μf METALMITE 350 V.D.C.
6	0·01 μf METALMITE 350 V.D.R.
7	0·05 μf METALMITE 350 V.D.R.
8	0·05 μf METALMITE 350 V.D.R.
9	4 μf MICROPACK 350 V.D.C.
10	4 μf MICROPACK 350 V.D.R.

METAL RECTIFIERS

No.	Description
MR. 1	STC 25R
2	STR 25R
3	STR M.4.3.T
4	STR 25R
5	STR 25R
6	STR 25R

VALVES

No.	Description
1	C.V.138
2	C.V.136
3	C.V.136
4	C.V.136
5	C.V.135

126. 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 remedy, is given in Table 4.

TABLE 4

Fault finding table

Symptom	Probable cause	Remedy
Instrument fails to start. **Warning . . .** *If gyro fails to start within a few seconds after switching on, switch off the power IMMEDIATELY. Failure to do so may seriously damage the gyro unit.*	Failure of power supply.	Check the power supply at the corrector control box.
	Blown Fuse, F1 or F2 (*fig.* 16).	Fit new 1·5 amp. fuse
	Faulty connections.	Check continuity of cables and connectors and verify correct mating of plugs and sockets. Test for short circuits and shorts to earth.
	Faulty gyro unit.	Check continuity of 3-phase circuits on the 12-pin plug at rear of unit. Fit new unit if faulty.
When correctly synchronized compass indicates a reciprocal course.	Incorrect phase rotation of power supply to equipment.	Check a.c. supply using test set (Stores Ref. 6C/848) a.c. supply must be 3-phase 115V ±11V 400 c/s. ±5% (380–420 c/s). Phase rotation A–B–C with phase B earthed.

Symptom	Probable cause	Remedy
Compass settles with a permanent error of 30 deg. 90 deg. or 150 deg.: e.g. if correct heading is North (0 deg. or 360 deg.) compass reads 30 deg., 90 deg., 150 deg., 210 deg., 270 or 330 deg.	One signal lead between flux valve and corrector control box or between corrector control box and gyro unit is open or earthed; or two leads are short-circuited.	Check with a.c. continuity tester. **Warning . . .** *It is most important that a d.c. continuity tester is NOT used for this test.*
Annunciator displays dot, cross, or null continuously for complete 360 deg. rotation of the compass card.	Short or open-circuit in excitation current supply circuit to detector unit.	Check continuity with a.c. continuity tester. **Warning . . .** *DO NOT use d.c. continuity tester for this test.*
	Defective valve in amplifier	Check and replace faulty valve.
Annunciator sluggish in operation	Incorrect power supply.	Check power supply.
	Faulty bonding on detector unit connector.	Check continuity of earth shield.
Precession rate too slow.	Fault in gyro unit or amplifier.	Connect sensitive voltmeter (2,000 ohms/volt to amplifier) and measure output from amplifier when compass card is offset 30 deg. or more from established null. If reading shown above 7V, gyro unit is faulty; if below 7V, amplifier is probably faulty.
No precession current.	Switch fault in gyro. Amplifier fault. Fuse blown (F.3, *fig.* 16).	Clear fault and/or fit new fuse
Compensator applies no correction for deviation.	No d.c. supply to compass.	Check d.c. supply from aircraft distribution board. Check continuity of cables.
Compensator applies wrong correction for deviation.	Indicator lamp in corrector control box burnt out.	Replace faulty lamp with lamp, Stores Ref. 5L/X951230.

TABLE 5

Check points, amplifier, Type A (*fig.* 19)

Test under dynamic conditions with input to V1 control grid short-circuited

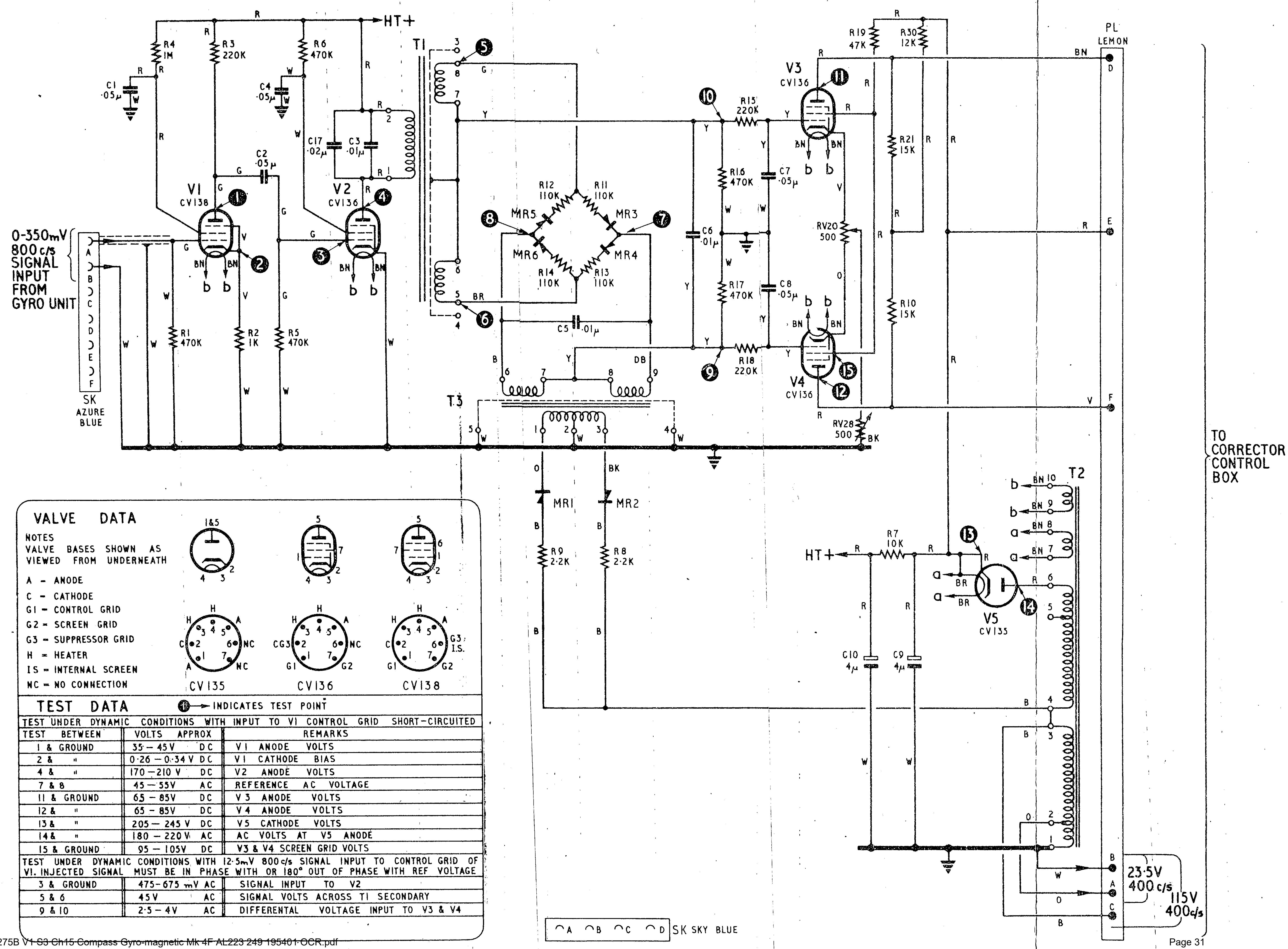
Test between	Volts approx.	Remarks
1 and Gnd.	35–45 V. d.c.	V1 anode volts
2 and Gnd.	0·26–0·34 V. d.c.	V1 cathode bias
4 and Gnd.	170–210 V. d.c.	V2 anode volts
7 and 8	45–55 V. a.c.	Reference a.c. voltage
11 and Gnd.	68–85 V. d.c.	V3 anode volts
12 and Gnd.	68–85 V. d.c.	V4 anode volts
13 and Gnd.	205–245 V. d.c.	V5 cathode volts
14 and Gnd.	180–270 V. a.c.	A.C. volts at V5 anode
15 and Gnd.	95–105 V. d.c.	

Tests under dynamic conditions with 12·5 mV 800 cycle a.c. signal input to control grid of V1. Injected signal must be in phase with, or 180 deg. out of phase with reference voltage.

Test between	Volts approx.	Remarks
3 and Gnd.	475–675 mV a.c.	Signal input to V2
5 and 6	45 V a.c.	Signal volts across T1 secondary
9 and 10	2·5V–4V	Differential voltage input to V3 and V4

Note . . .

Figures obtained depend on type of instrument used for measuring.



VALVE DATA

NOTES
VALVE BASES SHOWN AS VIEWED FROM UNDERNEATH

- A - ANODE
- C - CATHODE
- G1 - CONTROL GRID
- G2 - SCREEN GRID
- G3 - SUPPRESSOR GRID
- H - HEATER
- IS - INTERNAL SCREEN
- NC - NO CONNECTION

CV135 CV136 CV138

TEST DATA

● → INDICATES TEST POINT

TEST BETWEEN	VOLTS APPROX	REMARKS
TEST UNDER DYNAMIC CONDITIONS WITH INPUT TO V1 CONTROL GRID SHORT-CIRCUITED		
1 & GROUND	35 – 45V DC	V1 ANODE VOLTS
2 & "	0·26 – 0·34 V DC	V1 CATHODE BIAS
4 & "	170 – 210 V DC	V2 ANODE VOLTS
7 & 8	45 – 55V AC	REFERENCE AC VOLTAGE
11 & GROUND	65 – 85V DC	V3 ANODE VOLTS
12 & "	65 – 85V DC	V4 ANODE VOLTS
13 & "	205 – 245 V DC	V5 CATHODE VOLTS
14 & "	180 – 220 V AC	AC VOLTS AT V5 ANODE
15 & GROUND	95 – 105V DC	V3 & V4 SCREEN GRID VOLTS
TEST UNDER DYNAMIC CONDITIONS WITH 12·5mV 800c/s SIGNAL INPUT TO CONTROL GRID OF V1. INJECTED SIGNAL MUST BE IN PHASE WITH OR 180° OUT OF PHASE WITH REF VOLTAGE		
3 & GROUND	475 – 675 mV AC	SIGNAL INPUT TO V2
5 & 6	45 V AC	SIGNAL VOLTS ACROSS T1 SECONDARY
9 & 10	2·5 – 4V AC	DIFFERENTIAL VOLTAGE INPUT TO V3 & V4

Fig. 19 Amplifier Type A, circuit test diagram Fig. 19

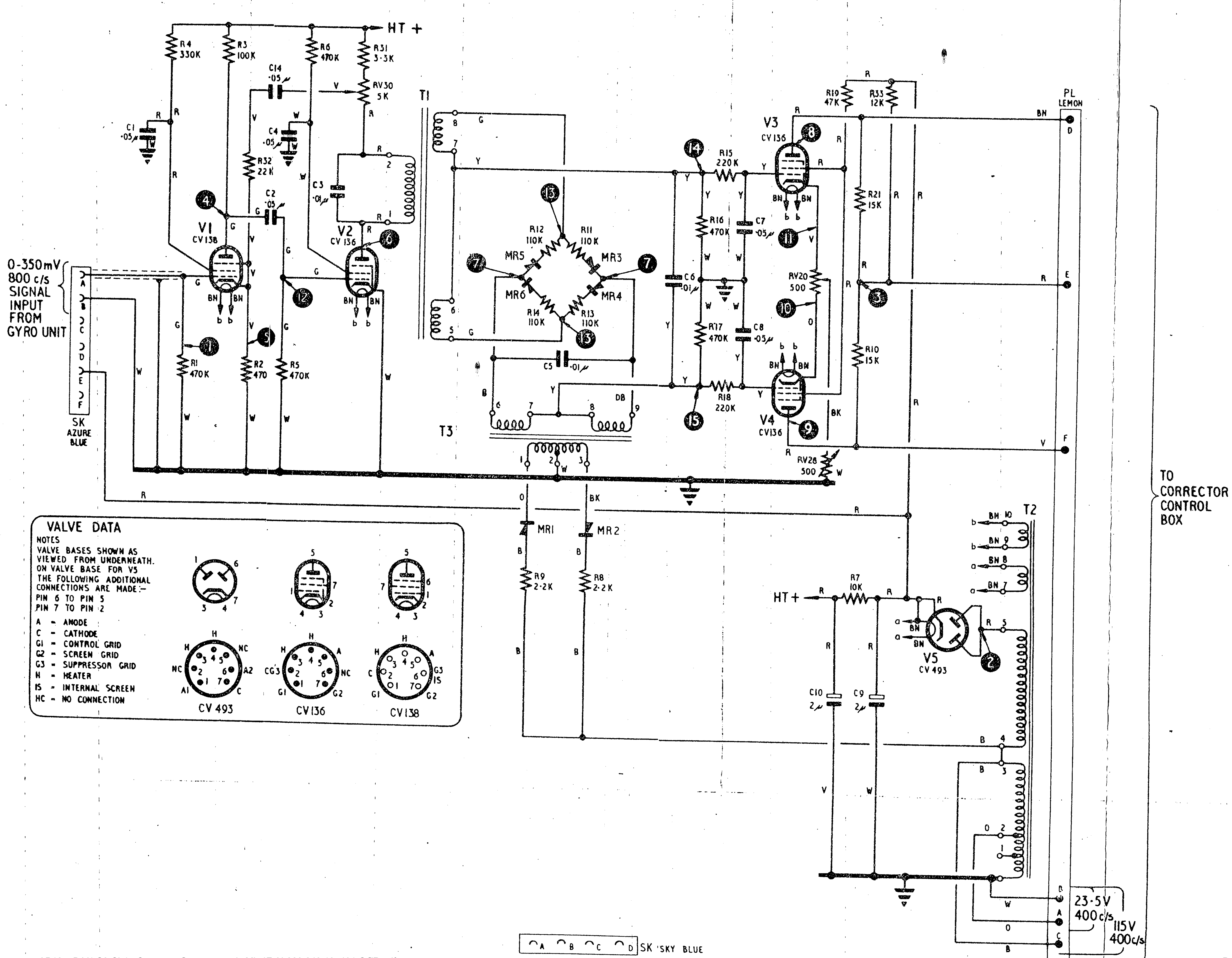


Fig. 20

Amplifier Type B circuit test diagram

Appendix I
STANDARD SERVICEABILITY TEST (S.G.51)
for
COMPASS, GYRO-MAGNETIC Mk. 4F

Introduction

1. The test described in this Appendix must be applied to Mk. 4F compasses immediately before they are installed in aircraft, and at any time that the serviceability of the compass is suspect. The tests should also be applied at re-inspection periods and should be carried out in the same sequence as they are described. The tolerances specified must not be exceeded.

Condition 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. and 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 at a minimum.

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

(a) A.C. supply must be 115 volts ±11 volts, 3-phase, 400 c/s ±20 c/s. Phase rotation must be 'A'–'B'–'C' with 'B' phase earthed.

(b) D.C. supply must be steady at 28 volts.

Note . . .

It is most important after switching on the a.c. supply to a gyro unit to verify at once that the gyro rotor commences to rotate and to accelerate 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. 4F bench test harness must be used for inter-unit connections. Details of the connections are given in fig. 1.

(5) Except where otherwise specified, all tests must be carried out with the full voltage 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) AC/DC testmeter, Type D. Stores Ref. 10S/10610.
(4) Stop watch. Stores Ref. 6E/287.
(5) Compass test set. Stores Ref. 6C/848.
(6) Detector unit calibration fixture. Stores Ref. 6C/944.
(7) Bench-test harness. Stores Ref. 6C/837.

Storage

4. The equipment comprising the G.4F compass is usually contained in airtight tropicalized preservative packs and, providing that the packing is intact, requires no attention for a considerable period. For details concerning the storage and life of this equipment reference should be made to A.P.830, Vol. 2, and A.P.3158, Vol. 2 respectively. After long storage the bearings in the gyro unit require re-lubrication, but the operation must only be carried out at a Unit authorized for the repair and overhaul of this type of compass.

Paragraphs 5 to 13 missing from original

(5) The procedure described in sub-para. (3) and (4) must be repeated successively on headings of 180 deg. and 270 deg., the drift being noted on the completion of each 10 minute running period.

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.

Types A and B

(6) 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.

Example	Heading				Total Drift	Remarks
	0	90	180	270		
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. 16 below for the method of correction.

14. 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.

15. The useful property of a gyroscope is the tendency of its spin axis to retain its direction in space unchanged. If the perfectly balanced compass gyro unit were to be set down at, say, the N. 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 deg. 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 deg. an hour at the poles, the law actually being:—

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

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

The manufacturer calibrates the gyro units to have zero observed drift at a particular latitude, 51 deg. N. for Type A units, and 21 deg. 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.

16. It should now be evident that if a gyro unit, say a Type A unit, has been calibrated to have zero observed drift at latitude 51 deg. N, in reality it has been given a real drift of +15 sin 51 deg., i.e., $+11\frac{1}{2}$ deg. an hour to counteract the effect of the earth's rotation of $-11\frac{1}{2}$ deg. an hour, so that its observed drift at 51 deg. N. is $+11\frac{1}{2} - 15$ sin 51 deg. $= 0$. If now this gyro is tested at some other latitude N. deg. north, the observed drift will be:—

$+11\frac{1}{2}$ deg. $-$ 15 sin N deg. degrees an hour

(If tested at S deg. south latitude, the observed drift will of course be $+11\frac{1}{2}$ deg. +15 sin S deg. degrees an hour). This amount, taking due account of sign, must therefore be subtracted from all observations of drift made at latitude N deg. north, before applying the criteria laid down in sub-para. 13 (6) above.

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

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

(2) Check exciter current taken by detector unit.

Test of monitoring system

18. (1) Remove the gyro unit from the test table.

(2) Mount the detector unit with its mounting flange horizontal on a calibration fixture situated in a position where local magnetic interference is at a minimum.

(3) The separate units comprising the compass should be interconnected by means of 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 corrector control box.

(4) Switch on the a.c. supply to the compass. Check that the gyros start and continue to run up, and leave the equipment running for approximately 20 minutes.

(5) Turn the D.G. selector switch on the gyro unit so that the annunciator is visible.

(6) Push in and turn the gyro unit synchronizing control knob in the direction indicated by the annunciator and check that the annunciator changes sign as the voltmeter pointer passes through zero.

(7) Synchronize the 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.

(8) Using the synchronizing control, offset the gyro compass card 7 deg. to one side of the established null position. Note the time taken for the gyro to precess from 5 deg. to within ½ deg. of zero, or until the centre-zero voltmeter reads not more than 2½ volts.

(9) Offset the 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 ½ deg. of zero or until the centre-zero voltmeter reads not more than 2½ volts.

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

(11) Use the synchronizing knob to obtain the null so that the annunciator is central in the window. Check that when the gyro is displaced in either direction from the null by 1 deg., the appropriate annunciator indication is fully displayed in the window.

Compensator lamps

19. 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 one (Stores Ref. 5L/X951230).

Functional tests of corrector control box

20. (1) Inter-connect all the units comprising the Mk. 4F compass as shown in fig. 1. The detector unit should be secured in its operating position to a detector unit test fixture which can be turned in azimuth and locked in any position.

(2) Connect the equipment to a proved 115 volt, 400 c/s 3-phase a.c. supply and a 28-volt d.c. supply (*para.* 2).

(3) Switch on the a.c. and the d.c. supplies and allow the equipment to run for a few minutes to warm up.

(4) Using a compass adjusting key (Stores Ref. 6E/337) turn the B and C correctors (potentiometers) on the control box to zero.

(5) Turn the detector unit in azimuth until the gyro unit when synchronized (i.e., annunciator is central) indicates an approximate North heading on the compass card. Lock the detector unit in this position.

(6) Turn the C (N/S) corrector to maximum so that the scale indicates +15. Verify that a cross is shown in the annunciator windows and that the compass card precesses to the corrected heading at a rate of not less than 2 deg. per minute.

(7) Turn the C corrector to —15. Verify that a dot is shown in the annunciator window and check the precession rate as in (6): Return the C corrector to zero.

(8) Turn the detector unit in azimuth so that the gyro unit, when synchronized, indicates an approximate East heading. Lock the detector unit in this position.

(9) Turn the B (E/W) corrector to maximum so that the dial reads +15. Verify that a cross is shown in the annunciator window and that the compass card precesses to the corrected heading at a rate of not less than 2 deg. per minute.

(10) Turn the B corrector to —15. Check that a dot is shown in the annunciator window and check the precession rate as in (9). Return the B corrector to zero.

Compass calibration

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

Lubrication

22. All bearings and moving parts are lubricated during assembly, and will thereafter be serviced in accordance with instructions given in A.P.830, Vol. 2 and A.P.3158, Vol. 2.

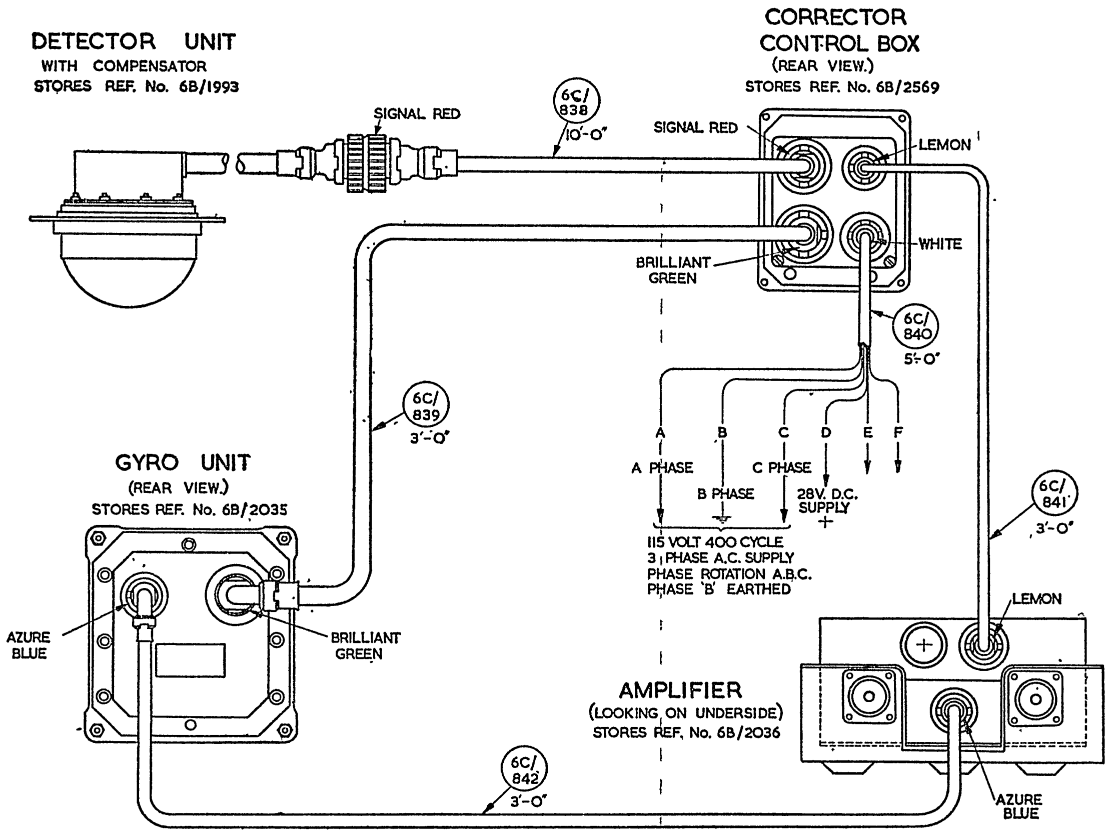


Fig I. Diagram of bench test harness, compass, gyro-magnetic, Mk 4F

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