Chapter 3

◀*Revised up to modification NDS* 55▶

OPERATION AND PRESENTATION OF COMPASS MODE

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LIST OF ILLUSTRATIONS

Introduction

1. The navigation display is the indicating instrument of a gyro magnetic compass system in the integrated flight instrument system. This instrument (*fig.* 1) presents magnetic heading, selected heading and, at any one time, either I.L.S. or Tacan displacement information according to the position of a mode selector switch on the instrument. Heading information is displayed in all positions of this mode switch but in the position COMP, other displays are excluded. A plain, black portion of the roller blind, located behind the annular compass card, shows in the area encircled by the card and assists by accentuating the figures and markers on the card (*fig.* 2).

General

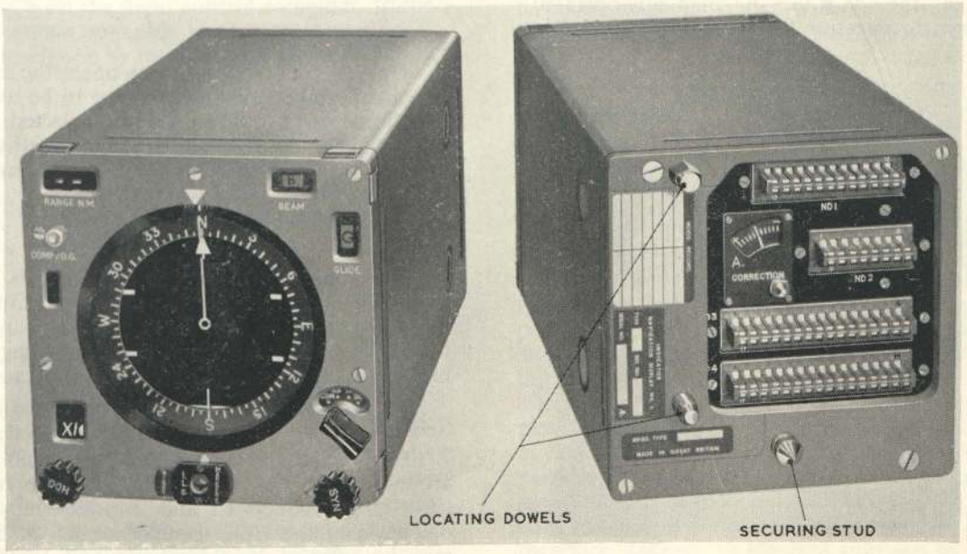
2. The units comprising the gyro magnetic compass system are as follows:—

(1) Navigation display (*fig.* 1).
(2) Detector unit (*fig.* 3).
(3) Navigation display amplifier (*fig.* 4).
(4) Azimuth gyro of an M.R.G., Mk. 1, Type E (*Chap.* 2 of this section).

For circuit details of the appropriate portions of these units reference should be made to fig. 5.

Note . . .

The various types of units used in this aircraft are listed in Table 1, *Chap.* 1 *of this section.*



◀**Fig. 1. Navigation display, Type C**▶

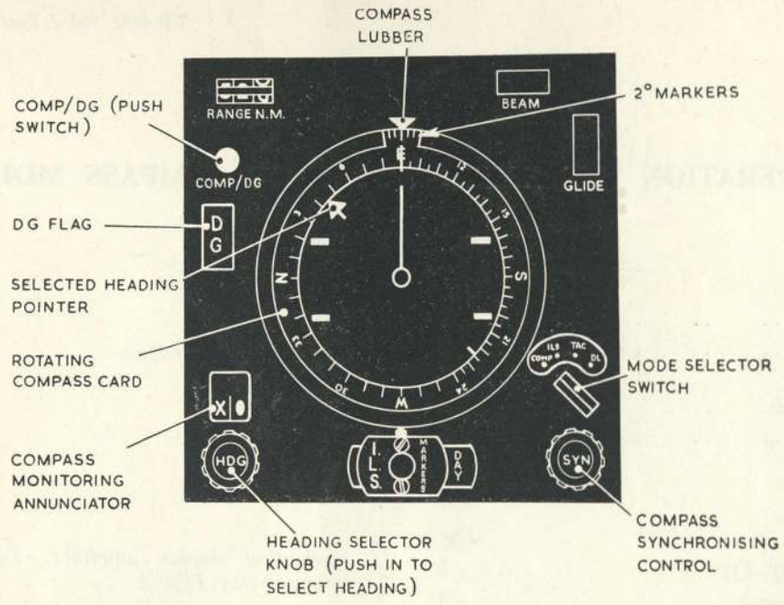


Fig. 2. Compass presentation

Compass card

3. Heading information is displayed by the rotation of the servo-operated annular compass card controlled from the M.R.G. The cardinal points are marked on the card, with the initial capitals viz : N, E, S, W; divisions are marked off from North in increments of 30 degrees and further sub-divisions are made with 2, 5 and 10 degree markers. ◀A cut-out at the top of the masking annulus allows the two degree markers to be visible. When synchronized, the magnetic heading of the aircraft is read against the fixed lubber above the card.▶

SYN control knob

4. The compass card is controlled by a three-line synchro transmission from the azimuth gyro section of the M.R.G. A manually-operated heading synchronization facility is also included in this link. This is provided because at times the azimuth gyro is on a random heading (e.g., immediately after the M.R.G. starting cycle has been completed) and the rate at which the system automatically synchronizes is comparatively slow. A differential control transmitter X7 is used between the azimuth gyro output and the compass card control transformer X6 (*fig.* 5). The rotor of the transmitter X7 is mechanically coupled to the synchronizing control (SYN) on the front of the navigation display. By depressing and rotating this control a suitable electrical angle can be added to the information from the gyro so that the compass card agrees with the magnetic reference. An alignment solenoid, which is a ratchet device, allows the knob to be turned in the correct direction only and so prevents the setting of a reciprocal heading.

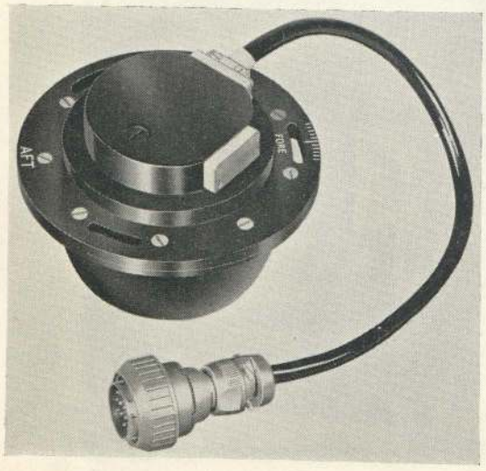


Fig. 3. Detector unit, Type A

DG switch

5. Operation of the DG switch opens the monitoring circuit and so enables the gyro to be used as a directional gyro. When DG is selected, a flag bearing the letters DG appears in a small window beneath the COMP/DG switch in the navigation display.

Annunciator

6. The annunciator consists of two coils, one in each lead of the monitoring amplifier output. A balanced magnetic system is arranged so that a flag indicates the polarity of the monitoring amplifier output by showing either a dot or a cross.

Selected heading pointer

7. A selected heading pointer, which travels around the inside periphery of the annular compass card, is servo-operated and is positioned by the operation of the HDG control knob. A heading may be selected by depressing and turning the control knob located in the bottom left-hand

Fig. 4. Navigation display amplifier, Type B and mounting tray, Type A

corner of the instrument front. This positions the heading control transmitter X11, and via the heading control transformer X12, selected heading servo amplifier and servo motor M4 the pointer is driven to the selected heading against the compass card. The outputs from the heading error potentiometer RV3–A and heading error switch S4 are fed, via FC6 on the flight control computer, to the autopilot (when engaged) so that the aircraft will fly a course chosen by means of the selected heading pointer.

◀**Note . . .**

With the inclusion of modification NDS/34, the single-section potentiometer RV3 is superseded by a two-section potentiometer RV3–A and RV3–B. The output from RV3–B is not used in this aircraft.▶

Function

8. In all modes the compass card displays the magnetic heading of the aircraft. The fluxgate detector, which is used as the magnetic reference, is located in the leading edge of the starboard wing, This is because it is necessary, so far as is practicable, to keep it away from the influence of magnetic disturbances arising from varying electrical and mechanical conditions in the aircraft. Correction coils are fitted to compensate for the modification to the earth's magnetic field by the magnetic field in the aircraft (B and C errors). The current in the corrector coils may be varied by adjusting the appropriate controls on the front of the navigation display amplifier (*fig.* 5, *Chap.* 7 of this section). 'A' error may be finally corrected by means of a control on the rear of the navigation display (*fig.* 1).

9. The detector has two pairs of elements so orientated in azimuth that one pair of elements lies parallel with the fore-and-aft axis of the aircraft and the other pair lies parallel with the athwartships axis of the aircraft. These elements are energized at 1·0V 400c/s. From each pair of elements an 800c/s output is produced which is proportional to the component of the earth's magnetic field along them.

10. The signal strength from each pair of elements depends upon the angles of the cores relative to the earth's magnetic field and the signal phase depends upon the direction of the lines of force of the earth's magnetic field through the cores. The amplitude and phasing of the signal from the fore-and-aft elements is therefore a measure of the cosine of the magnetic heading of the aircraft and that of the athwartships elements is a measure of the sine.

11. The output signals from the detector unit are fed to the stator cosine and sine coils of an a.c. resolver synchro X14 mounted in the navigation display (*fig.* 5). Here they are compared with the position of the compass card to which the rotor of this resolver is mechanically coupled. If the rotor winding is not at right angles to the resultant flux, a signal is produced indicating misalignment between the compass card and the aircraft heading.

12. This resultant signal is then amplified and rectified in a three-stage monitoring amplifier located in the navigation display amplifier. This output signal and its polarity are indicated by the annunciator which consists of two coils, one in each of the monitoring amplifier output leads. A balanced magnetic system is arranged such that a flag indicates the polarity of the output by showing either a dot or a cross. The signal is fed from this annunciator, via the closed contacts of the COMP/DG switch, to the azimuth gyro torque motor in the M.R.G. which precesses the azimuth gyro.

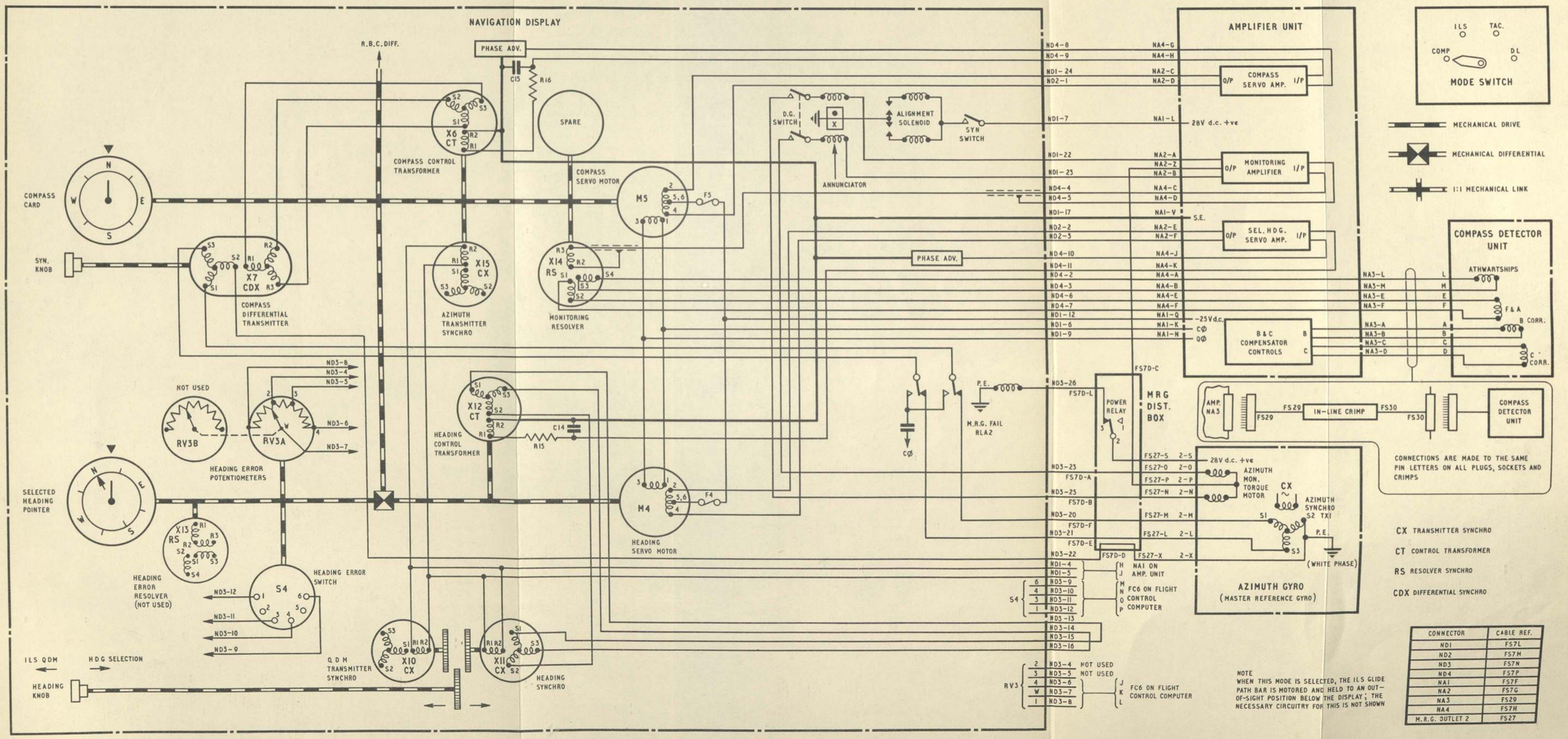
13. The stator of a synchro control transmitter TX1 in the M.R.G. defines the fore-and-aft axis of the aircraft. The rotor of this synchro defines the azimuth gyro spin axis. The relative angle in azimuth between the gyro spin axis and the aircraft fore-and-aft axis, as defined by the relative positions of the synchro rotor and stator, is applied as a signal voltage, via the contacts of the M.R.G. fail relay RLA2, to the stator of a compass differential transmitter X7 in the navigation display. The rotor output of this is fed to the stator of a compass control transformer X6 which is mechanically coupled to the compass card. After amplification, the output of X6 is used to drive the compass card to the null position. The card is therefore 'locked' to the gyro spin axis by a servo loop and if the gyro drifts, the compass card will

follow. An error voltage is then produced by the monitoring resolver and the resulting output from the monitoring amplifier is used to precess the gyro until misalignment between the aircraft heading and the compass card indication is zero.

14. If the power supplies from the M.R.G. distribution box are faulty or switched off, or if for any other reason the M.R.G. fails to complete a proper starting cycle, the power failure positive will be broken and relay RLA2 will not be energized so that S1 and S3 of the differential control transmitter X7 will no longer be connected to the M.R.G. synchro but instead are energized with 115V, 400c/s C phase. The resultant fixed field of the differential control transmitter X7 then takes the place of that normally provided by the M.R.G. azimuth synchro transmitter so that the compass card may be rotated to its correct position by means of the SYN control and annunciator. Since under this condition the compass card will no longer follow any change of course, it will be necessary to re-set the compass card manually using the annunciator to find the correct course at every change of heading; or it may be used simply as a means of fixing the card at some convenient position e.g. with North at the lubber.

Test point

15. A 25-pole test socket on the front of the navigation display amplifier (*fig.* 4) which is located in the main equipment bay, is the point at which the compass system signals are tested. By removing the captive mating plug from this socket and connecting a test set, Type 7 (Ref. No. 6C/2197) various compass continuity and simulation tests may be carried out. For details of these tests, reference should be made to the appropriate chapter of A.P.4685T. Details of connections for the compass signals are given in Table 1, Chap. 7 of this section.



CONNECTOR	CABLE REF.
ND1	FS7L
ND2	FS7M
ND3	FS7N
ND4	FS7P
NA1	FS7F
NA2	FS7G
NA3	FS29
NA4	FS7H
M.R.G. OUTLET 2	FS27

Fig. 5

(M.F.P.)

Navigation display system — compass mode schematic diagram

Fig. 5