Admiralty Signal Establishment.

BOOK OF INSTRUCTIONS.

FOR

D/F OUTFIT FH3 WITH RECEIVER B21B.

INTRODUCTION

D/F Outfit FH3 is an H/F Direction Finding set.

The Receiver (B21B) covers a frequency range from 1 to 20 mc/s. (1,000 - 20,000 kc/s).

This Outfit employs a fixed aerial system consisting of two crossed, screened loops (Bellini-Tosi system) for Direction Finding, and a vertical, open aerial for Sense Determination.

For testing the performance of the apparatus, Frame Coil S25B is incorporated. This is an arrangement by means of which a signal may be injected from the office, simulating a bearing at GREEN 45°.

Provision is also made for the Estimation of Ranges by means of calculating the Field Strength of the signal, and the Power of the Transmitter. If both these are known, an estimate of the range of the transmitter can be made.

CHAPTER 3.

FRAMECOIL S25B. (PATT.W6118A).

Framecoil S25B is so designed that the receiving apparatus of D/F Outfit FH4 can be lined up at sea or when required. In addition, it enables tests of the H/F D/F installation either D/F Outfit FH3 or FH4, to be carried out with the ship in harbour, thus saving time at the calibration berth.

The method of installation is similar to that for Framecoils S25, Patt.W2610/A, and Framecoil S25A, Patt. W3769, with the exception that the following additional stores are required for use with each Framecoil S25B:-

Patt. No.	Description.	Quantity.
W7834	Box junction for one Patt.13813 cable.	4 - Only when Framecoil S25B is supplied for use with D/F Outfit FH3.
13813	Cable, electric, Duradio No.13.	100 yds. (approx.)
W6798	Rod adjustment for trimmer condenser, Framecoil S25B.	1

NOTE:- Box junction, Patt.W7834 and Cable, Patt.13813 are required for use in replacement of Box junction, Patt. W3125 and Cable, Patt.13800, respectively, fitted with Framecoil S25. Patt.W2610/A.

1. THE LOOPS.

The crossed loops of the Framecoil S25B are 3 feet square, each consisting of one turn of rubber insulated cable inclosed in a steel tube. A small loop is provided at 45° to the main loops for the purpose of injecting a signal into the aerial system. All three loops are fixed to a casting which houses the transformer for the sense and injection systems. The various insulators, particularly the Tufnol box at the top of the framecoil, must be kept clean and MUST ON NO ACCOUNT BE PAINTED as a semi-conducting layer over these may cause large errors in D/F bearings.

2. THE SENSE AERIAL-COUNTERPOISE SYSTEM.

The Sense Aerial consists of a rod mounted vertically above the loops and a thinner rod running down the centre of the framecoil as a continuation of the upper rod, and entering the transformer box through an insulator on the cover. The counterpoise consists of a pyramid-shaped framework of rods having its apex at the transformer box, into which the rods pass through insulating bushes. The whole system is braced by insulating rods, the counterpoise being extended by tubes along the largest of these. The sense aerial is connected to the counterpoise through the primary of the sense transformer, and two matched 1,000 ohm resistors which ensure that the phase of the sense signal is correct.

The R/F transformers are air-cored and are provided with an electrostatic screen between primary and secondary windings. The sense transformer secondary has the same inductance as either of the loops, and is shunted by a pre-set condenser which is adjusted so that its value is the same as the self-capacity of either loop. This ensures

that over the range of frequencies used, the impedance presented by the sense circuit to the cables, is the same as that presented by either loop circuit.

The injection circuit is connected between the counterpoise and the sense transformer to supply the test signal in the sense system. A condenser (C100) is connected between the counterpoise and the framecoil structure. This is adjusted on installation, to balance out the unwanted pick-up by the sense system resulting from electrostatic coupling with the mast on which the framecoil is mounted, the latter having R/F voltages induced in it. This condenser requires no adjustment after it has been set by the fitting-out officer. Access to it is obtained by removing the plug which projects on the underside of the transformer box casting on the port side. An extension drive rod is provided to facilitate the operation.

3. THE INJECTION SYSTEM.

The injection system proper is coupled by means of a screened transformer to the supply cable. The injection circuit is arranged symmetrically, the secondary winding being split into two halves having the sense injection components arranged between them with the small injection loop connected across the outer ends. The current which passes through the loop therefore, also passes through the 20 ohm injection resistance (R104), the voltage drop across this supplying the sense signal. The inductor and condenser in this circuit, together with the 270 ohm (R102) resistance shunted across the injection loop, ensure the correct relative phase and amplitude of the sense and loop signals.

4. THE TRANSMISSION LINE SYSTEM.

The loop aerials and both transformer windings are brought to terminals in boxes at the base of the central column. From this point they are connected to the apparatus in the D/F office by four Patt.13813 (type BA41H) cables, which terminate at their lower ends at four Patt.W7834 junction boxes.

From the sense and the two loop junction boxes, Patt.13819 cables are run to the B21B receiver.

5. TRANSFORMER UNIT.

From the Patt. W7834 junction box, at which the Patt.13813 cable from the injection transformer terminates (one of the four mentioned above), Patt.13819 cables run to the Transformer Unit R/F design 5 (Patt.53609). This is a screened R/F transformer whose purpose is to convert to a symmetrical output, the unsymmetrical output of the wavemeter G73 (see Instruction Book SS.135), which is connected to the Transformer Unit by a connecting lead Patt.W4430.

CHAPTER 4.

RADIOGONIOMETER S29A. (Figs. 8 and 9).

This instrument has been designed for use on High frequencies and consists of a small rectangular search coil which can be rotated (on a spindle) inside two field windings. The search coil is enclosed in an electrostatic screen consisting of a number of 22 S.W.G. enamelled copper wires, wound on two halves of a cylindrical former. Two leads are run inside the spindle to connect the search coil to the slip rings and brush gear fitted at the bottom of the goniometer.

The field windings are wound on a former which is fitted over the electrostatic screen, and are connected to a terminal block on the top of the goniometer. This terminal block is fitted with links which can be removed for isolating aerials or goniometer field windings, as desired during testing operations.

As shown in the photograph (Fig.9), the slip-ring connections to the search coil consist of two pairs of fine wires maintained in tension by means of adjustable springs. These springs and wires should seldom require attention or adjustment, but, if in the course of time, it is found that noises are produced in the receiver by imperfect contact at the slip-rings, they should be cleaned and lightly oiled and the adjustment of the springs checked. Access to the slip-ring gear is gained by removing the bottom plate of the goniometer.

The goniometer is fitted with a dial bearing indicator, which consists of two scales. One scale is fixed and is marked 0^{o} to 180^{o}, Red and Green; the other is a rotating scale marked from 0^{o} to 360^{o}, driven by the ship's master Gyro Compass. The fixed scale enables relative bearings and the rotating scale true bearings to be read.

The dial bearing indicator is identical with that of modern M/F goniometers, and has fittings for cam correctors. These correctors are not used with H/F, and, in consequence, are not fitted in this goniometer. The white (cam) pointer is secured so that it reads the same bearing as the black fixed pointer.

A photograph of the dial bearing indicator is given in Fig.10. (NOTE:- The angle dividing mechanism shown is being omitted in present manufacture).

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CHAPTER 5.

RECEIVER B21B.

1. GENERAL.

The principal components in the office of D/F Outfit FH3 are, Receiver B21B and Radiogoniometer S29A, together with their associated switches, supplies etc. The connection between aerial system and D/F office is made by three identical screened H/F feeder cables for the collectors, with a fourth screened cable for the test loop.

This receiver is provided with a calibrated gain control which enables the field strength of the received signal to be estimated (See Chapter 2).

Receiver B21B is a Marconi RG42 Commercial Superheterodyne receiver which has been adapted as a High Frequency D/F receiver, and modified for use in conjunction with a fixed loop aerial arrangement incorporating a sense aerial and counterpoise and Radiogoniometer S29A.

The valves are as follows:-

(V1)	NR64	1st R/F Amplifier.
(V2)	NR64	2nd R/F Amplifier.
(V3)	6K8G	Frequency Changer.
(V4)	NR86	1st I/F Amplifier.
(V5)	NR82	2nd I/F and R.I.S. valve.
(V6)	NR86	3rd I/F Amplifier.
(V7)	NR68	2nd Detector and 1st A/F Amplifier.
(V8)	NR85	2nd A/F Amplifier (Output).
(V9)	NR86	2nd Heterodyne Oscillator.

(See Table 1 Chapter 7 for American equivalents).

The receiver consists of two tuned R/F stages, a frequency changer, three stages of I/F Amplification, a second detector and A/F amplifier, and an output stage. A separate Heterodyne Oscillator is provided for the reception of C.W.

The Frequency range of the receiver is 1 to 20 megacycles, covered in four, overlapping frequency bands, selected by means of a range switch which operates a turret containing the R/F and 1st Oscillator coils.

Tuning within each frequency band is effected by means of a single tuning control, which operates the four tuning condensers (C1) (C2) (C3) (C4) simultaneously. A pointer controlled by the tuning control, travels over a scale calibrated in approximate frequencies in megacycles, and an auxilliary scale with 160 equal divisions. This scale is changed by the operation of the range switch, so that an appropriate calibration for the range in use is shown.

An ivorine Logging Scale is attached to the front of the receiver on which adjustments may be recorded for reference.

Provision is made for the introduction of noise-suppression voltages from Outfit R.I.S.

A method of Sense-finding is employed which injects into the Search Coil circuit, simultaneously with the loop-aerials signal, a vertical aerial signal to produce a "cardioid" response curve in place of the "figure-of-eight" obtained when the loops alone are used.

This injection is effected by setting the "Search-D/F-Sense" switch to the "Sense" or "Reversed Sense" position. When this is done, the connections of the loops to the field coils of the radiogoniometer are altered to turn the field produced by the field coils through 90°. This operation produces a cardioid having its maximum and minimum on the bearing to which the radiogoniometer is set, instead of perpendicular to that direction.

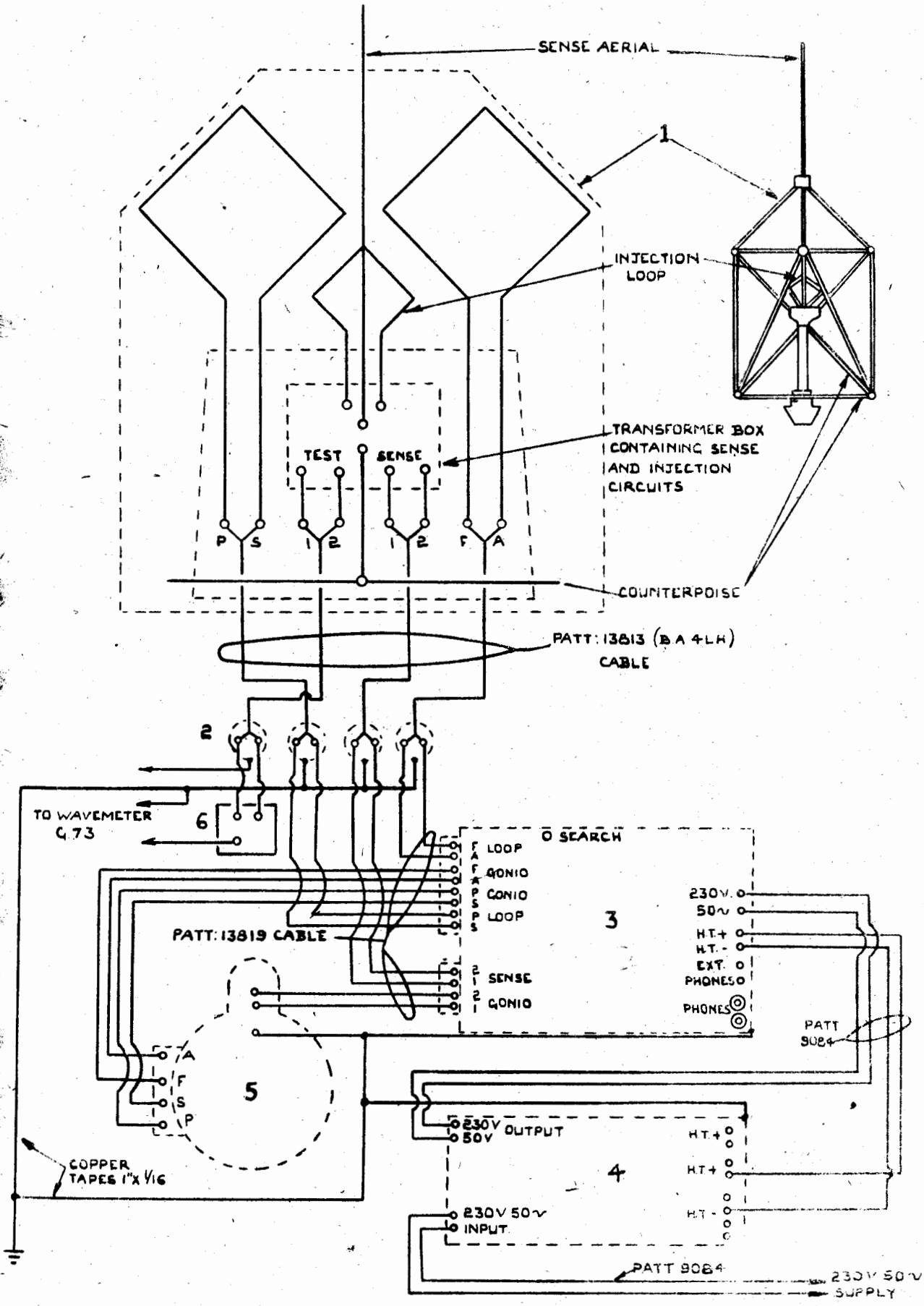
When the "Search-D/F-Sense" switch is switched from the "Sense" to the "Reversed Sense" position, the phase of the 'loop' signal is changed through 180°, thus reversing the cardioid, so that by switching from one "Sense" position to the other, the amplitudes of the maximum and minimum of the cardioid may be directly compared.

This Sense finding arrangement, which does not need rotation of search coil, allows rapid sense finding, even when the cardioid obtained is not perfect.

A complete circuit diagram of Receiver B21B is shown in Fig.1, simplified diagrams of the input circuit in Figs.4 and 5, and the construction of the model is shown pictorially in Figs. 11, 12, 13 and 14.

D/F OUTFIT FH3

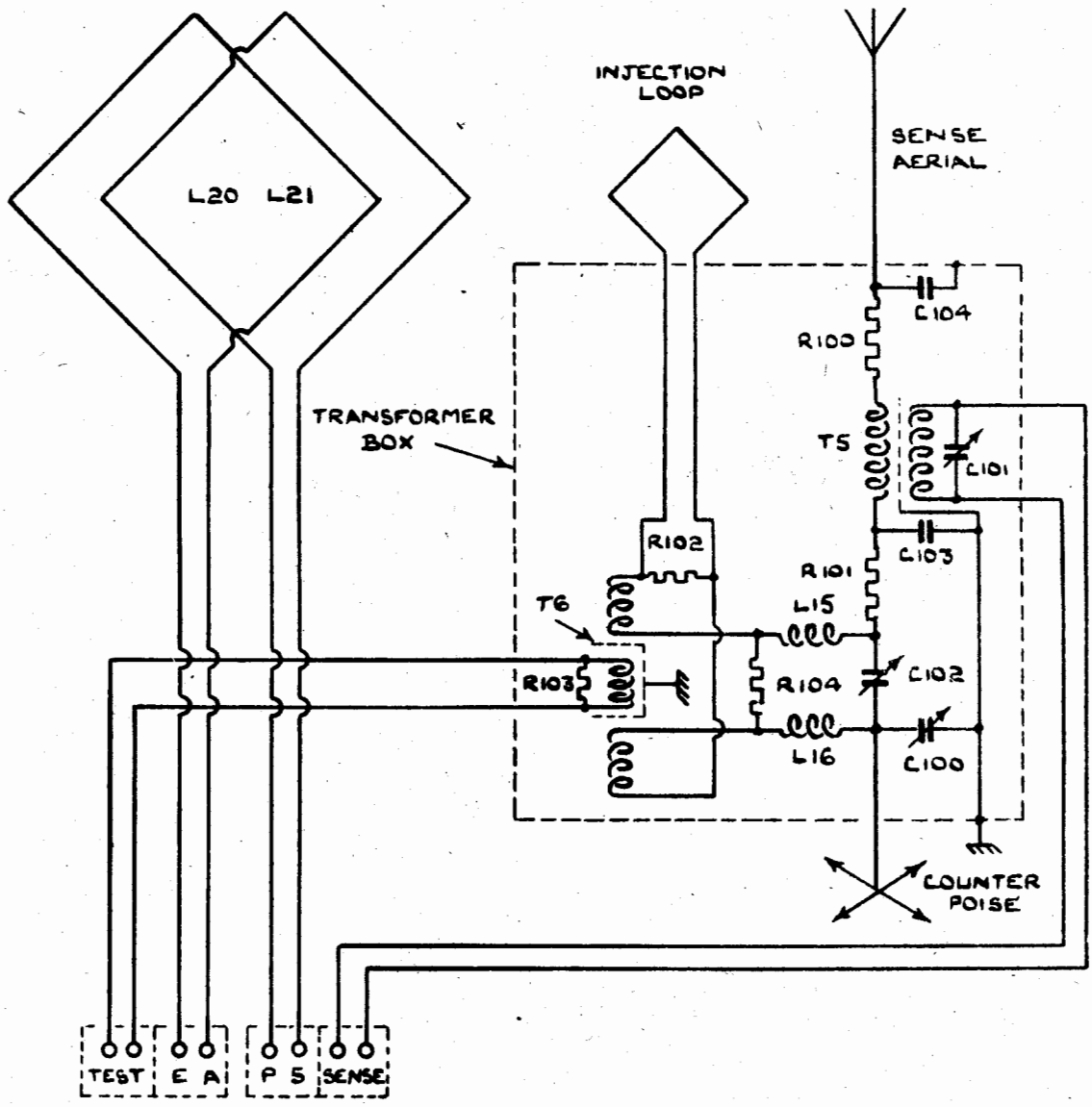
WIRING DIAGRAM & DETAILS



ITEM Nº	PATT: Nº	DESCRIPTION	Nº OFF
1	W6118A	FRAME COIL S25B	1
2	W7834	JUNCTION BOX FOR 1-TWIN & 2 SINGLE CABLES	4
3	W1516B	RECEIVER B21B	1
4	1204B	RECTIFIER UNIT DESIGN 'B'	1
5	5329A	RADIOGONIOMETER S29A	1
6	55609	RF TRANSFORMER UNIT DESIGN 5	1

D/F OUTFIT F.H.3. AERIAL SYSTEM

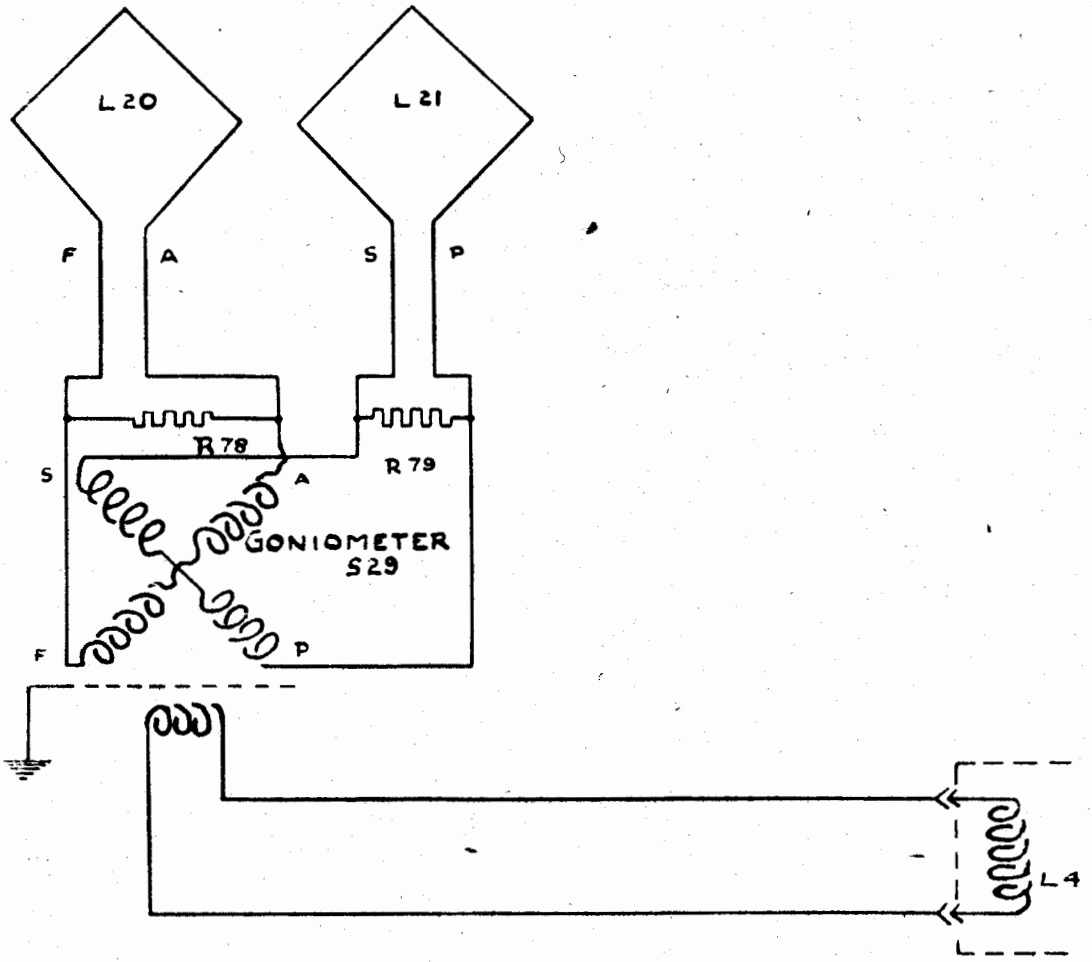
CIRCUIT DIAGRAM



SENSE CIRCUITS OF RECEIVER B21B.

SIMPLIFIED DIAGRAM OF INPUT CIRCUITS

SWITCH IN "D/F" POSITION

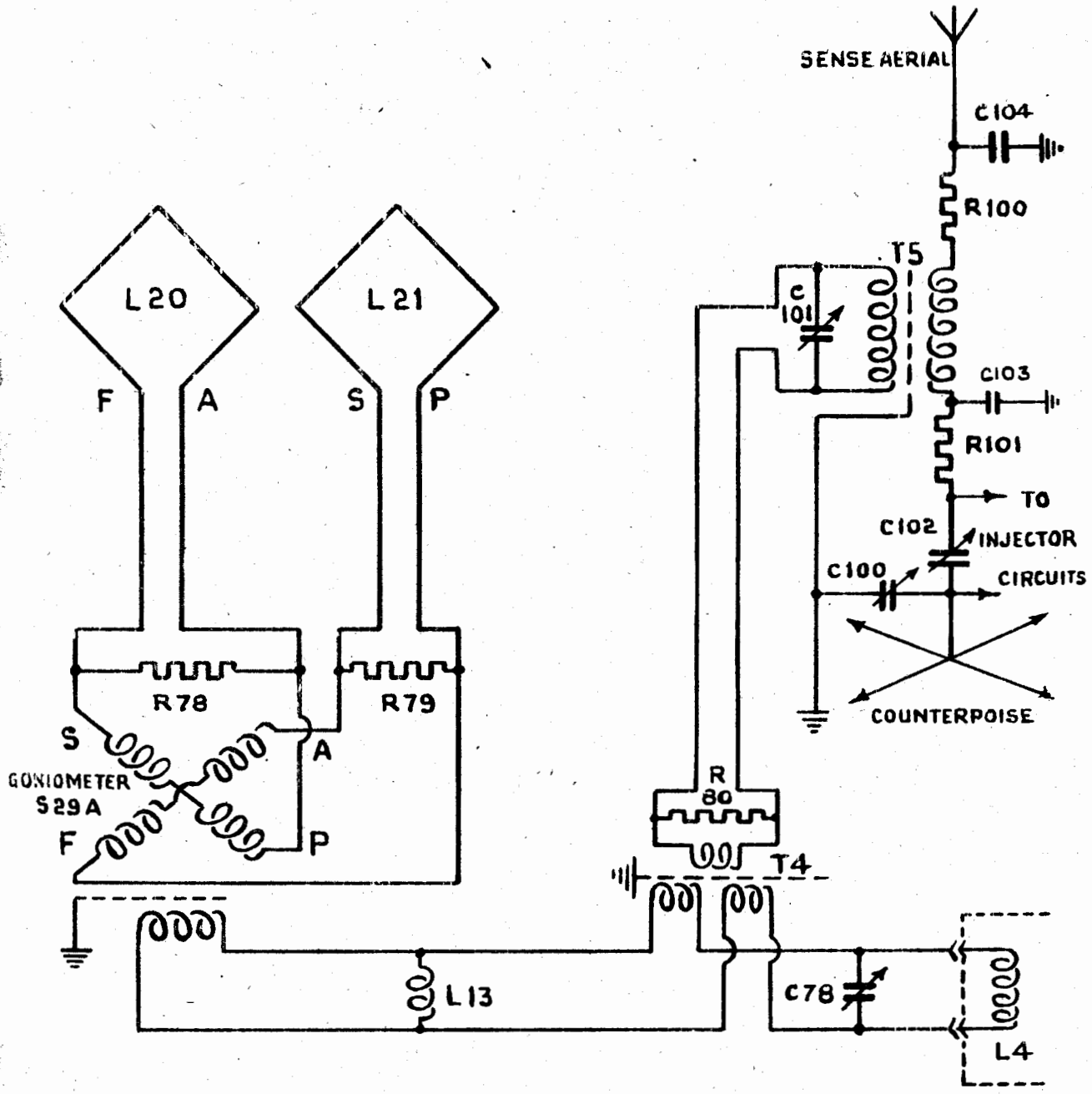


D/F OUTFIT FH3.

SENSE CIRCUITS OF RECEIVER B21B.

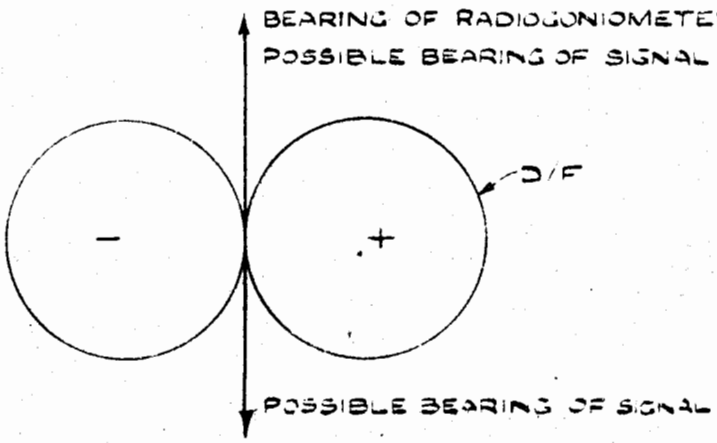
SIMPLIFIED DIAGRAM OF INPUT CIRCUITS.

SWITCH IN "SENSE" POSITION.

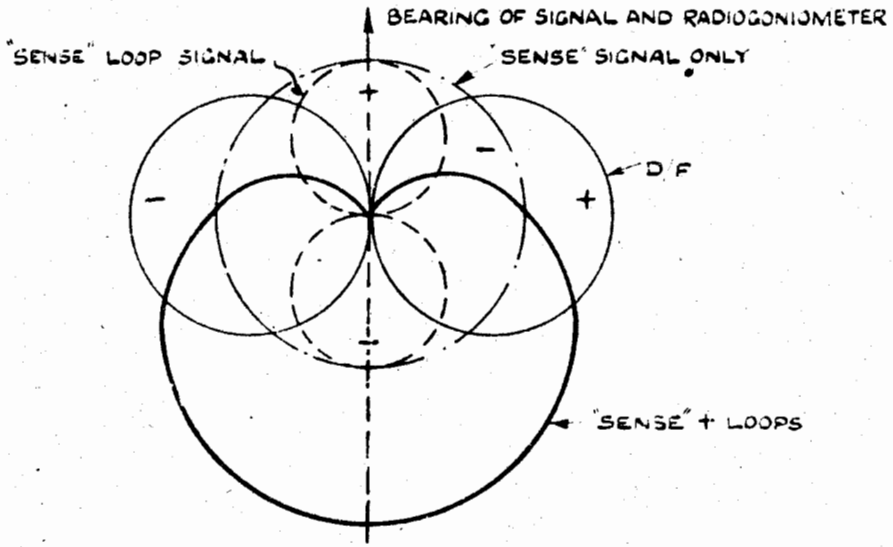


RECEIVER B 21B.

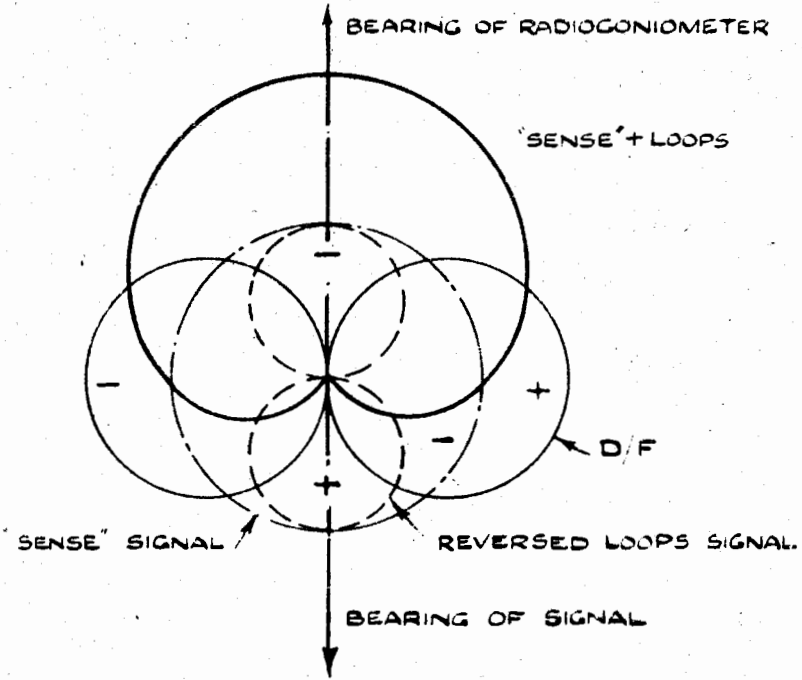
DIAGRAMS OF RESPONSE CURVES.



SWITCH IN "D/F" POSITION

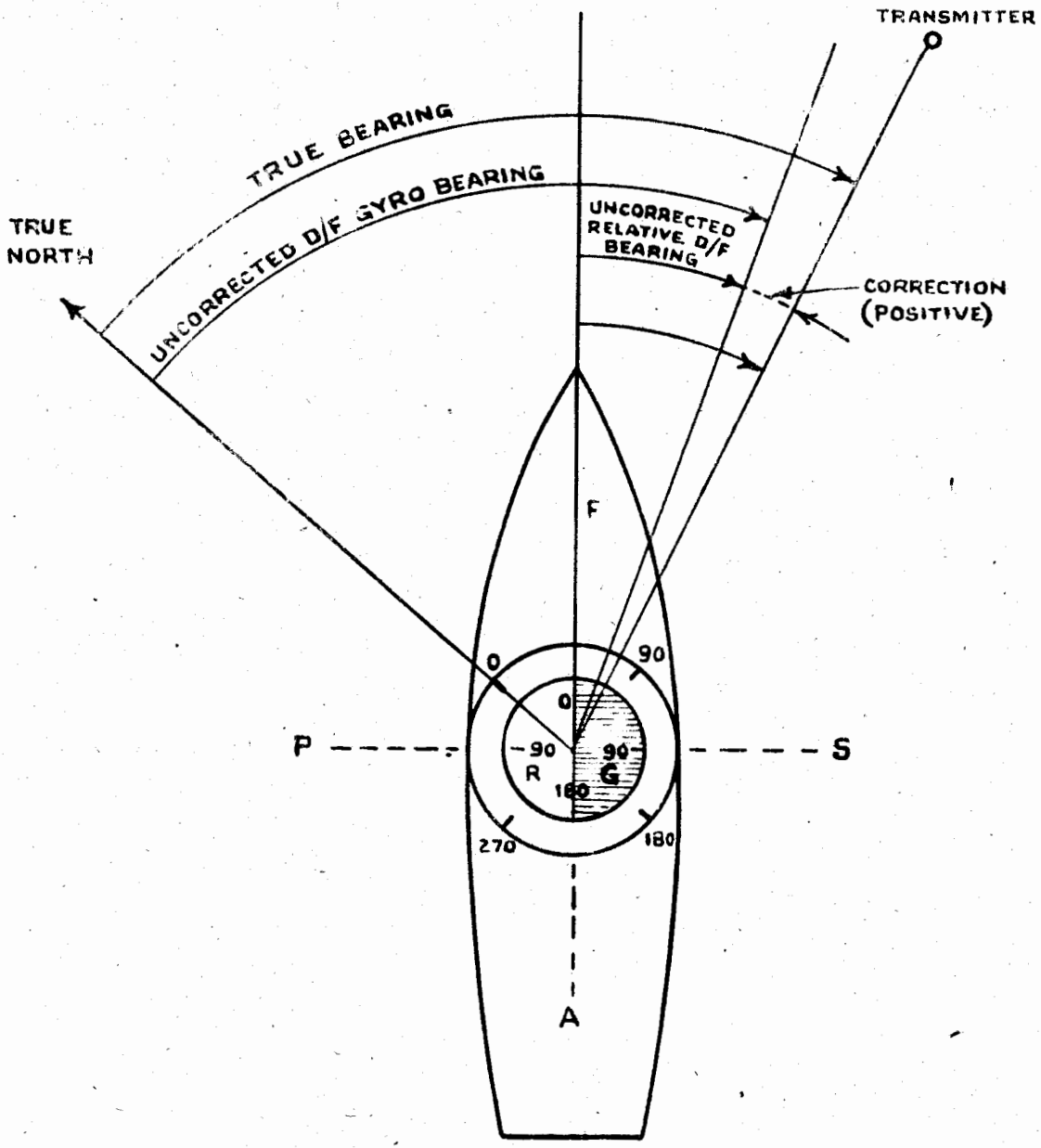


SWITCH IN "SENSE" POSITION



SWITCH IN "REVERSED SENSE" POSITION

TRUE AND RELATIVE BEARINGS.



DIAL BEARING INDICATOR.