D/F OUTFIT FM7

LA13

Date of Design :- 1940.
Frequency Range:- 42 - 1000 kc/s.
Components:- Framecoil S19, S22 or S17.
Tuner Amplifier B23.
Radio Goniometer S27.

Reference - Admiralty Handbook of W/T (1938) Vol. II, Paras. T12 to 37.

1. D/F Outfit FM7 is a ship's M/F direction finding set working on the Bellini-Tosi principle and employing a fixed frame coil system.

Three types of frame coil are used, S19, S22 and S17. Frame Coils S19 and S22 are normally mounted on a bracket fitted on the fore side of the bridge structure. S22 is fitted in destroyers and smaller vessels, and S19 in cruisers and above. S17 is fitted in ships where it is difficult to accommodate S22 or S19 and is usually fitted amidships on a pedestal.

The principle components comprising D/F Outfit FM7 are Tuner Amplifier B23 and Radiogoniometer S27 together with their associated switches, supplies, etc. A photograph of the complete apparatus is given in Fig. A.

Receiver Outfit CSB (Tuner-Amplifier B19) is sometimes fitted in the same rack as D/F outfit FM7, but is not used for D/F purposes.

DESCRIPTION OF COMPONENTS.

2. FRAME COILS S19/S22.

These two Frame Coils are similar except in size of loops. Each coil consists of two unequal sized rectangular tubular frameworks disposed accurately at right angles and mounted as a common upright. The fore and aft loop consists of two turns in series and the port and starboard loop three turns in series, of rubber insulated cable wound on Tufnol spacers fixed at each corner of the loops.

Frame Coils S19/22 are normally fitted on a bracket mounted on the fore side of the bridge structure as high as possible without fouling the line of sight from the bridge.

3. FRAME COIL S17.

Frame Coil S17 is mounted on a 5' 6" pedestal and normally fitted on the upper deck or other convenient position of certain classes of destroyers. It consists of two 4' 6" square loops placed at right angles to one another, each consisting of two turns in series of rubber insulated cable wound on loaded ebonite spacers inside a 1-inch metal tube framework. The four tubes enclosing the frame coil windings are interrupted near the top by moulded ebonite insulators. This arrangement prevents induced currents from circulating round the metal frame. THESE INSULATORS MUST BE KEPT CLEAN AND ON NO ACCOUNT SHOULD THEY BE PAINTED OVER.

A pointed rod, which is connected to the centre supporting strut, is fitted on the top of the frame coil as a protection against the effects of lightning.

4. OPEN OR SENSE AERIAL.

The open or sense aerial is a single wire receiving aerial of not more than 40-ft. and not less than 30-ft. in length. It should be erected as near vertical as possible, the inclination from vertical not exceeding 45 degrees unless compensated for by additional length. The aerial should also be as far removed from masts and from main aerial feeders as possible, particularly the upper end which should be at least 12 feet away.

The use of a cable connection between deck insulator and office introduces a loss of efficiency due to the capacity of the cable. This loss of efficiency is practically proportional to the length of the cable and has to be compensated for by increased length of aerial.

5. INDUCTANCE-CORRECTING AND SWITCH UNIT FOR D/F.

This unit consists essentially of three screened assemblies of apparatus mounted on a common metal plate and protected by a common metal cover. The two upper compartments are similar, each comprising a tapped inductance with switch (155)(157) having dial markings of "0-14"; a barrel type loop aerial switch (154)(156) with three positions and dial markings of "EARTH", "ON", "OFF"; a terminal box (160)(161) fitted with gas gap arrester (163)(164) and marked "To Loop"; and a plain terminal box marked "To Gonio". These two upper assemblies are connected in the F & A and P & S loops circuits, and when the outfit is calibrated the correct setting for the inductance correcting switches (155) and (157) is decided upon for different frequencies. IT IS ESSENTIAL THAT THESE SWITCHES SHOULD BE AT THE CORRECT SETTINGS FOR THE FREQUENCY IN USE SINCE A WRONG SETTING WILL INTRODUCE A BEARING ERROR.

The lower compartment contains a 50 volt relay (150) a barrel type switch (143) with two positions marked "Earth" "On" which brings the sense aerial into circuit, a terminal box (162) fitted with a gas gap arrester and marked "Sense Aerial" and a plain terminal box marked "To Key". The 50-volt relay (150) is operated from the transmitter control position and acts as a safety device by earthing the sense aerial during transmissions. A switch (149) marked "Key" "Off-On" situated at the bottom of the panel and obscured by the goniometer in Fig. A, is provided to break the relay circuit when there is no possibility of the receiver being damaged by own ship transmissions.

D/F OUTFIT FM7

FRONT VIEW

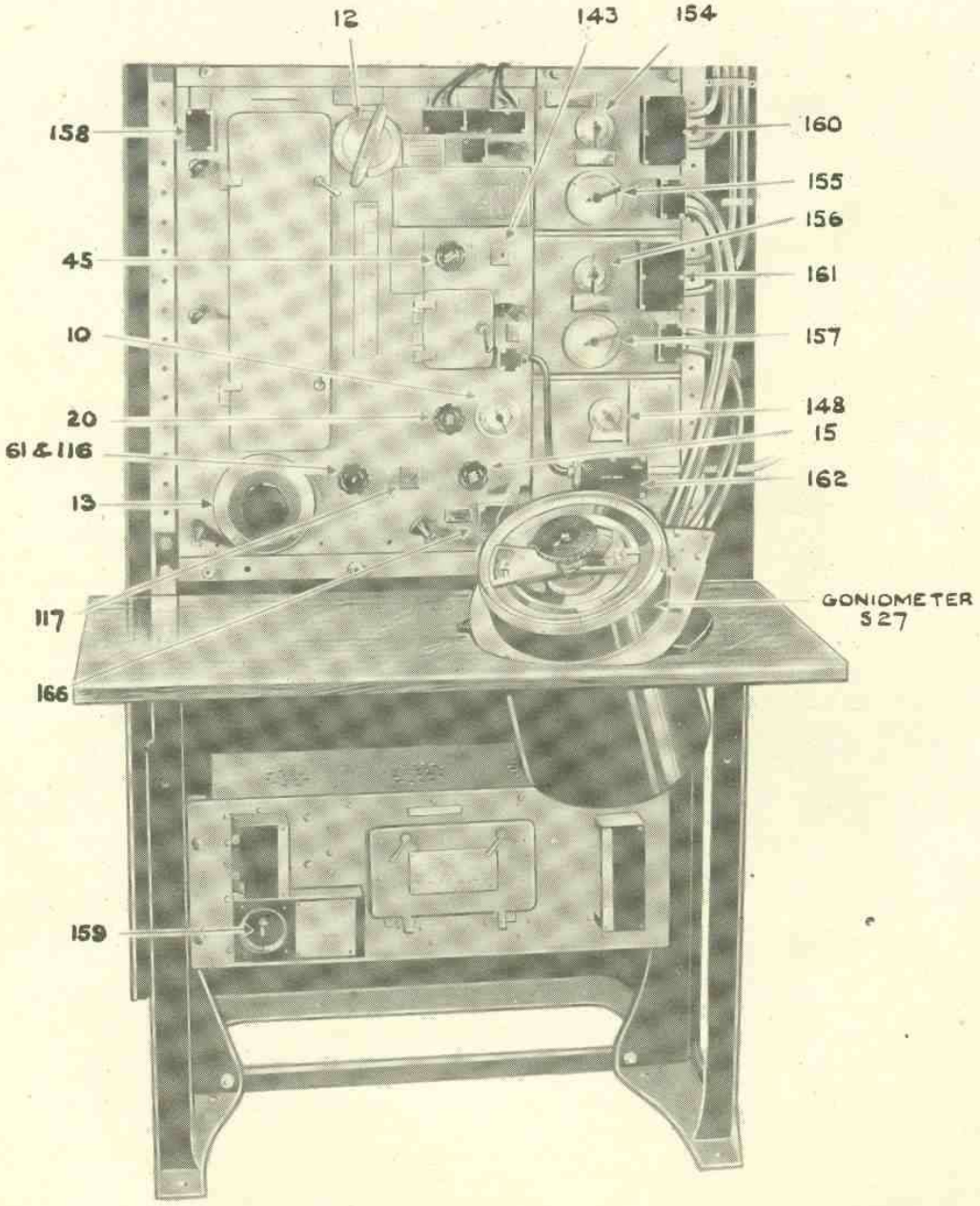

FIG. a.

The gas gap arresters are connected across the input terminals for each loop and between the sense aerial and earth. A circuit diagram of the unit is shown in Fig. B. From this it will be seen that the function of the switches on the inductance correcting and switch unit are as tabulated below :-

Switch	Position	Function
Loop Aerial Switches (154) (156)	"Earth"	Connects loops to earth.
	"ON" (The normal working position).	Connects loops to the Goniometer Field coils
	"OFF" (Used when carrying out tests)	Isolates the loops.
Inductance Correcting Switches (155)(157)	"0"	Disconnects one side of the correcting Inductances from the loop circuit.
	Any position other than "0" i.e. positions 1 - 14	Connects all, or part of the correcting inductances, depending upon the switch position, in parallel with the loop aerials, thus introducing a shunt across the loop concerned. This is done in order to balance up the efficiency of the aerials. As stated above, a wrong setting will introduce an error. In practice, only one inductance is used on any one frequency and in many ships it will be found that only the inductance (155) in the F & A loop is used, the inductance in the P & S loop always remaining on "0".
Sense Aerial Switch (148)	"Earth"	Connects the sense aerial to Earth.
	"ON" (The working position)	Connects the sense aerial via condenser (11) to the aerial switch (10) on the receiver.

6. RADIOGONIOMETER S27.

Owing to the smallness of the aerial system it has been found necessary to obtain the maximum sensitivity in all parts of the receiver apparatus and for this reason Goniometer S27 has been designed with a very high co-efficient of coupling between the field winding and the search coil. A higher degree of coupling than that obtainable in ordinary goniometers has been obtained by winding the coils round a centre core of specially prepared iron.

The goniometer consists of a fixed search coil (151) and two field coils (152)(153) placed very accurately at right angles to one another and which can be rotated in the space enclosed by the search coil (151).

The goniometer is fitted with a dial bearing indicator which consists of two scales. One scale is fixed and is marked 0 - 180 degrees, RED and GREEN; the other is a rotating scale, graduated from 0 - 360 degrees driven by the ship's master gyro compass system.

The fixed scale enables relative bearings and the rotating scale true bearings to be read.

CARE MUST BE TAKEN TO OBTAIN A CHECK FROM THE MASTER GYRO COMPASS AT LEAST ONCE A WATCH WHEN D/F WATCH IS BEING KEPT, AS ANY ERROR IN THE GYRO REPEATER WILL INTRODUCE AN ERROR IN THE TRUE BEARINGS READ.

That part of the quadrantal error which is not corrected by the Inductance-Correcting and Switch Unit is corrected by means of a quadrantal error correcting device in the goniometer consisting of a fixed cam fitted in the centre of the goniometer scales. This cam is cut according to the curve of errors obtained during the initial calibration. The white pointer is operated by the cam and thus gives a corrected bearing.

NOTE :- The maximum correction which can be applied by cam is ±10 degrees. If any additional correction has to be applied the white pointer must be ignored, the bearing read from the black pointer and the correction obtained from the curves provided at calibration. A specimen copy of a "Report of Calibration" is given on pages L24 and L25.

The angle dividing device is similar to that supplied on standard radiogoniometers and works on the same principle. This device is being omitted in radiogoniometers now being manufactured.

7. TUNER AMPLIFIER B23.

The receiving instruments of D/F Outfit FM7 are contained in Tuner Amplifier B23, which covers a frequency range of 42 - 1000 kc/s in five steps by means of a range switch (12) operating a turret drum containing the R/F and Beat Oscillator coils and trimming condensers. Tuning over each range is effected by means of a single tuning control (13) operating a 6-ganged condenser. The ranges are as follows :-

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SIMPLIFIED CIRCUIT DIAGRAM.

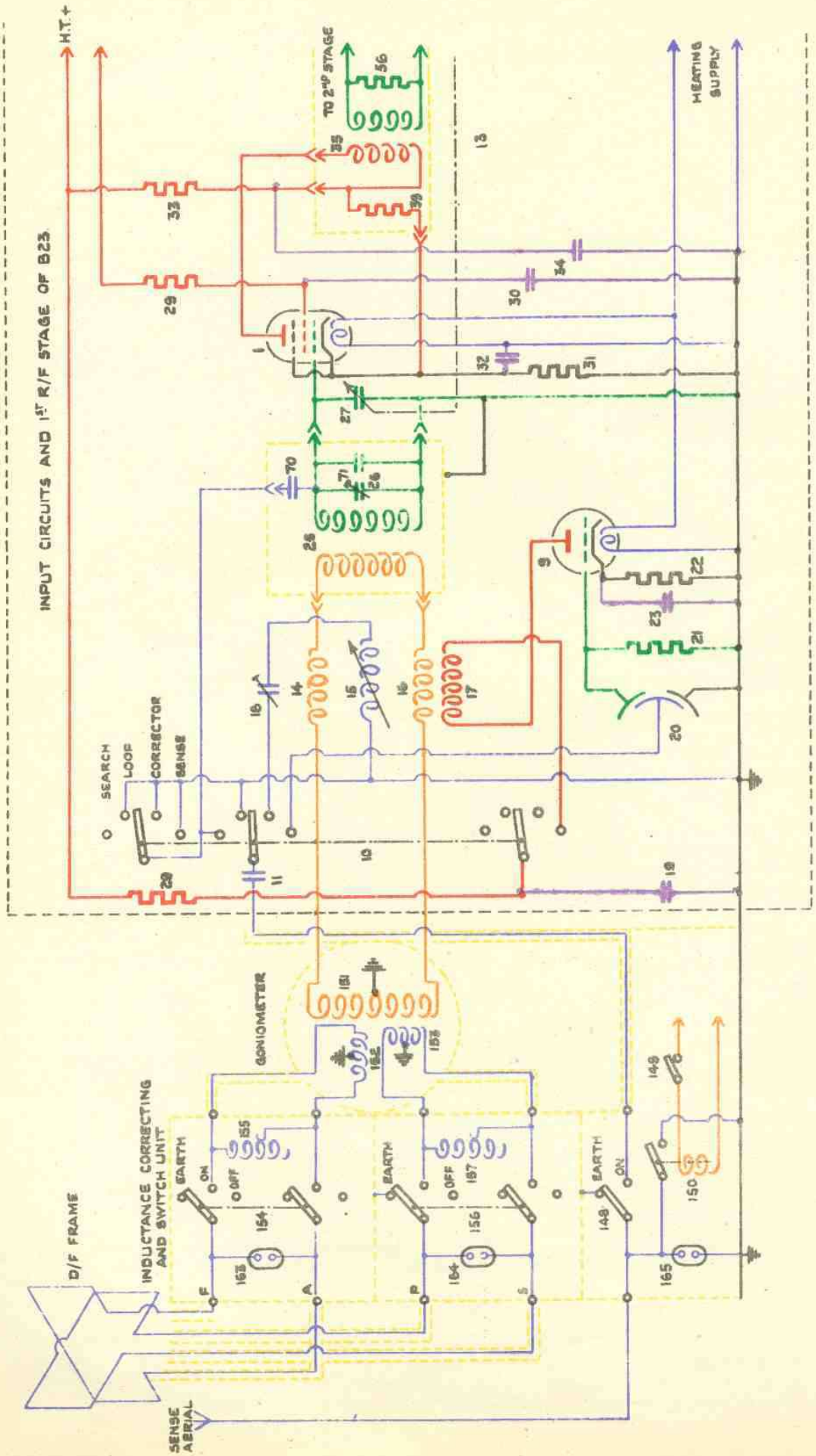

Fig. 6

Switch Position.	Frequency Band.
1	42 - 90 kc/s.
2	90 - 180 kc/s.
3	180 - 310 kc/s.
4	310 - 570 kc/s.
5	570 - 1000 kc/s.

The receiver comprises four stages of R/F amplification with tuned transformer coupling, an anode-bend detector, beat oscillator and two stages of A/F amplification. All six tuned circuits, including that of the beat oscillator, are matched and tuned by the 6-ganged tuning condenser. A pointer coupled to the tuning control travels over a scale calibrated in approximate frequencies. The scale is changed by the operation of the range switch to show the correct calibration for the range in use.

Volume control is effected by means of a knob (61 and 116) controlling two ganged potentiometers, one of which alters the gain of the second, third and fourth R/F stages, while the other alters the A/F gain.

The receiver has a very great reserve of amplification in hand and the output to the phone jack (143) is therefore deliberately curtailed at a certain power level to avoid aural shock.

If too much gain is used on a good signal the amplification of the noise components may reach the same cut-off level as the signal component and swamp the signal. Therefore the volume control should be used with discrimination in order to obtain the most favourable signal-to-noise ratio.

Output terminals (158) for a loud-speaker connection are provided.

All the controls are mounted on the front panel of the receiver and are as follows:-

(i) Range Switch (12).
(ii) Tuning Control (13).
(iii) Aerial Switch (10).
(iv) Sense Input Control (20).
(v) Semi-circular Corrector (15).
(vi) Volume Control (61 and 116).
(vii) R.I.S. Control (45).
(viii) Beat Oscillator Switch (117).

The control knob of the R.I.S. control (45) is coloured RED and it is essential that this knob be kept in the "OFF" position when the R.I.S. equipment is not in operation or is not fitted; otherwise the receiver will suffer some reduction in efficiency.

Access to all the valves, except the sense valve is obtained through the large door on the left-hand side of the panel, while the sense valve is accessible through the small door on the right-hand side.

8. INPUT CIRCUITS.

The arrangement of the input circuits of the receiver is determined by the setting of the aerial switch (10). This switch has four positions, labelled "Search", "Loops", "Corr" and "Sense" respectively. The circuit arrangements for each position of the switch are described below.

Fig. C (i) shows the equivalent input circuits when the aerial switch is in the "Search" position. The Sense/Search aerial is connected to the grid of the first R/F valve (1) through its 0.002 mfd. series condenser (11) and a 10-mmfd. condenser (70) in the coil turret. In all other positions of the switch the "aerial" side of the condenser is earthed, thus connecting the condenser in parallel with the tuning condenser (27).

Fig. C (ii) shows the equivalent input circuits when the aerial switch is in the "Loops" position. The Sense/Search aerial is disconnected and earthed, and as the radiogoniometer search coil is permanently connected to the input R/F transformer primary winding (25) via the semi-circular corrector coils (14) (16), bearings and reciprocals can be taken in the ordinary way.

Fig. C (iii) shows the equivalent input circuits when the aerial switch is in the "Corr " position. The Sense/Search aerial is connected to the moveable winding (15) of the Semi-circular Corrector through the aerial series condenser (11) and a 100-mmfd. preset condenser (18). The other end of the winding is earthed. With the switch in this position, correction for blurred zeros due to the semi-circular effect of the ship's field may be obtained by adjustment of the semi-circular Corrector control (15).

Fig. C (iv) shows the equivalent input circuits when the aerial switch is in the "Sense" position. The Sense/Search aerial is connected to the grid of the sense valve (9) via the 0.002 mfd. aerial series condenser (11) and the Sense Input differential condenser (20). The sense valve injects into the search coil circuit a signal 90° out of phase with that obtained from the goniometer and enables the true direction of the transmitting station to be determined by use of the cardioid characteristic thus obtained.

9. POWER SUPPLY.

The H.T. Supply of 200 volts D.C. is taken from a Patt. 1204B Rectifier Unit, Design B and is fed through the safety switch (147). When the valve access door is opened the safety switch (147) is broken.

The L.T. supply is obtained via the transformer (146), the Primary of which is fed from the 230 volt 50 cycle supply to the Rectifier Unit.

10. OPERATION.

The procedure for operating the D/F Outfit is as follows:-

(i) Make the A.C. supply switch (159) on the Patt. 1204B Rectifier Unit Design "B".

(ii) Set the loop and sense aerial switches (154), (156) and (148) to the "ON" position.

(iii) Set the Aerial Switch (10) to the "search" position and the semi-circular corrector (15) to its zero position i.e. upright.

(iv) Set the Inductance Correcting Switches (155) and (157) to the correct settings for the frequency in use as stated in the Report of Calibration. (Only one switch is used on any one frequency, the other switch being set to "0").

(v) Set the range switch (12) to the required frequency band.

(vi) Set the Heterodyne Oscillator switch (117) to C.W.

(vii) Set the tuning control (13) to the required frequency as shown on the calibration scale.

(viii) Tune either side of the indicated position until the signal is heard. If the signal is modulated the Heterodyne Oscillator Switch (117) should be set to "I.C.W.", except in the case of R/T signals.

(ix) Set the volume control (61) (116) to give reasonable signal strength in the telephones. The signal should not be too loud.

(x) Set the Aerial switch (10) to "Loops" position and obtain bearing (or reciprocal) in the usual manner by adjusting the goniometer pointer to a position of minimum signal. Increase Volume Control if necessary. Note the gyro and relative bearings, reading from the white floating pointer if the cam corrector is in use, otherwise from the block pointer.

(xi) Set the Aerial Switch (10) "to sense" (This operation brings in the sense aerial and strength of signals should increase). See that the "Sense Input Control" (20) is in the working position. If the working position is not known it should be obtained as instructed in para. 11.

(xii) Turn the goniometer pointer clockwise but not more than 90°. If the signals decrease when the pointer is rotated clockwise the bearing on which the pointer was trained (i.e. the bearing noted in operation (x) is the true bearing. If, however, signals increase then the bearing noted is the reciprocal and the goniometer pointer should be turned through 180° and trained on the true bearing before proceeding with the next operation. If the sense indication is poor, check the setting up of the sense input control (20) as detailed in para. 11.

(xiii) Set the Aerial Switch (10) to "Corrector" position and adjust the semi-circular corrector control (15) until a well-defined minimum is obtained, keeping the goniometer pointer trained on the true bearing. This procedure will give a well-defined minimum with a blurred reciprocal.

(xiv) Read off the gyro and relative bearings and if time permits check the sense.

(xv) If the Cam Corrector is not being used apply correction for quadrantal error from the curves provided. (See Note (ii) and Report of Calibration, Para. 17, Sub-para. (8).

Note:- (i) The minimum obtained at operation (x) may be good enough to allow omission of operation (xiii).

(ii) To avoid confusion when applying correction to relative bearings, as opposed to gyro bearings, the following rule is recommended:-

"Apply all POSITIVE Corrections CLOCKWISE and all NEGATIVE corrections ANTI-Clockwise along the scales concerned, irrespective of whether gyro or relative bearings are being corrected.

It should be noted that the sign of the correction given by the curves is arranged for application direct to the gyro bearing. If the gyro is out of action and relative bearings are being reported, the sign of the "RED" correction must be reversed if the correction is applied numerically. The rule recommended above makes it unnecessary to reverse the sign.

11. PROCEDURE FOR OBTAINING THE WORKING POSITION OF THE SENSE INPUT CONTROL.

(i) Set the Aerial Switch (10) to the "loops" position and train the goniometer pointer on the true bearing.

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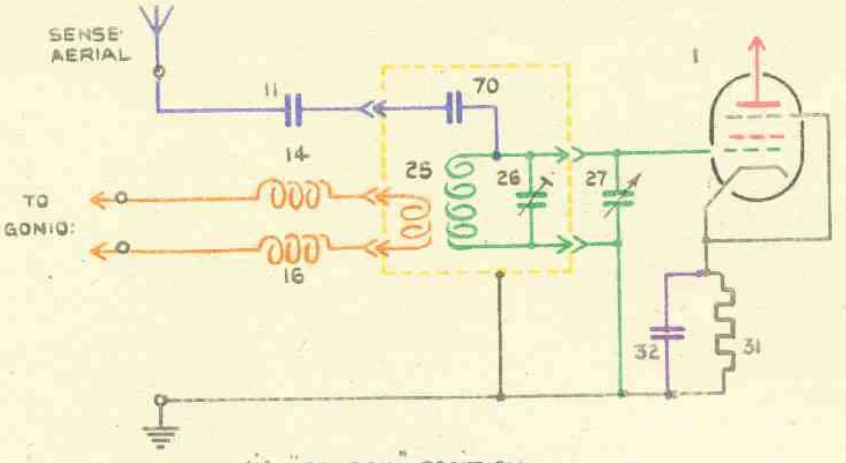
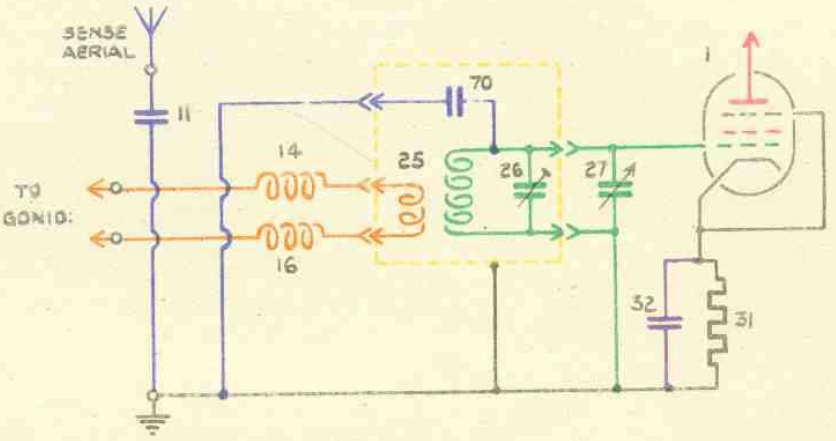
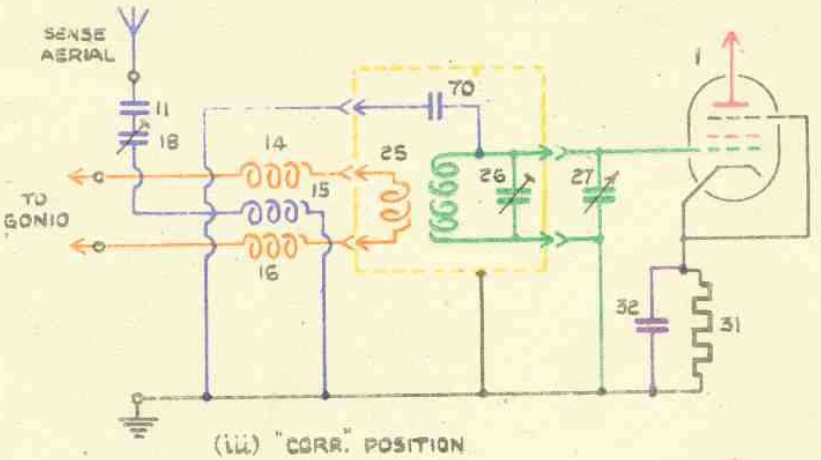
EQUIVALENT INPUT CIRCUITS



(i) "SEARCH" POSITION



(ii) "LOOPS" POSITION



(iii) "CORR." POSITION

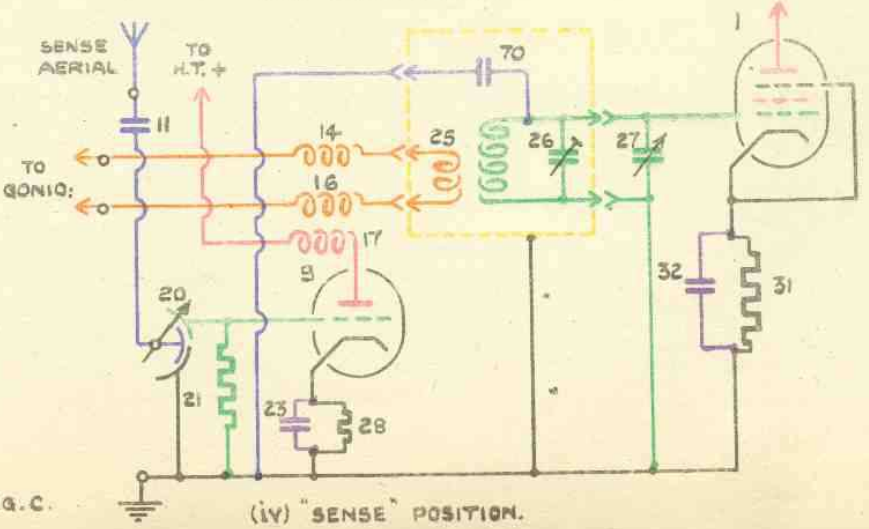


FIG. C.

(iv) "SENSE" POSITION.

(ii) Switch to "sense" and turn the goniometer pointer 90° in a clockwise direction.

(iii) Adjust the Sense Input Control until the Signal strength is a minimum. If the goniometer pointer was trained on the reciprocal bearing in (i) above no sense minimum will appear and the pointer should be turned through 180°. The sense minimum is very pronounced and is unlikely to be confused with normal variations in signal strength caused by adjusting the Sense Input Control.

The adjustment is fairly critical but once it is obtained no alteration is required unless a large change in frequency is made.

12. PROCEDURE FOR OBTAINING NAB BEARINGS.

When taking bearings of a station which has already been tuned in and which is only working for short periods, the Aerial Switch (10) may be left in the "Corrector" instead of the "Search" or "Loop" positions, thereby reducing the number of switch movements. Care should be taken to see that the Semi-circular Corrector (15) is set to its zero position i.e. upright, when not in use.

13. TESTS TO BE CARRIED OUT ON SETTING D/F WATCH.

(1) Check the goniometer gyro repeater against the ship's Master Gyro Compass. This check must be repeated at least once every watch.

(2) Check the alignment of the goniometer pointer. The procedure is as follows :-

(i) Tune in a strong signal.

(ii) Put the Aerial Switch (10) to the loop position.

(iii) Break the P & S loop by putting the P & S loop Aerial Switch (156) to the "Off" position.

(iv) Note the position of the zeros on the goniometer. They should appear at 0° and 180° on the relative scale thereby indicating that the pointer is correctly lined up with the rotating field coils.

The test may be carried out using the P & S loop, in which case the zeros should appear at R90 and 090.

Zeros may be sharpened by putting the sense Aerial Switch (148) to the "Earth" position during this test.

14. CARE AND MAINTENANCE.

The contact surfaces of all barrel type switches should be smeared every three months with a little white vaseline to ensure low resistance contact. It is most important that no resistance be introduced into the aerial circuits and that the resistance readings obtained in Routine Test No.4 at calibration should be maintained. An increase in resistance of only 1 ohm in one aerial may cause a bearing error of as much as 5 degrees.

The contact paths of filament rheostats should be smeared periodically with graphite grease.

Avoid removing a valve suddenly as it may be damaged by striking the panel overhead or the legs may become defective.

Do not slam the valve access doors. Keep the contact surfaces on the doors and panel as clean as possible.

The surfaces of instruments must be kept free from moisture and dust, and care taken not to damage the fine pointers, or slow-motion devices.

The grooves in the contact rings of variable condensers should be cleaned periodically with a soft rag and lightly smeared with white vaseline. This assists in keeping instruments from being noisy when the tuning condensers are in use.

The use of white vaseline is preferred to oil as it is less liable to evaporation.

It is essential for efficient operation that the instruments should be kept absolutely clean and under normal circumstances in instant readiness for use.

15. ROUTINE TESTS.

Periodical tests should be carried out to ensure the correct functioning of the apparatus. A list of tests is tabulated below and while no arbitrary rule can be laid down to state how often the tests are required, they should, in general, be applied in accordance with column (f).

All the tests should be carried out immediately prior to calibration.

Test No.1 should be done after the outfit is first fitted when the specification is available. The position of cables rigging etc., should be carefully noted for further reference when this test is required and the specification is not available.

TABLE OF ROUTINE TESTS.

(a) No.	(b) Test	(c) Fault	(d) Cause	(e) Remedy	(f) To be carried out.
1	Examine aerials and rigging in vicinity of the D/F coil and confirm that it is in accordance with specification. Check D/F frames and see that one coil is exactly fore and aft as seen from forecastle or quarter deck.	Items not in accordance with specification.	Faulty installation.	Correct as far as possible and call attention to points that cannot be rectified.	Monthly.
2	Test Insulation Resistance of each frame aerial to earth with a megger. Procedure :- (i) Remove cover plates from terminal boxes (160) and (161). (ii) Remove gas gap arrestors (163) and (164) from terminal boxes (160) and (161). (iii) Set loopaerial switches (154) and (156) to "ON". (iv) Set inductance correcting switches (155) and (157) to "O". (v) Remove cover plate from terminal box at rear of goniometer and disconnect leads marked F & A, P & S. (vi) Test insulation between one leg of each pair and earth, the other leg being isolated.	Insulation resistance less than 10 megohm or large difference between P & S and F & A Loops.	Probably junction box at base of frame coil but may be in frame or leads.	Localise fault, repair if possible, otherwise request assistance of Dockyard or D/F Officers.	Weekly.
3	Test insulation of Sense Aerial to earth with a megger. Procedure :- (i) Remove Cover Plate from sense aerial terminal box (162) and take out gas gap arrestor (165). (ii) Remove gas gap arrestor (if fitted) from Patt. 1914 J.B. x (iii) Remove cover plate from sense Aerial terminal box (166) on B23 and disconnect sense aerial lead. (iv) Put Sense Aerial Switch (148) to "ON". (v) Test between sense aerial lead and earth.	Insulation resistance less than 1 megohm.	Probably junction boxes or aerial but may be in cable.	Localise fault, repair if possible, otherwise request assistance of Dockyard or D/F Officers.	Weekly.
4	Measure ohmic resistance of each frame aerial circuit with bridge megger to two decimal places. Procedure :- (i) Carry out operations (i) to (v) of Test 2. (ii) Take readings of F & A and P & S Loops.	Difference in resistance exceeding 0.5 ohm. (see para. 14).	Broken wire or imperfect contacts in the circuit.	Localise fault by test and renew or repair where necessary.	Monthly.

x Gas gap arrestor in Patt. 1914 JB is not essential and may be removed provided one is fitted in terminal box (162) on the Inductance Correcting Unit.

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(a) No.	(b) Test	(c) Fault	(d) Cause	(e) Remedy	(f) To be carried out.
5	Measure the ohmic resistance of the windings of the goniometer. Procedure :- (i) With leads disconnected as in tests 2 and 4 measure field coils across terminals F & A and P & S. (ii) Remove Cover Plate over search coil terminals on the left hand side of the goniometer and disconnect leads. (iii) Measure search coil across the search coil terminals.	High resistance greater than the following figures :- Gonio S27 Field coil 1 ohm. Search coil 2 ohms	Broken or imperfect contacts in the circuit.	Examine all soldered connections and repair as necessary.	Monthly.
6	Test Tuner Amplifier B23 by receiving signals on all ranges.	No signals or intermittent or weak reception.	Defective Receiver or associated apparatus.	Make sure that all leads have been correctly connected and switches made. Test voltages and check against table in Handbook. If necessary try new valves. Make sure that turret coil contacts are clean and making contact and that loud speaker, if being used, is switched on. N.B. Coil trimmers should on no account be interferred with. In general, endeavour to localise fault and effect a repair.	Weekly.
7	Test Receiver. Rotate Goniometer pointer while receiving signals.	Poor or noisy reception.	Bad valve connections or imperfect contacts at the slip rings of search coil.	Make sure that the joints and leads from search coil of goniometer to B23 are correctly made soldered and fitted. Test for faulty valve. If necessary remove cover from Goniometer, clean rotating contacts and smear lightly with vaseline oil.	Weekly.
8.	Test sense-finder on known station. This should be checked at H/F end of range. See that Sense Aerial Switch (148) is turned to "ON".	Impossible to obtain a satisfactory sense; or sense reversed at high frequencies.	Defective valve or unsuitable sense aerial. Leads to Gonio too long or not of specified pattern.	Try new valve vary the length of the sense aerial.	Monthly.

(a) No.	(b) Test	(c) Fault	(d) Cause	(e) Remedy	(f) To be carried out.
9	Test Semi-circular Corrector. Procedure :- (i) Break frame aerial circuits by putting Loop Aerial Switches (154) and (156) to "EARTH". (ii) See that the sense Aerial Switch (148) is turned to "ON". (iii) Put Aerial Switch (10) to the "Corr." position. (In this position the sense aerial is connected to the semi-circular corrector).	No signals heard or minimum not observed when knob marked "Semi-Circ.Corr" is turned to the mid-point position.	Defect in instrument.	Put right as far as possible.	Monthly.
10	Line up the Goniometer (Part I). Procedure :- (i) Break the P & S Aerial circuit by putting the P & S Loop Aerial Switch (156) to "OFF". (ii) Earth the sense aerial by putting the sense Aerial switch (148) to "EARTH". (iii) Receive a strong signal on the F & A Frame Aerial. (F & A Loop Aerial Switch (154) set to "ON") (iv) Set Goniometer pointer so that one zero is at 0 degrees on the inner scale.	Reciprocal zero not at 180°.	Defective Goniometer.	New Goniometer.	Monthly. The setting of the pointer should always be checked on setting D/F watch.
11	Line up the Goniometer (Part II). Procedure :- (i) Break the F & A Aerial circuit by putting the F & A Loop Aerial Switch (154) to "OFF". (ii) Earth the sense aerial by putting the sense Aerial Switch (148) to "EARTH". (iii) Receive a strong signal on the P & S Frame Aerial (P & S Loop Aerial Switch (156) set to "ON").	Zeros not at 90 degrees Red and Green.	Defective Goniometer.	New Goniometer.	Monthly.
12	Test for sense. Take approximate bearing of suitable station. (Not BBC). At least two bearings should be taken. One on approximately 950 kc/s and the other on approximately 160 kc/s.	Reversed or unreliable sense. Bearing greatly in error.	(a) Possibly wrong value of ship's head. (b) Loop Aerials or leads wrongly connected to goniometer giving bearing in wrong quadrant. (c) Another Aerial near D/F coil tuned to same frequency.	(a) Check Ship's head. (b) Trace and check leads from frame coils to Goniometer. (c) Isolate Aerial.	Weekly.

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(a) No.	(b) Test	(c) Fault	(d) Cause	(e) Remedy	(f) To be carried out.
13	Test gyro repeater, e.g. by causing the master gyro to be turned slowly through 360° first clockwise and than anti-clockwise.	Lost motion between master and repeater i.e. failure to keep in step.	Gears meshed too tightly, imperfect transmission from the master gyro or defect in repeater motor.	Set gears so as to give a slight play (½°) on the rotating scale. Report other defects to the department in charge of gyros.	Weekly.
14	Earth link in rectifier 1204B should be connected to frame for B23 (See Note).				
15	Test R.I.S. gear with R.D.F. transmitter working.	Interference still continuous. Pilot light on phase control unit does not show.	Fuses in Phase Control Unit blown. A.C. not made in R.D.F.Office.	Check fuses and wiring, renewing where necessary.	

NOTE :- A B21 H/F D/F Receiver may be used in the same office with a B18 or B23 but a separate rectifier unit 1204B must be used since H.T.- for a B21 must not be earthed.

16. CALIBRATION.

D/F calibration should be carried out in new ships after completion and in existing ships :-

(a) When a new D/F Outfit is fitted.

(b) If the position of the frame coil is changed.

(c) If any alterations to the ship's structure in the vicinity of the coil is made.

Check calibrations should be carried out at intervals not exceeding twelve months.

When the D/F set requires calibration application should be made to the Senior Officer present. Full D/F calibrating facilities exist at the following ports :-

Scapa, Greenock, Liverpool, Barrow, Humber, Portsmouth, Devonport.

Special calibrating vessels are stationed at these ports and Admiralty Signal Establishment Officers carry out the calibration.

An interim report of the calibration will be prepared and left in the ship by the calibrating officers for use until the official report is received. The official report will be prepared in the Admiralty Signal Establishment and forwarded to the ship concerned. This report contains details of the aerial equipment and can be used as a guide for refitting the aerials if this becomes necessary. A specimen copy of a report of calibration is given below.

Whenever the set is calibrated by Admiralty Signal Establishment officers the correcting cams for the goniometer will be cut by them and sent direct to the ship. These cams must then be fitted to the dial bearing indicator and used in accordance with the instructions given in the report of calibration.

17. SPECIMEN COPY OF REPORT OF CALIBRATION.

REPORT OF CALIBRATION OF D/F OUTFIT FM7
IN H.M.S. "NONSUCH".

1. Date of Calibration. 1st Feb. 1943.

2. Calibrating Officer. Mr. R.H. Smith.
Mr. J. Jones.

3. Position of (a) D/F Framecoil - forward of the Bridge.

(b) Receiving instruments - in the W/T office.

4. The Calibration.

(a) Preliminary tests were satisfactory. Transmitting duties were carried out by H.M.S. NORTHWIND.

(b) The Inductance Correction was adjusted on Red 045° and 135° on the frequencies 270, 530, 750 and 970 kc/s.

From the results obtained the following number of stops of the correcting inductance must be used for any frequency in the range 42 - 1000 kc/s.

kc/s.	Number of stops of inductance in F & A LOOP.
42 to 1000	Seven.

(c) Swings were then carried out to determine the corrections necessary to observed D/F bearings on the frequencies 270, 530, 750 and 970 kc/s. The necessary corrections are shown on Admiralty Signal Establishment drawing No. 43D/F 83/A. A copy of the curve of correction was left in the ship on completion of the calibration.

(d) Minima are good on all frequencies. Any slight blurring present can be removed by means of the semi-circular corrector with the switch in the CORR position.

(e) Sensefinding is satisfactory on all frequencies in the range 42 - 1000 kc/s.

(f) A cam to correct automatically the deviations on all frequencies up to 1000 kc/s will be provided.

5. Accuracy.

Errors in M/F bearings should not exceed $\pm 2^{0}$ on all frequencies up to 1000 kc/s subject to the following conditions :-

(i) The inductance correcting adjusted in accordance with paragraph 4 (b) above.

(ii) Corrections applied by means of the curve referred to in (c) or the cams in (f) above.

(iii) Bearings taken over sea at distances not exceeding 100 miles by day and 25 miles by night.

(iv) Skilled operating.

(v) No alterations to rigging in the vicinity of the D/F aerials.

(vi) Tests described in Admiralty Signal Establishment Form No. 160A, "Tests to be carried out by ship's staff prior to D/F calibration" to be satisfactory.

(vii) The forward gun mounting trained Fore and Aft with the gun at normal elevation.

6. Other aerials in the ship were found to have no effect on the accuracy of D/F bearings.

7. The frequency range of the receiver is 42 - 1000 kc/s.

8. USE OF CORRECTING CAMS AND CURVES.

(a) When the correcting cam is used, the corrections are applied automatically and the bearings should be read off from the white floating pointer. (Reference should be made to A.F.O. 4892/42 for the correct fitting of cams).

(b) When the cam is not used, the corrections are taken from the correction curves, the following procedure should be carried out:-

(i) Note and record the D/F bearing on the outer or gyro scale.

(ii) Note and record the corresponding bearing on the fixed relative scale.

(iii) Read off the correction corresponding to the bearing given in (ii) above from the appropriate correction curve for the frequency range in use.

(iv) Apply this correction to the GYRO bearing (A positive correction will always increase the numerical value of the gyro bearing, and a negative correction will always decrease the numerical value of the gyro bearing).

REMARKS

7 STOPS OF INDUCTANCE CORRECTION ACROSS F&A. LOOP

REPORT OF CALIBRATION OF D/F OUTFIT ....EM.7.....

H.M.S. ..."NONSUCH"....

RESULT OF SWING FOR CURVE OF CORRECTION ON ..42-1000..... Kc/s

NB. CORRECTIONS MUST BE APPLIED TO GYRO BEARINGS
i.e. + VE CORRECTIONS CLOCKWISE
-VE. CORRECTION ANTI-CLOCKWISE

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