LA6 D/F OUTFIT SD.

Date of design — 1920
Frequency range — 60 – 870 kc/s
Components — A41, M9, N9, S25, S41, N5

D/F Outfit SD employs the Bellini-Tosi system of direction finding and is fitted in most heavyships and cruisers (See Admiralty Handbook of W/T (1931, paragraph 792) Two vertical single wire loop aerials (1)(2) about 20 feet high are used One loop (1) is fitted in the fore and aft line and is usually rectangular and the other (2) is fitted athwartships and is usually triangular. The loops are rigged at right angles to and bisecting each other

In two funnel ships the D/F office is usually on deck between the funnels with the two loop aerials rigged directly above it This is a good position since symmetry can be obtained both with regard to the aerials themselves and with respect to metal masses such as funnels, guns etc., (see Admiralty Handbook of W/T (1931) paragraph 806)

In one funnel ships there are two alternative positions for the loops –

(a) If the fore superstructure is suitable the aerials can be rigged between it and the funnel, the D/F office being either in the auxiliary office or on deck beneath the loops.

(b) The loops may be rigged from a small spur on the main topmast head to fore and aft and athwartship yards on the main top The D/F office is then placed in one bay of the C R R. This method suffers particularly from the disadvantage that very long leads from the aerials to the D/F office are necessary and they will have a large capacity to earth even if paper insulated cable is used (see page 72 and Admiralty Handbook of W/T (1931) paragraph 813). Loops rigged around the mainmast are also particularly influenced by the main aerial and the rigging of the mast

With aerials fitted between the funnels or between the funnel and the fore superstructure the beam loop is usually suspended from the triatic stay which should be at least 15 feet below the main aerial and if possible 30 feet above the funnels, and should be broken up in 30 foot lengths or less with rigging insulators

The fore and aft aerial (1) is rigged between the funnels or between the funnel and the fore superstructure and must be kept absolutely rigid. To enable this to be done, bottle screws should be fitted in this aerial close to the deck insulators When inserting these bottle screws the aerial lead must not be broken but must be firmly attached to each end of the bottle screw.

The beam loop (2) is hauled out on each beam to stump masts or booms and the ends of the aerial are taken in to the deck insulators which must always be situated at the point of inter section of the bases of the loops If the D/F office is immediately under the aerials they are taken through Pattern 1719 deck insulators mounted on the roof of the office If the office is at a distance from the base of the aerials a special deck insulator group called Group N deck insulator is used (see figure b)

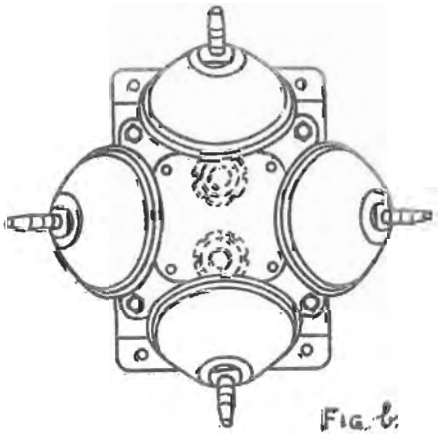

Fig. b.

In connecting up the cables from the office care must be taken that the two cores of each twin are connected to opposite and not to adjacent insulators, so that the fore and aft loop will use one twin cable and the athwartship loop the other

The leads from the deck insulators are taken to four terminal blocks inside the D/F office From these bare copper leads are run over earthed copper strips, to maintain a constant capacity to earth, to four L3 inductances (125)(126)(127)(128) these being mounted so that there can be no coupling between the inductances in the legs of the same loop Since inductance is only used in one loop at a time coupling between inductances in different loops is immaterial

From these inductances the four leads are taken to the aerial safety switch (601) which is provided for earthing the loop aerials when using main W/T. This switch has two external contacts which are in the 30 volt warning circuit, one of which breaks the warning buzzer circuit, the other making the circuit to the reply lamp on board ZG controlling in the central receiving room when aerials are earthed (see page D12) From this switch one leg of each loop goes to the centre of a 2-pole, 2-way, change over switch (122)(124), the other leg going to these switches through a buzzer tester G21 (see page G22) These switches enable either loop to be broken and earthed separately when testing From these switches the leads are taken to their respective terminals and the radiogoniometer S25 (see page L82). All these leads must be carefully spaced and arranged to have them as nearly the same length as possible

From the search coil terminals of the radiogoniometer leads are taken to the input terminals of tuner A41 (see page B2) This tuner has three positions. Direct position which is used when searching for signals and when finding sense. Coupled position – this is used when the required signal is picked up to give selectivity Coupled untuned position when receiving very strong signals the quality of the zeros may be improved by using an untuned intermediate circuit this being obtained by short circuiting the tuning condensers in this circuit by means of the intermediate condenser switch (50) Reaction is obtained from the amplifier M9.

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should be used as a sepa

Sensefinder S
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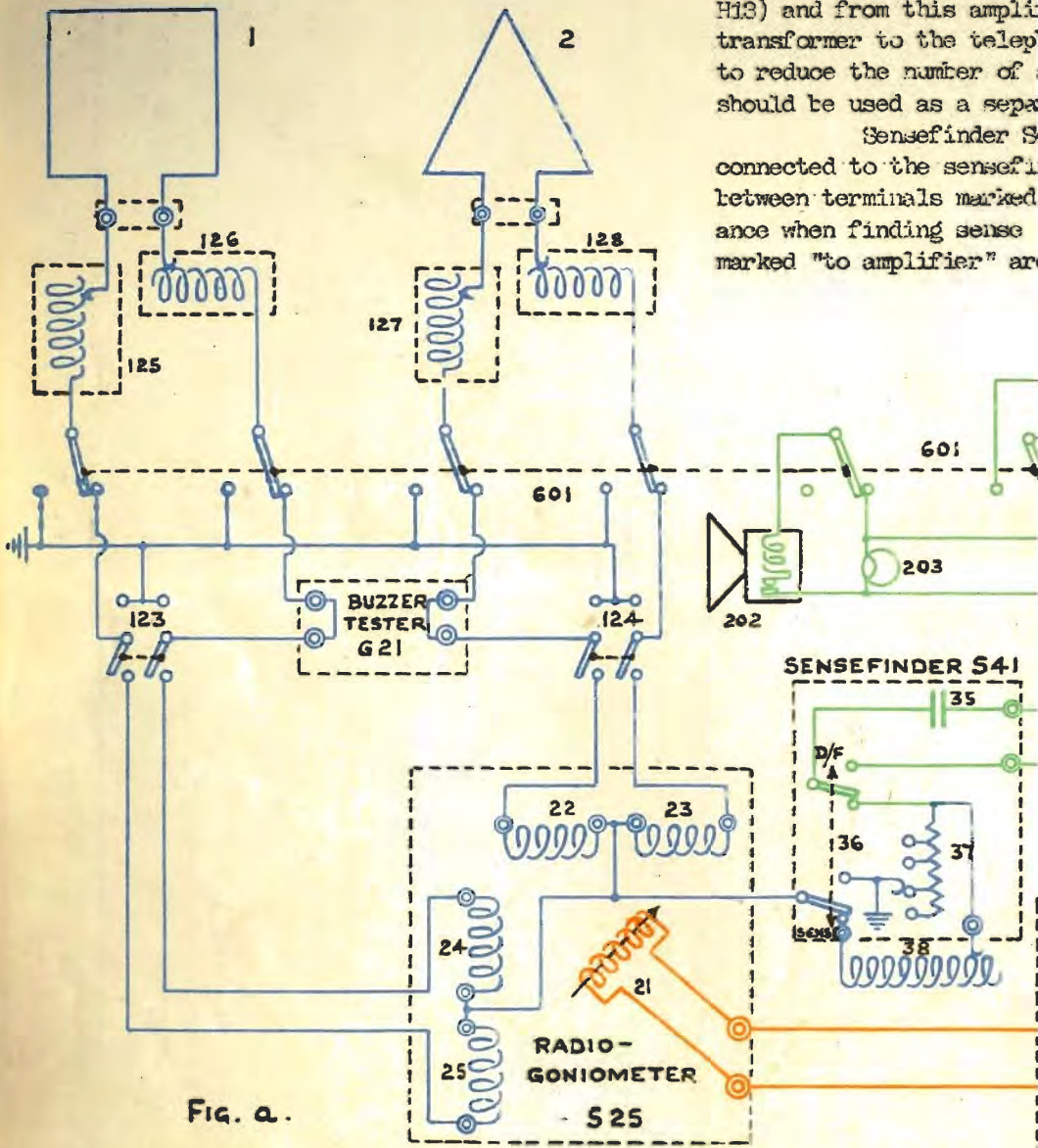
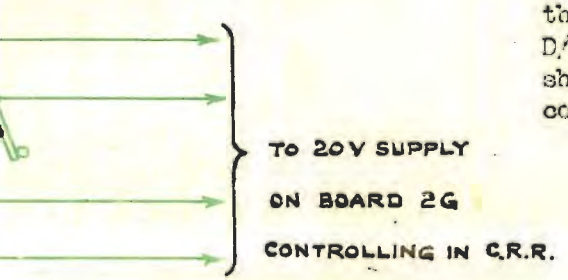


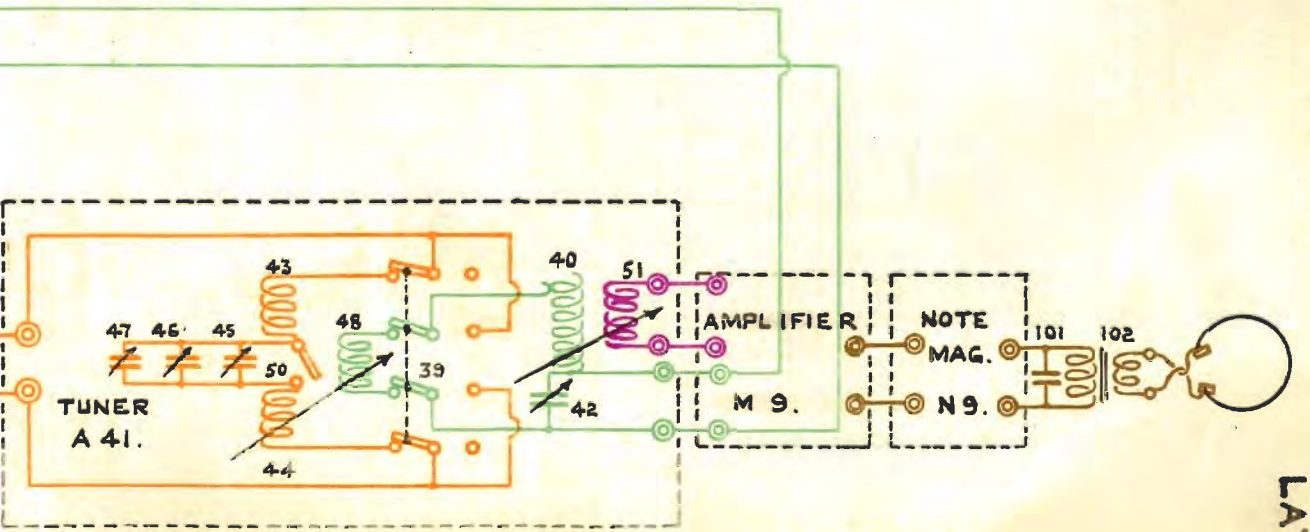
FIG. a.

rminals of tuner A41 are connected to grid and filament terminals of amplifier M9 (see page fier the output is taken through note magnifier N9(see page I3), telephone condenser and hones. When receiving C.W. signals amplifier M9 is generally used as an autodyne receiver adjustments necessary, but for greater selectivity the heterodyne unit K5 which is fitted rate heterodyne.

41 is used (see page LC2) the centre point of each field coil of the radiogoniometer being nder terminal marked "to mid point of goniometer" and a No. 1 inductance (38) is connected "to tuner" This inductance is used for detuning the aerials to ensure capacitive react- (see Admiralty Handbook of W/T (1931) paragraph 802). The terminals of the sensefinder e connected to the input terminals of amplifier M9.

Semicircular Corrector S61(see page LD2) is sometimes fitted, particularly in ships where there are long leads between the aerials and the D/F office when the zeros will specially need sharpening. It is connected between the search coil (21) and tuner A41.





LA8

D/F OUTFIT S D.

CALIBRATION

Reference.- Admiralty Handbook of W/T (1931) paragraph 811.

Calibration of D/F sets is necessary owing to a variety of errors which effect the bearing obtained. These calibrations may be divided into four parts:-

Tests to be carried out by ship's staff in harbour.
Balancing of Aerials.
Swing for curve of correction.
Determination of effect of change of frequency.

TESTS TO BE CARRIED OUT IN HARBOUR BY SHIP'S STAFF.

When calibration is being carried out by Signal School Officers, the ship is first supplied with Form 153 (see page LA11 and 12). This form gives details of tests, errors and remedies, and contains a colum in which the result of each test is inserted by the Ship's Staff. Forms Nos. 150 and 151 (see figures c. and d.) are supplied at the same time giving the programme and instructions for the rest of the calibration. The completed form should be returned to Signal School one week before the calibration is to take place. If a calibration is being carried out by a W/T officer from the Fleet, the preliminary tests should be carried out in accordance with pages LA11 and 12 and the results tabulated for his information.

The remaining portions of the calibration are carried out with the ship at sea and under way, and a W/T officer from the Fleet or from Signal School is in charge.

PROPOSED PROGRAMME FOR CALIBRATION OF D/F OUTFIT SD IN

H.M.S.

Position of Ship.

Ship to be approximately 5 miles off, and in sight of .....
W/T Station by .....

This distance should be maintained throughout the calibration. It may be reduced slightly if visibility is poor but a satisfactory calibration cannot be carried out if the distance is less than 3 miles. Intervening land should be reduced to a minimum.

Note. Satisfactory calibrations cannot be carried out within half an hour of sunrise or sunset.

Part I. Balancing Aerials.

Ship to be stopped, with station bearing Red (or Green) 45. This bearing to be held within 3 degrees on either side if possible. Time required:- about 1 hour.

Part II. Swing for Curve of Correction.

Ship to be turned slowly through 360° at about 6° per minute.
Time required:- about 1¼ hours.

Part III. Correction for Change of Wave Frequency.

Conditions as for Part I, preferably with the station on the same bow as in Part I. Time required:- about 1½ hours.

Bearings.

Throughout Parts I, II and III relative visual bearings of the station will be required, "Stand by —— stop" will be passed to the Bridge for each bearing, and the bearings should then be passed to the D/F office as soon as possible.

An interval of ½-hour is required between Parts I and II and Parts II and III.

Total time required for calibration, about 4 hours.

.....

H.M.Signal School,
R.N.Barracks,
Portsmouth.

Form No. 151.

D/F OUTFIT S D.
CALIBRATION.

LA9

INSTRUCTIONS FOR D/F CALIBRATION OF H.M. SHIPS.

Ship being calibrated

It is essential that reliable and rapid communication should be maintained with W/T transmitting station. If possible, remote control of the second office transmitter should be arranged for in the D/F office.

This transmitter should remain on 170 kc/s or as ordered in (e) of the calibration signal. See Portsmouth General Orders article 549, and Plymouth Port Orders article 1063.

Communication between compass platform and D/F office, whether by telephone or voicepipe should be as direct as possible in order to reduce the "time lag" to a minimum. If necessary flexible voicepipe should be run to eliminate human links.

W/T Transmitting Station

In Parts I and III the transmission should be of 2 minutes duration and in Part II of 10 minutes duration. In each case there should be an interval of 30 seconds between transmissions to enable the ship being calibrated to establish communication if necessary.

H.M. Signal School,
R.N. Barracks, Portsmouth.

Form No. 150.

PART I. BALANCING THE AERIALS

The ship is turned so that the Transmitting Station is on a relative bearing 45°(bow or quarter) to balance the aerials

The Transmitting Station transmits on a pre-arranged wave frequency and relative bearings are taken simultaneously by D/F and compass. If quadrantal error exists, it is then eliminated by adjusting the size of the fore and aft loop. The beam loop will have been rigged as large as possible, and it will normally be found that, when the error has been eliminated, the fore and aft loop will be considerably the smaller. If the error cannot be entirely eliminated by this method a small final adjustment can be made by inserting a small (and equal) amount of correcting inductance in each leg of one aerial.

PART II SWING FOR CURVE OF CORRECTION.

When the aerials are balanced the ship is swung to obtain a curve of correction in a similar manner to a swing for adjustment of compasses. The ship should be steadied every few degrees (intervals should not exceed 10°), and simultaneous relative bearings by compass and D/F are taken. If time does not permit of this being done a slow swing should be carried out through 360° at a rate not exceeding 5° per minute. If possible the ship should be swung through 360° but if time does not permit of this being done a swing of 180° should be carried out. Errors of synchronisation between bridge and D/F office can be avoided if the gyro compass and repeater scale on the goniometer are used. Gyro bearings of the transmitting station are passed down from the bridge, and the officer in the D/F office notes the ship's head by gyro scale at the instant of taking each D/F bearing. Great care must be taken that gyro compass and repeater scales are correctly lined up.

From the two sets of relative bearings obtained a curve of errors can be plotted showing the correction necessary on any bearing (see figure e.).

PART III. CORRECTION FOR CHANGE OF WAVE FREQUENCY.

It is now necessary to determine the effects of various wave frequencies on D/F bearings. The ship is again turned so that the transmitting station bears on the bow (or quarter). Bearings are now taken on various frequencies, quadrantal error being eliminated by the insertion of more or less correcting inductance in the legs of one aerial. If part I was done on, say 170 kc/s, it should first be confirmed that the quadrantal error is the same on any lower frequency; higher frequencies are then tried and it will usually be found that, at some point round about 200-300 kc/s, the error increases. It will then be found necessary, gradually, to cut inductance out of the legs of the beam aerial, and, when this is all cut out, to add inductance in the legs of the fore and aft aerial. From these results a curve will be constructed showing the amount of L3 inductance necessary for any given frequency (see figure f.).

The sense arrow has now to be set. Bearings are taken and both zeros obtained. The sensefinder is then switched over to the sense position, and if using sensefinder S41 the tuning is adjusted so that the reactance of the aerial circuit shall be capacitive. (See page LC2). The search coil is then moved until the maximum position is found (half way between the two zeros). It is known which of the two zeros gives the actual direction of the transmitting station, and so the sense arrow on the goniometer handle can then be set to point in the direction of that zero. (See page LB2).

D/F OUTFIT S.D.

CALIBRATION

This is done with the aerial de-tuned as described above. If too much inductance is inserted in the aerial circuit the aerial reactance will become inductive. This will change the phase of the antenna effect 180° relative to the loop effect and will thus cause a reversal of sense. It is therefore necessary on all occasions to de-tune with the No. 1 inductance so that the aerial impedance is capacitive. When finding sense, tuner A41 must be in the direct position to ensure correct phasing (see Admiralty Handbook of W/T (1931) paragraph 802).

During calibration it is customary to insulate the main aerial. Other conditions which affect the accuracy of D/F bearings after calibration are:-

Alterations in the loop aerials.

Alterations in the positions of instruments or wiring inside the office.

Positions of large moving masses of metal in the neighbourhood of the aerials, differing from their positions during calibration.

Although the calibration is carried out with the main aerial insulated it is advisable to take bearings with the main aerial connected when possible and to note the errors caused since it will not always be possible to insulate the main aerial before taking bearings in actual practice.

Waves. The balancing of aerials and swing should be carried out using the Reconnaissance wave of the fleet to which the particular ship is attached if possible.

When obtaining corrections for change of frequency the corrections necessary for the main waves in use in the fleet should be obtained and in addition, those for any other frequencies considered desirable.

REPORT OF CALIBRATION OF W/T DIRECTION FINDING OUTFIT S D

DATE 1/4/30

H.M.S. "Resource"

RESULT OF SWING FOR CURVE OF CORRECTION.

170 kc/s) STOPS OF L_3 INDUCTANCE IN EACH LEG OF BEAM AERIAL.

RADIOGONIOMETER No. 30

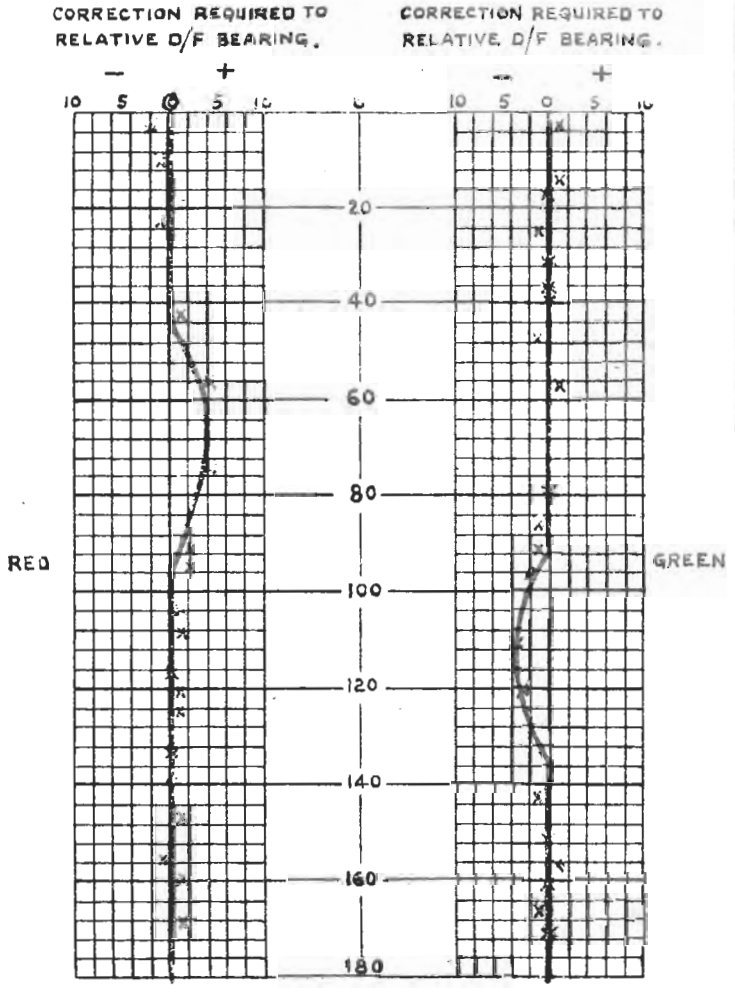


Fig. e.

REPORT OF CALIBRATION OF W/T DIRECTION FINDING OUTFIT S D.

DATE 17/1/30.

H.M.S "Rodney"

CURVE SHOWING CORRECTION FOR CHANGE OF FREQUENCY.

No. OF STOPS OF L_3 INDUCTANCE REQUIRED TO CORRECT ERROR DUE TO CHANGE OF FREQUENCY.

STOPS REQUIRED IN BOTH LEGS OF FORE AND AFT BEAM AERIAL

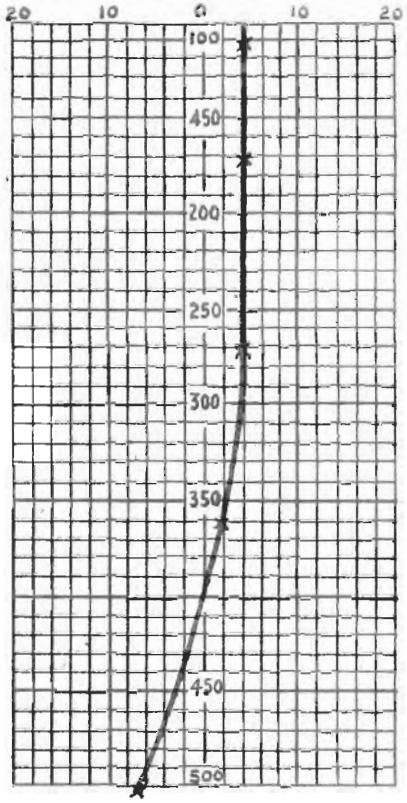


Fig. f

D/F OUTFIT SD

TESTS TO BE CARRIED OUT BY SHIP'S STAFF BEFORE D.F CALIBRATION

No.	Test	Fault.	Cause.	Remedy.	Result of Test and Remarks.
1	Examine aerials and plan of ship to see that each aerial lies in a vertical plane, and that the two planes are strictly perpendicular.	Planes not perpendicular.	Booms, deck insulators, or point of attachment to radial stay misplaced.	Correct, as far as possible and draw attention to what cannot be rectified.	
2	Test insulation resistance of each aerial to earth with a megger.	Insulation resistance less than 1 megohm.	Probably deck insulators.	Wipe surfaces with cloth. If possible wash with distilled water and leave to dry.	
3	Test insulation resistance between any point in one aerial and a point in the other. (Remove earths from goniometer).	Resistance less than 1 megohm	Leakage across switches or surface of goniometer.	Wash surfaces with very diluted ammonia followed by distilled water.	
4	Test insulation of amplifier and batteries to earth with filament disconnected.	Resistance less than 1 megohm.	Acid on battery supports.	Wipe clean all insulators, supports etc.	
5	Examine aerial rig, funnel guys, blocks, halyards, etc to see that they comply strictly with the specification	Items not in accordance with specification	Faulty installation.	Correct as far as possible, and call attention to points that cannot be rectified.	
6	Measure the ohmic* resistance of each aerial circuit, with switches and L3 inductances in the circuit	High resistance (More than 5 ohms) in ships fitted with P.I. cable and between deck offices. More than 2 ohms in ships fitted with Pattern 6895 cable and between deck offices More than 1 ohm in ships fitted with upper deck offices)	Broken wire, or imperfect contacts in the circuit.	Examine all contacts, switches and connections, repairing or renewing where necessary.	

7.	Measure the ohmic * resistance of the windings of the goniometer and of the search coil	High resistance (greater than following figures.) S23 and 25, 20 mic. Pattern 6764 or 7450 "Beam" Field Coil 0.2 ohms "Fore & Aft" Coil 0.2 ohms. Search Coil 1.6 ohm	Break or imperfect contact in the circuit.	Examine all contacts, soldered connections, etc., and repair as necessary. N.B. Great care must be taken not to disturb or damage the fixed windings of the field coils in any way.	
8.	Measure resistances in the eliminator reciprocal bearing between terminal marked "To mid point of gonio" and earth. (a) In D/F position (b) In sense position	High resistance i.e., more than the following (a) 0.1 ohm. (b) 30 ohms Stop 0 100 " " 1 200 " " 2 400 " " 3	Break in resistance or bad contact at switch.	Examine all contacts, soldered connections, etc. and repair as necessary.	
9.	Test amplifier and note magnifier stage by stage for satisfactory magnification. Rotate goniometer search coil while receiving signals.	Poor or noisy reception Noisy reception during movement of search coil	Defect in instrument, or batteries in bad conditions. Imperfect contact at search coil brush contacts.	Examine batteries for voltage and for acid density. Test instrument for broken winding of transformers, etc., Wipe plate of rubbing contact clean and smear lightly with pure vaseline oil.	

D/F OUTFIT SD.

TESTS TO BE CARRIED OUT BY SHIP'S STAFF BEFORE D.F CALIBRATION (CONT.).

No.	Test	Fault	Cause	Remedy	Result of Test and Remarks
10	Break both aerial circuits at the switches and try to receive signals on amplifier and tuned circuit alone	Signals heard	Imperfect screening of tuner and amplifier, or direct radiation inside the office from aerial leads.	Increase distance between aerial wires and tuner. Run leads as non-inductively as possible, or use braided cable where little space is available.	
11	Test heterodyne unit for C.W and I.C.W on each range.	Cannot be heard or tuned properly on amplifier and tuner.	Bad valve contact, or defective Coil. Coupling too tight.	Try new valve, and a coil from another heterodyne unit. Increase distance between heterodyne unit and amplifier.	
12	Trace leads from aerials to goniometer	Leads wrongly connected at goniometer terminals. (Zeros in wrong quadrant.)	Faulty installation.	Rewire to accord with markings on goniometer.	
13	Break beam aerial circuit and receive any strong signal on F. and A. aerial. Set pointer so that one zero is at 0°.	Opposite zero not at 180°.	Direct coupling between goniometer and tuner or amplifier.	Rearrange leads and instruments, keeping goniometer as far from all other instruments as possible.	
14	Break F. and A. aerial circuit and receive any strong signal on beam aerial.	Zeros 180° apart but not at 90° and 270°	Primary windings of goniometer not perpendicular.	New goniometer.	
15	Take an approximate bearing of Daventry. (Lat 52° 15 N. Long. 1° 08 W.) N.B Daventry bears $259\frac{1}{2}^{\circ}$ from Portsmouth, 309° from Chatham and 045° from Devonport	Bearing greatly in error, or in wrong quadrant.	(a) Wrong value of ship's head (b) Defect in the connections of the aerials (c) Defect in goniometer windings.	(a) Check ship's head (b) Examine connections and repeat tests 6 and 12 (c) Repeat test 7 and compare connections with diagram in lid of goniometer	
16	Test gyro repeater motor by causing master gyro to be turned slowly through 360° first clockwise and then 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.	Set gears so as to give a slight play ($1/4^{\circ}$) to the rotating scale. Report other defects to department in charge of gyros.	

Form No. 153.

NOTE:— * When measuring ohmic resistance in tests 6 and 7 above with an insulation test set and bridge the resistance of the leads joining the test set and the circuit under test should be measured. This resistance should be deducted from the total resistance of the circuit as measured.

Tests Nos. 2, 3, 4, 6, 13 & 14 should be carried out weekly, before going to sea, and before carrying out a D/F exercise.

Fig. 8.