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Marconi-Adcock Direction Finder Type DFG.24/2: General and Technical Information and Basic Servicing Schedules

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AIR PUBLICATION

2530E

VOLUME I

and

VOLUME 5

FGRI.5056
MARCONI-ADCOCK DIRECTION FINDER TYPE DFG.24/2

GENERAL AND TECHNICAL INFORMATION AND BASIC SERVICING SCHEDULES

Prepared by direction of
the Minister of Supply

A. Rowlands

Promulgated by Order
of the Air Council

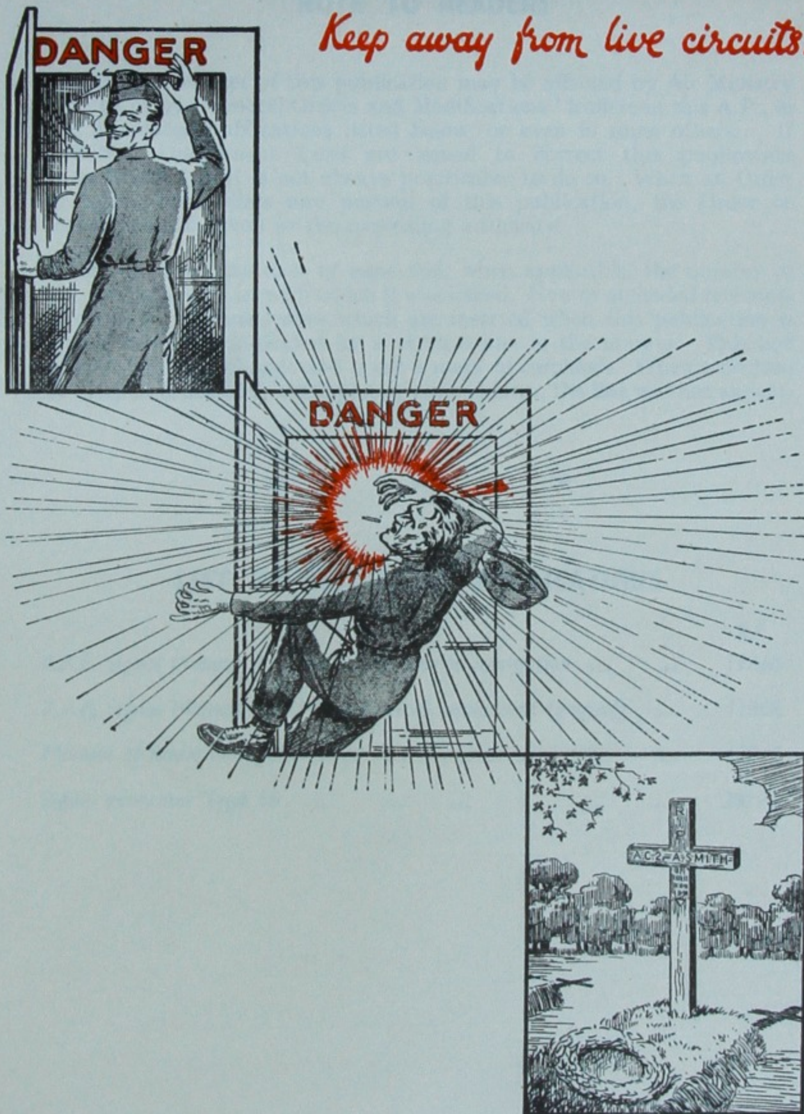
J. H. Barnes

AIR MINISTRY

P16632 6/50

LIVE WIRES MEAN—DEAD MEN

Keep away from live circuits!



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Each leaf bears the date of issue and, when applicable, the number of the Amendment List with which it was issued. New or amended technical information on new leaves which are inserted when this publication is amended will be indicated by a vertical line in the margin. This line merely denotes a change and is not a mark of emphasis. When a Section or Chapter is issued in a completely revised form, the line will not appear.

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LIST OF ASSOCIATED PUBLICATIONS

	A.P.
R.A.F. Signal Manual Part IV—Radio aids to navigation	*1186B*
R.A.F. Signal Manual Part IV—Electrical equipment (ground) ...	*1186E*
Manual of Radio Navigation Aids	*1234E*
Signal generator Type 56	*2879D*

VOLUME I

GENERAL AND TECHNICAL INFORMATION

P16633 M12605/G218 6/50 360 C & P Gp. 1

VOLUME I

GENERAL AND TECHNICAL INFORMATION

LIST OF CHAPTERS

Note.—*A list of contents appears at the beginning of each chapter*

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VOLUME 5

BASIC SERVICING SCHEDULES

P16633 M12605/G218 6/50 360 C & P Gp. 1

AIR MINISTRY

FGRI.5056

This is Amendment List No. 5 to Air Publication 2530E, Volume I

List of Chapters: *delete* "(*to be issued later*)" after the title of Chapter 3 and *write* ("A.L.5") in the outer margin against the deletion. *Insert* this Chapter 3 to follow Chapter 2. *Record* the incorporation of this A.L. in the Amendment Record Sheet.

SIGNALS

Chapter 3

CALIBRATION

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INTRODUCTION

1. When a D/F station is erected, an initial ground and air calibration is undertaken to verify that the operational performance is satisfactory and to ascertain the magnitude of the inevitable small errors due to imperfections of the D/F site etc. Periodical re-calibration and checks of the initial calibration are necessary during the life of the station to ensure that the original performance is being maintained.

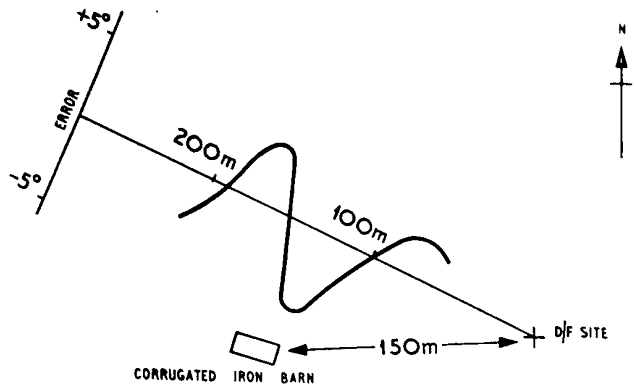
2. There are also certain adjustments required in the initial calibration and which are checked during re-calibration. These are the correction of aerial inequalities and the frequency calibration of the D/F circuits.

3. A complete re-calibration is performed after any major repair or adjustment to the installation and, in any case, at intervals not exceeding one year. The procedure for this is the same as the initial calibration.

4. A ground check is made every three months or upon a change of operating frequency; an air check is undertaken every six months. In addition a ground check is necessary after any minor repair or adjustment has been made which may affect the accuracy of the calibration.

5. The results obtained from the ground calibration are plotted and an error curve drawn. This curve is to be regarded solely as an indication of the general accuracy of the installation and of its stability under operational conditions. The correction curve used for operating purposes is obtained from the results of the air calibration.

6. The ground calibration is performed using a small portable test oscillator which is set out at a distance from the aerial system; this is also used for the frequency calibration and other adjustments. The oscillator, known as test set Type 46 (Stores Ref. 10S/111), is supplied as an item of the installation. A further item of equipment normally required only at the initial calibration is a medium landing compass (Stores Ref. 6B/634). An insulation resistance tester Type A (Stores Ref. 5G/1621) is used to make routine checks of the insulation resistance of the feeders.



Note . . . The transmitter on 5 Mc/s was moved along a line of constant visual bearing, the distances being as indicated. The bearing error is shown plotted about this line. Observations on distant stations in this sector showed small errors.

Fig. 1. Example of site error caused by re-radiation

Special precautions, etc.

7. The oscillator in all tests should be sited at a distance of at least 2 to 3 wavelengths from the aerial system. This amounts to about 50 to 75 yd. on the higher frequencies and about 150 to 200 yd. at the low-frequency end of the band. The absolute minimum distance to be maintained where local conditions prevent the ideal being attained is one wavelength. If the oscillator is any closer, direct pick-up and flat tuning will result.

8. The siting of the oscillator must always be done with care. It must be clear of any objects likely to cause re-radiation. These include metal buildings, thick belts of trees, metal fences, deep ditches, etc. The effect of a metal barn on the bearings obtained is illustrated in fig. 1.

9. It is advisable when using the test oscillator on several frequencies in the course of a test to make a note of the exact dial readings so that it can be set with the minimum of delay, and without the need to bring it alongside the receiver to tune in the signal.

10. The use of the meter in the GANG CHECK position will be found to give an added accuracy during tests with the local oscillator, especially when adjusting for maxima rather than minima. In these instances it is unlikely that there will be any other source of signal to cause possible confusion. It must not be used when obtaining operational bearings or during the air calibration of the station.

Preliminary check

11. Before commencing the aerial balancing and the ground and frequency calibration of the installation, the mechanical and electrical layout should be checked. The mechanical layout will not normally need checking after the initial installation.

12. The first stage is to ensure that all connections have been securely made and that the feeders are in good condition. Measure the insulation resistance of each feeder and aerial separately using an insulation resistance tester as described in Chapter 4, taking care to remove the vacuum gaps during the test. The insulation resistance should exceed one megohm when dry and be not less than 30,000 ohms in damp weather.

13. The alignment of the masts should then be checked to ascertain that they are true North and at right angles.

(1) Set-up a medium landing compass at a distance of about 50 yd. and directly in line with the N–S aerials.

(2) Sight on the aerials (the sense aerial should also be in line with the two masts) and read off the bearing.

(3) Apply the current magnetic variation at the site. Obtain this from an Ordnance Survey map for the area and take into account any annual change.

(4) If the orientation of the N–S aerials is not true (000 deg.) account will need to be taken later of the site error by displacing the pointer in relation to the goniometer search coil, so a note should be made of the figure.

(5) It is further advisable to check the orientation of the E–W aerials; it is not usually possible to make any adjustment to a fixed station but knowledge of any discrepancy may help to account for residual errors obtained later in the calibration.

Note . . .
If the aerial site is not orientated true N–S, markers should be placed at the true cardinal and sub-cardinal points at a distance of about 100 yd. for future reference.

14. The electrical layout of the installation is then checked. This operation is chiefly concerned with the alignment of the two radiogoniometers.

(1) Set the test oscillator to 6 Mc/s and place it to the North and in line with the N–S masts at a distance of about 75 to 100 yd.

(2) Disconnect and earth the E–W masts, feeders and associated field coils.

(3) Tune the receiver and search coil circuit to 6 Mc/s on Range 3.

(4) Swing the goniometer to the two minima; these should be sharp and opposite at 0 and 180 deg.

(5) If the minima are not correct, the pointer should be adjusted by slackening the grub-screw and moving it to 360 deg. with the goniometer spindle securely held in the position of minimum signal.

(6) Tune the receiver and search coil circuits to 6 Mc/s on Range 2.

(7) Swing the goniometer to the two minima which should again be sharp and at 0 and 180 deg.

(8) If the minima are not correct, hold the goniometer spindle securely with the pointer at 360 deg. and move the lower frequency radiogoniometer (the one further from the pointer) by the spigot provided until the minimum is reached.

(9) The two radiogoniometers are now in line and adjustments should be made at this stage, if necessary, for any deviation previously recorded in para. 13 (4) above. For example, if the masts are orientated 10 deg. W of N the pointer should be adjusted to read 350 deg. for minimum signal from the oscillator when it is in line with the masts.

CORRECTION OF AERIAL INEQUALITIES

15. Besides the inevitable errors in a D/F installation which cannot be eliminated, there are certain errors which arise during the installation and which are to be removed before calibration can take place. Some of these may be due to faulty installation and will have been discovered and rectified in the course of the preliminary check described above; some faults are, however, due to electrical unbalance in the aerial system.

16. The unbalance between the aerials of a pair or between the two pairs is due to inequalities in the effective heights of the aerials and in the lengths or attenuation of the feeders. These may reach a considerable magnitude over a restricted frequency band and will be most pronounced at the natural frequencies of the aerial system.

17. From the overall length of one complete U aerial, that is, two mast aerials, two feeders and the radiogoniometer field coil, which is approximately 112 ft. or 34·2 m. it will be seen that standing-wave conditions occur at the following wavelengths:—

68·4 metres (4·4 Mc/s) corresponding to $\frac{1}{2}\lambda$
45·6 metres (6·57 Mc/s) corresponding to $\frac{3}{4}\lambda$
34·2 metres (8·75 Mc/s) corresponding to 1λ
22·8 metres (13·2 Mc/s) corresponding to $1\frac{1}{2}\lambda$
17·1 metres (17·5 Mc/s) corresponding to 2λ

These conditions are illustrated in fig. 2. The magnitude of the error changes with frequency and is largest at the $\frac{3}{4}\lambda$ and $1\frac{1}{2}\lambda$ points. Normally, the errors around $\frac{1}{2}$, 1 and 2 wavelengths are small.

18. The types of aerial inequalities producing the major errors are shown in fig. 3. Inequalities occurring between individual halves of one U aerial produce errors with a maximum value in line with each pair of aerials, i.e., at 0, 90, 180 or 270 deg. and this error is most pronounced near 6·6 Mc/s (the $\frac{3}{4}\lambda$ mode). Inequalities occurring between each complete U aerial produce a quadrantal error with a maximum value at 45 deg. to the line of the aerials; the error is most pronounced near 13·2 Mc/s which is the $1\frac{1}{2}\lambda$ mode.

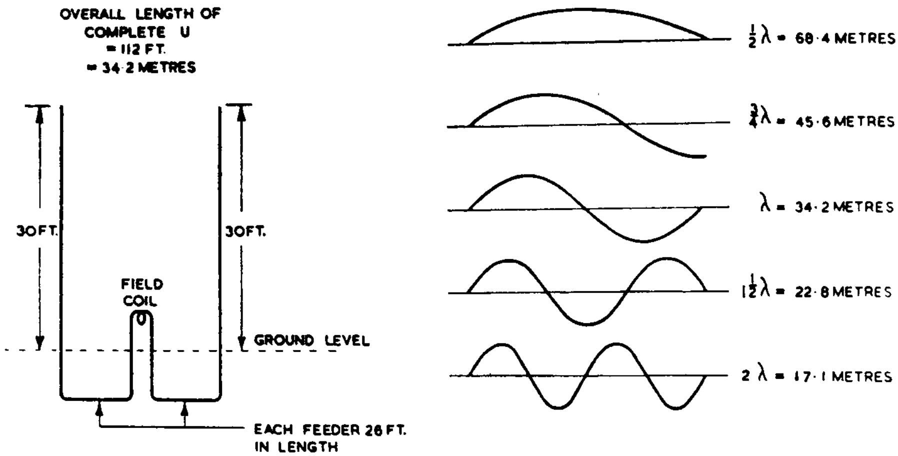
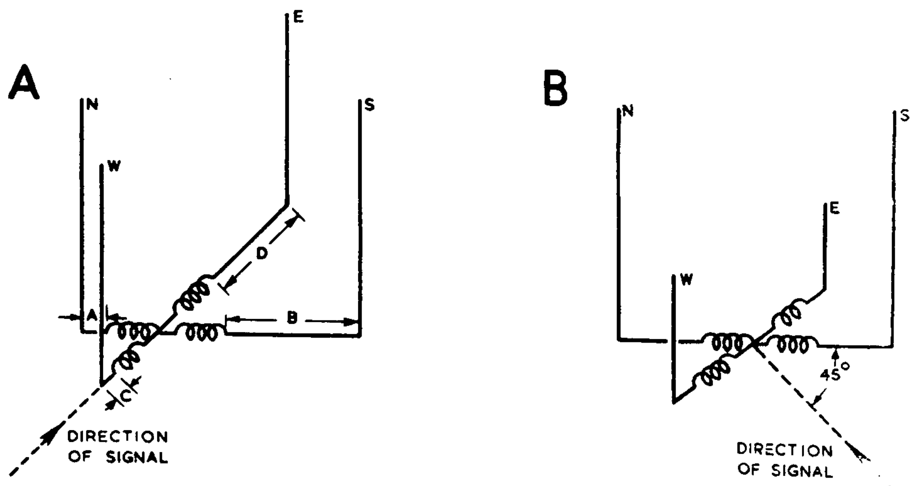


Fig. 2. Standing-wave conditions on aerials and feeders



(a) Exaggerated aerial inequality causing maximum error in line of aerials, (A, B, C and D unequal). Most pronounced at 4·4 metres.

(b) Exaggerated aerial inequality causing maximum error at 45 deg. to the line of aerials, (overall length of each complete 'U' unequal) most pronounced at 22 metres.

Fig. 3. Aerial inequalities

19. Balancing is therefore effected at these positions and frequencies. Small capacitance trimmers connected between each field coil terminal and earth are adjusted to compensate for the inequalities. The trimmers are operated by a small screwdriver through holes in the screening cover of the radio-goniometer. They can be seen in fig. 2 in Chapter 4.

In-line balance

20. The aerials are first balanced with the oscillator in the in-line position to eliminate inequalities between the two limbs of a U. The eight trimmers must first be set at the minimum value.

(1) Set the oscillator to 6·5 Mc/s and place it to the North and in line with the N–S masts at a distance of about 75 to 100 yd.

(2) Tune the receiver and search coil circuit to this frequency on Range 3.

(3) Adjust the E and W trimmers on the upper frequency radiogoniometer (the one nearer the front panel) to give a sharp correct bearing. It will be necessary to support the D/F panel in an intermediate position to do this. Increasing the E trimmer will have the effect of swinging the bearing in one direction; increasing the W trimmer will swing it in the opposite direction.

Note . . .
The adjustments are exceedingly critical and large bearing errors can result from over-correction. No attempt must be made to "pull" the bearing at the expense of its sharpness.

(4) Repeat for the N and S trimmers with the oscillator in line with and at the same distance from the E–W masts, using the same frequency.

(5) Check the balancing by placing the oscillator on the other two cardinal points, i.e., S and W.

Quadrantal balance

21. Balancing out the inequalities between the two U aerials is performed at the 1½ λ resonant frequency (about 13·2 Mc/s) and at the quadrantal points.

(1) Set the oscillator frequency to 13·2 Mc/s and place it at a sub-cardinal point (i.e., NE, SE, NW or SW) at a distance of about 50 yd.

(2) Tune the receiver and search coil circuit to this frequency and make any correction necessary to the bearing by increasing the N and S or E and W equalizing trimmers equally. If both the trimmers on one pair of aerials are not increased (or decreased) together, there is a danger of disturbing the in-line balance already obtained.

(3) Check the balance at the other sub-cardinal points.

Balancing on the lower frequencies

22. Balancing for the lower frequency radiogoniometer (1·5–6 Mc/s) is performed at one frequency only in the middle of the band, usually between 3 and 4 Mc/s. The trimmers for the radiogoniometer concerned, which is the one further from the front panel, are adjusted in the same manner—first with the oscillator in the in-line position, followed by re-adjustment at the sub-cardinal points.

23. At this frequency (between 3 and 4 Mc/s) the best compromise is obtained for the whole band. If better bearing ratios are required at any particular frequency in the lower band, balancing may be carried out at that frequency but the bearings in general will not be so good over the whole band.

FREQUENCY CALIBRATION

24. Owing to inevitable small differences between individual aerial and feeder systems, it is necessary to make the final D/F and sense calibrations after the receiver has been installed on the D/F site and the aerials have been balanced. This is carried out with the same local test oscillator as was used for balancing. A full check calibration will not normally be necessary at subsequent re-calibrations.

Search coil tuning calibration

25. It has been found that, to some extent, the search coil tuning on Ranges 1 and 2 is affected by the rotation of the search coil. If the frequency calibration of the search coil is performed with the oscillator on the E–W line and the goniometer pointer at about 17 deg., the variation of tuning will be about ±2 mm. at the low-frequency end of each range and considerably less at the high-frequency end. This variation has no effect on the sense calibration.

26. The frequency calibration of the receiver should be taken as the frequency reference and the D/F calibration adjusted to correspond. The D/F calibration should contain the same number of scale readings as the receiver. The nominal extreme frequencies on each range, i.e., 1·5–3 Mc/s, 3–6 Mc/s, 6–12 Mc/s and 12–20 Mc/s, are approximately determined in the factory and are lightly marked in pencil on the scale as a guide to the length of pointer sweep required.

27. The search coil tuning condenser bank has a pair of 50pF capacitance trimmers mounted upon it; these can be seen in fig. 3, Chapter 4. They are adjusted through two holes in the top of the screening cover; the locking rings must first be released with the small key clipped to the side of the sense unit. These trimmers should always be adjusted by increasing or decreasing by equal amounts to preserve the symmetry of the balanced search coil circuit. As a matter of interest it may be noted that a 5pF condenser (C.109, *fig.* 7, *Chap.* 4) assists in this by compensating for one end of the search coil having a greater capacitance to earth than the other.

28. The four drum sections of the coil turret contain the inductance units of the search coil circuit and the inductance and capacitance trimmers of the heart circuit. The sections are numbered 1 to 4 in fig. 7, Chapter 4, Section 1, being nearest to the front panel.

Section 1: This contains the coupling coil to the link circuit on all ranges and that portion of the search coil which couples to it.

Section 2: Contains a part of the search coil circuit and the coupling coil from the heart circuit.

Section 3: Contains a part of the heart circuit and the coupling to the vertical aerial.

Section 4: Contains the capacitance trimmer for the heart circuit.

On range 4 where there is no heart circuit, only Section 1 is used.

29. Range 2 has the lowest range factor so the search coil trimmers should be set to give a full sweep on this range. It is convenient to set the calibrating oscillator to a frequency of 3 Mc/s at a distance of about one wavelength from the receiver. The strength of the second harmonic should be sufficient to obtain a good strong signal at 6 Mc/s at this distance, thus avoiding the need to change the oscillator frequency when moving from the upper to the lower limit of the range.

30. With functions key in the D/F position, the tuning sweep should be made to fit the pencil marks as closely as possible. The capacitance trimmers have most effect at the high-frequency end of the range and the inductance trimmers have most effect at the low-frequency end. The capacitance trimmers on the condenser bank should then be locked in position by the locking rings provided.

Note . . .

The capacitance trimmers on the search coil condenser bank must not be adjusted on any other range after having been set on Range 2.

31. When the trimmers have been satisfactorily adjusted to give a full sweep corresponding approximately to the pencil marks, proceed to checking the sweeps of Ranges 1 and 3. (The actual calibration will be affected by the operation of the heart circuit controls and so must be done later.) On range 1 (1·5–3 Mc/s) the inductance trimmers in Section 1 and 2 of the turret can be adjusted to line up the search coil calibration at the low-frequency end; adjust the search coil trimmer in Section 4 of the turret for the high-frequency end. On Range 3 (6–12 Mc/s) adjustment at the low-frequency end is by the inductance trimmers in Section 2 and by the condenser trimmer in Section 4 at the high-frequency end.

32. No heart calibration is required on Range 4, so the frequency calibration may be checked at this stage. It will probably be found that the approximate calibration on this range is inaccurate as the addition of the aerial lead has a considerable effect. The upper and lower limits of the frequency (12–20 Mc/s) should, however, be covered easily by the sweep of the tuning condenser and the scale should be calibrated to correspond with the receiver calbiration. Use of harmonics of the calibrating oscillator is not always possible on these frequencies owing to the presence of a large number of interfering transmitters. No adjustment is provided by inductance trimmers on this range. Record also the bearing error at each frequency. Between 12 and 14 Mc/s reversals in the search coil tuning law may appear as the result of standing waves on the aerials and feeders.

Heart circuit calibration

33. To obtain a perfect heart diagram it is usually necessary to de-tune the heart circuit slightly to obtain the correct phase relationship between the spaced and vertical aerial E M F's. The V.A.PHASE control is provided for this purpose while the function of the V.A.AMPLITUDE control is, as its name implies, to keep the two E M F's at approximately the same amplitude.

34. The calibration of the heart circuit for sense determination consists of two series of readings of the V.A. amplitude and phase marked in red below the search coil tuning calibration; the search coil calibration is marked in black. The appropriate settings for the amplitude and phase controls are therefore determined and marked below the frequency for which they were obtained. With this arrangement the search coil circuit remains in tune and maximum sensitivity is maintained.

35. The procedure for calibrating the heart circuit therefore will consist of obtaining the optimum settings of the V.A. amplitude and phase controls for frequencies through the three ranges on which sense determination is possible. No approximate calibration of the heart circuit is supplied as in the case of the search coil tuning since it can only be determined when the receiver is installed.

Note . . .

When calibrating the heart circuit it is most important that the vertical aerial circuit is in good order. Inspect therefore all contacts and joints, the feeder connections and the contact screw at the top of the D/F panel. Bad contacts or faulty insulation will affect the performance of the heart circuit to a surprising extent.

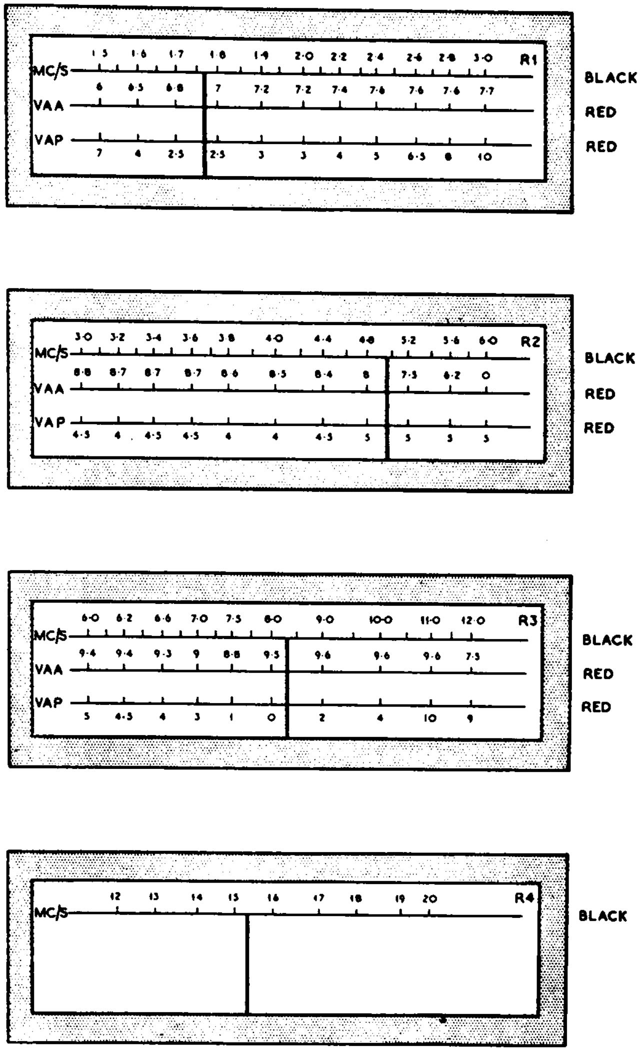


Fig. 4. Typical search coil and heart circuit calibrations

36. The oscillator should be placed at a distance from the aerial system greater than one wavelength on the lowest frequency, that is, at about 250 yd. It should be placed at the clearest sub-cardinal point as found during the balancing of the aerials.

37. Commence on Range 1 as follows:—

(1) Set the oscillator to 1·5 Mc/s.

(2) Tune in the receiver and search coil circuit accurately with the functions key at D/F. Record the bearing error for the oscillator in this sub-cardinal position.

(3) Switch the functions key to "Sense" and adjust the V.A.AMPLITUDE and V.A. PHASE controls to give minimum signal. Make a note of the readings.

(4) Tune the oscillator and receiver and search coil circuits to 3 Mc/s; observe the bearing error and then adjust the amplitude and phase controls as before. Make a note of the readings.

(5) If the phase correction required is excessive, the trimmer in the coil turret may be used to alter the range factor of the heart circuit to correspond more nearly to the search coil circuit. At the high-frequency end of the range, the capacitance trimmer in Section 4 should be adjusted and at the low-frequency end the inductance trimmer in Section 3.

(6) It may be necessary to repeat these adjustments several times before the best compromise is obtained. The ideal to aim at is to adjust the range factor of the

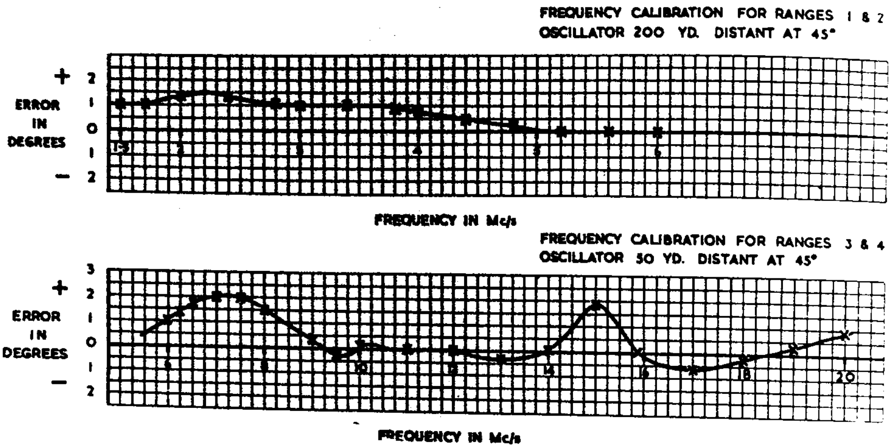


Fig. 5. Frequency calibration

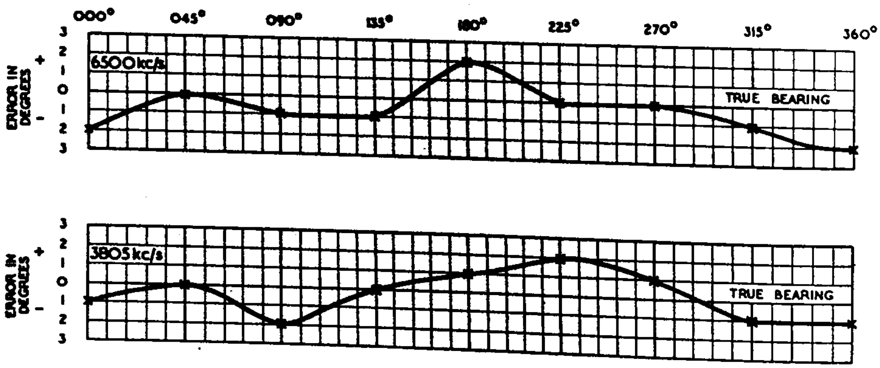


Fig. 6. Ground calibration of HF D/F

heart circuit so that the phase control is set as near as possible to its mid-scale reading (5) for the correct heart adjustment.

(7) When the upper and lower limits of the range have been fixed, the bearing error and the amplitude and phase control settings should be found for the following frequencies (as marked on the receiver tuning scale):—1·5, 1·6, 1·7, 1·8, 1·9, 2·0, 2·2, 2·4, 2·6, 2·8 and 3·0 Mc/s.

(8) It is advisable to mark in the settings on the scale lightly in pencil and to postpone inking in until all the ranges have been calibrated. This is because it may be necessary to adjust the search coil trimmers to minimize the phase adjustment on one of the ranges. This would affect all ranges and therefore necessitate re-calibration.

38. Proceed then to Range 2 and make similar adjustments for the following frequencies:—

3·0, 3·2, 3·4, 3·6, 3·8, 4·0, 4·4, 4·8, 5·2, 5·6 and 6·0 Mc/s.

Little difficulty should be experienced in calibrating either Range 1 or 2.

39. Calibration on Range 3, however, will be found to be a little more difficult since standing waves are present on the aerial and feeder system at certain frequencies in the band, namely, between 8 and 11 Mc/s. The same procedure should be followed but it will be found that the maximum excursion of the V.A. phase control will be needed to produce a good minima on the heart diagram. The bearing error and amplitude and phase control settings should be found for the following frequencies:—

6·0, 6·2, 6·6, 7·0, 7·5, 8·0, 9·0, 10·0, 11·0 and 12·0 Mc/s.

40. When the calibration has been completed, check the absolute sense of the bearing, that is, if the oscillator is at 45 deg., check that the sense pointer does in fact give a minimum at 45 deg. on all three ranges with sense circuits.

(1) If the sense on Ranges 1 and 2 is the same but is reversed on Range 3, then the connections between the appropriate search coil and the barrel switch must be interchanged.

(2) If the sense on Range 1 is opposite to that on Range 2, the connections to pins 5 and 6 on L17 or L21 in the appropriate turret section must be interchanged.

41. When it has been established that the calibration is satisfactory, the frequency and amplitude and phase control settings should be inked in on the scale. Fig. 4 shows a typical set of search coil and sense calibrations as they appear when completed.

42. The figures obtained for the bearing error should then be plotted against frequency as shown in fig. 5. This is a typical frequency calibration for the installation as a whole and together with the ground calibration will be kept as a record of the initial performance.

Note . . .

When operating the station it must be appreciated that the heart calibrations can only be considered to be approximations. If the controls are set to the values shown, good indications of sense should be obtained but further adjustment may be needed if a really sharp heart diagram is required. This is particularly true in the reception of high-angle rays from distant stations.

GROUND CALIBRATION

43. The most usual method of ground calibration makes use of the test oscillator previously used. In certain very favourable instances it may be possible to use distant stations and where very difficult conditions obtain over some sectors it may be very desirable to do so. In general, however, since distant stations may involve the uncertainties of indirect ray propagation on higher frequencies and have no compensating advantage, it is preferable to use the local oscillator method. Distant stations are however of considerable value for the routine daily checks.

44. Since the purpose of the ground calibration is to afford an indication of the accuracy of the installation, it is usually only necessary to take readings at the cardinal and sub-cardinal points, that is, every 45 deg. When the aerial system is not orientated true North, the oscillator must be set up at the true cardinal and sub-cardinal points as determined by compass during the preliminary checks of the system. If the system is orientated truly, the oscillator may be placed in the correct positions by sighting against the masts.

45.

(1) Set the oscillator frequency to 6·5 Mc/s.

(2) Tune the receiver and search coil circuits to this frequency on Range 3, thus using the upper frequency radiogoniometer.

(3) Place the oscillator on each of the true cardinal and sub-cardinal points in turn at a distance of about 80 yd. and record the bearings obtained on each. Check both the bearing and reciprocal and also the sense discrimination.

(4) Repeat this operation with the oscillator and receiver tuned to 3·5 Mc/s, thus using the lower-frequency radiogoniometer. The oscillator should be placed at a distance of about 150 yd.

46. The results obtained should be plotted as an error curve for both frequencies, that is, the true bearing plotted against error. Specimen error curves are shown in fig. 6. It is not usual to derive correction curves from the results of the ground calibration.

AIR CALIBRATION

47. The most satisfactory method of air calibration is for the aircraft to transmit when over a definite pin-point the bearing of which from the D/F station can be determined from a map. Alternatively, the aircraft can obtain its position by means of Gee fixes. In some instances, however, there may be sectors where suitable landmarks are not available (for example, over the sea) and where the Gee cover is not available; the third alternative of taking simultaneous optical bearings with a theodolite or compass is used in these cases.

Flight planning

48. The location of the D/F station is plotted by the navigator on a ¼ in. scale map. Then, at a radius of about 30 miles from the station and at intervals of not less than 20 deg., a series of suitable pin-points should be chosen. These may be cross-roads, churches, railway stations or other prominent landmarks. If a Gee chain is available, the Gee co-ordinates of points on the 30-mile circle can be used instead for sectors where there are no landmarks.

RESULTS OF TYPICAL AIR CALIBRATION

Name of station:

Frequency: 3805 kc/s

Map reference:

Date of calibration:

Type of D/F: HF D/F (DFg. 24/2)

Aircraft Type and No.:

Pilot:

Crew:

Run No.	Pinpoint Map reference (Lat. and Long or Gee co-ords.)	Description	True bearing of pinpoint from D/F Station in degrees	Observed bearing of aircraft Run A	Observed bearing of aircraft Run B	Average error in degrees
1	505600N, 004020E	Isfield rly. stn.	080	079	077	−2
2	B2.11, C43.51 B2.105, C43.51	Gee fix	098 098	097 —	— 097	−1
3	B2.84, C43.25 B2.75, 43.23	,,	120 118	119 —	— 117	−1
4	B3.75, C43.00 B3.68, C43.00	,,	138 136½	135 —	— 134	−2¾
5	B4.90, C42.73 B4.85, C42.75	,,	158 157	155 —	— 154	−3
6	B6.25, C42.59 B6.16, C42.60	,,	178 176	177 —	— 175	−1
7	B7.50, C42.50 B7.49, C42.56	,,	196 197	199 —	— 197	+1½
8	B8.70, C42.83 B8.92, C42.80	,,	220 221	220 —	— 222	+ ½
9	B10.03, C43.11 B 9.93, C43.17	,,	238½ 239	240 —	— 242	+2¼
10	504530N, 013200W	Lymington rly. stn.	259½	262	262	+2½
11	505700N, 012830W	North of rly. stn.	282	285	284½	+2¾
12	510700N, 012930W	Stockbridge	298½	300	302	+2½
13	511500N, 011530W	Overton rly. stn.	320	318	318	−2
14	511630N, 005715W	Hook rly. stn.	341	340	340	−1
15	511800N, 004515W	Railway crossing	357½	358	356	−½
16	511800N, 002330W	Railway bridge	023	021	019	−3
17	511400N, 000930W	Railway junction	042	042	040	−1
18	510445N, 000230W	W. Hoathley rly. stn.	061	059	060	−1½

Remarks: Gee fixes on Southern Chain.

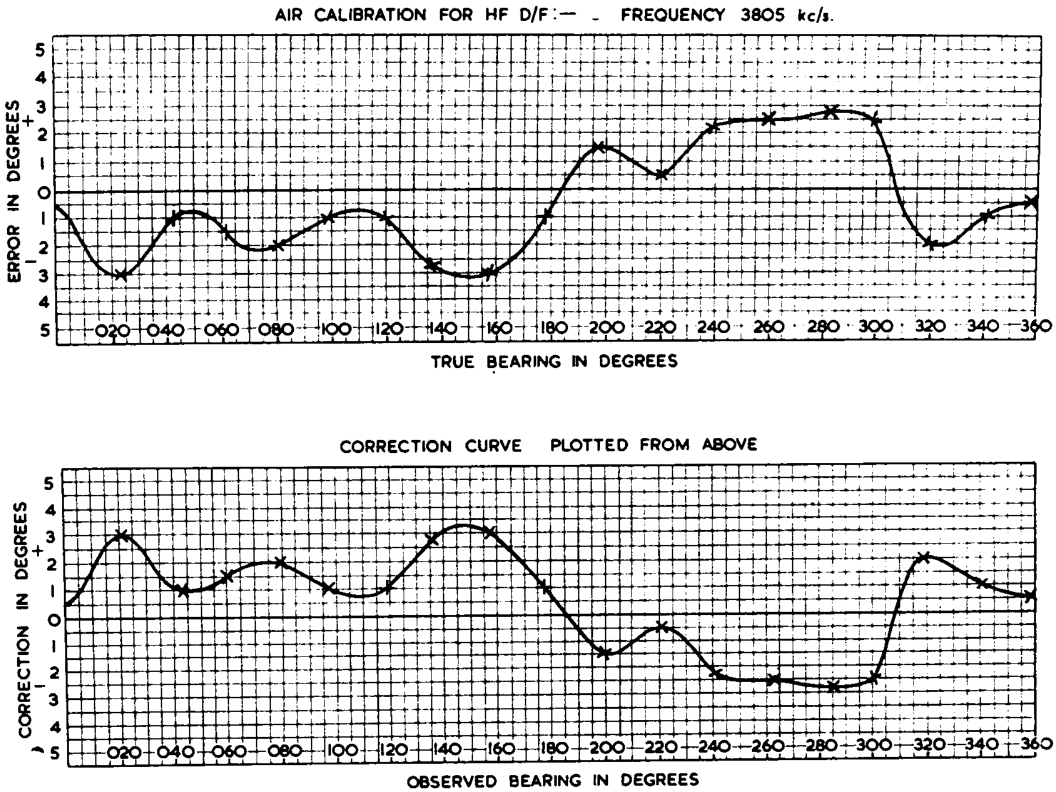


Fig. 7. Air calibration: error and correction curves

49. The pin-points are to be numbered in a clockwise direction. Over each pin-point two runs are to be made radially, that is, one heading towards the D/F station, the other away from the D/F station; the runs are identified as A and B respectively.

50. The supervisor or N.C.O. i/c D/F station is co-opted for the test and all final arrangements for call signs, frequency and procedure to be employed are confirmed with him.

Procedure during flight

51. Before commencing the calibration, the aircraft is flown over the D/F station so that the navigator can verify its location accurately on the ¼ in. scale map. At the same time communication is established with the D/F station on the frequency to be calibrated.

52. The aircraft is then flown to the first pin-point and before running over the pin-point the W/T operator transmits the number of the pin-point and the identification of the run. For example, to indicate to the D/F station the selected pin-point, the aircraft transmits:—

WA V MOPP 1A AS

53. The runs over the pin-points should normally be at a height of 3,000 ft. above the altitude of the D/F station but the height may be increased to ensure safety of the flight. Particular care is to be taken to fly accurately over the pin-point and to transmit for the bearing when immediately over it. For example, the aircraft transmits:—

WA V MOPP 1A 1A 1A (long dash)
1A 1A K

54. The D/F station then passes the observed bearing to the aircraft or asks for a repetition run on the same heading. If a repetition run is requested it should be made before proceeding with the other heading or to the next pin-point. The bearing received is to be recorded by the W/T operator who will inform the navigator of the figures received. If the received bearing varies a great deal from the actual bearing of the pin-point, the aircraft should repeat the run concerned and inform the D/F station accordingly. Runs 1A, 1B are followed by 2A, 2B etc. If the bearings for the A and B runs differ by more than 2 deg. (accuracy of a Class A bearing) both 1uns should be repeated. Where Gee is being used to determine pin-points the bearings are checked against the Gee fixes taken by the navigator at the same time as the transmission for the bearing is made.

Note . . .

HF D/F stations will, for the purpose of the air calibration test, designate bearings as either Class A, B or C. The classification C1 or C2 is not to be employed.

Use of theodolite or compass

55. Where visual pin-points or Gee fixes are not practicable, the air calibration may be carried out with the aid of a theodolite or suitable landing compass. The visual observer must be situated near to the D/F station so as not to introduce parallax errors but not so near as to interfere with the operation of the station. Communication between the D/F operator and the visual observer is usually maintained by whistle according to a pre-arranged code.

56. The aircraft flies radially away from and towards the D/F station and simultaneous wireless and optical bearings are taken by the D/F station. It will not generally be found possible to observe the aircraft visually at a distance much greater than about 7 miles by theodolite and considerably less by compass. The average difference between the two types of observed bearings taken during each run is to be considered as the error. Particular care should be taken to apply the correction for magnetic variation to the observed compass bearing before comparison with the true bearing obtained by the D/F station.

Calibration charts

57. The results of a typical air calibration are shown in the table facing fig. 7. These are used to compile the correction chart for operational use. The correction curve derived from these figures is shown in fig. 7. The correction to be applied is plotted against the observed bearing.

RE-CALIBRATION AND CHECK CALIBRATION

58. A complete re-calibration is performed after major repairs, etc., and at intervals not exceeding one year. The procedure to be followed is exactly the same as for the initial calibration.

59. If when plotting the re-calibration error curve, no deviation is shown from the initial error curve, a correction curve need not be prepared, the station continuing to use the original correction curve. If on re-calibration the D/F station is shown to be outside the accepted degree of tolerance, the matter should be investigated and appropriate remedial action taken.

60. Check ground calibrations are undertaken every three months, after change of frequency, or after minor repair or adjustments.

61. For the ground check, the test set Type 46 is tuned to the working frequency and placed at a point greater than one wavelength from and in line with the N–S masts. The bearing is observed, the sense checked and the error noted. The operation is then repeated at the other three cardinal points and at the four sub-cardinal points, using the masts as reference line in each case. Correct allowance must be made where the masts are not orientated truly.

62. The results should be compared with those obtained in the previous check. After due allowance has been made for seasonal variation of about ± 1 deg. the results should be similar. If any variation is in excess of this figure a functional test should be performed.

63. Routine checks at more frequent intervals are normally made by observing distant stations of which the true bearing is known.

Appendix I

AERIAL SPACING CORRECTION

ILLUSTRATION

1. When a D/F installation is operating at frequencies (greater than about 10 Mc/s in this installation) which are high enough for the aerial spacing to be comparable with the wavelength of the signals being received, additional bearing errors arose. This error is due to the polar diagram of the aerial system departing from the true cosine law obtained with the radiogoniometer. If the wavelength is greater than about ten times the aerial spacing, the errors are negligible. For shorter wavelengths the error will increase considerably for a given installation and therefore corrections must be made.

2. Aerial spacing error is usually known as the octantal error because the maximum errors occur at the octantal points, that is, at 45 deg. intervals. The errors for various frequencies with an aerial spacing of 6·1 metres have been calculated and plotted in the upper diagram in fig. 1. It will be seen that the maximum error is positive in the first half-quadrant and negative in the second half-quadrant.

3. The errors shown on these curves are obtained as follows:—

Let θ be the true angle measured clockwise from North and let φ be the actual observed angle. Then it can be shown that the relationship between θ and φ is

$$\tan \varphi = \frac{\sin\left(\frac{\pi d}{\lambda} \sin \theta\right)}{\sin\left(\frac{\pi d}{\lambda} \cos \theta\right)}$$

where d is the aerial spacing.

If $\frac{\pi d}{\lambda}$ is sufficiently small, then $\sin\left(\frac{\pi d}{\lambda} \sin \theta\right)$ and $\sin\left(\frac{\pi d}{\lambda} \cos \theta\right)$ become $\frac{\pi d}{\lambda} \sin \theta$ and $\frac{\pi d}{\lambda} \cos \theta$ so that $\tan \varphi = \tan \theta$ and $\varphi = \theta$.

Hence for smaller ratios of $\frac{d}{\lambda}$, that is, for the longer wavelengths, the octantal error is smaller.

An approximate value of the maximum error for a given wavelength may be obtained from :—

$$\text{Max. error} = 25\frac{d^2}{\lambda^2} \text{ (both d and } \lambda \text{ in metres).}$$

For example, for a wavelength of 30 metres (i.e., 5 times the spacing of the aerials), the maximum error is 1 deg.

4. The octantal error with sign for a particular frequency may be read from the upper set of curves in fig. 1; for intermediate frequencies the approximate errors can be obtained by interpolation unless the site calibration errors are very small, in which case a precise error curve should be calculated from the above formula. The lower set of curves in fig. 1 show the correction plotted against observed bearing and were obtained from the upper set. These will be found to be easier to use in correcting observed bearings.

5. It must be emphasized that the calculations and curves obtained here apply for ground waves only as any other direction of approach of the received waves will introduce variables which cannot be assessed in this equipment. The direct effect of a high-angle ray is to reduce the octantal error, since the effective spacing of the aerials is reduced.

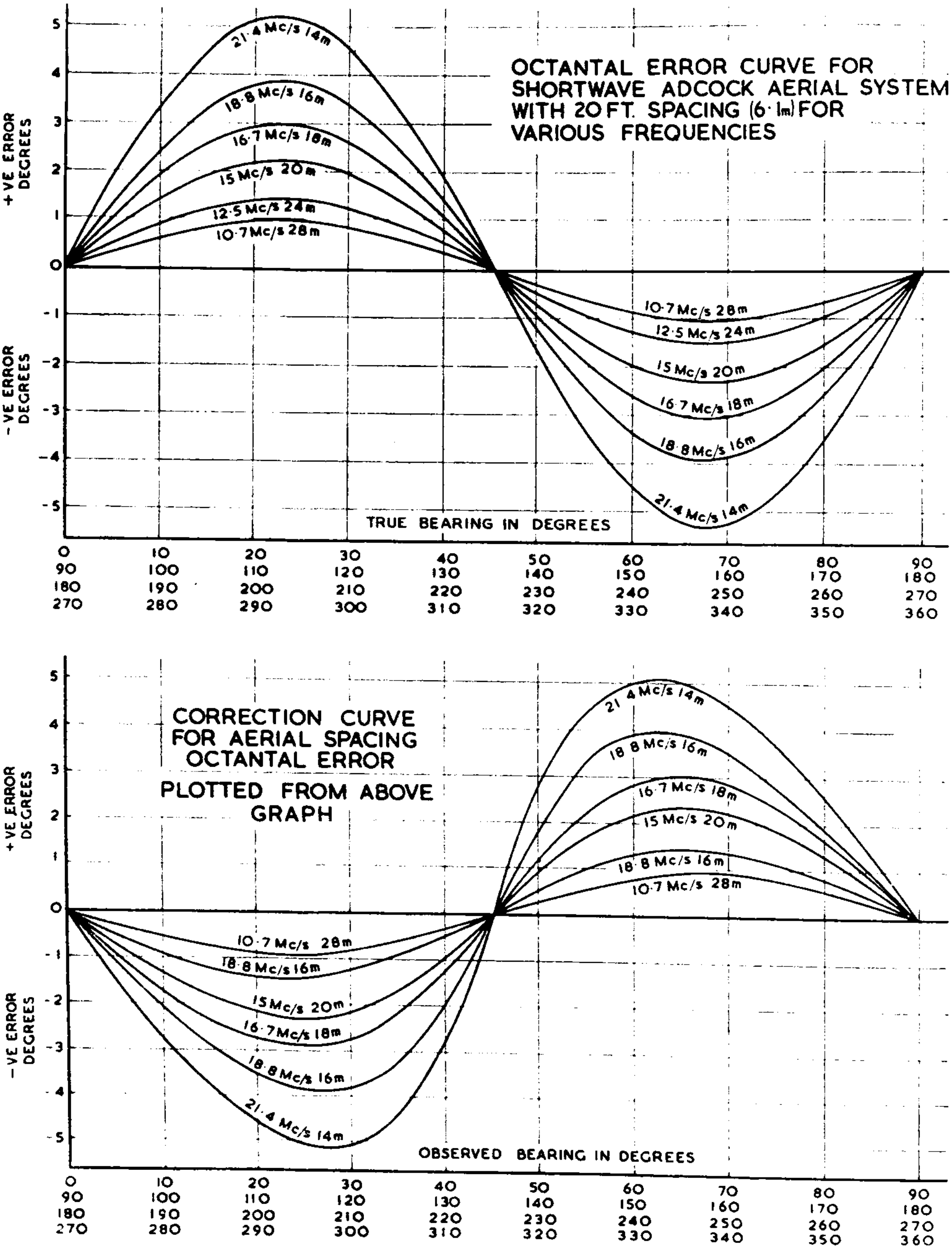


Fig. 1. Octantal error and correction curves

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AIR MINISTRY

This is Amendment List No. 4 to Air Publication 2530E, Volume I

List of Chapters: *delete* "(*to be issued later*)" after the title of Chapter 4 and *write* "(A.L.4)" in the outer margin against the deletion. *Insert* this Chapter 4 to follow Chapter 2. *Record* the incorporation of this A.L. in the Amendment Record Sheet.

SIGNALS

Chapter 4

SERVICING

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

AERIAL SYSTEM

Insulation checks

1. The aerial system should be regularly tested for satisfactory insulation resistance which under normal dry conditions should be in excess of 1 meghom. This should be measured using an insulation resistance tester (Stores Ref. 5G/1621).

2. By rotating the range switch or the D/F panel to a position mid-way between ranges, the aerials are isolated for resistance measurement. If the D/F panel is then hinged forward, the leads of the insulation resistance tester can be connected to the sockets at the back of the cabinet without the need for disconnecting the feeders.

Note . . .
The vacuum gaps mounted in the mast base insulators must be removed during these insulation tests.

Under wet conditions the resistance can fall to 30,000 ohms without serious consequences. The falling of the resistance under dry conditions may indicate that a fault is developing.

Vacuum gaps (fig. 1)

3. The vacuum gaps are fitted in the mast base insulators between the bottom of the mast aerial and earth. They are accessible by removing four bolts securing the cover to the gunmetal base. The vacuum gap tubes are supported in clips as can be seen in fig. 1. The vacuum gap associated with the vertical aerial is mounted in clips inside the D/F bay of the cabinet just behind the aerial contact screw. The operating voltage should be 300 volts but in time they may harden and require high-over voltages to operate. They should be renewed in such cases.

Vertical aerial

4. The vertical cage aerial should be periodically inspected to make sure that it has not become slack and that it is not showing any signs of chafing. Occasional cleaning of the insulators is also necessary.

RECEIVER TYPE R.1246—MECHANICAL ADJUSTMENTS

Removal of units

5. The receiver has been designed for ease of access to the inside for dismantling and servicing. Both the D/F and receiving panels hinge forward when the five captive thumb screws on each are released.

Note . . .

Before withdrawing the D/F panel, the contact screw for the vertical aerial must be released. This is located behind the small disc at the top of the panel.

6. The receiving unit panel can be lifted from the hinges and moved away from the cabinet to the limit of the flexible leads. This makes the underside of the receiver chassis more accessible. The D/F panel cannot be easily removed but all parts will be found to be accessible with it in the normal position on the table.

Removal of screens

7. A sheet metal plate must be removed to obtain access to the sense unit. It is secured by two screws at the top of the front panel of the unit and by three at the back of the chassis. Another plate is fastened by four screws over the base of the sense unit chassis but the few components and connections in the base will seldom require its removal. The sense circuit tuning condenser assembly is completely screened by a copper box secured by four wing nuts. Take care when removing this to avoid knocking against the scale and the pointer drive or the functions key assembly.

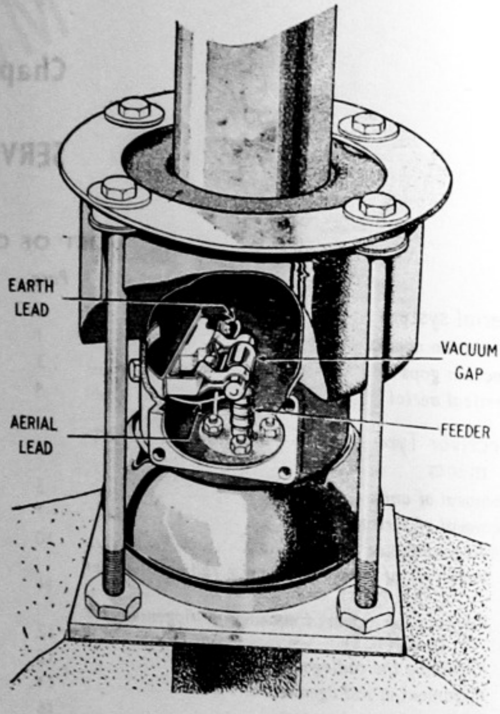

Fig. 1. Mast base insulator showing the vacuum gap

8. The gonoimeter is completely screened by a copper box which fits over the frame of the unit. This is secured by a dozen screws around the base of the frame. Removal of this box discloses also the barrel switch which is itself screened. There are four screws securing this screening cover which will need to be removed if the contacts of the switch require attention. When replacing the screening box of the gonoimeter care must be taken to fit the box in the correct position so that the holes are in line with the aerial trimmers.

9. The distribution panel which is mounted on the right-hand side of the partition between the two parts of the cabinet has a box-shaped cover which may be removed to allow the supply connections etc., to be adjusted. It is fastened by four wing nuts.

Note . . .

The screening covers of all D/F circuits should be screwed down tightly and all contact surfaces scraped clean where necessary to ensure good electrical contact.

Radiogoniometer unit (fig. 2)

10. If it is necessary to remove either of the two radiogoniometers for repair or replacement, the D/F panel should be swung forward and the screening box removed as already detailed. Then proceed in the manner detailed in the following paragraphs according to whether the lower or upper frequency radiogoniometer is to be removed. The radiogoniometer unit is shown dismantled in fig. 2.

Removal of lower frequency radiogoniometer (1·5-6 Mc/s)

11. This radiogoniometer will be found to be at the top when the panel is swung out.

(1) Disconnect the leads from the field coils and feeder trimmer condensers.

(2) Remove the slip-ring brush springs, taking great care not to bend the brushes out of position, otherwise re-tensioning will be necessary when reassembling.

(3) Remove the grub screws in the steel coupling nearest to the lower frequency radiogoniometer and the five clamping screws holding the spigotted end plate at the top of the casting.

(4) The radiogoniometer former may then be removed from the casting by lifting out vertically. Again care must be taken to ease the brushes over the slip-rings.

Removal of upper frequency radiogoniometer (6-20 Mc/s)

12. This radiogoniometer is mounted at the pointer end of the assembly.

(1) Disconnect the leads from the field coils.

(2) Remove the slip-ring brush springs.

(3) Remove the grub screws from the steel coupling nearest to the centre partition of the brass casting.

(4) Replace the D/F panel in the cabinet to allow access to the goniometer scale. It will be noticed that there are eight countersunk screws in the grey disc inside the D/F scales. The four smaller screws nearest to the spindle must be removed.

(5) The D/F panel must be now partly withdrawn so that the radiogoniometer takes up a horizontal position and it must be supported in this position.

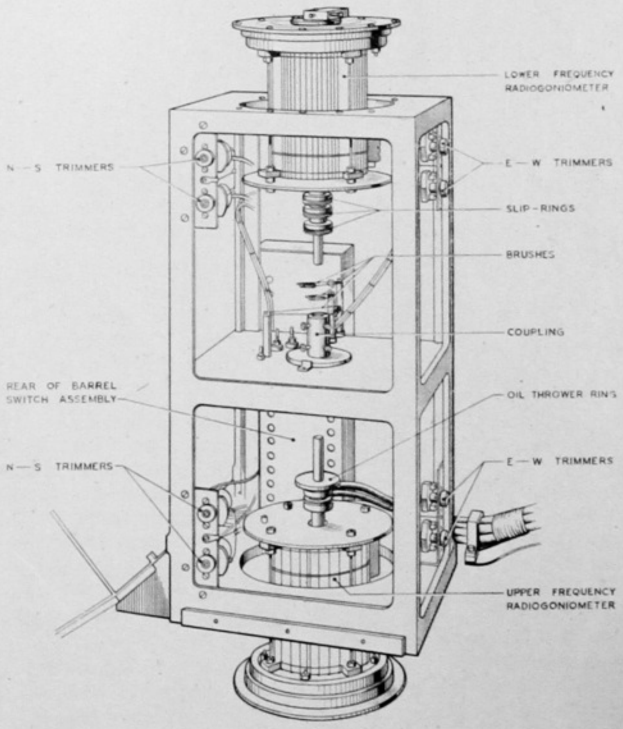

Fig. 2. Construction of radiogoniometer showing method of dismantling

(6) Withdraw the radiogoniometer former through the front of the assembly. The brushes may be bent to pass over the oil thrower ring, in which case they will require re-setting on reassembly. If more convenient the brushes may be removed from the supporting pillars.

Replacing the radiogoniometers

13. When the radiogoniometers are replaced, the procedure is the reverse of the above order.

Note . . .

It is important that the grub screws in the steel coupling between the two spindles are fitted in the same position as previously, the spindles being dimpled for this purpose.

Alignment of radiogoniometers

14. It will be observed that the steel coupling linking the two radiogoniometer spindles is fitted with an indicator disc and reference pointer on the casting. This indicator provides an approximate reference for the alignment of the search coils with respect to the D/F pointer. The mark on the indicator disc is engraved during the manufacturer's initial testing and shows the position in which the search coils are electrically at right angles to the N–S field coils. When the marks on the indicator disc and the reference pointer coincide, the D/F pointer should be at 0 deg. on the goniometer scale.

15. If it is necessary to rotate the D/F pointer with respect to the search coils to allow for the orientation of the aerial system, the indicator disc provides a useful reference point for the position of minimum coupling of the search coils. The spigoted end of the lower frequency goniometer is provided with a slot through which a clamping screw passes into the base of the casting. This allows the field coils to be rotated through an arc of approximately $\pm$ 2 deg. Minor corrections of the alignment of the two radiogoniometers with respect to each other can be made by this means. Alignment corrections are made during the preliminaries to the initial calibration of the installation as described in Chap. 3.

Radiogoniometer contacts

16. It is of extreme importance to the satisfactory operation of this equipment that all contacts in the radiogoniometer unit in particular are kept quite clean. The contact surfaces concerned are all of precious metal and must be operated dry, i.e., free from any form of grease. The contacts must be regularly cleaned with a suitable non-grease solvent (e.g., "white" carbon tetrachloride) applied with a soft camel-hair brush.

Search coil slip-rings

17. Neglect to ensure that the search coil slip-rings are clean may introduce series resistances in the aerial circuits and hence cause errors. The slip-rings are silver inserts in the body of the spindle and contact is made by gold-wire brushes. Brushes and slip rings must be kept clean as described above.

18. The gold-wire brushes are originally tensioned to give the correct spring pressure on the slip-rings (25 gm.). This pressure must not be exceeded or scoring of the silver insert may result. To enable the pressure of the springs to be periodically checked, a simple spring pressure gauge is supplied with the equipment. This is clipped to the casting of the radiogoniometer and should be used as follows:—

Insert the needle of the gauge under the slip ring brush as close as possible to the slip-ring. If the brush is correctly tensioned, it should lift from the slip-ring when the needle of the pressure gauge has moved to the centre of its full travel.

Barrel switch

19. The contacts of the barrel switch must be kept clean, since any dirt present may be "connected" in series with the aerial circuits and so introduce bearing errors. Considerable care must be taken, however, when cleaning these contacts to ensure that the spring contacts are not bent out of position.

20. The tensioning of the contact springs is set accurately at the manufacturer's and should not be tampered with. If, however, any spring is accidentally bent during cleaning, the adjustment is as follows:—

The springs which touch the studs on the barrel should be carefully bent so that they just clear the barrel in the unoperated position. The clearance between the contacts themselves should then be 1 mm. Then check for an adequate follow-through when the contacts are operated.

Sense unit

21. This unit contains the coil turret in which are the various transformers associated with link coupling to the receivers and the sense circuits; in addition there is the main tuning condenser assembly for the sense circuits. The arrangement of the unit is shown in fig. 3.

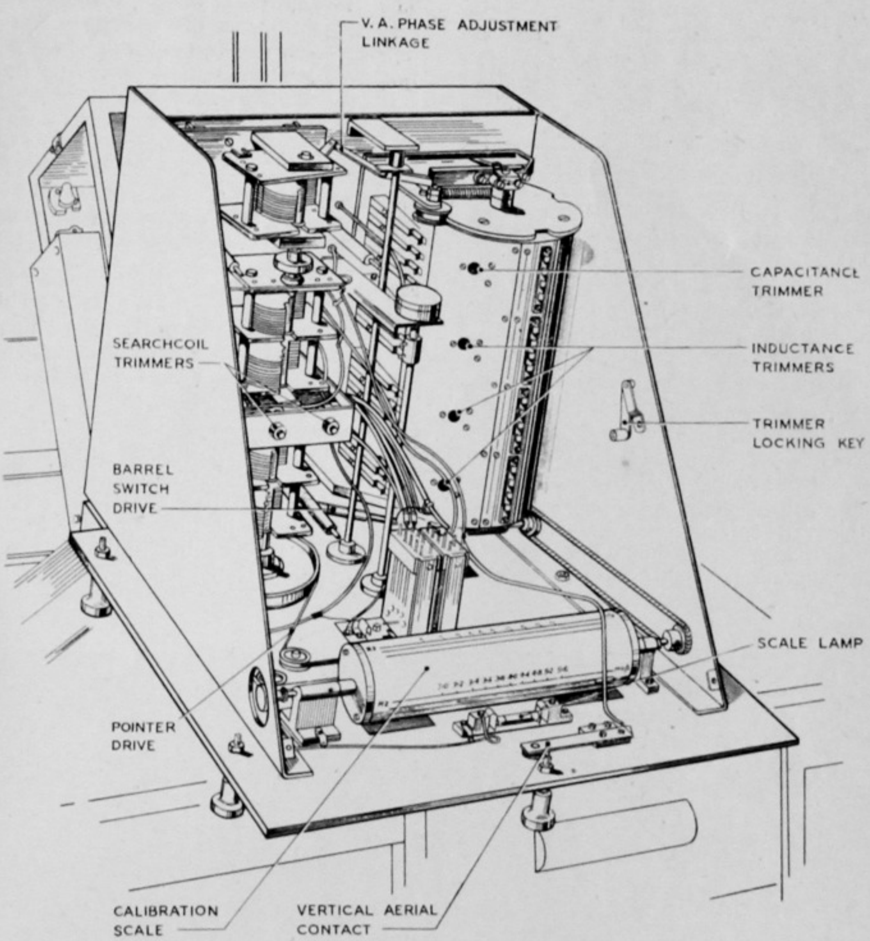

Fig. 3. Construction of sense unit

Coil turret contacts

22. The coil turret containing the sense circuit inductances etc. has four positions which make contact through four sets of four contacts. The contacts and the springs are rhodium plated and must be kept clean and free from grease. They should be inspected regularly and deposits of grease or dust removed with carbon tetrachloride. Frequent use will tend to keep the contacts cleaner than if the turret is seldom rotated. Care must be taken when cleaning the springs that their settings are not altered.

Functions key

23. The contacts on the functions key should be checked for adequate follow-through and kept clean and free from dust; great care must be exercised to avoid bending the springs when doing this.

Vertical aerial contact

24. The vertical aerial contact at the top of the D/F panel makes contact with a plate on the cabinet. Both contact surfaces must be kept clean and dry. The contact screw should be kept well tightened.

WARNING

A bad contact in the vertical aerial circuit will impair sense finding. All soldered joints and all movable contacts should be regularly inspected for security and cleanliness.

Pre-set trimmers

25. The search coil condensers are provided with capacity trimmers which are adjusted and locked during initial calibration. A key is provided, clipped to the side of the unit as shown in fig. 3, for locking these trimmers.

26. The coil turret in the sense unit is provided with permeability trimming for the inductances. These trimmers are accessible through holes in the casing of the turret and consist of a small Bakelite screw with a metal locking screw beside it. The locking screw should be just loosened before moving the trimmer itself and should be tightened before proceeding to the next adjustment.

Calibration scale drum

27. The calibration scale drum can be removed by drawing the spring-loaded end-thrust spindle on the left towards the left and disengaging the coupling on the left. Take care not to damage the scale pointer when doing this. The sprocket gear and chain will be left in position. Removal of these, if necessary, is quite straightforward.

Coil turret

28. The removal of the coil turret is seldom necessary nor is its dismantling. The procedure for removal however is as follows:—Remove the screw in the centre of the handle and take off the handle. Remove the two screws securing each bearing block to the casting. The turret can then be lifted away together with its associated bevel gear, leaving the other bevel gear and the barrel switch universal coupling in position. Hold back the retention lever when doing this.

29. To gain access to the inductances and condensers in the turret, the five screws along the edges of the sectors of the turret must be removed. The four sets of components for the range concerned can then be lifted out.

Receiving unit (*fig. 4 and 5*)

30. Although it is possible to remove the RF unit from the receiving unit as a sub-assembly it is seldom necessary and a complete receiving unit will normally be installed rather than a new sub-assembly. Removal when required is by removing three large

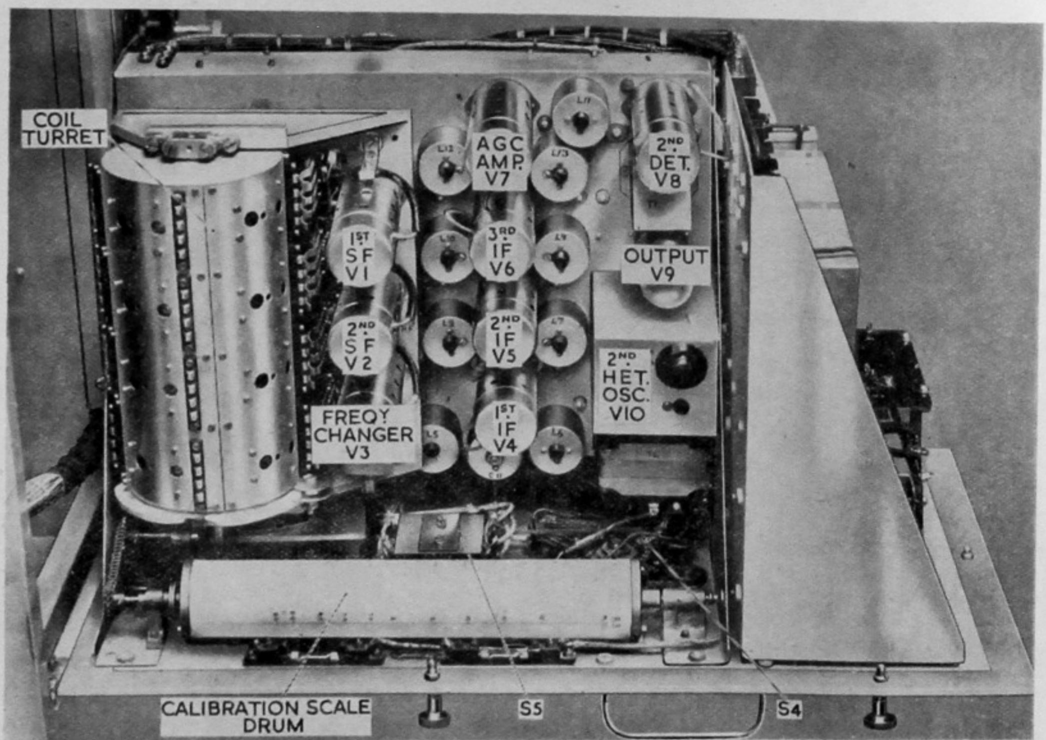

Fig. 4. View of top of the receiving unit chassis

screws which secure the sub-assembly to the main chassis, unsoldering the connections at the unit tag board and uncoupling the condenser and turret drives.

Calibration scale drum

31. Pull out the spring-loaded spindle and uncouple the drum from the coupling as for the scale drum in the sense panel.

Coil turret

32. Removal of the coil turret and access to the coil units inside is similar to that for the coil turret in the sense unit; the construction of the two is identical.

Coil turret contacts

33. These contacts must be kept clean and free from dust and grease. Take care when cleaning not to disturb the setting of the springs. Frequent operation of the range change switch will tend to keep the contacts clean.

Meter switch

34. The upper set of contacts is easily accessible for cleaning; the lower set are not so accessible and if cleaning is required it will be necessary to remove the switch. To do this, remove the knob and undo the fixing screws behind the front panel; the connection wires are made long and flexible to enable the switch to be pulled away from the panel.

Pass-band switch

35. The crystal filter associated with the first IF amplifier is contained in a screened box at the front end of the passband wafer switch assembly. Access to the contacts of S1A is by removal of the three screws securing the cover. No adjustments are to be made to the crystal or the associated phasing condenser, C11, which is mounted above the chassis and can be seen in fig. 4.

AGC relay

36. The relay which provides the change-over facilities in the AGC circuits is mounted in a screening can below the receiving unit chassis as can be seen in fig. 5. The contacts will very seldom need cleaning; should trouble be experienced however, the relay may be taken out by removing the four corner screws.

Relay details

Type No. 3000 (Post Office)

Armature No. 23C Normal travel 0·026 in. to 0·034 in.

Residual stud 0·020 in.

Contact springs are "make before break".

Relay resistance 4000 ohms.

Operating current 5 mA.

Key switch contacts

37. The contacts of the key switches controlling the AGC and the 2nd oscillator (S2 and S3 respectively) are liable to get dusty and therefore require occasional cleaning with carbon tetrachloride. Both are accessible from below the chassis as can be seen in fig. 5.

RECEIVER TYPE R.1246—ELECTRICAL ADJUSTMENTS

Lining-up the IF circuits

38. A standard signal generator, such as the signal generator Type 56 (Stores Ref. 10S/647), is required for the adjustments to the IF circuits. It is desirable that the generator has an attenuator associated with it so that figures for the relative gains of the stages can be obtained.

39. Before attempting to improve the gain of any or all of the IF stages, it is advisable to check the individual gains. Set the frequency of the generator to the IF of 600 kc/s and switch on the internal modulation and adjust to about 40 per cent. Connect a large (1 to 2 μF) condenser in series with the live lead with a clip on it so that it can be connected to various points in the amplifier, and earth the other generator lead. The local oscillator of the receiver should be rendered inoperative by turning the range change switch to a position intermediate between two ranges. The AGC should not be used during these tests, that is, the switch should be in the OFF position. The IF passband width should be 3 kc/s:—

(1) Connect the generator through the condenser to pin 5 of V8, i.e., to the anode of the diode second detector. A small output, variable by the volume control, should be observed on the meter in the GANG CHECK position. Tune the generator to give a peak reading on the meter at about half scale. Note this reading and also the amount of attenuation in the signal generator output.

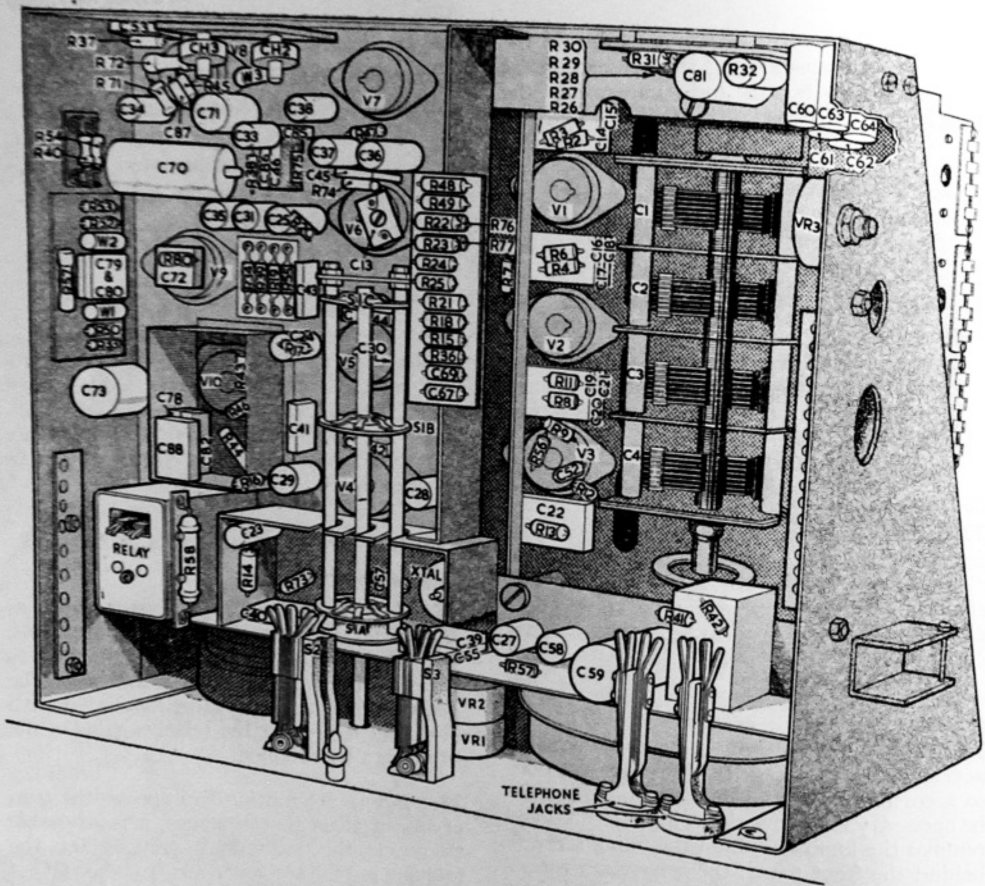

Fig. 5. View of underside of the receiving unit chassis

(2) Next connect the signal generator to the top cap of V6, i.e., to the grid of the 3rd IF amplifier. Note the attenuation necessary to give the same reading as before. The difference between this and the previous attenuator setting gives the gain of the 3rd IF stage.

(3) Similarly, inject a signal at the grid of V5, note the attenuator settings and so obtain the gain of the 2nd IF amplifier.

(4) Inject the signal at the grid of V4 and obtain the gain of the 1st IF amplifier.

(5) Inject the signal at the signal grid of the frequency changer (top cap), and obtain the gain of this stage.

40. The gain figures normally obtainable are as follows:—

Frequency changer	26 dB
1st IF amplifier	28 dB
2nd IF amplifier	28 dB
3rd IF amplifier	20 dB

These figures only apply for the 3 kc/s band width position.

41. Should any of the stages appear to be very much below the above figures it is advisable first to check that the drop in gain is not due to a faulty valve by checking the feed and, if necessary, fitting a new one. If no improvement is obtained the trimmers should then be adjusted.

42. The inductance trimmers of the tuned circuits of the IF amplifier should be adjusted in sequence, starting from the second detector and working back to the 1st IF amplifier. The trimmers should therefore be adjusted in the following order to give a maximum reading on the meter:—L13, L12, L10, L9, L8, L7.

The signal should be injected at the grid of V3 and as before the local oscillator should be in operation and the AGC switched OFF.

Note . . .

Do not attempt to trim the inductance or condenser associated with the crystal filter. (L5 and L6 and C11). Special equipment is required for these adjustments and the receiving unit will normally be replaced when faults develop in this stage.

43. If the AGC amplifier (V7) is not providing sufficient bias of the control valves (this will be shown by the overloading of the output with strong signals) the inductance trimmer of L11 should be adjusted. Adjustment of the condenser C13 which varies the input to V7 may also be found necessary; this condenser is situated below the chassis near the valve holder of V6 as can be seen in fig. 5.

Ganging of signal-frequency circuits

44. The signal generator Type 56 is suitable for the ganging of the signal frequency circuits of the receiver. Connect the live lead from the generator directly to either a or d on L4. Earth the other side of the generator. The generator should be in the CW position and the 2nd oscillator of the receiver should be switched ON. The 1st oscillator receiver should be in the centre position i.e., at zero. The AGC should be OFF and the passband switch at 3 kc/s.

(1) Set the generator and the receiver to the lower of the two frequencies marked on the range switch for the range in red.

(2) Carefully adjust the inductance trimmers of L2, L3 and L4 in turn to give a peak reading on the meter. Adjust the volume control and generator output so that the peak is obtained at about half-scale deflection. The main tuning control of the receiver should be rotated slightly on either side of the true tuning during the adjustment to check any tendency to "pulling".

(3) Now set the generator to the other frequency marked on the switch and tune the receiver to maximum output.

(4) Carefully adjust the capacity trimmers in the same order as the inductance trimmers.

(5) Repeat the trimming operations detailed above to ensure best results.

Note . . .

On the 12–20 Mc/s range, pulling of the local oscillator is more pronounced and it is very necessary to "wobble" the tuning control about the true setting to ensure that a true ganging compromise between the signal frequency and local oscillator circuits is obtained.

Overall sensitivity checks

45. It is possible to obtain useful comparative values for the overall sensitivity of the receiver by using a standard signal generator in conjunction with the universal meter in the GANG CHECK position. The check consists of three successive tests in which a standard CW signal is injected on the grid of the 1st signal-frequency amplifier, next across the receiver input mutual inductance and finally across one of the field coils of the radiogoniometer.

46. In all three tests, the following switches must be in the positions indicated:—

IF passband switch at 3 KC/S

Auto-gain switch at OFF

2nd oscillator switch at ON

The position of the D/F functions key is immaterial in the first two tests.

First test

47. The live side of the signal generator is connected to the grid top cap of V1 through a 1μF condenser, the other side of the generator being earthed. Care must be taken to use well-shielded leads between the generator and receiver. The leads should be taken through one of the thumb screw holes (remove the nut which makes the screw captive), and the panel closed. The screened lead should be earthed inside the receiver. These precautions will ensure that stray fields from the generator do not affect the receiver.

48. Checks are usually made at the top and bottom of each frequency range but it is advisable to check also at intermediate points.

(1) Set the generator to the desired frequency and carefully tune in the receiver.

(2) Now switch off the generator and adjust the volume control on the receiver until the noise alone gives a reading of 1 mA on the meter in the GANG CHECK position.

Note . . .

The setting of the volume control will be *different at different frequencies and must therefore be readjusted for each reading.*

(5) Switch on the generator (with an unmodulated CW signal) and adjust the generator attenuator so that the signal and noise together give a reading of 6 mA. Under these conditions, the reading of the meter corresponds to a signal-to-noise ratio of 10 dB.

49. The following table gives figures for the different frequencies as read off from the attenuator of the signal generator. If sensitivity figures approaching these are not obtainable, it may be due to any of the following causes:—

(1) Insufficient care in adjusting the receiver.

(2) Mis-ganging of the signal frequency circuits.

(3) Old valves in the input stages of the receiver.

Range	Frequency in Mc/s	CW input to V1 for 10 dB S/N in µV
1	1·5	1·4
	3·0	1·4
2	3·0	1·2
	6·0	1·4
3	6·0	1·3
	12·0	1·3
4	12·0	1·3
	20·0	1·3

Second test

50. Here the signal is injected through the input circuits to the receiver. Proceed as follows:—

(1) Unsolder from tags 14 and 15 on the main tag strip in the receiver the two leads joining these tags to the functions switch, thus disconnecting the link circuit. Refer to fig. 7.

(2) Connect the signal generator output leads to tags 14 and 15, inserting a 400-ohm resistor in series with the live lead.

(3) Set the signal-to-noise ratio to 10 dB as before and obtain a similar set of readings.

51. The following figures for sensitivity should be obtained:—

Range	Frequency in Mc/s	CW input for 10 dB S N in µV
1	1·5	1·3
	3·0	1·4
2	3·0	1·6
	6·0	1·2
3	6·0	1·1
	12·0	1·1
4	12·0	1·3
	20·0	2·1

Third test

52. Special care to screen the receiver from generator leakage fields must be taken in this test in which the signal is injected into the radiogoniometer.

(1) Set the functions switch to the "figure-of-eight" position.

(2) Connect the signal generator to either the N–S or E–W terminals of the radiogoniometer unit, inserting a 50-ohm resistor in series with each lead to give a balanced input.

(3) Connect a 100-ohm resistor across the other pair of terminals, E–W or N–S as the case may be.

(4) Carefully tune the search coil circuit and the receiver to the signal and adjust the goniometer handle to give maximum reading on the meter.

(5) Adjust the receiver volume control and generator attenuator as in the previous tests to give 10 dB signal-to-noise ratio.

53. The following figures for sensitivity should be obtained:—

Range	Frequency in Mc/s	Total CW input to field coils for 10 dB S/N in µV	Equivalent field strength in µV/m
1	1·5	0·4	1·25
	3·0	0·6	1·1
2	3·0	0·6	1·25
	6·0	0·7	0·5
3	6·0	1·3	0·5
	12·0	10·5	2·5
4	12·0	4·0	1·0
	20·0	1·0	0·5

Valves and feeds

54. The following list gives details of the valves used in the receiver and where applicable the average feed recorded on the

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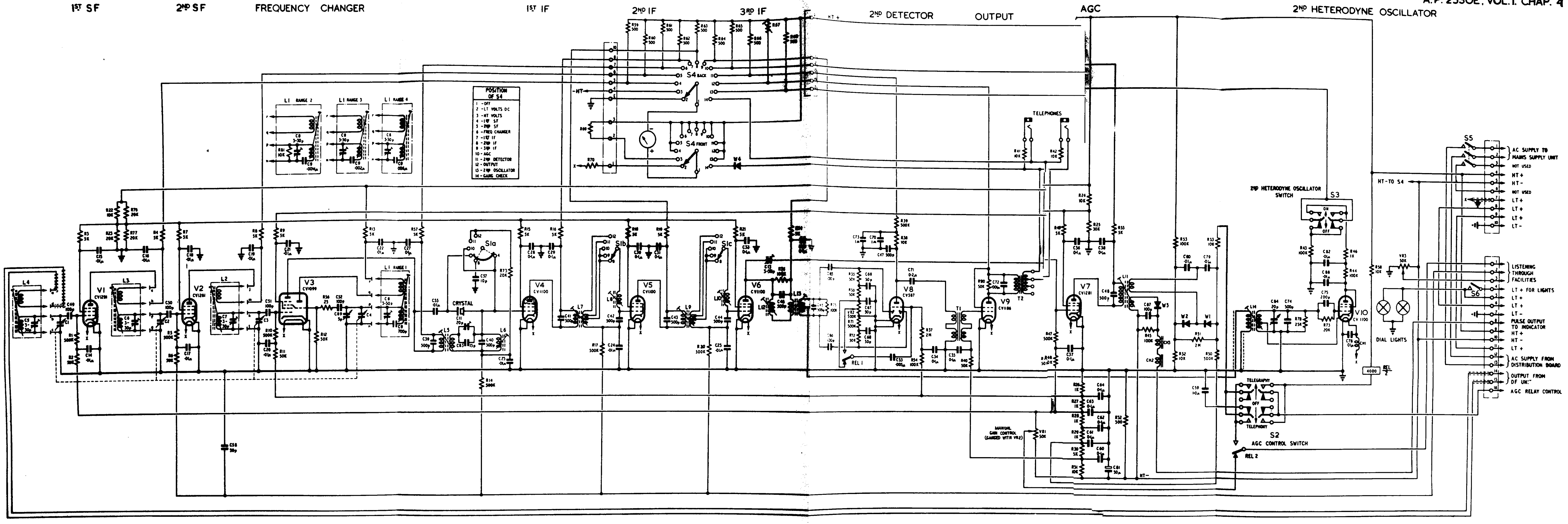
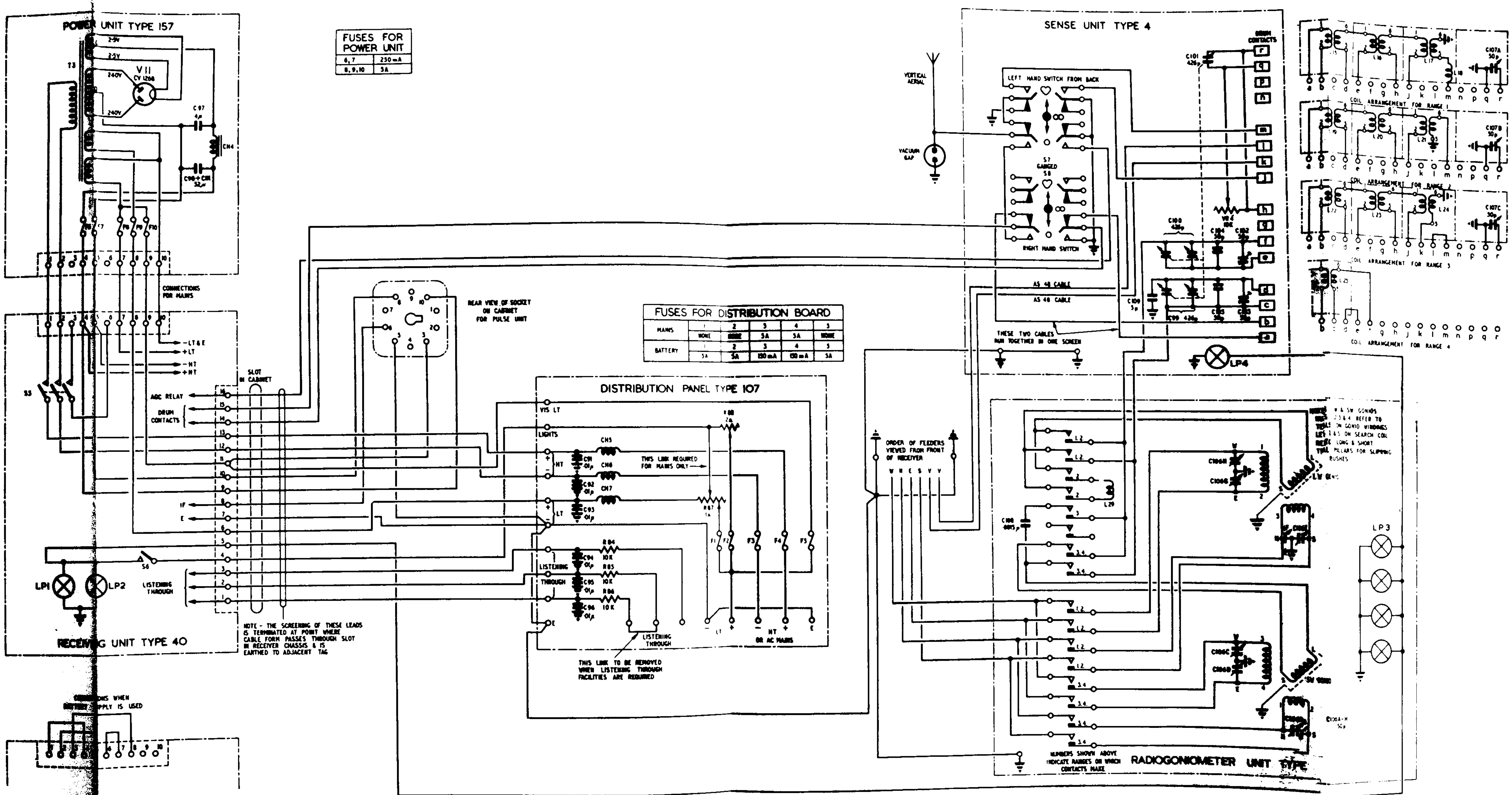


FIG. 6

RECEIVER TYPE R.1246, CIRCUIT

FIG. 6

PP6091 M14811, G754 6/50 440 C&P Gp. 959 (4)



FUSES FOR POWER UNIT	
6, 7	250 mA
8, 9, 10	3A

FUSES FOR DISTRIBUTION BOARD					
MAINS	1	2	3	4	5
	NONE	NONE	3A	3A	NONE
BATTERY	1	2	3	4	5
	3A	3A	150 mA	150 mA	3A

FIG.7

INTER-UNIT CONNECTIONS

RESTRICTED

FIG.7

meter. The appropriate multiplication factor is engraved on the meter. The figures were obtained with the volume control at maximum.

Stage	Type	Commercial equivalent	American equivalent	Average feed in mA	Remarks
V1: 1st SF amp. / V2: 2nd SF amp.	CV1281	KTW61	6K7G	6—7 / 3—4	— / Reduced by action of vol. control
V3: Frequency changer	CV1099	X65	6K8	0·5—1	—
V4: 1st IF amp. / V5: 2nd IF amp. / V6: 3rd IF amp.	CV1100	KTW63	6K7G	3—4	As for V2
V7: AGC amp.	CV1281	KTW61	6K7G	5—6	—
V8: 2nd det. and 1st AF amp.	CV587	DH63	6Q7G	0·2	Increases slightly when 2nd osc. switched on
V9: Output amp.	CV1186	KT63	6F6G	16—18	—
V10: 2nd osc.	CV1100	KTW63	6K7G	1·0—1·5	—
V11: Mains rectifier	CV1268	U50	5Y3G	70	With relay energized
W1, W2, W3: Metal rectifier	Type 17	WX.6	—	—	Stores Ref. 10D/11080
W4: Metal rectifier	Type 39	F.4	—	—	Stores Ref. 10D/414
LP1–4: Filament lamps	6V 3W	OS6338	—	3·5 A total	Stores Ref. 5L/54

Note . . . *Valve filaments take approx.* 3·4 *A*.

Distribution board connections

55. The distribution board for supply connections to the receiver is mounted on the right-hand side of the centre partition between the two units of the cabinet. Access to this board is from the front of the cabinet when the D/F panel is swung forward. The board has a cover secured by wing-nuts. The circuit of the board is given in the inter-connection diagram, fig. 7.

Battery operation

56. When the receiver is to be operated on batteries, an 8V LT supply is connected across the tags marked —LT+ and a 160 V HT supply is connected across the tags marked —HT+ OR AC MAINS. Fuses rated at 150 mA are fitted in the two HT fuse holders and the other three holders are fitted with 5A fuses.

57. The two adjustable resistances wound on slate formers on the right-hand side of the unit are for setting the LT voltage to its correct value. The smaller one on the extreme right, VR87, is used to adjust the valve heater voltage to 6·3 V. This may be measured by the meter on the receiver panel in the LT VOLTS position. The larger pre-set resistance, VR88, is for adjusting the scale lighting voltage. This must be measured by an external voltmeter and set to 6 V.

Mains operation

58. When the receiver is to be operated on AC supply mains, the 200–250 V 50 c/s supply should be connected across the tags marked "HT OR AC MAINS". The 150 mA fuses (No. 3 and 4) are replaced by 5 A fuses; the three 5 A fuses (No. 1, 2 and 5) in the LT+ and lighting circuits should be removed.

59. An additional connection is made between the spare slider on the variable resistance VR87 and the lighting tag. This slider should be adjusted so that the voltage on the scale lighting lamps does not exceed 5 V as measured by an external AC voltmeter at one end of the lamp holders. A convenient place to make this measurement is on the radiogoniometer scale.

60. Small bulbs rated for 6 V DC will be found to have a very much reduced life if run at 6 V AC. As the voltage reduction is effected by a series resistance, the failure of any one bulb will result in the remainder being run at a correspondingly higher voltage and so increase the likelihood of further bulbs burning out. Any burnt-out bulb should therefore be replaced immediately.

"Listening-through" circuit

61. In some installations a high-power transmitter is associated with the receiver and is sited fairly near to it. It is therefore desirable to "mute" the receiver during the operating periods of the transmitter. Normally the left-hand pair of the three terminals on the distribution board marked LISTEN THROUGH are linked together.

62. When it is required to use these facilities, the link is removed and the terminals are wired to the change-over contacts on the transmitter key. The third terminal carries a negative potential and this is connected to to the grids of the controlled valves (via the transmitter key and tag 2 on the receiver tag

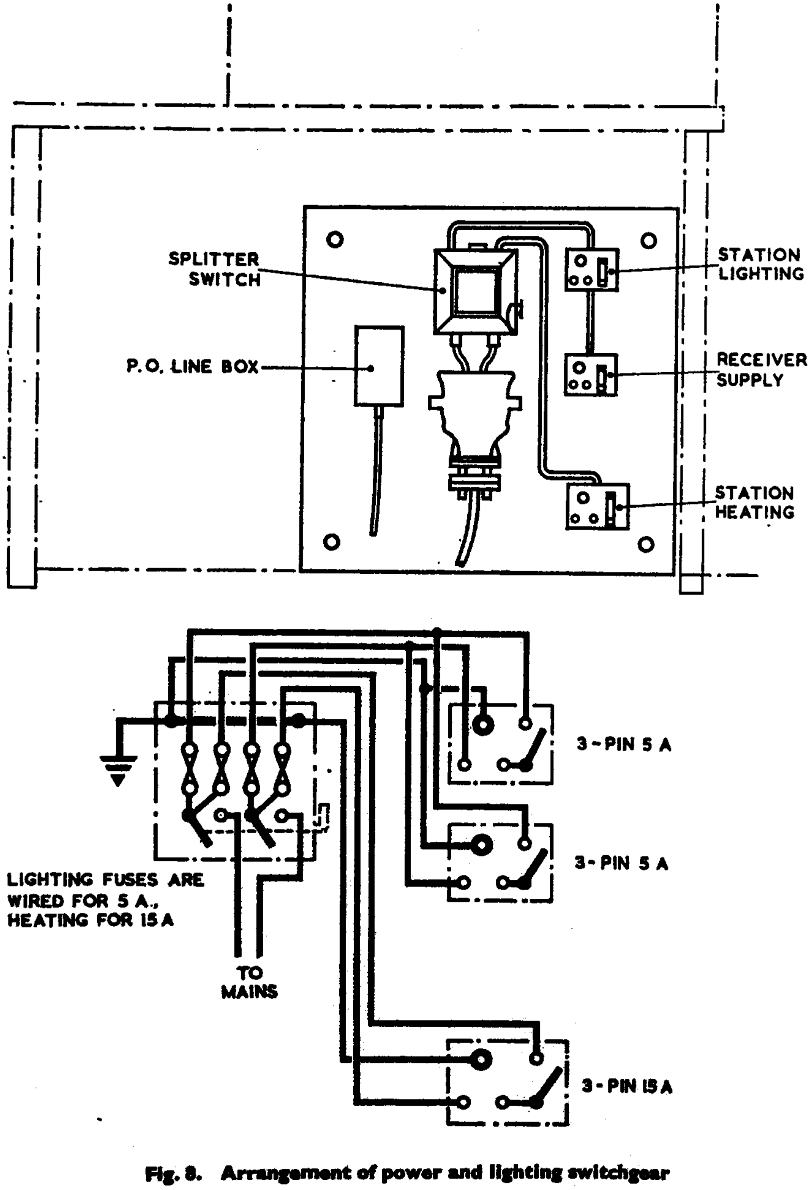


Fig. 8. Arrangement of power and lighting switchgear

board) when the key is down and the transmitter operating. The controlled valves are thus nearly cut-off and the receiver is protected from over-load. When the key is up, the controlled valves are connected to the gain control circuit (via tags 1 and 2 and the key contacts) and the receiver operates normally. Adjustment of the amount of negative bias applied is effected by the pre-set potentiometer, VR3, in the receiver.

Mains supply arrangements

63. The mains supply arrangements will obviously vary to a certain extent with different installations according to local requirements. However a typical installation will usually have the supply cable terminated at a small non-metallic hut situated at about 100 yd. from the D/F installation. The hut will contain a small stand-by petrol-electric set and switchgear which enables either the mains supply or the stand-by set to be used. A typical stand-by set is the Blue Diamond generating set (Stores Ref. 142BB/1) which supplies approximately 225 watts at 230 V 50 cycles and also 12 V DC for charging batteries. Other types of petrol-electric set may be met however.

64. The supply cable for the generator hut to the D/F hut is buried at a depth of 6 ft. and enters the hut at the centre with the feeders. It terminates at a switchboard mounted on the back of the receiver table. A typical arrangment and circuit of the switchboard is given in fig. 8 (it must again be emphasized that other arrangments may be found). It consists of a simple splitter switch and sockets for the supplies to the receiver and the station lighting and heating. The telephone line terminating box is often mounted on the same board for convenience.

P16915 M14810/G753 7/50 440 C & P Gp. 1

AIR MINISTRY

FGRL.5056

This is Amendment List No. 3 to Air Publication 2530E, Volume I

List of Chapters: *delete* "(*to be issued later*)" after the title of Chapter 2 and *write* "(A.L.3)" in the outer margin against the deletion. *Insert* this Chapter. *Record* the incorporation of this A.L. in the Amendment Record Sheet.

SIGNALS

Chapter

OPERATION

LIST OF CONTENTS

Introduction

1. The procedure for obtaining bearings with an Adcock direction-finder involves, firstly, searching for the required signal; secondly, taking a bearing on the signal when found and, finally, determining that the bearing observed is the correct one and not the reciprocal.

2. The technique of direction-finding in the high-frequency band calls for greater care than medium frequencies or, indeed, on the very-high frequencies. This is because of the amount of fading which is often experienced on these frequencies and which is caused by ionospheric reflections. When taking a bearing, which involves finding a position of minimum signal, care must therefore be taken to ensure that any decrease in signal observed is not due to fading. The precautions necessary are described below.

Searching

3. When searching for a wanted signal the following control positions should be initially set up:—

(1) Functions key at "0" (stand by).

(2) RANGE handle on receiver at appropriate range.

(3) 2ND OSC. at ON.

(4) 1ST OSC. vernier at its centre (zero) position.

(5) IF PASS BAND at 3 kc/s.

(6) AUTO GAIN usually OFF, but this depends to a certain extent on conditions in the band in use.

(7) VOLUME control at maximum (10).

4. Tune in the signal by means of the main TUNING control on the receiver. Make any fine adjustment required by means of the 1ST OSC. vernier control. The tuning scale only reads the correct frequency when the vernier is at zero. It is not necessary when tuning in the signal to adjust any of the controls on the D/F panel other than the functions key.

Measurement of bearings

5. Having tuned in and identified the signal of which the bearing is required, set the D/F panel controls as follows:—

(1) Functions key at "figure-of-eight" (D/F).

(2) RANGE handle to appropriate position.

(3) TUNING control to give the receiver frequency on the upper of the three scales on the D/F panel calibration scale.

6. The goniometer should then be swung to find the two positions of minimum signal. These two minima should be exactly 180 deg. apart (after any correction from the calibration of the installation has been applied) and should have the same amount of sharpness.

7. When taking swing bearings by observing the signal strength over a small arc and bisecting the angle between positions of equal signal strength, the action must be performed much more rapidly on fading signals. If the goniometer is moved slowly, the signal may fade before the opposite side of the minimum is reached and a false reading will result.

Note . . .

It is not permissible to use the GANG CHECK *meter position to observe the minima visually since it does not provide the discrimination between the wanted signal and interfering signals that is obtained by ear.*

Determination of sense

8. The correct bearing of the two minima will in some cases be obvious but if not, the sense ambiguity must be resolved using the sense finding circuits. Proceed as follows:—

(1) Read off the settings for the vertical aerial amplitude and phase controls from the lower two of the three scales on the calibration scale for the frequency shown on the upper of the three scales and set the controls accordingly.

(2) Set the functions key to the "heart" position.

(3) Swing the goniometer sense pointer to the two reciprocal bearings already observed. It will be found that one position gives a smaller signal than the other; in this position the sense pointer indicates the correct bearing.

(4) The pointer should be swung rapidly several times between these two positions to eliminate errors due to fading signals.

9. In some instances a really sharp heart minimum is not obtained at once and adjustment of the controls will be necessary. This adjustment is more important when considerable operation on one frequency is to take place. The procedure is as follows:—

(1) Ensure that the receiver tuning is correct. Check this on "stand by".

(2) Switch over to "D/F" and swing the goniometer to one of the minima.

(3) Adjust the D/F tuning control to give a maximum signal. It may be found helpful to use the GANG CHECK meter position in conjunction with the telephones when doing this. (This is only permissible when adjusting for a maximum signal.)

(4) Set the functions key to the "heart" position and the sense pointer of the goniometer to one of the minima.

(5) Adjust the V.A. AMPLITUDE control to give minimum signal in the telephones.

(6) Adjust the V.A. PHASE control to give minimum signal.

(7) Re-adjust the settings of the two controls to obtain a final accurate setting.

10. When an installation is working in, say, two fixed frequency bands such as 3,805 kc/s and 6,500 kc/s, the adjustment of the sense controls as detailed above should be checked against a fixed station when the routine change from one frequency to the other is made. This will ensure that the equipment is always in proper adjustment. The tuning-in of different stations within the band can then most conveniently be done by the 1st oscillator vernier, no other adjustment being usually required. It may not be found practicable always to obtain such precise re-adjustments for every bearing when the installation is operating over a complete range of the receiver, but if the slightest difficulty in sense-finding is experienced, the adjustments must be made.

P16663 M12626/G258 6/50 440 C & P Gp. 1

AIR MINISTRY

This is Amendment List No. 2 to Air Publication 2530E, Volume I

List of Chapters: *delete "(to be issued later)"* after the title of Chapter 6 and *write* "(A.L.2)" in the outer margin against the deletion. *Insert* this Chapter. *Record* the incorporation of this A.L. in the Amendment Record Sheet.

FGRI.5056

Chapter 6

TEST SET TYPE 46

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

DESCRIPTION

1. The test set Type 46 (Stores Ref. 10S/111) is a portable low-powered test oscillator designed for the calibration and testing of short-wave D/F stations. It carries a vertical rod aerial and radiates unmodulated oscillations over the range 1·25 to 23 Mc/s (240—13 m).

2. The oscillator is completely self-contained and is enclosed in a weatherproof case. All the components are mounted on a chassis with the front panel secured to the case by six screws. Below the chassis are the supply batteries, one 120-volt dry battery and one 2-volt accumulator. A vertical rod aerial is secured to the side of the case by porcelain insulators; it may be extended to a total height of 6 ft. by the addition of 2-ft. sections.

3. There are only three controls—tuning condenser, range switch and a supplies

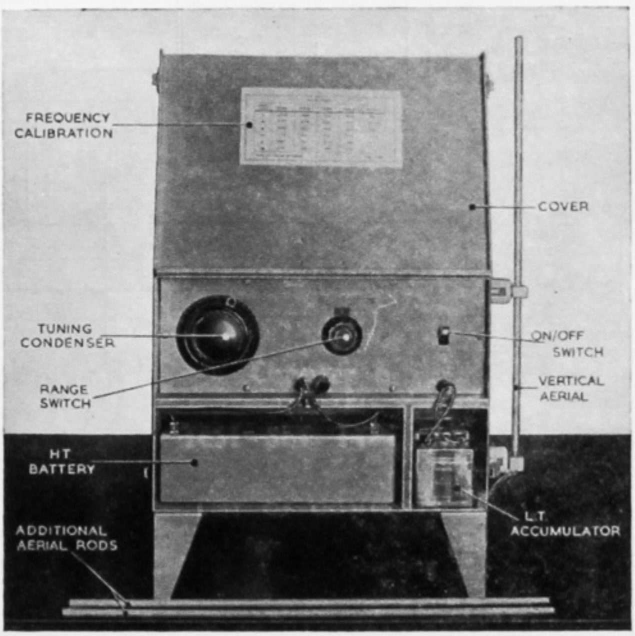


Fig. 1. Test set Type 46

switch. A calibration chart is fastened to the inside of the cover as can be seen in fig. 1.

4. The frequency band of 1·25 Mc/s to 23 Mc/s is covered by five overlapping ranges with the following approximate values:—

Range 1 :	23·1 — 8·2
2 :	13·2 — 4·8
3 :	7·5 — 2·8
4 :	5·4 — 2·1
5 :	3·2 — 1·2

Individual instruments may vary in the exact limits of each range.

5. The oscillator employs a Hartley circuit as shown in fig. 2. The single triode valve, a CV185 (commercial equivalent, P2), is used and the tuned circuit is connected between anode and grid. On ranges 1 to 3 the aerial is coupled inductively to the oscillator circuit; on ranges 4 and 5 (the lower frequencies) direct coupling via a blocking condenser is used.

6. The HT and LT supplies are connected via plugs and clips respectively; the switch, S2, breaks both circuits.

SERVICING

7. The test set requires very little attention or adjustment. The batteries should be inspected regularly to ensure that they are not run down and that the terminals are not corroded. The contacts of the wafer switch, S1, used for range changing, should be occasionally checked for freedom from dust or grease. If moving the switch several times does not remove any deposit, the contacts should be carefully cleaned with carbon tetrachloride. The ends of the sections of the rod aerial should be kept clean and bright to ensure a good electrical contact.

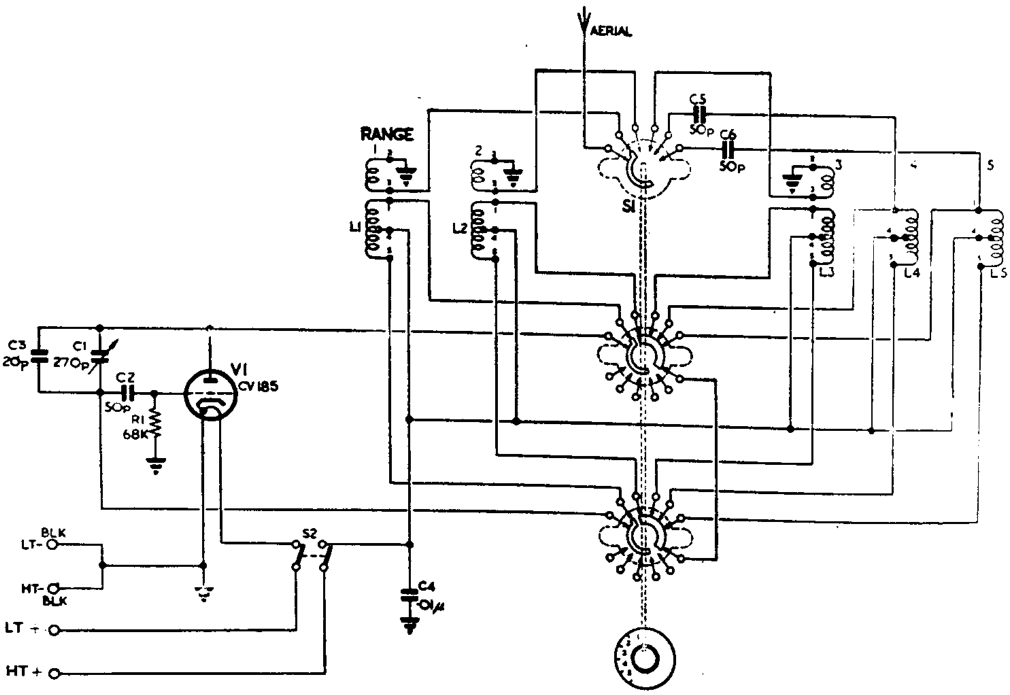


Fig. 2. Circuit diagram of test set Type 46

P16662 M12625/G259 6/50 440 C & P Gp. 1

FGRI.5056

This is Amendment List No. 1 to Air Publication 2530E, Volume 1 and Volume 5

Vol. 1. *Insert* this Chapter 1 to follow the List of Chapters. *Record the* incorporation of this A.L. in the Amendment Record Sheet.

SIGNALS

Chapter 1

GENERAL DESCRIPTION

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

LEADING PARTICULARS

Aerial system	*Adcock (aerial system Type 91)*
Receiver	*Receiver Type R.1246*
Frequency range	*1·5 – 20 Mc/s*
Sensitivity	*0·5 – 2·0μV/m*
Intermediate frequency	*600 kc/s*
IF pass-band widths	*0·4, 1·0, 3·0, 6·5 and 12 kc/s*
Valves	*4 CV1100, 3 CV1281, CV1099, CV587 CV1186, CV1268*
Power supplies	*Mains operation: 230V, 100W, AC* *Battery operation: 160V, 70mA; 8V, 7A*

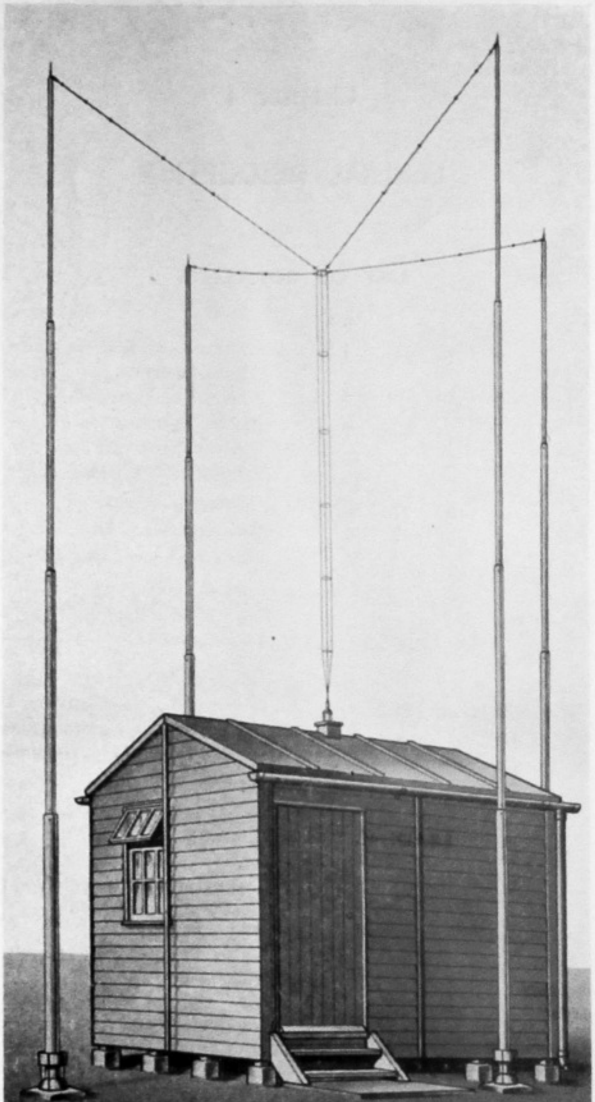


Fig. 1. FGRI.5056—General view of installation

INTRODUCTION

1. The FGRI.5056 is a ground station direction-finder using the Marconi DFG.24/2 equipment and covering the short-wave band between 1·5 and 20 Mc/s. The installation employs an Adcock-type aerial system with the receiver housed in a hut at the centre of the site. For a theoretical description of the Adcock system, reference should be made to A.P.1093, Part 2, Chapter XVI.

2. The aerial system has four vertical masts, mounted on insulators and connected to the receiver by underground feeders. A vertical aerial is supported above the hut and is used for sense-finding.

3. The receiver consists of a D/F section with radiogoniometer and associated circuits and a receiving unit which is of the superheterodyne type. The receiver covers the band in four overlapping ranges. A power pack for operation from AC mains is incorporated and operation from batteries is possible as an alternative.

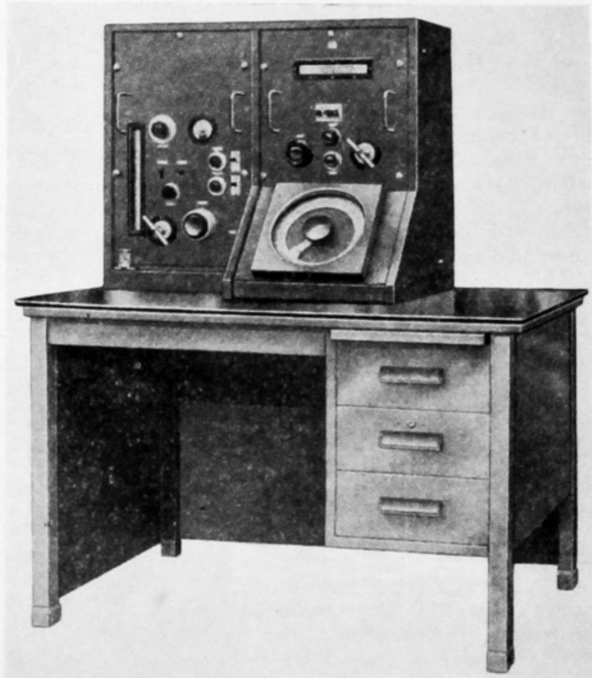


Fig. 2. Receiver Type R.1246

4. The receiver is housed in a small wooden hut situated about the centre of the site. The type normally used in the U.K. (the Brown and Lilley) is illustrated in fig. 1.

AERIAL SYSTEM

5. The aerial system used with the FGRI. 5056 is known as the aerial system Type 91. Four vertical tubular masts, mounted on porcelain insulators, are erected at the four corners of a square as can be seen in fig. 1. The masts, which are bedded in concrete, are self-supporting. They are 30 ft. high and the spacing between them (the length of the diagonal) is 20 ft. This spacing represents a compromise between the conflicting claims of sensitivity and the need for keeping the octantal correction on the highest frequencies within reasonable limits.

6. A vertical cage aerial is suspended above the hut from triatics. The triatics are supported from the tops of the masts and are broken up into short non-resonant lengths by insulators. This aerial is used for sense determination and for stand-by operation.

7. The spaced aerials are connected to the receiver at the centre of the site by special low-loss feeder cables which are buried in the ground at a depth of about 6 ft. The feeder cable is armoured and served (covered with jute and bitumen): each is 26 ft. in length and just under one inch in diameter. A fifth length of feeder is buried in the ground below the hut; this is connected in series with the vertical sense aerial on one of the frequency ranges. Inside the metal part of the mast base insulators is fitted a vacuum-gap type lightning arrestor. This is accessible through a plate bolted to the side of the insulator.

8. The earth system for the installation consists of nine copper plates buried in the ground at feeder level. One is beneath the hut and serves as receiver earth; the others are in line with each feeder on either side of the mast positions.

RECEIVER TYPE R.1246

9. Receiver Type R.1246 is a complete direction-finder comprising goniometer and receiver units. It is mounted in a two-bay cabinet type rack on an operator's table as shown in fig. 2. The D/F units are in the right-hand bay and the receiving unit with power pack for mains operation in the left-hand bay.

10. The various units are all mounted on the front panels which are hinged at the bottom and can be swung down on to the table for servicing, as shown in fig. 5. Flexible connectors enable the equipment to continue operating when this is done. The feeder cables terminate at the rear of the D/F panel, while a lead from the vertical aerial is brought down from the roof of the hut to a terminal on top of the cabinet.

11. The frequency range of 1·5 to 20 Mc/s is covered by the receiver in four ranges with a small amount of overlapping. The ranges are as follows:—

Range	Frequency (Mc/s)	Wavelength (metres)
1	1·5 – 3	200 – 100
2	3 – 6	100 – 50
3	6 – 12	50 – 25
4	12 – 20	25 – 15

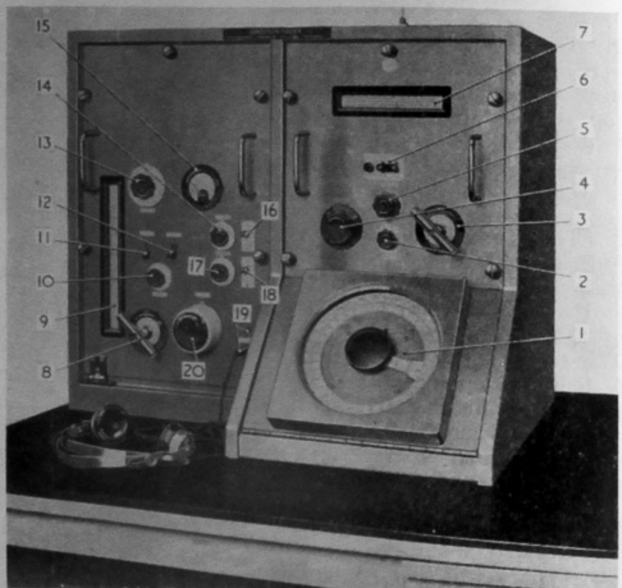
The tuning of the D/F circuits and the receiver is effected by separate range switches and tuning controls but the same ranges are used for both.

12. The D/F panel in the right-hand bay contains the radiogoniometer at the bottom with the search-coil tuning and sense-finding circuits in the sense panel above. The D/F circuits are connected to the receiving unit in the other bay by an aperiodic link coupling.

13. The receiving unit employs a superheterodyne circuit with a second heterodyne oscillator for reception of CW signals. The IF amplifier has variable band-width and the output normally feeds head telephones.

14. The items making up the receiver Type R.1246 (Stores Ref. 10D/318) are as follows:—

	Stores Ref.
Radiogoniometer unit Type 11	10D/749
Sense unit, D/F, Type 4	10A/13304
RF unit Type 14	10D/750
Receiving unit Type 40	10P/42
Power unit Type 157	10K/595
Panels (distribution) Type 107	10D/748



1 GONIOMETER
2 V.A. PHASE CONTROL
3 RANGE CHANGE HANDLE FOR D/F CIRCUITS
4 TUNING CONTROL FOR D/F CIRCUITS
5 V.A. AMPLITUDE CONTROL
6 FUNCTIONS KEY
7 CALIBRATION SCALE FOR D/F CIRCUITS
8 RANGE CHANGE HANDLE FOR RECEIVER
9 CALIBRATION SCALE FOR RECEIVER
10 1ST OSCILLATOR VERNIER CONTROL
11 SUPPLIES SWITCH
12 LIGHTS SWITCH
13 METER SWITCH
14 IF PASS-BAND SWITCH
15 UNIVERSAL METER
16 AGC SWITCH
17 VOLUME CONTROL
18 2ND OSCILLATOR SWITCH
19 TELEPHONE JACKS
20 MAIN TUNING CONTROL FOR RECEIVER

Fig. 3. Receiver controls

Receiver controls

15. The positions of the various controls on the receiver are shown in fig. 3. Those on the D/F panel are as follows: –

Goniometer (1): This carries the D/F pointer and, at right angles to it, the pointer for sense indication.

RANGE switch for D/F circuits (3).

TUNING control for D/F circuits (4).

Scale for D/F circuit tuning and corresponding settings of the amplitude and phase control for sense-finding (7).

V.A. AMPLITUDE (5).

V.A. PHASE (2).

D/F functions key (stand by—D/F sense) (6): Gives the appropriate polar diagram. The LOCK—NON-LOCK switch prevents bearings being taken with the key on sense.

16. The controls on the receiving unit panel are as follows:—

TUNING (20): Main control which incorporates a slow-motion device.

Scale for main tuning control (9).

1st OSC. VERNIER (10).

RANGE switch for the tuning of the receiver (8).

I.F. PASS BAND switch (14): Five pass-band widths between 400 c/s and 12 kc/s.

AUTO GAIN switch (16).

VOLUME control (17).

2nd OSC. switch (18).

METER SWITCH (13).

SUPPLY ON/OFF switch (11): Main supply switch for both battery and mains operation.

LIGHTS switch (12): For tuning and goniometer scales.

Universal meter associated with meter switch (15).

TELEPHONES (19).

Radiogoniometer unit Type 11

17. The assembly contains two radiogoniometers mounted on the same spindle with common D/F scales and pointers. The scales are mounted at an angle to the desk and consist of an inner scale giving geographic or QTE bearings and an outer concentric scale giving the magnetic reciprocal or QDM bearings. The outer scale can be rotated about the inner and clamped to suit the magnetic deviation at the station. The pointer has a radially sliding indicator which enables either scale to be used; letters QTE or QDM appear at a circular hole in the slider thus showing the scale in use. The sense pointer is common to both scales. There are four scale illuminating lamps mounted underneath the external cowling and controlled by the LIGHTS switch on the receiver panel.

18. The radiogoniometers are mounted in a casting bolted to the D/F panel. The common spindle of the search coils rotates in three ball races mounted in the casting. The two goniometer formers are identical except for winding data. The goniometer nearer the pointer covers the high-frequency bands, that is, 6 to 20 Mc/s; the lower frequency goniometer covers from 1·5 to 6 Mc/s and is mounted at the end of the spindle remote from the pointer. Connections to the search coil are made through gold wire brushes. A barrel switch mounted at the side of the goniometer casting switches the appropriate goniometer in circuit and is operated by the range switch on the D/F panel through a bevel gearing and universal couplings. In addition to connecting the field and search coils of the goniometers in circuit, the switch connects an inductance or capacitance across the search coils on ranges 2 and 3 respectively to enable the coils to cover the frequency ranges of these bands. Trimmers for balancing the aerial feeders are provided on both goniometers.

19. The sense unit is mounted on the right-hand side of the cabinet above the radiogoniometers and contains the search coil tuning circuits, sense circuits and controls and the range switching for the D/F circuits.

20. The main inductances of the search coil and sense circuits are contained in a coil turret which is identical in dimensions to the coil turret used in the receiving unit. The turret is operated by the range switch on the right-hand side of the panel. The tuning

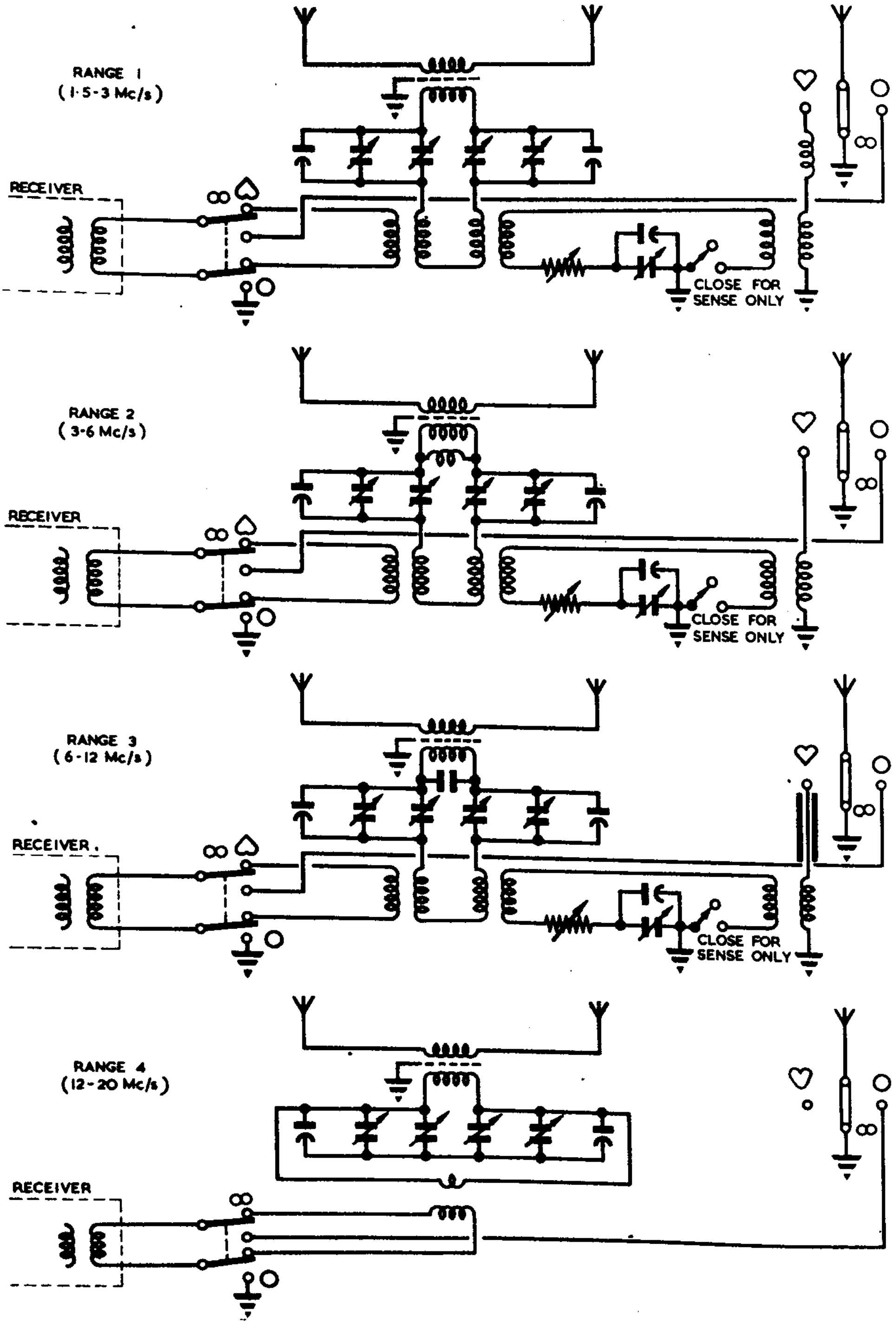


Fig. 4. Simplified input circuits

RESTRICTED

control on the left-hand side of the panel operates ganged condensers in the search coil and sense circuits. This control also operates the tuning pointer of the calibration scale at the top of the panel. In the centre below the calibration scale is the "stand by - D/F - sense" key and immediately below this are the amplitude and phase controls for adjustment of the vertical aerial EMF for sense determination.

21. A simplified diagram of the D/F circuits is given in fig. 4; full details of the switching are given in fig. 7 in Chapter 4. On ranges 1, 2 and 3 the search coil is series-tuned by two pairs of ganged condensers, while on range 4 the condensers are connected in parallel across the search coil and coupling coil.

22. The heart tuning condenser is ganged on the same shaft as the search coil condensers but a separate control is provided on the front panel engraved V.A. PHASE which is a fine adjustment on the heart tuning. This operates by rocking the stator of the tuning condenser over a limited sweep and provides an essential phase adjustment for the heart circuit at certain points in the waveband where standing waves occur on the aerials. On early models of the receiver this phase control is not to be found, only the amplitude control being fitted. The V.A. AMPLITUDE control is a variable resistor, VR4, in parallel with the V.A. PHASE condensers.

23. A length of feeder, equal to half the length of one "U" of the spaced aerials, is buried in the ground and connected in series with the vertical aerial on range 3 only. This has the effect of matching the vertical aerial and spaced aerial EMF's in phase and amplitude and is necessary where standing waves are present in the aerials.

24. The coupling to the receiver is by an aperiodic link between the search coil and the first tuned circuit of the receiver. Separate link couplings are provided for each range and these are housed in the coil turrets on the D/F panel and the receiving unit. The coils are designed to give an optimum transfer over each range of the receiver. This method of coupling enables the receiver circuits to be ganged independently of the D/F circuits and simplifies initial testing and servicing.

25. The aerial feeders, including the extra length of feeder used on range 3, are led up from the ground to terminals at the back of the cabinet and are connected to the radio-goniometer panel by flexible screened leads. The D/F panel assembly is hinged at the lower edge and can thus be lowered forward for examination with the aerial connections (and link coupling to the receiver) remaining undisturbed.

26. The vertical aerial used for stand-by operation and sense-finding is led through a porcelain insulator on the top of the cabinet. The lead-in is connected to an insulated brass strip which makes contact with a phosphor-bronze finger on the D/F panel. A positive contact with the strip is ensured by means of a large-headed brass screw accessible through a hole in the front of the panel. The screw must be removed before the panel is withdrawn. A vacuum tube lightning arrestor, similar to those used at the mast bases, is mounted inside the cabinet just below the lead-in insulator to protect the receiver from sudden charges on the vertical aerial.

27. The functions key or "stand by - D/F - sense" switch consists of two low-capacity keys linked together by means of a bar. In the stand-by position the vertical aerial is connected directly into the link circuit of the receiver so that, for searching, the D/F circuits are entirely isolated. In the D/F position the sense aerial is connected to earth and the D/F circuits alone are coupled to the receiver. This gives the "figure-of-eight" polar diagram. In the sense position the sense aerial is coupled into the link circuit together with the D/F circuits, giving a heart-shaped diagram. A locking switch is fitted beside the functions switch so that, if necessary, the switch can be prevented from remaining in the sense position when depressed. This guards against the taking of bearings with the circuits set for sense finding. A connection from the switch operates a relay which prevents the AUTO-GAIN being used when taking bearings or sense-finding; auto-gain can only be used when the switch is at "stand-by".

Receiving unit Type 40

28. The chassis of the receiver is mounted in a vertical end-on position on the front panel as shown in fig. 5 so that on hinging the panel forward both sides of the chassis are accessible. (The power unit is mounted on top of the receiver chassis but is a self-contained unit). The signal-frequency circuits consisting of the coil turret assembly, main tuning condenser, valves and associated components are mounted as a sub-assembly (RF unit Type 14) on a rigid aluminium casting which is attached to the main chassis on which are mounted the IF and LF amplifiers and control circuits etc.

29. A simplified circuit diagram, omitting switching and power supplies, but showing the D/F circuits, is given in fig. 6; a full circuit diagram will be found in fig. 6, in Chapter 4. It will be seen that the receiver has two stages of signal frequency amplification, frequency changer, a three-stage IF amplifier, second detector, LF amplifier and output stage. In addition there is an auto-gain system, a beat-frequency oscillator for CW reception and also metering circuits.

Signal-frequency amplifier

30. The signal-frequency amplifier consists of two variable-mu pentodes (Type CV1281). Each set of four inductances and capacity trimmers for the four wave bands associated with each of the above circuits is mounted in a well screened drum section. These three sections, together with a fourth housing the inductances of the frequency change oscillator, are mounted as a turret which is rotated together with the calibration scale by the frequency range control handle. Rotation of the turret places the required inductances across self-cleaning contacts close to the tuning condenser, thus avoiding the use of long leads.

31. The signal-frequency coils are of the adjustable permeability type, each coil being mounted in a magnetic screen. The inductance trimmer is accessible through a small hole in the outer screening of the turret. A small trimmer condenser is mounted with the inductance and in parallel with it and is similarly adjustable through a small hole.

Frequency-changer

32. This uses a triode-hexode valve (Type CV1099). The input signal is fed into the control grid of the hexode portion and is mixed with the local oscillation generated by the triode portion. This uses the fourth set of inductances in the coil turret and the tuning condenser is ganged to the main signal frequency tuning control, thus giving single control of tuning on the receiver. There is a vernier condenser connected in parallel with the tuning condenser of the 1st oscillator to give a fine adjustment. The scale of this control has a centre zero with the engraving on the side representing an increase frequency marked "+" and the side representing a decrease marked "—".

Intermediate-frequency amplifier

33. There are four variable-mu pentode stages (three CV1100 and one CV1281) with nine tuned circuits operating at the intermediate frequency of 600 kc/s. The output of the third stage is used to feed the second detector while the fourth stage feeds the AGC rectifier, which is a non-thermionic type.

34. The IF circuits are all permeability tuned and employ tuned transformer couplings. A crystal resonator is used as a coupling with a very narrow bandwidth between the frequency changer and the first IF amplifier. The intermediate frequency is nominally 600 kc/s, variations of ± 1 per

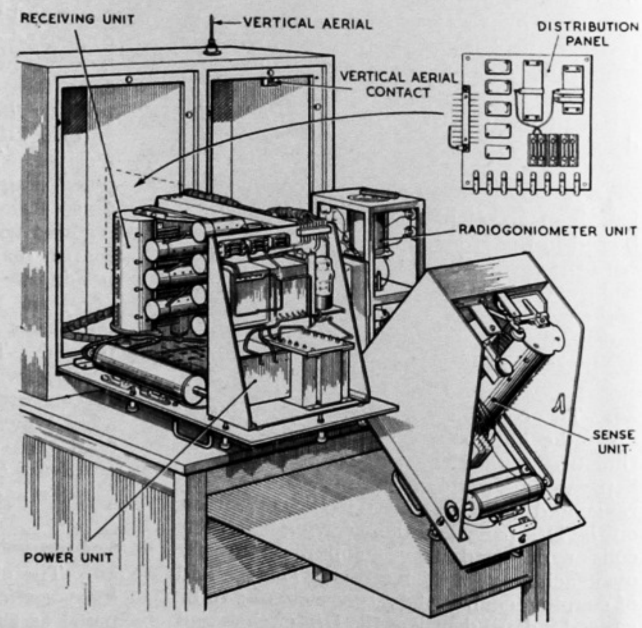


Fig. 5. Receiver with panels swung forward for servicing

cent occurring between receivers to accommodate different crystal resonator values.

35. In the two narrowest pass band settings (400 c/s and 1 kc/s) the pass band control switch inserts the crystal resonator, the difference in pass band being obtained by alterations to the phase angles and impedances of the circuits associated with the crystal. For the three wider settings (3, 6·5 and 12 kc/s) the crystal is not used and the pass band characteristics are obtained by selecting different mutual coupling values between the tuned IF circuits.

Second detector and LF amplifier

36. This stage consists of a double-diode-triode, V8 (Type CV587) which operates as second detector and LF amplifier, and a tetrode V9 (Type CV1186) which is the output amplifier. The diode section is connected as a full-wave rectifier and its output is taken through a low-pass filter to the grid of the triode LF amplifier. A parallel-fed transformer couples the triode to the output valve.

37. There are two "low-level" output jacks on the front panel for head telephones. These are connected in parallel across the 10 : 1 tappings of the output transformer. If a loudspeaker output is required, leads can be taken to the lower ratio tappings and an external speaker connected.

Manual and automatic gain control

38. The control of both manual and automatic gain is effected by varying the bias applied to the grids of the second signal-frequency amplifier, V2, and the three IF amplifiers, V4, 5 and 6. When manual control is in use, the bias is derived from a potentiometer between earth and the HT negative rail. The bias is obtained from the output of the AGC rectifier for automatic control.

39. The AGC voltage is derived from the output of the third IF amplifier; it is amplified by a fourth IF amplifier, V7, and rectified by a pair of non-thermionic rectifiers, W1 and W2, which are connected in a voltage-doubling arrangement. This voltage is then passed to the grids of the controlled valves.

40. The use of automatic or manual gain is determined by a three-position switch S2 on the receiver panel, and also by a relay. In the centre or OFF position, the output of the AGC rectifier is isolated and the relay REL 2 is unenergized. The contact REL 2 then connects the grids of the controlled valves to the slider of the potentiometer VR1 which is moved by the VOLUME control on the receiver panel. This potentiometer, which is across part of a chain of resistors between HT negative and earth, is ganged with VR2. The relay contact REL 1, in the OFF or unenergized position, disconnects the grids of the triode LF amplifier V8 from VR2 and instead connects it to a fixed point on the load resistors of the second detector. The volume control thus operates by altering the gain of the second SF amplifier and the IF amplifiers.

41. With AGC in use, in either the TELEGRAPHY or TELEPHONY positions, the relay is energized and the contact REL 2 connects the output of the rectifier to the grids of the controlled valves. The potentiometer VR1 is disconnected and inoperative while the contact REL 1 switches the input to the triode section of V8 to the slider of VR2. The VOLUME control therefore has no effect on the controlled valves and merely serves to adjust the level of the signal in the telephones to a comfortable value. In the TELEGRAPHY position, a condenser C59 is connected across the AGC line and thus introduces a longer time constant than is obtained in the TELEPHONY position. This is sufficient to prevent the noise level rising between morse characters except at very slow signalling speeds.

42. The energizing of the relay can only take place when the "stand-by – D/F – sense" switch on the panel is at "stand-by"; thus bearings cannot be taken with the AGC in operation. The action of the AGC would be to reduce the sharpness of the minima.

Listening-through facilities

43. The grid circuits of the controlled valves are connected to the controlling voltage via two terminals on the distribution panel which are normally bridged by a link. In installations where the receiver is used in conjunction with a nearby transmitter this link is removed and the terminal leading to the valve grids is connected to a contact on the transmitter key. When the transmitter key is depressed and the transmitter working, the valve grids are connected to a considerably negative source of bias. This de-sensitizes the receiver and so protects it. When the transmitter key is up, the valve grids are connected to the controlling voltage and the receiver operates normally. The negative bias required is adjusted by means of the potentiometer, VR3, which is connected between HT negative and earth.

Second heterodyne oscillator

44. This uses a single pentode V10 (Type CV1100) which operates in a Hartley circuit at a frequency which is approximately 1 kc/s off the mid-frequency of the IF amplifier passband. The oscillator, which is completely screened, is coupled to the input of the diode detector. The frequency can be adjusted by means of a small control (C84), accessible on lowering the chassis forward.

Visual pulse indicator

45. There is provision made for the use of a cathode-ray tube to give visual indication of pulsed signals. This facility is not normally used in the R.A.F., but it will be found that the components for the output to this indicator, which is taken from the AGC amplifier, are wired up and lead to a socket on the side of the cabinet. Details are shown in the full wiring diagrams.

Metering circuits

46. The meter switch provides means of checking the anode currents of all ten valves in the receiver by connecting an ammeter across resistors in series with the HT lead to each valve. The meter is calibrated from 0 to 10 mA, and the appropriate multiplying factor is marked on the switch. Other positions on the switch connect the meter across the HT and LT lines in series with meter resistors; the meter is calibrated 0 to 200 volts and 0 to 10 volts respectively for these positions. The LT voltage can only be measured when the receiver is being used with battery supplies. In the "gang check" position the LF output is rectified and provides a visual indication of the output which is useful for alignment purposes.

Power unit Type 157

47. The wiring arrangements of the receiver allow for operation from either AC mains or batteries. The power unit for use with AC mains is mounted above the receiving unit and is connected to it by a small cable form. Full details of this power unit, which has a normal full-wave rectifying circuit with condenser-input smoothing circuit, are given in Chapter 4.

Distribution panel Type 107

48. The distribution panel for supply connections to the receiver is mounted on the right-hand side of the centre partition between the two units of the cabinet and can be seen in fig. 5. Access to this panel is from the front of the cabinet when the D/F panel is withdrawn.

49. When the receiver operates on batteries, 8-volt LT and 160-volt HT supplies are connected across the tags marked "H.T. or A.C. MAINS" and fuses are fitted as shown in the circuit diagram in Chapter 4. When the receiver is used on AC mains, the supply is connected across the same tags and the fuses are rearranged. The leads associated with the "listening-through" circuits are also brought to tags on the distribution panel. The HT and LT supplies are fed to the receiver from the panel.

50. Choke-capacitor and resistor-capacitor sections are connected in series with the power supplies and "listening-through" leads respectively. Their function is to prevent unwanted noise entering the receiver via the supply mains or external leads or circuits.

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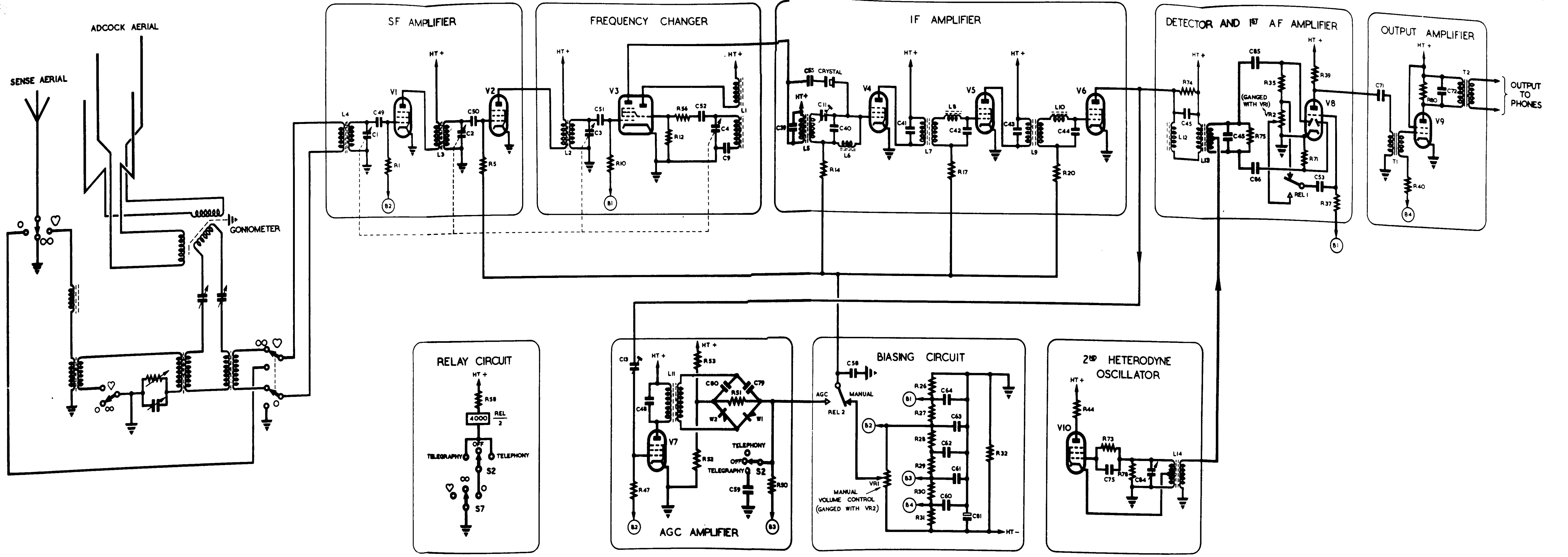

FIG. 6

RECEIVER TYPE R.1246, SIMPLIFIED CIRCUIT

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FIG. 6

PP6019 M12607 G220 4.50 440 C&P Gp. 959 (6)