WIRELESS SET No. 46

SECOND TO FOURTH ECHELON WORK

ALIGNMENT AND PERFORMANCE TESTING

I.F. alignment

1. When testing I.F. alignment, it is essential to adjust the signal generator to within ±1kc/s of 1,550kc/s. The signal generator should be tuned carefully for zero beat with a crystal-controlled oscillator, which may be either :—

(*a*) A special oscillator for 1,550kc/s ±0.01%, or

(*b*) another No. 46 set switched to the same channel as the set on test, and fixed at send R/T, which will cause an I.F. signal to be generated by V1A, and will give a squeak when the strength of signal is suitable. Usually no aerial is required if the second set is in the same room.

The signal generator should be connected to the aerial socket through a 20pF condenser. The I.F. cores can then be adjusted for maximum output, care being taken always to keep the input from the generator low (around 0.1mW). The bandwidth for –6db. (i.e. generator input doubled) is about 10kc/s and that for –40db. is about 60kc/s; the peak of the curve must be symmetrical about the 1,550kc/s point.

Performance testing

2. The following performance testing procedure (paras. 5 to 22) is extracted from C.I.E.M.E. specification R.S./PROV/4109.

Preliminary tests

3. The following mechanical and resistance tests should be carried out before the main electrical tests :—

(*a*) Examine the combined morse key and send-receive switch for alignment, and measure the movement at the centre of the control knob. This movement should be between 0.035 in. and 0.022 in.

(*b*) The contact resistance should be less than 0.005Ω.

(*c*) Apply test weights of ½ lb. and 1½ lb. to the operating knob. With the ½ lb. weight applied, the key should not move down to the stop.

(*d*) Measure the insulation resistance at selected points in the wiring with a 250V Megger. Insulation between any separated circuits or between any live circuit and earth should exceed 20MΩ.

Battery voltages

4. Where reference is made to normal and used battery voltages, the voltages indicated are those stated below :—

(*a*) Normal voltages are :— H.T. 150V : L.T. 3V : G.B. 12V.

(*b*) Used voltages are :— H.T. 100V : L.T. 2.25V : G.B. 8B.

Normal voltages should be used except where specified.

SENDER TESTS

Current consumption

5. Using normal supply voltages, check the power consumption with the sender correctly tuned. The L.T. current should not exceed 0.68A and the H.T. current should not exceed 36mA on R/T or 46mA on M.C.W. transmission at any frequency.

Output

6. The dummy aerial should consist of a condenser of 20pF (±0.5pF) in series with a resistance of 10Ω (±2%). The resistance and the meter must be connected on the *cold* side of the condenser. Alternatively, the current may be measured by a valve voltmeter connected across the 10Ω resistor. The aerial current or voltage across the 10Ω resistor on R/T or M.C.W., as indicated on the thermo-ammeter or valve voltmeter, must not be less than that shown in Table 1 with normal batteries (the current on an averate set is 10–20% above these figures). With used batteries the current must not be below 50% of the figures given in Table 1.

Carrier frequency	*Aerial current*	*Voltage measured across* 10Ω
3.6Mc/s	60mA	0.60V
4.3 ,,	75 ,,	0.75 ,,
5.0 ,,	65 ,,	0.65 ,,
6.0 ,,	90 ,,	0.90 ,,
6.4 ,,	75 ,,	0.75 ,,
7.6 ,,	100 ,,	1.00 ,,
7.9 ,,	90 ,,	0.90 ,,
9.1 ,,	110 ,,	1.10 ,,

Table 1 — Aerial current test figures

Noise

7. Confirm by a listening check with a sensitive receiver that noise is absent from the R/T carrier.

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Modulation

8. Disconnect the throat microphone. Apply an input of 5mV from a 30Ω source across the microphone transformer primary winding. The R/T carrier should be modulated at least 80% with an input frequency between 600c/s and 2,000c/s. With an input frequency of 300c/s or 4,000c/s, the modulation depth should not be less than 50%. On M.C.W. the modulation should be at least 75% with a frequency between 1,000 and 1,500c/s. With used batteries this figure should not be less than 50%. Reading of modulation depth should be taken by observation of the modulation envelope on a C.R.O. The M.C.W. modulation envelope is not sinusoidal and readings are of peak value.

Tuning

9. The position of cores of coils and the settings of the variable condensers used for trimming should not be at the extreme ends of their adjustments for any frequency.

Frequency drift

10. At 20°C. the deviation from the nominal frequency marked on the crystal should not exceed ±0.015% including the effects of switching on from cold and of reducing the supply voltage by 25%. Frequency should not change by more than 0.01% from its value at 20°C. when the set is subjected to any temperature between 0°C. and 40°C.

Sidetone

11. The sidetone level on M.C.W. should be between 0.02 and 0.06mW, measured at the receiver output terminals in 500Ω termination. The sidetone level should be within the same limits on R/T with 70% modulation at 1,000c/s.

RECEIVER TESTS

Current consumption

12. With normal battery voltages, the L.T. current should not exceed 0.42A for R/T conditions and 1A for M.C.W. conditions. The H.T. current should not exceed 13mA at any frequency on R/T or M.C.W.

Sensitivity

13. The R.F. input from the signal generator required to give 0.1mW output should not exceed the figures given in Table 2. With used batteries, the output for double the input levels given in the tables should not be less than 10μW.

Signal-to-noise ratio

14. When the inputs specified in Table 2 are applied, the drop in output level when the modulation is switched off should not be less than 10db.

Second channel selectivity

15. When sensitivity measurements are made as in para. 13, the input required at the second channel frequency for 0.1mW output should be higher than the normal sensitivity input by figures not less than those given in Table 2.

I.F. signal rejection

16. Apply the signal generator output as for the sensitivity tests but with the signal generator tuned to the I.F. The relation of such figures to the normal sensitivity figures should not be less than those given in Table 2.

Mc/s	*Max. signal generator output for output of A.F. 1mW*	*Min. second channel signal suppression*	*Min. I.F. rejection*
9.1	5μV	35db.	66db. (80db.)
7.9	8μV	40db.	66db. (80db.)
7.6	5μV	38db.	66db. (80db.)
6.4	8μV	44db.	66db. (80db.)
6.0	4μV	46db.	66db. (80db.)
5.0	7μV	56db.	66db. (80db.)
4.3	4μV	26db.	66db. (70db.)
3.6	7μV	30db.	66db. (70db.)

Table 2 — Test figures for receiver

Note: Figures for I.F. rejection given in brackets apply for coil units supplied with equipments bearing serial Nos. 1000 and onwards.

A.V.C. and output levels

17. Adjust the receiver to receive signals at 7.6Mc/s and tune the signal generator accurately to the receiver, using a 5mV, R.F. signal. The receiver output should be within ± 6db. of 0.5mW at all imputs from 20μV to 20mV.

Acoustic response

18. Carry out this test at 7.6Mc/s. The signal generator should be set to give an output of 100μV and modulated to a depth of 30% at 1,000c/s. At any frequency between 400 and 3,000c/s, the receiver output should be within 8db. of that obtained at 1,000c/s.

Adjacent channel selectivity

19. Tune the signal generator to within ±0.5kc/s of 1,550 kc/s (using a crystal monitor) and set up the receiver for 7.6Mc/s. Remove the frequency-changer grid connector and connect the signal generator lead to the frequency-changer grid in series with a 0.001μF condenser. Connect a 1,000Ω resistor between grid and the clip on the F.C. grid lead. Adjust the generator input so that the receiver output is 0.1mW; an input of about 20μV will be required. Detune the signal generator from 1,550kc/s. Increase the output by 6db., and alter the frequency, (*a*) by +4 kc/s and (*b*) by -4 kc/s. The output reading in each case should be less than 0.1mW. A normal 6db. bandwidth measurement should then be made (first tuning the generator for maximum output and then finding the difference in frequency in kc/s between the two generator tuning points at which 0.1mW output is obtained with input increased by 6db.). The bandwidth should not exceed 15kc/s. This operation should then be repeated for bandwidth on 40db.; the bandwidth should not exceed 75kc/s.

FINAL TEST OF COMPLETE EQUIPMENT

20. When completed, the set should be given a functional test; this may be carried out between two sets at about 100 yd. apart, in which case a single B section should be used on each set as an aerial. The functional test should cover R/T and M.C.W. communication on at least three frequencies, absence of distortion on R/T and satisfactory morse signalling on M.C.W. up to 3 w.p.m. being confirmed.

21. All crystals and coil units intended for use with any W.S. No. 46, whether forming part of a station or supplied as spares, should be subjected to a test under working conditions.

22. The dummy aerial, which is intended to indicate when batteries require to be changed, should be checked with normal and used battery voltages as given in para. 4 to see that the bulb lights with normal batteries but gives a very dim glow on used ones.

FAULT-FINDING

Aerial current

23. Connect a 0–200mA aerial ammeter (thermo-ammeter) between the aerial socket and the dummy aerial plug, taking care to minimize stray capacity by using very short leads and keeping the meter away from earthed objects. When tuned in the usual way, by sidetone, the normal reading ranges from about 140mA at 9Mc/s to 80mA at 3.6Mc/s (these figures are also approximately correct for current into the actual 8-section aerial). The reading should rise slightly (about 5%) when switched to M.C.W., and should rise by 20–25% on R/T with loud sounds at the microphone. The H.T. current when the sender is accurately tuned should not exceed 35mA on R/T or 45mA on M.C.W.; the rise in current (which should be 8-11mA) on switching to M.C.W. provides a check on the percentage modulation.

Modulator circuits

24. Faults in the modulator can best be tested with an A.F. generator with attenuator, as in Table 3. In each case the aerial current reading should rise with the input given, by between 15% and 25%, indicating 80–100% modulation.

Point of injection	*Frequency*	*Input voltage*
In place of microphone*	1kc/s	4mV
„ „ „ „	400c/s or 4kc/s	8mV
To *hot* end of T3A secondary	1kc/s	300mV
„ „ „ „ T2A primary	1kc/s	3mV
„ either grid of ARP 37	1kc/s	7mV

Table 3 — A.F. generator tests

Note: * Generator output impedance must be approximately 30Ω for this test.

25. The modulation may also be examined by feeding a C.R.O. from the aerial socket through a 20pF condenser, with a resistor of about 1,000Ω shunted across the input terminal of the oscillograph. The M.C.W. wave form is not sinusoidal and peak-to-peak modulation is normally 80–90%.

NORMAL RECEIVER CHECK TESTS

Sensitivity

26. An audio output meter, capable of reading 0.1mW and having an impedance of about 500Ω is required. (Note: If a larger output were used for the tests, some A.V.C. action might be present and give rise to false results. As an alternative, 0.5mW may be used if the generator will provide 70% modulation.) The R.F. signal generator is connected through a 20pF condenser to the aerial socket; the generator is tuned in to the set and C4A must be adjusted for maximum output. With 30% modulation at 400c/s, the input required for 0.1mW output should be about 5μV on all bands; if the generator is fully modulated with speech, signals should be intelligible at about 1μV input. If the input is increased to 1mV or 10mV, the output should be approximately between 0.25mW and 2mW.

27. Faults can best be located by testing each stage as in Table 4. In each case, the signal generator or heat frequency oscillator will be connected to the point stated through the condenser specified; the input figure given is that for 0.1mW output.

Frequency	*Point of injection*	*Through given capacity*	*Input voltage*
1kc/s	*Hot* end of C11B	0.1μF	0.25V
400c/s or 3kc/s	„ „ „ „	0.1μF	0.5V
1kc/s	V2B grid	0.1μF	75mV
1,550kc/s	V2B grid	0.001μF	70mV
1,550kc/s	V2A grid	0.1μF	700μV
1,550kc/s	V1A grid	0.1μF	20μV
1,550kc/s	Aerial socket	20pF	10–100mV
R.F. signal	V1A grid	0.1μF	30μV

Table 4 — Fault location tests

COMPONENT SPECIFICATIONS

Transformers

28. T1A, the output transformer, is constructed as follows :—

(*a*)	*Barrel*	3 layers of Kraft paper, 0.007 in. thick × $\frac{9}{16}$ in. wide.
(*b*)	*First primary*	3,000 turns of 44 S.W.G. (0.0032 in.), enamelled copper wire.
(*c*)	*Insulation*	3 turns of 0.0015 in. Kraft paper.
(*d*)	*Second primary*	3,000 turns of 44 S.W.G. (0.0032 in.), enamelled copper wire.
(*e*)	*Insulation*	3 turns of 0.0015 in. Kraft paper.
(*f*)	*Secondary*	400 turns of 40 S.W.G. (0.0048 in.), enamelled copper wire.
(*g*)	*Covering*	1 layer of oiled silk, $\frac{5}{8}$ in. wide, secured with Egyptian tape, $\frac{1}{2}$ in wide.
(*h*)	*Impregnation*	Assembly to be impregnated with one coat Symons S.475 varnish and then dipped in Trinidite compound, type H.M.P. (coating not to exceed $\frac{1}{16}$ in.). Core to be marked with red spot before and after impregnation.
(*j*)	*Connections*	Leads to be brought out with 18/40 d.c.c. copper wire, green or red, $\frac{1}{2}$ in. long, to tags :— A — First primary, inner B — Secondary, inner C — Second primary, inner D — First primary, outer E — Secondary, outer F — Second primary, outer
(*k*)	*Resistance*	First primary, 600Ω (A to D) Second primary 700Ω (C to F) Secondary 50Ω (B to E)
(*l*)	*Inductance*	First primary 6H, measured with 1V, A.C. Second primary 6 H at 400 c/s.

29. T2A, the modulator input transformer, is constructed as follows :—

(*a*)	*Barrel*	3 layers of Kraft paper, 0.007 in. thick × $\frac{9}{16}$ in. wide.
(*b*)	*Primary*	1,000 turns of 44 S.W.G. (0.0032 in.), enamelled copper wire.
(*c*)	*Insulation*	2 turns of 0.0015 in. Kraft paper.
(*d*)	*Secondary*	6,000 turns of 44 S.W.G. (0.0032 in.), enamelled copper wire, tapped at centre.
(*e*)	*Covering*	1 layer of oiled silk, $\frac{5}{8}$ in. wide, secured with Egyptian tape, $\frac{1}{2}$ in. wide.
(*f*)	*Impregnation*	Assembly to be impregnated with one coat of Symons S.475 varnish and then dipped in Trinidite compound, type H.M.P. (coating not to exceed $\frac{1}{16}$ in.). Core to be marked with white spot before and after impregnation.
(*g*)	*Connections*	Leads to be brought out with 18/40 d.c.c. copper wire, red or green, $\frac{1}{2}$ in. long, to tags :— A — Secondary, inner B — Secondary, centre tap C — Secondary, outer D — Primary, outer E — Primary, inner
(*h*)	*Resistance*	Primary 180Ω Secondary, inner half (A to B) 700Ω, outer half (B to C) 800Ω
(*j*)	*Inductance*	Primary 5 H, measured with 1V, A.C. at 400 c/s.

30. T3A, the microphone transformer, is constructed as follows :—

(*a*)	*Barrel*	3 layers of Kraft paper, 0.0007 in. thick × $\frac{9}{16}$ in. wide.
(*b*)	*Primary*	60 turns of 40 S.W.G. (0.0048 in.), enamelled copper wire.
(*c*)	*Insulation*	2 turns of 0.0015 in. Kraft paper.
(*d*)	*Secondary*	6,000 turns of 44 S.W.G. (0.0032 in.), enamelled copper wire.
(*e*)	*Covering*	1 layer of oiled silk, $\frac{5}{8}$ in. wide, secured with Egyptian tape, $\frac{1}{2}$ in. wide.
(*f*)	*Impregnation*	Assembly to be impregnated with one coat of Symons S.475 varnish, and then dipped in Trinidite compound, type H.M.P. (coating not to exceed $\frac{1}{16}$ in.). Core to be marked with yellow spot before and after impregnation.
(*g*)	*Connections*	Leads to be brought out with 18/40 d.c.c. copper wire, red or green, $\frac{1}{2}$ in. long, to tags :— A — Secondary, inner B — Secondary, outer C — Primary, inner D — Primary, outer
(*h*)	*Resistance*	Primary 4.5Ω (C to D) Secondary 1350Ω (A to B).
(*j*)	*Inductance*	Primary 18mH, measured with 1V, A.C. at 400c/s.

31. T4A, the modulation auto-transformer, is constructed as follows :—

(*a*)	*Barrel*	3 layers of Kraft paper 0.007 in. thick × $\frac{9}{16}$ in. wide.
(*b*)	*Winding*	4,000 turns of 40 S.W.G. (0.0048 in.), enamelled copper wire, tapped at centre.
(*c*)	*Covering*	1 layer of oiled silk, $\frac{5}{8}$ in. wide, secured with Egyptian tape, $\frac{1}{2}$ in. wide.
(*d*)	*Impregnation*	Assembly to be impregnated with one coat of Symons S.475 varnish and then dipped in Trinidite compound, type H.M.P. (coating not to exceed $\frac{1}{16}$ in.).
(*e*)	*Connections*	Leads to be brought out with 18/40 d.c.c. copper wire, red or green, $\frac{1}{2}$ in. long, to tags :— A — Centre tap B — Outer C — Inner
(*f*)	*Resistance*	Outer half 250Ω (B to A) Inner half 200Ω (C to B)
(*g*)	*Inductance*	Each half 2H; measured with 1V, A.C. at 400c/s with 20mA, D.C. flowing.

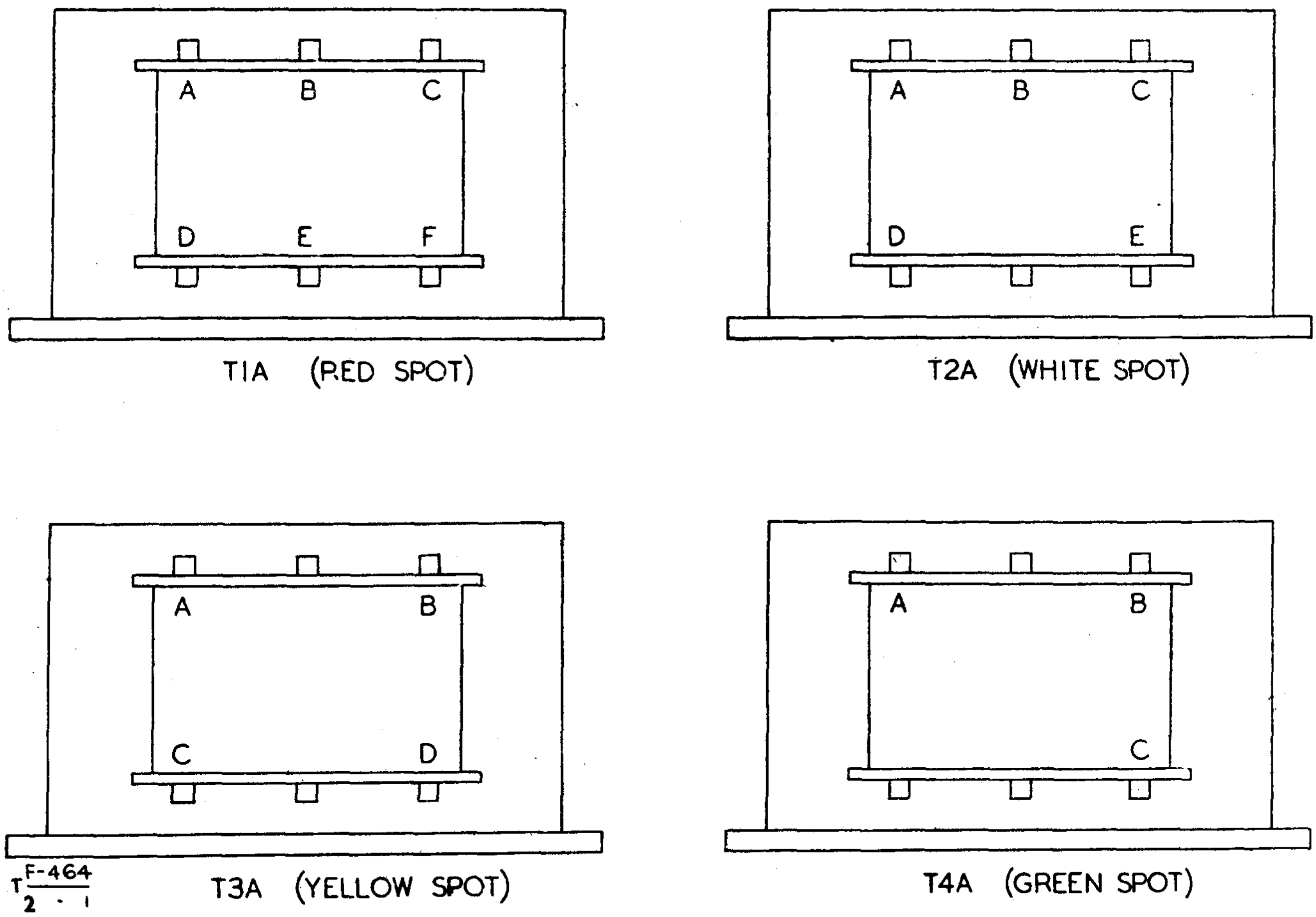

Fig. 1 — View of transformers, looking at tags

Coils

32. The aerial coil L1A is wound in a different way for each of the four ranges. On range 1 (7.9—9.1 Mc/s) it consists of 20 turns of 26 S.W.G., d.s.c. copper wire, tapped at 16½ turns, and has a total inductance of 3.05μH without core. On range 2 (6.4—7.6Mc/s) it has 25 turns of 28 S.W.G., d.s.c. copper wire, tapped at 17½ turns, with an inductance of 4.7μH without core. On range 3 (5.0—6.0 Mc/s) it consists of 34 turns of 30 S.W.G., d.s.c. copper wire, tapped at 21½ turns, and has a total inductance of 7.7μH without core. On range 4 (3.6—4.3 Mc/s) it consists of 46 turns of 38 S.W.G., d.s.c. copper wire, tapped at 29½ turns, and has total inductance of 16.5μH without core.

33. The oscillator coil L2A is wound in three different ways for the four ranges, the same coil being used for ranges 2 and 4. On range 1 it has 40 turns of 38 S.W.G., s.s.c., enamelled copper wire and its inductance is 13.5μH without core. On ranges 2 and 4 it consists of 53 turns of 38 S.W.G., s.s.c., enamelled copper wire and its inductance is 20μH without core. On range 3 it is wave-wound in two sections, each of 30 turns of 38 S.W.G., s.s.c., enamelled copper wire, and its inductance is 32μH without core.

34. There are two types of coils used in the first and second I.F. transformers. The first type L3A–C are marked with red paint and the second L4A with green. The first I.F. transformer has two red coils ; the upper of the second transformer is red and the lower one is green. The coils have two sections, the first section being nearer to the base of the former. Each section of the red coil consists of 62 turns of 10/47 S.W.G., d.s.c., enamelled copper wire, wave-wound. The total inductance of the coil is 130μH. The first section of the green coil consists of 77 turns of 10/47 S.W.G., d.s.c., enamelled copper wire, wave-wound. The second section has 42 turns of similar wire, wave-wound. The total inductance is 130μH and the inductance of the first section is 87μH.

35. The third I.F. transformer has a primary winding L5A of 100 turns of 10/47 S.W.G., d.s.c., enamelled copper wire, wave-wound, and a secondary winding L6A of 85 turns. The inductance of the primary is 140μH, and that of the secondary is 100μH.

END

RESTRICTED