STATION RADIO B.C.C. HF 156

TECHNICAL HANDBOOK - FIELD AND BASE REPAIRS

Errata

Note: These Pages 0 and 01, Issue 1, will be filed immediately in front of Page 1, Issue 1, dated 8 Nov 63.

1. The following amendments will be made to the regulation.

2. Page 7, para 25, lines 1 to 3
   Delete: 'Short circuit ------- (para 36). Set'
   Line 3, immediately before 'the controls'
   Insert: 'Remove the channel 1 crystal and set'

3. Page 8, para 29

   a. Line 1
   Delete: 'Set'
   Line 1, immediately before 'the controls'
   Insert: 'Remove the channel 1 crystal and set'

Distribution - Class 333. Code No 6

   b. Line 6, immediately after 'than 5kc/s.'
   Insert: 'If the i.f. is not symmetrical about 465kc/s, adjustment of T5 should produce symmetry.'

EME/8c/2361(TELS)

ELECTRICAL AND MECHANICAL ENGINEERING REGULATIONS
(By Command of the Army Council)

TELECOMMUNICATIONS
F 194

STATION RADIO B.C.C. HF 156

TECHNICAL HANDBOOK - FIELD AND BASE REPAIRS

This EMER must be read in conjunction with F 192 Part 1 and 2 which contains figures and tables to which reference is made.

SUBJECT INDEX

SUBJECT INDEX - (cont)

INDEX TO TABLES

INDEX TO FIGURES

INTRODUCTION

1. This regulation covers the repair and testing of the transmitter/receiver as a complete unit using its own transistorized power pack. There is no breakdown into sub units, the complete radio station being accommodated on one chassis.

2. The equipment is not at present fully sealed, but may in the future become so as a result of modification. In this event, instructions for drying and sealing will be issued as an addenda to this EMER.

MECHANICAL REPAIRS AND REPLACEMENTS

General precautions

3. On withdrawing the chassis from its case, care should be taken not to damage the air trimmer capacitors located at one end of the equipment (Fig 2505-2506 refers, eight shown top chassis and four under chassis). The capacitors are normally protected by their shielding strips and it is advisable to leave these strips in position unless it is essential they be removed to carry out repairs.

Antenna tuning unit

4. To obtain access to Antenna tuning unit (a.t.u.), disconnect the wander lead from the antenna terminal on the front panel and loosen the four retaining screws holding the hooped clamps round the a.t.u. The unit should now slide out of position.

5. Remove the three countersunk screws round the base of the a.t.u. and then pull the base away from its protecting tube. Some slight pressure may be required as the base is held in position by the friction of the contact spigot located at the top of the antenna tuning unit (see Fig 4001).

Collet type knobs

6. To remove the collet type knobs from the front panel controls:-

(a) In the case of pointer knobs note their setting.

(b) Unscrew the central dome-headed cap two or three turns, at the same time holding the knob firmly to ensure that the unscrewing torque is not absorbed by the mechanical stops of the controls.

(c) Push in the cap to release the collet.

(d) Carefully ease off the knob assembly using, if necessary, a screwdriver or similar tool as a lever.

(e) It is not normally necessary to dismantle the knob assembly unless it is tightly stuck to its spindle.

7. On replacement, place the complete knob assembly on the appropriate spindle with the correct orientation as noted in para 6(a). Ensure that there is a small clearance between knob and panel then tighten the cap, gripping the knob as before to maintain the correct setting and to absorb the screwdriver torque.

Replacement of the panel meter

8. With the equipment out of its case, remove the insulated board securing the transmitter crystals in their sockets. Remove these six crystals taking note of their respective positions. Remove V2, V4 and V5 together with their associated screening cans. Unsolder the red lead from the positive meter terminal also the black lead and resistor R26 from the negative meter terminal. By means of a 'C' spanner, unscrew the locking ring holding the meter in position, allowing the meter to be lifted clear.

9. Replace the meter using the reverse order of operations, taking care to use a new rubber sealing ring.

Front panel components

10. All other front panel components are readily changed by using first the procedure detailed in para 6-7 to remove the collet knobs, then unsolder any connections at the rear of the panel. Care must be taken to ensure that any sealing washers and glands are replaced when re-assembling.

Access to the transistorized power unit

11. Access to the power unit is obtained by loosening the four No 6 BA cheese-headed screws located round the base of the power unit, allowing the metal cover to slide upwards. To gain access to the components in the base of this chassis, remove the four No 4 BA screws from the base plate allowing the whole unit to be lifted clear, then remove the bottom cover plate held in place by two screws.

SPECIFICATION TESTS TO TRANSMITTER/RECEIVER

Test equipment required

12. Table I lists the test equipment required, together with suitable alternatives where applicable to carry out the complete specification tests of the equipment.

Preferred equipment	Part No	Alternative	Part No
Signal generator, No 12	Z4/ZD 02674		
Voltmeter, valve, No 3	Z4/6625-99-949-0470	Multimeter, electronic CT429	Z4/6625-99-943-8384
Wattmeter, absorption, a.f. No 1	Z4/6625-99-949-0510		
Signal generator, video frequency No 1	Z4/ZD 0427	Oscillator, b.f.o. No 8	Z4/ZD 00198
Multimeter, Avo Model 8S	Z4/6625-99-943-1524	Multimeter, Avo Model No 7	Z4/6625-99-943-1523
Oscilloscope set CT436	Z4/6625-99-913-8618	Oscilloscope, type 13A	Z4/10S/831
Wattmeter, absorption, h.f. No 2	Z4/ZD C0748		
Attenuator, variable, CT421	Z4/5905-99-972-9733		
Cables test	Z1/5820-99-949-1291		
Amplifier, wide band, BPL type WA 1157	Z4/ZD 04495		

Table I - Test equipment

General conditions

13. All tests shall be carried out using a known good power unit and the batteries shall be in a fully charged condition. All tests shall be applied without the use of the antenna tuning unit (a.t.u.), except where this is specified in the field tests.

14. For all transmitter tests the antenna and earth terminals shall be connected to the 70Ω termination of the Wattmeter h.f. No 2, The cathode ray oscilloscope shall also be connected across these terminals to observe the output waveform. As an alternative to the wattmeter, the voltmeter valve used in conjunction with a 68Ω 3W r.f. dummy load may be used.

15. For transmitter RT test, the Signal generator, video frequency, No 1, output shall be connected to the input sockets SKTB or SKTC terminals F and chassis.

16. For receiver tests, the a.f. output shall be terminated with the Wattmeter absorption, a.f. No 1, switched to the 150Ω termination. The cathode ray oscilloscope shall be connected across the wattmeter.

TRANSMITTER TESTS

C.W. power output

17. Connect the morse key to the control panel. Set the controls to c.w. send (S), key depressed and channels 1 to 6 in sequence.

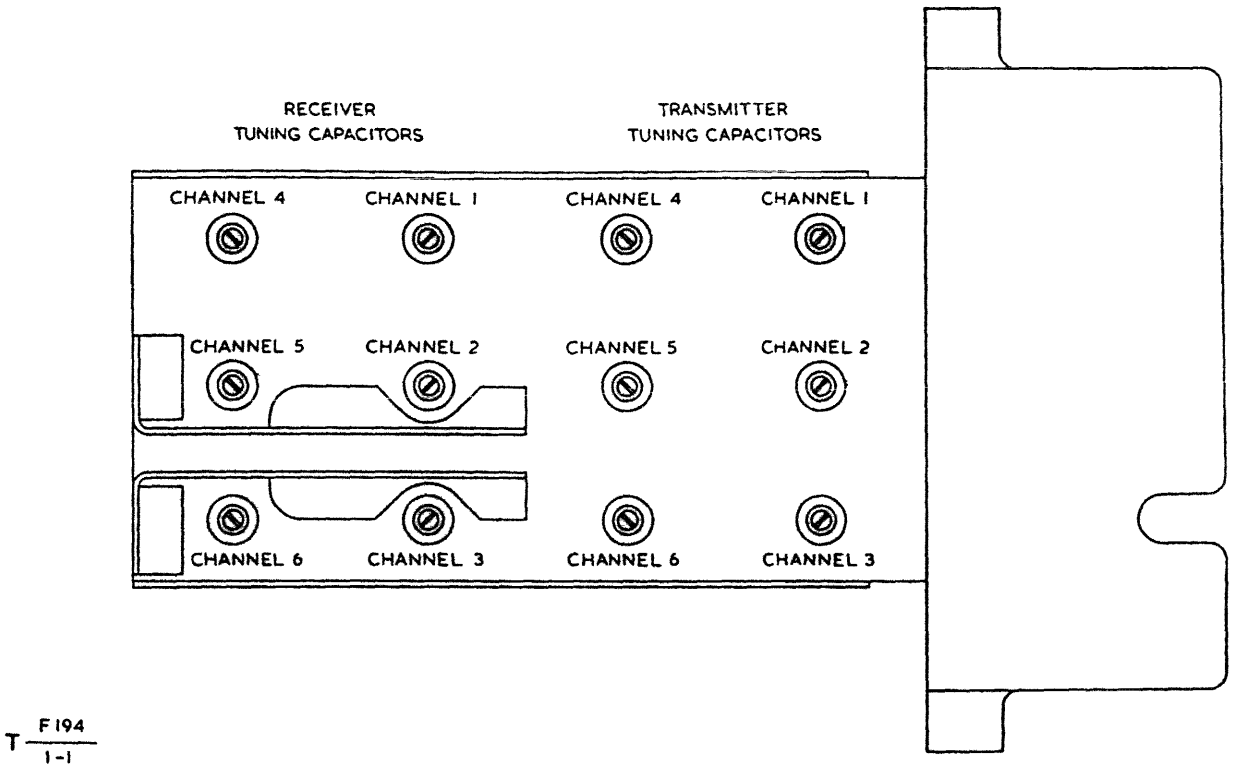


Fig 1 - Layout of tuning capacitors

At each channel position, adjust the appropriate trimming capacitors, C17 to C12 in that order, for maximum power output corresponding to channels 1 to 6 respectively. Fig 1 shows the location of each trimmer for the transmitter and receiver. After tuning for maximum output lock each trimmer, taking care not to alter its setting when tightening the lock-nut. The indicated power output shall be as detailed in Table 2.

Channel	Wattmeter	Valve voltmeter
1 to 3	1.3 to 2.5W	9.4 to 13V
4 to 6	1.1 to 2.0W	8.6 to 11.6V

Table 2 - C.W. power output

R.T. power output

18. Remove the morse key and connect the handset lead to SKTB. Set the controls to RT, channel 1 to 6 in sequence, pressel switch operated.

The indicated power output shall be as detailed in Table 3.

Channel	Wattmeter	Valve voltmeter
1 to 3	1.0 to 1.3W	8.25 to 9.4V
4 to 6	0.85 to 1.3W	7.6 to 9.4V

Table 3 - R.T. power output

Depth of modulation

19. Connect the output from the Signal generator, video frequency, No 1, between pin F of SKTC and chassis. Set the controls to RT, channels 1 to 6 in sequence, pressel switch operated.

Set the v.f. signal generator to 1000c/s and increase the output until 100% modulation is observed on the oscilloscope. The signal level required to achieve this shall be less than 400mV on all channels. Reduce the modulation to 85%, the distortion observed on any one channel shall not be excessive. Note that sidetone is present in the headset earpiece.

A.F. characteristics

20. Set the controls to RT, channel 1, pressel switch on. Inject a 1000c/s signal from the Signal generator, video frequency, No 1, to give a modulation depth of 30%. Note the reading of signal required to achieve this. Vary the a.f. from 300c/s to 3kc/s and adjust the signal level for 30% modulation depth at those frequencies detailed in Table 4. The signal level required shall be within the limits shown, using the 1000c/s input as the 0dB reference level.

Modulating frequency	300c/s	700c/s	1000c/s	2000c/s	3000c/s
A.F. signal relative to level at 1000c/s	0 to +6dB	0 to+3dB	0dB	-2 to +1dB	-2 to +1dB

Table 4 - Transmitter a.f. characteristics

Keying

21. Remove the headset and connect the morse key. Set the controls to c.w. send (S), channel 1.

Operate the morse key. The dots and dashes, as viewed on the oscilloscope screen, should be approximately rectangular. Repeat this operation using the alternative Mk 4 socket. The results should be identical.

T AE position

22. Set the controls to T AE and channel 1. The transmitter should operate, although neither the key nor pressel switch is operated. The power output should be the same as that for c.w. operation on channel 1. Remove the Wattmeter, absorption, h.f. No 2 from the antenna and earth terminals.

RECEIVER TESTS

A.F. sensitivity

23. Connect the Wattmeter, absorption, a.f., No 1, to pins C and E of socket SKTB. Set the controls to RT, channel 1, GAIN control to maximum. Inject 1000c/s from the Signal, generator, video frequency, No 1, to the junction of R22, R24. Adjust the signal generator output to obtain a wattmeter reading of 200μW. Measure the injected voltage using the valve voltmeter, this value shall be 300 to 400mV.

A.F. characteristics

24. Leaving the controls set as in the preceding paragraph vary the input frequency from 300c/s to 3000c/s keeping the input voltage constant. The wattmeter output shall be in accordance with Table 5.

Frequency	300c/s	700c/s	1000c/s	2000c/s	3000c/s
Output level relative to 1000c/s	-5 to -7dB	-1 to +4dB	0dB	-6 to -9dB	-10 to -13dB

Table 5 - Receiver a.f. characteristics

I.F. tuning and sensitivity

25. Short circuit the a.g.c. voltage by connecting to chassis the junction of R19 and terminal 4 of T6. This short-circuit need not be removed until the commencement of the a.g.c tests (para 36). Set the contols to RT, channel 1, GAIN control at maximum. Connect the output of the Signal generator, No 12 via a 0.1μF capacitor to pin 6 of V8. Set the frequency to 465kc/s modulated at 1000c/s, to a depth of 30%. Adjust the generator output voltage to approximately 150μV.

26. Initially tune the i.f. transformers T5, T6 and T7 for maximum output without damping. Repeat the tuning of each stage; tuning first the grid circuit with the anode coil damped, then the anode circuit with the grid coil damped, using a 1kΩ resistor in series with 1000pF capacitor as the damping pad. Fig 2 shows the grid and anode core positions.

27. On completion of the i.f. alignment, check that the input required to achieve an audio output of 0.1mW is between 75 and 300μV.

28. Should the i.f. sensitivity be low the faulty stage can be determined by injecting the i.f. signal to either V10 or V11 grid. Table 6 gives the input voltages required for 0.1mW output.

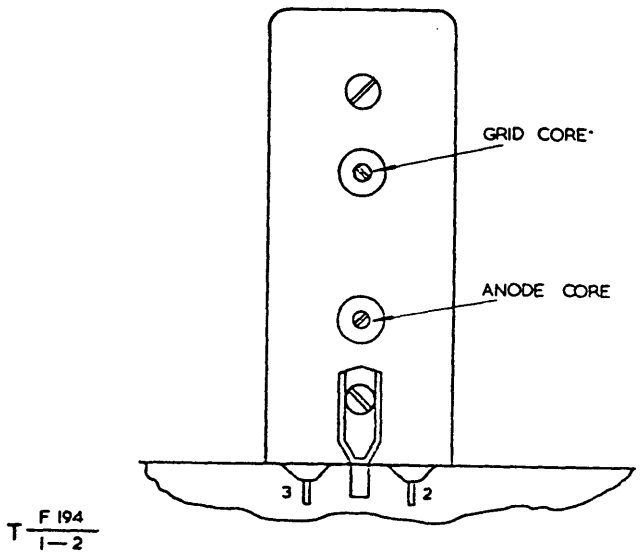


Fig 2 - Position of i.f. tuning cores

Valve	Input voltage
pin 6 V11	66 to 79mV
pin 6 V10	0.89 to 1.75mV
pin 6 V8	75 to 300μV

Table 6 - I.F. sensitivity

I.F. selectivity

29. Set the controls to RT, channel 1, GAIN control at maximum. Inject a signal, at the i.f. frequency of 465kc/s modulated at 1000c/s to a depth of 30%, to pin 6 of V8, adjust the level of the input signal to obtain a wattmeter reading of 0.1mW. Increase the input by 6dB and detune the signal generator each side of the i.f. frequency to give an output of 0.1mW. The bandwidth shall be greater than 5kc/s.

30. Increase the signal generator output by a further 14dB, ie 20dB total, detune the signal generator each side of the i.f. centre frequency for 0.1mW output. The bandwidth shall not exceed 13kc/s.

B.F.O. tuning

31. Set the controls to c.w. receive (R), channel 1, GAIN control to maximum. Adjust the b.f.o trimming capacitor to the half open position, inject an unmodulated i.f. signal of 150μV to pin 6 of V8. Tune both cores of T9 for a zero beat output.

Receiver gain adjustment and sensitivity

32. Set the controls to RT, channels 1 to 6 in sequence, GAIN control at maximum. Inject an r.f. signal, modulated at 1000c/s to a depth of 30% to the antenna and earth terminals on the front panel. The frequency of input, will be that of the first crystal frequency of the transmitter, ie channel 1. Adjust trimmer C25, labelled channel 1 receiver trimmer in Fig 1, for maximum output.

33. Repeat for channels 2 to 6 adjusting capacitors C24 to C20 in that order. Lock all trimmers after adjustment taking care not to detune them. The signal level required on any channel for an output of 0.1mW shall not exceed 12μV.

R.T. signal to noise ratio

34. Set the controls to RT, channel 1, GAIN control at maximum. Inject a channel 1 r.f. signal of 6μV modulated at 1000c/s to a depth of 30% and note the wattmeter reading. Switch off the signal generator output, the wattmeter reading shall fall by at least 12dB.

C.W. signal to noise ratio

35. Set the controls to c.w. receive (R), channel 1, GAIN control at maximum. Inject an unmodulated channel 1 r.f. signal of 6μV, tune the B.F.O. control for maximum audio output and note the reading. Tune the B.F.O. control for minimum audio output, the difference shall be greater than 20dB.

A.G.C. operation

36. Remove the short circuit from the junction of R19 and terminal 4 of T6. Set the controls to RT, channel 1, GAIN control at maximum. Switch the Signal generator, No 12, to its force output of 1V, and feed in a channel 1 r.f. signal modulated at 1000c/s to a depth of 30% via the Attenuator, variable, CT421, this attenuator should be adjusted to have an insertion loss of 100dB. Gradually reduce the CT421 attenuator setting until the a.f. wattmeter indicates 0.1mW. Increase the signal input by 70dB; the wattmeter reading shall not increase by more than 12dB. The a.f. distortion as viewed on the oscilloscope should not be excessive. Reduce input and remove the attenuator variable.

Maximum a.f. output

37. Set the controls to RT, channel 1, GAIN control at maximum. Inject a channel 1 r.f. signal modulated at 1000c/s to a depth of 30% to give an a.f. output of 0.1mW. Increase the depth of modulation to 50% and increase the signal level input until distortion is observed on the oscilloscope. The input voltage shall be between 1 to 20mV, with the wattmeter reading at least 2.0mW.

TRANSISTORIZED POWER UNIT

Controls

38. The power unit has two variable potentiometers RV1 (500Ω) and RV2 (10Ω). RV1 controls the transistor base biasing in the receive condition and RV2 the base biasing in the transmit condition. In both cases bias is reduced by clockwise rotation of the potentiometer.

Setting up procedure

39. Connect the morse key to the control panel. Switch the system switch to R (c.w.) position and adjust RV1 for maximum h.t. output measured at RLA 1 contact 22. This setting is very near the extreme clockwise position. Turn RV2 fully clockwise and set the system switch to the S position. Press the morse key and gradually turn RV2 counter-clockwise until the indicated voltage is approximately 155V. Leave RV2 in that position. (The resistance of RV2 when correctly adjusted should be approximately 2-3Ω).

Fault finding

40. The power unit is essentially a push-pull oscillator functioning at approximately 1000c/s on receive and 800c/s on transmit. When the unit is out of the equipment case these tones can be heard when the oscillator is working. This should occur in all positions of the system switch other than the OFF position or when set to S with the morse key unoperated. If the characteristic 'whine' of the oscillator is not heard check the fuse, the battery voltage and the accumulator connections.

41. Should the equipment appear to be in order set the system switch to R and gradually adjust RV1 counter-clockwise until the oscillator functions. When oscillations commence set the system switch to S and, with the morse key depressed, turn RV2 slightly counter-clockwise until the oscillator again starts working.

42. These adjustments may slightly alter the output voltages as quoted in Tels F 192 Table 2504, but these voltages are a compromise between the maximum availalbe output and reliability of operation, especially in S (c.w.) system of operation.

FIELD TESTS

43. Assemble the complete equipment in its case together with its own power unit; insert an 8 ft rod antenna in the antenna tuning unit (a.t.u.). Connect the a.t.u. to the antenna terminal on the front panel. Connect either the headset and key or handset and key to the sockets SKTB and SKTC and set the system switch to the T AE position.

44. The antenna tuning unit should now be tuned for maximum deflection on the meter on all channels. Note that on each channel there is only one peak reading for the whole traverse of the a.t.u. scale. The a.t.u. shall give a peak on all channels up to 7.4Mc/s. Above 7.4Mc/s leave the tuning indicator set to position 1 as seen in the round aperture in the centre of the a.t.u.

45. The maximum tuning indication on the panel meter will not be constant on all ranges, in fact a variation, of between the 2V (approximately) graduation mark and almost full scale deflection, can be expected when tuning from the lower to the higher frequency channels.

Note: The next page is page 1001

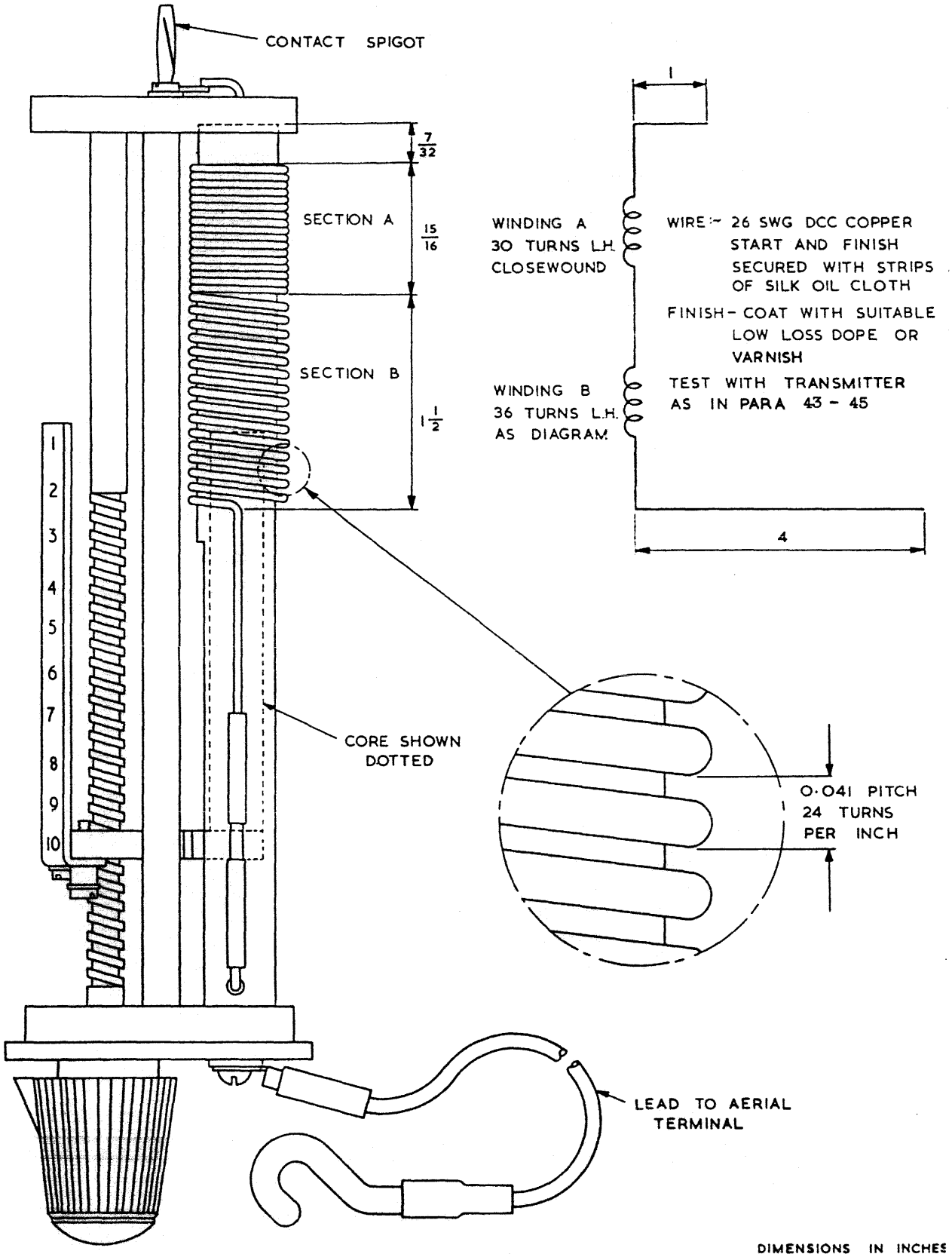
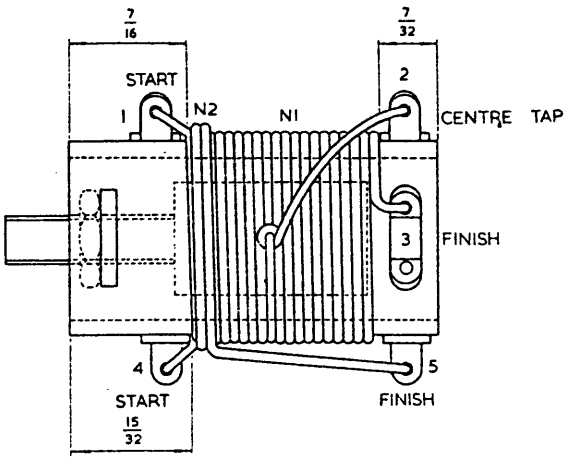
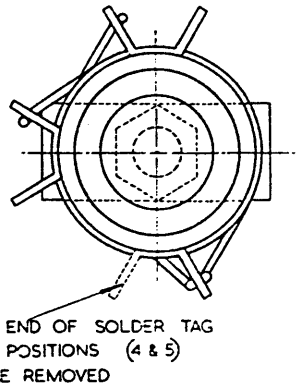


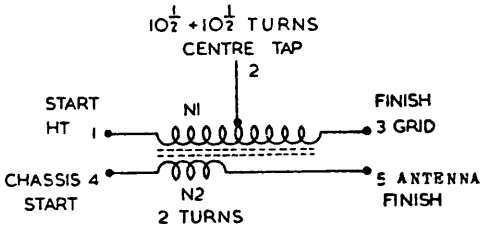
Fig 4001 - Antenna tuning unit





WINDING 26 SWG. D.C.C. COPPER CLOSEWOUND L.H. START AND FINISH SECURED WITH STRIPS OF SILK OIL CLOTH

FINISH COAT WITH SUITABLE LOW LOSS DOPE OR VARNISH.

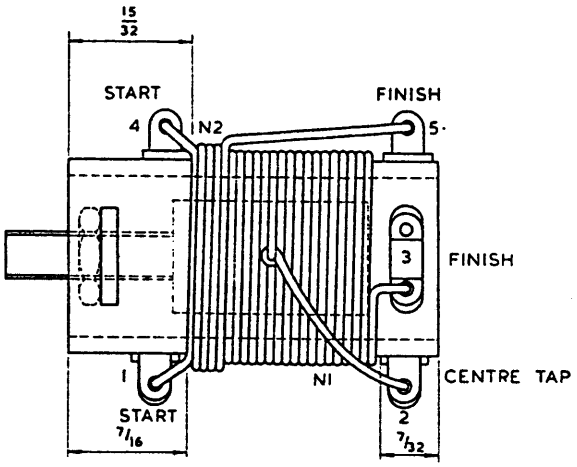


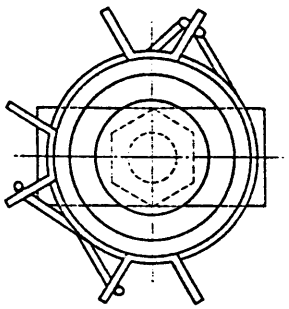
TEST DATA-(TAGS 1 AND 3)
RESONATING CAPACITY 105 ± 5pF
Q - 95 OR BETTER AT 4·7 Mc/s

T F194 / 1 4002

DIMENSIONS IN INCHES.

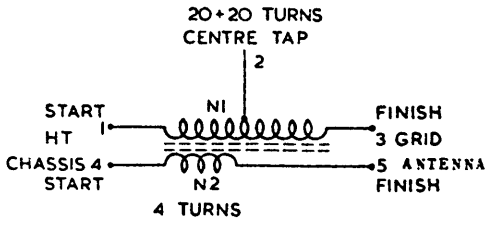
Fig 4002 - H.F. transformer T1





WINDING - LITZ WIRE 30/48 DSC EN. COPPER CLOSEWOUND L.H. START AND FINISH SECURED WITH STRIPS OF SILK OIL CLOTH

FINISH COAT WITH SUITABLE LOW LOSS DOPE OR VARNISH

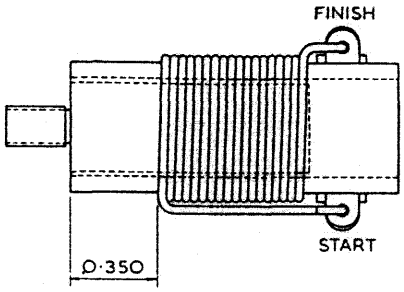


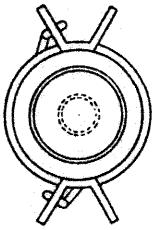
TEST DATA TAGS 1 AND 3
RESONATING CAPACITY 108 ± 5pF
Q-115 OR BETTER AT 2·5 Mc/s

T F 194 / 1-4003

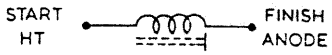
DIMENSIONS IN INCHES

Fig 4003 - H.F. transformer T2





T F194 / I-4004

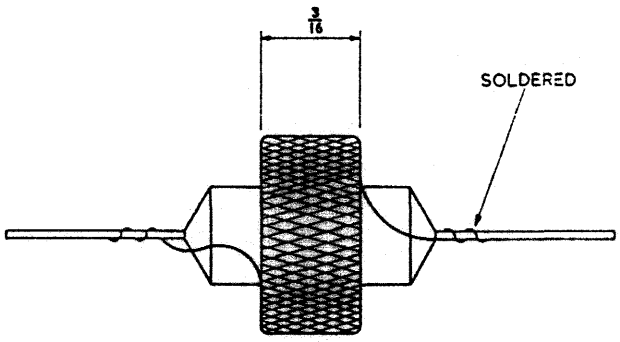


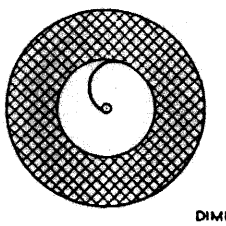
DIMENSIONS IN INCHES

	L2	L3
WIRE (S.W.G)	30/48	9/46
(Close wound Litz wire)	En. Cu. D.S.C.	En. Cu. S.S.C.
NO OF TURNS	18	35
RESONANT FREQUENCY	4.7 Mc/s	2.5 Mc/s
RESONANT CAPACITY	112±5pf	133±5pf
MINIMUM Q	140	110

FINISH: Coat with suitable low loss dope or varnish

Fig 4004 - H.F. coils L2 and L3





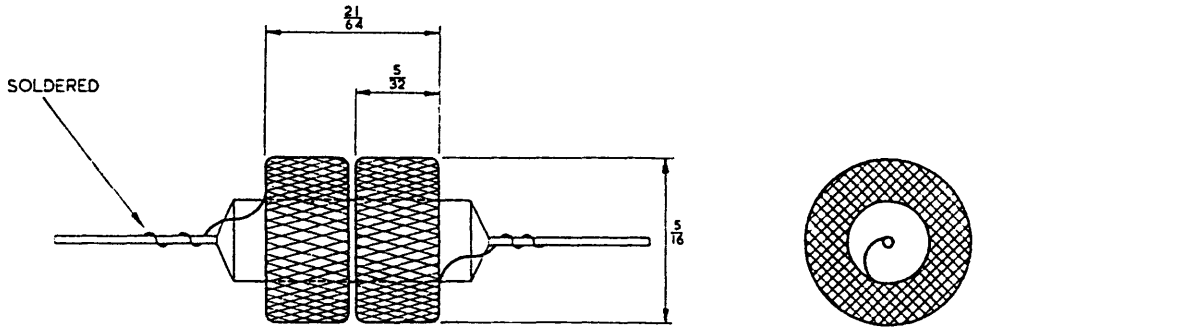
T F194 / I-4005

DIMENSIONS IN INCHES

	RFC 1 & 3	RFC 4, 5, 6, 7
WIRE (S.W.G.)	42	36
(En. Cu. S.A.S. Wavewound)		
NO OF TURNS	240	220
RESISTANCE (±5%)	90Ω	30Ω
INDUCTANCE (±10%)		180µH

FINISH: Coat with suitable dope or varnish.

Fig 4005 - R.F. chokes, RFC 1, 3, 4, 5, 6, 7

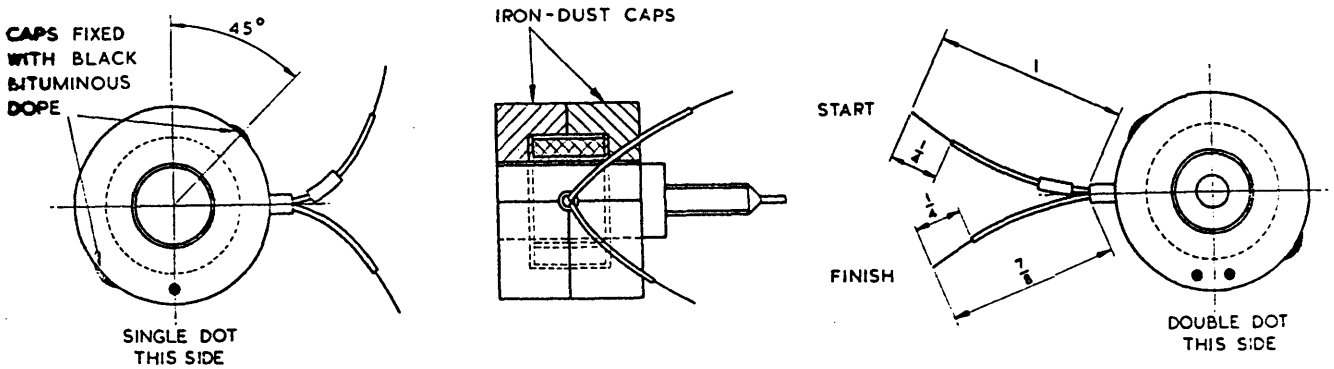


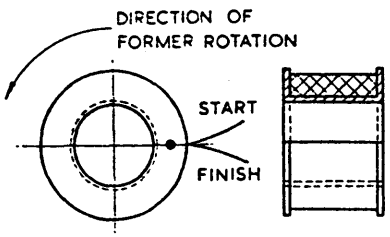
T F194 / 1-4006

DIMENSIONS IN INCHES

FORMER: Resistor Ins. 470k±10% 1/4W (5905-99-022-3121)
WINDING: Two coils each 240 turns No 42 S.W.G. E.C.C. half wave wound
FINISH: Coat with suitable dope or varnish
TEST DATA: Resistance 18Ω ±20%

Fig 4006 - R.F. choke RFC2





WINDING - 230 TURNS 42 SWG EN. COPPER SRC WIRE SCRAMBLE WOUND LEAVE ENDS OF LENGTH SHOWN

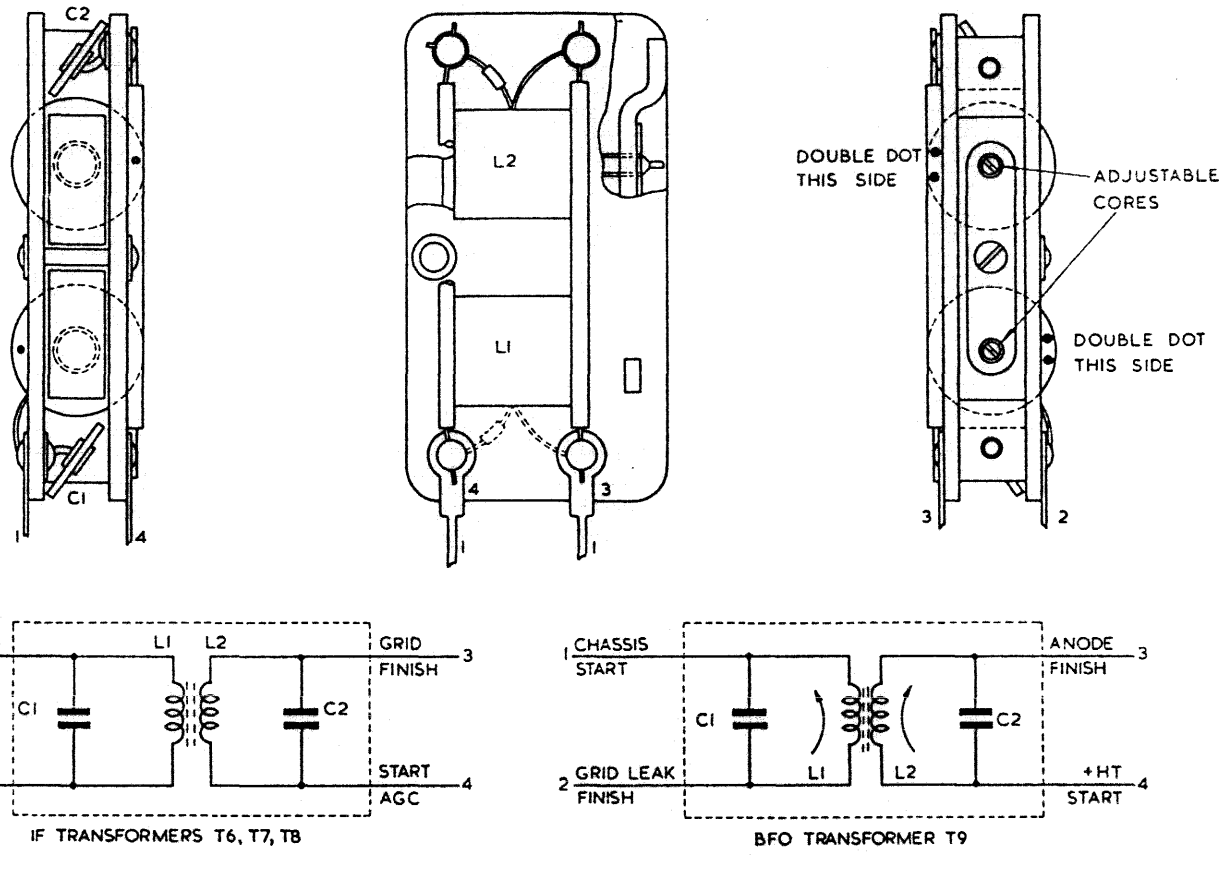
CAPS - SINGLE AND DOUBLE DOTS ON POT CORES TO BE AT SAME ENDS AS CORRESPONDING DOTS ON FORMER

ASSEMBLY & TEST - SEE FIG 4008

T F 194 / 1-4007

DIMENSIONS IN INCHES

Fig 4007 - I.F. and b.f.o transformers, winding data



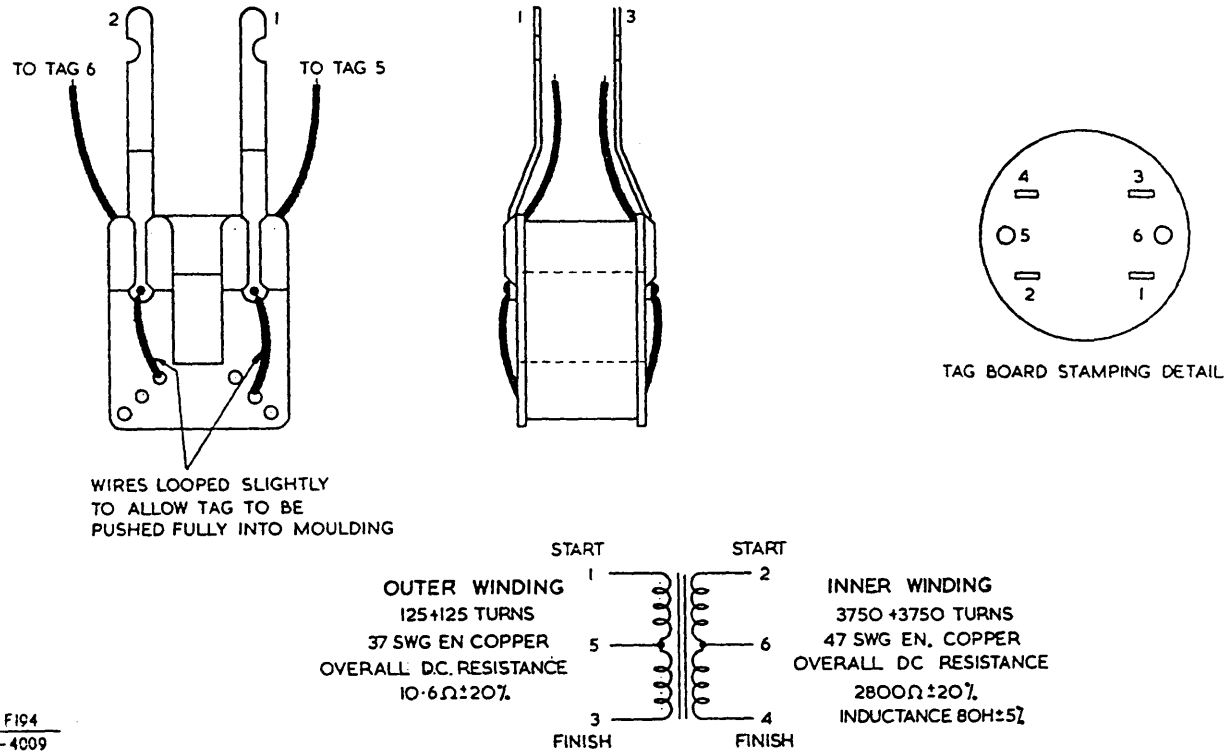
T F194 / 1-4008

Value of capacitors C1 & C2 - 100pF±2% (Z1/5910-99-012-5616)
For test purposes only, connect additional 25pF between terminals 1 and 2 on T9, then test as T6, 7 and 8

TEST DATA

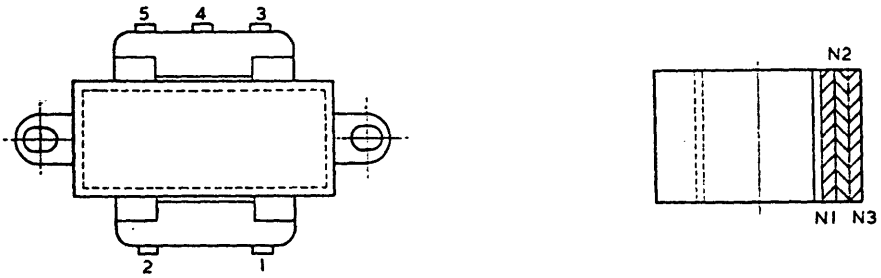
Bandwidth at 465kc/s	4.4kc/s ± 10% at 1.2dB down 14kc/s ± 10% at 10dB down

Fig 4008 - I.F. and b.f.o. transformers, assembly and test data



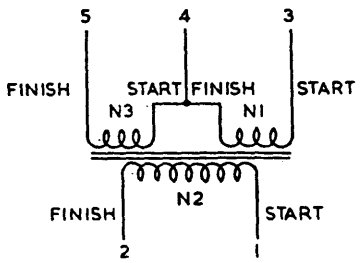
T F194 1-4009

Fig 4009 - AF transformer T8 and T9



TEST DATA

	TAGS 1&2	TAGS 3&5
DC RESISTANCE (OHMS)	380±20%	530±20%
INDUCTANCE AT 10V 50c/s WITH 10mA DC	9H MIN	—



WINDING DATA

WIRE - 41 SWG EN. COPPER

N1 - 1440 TURNS IN 10 LAYERS

N2 - 2160 TURNS IN 15 LAYERS

N3 - 1440 TURNS IN 10 LAYERS

INTERLEAVE BETWEEN LAYERS WITH VARNISHED INSULATING PAPER 0·001in THICK

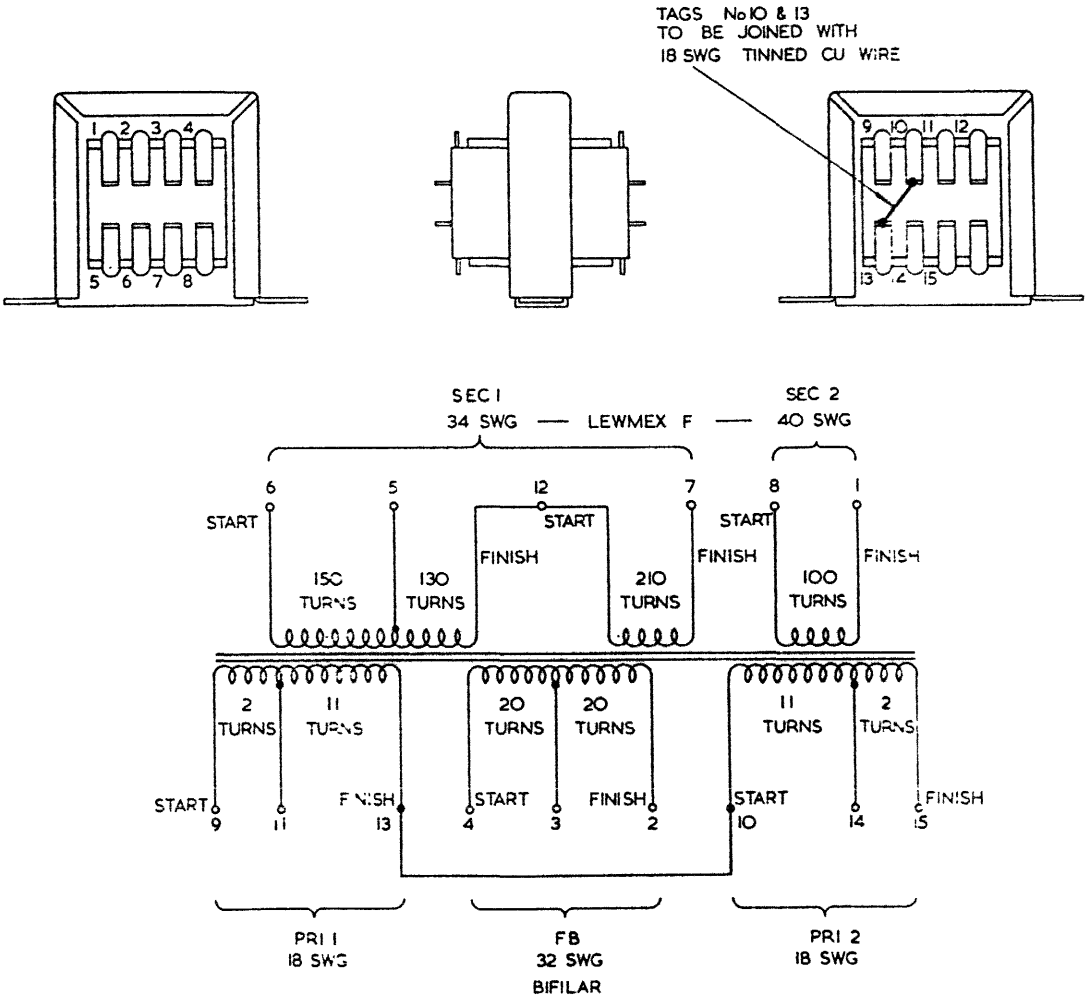
INSULATE N1 FROM N2 WITH 3 LAYERS VARNISHED SILK 0·003in THICK

TERMINAL LUGS SEC[illegible] TO OUTER WRAPPING OF PRESSPAHN

FINISH - IMPREGNATE

T F194 1-4010

Fig 4010 - Modulator transformer T3



T F 194 / 1-4011

TEST DATA

Switch position	h.t. voltage	bias voltage
C.W. Receive	51V	-20V
C.W. Send	155V	-19V
R.T. Receive	51V	-20V
R.T. Send	153V	-19V

All voltages to be measured when the power unit is used with a correctly aligned equipment. Readings tolerance may be ±10%

Fig 4011 - Power unit transformer