WIRELESS SET A40

TECHNICAL HANDBOOK - TECHNICAL DESCRIPTION

Tels F 462 Part 2 must be read in conjunction with this Part 1 which contains references to figures and tables in the Part 2.

SUBJECT INDEX

INDEX TO FIGURES

Introduction

1. The Wireless set A40 is a manpack set intended to replace the Wireless set 88 for infantry communication at Platoon and Company levels. It is similar to the Canadian Radio Set CPRC-26 and details of interchangeability between the two sets are given in paras 12 and 13.

2. The set is a v.h.f. f.m. transceiver operating on six preset crystal controlled channels in the band 47-55.4 Mc/s (see Table 2014). The r.f. power output is about 300mW and communication ranges of 1.1/2 miles over open country can be expected between sets fitted with 4 foot rod aerials. Sets fitted with remote 10 foot aerials can communicate over distances of 3-5 miles.

3. The following aerial systems can be used:-

(a) 4 foot vertical rod.

(b) 4 foot rod with an earthed counterpoise wire ie item (a) and item (c).

(c) 4 foot wire

(d) Remote half-wave aerial which includes a matching unit

(e) Portable homing loop.

4. The audio equipment normally used with the W.S. A40 is:-

(a) Officer's handset; Telephone, Hand, SI, No 4G

(b) Operator's headset; Microphone and Receivers Headgear Assembly, SI, No 1A.

BRIEF TECHNICAL DESCRIPTION

Principles of operation

5. A block diagram of the set is shown in Fig 1. Receive send switching is achieved by using the pressel switch on the headset to connect the l.t. to the valve filaments required. The mixer, (V5) crystal oscillator, (V13) and a.f. amplifier (V11) filaments are in circuit on both send and receive.

Receive

6. Additional valves in circuit on receive are V4, V6, V7, V8, V9 and V10. The signal path is:- r.f. amplifier (V4) mixer (V5) with crystal controlled local oscillator operating at 4.3 Mc/s below the signal frequency; four stages of i.f. amplification (V6, 7, 8, 9) a limiting stage (V10) and a discriminator with germanium diodes MR1, MR2. The discriminator output is fed to a.f. amplifier (V11), direct when the control switch (S-B) is on NORMAL and via a 20dB attenuator when S-B is on WHISPER. The output from V11 is connected via the transformer unit to the headgear.

Send

7. On send the pressel switch disconnects the l.t. volts from the 'receive' valves and connects the supply to V1, V2, V3 and V12. The microphone output is coupled via the transformer unit to the modulator (V1), the level of modulation

voltage being increased on WHISPER by removing part of the damping on the microphone transformer primary. The modulator includes a ferrite reactor which frequency modulates the master oscillator (V2). The m.o. output is fed to the power amplifier stage (V3) and hence to the aerial. A small portion of the output is coupled by the r.f. valve (V4) capacity to the mixer (V5), referred to the crystal oscillator. The resultant i.f., amplified by the a.f.c. driver (V12), is fed to the a.f.c. discriminator (MR3, MR4). The a.f. output from this discriminator is connected to V11, amplified and heard as sidetone in the headgear while any d.c. output varies the grid bias of the modulator (V1) and thus controls the m.o. frequency.

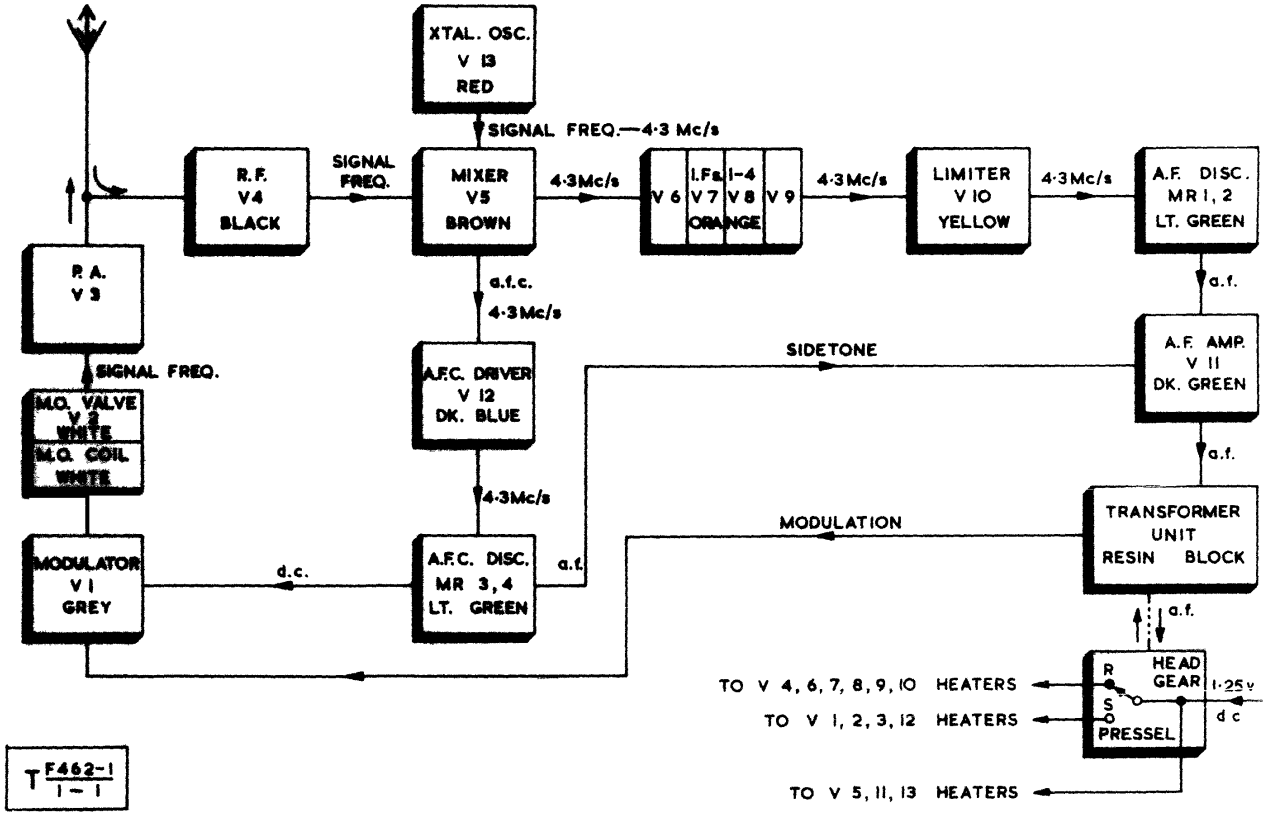

Fig 1 - Block diagram

Power supplies

8. The set operates from a Leclanche type battery, having a life of approximately 18 hours and giving the following voltages:

L.T.	1.5V
H.T.1	45V
H.T.2	90V
G.B.	-3V

Construction

9. The set case and battery box are magnesium alloy castings while the front panel is made of aluminium. The set and battery box strap together to form a unit approximately 10 3/4 in x 5 in x 3 in. The weight including the battery is about 10 lb. The set is fully sealed, can be used anywhere in the world, parachute dropped or transported by air at altitudes up to 25,000 ft.

10. To facilitate maintenance the set can be split into a number of units using only a screwdriver. These are illustrated in Fig 2 and consist of:-

(a) Front panel unit

This unit includes the transformer block, the audio and aerial sockets, and the control switch. A single plug and socket (PLD and SKTD) connect the aerial sockets to the trimmer deck while all other connections to the front panel are made by a ten way plug to a socket on the main chassis.

(b) Main chassis

This consists of a moulded polythene deck of sockets for the valves and plug in units. The deck carries most of the coupling and decoupling components with their interconnections and is screwed to a shallow aluminium chassis. Connection is made by a plug on this chassis (through an adaptor on the set case) to the battery. An eight way plug connects to the r.f. circuits on the trimmer deck.

(c) Trimmer deck and shield

The r.f. and p.a. inductors, the channel switch, and the 18 trimmers for aligning the m.o., p.a. and r.f. stages are mounted on this unit. The trimmer shield mechanically secures the deck to the main chassis.

(d) Crystal bank

The clip of six crystals plugs into the trimmer deck and is secured by a spring clamp on the trimmer shield.

(e) Plug in units

Each stage of the set (except the m.o. and p.a.) is built into a can 2 in x 1/4 in x 3/4 in containing a subminiature valve, with its associated wiring and components. These units are fitted with B7G valve bases which locate in the main chassis. Fig 4 shows the location of each unit and its identification colour code. In the case of the m.o. the inductor alone forms a plug in unit.

(f) P.A. valve

The p.a. and the m.o. use normal miniature B7G based valves whose locations are also shown in Fig 4.

(g) Unit securing plate

This plate acts as a retainer for the plug in units and is engraved with their locations and an elementary fault finding table.

(h) Desiccator

This is of similar size to a stage unit and is fitted over a test socket (see Table 2013).

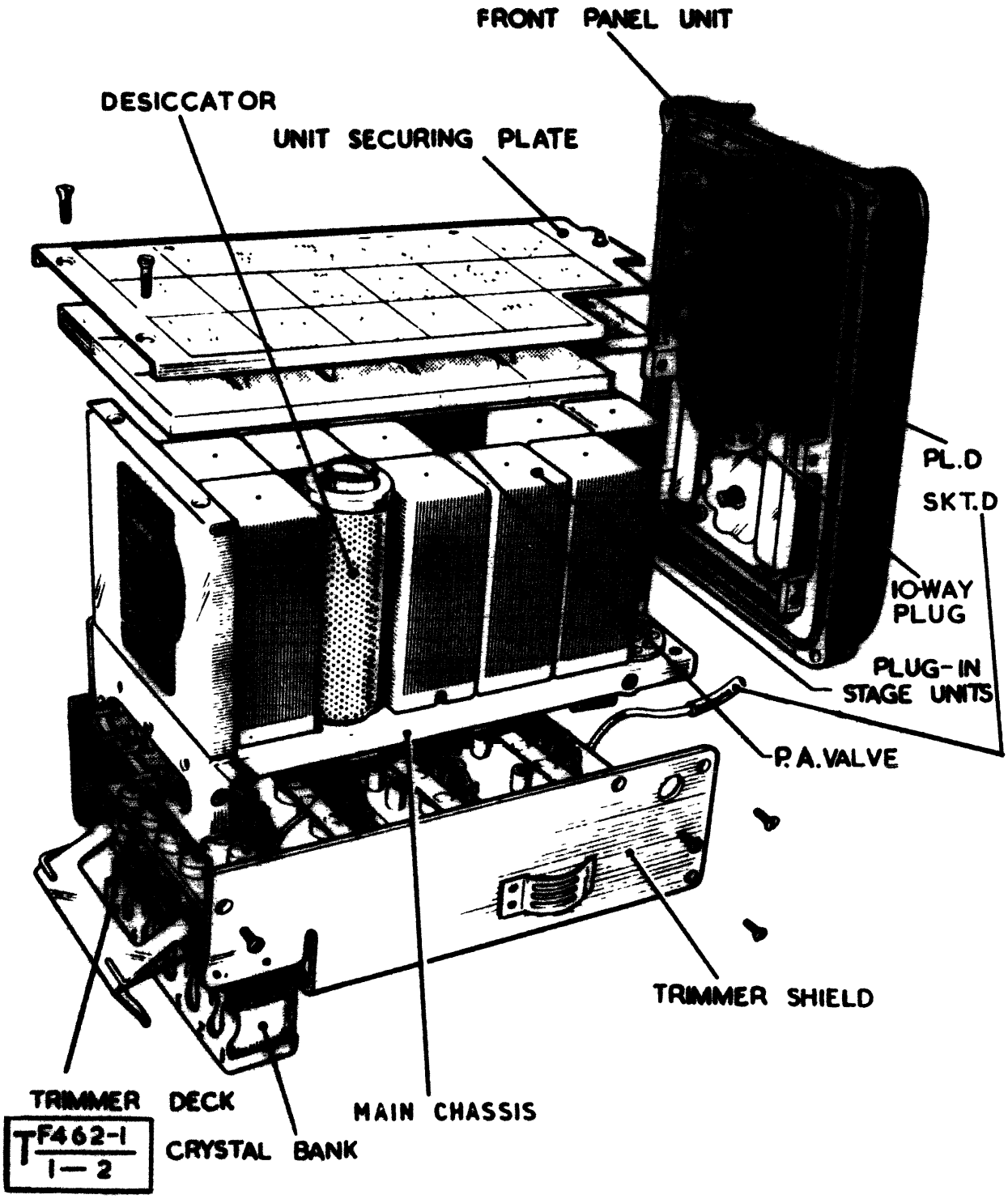

Fig 2 - Breakdown of set

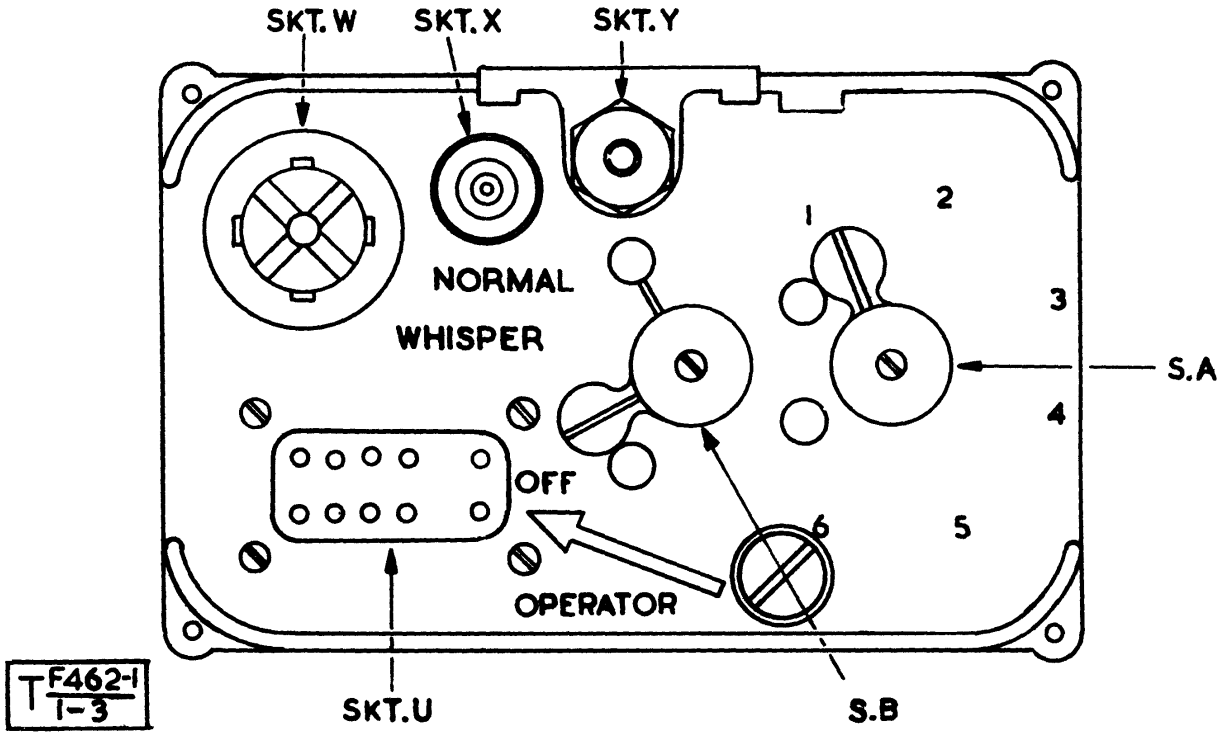

Fig 3 - Front panel controls

Controls (Fig 3)

11. The controls mounted on the front panel consist of the following:-

S-A Channel selector switch - selects one of six frequency channels

S-B Control switch - OFF - all power to set switched off

WHISPER - gives increased modulation sensitivity with reduced a.f. output

NORMAL - gives normal modulation and a.f. output.

SKT-U Handset and headset connecting sockets

SKT-W Aerial socket for rod aerial

SKT-X Coaxial socket for remote aerial

SKT-Y Counterpoise earth socket.

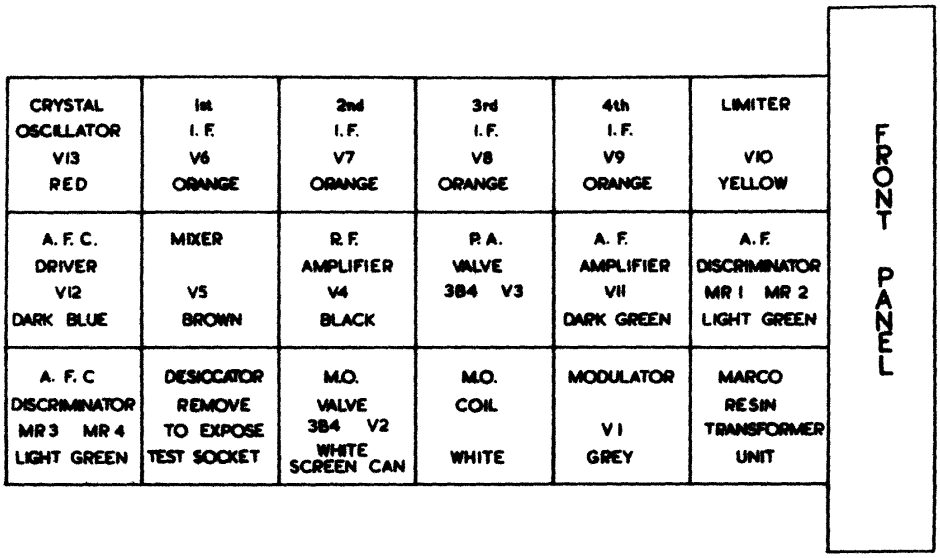

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Fig 4 - Plug-in unit layout

Interchangeability with Canadian/US Set CPRC-26

12. The British wireless set A40 is functionally completely interchangeable with the Canadian CPRC-26 and is of identical physical dimensions. The headgear, aerials, and batteries can be used with either set.

13. The two sets use the same valve types and the CPRC-26 plug in units listed below may be used as spares for the A40. Some combinations of Canadian units in the W.S. A40 can, however, cause a degradation of performance. It is important, therefore, that the set is tested to specification (see Table 2016 and Tels 464) as soon after the change as possible. This is additional to the normal checks carried out using the functional tester when the unit is changed (Tels F 463).

(a) Crystal oscillator
(b) Master oscillator coil
(c) Mixer
(d) I.F. amplifier
(e) Limiter
(f) Discriminator
(g) A.F.C. driver.

DETAILED TECHNICAL DESCRIPTION (See Fig 2001)

Receive

R.F. amplifier

14. The signal is coupled from the aerial socket in use (SKTW or SKTX) by PL-D, SKT-D and C18 to the junction of inductors L4 and L6. These inductors with the

trimmer capacitor (C20-25) switched across them by the channel switch (SA-a) form the grid circuit of the r.f. amplifier (V4). The signal, amplified by V4, is developed across the anode tuned circuit formed by r.f. inductor (L5) and trimmer capacitors (C32-C37) and fed to the mixer (V5). Trimmers C20-25 are engraved P.A. on the trimmer shield since L4 with these capacitors also form the tank circuit of the p.a. valve V3 on send. C27 blocks the p.a. anode volts from V4 grid.

Mixer

15. V5 is a normal electron coupled mixer with the signal input on the grid and the local oscillator (V13) input developed across L7 in the filament circuit. The anode tuned circuit (T1, C41) is resonant at the intermediate frequency (4.3 Mc/s) and a secondary winding on T1 couples to the 1st i.f. stage.

Crystal oscillator

16. The frequency of the oscillator (V13) is below that of the signal and is controlled by six independent crystals which are switched into the circuit shown in Fig 5. This circuit has been designed to make the frequency dependent only on the crystal selected and to prevent uncontrolled oscillation in the event of crystal failure.

17. A bridge circuit is formed by the halves of T10 secondary, the crystal, and R48 C110. Input to the bridge is coupled from the anode by a toroidal wound transformer T10 whose windings are so arranged that the primary induces equal voltages into each half of the secondary. The output from the bridge is taken between T10 secondary centre tap and earth and fed to the grid through L25. Off resonance this output will be small since R48 and C110 balance the crystal impedance and the grid input is insufficient to maintain oscillation. The impedance of the crystal, however, drops to less than 50Ω at its series resonant frequency, the bridge is unbalanced, and the voltage coupled to the grid sets the circuit into oscillation.

18. The band of frequencies over which the feedback voltage will be of the correct phase for the oscillator to operate is governed to a large extent by the frequency to which T10 primary is tuned by the valve capacity and C116. In practice the trimmer C116 is preset to give a satisfactory output from 42.7 to 51.1 Mc/s. C110 is also a preset trimmer which is adjusted to balance out the capacity of the crystal holder and wiring and, with R48, provides self bias for the oscillator. The inclusion of a small inductor (L25) in series with the feedback is found to improve operation on low battery volts.

19. Output from the oscillator is taken by a third winding on T10 and fed in series with the l.t. to the filament of the mixer V5. In addition to acting as a local oscillator on receive V13 is in circuit on send as a reference for the a.f.c. (paras 29-30).

I.F. amplifier (V6, 7, 8, 9)

20. The i.f. amplifier consists of four identical plug-in stages. The mixer output is coupled by T1 link winding into the tuned grid circuit (L8 and C44) of the 1st i.f. stage (V6). R15, C45 provide self bias for the stage. The amplified signal is developed across T2 primary tuned by C49 and coupled by the link secondary winding on T2 to the 2nd i.f. stage. The 2nd, 3rd and 4th i.f. units are identical in operation.

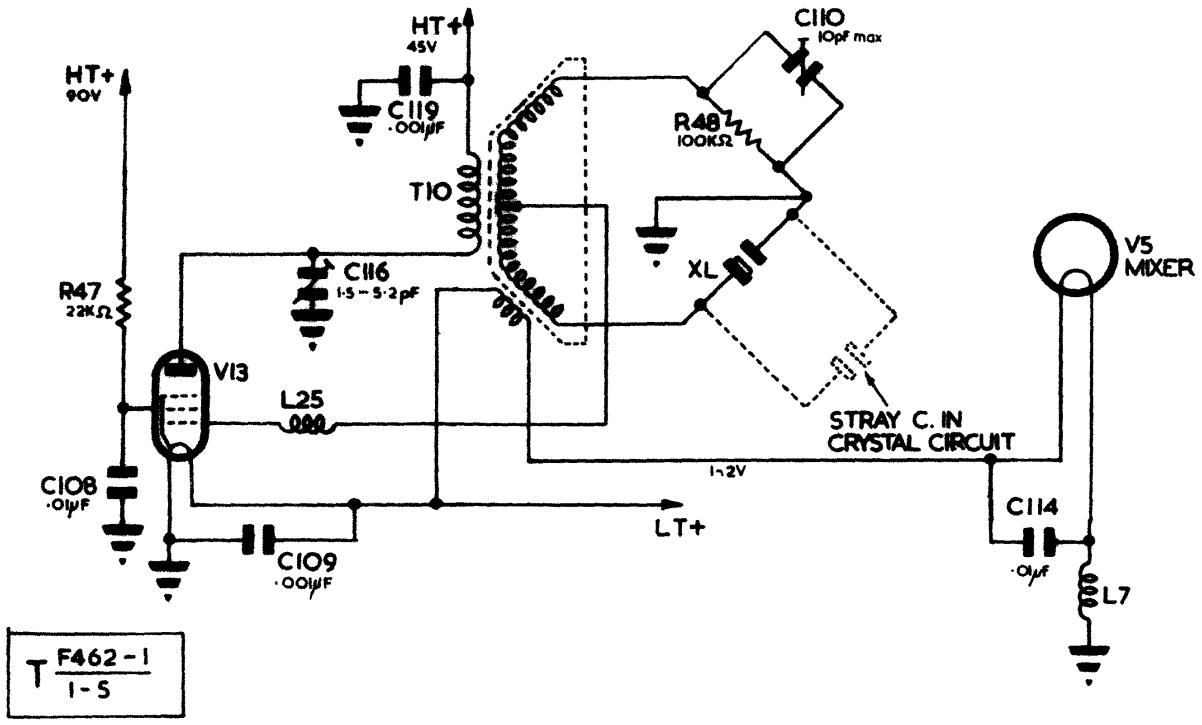

Fig. 5 - Crystal oscillator circuit

21. Each stage has a gain of about 20dB. The overall bandwidth of the four units is about 70kc/s at 6dB down; to achieve this, slight overcoupling is employed between stages. Drift of the i.f. tuned circuits with temperature is reduced by using negative temperature coefficient types of tuning capacitors (C44, C49, C52 etc.).

Limiter (V10)

22. The output of the 4th i.f. unit is link coupled to the grid tuned circuit (L18, C72) of the limiter. This unit is similar to an i.f. stage except that:-

(a) The anode circuit (T6, C78) is tuned to a frequency slightly higher than the i.f. anode circuits to compensate for inherent assymetry in the discriminator.

(b) T6 coupling winding has more turns giving tighter coupling to the discriminator.

(c) The anode and screen voltages for V10 are taken from the 90V supply through R32.

The input to the limiter is connected via R28, C71 to the test socket (SKT-F) where an indication of grid current can be obtained. Limiting occurs with a grid input of about 2V.

Discriminator

23. The limiter output is coupled by T6 link winding to a Bond type discriminator (Tels A013, Issue 2). The discriminator primary tuned circuit consists of L21 and C80 and the secondary tuned circuit is made up of L22 and C84 with C81, C83, providing a centre tap. Coupling between the two circuits is achieved by direct connection from C80 to the centre tap and by C82 which provides the phase reference voltage. The resultants of these voltages (varying in amplitude with frequency) are applied to the germanium diodes (MR1 and MR2). The rectified voltages across R33 and R34 give an a.f. output, from the discriminator between PLR7 and PLR1. The output is connected to a test point (TP1) on the transformer unit socket SKT-T via i.f. filter C86 R35.

A.F. amplifier

24. The a.f. discriminator output is fed via the i.f. filter (C86, R35, C88) and coupling capacitor C89 to the grid of the a.f. amplifier (V11). The amplified signal is coupled to the phone socket (SKTU) by transformer T7 giving an output of about 6mW when S-B is at NORMAL. On WHISPER the output is reduced by about 17dB since S-Ba connects R50 to earth, forming with R35, a potential divider for the grid input voltage to V11. The valve is biassed through R31 from the -3V battery supply.

Send

Microphone circuit

25. On send the pressel switch (S-C) on the microphone or handset connects the 1.5V to the heater circuits of the modulator, m.o., p.a., and a.f.c. driver valves (V1, V2, V3 and V12) and to the carbon microphone MC1 as an energising voltage. The microphone transformer (T8) primary is shunted by R49 and R41 when the control switch S-B is on NORMAL but by R49 only when S-B is on WHISPER thus effectively increasing the modulation sensitivity by about 20dB in this position.

Modulator (V1)

26. The a.f. signal from T8 secondary is developed across C118 in V1 grid circuit. Grid resistor R1 is short circuited on the A40 in order to maintain the correct modulation level, but is left in the unit for interchangeability with other equipments. The amplified signal is developed across the primary of Ferrite reactor X1, whose construction is shown in Fig 6. The primary (a.f. winding) has silicon iron laminations and its magnetic circuit is completed by a block of Ferroxcube. Ferroxcube is a ferrite material which has the property of giving an appreciable fall in permeability for an increase in flux density. The flux density of the magnetic circuit will depend upon the a.f. current changes in the reactor primary and thus the permeability of the Ferroxcube core will vary according to the modulating signal. A coil of approximately 8 turns wound toroidally on this core forms the secondary of the reactor. The inductance of this coil will vary with the a.f. since inductance is directly proportional to permeability. The secondary coil is connected across part of the master oscillator inductor L2, whose inductance will thus be varied at a.f., i.e. the m.o. will be frequency modulated.

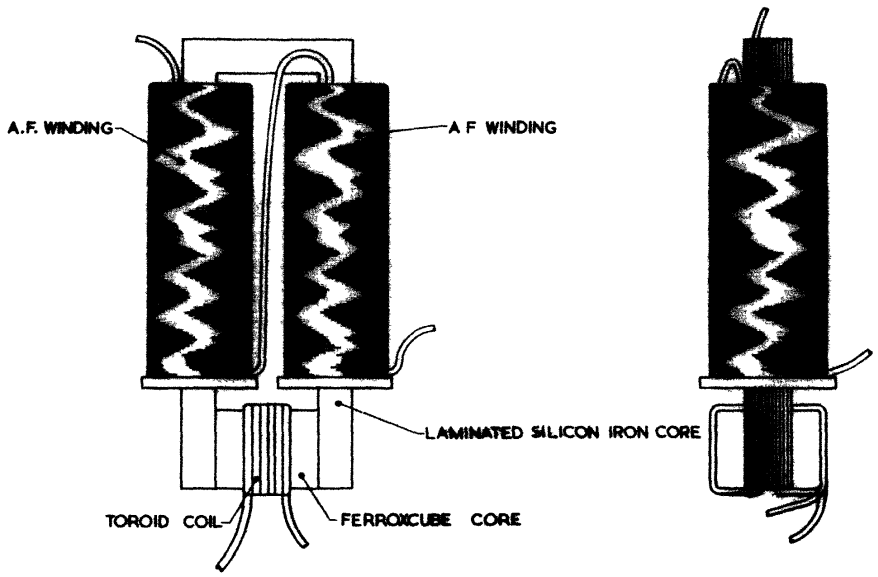

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Fig 6 - Construction of ferrite reactor

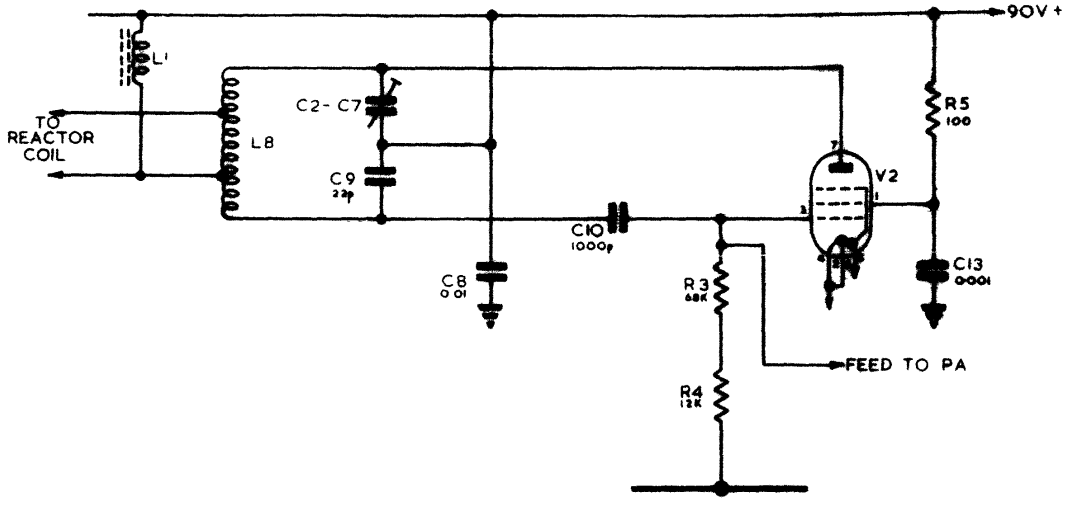

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Fig 7 - Master oscillator circuit

Master oscillator (V2)

27. The master oscillator employs a miniature B7G based pentode (V2) with half of its 3V centre tapped filament in use. Fig 7 shows the Colpitts circuit arrangement. L2 is connected between the anode and grid of the valve and C9 with the selected trimmer (C2-C7) form the capacitive tap of the tuned circuit. This tap, decoupled to r.f. by C8, is taken to 90V h.t. to keep both plates of the concentric trimmers at the same d.c. potential so reducing the risk of breakdown. The anode voltage

for V2 is supplied from the 90V h.t. through an r.f. choke (L1) and the automatic bias is developed by C10, R3 and R4. The oscillator is modulated as explained in para 26 by connecting the reactor (X1) secondary in parallel with part of the m.o. coil (L2). Output from the m.o. is taken from the grid circuit via C115 to the power amplifier.

Power amplifier (V3)

28. The p.a. stage uses the same type valve as the m.o. but the filament halves are paralleled in this case to give the necessary emission. The r.f. drive voltage from the m.o. is applied to the grid of V3 which is self biassed by C115 R36. The amplified signal is developed across the anode tank circuit which consists of inductors L4 and L6 with the selected trimmer capacitor C20-C25. Output is taken from the junction of L4 and L6 (approximately 50Ω impedance) direct to the coaxial aerial socket SKTX and via loading inductor L3 to the rod aerial socket SKTW. The p.a. stage is therefore matched to the coaxial fed remote aerial or homing loop via SKTX and to the 4 ft rod aerial which fits direct to SKTW. Neutralising capacitor C14 consists of a single plate whose proximity to the p.a. coil L4 can be adjusted to feed back to the m.o. a voltage equal to that coupled by the anode grid capacity of V3. The voltages will be in antiphase since they are connected to opposite ends of the m.o. coil (L2) and thus the effect on the m.o. of any changes in the p.a. anode or aerial circuits will be neutralised.

Automatic frequency control and sidetone

29. A small amount of the p.a. output is coupled by the grid anode capacitance of V4, whose filament is switched off on send, to the mixer (V5) grid. This channel frequency and the crystal oscillator output are mixed to give an intermediate frequency (4.3 Mc/s) which is fed to the a.f.c. driver unit. This unit acts as an i.f. amplifier and, because of the amount of drive, will grid limit. The amount of grid current can be measured at the test socket (SKTF-7). The grid to cathode capacity of the stage is adjusted by C105 to be the same in each unit so that replacement of the unit does not detune the mixer anode circuit. The amplified signal is developed across the tuned transformer (T9 and C103) and is coupled by T9 link winding to the a.f.c. discriminator unit.

30. This unit is identical to, and interchangeable with, the a.f. discriminator described in para 23. There will be a d.c. output across the discriminator if the m.o. drifts from the correct channel frequency, i.e. crystal frequency + intermediate frequency. This output, which can be monitored between pins 1 and 4 of the test socket (SKT-F), is connected via a long time constant circuit, R54 C118, to the grid of the modulator V1. This voltage alters V1 anode current in such a way as to correct the frequency error by virtue of the reactor X1 (see para 26). The operating point of the modulator and the m.o. centre frequency depend upon the normal bias on V1. This bias is fed in series with the control voltage (if any) by connecting one side of the discriminator to the junction of R3, R4. The voltage developed across R4 by the m.o. grid current will vary with the battery voltages. This variable bias helps to prevent changes of both the operating point of the modulator and the m.o. frequency which would result from supply voltage variations if a fixed bias supply were used. The value of the bias can be measured between test socket (SKT-F) pin 4 and chassis.

31. If the r.f. coupled from the p.a. stage to the a.f.c. loop is modulated there will be an a.f. output from the a.f.c. discriminator which is used as an indication of sidetone. This output is connected to the a.f. amplifier (V11) grid via C87, i.f. filter C90, R37, C88 and C89. The level of sidetone will be reduced by 17dB in the WHISPER position of S-B in a similar way to the received a.f. (para 24).

END of Part 1