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UHF SIGNAL GENERATOR CT394

GENERAL AND TECHNICAL INFORMATION

Prepared by direction of
the Minister of Supply

Promulgated by Command of
Their Lordships

ADMIRALTY

Promulgated by Command of
the Air Council

AIR MINISTRY

LAYOUT OF A.P.2531H

Heavy type indicates books being issued under this A.P. number; when issued they will be listed in A.P.113 and 2463

VOLUME 1,	**Part 1**	**Leading particulars and general information**
	Part 2	**Technical information (servicing)**
VOLUME 2		**General orders and modifications**
VOLUME 3		*Inapplicable*

Note . . .
The schedule of spare parts and scales of equipment are to be issued in A.P.2276F.

VOLUME 4		*Inapplicable*
VOLUME 5		*Inapplicable*
VOLUME 6		*Inapplicable*

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PRELIMINARIES

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PART 2

TECHNICAL INFORMATION (SERVICING)

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

LEADING PARTICULARS

SIGNAL GENERATOR CT394

REF. NO.	6625-99-943-1911
FREQUENCY RANGE	*12 Mc/s to 485 Mc/s in five bands*
OUTPUT IMPEDANCE	50 *ohms*
OUTPUT VOLTAGE RF (OPEN CIRCUIT)	
Normal	*Calibrated attenuator—continuously variable from 0·1 microvolt to 1·0 volts*
High	*Variable from 1 volt to 2 volts using the carrier meter scale*
MODULATION	
Internal	*Amplitude modulation from a 1 000 c/s sine wave oscillator. Variable up to 30 per cent which can be extended to 90 per cent at most carrier frequencies having a level of between 0·1 microvolt and 1 volt, RF outputs above 1 volt cannot be modulated* **Note . . .** For 30 per cent amplitude modulation at the NORMAL level spurious frequency modulation is less than 2 kc/s at all carrier frequencies up to 425 Mc/s. In the conditions quoted under internal modulation it can never exceed 3·5 kc/s. Figures are not available for frequencies above 425 Mc/s
EXTERNAL	
Sine wave	*Sine wave modulation is possible at frequencies between 30 c/s and 50 kc/s. An input of 1 volt RMS (approximate) is required for 30 per cent modulation*
Pulse	*Pulse modulation may be applied at p.r.f.s. up to 50 kc/s, the amplitude of the pulse must not be less than 25 volts. The RF bandwidth lies between 500 kc/s and 3 Mc/s depending on carrier frequency, i.e. the shortest usable pulse at say 12-30 Mc/s is about 4µ seconds duration falling to 0·7µ seconds towards the 485 Mc/s region. (Video bandwidths 250 kc/s and 1·5 Mc/s respectively.)*
CRYSTAL CHECK	*A separate sub-unit incorporating a crystal oscillator is included in the signal generator to confirm the accuracy of the frequency to which the signal generator has been tuned. Normally, the frequencies of the two crystals supplied with the equipment are 2 Mc/s and 10 Mc/s but, when required, crystals having frequencies between 1 Mc/s and 10 Mc/s may be used. Crystal units should be Style D to DEF 5271, dated 23/4/57*

Power supplies	*AC 100 volts to 150 volts or 180 volts to 250 volts at 40 c/s to 100 c/s, or 180V at 500 c/s*
Dimensions	*Height* 14½ *in.* (37 *cm.*) — *Width* 23½ *in.* (60 *cm.*) — *Depth* 10½ *in.* (27 *cm.*)
Weight	67 *lbs.* (31 *kg.*)

PART 1

LEADING PARTICULARS AND GENERAL INFORMATION

Chapter 1

INTRODUCTION AND GENERAL DESCRIPTION

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Introduction

1. A general view of the signal generator CT394 is given in fig. 1, the dimensions and weight of the equipment are given in the Leading Particulars at the beginning of Part 1 of this A.P. The signal generator, which incorporates its own AC mains operated power unit, is enclosed in a metal case which acts as a screen and also as a dust cover. Suitably shaped cavities on the left- and right-hand sides of the case serve as carrying handles. The operational controls are all on the front panel of the signal generator. Access to the crystals in the crystal calibrator unit is obtained through a trap-door at the rear of the case.

2. The signal generator operates over the frequency range of 12 Mc/s to 485 Mc/s in five bands as follows:—

Band	*Frequency range*
A	12 Mc/s to 24 Mc/s
B	24 Mc/s to 48 Mc/s
C	48 Mc/s to 110 Mc/s
D	110 Mc/s to 260 Mc/s
E	260 Mc/s to 485 Mc/s

3. The tuning dial is directly calibrated in frequency, and it has a scale length of about 80 in. The manual control which operates the tuning dial also drives an incremental frequency dial and this together with a fine tuning control provides for accurate tuning of the signal generator, receiver bandwidth and other similar measurements. Capacitance switching is employed for wave band selection purposes which eliminates the variable factor of RF resistance.

RF output—normal

4. The output impedance of the signal generator is 50 ohms. Under normal operating conditions the RF output level is continuously variable from 0·1μV to 1·0V by means of a calibrated attenuator having a dial incorporating four scales:—

(1) A dB, μV scale which indicates the output EMF in decibels relative to 1μV.

(2) An EMF scale which indicates the output EMF in units of voltage.

(3) A dB scale which indicates the power delivered to an external 50-ohm load in terms of decibels relative to 1 mW.

(4) A scale to indicate the power output to an external load in decibels relative to thermal noise for a noise-bandwidth of 10 kc/s. It is understood that this scale has no Service application.

5. The RF output can be continuous wave or amplitude modulated from an internal sine-wave oscillator operating at a frequency of about 1 000 c/s. The modulation depth can be varied up to 30 per cent throughout the frequency range of the generator and at most frequencies the modulation depth can be extended to 90 per cent.

6. Facilities exist for both sinewave and pulse modulation from external sources. The sine wave modulation can be at frequencies between 30 c/s and 50 kc/s. A signal input of not less than 1V is required from the external source to produce 30 per cent modulation. The input impedance for sine-wave modulation is equivalent to a resistance of 1 megohm shunted by a capacitance of 100 pF.

7. The pulse modulating signals from the external

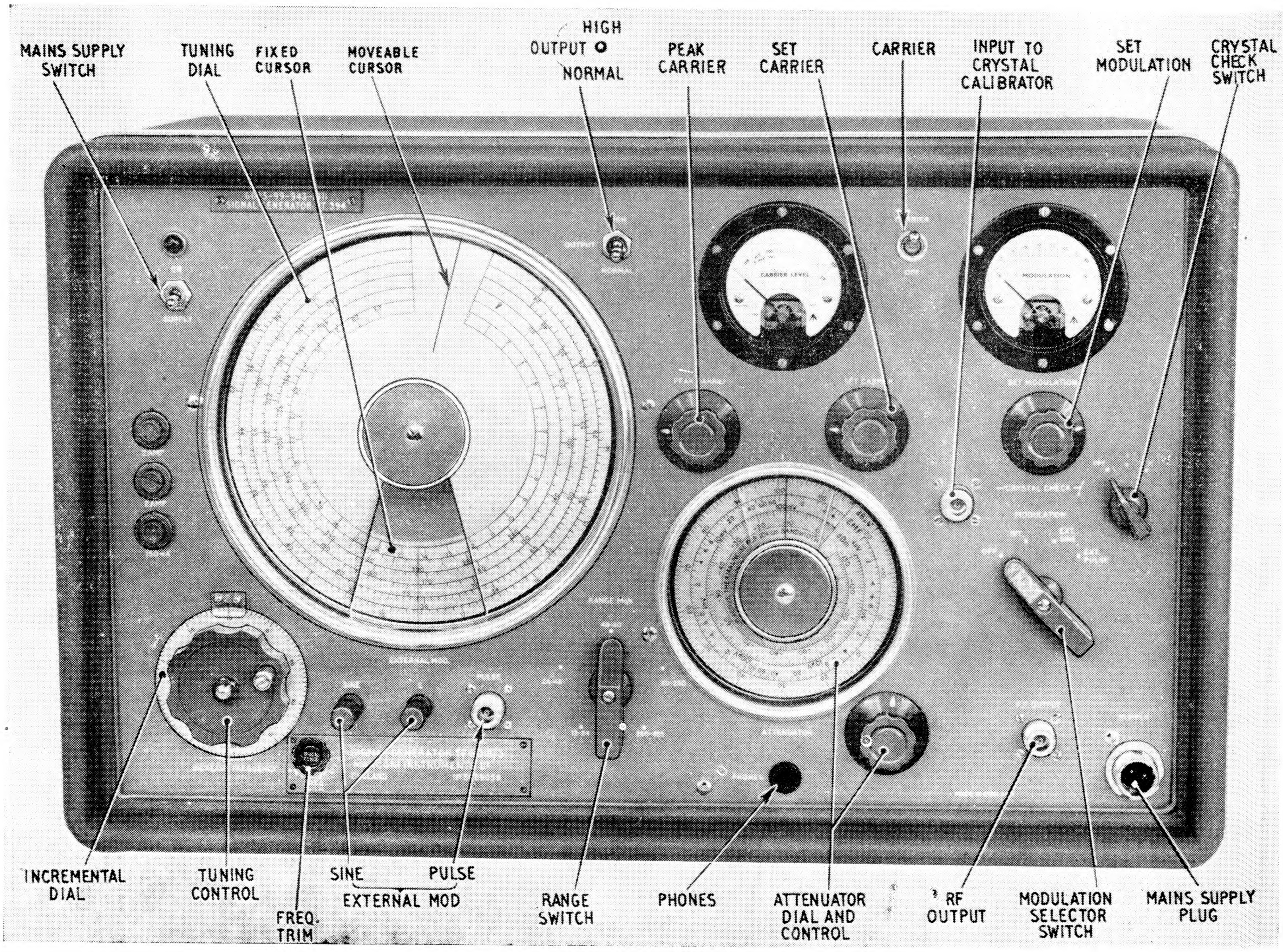

Fig. 1. Signal generator CT394

source can be at pulse recurrence frequencies up to at least 50 kc/s, the amplitude of these pulses should not be less than 25V. The input impedance for pulse modulation is a resistance of 1 megohm shunted by a capacitance of 50 pF.

RF output—high

8. A switch is provided on the front panel to permit the RF output to be increased to a maximum of 2V over most of the RF range of the equipment. This facility is for use where the normal RF output (*para.* 4) is less than that required. When the high RF output is in use, the oscillator valve is being operated close to the maximum permissible anode dissipation. Therefore, to conserve the life of this valve, the signal generator should only be used on high RF output for limited periods when the normal RF output is below the level of that required.

9. There are two conditions associated with high RF output operation as follows:—

(1) When the level of the required RF output is between 0·5V and 1V, the calibrated attenuator can be used to set the level of the output (*para.* 4). The RF output can be either continuous wave or amplitude modulated (*para.* 5 to 7).

(2) When the required RF level is between 1V and 2V, the output is continuous wave only. The level of the signal is set by using the calibrations on the scale of the set carrier meter.

Note . . .

The operating instructions for using the various RF levels are given in Chap. 2 of this Part.

Crystal check

10. To provide a ready means of determining the accuracy of the frequency of the signal generator a separate sub-unit incorporating a crystal oscillator with crystals operating at frequencies of 2 Mc/s and 10 Mc/s is included in the generator. With the exception of the HT and LT supplies the crystal oscillator circuit is quite independent of the signal generator. A CRYSTAL CHECK switch is brought out to the front panel and it enables the HT supply to be switched on and also the required crystal frequency to be selected. A connector is provided with the equipment to permit the RF output of the signal generator to be fed to the crystal check circuit. The heterodyne beat system is used and the subsequent beat frequency can be heard in the telephones.

Accessories (*fig. 2 at end of chapter*)

11. The mains connector Type 3429 or 3429/1 is supplied with the equipment. The following accessories are available for use with the signal generator CT394 and they are to be obtained independently as required:—

(1) RF output connectors.

(a) Connector, 54 in. long (5995-99-972-8884) (Marconi TM 4824/1).

(b) Connector, 12 in. long (5995-99-972-8882) (Marconi TM 4824/2).

They are fitted at either end with a standard coaxial Type N free plug for mating with a coaxial Type N socket (50-ohm version).

(2) Attenuator, fixed, 20 dB (5905-99-972-8881) (Marconi TM 4919).

This is a conventional pi-section pad with a 20 dB insertion loss. The input and output resistances are each of 50 ohms. One end of the pad is fitted with a coaxial Type N socket and it is for connection between the free end of the RF output connector (*sub-para.* (1)) and the equipment under test. This pad is for use with equipment having an input impedance differing from the 50-ohm impedance of the generator. The effect of this pad is to isolate the two impedances and thus prevent any appreciable mismatch between the generator and the equipment under test. The pad can also be used whenever it is necessary to reduce the output of the generator by 20 dB.

(3) Attenuator pads.

(a) Attenuator, fixed, 50-75 ohms (5905-99-972-8901) (Marconi TM 5548).

(b) Attenuator, fixed, 50-75 ohms (5905-99-972-8900) (Marconi TM 5549).

These serve as matching units and they are used to convert the effective source impedance of the signal generator from 50 ohms to 75 ohms. A resistor of 25 ohms is incorporated in each unit and it is connected in series with the inner conductor of the coaxial line. The input end of each unit is fitted with a Type N socket for connecting the unit to the signal generator via either the 12 in. or 54 in. 50-ohm RF output connector. The output end of the attenuator 8901 has a plug for mating with a socket 0560044 (Burndept), while the output end of the other attenuator 8900 has a plug for mating with a socket AP61340 (Plessey major).

(4) Leads test (6625-99-943-3486) (Marconi TM4917).

This is a DC isolating unit containing a capacitor of 0·001 μF, 300V working, connected in series with the output line. This is to permit the signal generator to be connected to a point of relative high DC potential on the equipment under test. It is fitted with a coaxial type socket at one end for fitting to the RF output connector, while two crocodile clips are attached to the output end.

(5) Adaptor, plug/socket 'T' (5935-99-972-8894) and a 12 in. RF connector 50-ohm (5995-99-972-8883) (Marconi TM 5599).

This special adaptor and connector is to permit the RF output of the signal generator to be fed to the crystal calibrator circuit for determining the accuracy of the frequency of the signal generator. The connector includes an outlet to permit the RF output of the generator to be simultaneously fed to the equipment under test during crystal calibration operation. This method causes mismatching to occur and therefore the RF level cannot be defined accurately; in addition crystal harmonics are fed to the receiver under test at indeterminate but low levels.

Power supplies

12. The signal generator incorporates its own power unit which can be operated from AC supplies as follows:—

(1) In steps of 10V from between 180V and 250V at 40 c/s to 100 c/s.

(2) In steps of 5V from between 100V and 120V and also in steps of 10V from 120V to 150V at 40 c/s to 100 c/s.

(3) 180V at 500 c/s.

Operation

13. A functional diagram of the signal generator CT394 is given in fig. 3 at the end of this chapter. The valve V2 functions as the master oscillator, the output of which is fed to the grounded grid amplifier valve V6. The circuits of the master oscillator and the amplifier have each a turret tuning system, ganged together for both range selection and tuning purposes. To permit the amplifier to be tuned accurately to the master oscillator, a PEAKING control is provided to enable the capacitor rotor of the amplifier to be rocked slightly to and fro independently of the capacitor rotor of the master oscillator. A fine tuning control, consisting of a small trimming capacitor for varying the capacitance between anode and earth of the M.O. valve V2, is brought out to the front panel (*fig.* 1).

14. Each of the turrets has five tuned circuits, one for each of the five ranges. Each circuit has its own inductors and also a set of fixed plates which are brought into circuit with a set of variable plates to form the main tuning capacitor when the required frequency band is selected by the RANGE switch. This capacitor is adjusted by the main tuning control on the front panel of the signal generator (*fig.* 1).

15. Fixed plates connected to the anode and grid of the master oscillator valve V2 are mounted so that additional fixed plates for each of the five ranges of the turret tuner form coupling capacitors between the valve and the selected tuned circuit.

16. Coupling between the output circuit of the master oscillator and the amplifier is dependent upon the frequency range in use. Three types of coupling are employed as follows:—

(1) Capacitance potential divider is used on ranges A and B occupying the low frequency end of the signal generator.

(2) Tapped inductance is used on ranges C and D operating at the middle frequencies of the coverage of the signal generator.

(3) Tapped inductance and capacitance coupling is used on the high frequency range E.

17. The turret of the amplifier stage is similar to that of the master oscillator in that each range has separate fixed plates which together with one set of variable plates form the main tuning capacitor ganged to the main tuning control (*para.* 14).

18. The capacitance coupling between the amplifier valve V6 and its tuned circuits is similar to that described in para. 15 except it applies only to the anode of the valve. All the ranges of the amplifier have inductive coupling between the output of the amplifier and the piston type attenuator.

19. The attenuator is continuously variable throughout its range and it provides a constant output impedance of 50 ohms. The dial of the attenuator has four scales described in para. 4. The attenuator is inductively coupled to the RF carrier monitoring circuit consisting of the rectifier crystal X1 and the CARRIER LEVEL meter M1. The scale of the meter includes a SET CARRIER reference mark, but the scale is extended to twice the level of the reference mark to provide facilities for setting the RF output when operating at levels exceeding 1V (*para.* 8).

20. In order to conserve the life of the disc-seal master oscillator valve V2, facilities exist to operate the valve below its permitted rating. This is accomplished by introducing a series resistor in the HT supply to the valve when the NORMAL/HIGH switch is set to the NORMAL position. This provides a nominal RF output of 0·5V which is adequate for the majority of purposes for which the signal generator is normally used. To provide for higher output levels which cannot be obtained with the switch in the NORMAL position, the switch has a HIGH position which short circuits the resistor and the valve V2 operates near its maximum anode dissipation. It should be noted that at certain frequencies a CW signal of 2V can be obtained with the switch set to the NORMAL position. As far as possible the equipment should be operated in the NORMAL position and the HIGH setting used only when essential to obtain the required RF level.

21. Internal sine-wave modulation is obtained from a 1 000 c/s oscillator V7 which drives the modulator amplifier valve V9. The output of this valve is then fed to the cathode of the RF amplifier V6. The modulation level is determined by the SET MOD LEVEL control which is used to adjust the level of the output of the 1 000 c/s oscillator V7 to the modulator amplifier V9. The modulation percentage is indicated by the MODULATION meter. The rectified output from X1 is fed to the amplifier valve V8A and thence to the cathode follower V8B. The output of this valve is rectified by X3 and then fed to the MODULATION meter which is calibrated in percentage modulation. The output of the modulator stage is sufficient to provide 30 per cent modulation over the whole frequency range of the equipment, but this can be extended to 90 per cent at most frequencies within the range of the generator. At certain frequencies the RF drive from the oscillator may be insufficient to give linear modulation up to 90 per cent even with the NORMAL/HIGH switch set to HIGH.

22. For sine or pulse external modulation, the internal oscillator valve V7 is switched off and the external modulating signals are fed in at the SINE terminals or PULSE socket as applicable. The signal levels and other information is given in para. 6 and 7.

23. The crystal check circuit is an independent sub-unit except for the HT and LT power supplies which are both obtained from the power unit of the signal generator. To differentiate between the components of this sub-unit and those of the signal generator itself, the components of the crystal check circuit are prefixed with the fig. 2 in the subsequent paragraphs. The crystal oscillator consists of the double triode 2V1, one-half of this valve uses a crystal operating at a frequency of 2 Mc/s, while the other half uses a crystal frequency of 10 Mc/s. The CRYSTAL CHECK switch has three positions as follows:—

(1) OFF. In this position the HT is switched off and the crystal oscillator is inoperative.

(2) 1. In this position only the 10 Mc/s crystal frequency is available.

(3) 2. In this position both the 10 Mc/s and the 2 Mc/s crystal frequencies are in circuit.

24. The output of the crystal oscillator 2V1 is fed to the valve 2V2 which functions as a mixer. The RF output of the signal generator and that of the crystal oscillator are fed to the frequency changer or mixer and the frequency difference between these two signals is fed to the double triode valve 2V3, which functions as a two-stage audio frequency amplifier. When the signal generator is being tuned to obtain zero beat the audio output from this stage can be heard in the telephones plugged into the PHONES jack on the front panel of the generator. When the CRYSTAL CHECK switch is in position 1, beat notes at incremental frequencies of 10 Mc/s are heard in phones and when position 2 is in use beat notes are heard at 2 Mc/s intervals throughout the frequency range of the generator. To identify beat notes at 10 Mc/s signals, it is only necessary to switch to position 1, when the 10 Mc/s crystal only is in operation.

25. The crystal check circuit can be used to provide a crystal check point at some frequency not given by the combination of the 10 Mc/s and the 2 Mc/s crystals. This is done by removing the 2 Mc/s crystal and substituting an appropriate crystal. Assume the required frequency is 482·3 Mc/s, then a 2·3 Mc/s crystal should be fitted into the position normally occupied by the 2 Mc/s crystal. The upper sideband of 2·3 Mc/s crystal would modulate the 48th harmonic of the 10 Mc/s crystal and this together with the RF output from the signal generator could be used to produce zero beat at a frequency of 482·3 Mc/s.

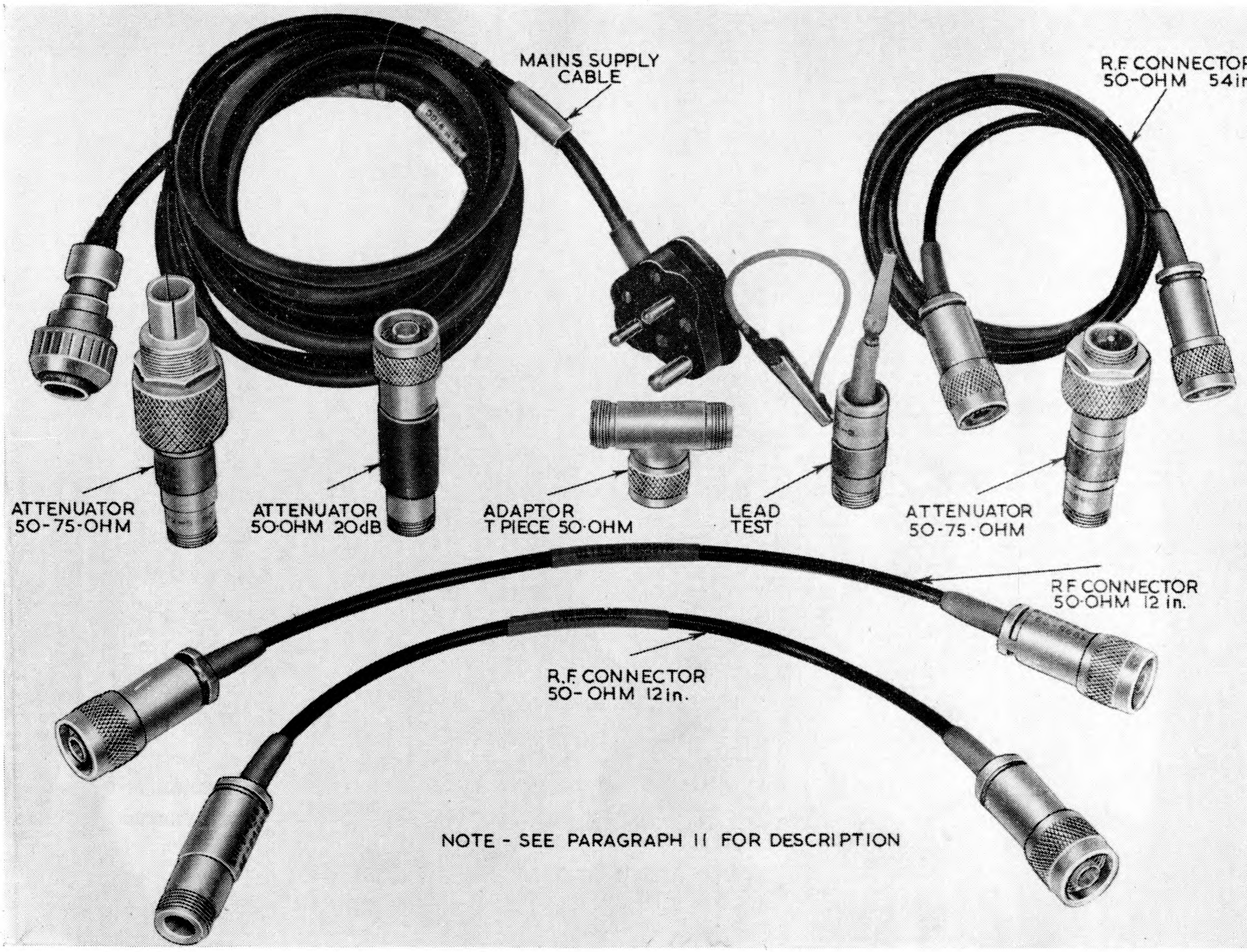

Fig. 2. Accessories

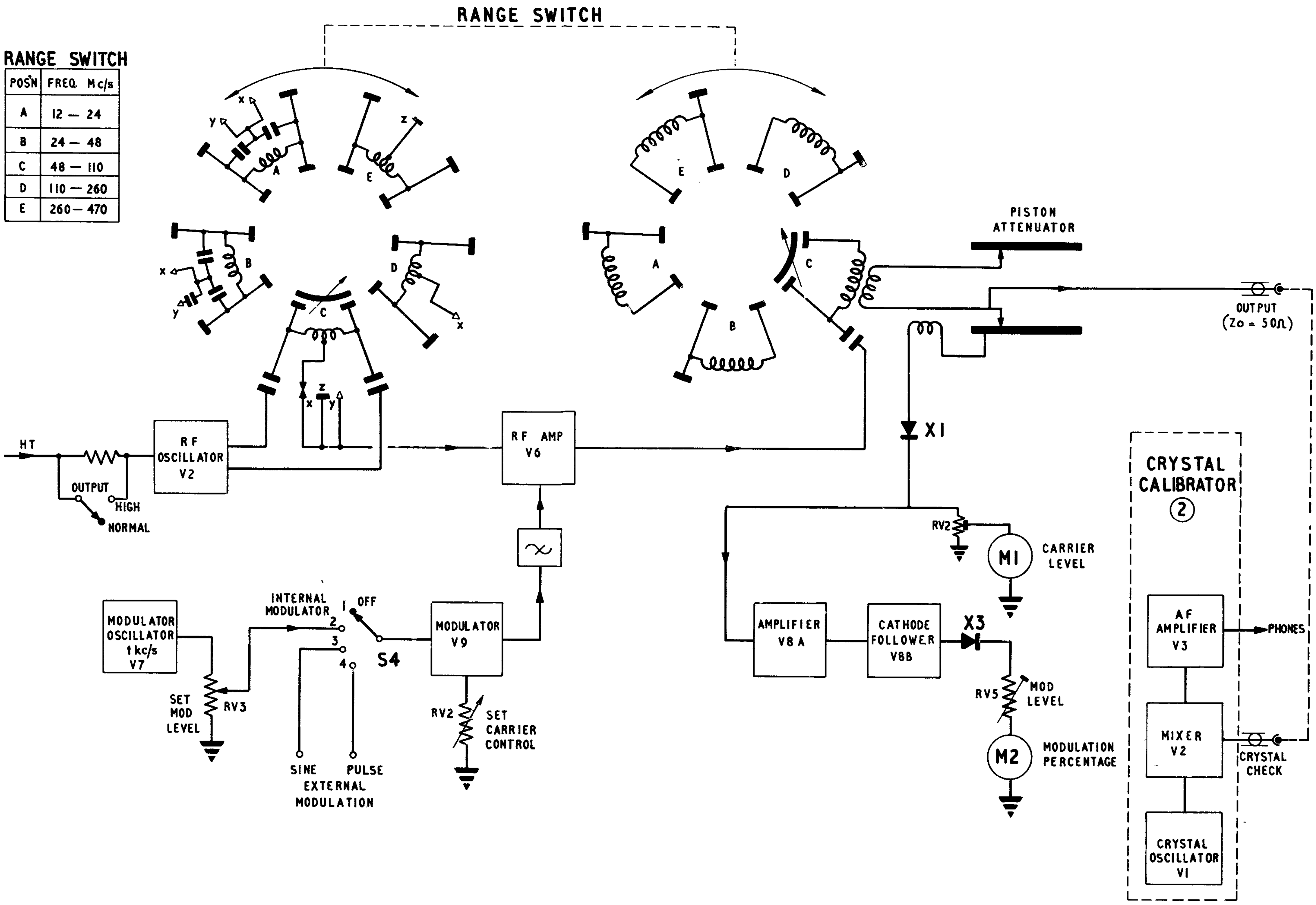

Fig.3 Signal generator CT 394 - functional diagram Fig.3

Chapter 2

OPERATING INSTRUCTIONS

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General

1. The signal generator CT394 (*Chap.* 1, *fig.* 1) is normally despatched with all the valves in their respective holders and the tappings of the mains transformer adjusted for operation from an AC supply of 230V at 40 c/s to 100 c/s. Before the equipment is used, it is essential to ensure that the tappings are correct for the local AC supply. Instructions for this purpose are given in para. 3 to 7.

Controls

2. All the operational controls, switches, plugs and sockets are brought out to the front panel of the generator and a brief summary of their various functions is as follows:—

(1) SUPPLY. Mains ON/OFF switch. This is associated with a red coloured lamp which glows when the AC mains supply is present at the equipment.

(2) The main tuning dial is operated by the INCREASE FREQUENCY control, the shaft of which supports the incremental dial. The INCREASE FREQUENCY control is used to adjust the ganged tuning capacitors of the master oscillator and the

power amplifier. The frequency is indicated in Mc/s on the main tuning dial in line with a fixed cursor. The dial has six scales, one for each of the five ranges A, B, C, D and E and also one marked 0 to 29 for use with the incremental dial (*sub-para.* (3)). The perspex cover of the main dial is engraved with a cursor line for use as a moveable cursor with the crystal calibrator unit. This moveable cursor is used to provide a reference line for use with the incremental dial when the crystal check point differs from the corresponding frequency engraving on the main tuning dial.

(3) Incremental dial. This is a disc calibrated from 0 to 100 to provide facilities for sub-dividing linearly any required portion of the frequency band of the signal generator. The disc is attached to the shaft of the INCREASE FREQUENCY control by a friction type clutch.

(4) FREQ. TRIM. This is a fine tuning control with two ranges, one with the knob of the control 'pushed in' and the other with it 'pulled out'. The 'pushed in' position is for use at the lower frequency ranges of the signal generator and 'pulled out' (PULL FINE) is for use at the higher frequencies. Clockwise rotation of the knob increases frequency. The knob controls a capacitance flag adjacent to the anode of the oscillator valve V2 and thus permits the capacitance of the anode to earth to be varied as required. With reference to a fixed cursor line on the knob, a rotation of 45 deg. in either direction is available. The control is fitted with convenient click stop positions for use on each range. Intermediate positions between these stops can be used as required. It may be found advantageous to adopt the dual motions of pushing and rotating or pulling and rotating the knob. The dial of the signal generator is calibrated with the FREQ. TRIM cursor line in a central position. Typical frequency variations for a 90 deg. rotation of this control are given in para. 47 at the end of this chapter.

(5) RANGE MC/S. This switch has five positions to correspond with the frequency ranges A, B, C, D and E. The turrets of the master oscillator and power amplifier are ganged to this switch for wave changing purposes.

(6) PEAK CARRIER. This control provides facilities to permit the rotor section of the variable capacitor of the power amplifier to be moved through a small angle independent of the rotor of the capacitor of the master oscillator, thus enabling the power amplifier to be finally tuned to resonance with the master oscillator.

(7) SET CARRIER. Operates in conjunction with the CARRIER LEVEL meter to set the reference level of the RF carrier. For RF outputs not exceeding 1V, with the CARRIER LEVEL set to 1V, the ATTENUATOR control is used to set the actual level of the signal fed to the equipment under test. The scale of the CARRIER LEVEL meter is extended and calibrated from 1V to 2V, and this is used in conjunction with the SET CARRIER control to set the level of the RF output when more than 1V is required. For this purpose the ATTENUATOR must be set to the minimum loss position, i.e. at 1V EMF.

(8) SET MODULATION. Operates in conjunction with the percentage calibrated MODULATION meter to set the modulation depth for internal 1 000 c/s modulation only. When the modulating signal is obtained from an external source, the level of the injected signal must be controlled externally.

(9) CARRIER. This switch is spring-loaded and is normally in the ON position (contacts closed). It is in series with the HT supply to the master oscillator valve V2. The purpose of the switch is to permit the operator to momentarily switch the carrier off and on again for signal identification only. A spring-loaded switch is used to ensure that, during short standby periods the HT supply is not switched off, otherwise the heating and cooling of the valve during such periods would cause comparatively large frequency drifts for several minutes each time the supply was switched on.

(10) OUTPUT. This switch has two positions as follows:—

(a) NORMAL. In this position a calibrated RF output EMF of from 0·1 µV to 0·5V is available and also sine-wave modulation up to not less than 30 per cent.

(b) HIGH. In this position the RF output EMF can be increased to a maximum of 2V unmodulated or 1V modulated at most carrier frequencies. In order to conserve the life of the master oscillator valve, the HIGH position of the switch should be used only when RF output EMF exceeding 0·5V is required and it cannot be obtained in the NORMAL position.

(11) ATTENUATOR. This control is used to adjust the piston attenuator and set the level of the RF output EMF when it lies between 0·1 µV and 1V as indicated on the dial of the attenuator (*para.* 18).

(12) MODULATION. This is a four-position switch as follows:—

(a) OFF. Modulation switched off.

(b) INT. Internal sine-wave at 1 000 c/s switched on.

(c) EXT. SINE. Signal generator switched for sine-wave modulation from an external source.

(d) EXT. PULSE. Signal generator switched for pulse modulation from an external source.

(13) CRYSTAL CHECK. This is a three-position switch as follows:—

(a) OFF. Crystal check circuit switched off.

(b) 1. This position selects the 10 Mc/s crystal to provide crystal check points at intervals of 10 Mc/s over the frequency range of the signal generator.

(c) 2. This position brings both the 2 Mc/s and the 10 Mc/s crystals into circuit and provides crystal check points at 2 Mc/s intervals over the frequency range of the signal generator.

(14) The following plugs and sockets are mounted on the front panel of the signal generator:—

(a) SUPPLY. AC mains supply socket.
(b) RF OUTPUT. Socket. Impedance 50 ohms.

(c) CRYSTAL CHECK. Socket used for feeding the RF output of the signal generator to the crystal check circuit when testing the frequency accuracy of the signal generator.

(d) PULSE. Socket used to connect the signal generator for modulation by pulse signals from an external source.

(e) TERMINALS SINE AND E. These are used to connect the signal generator for modulation by sine-wave signals from an external source.

(15) FUSES. There are two 2A fuses for the AC mains supply and one-150 mA for the HT supply circuit.

(16) PHONES. For use with telephones during crystal calibration for listening for the beat note. Either high or low impedance telephones can be used but high impedance (2 000 to 4 000 ohms) are preferred for the weaker beat notes.

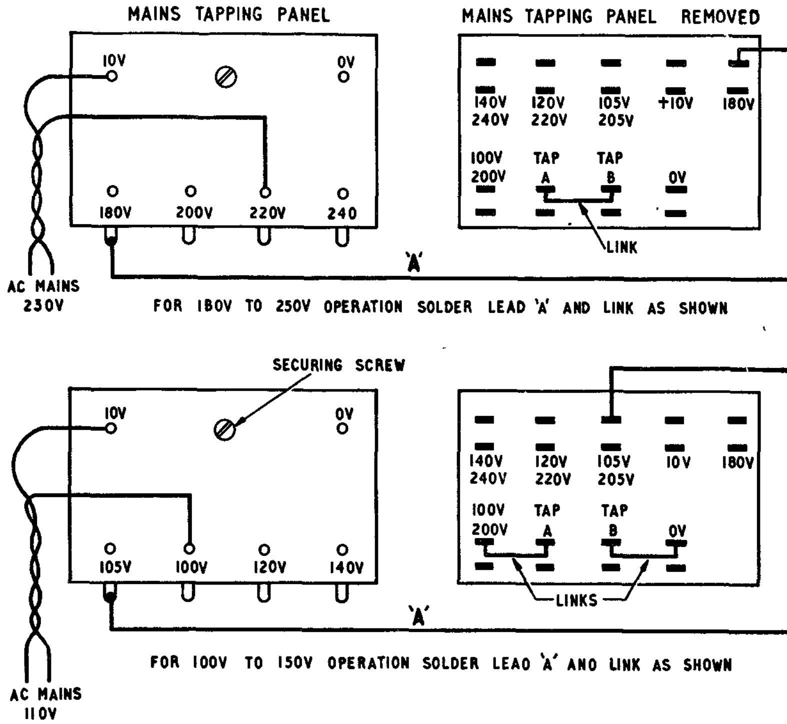


Fig. 1. Mains tappings—adjustments

OPERATING INSTRUCTIONS

Mains tappings

3. If the signal generator is being used for the first time, it is essential that the tappings of the mains transformer are set to the local AC mains supply (45 c/s to 55 c/s) before the mains supply connector is fitted and the equipment switched on. Access to the tapping panel is obtained by removing a cover plate on the right-hand side of the instrument cover, within the cavity serving as a carrying handle.

4. The arrangement of the connections between the tapping panel and the mains transformer is shown in fig. 1. The reversible tapping panel is marked on one side with the voltages applicable to the 180V to 250V range and on the other side with those of the 100V to 150V range. The panel is secured in position by one screw and the panel should be adjusted so that the AC range to be used is uppermost. If the panel is set for operating the equipment over the correct range of voltage it is only necessary to fit the screws of the input mains leads into the appropriate tapping points. The upper part of fig. 1 shows the tapping panel adjusted for 230V operation, while the lower part of fig. 1 shows the panel set for 110V operation.

Removing the cover

5. If the panel is incorrectly set for the local AC mains supply, or if it is required to examine the soldered connections appropriate to the AC mains supply in use, it is necessary to remove the cover of the equipment. The procedure for this is as follows:—

(1) Lay the signal generator face downwards on the bench.

(2) Release the screws holding the four metal domes, which serve as feet for the equipment, and remove the domes.

(3) There are four similar domes at the back of the cover and these should also be removed.

(4) Separate the cover from the rest of the equipment.

180V to 250V operation

6. After removing the cover of the signal generator, the procedure for ensuring that the equipment is set correctly for operation from the AC supply range of 180V to 250V is as follows:—

(1) Take out the screw securing the mains tapping panel to the transformer assembly and remove the panel.

(2) Ensure that the lead marked A in the upper part of fig. 1 is soldered, one end to the 180V tag on the tapping panel and the other end to the 180V tag on the tag panel.

(3) Ensure that a link is soldered between the tags marked TAP A and TAP B on the tag panel and that no other links are connected.

(4) Fit the tapping panel in position with the 180V to 250V tapping range uppermost. (250V is the 240V tapping plus the 10V tapping.) Secure the panel in position with the appropriate screw.

(5) Fit the screws of the two leads of the mains cable into the tappings appropriate to the local AC mains supply.

(6) The cover of the equipment should be fitted by following the reverse of the procedure given in para. 5.

100V to 150V operation

7. After the cover has been removed from the signal generator the procedure for setting the equipment for operation on the 100V to 150V AC range is as follows:—

(1) Take out the screw securing the mains tapping panel to the mains transformer assembly and remove the panel.

(2) Ensure that the lead marked A in the lower part of fig. 1 is soldered, one end to the 105V tag on the tapping panel and the other end to the 105V tag on the tag panel.

(3) Ensure that the links are soldered on the tag panel as follows:—

(a) Between TAP A and the 200V tapping.

(b) Between the TAP B and the 0V tapping.

(4) Fit the tapping panel in position with the 100V to 150V tapping range uppermost. (150V is the 140V tapping plus the 10V tapping.) Secure the tapping panel in position with the appropriate screws.

(5) Fit the screws of the two leads of the mains cable into the tappings appropriate to local AC mains supply.

(6) The cover of the equipment should be fitted by following the reverse of the procedure given in para. 5.

Switching on and warming up

8. After the mains tappings have been correctly set, the mains cable should be plugged into the SUPPLY socket on the front panel of the equipment and also to the mains supply. After this proceed as follows:—

(1) Ensure that the NORMAL/HIGH OUTPUT switch of the signal generator is set to NORMAL (*para.* 2, *sub-para.* (9)).

(2) Set the SUPPLY switch to ON and ensure that the red indicating lamp on the front panel is glowing.

(3) Allow a period of not less than 5 minutes to elapse for the valves to warm up and attain thermal equilibrium.

Important

Where a high order of stability is required, the generator should be operated from a stabilized AC mains supply and the warming up period extended to 30 minutes.

Note . . .

In all the subsequent operating instructions it is assumed that the generator will be switched on and adequate warming up allowed consistent with the stability requirements, and also that the generator will be switched off when it is no longer required.

Range selection (*Chap.* 1, *fig*, 1)

9. The RF oscillator can be tuned over the frequency range of 12 Mc/s to 485 Mc/s in five frequency bands as follows:—

Band	*Frequency range*
A	12 Mc/s to 24 Mc/s
B	24 Mc/s to 48 Mc/s
C	48 Mc/s to 110 Mc/s
D	110 Mc/s to 260 Mc/s
E	260 Mc/s to 485 Mc/s

10. To select the required band, the RANGE MC/S control must be rotated through one and one-fifth turns per band until the mechanism locates positively with the knob of the switch pointing to the required band.

Note . . .

Ensure that the FREQ. TRIM *control is set to its central position before using the main tuning control to select a frequency* (*para.* 2 (4)).

Frequency selection—without use of crystal calibrator

11. The tuning dial is operated by the main tuning control (FREQUENCY INCREASE) which should be rotated until the required frequency is indicated on the main tuning dial. This is when the selected frequency engraved upon the appropriate band scale of the tuning dial coincides with the centre hairline on the fixed cursor of the main tuning dial. This cursor is carried on the perspex sector plate behind the dial cover. An additional cursor is engraved on the perspex cover over the tuning dial. This serves as a moveable cursor for use with the crystal calibrator unit and the incremental dial (*para.* 19).

Incremental dial

12. To facilitate setting the main tuning dial to the correct frequency, an incremental dial is fitted on to the main tuning control. This incremental dial is calibrated linearly from 0 to 100 around the whole of its periphery. The incremental dial plate is attached to the shaft of the tuning control by a friction device so that the zero of the dial can be lined up with its panel cursor. It can be reset to agree with the linear scale of the main tuning dial by holding the knob of the INCREASE FREQUENCY control and rotating the incremental disc until the 0/100 engraving coincides with the white line adjacent to the handle of the knob. The incremental dial can be used to sub-divide linearly any selected portion of the frequency band of the signal generator. The main tuning control turns approximately 30 revolutions to one complete revolution of the main tuning dial.

13. The main tuning dial on each signal generator is individually calibrated and, therefore, only typical figures can be given for the frequency change which occurs for a single division of the incremental dial. These figures are given for the centre of each of the frequency bands and they are of the following order:—

Band	*Frequency*	*kc/s per division of the incremental dial*
A	12 Mc/s to 24 Mc/s	5 kc/s
B	24 Mc/s to 48 Mc/s	10 kc/s
C	48 Mc/s to 110 Mc/s	25 kc/s
D	110 Mc/s to 260 Mc/s	50 kc/s
E	260 Mc/s to 485 Mc/s	100 kc/s

Note . . .

For frequency coverage by the FREQ. TRIM *control see para.* 47.

14. From this it follows that for any given signal generator it is essential to establish the change of frequency which occurs for one division of the incremental dial about a portion of the frequency band which includes the required frequency. This can be accomplished by either of the following two methods:—

(1) Using two adjacent whole numbers of Mc/s engravings on the appropriate scale of the main tuning dial as reference, determine the number of divisions which must be traversed by the incremental dial to cover the frequency band between the selected engravings. This method is described in para. 15 and 16.

(2) Using either the 2 Mc/s or the 10 Mc/s crystal frequency (as appropriate) of the crystal check circuit to establish two adjacent suitable references within the frequency band under investigation, then determine the number of divisions the incremental dial must traverse to cover the frequency band between the two references. This method is described in para. 17.

Tuning using main tuning dial engravings as references

15. The procedure for establishing the frequency change per division of the incremental dial using the engravings of the main tuning dial as references is as follows:—

(1) First set the FREQ. TRIM control to FREQ. PULL and the knob to its central position. Rotate the tuning control knob and, observing the hair line of the cursor, set the main tuning dial at some convenient whole number of Mc/s adjacent to the required frequency on the appropriate scale (*para.* 9).

(2) Rotate the 0-100 incremental dial independently of the tuning control knob, so that its engraving 0 coincides with the cursor of the incremental control. Ensure that the frequency indicated on the main tuning dial has not changed.

(3) Carefully rotate the main tuning control until the frequency indicated on the main tuning dial has changed by a whole number of Mc/s. During this operation it is essential to watch the incremental dial to observe whether or not it makes more than one complete revolution during this tuning operation. Make a note of the number of incremental divisions which have been traversed by the incremental dial during the frequency changing operation. Ascertain the actual frequency change which is the difference between that obtained in operation (1) and the current indication.

(4) Divide the frequency change obtained in operation (3) by the number of incremental divisions of the incremental dial which caused the change. This will give the frequency change per division of the incremental dial for that part of the frequency band under investigation.

16. The following example illustrates the method described in para. 15 for finding the incremental frequency change per division of the incremental dial. It is assumed that the required frequency is 194·860 Mc/s.

(1) Set the RANGE MC/S control to band D.

(2) Rotate the main tuning control and set the main tuning dial to 190 Mc/s on scale D.

(3) Rotate the incremental dial independently of the main tuning control and set the incremental dial to 0. Ensure that the setting of the main tuning dial is unchanged from 190 Mc/s.

(4) Rotate the main tuning control until the main tuning dial indicates 200 Mc/s (assume that, to achieve this frequency change of 10 Mc/s, the incremental dial has turned one complete revolution plus a further 85 divisions, making a total of 185 divisions).

(5) A change of 1 division of the incremental dial in the frequency band of 190 Mc/s to 200 Mc/s corresponds with a nominal frequency change of 54·05 kc/s per division, *i.e.*

$$\frac{10{,}000 \text{ kc/s}}{185 \text{ divisions}} = 54{\cdot}05 \text{ kc/s per division}$$

For practical purposes this can be regarded as 54 kc/s.

(6) The difference between the required frequency of 194·860 Mc/s and the reference frequency of 190 Mc/s (*operation* (2)) is 4·860 Mc/s

or 4,860 kc/s. The difference frequency is equal to 90 divisions of the incremental dial, that is

$$\frac{4{\cdot}860 \text{ kc/s}}{54 \text{ kc/s}} = 90 \text{ divisions}$$

(7) From sub-para. (1) to (6) it follows that the signal generator can be tuned to 194·860 Mc/s by the following method:—

(a) Set the RANGE MC/S control to range D (*para.* 10).

(b) Using the main tuning control and the cursor of the tuning dial set the tunng dial to 190 Mc/s on the appropriate scale.

(c) Rotate the incremental dial independently of the main tuning control to set 0 division opposite the cursor of the incremental dial. Ensure that the main tuning dial remains set to 190 Mc/s.

(d) Finally rotate the main tuning control until the 90 divisions mark on the incremental dial coincides with the incremental cursor.

Note . . .

The main tuning dial of the signal generator is substantially linear with respect to frequency. Where a departure from this law occurs it will generally be in the upper quarter of each of the five frequency bands of the signal generator. For general working over the lower three-quarters of each of the frequency bands, it will be sufficient only to establish the relationship between the frequency change per division of the incremental dial at a point near the centre of each frequency band. This relationship can then be used over the whole of the lower three-quarters of the appropriate band. However, when working in the upper quarter of any of the frequency bands, or when a high degree of accuracy is required in part of these bands, the relationship between the frequency change per division of the incremental dial should be established over a small portion of the frequency band which includes the required frequency. The method for establishing this relationship is described in para. 15 *and* 16.

Tuning using crystal calibrator as a reference

17. The crystal calibrator circuit (*Chap.* 1, *para.* 23 *to* 25) is brought into operation by first fitting the T piece adaptor between the RF output socket of the signal generator and the CRYSTAL CHECK socket. To avoid a rigid assembly use the two 12 in. RF connectors (*Chap.* 1, *para.* 11 (1) *and* (5)). Then set the CRYSTAL CHECK switch to position 1 or 2 as required. In position 1, the 10 Mc/s crystal oscillator only is in circuit and the harmonics of this oscillator are mixed with the RF signal from the generator, therefore, beat notes at 10 Mc/s intervals will be heard in the telephones. With the CRYSTAL CHECK switch in position 2, both the 10 Mc/s and the 2 Mc/s crystal oscillators are in circuit and the 10 Mc/s frequency is then modulated by the 2 Mc/s frequency. This causes beat notes at 2 Mc/s intervals to be heard in the telephones. At lower frequencies of the signal generator, weak beat notes will often be heard at intermediate points. These are due to second harmonics of the signal generator beating with whole numbers of harmonics of the 10 Mc/s crystal. These occur when nF is approximately equal to 2f (where n is a whole number, F is the 10 Mc/s crystal frequency and f the frequency of the signal generator). An example is given at the end of this paragraph. To obtain satisfactory results the output EMF from the signal generator will vary between about 10 mV and 100 mV according to the frequencies for which crystal check points are required.

Example:—*Assume that the signal generator is set to* 15 *Mc/s, its second harmonic* (2*f or* 30 *Mc/s*) *is equal to the third harmonic of the* 10 *Mc/s crystal* (3*F or* 30 *Mc/s*). *From this it follows that a beat difference between these two signals can give a beat note in the telephones. Zero beat will be obtained at* 15 *Mc/s.*

18. To facilitate using the crystal calibrator with the incremental frequency dial, the moveable cursor engraved on the perspex cover of the main tuning dial (*para.* 2) should be set exactly over the point to which the main tuning dial has been set to obtain zero beat. The setting of the moveable cursor should now be used as a reference point when operating the incremental frequency dial. The moveable cursor will provide a more accurate indication of the zero beat setting for a given frequency, and also that of the incremental frequency over a small angle either side of the calibration zero beat point, than the fixed cursor.

19. The procedure for using the crystal calibrator is as follows:—

(1) Assume that the required frequency is 194·240 Mc/s.

(2) Select the 10 Mc/s crystal by setting the CRYSTAL CHECK switch to position 1.

(3) Fit the T piece adaptor and the two 12 in. RF connectors between the RF output socket and the CRYSTAL CHECK socket and also a pair of telephones into the PHONES jack.

(4) Set the RANGE MC/S switch to range D.

(5) Using the tuning control set the main tuning dial to 190 Mc/s on scale D. A beat note should be heard in the telephones, providing the scale of the generator is accurate, in any case not more than a very slight adjustment should normally be necessary. Carefully tune the signal generator for zero beat. It may be necessary to adjust the level of the RF output (*para.* 17) to obtain a beat note.

(6) Carefully set the moveable cursor on the perspex cover of the main tuning dial so that it is directly over the zero beat setting of the main tuning dial.

(7) Rotate the incremental dial independently of the tuning control and set the incremental dial to 0 divisions. Ensure that the setting of the main tuning dial has not been disturbed.

(8) Rotate the tuning control in a clockwise direction and observe the number of divisions which are traversed by the incremental dial to reach the next beat note which occurs at 200 Mc/s. Carefully tune the signal generator for zero beat.

(9) Assume that 196 divisions are traversed by the incremental dial to cover the 10 Mc/s between 190 Mc/s and 200 Mc/s, then each division causes a frequency change of 51·02 kc/s (which can be regarded as 51 kc/s for practical purposes).

(10) The required frequency is 194·182 Mc/s, therefore the number of incremental divisions which correspond to the difference between the reference frequency of 190 Mc/s and 194·182 Mc/s is

$$\frac{4\ 182 \text{ kc/s}}{51 \text{ kc/s}} = 82 \text{ divisions}$$

(11) To tune the signal generator to 194·182 Mc/s, first set the main dial to the 190 Mc/s beat note, then set the incremental dial independently of the main tuning control to 0 divisions. After this rotate the main tuning control until the mark for 82 divisions coincide with the cursor of the incremental dial.

(12) When the relationship between the frequency and the incremental divisions has been established at or near the centre of the frequency band of each range, the signal generator should be used in accordance with the information contained in the note following para. 16.

(13) Where a greater degree of accuracy is required, the 2 Mc/s crystal can be switched into circuit, to modulate the 10 Mc/s frequency. This will provide zero beat signals at 2 Mc/s intervals throughout the frequency range of the signal generator. The procedure for doing this is as follows:—

(a) First find the nearest 10 Mc/s signal adjacent to the required frequency. In this paragraph the frequency chosen (*operation* (5)) is 194·182 Mc/s, therefore the nearest 10 Mc/s signal is 190 Mc/s.

(b) Set the CRYSTAL CHECK switch to position 2 and rotate the main tuning control to obtain the second 2 Mc/s beat note, that is, 194 Mc/s. Set the movable cursor to coincide with the zero beat setting of the main tuning dial.

(c) Set the incremental dial to 0 and then rotate the main tuning control and make a note of the number of incremental divisions traversed by the incremental dial to obtain zero beat at the next 2 Mc/s signal. After this the procedure is the same as that given in operations (9) to (12).

Use of crystal calibrator for spot frequencies

20. The crystal calibrator can be used to obtain a crystal check point at some frequency not given by the combination of the 10 Mc/s and the 2 Mc/s crystals. This is done by opening the crystal cover plate at the back of the signal generator, removing the 2 Mc/s crystal and substituting an appropriate crystal. Assume the required frequency is 362·4 Mc/s, a 2·4 Mc/s crystal should be fitted into the position normally occupied by the 2 Mc/s crystal. The preferred crystal is Style D to DEF 5271 (dated 23/4/57). The upper sideband of the 2·4 Mc/s crystal can be used to modulate the 36th harmonic of the 10 Mc/s crystal and this, together with the RF output from the signal generator, will produce zero beat at a frequency of 362·4 Mc/s. The procedure for using this method is similar to that given in para. 19 with the exception that the incremental dial is not required.

Attenuator

21. The output impedance of the generator is 50 ohms. The ATTENUATOR dial has four scales as follows:—

(1) A dB μV scale calibrated from −20 dB to +120 dB to indicate the output EMF in dB relative to 1 μV.

(2) An EMF scale calibrated from 0·1 μV to 1V which indicates the output EMF directly.

(3) A dBm scale calibrated from +7 dB to −130 dB to indicate the power delivered to an external 50-ohm load in terms of dB relative to 1 mW.

(4) The fourth and inner scale is calibrated from 0 to 70 to indicate the power output to an external load in dB relative to thermal noise for a bandwidth of 10 kc/s. At present this scale has no service application.

Note . . .

In the subsequent paragraphs the references to RF output level apply only when the output is being fed direct from the signal generator to the equipment ucnder test. When the T-piece connector is being used and connection made to the crystal calibrator a degree of mis-match will be introduced. The setting of the attenuator dial will continue to give an accurate measurement of the source EMF and can, therefore, be used to make changes of the RF level but the absolute level fed to the equipment under test will be reduced by approximately 6 dB.

Normal output

22. With the OUTPUT switch set to NORMAL and the SET CARRIER control adjusted to set the pointer of the CARRIER LEVEL meter to the SET CARRIER mark, the scales of the ATTENUATOR dial are direct readings in the units appropriate to the scale being used. The nominal rated RF output to be obtained under normal operating conditions is between 0·1 µV and 0·5V. It is important to note that the instrument is calibrated in terms of open circuit EMF and, therefore, the output level must be set to twice that required to be fed to the equipment under test.

Increased output to 1V

23. Should it be necessary to increase the RF output of the generator to a value between 0·5V and 1V, the portion of the ATTENUATOR dial calibration above 0·5V can be used. At these high settings of the attenuator, the coupling between the attenuator and the tuned RF amplifier stage is sufficient to reduce the output from the amplifier. Therefore, at some frequencies it may be necessary to set the OUTPUT switch to HIGH in order to bring the readings of the CARRIER LEVEL meter to the SET CARRIER mark, or to obtain the required modulation percentage.

Increased output to 2V

24. Facilities are available to extend the RF output range to 2V. Where this is required, the ATTENUATOR control should be set to 1V which removes the last 6 dB of the attenuation and permits the output stage of the signal generator and the external load to be tightly coupled. With the SET CARRIER control adjusted to set the pointer of the CARRIER LEVEL meter to the SET CARRIER mark, the output EMF is 1V. From this point the scale of the CARRIER LEVEL meter is calibrated up to a maximum of 2V. The SET CARRIER control is then used to set the RF output to the required open circuit level of between 1V and 2V. If it is not possible to obtain the required output with the OUTPUT switch set to NORMAL, the switch should be put in the HIGH position. It is important to note that there may be some frequencies where the maximum output of 2V cannot be obtained with the equipment set for HIGH level operation. The extended range of 1V to 2V can be used for continuous wave operation only.

Warning

To conserve the life of the master oscillator valve it is essential that the HIGH *output position is used only when the required RF output cannot be obtained with the equipment set for* NORMAL *operation.*

Continuous wave operation

25. The following is the procedure for setting up the signal generator for CW operations:—

(1) Set the OUTPUT switch to NORMAL.

(2) Set the SUPPLY switch to ON and ensure that the red pilot lamp glows. Allow at least 5 minutes to elapse for stabilization purposes before tuning the signal generator. If a high degree of accuracy is required a stabilized AC mains supply should be used and the warming-up period should be extended to 30 minutes.

(3) Ensure that the MODULATION and the CRYSTAL CHECK switches are set to OFF.

(4) Set the RANGE MC/S control to the appropriate range. Rotate the control one and one-fifth turns for each range through which it is turned and ensure that the mechanism locates positively and that the knob points to the required range.

(5) Tune the signal generator to the required frequency in accordance with the information contained in para. 9 to 20 as applicable.

(6) Set the ATTENUATOR dial to the required open-circuit voltage.

(7) Adjust the SET CARRIER control to obtain a deflection on the CARRIER LEVEL meter. If a reading cannot be obtained, turn the SET CARRIER control to a point corresponding with three-quarters of its travel in a clockwise direction.

(8) Carefully tune the PEAK CARRIER control for maximum reading on the CARRIER LEVEL meter. The SET CARRIER control must be adjusted as required to keep the pointer of the CARRIER LEVEL meter on the scale.

(9) Adjust the SET CARRIER control to set the pointer of the CARRIER LEVEL meter to coincide with the SET CARRIER (*red*) mark on the scale of the meter.

(10) Connect the equipment to be tested via the RF output connector to the RF OUTPUT socket on the signal generator.

(11) If the signal level required from the signal generator cannot be obtained with the OUTPUT switch set to NORMAL, the switch should be put in the HIGH position and the signal level set in accordance with operations (7) to (9).

(12) If the required RF output is between 1V and 2V, set the ATTENUATOR to 1V. Then using the SET CARRIER control in conjunction with the 1V to 2V scale on the CARRIER LEVEL meter set the pointer to the required output voltage. It may be necessary to set the OUTPUT switch to HIGH in order to obtain the required reading on the CARRIER LEVEL meter.

Sine-wave modulation—internal

26. For internal modulation purposes the signal generator includes a 1 000 c/s sine-wave oscillator. It must be remembered that RF output levels exceeding 1V cannot be modulated. The procedure for internal modulation is as follows:—

(1) Set the MODULATION switch to INT.

(2) Tune the signal generator and set it to the required level as for continuous wave described in para. 25 (1) to (11).

(3) Adjust the SET MODULATION control to give the required modulation percentage as indicated on the MODULATION meter.

(4) Ensure that the reading on the CARRIER LEVEL meter is maintained at the SET CARRIER mark by making any adjustment of the SET CARRIER control that may be necessary.

(5) With the RF output switch set for NORMAL operation, difficulty may be experienced in obtaining modulation depth exceeding 30 per cent and aso maintaining the CARRIER LEVEL meter reading at the SET CARRIER mark. Under these circumstances the OUTPUT switch should be set to HIGH and the SET CARRIER, PEAK CARRIER and SET MODULATION control adjusted to obtain the correct operating conditions. Do not use the HIGH output position unless necessary.

Sine-wave modulation—external

27. The external sine-wave source should be connected to the EXTERNAL MOD SINE and E terminals on the front panel of the signal generator. The impedance presented between these terminals to the external modulating source is nominally one megohm resistive shunted by a capacitance of 100 pF. An external input of about 1V RMS is required to produce 30 per cent modulation. When the MODULATION switch is set to EXT SINE, the frequency characteristic of the modulating circuits is ±1 dB with reference to 1 kc/s.

28. The procedure for external sine-wave modulation is as follows:—

(1) Set the MODULATION switch to the EXT SINE position.

(2) Connect the external sine-wave source to the EXTERNAL MOD terminals marked SINE and E.

(3) Tune the signal generator and set it to the required level as for continuous wave described in para. 25 (1) to (11).

(4) Adjust the level of the sine-wave input from the external source to give the required modulation percentage as indicated on the MODULATION meter.

(5) Ensure that the reading on the CARRIER LEVEL meter is maintained at the SET CARRIER mark by making any adjustment of the SET CARRIER control that may be necessary.

(6) If the equipment is being operated with the OUTPUT switch set to NORMAL and a modulation depth in excess of 30 per cent is required, it may be necessary to operate the signal generator with the OUTPUT switch set to HIGH. Under which circumstances, the SET CARRIER, and the PEAK CARRIER controls must be adjusted to obtain the correct operating conditions.

Note . . .

Since the amplifier only is switched by the pulse, whilst the oscillator remains active continuously, there will be a certain amount of 'break through' at all carrier frequencies. In general, the unwanted signal in the 'off pulse' condition will be at least 60 dB down with reference to the 'on pulse' condition, but the rejection is a function of carrier frequency and stray capacitances, etc., of any given signal generator. This break-through may be a source of considerable trouble when working with logarithmic response IF amplifiers. The design has been carefully investigated and it is not possible to switch both oscillator and amplifier without considerable re-design and loss of present facilities. For Admiralty use (between 5 Mc/s and 75 Mc/s) signal generator CT215 should be used.

Pulse modulation—external

29. For external pulse modulation, the MODULATION switch should be set to EXT PULSE and the external source connected to the EXTERNAL MOD PULSE socket. Under these conditions the pulse source is connected direct to the control grids of the modulator valve; otherwise the internal circuits of the signal generator remain the same as that for continuous wave. Therefore, in the absence of an input from the pulse source, the signal generator gives a normal continuous wave output.

30. The impedance presented at the PULSE input socket to the external modulating source is nominally 1 megohm shunted by 50 pF. The external source must supply an input of not less than 25V pulse amplitude for satisfactory modulation. However, for the best carrier suppression and time of rise, an input of about 50V should be used.

31. The RF bandwidth of the signal generator changes with carrier frequency; it is approximately 500 kc/s when the equipment is tuned to 12 Mc/s and it increases to about 3 Mc/s at the 485 Mc/s end of the frequency range. These bandwidths correspond to video frequency responses of 250 kc/s and 1·5 Mc/s respectively.

Square-wave modulation—external

32. If a square wave of unity mark/space ratio is applied to the PULSE input socket, the mean level of the carrier, which is ON during the positive periods, is reduced by half and there is a corresponding reduction in the reading on the CARRIER LEVEL meter. When the SET CARRIER control has been adjusted to set the pointer of the CARRIER LEVEL meter to the SET CARRIER mark, the output level is such that the RMS voltage during the positive periods is equal to twice that indicated on the ATTENUATOR dial.

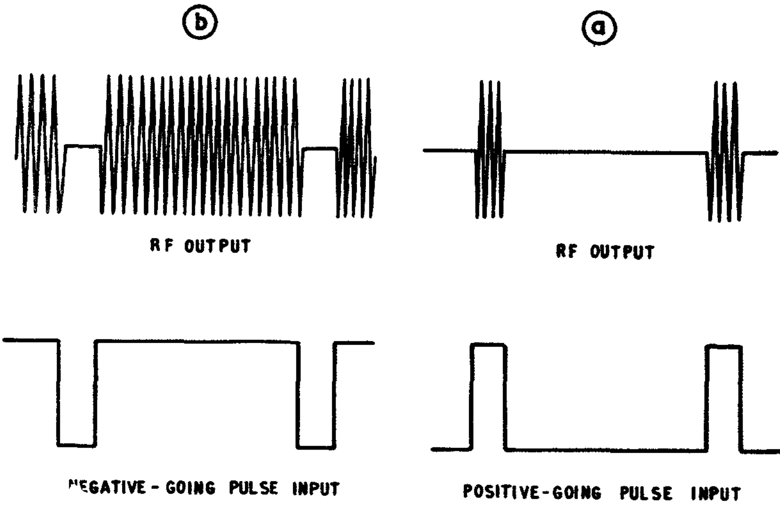


Fig. 2. Pulse modulation — waveforms

33. Unless the square wave is completely negative going with respect to zero, a blocking capacitor must be connected in series with the external source and the PULSE socket. The capacitance must be large enough to give, in conjunction with the 1 megohm grid leak of the modulator valve, a time constant which is long compared with the periodic time of the square wave input. By this means the square wave is restored to the correct mean DC level by the diode action of the grid and cathode of the modulator valve.

Positive pulse modulation

34. A positive-going pulse input signal can be used to produce the usual type of pulse-modulated RF output where the ON period is the duration of the pulse ((a) of *fig*. 2). The mean RF output level is not sufficient to cause any significant deflection of the CARRIER LEVEL meter and, therefore, it is not possible to monitor the output voltage directly on the meter but the ATTENUATOR can still be used to adjust the level of the output. In order to provide a means of measuring the RF output during the positive pulse period, it is necessary to use an external DC restorer circuit incorporating a battery; if the RF output level is not important, however, the external circuit can consist of an input capacitor only.

35. The procedure for external positive-pulse modulation is as follows:—

(1) Construct a DC restorer circuit as shown in fig. 3. The components are as follows:—

(a) Germanium crystal diode (either Type CV425 or CV448 is suitable).

(b) Variable DC source consisting of a battery of about 10V and a 10K potentiometer.

(c) Two 0·1 μF capacitors.

It is important to ensure that the diode is connected, as shown, with the electrode corresponding with the anode of a thermionic diode connected to the inner conductor of the PULSE socket. It is also important that the crystal diode has a relatively high backward resistance.

(2) Set the MODULATION switch to EXT PULSE. Then with no pulse input, turn the SET CARRIER control of the signal generator to maximum, tune the signal generator as for continuous wave operation (*para.* 25 (1) to (6)). Adjust the PEAK CARRIER control for maximum reading on the CARRIER LEVEL meter, using the external potentiometer to maintain the pointer on the scale and also to set the pointer to the SET CARRIER mark.

(3) Connect the external positive-going pulse source via the capacitor C1 (*as shown in fig* 3) to the PULSE socket of the signal generator. The RMS voltage output during the pulse periods will be determined by the setting of the ATTENUATOR and can be read directly from the EMF scale on the dial of the attenuator.

36. When the absolute output RF level is unimportant during external positive pulse modula-

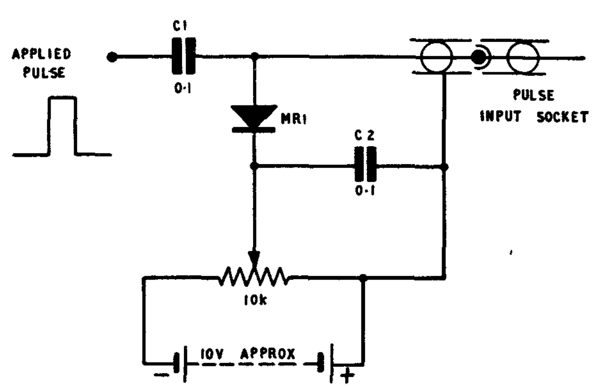


Fig. 3. Positive pulse modulation — input circuit

tion, the input signal may be fed via a single input capacitor to the PULSE socket of the signal generator. This capacitor is in series with the input signal and its capacitance should be such that its time constant in conjunction with the 1 megohm grid leak of the modulator valve is large compared with the periodic time of the pulse signal. With the external pulses applied in this way, the modulator valve, by normal self-bias action, DC-restores the positive peaks of the pulses to zero as described for square-wave modulation (*para.* 33). When the positive-going pulses are applied in this way, the signal generator should be regarded as uncalibrated in respect of absolute output level. The attenuator can, however, be used to vary the output level and its decibel scales can be used to make known increments or decrements in the output level.

Negative pulse modulation

37. The application of negative-going pulses from an external source can be made directly to the PULSE socket of the signal generator. The effect of these pulses is to suppress the RF output for the duration of the applied pulse ((b) of *fig.* 2). Providing that the pulse length is not more than five per cent of the complete cycle, and that the signal generator is set up for CW operation with the SET CARRIER and PEAK CARRIER controls adjusted to set the pointer on the CARRIER LEVEL meter to the SET CARRIER mark, the amplitude of the RF output signal is very nearly equal to the level indicated on the ATTENUATOR dial.

RF output arrangements

38. The accessories for use with the signal generator are to be obtained separately. These items are listed in Part 1, Chap. 1. The circuits of these items together with a technical description is to be found in Part 1, Chap. 3, which describes the circuit of the signal generator. The operating instructions for the use of these accessories are given in the subsequent paragraphs.

RF output connectors 54 in. and 12 in.

39. The RF output connectors have an impedance of 50 ohms and are fitted with a Type N plug at each end. They can be fitted directly between the signal generator and the equipment under test as shown at A of fig. 4. The generator can be regarded as a zero-impedance voltage generator in series with a resistance of 50 ohms and, when the input impedance of the equipment under test is also 50 ohms, therefore, the voltage V_L across the load Z_L is equal to $\frac{E}{2}$ (where E is the source EMF as indicated on the ATTENUATOR dial when the CARRIER METER is set to 1V or the SET CARRIER mark). Alternatively if the HIGH output is being used and the ATTENUATOR dial set to zero dB, V_L is half of the reading on the meter. Where the impedance of the equipment under test differs from 50 ohms, the load voltage V_L is calculated as follows:—

$$V_L = \frac{E \times Z_L}{50 + Z_L}$$

(Where E is the source EMF, 50 ohms the source impedance and Z_L the load impedance.)

Attenuator pad—20 dB (*Chap.* 1, *fig.* 2)

40. The 50-ohm attenuator pad (20 dB) may be used where the input impedance of the equipment under test differs from that of the output impedance (50 ohms) of the signal generator and it is important that the signal is derived from a source impedance of 50 ohms. The arrangements of the attenuator pad are such that the variation of the load impedance from zero to infinity does not cause the effective line terminating resistance to vary from its correct value by more than 1 ohm (approximately); thus, errors due to standing waves on the line are avoided. The pad can only be used where it is possible to tolerate the insertion loss of 20 dB. When the pad is in use, the voltage standing wave ratio is always better than 1·2, providing that signal level is less than 10 mV (EMF). The pad is fitted with a Type N socket at one end for coupling it to the output socket of the 50-ohm RF connector. The other end of the pad has a Type N plug for fitting into the socket of the equipment under test. The attenuator pad should always be connected (B of *fig.* 4) between the output end of the 50-ohm RF connector and the equipment under test to ensure that the voltage standing wave ratio is maintained at its best.

Note . . .

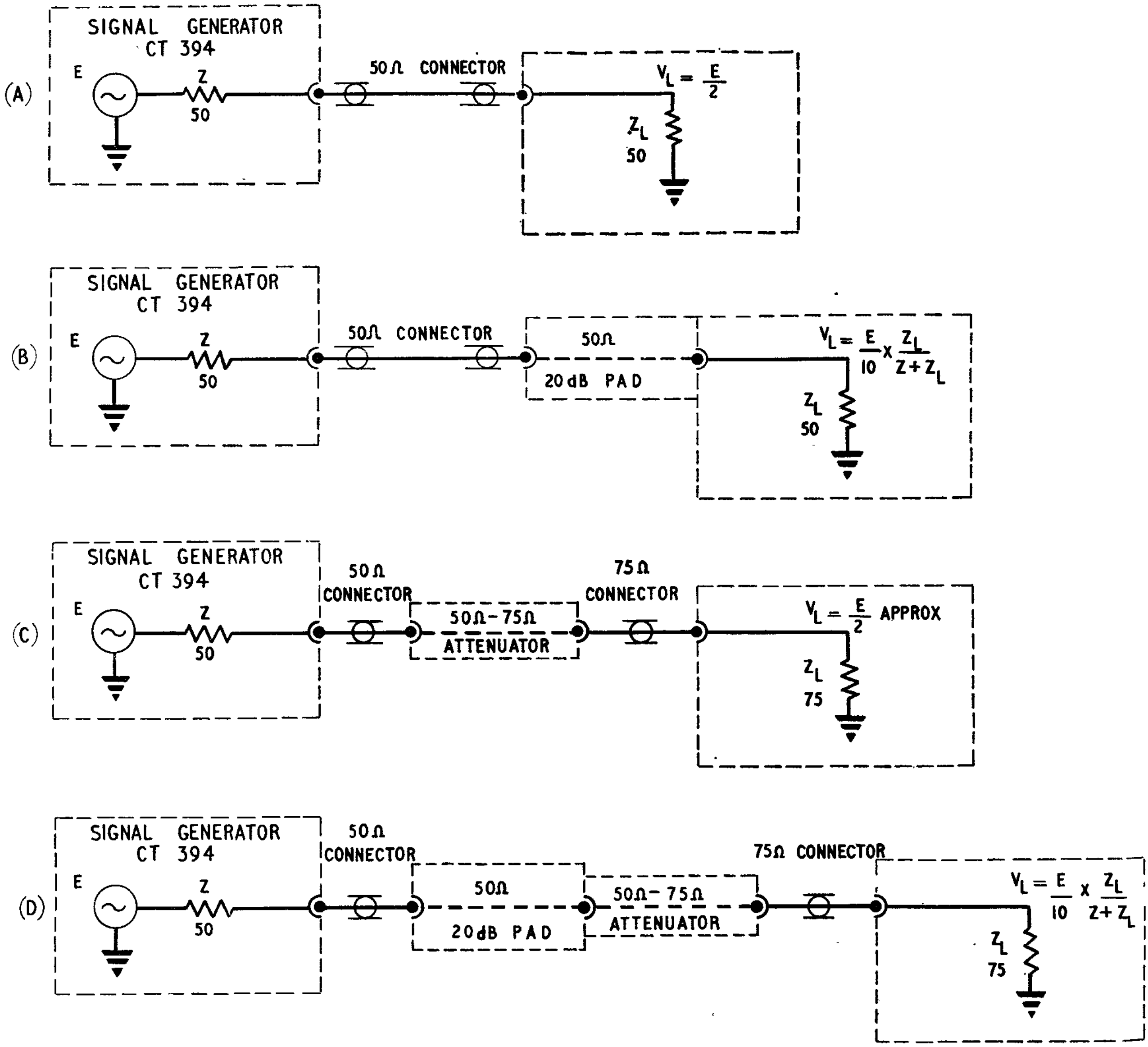
It is always advisable to use the attenuator pad if the insertion loss can be tolerated, particularly when operating at the higher frequency ranges of the equipment. With the 20 dB pad in circuit the effective EMF relative to the setting of the ATTENUATOR *dial is reduced by 20 dB.*

41. Where E represents the voltage output of the signal generator as indicated on the ATTENUATOR dial or, where the voltage exceeds 1V, as shown on the scale of the CARRIER LEVEL meter, 50 ohms is the output impedance of the signal generator and Z_L the impedance of the equipment under test. The effective voltage V_L across the load can be calculated as follows:—

$$V_L = \frac{E}{10} \times \frac{Z_L}{50 + Z_L}$$

75-ohm impedance matching units

42. To widen the range of equipment with which the signal generator can be used, two types of 50-ohm to 75-ohm matching units or adaptors are available for use when it is important that the signal is derived from an impedance source of 75 ohms. Each of these units incorporate a 25-ohm resistor which, when a unit is in use, is in series with the 50-ohm impedance of the signal generator and thus increases the effective impedance of the generator to 75 ohms. Each unit has a Type N socket at one end for connecting the unit to the signal generator via a 50-ohm RF connector (*Chap.* 1, *para.* 11 (3)). The output end of one of the units has a plug which mates with a socket 0560044, whilst the output end of the other unit has a plug which mates with a socket AP61340 (C of *fig.* 4). It will be appreciated that if the 50-ohm connector is used it will be mismatched at its output end and,



THERE ARE TWO TYPES OF 75 OHM ATTENNUATOR FOR THEIR USES SEE PART 1, CHAP. 1

E = SOURCE EMF
Z = SOURCE IMPEDANCE
Z_L = LOAD IMPEDANCE
V_L = VOLTAGE ACROSS LOAD

Fig. 4. Accessories—interconnections

therefore, if the insertion loss of the 20 dB attenuator pad can be tolerated it should be fitted between the signal generator and the matching unit (D of *fig.* 4). The effective source EMF or open circuit RF output voltage will then be −20 dB relative to the setting of the ATTENUATOR dial. Establishments having suitable 75-ohm connectors should use them in preference to the 50-ohm RF connector when testing equipment having an input impedance of 75 ohms.

43. With a 75-ohm matching unit in use with the 50-ohm RF connector the voltage across the load is calculated as follows:—

$$V_L = \frac{E \times Z_L}{75+Z_L} \left(\frac{E}{2} \text{ approximately} \right)$$

Where:—

E is the source EMF, 75 ohms the source impedance, Z_L is the load impedance and V_L the voltage across the load.

When the 20 dB pad is inserted between the signal generator and the 75-ohm matching unit, V_L is calculated as follows:—

$$V_L = \frac{E}{10} \; \frac{Z_L}{75+Z_L}$$

Note . . .

For Naval service A.P.71231 and A.P.71232 attenuator and pads can be used with 75-ohm leads.

Output impedance less than 50 ohms

44. Where the required source impedance is less than 50 ohms, a suitable resistor can be connected in parallel with the impedance of the generator to adjust its effective output impedance to the required value. The value of the parallel resistor can be found from the following:—

$$RP = \frac{R_O \times R_{EO}}{E_O - E_{EO}}$$

Where R_P is the value of the parallel resistor.

Where R_O is the output impedance of the generator.

Where R_{EO} the required output impedance of the generator.

Under these conditions, the effective open circuit source (EMF) (E_E) is given by the expression

$$E_E = \frac{E \times R_P}{R_P \times E_O}$$

Where E is the EMF indicated on the ATTENUATOR dial.

Note . . .

The mounting and choice of the external correcting resistors mentioned in para. 44 and 45 must be carefully considered, especially at VHF and UHF. At the frequencies covered by the signal generator, a grade II carbon resistor is usually better than a spiral cut grade I component. However, at certain ohmic values, special non-spiralled (non-inductive) types of resistors can be obtained.

Output impedance greater than 50 ohms

45. Where the required source impedance exceeds 50 ohms a suitable series resistor can be connected between the output of the signal generator and the equipment to be tested. Under these conditions the value of the series resistor is equal to the difference between the impedance of the signal generator and that of the equipment to be tested. The open circuit or source EMF will then be as indicated on the ATTENUATOR dial or on the CARRIER LEVEL meter as appropriate.

46. When the effective output impedance of the signal generator is altered by using either of the methods described in para. 44 and 45, the 50-ohm RF connector is mismatched at its output end. Therefore, where the insertion loss of the 20 dB attenuator pad can be tolerated, it should be inserted between the output end of the connector and the correcting resistor. The effective source EMF will, of course, be reduced by 20 dB.

Frequency variations using FREQ. TRIM control

47. The following figures for the frequency variation covered by a 90 deg. rotation of the FREQ. TRIM control are typical only. They may differ slightly from generator to generator. In general the fine tuning facility provided by this control will not be necessary for the lower frequency bands since the incremental scale control will normally be adequate for these bands.

Mc/s	*Fine (pull) kc/s*	*Fine (push) kc/s*	*Mc/s*	*Fine (pull) kc/s*	*Fine (push) kc/s*
110	6	62	280	21	180
150	14	142	300	24	250
190	28	300	360	48	580
210	41	450	400	90	1 050
230	68	600	440	124	1 650
260	86	977	480	216	2 514

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Chapter 3

CIRCUIT DESCRIPTION

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. A general description of the signal generator CT394 is given in Part 1, Chap. 1, which also includes the following illustrations:—

General view of the signal generator

The various accessories

Functional diagram

2. A general view of the signal generator with its cover removed is given in fig. 1, and the circuit is given in fig. 2, at the end of this chapter. Fig. 1 shows the rear of the unit and the general layout of the four major sections constituting the generator. These sections are:—

(1) The power unit.

(2) The RF unit, which is completely enclosed in a metal cover.

(3) The LF unit, which includes the sinewave oscillator, the modulation amplifier and also the monitoring circuits.

(4) The crystal calibration unit.

Power unit

3. The power unit (*fig.* 2) consists of the double-diode valve V1 which is connected as a full-wave rectifier to the mains transformer T1. The primary winding of this transformer is wound in two tapped sections which can be connected in series for operating the signal generator from AC supplies of between 180V and 250V at 40 c/s to 100 c/s or in parallel for supplies of 100V to 150V, at the same frequency. The equipment can also be used with an AC supply of 180V at 500 c/s.

4. The change from one voltage range to the other is made by soldering the required link or links in position as shown in fig. 2. To permit the correct primary winding tappings to be selected for the local supply voltage, a tapping panel is provided close to the transformer. This panel can be reversed, one side being engraved for the 100V to 150V range and the other for the 180V to 250V range. Access to the tapping panel is obtained by removing a cover inside the cavity on the right-hand side of the instrument case. To alter the soldered links, however, the instrument case must first be removed. Instructions for the removal of the case and the practical layout of the links are given in Chapter 2.

5. The secondary of the transformer T1 has sufficient windings to provide all the AC voltages required by the signal generator for the HT and LT supplies. The HT supply is obtained from a centre-

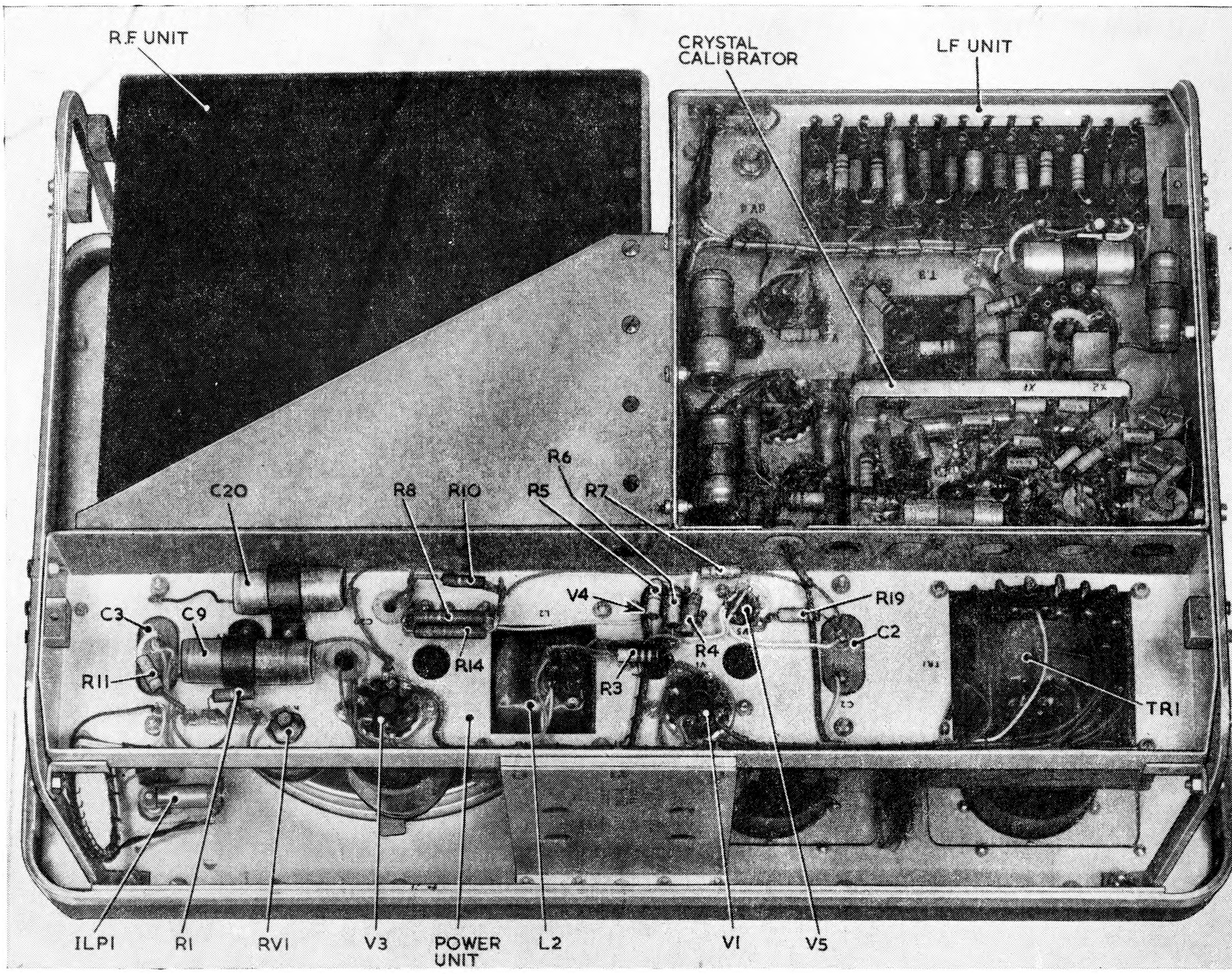


Fig. 1. Signal generator CT394 — cover removed

tapped winding connected to the double-diode valve V1, the rectified output of which is fed to the reservoir capacitor C2. The HT output of the power unit is regulated by the series stabilizing circuit incorporating the valves V3, V4 and V5. HT for the regulator circuit is smoothed by L2 and C3. The tetrode valve V3 serves as a variable ballast resistor in series with the rectified output of V1. The pentode valve V4 functions as a high gain amplifier, while the gas filled valve V5 provides a reference voltage of about 83V for the cathode of V4. Bias for the control grid of V3 is obtained from the anode output of the amplifier valve V4. Any tendency for the rectified voltage to rise causes an increase of the potential across the voltage divider network R10, RV1 and R11. The control grid of the amplifier V4 is connected to the slider of RV1 and, therefore, any increase of the voltage across the network raises the grid voltage of V4 towards that of its cathode, giving a rise in the anode current and a corresponding reduction in its anode voltage. This reduced anode voltage is fed via R4 to the control grid of the ballast valve V3. This causes a decrease in the anode current of V3, which corresponds to an increase in the series resistance of V3. The effective voltage output from the rectifier is reduced and stabilization occurs. From this it follows that any fluctuations in either rectified voltage output or load conditions will produce corresponding changes in the grid bias of the amplifier valve V4, the anode output of which controls the grid bias of the ballast valve V3, thus stabilizing the HT output of the power unit.

6. The preset potentiometer RV1, which is connected in series with R10 and R11 across the output of the rectifier, provides facilities for setting the stabilized HT output of the power unit to 300V. The instructions for using RV1 are given in Part 2, Chap. 1, which deals with servicing.

RF oscillator unit

7. The RF oscillator unit (*fig.* 1 *and* 2) incorporates two disc seal triodes, V2 and V6, one of which functions as the master oscillator and the other as a grounded-grid RF amplifier. The valve V2 is connected as a shunt-fed Colpitts oscillator, the output of which is fed to the RF amplifier V6. The oscillator and the amplifier stages have each a separate turret tuning system incorporating five ranges to cover the frequency band of 12 Mc/s to 485 Mc/s. The two turret systems and their variable capacitors are ganged together for both range selection and tuning purposes respectively. To

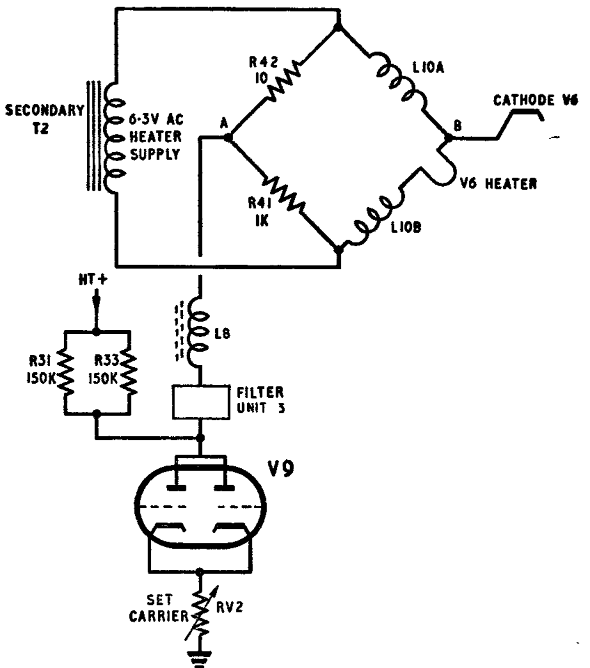


Fig. 3. LT bridge circuit for RF amplifier

reduce the torque required to turn the turrets, gearing is incorporated between the turrets and the RANGE switch, this makes it necessary to rotate the RANGE switch $1\frac{1}{8}$ turns between each of its settings when the frequency band is being changed. ◀To provide fine tuning of the MO circuits a capacitance flag is located close to the anode of V2. This flag is coupled to the FREQ TRIM control (*Chap.* 2) which permits the capacitance of the anode to earth to be varied and hence the frequency.▶

8. Facilities are included to permit the variable capacitor of the RF amplifier to be adjusted slightly, independently of the turrets, by a PEAKING control. This enables the RF amplifier to be tuned more accurately to the master oscillator circuit. Both the oscillator and the amplifier use capacitance switching to avoid the necessity of passing relatively high RF circulating currents through metal contacts which introduce undesirable variable RF contact resistances.

9. The HT and LT power supplies to the oscillator valve V2 and to the RF amplifier valve V6 are fed via filter units to prevent RF leakages via the supply leads.

10. Experience in the development of this signal generator has shown that better service can be obtained from the valve V2 (CV273), when operating at the frequencies used by this equipment, if the heater is supplied with 6·9V instead of 6·3V. Therefore the heater supply from the mains transformer T1 is fed to V2 via the primary winding of the transformer T2. This winding functions as an auto-transformer to give an output of 6·9V to the heater of V2.

11. The heater of the RF amplifier valve V2 is connected internally to the cathode of this valve, therefore to prevent the RF amplifier being modulated at the frequency of the mains supply it is necessary to decouple the cathode with respect to this frequency. This is achieved by feeding the LT supply to the heater via the secondary winding of the transformer T2 operating into a bridge circuit (*fig.* 3).

12. The resistors R42 (10 ohms) and R41 (1K) constitute one-half of the bridge while the inductor L10A and the heater of V2 in series with L10B form the other half. The ratio between the resistive values of R42 and R41 is approximately the same as that between L10A and the heater plus L10B. From this it follows that the AC potentials at points A and B are the same and, therefore, the cathode of V2 which is connected to point B is at the same potential as point A. Since point A is connected to earth via the low resistance filter L8, the filter unit 3 and the modulator valve V9 and because the impedance of this circuit at the frequency of the mains supply is only a few ohms, the cathode of V6 is decoupled with respect to the heater supply. The capacitors C11 and C10 serve to decouple the secondary winding of T2 with respect to RF.

13. The HT supply for the master oscillator valve V2 is fed via the CARRIER ON/OFF switch S6, the RF OUTPUT switch S3 the RANGE switch S5 and also S2 to the anode circuit of V2. With the switch S3 in the NORMAL position, the parallel resistors R12 and R15 are connected in series with the HT supply to the anode of V2. This reduces the HT current of V2 and the valve is operated at well below its permitted rating; under these conditions the RF output from the signal generator is an open circuit EMF of ◀at least 0·5V at all frequencies.▶ This is generally satisfactory for most purposes for which the signal generator is required.

14. The CARRIER/OFF switch S6 is spring-loaded so that it is normally in the CARRIER ON position. The switch is provided to enable the operator to cut off the carrier, momentarily, for identification purposes. The spring-loading ensures that the carrier is automatically switched on immediately the switch is released, thus eliminating frequency drift due to variations in thermal heating and cooling caused by switching the ◀oscillator valve▶ on and off. In circumstances where the carrier is not required, it is preferable to disconnect the RF output connector rather than switch off the signal generator.

15. When the normal RF output of the signal is insufficient, the RF OUTPUT switch can be set to the HIGH position, which short-circuits the series network R12 and R15; V2 is then operated at or near its maximum anode dissipation. This provides the maximum possible RF drive to the RF amplifier valve V6. This position of the switch should be used only when RF output levels exceeding 0·5V are required and they cannot be obtained with the switch in the NORMAL position.

16. The switch S2 is included in the HT circuit of the master oscillator valve V2 to interrupt the HT supply to this valve when frequency-band changing is in progress. The switch is located in the RF unit and it is automatically operated when the turret is being rotated during frequency band changing.

17. The inductors L13 and L14, which are used on the lower frequency ranges A and B, are constructed of somewhat fine wire and, to prevent overheating of these inductors, it is necessary to limit the circulating currents flowing in them. This is achieved by the HT dropping resistors R39 and R40 which are automatically connected in series with the HT supply to the master oscillator valve V2 by the RANGE switch when it is set to either range A or B.

18. The method of coupling the master oscillator circuit of V2 to the RF amplifier valve V6 is dependent upon the frequency band in use. Reference to fig. 2 at the end of the chapter shows that three types of coupling are used, which are as follows:—

(1) Capacitance potential divider at the lower frequencies (range A and B).

(2) Tapped inductance for the middle frequencies (range C and D).

(3) A combination of tapped inductance and series capacitance on the higher frequencies (range E).

19. On range E the coupling capacitor is divided into two sections, one of which is mounted on the rotating turret of the oscillator and the other on the tuning unit assembler. This capacitor C8 is only completed when the frequency band E is selected by the RANGE switch.

20. On all ranges the RF output of the master oscillator valve V2 is coupled via R45 and C31 to the cathode of the RF amplifier valve V6. On range A and B this coupling does not give sufficient RF drive to the amplifier valve V6 and, therefore, the drive is increased by coupling a parallel RF output from V2 via the coil L10B to the cathode. The impedance of this coil is relatively low at the frequency band of 12 Mc/s to 28 Mc/s covered by ranges A and B. The resistor R45 functions as a grid stopper while R44 is to prevent parasitic oscillations occurring in the heater circuit of V6. The resistor R13 serves as a damping device to prevent similar oscillations being developed in the coils L10A and B.

21. The level of the output from the RF amplifier is controlled by the potentiometer RV2 (SET CARRIER) which is in series with the modulator valve V9. Because the DC cathode bias for the RF amplifier valve V6 is tapped at the anode of V9, RV2 can be used to control the bias of the RF amplifier valve V6 and, therefore, set the level of the carrier output from the amplifier.

22. The output circuit of the RF amplifier valve V6 is inductively coupled on all frequency bands to a continuously variable piston type attenuator. The coupling between the amplifier and the input or launching coil of the attenuator is formed by the whole or part of the appropriate inductor (in the series L18 to L22) of the amplifier circuit according to the frequency band being used. The piston attenuator provides a constant output impedance of 50 ohms and it is operated in conjunction with the ATTENUATOR dial on the front panel of the signal generator. The use of this dial is described in the operating instructions in Part 1, Chap. 2.

23. The RF output from the amplifier valve V6 is monitored by a crystal voltmeter consisting of the crystal diode X1, preset control RV4 and the CARRIER LEVEL meter M1. The monitoring circuit is inductively coupled by L12 to the appropriate inductor of the series L18 to L22 forming part of the tuned circuits of the amplifier stage V6. The scale of the CARRIER LEVEL meter includes a SET CARRIER reference mark for setting up the equipment. For indicating levels between 1V and 2V the scale is extended by 6 dB above the SET CARRIER reference level mark. The preset potentiometer RV4 provides facilities for setting the electrical zero of the CARRIER LEVEL meter.

Modulation

24. The four-position MODULATION switch must be set to a position corresponding with the type of modulation to be used. For internal modulation, this switch is set to the INT position and the modulation voltage is obtained from a 1,000 c/s sinewave oscillator consisting of the triode valve V7 operating as a series-fed Hartley oscillator circuit which includes the transformer T3. The output from the secondary of this transformer is fed via RV3, the SET MOD control, to the grid of the modulator valve V9. This valve is connected in series with the cathode of the RF amplifier V6 to form a series, amplitude-modulating circuit.

25. The modulation depth is determined by adjusting the SET MOD control, RV3, and it is monitored on the MODULATION meter (which is calibrated in percentage from 0 to 90 per cent), the indication is produced by amplification and rectification of the AF component of voltage from the carrier level detector X1 (*para.* 23). This component from the diode X1 is fed via the filter unit 5 to the grid of the AF amplifier V8A (one-half of a double triode). The output from V8A is fed to the grid of V8B (the other half of the double triode) which functions as a cathode-follower. The output from the cathode is rectified by the germanium diodes X2 and X3 and then fed to the MODULATION meter M2. From this it follows that the modulation percentage is based on absolute measurements and is independent of any indirect calibration associated with the level of the modulating voltage applied to the modulator stage V9.

26. A modulation depth of not less than 30 per cent can be obtained at all frequencies within the frequency range of the signal generator. This can be extended to 90 per cent at most frequencies, although in some instances it may be necessary to increase the amplitude of the carrier by setting the RF OUTPUT switch to HIGH instead of NORMAL in order to obtain modulation depth exceeding 30 per cent. At some frequencies it may be found that a badly distorted modulated wave is produced at modulation levels exceeding 60 per cent. This is caused by lack of RF drive which may occur even with the OUTPUT switch set to HIGH. Under this condition the modulation meter may still be set to indicate 90 per cent modulation. The built-in meters of the CT394 will not indicate this lack of RF drive. Where waveform distortion is suspected, an oscilloscope should be used to examine the waveform.

External modulation—sinewave

27. The RF carrier of the signal generator can be sinewave modulated from an external source operating at frequencies between 30 c/s and 20 kc/s. The external source is required to provide an input signal level of approximately 1V RMS to produce 30 per cent modulation of the carrier. For sinewave modulation from an external source, the MODULATION switch S4 should be set to EXT SINE. This action disconnects the HT supply from the internal sinewave oscillator V7 and connects the grid of the double-triode modulator valve V9 via C17 to the EXTERNAL MODULATION SINE terminal on the front panel of the equipment. In addition the SET MODULATION control RV3 is cut out of circuit. The input impedance is determined by the 1 megohm resistor R17 shunted by the 100 pF capacitor C27. To ensure good frequency response the source impedance of the external audio frequency generator should be comparatively low, e.g. 600 ohms.

External modulation—pulse

28. The RF carrier of the signal generator can be pulse modulated from an external source when the modulation switch is set to EXT PULSE and the signal input is connected to the PULSE socket on the front panel of the equipment. In the EXT PULSE position of the MODULATION switch, the HT is disconnected from the internal sinewave oscillator and the grid of the modulating valve V9 is DC coupled via R21 to the PULSE source. The input impedance is determined by the 1 megohm resistor R17. For satisfactory pulse modulation the amplitude of the external pulse signal should not be less than 25V, this should be increased to 50V where the best carrier suppression is required.

29. The RF bandwidth of the signal generator changes with the carrier frequency; it is approximately 500 kc/s when the equipment is being operated at a frequency of 12 Mc/s and increases to about 3 Mc/s at the 485 Mc/s end of the frequency range. The bandwidths of 500 kc/s and 3 Mc/s correspond with video-frequency responses of 250 kc/s and 1·5 Mc/s respectively.

Crystal calibrator unit

30. The crystal calibrator unit is illustrated in fig. 1, while the circuit forms part of fig. 2. For purposes of identification the components constituting the circuit of the calibration unit are prefixed with the figure 2. With the exception of the power supplies it is entirely self-contained. The HT and LT power supplies are both obtained from the main power unit of the signal generator (*para.* 3). The object of the crystal calibrator unit is to provide calibration signals at either 10 Mc/s or 2 Mc/s intervals throughout the frequency range of the equipment, thus permitting the accuracy of the engravings on the main tuning dial of the signal generator to be confirmed; or alternatively set the dial to the required frequency using the appropriate calibration signal from the crystal unit in conjunction with the tuning dial and the incremental dial of the signal generator. A cursor is engraved on the perspex cover of the main tuning dial. The cover can be rotated to serve as a movable cursor for use with the crystal calibrator. It can be set over the dial engraving corresponding with the frequency check point provided by the crystal calibrator, and then used in conjunction with the incremental dial as described in the operating instructions in Chap. 2 of this Part.

31. The crystal calibrator consists of the double-triode valve 2V1, which functions as a harmonic generator, the frequency changer or mixer pentode 2V2 and the double-triode 2V3 operating as a two-stage audio-frequency amplifier.

32. The HT for the crystal calibrator is controlled by the three-position CRYSTAL CHECK switch. This switch has an OFF position which disconnects the HT from the unit. In position 1, HT is fed to the anode of the triode 2V1A and this section of the double-triode functions as a 10 Mc/s crystal oscillator. The crystal 2X1 is connected between the anode and grid of this valve. The anode output of 2V1A consists of harmonics of 10 Mc/s and it is fed via 2C20 and 2C9 to the pentode frequency-changer 2V2. When required for calibration purposes, the RF output from the signal generator is fed via the CRYSTAL CHECK socket 2SKT1 to the suppressor grid of the frequency changer 2V2 where heterodyning takes place between the appropriate harmonic of the 10 Mc/s oscillator and the signal from the generator. RF decoupling is provided by 2R13 and 2C13, while the AF output is fed via 2C16 to the two stage amplifier 2V3, the output of which is coupled via 2C17 to the telephone jack 2JK1. The audio output from this stage can be heard in the telephones plugged into the PHONES socket on the panel of the signal generator. The heterodyne method can be used to find the 10 Mc/s increments of frequency on the tuning dial of the signal generator.

33. When 2 Mc/s increments of frequency are required, the CRYSTAL CHECK switch is set to position 2. In this position HT is fed to the anodes of both 2V1A and 2V1B. The 2 Mc/s crystal is connected between the anode and grid of 2V1B and, therefore, both the 2 Mc/s and the 10 Mc/s crystal oscillators are operating simultaneously. This is necessary owing to the relatively high frequency range of the signal generator and the low RF energy of the appropriate harmonics of the 2 Mc/s crystal oscillator.

34. For a frequency of 480 Mc/s, the 48th harmonic of the 10 Mc/s crystal oscillator provides a beat note which is easily detected. However, a frequency of 482 Mc/s corresponds with the 241st harmonic of the 2 Mc/s crystal. At this harmonic the level of the RF energy of the 2 Mc/s oscillator is too low to permit the resultant beat note to be detected. However, by heavily modulating the 48th harmonic of the 10 Mc/s crystal oscillator with energy from the 2 Mc/s oscillator; the upper sideband of the 48th harmonic of the 10 Mc/s crystal will have an energy level approximating 25 per cent of that of the 480 Mc/s frequency for 100 per cent modulation. From this it follows that there would be no difficulty in hearing the beat note corresponding with 482 Mc/s.

35. When the switch 2SA (CRYSTAL CHECK) is set to position 2, both crystals are in operation. The RF output of the 2 Mc/s crystal oscillator 2V1B is coupled via 2C5 to the grid of the 10 Mc/s crystal oscillator 2V1A. Therefore, the 10 Mc/s oscillator is heavily modulated by the 2 Mc/s oscillator and thus, for all practical purposes, the double-triode valve 2V1 produces a large number of harmonics spaced at 2 Mc/s intervals over the frequency range of the generator. The subsequent heterodyning operation is the same as that described in para. 32. When it is desired to identify the 10 Mc/s increments of frequency, it is only necessary to switch off the 2 Mc/s crystal by setting the CRYSTAL CHECK switch to position 1, thus leaving only the 10 Mc/s oscillator in operation.

36. For tuning purposes the preset capacitors 2C1 and 2C3 are incorporated in the circuit of the 10 Mc/s oscillator and 2C6 and 2C10 in the circuit of the 2 Mc/s oscillator. For servicing purposes, limited access to the crystals and the trimmers can be obtained through a panel which can be removed from the back of the cover enclosing the signal generator. Servicing instructions for the crystal calibrator unit will be found in Part 2, Chap. 1.

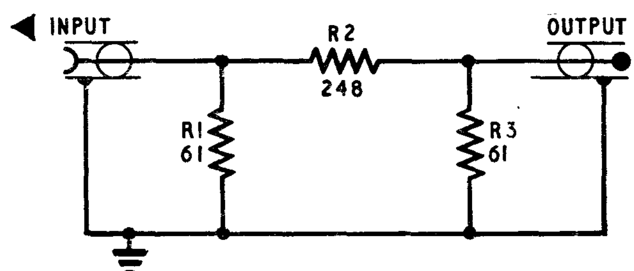
Accessories

37. The accessories for use with the signal generator are listed in Part 1, Chap. 1, while their operational uses are described in Part 1, Chap. 3. It must be appreciated that these accessories are optional and must be obtained according to the requirements. For Naval (ship) purposes they will be issued as required by the relevant E list.

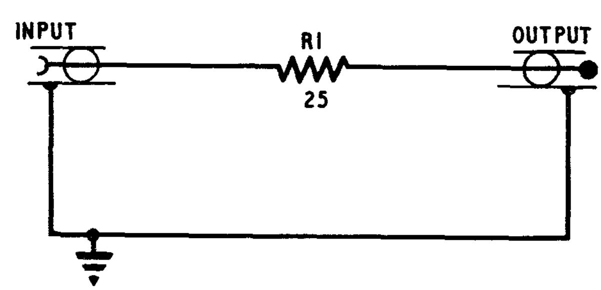
38. The circuit of the 20 dB pi-type matching attenuator is given in fig. 4. The matching unit is primarily for use with equipment having input impedances differing from the 50 ohm output impedance of the signal generator. With the attenuator in circuit, the possibility of error in apparent EMF or effective output impedance due to standing waves is avoided because variations in load impedance from zero to infinity do not cause the effective line terminating resistance to depart from its correct value by more than 1 ohm approximately.

39. When the signal generator is being used with equipment having the same input impedance as the 50-ohm output impedance of the generator and where the insertion loss of 20 dB can be tolerated, the matching unit should continue to be used. This is because any variations in the effective source EMF due to random RF leakages or radiation are reduced by the ratio between the input to the attenuator and the output, i.e. 10:1.

40. There are two ◀attenuators which serve as▶ matching units for use with the signal generator when it is being used with equipment having an input impedance of 75 ohms. The circuits (*fig.* 4) of these matching units are the same and each of them include a 25-ohm resistor which is connected in series with the output impedance of the generator, and thus the effective impedance of the generator becomes 75 ohms. The only difference between the two units is in the type of sockets used at their output ends which increase the range of connectors and equipments with which the signal generator can be used. The matching unit in use should be connected ◀via either the 12 in. or 54 in. RF 50-ohm connector▶ to the RF output of the signal generator. ◀The shorter connector should be used where this is possible.▶ The recommendations contained in para. 39 regarding the use of the 20 dB attenuator are also applicable when either of the 75-ohm matching units is used. Instructions for using the various accessories are contained in Part 1, Chap. 2, which is concerned with the operating information.



20dB ATTENUATOR



ATTENUATOR

50 TO 75 OHMS

Fig. 4. Accessories—circuits

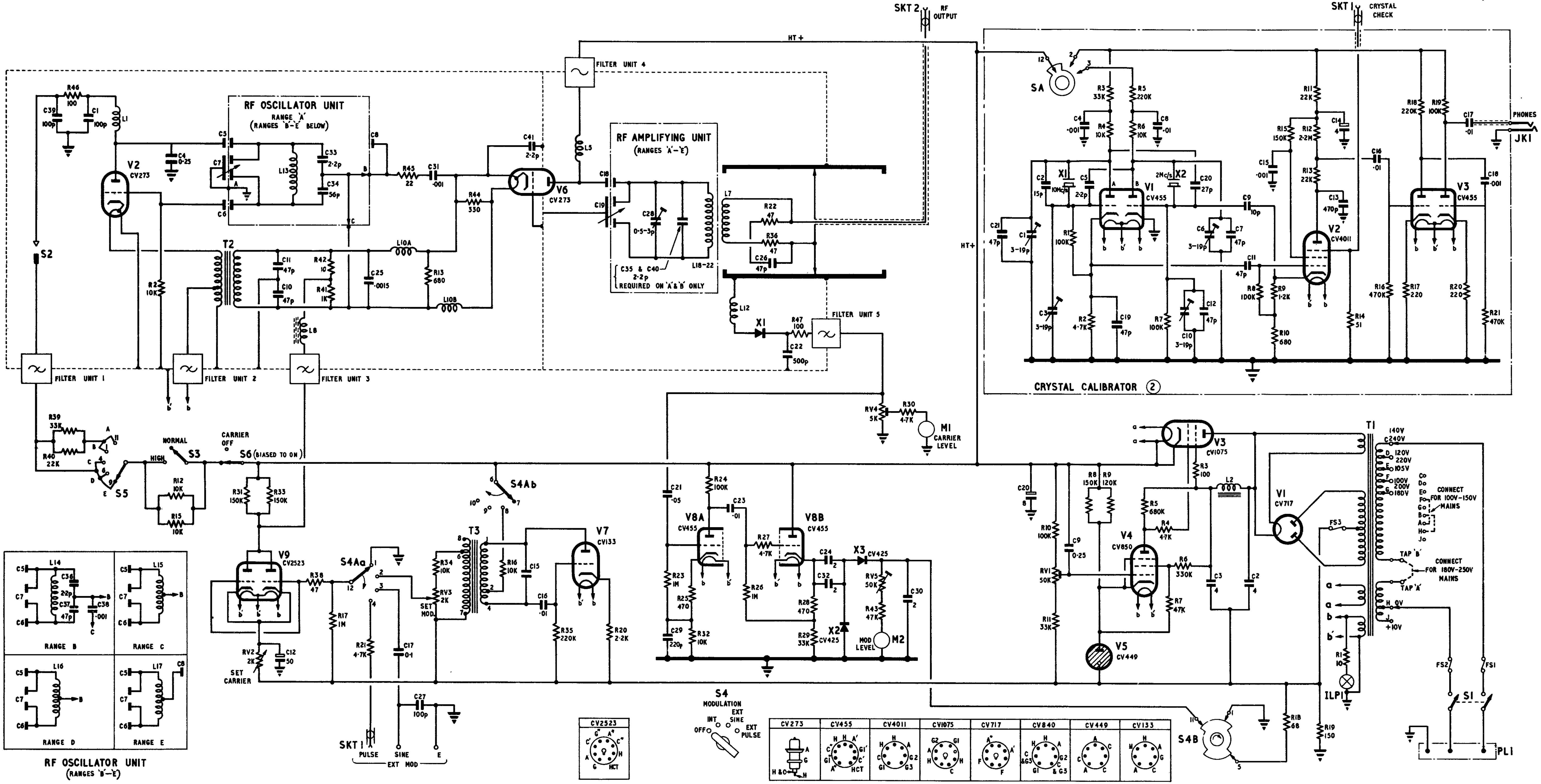


Fig. 2 Signal generator CT394— circuit Fig. 2

924/8/7879/50138/755/12/60 J. T. & S.

Chapter 4

CONSTRUCTION

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General

1. A general view of signal generator CT394 is given in Part 1, Chap. 1, fig. 1 and the accessories are shown in fig. 2 of the same chapter. A further view of the equipment, with the cover removed, is shown in Part 1, Chap. 3, fig. 1.

2. The signal generator is enclosed in a case with an open front. The case serves as a screen and a dust cover. There are two sub-units, the main chassis assembly, and the crystal calibrator. The main chassis includes the components constituting the following:—

(1) RF stage.

(2) LF and modulation stage.

(3) Power supplies stage.

3. The weight and dimensions of the equipment are given in the leading particulars at the beginning of Part 1.

4. Cavities are cut into the sides of the case and shaped to serve as handles for carrying the instrument. The mains lead for use with the signal generator can be stowed in the left-hand cavity, while a removable cover in the right-hand cavity, permits access to the mains tapping panel. A cover at the rear of the case provides access to the trimming capacitor of the crystal calibrator.

5. The case is held in position by eight metal domes and securing screws. Four of these are at the back of the equipment, while the other four are at the base, and serve as feet for the instrument. In addition, each of the four domes at the base enclose a hexagonal pillar which also secures the case to the chassis.

6. After the case has been removed, access to all the valves, other than V2 and V6, can be obtained. The valves V2 and V6 are of the disc seal type, and these, together with the r.f. level monitor crystal diode XI are contained in the screening box of the r.f. oscillator circuits.

7. The power supplies stage and l.f. chassis are supported on two U-shaped rectangular metal ribs bolted to the rear of the front panel.

RF stage

8. The r.f. stage is contained in a double screened box and has four separate compartments. The r.f. stage with the covers in position is shown in Part 1, Chap. 3, fig. 1. The outer screen cover is removed by taking out 23 screws from its outer edges, the r.f. stage with the outer screen removed can be seen in fig. 1 of this chapter. The removal of this screen exposes the main tuning wire-drive mechanism.

9. The main tuning drive is a positive action wire and pulley mechanism and employs a stainless steel wire. It controls the rotor of the r.f. oscillator tuning capacitor C7 and also that of C19 of the r.f. amplifier. The drive from the main tuning control is accomplished by a worm gearing coupled to drum B (fig. 1). The PEAK CARRIER control, which varies the angular position of the r.f. amplifier rotor relative to the r.f. oscillator rotor, operates a rocking arm carrying two pulleys. This arm is actuated by a worm drive, attached to the outside of the r.f. stage above the piston attenuator. The instructions for changing the main tuning drive wire are given in Part 2, Chap. 1.

10. The inner screened box of the r.f. stage is divided into three compartments. Viewed from the underside of the instrument (fig. 2) the right-hand compartment contains the tuning capacitor, the turret tuning system, and associated circuits of the r.f. amplifier.

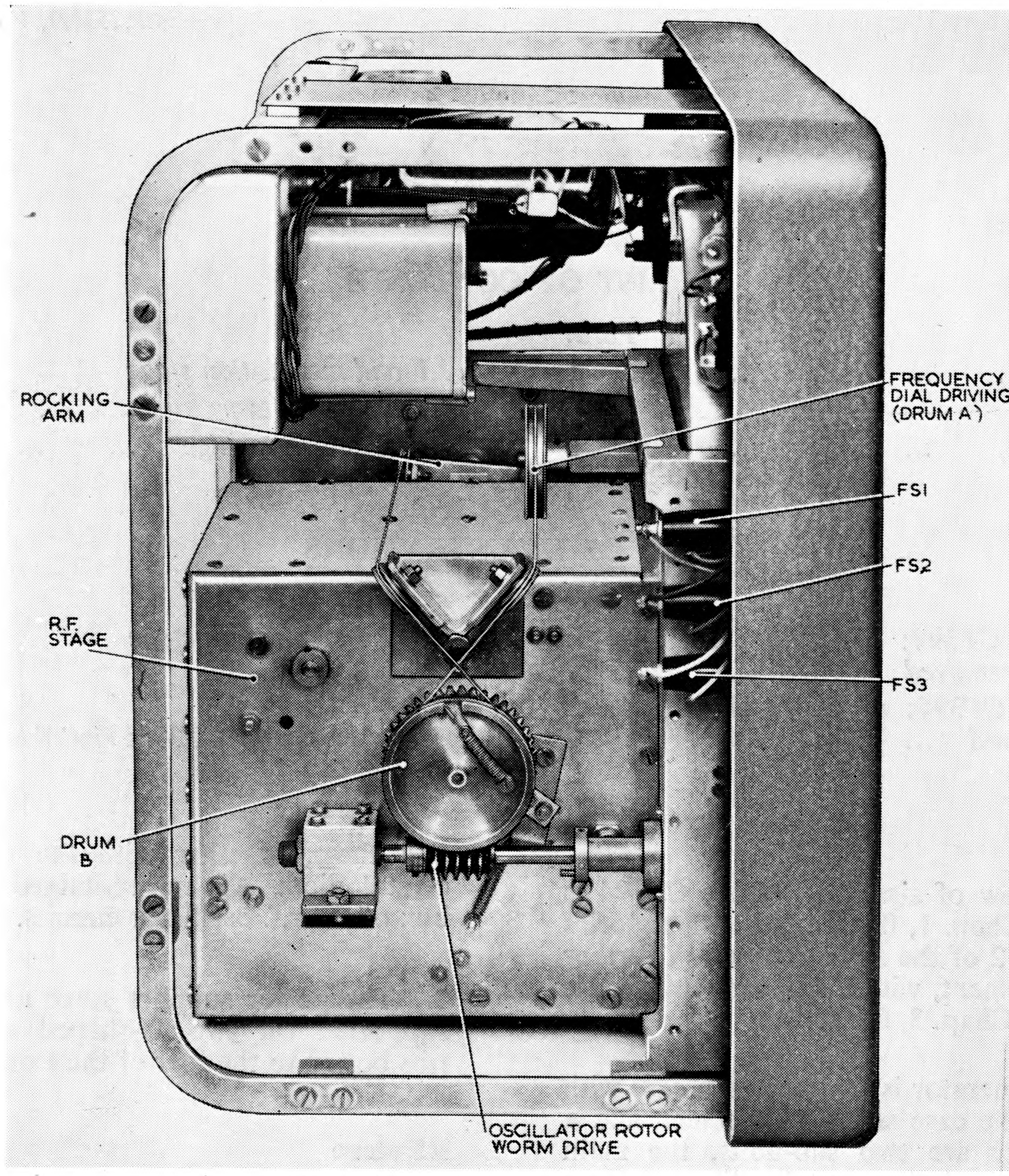

Fig. 1. Signal generator CT394: left-hand side: RF stage outer cover removed

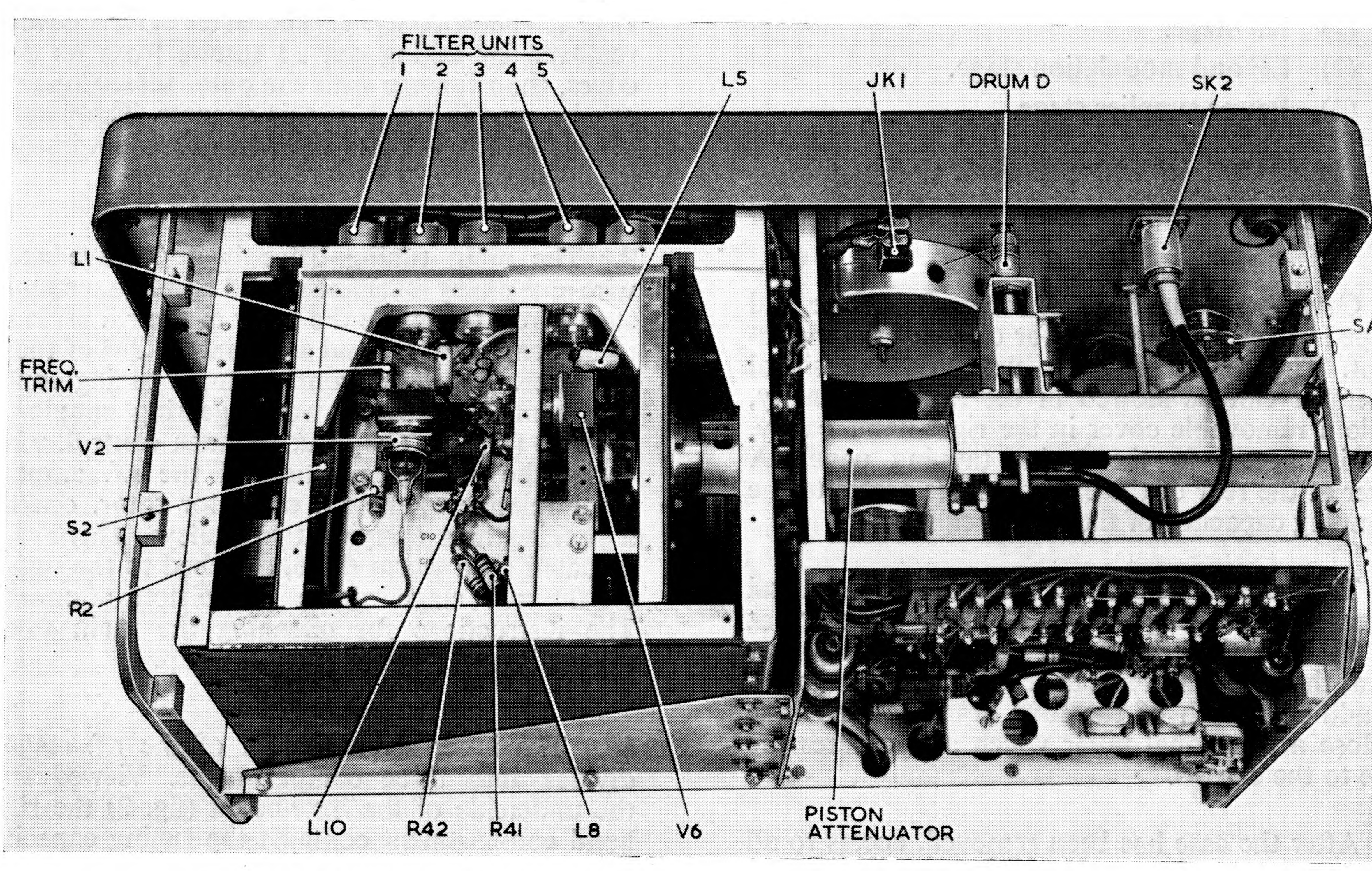

Fig. 2. Signal generator CT394: underside view: RF stage covers removed

11. The left-hand side of the r.f. stage is divided into two compartments. In the lower one, viewed from the underside of the instrument, are housed the tuning capacitor, the turret tuning system, and associated circuits of the r.f. oscillator. This compartment also contains the transformer T2 which provides the heater supplies for valves V2 and V6.

12. The upper left-hand compartment of the r.f. stage houses the master oscillator valve V2 and its associated components. The r.f. amplifier valve V6 is between the left-hand upper and right-hand compartments, the anode, being in the right-hand side, while the grid and cathode are in the left-hand side.

13. When viewed from the underside, the piston attenuator is on the right-hand side of the r.f. stage (fig. 2). This attenuator passes through the outer screen of the r.f. stage and is bolted to the inner screen. A flexible coaxial cable connects the attenuator to the r.f. output socket on the front panel. The degree of coupling is adjusted by moving the coil along the tube by a rack and pinion mechanism which is driven from the ATTENUATOR drive control on the front panel. This control also carries drum D, which, with drum E and the stainless steel driving wire, form the drive for the attenuator dial. The instructions for changing the attenuator drive wire are given in Part 2, Chap. 1.

14. The five filter units carrying h.t. and l.t. supplies to the r.f. stage, are mounted through the stage screen on the side facing the front panel (fig. 2).

LF and modulation stage

15. The components of the l.f. and modulation unit are mounted on a chassis of conventional construction which is bolted to the right-hand metal rib and the r.f. stage (fig. 3). The chassis

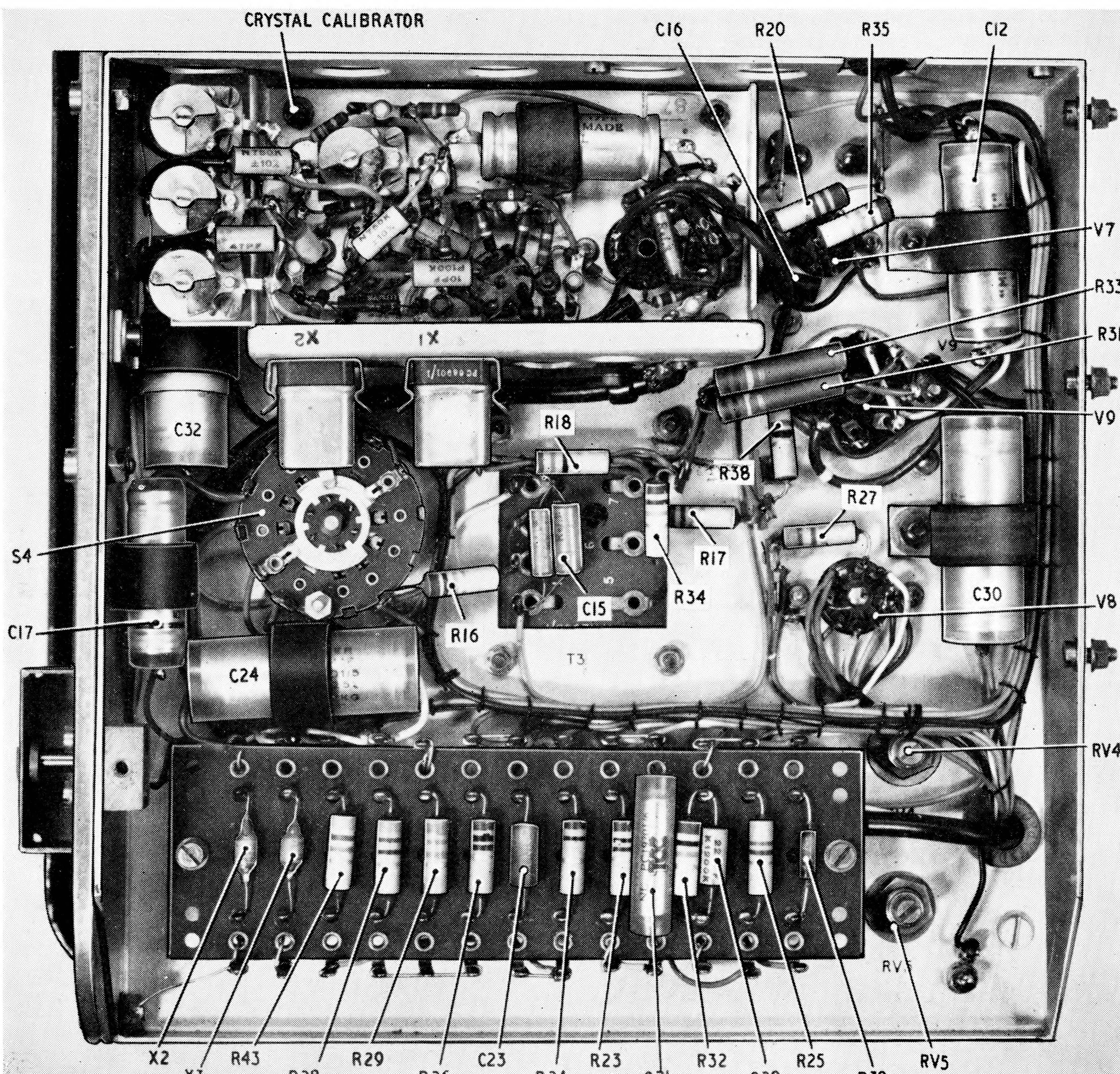

Fig. 3. LF and modulation stage

accommodates the following valves and their associated circuits:—

V7 triode, modulator oscillator (1000 c/s).
V8 double triode, V8A being the l.f. amplifier and V8B the cathode follower.

16. The MODULATION switch S4 is mounted on this chassis and controlled by a knob on the front panel. The preset controls RV4 and RV5, for setting up the levels of the outputs from the r.f. oscillator and modulator stages respectively, are located at the bottom right-hand corner of the chassis. The modulation oscillator transformer T3 is mounted in the middle of the chassis.

Crystal calibrator

17. The components for the crystal calibrator are mounted on a sub-chassis bolted to the top left-hand corner of the l.f. and modulation chassis. Its position in the main chassis is shown in fig. 3, while the location of the various components of the crystal calibrator is given in fig. 4. This sub-chassis has two faces, one being at right angles to the main face of the l.f. and modulation chassis.

18. The two crystals 2X1 and 2X2 are held in position by spring clips. The preset tuning capacitors 2C1 and 2C3, for the 10 Mc/s crystal oscillator, are situated in the top left-hand corner. The preset tuning capacitors, 2C6 and 2C10 for the 2 Mc/s crystal oscillator are located below the capacitor 2C1. With the case in position, access to these trimmers is gained by removing the cover at the rear of the case (para. 4).

19. The following valves are accommodated on the chassis:—

Valve	*Function*
Double triode 2V1:—	
2V1A	10 Mc/s crystal oscillator
2V1B	2 Mc/s crystal oscillator
Pentode 2V2	Frequency changer
Double triode 2V3:—	
2V3A	1st a.f. amplifier
2V3B	2nd a.f. amplifier

Power supplies stage

20. The chassis of the power supplies stage is located above the l.f. and r.f. stages and is bolted between the left-hand and right-hand ribs of the main chassis assembly.

21. It contains the mains transformer T1 and all the components for the stabilized h.t. power supply. Fig. 1 of Part 1, Chap. 3 shows the position of these components. The h.t. voltage control, preset potentiometer RV1, is situated on the right-hand side of the chassis adjacent to V3.

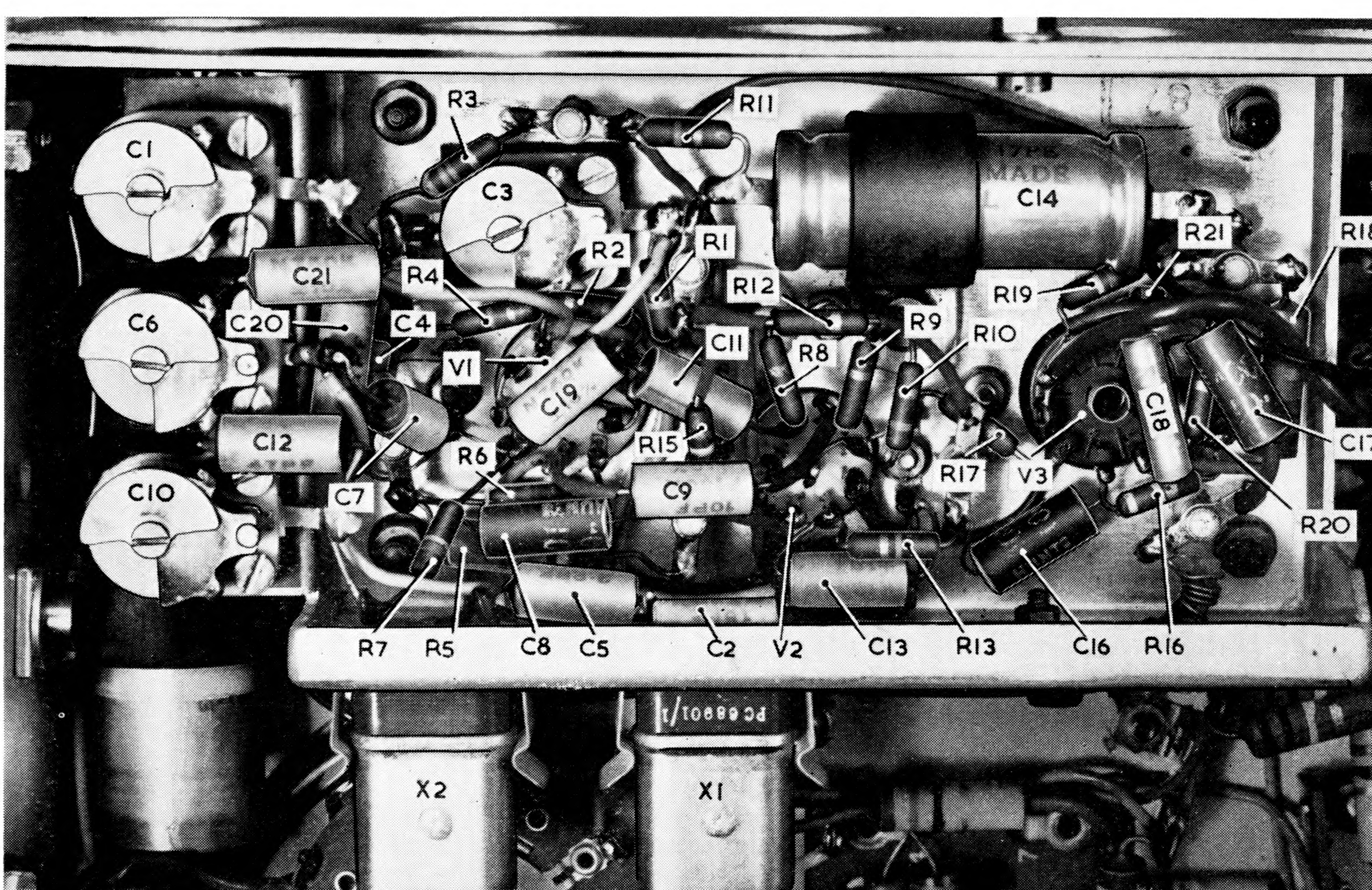

Fig. 4. Crystal calibrator

22. This chassis accommodates the following valves:—

V1, full wave rectifier.
V3, tetrode, series ballast valve.
V4, pentode, high gain amplifier.
V5, stabilizer, voltage reference level.

23. The mains tapping panel, (fig. 5) is bolted to the l.f. and modulation chassis, and access to it is gained by removing the cover in the cavity at the right-hand side of the instrument case (para. 4).

24. The fuses for the power supplies are situated on the left-hand side of the front panel. FS1 and FS2 are in the circuit of the mains supply, while FS3 is in the h.t. negative line. The mains input supply plug is situated in the bottom right-hand corner of the front panel.

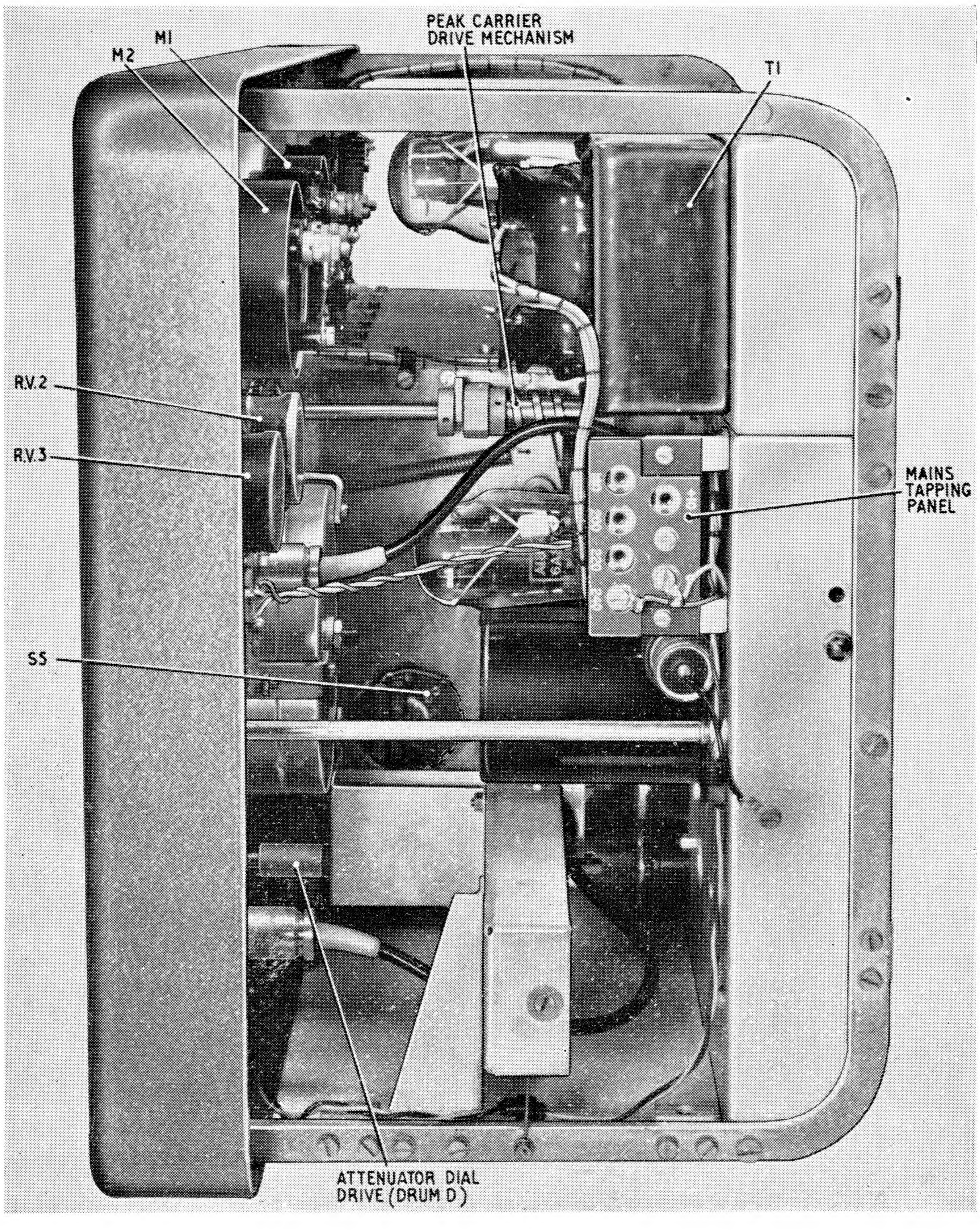

Fig. 5. Signal generator CT394: right-hand side

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PART 2

TECHNICAL INFORMATION (SERVICING)

Chapter 1

MINOR SERVICING

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Introduction

1. The signal generator CT394 is a precision instrument which should be handled with care. The servicing notes given in this chapter contain the information required to maintain the instrument in a serviceable condition. The signal generator should not require any routine adjustment.

2. The various components are identified and located in Part 1, Chap. 4 which describes the construction of the signal generator. The circuit diagram is given in Part 1, Chap. 3, fig. 2.

Cleaning

3. Periodically the instrument should be removed from its case and dusted by using an air blower in conjunction with a soft hair dusting brush. Care must be taken not to disturb components or blow dust into the gearing for the main tuning, attenuator, and peak carrier drive.

Power supplies test

4. The following equipment will be required to test the power supplies:—

Ref. No.	*Description*
10S/17001	Multimeter Type 9980

5. Before measuring the working voltages ensure that the mains transformer tappings are adjusted to suit the local supply. This adjustment is described in Part 1, Chap. 2. When measured with a multimeter Type 9980 set to the correct range, the working voltages are as follows:—

Transformer T1

H.T. secondary winding	480V–0V–480V a.c.
L.T. winding (a–a)	6·3V a.c.
L.T. winding (b–b)	6·3V a.c.
L.T. winding (rectifier)	5·0V a.c.
H.T. rectified (across C2)	560V d.c.
H.T. smoothed (across C3)	560V d.c.

Stabilized h.t. adjustment

6. After ensuring that the mains transformer tappings are correctly adjusted, and the working voltages within the ranges spectified in para. 5, measure the stabilized h.t. voltage between pin 8 (cathode) and chassis of the series ballast valve V3. Using the multimeter Type 9980, set to the 1000V d.c. range, the h.t. should be 300V d.c. If necessary the voltage should be corrected by adjusting RV1 (Part 1, Chap. 3).

Caution . . .

Valves should not be removed from the CT394 for test on the valve tester CT160 unless the voltage measurements in Table 1 indicate that a faulty valve exists. Whenever a valve has been tested and found serviceable it must be returned to the valve holder from which it was taken. If a valve is found to be faulty, the changing of which would entail recalibration, the instrument must be returned to the appropriate calibration authority.

Valve electrode measurements

7. After ensuring that the voltages given in para. 5 and 6 are correct, measurements of the valve electrode potentials may be taken. Typical test voltages are given in Tables 1 and 2. The measurements have been made with a multimeter Type 9980 set to the range shown against the reading in Tables 1 and 2. The figures given in Table 1 should not be regarded as absolute, but used as a guide to servicing. The signal generator should be operating normally with the panel controls (Part 1, Chap. 1, fig. 1) set as follows:—

Control	*Setting*
RANGE	48–100 Mc/s Band C
Main tuning dial	70 Mc/s
SET CARRIER	Centre of its travel
MODULATION	INT
SET MODULATION	Set to zero (fully counter-clockwise)
ATTENUATOR	200mV e.m.f.
OUTPUT	NORMAL
PEAK CARRIER	Adjusted for maximum CARRIER LEVEL meter deflection

WARNING . . .

Table 1. Because of the presence of high voltage at pins 2 and 8 of the valve V1 great care must be taken when making this measurement.

Note . . .

(1) *All measurements are made with the negative meter lead connected to chassis unless otherwise stated.*

(2) *Unless otherwise stated all voltages are d.c.*

TABLE 1

Typical valve electrode voltages

Valve	Electrode	Pin	Meter range	Meter reading
V1	Anodes	4 and 6	1000V a.c.	460V a.c.
V1	Heaters	across pins 2 and 8	10V a.c.	5·0V a.c.
V3	Anode	3	1000V	540V
V3	Screen grid	4	1000V	540V
V3	Cathode	8	1000V	300V
V4	Anode	5	1000V	265V
V4	Cathode	2 and 7	100V	83V
V4	Screen grid	6	250V	137V
V7	Anode	1 and 5	1000V	280V
V7	Cathode	7	100V	22V
V8	Anode	6	250V	105V
V8	Cathode	8	100V	22V
V8	Anode	1	1000V	300V
V8	Cathode	3	250V	147V
V9	Anodes	2 and 5	25V	14V
V9	Cathodes	3 and 6	2·5V	1·3V
		Crystal calibrator unit (prefix 2)		
2V1	Anode	6	250V	100V
2V1	Cathodes	3 and 8	25V	16V
2V1	Anode	1	250V	80V
2V2	Anode	5	250V	60V
2V2	Screen grid	6	250V	60V
2V2	Cathode	2	10V	3V
2V3	Anode	6	250V	185V
2V3	Cathode	8	2·5V	0·2V
2V3	Anode	1	250V	50V
2V3	Cathode	3	2·5V	0·2V

8. The anode voltage of V2 is a function of the frequency range in use and also of the setting of the OUTPUT switch. Before measuring the anode voltage of V2 ensure that the continuity of L1 is satisfactory and then make the measurements at the junction of R46, C1 and L1. The measurements are d.c. with respect to chassis. The typical values for V2 at each frequency range and output setting are given in Table 2, these should not be regarded as absolute but used as a guide to servicing.

TABLE 2

Typical anode voltages for V2

Frequency range	Output	Meter range	Meter reading
A.12–24 Mc/s	NORMAL	1000V	160V
	HIGH	1000V	180V
B.24–48 Mc/s	NORMAL	1000V	175V
	HIGH	1000V	190V
C.48–110 Mc/s	NORMAL	1000V	230V
	HIGH	1000V	293V
D.110–260 Mc/s	NORMAL	1000V	235V
	HIGH	1000V	295V
E.260–485 Mc/s	NORMAL	1000V	230V
	HIGH	1000V	295V

9. The anode voltage of V6 should be measured at the junction of filter unit 4 and inductor L5 with the multimeter Type 9980 set to its 1000V d.c. range, and should be 300V d.c. The heater voltages of V2 and V6 are measured with the multimeter set to its 10V a.c. range. The heater of V6 is isolated from earth. The measurements are as follows:—

V2 heater 6·3V a.c. (tolerance 0 per cent + 10 per cent)

V6 heater 6·3V a.c.

R.F. stage

10. Adjustments to the r.f. stage other than those required when changing the main tuning drive wire or measuring valve electrode voltages are not to be effected. Changes of the r.f. oscillator valve V2 and alterations to the location of the r.f. stage components may entail the recalibration of the instrument.

11. The r.f. stage is contained in a double screened box and this should only be opened to renew the main tuning wire drive (para. 13) or to measure the electrode potentials of V2 and V6 (para. 8 and 9). Most of the screws holding the screens of the r.f. stage are special flat-headed types and must not be substituted by ordinary round-headed or cheese-headed types, otherwise fouling will occur. Before fitting the instrument into its case ensure that the inner and outer screens are fitted over the r.f. oscillator compartment and all screws refitted correctly. Particular attention must be given to screwing the five longer screws of the inner screen into their correct positions.

Crystal calibrator

12. Adjustments which may affect the calibration of the crystal calibrator circuits should not be made to this unit. If the calibration is suspect the instrument should be returned to the appropriate calibration authority.

Main tuning drive wire renewal

13. To renew the main tuning drive wire, reference should be made to fig. 1 of this chapter, and also Part 1, Chap. 4, fig. 1. The sequence of operations is as follows:—

(1) Remove the instrument from its case (Part 1, Chap. 2, para. 5) and lay it face downwards on the bench.

(2) In order to expose the wire drive mechanism take out the 23 fixing screws from the r.f. stage outer screen and remove the screen by lifting it out vertically. To improve access to the wire drive mechanism the valve V3 (Part 1, Chap. 3, fig. 1) may be removed from its socket on the power supplies chassis.

(3) Stand the instrument on the bench in its normal operating position.

(4) At drum B (Part 1, Chap. 4, fig. 1 and fig. 1 of this chapter) remove the set screw, the spring, and wire 1, from this drum.

(5) At drum A, push out the wire securing pin and remove the wire 1 from this drum. (If the securing pin has dropped out of the drum when the wire snapped, it should be found and retained.)

(6) At drum C, release the grub screws and remove the drum from its spindle. Then take out the set screw, remove the spring and the end of wire 2.

(7) Wire 2 is the shorter of the two new drive wires. It should be fitted by inserting the larger loop of the wire through slot (c) in Drum C and then securing the end of the wire to the drum by the set screw.

(8) Wire 1 is the longer of the two new drive wires and it should be fitted as follows:—

(a) By folding the wire find its centre, then, facing the rear of the instrument, insert the loop, formed at the centre of the wire, through slot (a) in drum A and at the same time fit the wire securing pin.

(b) Make one complete turn of the wire round the securing pin so that the end of wire 1 having the larger loop is on the left-hand side of the slot (a) in drum A.

(c) The end of the wire 1 having the smaller loop should be wound round drum A in a clockwise direction and passed over the rocking arm pulley 1.

(d) On drum C, when viewed from the spring side, the wire 1 should be wound round in a counter-clockwise direction. Then, after passing through slot (c) it is attached to the spring by the small hook.

(9) At drum C, viewed again from the spring side, wire 2 is now passed round the drum in a clockwise direction. Wires 1 and 2 should be temporarily fixed in position on drum C with a piece of adhesive tape. Refit drum C on its spindle but do not tighten the grub screws.

(10) Rotate the drum A to bring slot (a) to the upper position. Lead the free end of wire 1 round drum A in a counter-clockwise direction, pass it over the inclined pulley 3 and round drum B in a counter-clockwise direction for one turn. Insert the loop through slot (b) and secure it, together with the spring, by the set screw.

(11) Wire 2 is brought from drum C over the rocking arm pulley 2 and the inclined pulley 4 to make one turn round drum B, in a clockwise direction. Insert the loop through slot (b) and attach it to the spring. To do this, lift the spring with a pair of instrument pliers. The adhesive tape can now be removed from drum C.

(12) Extract the 42 fixing screws holding the inner screen cover of the r.f. stage and remove the cover (para. 11). The PEAK CARRIER control should be adjusted to its mid-travel position. The vanes of the oscillator rotor are brought to the same angular position as those of the amplifier rotor by rotating the FREQUENCY control. Tighten the grub screws securing drum C to the amplifier capacitor rotor spindle.

(13) The FREQUENCY control is now turned to its full counter-clockwise position. Release the grub screws securing drum A to its spindle. Adjust the position of the spindle so that 0 on the linear scale of the tuning dial coincides with the cursor hairline. Finally, tighten the grub screws and refit the covers back on the r.f. stage.

Attenuator drive wire renewal

14. To renew the attenuator drive wire reference should be made to fig. 1 of this chapter and Part 1, Chap. 4, fig. 2 and 5. The sequence of operations is as follows:—

(1) Remove the instrument from its case (Part 1, Chap. 2, para. 5) and place it on the bench with the underside of the instrument uppermost (Part 1, Chap. 4, fig. 2).

(2) At the front panel, the plastic window and cursor assembly of the attenuator dial should be removed by taking out the fixing screw from the attenuator dial boss. The attenuator dial is then removed by taking out the three countersunk fixing screws, this exposes drum E.

(3) At drum E (fig. 1 of this Chapter), remove any broken pieces of wire that remain attached to the mechanisms. Then remove the set screw and take out the spring.

(4) At drum D (Part 1, Chap. 4, fig. 2, and fig. 1 of this chapter) ensure that the wire securing pin is in position. If the securing pin has dropped out of the drum when the wire snapped, it should be found and retained.

(5) Set the attenuator drive rack to the centre of its travel by using the ATTENUATOR control. Then rotate the control to bring slot (d) on drum D to the position furthest from drum E (situated behind the attenuator dial).

(6) The drive wire is a 36-inch length of stainless steel wire and should be fitted as follows:—

(a) Working from the rear of the instrument, fold the wire into equal halves and insert the loop so formed into slot (d) on drum D and fit the wire securing pin.

(b) Cross the two wires to form a loop round the securing pin. Wind one end of the wire from slot (d) for three and a quarter turns in a clockwise spiral travelling away from the front panel. Wind the other end of the wire from slot (d) for four and a quarter turns in a counter-clockwise spiral travelling towards the front panel. Lead the two ends through the holes in the dial housing to drum E.

(7) Drum E should be rotated to the position where slot (e) is opposite drum D. The two ends of the wire should be passed round drum E, in opposite directions, each end making three-quarters of a turn before entering slot (e).

(8) The two ends of the wire should be passed through slot (e) then the wire is pulled tight round the system and the two ends knotted together. Attach the spring to the loop formed by the knotting, and secure the spring to drum E by the fixing screw.

(9) The attenuator dial, cursor assembly, and plastic window should be fitted in the order given, finally tighten the fixing screw in the attenuator dial boss.

(10) When viewed from the front of the instrument the ATTENUATOR control should be turned in a clockwise direction as far as the stop. The two grub screws holding drum D to the attenuator dial spindle should be released. With the ATTENUATOR control stationary, rotate drum D on the spindle until the maximum output mark on the scale coincides with the cursor line. Finally tighten the two grub screws of drum D.

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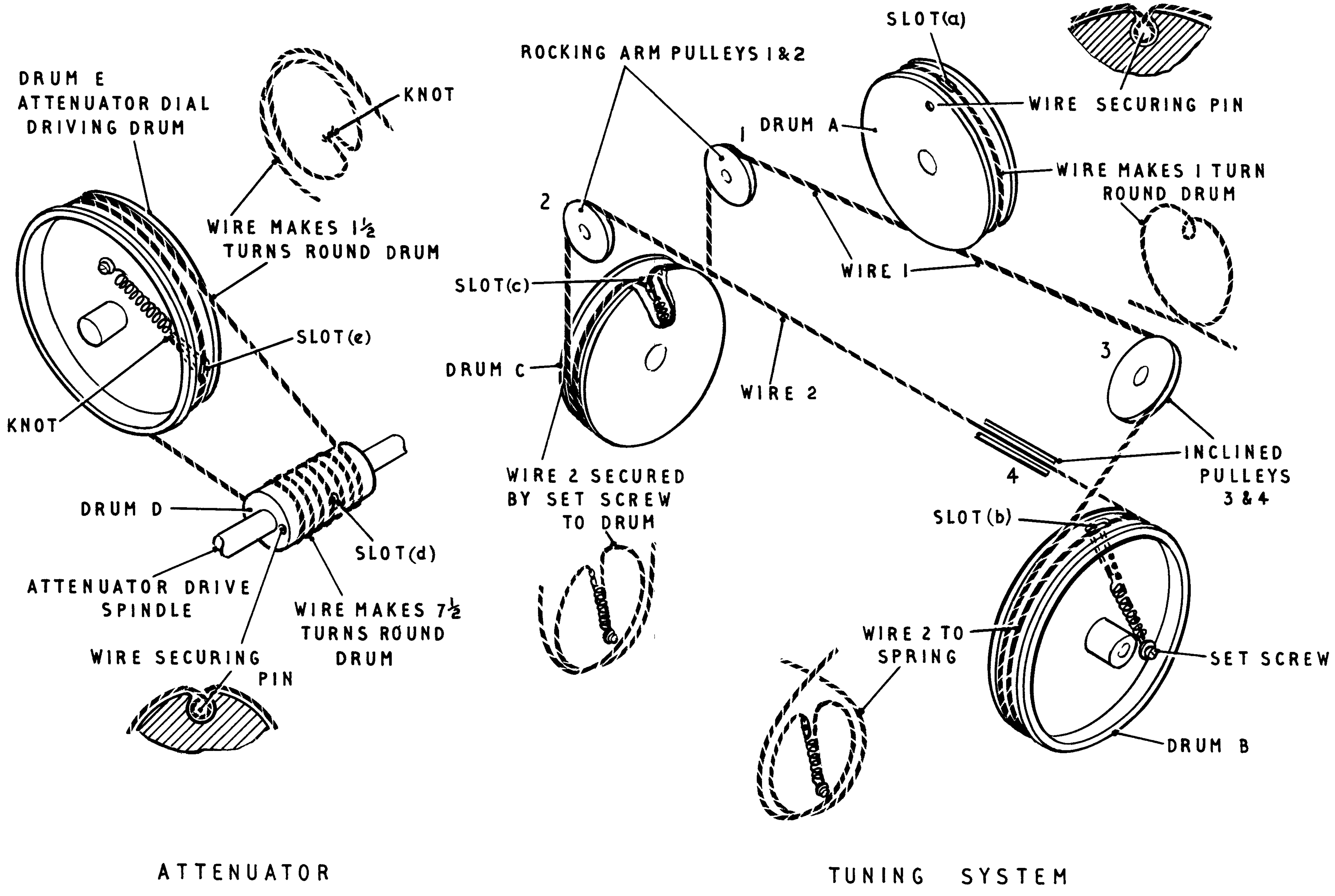

Fig. 1. Signal generator CT 394.-drive wire renewal Fig. 1.

Chapter 2

MAINTENANCE AND FAULT FINDING IN NAVAL SERVICE

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General

1. The signal generator should not require any routine adjustment. The instrument should not be removed from its cover, nor any of the preset controls adjusted, until the need to do so has been clearly established. The data in the subsequent paragraphs is given for emergency use only. In the event of failure of the equipment and subsequen t shipboard repair, signal generators in Naval Service should be recalibrated by the Defect List procedure.

2. The front panel of the equipment showing all the operational controls is shown in Part 1, Chap. 1, fig. 1. To facilitate location of the various components, they are identified in Part 1, Chap. 4, which describes the construction of the signal generator. The circuit diagram is given in Part 1, Chap. 3, fig. 2 (*at the end of the chapter*).

RAPID PERFORMANCE TESTS

3. To determine quickly whether or not the instrument is functioning normally, a number of tests are described in para. 4 to 7. These tests can be performed without removing the signal generator from its case.

Apparatus required

4. The following apparatus is required to perform the rapid performance tests:—

(1) The signal generator CT.394 to be tested.

(2) A.P.32144, avometer model 7X or A.P. 12945A, model 8SX.

(3) A.P.67921, valve voltmeter CT.54.

(4) Headphones, high or low impedance.

(5) Crystal detector, e.g. CV425, or CV448 or CV261 or any other similar type.

Preparation for test

5. (1) On the front panel of the signal generator (*Part* 1, *Chap*. 1, *fig*. 1) set the switches and controls as follows:—

(a) Mains SUPPLY switch to OFF.

(b) CRYSTAL CHECK and MODULATION switches to OFF.

(c) RANGE Mc/s switch to A 12-24 Mc/s.

(d) ATTENUATOR control to 100 mV EMF and the OUTPUT switch to NORMAL.

(2) Fit the A.P.67384 connector to the SUPPLY plug of the signal generator.

(3) Using an avometer, test the continuity of the earth lead of the instrument as follows:—

(a) Set the avometer to the appropriate ohms range.

(b) Connect one lead of the avometer to the E terminal on the front panel of the signal generator and the other lead to the earth pole of the three-pole plug of the mains connector A.P.67384.

(c) The continuity resistance should not exceed 0·5 ohms. If this value is exceeded, the defective earth lead must be repaired before proceeding any further with the subsequent rapid performance tests.

(4) Using the avometer A.P.32144, test the continuity of the RF attenuator of the signal generator as follows:—

(a) Set the avometer to its 10,000 ohm range.

(b) Connect one lead of the avometer to the chassis of the signal generator and the other lead to the centre pole of the RF output socket of the generator.

(c) The continuity resistance should be 45 to 55 ohms (nominal). The resistance should be constant over the whole travel of the ATTENUATOR dial. Intermittent readings point to either a faulty RF cable in the generator or a faulty resistor in the attenuator.

(5) Ensure that the tappings of the mains transformer are set correctly to the local AC mains supply, in accordance with the instructions contained in Part 1, Chap. 2. Using the avometer, monitor the AC mains supply and if the measurements show that the voltage is not within the tolerance, laid down for the local supply, the electrical officer should be informed so that appropriate action can be taken.

(6) Fit the connector A.P.67384 to the mains supply point.

(7) Switch the mains on at the supply point and also set the mains SUPPLY switch on the signal generator to its ON position. Ensure that the mains pilot indicator lamp is glowing and allow the instrument to warm up for a period of five minutes.

CW output test

6. The CW output can be tested as follows:—

(1) (a) Using the INCREASE FREQUENCY control, set the main tuning dial to a frequency of 18 Mc/s.

(b) With the OUTPUT switch set to NORMAL, adjust the SET CARRIER and PEAK CARRIER controls as detailed in Part 1, Chap. 2, and ensure that the CARRIER LEVEL meter can be set to 1V EMF (SET CARRIER mark).

(c) Set the OUTPUT switch to HIGH and ensure that, by adjusting the SET CARRIER and PEAK CARRIER controls, 2V EMF can be obtained at most frequencies (*sub-para.* (2)) within the range of the equipment. It is emphasized that the PEAK CARRIER control should not reach either of its end stops with the RF output still rising.

(2) The instructions contained in sub-para. (1(c)) should be effected at the following frequencies:—

RANGE *Mc/s switch setting*	*Main tuning dial frequency* (INCREASE FREQUENCY *control*)
A 12-24	13 Mc/s and 23 Mc/s
B 24-48	25 Mc/s, 35 Mc/s and 47 Mc/s
C 48-110	49 Mc/s, 77 Mc/s and 109 Mc/s
D 110-260	111 Mc/s, 160 Mc/s and 258 Mc/s
E 260-485	270 Mc/s, 350 Mc/s and 470 Mc/s

(3) (a) Set the switches and controls of the signal generator as follows:—

(i) OUTPUT switch to NORMAL.

(ii) ATTENUATOR control to 1V EMF.

(iii) RANGE Mc/s to 12-24 and the main tuning dial to a frequency of 12 Mc/s.

(iv) Adjust the SET CARRIER and PEAK CARRIER controls to obtain a SET CARRIER reading (1V EMF) on the meter of the signal generator.

(b) Using a valve voltmeter CT54 measure the CW voltage at the RF output socket of the signal generator as follows:—

(i) Set the valve voltmeter CT54 to the 2·4V range.

(ii) Using very short leads connect the probe of the CT54 with its earthing terminal in contact with outer conductor of the RF OUTPUT socket and the live probe terminal contacting the inner conductor of the socket.

(iii) The output RF voltage as measured by the CT54 should be about 1V (AC). Make a note of this reading.

(iv) With the probe of the CT54 remaining connected, set the OUTPUT switch of the signal generator to HIGH and adjust the SET CARRIER control to obtain an indication of 2V EMF on the CARRIER LEVEL meter. The CT54 should now read approximately twice that obtained in the preceding sub-sub-para. (iii), i.e. about 2V AC.

(v) Momentarily depress the CARRIER switch of the signal generator to OFF and ensure that the readings on both the CT54 and the CARRIER LEVEL meter fall to zero.

AM output test

7. The AM output should be tested as follows:—

(1) Set up the signal generator at a frequency of 12 Mc/s and a level of 1V EMF in accordance with para. 6, sub-para. (3).

(2) Ensure that the OUTPUT switch remains at NORMAL, then set the MODULATION switch to INT.

(3) Adjust the SET MODULATION control to obtain a reading of 30 per cent on the MODULATION meter.

(4) Connect one lead of a pair of headphones to E of the EXTERNAL MOD. terminals of the signal generator and the other lead in series with a detector diode (such as CV425, CV448, CV 261 or any other similar detector diode) to the inner conductor of the RF OUTPUT socket. A clean 1,000 c/s tone should be heard in the headphones. Ensure that the volume of the note can be adjusted by the SET MODULATION control.

(5) If an AM output is not obtained in operation (4) (*see fault finding, Table* 1), a 1,000 c/s tone at a level of up to 2·5V RMS and derived from an external audio source should be injected between the SINE AND E EXTERNAL MOD terminals. The equipments J1 or G205 can be used to provide the audio signal.

Note . . .
For this test the SET MODULATION *control is out of circuit.*

(6) Set the MODULATION switch to EXT. SINE and with the headphones connected as described in sub-para. (4) a 1,000 c/s note should be heard in the telephones. For an audio input of 2·5V RMS or less the MODULATION meter should read up to 90 per cent. Variations in the level of the audio input voltage of up to 2 or 3:1 to obtain 30 per cent modulation at differing frequencies are acceptable for this test.

Pulse modulation test

8. Unless the pulse modulation circuits of the CT394 are suspected of being defective, the pulse modulation test should be omitted at this stage. A rapid test of the pulse modulation circuits can be made by using a variable DC supply. A 60V battery with suitable tappings or a variable DC power supply similar to the CT397 varipack ◀with additional smoothing consisting of a 10K resistor and a 32 μF capacitor▶ could be used for this test. The DC supply must be isolated from earth; its positive pole should be connected to E of the EXTERNAL MOD terminals and its negative pole to the inner conductor of the PULSE socket. After this proceed as follows:—

(1) Set up the signal generator to CW at a frequency of 12 Mc/s and a level of 1V EMF (*para.* 6, *sub-para.* (3)).

(2) Set the MODULATION switch to OFF and then adjust the external DC supply to a level of about 10V.

(3) Set the MODULATION switch to EXT. PULSE. It should now be possible to control the carrier level by varying the voltage of the external DC supply. Providing this can be done, the pulse performance can be regarded as satisfactory. A more detailed test of the operation of the pulse circuits can be implemented by the Dockyard only using more accurate measuring equipment.

Crystal calibrator unit test

9. The test of the crystal calibrator unit described in this paragraph is intended to ensure that the calibrator is functioning correctly and it does not test the accuracy of the frequency of the unit. The test is as follows:—

(1) Ensure that the normal 2 Mc/s and 10 Mc/s crystals are fitted. Access to these is obtained via a cover at the rear of the case enclosing the signal generator.

(2) Set up the signal generator switches and controls as follows:—

(a) RANGE Mc/s switch to A 12 to 24.

(b) Main tuning dial to a frequency of about 20 Mc/s.

(c) OUTPUT switch to NORMAL.

(d) Using the SET CARRIER and PEAK CARRIER controls set the CARRIER LEVEL meter to read SET CARRIER (EMF 1V).

(e) Set the ATTENUATOR CONTROL to give an EMF of about 50 mV.

(3) Using ◀either the 12 in. or 54 in.▶ RF output connector (Type N to Type N) connect the RF OUTPUT socket of the signal generator to the CRYSTAL CHECK socket.

(4) Set the CRYSTAL CHECK switch to position 1 (10 Mc/s crystal only in circuit).

(5) Plug a pair of headphones into the PHONES jack on the panel of the signal generator.

(6) Adjust the main tuning dial as required until a loud beat note is heard in the telephones. This should occur with the tuning dial set to a frequency of 20 Mc/s±0·2 Mc/s. The note should be a clean whistle. Set the CRYSTAL CHECK switch to OFF and ensure that the beat note is no longer present.

(7) Set the CRYSTAL CHECK switch to position 2 (both the 2 Mc/s and the 10 Mc/s crystals are now in circuit).

(8) Again adjust the main tuning dial for a clear audio beat near a frequency setting of 20 Mc/s.

Note . . .
Immediately after switching on, a low constant frequency audio note may be heard in the headphones. This is caused by both the 2 Mc/s and the 10 Mc/s crystals oscillating together and, due to the fact that they have not reached their normal operating temperature, a beat frequency may occur between the fifth harmonic of the 2 Mc/s crystal and the fundamental frequency of the 10 Mc/s crystal. This constant frequency tone should be ignored at this stage.

(9) Adjust the frequency setting of the main dial to the frequencies of 18 Mc/s, 16 Mc/s, 15 Mc/s, 14 Mc/s and 12 Mc/s in turn. Loud beat notes should be heard at the even frequencies and a somewhat weaker beat note at 15 Mc/s. The beat note at 15 Mc/s is due to the 15th harmonic of the 2 Mc/s crystal beating with the 3rd harmonic of the 10 Mc/s crystal. This and other weak notes which may be located at other complex functions of the frequencies of the two crystals and the signal generator should be ignored.

(10) Set the frequency of the signal generator to about 460 Mc/s on RANGE E and using the ATTENUATOR control adjust the level of the output to about 100 mV.

(a) Set the CRYSTAL CHECK switch to position 1 (10 Mc/s crystal only).

(b) Using the INCREASE FREQUENCY control to adjust the main tuning dial, ensure that beat notes are heard at 10 Mc/s intervals at frequencies of 440 Mc/s, 450 Mc/s, 460 Mc/s, 470 Mc/s and 480 Mc/s. These notes will probably be much weaker than those obtained on RANGE A at a frequency of 20 Mc/s but they should be clear and distinct.

(c) Set the CRYSTAL CHECK switch to position 2 (both the 2 Mc/s and the 10 Mc/s crystals in operation) and using the INCREASE FREQUENCY control ensure that beat notes are heard clearly at each of the 2 Mc/s intervals between 460 Mc/s and 470 Mc/s.

Fault symptoms and diagnosis

10. As result of the rapid performance tests it should be possible, by inference and by studying Table 1 which describes a number of fault symptoms and their diagnosis, to localize most defects to a small part of the circuit of the signal generator. To determine the actual defective component it will be usually necessary to remove the equipment from its case. The procedure for this is given in para. 11.

Table 1

Fault symptoms, diagnosis and possible remedies

Symptom	Possible fault	Possible remedy
RF ATTENUATOR (*para.* 5, *sub-para.* (4)). Continuity resistance less than 45 ohms or exceeds 55 ohms	RF ATTENUATOR defective	Major defect which requires the instrument to be removed from the case (*para.* 12). If the cable can be repaired at the front panel this should be done; otherwise the servicing must be done by a definite procedure in the Dockyard
After setting SUPPLY switch to ON (*para.* 5, *sub-para.* (5) to (7)) the pilot lamp does not glow	(1) No mains supply voltage	(a) Measure the mains supply voltage at the mains supply point. If the supply is satisfactory, disconnect the mains connector A.P.67384 and test it for continuity. If necessary repair connector or substitute new item
		(b) Mains fuse defective. Remove the two 2A fuses from the front panel of the signal generator (*Part* 1, *Chap.* 1, *fig.* 1) and using the avometer A.P. 32144, test the continuity of the fuses. If the fuses are serviceable they should be refitted, otherwise substitute new fuses of the correct rating
		Note . . . *Unserviceable fuses can be due to age or overload. If a substitute fuse is blown, the fault is probably due to an overload. This is a major defect which may require separate investigation of the circuit. This will require the instrument to be removed from its case* (*para.* 11 *and* 12)
	(2) Defective indicator lamp	(a) Substitute new pilot lamp (6·3V, 0·15A) of the correct type
CW output test (*para.* 6, *sub-para.* (1) and (2). During this test CARRIER LEVEL meter indicates zero	(1) HT panel fuse defective	(a) Remove HT fuse from the front panel and test it for serviceability. If it is unserviceable substitute new fuse of the correct rating (150 mA)
	(2) Faulty circuit components	(a) If after renewing the HT fuse (*sub-para.* (1(a)) the CARRIER LEVEL meter indicates zero, the test (*described in para.* 6, *sub-para.* (3)) using the valve voltmeter CT54 should be effected. If this test is unsatisfactory, the defect may be in the oscillator circuits of the V2, or the power amplifier (V6) or the power supply (V1, V3, V4 and V5). This is a major defect requiring detailed investigation of the appropriate parts of the circuit—for which the instrument must be removed from its case (*para.* 11 *and* 12)

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TABLE 1 (*continued*)

Symptom	Possible fault	Possible remedy
	(3) CARRIER LEVEL meter circuit	(a) If the test described in sub-para. 2(a) is satisfactory the circuit of the CARRIER LEVEL meter is probably defective. This is a major defect calling for the removal of the case from its instrument (*para.* 11 *and* 12) and detailed investigation of the components of the CARRIER LEVEL meter circuit
During CW output test the SET CARRIER control can be set up as described in para. 6(1) and (2) but no RF output is obtained during the test in para. 6(3)	(4) Defective attenuator circuit	(a) Major defect requiring similar investigation of the attenuator circuits to that in sub-para. 3(a)
No AF output in the headphones during the test described in para. 7	(5) Defective AF oscillator, modulator or monitoring circuits	(a) Test EXTERNAL MODULATOR circuits as described in para. 7, sub-para. (5) and (6). If this test is satisfactory, the AF oscillator V7 circuit is defective
		(b) Should the test in sub-para. 5(a) prove unsatisfactory, the modulator V9 circuit is probably defective. This is a major defect requiring similar investigation of the appropriate circuit parts to that in sub-para. 3(a)

Removal of signal generator from its case (Part 1, Chap. 1, fig. 1)

11. (1) Remove the 4BA screws from the four feet of the case (where Barry mounts are fitted, these should also be removed). Place the instrument face downwards, taking care that it rests upon the guards and not on the front panel. After this, lift the case clear of the chassis.

(2) If it is necessary to have access to the RF oscillator and amplifier circuits, remove the twenty-two 6BA screws from the bottom outer screen (*Part* 1, *Chap.* 3, *fig.* 1) and also the twenty-five screws from the inner screen. Five of the screws of the inner screen are longer than the remainder and care must be taken to note the positions from which they are taken so that they can be screwed back into their correct places.

WARNING

Most of the screws are special flat-headed types and MUST NOT be substituted by ordinary round-headed or cheese-headed types, otherwise fouling will occur. Emergency renewal of components should be limited to the valves V2 and V6 and to other items which are readily accessible and appear in the appropriate component lists as pattern articles. NO ATTEMPT MUST BE MADE TO STRIP THE EQUIPMENT ANY FURTHER THAN INDICATED IN PARA. 12 AND THIS WARNING. BEFORE FITTING THE INSTRUMENT INTO ITS CASE ENSURE THAT THE INNER AND OUTER SCREENS ARE FITTED OVER THE RF OSCILLATOR COMPARTMENT AND THAT ALL THE SCREWS ARE PUT BACK WITH PARTICULAR REFERENCE TO SCREWING THE FIVE LONGER SCREWS OF THE INNER SCREEN INTO THEIR CORRECT POSITIONS.

Repair data and typical voltages

12. After the instrument has been removed from its case, carefully inspect it for visual signs of failure, broken or charred components or connections. Repair any obvious defects and then proceed as follows:—

(1) Ensure that the mains SUPPLY switch on the signal generator is set to OFF (*Part* 1, *Chap.* 1, *fig.* 1).

(2) Fit the connector A.P.67384 to the mains supply point and also to the signal generator.

(3) Set the mains SUPPLY switch of the signal generator to ON. Ensure that the indicator lamp on the generator is glowing and also that the heaters of all the valves which are visible are glowing. If the outer and inner screens of the RF oscillator have been removed, the examination should include V2 and V6.

(4) Allow a warming up period of five minutes to elapse before proceeding any further.

(5) Set the avometer to its DC 1,000V range and measure the voltage across C2 and C3 (*Part* 1, *Chap.* 3, *fig.* 1). The meter reading should be approximately 540V DC.

(6) Measure the stabilized HT by connecting the

avometer between pin 8 of V3 and the chassis. The meter should read 300V DC. If necessary the present control RV1 should be used to set the stabilized HT to 300V.

(7) When the voltages given in sub-para. (5) and (6) are correct, additional tests can be made on the suspected parts of the circuit. Typical test voltages are given in Table 2 and 3. The measurements have been made with the signal generator operating normally, with the controls (*Part* 1, *Chap*. 1, *fig*. 1) set as follows:—

Switch or control	*Setting*
RANGE	C48-110 Mc/s band
Main tuning dial	70 Mc/s
SET CARRIER	Centre of its travel
MODULATION	INT.
SET MODULATION	Set to zero (fully counter-clockwise)
ATTENUATOR	200 mV EMF
OUTPUT	NORMAL
PEAK CARRIER	Adjusted for maximum CARRIER LEVEL meter deflection
CRYSTAL CHECK	Position 2 (2 Mc/s and 10 Mc/s crystals in use).

WARNING

Valves should not be removed from the CT394 for test on the valve tester CT160 unless the voltage measurements in Table 2 or Table 3 indicate that a faulty valve exists. Whenever a valve has been tested and found serviceable it must be returned to the valve holder from which it was taken. Changes of the RF oscillator valve V2 may entail a recalibration of the frequency scale. This is a major operation and should only be done at a major repair centre or dockyard.

Note . . .

Since the testmeter reading is sometimes a function of the range in use, all the figures in Table 2 and 3 are given in the following form, e.g. 540/1,000, which means a measurement of 540V on the 1,000V range. All voltages are DC measured with the negative meter lead connected to the chassis, unless otherwise stated. The heaters of the valves are all 6·3V AC unless otherwise stated in Table 2 and 3. The component location illustrations are incorporated in Part 1, Chap. 4.

TABLE 2

Typical test point voltages
(all measurements are DC unless otherwise stated)

Test points	**A.P.12945A Multimeter Type 1** *Ref. No.* 10S/16411 **Volts**	**Instruments used A.P.321144 Testmeter Type F** *Ref. No.* 10S/1 **Volts**	**A.P.67921 CT54** *Ref. No.* 10S/16373 **Volts**
V1 Pins 4 and 6	460/1000 AC	460/1000 AC	460/480 AC
V1 across Pins 2 and 8 filament	5/10 AC	5/10 AC	Not measured
	(Because of the presence of high voltage at pins 2 and 8 of V1 great care must be taken when making this measurement)		
V2 (*Given at end of table*)			
V3 Pin 3 anode	540/1000	540/1000	540 using multiplier
V3 Pin 4 screening grid	540/1000	540/1000	540 using multiplier
V3 Pin 8 cathode	300/1000	300/400	300/480
	Note . . . *The range of control of the 300V line by RV1 is approximately from 175V to 340V.*		
V4 Pin 5 anode	265/1000	230/1000	272/480
V4 Pins 2 and 7 cathode	83/100	83/100	83/420
V4 Pin 6 screening grid	137/250	117/400	136/240
V6 (*Given at end of table*)			
V7 Pins 1 and 5 anode	280/1000	272/1000	280/480
V7 Pin 7 cathode	22/100	19/100	22/48
V8 Pin 6 anode	105/250	90/400	106/240
V8 Pin 8 cathode	22/100	19/100	22/48
V8 Pin 1 anode	300/1000	300/400	300/480
V8 Pin 3 cathode	147/250	141/400	147/240
V9 Pins 2 and 5 anodes	14/25	14/100	14/48
V9 Pins 3 and 6 cathodes	1·3/2·5	1·2/10	1·3/2·4

Note . . .

The cathode voltages of V9 are determined by the setting of the SET CARRIER *control.*

TABLE 2 (*continued*)

Test points	A.P.12945A Multimeter Type 1 *Ref. No.* 10S/16411 Volts	Instruments used A.P.321144 Testmeter Type F *Ref. No.* 10S/1 Volts	A.P.67921 CT54 *Ref. No.* 10S/16373 Volts
	Crystal calibrator unit (prefix 2)		
2V1 Crystal oscillator			
2V1 Pin 6 anode	100/250	95/400	100/240
2V1 Pins 3 and 8 cathodes	16/25	15/100	17/24
2V1 Pin 1 anode	80/250	63/400	80/240
2V2 Mixer			
2V2 Pin 5 anode	60/250	20/400	65/240
2V2 Pin 6 screening grid	60/250	50/400	53/240
2V2 Pin 2 cathode	3/10	2·3/10	3·3/4·8
2V3 AF amplifier			
2V3 Pin 6 anode	185/250	130/400	185/240
2V3 Pin 8 cathode	0·2/2·5	0·1/1	0·2/2·4
2V3 Pin 1 anode	50/250	45/400	50/240
2V3 Pin 3 cathode	0·2/2·5	0·15/1	0·2/2·4
	RF oscillator and amplifier		
V2 heater	AC 6·3/10	AC 6·3/10	AC 6·3/24
	Note . . . *The heater voltages of V2 must be within the tolerances of —0 per cent and +10 per cent.*		
V6 heater	AC 6·3/10	AC 6·3/10	AC 6·3/24
	Note . . . *Both sides of the heater of V6 are isolated above earth.*		
	WARNING *Due to the presence of RF voltages, the CT54 is not very satisfactory for the heater voltage measurements of V2 and V6.*		
	Note . . . *Before measuring the anode volts of V6, first ensure that the continuity of L5 is satisfactory.*		
V6 anode at junction of filter unit 4 and L5	300/1000	300/400	300/480

Note . . .
The anode voltage of V2 is a function of the frequency range in use and also the setting of the OUTPUT *switch. Before measuring the anode voltage of V2, ensure that the continuity of L1 is satisfactory and then make the measurement at the junction of R46, C1 and L1. The measurements are DC and with respect to the chassis. The typical values are given in Table 3.*

TABLE 3

Typical voltages at the anode of the RF oscillator valve V2

Frequency	Output	Multimeter Type 1	Testmeter Type F	CT54
RANGE switch	Switch			
A 12-24 Mc/s	NORMAL	160/1000	155/400	160/240
	HIGH	180/1000	170/400	160/240
B 24-48 Mc/s	NORMAL	175/1000	166/400	175/240
	HIGH	190/1000	182/400	190/240
C 48-110 Mc/s	NORMAL	230/1000	230/400	230/480
	HIGH	293/1000	295/400	295/480
D 110-260 Mc/s	NORMAL	235/1000	233/400	235/480
	HIGH	295/1000	295/400	295/480
E 260-485 Mc/s	NORMAL	230/1000	225/400	230/480
	HIGH	295/1000	295/400	295/480

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Appendix 1

LIST OF RENEWABLE COMPONENT PARTS FOR SIGNAL GENERATOR

CT394(6625-99-943-1911)

(ROYAL NAVY)

LIST OF CONTENTS

LIST OF TABLES

Introduction

1. This appendix contains details of the components parts which are to be made available for use by the Royal Navy when servicing the signal generator CT394. For the Royal Air Force, the schedule of spare parts and scales of equipment is given in A.P.2276F.

Note . . .

The parts listed in the subsequent tables may not be identical to those used in production; however, where differences occur they are newer or improved versions thereof. Unless otherwise stated, the tolerances are expressed as a ± percentage.

Table 1

Resistors

Circuit Ref.	Description	J.S.C. Reference No.	Value Ohms	Rating	Tolerance
R1	Composition	5905-99-022-1003	10	½ watt	10
2	,,	5905-99-022-2132	10K	½ ,,	10
3	,,	5905-99-022-1111	100	½ ,,	10
4	,,	5905-99-022-2090	4·7K	½ ,,	10
5	,,	5905-99-022-3144	680K	½ ,,	10
6	,,	5905-99-022-3102	330K	½ ,,	10
7	,,	5905-99-022-2216	47K	½ ,,	10
8	,,	5905-99-022-3060	150K	½ ,,	10
9	,,	5905-99-022-3051	120K	½ ,,	10

Table 1 (*cont.*)

Circuit Ref.	Description	J.S.C. Reference No.	Value Ohms	Rating	Tolerance
R10	Composition	5905-99-022-3039	100K	½ watt	10
11	,,	5905-99-022-2195	33K	½ ,,	10
12	,,	5905-99-011-1483	10K	1 ,,	10
13	,,	5905-99-022-1216	680	½ ,,	10
14		Not used			
15	,,	5905-99-011-1483	10K	1 ,,	10
16	,,	5905-99-022-2132	10K	½ ,,	10
17	,,	5905-99-022-3164	1M	½ ,,	10
18	,,	5905-99-022-1090	68	½ ,,	10
19	,,	5905-99-022-1132	150	½ ,,	10
20	,,	5905-99-022-2048	2·2K	½ ,,	10
21	,,	5905-99-022-2088	4·7K	¼ ,,	10
22	,,	5905-99-022-1067	47	¼ ,,	10
23	,,	5905-99-022-3164	1M	½ ,,	10
24	,,	5905-99-022-3039	100K	½ ,,	10
25	,,	5905-99-022-1195	470	½ ,,	10
26	,,	5905-99-022-3164	1M	½ ,,	10
27	,,	5905-99-022-2090	4·7K	½ ,,	10
28	,,	5905-99-022-1195	470	½ ,,	10
29	,,	5905-99-022-2195	33K	½ ,,	10
30	,,	5905-99-022-2089	4·7K	¼ ,,	10
31	,,	5905-99-022-3309	150K	¾ ,,	10
32	,,	5905-99-022-2132	10K	½ ,,	10
33	,,	5905-99-022-3309	150K	¾ ,,	10
34	,,	5905-99-022-2132	10K	½ ,,	10
35	,,	5905-99-022-3081	220K	½ ,,	10
36	,,	5905-99-022-1067	47	¼ ,,	10
37					
38	,,	5905-99-022-1069	47	½ ,,	10
39	,,	5905-99-022-2247	33K	¾ ,,	10
40	,,	5905-99-022-2245	22K	¾ ,,	10
41	,,	5905-99-022-2006	1K	½ ,,	10
42	,,	5905-99-022-1003	10	½ ,,	10
43	,,	5905-99-022-2216	47K	½ ,,	10
44	,,	5905-99-022-1172	330	¼ ,,	10
45	,,	5905-99-022-1026	22	¼ ,,	10
46	,,	5905-99-022-1111	100	½ ,,	10
RV1	Wire preset	5905-99-027-2410	50K	1 ,,	10

Table 1 (*cont.*)

Circuit Ref.	Description	J.S.C. Reference No.	Value Ohms	Rating	Tolerance
RV2	Wire semi-log	5905-99-972-8998	2K	3 watt	10
RV3	Wire inverse, semi-log	5905-99-972-8999	2K	3 ,,	10
RV4	Wire preset	5905-99-027-2005	5K	1 ,,	10
RV5	Wire preset	5905-99-027-2410	50K	1 ,,	10

Note . . .
RV2 and RV3 are not interchangeable.

Table 2

Capacitors

Circuit Ref.	Description	J.S.C. Reference No.	Value	Voltage Rating	Tolerance
C1	Ceramic	5910-99-011-8321	100 pF	750V	10
2	Paper	5910-99-011-2824	4 μF	600	20
3	Paper	5910-99-011-2824	4 μF	600	20
4	Trimmer frequency				
5					
6	Special—part of oscillator assembly—non-pattern (4–8)				
7					
8					
9	Paper	5910-99-011-5509	0·25 μF	350	20
10	Feed-through	5910-99-972-9054	50 pF	350	20
11	,,	5910-99-972-9054	50 pF	350	20
12	Electrolytic	5910-99-014-5200	50 μF	12	—20+100
13	Not used (*see note*)				
14	Not used (*see note*)				
15	Paper—two in parallel	5910-99-011-5827 5910-99-011-5824	0·01 plus 0·005 μF	400 400	Parallel to ±10%
16	Paper	5910-99-011-5625	0·01 μF	350	20
17	Paper	5910-99-011-5506	0·1 μF	350	20
18	Special—part of r.f. amplifier assembly—non-pattern (18–19)				
19					
20	Electrolytic	5910-99-014-5504	8 μF	350	—20+50
21	Paper	5910-99-011-5554	0·05 μF	350	20
22	Ceramic tub.	5910-99-972-9055	500 pF	500	—
23	Paper	5910-99-011-5827	0·01 μF	400	25

Table 2 *(cont.)*

Circuit Ref.	Description	J.S.C. Reference No.	Value	Voltage Rating	Tolerance
C24	Paper	5910-99-011-5572	2 μF	150	25
25	Ceramic tub.	5910-99-911-3830	1500 pF	350	—
26	Ceramic tub.	5910-99-972-9128	47 pF	500	10
27	Ceramic tub.	5910-99-011-8321	100 pF	500	10
28	Special—part of r.f. amplifier—non-pattern (0·5-3 pF)				
29	Ceramic	5910-99-013-2562	220 pF	350	20
30	Paper	5910-99-011-5572	2 μF	150	25
31	Ceramic tub.	5910-99-972-9684	1000 pF	500	20
32	Paper	5910-99-011-5572	2 μF	150	25
33	Ceramic	5910-99-918-8115	2·2 pF	500	±0·5 pF
34		5910-99-918-8114	56 pF	750	2
35		5910-99-011-8270	2·2 pF	500	±0·5 pF
36	Ceramic	5910-99-011-8270	2·2 pF	500	±0·5 pF
37	Ceramic	5910-99-011-8307	27 pF	500	10
38	Ceramic tub.	5910-99-972-~~8910~~ 9684	1000 pF	500	20
39	Ceramic tub.	5910-99-011-8321	100 pF	500	10
40	Ceramic	5910-99-918-8115	2·2 pF	500	±0·5 pF
41	Ceramic	5910-99-918-8115	2·2 pF	500	±0·5 pF

Note . . .
For the capacitors in the filters No. 1 *to* 5 *leading into the r.f. box see Table* 4.
C10 *and* C11. *Capacitors of* 47 *pF may be used in these positions* (*Part* 1, *Chap.* 3, *Fig.* 2).

Table 3

Switches, sockets, transformers, inductors, meters, valves, drive cords and terminals

Circuit Ref.	Description	J.S.C. Reference No.
S1	Toggle	5930-99-051-0554
S2	Special—part of frequency range control, non-pattern	
S3	Normal—high	5930-99-051-0551
S4	2-pole, 4-way non-pattern	
S5	Special—part of frequency range control, non-pattern	
S6	Biased toggle	5930-99-051-0555
—	Stand-off ceramic insulators	5940-99-056-0881 and
SKT1	50 ohms impedance	5970-99-932-5404
SKT2	UG 22 B/U Transradio Code No. DEO71	5935-99-972-9184

Table 3 (*cont.*)

Circuit Ref.	Description	J.S.C. Reference No.
T1	Mains transformer	5950-99-972-8822
T2	V2 and V6 heater	5950-99-972-8823
T3	Modulator oscillator	5950-99-972-8821
M1	Carrier level 100 μA f.s.d.	6625-99-943-3791
M2	Mod. level 100 μA f.s.d.	6625-99-943-3805
	Inductors:	
L1	160 turns close wound 42 s.w.g. 7 ohms 49·4 μH	
L2	Smoothing 27H-50 mA	5950-99-972-8824
L3	Not used	
L4	Not used	
L5	160 turns close wound 42 s..g. 7 ohms 49·4 μH	
L6	Not used	
L7	Special—non-pattern	
L8	70 turns close wound 42 s.w.g. 5 ohms 95 μH core as in filters	
L9	Not used	
L10	2×20 turns of 7/·0048″ D.S.C. Cu. Bifilar. 1½″ ends (Inductance 0·25 μH$\pm$0·005 μH at 1 Mc/s)	
L11	Not used	
L12	Special—non-pattern	
L13, L14, L15, L16, L17	Oscillator coils—range 'A' to 'E' All special	
L18, L19, L20, L21, L22	R.F. amplifier output coils—ranges 'A' to 'E' All special	
	Note . . . *The inductors in filter units No. 1 to 5 are given in Table 4.*	
V1	CV717	
V2	CV273	
V3	CV1075 (CV1947 possible alternative)	
V4	CV850/4010	
V5	CV449/4048	
V6	CV273	
V7	CV133/4058	

Table 3 (*cont.*)

Circuit Ref.	Description	J.S.C. Reference No.
V8	CV455/4024	
V9	CV2523	
X1	CV291	
X2	CV425	
X3	CV425	
1LPL	Lamp 8V 1·2W	6240-99-995-1148
	Valve and crystal bases:	
	V1, V3, V9	5935-99-056-0031
	V2, V6	Special non-pattern
	Retaining clips for V2 and V6	5960-99-972-9438
	V4, V5, V7	5935-99-056-0127
	V8	5935-99-056-0131
	X1	Special non-pattern
	Valve screens	
	V1	5960-99-011-3589
	V3, V9	5960-99-011-3580
	V4	5960-99-056-0145
	V5, V7	5960-99-056-3003
	V8	5960-99-056-3007
	(For V2 and V6 see bases)	
	Tuning and attenuator drive cords consisting of:—1 packet of 6 foot plus 6 ferrules for replacement of both drives	
	Terminals E, SINE, etc.	5940-99-932-5591

Table 4

Filters into r.f. box

Note . . .

For repair, it is intended that capacitors and/or inductors be changed individually. Before dismantling the filters, make a careful note of the method of their assembly to assist in the correct reassembly of the filters. If necessary the dust cores can be changed and the winding rewound using the information immediately following the details of filter No. 5. The windings should be fixed with dope or varnish according to the type available.

Filters	Description
Filter No. 1 and No. 4	V2 and V6, h.t. feed C1, C2, C3 4700 pF
	L1, L2 100T 44 s.w.g. 5 ohms 95 µH

Table 4 (*cont.*)

Filters	Description
Filter No. 2	V2 and V6, l.t. feed C1, C2, C3 4700 pF L1, L2 32T 30 s.w.g. 0·13 ohms 11 μH
Filter No. 3	Modulation input C1, 100 pF, C2, C3 200 pF L1, L2 100T 44 s.w.g. 5 ohms 95 μH
Filter No. 5	C1, C2, C3 100 pF L1, L2 100T 44 s.w.g. 5 ohms 95 μH
All inductors wound on:—	Dust core former Neosid CHI. 5950-99-972-9131
Capacitors all:—	Fixed, ceramic, bush mounting, feed-through 350V d.c. working 4700 pF 5910-99-972-8785 200 pF +20 −0 per cent 5910-99-972-8769 100 pF +20 −0 per cent 5910-99-932-5672

Note . . .
With the exception of filter 3 all the respective capacitors have the same value. C1 (100 pF) of filter 3 is outside the r.f. box and C3 (200 pF) inside the box.

Table 5

◀ Adaptors, leads and coaxial fuse ▶

Description		Value	J.S.C. No.
Attenuator 20 dB	TM4919	50 ohms	5905-99-972-8881
*Leads test	TM4917	—	6625-99-943-3486
†Attenuator	TM5548	50–75 ohms	5905-99-972-8901
†Attenuator	TM5549	50–75 ohms	5905-99-972-8900
‡Connector 54 in.	TM4824/1	50 ohms	5995-99-972-8884
‡Connector 12 in.	TM4824/2	50 ohms	5995-99-972-8882
‡Connector 12 in.	TM5599	50 ohms	5995-99-972-8883
Connector 8 ft.	—	Mains	5995-99-940-0491
Adaptor plug socket	UG-107A/U	50 ohms	5935-99-972-8894
◀ Fuse unit r.f. concentric	—	—	5920-99-932-4381 ▶

*Spare capacitor for TM4917 is 5910-99-013-2630. 1000 pF ± 10 per cent N750.
†Internal resistor for TM5548 or TM5549 is 25 ohms ± 2 per cent, Welwyn type SWA 611 non-pattern.

‡Note . . .
The 50-ohm r.f. connectors (54 in. and 12 in.) in Table 5 consist of the following materials:—
(*a*) *Uniradio* 43.
(*b*) *Series N plug straight, free, single-pole,* 5935-99-940-1095.
(*c*) *Series N jack socket, free, straight, single-pole,* 5935-99-972-9391.
(*d*) *Plastic sleeve,* 5935-99-972-9531, *for use with the plug and jack-socket in sub-para.*(*b*) *and* (*c*).

Table 6

Crystal calibrator sub-chassis, 6625-99-943-1911, resistors and capacitors

Circuit Ref.	Description	J.S.C. Reference	Value	Rating	Tolerance
R1	Composition	5905-99-022-3037	100K	¼ watt	10
R2	,,	5905-99-022-2085	4·7K	¼ ,,	5
R3	,,	5905-99-022-2193	33K	¼ ,,	10
R4	,,	5905-99-022-3037	10K	¼ ,,	10
R5	,,	5905-99-022-3036	150K	½ ,,	10
R6	,,	5905-99-022-2127	10K	¼ ,,	5
R7	,,	5905-99-022-3037	100K	¼ ,,	10
R8	,,	5905-99-022-3037	100K	¼ ,,	10
R9	,,	5905-99-022-2016	1·2K	¼ ,,	10
R10	,,	5905-99-022-2214	680	¼ ,,	10
R11	,,	5905-99-022-2172	22K	¼ ,,	10
R12	,,	5905-99-022-3205	2·2M	¼ ,,	10
R13	,,	5905-99-022-2172	22K	¼ ,,	10
R14	,,	5905-99-022-1073	51	¼ ,,	5
R15	,,	5905-99-022-3058	150K	¼ ,,	10
R16	,,	5905-99-022-3121	470K	¼ ,,	10
R17	,,	5905-99-022-2151	220	¼ ,,	10
R18	,,	5905-99-022-3081	220K	½ ,,	10
R19	,,	5905-99-022-3037	10K	¼ ,,	10
R20	,,	5905-99-022-2151	220	¼ ,,	10
R21	,,	5905-99-022-3121	470K	¼ ,,	10
C1	Trimmer	5910-99-016-0048	3-19 pF	—	—
C2	Ceramic	5910-99-013-2073	15 pF	500V	10
C3	Trimmer	5910-99-016-0048	3-19 pF	—	—
C4	Paper	5910-99-011-5812	0·001 μF	400	20
C5	Ceramic	5910-99-013-2250	2·2 pF	500	10
C6	Trimmer	5910-99-016-0048	3-19 pF	—	—
C7	Ceramic	5910-99-013-2289	47 pF	500	10
C8	Paper	5910-99-011-5827	0·01 μF	400	20
C9	Ceramic	5910-99-013-2426	10 pF	500	10
C10	Trimmer	5910-99-016-0048	3-19 pF	—	—
C11	Ceramic	5910-99-013-2289	47 pF	500	10
C12	Ceramic	5910-99-013-2289	47 pF	500	10
C13	Ceramic	5910-99-911-6460	470 pF	350	−20+80
C14	Electrolytic	5910-99-014-5301	4 μF	350	−20+50
C15	Paper	5910-99-011-5812	0·001 μF	400	20
C16	Paper	5910-99-011-5827	0·01 μF	400	20
C17	Paper	5910-99-011-5827	0·01 μF	400	20

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Table 6 (*cont.*)

Circuit Ref.	Description	J.S.C. Reference	Value	Rating	Tolerance
C18	Paper	5910-99-011-5812	0·001 μF	400	20
C19	Ceramic	5910-99-013-2251	4·7 pF	500	+0·5 pF
C20	Ceramic	5910-99-013-2280	27 pF	500	10
C21	Ceramic	5910-99-013-2277	22 pF	500	10

Table 7

Crystal calibrator-miscellaneous items

Circuit Ref.	J.S.C. Reference or description		
V1 holder	5935-99-056-0096		
V2 holder	5935-99-056-0094		
V3 holder	5935-99-056-0131		
V1 Screen	5960-99-056-3007		
V2 Screen	5960-99-056-0145		
V3 Screen	5960-99-056-3007		
V1	CV455/4024		
V2	CV4011		
V3	CV455/4024		
Switch SA	1-pole	3-position	Non-pattern
—	Crystal socket	McMurdo	X.2/WB for style D non-pattern
—	Crystal clip	Marconi WT for style D	
	Crystal X1	ZDK 10,000	
	X2	ZDK 2,000	
	For other frequencies order style ZDA...giving frequency in kc/s		
Telephone jack	5935-99-911-5733		
SKT1 (r.f. input)	50 ohms UG 22B/U 5935-99-922-8184		
	Transradio code DEO 71		

F.S./5
334/1 ON 364242 Dd 6462 Wt 32048 APL 750 4/59