ADMIRALTY
B.R. 1771 (14)

HANDBOOK FOR

A.P. 61335
FREQUENCY - SWEPT - OSCILLATOR
&
J.S. CAT. No. 6625-99-943-2420
SIGNAL GENERATOR, FREQUENCY SWEPT
(7 - 70 Mc/s) CT202

Prepared by direction of the Admiralty
and is hereby promulgated.

By Command of
Their Lordships

By Command of the
Air Council

78/58 N.C.

A.P. 2563 DV

B.R. 1771 (14)

A.P. 2563 DV.

COMMON NAVAL RADIO TEST EQUIPMENT

Handbook for

A.P. 61335

FREQUENCY - SWEPT - OSCILLATOR

and J. S. Cat. No. 6625-99-943-2420 Signal Generator - Frequency Swept.

(7-70 Mc/s) CT 202

JOINT - SERVICES DESIGNATION :

FREQUENCY - SWEPT - OSCILLATOR (7-70 Mc/s) CT202

ANY SUGGESTIONS FOR AMENDMENTS OR ADDITIONS TO THIS BOOK SHOULD BE SUBMITTED TO THE CAPTAIN SUPERINTENDENT, A.S.R.E., THROUGH THE USUAL CHANNELS

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RADIO EQUIPMENT DEPARTMENT · ADMIRALTY
MAR., 1956 (R.E. 109/56)

Admiralty, S.W.1.

March, 1956.

R.E.109/56

B.R.1771(14) "Handbook for A.P.61335 Frequency-Swept-Oscillator (7-70 Mc/s) CT202, 1956", having been approved by My Lords Commissioners of the Admiralty is hereby promulgated.

By Command of Their Lordships

J. F. Lang

To:-
Flag Officers and
Commanding Officers
of H.M. Ships and
Vessels concerned.

H A N D B O O K

F O R

A . P . 6 1 3 3 5 F R E Q U E N C Y - S W E P T - O S C I L L A T O R

(7 - 7 0 M c / s) C T 2 0 2

(Joint-Services:- Frequency-Swept Oscillator (7-70 Mc/s) CT202)

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FIGURE 1 CIRCUIT DIAGRAM OF CT202

FIGURE 2 COMPONENT LAYOUT: TOP VIEW OF CHASSIS

FIGURE 3 " " R.F. CHASSIS

FIGURE 4 " " UNDER-CHASSIS VIEW

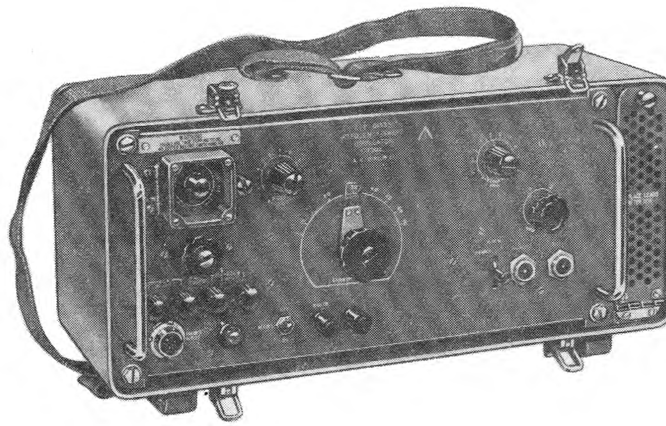
FIGURE 5 " " ATTENUATOR BOX ASSEMBLY

A.P.61335 FREQUENCY-SWEPT-OSCILLATOR, (7-70 Mc/s), CT202

(Joint-Services Designation:- Frequency Swept Oscillator, (7-70 Mc/s), CT202)

PURPOSE

Primarily for use in the visual checking and measurement of bandwidth at the -3 dB or -6 dB levels of radar I.F. amplifiers. (If bandwidth is being measured between -6 dB points, the bandwidth must be between 0.5 Mc/s and 7 Mc/s.) In addition, the response curves of some wireless receivers may be inspected but the bandwidths are not measurable.



BRIEF DESCRIPTION

The output signal of the CT202 is derived from the beat frequency between two oscillators, one of which has its frequency swept over a selected range by a saw-tooth modulating voltage obtained from the timebase generator of an external oscilloscope. The maximum frequency deviation is ± 5 Mc/s. The frequency modulated signal is fed to the I.F. amplifier under test, the video output being displayed as a response curve on the oscilloscope. Bandwidth is measured with the aid of a marker-pip provided by an external signal generator.

PERFORMANCE

(a) Carrier Frequency variable 7-70 Mc/s, directly calibrated.

Accuracy ± 2 Mc/s. Provision is made for the injection of a marker-pip from an external signal generator for accurate frequency measurement.

(b) F.M. Deviation variable up to 10 Mc/s total sweep (i.e. ± 5 Mc/s).

Modulation depth of unwanted A.M. on the F.M. sweep is not more than 10% at carrier frequencies between 10 Mc/s and 60 Mc/s and not more than 20% at 70 Mc/s. When using the full 10 Mc/s sweep at a carrier frequency of 7 Mc/s, there is some undesirable interaction of the oscillators.

NOTE: The sweep is obtained from the X-sweep voltage of an oscilloscope and a preset control is provided which enables the CT202 to accept the timebase generator voltages of most oscilloscopes in which the X-sweep is easily extracted, including the following:-

10S/831 Air Ministry Type 13A

A.P.3336A Cossor Double Beam

A.P.68622 Miniature Oscilloscope CT52

(c) Attenuation

When terminated in 75 ohms, and with output controls at maximum, the output is not less than 100 mV. Output is variable from 5 µV to at least 100 mV. A -3 dB or -6 dB pad may be switched into circuit to facilitate bandwidth measurements.

(d) Output Impedance

72 ohms ± 3 ohms

400 ohms using adaptor pads

POWER REQUIREMENTS AND CONSUMPTION

115, 180, 200, 210, 220, 230, 240 or 250V, ± 6% 50 to 500 c/s ± 10%. 45 watts approx.

PHYSICAL DATA

Weight 42 lb approx. Height 9½ in.

Depth 8½ in. Width 19½ in.

NEAREST COMMERCIAL EQUIVALENT

Cossor Tele-check

REMARKS

The instrument is essentially for Service use and is not intended for basic design work or measurements.

HANDBOOK

B.R.1771(14)

ESTABLISHMENT LIST

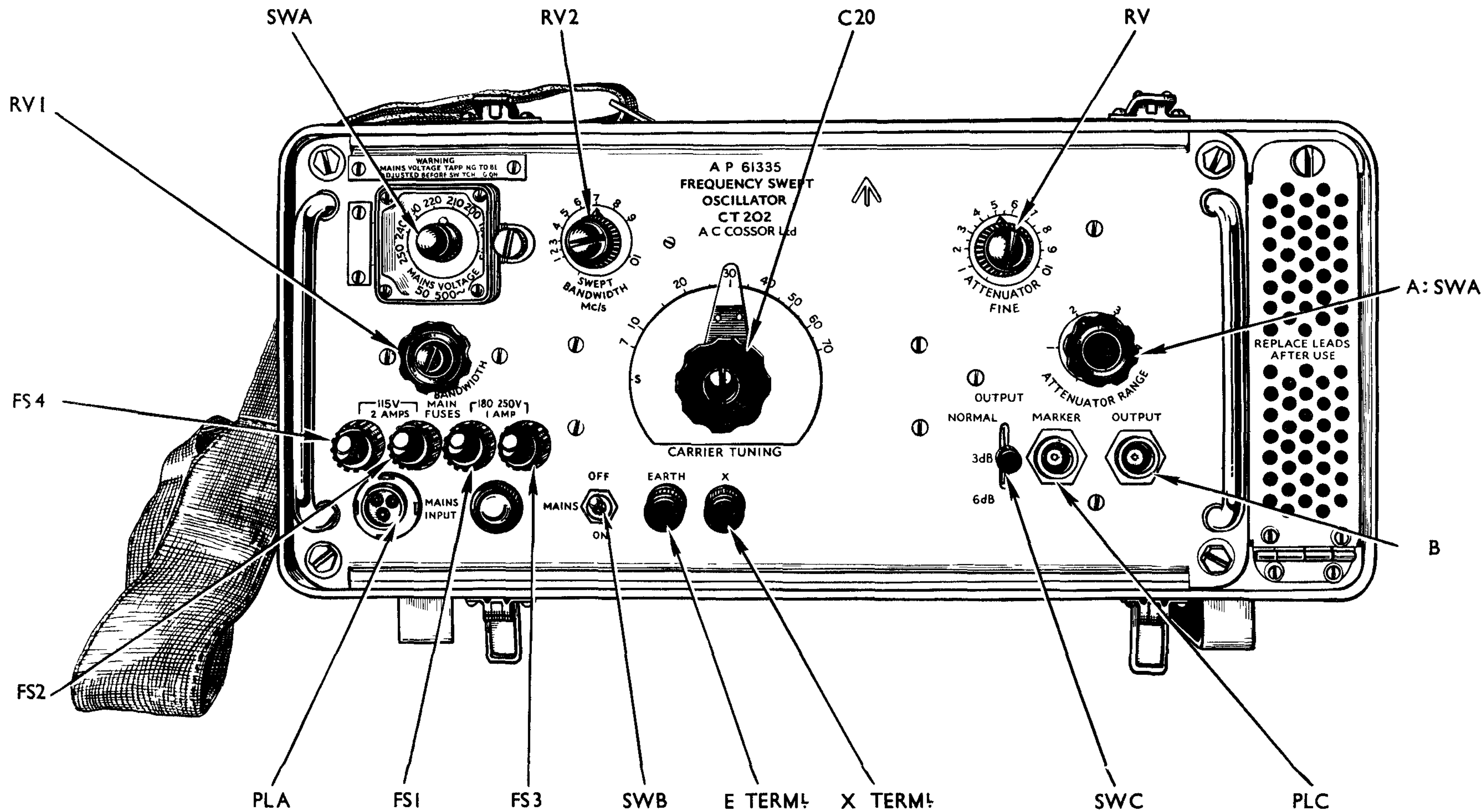
E1115

PRODUCTION SPECIFICATION

15451

FREQUENCY – SWEPT – OSCILLATOR CT 202

FRONT PANEL VIEW



DIAG. 1.1.1

HANDBOOK FOR

A.P.61335 FREQUENCY-SWEPT-OSCILLATOR

(7-70 Mc/s) CT202

PART 1

CHAPTER 1

INTRODUCTION

Note: Diagrams and Tables are numbered on the "decimal" system, the first number representing the Part and the second the Chapter.

1. In recent years, the visual alignment of receivers and amplifiers has found increasing popularity, particularly in the widening spheres of Television and Radar. Considerable time can be saved and the response-curve obtained much more easily by using a frequency-swept-oscillator and a separate oscilloscope to display the frequency-response curve. The overall response and the bandwidth of a receiver or IF amplifier become immediately ascertainable. This is particularly useful in the case of stagger-tuned or other band-pass types of amplifier which have a relatively wide response.

2. The Frequency-Swept-Oscillator CT202 is a generator of continuous oscillations whose frequency is periodically varied above and below its mean value. The carrier frequency (i.e. the frequency when no frequency-modulation is taking place) is adjustable between 7 and 70 Mc/s and the output amplitude is variable between zero and maximum (which is not less than 100 mV). The total frequency sweep (i.e. between upper and lower limits) is 10 Mc/s maximum. The output is thus varied from (f_3 + 5 Mc/s) to (f_3 - 5 Mc/s) where f_3 is the carrier frequency (see Diagram 1.2.1). The total sweep band is selectable between zero and 10 Mc/s and the modulation is produced by a periodic voltage of sawtooth waveform derived from an external source (e.g. the timebase-generator of an oscilloscope). The midband IF frequency of the apparatus under test requires to be between 7 and 70 Mc/s. The bandwidth should not exceed about 8 Mc/s. Bandwidth is measured with an external signal generator.

3. Two important features of the Frequency-Swept-Oscillator CT202 are:-

(a) Synchronisation of the frequency sweep with the oscilloscope timebase is automatically correct.

(b) By merely turning the Swept Bandwidth control, the total frequency sweep can be varied from 0 to 10 Mc/s. This means that both narrow and wide-band IF or RF amplifiers can be aligned, and their response-curves opened out to occupy the full width of the oscilloscope trace.

4. When using a frequency-swept oscillator for obtaining the overall response-curve of an equipment including the pre-amplifier (and, if fitted, the A.F.C. unit), there are a few simple precautions to take and they are discussed fully in Part 2, Chapter 1, Para. 22 et seq.

PANEL CONTROLS, SWITCHES, ETC.

5. Words underlined are engraved on panel.

CARRIER TUNING (C20)	Variable capacitor which, by altering the frequency of one oscillator, produces a difference-frequency with another oscillator. The difference-frequency is adjustable between 7 and 70 Mc/s and constitutes the carrier frequency.
PRESET BANDWIDTH (RV1)	Variable resistor which is preset to suit the X-sweep voltages of different makes of oscilloscope; by this means the Swept Bandwidth control (RV2) can be made to give a total RF sweep variation of up to 10 Mc/s.
SWEPT BANDWIDTH Mc/s (RV2)	Potentiometer which enables the total frequency-sweep to be adjusted to any value up to 10 Mc/s (i.e. ± 5 Mc/s).
ATTENUATOR RANGE (A.SWA)	Switch that taps-off a resistance network to give coarse attenuation of output.
ATTENUATOR FINE (RV4)	Potentiometer giving a fine adjustment of attenuation.
OUTPUT NORMAL, -3 dB, -6 dB SWITCH (SWC)	Switch that provides a fixed attenuation of -3 dB and -6 dB as required; in NORMAL position there is no attenuation.
OUTPUT plug (PlB)	Provides the frequency-modulated output.
MARKER plug (PlC)	An RF signal (of known frequency) from a signal generator is fed to this plug and produces a marker-pip on the trace, thus indicating the frequency at the position of the pip.
MAINS FUSES (FS4 and FS2) 115V 2 AMP	Fuses for use with 115V.
MAINS FUSES (FS1 and FS3) 180-250V 1 AMP	Fuses for 180 to 250V.
MAINS VOLTAGE selector (SWA)	Adjusted for mains voltages: 115, 180, 200, 210, 220, 230, 240, 250V
MAINS ON-OFF switch (SWB)	
MAINS INPUT plug (PlA)	For connection to mains

Pilot lamp ILP1	Lights up when mains are "on".
Terminals: EARTH	Used for earthing instrument.
X	Connected to timebase-generator of oscilloscope; a sawtooth waveform is thus fed to the CT202 for frequency-modulating the carrier frequency.

PRESET CONTROLS ETC. INSIDE INSTRUMENT

6. L1 — Inductor adjusted to "tune-out" the grid-to-cathode capacitance of the reactance valve; see Part 1, Chap. 2, Para. 21. (Adjusted by manufacturer or Dockyard Staff.)

L3 — Inductor adjusted to vary the frequency of "fixed-frequency" oscillator.

RV3 — Adjusts positive voltage inserted in grid circuit of V1 and (in conjunction with fixed cathode resistor) is set to ensure an appropriate net negative potential on the grid.

A, B, C — Stand-off terminal studs for test purposes.

VALVES

7.

V1, V2, V3, V5	CV858
V4	CV455
V6	CV493

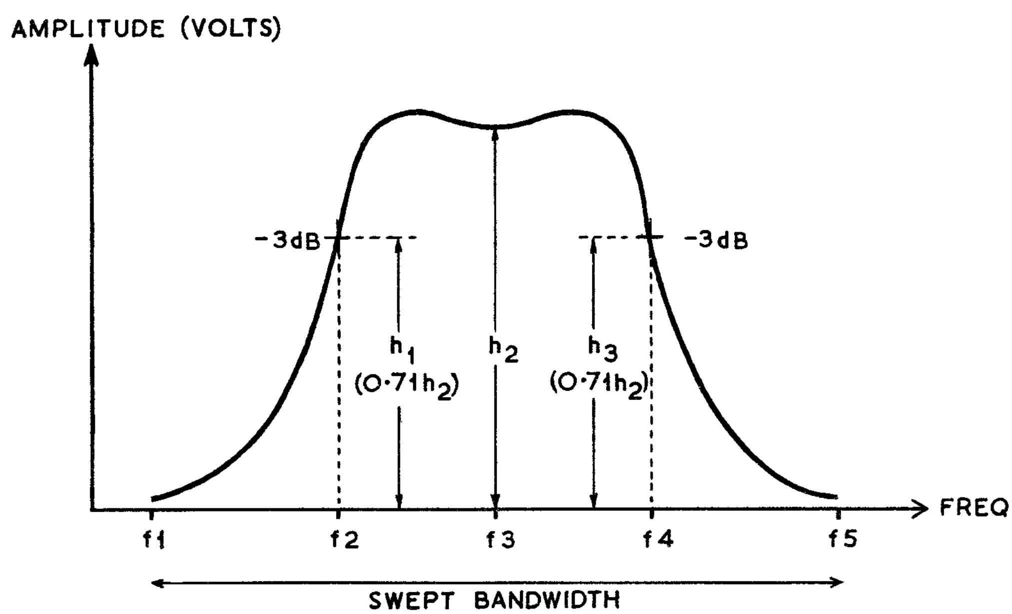
Replacement types are listed in Part 2, Chapter 2, Para. 9.

PART 1

CHAPTER 2

TECHNICAL DESCRIPTION

1. The Frequency-Swept-Oscillator CT202 produces continuous oscillations whose frequency is varied periodically over a predetermined band. These oscillations are fed into an IF amplifier under test in order to produce a visible response-curve on a cathode ray tube. The Y-plates of the C.R.T. are fed with the rectified signal from the second detector which terminates the IF amplifier. The signal that is displayed is therefore a video signal having a recurrence frequency equal to that of the periodic sweep voltage (say, 50 c/s or 100 c/s) which is frequency-modulating the RF carrier output of the CT202. The signal is usually taken from the load resistor of the second detector, but sometimes from a cathode-follower following the second detector; sometimes the signal used is taken from a video amplifier following the second detector, but in some cases (as described later) this may be undesirable. The response-curve will normally take the usual double-humped form (with flattish top) shown in Diag. 1.2.1 (it may appear inverted on the C.R.T.). From the trace on the C.R.T. it is possible to see how the IF amplifier performs and to measure the bandwidth of the amplifier. It is also possible to line-up the IF amplifier by tuning the resonant circuits of the IF amplifier until the required response-curve is obtained.



DIAG. 1.2.1 TYPICAL FREQUENCY-RESPONSE CURVE

2. Diag. 1.2.1 shows a typical response-curve (voltage amplitude plotted against frequency) of an IF amplifier and the CT202 reproduces this graph by writing a similar trace on the screen of the associated oscilloscope. The frequency applied to the IF amplifier is normally f3 (the "IF frequency", i.e. the midband frequency). This is periodically increased to f5, decreased by the same number of megacycles to f1 and restored to f3. The bandwidth sweep (i.e. the total sweep) is f5 - f1 and may be varied between zero and a maximum of 10 Mc/s.

3. As the response-curve is not rectangular but has rounded "shoulders" and sloping sides with "skirts" that tail off indeterminately, the bandwidth is usually measured between points 3 dB below the maximum. These are points where the output power drops to one half of maximum as a result of changing the applied frequency.

4. The C.R.T. displays voltage amplitude; half-power is indicated by a fall in voltage amplitude to 0.71 of the maximum. (The power is proportional to the square of the voltage, so half-power is indicated by 0.71 maximum amplitude, 0.71 being the square-root of $\frac{1}{2}$.)

5. To measure bandwidth we can first mark (in ink) the response-curve on the C.R.T. screen at the points marked -3 dB in Diag. 1.2.1, the heights h1 and h3 being equal and 0.71 of the peak height h2. (If bandwidth is to be measured between -6 dB points these will be at 0.5 of the maximum amplitude.)

6. To find the bandwidth, the frequency f2 at the left-hand -3 dB point is subtracted from the frequency f4 at the right-hand -3 dB point. These frequency measurements are accurately made by injecting oscillations from a Signal Generator (calibrated in frequency) into the output (MARKER plug PLC) of the CT202. This signal will produce a pip on the trace of the C.R.T. The pip is moved (by altering the frequency of the Signal Generator) to the left-hand -3 dB point and the frequency f2 is read off the Signal Generator; the pip is then moved over to the right-hand -3 dB point and the frequency f4 is noted. The difference (f4 - f2) between these frequencies is the bandwidth.

7. The Frequency-Swept-Oscillator provides the following necessary facilities:

(a) Output midband frequency can be varied over the range 7-70 Mc/s.

(b) The output frequency can be periodically varied (electronically) over a total band of 10 Mc/s (or less as required).

(c) The output power of the Frequency-Swept-Oscillator is adjustable so that the output voltage can be varied between zero (approx.) and at least 100 mV. Coarse and fine adjustments of output power can be made.

Additional refinements comprise:

(d) A low-pass filter to remove (ideally) frequencies above the maximum output frequency of the CT202; these are unwanted.

(e) A preset adjustment of the input voltage used to provide the 10 Mc/s sweep mentioned in (b).

(f) A switch to give output-reductions of 0 dB, 3 dB and 6 dB; this facilitates measuring bandwidth at -3 dB and -6 dB points.

8. External instruments used with the Frequency-Swept-Oscillator are an oscilloscope (which provides the C.R.T. display and also the recurring sweep-voltage which electronically provides the band of 10 Mc/s mentioned in (b) above) and a signal generator which provides the movable pip on the trace for accurate measurement of the frequencies corresponding to different points on the response-curve.

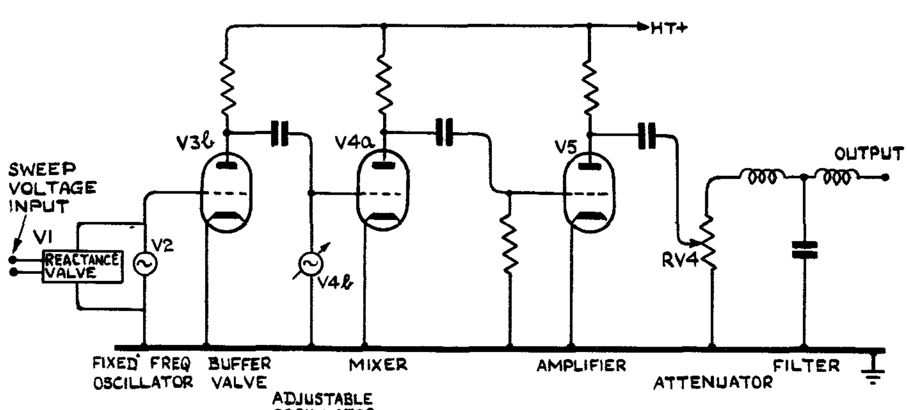
Automatic display of response-curve

9. A response-curve of an IF amplifier could be obtained by feeding a series of different frequencies into the IF amplifier, measuring the output voltage of the amplifier and plotting the results on paper. This laborious procedure is avoided by a recurrent sweep of the frequency (over, say, 10 Mc/s), the instantaneous output voltage at any selected frequency being indicated by the height of the trace on a cathode-ray tube. By synchronising these sweeps with the timebase voltage sweeps of the oscilloscope, a stationary display of the response-curve is obtained; the obvious way to achieve this is to use the timebase voltage sweeps (of sawtooth waveform) to vary the frequency of the Frequency-Swept-Oscillator. The timebase voltage is easily extracted from most types of oscilloscope, an external terminal being usually provided.

10. The methods of obtaining the facilities set forth in Para. 7 will now be described.

Production of Carrier Frequency

11. The carrier frequency, i.e. the midband frequency of the output signal, is obtained by applying two frequencies to a mixer valve (operating as a detector) and taking out the difference-frequency. This is shown schematically in Diag. 1.2.2 where V2 represents a "fixed-frequency" oscillator valve which feeds

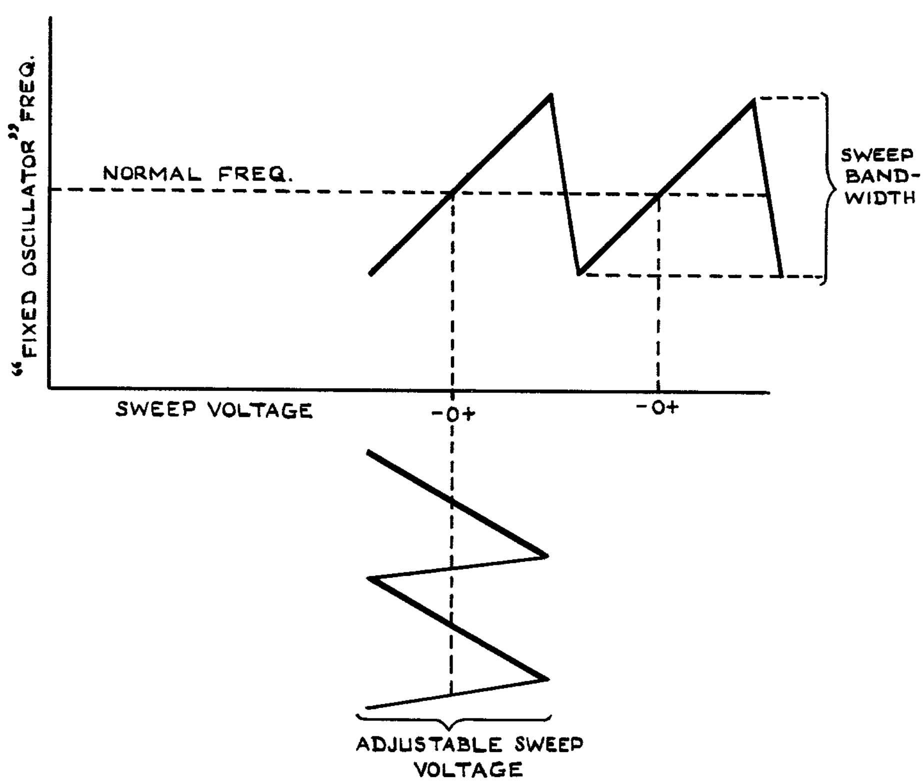


DIAG. 1. 2. 2. SCHEMATIC DIAGRAM OF CT 202

(via a buffer valve V3b) the grid of the mixer V4a. The other oscillator V4b is tunable by the CARRIER TUNING control (C20) on the panel of the instrument; its output is also fed to the grid of the mixer V4a. The difference-frequency appears in the output of the mixer and, after amplification by V5, is fed to the variable attenuator system which terminates at the OUTPUT terminal; a low-pass filter system ensures a relatively pure carrier frequency. The buffer valve V3 prevents interaction between the two oscillators and its stage-gain is only a little more than unity; the phenomenon of "pulling" would otherwise be liable to occur when the two frequencies approached each other, one oscillator "pulling" the other to its own frequency, thus producing no difference-frequency. The "fixed frequency" (when no sweep is applied) is 105 Mc/s but the CARRIER TUNING control can vary the tunable oscillator V4b between 112 and 175 Mc/s. The carrier (i.e. output) frequency is thus adjustable by the operator between 7 Mc/s (the difference between 112 and 105 Mc/s) and 70 Mc/s (the difference between 175 and 105 Mc/s). This process (which is similar to that used for obtaining the IF frequency in a superheterodyne receiver and the audio frequency in a beat-frequency oscillator such as G205) permits a very wide range of output frequencies to be obtained by the simple means of a single variable capacitor. The output frequency is selected to equal the IF frequency (i.e. the midband frequency) of the IF amplifier under test.

Method of "Sweeping" the Frequency

12. The output continuous oscillations are "swept" in frequency. Thus, if the output frequency is set to, say, 30 Mc/s, this frequency is smoothly and progressively raised to, say, 35 Mc/s and then very rapidly lowered from this latter value to 25 Mc/s and then raised back to 30 Mc/s, the process being continually repeated; the sweep from 25 to 35 Mc/s is uninterrupted. The output is thus swept over a total band of 10 Mc/s. A narrower sweep-band is more usual, but the actual band used is not critical. If the IF amplifier being fed has a narrow bandwidth, a wide sweep is unnecessary because towards both ends of the sweep the output from the IF amplifier would be substantially zero.

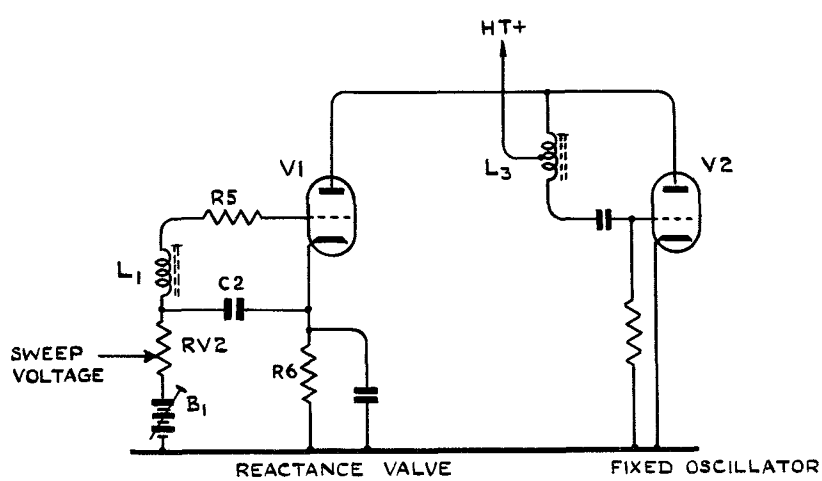


DIAG. 1. 2. 3. EFFECT OF SWEEP VOLTAGE ON FREQUENCY

13. The speed of an individual sweep and the repetition rate of the sweeps are both of secondary importance. In practice, it is desirable to keep the speed of a sweep fairly low to prevent "ringing" (in this case, generation of oscillations by shock-excitation). The repetition-rate requires to be high enough to make use of visual persistence, i.e. to give a non-flickering trace on the C.R.T.

14. Theoretically, sweeping of the frequency could be effected by mechanical means, e.g. by altering the value of a variable capacitor, but apart from the mechanical difficulties, it would be difficult to synchronise the sweeps with the timebase sweeps of the oscilloscope. Electronic means of sweeping are therefore used, a repeating voltage sweep being used to vary the frequency output. By using the timebase sawtooth voltage of the oscilloscope, the frequency will automatically be swept in synchronism with the timebase-generator and a stationary display (resembling a response-curve) obtained. The effect of the sweep voltage on the "fixed" oscillator frequency (and therefore the output frequency) is illustrated in Diag. 1.2.3.

15. The problem is to cause a voltage variation to alter the frequency of an oscillating valve - the same problem, in fact, involved in frequency-modulation - and a common method of frequency-modulation is actually used in the present instrument. A so-called "reactance-valve" is employed, and the method consists in connecting its anode-cathode path in parallel with part of the tuned circuit of the "fixed oscillator". The oscillatory circuit (of the fixed oscillator) is connected to a network so designed that a proportion of the RF voltage at the anode of the reactance valve is given a phase-shift of 90 degrees and applied to the control-grid of the reactance valve. The anode current is in phase with the grid voltage and is therefore out of phase with the anode voltage. The valve therefore appears as a reactance. The reactance valve introduces a reactance into the oscillatory circuit.



DIAG. 1.2.4. REACTANCE VALVE USED FOR FREQUENCY- MODULATION

16. This reactance may be positive (equivalent to an inductance) or negative (equivalent to a capacitance) according to the network arrangement; if the A.C. control-grid voltage of the reactance valve lags by 90 degrees the voltage across the oscillatory circuit, an inductance is injected; but if the A.C. control-grid voltage of the reactance valve leads by 90 degrees the voltage across the oscillatory circuit, a capacitance is injected.

17. In the present instrument, a capacitance is introduced and this alters the frequency of the "fixed" oscillator. The network includes the inter-electrode capacitance between anode and grid of V1 and the components between grid and cathode. The amount of capacitance introduced depends on the mutual conductance of the reactance valve; this mutual conductance can be varied by altering the control-grid voltage. It is thus possible to vary the frequency of the "fixed" oscillator (and therefore of the output of the CT202 by the same amount) by applying a varying voltage to the control-grid of the reactance valve.

18. The capacitance introduced is proportional to the mutual conductance of the reactance valve. If the mutual conductance is proportional to the applied grid voltage (i.e. the modulating voltage which is superimposed on the normal negative bias), the deviation in frequency is proportional to the modulating voltage. (For a small change of capacitance in an oscillatory circuit the change in frequency varies as the change in capacitance.)

19. (The theory of reactance valves may be studied in the following books: "Frequency Modulation" by K. R. Sturley and "Frequency Modulation" by August Hund. See also an article "The Wobbulator" by O. H. Davie in "Electronic Engineering", August 1941.)

20. Diag. 1.2.4 shows the frequency-modulation part of the instrument. The valve V2 is the fixed oscillator operating in conventional fashion, a tuned circuit (using inter-electrode and stray capacitances) being connected across grid and anode with a middle tapping to the cathode. The frequency is adjustable by means of the preset iron-dust core of L3. The reactance valve V1 presents a virtual capacitance across the tuned circuit. The mutual conductance of V1 is altered by applying the external sweep voltage via the potentiometer RV2 to the grid, the sweep frequency band being increased by increasing the sweep voltage applied to the grid. The correct negative bias on the grid is obtained by a fixed negative bias provided by the usual cathode resistor R6 and a smaller adjustable (preset) positive bias shown schematically as B1 (actually a potentiometer, RV3 in Fig. 1, associated with the H.T. supply).

21. It will be seen that a preset variable inductor L1 (having an iron-dust core) is inserted in the grid circuit of V1. Its correct adjustment is of great importance and details are given in Part 2, Chap. 3, Para. 20 et seq. The purpose of L1 is to "tune out" the grid-to-cathode capacitance of the valve V1 or, at any rate, to reduce its effect. The grid is a tapping on a potential-divider consisting of the anode-to-grid capacitance and the grid-to-cathode capacitance. The RF voltage of the grid will depend chiefly on the ratio of these capacitances; the correct tuning of L1 increases the grid-to-cathode impedance and ensures that the RF voltage of the grid (with respect to the cathode) is adequate.

22. The tuning of L1 must be carried out so that

(a) L1 does not resonate with the grid-to-cathode capacitance within the sweep of the fixed oscillator V2.

(b) L1 resonates as near as possible to this swept band so that it produces the maximal reduction of the effect of the grid-to-cathode capacitance.

23. The sweep-band is controlled by the operator's use of RV2 operating (as regards the input) as a variable resistor. To keep the maximum sweep to 10 Mc/s, the preset potentiometer RV1 (PRESET BANDWIDTH) - see Diag. 1.2.6 - is appropriately adjusted and its setting will depend on the magnitude of the timebase voltage fed to the terminal X of the CT202; a change of oscilloscope will probably call for a new setting of the potentiometer RV1.

Variation of Output Power

24. The output voltage is variable from (ideally) zero (actually about 5 μV) to at least 100 mV by means of a potentiometer RV4 used in conjunction with a "ladder" type attenuator consisting of a network of resistors. An attenuator switch, A.SWA of Diag. 1.2.6, provides four steps in output corresponding to approximately 0, 20, 40 and 60 dB reduction of the output. The potentiometer RV4 provides a fine control to give a continuous variation in output.

25. A separate potential-divider is provided with a switch SWC to give a reduction of 0 dB, 3 dB or 6 dB from the output power in use. Such a switch enables the operator to measure the bandwidth of an IF response at either the -3 dB or -6 dB points. This obviates the need for measuring the -3 dB (or -6 dB) points on the normal response-curve on the C.R.T. screen.

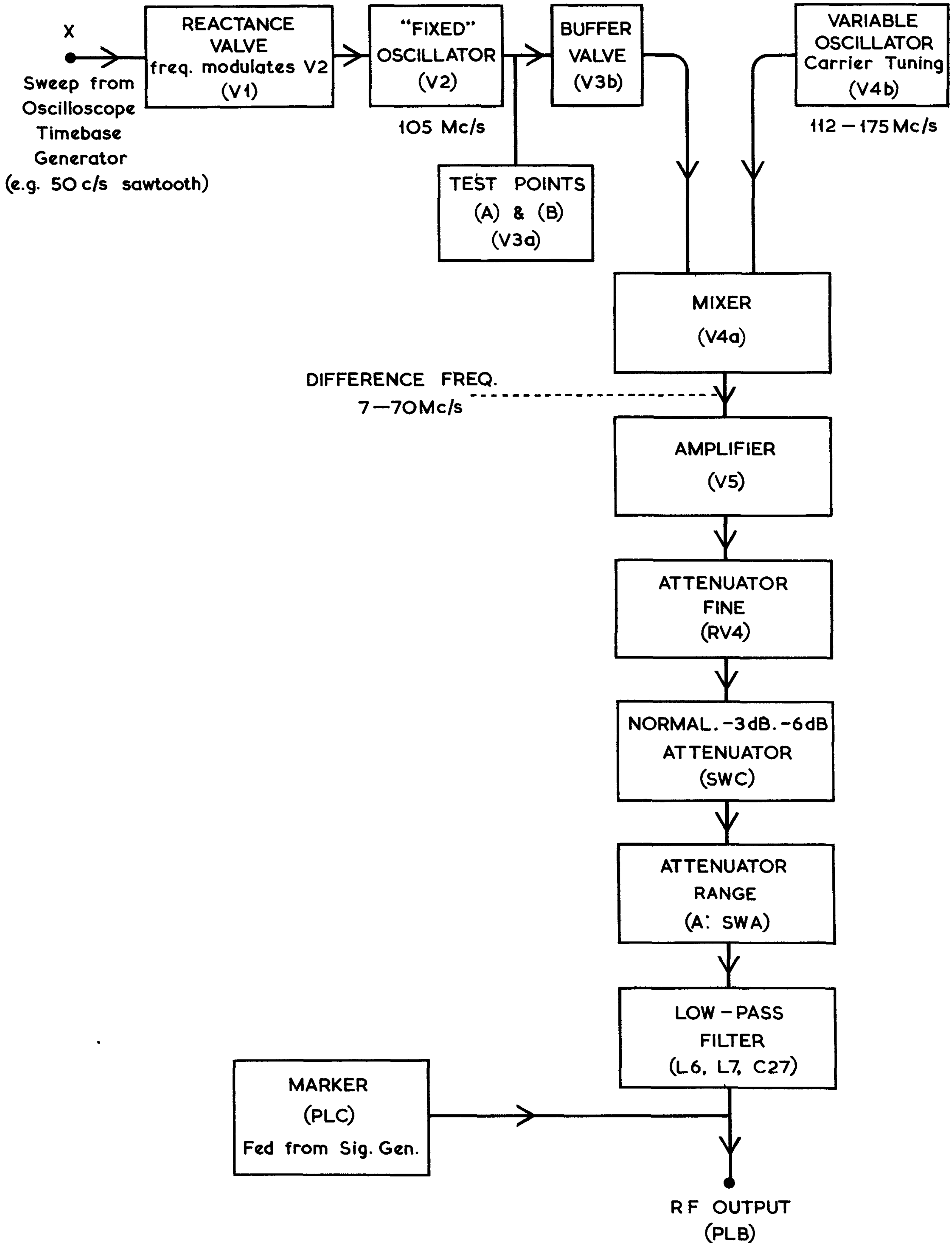
26. The nominal output impedance of the instrument is 75 ohms.

Low-pass Filter

27. To remove (ideally) unwanted frequencies (those above, say, 80 Mc/s), a low-pass filter L6, L7, C27 is provided.

Method of Measuring Bandwidth

28. All accurate frequency measurements are made with a separate RF signal generator. The signal is injected into the IF amplifier input simultaneously with the output signal of the frequency-swept-oscillator. To facilitate this, the final output resistance system of the CT202 has a tapping connected to the panel plug PLC engraved MARKER and the output of the signal generator is fed to this point. When the frequency of the signal generator is close to that of the instantaneous output frequency of the swept-oscillator the resultant beat produces a "pip" (called the marker-pip) on the trace of the oscilloscope. Although the swept-oscillator frequency is continually changing, the pip is stationary on the response-curve; it occurs momentarily as the two frequencies nearly coincide and recurs at every sweep and thus a visible pip is produced. If the frequency of the signal generator is altered, the pip moves along the response-curve and so the frequency at any point on the response curve can be measured by reading the frequency off the signal generator dial. As a response-curve tails off at either side, it is usual to measure the frequencies at two -3 dB points, i.e. 0.71 of the maximum height of the voltage response-curve. Instead of measuring 0.71 of the height, the following method may be used. The OUTPUT switch SWC is first set to -3 dB which reduces the input power to the amplifier to one half of the normal power; the voltage response-curve is, as a result, reduced to 0.71 of its normal height. A horizontal ink line is now drawn



DIAG. 1.2.5. BLOCK DIAGRAM OF CT202

on the graticule to touch the maximum height of the curve. The OUTPUT switch is then set to NORMAL which will result in a response-curve of larger amplitude intersected at two points by the ink line; the frequencies at the intersections are then measured. (See Part 2, Chap. 1, Para. 12(c).) The difference between the two frequencies represents the bandwidth of the IF amplifier under test. (When measuring bandwidth at -6 dB points, 0.5 of the height is used instead of 0.71.)

29. To ensure that the marker-pip shall be narrow, a capacitor (0.01 to 0.05 μF) is connected across the input terminal of the oscilloscope amplifier and the earth terminal to limit the frequency-response of the amplifier.

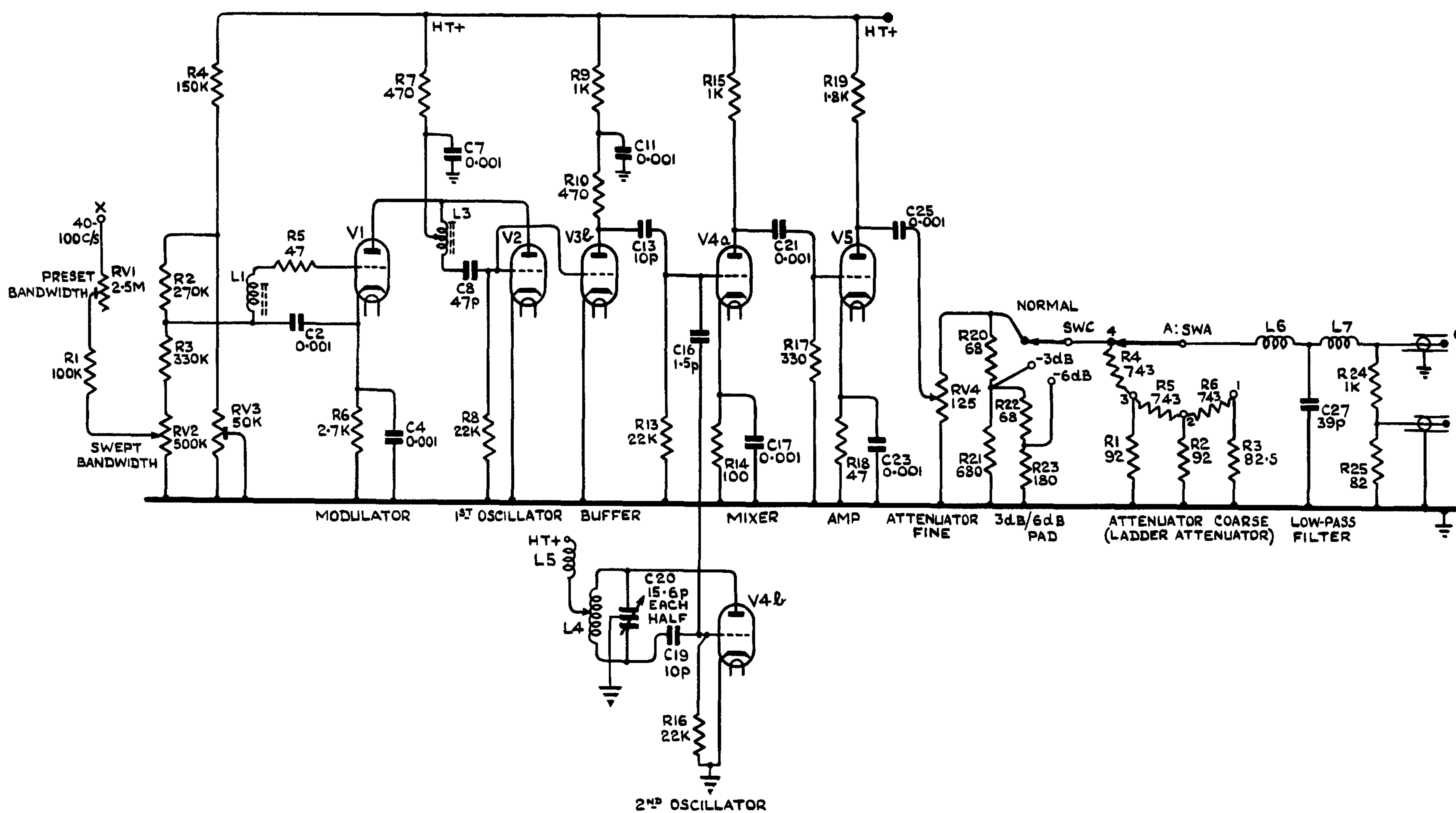
Complete Circuit

30. A block diagram of the CT202 is given in Diag. 1.2.5 and a simplified circuit in Diag. 1.2.6. The complete circuit is shown in Fig. 1 and employs five double-triodes in the main circuit and a full-wave rectifier valve V6 for the H.T. supply. The reactance valve V1, the "fixed-frequency" oscillator V2 and the output valve V5 are of CV858 type used as single triodes, the two grids in each valve being commoned and the two anodes being similarly connected, a single cathode connection being provided. The valve V3 has one triode V3b used as a buffer valve and the other triode V3a used for frequency checks of V2 and V4b (see Para. 35). The valve V4 is of CV455 type and the two triodes within it are used for two different purposes, separate cathode connections being employed; the valve is therefore equivalent to two entirely separate triodes mounted for convenience within the same glass envelope. The portion V4a is used as the mixer while V4b is the second (adjustable) oscillator.

31. The sawtooth voltage (obtained from the external oscilloscope's timebase-generator) used for producing the sweep is fed to terminal X of the CT202. It is applied to a resistor network RV1, R1, R2, R3, R4, RV2, RV3. The PRESET BANDWIDTH potentiometer RV1 is a present adjustment to suit the input voltage which depends on the type of oscilloscope in use. As the timebase-generator voltage depends on the make of oscilloscope, RV1 acts as a preset attenuator to ensure that the manually-controlled continuously variable potentiometer RV2 (a panel control marked SWEPT BANDWIDTH) shall give a maximum bandwidth sweep of 10 Mc/s. The preset potentiometer RV3 in conjunction with R4, R2, R3 and the 500 kilohms of RV2 determines the positive voltage (derived from the H.T. source) inserted in the grid circuit of V1. This variable positive voltage is in opposition to the larger fixed negative bias provided by the usual cathode resistor R6, and RV3 thus serves as a means of adjusting the negative bias on the grid of V1.

32. The purpose of adjusting the preset inductor L1 is explained in Para. 21 above. The setting-up of L1 is a matter only for the manufacturers or Dockyard Staff.

33. The oscillator valve V2 is the "fixed oscillator"; the original selection of the frequency (105 Mc/s) at which it oscillates is not of special significance as the midband output frequency of the instrument is determined by the difference between the V2 "fixed" frequency and the adjustable frequency of the second oscillator V4b. (The need, however, for accurate adjustment of the chosen frequency is explained in the setting-up procedure.) The valve V2 is a fixed-frequency oscillator in the sense that it is not manually tunable; its frequency is altered electronically by the varying grid potential of the reactance valve V1. The resistor R26 (see Fig. 1) feeds part of the sweep voltage to the grid of V2 so as to oppose the amplitude variations (of the oscillations) caused by the damping effect which varies with the mutual conductance and so with the sweep voltage.



DIAG. 1. 2. 6. SIMPLIFIED CIRCUIT OF CT202

34. The triode V3b serves as a buffer amplifier to isolate the first oscillator V1 from the effect of the second oscillator V4b. This prevents interaction between the oscillators; such interaction might take the form of the oscillators pulling into the same frequency when the two frequencies are close together; without a buffer circuit the tuning of the variable capacitor C20 associated with the second oscillator V4b might alter the frequency of the first oscillator V2. The gain of the buffer valve V3b is little more than unity.

35. The triode V3a is for calibration only and takes no part in the operation of the instrument. It is a leaky-grid detector with a test-point (A) connected to its grid through a capacitor C15, and a test-point (B) connected to its anode through the capacitor C12. Both test-points are within the instrument and are used in checking the frequencies of V2 and V4b. (See Part 2, Chap. 3, Para. 8 et seq. and Para. 20 et seq.)

36. The triode V4a is a mixer of conventional type and its grid is fed simultaneously with the V2 oscillations of "fixed" frequency (via the buffer triode V3b) and the oscillations from V4b (the tunable second oscillator). Oscillations at the difference-frequency appear at the anode of V4a and pass to the commoned grids of the output valve V5. The triode V4b is a conventional oscillator with the main elements L4 and C20 across anode and grid, the rotor of the twin variable capacitor C20 being connected to earth.

37. The output valve V5 consists of a double-triode valve with the triodes connected in parallel, the grids being fed from the anode of the mixer valve V4a. The output oscillations pass to the output attenuator system.

38. The output attenuator network consists of a potentiometer RV4 in combination with resistors R20, R21, R22, R23, A.R1, A.R2, A.R3, A.R4, A.R5, A.R6. (The Attenuator Unit A.P.61219 is a patternised unit with separate component references.) The potentiometer RV4 is engraved ATTENUATOR FINE and provides a continuous variation of output. The switch SWC marked OUTPUT has three positions: NORMAL, -3 dB and -6 dB; its purpose is to reduce the amplitude of the response-curve and it enables an ink line to be used to cut the normal response-curve at two points which are equivalent to points 3 dB (or 6 dB) below the maximum height of the normal response-curve (see Para. 28); this permits the bandwidth between -3 dB (or -6 dB) points to be measured without having to calculate the position of the points on the original response curve. The accuracy of the -3 dB and -6 dB positions is satisfactory when the ATTENUATOR RANGE switch A.SWA is in positions 1, 2 and 3 but is seriously inadequate in position 4 which should therefore not be used when the OUTPUT switch SWC is operated.

39. The switch A.SWA, marked ATTENUATION RANGE, has six positions of which four provide coarse attenuation. In the two end positions the switch is "off". This switch is used in conjunction with the ATTENUATOR FINE potentiometer RV4.

40. A low-pass output filter L6, L7, C27 is provided after the attenuator system to minimise any frequencies above 80 Mc/s. Across the inner conductor of OUTPUT plug and earth are two resistors R24 and R25 in series. The output is taken from the coaxial plug marked OUTPUT; the coaxial plug MARKER has its central conductor connected to the junction of R24 and R25. The output of a signal generator is fed, when desired, to the MARKER plug to provide a pip on the response curve for frequency measurement.

41. The mains unit is shown in the lower half of Fig. 1. It is of conventional design using a full-wave rectifier valve V6, whose output circuit includes the reservoir capacitor C6 and the filter L2C3. An output of 60 mA is obtained at 165V. Mains voltage selection is by means of the switch SWA which has four banks providing connection to transformer primary tappings corresponding to 115, 180, 200, 210, 220, 230, 240 and 250 volts. Fuses FS1, FS2, FS3 and FS4 ensure that there is a fuse in each input lead whatever the mains voltage. The secondary of the transformer has the usual low-voltage winding for supplying the heaters, the point y being connected to the legs y in the main circuit.

Lead Stowage and Adaptors

42. The mains lead is A.P.67384 (consisting of a Plessey Mark IV 3-pin socket (Z560505) in position 5 and a 3-pole 5-amp mains plug A.P.17943). A separate twin-core screened cable is supplied for the X sweep and Uniradio 70 coaxial leads are supplied with sockets for use with OUTPUT and MARKER plugs.

43. All these leads are stowed in the small compartment on the right-hand side of the front panel.

44. The box of leads supplied with the Noise Generator CT82 (A.P.67166) can be used in conjunction with the CT202. (See Operating Instructions in lid of the CT202 and Part 2, Chap. 1 of this Handbook.)

45. The two 400-ohm adaptor pads which are used to replace the crystal holder should not be used; it is intended to supply special adaptors at a later date with the CT202; these will simulate a crystal and holder as regards impedance, etc. (The holder with the flange is for use with Radar Types 293, 293M and 277 and the holder without flange is for use with Radar Types 293P, 293Q, 277P, 277Q, 982 and 983.) (See Part 2, Chap. 1, Para. 22 et seq.)

PART 2

CHAPTER 1
OPERATING INSTRUCTIONS

★

CHAPTER 2
MAINTENANCE AND FAULT FINDING

★

CHAPTER 3
ALIGNMENT. CALIBRATION AND ACCEPTANCE TESTS FOR DOCKYARD RADIO CENTRES

★

CHAPTER 4
COIL-WINDING DETAILS

★

APPENDIX 'A'	LIST OF COMPONENTS
APPENDIX 'B'	LIST OF ALTERNATIVE INSTRUMENTS
APPENDIX 'C'	USE OF CT202 IN ALIGNMENT OF VERY-WIDE-BAND AMPLIFIERS
APPENDIX 'D'	AMPLIFIER USED TO MEASURE AM ON FM, AND RF OUTPUT

PART 2

CHAPTER 1

OPERATING INSTRUCTIONS AND

SETTING-UP PROCEDURE

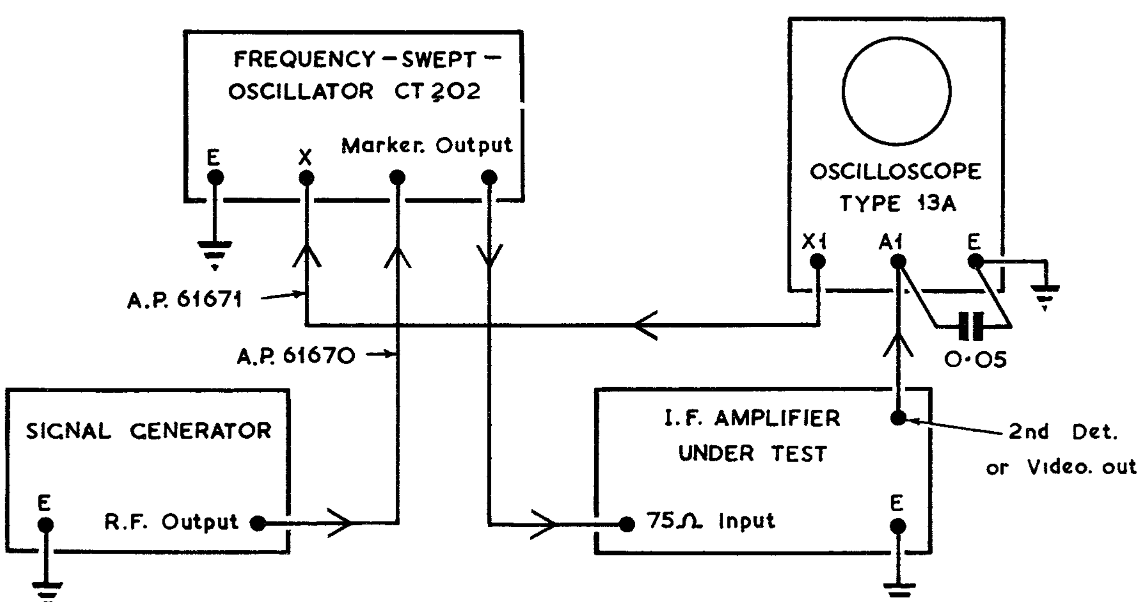
THE OPERATION AND USE OF THE FREQUENCY-SWEPT-OSCILLATOR CT202 FOR ALIGNMENT OF IF AMPLIFIERS

1. Test Rig: As Diag. 2.1.1 Connectors as indicated.

2. Apparatus required

   Oscilloscope: Ref. No. 10S/831, Type 13A
   A.P.W3336A (double-beam) or A.P.68622 (miniature)

   Signal Generator of suitable accuracy and capable of covering the IF frequency in use and the variation of ± 5 Mc/s. Suitable types are: A.P.54704, A.P.54704A, A.P.54705, CT218 (or Test Oscillator CT212), XT42 (WD3942) (XT42 being a provisional designation).



DIAG. 2.1.1. TEST RIG FOR TAKING RESPONSE-CURVES

OPERATING AND SETTING-UP

CONNECTIONS (See Diag. 2.1.1 for special connectors)

3.(a) Connect terminal X of CT202 to timebase-generator output of oscilloscope (e.g. terminal X1 of Type 13A or X of Miniature Oscilloscope A.P.68622).

(b) Connect OUTPUT of CT202 to input of IF unit, using appropriate adaptor. (Box of leads supplied with A.P.67166 Noise Generator CT82 may be used; the A.P.60860 46-ohm connector should not be used.) Care should be taken to feed the CT202 into a 70 to 80 ohm input, or to use a suitable pad if necessary. (See Para. 23 et seq.)

(c) Feed video output of IF unit to input (terminal A1 of Diag. 2.1.1; note that the correct terminal, if the CT52 is used, is Y, the Y-plate switch being set to AMP) of Y-amplifier of oscilloscope. The video output is preferably taken from the 2nd detector load or as soon thereafter as possible. (See Para. 38.)

(d) Connect a 0.05 μF capacitor between input of Y amplifier of oscilloscope and earth (this is to ensure a narrow marker-pip). The capacitance of this component may be between 0.01 and 0.05 μF.

(e) Connect RF output of Signal Generator to MARKER on CT202, using A.P.61670 cable whose outer is earthed.

SETTINGS AND ADJUSTMENTS

4. Having connected the instruments as in Para. 3 above, it is now necessary to adjust the X sweep voltage of the oscilloscope to suit the frequency-swept oscillator. It is easier to make this adjustment after the response-curve of the IF amplifier under test has been obtained. To obtain this response-curve the instruments' controls should be set as in Tables 2.1.1 and 2.1.2.

TABLE 2.1.1

Oscilloscope Type 13A

Control	Setting
Trig Sync	50 c/s
Cal.	OFF
Flyback	Fully clockwise at first. Adjust later if necessary
Power	H.T.
Probe Selector	OFF
Y2 Attenuator	÷1
A1 gain	Fully clockwise (max.)
A2 gain	" " "

Control	Setting
Y plate selector	2 A1 H.F.
Vel. Range	10 c/s } Adjust fine control to lock to mains frequency of 50 c/s
Fine Velocity	5-15 } Adjust fine control to lock to mains frequency of 50 c/s
Sync Amplifier	Set to half-way and then adjust as required
Amplitude	Set to give a trace 8-10 cm long

TABLE 2.1.2

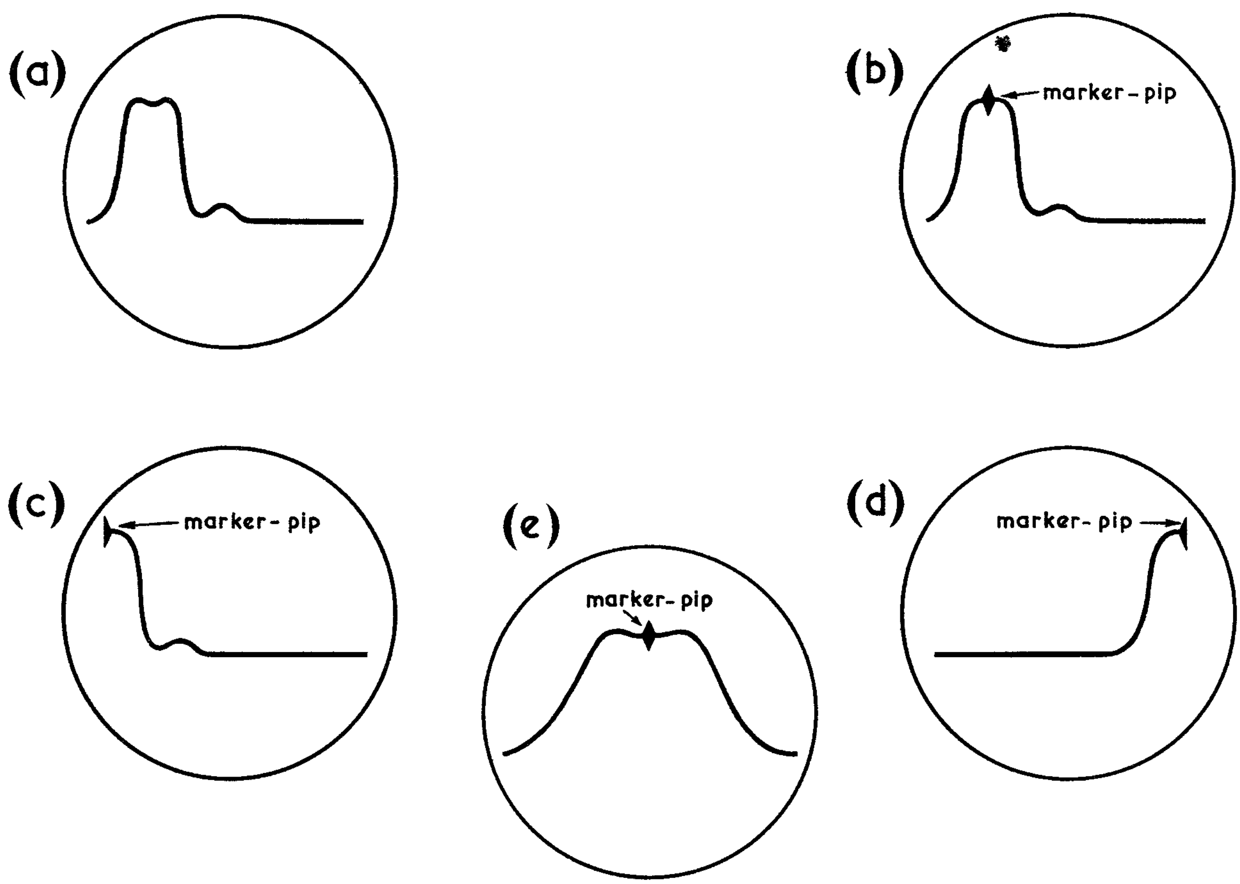
FREQUENCY-SWEPT-OSCILLATOR CT202

Control	Set to
Mains Selector	To correct voltage
Mains Switch	ON
Preset Bandwidth	Fully clockwise (max.)
Swept Bandwidth	10 Mc/s (fully clockwise)
Carrier Tuning	To midband frequency of IF amplifier
Attenuator Range	1
Fine Attenuator	10 (fully clockwise)
Output Switch (SWC)	Normal
Marker Plug	Connect to signal generator (see Diag. 2.1.1)
Output Plug	Connect to input of IF amplifier (70 to 80-ohm input)
X Terminal	Connect to X1 on oscilloscope
E Terminal	Connect to earth and (using one wire of connector A.P.61671) tc E on oscilloscope

5. With the controls set as above, and with the IF amplifier gain set to its normal position, a response-curve should be obtained on the oscilloscope trace (Diag. 2.1.2(a)). At this stage there may be considerable non-linearity of the sweep, and more than one response-curve (the result of harmonics) may be observed. This is quite in order, but when the frequency sweep is adjusted to the correct value of 10 Mc/s, no trouble with non-linearity or harmonics will be experienced. Adjust the ATTENUATOR RANGE and ATTENUATOR FINE controls of CT202 until the response-curve is about 4 to 5 cm high and centre this response-curve on the oscilloscope trace by adjusting the CARRIER TUNING control of the CT202.

6. Limiting effects must not be allowed to occur. To check if limiting is occurring, slightly increase the CT202 output. In the absence of limiting there should be a corresponding increase in the amplitude of the response-curve. Reset the amplitude to its original level.

7. Increase the C.W. output of the signal generator, and vary its frequency about the midband frequency of the IF amplifier, until a small marker-pip is centred on the response-curve (Diag. 2.1.2(b)).



DIAG. 2.1.2. TYPICAL TRACES

8. The Preset Bandwidth control of the CT202 should now be adjusted as follows, to suit the type of oscilloscope used.

9. Move the response-curve to the left along the trace (by altering the Carrier Tuning control) until the marker-pip reaches the left-hand end of the trace. (See Diag. 2.1.2(c).) Make a note of the Carrier Tuning Frequency as shown in megacycles on the scale; call this f1. (The pip remains throughout in the same centre position on the response-curve, the curve and pip moving to the left together; when the pip is at the left-hand end of the trace, the left-hand half of the response-curve will have disappeared off the screen.)

10. Adjust the Carrier Tuning control to move the response-curve along the trace until the marker-pip reaches the right-hand end of the trace (Diag. 2.1.2(d)) and again note the Carrier Tuning frequency; call this f2. The difference of frequency (f2-f1) should be 10 Mc/s, but at first will usually be of the order of 14 Mc/s.

11. Adjust the Preset Bandwidth control and repeat the operations in Paras. 9 and 10 above until (f2-f1) is 10 Mc/s. The Preset Bandwidth control should be carefully locked and, provided the oscilloscope timebase controls are not changed, no resetting of the Preset Bandwidth control will be necessary. Set the response-curve in the centre of the trace and, by adjusting the Swept Bandwidth control, open out the response-curve to occupy the full width of the trace (Diag. 2.1.2(e)). The Swept Bandwidth control varies the frequency-sweep from zero to 10 Mc/s (when the PRESET BANDWIDTH has been correctly adjusted) and, for this reason, the CT202 can be used both for relatively narrow IF bandwidths (e.g. 100 kc/s at -3 dB level) and wider bandwidths (up to about 7 Mc/s at -6 dB level). In either case, the response can be made to occupy the full width of the oscilloscope trace by adjusting the Swept Bandwidth control. The calibration of the Swept Bandwidth control is a nominal one and accurate measurement of bandwidth must be made as follows:-

MEASUREMENT OF BANDWIDTH

12.(a) To measure bandwidth, adjust the frequency and output amplitude of the signal generator until a marker-pip of suitable size appears on the trace. By altering the frequency of the signal generator, move pip between two points on response-curve between which the bandwidth is to be measured, noting the frequency-change on the signal generator. If the -3 dB (or -6 dB) attenuator OUTPUT switch SWC is not favoured, proceed as in (b) below; if the switch SWC is to be used, proceed as in (c). When performing this test on very-high-gain head amplifiers and main amplifier assemblies it is better to use the method (b) given below.

(b) Method using direct-measurement of -3 dB (or -6 dB) points

By using the Y-shift on the oscilloscope, move the baseline of the trace so that it coincides with a horizontal graticule line (which should be offset vertically from the centre of C.R.T. screen to ensure that the response-curve is more or less centrally placed). Measure the amplitude of the response-curve by means of the graticule and calculate 0.7 of the amplitude (marking the graticule with a pen if necessary). Move marker-pip between the two calculated points on either sloping side of the curve; these points correspond to -3 dB. (If the bandwidth at -6 dB is required, select 0.5 of the amplitude.)

(c) Alternative method using -3 dB -6 dB OUTPUT switch SWC

(This method should not be used on very-high-gain systems where leakage can be appreciable.) Set OUTPUT switch SWC to -3 dB (or -6 dB) and, using

Y-shift, move the baseline to coincide with a horizontal graticule line. Mark in ink a horizontal line touching the maximum amplitude part of the curve. Set OUTPUT switch SWC to NORMAL and alter Y-shift slightly to restore baseline to original horizontal graticule line. The curve will now resemble that produced in the -3 dB (or -6 dB) position but will be of larger amplitude and the ink line will intersect the curve at two points. The marker-pip is moved in turn to these intersections and the frequency-difference on the signal generator is the bandwidth at -3 dB (or -6 dB). The accuracy of -3 dB and -6 dB attenuation is 0.5 dB on ATTENUATOR COARSE Positions 1, 2, 3. (Position 4 should not be used in this measurement as certain inaccuracies may then occur.) Make sure "limiting" does not occur.

ALIGNMENT PROCEDURE

13. After measuring the bandwidth of an IF amplifier response-curve it may be necessary to carry out alignment of the IF amplifier. For detailed instructions reference should be made to the handbook of the equipment under test. The instructions given below are in general terms only.

14. In general, there are two types of alignment:-

(a) A complete alignment of a new or rebuilt IF amplifier.

(b) A quick check of alignment, or alignment after repair to only one or two coils.

ALIGNMENT OF NEW OR COMPLETELY-REPAIRED IF AMPLIFIER

15. Connect up as in Diag. 2.1.1 and insert a microammeter in the second detector load circuit, adjusting the gain control to give the normal amount of noise current.

16. With the CT202 switched off, roughly align the IF amplifier according to the instructions given in the equipment handbook, using the second detector current meter as an indicator, and the signal generator as the signal source.

17. In general, there is sufficient RF transference between the MARKER and OUTPUT plugs of the CT202 to enable an adequate signal to be fed from the signal generator into the IF amplifier without disconnecting the test rig shown in Diag. 2.1.1.

18. The preliminary alignment of the IF circuits need take only a few moments, after which the CT202 is switched on, and the response-curve of the IF unit under test obtained as in Para. 4 et seq. Slight adjustments can then be made to the IF circuits to obtain a symmetrical response-curve of the correct bandwidth. Usually an adjustment of the inductor preceding the second detector and of the input inductor will be found to have most effect on the response-curve.

19. The frequency-swept oscillator should not be used to align a new IF unit without carrying out the preliminary alignment described above, as the operation will be unduly lengthy.

ALIGNMENT AFTER SLIGHT REPAIR

20. In this case it is assumed that it is necessary either to check the alignment of an IF unit, or to re-align it after slight repair. It is then permissible to connect up as in Diag. 2.1.1 and proceed as in Para. 4 et seq.

21. Having obtained the response-curve, the IF circuits of the repaired instrument can be adjusted to give a symmetrical response-curve of correct bandwidth.

OVERALL ALIGNMENT INCLUDING I.F. PRE-AMPLIFIERS AND A.F.C. UNITS

22. The procedures given in Para. 15 et seq. and Paras. 20 and 21 apply equally to broadband receivers, IF amplifiers and pre-amplifiers, but some precautions are necessary. These are discussed fully below, Para. 23 et seq.

PRECAUTIONS TO BE TAKEN IN ALIGNMENT

Use of Crystal Adaptors

23. In alignment operations it is essential that the frequency-swept oscillator should be correctly matched to the input of the receiver or amplifier being tested; if this matching is incorrect, the load reflected across the input circuit of the apparatus under test will be incorrect and an erroneous bandwidth may be obtained.

24. The CT202 has a 75 ohm nominal output impedance, and in general most radar IF amplifiers have the same input impedance.

25. This is not the case with "head" or pre-amplifiers, however, as it is generally necessary to match into the crystal circuit. The impedance is normally of the order of 400 ohms, and it is intended to provide special adaptors for all such radar IF amplifiers, such adaptors being fitted in place of the crystal for use with the Frequency-Swept-Oscillator CT202, Noise Generator CT82 and Signal Generator, Pulse-modulated, CT215.

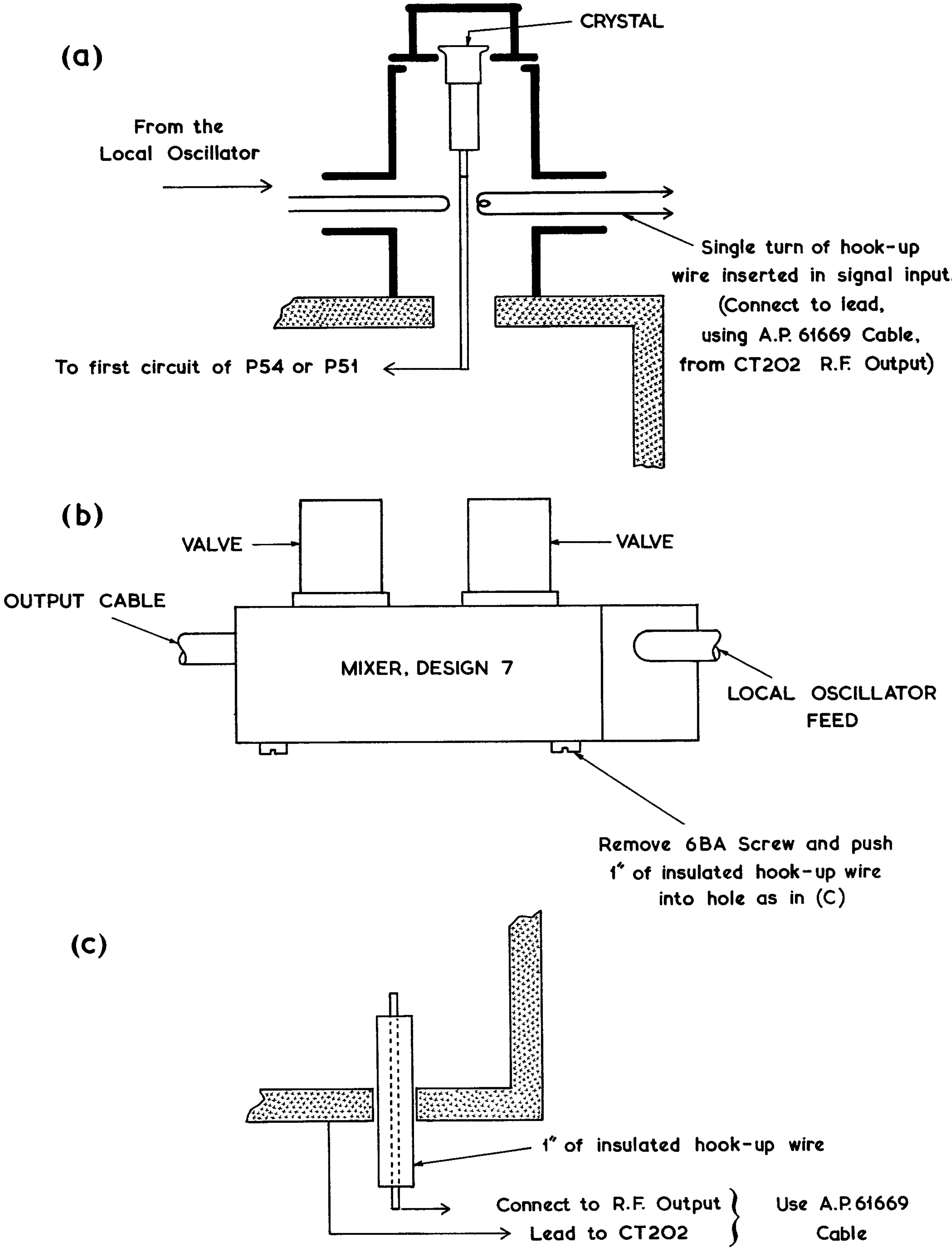
26. Such adaptors will correctly load the first tuned circuit and will also provide a fixed degree of coupling for sensitivity measurements.

27. Two such adaptors (A.P.60871 and A.P.60872) are provided in the box of adaptors used with the Noise Generator CT82.

(A.P.60871 is used on Types 277P/Q, 293P/Q, 982, 983, in the Mixer Unit Design 7, while A.P.60872 is used on the Types 274, 275, 277, 293 and Receivers P51 and P54.)

28. While these two adaptors are suitable for use with the Noise Generator CT82, they do not simulate a crystal sufficiently accurately for use with the Frequency-Swept-Oscillator CT202 or the Signal Generator, Pulse-modulated, CT215. It is intended to substitute two other adaptors, but these are not available at the time of writing. For this reason the following methods have been found useful in an overall alignment, when no crystal adaptor is available.

29. If no adaptors are available, it is necessary to keep the crystal mixer in circuit, and adjust the local oscillator until the crystal-mixer current is at its normal value. The output of the CT202 is then fed by very loose coupling



DIAG. 2.1.3. METHODS OF FEEDING CT202 OUTPUT TO MIXER

) the mixer circuit either by a single turn of wire spaced a short distance a the input inductor of the IF amplifier or by a short straight piece of wire r 1 in. to 2 in. long), inserted through a screw hole in the cover, near the st coil.

In Diag. 2.1.3(a) the first method is shown on the P51, P54 type of mixer, while in (b) and (c) the second method is shown and can be used on the ər Design 7 type of pre-amplifier. In general, the CT202 will be found to ə ample output even when the loosest coupling is used.

In many cases, e.g. Radar Type 275, there is a considerable length of coaxial cable between the head amplifier and the main amplifier, it is ortant, when aligning the complete assembly, to use the same length and type able used on the original installation, when connecting the two units. The ibook of the particular equipment should be consulted for fuller details. siderable errors in the shape of the response-curve can be obtained unless this aution is taken.

The methods of loose coupling described above are recommended for use until all the crystal adaptors are available.

.C. ALIGNMENT

The CT202 can also be used for the display and adjustment of the A.F.C. unit, and by using a double-beam oscilloscope it is often possible to play both the response-curve and the A.F.C. curve, and to note whether the ss-over of the A.F.C. is centred on the IF frequency (see Diag. 2.1.4(a) and).

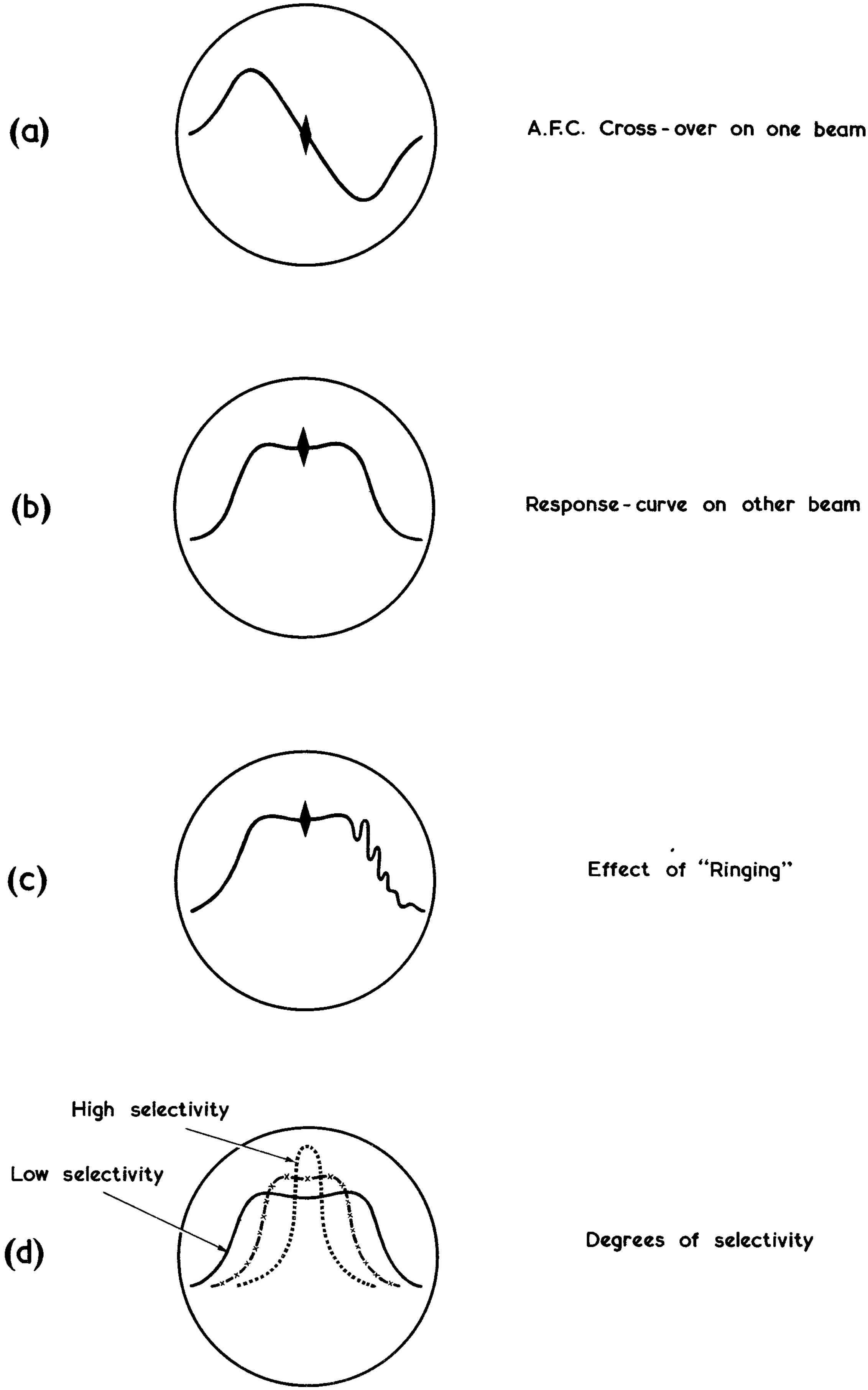
It is intended that fuller details of alignment procedure will be given later in the handbooks of the various equipments.

QUENCY OF SWEEP

In general, the oscilloscope timebase-generator should be set to 40-100 c/s, and if 50 c/s mains frequency is used the timebase-generator can with antage be locked to the mains frequency.

The Frequency-Swept-Oscillator CT202 can be swept at speeds from about 10 c/s to 500 c/s, but if the very slow sweep is used, it is essential to an oscilloscope that has an amplifier with D.C. coupling. If the C.R.T. lates are fed from the output of IF amplifier video stages (following the ond detector), it is necessary to check that the video stages can pass the low əp frequency; in some equipments the video amplifier excludes video signals ow a frequency limit (see Para. 38 below).

If, on the other hand, the higher frequency of sweep is used, trouble may be experienced with "ringing" of the tuned circuits of the IF amplifier. s is most likely with narrow-band circuits of high Q-factor or circuits which ə response-curves with very steep sides, e.g. gunnery and high-definition radar ipments (see Diag. 2.1.4(c) and (d)).



DIAG. 2.1.4. SHOWING A.F.C. ALIGNMENT, RINGING AND DEGREES OF SELECTIVITY

VIDEO OUTPUT OF I.F. AMPLIFIER

38. In general, it is better to extract the video signal immediately after the second detector, as in some cases the video stages of the IF unit under test may have frequency-selective rejector circuits included. It is essential to check this if the video signal to the oscilloscope is extracted after the video stages.

OVERALL CHECKING OF WIRELESS RECEIVERS

39. The CT202 may be used to display the overall response of wireless receivers, particularly those having variable selectivity (see Diag. 2.1.4(d)) or to display the response-curve of the FM detector where fitted. Care must be taken to prevent "ringing" and the remarks in Paras. 35 to 37 should be noted (see Diag. 2.1.4(c)). The Frequency-Swept-Oscillator CT202 is not suitable for receivers where the bandwidth is less than about 50 kc/s at the -6 dB points, as spurious FM is caused by the HT ripple voltage modulating the reactance valve.

PART 2

CHAPTER 2

MAINTENANCE AND FAULT-FINDING

Note: Component layouts (Figs. 2 to 5) are provided (at the end of this book) to facilitate the identification of components.

GENERAL NOTES

1. (a) Oscillators V2 and V4b are working at frequencies greater than 100 Mc/s and on no account should the physical position of components be changed. If replacement of defective components becomes necessary it is important to use serviceable components that have similar electrical and physical specifications.

(b) Instruments containing valves should always be allowed to warm-up for at least five minutes before voltage, calibration or similar checks are carried out.

(c) On no account should ships' staffs attempt adjustment of the cores of L1 or L3, or the spacing of L4. These adjustments should be carried out only in Dockyards.

RAPID PERFORMANCE-CHECKS

2. The following paras. 3 to 8 provide a quick method of determining whether the instrument is working normally. These tests can be performed without removing the instrument from its case. These checks should not be regarded as a substitute for the full calibration procedure given in Part 2, Chap. 3.

3. Apparatus required:-

1. The CT202 under test.

2. IF amplifier or receiver with a bandwidth between 100 kc/s and 7 Mc/s and a midband frequency in the range 7-70 Mc/s.

3. Oscilloscope, e.g. Type 13A or CT52.

4. Signal Generator able to cover 5 Mc/s on either side of the midband frequency of the IF amplifier or receiver.

5. Capacitor 0.05 μF, 350V working.

4. Connections:-

1. Connect apparatus as in Diag. 2.1.1 and set instrument controls as in Tables 2.1.1 and 2.1.2.

2. Proceed as in Part 2, Chap. 1, Paras. 1 to 11 and obtain a response-curve (of the IF amplifier or receiver) centred on the oscilloscope trace.

5. If the Setting-up Procedure (Part 2, Chap. 1, Paras. 1 to 11) can be satisfactorily performed, this indicates the following controls are functioning properly:

PRESET BANDWIDTH

SWEPT BANDWIDTH (if used)

CARRIER TUNING

ATTENUATION RANGE

ATTENUATION FINE

In fact, it indicates that the instrument as a whole is probably functioning correctly. The -3 dB and -6 dB OUTPUT Attenuator (which uses SWC) requires separate testing, as it will not have been used.

6. If during the movement of the response-curve along trace by altering CARRIER TUNING, (a) the response-curve changes in amplitude by 15 per cent or more as from one end of trace to the other end or (b) response-curve disappears at one point, this indicates V1 and/or V2 and their associated adjustments are faulty or out of adjustment. (See Part 2, Chap. 3, Paras. 23-28.) The only maintenance possible in this case is replacement of V1 and/or V2. (See Part 2, Chap. 2, Paras. 11 and 12.)

7. During Setting-up Procedure (Part 2, Chap. 1, Paras. 1 to 11) the following symptoms of faults may be revealed. (It is assumed that all ancillary equipment and the connections have previously been checked and that control settings are correct.)

(a) No response-curve can be obtained. Either (i) there may be no carrier at all or (ii) the carrier is not being frequency-modulated. In both cases the instrument should be removed from its case and the fault-finding drill performed.

(b) PRESET BANDWIDTH fails to control width of response-curve. Probably RV1 is faulty.

(c) SWEPT BANDWIDTH fails to control width of response-curve. Probably RV2 is faulty.

(d) CARRIER TUNING, when altered, fails to move response-curve along trace. Examine C20 and associated circuits.

(e) ATTENUATOR RANGE (A:SWA), when altered, has no effect on amplitude of response-curve. Check A.P.61219. (See Table 2.2.4.)

(f) ATTENUATOR FINE (RV4), when altered, has no effect on amplitude of response-curve. Check RV4 and associated circuits.

8. Assuming that the Setting-up Procedure (Part 2, Chap. 1, Paras. 1 to 11) has been satisfactorily completed, check effect of -3 dB and -6 dB switch SWC on amplitude of response-curve as detailed in Part 2, Chap. 3, Para. 32. If faulty, proceed with Part 2, Chap. 3, Para. 46.

VALVE REPLACEMENT

9. Replacement valves:-

V1, V2, V3, V5:	CV858	Commercial substitutes: 6J6, ECC91 ("reliable" version: CV4031)
V4:	CV455	Commercial substitute: 12AT7 ("reliable" version: CV4024)
V6:	CV493	Commercial substitute: 6X4 ("reliable" version: CV4005)

The types underlined are the original valves fitted. When V1, V2 or V4 becomes unserviceable it should be replaced, if possible, by the reliable version as recalibration may be necessary when these valves are changed.

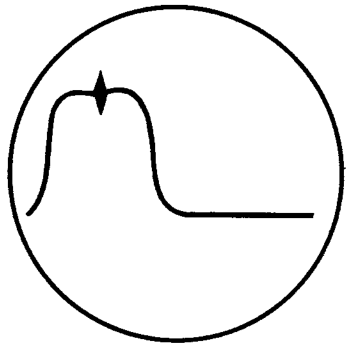
10. In all cases of valve replacement except of V1, no recalibration will normally be required and, in many cases, even replacement of V1 will require only adjustment of the RV3 bias control. Owing to variations in valve characteristics, however, some valves will alter the CARRIER TUNING calibration by as much as 2 Mc/s. When this occurs, although it does not affect the working of the instrument (as accurate frequency measurement is made with a signal generator), it is desirable, on reaching base, that the CT202 should be returned for recalibration in the Dockyard. The procedure for this recalibration is given in Chapter 3.

11. Replacement of V1 (CV858)

The method of adjusting the preset bias RV3 is as follows:-

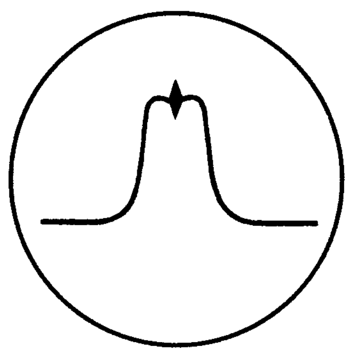
Set up the CT202 test rig as in Part 2 Chapter 1 Para. 1 et seq.(Diag. 2.1.1.), preferably using a narrow-band (e.g. 1 or 2 Mc/s) IF amplifier and carry out the procedure given in Part 2 Chapter 1 Paras. 4-7, when a response-curve similar to that in Diag. 2.1.2.(e) will be obtained. Turn the Swept Bandwidth control to 10 Mc/s and adjust the Carrier Tuning control to move the response-curve from left to right along the oscilloscope trace (Diag. 2.2.1). It may be found that at one end (Diag. 2.2.1.(a)) the response-curve becomes much wider, while at the middle (Diag. 2.2.1.(b)) and other end (Diag. 2.2.1.(c)) it remains a fairly uniform width. The preset bias control RV3 (placed internally as shown in Fig. 2) should be adjusted so that when the response-curve is moved from one side to the other the width of the curve remains uniform. In practice, it may be found that, even then, at the extreme ends the width does increase slightly and RV3 should be adjusted so that the response-curve remains of uniform width near the middle of the oscilloscope trace. Repeat the procedure given in Part 2, Chapter 1, Para. 4 et seq. so that when the Swept Bandwidth is at 10 Mc/s, the width of the complete trace on the oscilloscope represents 10 Mc/s. RV3 should now be readjusted if necessary to obtain the width-uniformity mentioned, RV3 being then locked. It is important to note that only at the ends of the trace should there be any appreciable widening of the response-curve. It may be advisable to try several CV858's to obtain the best results. If V1 has been replaced, the instrument must be returned as soon as convenient to the Dockyard for recalibration and further checks.

(a)



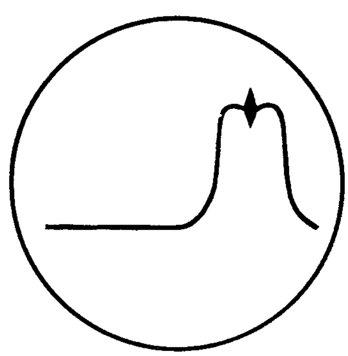
Response-curve wide when at left of screen

(b)



Response-curve width normal when curve is central

(c)



Response-curve width normal when curve is at right of screen

DIAG. 2.2.1. NON-LINEARITY WHEN ALTERING "CARRIER TUNING"

12. Replacement of V2 (CV858)

Replacement of this valve may cause an error of up to 2 Mc/s in the Carrier Tuning calibration but, as all accurate frequency measurements are performed with a signal generator, this error is not important and no recalibration is normally required. However, after replacement of V2 it is advisable to return the CT202 to the Dockyard recalibration centre as soon as possible for a check of amplitude-modulation (AM) on frequency-modulation (FM). (See Part 2, Chapter 3.)

13. Replacement of V3 (CV858)

Replacement of this valve does not affect the calibration of the instrument.

14. Replacement of V4 (CV455)

Replacement of this valve may cause an error in frequency of up to 2 Mc/s in the Carrier Tuning calibration but as a signal generator is used for all accurate frequency measurement, no recalibration need be performed. A slight change in the maximum output voltage can be caused by replacement of V4.

15. Replacement of V5 (CV858)

Replacement of this valve does not affect the calibration of the instrument.

16. Replacement of V6 (CV493)

This is the rectifier and can be replaced without any recalibration.

17. The maximum output voltage of the CT202 cannot be accurately measured by ships' staffs as the necessary apparatus is not available. This test need be performed only in Dockyards and the method is given in Part 2, Chapter 3.

FAULT-FINDING

18.(a) Test Voltages and Currents

Measure the mains voltage and set the mains selector at the nearest voltage. Table 2.2.3 gives typical test voltages with the CT202 working on 230V 50-cycle mains, the mains selector being set at 230 volts. It must be remembered that many of the components have 10 per cent tolerance and variations of 20 per cent in voltage or current quoted are permissible.

(b) Current Measurement

For current measurement the following instruments (Table 2.2.1) can be used:-

TABLE 2.2.1

Meter	Admiralty Pattern No.	Nearest Commercial Equivalent
Avometer	A.P.47A	Avo model 40
Avometer test set	A.P.48A	Avo model 40
Avometer	A.P.12945	Avo models 8, 8SX
Avometer	-	Avo model 7 or 7X

Note: Model 8, 8SX and A.P.12945 are electrically substantially the same.

(c) Voltage Measurement

For the measurement of voltage the following instruments can be used; the order of preference is as shown:-

TABLE 2.2.2

Meter	Pattern No.	Nearest Commercial Equivalent
(1) Valve Voltmeter CT54	A.P.67921	Micovac Valve Voltmeter
(2) Avo Model 8 or 8SX Avo " 7 or 7X	A.P.12945 -	Model 8 and 8SX are commercial types " 7 and 7X " " "
(3) Avometer Avometer Test Set	A.P.47A A.P.48A	} Avometer model 40

(d) Typical Voltages on CT202

All voltages, unless otherwise stated, measured on 240V D.C. range on CT54
" " " " " " " 250V D.C. range on Avo Model 8 (A.P.12945)

" " " " " " " 480V D.C. range on A.P.47A and 48A

" " " " " " " 400V D.C. range on Avo Model 7

NOTE:- (i) When using CT54 valve voltmeter, connect CASE to earth, LOW terminal to earth, and connect the D.C. HIGH terminal by rubber covered lead to test point.

(ii) Set CARRIER TUNING of the CT202 to position engraved S (i.e. vanes of capacitor C20 fully meshed).

TABLE 2.2.3

TEST VOLTAGES

Test Point	Voltage to earth			
	Valve Voltmeter CT54	Avo Model 8 20 000 ohms/volt	Avo Model 7 500 ohms/volt	Avo A.P.47A (or 48A) 167 ohms/volt
V6 cathode (blue-white sleeve)	190	190	188	187
HT line (blue-purple sleeve)	165	163	162	160
V1 & V2 anodes (at junction R7, C7)	138	135	133	130
V1 cathode (pin 7)	14.6 (on 24V range)	14.5 (on 25V range)	14.3 (on 100V range)	14.0 (on 120V range)
V3b anode (pin 1)	150	147	145	140
V3a anode (pin 2)	34	32	28	24
V4a mixer anode pin 6	160	157	154	152
V4b osc-anode (at junction L4, L5)	165	163	162	160
V4a cathode (pin 8)	0.35 (2.4V range)	0.35 (2.5V range)	0.28 (1.0V range)	0.24 (1.2V range)
V5 anode (pins 1 & 2)	130	127	124	120
V5 cathode (pin 7)	1.4 (2.4V range)	1.3 (2.5V range)	1.25 (10V range)	1.0 (1.2V range)
Mains Transformer Secondary	186-0-186 volts A.C. (60 mA D.C. output from rectifier circuit)			

19. The first test to perform if the CT202 is not working is to check the fuses and see if the valve heaters light up. The D.C. checks in Table 2.2.3 should then be carried out.

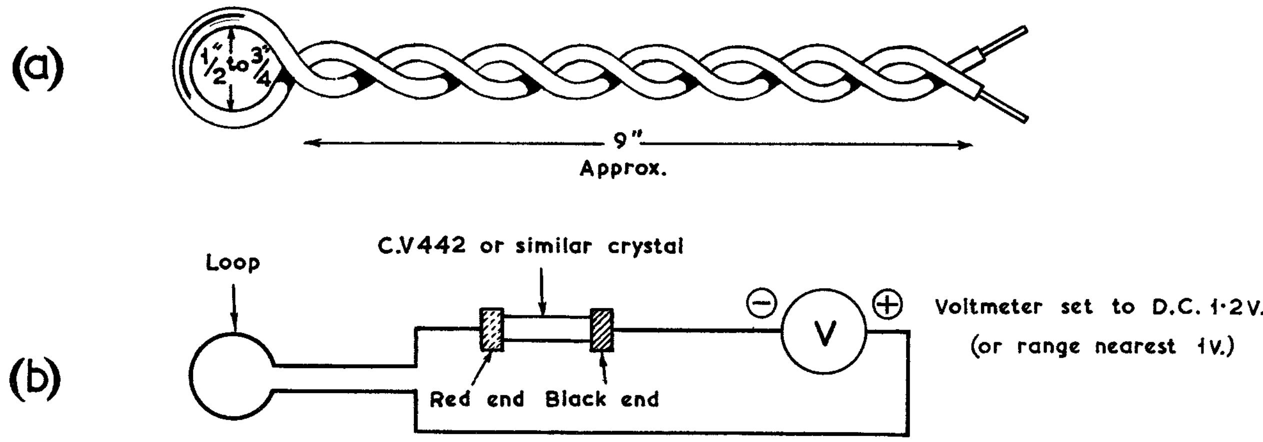
20. The most likely fault is non-operation of one or both of the oscillators V2, V4b. A quick method of testing is as follows: Take about 18 in. of connecting wire (or similar insulated stiff wire about 20 S.W.G.), bend it round the left forefinger and twist it to produce a loop as shown in Diag. 2.2.2(a); strip off the insulation from the two ends for about $\frac{1}{2}$ in.

21. If a CT54 is available, switch to PROBE and 4.8 volts, adjust for zero and connect one end of the loop to the metal of the probe itself and the other end to the terminal on the probe. Short-circuit these probe connections with a short piece of wire and adjust the SET ZERO of the CT54. Remove the short-circuit If the loop is now brought close to coil L4, a large deflection should be obtained on the meter for all settings of the CARRIER TUNING control between 7 and 70 Mc/s.

22. This will indicate that V4b is oscillating over the whole of its working range. The loop should now be moved and placed over the coil-former of L3, when again a substantial deflection should be obtained; this will indicate that V2 is oscillating. The deflection given by L4 will be greater than that given by L3. If either valve is not operating, replace it, noting the instructions on Valve Replacement (Part 2, Chapter 2, Para. 9 et seq.).

23. If a CT54 is not available, an A.P.47A or A.P.48A or Avo Model 7, 7X, 8 or 8SX may be used as follows: Set the meter to D.C. volts 1.2 (or range closest to 1 volt). Take the loop mentioned above and connect one end to the positive terminal of the meter and the other end to the red end of a CV442 (or similar crystal); connect the black end of the CV442 to the negative terminal of the meter. This arrangement, illustrated in Diag. 2.2.2(b), can be used in the manner described in Paras. 21 and 22 above.

24. Table 2.2.4 gives the appropriate tests for some possible faults. The table is not comprehensive, but much additional fault-finding information is to be found in Part 2, Chapter 3. The Attenuator Unit A.P.61219 box should not normally be investigated unless it is certain that it is at fault and after all other tests have been performed.



DIAG. 2.2.2. LOOP FOR CHECKING OSCILLATION

TABLE 2.2.4

FAULT-FINDING

Fault	Cause and Remedy
Output low No output	Make sure mains voltage selector is set to mains voltage. Check connecting leads. Check R24, R25 not short-circuited. Check D.C. voltages. Check valves one at a time (if any have to be replaced see Valve Replacement, Part 2, Chapter 2, Para. 9 et seq.). Use Valve Tester CT160 Check attenuator as below.
Excessive AM on FM or insufficient sweep. (The first fault may be suspected if height of response-curve varies greatly as curve is moved along trace.)	Emission of V1 (CV858) low; replace valve (See Part 2, Chapter 2, Para. 9 et seq.). Incorrect adjustment of L1 (but see Para. 1(c)).
Attenuators not operating or appearing inaccurate.	(a) -3 dB and -6 dB Pad See Part 2, Chapter 3, Para. 46. (b) Attenuator Unit A.P.61219 The resistors in this unit should not be replaced. If the attenuator unit is found defective, the whole unit should be replaced and the defective unit returned to Dockyard for repair. Testing procedure is given in Part 2, Chapter 3, Para. 47. To check a new unit proceed as in Part 2, Chapter 3, Para. 47(e). It is important that all faces where back cover plates make contact with the shell should be clean. All screws holding the back plates of this unit should be clean and tight.
No sweep (i.e. no FM) but output satisfactory.	Check there is a trace on the oscilloscope. Check lead from X terminal of oscilloscope to X terminal of CT202. Check RV1, R1, R2, RV2, R3, R4, R5, R6, R7. Replace V1 (CV858). (If new valve required proceed as in Part 2, Chapter 2, Para. 9 et seq.)
IF response-curve progressively disappears part way along trace when CARRIER TUNING is altered.	This will normally not occur in operation since this is usually caused by incorrect adjustment of the core of L1 (or more rarely of L3). Only Dockyard Staff should normally attempt the operation of readjustment. See Part 2, Chap. 3, Para. 20 et seq.
Excessive RF leakage	Bolts and retaining screws on A.P.61219 attenuator unit, or attenuator box not tight, or connections dirty. Clean all contacting surfaces and tighten all screws.

PART 2

CHAPTER 3

ALIGNMENT, CALIBRATION AND ACCEPTANCE TESTS FOR DOCKYARD RADIO CENTRES

SECTION HEADINGS

1. Para. 2. Introduction.

Para. 6. Adjustments.

Para. 7. Apparatus required.

Para. 8. Adjustment of the frequency of the Variable Oscillator V4b.

Para. 20. Adjustment of the frequency of the Fixed Oscillator V2, inductors L1 and L3 and bias-control RV3.

Para. 30. Check of accuracy of -3 dB and -6 dB OUTPUT attenuator.

Para. 33. Measurement of Percentage AM (on FM sweep) and RF output.

Para. 42. Overall check of adjustment of V2 and V4b and calibration of Carrier Tuning control.

Para. 45. Resistance check of Attenuator A.P.61219 and of -3 dB and -6 dB OUTPUT attenuator.

Para. 48. Conclusion.

INTRODUCTION

2. The "setting-up" procedure given for the CT202 is relatively simple and sufficiently accurate for all working purposes. The Carrier Tuning dial is directly calibrated in megacycles per second but a high degree of accuracy is not important as by the use of the marker-pip from an external signal generator, frequency accuracy is assured in all bandwidth measurements on IF amplifiers. Before carrying out any practical work described in this Chapter it is desirable to read Paras. 48 to 53. In all displays of the response-curve, limiting must be carefully avoided. This can be checked by increasing slightly the output of the CT202 (using the ATTENUATOR FINE control of the CT202); an appropriate increase of amplitude of response-curve should be obtained.

3. When a CT202 is received form recalibration or repair, the valves should be removed one at a time and checked on the valve-tester CT160, particular note being paid to V1 and V2. A valve should be replaced before another is removed to prevent interchanging positions of valves. If there is the slightest indication that either V1 or V2 is beginning to fail it should be replaced and the appropriate recalibration completed.

4. In order that the CT202 shall reproduce the true response-curve of the IF amplifier under test it is very important that the frequency-modulated (FM) carrier shall not have more than 10 per cent depth of amplitude modulation (AM) superimposed on it for most of the 7-70 Mc/s coverage. To ensure that this condition is met a special test is performed (see Para. 33 et seq.).

5. Internal test-points (A) and (B) are provided by V3a (see Part 1, Chap. 2, Para. 35) for the adjustment of the frequency of V2 and V4b oscillators.

ADJUSTMENTS AND MEASUREMENTS TO BE MADE:-

6. (a) Frequency of variable oscillator V4b (Para. 8 et seq.).

(b) Frequency of fixed oscillator V2, inductance L1 and L3 and bias-control RV3 (Para. 20 et seq.).

(c) Accuracy of -3 dB and -6 dB attenuator (Para. 30 and Para. 45 et seq.).

(d) Percentage AM on FM sweep and RF output (Para. 33 et seq.)

(e) Calibration of Carrier Tuning Control (Para. 42 et seq.)

(f) Resistance check of Coarse Attenuator A.P.61219 and of -3 dB and -6 dB OUTPUT Attenuator (Para. 45 et seq.).

APPARATUS REQUIRED (FOR ALTERNATIVES SEE APPENDIX "B")

7. (a) Frequency-Swept-Oscillator CT202 under test.

(b) Signal Generator XT42 (WD3942).

(c) Oscilloscope A.M. Type 13A (10S/831).

(d) Voltmeter to read 250 volts A.C./D.C.

(e) Bridge Megger A.P.6496 or resistance-measuring bridge.

(f) IF amplifier in the frequency range 7 to 70 Mc/s, preferably narrow-band i.e. 0.5 to 2 Mc/s wide at -6 dB level.

(g) Amplifier as described in Appendix "D".

(h) 0.01 to 0.05 μF, 350-volt-working capacitor (0.05 μF shown in diagrams).

(j) Insulated trimming tool.

NOTE:- XT42 is an experimental designation and at the time of writing the CT number has not been allocated.

ADJUSTMENT OF THE FREQUENCY OF THE VARIABLE OSCILLATOR V4b

8. Test Rig: As Diag. 2.3.1

9. Apparatus Required

1. Signal Generator covering frequency 112-180 Mc/s e.g. XT42 (WD3942), Marconi TF995 or TF995A, or A.P.54705 and A.P.W5001A.

2. Oscilloscope Type 13A or suitable alternative.

3. Insulated trimming tool.

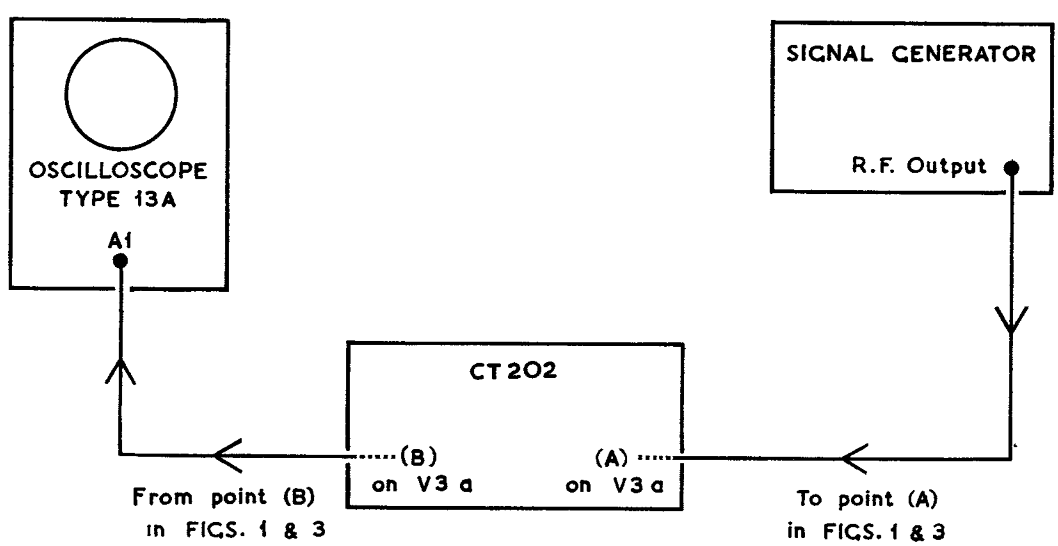
See Appendix "B" for alternative instruments.

INITIAL MECHANICAL CHECK

10. Set Carrier Tuning to the mark S and make sure the vanes of capacitor C20 are fully meshed; if they are not, loosen grub screws on slow motion and reset. Also check that no mechanical damage has been sustained by the vanes, as this will alter the "law" and therefore the frequency calibration of the Carrier Tuning control.

FREQUENCY COVERAGE OF V4b

11. 112-175 Mc/s, corresponding to 7-70 Mc/s on Carrier Tuning scale.



DIAG. 2.3.1 TEST RIG FOR V4 b FREQ. MEASUREMENT

INTRODUCTION AND PROCEDURE

12. The variable-frequency oscillator V4b is tunable over the range 112-175 Mc/s by variation of the CARRIER TUNING control from 7 to 70 Mc/s.

13. Table No. 2.3.2 gives the V4b variable-oscillator frequency corresponding to a particular setting of the CARRIER TUNING control. It is possible to set-up the oscillator so that the maximum frequency error at any position of the CARRIER TUNING is ± 2 Mc/s. This maximum error occurs at the extreme ends of the frequency range. The initial mechanical check of Para. 10 is essential.

14. Connect the instruments as shown in Test Rig Diag. 2.3.1 with signal generator RF output fed to internal test-point (A) in the circuit (Figs. 1 and 3) and the A1 socket of the oscilloscope connected to test-point (B) in Figs. 1 and 3. (The test-points are shown in layout Fig. 3.) Set the oscilloscope controls as in Table 2.3.1 and adjust the signal generator to give a CW signal of 100 mV at 145 Mc/s.

TABLE 2.3.1

Oscilloscope Type 13A

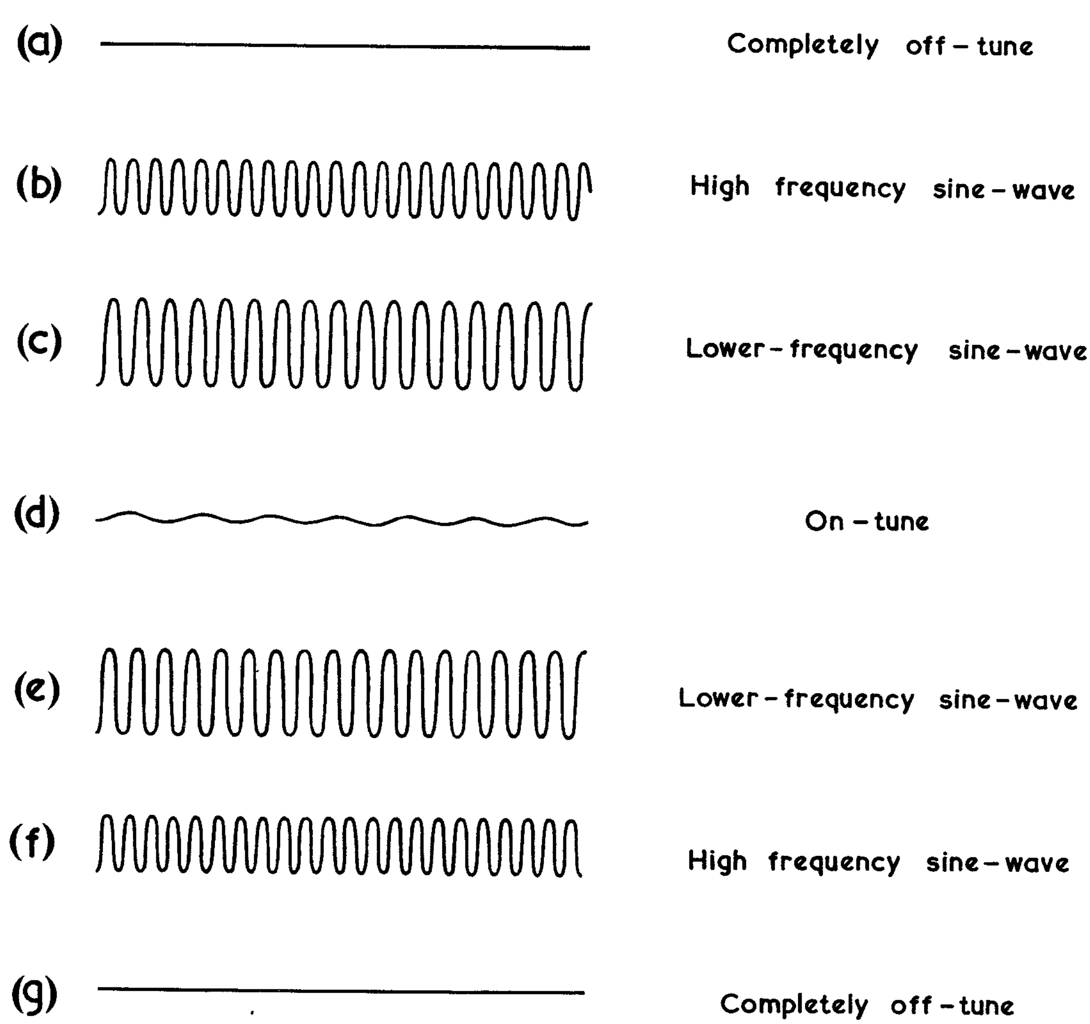
Control	Setting
Trig. Sync	50 c/s
Cal.	Off
Flyback	Fully clockwise at first. Adjust if necessary later.
Power	HT
Probe selector Y2 attenuator A1 gain A2 gain Y plate selector Vel. Range Fine Velocity Sync Amplifier Amplitude	OFF ÷ 1 Fully clockwise (max.) Fully clockwise (max.) 2A1 HF 10 c/s) Adjust fine velocity to lock 5-15) trace to mains frequency. Set to half-way and adjust as required. Set to give a trace 8 to 10 cm long.

15. Remove V2 from the CT202 (to prevent V2 oscillations from interfering). Set the Carrier Tuning control to 40 Mc/s. Switch all instruments on and allow them at least five minutes to warm up.

16. Vary the signal generator frequency very slowly through the frequency range 130-160 Mc/s, during which operation a beat effect should be seen on the oscilloscope (Diag. 2.3.2). This beat is the difference-frequency between the frequency of the V4b oscillations (which are fed to the grid of V3a via the anode to grid capacitance of V3b) and the frequency of the signal generator. As the frequency of the signal generator is increased slowly from 130 to 160 Mc/s, the trace on the oscilloscope will at first appear as at (a) Diag. 2.3.2; at a certain point a high-frequency sine-wave (b) will appear on the trace and a slight increase of the signal generator frequency will result progressively in traces (c), (d), (e), (f) and (g). The condition required is that shown at (d). The setting is very critical and only a slight change of the signal generator frequency is required to cover conditions (a) to (g).

The signal generator frequency required to give the zero beat as at (d) should be noted; this is the frequency of the variable oscillator V4b and should be 145 Mc/s with the Carrier Tuning set to 40 Mc/s. If the Carrier Tuning frequency is low, switch off CT202 and slightly increase the spacing of the turns of coil L4. Switch on CT202 and recheck frequency. Continue adjustment of spacing of L4 until the zero beat is obtained when the signal generator reads 145 Mc/s with the Carrier Tuning at 40 Mc/s. If the Carrier Tuning frequency is too high, the spacing of the turns of L4 should be slightly decreased by pressing the side of the coil with the insulated tool supplied.

17. Check the variable oscillator V4b's frequency by the zero-beat method described above for various spot-frequency settings of the Carrier Tuning control given in Table 2.3.2. (No alteration of L4 must be made during these additional checks.) The frequency of the variable oscillator V4b should be within ± 2 Mc/s at any position of the Carrier Tuning control; if not within this tolerance, repeat procedure.



DIAG. 2.3.2. MEASUREMENT OF V4b FREQUENCY

18. This completes the adjustment of the variable-frequency oscillator V4b which should not require any further adjustment throughout the setting-up procedure. Replacement of V4 or L4 will normally mean slight alteration of spacing of L4.

19. Replace the valve V2 and proceed as Para. 20 et seq.

TABLE 2.3.2

Carrier Tuning Mc/s	Variable Oscillator frequency Mc/s
7	112
10	115
20	125
30	135
40 initial test	145
50	155
60	165
70	175

ADJUSTMENT OF FREQUENCY OF THE FIXED OSCILLATOR V2, INDUCTORS L1 AND L3 AND BIAS-CONTROL RV3

20. Test Rigs required: As Diag. 2.3.1 and Diag. 2.3.3.

21. Apparatus Required

1. Signal Generator covering frequency 80 to 120 Mc/s (XT42 (WD3942) or one of alternative types given in Appendix "B").

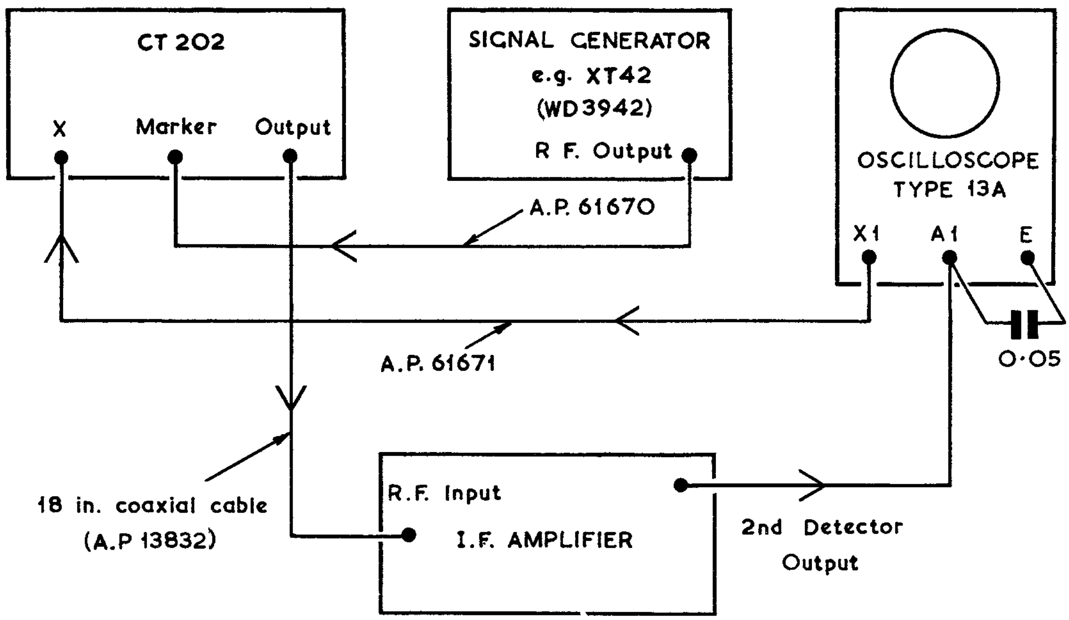
2. Oscilloscope Type 13A 10S/831 (suitable alternatives given in Appendix "B").

3. Insulated trimming tool.

4. IF amplifier (preferably narrow-band and in the frequency-range 7-70 Mc/s).

5. Voltmeter (see Para. 29(b)).

22. Frequency of fixed oscillator V2 = 105 Mc/s.



DIAG. 2.3.3. TEST RIG FOR ADJUSTING V2 FREQ. ETC.

PRELIMINARY NOTES

23. The adjustments to L1, L3 and RV3 are interconnected and a certain amount of rechecking is necessary. These are very important adjustments and take the major part of the time in realignment. Replacement of V1 or V2 does not necessarily mean a complete realignment of this circuit; slight adjustments will often suffice.

24. When adjusting L1, or possibly L3, a peculiar effect can be observed. When altering the Carrier Tuning to move the IF response from one end of the oscilloscope trace to the other, it is possible that the response-curve will appear to run into a "wall" and disappear part way along the trace. This is usually caused by the inductance L1 being too great and the core should be unscrewed slightly until the effect mentioned is not apparent.

25. In general, L1 is adjusted for minimum inductance consistent with a reasonably linear 10 Mc/s sweep. The object is to obtain the minimum AM on FM.

26. When moving the response-curve of an IF amplifier from one side of the trace to the other, the amplitude of a particular point on the response-curve (e.g. the peak) should not change by more than 10 per cent and can usually be kept below 5 per cent.

27. Thus if the peak height of a response-curve when at the right-hand end of the trace is, say, 5 cm, the height, when the curve is moved to the left-hand end, should not normally drop below 4.5 cm and should usually be about 4.8 cm.

28. The above remarks assume that the sweep has been set to 10 Mc/s.

PROCEDURE

29. The instructions given below are for a complete realignment of this part of the circuit. As stated previously, only slight adjustments will normally be required after valve replacement.

(a) Leave the connections as in previous test, i.e. Test Rig of Diag. 2.3.1. Remove valve V4 (to prevent interference from its oscillations) and set Carrier Tuning control of CT202 to 70 Mc/s.

(b) Provisionally adjust RV3 until the voltage to earth of the junction of RV3 and R2 is about:-

8 volts when using A.P.47A or 48A on 120V range.
10 volts when using Model 7 AVO on 100V range.
12 volts when using Valve Voltmeter CT54.

(c) Unlock the iron-dust core of L1 and unscrew it to the top of the former (i.e. minimum inductance).

(d) Set Swept Bandwidth control RV2 and Preset Bandwidth RV1 to minimum position, i.e. fully counter-clockwise.

(e) Using the method described in Para. 8 et seq., and with the same oscilloscope settings, slowly adjust the frequency of the signal generator over the range 90 to 120 Mc/s when a beat as shown in Diag. 2.3.2 should be observed. The core of L3 should be adjusted (using the insulated trimming tool supplied) until the zero beat, as shown at (d), occurs with the signal generator set to 105 Mc/s. This adjustment will be found critical and the core should be lightly "locked". Check after locking to ensure that the setting has not been altered; repeat the operation if necessary. Switch off CT202.

NOTE:- Adjustment of the core of L3 is critical and it will be found easiest to unlock the Tufnol core say one-eighth of a turn, adjust the dust core a similar small amount and "lock". In this way, only small adjustments at a time are made and it is easier to get the correct frequency.

(f) Replace V4 and connect the apparatus as in Test Rig Diag. 2.3.3, using a narrow-band IF amplifier (output being taken from the 2nd-detector load) and setting the CT202 controls as in Table 2.3.2. Set the oscilloscope controls as shown in Table 2.3.3.

(g) Set signal generator frequency to the midband frequency of the IF amplifier and the appropriate controls to give a CW signal of about 1 μV (i.e. attenuators set for minimum output).

TABLE 2.3.2

FREQUENCY-SWEPT-OSCILLATOR CT202

Control	Setting
Mains Voltage Selector	To mains voltage
Mains Switch	ON
Preset Bandwidth	Fully clockwise
Swept Bandwidth	10 Mc/s
Carrier Tuning	To midband frequency of IF amplifier
Attenuator Range	1
Attenuator Fine	10
OUTPUT switch (attenuator)	Normal
Marker plug	Connected to signal generator
Output plug	Connected to input of IF amplifier (70 to 80-ohm input)
X Terminal	Connected to X1 on oscilloscope
E Terminal	Connected to earth and (using one wire of connector A.P.61671) to E on oscilloscope

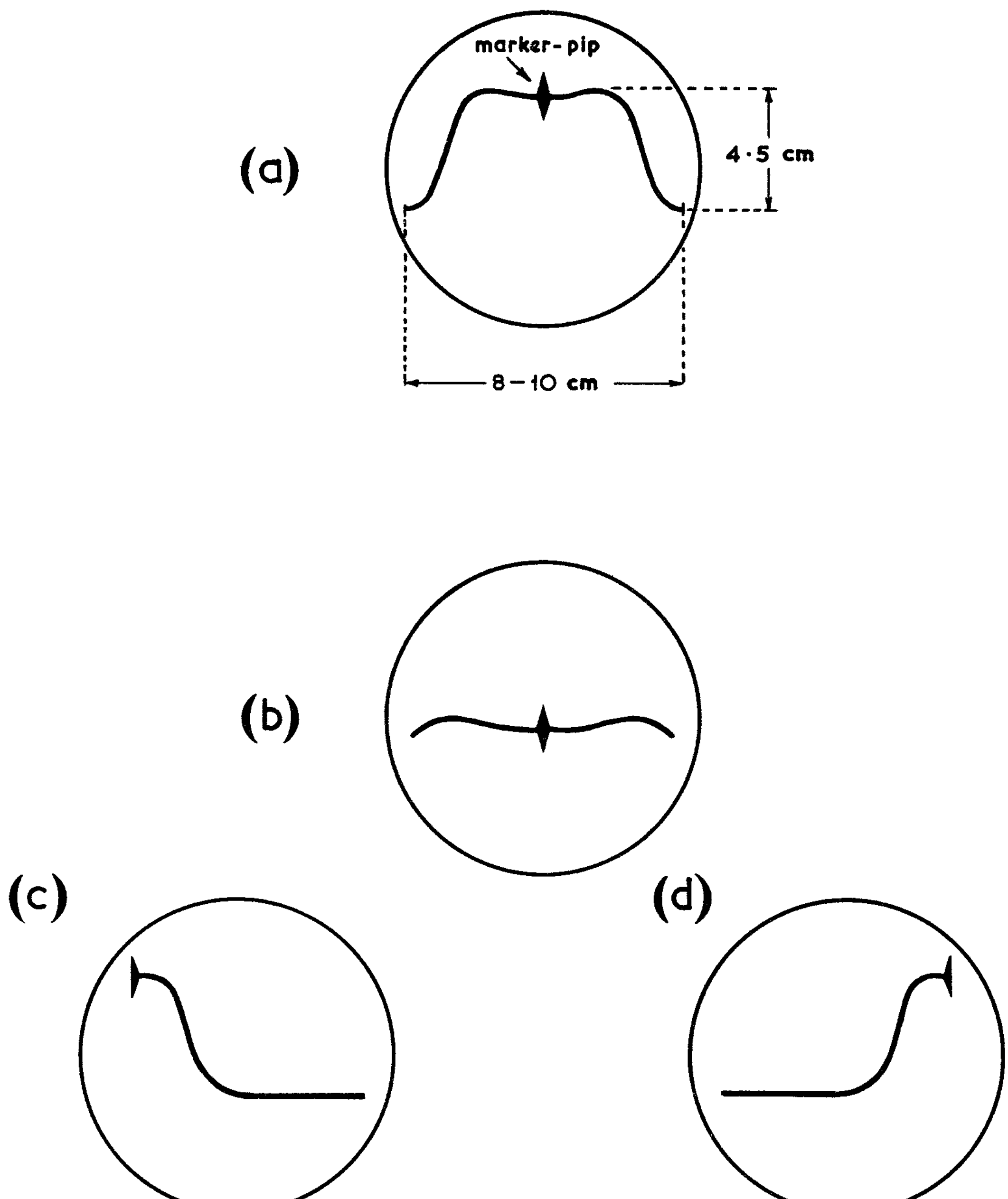
TABLE 2.3.3

OSCILLOSCOPE TYPE 13A

Control	Setting
Trig. Sync	50 c/s
Cal.	OFF
Flyback	Fully clockwise at first; adjust if necessary when IF response is displayed.
Power	H.T.
Probe selector	OFF
Y2 Attenuator	+ 1
A1 Gain	Fully clockwise (max.)
A2 Gain	Fully clockwise (max.)
Y Plate Selector	2A1 HF
Vel. Range	10 c/s) Adjust Fine Velocity, when response is obtained, to "lock" to mains frequency.
Fine Velocity	5-15)
Sync Amplifier	Set to half-way and then adjust as required to lock response.
Amplitude	Set to give a trace of 8-10 cm

(h) Switch on all the instruments and the power supply to the IF amplifier and allow about five minutes for instruments to warm up.

(j) With the settings given, a response-curve of the IF amplifier should be obtained, although at this stage it may be distorted and rather wide, part only of the response-curve being visible. The attenuators of the CT202 should be adjusted to give a response of suitable amplitude (avoiding limiting). Adjust Carrier Tuning to centre response-curve on oscilloscope trace.



DIAG. 2.3.4. TRACES SEEN DURING SETTING–UP

(k) Increase the RF output voltage of the signal generator until a marker-pip is observed on the response-curve and centre this pip on the response-curve by adjusting the signal generator frequency (see Diag. 2.3.4 (a) or (b)).

(l) Adjust the CT202 Carrier Tuning control to move the response-curve along the trace until the marker-pip is at the left-hand end of the response-curve as in Diag. 2.3.4 (c). Make a note of the Carrier Tuning frequency as shown in megacycles on the scale; call this f1. Readjust the Carrier Tuning to move the response-curve along the trace until the marker-pip is at the right-hand end of the trace (Diag. 2.3.4 (d)) and again note the frequency of the Carrier Tuning control; call this f2. The difference of frequency (f2 - f1) gives the frequency-sweep in Mc/s. (See end of next paragraph if any difficulty is encountered.)

(m) At this stage the sweep will be very restricted and the iron-dust core of L1 should be slowly turned into the former towards maximum inductance. After 10 to 12 turns, repeat (l) above. As the inductance of L1 is increased, so the total sweep (f2 - f1) Mc/s should increase, but it may be found when moving the response-curve from one side to the other that the sweep becomes very non-linear either at one or both ends. (Non-linearity is indicated by the response-curve's width varying as the curve is moved.) The control RV3 should be adjusted to bring the linear portion of the sweep in the centre of the trace; under these conditions the width of the curve remains constant when the response-curve is moved to either side of the centre of the screen; some slight non-linearity can be tolerated at each end of the trace.

Adjustment of L1 should be continued until a sweep of more than 10 Mc/s is achieved. Usually 12 to 16 Mc/s is obtainable. At this point it is advisable to recheck the frequency of the fixed-oscillator valve V2. Whilst rechecking this frequency it is necessary to set the Swept Bandwidth control to zero (fully counter-clockwise) and to disconnect the oscilloscope amplifier lead from the video output of the IF amplifier and reconnect it to test-point (B) in the CT202 circuit (Fig. 1) and also to reconnect the signal generator to test-point (A) in the CT202. Remove V4. After making any necessary slight adjustment to the core of L3 to bring the fixed oscillator back to 105 Mc/s, reconnect the leads, replace V4 and continue with the adjustment of L1 if necessary. The object is to adjust L1 towards maximum inductance, consistent with no appreciable change of amplitude or disappearance of the response-curve when the response is moved across the oscilloscope trace. This disappearance of the response-curve (or appreciable change of amplitude of the response-curve) towards one end is nearly always caused by the inductance of L1 being too great (or very rarely by incorrect setting of L3). If either of these effects is noticed, the core of L1 should be unscrewed to reduce the inductance of L1 until the effect disappears.

NOTE:- It is normally possible to get a total sweep of at least 12 to 16 Mc/s under the conditions mentioned above and the sweep will be found very non-linear at each end and several harmonics of the IF may be noted. This is to be expected and is due to the design of the CT202. When the Preset Bandwidth is adjusted to give a maximum sweep of 10 Mc/s no trouble with excessive non-linearity or harmonics should be experienced.

(n) Having completed the adjustments in (m), adjust the Preset Bandwidth until the total sweep is 10 Mc/s, and alter the Carrier Tuning control about the IF frequency to move the response-curve from one end of the trace to the other. Any slight non-linearity at one end can be corrected by adjustment of RV3 and any appreciable amplitude change or complete disappearance of the response-curve at one point can be corrected by slightly reducing the inductance of L1 by unscrewing the core. Carefully check the frequency of the fixed oscillator V2 (as described previously), making any slight final adjustment to the core of L3 to set this oscillator to 105 Mc/s; then carefully lock the core taking care not to alter the frequency. It may be necessary to repeat adjustments of L1, L3 and RV3 a number of times to obtain the final desired accuracies. Lock the core of L1 carefully and secure the bias-control RV3 locking-screw.

(c) As a final check observe linearity, amplitude change and frequency sweep, by moving the response-curve along the oscilloscope trace. This completes the alignment of the CT202 and the remaining tests are performance checks to ensure that the CT202 is functioning as intended. If V1 or V2 is replaced it may be necessary to repeat the above procedure.

CHECK OF ATTENUATOR PAD (-3 dB AND -6 dB)

30. Test Rig: As Diag. 2.3.3.

31. Apparatus Required: As Part 2, Chap. 3, Para. 21.

32. Whilst the response-curve of the IF amplifier is being displayed on the oscilloscope as in Part 2, Chap. 3, Para. 29(f), it is convenient to check the accuracy of the -3 dB and -6 dB attenuator.

This is best performed as follows:

(a) Centre the response-curve on the trace by adjusting the Carrier Tuning control and adjust the output attenuators of the CT202 until a response-curve of about 6 cm amplitude is obtained. Make sure limiting does not occur; a change in Attenuator Fine setting should produce an appropriate change in amplitude.

(b) Turn OUTPUT switch to -3 dB, readjust the baseline to its original level (using Vertical Shift of oscilloscope) and measure the amplitude of the response-curve. The response-curve amplitude should fall to 0.7 of its original value.

(c) Switch to -6 dB position, reset the baseline and again measure the response-curve amplitude which should now have fallen to half its original amplitude.

(d) If the original amplitude was 6 cm, the amplitude with the -3 dB pad in circuit should be 4.25 cm ± 0.2 cm and with the -6 dB pad in circuit the amplitude should be 3.0 cm ± 0.2 cm. If errors greater than these occur, the resistance checks quoted in Part 2, Chap. 3, Para. 46 et seq. should be performed and any defective component replaced.

(e) There is an increase in the output impedance of the CT202 when the ATTENUATOR RANGE is in Position 4, and the OUTPUT switch is at -3 dB or -6 dB. It is therefore possible for inaccuracies to occur in the -3 dB and -6 dB levels when Position 4 is used.

MEASUREMENT OF PERCENTAGE AMPLITUDE-MODULATION (ON THE FM SWEEP) AND RF OUTPUT

33. Test Rig: As Diag. 2.3.5.

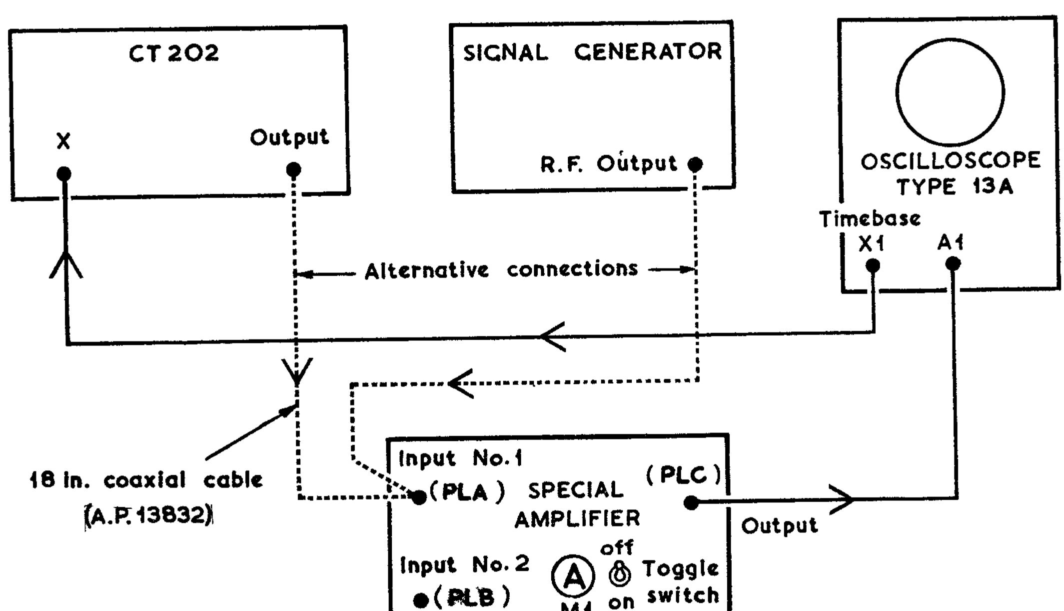
34. Apparatus Required: Signal Generator (XT41 or XT42, Marconi TF995A or Marconi TF948).

Oscilloscope Type 13A 10S/831 (or alternatives in Appendix "B").

Special A.S.R.E. amplifier (see Appendix "D" and Diag. Appendix "D").

NOTE:-

At the time of writing it is not definitely known that the A.I.D. crystal millivolt-meter (CT88) will be available, and so a crystal detector has been built into the amplifier together with a 12.5-0-12.5 microammeter; if greater sensitivity is required an external microammeter can be used. A measure of the RF output (fed to the input of the special amplifier) can be obtained by observing the crystal current. The special amplifier mentioned above is required because of the residual hum in the amplifiers of the Type 13A oscilloscope and because of the necessity for a crystal detector. The signal generators XT41 and XT42 are very accurate instruments and therefore suitable for checking the Frequency-Swept-Oscillator CT202 for maximum RF output, AM content and frequency accuracy.



DIAG. 2.3.5. MEASUREMENT OF AM ON FM AND OF CT202 OUTPUT

35. When measuring AM on FM it is also convenient to measure the RF output voltage of the CT202. This is done by setting the Signal Generator to 100 mV and feeding the output to the INPUT No. 1 (PLA) of the special amplifier.

With the toggle-switch SA of the amplifier in the "on" position (depressed), the crystal current is measured by the microammeter of the amplifier. The Signal Generator is then replaced by the CT202 adjusted to give its maximum output: This output is indicated by the crystal current which should exceed the previous reading obtained (see Paras. 36 to 40).

INTRODUCTION

36. In the following operations, the Signal Generator RF output is set to 100 mV from the scale on the signal generator. This RF signal is rectified by a crystal in the special amplifier and the rectified current is measured by the microammeter in the amplifier. The measured crystal current is thus equivalent to 100 mV RF. When the CT202 replaces the signal generator and is connected to the special amplifier, the crystal current is a measure of the output of the CT202. The output of the CT202 can be adjusted to give the same crystal current as 100 mV from the Signal Generator. Amplitude-modulated signals are not measured by the crystal-current method but by rectifying them with the crystal, amplifying the resultant audio-frequency signals and displaying the waveform on the C.R.T. screen where its amplitude is measured. Amplitude-modulated signals from the signal generator are measured in this way, the amplitude of the waveform being measured on the screen. The unwanted amplitude-modulation in the output of the CT202 is measured in the same way and compared with the amplitude obtained with amplitude-modulated signals from the signal generator. (It is to be noted that unmodulated RF signals and pure frequency-modulated signals would give no output signal from the amplifier and therefore the oscilloscope would in these cases have nothing to display.)

37. In measuring AM on FM the signal generator is first set to give an unmodulated RF output of 100 mV which is then amplitude-modulated by a 300 c/s signal to give 10 per cent and 20 per cent modulation depth. This output is detected by the crystal, the resultant audio-frequency signals after amplification being displayed on the oscilloscope. The amplitude of the sine wave for 10 per cent and 20 per cent modulation-depth is then measured. The detector (crystal) current is now measured with an unmodulated RF output from the signal generator (which is set to 100 mV); the crystal current therefore corresponds to 100 mV. The frequency-swept-oscillator CT202 is then substituted for the signal generator and the output of the CT202 adjusted so that the same crystal current is obtained. The amplitude of the detected signal (due to amplitude-modulated contamination of the FM output) is then measured on the C.R.T. and by comparison with that obtained with the modulated signals from the signal generator, the percentage of AM on FM can be estimated as a depth of modulation. If there were no AM on the FM of the CT202 the trace on the oscilloscope would be a straight line; a purely frequency-modulated RF input to the special amplifier would produce no output signal from the amplifier.

IMPORTANT

(a) It is important that a crystal-current comparison of signal generator and CT202 should be made at a number of frequencies (e.g. 10, 15, 20, 30, 40, 50, 60 and 70 Mc/s) depending upon the signal generator available. If the signal generator goes down to 7 Mc/s this may be added to Table 2.3.4; if not, the lowest frequency available should be used. Crystal current is always measured with toggle-switch SA of amplifier "on", the oscilloscope display being measured with toggle-switch "off".

(b) The SWEPT BANDWIDTH of the CT202 should be correctly set for 10 Mc/s before carrying out these tests.

(c) The signal generator and CT202 must be correctly terminated in 75 ohms during these tests. (The special amplifier whose circuit is given in Appendix "D" ensures this when INPUT No. 1 of the amplifier is used.) If a signal generator with a different output impedance is used, provision must be made for correct matching.

PROCEDURE

Using Output from Signal Generator

38.(a) Connect signal generator to the amplifier INPUT No. 1 (PLA) using a coaxial cable (e.g. A.P.13832) cut to 18 in. Connect the amplifier OUTPUT plug PLC to the A1 terminal of the oscilloscope using a screened lead. Keep oscilloscope controls set as in previous tests (Table 2.3.3).

(b) Set signal generator to give a C.W. signal of 100 mV (as indicated on the signal generator) and (with toggle-switch SA "on", i.e. depressed), note crystal current (of special amplifier) at 10 Mc/s and fill in reading in Column 2, Table 2.3.4. Representative figures have been inserted in this table, but wide variations are possible. Repeat for other frequencies shown in Table 2.3.4, Column 1. (Signal generators vary as regards their lowest frequency; the first entry in Table 2.3.4 should be the lowest frequency nearest 7 Mc/s.)

(c) Set signal generator to give 100 mV, modulated to 10 per cent depth with 300 c/s, and (with toggle-switch SA "off") note (on oscilloscope) the peak-to-peak amplitude in millimetres of the detected sine wave, inserting figure in Column 3 of Table 2.3.4. Repeat for other frequencies shown in Table 2.3.4, Column 1.

(d) Repeat (c) above for 20 per cent AM and insert figures in Column 4, Table 2.3.4.

Using Output from CT202

(e) The lead from amplifier INPUT No. 1 (PLA) is then disconnected from the signal generator and transferred to the OUTPUT plug of the CT202. Set the CT202 CARRIER TUNING to 10 Mc/s. (If the signal generator does not go down to 7 Mc/s start at the lowest possible figure in Column 1 Table 2.3.4; 10 Mc/s is given in the Table as this is probably attainable.)

(f) Set the attenuator controls of CT202 until the crystal current obtained (with toggle-switch SA "on") is the same as that for the same frequency in Column 2, Table 2.3.4. Switch off toggle-switch SA and measure amplitude of waveform; inserting this figure in Column 6, Table 2.3.4. (See Diag. 2.3.6 for typical examples of amplitude h and note Para. 41(b) below.) Column 6 is a measure of the AM on FM.

(g) Obtain maximum output of CT202 by turning ATTENUATOR RANGE to Position 4, ATTENUATOR FINE to Position 10 and OUTPUT switch SWC to NORMAL. Measure crystal current (with toggle-switch SA "on") and insert reading in Column 5,

Table 2.3.4. The purpose of this operation is to measure the RF output of the CT202 which should exceed 100 mV; the CT202 output is being compared with the 100 mV output of the signal generator.

(h) Repeat (f) and (g) for other frequencies shown in Column 1, Table 2.3.4.

ANALYSIS OF RESULTS IN TABLE 2.3.4.

39. For frequencies up to 60 Mc/s, the figure in Column 6 should not be greater than that in Column 3 (10 per cent AM) and for 70 Mc/s the figure in Column 6 should not be greater than in Column 4 (20 per cent AM). (The AM on the CT202 output of 100 mV is being compared with 10 per cent and 20 per cent AM on the signal generator's 100 mV output.)

40. At no carrier frequency should the figure in Column 5 be less than that obtained in Column 2. In other words, the RF output of the CT202 should not be less than 100 mV. (But see Para. 52.)

IMPORTANT NOTE

41.(a) During observation of the detected RF output of the CT202 at some frequencies, beats may be seen, as shown in Diag. 2.3.6 (a) and (b). These should be ignored when measuring the peak-to-peak distance h in Diag. 2.3.6 (a) and (b).

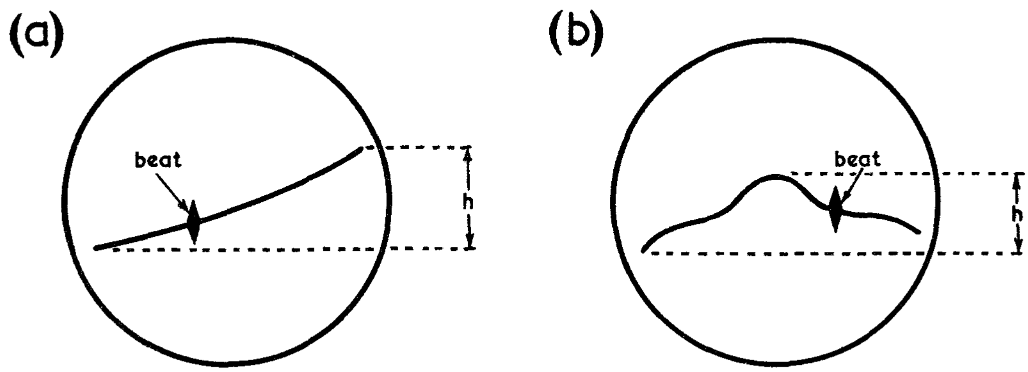
(b) The maximum AM on FM occurs at 7, 10, 15, 60 and 70 Mc/s. If the AM on FM is too great at 60 and 70 Mc/s and all valves, voltages, etc. are satisfactory the cause will be that the inductance of L1 is too great. The waveform shown on the oscilloscope for AM on FM at 60 and 70 Mc/s is shown in Diag. 2.3.6 (a) If the AM on FM is too great at the low frequency end of the Carrier Tuning (10 or 15 Mc/s) and is in the form of an excessive bump (Diag. 2.3.6 (b)), this will have been caused by the inductance of L1 being too great.

TABLE 2.3.4

FREQ.	SIGNAL GENERATOR	OSCILLOSCOPE		CT202	OSCILLOSCOPE
(1) Mc/s	(2) Crystal current (µA) corresponding to 100 mV (as marked on Sig. Gen.) into 75 ohms. (Toggle-switch SA "on" i.e. depressed.)	(3) Peak-to-peak in millimetres. (Toggle-switch SA "off".) 10% AM	(4) 20% AM	(5) Crystal current (µA) for max. output of CT202. (Toggle-switch SA "on".)	(6) AM on FM Peak-to-peak in millimetres. (Toggle-switch "off".) CT202 giving a crystal current equal to that of Sig. Gen. set to 100 mV
10	10.0	20	40	More than 12.5	18
15	10.0	20	40	12.5	16
20	10.0	20	40	10.0	10
30	10.0	20	40	10.0	8
40	10.0	20	40	11.5	4
50	9.8	19	38	12.0	6
60	9.8	19	38	12.0	12
70	9.8	19	38	12.0	16

NOTE:- The term "peak-to-peak" in this table means the difference between the highest and lowest points on the waveform (h in Diag. 2.3.6).

AM on FM around 10 or 15 Mc/s may be found to be outside of specification as a result of an excessive dip at the right-hand end (Diag. 2.3.6 (b)) which may be lower than the left-hand end. (The diagram shows the more usual condition where the right-hand end is higher than the left-hand end.) This is caused by the inductance of L1 being too small. A compromise is thus sought to obtain a reasonably linear 10 Mc/s sweep whose AM on FM is within specification. In practice, it will be found that a little experience will enable L1 and RV3 to be speedily adjusted.



DIAG. 2.3.6. TRACES OBTAINABLE WHEN MEASURING AM ON FM

(c) It has also been found that the results obtained at the high frequency end depend slightly on the length of cable used between the CT202 OUTPUT and the special amplifier, and to obtain consistent results a coaxial cable 18 in. long is used for all test purposes. This lead should be kept for test purposes only.

<u>OVERALL CHECK OF ADJUSTMENT OF OSCILLATORS V2 AND V4b AND CALIBRATION OF CARRIER TUNING</u>

42. <u>Test Rig</u>: As Diag. 2.3.5. Signal Generator output is fed to INPUT No. 2 (PLB)

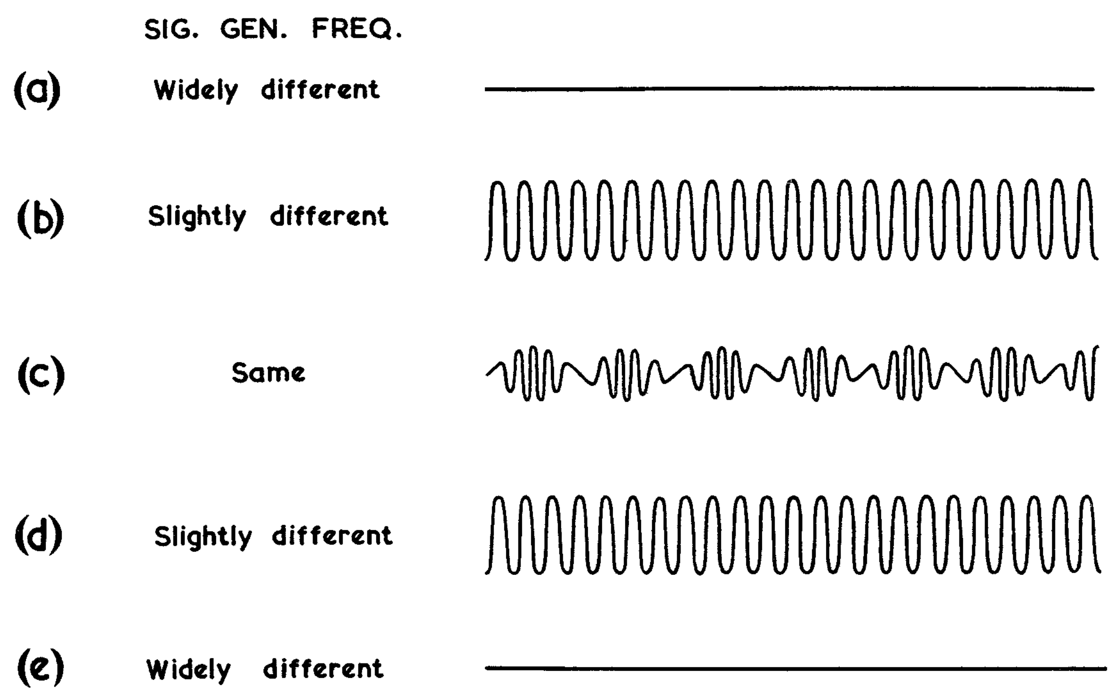
43. <u>Apparatus Required</u>: As Part 2, Chap. 3, Para. 34.

44. <u>Accuracy of Carrier Tuning Calibration</u>

The method consists in applying the unmodulated output of the CT202 (set to a spot frequency), together with the unmodulated output of the signal generator, to the crystal of the special amplifier; the crystal acts as a mixer and produces a beat-frequency output which is observed on the oscilloscope. When the two RF frequencies are the same a zero beat is obtained but, in practice, the trace obtained is as (c) in Diag. 2.3.7. The object of having a separate INPUT No. 2 for the signal generator is the prevention of pulling between signal generator and CT202 and this is effected by R1 in the special amplifier.

(a) Set Swept Bandwidth of CT202 to zero, Carrier Tuning to 15 Mc/s, ATTENUATOR RANGE at Position 4, ATTENUATOR FINE fully clockwise. Connect CT202 output to INPUT No. 1 (PLA) of special amplifier. (This connection will already have been made if the present check follows on from the preceding tests.)

(b) Set signal generator to 100 mV C.W. (or, if necessary, use the 1 volt output) at 15 Mc/s and connect by a suitable RF lead to INPUT No. 2 (PLB) of the amplifier and slowly tune signal generator about 15 Mc/s until a beat is visible on the oscilloscope trace. Tuning the signal generator through this beat position should result in traces shown in Diag. 2.3.7 (a) (b), (c), (d), (e) as the frequency is progressively changed. The condition (c) is the required one and the frequency of the signal generator should be noted and inserted in Line 2 of Table 2.3.5.



DIAG. 2.3.7. CHECKING CARRIER TUNING FREQUENCY

TABLE 2.3.5

COMPARISON OF CARRIER TUNING CALIBRATION WITH SIG. GEN. FREQUENCY

(1)	CT202 Carrier Tuning Mc/s	7	10	15	20	30	40	50	60	70
(2)	Signal Generator Mc/s									

(c) Set Carrier Tuning control to the other frequencies in Table 2.3.5 and insert the appropriate signal generator frequencies in Line 2. (Some signal generators will not go down to 7 or 10 Mc/s.)

(d) On no frequency should the difference between Lines 1 and 2 be more than 2 Mc/s.

(e) If adjustments of V4b and V2 frequency (Part 2, Chap. 3, Paras. 8 et seq. and 20 et seq.) have been correctly performed, the calibration should be within the limits specified above. If errors greater than 2 Mc/s occur, the adjustments mentioned should be repeated: if adjustments are necessary to the frequency of V2, the section beginning at Part 2, Chap. 3, Para. 33 should also be repeated.

RESISTANCE CHECK OF ATTENUATOR UNIT A.P.61219 AND OF THE -3 dB AND -6 dB SWITCH ATTENUATOR

45. Apparatus Required: Resistance Bridge for resistors in range 10 ohms to 1000 ohms with accuracy not worse than 0.5 per cent, or Bridge Megger A.P.6496.

-3 dB AND -6 dB SWITCH ATTENUATOR

46. This has already been tested under RF conditions in Part 2, Chap. 3, Para. 30 et seq. If the performance was satisfactory no further check is required, but if errors were apparent the following tests should be performed:

(a) Remove the earth connection of RV4, R21 and R23.

(b) Check resistance values of RV4, R21, R20, R22 and R23 against the Component List in Appendix "A".

NOTE:- It is important that resistors should not be overheated during soldering and that, if replaced, they should be fixed in the same physical position as previously. Check values of all replacement resistors (before insertion) with due regard to the specified tolerance limits given in list of components (Appendix "A").

ATTENUATOR UNIT A.P.61219

47. This unit is contained in a die-cast aluminium case inside the silver-plated attenuator box. The checking procedure is as follows:-

(a) With the OUTPUT switch SWC in the NORMAL position, make separate checks of the resistance between the centre pin of the OUTPUT plug PLB of the CT202 and earth with the ATTENUATOR RANGE Switch A:SWA in positions 1, 2, 3 and 4. In each position the resistance should be 72 ohms ± 3 ohms.

(b) Check that the resistance between the centre pin of the OUTPUT plug PLB and earth is 1082 ohms ± 15 per cent in both off positions of ATTENUATOR RANGE Switch A:SWA (i.e. within the limits 920 ohms and 1244 ohms).

(c) With ATTENUATOR RANGE Switch in Pos. 1 check that the resistance between the centre pin and earth of the MARKER plug PLC is 75 ohms ± 15 per cent (i.e. within the limits 64 ohms and 86 ohms).

(d) If either (a) or (b) are found to be outside the tolerance, disconnect the lead from A:SWA to L6 and also the lead from SWC to the attenuator unit A.P.61219.

(e) Check the resistance between the output lead from A:SWA and earth with the ATTENUATOR RANGE switch A:SWA in positions 1, 2, 3 and 4 in turn. The values should (within 2 per cent) be Pos. 1: 75 ohms, Pos. 2: 75 ohms, Pos. 3: 85 ohms, Pos. 4: 826 ohms.

(f) Replace any defective resistor by a new resistor whose value must be measured and must come within the required tolerance (see List of Components, Appendix "A"). Great care is necessary when soldering to prevent the undesirable overheating of resistors. Recheck.

(g) Inspect cover plates to ensure that all faces are clean and that screws are clean, tight and locked.

CONCLUSION

48. The alignment and calibration procedure has been given for a complete overhaul of the equipment, but, in general, only the section that has been repaired will need recalibration. Sufficient information is contained in Part 2, Chap. 3 to cover all requirements. However, to ensure "as new" condition, tests given in Sections beginning with Part 2, Chap. 3, Paras. 30, 33, 42, 45 and 47 must be performed on all CT202's being accepted for operational use.

49. Only operational experience can determine how often a complete recalibration will be needed, but though Part 2, Chap. 3 appears rather long it will be found that after a certain amount of experience the whole procedure takes less than two hours.

50. Valve selection is not normally necessary but, owing to the extremely wide tolerances of the CV858, it may be found occasionally that in the case of either V1 or V2 an "awkward" valve may be encountered and give either a restricted sweep or excessive AM on FM at 10, 60 and 70 Mc/s.

51. If the normal setting-up procedure does not give the correct results it is easier to substitute another valve.

52. The RF output voltage of the CT202 when terminated in 75 ohms (the normal input impedance of an IF amplifier) should exceed 100 mV. However, as a result of inaccuracies in measurement, and possible use of valves with parameters near their tolerance limits it may occasionally be found that the output may be as low as 90 mV. This is permissible; proportional changes should then be entered in Table 2.3.4.

53. AT ALL TIMES DURING CALIBRATION AND TEST THE MAINS VOLTAGE MUST BE CORRECT AND IT IS USUALLY MORE CONVENIENT TO USE A "VARIAC" SUPPLY WHICH CAN BE KEPT TO THE CORRECT VOLTAGE.

PART 2

CHAPTER 4

COIL WINDING DETAILS FOR CT202

INTRODUCTION

1. Inductors L1, L3 should be replaced by their patternised spares; L4, L5, L6, L7 should be wound as described in Para. 2(c), (d), (e) below.

WINDING DETAILS

2. For use in an emergency the following winding details are given:-

(a) Inductor L1 Diag. 2.4.1(a)

The inductor L1 consists of three turns of 24 S.W.G. enamel-covered wire close-wound, the start being close to the base.

Start tag 3

Finish tag 1

The former is an Aladdin Type PP 5938

The core " " " " PP 5839

(b) Inductor L3 Diag. 2.4.1(b)

The inductor L3 consists of $4\frac{1}{2}$ turns of 24 S.W.G. enamel-covered copper wire, spaced its own diameter. A tap is made $2\frac{1}{4}$ turns from the start by twisting the wire around tag 3 as shown in Diag. 2.4.1(b).

The start of the winding to be against the base of the former.

Start tag 6

Tap tag 3

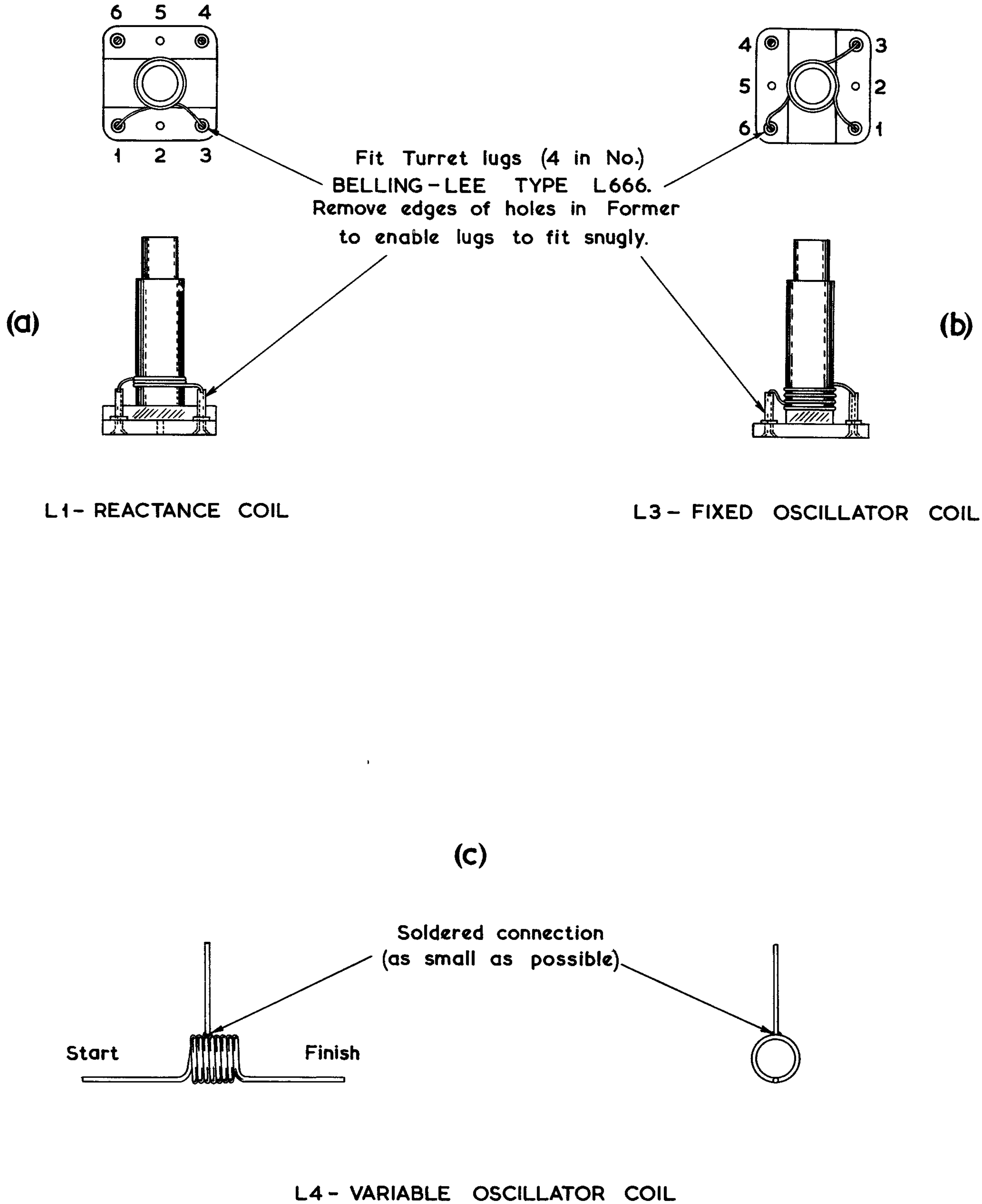
Finish tag 1

(c) Inductor L4

The inductor L4 consists of eight turns of 18 S.W.G. tinned copper wire space wound on $\frac{1}{4}$-inch diameter mandrel to an overall length of 19/32 inch. A tap at $3\frac{1}{2}$ turns from the start is made by soldering a $\frac{3}{4}$-inch length of 26 S.W.G. tinned copper wire at the tapping point (see Diag. 2.4.1(c)).

(d) Inductor L5 (RF choke)

The inductor L5 consists of three sections, each of 10 turns of 34 S.W.G. enamel-covered copper wire wound to fill one section of a 5-way tag strip Joint-Services Cat. No. Z560010 i.e. a total of thirty turns (see Diag. 2.4.2(a) on p. 60).



DIAG. 2.4.1. COIL DETAILS

(e) Inductors L6 and L7 (Low-pass output filter)

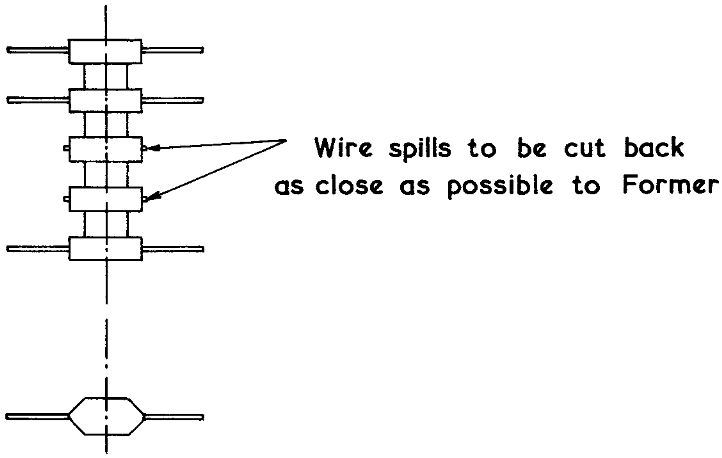
Inductors L6 and L7 consist of two identical sets of windings each of 5 turns of 26 S.W.G. enamel-covered copper wire, each inductor being wound on one section of a 6-way tag strip Z560010 (see Diag. 2.4.2(b) on p.60).

Approximate inductance of each section = 0.16 μH.

NOTE:- When wound, each choke or inductor except L4 should be treated with a protective varnish of approved standard.

(a)

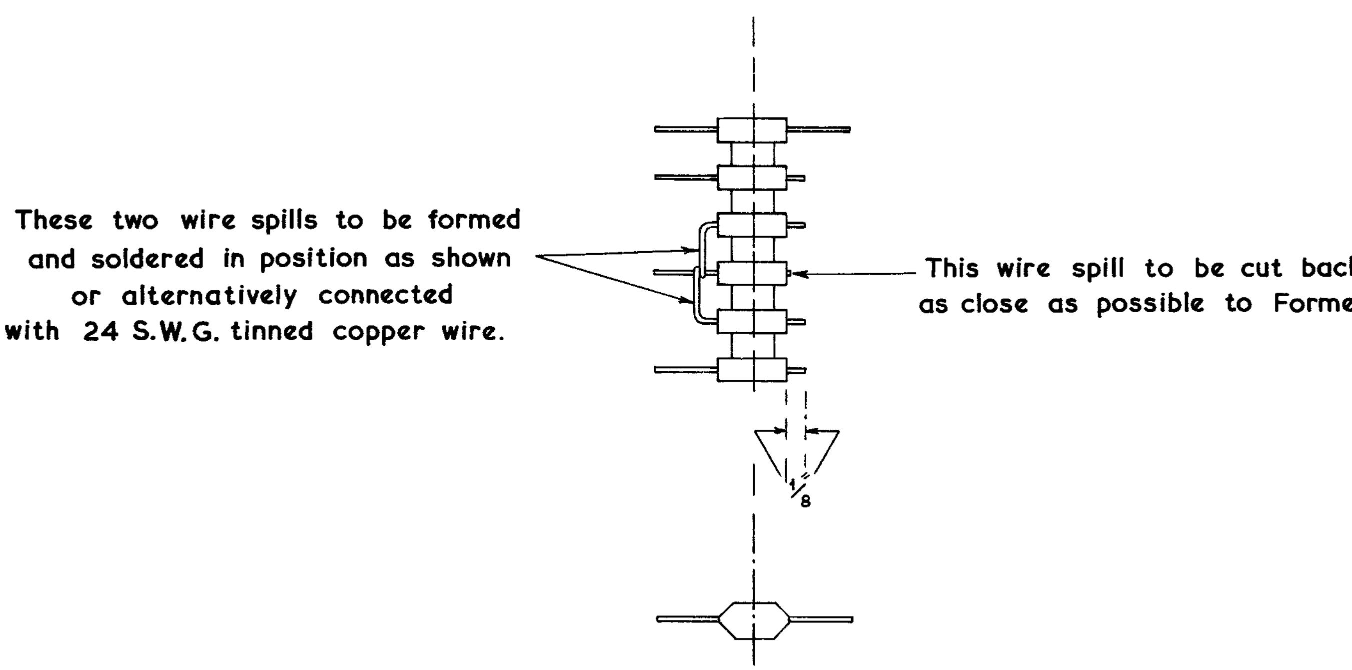
L5 – R.F. CHOKE



Five-way tag strip
(Z 560010 cut down)

(b)

L6 & L7 OUTPUT FILTER



Six-way tag strip
(Z 560010 cut down)

DIAG. 2.4.2. COIL DETAILS

APPENDIX "A"

A.P.61335, FREQUENCY-SWEPT-OSCILLATOR CT202

LIST OF COMPONENTS

NOTE:- A.P.61335 includes A.P.61219 Attenuator Unit Design 34, the components for which are listed separately.

RESISTORS

Circuit Ref. No.	Name	Joint-Services Cat. No.	Value	Tol.	Rating
R1	Resistor, Composition, Grade 2, insulated	Z223037	100K	± 10%	$\frac{1}{4}$W
R2	" " " " "	Z223091	270K	± 10%	$\frac{1}{4}$W
R3	" " " " "	Z223100	330K	± 10%	$\frac{1}{4}$W
R4	" " " " "	Z223059	150K	± 10%	$\frac{1}{2}$W
R5	" " " " "	Z221067	47 ohms	± 10%	$\frac{1}{4}$W
R6	" " " " "	Z222058	2.7K	± 10%	$\frac{1}{4}$W
R7	" " " " "	Z221194	470 ohms	± 10%	$\frac{1}{2}$W
R8	" " " " "	Z222172	22K	± 10%	$\frac{1}{4}$W
R9	" " " " "	Z222005	1K	± 10%	$\frac{1}{2}$W
R10	" " " " "	Z221194	470 ohms	± 10%	$\frac{1}{2}$W
R11	" " " " "	Z223205	2.2M	± 10%	$\frac{1}{4}$W
R12	" " " " "	Z223091	270K	10%	$\frac{1}{4}$W
R13	" " " " "	Z222172	22K	± 10%	$\frac{1}{4}$W
R14	" " " " "	Z221109	100 ohms	± 10%	$\frac{1}{4}$W
R15	" " " " "	Z222005	1K	± 10%	$\frac{1}{2}$W
R16	" " " " "	Z222172	22K	± 10%	$\frac{1}{4}$W
R17	" " " " "	Z221172	330 ohms	± 10%	$\frac{1}{4}$W
R18	" " " " "	Z221067	47 ohms	± 10%	$\frac{1}{4}$W
R19	" " " " "	Z222232	1.8K	± 10%	1W
R20	Resistor, Composition, Grade 1	Z215376	68 ohms	± 2%	$\frac{1}{4}$W
R21	" " " "	Z215221	680 ohms	± 5%	$\frac{1}{4}$W
R22	" " " "	Z215376	68 ohms	± 2%	$\frac{1}{4}$W
R23	" " " "	Z215460	180 ohms	± 2%	$\frac{1}{4}$W
R24	Resistor, Composition, Grade 2 insulated	Z222004	1K	± 10%	$\frac{1}{4}$W
R25	" " " " "	Z221100	82 ohms	± 10%	$\frac{1}{4}$W
R26	" " " " "	Z223058	150K	± 10%	$\frac{1}{4}$W

POTENTIOMETERS

Circuit Ref. No.	Name	Joint-Services Cat. No. or A.P.	Value	Tol.	Rating
RV1	Resistor, Variable, Composition	Z262942	2.5M ohms	± 20%	$\frac{3}{4}$W
RV2	" " "	Z262551	0.5M ohms	± 20%	$\frac{3}{4}$W
RV3	" " Wirewound	Z272410	50K	± 10%	1W
RV4	" " "	A.P.61663	125 ohms	± 10%	1W

CAPACITORS

Circuit Ref. No.	Name	Joint-Services Cat. No. or A.P.	Value	Tol.	Rating
C1	Capacitor, Ceramic	A.P.61665	1000 pF	- 0 + 100%	
C2	" "	A.P.61666	1000 pF	± 20%	
C3	" Paper	Z112825	8 µF	± 20%	400V
C4	" Ceramic	A.P.61666	1000 pF	± 20%	
C5	" "	A.P.61665	1000 pF	- 0 + 100%	
C6	" Paper	Z112825	8 µF	± 20%	400V
C7	" Ceramic	A.P.61665	1000 pF	- 0 + 100%	
C8	" "	Z132289	47 pF	± 10%	500V
C9	" "	A.P.61665	1000 pF	- 0 + 100%	
C10	" "	A.P.61665	1000 pF	- 0 + 100%	
C11	" "	A.P.61665	1000 pF	- 0 + 100%	
C12	" "	A.P.61666	1000 pF	± 20%	
C13	" "	Z132253	10 pF	± 10%	500V
C14	" "	Z132264	1.5 pF	± $\frac{1}{2}$ pF	500V
C15	" "	Z132264	1.5 pF	± $\frac{1}{2}$ pF	500V
C16	" "	Z132264	1.5 pF	± $\frac{1}{2}$ pF	500V
C17	" "	A.P.61666	1000 pF	± 20%	
C18	" "	A.P.61665	1000 pF	- 0 + 100%	
C19	" "	Z132253	10 pF	± 10%	500V
C20	Capacitor, 2 section, split stator	A.P.61664	2 x 15.6 pF		
C21	Capacitor, Ceramic	A.P.61666	1000 pF	± 20%	
C22	" "	Z132289	47 pF	± 10%	500V
C23	" "	A.P.61666	1000 pF	± 20%	
C24	" "	A.P.61665	1000 pF	- 0 + 100%	
C25	" "	A.P.61666	1000 pF	± 20%	
C26	" "	A.P.61665	1000 pF	- 0 + 100%	
C27	" "	Z132285	39 pF	± 5%	500V

TRANSFORMERS AND CHOKES

Circuit Ref. No.	Name	A.P.	Value	Tol.	Rating
TR1	Mains transformer	A.P.62229	-	-	-
L2	Smoothing choke	A.P.62230			
L1	Reactance coil	A.P.63453			
L3	F.M. oscillator coil	A.P.63454			
L4	Variable oscillator coil	See text Part 2 Chap. 4			
L5	RF Choke	"			
L6) L7)	Low-pass filter chokes	"			

MISCELLANEOUS

Circuit Ref. No.	Name	Joint-Services Cat. No. or A.P.	Value	Tol.	Rating
ILP1	Pilot lamp bulb	X951148	8V 0.15A		
-	Pilot lamp holder	A.P.W6547A			
X	Terminal	A.P.W7483			
E	"	A.P.W7483			
SWA	Switch 2 S.R.P.B. Wafers 4 pole 8 way	A.P.61667			
SWC	Switch 1 S.R.P.B. Wafers 1 pole 3 way lever operated	A.P.61668			
SWB	Switch toggle	Z510302			
-	Dust core as used in L1 and L3 (2)	A.P.63452	2 in No.		
PLA	Plug fixed Plessey Mark IV	Z560565			
PLB	Plug fixed coaxial	Z560045			
PLC	" " "	Z560045			
FS1)	Fuse link 1 amp	Z590109	1A		
FS1)	Fuse holder	Z590100			
FS2)	Fuse link 2 amp	Z590110	2A		
FS2)	Fuse holder	Z590100			
FS3)	Fuse link 1 amp	Z590109	1A		
FS3)	Fuse holder	Z590100			
FS4)	Fuse link 2 amp	Z590110	2A		
FS4)	Fuse holder	Z590100			
	Knob finger adjustable	Z970173	2 in No.		
	" " non adjustable	Z970181			
	Frame for Knob adjustable 3 in No.	Z970183			
	Retaining cap for Knob adjustable 3 in No.	Z970184			
	Knob finger adjustable	Z970189			

MISCELLANEOUS (Contd.)

Circuit Ref. No.	Name	Inter-Service Cat. No.	Remarks
	Knob finger	10A/12168	Use on A.P.61219 A:SWA
	Knob with lock device	A.P.61218	Use on RV1
Attenuator	Attenuator Unit Design 34	A.P.61219	
	Strap webbing	A.P.5890	
	Valveholder B7G Grade 1 Class H1	Z560092	2 in No. (Used on V3 and V5)
	Valveholder B7G Grade 1 Class H1	A.P.61142	2 in No. (Used on V1 and V2)
	Valveholder B7G Grade 2 Class H2	Z560132	1 in No. (Used on V6)
	Valveholder B9A Grade 1 Class H1	Z560134	1 in No. (Used on V4)
	Valve retainer B7G	A.P.61456	2 in No. (Used on V1 and V2)
	Valve screen B7G	Z563004	2 in No. (Used on V3 and V5)
	Valve screen B9A	Z563008	
	Valve retainer	Z970291	Used on V6
V1	Double triode	CV858 CV4031*	
V2	" "	CV858 CV4031*	
V3	" "	CV858 CV4031*	
V4	" "	CV455 CV4024*	
V5	" "	CV858 CV4031*	
V6	Rectifier F.W.	CV493 CV4005*	
	Connector flexible screened	A.P.67384	Mains lead
	Connector flexible screened 5 ft long with Z560044 socket and A.P.W5845 croc. clips	A.P.61669	RF lead
	Connector flexible screened 5 ft long with Z560044 sockets	A.P.61670	RF lead
	Connector flexible screened 7 ft long A.P.W7484/5 spade terminals and A.P.W5845 croc. clips	A.P.61671	(X sweep from oscilloscope)

* Indicates the reliable versions of the valves.

ATTENUATOR UNIT A.P.61219

Circuit Ref. No.	Name	Joint-Services Cat. No.	Value	Tol.	Rating
A.R1	Resistor, Composition, Grade 1		92 ohms	± 2%	$\frac{1}{8}$W
A.R2	" " " "		92 "	" "	"
A.R3	" " " "		82.5 "	" "	"
A.R4	" " " "		743 "	± 1%	"
A.R5	" " " "		743 "	" "	"
A.R6	" " " "		743 "	" "	"
A.SWA	Switch, integral part of A.P.61219	-	-	-	-

APPENDIX "B"

LIST OF ALTERNATIVE INSTRUMENTS

INTRODUCTION

1. The Frequency-Swept-Oscillator CT202 is one of the earlier C.N.R.T.E. instruments and it will, therefore, be in service before many of the other instruments with which it should normally be used and calibrated.

2. For this reason, though the text of this handbook is written having C.N.R.T.E. instruments in mind, the most suitable ancillary instruments are not necessarily available to Dockyards and Depot Ships.

3. The following Table APPENDIX "B" (p.70) has been compiled to give the nearest commercial alternative, or the nearest existing Service equivalent. It must be realised, however, that in many cases the existing Service or commercial instrument will have a more restricted range and a reduced accuracy.

TABLE APPENDIX "B"

Suggested Service Instrument	Nearest Commercial or Service Alternatives	Remarks on Alternatives
Oscilloscope A.M. Type 13A (10S/831)	(a) Cossor Double-beam (A.P.W3336A or 10SB/180) (b) Miniature Oscilloscope CT52, A.P.68622	Is being superseded Single-beam tube only
Signal Generator XT42 (WD3942)	Marconi Instruments TF995A/1) " " TF995A) " " TF948) same instrument XT41) Signal Generator A.P.54705 (10 to 150 Mc/s)) " " A.P.W5001A (150 to 300 Mc/s))	Cover frequency-range Restricted frequency-range (20-80 Mc/s) May be used together to cover frequency-range. It will not be possible to perform some tests in Part 2, Chap. 3.
Signal Generator CT218 (formerly XT40)	Marconi TF144G) Signal Generator A.P.54704) " " A.P.54704A) Test oscillator CT212 ZD00784	Lower accuracy and less control of amplitude-modulation level, etc.
Attenuator RF 0-9 dB (accuracy ± 0.1 dB at 60 Mc/s)	STC Type 74600A Marconi Instruments TF1073	Covers wider frequency-range Covers wider range of attenuation and frequency Both substitutes sufficiently accurate

APPENDIX "C"

ADDITIONAL USE OF THE FREQUENCY-SWEPT-OSCILLATOR CT202 FOR THE ALIGNMENT OF VERY-WIDE-BAND AMPLIFIERS

1. The maximum permissible sweep of the CT202 is 10 Mc/s and a completely different design of circuit would be required to increase this sweep appreciably. However, it is possible to use the CT202 to obtain some idea of the bandwidth and response-curve shape of very-wide-band IF amplifiers (up to 18 Mc/s) by using the following method. In essence the method consists in displaying half the response-curve at a time. The frequency at the -3 dB (or -6 dB) point on one half is measured by the marker-pip method using a signal generator; the frequency at the corresponding point on the other half is then similarly measured, and the difference between these frequencies will give the approximate bandwidth. The procedure is as follows:

2. Set up the CT202 as described in Part 2, Chapter 1, Para. 1 et seq. The complete response-curve cannot be displayed and the true centring of the marker-pip is thus impossible. The signal generator is set to the nominal midband IF frequency of the IF amplifier.

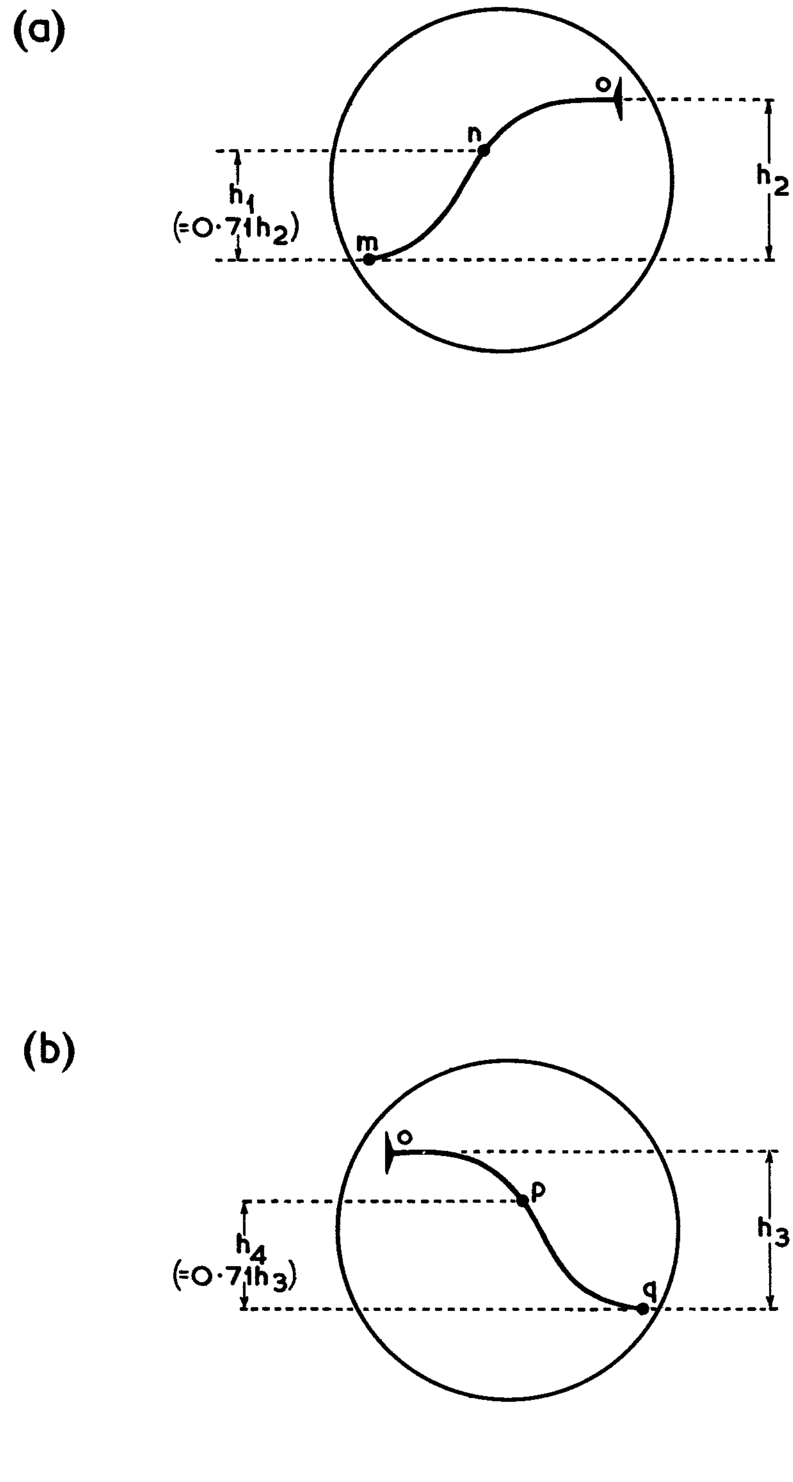
3. Adjust the Carrier Tuning of the CT202 until one-half of the response-curve is displayed, the marker-pip being at the right-hand end of the trace. The display should now resemble Diag. Appendix "C" (a). Measure and record the height h2 in millimetres and mark in ink (on the graticule) a point n on the curve so that the height h1 = 0.7h2. (This applies to bandwidth measured between -3 dB points; if -6 dB points are desired h1 should be 0.5h2.) Alter the frequency of the signal generator until the marker-pip coincides with point n and note the frequency; call this f1. Return the marker-pip to its original position by changing the frequency of the signal generator.

4. Adjust the Carrier Tuning so that the other half of the response-curve is displayed, the marker-pip now being at the left-hand end of the trace. The display should now resemble Diag. Appendix "C" (b) and the amplifier gain of the oscilloscope should be adjusted to ensure that the height h3 is equal to the height h2 of Para. 3 above. (The readjustment of gain is necessary because of AM on FM sweep.) Mark in ink (on the graticule) a point p on the curve so that the height h4 = 0.7h3 (or 0.5h3 if -6 dB points are desired). Alter the frequency of the signal generator until the marker-pip coincides with point p and note the frequency; call this f2.

5. The approximate bandwidth is the difference between f1 and f2.

<u>NOTE</u>:- This method gives a reasonable approximation of the bandwidth but is obviously more inaccurate than the normal method of measuring narrower bandwidths which permits the display of the whole response-curve.

ON NO ACCOUNT SHOULD THIS METHOD BE USED IF ACCURATE RESULTS ARE DESIRED.



DIAG. APPENDIX "C"

APPENDIX "D"

A.P.61335 FREQUENCY-SWEPT-OSCILLATOR CT202

AMPLIFIER USED TO MEASURE

AM ON FM AND RF OUTPUT LEVEL

LIST OF COMPONENTS

(See Diag. Appendix "D" for circuit)

RESISTORS

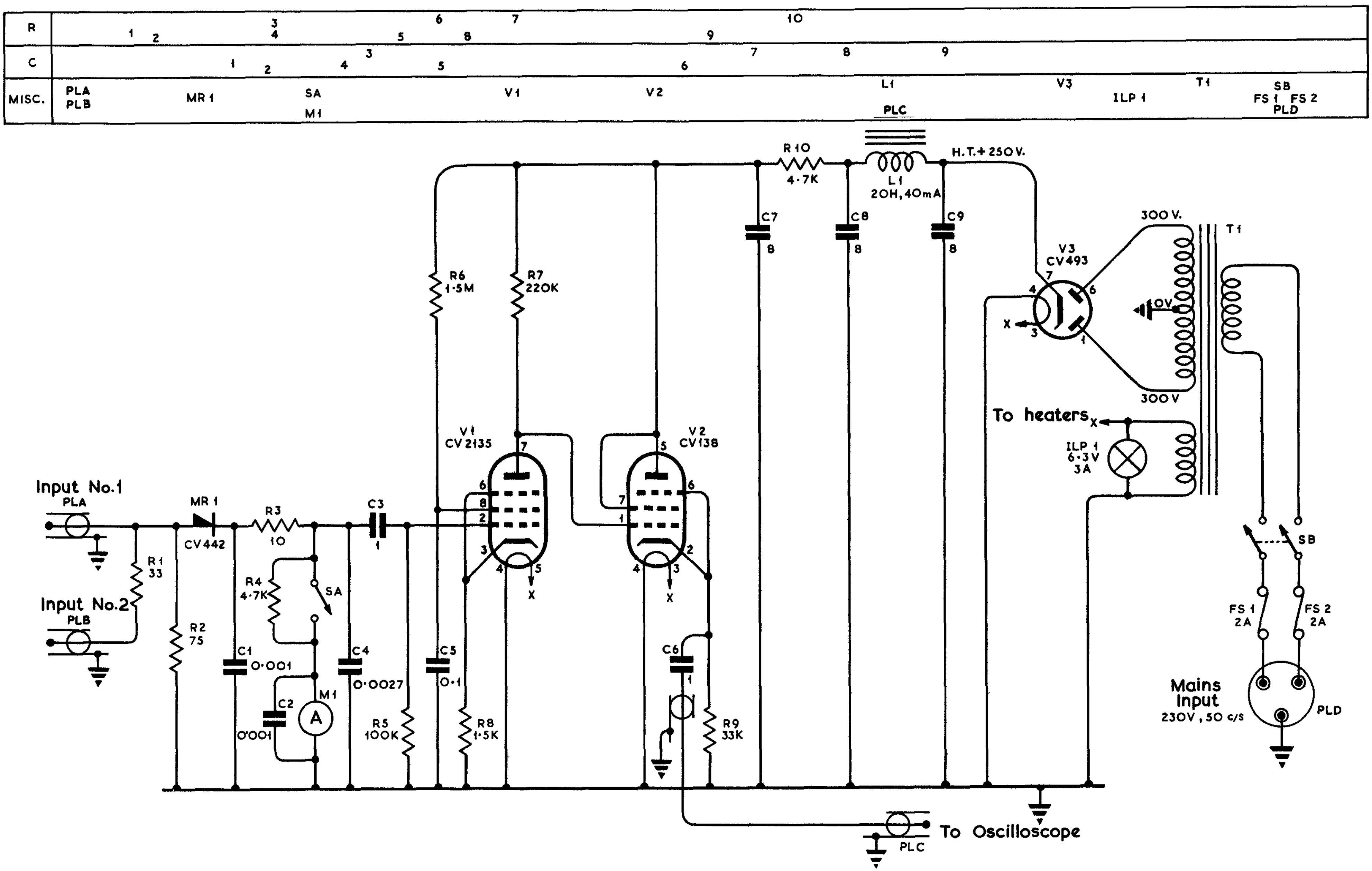
Circuit Ref. No.	Name	Joint-Services Cat. No.	Value	Tol. ± %	Rating (W)
R1	Resistor fixed, composition, Grade 2, ins.	Z221047	33 ohms	10	½
R2	" " " Grade 1, non ins.	Z215107	75 "	5	½
R3	" " " " 2, ins.	Z221002	10 "	10	½
R4	" " " " 2, "	Z222089	4.7K ohms	10	½
R5	" " " " 2, "	Z223038	100 "	10	½
R6	" " " " 2, "	Z223185	1.5 M	10	½
R7	" " " " 2, "	Z223080	220K ohms	10	½
R8	" " " " 2, "	Z222026	1.5 "	10	½
R9	" " " " 2, "	Z222247	33 "	10	1
R10	" " " " 2, non-ins.	Z212090	4.7 "	10	2½

CAPACITORS

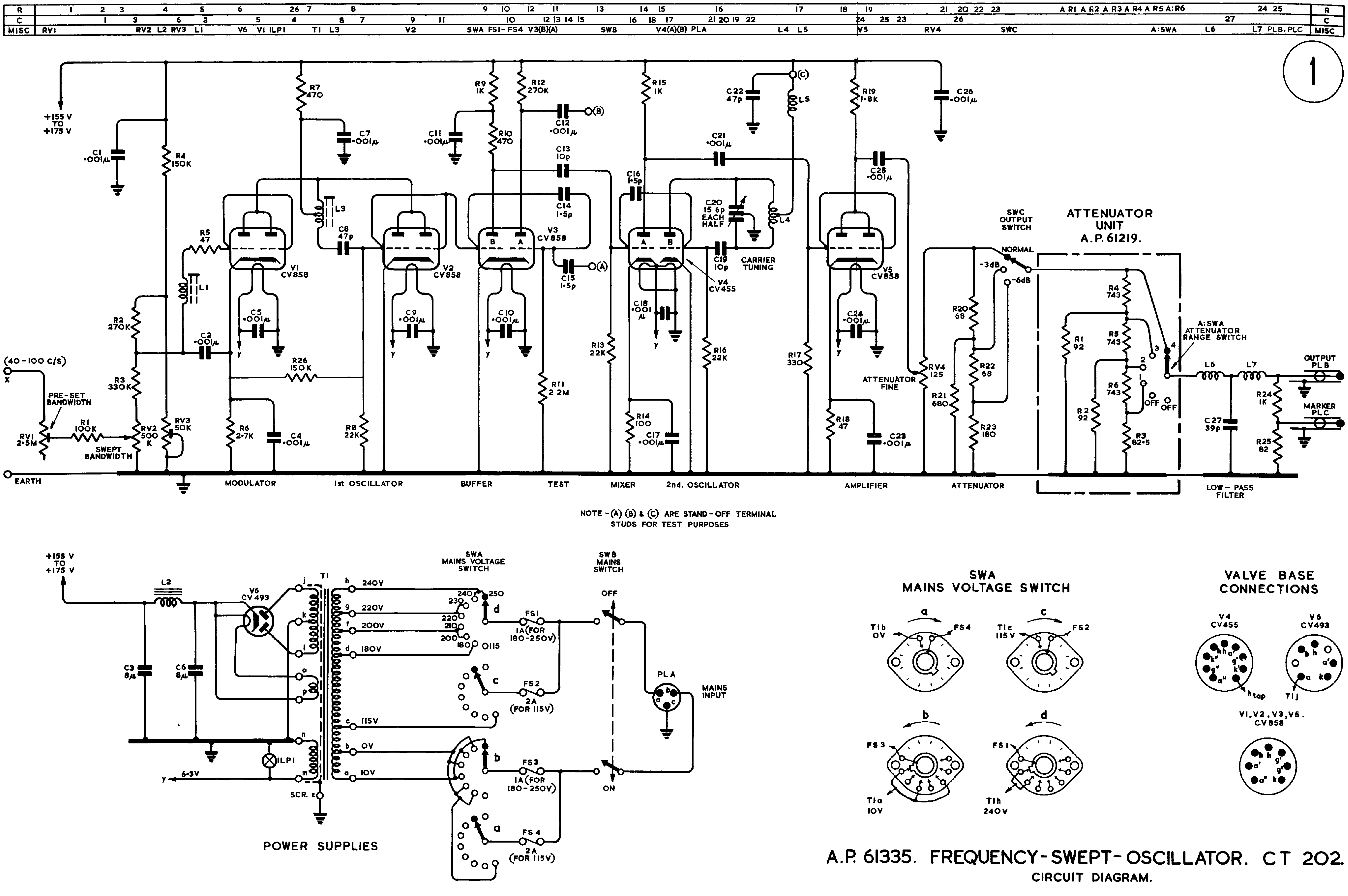
C1	Capacitor, ceramic, ins. HI-K	Z132630	1000 pF	20	350V
C2	" Mica, T.C.C.	Z124038	0.001 µF		
C3	" fixed, paper dielectric tubular metal case ins.	Z115571	1.0 µF	20	350V
C4	Capacitor, Mica Dubilier	Z124215	2700 pF		
C5	Cap fixed, paper dielectric, tubular metal case, ins.	Z115507	0.1 µF	20	350V
C6	Cap fixed, paper dielectric, tubular metal case, ins.	Z115571	1.0 µF	20	350V
C7	Capacitor, fixed, paper, dielectric, Rectangular metal case	Z112825	8 µF	20	400V wkg.
C8	Capacitor, fixed, paper, dielectric, Rectangular metal case	Z112825	"	20	"
C9	Capacitor, fixed, paper, dielectric, Rectangular metal case	Z112825	"	20	"

MISCELLANEOUS

Circuit Ref. No.	Name	Inter-Service Cat. No.	Value
T1	Transformer, 230V, 50 c/s, 300V-0-300V 40 mA 6.3V, 3A	W4621	
L1	Choke, 20H 40 mA	W1400	
M1	Meter, 12.5-0-12.5 μA	W1488	
SA	Toggle-switch	A.P.W1511A	
SB	Switch, Mains ON/OFF Switch	A.P.W4239	
ILP1	Lampholder	A.P.W6766	
PLD	Mains Input Plug	Z560565	
PLA	Input Plug 1 Burndept	Z560045	
PLB	Input Plug 2 Burndept	Z560045	
PLC	Output Plug, Burndept	Z560045	
FS1	Fuse 2A		
FS2	" "		
MR1	Valve	CV442	
V1	Valve	CV2135/4006	
V2	"	CV138/4014	
V3	"	CV493/4005	
	Valveholder B7G (for V1)	Z561156	
	" " (for V2)	Z561156	
	" B9A (for V3)	Z560135	



DIAG. APPENDIX "D"



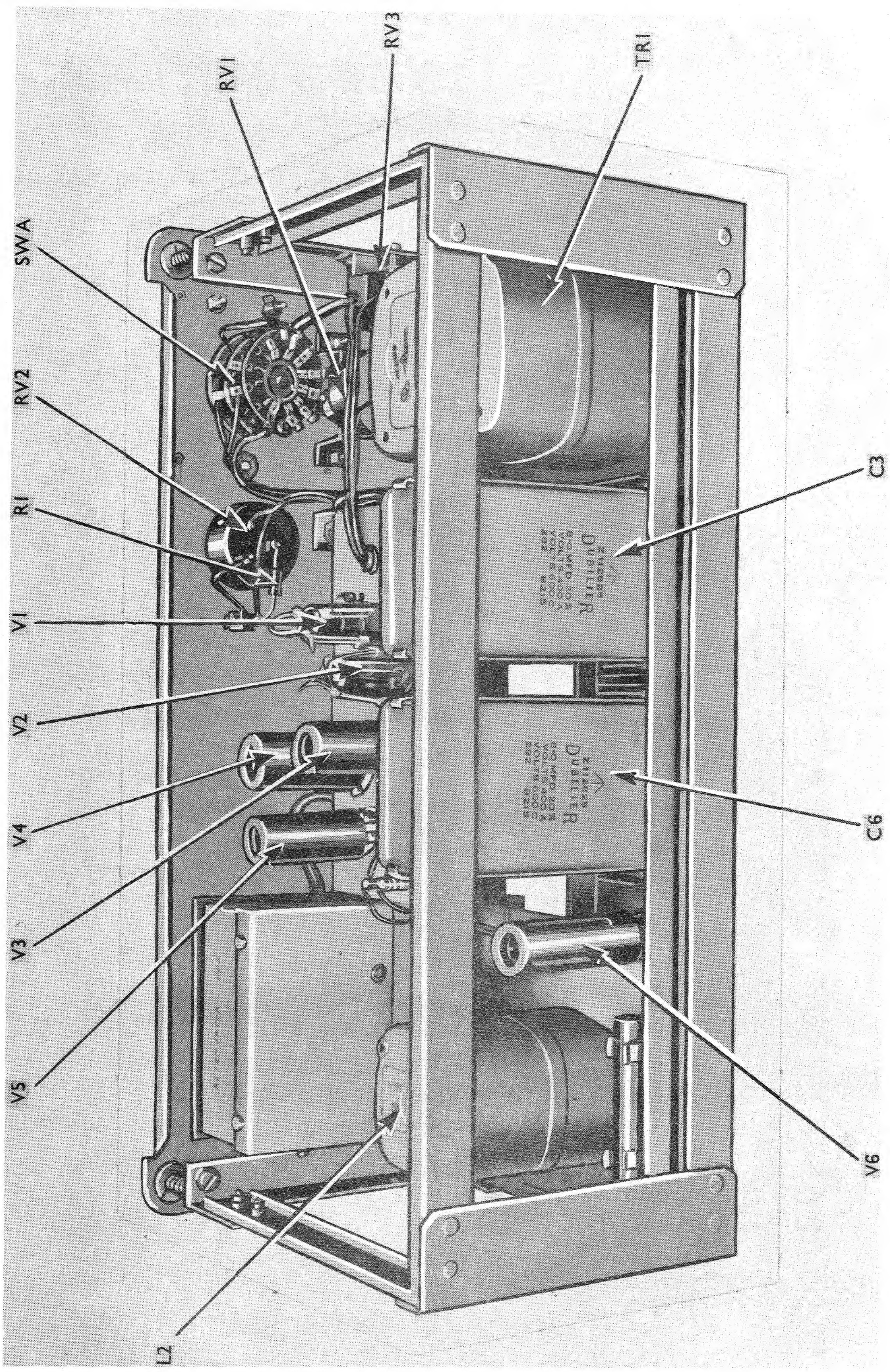
A.P. 61335. FREQUENCY - SWEPT - OSCILLATOR. CT 202.

CIRCUIT DIAGRAM.

FREQUENCY–SWEPT–OSCILLATOR CT 202

2

TOP VIEW OF CHASSIS
COMPONENT LAYOUT

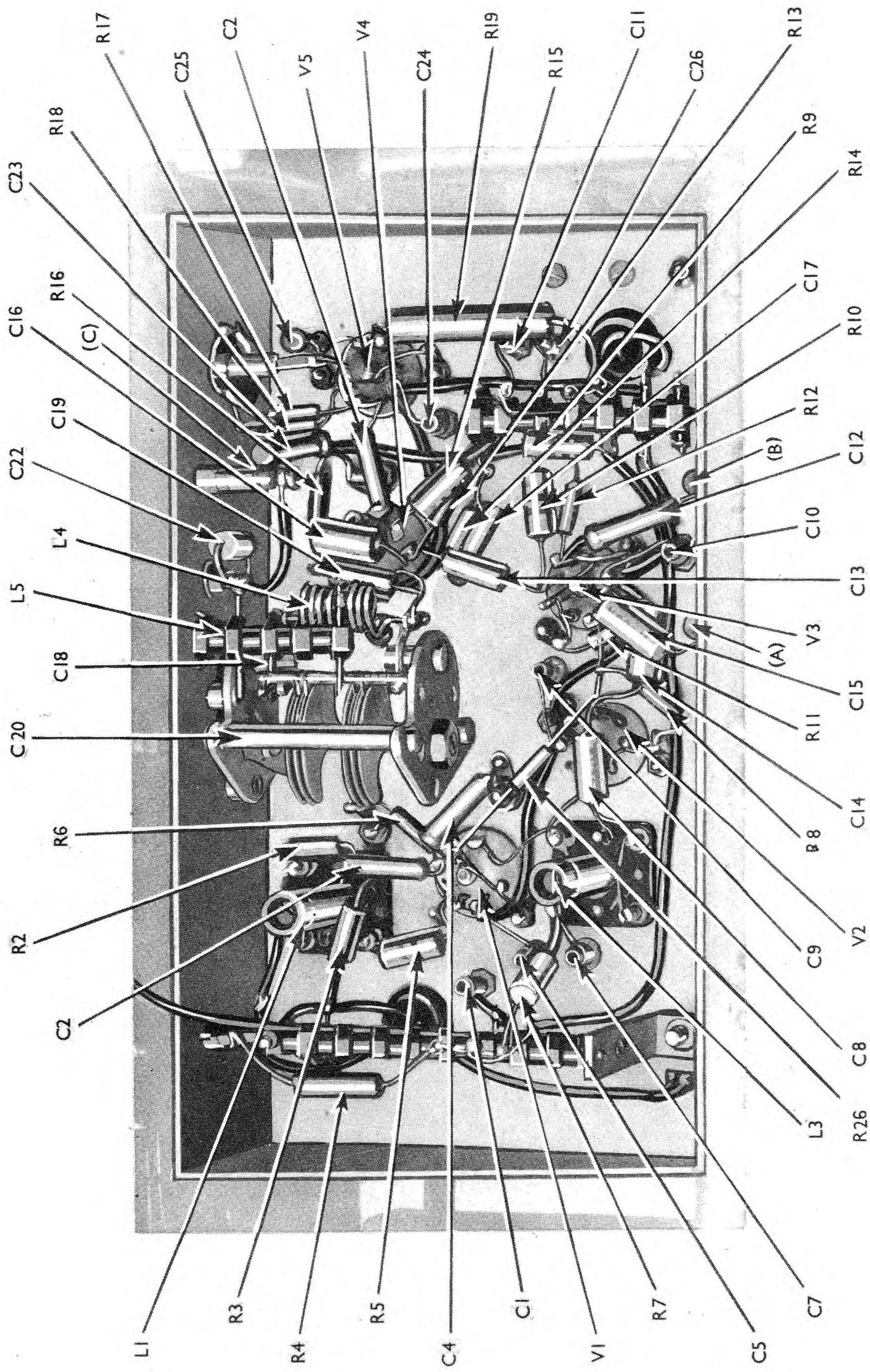


FREQUENCY–SWEPT–OSCILLATOR CT 202

R.F. CHASSIS

COMPONENT LAYOUT

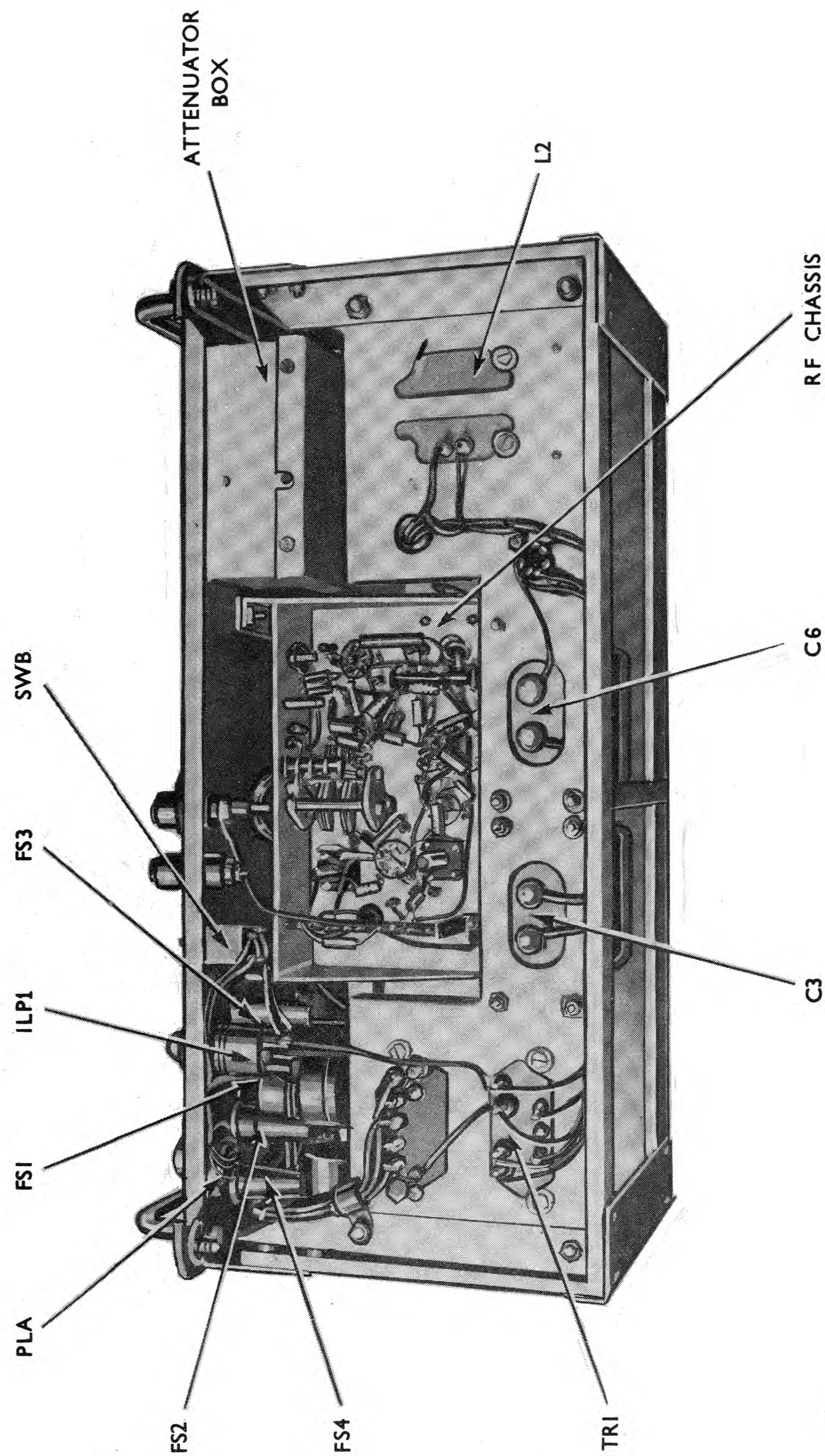
3



FREQUENCY-SWEPT-OSCILLATOR CT 202

UNDER – CHASSIS VIEW

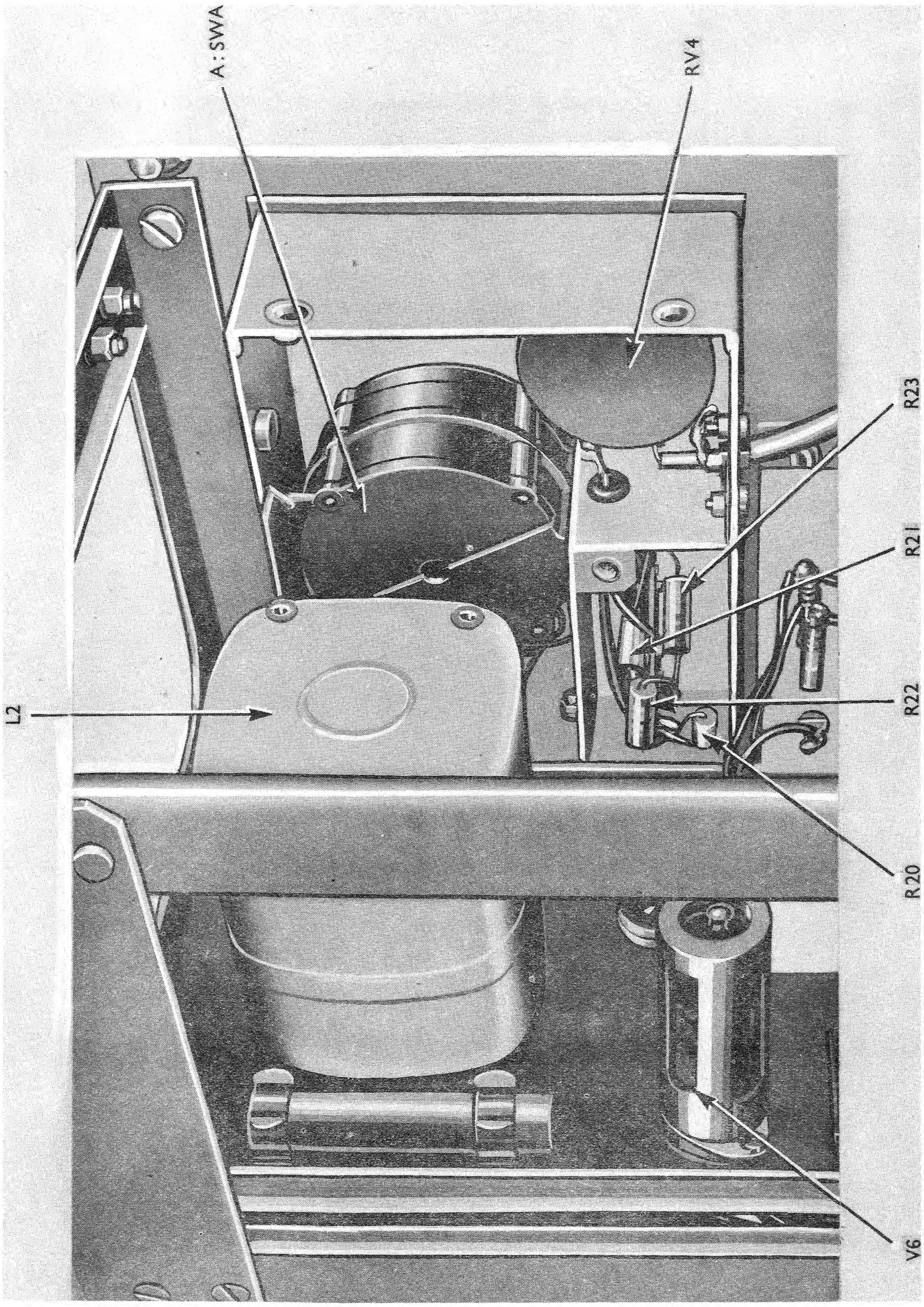
COMPONENT LAYOUT



FREQUENCY-SWEPT-OSCILLATOR CT 202

5

ATTENUATOR BOX ASSEMBLY
COMPONENT LAYOUT



NOTE:— R24, R25, L6, L7 AND C27 ARE ALL WITHIN THE ATTENUATOR BOX BUT ARE HIDDEN BY L2