(f) If the distortion is located to one stage, measure the heater, H.T., anode, screen, and cathode voltages, as detailed in Section 3.8.1 and 3.7.2.

(g) Measure the D.C. grid voltage as detailed in Section 3.7.2 with no signal applied. This should normally be zero, a positive voltage generally indicating a faulty coupling capacitor from the previous stage.

If the distortion is excessive high frequency response, proceed as (a) to (d) above, noting the voltage carefully at each side of the coupling capacitors. The A.C. voltage at the grid should be nearly as large as that at the previous anode. If it is not, the coupling capacitor is probably faulty. If a pentode output valve is used, the distortion may be due to a faulty shunt capacitor across the output transformer. Disconnect this capacitor to determine whether it is reducing the high frequency response.

If none of the above tests indicate the cause of the distortion, the detector should be examined. The only likely faults are defective valve, crystal rectifier, or load resistor. In each case the components are best checked by temporary substitution of a good component.

4.4.3 Excessive Hum

First ensure that the fault is mains hum and not picture break-through. Disconnect the aerial. If the hum disappears the fault is picture break-through. If it does not, turn the background control to minimum and stop the frame scan generator. On an A.C. set this can be achieved by removing the scan generator valve, but on an A.C./D.C. set it will be necessary to short-circuit the heater on this valve for a short period. If the hum now disappears the fault is low frequency break-through of the frame generator. If the hum persists it is due to the power supplies.

Possible causes:-

(a) Failure of the H.T. smoothing
(b) Faulty decoupling component
(c) Heater to cathode short-circuit in valve
(d) Open circuit grid on audio amplifier or output valves
(e) Faulty sound I.F. or sound detector circuit

Proceed as follows:-

(a) Connect the grid of the output valve to chassis with a short lead.

(b) If the hum persists change the output valve.

(c) If there is no improvement check the H.T. smoothing capacitors, either by disconnecting in turn to prove that the hum worsens when they are disconnected, or by connecting another capacitor in parallel and noting whether the hum is reduced.

(d) If the hum disappears when the grid of the output valve is connected to chassis, remove the short-circuit and repeat on the grid of the audio amplifier valve.

(e) If the hum remains, check the anode decoupling capacitor for the amplifier stage and the H.T. smoothing capacitors by connecting capacitors of similar rating in parallel.

(f) If this fails, check the grid resistor in the output stage by connecting a 1 megohm resistor from the grid of the output stage to earth.

(g) If on test (d) the hum disappears, the fault is in the input circuit of the audio amplifier.

(h) Change the audio amplifier valve.

(i) If this fails to remove the hum, replace the old valve, and check the grid circuit for open circuit connections or faulty screening on leads.

(j) If the cause of the hum is still not apparent, dis disconnect the lead from the detector to the 'live' end of the volume control.

(k) If the hum disappears, restore the connection, and earth the grid of the last valve in the sound I.F. amplifier. This will prove whether the trouble is on the detector or the I.F. amplifier. The valve on the I.F. amplifier causing the trouble should be located by the process of earthing the grid of each valve in turn.

4.4.4 Picture Break-through

Possible causes:-

(a) H.F. break-through due to misalignment of the sound amplifier.

(b) L.F. break-through due to coupling between the frame generator or amplifier, and the audio amplifier.

Proceed as follows:-

(a) Earth the grid of the last valve in the sound I.F. amplifier. If the hum disappears H.F. break-through exists. This may be due to misalignment, particularly if some misalignment has been intentionally introduced to avoid instability on the amplifier. The sound channel alignment should be checked as detailed in Section 3.4.2.

(b) If the hum remains, the most probable cause is coupling via the H.T. power supply. Check the decoupling capacitors on the frame time-base circuits and the audio amplifier, and the smoothing capacitors on the H.T. supply, by connecting additional capacitor of similar rating in parallel.

4.5 Poor Picture Reproduction

4.5.1 Picture Faint

Before removing the set from its case, manipulate the contrast and background controls, if possible using the B.B.C. transmission, if not, using the Pattern facility of the TeleVet as detailed in Section 3.5. It may be possible to produce a bright picture having incorrect contrast, in which case refer to Section 4.5.2. If the picture remains faint, even with the contrast and background controls at maximum, check whether a noise limiter is employed, and if so, rotate the preset control to determine whether incorrect adjustment is causing the picture to be faint. If these initial checks show that a fault exists, remove the set from its cabinet and apply the following tests.

Possible causes:-

(a) Faulty C.R. tube
(b) Low E.H.T. or heater voltage on C.R. tube
(c) Faulty video output stage
(d) Incorrect setting of noise limiter ('spotter') control.

Proceed as follows:-

(a) Connect the grid and cathode of the C.R. tube by means of a short length of wire. If a very bright raster is not obtained, measure the E.H.T. voltage on the final anode of the C.R. tube, and the heater voltage on the C.R. tube as detailed in Section 3.7.1 and 3.8.1. If these are both in order the tube is probably faulty. It should be noted that some C.R. tubes use a small magnet assembly round the neck of the tube to act as a deflector for an ion trap. If such a device is used, its adjustment should be checked before condemning the C.R. tube.

(b) If the C.R. tube becomes very bright when grid and cathode are connected together, remove the short circuit and measure the D.C. voltage between grid and chassis, and cathode and chassis, of the C.R. tube, using the procedure detailed in Section 3.7.2.

(c) The voltage between cathode and chassis should be greater than the voltage between grid and chassis, with the aerial disconnected.

(d) As the background control is turned clockwise the voltage difference should reduce to not more than 10 volts.

(e) Turn back the background control until the voltage difference is about 30.

(f) Connect the screened lead from Probe A to the aerial socket.

(g) Plug the flying lead of Probe A into the socket marked X0.01.

(h) Turn the R.F. OUTPUT control to maximum (clockwise).

(i) Set the CHECK switch at NORMAL.

(j) Set the SELECT switch at T.B. FRAME.

(k) Set the CENTRE FREQUENCY control at the vision carrier frequency.

(l) A C.W. signal will now pass through the vision chain and this should result in the voltage difference reducing to not more than 5.

(m) If either tests (d) or (e) fail to give the proper result, the D.C. couplings to the grid and cathode of the C.R. tube should be examined.

4.5.2 Contrast Incorrect

Inability to adjust background and contrast controls to give correct contrast may take two forms. If it is possible to turn up the contrast control to obtain full white, but impossible to adjust the background to obtain correct gradation between black and white, the background control is faulty. The operation of the background control should be checked by carrying out the tests (b), (c), and (d) of Section 4.5.1. Alternatively it may be possible to obtain full white by turning up the background control, but impossible to obtain contrast, even when the contrast control is at maximum. This indicates too low a sensitivity on the vision channel. The procedure for investigating this fault is given below.

Possible causes:-

(a) Faulty power supply
(b) Faulty frequency-changer
(c) Faulty R.F. stage
(d) Faulty aerial
(e) Faulty video amplifier
(f) Faulty vision I.F. amplifier

The first four possible causes will result in a drop in sound as well as picture sensitivity. First ascertain whether this is the case, if so, the fault should be treated as a fault on the sound channel and the procedure given in Section 4.4.1 adopted.

If the picture sensitivity alone is low, proceed as follows:-

(a) Disconnect the aerial and turn the background control to give a just visible dark grey raster.

(b) Disconnect the lead to the grid of the video amplifier. Connect the D.C.X10 and the A.C.X1 leads of Probe C to the input of the video amplifier, and the earth lead of Probe C to the chassis.

(c) Set the CHECK switch at NORMAL

(d) Set the SELECT switch at SOUND

(e) Set the Y GAIN switch at X1

(f) A bright mottled raster should be obtained. If the contrast range of the mottled raster does not extend from full white to black, the video amplifier is faulty.

(g) If a fully contrasting raster is obtained, the fault is on the vision I.F. or detector stage. Use the wobbulator as described in Section 3.3 to check each stage in turn.

4.5.3 Picture Incorrect Size

The picture may have either insufficient height, insufficient width, or be too small or too large while retaining the correct height to width ratio. The first two possibilities are due to faulty frame and line time-bases respectively. Tracing these faults is very much simplified if the manufacturers information on A.C. and D.C. voltages to be expected on the time-base circuits are available, since these voltages may be checked using the procedure detailed in Sections 3.8.1 and 3.7.2. If no such information is available, check that the linearity and amplitude controls of the faulty time-base are operating correctly. Note particularly what occurs when the amplitude control approaches maximum. If the height or width reaches a particular value, and thereafter any further rotation of the control causes a compression at the beginning or end of the scan, but no effective increase in height or width, the fault is overloading of the time-base output valve. The valve should be changed, and if this fails to effect a cure, the D.C. grid voltage, and anode, screen and cathode voltages should be measured, using the procedure details in Sections 3.8.1 and 3.7.2. If there is no evidence of compression when the height or width controls are turned to maximum the fault is probably in the time-base generator, and the following procedure should be adopted.

(a) Remove the aerial and note whether the width or height increases by an appreciable amount. If so, the fault is probably due to the time constant of the time-base generator becoming too long. The synchronising pulses will then fire the generator before the full sweep voltage has been obtained.

(b) If the amplitude does not increase sufficiently when test (a) is applied, change the time-base generator valve.

(c) If changing the valve fails to effect a cure, measure the heater and H.T. voltages of the time-base generator, using the procedure detailed in Sections 3.8.1 and 3.7.2.

Where the fault is an abnormally large picture, the cause will probably be found to be low E.H.T., and will be accompanied by decreased picture brightness and probably defocusing. Measure the E.H.T. voltage as described in Section 3.7.1.

Where the picture is small, but preserves the correct aspect ratio, the fault is probably low H.T. voltage on the time-base generators or time-base output valves. The voltage should be measured as detailed in Section 3.7.2.

4.5.4 Picture Distorted

Picture distortion will generally take one of the following forms:-

(a) Irregular white spots caused by interference. This may be proved by disconnecting the aerial. The only set fault which may cause this effect is a fault on the noise limiter which would make the interference more serious. This may best be proved by rotating the preset control associated with the vision noise limiter circuit, and checking whether this circuit is in fact reducing the effects of interference noise.

(b) A shimmering picture can be caused by poor synchronisation. This can be checked by observing the edge of the picture, which will be ragged if the trouble is due to poor synchronisation. This fault is dealt with in Section 4.6.3. A similar effect, if occurring only when sound is present, is due to sound break-through on the vision channel. The vision channel should be aligned using the procedure detailed in Section 3.3, particular attention being given to the correct adjustment of the sound rejector.

(c) A ghost picture, consisting of a secondary faint picture displaced to the right of the correct picture is caused by reflections which result in a delayed signal reaching the set. When tracing the cause of such reflection the fraction of the line width by which the image is displaced should be observed. One complete line width represents an additional path length for the received signal of about 17 miles.

(d) A white fringe on the right-hand side of black objects on the picture is caused by a resonance in the response of the vision receiver. This generally occurs in the vision I.F. amplifier. The procedure detailed in Section 3.3 should be adopted to re-align the amplifier.

(e) Distortion of the shape of objects is caused by faults on, or misadjustment of, the height, width, or linearity controls. Incorrect height and width have been dealt with in Section 4.5.3. Non-linearity can be checked by means of the pattern produced by the TeleVet, using the procedure detailed in Section 3.5. If readjustment of the linearity control fails to correct the distortion, reduce the picture size by turning down both height and width, and check whether adjustment is possible. If it is, the non-linearity is being introduced by the time-base output stage, which is overloading. The valve should be changed, and if this does not result in an improvement the D.C. grid voltage, and the anode, screen, cathode and heater voltages of the output should be measured using the procedure detailed in Sections 3.7.2 and 3.8.1.
If it is not possible to produce a smaller correctly proportioned picture the linearity control is probably faulty.
Trapezium distortion is usually caused by short-circuited turns on one of the deflector coils. Tapering towards one side is due to a faulty frame deflection coil, and tapering towards top or bottom is due to a faulty line deflection coil.

4.5.5 Picture Indistinct

By indistinct picture is meant a steady picture having correct size, correct gradations from full white to black, but blurred and indistinct outlines.

Possible causes:-

(a) Faulty focus on the C.R. tube
(b) Insufficient bandwidth on I.F. vision amplifier
(c) Insufficient bandwidth on video amplifier

Proceed as follows:-

(a) Check the focusing by manipulating the focus control. This will be a knob if a focusing coil is used, or a lever if a permanent magnet focusing system is employed. The control should be capable of being adjusted to an optimum point at some intermediate setting, which is not too close to the end of the range of adjustments in either direction.

(b) If the focusing control appears to be functioning correctly, check the response of the vision channel by means of the wobbulator as described in Section 3.3.

(c) If the bandwidth of the R.F. and I.F. vision amplifier is satisfactory check the load circuits of the vision rectifier and video amplifier for high value resistors or faulty inductors, either of which may reduce the effective high frequency response of the video amplifier.

4.6 Faulty Picture Synchronisation

4.6.1 No Synchronisation

If the frame lock only is failing it will generally be possible to see the picture moving either upwards or downwards, and this case is dealt with in Section 4.6.2. If the line lock is failing, a mottled raster should be obtained when a programme is received, or the pattern of the TeleVet is applied to the set as described in Section 3.5. This raster should contain the full contrast range from full white to black, and should disappear when the aerial is removed. If not the fault may not be faulty synchronisation, and reference should be made to Section 4.3.

Possible causes:-

(a) Faulty sync-separator
(b) Faulty time base generator

Proceed as follows:-

(a) Change the time-base generator valve.

(b) If this fails to effect a cure, the presence of the synchronising pulses should be checked.

(c) Connect Probe A of the TeleVet to the aerial socket.

(d) Plug the flying lead on Probe A into the socket marked XO.01.

(e) Set the CHECK switch to NORMAL.

(f) Set the SELECT switch to SOUND.

(g) Set the CENTRE FREQUENCY dial at the sound carrier frequency.

(h) Adjust the R.F. OUTPUT control and/or the volume control on the television set until a strong audible note is heard on the loudspeaker.

(i) Change the frequency setting to the vision carrier frequency and check that the audible note stops.

(j) Identify the line which connects the sync. amplifier output to the coupling to the time-base generator. The coupling is generally a differentiating circuit.

(k) Disconnect this lead at the 'feed' end, and connect the lead to the 'live' end of the volume control.

(l) The modulation on the R.F. signal applied to the set consists of pulses similar to the line synchronising pulses, and these pulses should now be applied to the audio amplifier instead of the frame time-base generator. A loud high frequency (5 kc/s) note should be heard. If no note is obtained, the sync. amplifier or sync. separator are faulty.

(m) If a note is obtained, either the differentiating coupling circuit to the sync. generator is faulty, or the time constant of the generator is incorrect. The components of these two sections of the circuit should be checked by substitution of components known to be of correct value.

4.6.2 Picture Jumping

Faulty frame synchronisation results in a recognisable picture which moves continuously up or down, either steadily or in jumps. Since a picture is obtained, the line synchronisation is functioning, and line synchronising pulses are present. If the picture is moving downwards, the time-base is firing before the synchronising pulse arrives, and the fault is probably too short a time-constant in the time-base generator. If the picture is moving upwards, the synchronising pulses are failing to fire the time-base.

Possible causes:-

(a) Faulty time-base generator
(b) Faulty sync. separator

Proceed as follows:-

(a) Change the time-base generator valve.

(b) If changing the valve fails to clear the fault proceed as in Section 4.6.1 (b) to (m) using the frame sync. pulse lead instead of the line sync. pulse lead. The two outputs consist of the same pulses, but are generally isolated by using separate valves or separate electrodes of the same valve. The same 5 kc/s note should therefore be obtained in the loudspeaker, proving that the synchronising pulse train is present at the input of the pulse shaping circuit.

(c) If the pulse train is present at this point, the fault is probably either in the shaping circuit, which provides a voltage build up from the closely grouped pulses during the frame synchronising period, or in the time constant of the time-base generator. The components and wiring in these two circuits should be examined.

4.6.3 Picture Tearing

Picture tearing consists of irregular line synchronisation, giving rise to an irregular right-hand edge on the picture, or blocks of lines losing synchronisation and distorting the picture. The setting of the line-lock preset should first be checked, to ensure that the best setting is not at one end of the control range.

Possible causes:-

(a) Faulty line time-base generator valve
(b) Picture break-through on synchronising circuit
(c) Interference
(d) Incorrect alignment of vision I.F. amplifier

The presence of interference is self-evident, and the pattern facility of the TeleVet, as described in Section 3.5, may be used to prove that synchronisation is satisfactory in the absence of interference. An irregular right-hand edge may be caused by a faulty time-base generator valve, particularly if a thyratron is used as the line time-base generator. The procedure should therefore be:-

(a) Change the line time-base generator valve.

(b) If this fails to clear the fault, locate the circuit components of the sync. separator, which suppresses all signal components above black level from the synchronising signals.

(c) If the video signal is coupled to this circuit through a capacitor from a valve anode, a leaky capacitor may result in incorrect bias on this circuit. Disconnect the aerial to remove all signal, and measure the D.C. voltage on the output side of this capacitor, using the procedure detailed in Section 3.7.2.

(d) If there is no D.C. leakage through this capacitor, the components which set the suppression level of this circuit to black level, that is, 30% of full white level, should be examined. The effects of altering the resistor values in this circuit by shunting additional resistors in parallel should be observed.

(e) If no improvement is obtained from (d), the response of the vision I.F. should be checked as detailed in Section 4.2. The particular fault in alignment is most likely to be that the sensitivity at the vision carrier is incorrect, (see Figure 1).

4.6.4 Picture Folding Over

An apparent folding over of the top of the picture is caused by a slow frame fly-back. The picture content then starts before the spot has reached the top of the C.R. tube and the top section of the picture is inverted.

Possible causes:-

(a) Faulty frame time-base generator valve
(b) Faulty time-base generator supplies

The fault is nearly always the time-base generator valve, which has become incapable of passing the heavy surge current required to discharge the time-base capacitor rapidly. The valve should therefore be changed. If this fails to effect a cure, the heater and electrode supplies to this valve should be measured as described in Sections 3.8.1 and 3.7.2.

4.7 Additional Information

The information given in Sections 4.1 to 4.6 has dealt as far as possible with faults arising on television sets using conventional circuits. A number of additional features and their effect on fault finding are mentioned in this section.

4.7.1 Flywheel Synchronisation

Flywheel synchronisation is included in certain fringe area sets. A line sync. oscillator runs at 10,125 c/s and is used to synchronise the line time-base. The oscillator is phase locked to the synchronising pulses by means of a reactor valve, and the flywheel effect of the oscillator enables line synchronisation to be maintained in the presence of severe interference. The phase discriminator checks the phase of the oscillator at each synchronising pulse, an error in phase at this instant giving rise to a voltage which is applied to the reactor valve. Additional pulses will prevent the correct action of this circuit. As explained in Section 3.5, the vertical lines produced by the TeleVet are due to repetition of the line synchronising pulse, and the pattern waveform will not therefore synchronise a set using flywheel synchronisation.

If the TeleVet is used frequently with such sets the frequency of the line synchronising pulses may be reduced to 10,125 c/s by connecting an additional capacitor of approximately 470 pF across the line frequency trimmer C17 - the position of which is shown in Figure 9b. Only one synchronising pulse per line then occurs. Correct lock is then indicated by a white raster having a single horizontal bar. The repetition frequency may be adjusted to 10,125 c/s by means of the trimmer C17 as detailed in Section 7.2.

4.7.2 Noise Limiters

Noise limiters are frequently incorporated on both sound and vision channels. In each case they generally take the form of biassed rectifiers, the bias being automatically set by the signal to absorb pulses exceeding 100% modulation on sound, and set by means of a preset control to absorb pulses exceeding peak white on vision. Faults on these limiters will either be failure to suppress interference, or too small a bias, resulting in the limiting action taking place at too low a level. The first fault can be identified by disconnecting the suspected circuit and checking whether the interference increases on the sound channel, and by rotating the preset control and noting that the interference pulses are clipped on the vision channel. If not the rectifier or the capacitor in the biassing circuit or the preset control in the vision channel are probably faulty. Too low a bias will cause distortion of the sound or suppression of the normal picture peak white on vision, and is probably caused by a fault in one of the components of the biassing circuit.

4.7.3 Projection C.R. Tubes

Two points may arise when fault finding on projection television sets. The first is that optical as well as electrical focusing is required, and poor picture definition may be caused by faulty adjustment of the optical system. The second is the higher values of E.H.T. employed for the

C.R. tube. These voltages may in fact exceed the maximum voltage which can be handled by Probe B. If the voltage, when measured as described in Section 3.7.1 is too high to enable the trace to be brought back to the horizontal cursor line by means of the Y SHIFT control, note the position of the trace when the knob is turned to 2, disconnect the probe from the E.H.T. and note the position to which the knob must be moved to bring the line to the same position. The total voltage shift of the Y SHIFT control will be the sum of the two readings, and will exceed 2. The E.H.T. is then this value multiplied by 100, multiplied by the factor indicated on the Y GAIN control, which should be X100.

4.7.4 Fringe Area Sets

Fringe area sets incorporate refinements intended to improve the results obtained in localities where signal strength is low. These refinements may be:-

(a) Flywheel synchronisation
(b) Higher sensitivity
(c) A.G.C. on sound and vision channels

Flywheel synchronisation has been dealt with in Section 4.7.1. Fringe area sets usually provide full picture contrast on an input from the aerial of the order of 10 microvolts. The minimum output from the TeleVet is of the order of 50 microvolts, and when injecting signal into the aerial socket it should therefore be necessary to turn down the contrast or sensitivity control on the television set to reduce the sensitivity. Care will also be necessary with the lead termination when making connection to the aerial socket, and it is advisable to fit a coaxial plug of the correct type to the lead on Probe A, so that a true coaxial connection may be made to the aerial socket.

Automatic gain control is obtained by applying bias to one or more of the sound and vision I.F. amplifier valves. The bias for the sound I.F. is obtained from the sound detector, and the bias for the vision I.F. from the rectified vision signal, the actual voltage being derived from the sync. pulse peak amplitude, or from the peak white signal amplitude. The A.G.C. will influence fault finding when taking measurements on the R.F. and I.F. gain of sound and vision channels. In order to check the gain of any stage it will be necessary to make the A.G.C. inoperative. Similarly the A.G.C. must be made inoperative if the sound channel is to be aligned, although it is unlikely that the vision A.G.C. will follow the wobbulator response, and a response characteristic should be obtainable with the A.G.C. operating.

4.7.5 Straight Sets

Sets in which all the R.F. amplification on both sound and vision channels takes place at signal frequency are limited to certain pre-war and immediate post-war sets designed for reception of one station only. Alignment procedure is similar, except that only signal frequencies are required, and no local oscillator has to be adjusted. Attention is drawn however to the remarks in Section 3.3 regarding the side-band response of straight sets, since in certain sets designed for the reception of the Alexander Palace transmission either double side-band or upper side-band reception may be employed.

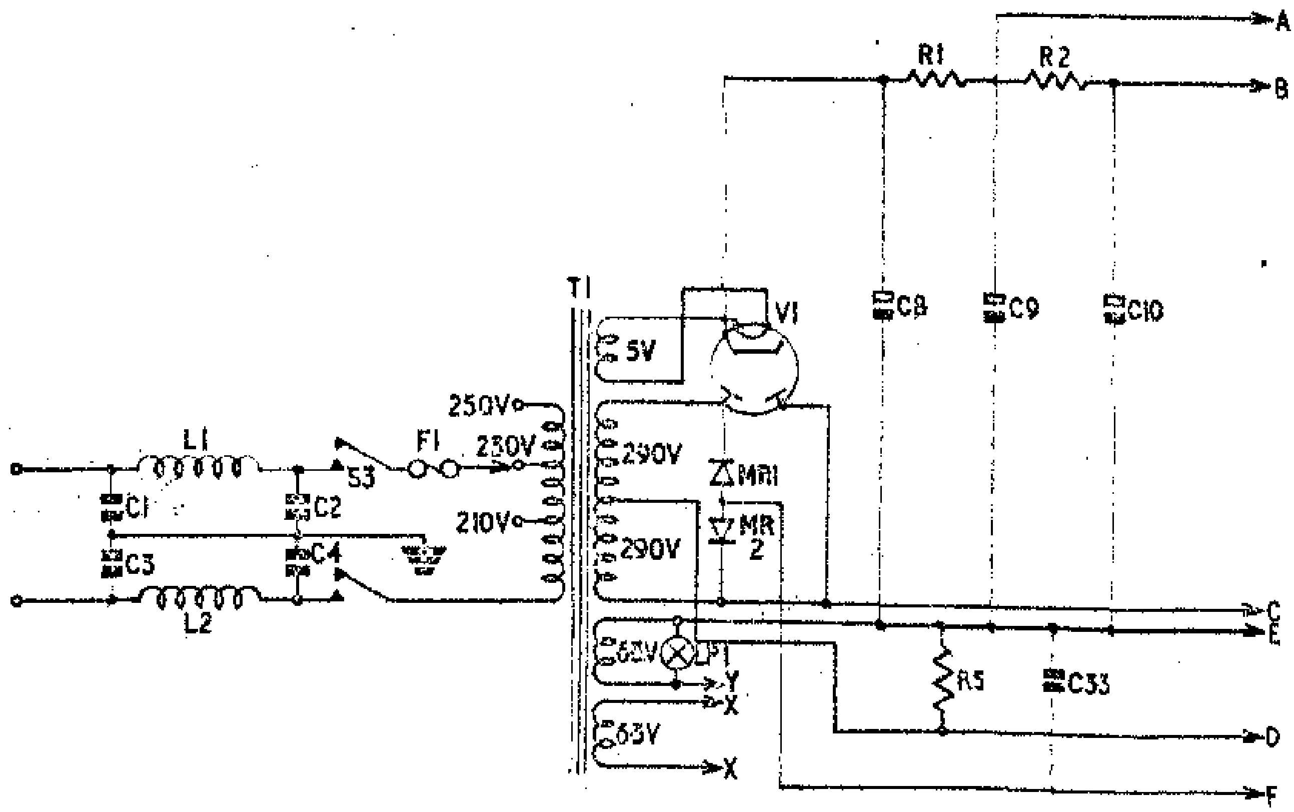

FIGURE. 7A. TELEVET TYPE 877 CIRCUIT DIAGRAM. POWER UNIT.

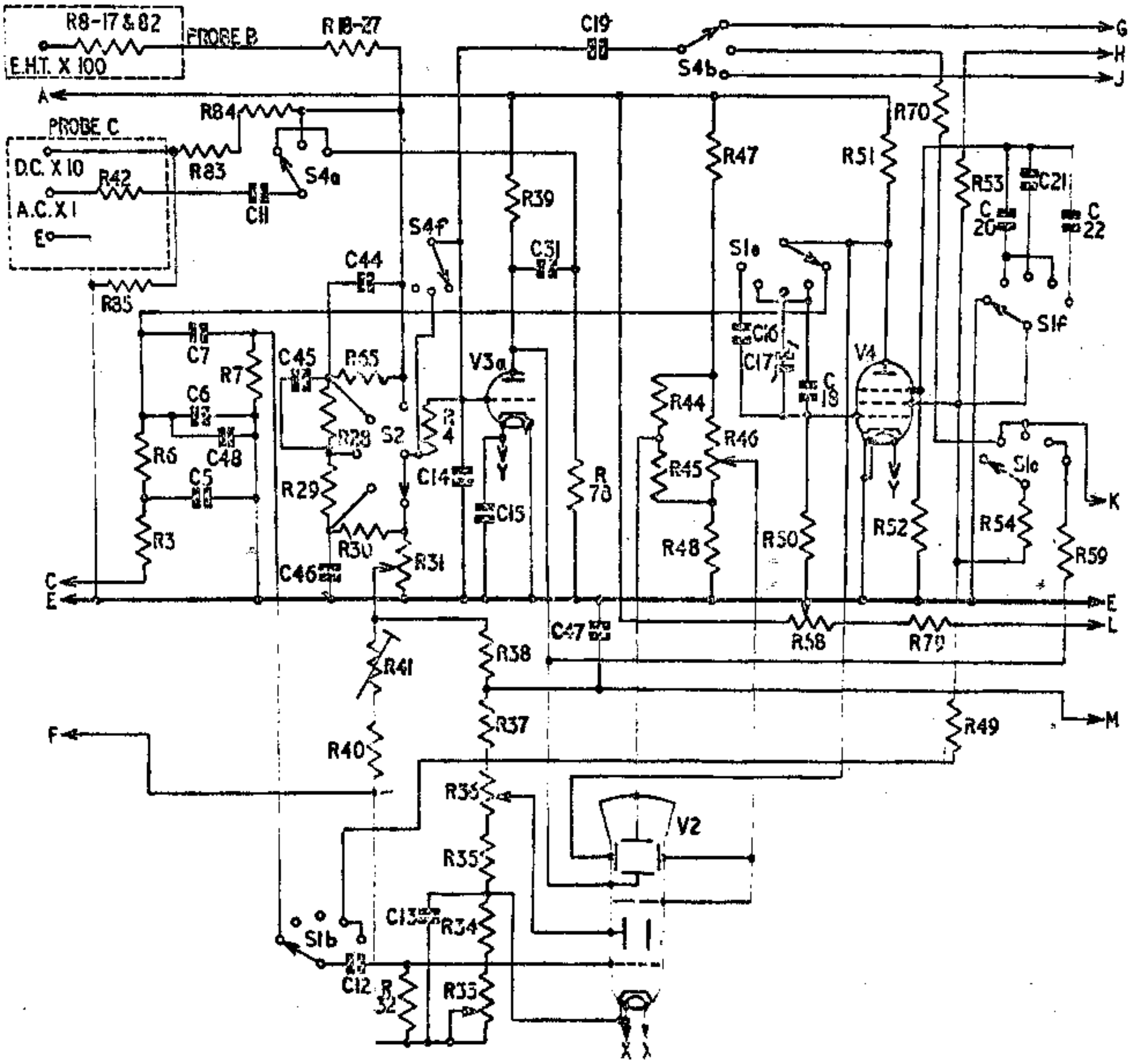

FIGURE 7.B TELEVET TYPE 877. CIRCUIT DIAGRAM.

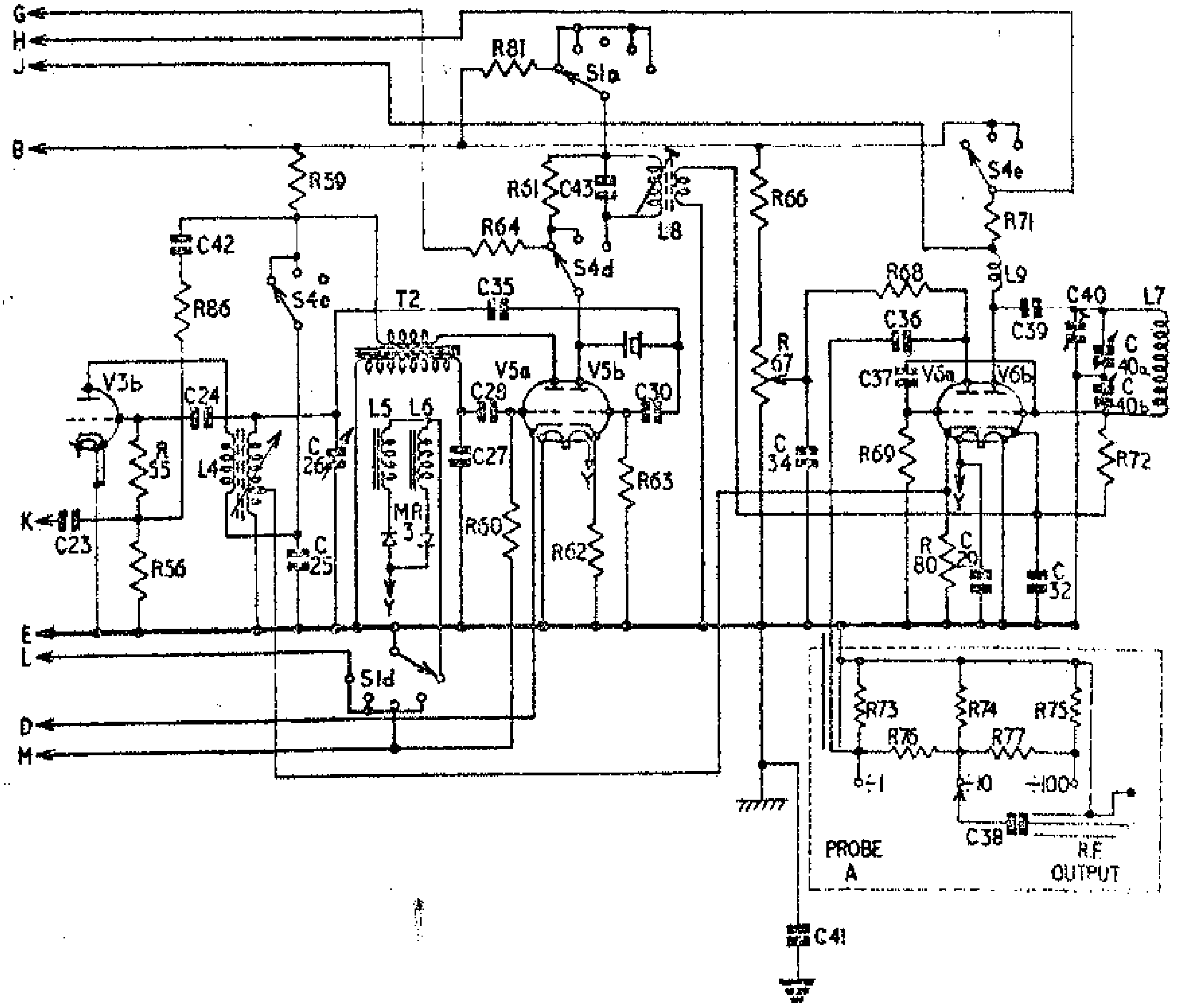

FIGURE. 7.C. TeleVet TYPE 877. CIRCUIT DIAGRAM

5. DESCRIPTION OF THE CIRCUIT

5.1 General

The circuit diagram of the TeleVet is shown in Figure 7 (a), (b), and (c), and a schedule of components is given in Table 2. Considerable economy in the number of valves required has been made by using the CHECK and SELECT switches S4 and S1 to set up the required circuit arrangements. Block schematic diagrams illustrating the basic circuit arrangement for each function are shown in Figure 8 (a) to (f).

Two oscillators are used. The variable oscillator V6b is tunable over the frequency range 88 to 150 Mc/s, and the oscillator V3b operates normally at 80 Mc/s. Hence the difference and sum frequency ranges are 8 to 70 Mc/s and 168 to 230 Mc/s respectively, and these frequency calibrations appear on the CENTRE FREQUENCY dial. Part of the tuning capacitance for the 80 Mc/s oscillator consists of the capacitor C26, which may be mechanically vibrated to provide the frequency sweep required for the wobbulator.

The two frequencies are mixed in the valve V6a, the sum and difference frequencies appearing across the anode load, which is coupled to the output cable and H.F. probe.

The function of the other valves, which are dealt with in greater detail in Section 5.2 to 5.6, are:-

V1	...	H.T. rectifier
V2	...	C.R. Tube
V3a	...	L.F. Amplifier
V4a	...	Transitron sawtooth and pulse generator
V5a	...	Blocking oscillator pulse generator
V5b	...	5 Mc/s crystal oscillator

5.2 Wobbulator

The circuit arrangement for the wobbulator is shown in block schematic form in Figure 8a. These conditions are set up when the SELECT switch is in the VISION position and the CHECK switch at NORMAL. The moving vane of C26 is vibrated at a frequency of 50 c/s by means of the coils L5 and L6 which are energised from a 50 c/s supply through the rectifier MR3. Variation of this capacitance causes the frequency of the 80 Mc/s oscillator to sweep over a maximum range of 80 Mc/s ± 1, ± 6 Mc/s. The amplitude of vibration, and hence the frequency sweep, may be varied by means of the DEVIATION control, which limits the travel of the moving vane. Since the frequency of this oscillator is being swept a similar frequency sweep is obtained in the sum and difference output frequencies appearing at the Probe A, and this is the R.F. output applied to the television set. The amplitude of this output may be varied by means of the attenuator R73 to R77 in Probe A, which provides steps of X1, X0.1 and X.0.01, and a continuous control from X1 to approximately X0.1 is provided by the R.F. OUTPUT control R67, which varies the anode voltage of the mixer V6a. A capacitor C38 is included in Probe A to enable connection to be made to points at H.T. potential.

The signal level at the detector in the television set is determined by the receiver gain at the particular frequency being produced by the TeleVet. Hence an A.C. signal, with a repetition rate of 50 per second will appear across the video detector and be amplified by the video amplifier. This signal may be picked up on the A.C.X1 lead of Probe A, passed through the Y GAIN attenuator and Y amplifier valve V3a of the TeleVet, and applied to the Y plate of the C.R. tube, producing a vertical spot deflection proportional to the rectified signal level at any instant.

A 50 c/s voltage is applied to the X plate of the C.R. tube to obtain the horizontal deflection. This voltage is phase-shifted by the network R3, C5, R6, C6 so that the limits of travel of the spot coincide with the limits of travel of the reed and of the output frequency. The horizontal axis of the C.R. tube then becomes a frequency axis, and the vertical axis represents gain. The display is therefore the gain versus frequency characteristic of the amplifier and filter under test.

Traces would normally be obtained when the spot moves from left to right, and from right to left. To avoid this, one of the traces is suppressed by applying a 50 c/s signal, phase shifted 90 degrees by means of C7, R7, C12, R32, to the grid of the C.R. tube.

5.3 <u>Sound</u>

With the CHECK switch at NORMAL and the SELECT switch at SOUND the circuit is arranged as shown in the block schematic diagram Figure 8d. The 50 c/s supply to the vibrator is switched off and V3b therefore oscillates at 80 Mc/s with no frequency sweep.

The valve V4 operates as a Miller transitron, and rectangular pulses having a repetition frequency of approximately 5 kc/s are obtained from the screen of this valve. The repetition frequency may be varied by means of the T.B. FREQUENCY control. These rectangular pulses are applied to the grid of the 80 Mc/s oscillator V3b, and result in oscillation being stopped during the pulse. The 80 Mc/s oscillator is therefore pulse amplitude modulated at 5 kc/s. The sum and difference frequencies will also retain the same pulse amplitude modulation, hence an amplitude modulated signal having the frequency indicated on the CENTRE FREQUENCY dial is available on Probe A for sound channel alignment.

At the same time a proportion of the pulse waveform derived from the screen of V4, is fed out on the A.C.X1 lead of Probe C. The peak-to-peak voltage with the Y GAIN switch in the X1 position, is approximately 2, and this provides a low frequency signal for testing the audio amplifier.

5.4 Pattern

With the CHECK switch at NORMAL and the SELECT switch at PATTERN the circuit arrangement is as shown in Figure 8b. The vibrator supply is off, and the valve V3b oscillates at 80 Mc/s. To obtain a satisfactory pattern, the 80 Mc/s oscillator must be amplitude modulated with the synchronising and pattern waveform.

In this condition the Miller transitron V4 generates a rectangular pulse having a repetition frequency of 30.375 kc/s. This is three times the frequency of the line synchronising pulses, and may be accurately adjusted by means of the preset capacitor C17, which is accessible through a hole in the bottom of the case. The rectangular pulse obtained from the screen of V4 is differentiated by capacitor C23 and resistor R56, and this differentiated waveform is used to grid modulate the 80 Mc/s oscillator V3b. Normally the negative pulse produced by differentiation stops the oscillation, and the carrier frequency is interrupted at a frequency of 30.375 kc/s. A positive pulse is produced by differentiation at the end of each rectangular pulse, but this is normally absorbed by grid current in V3b and has no effect on the 80 Mc/s oscillator. One in every three of the pulses acts as a line synchronising pulse and the other two produce the two vertical black lines on the pattern.

Pulses for frame synchronisation are obtained from the blocking oscillator V5a. This operates at 100 c/s, and is synchronised to the A.C. supply, a 100 c/s locking pulse being obtained from the voltage developed across R5 when the main smoothing capacitor C8 is charged. Valve V5a is made inoperative on all other positions of the SELECT switch by means of a negative bias applied to its control grid.

During the pulse produced by V5a, the increase in voltage across R59 reduces the anode voltage of the 80 Mc/s oscillator V3b, and the amplitude of oscillation is reduced to 30% of normal, that is, to black level. The pulse is also applied to the grid of V3b through C42, and R86, where it is superimposed on the differentiated line synchronising pulse. For the first few line synchronising pulses occurring during the frame pulse period, V3b is completely cut off except for the short periods during which the positive pulse of differentiation lifts the bias. This provides the reversal of line synchronising pulses required to operate the integrating circuit in the television receiver, and provide a frame locking signal. The time constant of the coupling circuit C42, R86 is so chosen that the bias on V3b decreases during the frame synchronising period, with the result that the pulse width of the line synchronising pulses decreases until at the end of the frame synchronising period they are once again of 10 microseconds duration as required for the normal line synchronisation. The synchronising waveform produced by the TeleVet, and for comparison purposes, that radiated by the B.B.C., are shown in Figure 4. The frame synchronising waveform occurs one hundred times per second, and synchronisation of the frame time-base occurs only fifty times per second. Since the signal during the frame synchronising pulse period does not exceed black level, one frame pulse period produces the horizontal black band across the centre of the picture, and the next locks the frame time-base.

5.5 Oscilloscope

With the CHECK switch at NORMAL and the SELECT switch at T.B. LINE or T.B. FRAME the circuit is arranged as shown in the block schematic diagram Figure 8c.

In this condition V3a operates as the Y amplifier and V4 as a transitron time-base generator feeding the X plate. The Y amplifier is direct coupled, and either alternating or direct voltages may be applied via the Y GAIN attenuator to the amplifier. Three connections are provided, these are, A.C.X1. in which a blocking capacitor C11 is provided, and which is intended for observation and measurement of A.C. waveforms; D.C.X10, in which R83 and R84 are included to give a reduction of ten times on a D.C. input; and E.H.T.X100, in which R8 to R27 are included to give a hundred to one reduction of D.C. input, enabling E.H.T. voltages to be measured.

The normal bias required by V3a to obtain a trace in the centre of the C.R. tube is two volts, and this is provided when the slider of the Y SHIFT control P31 is in a mid-position.

Variation of the shift control changes the bias between zero and four volts, giving an effective shift of ± 2 volts on the centre position. Since this shift voltage is in series with the input voltage, it may be used to re-centre the trace after an input signal is applied, in which case the shift voltage which is required must be equal, but of opposite polarity, to the signal. The amplitude of both A.C. and D.C. signals may therefore be measured. In conjunction with the Y GAIN attenuator, which reduces the input voltage in known steps, and the probe multipliers D.C.X10, and E.H.T.X100, this feature enables a wide range of A.C. and D.C. voltage measurements to be made.

A proportion of the signal appearing at the anode of V3a is fed through R59 to synchronise the time-base generator V4. Two time-base frequency ranges are provided, suitable for investigating the television line and frame time-base circuits, and each having a velocity range of approximately 2:1.

A negative pulse derived from the screen of V4 during the flyback period is applied to the grid of the C.R. tube via R49 to provide fly-back blanking.

5.6 Frequency Checking

V5b is a 5 Mc/s crystal controlled oscillator. The centre frequency of the 80 Mc/s oscillator, and the frequency of the variable oscillator at 5 Mc/s intervals, may be checked by beating with harmonics of this standard oscillator.

5.6.1 Check Variable Oscillator

When the CHECK switch is at VAR.OSC. and the SELECT switch is at VISION the circuit arrangement is as shown in Figure 8f. To avoid the generation of additional beat notes, the 80 Mc/s is switched off.

The output of the crystal oscillator is fed via the transformer L8, the secondary of which is tuned to 5 Mc/s, to the cathode of V6b. Harmonics of 5 Mc/s are generated in V6b where they beat with the fundamental oscillator frequency. A small audio frequency signal is therefore produced across R71 when the frequency of oscillation is very near to a multiple of 5 Mc/s. This audio signal is amplified by the Y amplifier V3a and the signal appears on the C.R. tube, but at low amplitude. This audio signal is therefore connected to the A.C.X1 lead of Probe C, so that it may be fed into the sound channel of the television receiver for further amplification and audible indication in the loudspeaker.

5.6.2 Check Sweep Oscillator

When the CHECK switch is at SWEEP OSC. and the SELECT switch at SOUND or VISION the circuit arrangement is as shown in Figure 8e. The SOUND position is used when setting the frequency of the 80 Mc/s oscillator accurately. In the VISION position the vibrator is operating, and this condition is used to obtain the frequency calibration pips on the C.R. tube as a frequency check for the wobbulator.

With the SELECT switch at SOUND the H.T. supply to V6b is removed, making the variable oscillator inoperative, and also the H.T. supply to V4 is removed to prevent the generation of the 5 kc/s sound signal. The output from the 80 Mc/s oscillator is fed via C35 to the crystal oscillator V5b, where it mixes with the sixteenth harmonic of the 5 Mc/s signal. When these frequencies are nearly equal, a small audio signal appears across R61, which is amplified by means of the Y amplifier, and produces a small deflection on the C.R. tube. Further amplification may be obtained from the audio amplifier of the television set as described in Section 5.6.1.

The CALIBRATE control operates an adjustable core on the 80 Mc/s oscillator tuned circuit, and enables an accurate adjustment of frequency to be made.

When the SELECTOR switch is at VISION, the operation is similar to that described above except that the vibrator is operating. The audio beat note is therefore produced in short bursts as the oscillator frequency sweeps through 75, 80, and 85 Mc/s. The deflection produced by these bursts on the C.R. tube will be as shown in Figure 2. Marker pips are therefore produced which mark accurately the positions on the trace representing 75, 80, and 85 Mc/s.

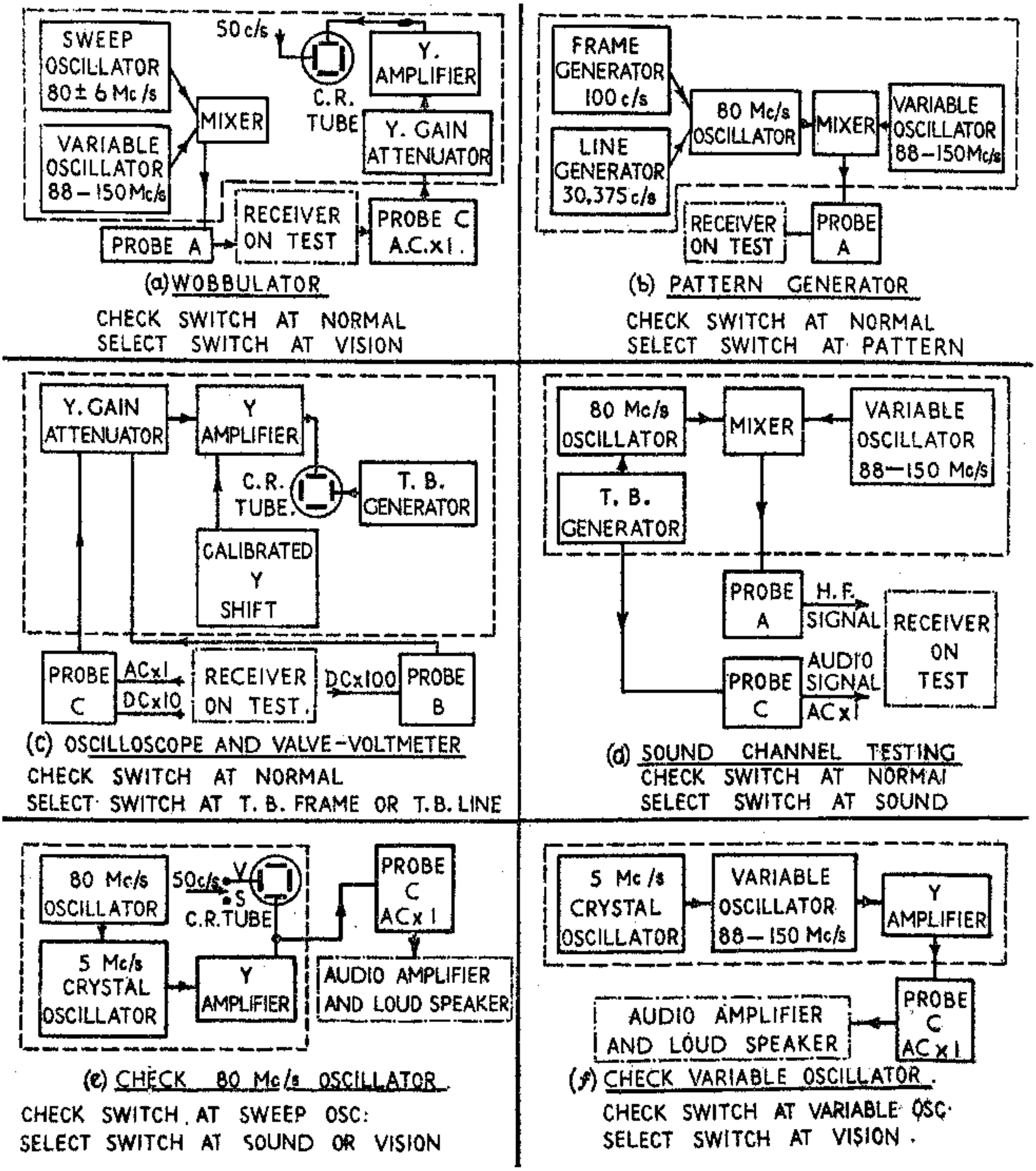

FIGURE 8 TELEVET TYPE 877. BLOCK SCHEMATIC DIAGRAMS

6. SPECIFICATION

Frequency Range:	The instrument covers the I.F. Band and Television Bands 1 and 3. Two ranges are provided, which are:- 8 to 70 Mc/s 168 to 230 Mc/s
Frequency Calibration:	The tuning control is directly calibrated in frequency with a calibration accuracy of ± 1 Mc/s.
Slow Motion Drive:	A reduction drive of 6:1 is provided on the tuning capacitor. An additional scale, bearing a 1 to 180 division scale is fixed to the knob shaft and enables accurate interpolation to be made.
Crystal Check:	A 5 Mc/s crystal is incorporated in the tester. This provides audio beat notes at all multiple frequencies of 5 Mc/s and enables the exact location of any crystal check point to be made. The arbitrary scale enables accurate interpolation between adjacent 5 Mc/s points to be made.
Frequency Modulation:	Frequency modulation is provided, with a sweep variable between 4 and 12 Mc/s. The frequency of modulation is 50 c/s.
Wobbulator Display:	The video output of the television set obtained with the frequency modulated signal applied, can be observed on a $2\frac{3}{4}$ inch C.R. tube.
Marker Pips:	When used as a wobbulator, marker pips, generated by the 5 Mc/s crystal, may be made to appear at 5 Mc/s intervals on the trace. The pips represent the position in the response trace of frequencies which are 5 Mc/s apart, and the centre pip represents the frequency selected by the tuning control.
Bandwidth Measurement:	Effective circuit bandwidth may be measured by shifting the response pattern by altering the tuning, and measuring the frequency movement from the tuning scale.
R.F. Output:	The maximum R.F. output is approximately 50 millivolts. This output is provided on an H.F. probe at the end of 3-ft. of screened twin cable. Attenuated outputs of one tenth and one hundredth are provided on this probe. A continuously variable level control enables the output to be reduced.

R.F. Output, Amplitude Modulation:	The R.F. output may be amplitude modulated with a 5 kc/s pulse waveform which enables the R.F. and I.F. sound channels to be aligned.
R.F. Output, Pattern Modulation:	The R.F. Output may be modulated with an internally generated signal containing line and frame synchronising pulses. This modulated signal will produce a pattern consisting of one horizontal and two vertical black lines on a white background.
Time Base:	In addition to the 50 c/s sweep used with the wobbulator, a time-base is provided which has velocity ranges suitable for viewing the line and frame time-base and synchronising waveforms of the television set.
Y Amplifier:	A Y amplifier is incorporated which has a gain of approximately 50 times and a frequency response from D.C. to 50 kc/s. The gain at 50 kc/s is approximately half the gain at 1 kc/s. This amplifier is always in circuit when the C.R. tube is used.
Y Amplifier Sensitivity:	The deflection sensitivity obtained with the Y amplifier and C.R. tube is approximately 1.5 cms. per volt.
Y Amplifier Attenuator:	A Y amplifier attenuator which divides the input voltage by 1, 3, 10, 30, or 100 is incorporated. This is effective on all facilities for which the C.R. tube is used.
Calibrated Y Amplifier Shift:	A calibrated D.C. shift control is provided on the Y amplifier. The calibration is +2 to -2 volts, and enables the peak-to-peak amplitude of the input signal to the Y amplifier to be measured.
L.F. Probe:	An L.F. Probe is provided which may be connected to the part of the television set from which the Y amplifier signal is to be derived, that is, the time bases when investigating time-base waveforms, and the video amplifier when using the wobbulator facility. The same probe is also used to inject the audio beat note obtained on crystal check into the television set audio amplifier, to enable the beat note to be heard on the loudspeaker.

Audio Test Signal:	An audio signal consisting of a 5 kc/s pulse may be fed out on the L.F. probe to enable the audio amplifier of the television set to be tested. The level of this signal is approximately 2 volts peak-to-peak and is suitable for feeding direct to the grid of the amplifier valve, or to the top end of the volume control.
D.C. Valve Voltmeter, E.H.T. Measurement:	Measurement may be made into an impedance of 100 Mohms using the E.H.T. Probe over the following ranges:- 0 to 2 kV Accuracy ± 10% 0 to 6 kV Accuracy ± 10% 0 to 20 kV Accuracy ± 10% up to 10 kV, ± 20% up to 20 kV.
D.C. Valve Voltmeter, H.T. Measurement:	Measurements may be made into an impedance of 100 Mohms, using the E.H.T. probe, over the following ranges:- 0 to 600V Accuracy ± 10% 0 to 200V Accuracy ± 10% Measurement may be made into an impedance of 1 Mohm, using the D.C.X10 lead of Probe C, over the following ranges. 0 to 600V Accuracy ± 10% 0 to 200V Accuracy ± 10% 0 to 60V Accuracy ± 10% 0 to 20V Accuracy ± 10%
A.C. Valve Voltmeter:	Measurement may be made into an impedance of 1 Mohm using the A.C.X1 lead of Probe C over the following ranges:- 0 to 400V peak-to-peak accuracy ± 10% 0 to 120V peak-to-peak accuracy ± 10% 0 to 20V peak-to-peak accuracy ± 10% 0 to 6V peak-to-peak accuracy ± 10% 0 to 2V peak-to-peak accuracy ± 10% Accuracy decreases at frequencies above 15 kc/s due to the falling response of the Y amplifier.
Probe Stowage:	The instrument has the following leads permanently connected, and stowage for these leads is provided in the ends of the case. E.H.T. Probe H.F. Probe L.F. Probe Mains Lead

Earthing:	The chassis and earth line of the instrument are insulated from the case, and the tester may therefore be used for testing A.C./D.C. type television sets.
Power Supplies:.	The instrument operates from 200-250 volts 50 c/s supply. The consumption is approximately 80 watts.
Dimensions:	The overall dimensions are 15½" x 9½" x 8" high. The front panel is designed to give protection to the knobs.
Weight:	The weight of the instrument is 25 lbs.
Finish:	The steel case is finished in grey wrinkle enamel, and the front panel in black with white lettering.

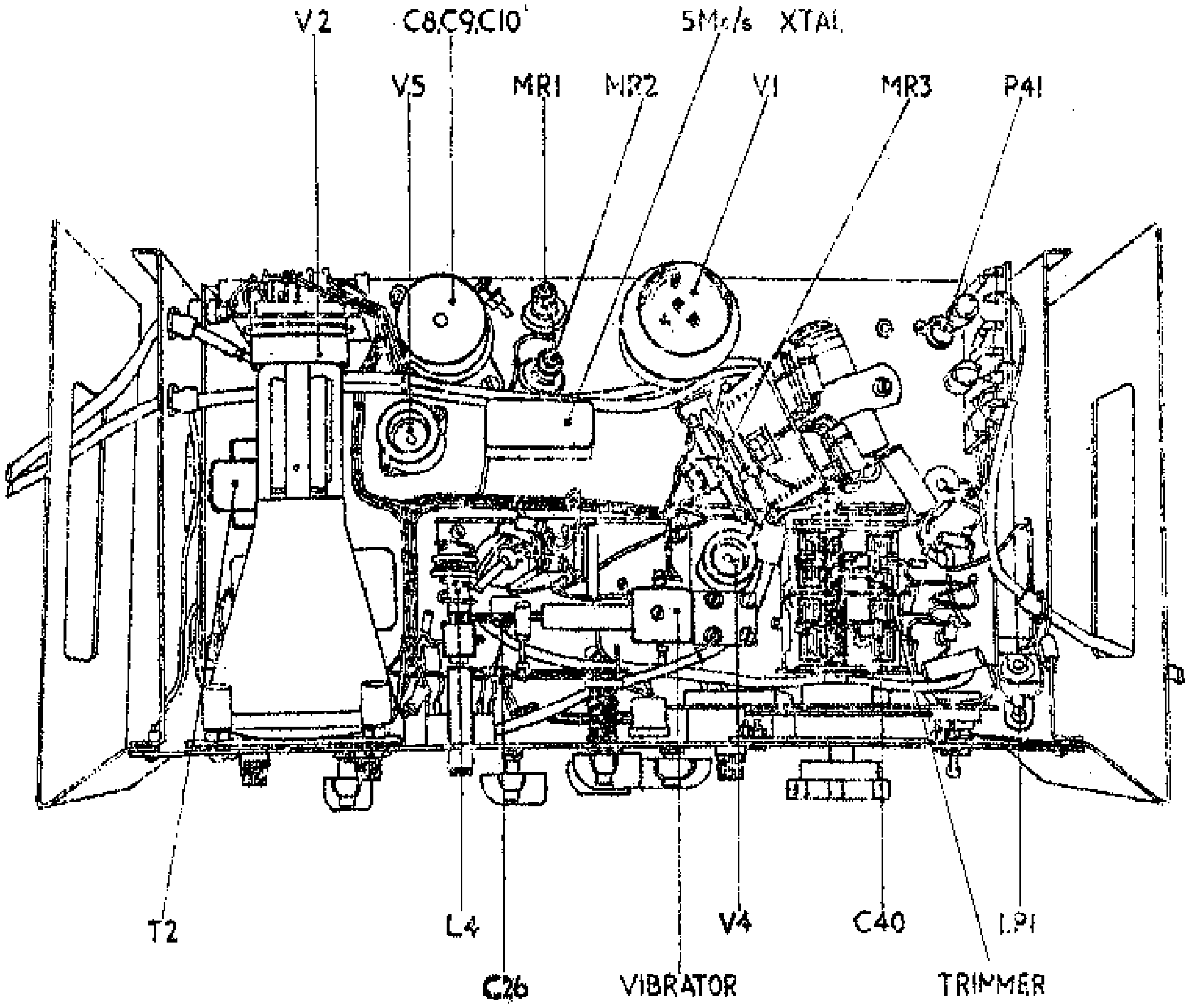

FIGURE. 9A. TELEVET TYPE 877. CHASSIS - TOP - VEW

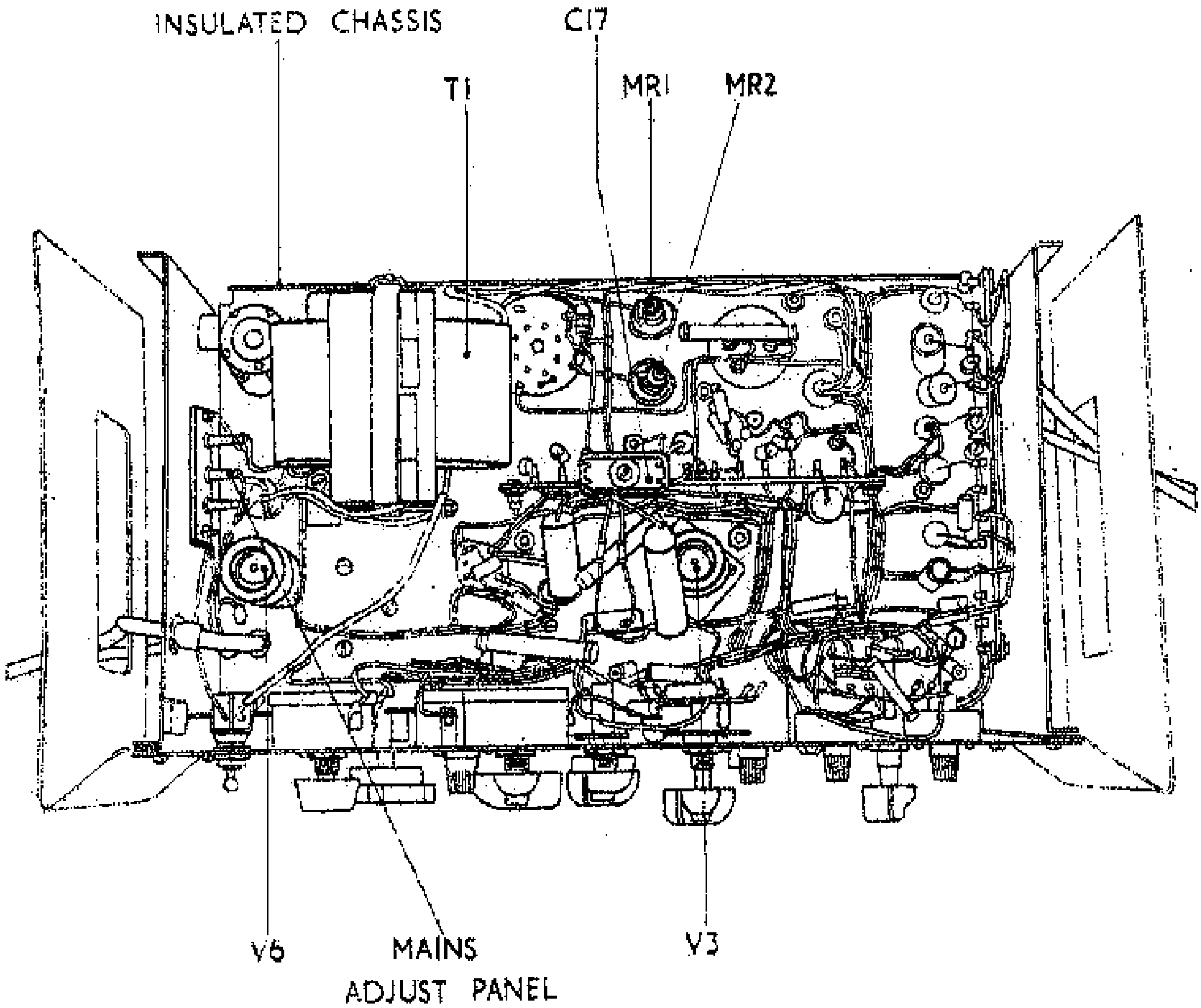

FIGURE 9B TELEVET TYPE 877 CHASSIS - UNDERSIDE VIEW

7. MAINTENANCE

Maintenance and adjustment of the TeleVet should normally be limited to valve changes, adjustment of preset controls, and possibly adjustment of the vibrating reed. These are dealt with below, and the positions of the valves and components referred to can be ascertained from the line diagram, Figure 9.

7.1 Valve Changes

It should be possible to change any valve other than V3 and V6 without affecting the performance of the TeleVet.

If V3 is changed it is first necessary to check the position of the horizontal trace when the CHECK switch is at NORMAL and the SELECT switch at T.B. FRAME, with no input applied to Probes B or C. If the trace does not lie along the horizontal cursor line when the Y SHIFT control is at 0, adjust the Y SHIFT control until the lines coincide, then loosen the grub screw in the Y SHIFT knob, and turn the knob so that the pointer indicates 0 with this setting. The interelectrode capacitance of V3b may effect the frequency of the 80 Mc/s oscillator, hence the check facility described in Section 3.2.1 should be used. Care should be taken however to ensure that no ambiguity occurs with regard to the crystal harmonic, and a test of output frequency should be performed using a television receiver known to be tuned to a particular frequency. A frequency error of 5 Mc/s will indicate that the 80 Mc/s oscillator has been adjusted to either 75 Mc/s or 85 Mc/s. If difficulty is experienced in tuning to the correct frequency of 80 Mc/s, the tuning inductor L4 should be adjusted by closing up or opening the turns by a small amount, or alternatively a suitable valve may be selected.

Change of V6 may result in small errors in the frequency calibration of the CENTRE FREQUENCY control. The accuracy of this calibration should be checked as described in Section 3.2.2. As a change of valve will have negligible effect at the low-frequency end of the scale, all 5 Mc/s points should be checked in turn starting at 10 Mc/s. An error at the high-frequency end of the scale will then be obvious, and can be corrected by means of a small trimmer capacitor consisting of a plate fixed to the centre screen of the tuning capacitor C40. If the scale readings are high, this capacitor should be bent slightly away from the screen to correct the calibration and vice versa.

7.2 Preset Controls

Two preset controls are provided, C17 and R41. C17 enables the line pulses of the Pattern to be set to a frequency of 30.375 kc/s, and R41 enables the correct shift voltage to be developed across the Y SHIFT control R31.

C17, which is accessible through a hole in the bottom of the case, should be adjusted using a television set which is working satisfactorily. The television set should be observed on a B.B.C. transmission, and the picture width measured, the width control being adjusted if necessary to enable both picture edges to be seen. The TeleVet should then be substituted for the B.B.C. transmission, using the Pattern facility as detailed in Section 3.5. The output level should be adjusted to obtain a steady picture, and C17 should then be adjusted to obtain a picture having two vertical black lines and a width the same as that obtained with the B.B.C. transmission.

The preset control R41 is normally accurately set before the TeleVet leaves the Works, and should not require readjustment. If the accuracy of voltage measured is suspected, a check should be made using an A.C. 50 c/s voltage known to be accurate. This voltage should be approximately 2 volts peak-to-peak, and should be measured with the Y GAIN switch in the X1 position, as described in Section 3.8.1. An error may then be corrected by adjusting R41. If this range is accurate, but errors occur on other ranges, the attenuator, and not the shift voltage calibration, is faulty.

7.3 Vibrator

Adjustments are provided on the vibrator for tuning, and for centralising the moving vane between the two fixed vanes. These adjustments are made before despatch from the Works, but should any movement subsequently take place, readjustment can be carried out by the user.

Tuning of the reed to 50 c/s is achieved by altering the free length of the reed, which is rigidly clamped at one end by means of a plate held by four screws. An error in tuning will result in inability to obtain maximum deviation, a non linear frequency scale, or slow cyclic variation in amplitude of vibration. Before readjusting the tuning, ensure that the trouble is not due to the supply, which may not have a frequency of exactly 50 c/s during periods of severe power-cuts, or if the supply is not obtained from the grid system. When making readjustment a change in pressure on the clamping screws may be sufficient to restore correct tuning, but care should be taken not to leave these screws loose.

The reed assembly and the fixed vanes are independently fixed to the base of the vibrator unit, and the alignment of the vanes, and the depth of mesh, may therefore be adjusted. If the vanes require to be centralised, only one of the screws fixing the assembly should be unscrewed, and the assembly pivotted on the other screw to centralise the moving vane.

Whenever any readjustment to the vibrator is carried out, the centre frequency of the 80 Mc/s oscillator should be checked as detailed in Section 3.2.1.

TABLE 1

SUMMARY OF SPURIOUS RESPONSE CURVES ON WOBBULATOR

Spurious Signal (Note 1)	Frequency Band Affected (Note 2) (Mc/s)	Vision I.F. of Television Set (Note 3) (Mc/s)	Point of Signal Injection	Width of Spurious Response (Note 4)	Shape of Spurious Response (Note 4)	Position of Spurious Response when required response is central	Movement of Trace when CENTRE FREQUENCY is increased: Required Trace	Movement of Trace when CENTRE FREQUENCY is increased: Spurious Trace	Movement of Trace when CENTRE FREQUENCY is increased: Speed of Movement of Spurious Trace (Note 4)
2 (V-F)	8 to 15	8 to 15	I.F.	Half	Similar	Left of required response	Left	Left	Same
2 F-V	33 to 40	33 to 40	I.F.	Half	Reversed	Right of required response	Left	Left	Half
2 F-V	40 to 47	Any	R.F.	Half	Reversed	Left of required response	Left	Left	Half
2 F-V (Note 5)	40 to 55	Approx. 34.5	Grid of Frequency Changer (Local Oscillator on)	Half	Similar	Dependent on Frequency	Left	Left	Half
2 F-V (Note 5)	54 to 70	Approx. 16	"	Half	Similar	"	Left	Left	Half
2 F-V (Note 5)	58 to 70	Approx. 12	"	Half	Reversed	"	Left	Left	Half

Note 1. V represents the variable (88 to 150 Mc/s) oscillator, and F the 80 Mc/s swept oscillator.

Note 2. The frequency band affected is taken as being the range of the CENTRE FREQUENCY control setting for which the spurious response may appear on the trace at the same time as the wanted response.

Note 3. It is assumed that intermediate frequencies above 15 Mc/s employ a local oscillator above the signal frequency, and an I.F. of 12 Mc/s employs a local oscillator below the signal frequency.

Note 4. The information in these columns refers to a comparison with the trace of the wanted response.

Note 5. This unwanted trace is due to direct I.F. break-through of the 2 F-V tone, and occurs when a test is made at signal frequency directly on the grid of the frequency changer with the local oscillator operating. In this condition there is no I.F. rejection. Presence of this unwanted response when testing direct on the aerial is indicative of low I.F. rejection by the R.F. tuned circuits.

TABLE 2

SCHEDULE OF COMPONENTS

Reference	Description	Reference	Description
R1	1 kohm	R42	4.7 kohms
R2	4.7 kohms	R43	22 "
R3	47 "	R44	150 "
R4	100 "	R45	150 "
R5	68 ohms	R46	250 " Var.
R6	100 kohms	R47	100 "
R7	100 "	R48	100 "
R8	4.7 Mohms	R49	1 Mohm
R9	4.7 "	R50	470 kohms
R10	4.7 "	R51	100 "
R11	4.7 "	R52	330 "
R12	4.7 "	R53	47 "
R13	4.7 "	R54	47 "
R14	4.7 "	R55	10 "
R15	4.7 "	R56	10 "
R16	4.7 "	R57	6.8 "
R17	4.7 "	R58	25 " Var.
R18	4.7 "	R59	2.2 Mohms
R19	4.7 "	R60	27 kohms
R20	4.7 "	R61	22 "
R21	4.7 "	R62	100 ohms
R22	4.7 "	R63	47 kohms
R23	4.7 "	R64	47 "
R24	4.7 "	R65	620 "
R25	4.7 "	R66	10 "
R26	4.7 "	R67	68 "
R27	4.7 "	R68	47 ohms
R28	220 kohms	R69	47 kohms
R29	68 "	R70	4.7 Mohms
R30	22 "	R71	22 kohms
R31	10 " Var.	R72	15 "
R32	220 "	R73	82 ohms
R33	220 " Var.	R74	82 "
R34	47 "	R75	82 "
R35	470 "	R76	750 "
R36	250 " Var.	R77	750 "
R37	330 "	R78	330 kohms
R38	220 "	R79	22 "
R39	100 "	R80	330 ohms
R40	1.5 Mohm	R81	10 kohms
R41	1 " Var.	R82	4.7 Mohms

TABLE 2 (CONTINUED)

SCHEDULE OF COMPONENTS

Reference	Description	Reference	Description
R83	3.9 Mohms	R85	1 Mohm
R84	4.7 "	R86	150 kohms
C1	560 pF	C25	100 pF
C2	560 "	C26	Special
C3	560 "	C27	0.005 uF
C4	560 "	C28	0.25 "
C5	0.05 uF	C29	470 pF
C6	0.025 "	C30	47 "
C7	0.005 "	C31	330 "
C8	8 "	C32	470 "
C9	8 "	C33	0.5 uF
C10	8 "	C34	6800 pF
C11	0.25 "	C35	2.2 "
C12	0.1 "	C36	6800 "
C13	1 "	C37	10 "
C14	100 pF	C38	0.001 uF
C15	100 "	C39	47 pF
C16	0.1 uF	C40	100 pF + 30 pF. Var.
C17	260 pF	C41	6800 pF
C18	0.001 uF	C42	0.05 uF
C19	220 pF	C43	15 pF
C20	470 "	C44	100 "
C21	22 "	C45	22 "
C22	0.025 uF	C46	330 "
C23	220 pF	C47	0.1 uF
C24	47 "	C48	0.01 "
V1	5Z4G	V4	EF91
V2	DG76	V5	12AT7
V3	12AT7	V6	12AT7
LP1	6.3V, 0.3A	MR1, MR2	Rectifier STCN8/25
		MR3	" STCD45/1/1W
F1	2A		

GENERAL LIABILITY AND MAINTENANCE GUARANTEE

In lieu of any warranty, condition or liability implied by law, our liability in respect of any defect in or failure of the goods supplied, or for loss, injury, or damage attributable thereto, is limited to making good by replacement or repair defects which, under proper use by the original purchaser, appear therein and arise solely from faulty materials or workmanship within a period of twelve calendar months after the original goods shall have been first despatched, at the termination of which period all liability on our part ceases; provided always that such defective instruments are carefully packed and returned free to our Works unless otherwise arranged, and provided they have not been tampered with in any way. The repaired instrument will be delivered free to its destination in Great Britain or f.o.b. British Port, for overseas shipments. Reasonable charges will be made for attendance of Personnel at Customers' premises and for any dismantling should this be necessary in order to effect the required replacements.

For components not of our manufacture we extend only such benefits as we may receive under any guarantee given to us by the makers thereof. Electronic valves and cathode ray tubes manufactured by members of the British Radio Valves Manufacturers' Association are marked with the letters B.V.A. which is a guarantee of efficiency and quality. Our equipment has been designed and tested for use with the specific types of components supplied by us therein and no responsibility can be accepted for the performance of the equipment if other components are employed.

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