AIRMEC

OPERATING INSTRUCTIONS

TELEVET TYPE 677

AIRMEC LIMITED · HIGH WYCOMBE · BUCKS

C O N T E N T S

CONTENTS

(Continued)

1. INTRODUCTION

The TeleVet is an extremely versatile instrument, which, despite its small size, enables a wide range of tests to be carried out on television sets, and provides facilities to the service engineer previously available only in laboratories or very well equipped service workshops. It is indispensable for the relatively inexperienced service-man, enabling faults to be tracked down logically, and provides an extremely useful tool for the highly experienced service engineer to whom the limitations of the normally available test gear are well-known. This handbook is intended to be of maximum assistance to all potential users.

A brief summary of the facilities of the TeleVet is given in Section 2, from which the experienced service engineer will be able to work out his own methods of employing the instrument. In order to assist him, however, in obtaining the fullest possible benefit from the TeleVet a complete programme for logically tracing faults is given in Section 4.

A detailed technical description of the circuit appears in Section 5, the electrical specification in Section 6, and maintenance instructions in Section 7.

Full instructions for operating the TeleVet to obtain each of the facilities provided are given in Section 3. Great care has been taken to make these instructions as simple and straightforward as possible, and it is absolutely essential for successful operation that they should be followed exactly as given. The user is recommended to work completely through Section 3 on a television set in order to familiarise himself thoroughly with the operation of the instrument before using it for servicing purposes.

IMPORTANT

PROBE A MUST BE REMOVED FROM RIGHT HAND RECESS BEFORE CONNECTING INSTRUMENT TO THE MAINS SUPPLY.

2. SUMMARY OF FACILITIES

The facilities provided by the TeleVet are listed below, and further information on voltage ranges, accuracy, etc. is given in Section 6.

Signal Generator

The signal generator covers the frequency bands of 8 to 70 Mc/s and 168 to 230 Mc/s, that is, the I.F. band, and bands 1 and 3. The output is obtained by mixing the outputs of two oscillators, so that signals in each range are present simultaneously, and no wave-change switch is required. The signal generator output is fed out through a coaxial cable to a probe unit, which also contains an attenuator. This signal generator can be frequency and amplitude modulated to provide the various required signal conditions.

Wobbulator

The signal generator may be frequency modulated with a frequency sweep of up to at least 12 Mc/s, at a modulating frequency of 50 c/s. If this signal is applied to the R.F. or vision I.F. sections of the television set, a rectified and amplified signal can be obtained from the modulating electrode of the C.R. tube, which represents the response of the tuned circuits. When using the wobbulator, the rectified signal is applied to the Y plates of the small C.R. tube in the TeleVet, and a 50 c/s signal is applied to the X plates. A complete response curve of the tuned R.F. and I.F. amplifiers is therefore displayed, enabling the effects of any adjustments to be observed at once.

Amplitude Modulated Signal

The signal generator may be amplitude modulated in order to test the sound channel of the television set. The signal may be injected into the R.F. or sound I.F. sections of the set, and should result in an audible note in the loudspeaker.

Audio Signal

An audio signal of variable level is available for testing the audio amplifier only. This may be fed in at the audio volume control, and should result in an audible note in the loudspeaker.

Pattern Generator

The signal generator may be amplitude modulated by a waveform which closely resembles the synchronising waveform used by the B.B.C. This modulated signal locks the raster, and also produces one horizontal and two vertical black lines, the pattern thus produced enabling the operation of the synchronising circuits and the linearity control adjustments of the television set to be checked.

Oscilloscope

The C.R. tube has an associated Y amplifier and attenuator, and a sawtooth time-base generator for the Y plates. It may therefore be used to examine the waveforms associated with the line and frame time-bases of the television set. Two ranges are provided on the sawtooth generator, one suitable for observing the frame, and the other the line time-base waveforms. A small range of velocity adjustment and internal synchronisation, are provided. The Y attenuator is calibrated, and in conjunction with a 'calibrated shift' control, enables the amplitude of any observed waveform to be measured.

D.C. Valve Voltmeter

The C.R. tube, calibrated 'Y' attenuator and calibrated 'Y' shift control form a D.C. valve voltmeter which enables voltages to be measured without placing an appreciable load on the circuit. This is particularly useful when measuring the potentials of valve electrodes, where an appreciable current drawn by the measuring instrument can completely change the voltage and provide very misleading results. Furthermore, as a special probe is provided which extends the maximum voltage which can be measured up to 20 kV, the D.C. valve voltmeter may be used to measure E.H.T. voltage.

A.C. Valve Voltmeter

As mentioned in the paragraph dealing with the oscilloscope facility above, the amplitude of a waveform displayed on the C.R. tube may be measured by means of the 'Y' attenuator and calibrated 'Y' shift control. The input impedance is high, as in the case of the D.C. measurements, and the instrument therefore operates as an A.C. valve-voltmeter at 50 c/s and audio frequencies.

Frequency Calibrator

The instrument contains a 5 Mc/s crystal oscillator which may be used to calibrate the output frequency to a very high degree of accuracy. This high setting accuracy is essential if television sets are to be adjusted when no B.B.C. transmission is taking place.

Suitability for A.C./D.C. Television Sets

The chassis and 'earth line' of the TeleVet are isolated from earth and from the case, and the instrument may therefore safely be used with A.C./D.C. television sets where the chassis may be 'live' relative to earth.

Unmodulated Oscillator and Output Meter

The servicing instructions for some television sets specify an alignment procedure which requires a CW oscillator and output meter. The instructions specify the frequency at which each trimmer should be adjusted for maximum reading on the output meter. Facilities for obtaining an unmodulated R.F. output of variable frequency are provided on the TeleVet. This together with the D.C. valve voltmeter facility described above enables alignment to be carried out in this manner.

All of the above facilities may be obtained by operation of switches on the TeleVet. The connections to the mains and to the television set are all made by leads and probes which are supplied permanently connected to the TeleVet, and stored during transit in recesses in the side of the case. The procedure required to obtain these facilities is given in Section 3.

3. OPERATION

IMPORTANT

For successful operation the instructions given in this Section MUST be strictly adhered to.

3.1 Initial Adjustment

The TeleVet is supplied complete and ready for use. All probes are permanently connected, and a mains lead is provided. A plug should be connected to the mains lead, the red, black, and green leads are line, neutral, and earth respectively. It is important that the earth lead should be connected to ensure correct screening.

The TeleVet is despatched with the mains tapping panel set for operation on 230 volt supplies. If operation on supplies of different voltage is required the fused plug on the tapping panel, which is accessible inside the right-hand probe storage hole should be moved to the required tap.

3.2 Frequency Calibration

Calibration against the internal crystal must be carried out whenever a high degree of frequency accuracy is required. The R.F. output signal of the TeleVet is obtained by beating the signals from two oscillators, one operating at 80 Mc/s and the other being variable from 88 to 150 Mc/s. Calibration entails checking each oscillator in turn as follows:-

3.2.1 Check 80 Mc/s Oscillator

(a) Set CHECK switch at SWEEP OSC.

(b) Set SELECT switch at SOUND

(c) Connect lead A.C.X1 of Probe C to live side of volume control on Television Set, and braided lead of Probe C to earth side of volume control.

(d) Switch on Television Set and turn volume control to maximum.

(e) Adjust preset CALIBRATE control carefully until audible beat note is heard in loudspeaker. The Oscillator is now adjusted exactly to 80 Mc/s.

NOTE The TeleVet must not be vibrated during the above procedure as movement of the frequency modulator reed will render the adjustment impossible.

3.2.2 Check Variable Oscillator

(a) With Connections as given in Section 3.2.1 above alter CHECK SWITCH to VAR.OSC. and SELECT SWITCH to VISION.

(b) If the required frequency is an exact multiple of 5 Mc/s rock the CENTRE FREQUENCY control slowly about this point on the dial until a beat note is heard in the loudspeaker. The variable oscillator is now adjusted to give the precise output frequency required.

(c) If the required frequency is not an exact multiple of 5 Mc/s locate the two multiples of 5 Mc/s on either side of the required frequency by obtaining beat notes as in (b) above. Note the readings on the subsidiary tuning dial at these two check points, and by subtraction obtain the number of divisions between them. Divide this number by 50 to obtain the number of divisions representing 100 kc/s, and multiply the result by the number of 100 kc/s by which the required frequency differs from the nearest check point. Shift the dial from the nearest check point by this amount. The variable oscillator is then adjusted to give the exact frequency required.

EXAMPLE: Required frequency 41.5 Mc/s

Reading of dial at 40 Mc/s = 51
Reading of dial at 45 Mc/s = 82.5

Number of divisions representing 5 Mc/s = 31.5
Number of divisions representing 100 kc/s = $\frac{31.5}{50}$

therefore Setting of dial for 41.5 Mc/s

$$= 51 + \left(\frac{31.5}{50} \times 15\right)$$

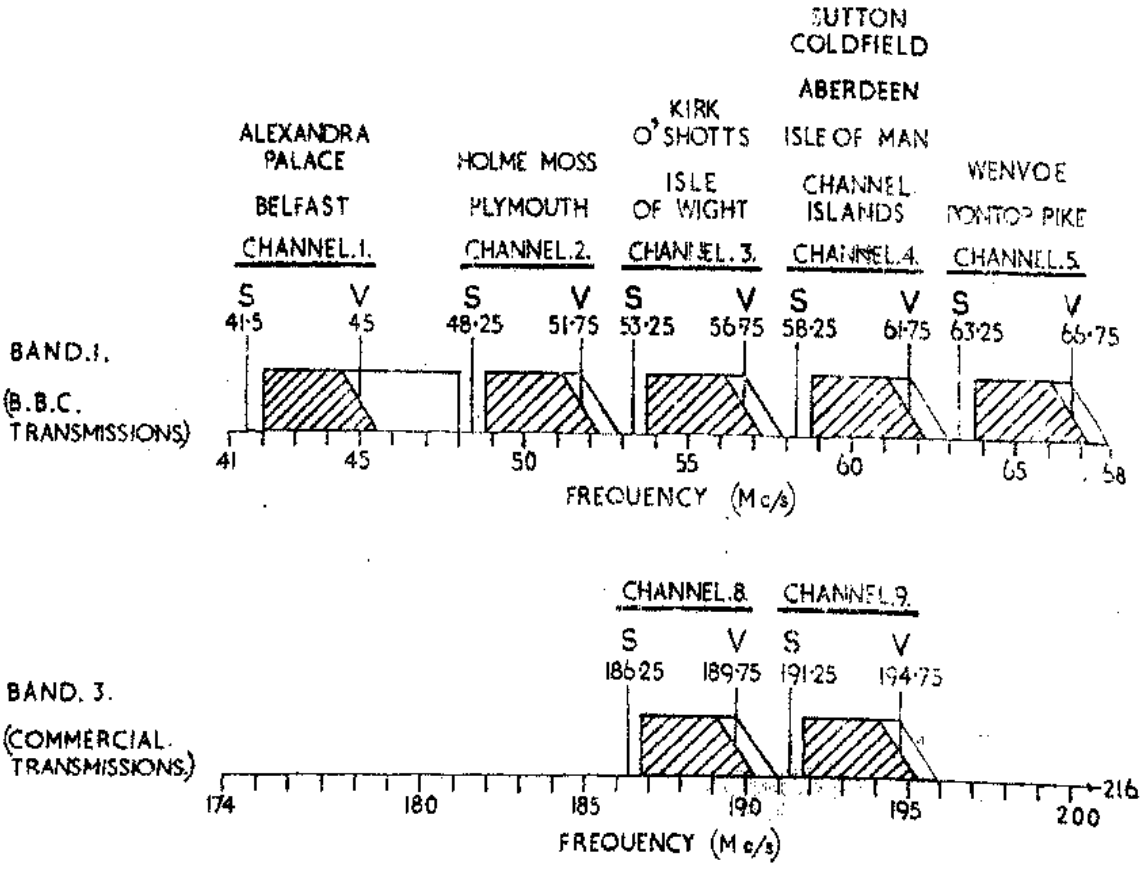
$$= 51 + 9.45$$

$$= 60.45$$

3.3 Wobbulator

The wobbulator is used to align the I.F. vision and R.F. tuned circuits by working on each stage in turn from the detector back towards the aerial input.

Wherever possible the set should be aligned to provide the response curve specified in the manufacturers service sheet. This information is essential for older types of straight set which may have double sideband or upper sideband response, but



NOTE:- IDEAL VISION RESPONSE CURVES ARE SHOWN SHADED.

FIGURE. 1. TELEVET TYPE 877 TELEVISION FREQUENCY ALLOCATION. (BASED ON INFORMATION AVAILABLE AT DATE OF PUBLICATION)

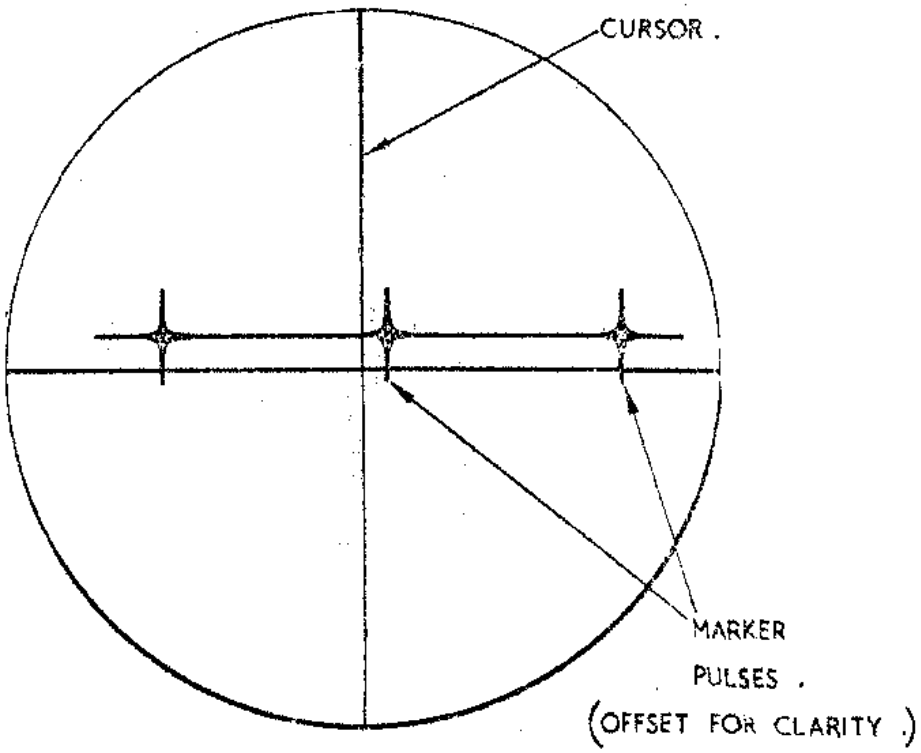


FIGURE 2. TELEVET TYPE 877. TYPICAL MARKER PULSE DISPLAY

Figure 1 gives the required vestigial sideband responses used by most modern super-heterodyne receivers.

The following points should be noted regarding vestigial sideband receivers.

(i) The sound carrier is always 3.5 Mc/s below the vision carrier.
(ii) The frequency bands of the vision signal always extend to 3 Mc/s below the vision carrier.
(iii) The height of the curve at the vision carrier frequency is exactly half that of the flat portion of the curve.
(iv) If the Local Oscillator is operating above the carrier frequency, signals fed into the I.F. circuits will produce a mirror image of curves shown in Figure 1.

Having ascertained the precise shape and frequency limits of the response curve required proceed as follows:-

(a) Check calibration at required points as detailed in Section 3.2. Note the subsidiary scale readings for these points.

(b) Connect lead A.C.X1 of Probe C to modulating electrode of C.R. tube. If not known connect to anode of video output valve.

(c) Connect centre conductor of coaxial lead on Probe A to grid of valve feeding tuned filter under adjustment. Connect braid of same lead to chassis as close to the earth of the valve as possible. (Note. Miniature Crocodile clips may be fitted to the Probe A lead for use at I.F. frequencies providing the lead lengths are kept to an absolute minimum. They are, however, unsuitable for R.F. frequencies).

(d) Set CHECK switch at SWEEP OSC.

(e) Set SELECT switch at VISION

(f) Adjust FOCUS control for sharp trace on TeleVet C.R. tube.

(g) Turn DEVIATION control in anti-clockwise direction until 3 marker pips are visible on C.R. tube. (The distance between adjacent pips represents 5 Mc/s).

(h) Adjust X SHIFT control to bring middle marker pip exactly under the vertical centre line on the graticule. (Do not alter X SHIFT again subsequently or accuracy of calibration will be lost).

(i) Set Y GAIN control at X10.

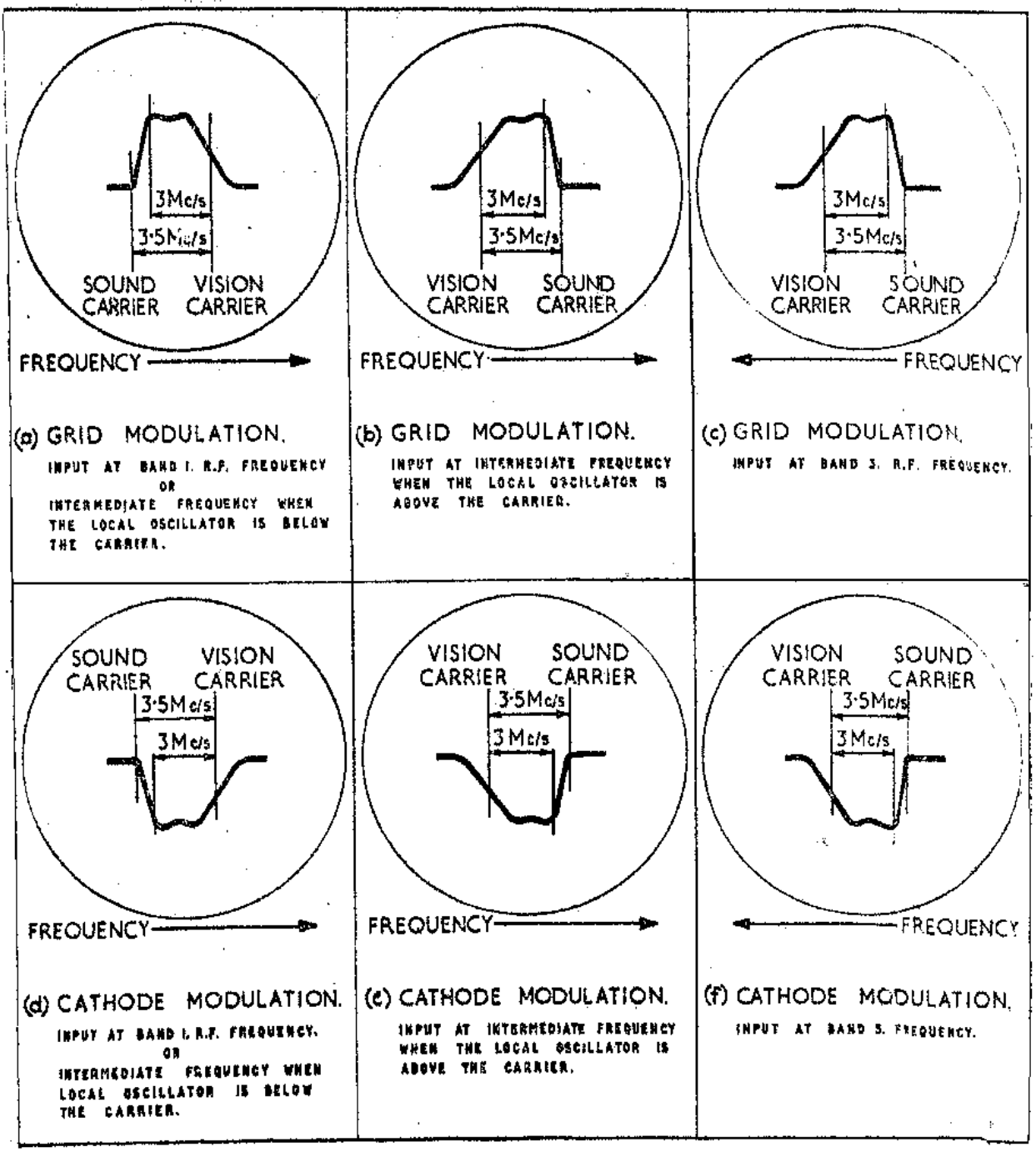


FIGURE. 3. TELEVET TYPE 877. TYPICAL WOBBULATOR RESPONSE CURVES.

(j) Set CHECK switch to NORMAL. (The markers pips will vanish).

(k) Fit the movable plug on Probe A into socket X1.

(l) Turn R.F. OUTPUT control to maximum (fully clockwise).

(m) If I.F. circuits are being aligned, stop Local Oscillator operating by short-circuiting oscillator coil or removing valve.

(n) Turn CENTRE FREQUENCY control to vision carrier I.F. or R.F. frequency as required. A response curve should appear on C.R. tube.

(o) If response curve nearly fills screen reduce input by means of the R.F. Output control and/or by plugging lead on Probe A into XO.1 or XO.01 sockets until signal reduces in amplitude without changing shape.

(p) Adjust Y SHIFT to centralise picture.

(q) If grid modulation is employed the curve will appear above the centre line (as shown in Figure 3 (a), (b), and (c)) whilst if cathode modulation is used the curve will drop below the centre line (Figure 3 (d), (e), and (f)). The frequency increases from left to right for I.F. and Band 1 (figure 3 (a) and (d)) and from right to left on Band 3 (figure 3 (c) and (f)). With inputs to the I.F. when the Local Oscillator is above the carrier frequency a mirror image is obtained (figure 3(b) and (e)).

(r) To identify any particular point on the curve, set the CENTRE FREQUENCY dial to the required frequency using the reading on the subsidiary scale calibrated in (a) above. This frequency now appears precisely under the centre vertical cursor line on the C.R. tube.

(s) To measure the bandwidth of the curve shift the picture past the centre vertical cursor line by adjusting the CENTRE FREQUENCY control. The bandwidth can then be read directly in frequency on the tuning dial.

(t) Adjust the trimmers in the stage under test to obtain the required response.

(u) Transfer Probe A to the preceding stage and repeat the procedure with reduced input. (Note. If reduction in input is not required the stage is probably faulty).

(v) Repeat procedure until entire I.F. amplifier is aligned. If a sound rejector circuit is provided in one of the stages it should be adjusted for maximum rejection at the sound carrier I.F. frequency.

(w) Finally, restore the operation of the Local Oscillator and connect Probe A to the aerial terminal using, if possible, a suitable coaxial plug. Should no plug be available great care must be taken particularly on Band 3 to keep the leads very short indeed.

(x) On A.C./D.C. type sets connect braided earth lead of Probe C to nearest earth point to the A.C.X1 lead connection. (This is unnecessary on A.C. type sets since a D.C. earth connection will already be made by Probe A to the aerial input).

(y) If minimum signal from TeleVet is still too high for operating the wobbulator with input on the aerial, the Contrast control on the Television Set should be turned down to reduce sensitivity.

(z) Check with wobbulator at R.F. frequency and align R.F. tuned circuits to provide correct overall response. (Correct adjustment of the Local Oscillator frequency should be carried out on a sound signal as described in Section 3.4.2 following).

Since the output for the TeleVet is obtained by mixing two signals, spurious responses may occur under some circumstances. These responses are not in general troublesome since they are considerably smaller in amplitude than the required response and may be identified by reference to Table 1.

3.4 Sound Channel Output

The audio amplifier of the sound channel may be tested by injecting a low frequency signal at the grid of the output valve, or on the 'live' end of the volume control. The R.F. and I.F. sound channel may be tested by means of a carrier modulated with an audio signal.

3.4.1 Audio Test Tone

(a) Connect lead A.C.X1 of Probe C to grid of output valve or live end of volume control, and earth lead from Probe C to chassis.

(b) Set CHECK switch at NORMAL.

(c) Set SELECT switch at SOUND

(d) Set Y GAIN switch at X1. A 5 kc/s audio signal of approximately 2 volts amplitude will now be fed into the audio section of the television set, and an audible note should be heard in the loudspeaker. The signal can be reduced by rotating the Y GAIN control.

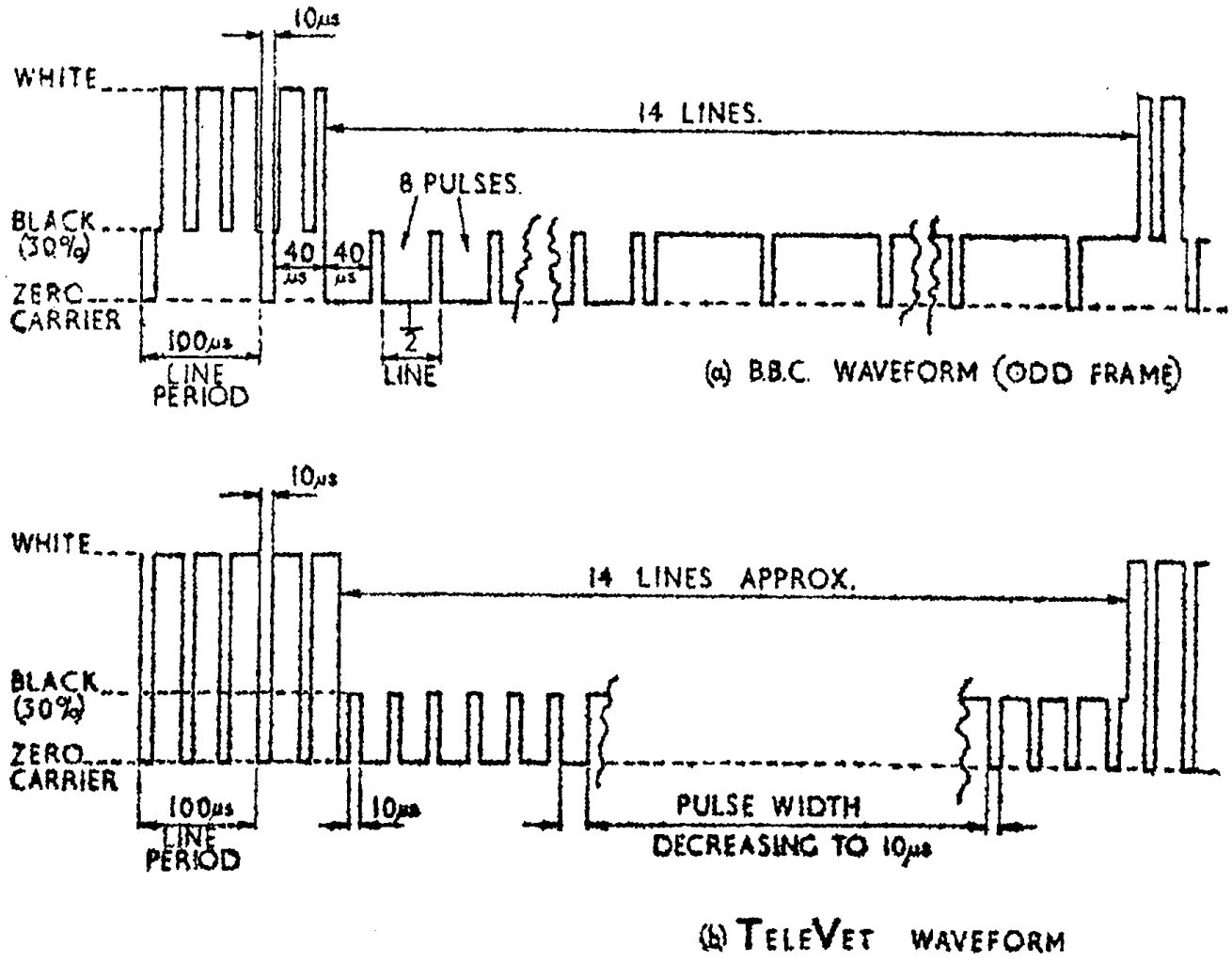


FIGURE 4 TELEVET TYPE 877. SYNCHRONISING WAVEFORMS.

3.4.2 Modulated Carrier Test Tone

(a) Check frequency calibration at the required frequency as detailed in Section 3.2. Note the subsidiary scale readings.

(b) Connect centre conductor of Probe A coaxial lead to grid of final sound I.F. valve, and the outer conductor to earth, preferably close to the earth associated with the valve.

(c) Fit the movable plug on Probe A into Socket X1 and turn R.F. OUTPUT control to maximum.

(d) Set CENTRE FREQUENCY control at the I.F. sound carrier frequency.

(e) Turn volume control of television set to maximum.

(f) Adjust the trimmers of the anode tuned circuit of the last sound I.F. valve until an audible note is heard in the loudspeaker.

(g) Progressively reduce the input by means of the R.F. OUTPUT control and/or the plug on Probe A, until a clearly defined maximum volume condition can be obtained by adjusting the trimmers.

(h) Remove Probe A and repeat procedure on the previous stage.

(i) Repeat until all tuned circuits in the sound I.F. amplifier have been aligned, the last test being made by applying Probe A to the grid of the frequency changer with the local oscillator made inoperative.

(j) Set the frequency very carefully to the sound carrier frequency (re-checking calibration if necessary) and connect Probe A lead to the aerial socket. Restore Local Oscillator and tune to give maximum volume from loudspeaker. (If the transmitter is operating, this final adjustment may more readily be carried out by plugging the aerial in and tuning for maximum volume on the transmitted signal).

3.5 Pattern

The TeleVet carrier signal may be modulated by a synchronising waveform to give the pattern shown in Figure 5. The synchronising signal is very similar to that transmitted by the B.B.C. as may be seen from Figure 4. It is, however, unsuitable for use on the flywheel synchronising circuits

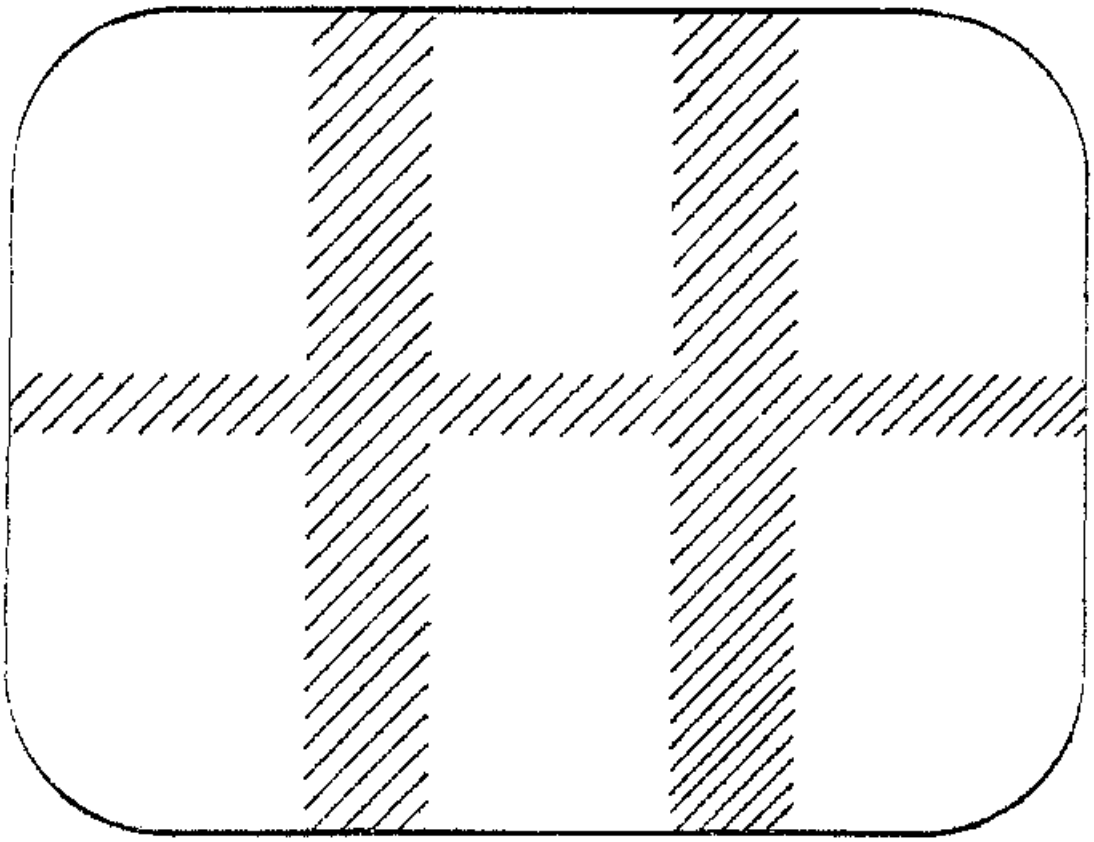


FIGURE 5 . TELEVET TYPE 877 . TYPICAL PATTERN

employed in fringe area sets, and if a pattern facility is needed in these circumstances reference should be made to Section 4.7.1.

(a) Connect centre conductor of Probe A coaxial lead to the grid of a vision I.F. valve, the grid of the frequency changer, or the aerial socket as required. Connect outer conductor to valve earthing point or to low potential aerial terminal. Keep leads as short as possible.

(b) Set the CENTRE FREQUENCY control at the vision I.F. carrier, or the vision carrier as required.

(c) Set CHECK switch at NORMAL.

(d) Set SELECT switch at PATTERN.

(e) Set movable plug on Probe A into the socket X1 and turn R.F. OUTPUT control to maximum.

(f) A bright white raster should appear on the C.R. tube of the television set. Reduce R.F. voltage by means of the R.F. OUTPUT control and/or by moving plug on Probe A to X0.1 or X0.01, until a black and white picture appears.

(g) Lock pattern by manipulating line and frame hold controls in television set. The pattern should appear as shown in Figure 5.

(h) Since the pattern should be symmetrical, it may be used to check the picture linearity as well as the line and frame hold synchronising circuits.

3.6 Oscilloscope

Both synchronising and sweep voltage waveforms associated with the line and frame time-base circuits may be displayed on the C.R. tube of the TeleVet. Information on the waveforms to be expected at various test points is usually given by the set manufacturer in the servicing instructions.

(a) Connect the lead A.C.X1 of Probe C to point at which the waveform is to be observed.

(b) Connect earth lead from Probe C close to the point of connection of the A.C.X1 lead.

(c) Set CHECK switch at NORMAL.

(d) Set SELECT switch at T.B. LINE or T.B. FRAME as required.

(e) Rotate Y GAIN switch until a picture of reasonable height is obtained.

(f) Rotate T.B. FREQ. control until a steady picture is obtained.

(g) Adjust FOCUS and BRILLIANCE controls to obtain the best focus.

(h) If the peak-to-peak voltage of the signal is required, rotate the Y SHIFT control until the bottom of the waveform coincides with the horizontal cursor line, and note reading on Y SHIFT dial. Then rotate control until the top of the waveform coincides with the horizontal line. The value of the volts 'shifted' on the Y SHIFT control, multiplied by the factor indicated on the Y GAIN control is the peak-to-peak voltage of the observed signal.

3.7 Valve Voltmeter D.C.

Two probes are provided for D.C. voltage measurements. Probe B is for E.H.T. measurements up to 20 kV and is marked D.C.X100. A lead on Probe C is marked D.C.X10 and this is intended for H.T. measurements up to 2 kV and bias voltage measurements down to 2 volts.

3.7.1 E.H.T.

(a) Set CHECK switch at NORMAL

(b) Set SELECT switch at VISION

(c) Adjust BRILLIANCE and FOCUS controls to give clear horizontal line on C.R. tube.

(d) Rotate Y SHIFT control until this line coincides with horizontal cursor line. (The pointer on the Y SHIFT control should then point to 0. If it does not a correction may be made to any subsequent measurements, or the grub screw on the knob may be loosened and the knob turned round to register correctly at the 0 mark).

(e) Switch off television set.

(f) Connect Probe B to the point at which the E.H.T. (D.C.) is to be measured.

(g) Connect earth lead of Probe C to chassis of the television set.

(h) Switch on television set. Turn BRILLIANCE to minimum.

(i) The Line will be deflected upwards if the E.H.T. is positive and downwards if it is negative.

(j) Rotate Y GAIN switch until a reasonable deflection is obtained. (For instance, when measuring 5 kV, the switch should be in the X30 position).

(k) Rotate Y SHIFT control until trace once more coincides with horizontal cursor.

(l) The E.H.T. voltage is then the reading on the Y SHIFT control multiplied by the reading of the Y GAIN control multiplied by 100.

3.7.2 H.T.

(a) Proceed as in 3.7.1 (a) to (d).

(b) Connect lead D.C.X10 of Probe C to point at which measurement is required, and earth lead to chassis.

(c) The line should be deflected upwards if the voltage is positive and downwards if it is negative.

(d) Rotate Y GAIN switch until a reasonable deflection is obtained. (For instance, when measuring 120 volts, the switch should be in the X10 position).

(e) Rotate Y SHIFT control until trace once more coincides with horizontal cursor.

(f) The voltage to be measured is then the reading on the Y SHIFT control multiplied by the reading on the Y GAIN control multiplied by 10.

3.8 Valve Voltmeter A.C.

The peak-to-peak voltage of A.C. signals in the voltage range of 0.2 to 400, and frequency range 50 c/s to 15 kc/s may be measured by means of Probe C. Higher values of power supply voltage at 50 c/s may be measured by employing Probe B.

3.8.1 A.C. Voltages Below 400 Peak-to-Peak

(a) Set CHECK switch at NORMAL

(b) Set SELECT switch at T.B. FRAME or T.B. LINE

(c) Set Y GAIN switch at X100

(d) Set Y SHIFT control at 0

(e) Adjust FOCUS and BRILLIANCE controls to give a clear trace.

(f) Connect lead A.C.X1 of Probe C to point at which measurement is required, and Probe C earth lead to chassis.

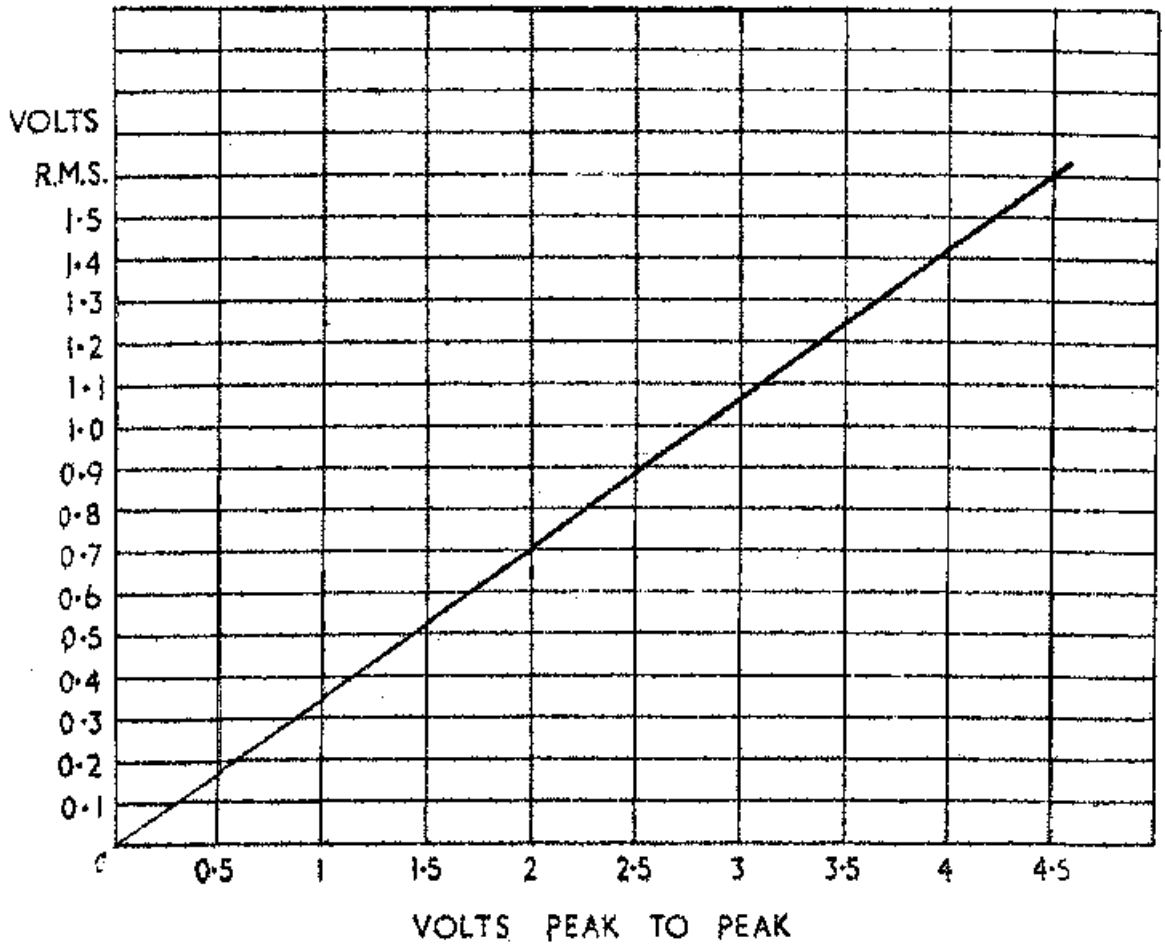


FIGURE 6 TELEVET TYPE 877 . VOLTAGE CONVERSION CHART

(g) Rotate Y GAIN switch until a trace of reasonable height is obtained. If the signal is at 50 c/s it will be possible to synchronise this signal, but this is unnecessary for voltage measurements. Higher frequencies will appear as a broad band of light on the C.R. tube.

(h) Rotate Y SHIFT control until the bottom of the trace, (representing the negative peak of the waveform) coincides with horizontal cursor. Note reading on Y SHIFT dial.

(i) Rotate Y SHIFT control until the top of the trace (representing the positive peak of the waveform) coincides with horizontal cursor. Note reading on Y SHIFT dial.

(j) The difference between the two readings is then equal to the total 'shift' volts required to move the trace from negative to positive peak. The peak-to-peak voltage is equal to this voltage multiplied by the factor indicated on the Y GAIN switch. For measurements at 50 c/s, the R.M.S. voltage is generally required. The relation between peak-to-peak and R.M.S. voltage is 2.83:1, and a conversion chart is given in Figure 6.

3.8.2 50 c/s Voltage above 400 Volts

(a) Proceed as (a) to (e) in Section 3.8.1.

(b) Connect Probe B lead to point at which measurement is required, and earth lead of Probe C to chassis.

(c) Proceed as (g) to (i) in Section 3.8.1.

(d) The peak-to-peak voltage is equal to the 'shift' voltage required to move from the negative to the positive peak multiplied by 100, multiplied by the factor indicated on the Y GAIN switch. Conversion to R.M.S. value may be obtained from Figure 6.

3.9 Unmodulated Carrier and Output Meter

Some manufacturers recommend aligning their sets by adjusting the trimmers to obtain maximum responses at certain specified frequencies. This procedure may be carried out as follows:-

(a) Check the frequency calibration at required points as detailed in Section 3.2. (Note readings on the subsidiary scale).

(b) Connect lead marked D.C.X10 of Probe C to modulating electrode of C.R. tube. If not known connect to video amplifier valve anode. Connect the screen lead from Probe C to chassis.

(c) Turn Y GAIN switch to X10 position.

(d) Set CHECK switch at NORMAL.

(e) Set SELECT switch at T.B. LINE.

(f) Rotate Y SHIFT control to bring trace back to within 0.5 inch of the horizontal cursor.

(g) Adjust FOCUS and BRILLIANCE controls to give a fine trace.

(h) Connect centre conductor of coaxial lead on Probe A to the point of signal injection called for in the alignment procedure of the set. Connect braid of same lead to chassis as close to the earth of the valve as possible.

(i) Set CENTRE FREQUENCY control to give frequency called for in alignment procedure.

(j) Plug movable lead of Probe A into socket XO.01, and set R.F. OUTPUT control at minimum.

(k) Progressively increase the input by means of the R.F. OUTPUT and/or the Probe A attenuator until the line on the C.R. tube is displaced.

(l) Tune the trimmer specified to give maximum displacement of the trace.

(m) Transfer Probe A to the next point of signal injection called for in the alignment instructions and repeat (i) to (l).

(n) Proceed to earlier stages in accordance with instructions until all circuits have been aligned.

4. PROCEDURE FOR FAULT FINDING

In this section the various faults which may occur on a television set are grouped under headings which are readily identified. A logical procedure for finding the cause of the fault, and the manner in which the TeleVet should be employed to assist in tracing the trouble, is given for each particular category of fault.

4.1 Sound and Picture Off

Possible causes:-

(a) Aerial disconnected or faulty
(b) Heater supply off
(c) H.T. faulty
(d) R.F. stage faulty
(e) Local oscillator or Frequency Changer faulty
(f) Both sound and vision I.F. amplifier or output circuits faulty.

Before removing the set from the cabinet:-

(a) Connect Probe A to the aerial terminals.

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

(c) Set the CHECK switch at NORMAL.

(d) Set the SELECT switch at SOUND.

(e) Set the R.F. OUTPUT control at maximum (clockwise).

(f) Rotate the CENTRE FREQUENCY control through the sound and vision bands to which the television set should be tuned.

(g) As the frequency is swept through the sound carrier frequency, a note should be heard in the loudspeaker. As it is swept through the vision band, the screen of the television C.R. tube should brighten. If this occurs the fault is probably in the aerial. If not, proceed as below.

Remove the set from the case and switch on. Inspect for heaters glowing. If heaters on an A.C./D.C. set do not glow, the fault may be due to one faulty heater. Use procedure of Section 3.8.1 to measure heater voltage. For an A.C. set, the heater supply should be checked at the transformer. For an A.C./D.C. set, the voltage should be measured between each valve heater and earth, until the break in the series chain is located.

If heaters glow, check the H.T. voltage as detailed in Section 3.7.2.

If H.T. and heaters appear in order:-

(a) Connect Probe A to the grid of the frequency-changer and the earth lead to earth at a point conveniently close.

(b) Plug the flying lead on Probe A into the socket marked XO.1.

(c) Set the CHECK switch at NORMAL.

(d) Set the SELECT switch at SOUND.

(e) Set the R.F. OUTPUT control at maximum.

(f) Rotate the CENTRE FREQUENCY control through the sound and vision I.F. bands, and then through the sound and vision bands to which the set should be tuned.

(g) As the frequency is swept through the sound carrier frequencies, a note should be heard in the loudspeaker, and as it is swept through the vision band the screen of the C.R. tube should brighten. If this occurs on both I.F. and R.F. frequencies, the fault lies between aerial and frequency changer, that is, in the R.F. stage. If this occurs on the I.F. band but not the R.F., the fault probably lies in the local oscillator which is failing to oscillate. If this does not occur in either band the frequency changer stage is faulty, or both sound and vision channels are faulty.

(h) The latter possibility can be checked by proceeding as in (a) to (f), but making connection to the grid of the first sound or vision I.F. amplifier. As the oscillator is manually swept through the I.F. sound and vision frequencies a note should be obtained from the loudspeaker, and the screen should brighten, respectively. If either of these checks fail, faults exist on the individual sound or vision channels, and the procedure detailed in 4.2 or 4.3 should be followed.

4.2 Sound Off, Picture On

Possible causes:-

(a) Local oscillator off frequency
(b) Audio amplifier or loudspeaker faulty
(c) Sound I.F. amplifier faulty

Before removing the unit from its case, proceed as in (a) to (e) of Section 3.2. Manually rotate the CENTRE FREQUENCY

dial to about 5 Mc/s on either side of the sound carrier frequency to which the set should be tuned. An audible note should be heard in the loudspeaker as the sound carrier frequency is swept through. If a note is heard, it is probable that the frequency at which it occurs differs from the correct frequency, which indicates a local oscillator frequency error. Remove the instrument from its case, and tune the local oscillator, on the B.B.C. transmission if it is operating, or by means of the TeleVet using the procedure of Section 3.4.2 if the B.B.C. is not transmitting.

If no note is heard, proceed as below.

(a) Apply an audio signal from Probe C to the grid of the output valve as detailed in Section 3.4.1.

(b) If no audible note is heard in the loudspeaker, measure the D.C. voltage on the cathode of the output valve as detailed in Section 3.7.2. If no voltage exists, the valve or power supplies to the valve are faulty. If a voltage of between about 3 on 12 is found on the cathode, the fault is probably on the loudspeaker.

(c) If an audible note is heard, apply the audio test tone to the grid of the L.F. amplifier, the slider of the volume control and the 'live' end of the volume control in that order. Failure at any of these stages will indicate the locality of the fault. If a note is obtained from the 'live' end of the volume control the fault is in the I.F. sound amplifier.

(d) If the I.F. amplifier is faulty, proceed as in Section 3.4.2. As the fault may be a valve, it is advisable not to alter the trimmer settings unless they are found to be seriously in error, or until all stages have been checked to ensure that another fault does not exist.

4.3 Picture Off, Sound On

If the picture fails, the C.R. tube of the television set will in general be either fully illuminated, fully dark, or a dark background with an incomplete raster consisting of either a horizontal or vertical line, or a bright spot.

4.3.1 Bright Raster

Possible causes:-

(a) Incorrect setting of contrast control, or faulty contrast control.
(b) Faulty synchronisation
(c) Instability
(d) Faulty background control
(e) Faulty video stage

Proceed as follows:-

(a) Turn down the contrast control. If the picture darkens suddenly the fault may be either a faulty contrast control, or instability. If it darkens gradually and the picture does not appear, the fault is probably lack of synchronisation. (See Section 4.6).

(b) Disconnect the aerial. If the picture darkens, the fault is probably in the contrast control. If it does not darken continue as below.

(c) Connect the grid of the last vision I.F. valve to chassis with a short length of lead. If the screen darkens the fault is probably instability. If so it will be necessary to check the alignment of the vision I.F. and R.F. sections using the procedure detailed in Section 3.3. Instability will generally be indicated by a sharp peak on the response curve as shown on the wobbulator.

(d) Leaving the grid of the last sound I.F. valve earthed, rotate the background control anticlockwise. If the screen darkens the fault lies in the video output valve or coupling to the C.R. tube. In the absence of signal, the current through this valve should be high, (greater than 10 milliamps) if grid modulation is used on the C.R. tube; and the valve should be almost cut off if cathode modulation is used. These conditions can be checked by measuring the H.T. voltage between each end of the anode load resistor and earth using the procedure detailed in Section 3.7.2.

(e) If when test (d) is made the screen does not darken, measure the D.C. voltage between grid and earth, and cathode and earth of the C.R. tube using the procedure detailed in Section 3.7.2. The first voltage should be between 20 and 50 volts less than the first, and the difference should increase as the background control is rotated anticlockwise.

4.3.2 Dark Raster

Possible causes:-

(a) Faulty or grossly misadjusted contrast or background controls.
(b) Faulty E.H.T.
(c) Faulty C.R. tube
(d) Faulty video amplifier
(e) Faulty vision I.F. amplifier

Proceed as follows:-

(a) Turn the background control to maximum (clockwise). A bright raster should be obtained. If a bright raster is not obtained, measure the E.H.T. voltage as detailed in Section 3.7.1, and the heater voltage on the C.R. tube as detailed in Section 3.8.1. If these are correct, connect the grid and cathode of the C.R. tube together. If a bright raster is still not obtained, the C.R. tube is probably faulty. If a bright raster is obtained, remove the short circuit and apply test (e) of Section 4.3.1, and check that the voltage difference decreases as the background control is rotated clockwise. It should be possible to reduce the voltage difference to not more than 10 volts, if not, the background control circuit or video output circuit are faulty.

(b) If a bright raster is obtained when the background control is rotated, either the video amplifier or video I.F. amplifier are faulty.

(c) Adjust the background control to give a grey raster.

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

(e) Set the CHECK switch at NORMAL.

(f) Set the SELECT switch at SOUND.

(g) Set the Y GAIN switch at X1

(h) A brighter raster of mottled appearance should be obtained. If no change in the raster occurs, the fault is in the video amplifier.

(i) If a mottled raster is obtained from (h), the fault is in the vision I.F. amplifier or detector. Use the wobbulator as described in Section 3.3 to check each stage in turn. Check each stage before readjusting the trimmers, to ensure that a definite fault does not exist. Also check that the contrast control varies the gain of the complete amplifier.

4.3.3 Incomplete Raster

Possible causes:-

(a) No line scan
(b) No frame scan
(c) No frame or line scan

The symptoms of the three faults listed above are a single bright vertical line on a dark screen, a single horizontal line on a dark screen, and a single very intense spot on a dark screen respectively. It should be pointed out that in sets employing flyback E.H.T., the absence of line scan will probably appear as a failure of E.H.T., and no bright vertical line will appear when this occurs.

Faults on either time-base may best be located by using the oscilloscope on the TeleVet as detailed in Section 3.6, and observing the waveform in turn on the time-base generator, time-base amplifier, and deflection coils.

Failure of both time-bases will almost certainly be caused by failure of a power supply to the time-base part of the chassis. The H.T. and heater supplies to each valve should be checked, first by inspecting for glowing heaters, and then by measurement using the TeleVet as detailed in Sections 3.7.2 and 3.8.1.

4.4 Poor Sound Reproduction

Complete failure of the sound has been dealt with in Section 4.2. Poor sound reproduction may be subdivided into faint or distorted sound, or sound in the presence of excessive hum. Picture break-through in the sound channel may however produce a strong 50 c/s note which is hard to distinguish from mains hum. The note is caused by the frame synchronising pulses, and will generally disappear when the aerial is removed.

4.4.1 Sound Faint

Possible causes:-

(a) Aerial faulty
(b) Frequency changer faulty
(c) R.F. stage faulty
(d) Power supplies low
(e) Local oscillator off-tune
(f) Audio amplifier faulty
(g) Sound I.F. amplifier faulty

The first four possibilities will affect both sound and vision, hence first ascertain whether vision has deteriorated as well as sound. If so, measure the H.T. and heater voltages as detailed in Sections 3.7.2 and 3.8.1 respectively. If these voltages are normal proceed as follows:-

(a) Connect the inner conductor of the lead of Probe A to the anode of the frequency-changer. Connect the outer conductor to the chassis at a point close to the point of connection of the inner conductor.

(b) Set the CHECK switch at NORMAL

(c) Plug the flying lead on Probe A into the XO.1 socket and set the R.F. OUTPUT control at maximum (clockwise).

(d) Set the CENTRE FREQUENCY control at the sound intermediate frequency, and rock the control about this point until an audible note is heard in the loudspeaker.

(e) Adjust the R.F. OUTPUT control and/or the plug on Probe A until the note is faint.

(f) Transfer the connections from Probe A to the grid of the frequency changer, the grid of the R.F. amplifier, and the aerial socket in turn.

(g) Set the CENTRE FREQUENCY control in each case to the sound carrier frequency, and rock the control about this point until an audible note is heard. This note should become progressively louder on the successive points of connection. If the volume does not increase when transferring from frequency changer anode to grid, frequency changer grid to R.F. stage grid, or R.F. stage grid to aerial socket, the fault exists in the frequency changer, R.F. stage or input tuned circuit respectively.

If the vision has not deteriorated proceed as follows:-

(a) If the B.B.C. is transmitting, adjust the local oscillator trimmer for maximum volume.

(b) Connect the lead A.C.X1 of Probe C to the live end of the volume control. Turn the volume control to maximum and proceed as detailed in Section 3.4.1. A loud note should be heard in the loudspeaker. If not, the audio amplifier or loudspeaker are faulty.

(c) If the audio amplifier appears to be in order, check the alignment of the sound I.F. and local oscillator as detailed in Section 3.4.2. Note that when properly aligned the volume obtained increases considerably for each additional stage introduced during the alignment procedure.

4.4.2 Sound Distorted

Possible causes:-

(a) Faulty loudspeaker
(b) Faulty audio amplifier
(c) Faulty detector
(d) Unstable I.F. amplifier

The distortion may be either frequency distortion, giving rise to excessive base or top response, or harmonic distortion, causing harshness and rattle in the reproduction. Excessive base response may be due to instability in the sound I.F. amplifier resulting in a small effective bandwidth. The bandwidth is normally so wide however, that this is a very rare fault. If it occurs the sound I.F. amplifier should be aligned as detailed in Section 3.4.2.

If harmonic distortion is present, proceed as follows:-

(a) Obtain a small voltage at 50 c/s (say one volt R.M.S. from the heater supply in the television set, and apply this to the 'live' end of the volume control. A 50 c/s note should be heard in the loudspeaker.

(b) Adjust the volume control until distortion is present.

(c) Connect the lead A.C.X1 of Probe C in turn to the 'live' end of the volume control, the slider of the volume control, the grid of the audio amplifier valve, the anode of the audio amplifier valve, the grid of the output valve, the anode of the output valve, and the secondary of the output transformer, using the procedure outlined in Section 3.6. The T.B. FRAME position of the SELECT switch should be used.

(d) Obtain a steady trace at each position and examine for distortion. This will be shown up by a marked difference from the original waveform as applied to the 'live' end of the volume control. This should enable the point at which distortion is introduced to be located.

(e) If no distortion is apparent the fault may be due to the loudspeaker. A torn cone, moving coil out of centre, or foreign matter in the gap may result in serious distortion.