# SECTION 3

## TELEVISION TEST GENERATOR TV/TG/2

### Introduction

The Television Test Generator TV/TG/2 has been developed as a portable unit for use in the field. It does not provide a true television signal waveform, but only line-sync pulses in combination with one of a set of picture signals. The available picture signals comprise a line bar, a frame bar and a line sawtooth; alternatively a signal from an external source can be employed. To the line sawtooth, frame bar and external signals, suppression pulses are applied, and a variable d.c. component (' lift ') can be added. The output impedance of the unit is 75 ohms, and the normal output into a matched load is one volt d.a.p.

A small waveform-monitoring cathode-ray tube is incorporated and this can be used to observe the output waveform, or for servicing purposes. To assist in setting up, the tube is provided with a calibrated graticule.

The generator is mounted on a 19 × 10½ inch panel suitable for bay mounting; when so mounted it projects through the bay. Power supplies are normally obtained from a stabilised power-supply unit SPS/7. For portable use, the test generator and power-supply unit can be fitted with standard side cheeks.

### Circuit Description

A circuit diagram of the complete unit is shown in Fig. 9. For the purpose of description it is convenient to consider first the picture/sync mixer and output stages, since the complete waveform is generated by adding the sync pulses to a composite picture signal, which includes the suppression pulses. In the subsequent description the master oscillator is first described followed by the suppression-pulse generator, the suppression-pulse/picture mixing stages, the sync-pulse generating stages and the picture generating stages. The waveform monitor is described separately later.

The mixing stages in which the picture and sync signals are combined comprise V6 and V7. These are two valves sharing a common anode load, the picture signal being applied to the grid of one (V6) and the sync signals to that of the other (V7). Each valve has negative feedback provided by its cathode-resistance chain, so that the amplitudes of the picture and sync signals can be adjusted independently. In V6 the grid bias is provided by R162 only; bias conditions are thus not altered as the feedback is varied. In V7, this precaution is not necessary since linear amplication is not particularly required; the valve is nearly at cut-off except at the periods when sync pulses occur. The major portion of the common anode load is provided by the shunt-fed resistor R34. The value of this resistance is low to minimise the effect of shunt capacitance.

The output stage comprises V8, V9 and V10 with negative feedback applied from the cathode of V10 to the cathode of V8. The output is taken from the anode of V10, and the effect of the feedback is to improve the output current/input voltage characteristic. For this reason, the load resistance must of necessity be small. In fact, it is normally some 37·5 ohms provided by R48 and the external load in parallel. To produce the standard output of 1 volt d.a.p. the output valve has thus to deliver a current of some 27 milliamps d.a.p. The bias for V8 is determined largely by the current of V10 and hence the amplifier should not be operated with V10 removed.

The anode load resistors of V8 and V9 are chosen in accordance with the conditions for maximal flatness with the degree of feedback employed*, approximately 28 db at medium frequencies.

The interstage-coupling capacitors are also proportioned to meet maximal flatness conditions at low frequencies.

### Master Oscillator Stage

The master oscillator stage is a free-running Miller-transitron sawtooth generator V11. The stage is of conventional design; the repetition frequency is about 10 kc/s, and this frequency can be adjusted within narrow limits by means of the control R56 (*Master Oscillator Frequency*). The output at the anode comprises a sawtooth, which is used as one of the picture signals (*Line sawtooth*); R170 (*Sawtooth Amp*) gives a pre-set control of this signal

* For a discussion of this technique, reference should be made to *Television Engineering*: Volume 2, and an article by C. F. Brockelsby 'Negative Feedback Amplifiers', *Wireless Engineer*, February, 1949.

amplitude. At the screen grid a rectangular waveform is developed, and a portion of this output (across R163) is used to trigger the suppression-pulse generator. These pulses are negative-going, and the leading and trailing edges are coincident with the beginning and end of the flyback period of the sawtooth waveform.

### Suppression-pulse Generator

The suppression pulse is generated by the monostable cathode-coupled stage V12. The stage is biassed so that under quiescent conditions, V12(a) is conducting whilst V12(b) is at cut-off. Negative-going pulses from the master oscillator are applied to the grid of V12(a) via the short time-constant network C29, R60, with the effect that the signals applied to the grid are alternately negative-going and positive-going spikes. The amplitude of the positive-going spikes is very small, due to the action of the crystal diode connected in parallel with R60; this conducts when these spikes occur.

The negative-going spikes are coincident with the trailing edges of the sawtooth waveform of the master oscillator, and serve to cut off anode current in V12(a) and initiate the period of conduction in V12(b). The current in V12(b) is then sufficient to maintain the common cathode potential at such a value that V12(a) remains cut off after the effective duration of the spike at its grid. This condition persists until C30 discharges sufficiently for current to re-commence in V12(a), whereupon the circuit reverts rapidly to its initial state. The magnitude of the timing components C30, R64 are so chosen that the duration of the unstable state is some 18 micro-seconds.

The output pulse which is negative-going is taken from the anode of V12(b) and is fed to the pulse 'cleaner' stage V13, and also to the sync-pulse generator V17, via a delay line; this delay line establishes the duration of the pre-sync suppression period.

#### *Suppression 'Cleaner' Stage*

The suppression-pulse 'cleaner' stage comprises the pentode V13, which is arranged as a normal amplifier, biassed somewhat towards cut-off. The suppression pulses fed from the anode of V12(b) are negative-going, and are of sufficient amplitude to cut off anode current in V13 when they occur. The 'sag' of the pulse output from V12(b) is thus removed from the waveform at the anode of V13, and the rise and fall times of the pulses at V13 anode are improved by the 'gating' action.

### Suppression Pulse/Picture Mixing Stages

The suppression pulses and the picture signal are mixed in the stages comprising V3, V4, V5, where the removal of any picture signal existing in the suppression period is also effected. The picture signal and the suppression pulses are applied to the grids of valves V3 and V4 respectively. These valves share a common anode load and the signal at the anode thus comprises a mixture of the two signals as shown in Fig. 3.1(a). The picture signal at this point is not eliminated in the suppression pulse period but raised on a positive-going 'pedestal' provided by the suppression pulse.

The composite signal is fed to the grid of V5, which is a cathode follower. By means of R22 (*Lift*), the standing bias applied to V5 can be varied; the effect of this control will be apparent later. The cathode load of V5 comprises resistor R24, the crystal diodes CL1, CL2, and the biassing chain R27, R28. The crystal diodes CL1 and CL2 are so connected that they are non-conducting, provided that the potential of the cathode of V5 is negative with respect to the bias voltage developed across C12. If, however, the cathode voltage of V5 rises above the bias value, the diodes commence to conduct, and a low impedance is presented to V5. The cathode potential can thus not rise appreciably above the bias voltage.

The amplitude of the suppression pulses at the cathode of V5 is such that the diodes are driven into conduction each time a suppression pulse occurs, irrespective of the setting of R22; consequently any picture signal occurring in the suppression pulse period is removed. However, R22 determines the amount by which the cathode potential of V5 can rise before the limiting action commences, since it adjusts the quiescent value of the voltage at the cathode of V5. By adjustment of the setting of R22 it is therefore possible to vary the height of the suppression pulse in the output. Since the bottom of the suppression pulse is usually reckoned as black level, this is equivalent to varying the magnitude of a d.c. component (*Lift*) added to the picture signal, as shown in Fig. 3.1(b).

Two crystal diodes are used in parallel in order to provide a sufficiently low resistance for good limiting when driven into conduction. The low output impedance of the cathode follower (about 100 ohms) necessitates this. The bias applied to the diodes is somewhat less than the value apparent from consideration of the magnitudes of R28 and R27. This is because the back resistance of the diodes are effectively in parallel with R27 under quiescent conditions, and hence reduce the effective resistance in parallel with C12.

The output from V5 is fed to one pole of the switch SW3, which feeds the grid of picture-input stage V6 of the picture/sync mixer stages described previously. To the other contact of this pole of the switch is fed the output from the bar generator in the *Line-bar* position. Thus when this latter picture waveform is selected, it is not transmitted via V5, and hence suppression pulses and 'lift' cannot be added to this signal.

Valve V17(a) is triggered by negative-going spikes at the grid. These spikes are derived by the short time-constant network C47, R99 from negative-going delayed suppression pulses. The delay network introduces a delay of 1·5 microseconds, and hence the leading edges of the sync pulses are delayed by this amount relative to the leading edges of the suppression-pulses. The amplitude of the positive-going spikes coincident with the trailing edges of the delayed suppression pulses are reduced to a very small amplitude by the action of the crystal diode CL6.

*Sync-pulse 'Window' Stage*

The sync-pulse waveform is improved prior to

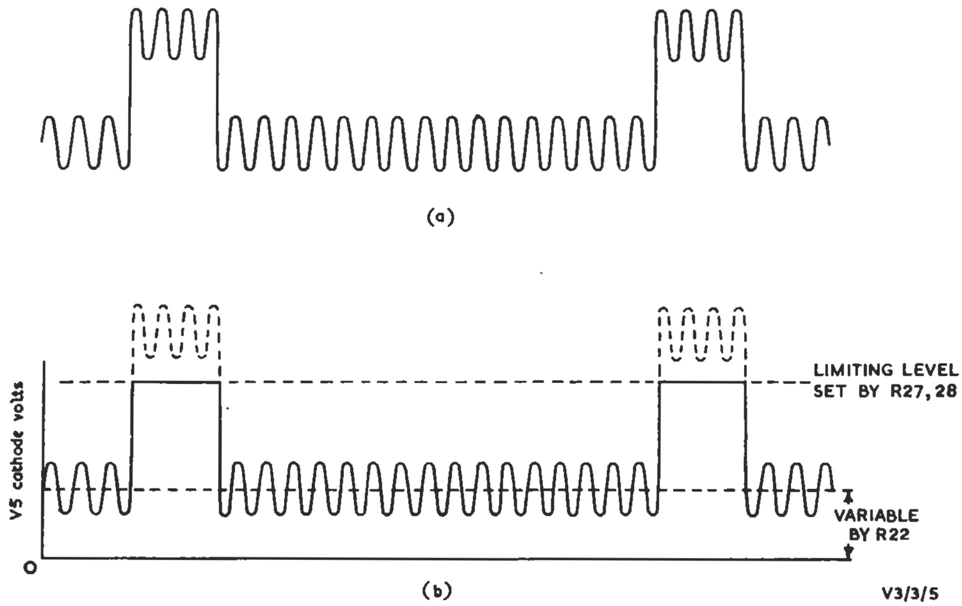



*Fig. 3.1. Picture and Suppression Pulses: (a) Mixed before Limiting, (b) Mixed after Limiting*

**Sync-pulse Generator**

The sync-pulse generator comprises the monostable cathode-coupled multivibrator V17. It is essentially similar to the suppression-pulse generator stage V12; V17(a) is normally conducting whilst V17(b) is cut off. Provision is made for varying the duration of the line-sync pulse by means of R104. This determines the rate of discharge of C50 after the transition to the unstable state, when V17(b) is conducting. The output pulse from the anode of V17(b) has a 'sag' due to the discharge of C50, and is fed to the 'window' stage V18 to improve the output waveform.

addition to the composite picture- and suppression-pulse signal by the sync-pulse 'window' stage V18. The output signal from the anode of V17(b) is applied to the grid of the triode V18(a), which is cathode-coupled to the second triode V18(b). The valve grids are returned individually to sources of positive potential, such that, under quiescent conditions, V18(a) is conducting whilst V18(b) is almost cut-off. At the occurrence of each sync pulse, V18(a) is driven beyond cut-off, so that V18(b) is driven into conduction. This state persists until V17(b) ceases to conduct at the end of the sync-pulse period, when V18(a) reverts to its initial conducting state, and V18(b) reverts to its initial state nearly cut-off. Since V18(a) is cut off for the duration of the sync pulse, the 'sag' of the waveform at the anode of V17(b) is not transmitted to the output. Further, the rise and fall times of the sync pulses are improved by the 'gating' action of the circuit.

The output from the anode of V18(b) is fed to the grid of V7, where it is added to the composite picture- and suppression-pulse signal as described previously.

### Picture-signal Generating Stages

Provision is made for three types of internally generated picture signal; a line sawtooth, a line bar and a frame bar. Additionally, a picture signal from an external source can be applied. For the purposes of description, it is convenient to commence with the external picture-signal amplifying stages, V1–V3.

When an external source is used to supply the picture signal, the three valves V1–V3 are connected to form an amplifier with overall feedback applied, from the cathode of V3 to the cathode of V1. V3 is however, used as an independent amplifier for the line-sawtooth signal and frame-bar signals and hence switching at the grid and cathode of this valve is necessary. Switch SW1 is the picture selector switch. When in the *Ext. Sig.* position one pole selects the output from the anode V2 to feed to the grid of V3, whilst the others complete the feedback chain. At the other positions of the switch, the pole in the cathode circuit of V1 serves to introduce a bias resistor for V1. It should be noted that when the feedback connection is made, the bias for V1 is provided very largely by the current of V3; hence this section of the amplifier should not be operated with V3 removed. The design of the feedback amplifier is almost identical with that of the output amplifier V8–V10. The stage gains are staggered to meet the conditions for maximal flatness, as discussed earlier. A shunt inductance circuit at the anode of V3 is however necessary because the load and output capacitance are higher than that at the anode of V10.

The input signal from the external source is applied to one of three coaxial input sockets (two at the front and one at the rear of the unit). The input is terminated by the chain of resistors R1, R2 and R171, which together provide a terminating impedance, of 72 ohms approximately. The values of R1, R2 and R171 are proportioned so that the attenuation from the input to the grid of V1 is about 9 db at minimum. Gain control is effected by R2 (*Ext. Signal Gain*). The overall gain of the amplifier from input to the anode of V4 is some 24 db.

At the *Sawtooth* position of switch SW1, the input to V3 is taken from the anode of the master oscillator V11. As explained earlier, this latter stage is a conventional Miller-transitron sawtooth generator, and the output at the anode is used for the sawtooth picture signal. As the suppression-pulse generator is locked to the master-oscillator output, the correct timing of the sawtooth waveform is automatically assured. A pre-set control of the sawtooth picture amplitude is given by R52.

At the *Bars* position of switch SW1, the input to V3 is taken from the slider of R19 (*Frame Bar Amp.*). An input is, however, only available if the *Bar Selector* switch SW3 is set to *Frame*. At the *Line* position, the output from the common bar 'window' stage, V16, is fed to the grid of V6 direct. When the frame-bar output is employed, the output from the 'window' stage is fed to R19, which provides a pre-set control of the signal amplitude.

At the *Lift* position of Switch SW1, the input to V3 is earthed; there is thus no picture signal fed to the grid. The magnitude of the suppression pulses can, however, still be varied, and hence a 'Lift' signal, alone, is available at the output.

### Bar Generators

Two bar signals are available, a line bar and a frame bar. The duration of the former can be varied over the range 2–55 microseconds approximately, and the delay of its leading edge relative to the beginning of each line period can be varied between 0 and 40 microseconds approximately. The frame bar is synchronised with the mains supply, and has a repetition frequency equal to that of the mains supply. The mark/space ratio is unity. Effectively it provides a picture signal with alternating periods of high and low amplitude.

The bar generators employ a common 'window' stage, the input to which is selected by one pole of the *Bar Selector* switch, according to which bar output is required.

#### *Line-bar Generator*

The line-bar generator comprises two sections, the line-bar generator proper, and the delay generator which provides the triggering pulses for the generator proper.

The delay-generator stage is V14, which is a monostable cathode-coupled multivibrator, the circuit of which is almost identical with that of the suppression-pulse generator. Under quiescent conditions, V14(b) is cut-off whilst V14(a) is conducting. To the grid of V14(a) are applied the output negative-going pulses from the suppression-pulse generator, via the short time-constant network C36, R72. Consequently, the signal at the grid of V14(a) comprises alternate negative- and positive-going spikes. The amplitudes of the positive-going spikes is very small, due to the action of the crystal diode connected in parallel with R72. When the positive-going spikes occur, the diode conducts, presenting a very low resistance. The negative-going spikes are coincident with the leading edges of the suppression pulses, and serve to cut off anode current in V14(a), and initiate the period of conduction in V14(b). The current in V14(b) is then sufficient to maintain the common-cathode potential at such a value that the anode current of V14(a) remains cut off after the effective duration of the spike at its grid. This condition persists until C38 charges sufficiently for current to re-commence in V14(a), whereupon the circuit reverts rapidly to its initial state. At the reversion the negative-going trailing edge of the pulse developed at the anode of V14(b) tends to drive the grid of V14(b) below earth potential. This is prevented, however, by the action of diode V24(b), which halts the grid potential fall at earth potential, at which potential it remains. This arrangement ensures that the circuit can be readily triggered by a succeeding pulse. Without V24(b), C38 might not be sufficiently discharged for the next positive-going edge from V14(b) anode to initiate current in V14(b).

The magnitudes of the timing components C38, R77 and R78 are chosen to give the range of delays required, some 8–60 microseconds. The delay period can be varied by R78 (*Line Bar Delay*) and it should be noted that this delay is established with reference to the *leading* edge of the suppression pulse. The line bar can thus be made to overlap, or commence immediately after, the end of the line-sync pulse. For this reason, the line-bar pulses are not fed through the picture/suppression-pulse mixer stages, which would otherwise obliterate any portion of the line-bar pulse lying in the post-sync suppression period.

The line-bar generator stage proper comprises V15, a monostable cathode-coupled multivibrator, similar to the delay generator described above. In this circuit, anode current in valve V15(a) is cut off under quiescent conditions. The output from the anode of V14(b) is fed to the grid of V15(a) via the short time-constant network C40, R81. The signals at the grid of V15(a) thus comprise alternate positive- and negative-going spikes. The amplitude of the negative-going spikes is very small due to the action of the crystal diode in parallel with R81. When these negative-going spikes occur, the diode conducts, presenting a low resistance.

The positive-going spikes are coincident with the trailing edges of the pulses from the delay generator, and serve to drive V15(a) into conduction; when this happens, anode current in V15(b) is cut off. When C42 has discharged sufficiently for current to re-commence in V15(b), the circuit reverts rapidly to its initial state. The duration of the unstable state, which is that of the line bar, is determined by C42 and R86, R87. The latter is variable (*Line Bar Width*) and provides a control of the range of line-bar durations available.

*Frame-bar Generator*

The frame-bar generator stage comprises V19, which is an astable anode-coupled multivibrator. Anode current flows in one valve only at any given time; the other is cut off by the negative pulse at its grid, transmitted from the anode of the other. When the coupling capacitor has discharged sufficiently for current to recommence in the valve previously cut off, the negative-going pulse developed at its anode tends to reduce the anode current of the valve formerly conducting. The process is regenerative, inducing a rapid change over of the conduction states. This process is repeated at intervals determined by the magnitudes of the inter-valve coupling components. The multivibrator is synchronised by the injection of a small 50 c/s component from the heater supply via C13. This injected voltage achieves synchronism by determining the instant at which V19(b) recommences to conduct, at the end of its period of non-conduction. At this instant the sum of the grid bias and the synchronising voltage exceeds the value for anode current cut-off. The point of the mains waveform at which the recommencement of current in V19(b) occurs can be varied within narrow limits by R117, which alters the discharge time constant in the grid circuit. This alters the duration of the period during which the anode current of V19(b) is cut off without altering the total repetition period. In this way the mark/space ratio can be adjusted and it is usually set to unity.

*Bar ' Window ' Stage*

The bar ' window ' stage is used to improve the waveform from the particular bar generator supplying the picture signal. Switching of the input to, and the output from, the stage is accomplished by the *Bar Selector* switch SW3. The output signal from the selected bar generator is applied to the grid of the triode V16(a), which is cathode-coupled to the second triode V16(b). The valve grids are returned individually to sources of positive potential, such that under quiescent conditions, V16(b) is conducting whilst the anode current of V16(a) is almost cut off. With the output of the line-bar generator selected, V16(a) is driven hard into conduction at the occurrence of each positive-going line bar. The amplitude of the input is such that the common cathode potential rises to the value where anode current in V16(b) is cut off, producing a negative-going pulse output at the anode V16(b). In this way the ' sag ' associated with the line-bar output from V15(b) is not transmitted to the output and the rise and fall times of the waveform are improved by the ' gating ' action.

When the output from the frame-bar generator is applied to the grid of V16(a), the action is somewhat different, since the frame-bar signal comprises a wave of approximately unity mark/space ratio. On the negative-going excursions of the waveform, anode current is cut off in V16(a). On the positive-going excursions anode current is cut off in V16(b), by the rise of the common cathode potential. The anode current of V16(b) is thus swept between zero and a maximum value, giving a substantially square-wave output. As with the line-bar signal, the ' sag ' associated with the output from V19 is removed by the action of the ' window ' stage, and rise and fall times are improved by the gating action. A pre-set control of bar output is given by R92, which varies the anode load of V16(b). This is normally set to give the required amplitude of the line-bar output; the frame-bar amplitude is then set by R19.

**Waveform Monitor**

The waveform monitor is a completely independent section of the generator and can be used for setting-up, monitoring the output waveform of the generator, or in conjunction with external apparatus.

The cathode-ray tube and its associated supplies are arranged in a conventional circuit, with the final anode of the tube at earth potential. E.h.t. for the tube is obtained from a voltage-doubling circuit fed from the transformer TR1; the primary winding of this transformer is fed from the heater supply. A potential divider chain R146–R150 is fed from the e.h.t. supply and the tube electrodes are fed from appropriate points. The trace brightness is controlled by R150 (*Brilliance*) which adjusts the tube grid-cathode bias. Focussing is accomplished by R148, which varies the potential of the first anode which, together with the second anode, forms an electron lens. The Y deflection arrangement is asymmetrical; the signal is applied to the plate Y1, whilst plate Y2 is connected to earth. A positive potential is applied to plate Y1 from the junction of R146 and R147, and this, under quiescent conditions, sets the trace below the centre line of the tube. D.C. restoration is applied to the incoming signal by the action of the diode V24(a), which serves to clamp the most negative-going portion of the input signal at the potential of the junction of R146 and R147. Thus irrespective of the nature of the signal displayed, its most negative portion is at the height of the base line under quiescent conditions. When a television signal is displayed, measurement of sync-pulse and picture amplitude can be made readily since the sync bottoms are held at a constant level on the tube face. Additionally a graticule is provided with four horizontal lines engraved. The lines are marked 30, 0, 50 and 100 respectively, and correspond to sync bottom, black level, 50 per cent peak-white, and peak white of a signal having a picture/sync ratio 70/30. If the *Gain* control is adjusted so that the sync signal of a signal under test occupies the height allotted to the sync pulse, the picture/sync ratio and the magnitude of any given picture element can be estimated. To minimise parallax errors, the graticule is engraved on both sides, and the appropriate markings should be aligned when making observations. The position of the graticule relative to the tube face can be adjusted so that the line engraved ' 30 ' can be aligned with the quiescent trace.

*Y Amplifier*

The Y amplifier comprises two stages in cascade, V20 and V21. The input to V20 is from a test socket mounted on the front panel of the unit. The input impedance is high, so that the amplifier may be connected to other apparatus without appreciable loading. Negative feedback is applied to V20 by R120 and R121 in the cathode circuit; the latter is variable, and provides the *Y Gain* control. In parallel with R120 is capacitor C32, the reactance of which is comparable with the resistance of R32 at high frequencies. This reduces the feedback applied at these frequencies, with the effect that the overall gain tends to rise. The magnitude of the capacitor is chosen so that it compensates for the loss of gain at the anode due to the effects of shunt capacitance. A similar arrangement is employed with V21, the output of which feeds the Y deflection plate of the cathode ray tube. From the cathode, a signal is taken via a small capacitor to the time-base circuit for synchronising purposes.

*Time-base circuit*

The time-base employs a conventional Miller-transitron circuit (valve V22). Switch SW2 (*T.B. range*) provides a coarse control of the time-base frequency. The switch has two positions, *Frame* and *Line*, at which the repetition frequency is about 25 per second and 5,000 per second, respectively. A fine control of the time-base sweep velocity is provided by R136, and this is usually adjusted so that the time-base is synchronised by the signal applied to the Y amplifier. Synchronisation is achieved by injecting a signal from the cathode of V21 of the Y amplifier into the suppressor grid of V22 via a short time-constant network, C63, R133. With the selector switch set to *Line* and with a normal television picture-signal input (i.e. picture signal positive-going), the sync pulses of the signal are positive-going at the cathode of V21 and positive-going 'spikes' derived from the leading edges of alternate sync pulses initiate anode current in V22, and hence initiate the sweep. By adjustment of the fine frequency control it should be possible to display almost two complete lines of a waveform. With a picture signal containing a number of negative-going edges, the time base is, of course, liable to spurious triggering.

In the *Frame* position of the selector switch, the time base will not be synchronised by the frame-sync pulses of a television signal, since there is no sync-separation stage. The time base, can, however, be synchronised with the frame-bar picture signal from the generator. With this picture signal, there is a large positive-going 'spike' generated at the commencement of each 'white' bar, and alternate 'spikes' will trigger the time base.

*Monitoring Facilities*

The input to the waveform monitor is brought to a test socket on the front panel. Adjacent to this socket is a *Monitor* test point to which the output of the generator is fed. By means of a short double-ended cord, the output from the generator may be applied to the waveform monitor. A second, longer, double-ended cord is provided for use when the waveform monitor is used in conjunction with the test points inside the generator, or with other apparatus. When not in use, this cord is held in a clip fastened to the rear of the plate giving access to the valves.

## Mechanical Design

The unit is mounted on a standard CH/39F chassis. The front panel dimensions are 19 × 10½ inches, and the unit is designed for bay mounting; when so mounted it projects through the bay. For portable use, the unit can be fitted with standard side cheeks.

Behind the front panel, and at a distance of 5½ inches from it, is a sub-panel secured to side panels attached to the front panel. On this sub-panel are mounted the amplifier valves and components. The unit is enclosed by a cover, which is detached from the rear, to give access to the *Ext. Sig. In*, *Output* and power supply plugs respectively.

Access to the valves from the front of the unit is through a detachable plate secured to the front panel. The plate is fitted with a handle, and is held in place by the pressure of spring mountings on two fasteners at the top and bottom centre of the plate. Additionally, handles are attached to the front panel, to assist removal and replacement of the amplifier. The general layout of the unit can be seen in Plates VII to X.

## General Data

*Input and Output Plugs*

P.O. Coaxial Plug No. 1

*Waveform Monitor Input and Test-point Plugs*

Belling Lee Type L316 (modified)

*Impedances*

External signal input; Z = 75 ohms resistive
Generator output: Z = 75 ohms resistive
Waveform monitor input: greater than 1 megohm, with parallel capacitive component.

*Normal Working Levels*
External signal input: 1 volt d.a.p.
Generator output: 1 volt d.a.p.
Maximum output: 1·2 volt d.a.p.

*Power Consumption*
H.T.: 230mA at 300 volts
L.T.: 8·7 A at 6·3 volts and 0.3 A at 6·3 volts.

**Power Supplies**

Power supplies are normally obtained from a Stabilised Power-Supply Unit SPS/7, which is described in Technical Instruction V4, Section C. Connection to the power-supply unit is by means of six-way plug at the rear of the unit. The circuit to the tags of the plug are as follows:

| *Tag No.* | |
|---|---|
| 7 | H.T.+ |
| 8 | H.T.— |
| 9, 10 | 6·3 V |
| 11, 12 | 6·3 V (tag 12 connected to H.T.—) |

**Valve Data**

All readings measured with AVO Model 7. With the exception of V25 (1,000-V range all readings), all anode and screen voltages measured on the 400-V range, control-grid voltages on the 100-V range, cathode voltages on the 1, 10 or 100-V ranges as appropriate.

Tolerance on all readings ±25 per cent.

| *Valve* | *Anode Volts* | *Screen Volts* | *Control Grid Volts* | *Cathode Volts* | *Remarks* |
|---|---|---|---|---|---|
| V1 CV138 | 215 | 240 | — | 3·4 | 'Lift' Condition |
| | 110 | 200 | — | 1·5 | Ext. Sig. Condition |
| V2 CV138 | 137 | 223 | — | 1·7 | |
| V3 CV2127 | 74 | 208 | — | 2·7 | 'Lift' Condition |
| V4 CV138 | 74 | 300 | — | 1·5 | |
| V5 CV138 | 300 | 300 | — | 8·5 | Zero Lift |
| | 300 | 300 | — | 19 | 100% Lift |
| V6 CV138 | 190 | 300 | — | 10 | Suppressor and cathode potentials vary with position of R29 and R32. Values quoted for controls at correct setting. (V6, V7) |
| V7 CV138 | 185 | 300 | — | 4 | |

| *Valve* | | *Anode Volts* | *Screen Volts* | *Control Grid Volts* | *Cathode Volts* | *Remarks* |
|---|---|---|---|---|---|---|
| V8 CV138 | | 80 | 205 | — | 2 | The electrode potential of V8, V9 and V10 will vary slowly when voltmeter is connected. Readings at 100% Lift. |
| V9 CV138 | | 150 | 220 | — | 2 | |
| V10 CV2127 | | 150 | 245 | — | 4 | |
| V11 CV138 | | 120 | 240 | — | 0·35 | |
| V12 CV455 | (a) | 205 | — | 6 | 11 | Junction R61 and R62, 225 V. |
| | (b) | 210 | — | — | 11 | |
| V13 CV138 | | 60 | 200 | — | 4·5 | Junction of R66 and R67, 85 V. |
| V14 CV455 | (a) | 210 | — | 7·5 | 14 | Junction of R74 and R75, 220 V. |
| | (b) | 200 | — | — | 14 | |
| V15 CV455 | (a) | 190 | — | 6·0 | 18 | Grid potentials vary with *Line Bar width* control setting. Potentials for min. width. |
| | (b) | 180 | — | 12 | 18 | |
| V16 CV455 | (a) | 300 | — | 4 | 56 | |
| | (b) | 300 | — | 5 | 56 | |
| V17 CV455 | (a) | 210 | — | 7 | 12 | Junction of R101 and R102, 235 V. |
| | (b) | 230 | — | — | 12 | |
| V18 CV455 | (a) | 235 | — | 5 | 50 | Junction of R108 and R109, 237 V. |
| | (b) | 235 | — | 4 | 50 | |
| V19 CV455 | (a) | 300 | — | — | — | V19(b) anode potential varies with *Frame Bar Sym.* control setting. |
| | (b) | 230 | — | — | — | |
| V20 CV138 | | 200 | 240 | — | — | Cathode and suppressor potential vary with *Gain* control. Volts across R120, 2 V. |

| *Valve* | *Anode Volts* | *Screen Volts* | *Control Grid Volts* | *Cathode Volts* | *Remarks* |
|---|---|---|---|---|---|
| V21 CV138 | 240 | 240 | — | 4·5 | |
| V22 CV140 | 140 | 240 | — | 0·27 | |
| V23 CV138 | 170 | 230 | — | 22 | |
| V25 DG7-5 | –240* | — | –500* | –460* | |

* AVO Model 7, 1000-V range.

**Lining-up Instructions**

Apparatus required:

Television Waveform Monitor, TV/WM/1*,
Avometer, Model 7,
Video-frequency Oscillator 10 kc/s–6 Mc/s.

1. Switch on power supplies, and allow ten minutes to elapse for the unit to warm up.
2. Check that the h.t. voltage is 300, and that the l.t. voltages are each 6·3±0·3 volts.
3. Check that the output from the generator is terminated in 75 ohms, and connect the output to the *DC* input socket of the TV/WM/1. Set the picture selector switch to BARS and the *Bar Selector* switch to LINE, and set the controls of the TV/WM/1 to display the generator output.
4. Measure the amplitude of the line bar and sync signals and adjust the *Picture Amplitude* and *Sync Amplitude* controls if necessary until the two components measure 0·7 volt and 0·3 volt respectively. Check that the line bar amplitude is independent of the setting of the *Line Bar Width* control.
5. Set the *Line Bar Width* control to give the minimum pulse width, and set the *Line Bar Delay* control to bring the pulse to the centre of the line approximately. Measure the line-bar duration; this should be 2±0·4 microseconds. The rise and fall times (between 10 and 90 per cent amplitude points) should be not greater than 0·13 microseconds. The overshoot amplitude should be less than 10 per cent, and the ringing frequency above 3 Mc/s.
6. Set the *Bar Selector* switch to FRAME, and set the *Lift* control to minimum position. Set the TV/WM/1 to display the frame bar, and measure the picture amplitude; this should be 0·7 volt. If necessary, adjust the *Set Frame Bar Amplitude* control to achieve this. Check that the 'sag' of the frame bar does not exceed 5 per cent.
7. Set the picture selector switch to SAWTOOTH, and set the *Lift* control so that there is no 'crushing' of the picture waveform apparent. Set the TV/WM/1 to display the sawtooth waveform, and measure the sawtooth amplitude. This should be 0·7 volt. If necessary, adjust the *Sawtooth Amplitude* control to achieve this.
8. Set the picture-selector switch to LIFT, and set the *Lift* control to maximum; the measured picture amplitude should be greater than 0·7 volt.
9. Set the picture-selector switch to EXT. SIG., and apply the output from the video-frequency oscillator to the *Ext. Signal Input* plug. Set the oscillator frequency to 100 kc/s, and the signal amplitude at the input to the generator

* If this item is not available, the internal waveform monitor may be used instead for certain of the adjustments, and in particular, adjustments of signal amplitudes. The internal waveform monitor may be calibrated by employing the output from monitoring point M1; this should be 1 ± 0·05 volts (d.a.p.).

to 1 volt d.a.p. (0·35 volt r.m.s.). Adjust the frequency of the oscillator so that the picture signal is stationary. The oscillator frequency should be 101·25±2 kc/s. If it is not, set the oscillator frequency to 101·25 kc/s, and adjust R56 (*Master Osc. Freq.*) until the picture signal is stationary. Check that the picture waveform comprises more than seven and less than eight complete cycles of the sinusoidal waveform. Set the *Lift* control so that the bottom of the sine wave pattern is not distorted. Check that the sinusoid picture amplitude can be set to 0·7 volt d.a.p. by means of the *Ext. Signal gain* control.

10. Set the oscillator frequency to 20 kc/s, 50 kc/s, 500 kc/s, 700 kc/s, 1 Mc/s, 1·5 Mc/s, 2·0 Mc/s, 2·5 Mc/s, 3·0 Mc/s, 4·0 Mc/s and 5·0 Mc/s, with the output set to 1 volt at each frequency. The picture amplitude should be equal to that at 100 kc/s within 0·25 db (3 per cent), and the output should be down by 3 db between 4·0 and 5·5 Mc/s. If necessary, adjust the position of the core of inductor L1 to achieve this.
11. Connect the output of the oscillator to the input plug of the generator waveform monitor; the output from the oscillator should be terminated in 75 ohms. Set the *T.B. Range* switch to L and check that the trace length is about 2 inches. Set the oscillator output to 1 volt d.a.p: and its frequency to 10 kc/s. Set the *Y Gain* control to maximum and check that the display height is 1 inch (d.a.p.). Check that a clockwise rotation of the *Y Gain* control increases the display height. Set the *Velocity* control so that the display is stationary, and check that the display comprises nearly two complete cycles of the waveform. Check that locking occurs over a range of settings of the *Velocity* control; adjust C63 if necessary to achieve this. Check that clockwise rotation of the *Velocity* control decreases the proportion of the waveform displayed. Check that the *Brill.* and *Focus* controls operate correctly.
12. Set the oscillator frequency to 2 kc/s, and output to 1 volt d.a.p.; check that the height of the display is not less than 0·7 inch (d.a.p.).
13. Connect the *Monitor* plug of the generator to the input of the waveform monitor by means of the double-ended cord provided. Set the generator picture selector to LIFT. Set the monitor graticule so that the line '30' corresponds to the bottom of the sync pulse. Adjust the *Y Gain* control so that black level corresponds to the line '0', and check that adjustment of the *Lift* control does not vary the position of sync bottom or black level. Check that at the maximum picture-signal amplitude, the picture display comes above the line 100.
14. Set the picture-selector switch to BARS and the *Bar Selector* switch to FRAME. Check that the trace length is about 2 inches. Set the *T.B. Range* switch to F and check that nearly two complete frame bars are displayed. Check that the display can be locked over a range of the *Velocity* control settings.

## Test Specification

Apparatus required:

Television Waveform Monitor TV/WM/1
Video-frequency Oscillator 10 kc/s–6 Mc/s
Moullin Valve Voltmeter.

During all tests, except where otherwise specified, the output of the unit should be terminated in a 75-ohm load. In the following tests, voltages are given in d.a.p.; the corresponding approximate r.m.s. figures for sinusoidal waveforms are given in brackets.

1. The impedances measured at d.c. at the *Ext. Signal Input* and *Output* sockets should be 75±7·5 ohms and 77±3·8 ohms respectively. If the *Ext. Signal Input* impedance is outside the limits, the value of R1 should be altered.
2. Switch on power supplies, and allow ten minutes to elapse for the unit to warm up.
3. Check that the h.t. voltage is 300, and that the l.t. voltages are each 6·3±0·3 volts.
4. Connect the d.c. input of the Waveform Monitor TV/WM/1 to the monitoring point M1. Set the TV/WM/1 to display the sawtooth output and check that the waveform is similar to that shown in Fig. 10. Measure the amplitude of the waveform; this should be 1±0·05 volts. If necessary alter the value of R170 to achieve this.
5. Connect the monitoring point M1 to the *Ext. Time Base* input of the TV/WM/1. Connect the output from the video-frequency oscillator to the AC input of the TV/WM/1, and set the oscillator frequency to 10·125 kc/s precisely. Set R56 (*Master Osc. Freq.*) to its mid position, and adjust C94 until the picture displayed is stationary. Rotate R56 (*Master Osc. Freq.*) to each of its extreme positions in turn. At

each extreme position check the oscillator frequency required to produce a stationary picture. This should differ from 10·125 kc/s by more than 500 c/s.

6. Connect the monitoring point M2 to the AC input of the TV/WM/1, and set the waveform monitor to display the suppression pulses. Check that the waveform is similar to that shown in Fig. 10. Measure the amplitude of the pulse, which should be 28±5·3 V. Check that the pulse duration is 18±1 microseconds. If the duration is outside these limits, adjust the value of R64.
7. Connect the monitoring point M3 to the DC input of the TV/WM/1 and set the waveform monitor to display the 'cleaned' suppression pulses. Check that the waveform is similar to that shown in Fig. 10. Measure the amplitude of the pulse, which should be 50±10 V.
8. Connect the monitoring point M7 to the DC input of the TV/WM/1 and set the waveform monitor to display the sync pulses. Check that the waveform is similar to that shown in Fig. 10. Check that the duration of the pulses can be varied over the range 7–14 microseconds by means of the *Line Sync Width* control R104. Set the *Line Sync Width* control so that the pulse duration is 9·0±1·0 microseconds. Measure the amplitude of the pulse which should be 19±3·8 V.
9. Connect the monitoring point M8 to the *DC* input of the TV/WM/1, and set the waveform monitor to display the 'cleaned' sync pulse. Check that the waveform is similar to that shown in Fig. 10. Measure the amplitude of the pulse which should be 5±1 V.
10. Connect the monitoring point M4 to the *DC* input of the TV/WM/1 and set the waveform monitor to display the delay generator output pulses. Check that the waveform is similar to that shown in Fig. 10. Check that the duration of the pulse can be varied over the range 8–60 microseconds by means of the *Line Bar Delay* control R78. The exact value of the maximum duration is not important, but it should be greater than 50 microseconds. Check also that clockwise rotation of the control increases the duration of the pulse. Measure the amplitude of the pulse, which should be 40±8 V.
11. Connect the monitoring point M5 to the *DC* input of the TV/WM/1 and set the waveform monitor to display the line bar. Check that the waveform is similar to that shown in Fig. 10. Check that the duration of the pulse can be varied over the range 2±0·4 to 55±14 microseconds by means of the *Line Bar Width* control R87. If the minimum duration falls outside the limits, the value of C42 should be altered. Check that clockwise rotation of the *Line Bar Width* control increases the duration of the pulse. Measure the amplitude of the pulse which should be 22±4·4 V. Check that the amplitude is within these limits of all settings of the *Line Bar Width* control.
12. Connect the monitoring point M9 to the TV/WM/1 DC input, and set the *Bar Selector* switch to LINE. Set the waveform monitor to display the 'cleaned' line-bar pulse and check that the waveform is similar to that shown in Fig. 10. Set the *Bar Amp* control R92 so that the amplitude of the output pulse is 6 volts.
13. Connect the monitoring point M6 to the *DC* input of the TV/WM/1 and set the waveform monitor to display the frame bar. Set the TV/WM/1 *Sync Selector* switch to 50 c/s and check that the display is stationary i.e. the frame-bar generator is synchronised with the mains supply. Check that the waveform is similar to that shown in Fig. 10. Measure the amplitude of the pulse which should be 30±6 V. Set the waveform monitor so that more than one complete cycle is displayed, and check that the mark/space ratio can be varied above and below 1/1, by means of the *Frame Bar Sym* control R117. Set the control so that the mark/space ratio is unity.
14. Connect the monitoring point M9 to the TV/WM/1 *DC* input, and set the *Bar Selector* switch to FRAME. Set the waveform monitor to display the 'cleaned' frame bar, and check that the waveform is similar to that shown in Fig. 10. Measure the amplitude of the pulse, which should be 3±1·5 V.
15. Remove valve V4, and set the picture selector switch to EXT. SIG. Apply the output from the video-frequency oscillator to the *Ext. Signal Input* socket; set the oscillator frequency to 100 kc/s and its output to 1 V (0·35 V). Connect the monitoring point M10 to the TV/WM/1 DC input, and set the waveform monitor to display the waveform. Set the *Ext. Signal Gain* control to maximum, and measure the signal amplitude; this should be

15±3 V (5·2±1·7 V). Replace V4, and check that the waveform at each position of the picture-selector switch is similar to that shown in Fig. 10. Measure the amplitude of the lift pulses, which should be 32±6·4 V.

16. With the waveform monitor set to display the output from monitoring point M11, set the *Bar Selector* switch to FRAME and set the picture selector switch to LIFT, BARS and SAWTOOTH in turn. Check that the waveforms are similar to those shown in Fig. 10. Measure the amplitude of each waveform. The maximum amplitude signal should occur with the control at maximum clockwise rotation, and should be greater than 6 V. The amplitude of the *Frame Bar* should be set to 6 V by means of the *Frame Bar Amp*. control; sufficient lift should be added to the signal when this measurement is made to ensure that there is no crushing of the bar.

    The amplitude of the sawtooth signal should be set to 6 V by means of the *Sawtooth Amp* control; sufficient lift should be added to the signal when this measurement is made to ensure that there is no crushing of the waveform apparent.

17. Connect the monitoring point M12 to the TV/WM/1 *DC* input. Set the picture selector switch to BARS, set the *Bar Selector* switch to LINE. Measure the amplitude of the picture and sync pulses. These should be set to 0·7 V and 0·3 V respectively by means of the *Pic. Amp* and *Sync Amp* controls. Check that the range of these controls is such that the picture/sync ratio can be varied between 70/30 and 50/50 at an output of 1 V. Check also that the actions of the two controls are independent, and that the output increases with clockwise rotation of the controls.

18. With the signal at M12, set at 1 V d.a.p. as described in 17 above, transfer the TV/WM/1 *DC* input to one of the *Output* socket generator. Measure the amplitude of the signal; this should be 1±0·02 V.

19. Disconnect C15, and feed the output of the video-frequency oscillator to the grid of V8; a resistor of 150 ohms should be connected in parallel with R34 to provide a 75 ohm termination. Connect the valve voltmeter to the *Output* socket of the generator via a coupling network comprising a series capacitor (0·01 μF) and shunt resistor (1 M). Set the oscillator output to 1 V (350 mV) and the frequency to 100 kc/s. The output should be 1±00.2 V (350±7 mV).

20. Repeat (19) at frequencies of 10 kc/s, 20 kc/s, 50 kc/s, 250 kc/s and then at 250 kc/s intervals to 5 Mc/s. The output in the range up to 3 Mc/s should be within 0·25 db (±3 per cent) of that at 100 kc/s; the 3 db point should lie between 4·7 and 5·5 Mc/s. Disconnect the video frequency input, and re-connect C15.

21. Carry out items (3)–(14) of Lining-up Instructions.

G.G.J. 1255

# COMPONENT TABLE: FIG. 9

*All capacitors are 350 volt d.c. (working) ± 20 per cent tolerance, unless otherwise specified*

| Comp. | Loc. | Type | Tolerance Per cent |
|---|---|---|---|
| C1 | B3 | T.C.C. CP37N/PVC | |
| C2 | D2 | Plessey CE809/1 450V | −20, + 50 |
| C3 | D3 | T.C.C. CP37N/PVC | |
| C4 + C7 | B2 | Plessey CE820/1 450V | " " |
| C5 | E5 | " CE17069/1 50V | −20, + 100 |
| C6 | G3 | T.C.C. CP37N/PVC | |
| C7 | E2 | Combined with C4 | |
| C8 | I4 | Plessey CE809/1 450V | −20, + 50 |
| C9 | J4 | T.C.C. CP33N/PVC | |
| C10 | L3 | " CP37N/PVC | |
| C11 + C16 | H2 | Plessey CE821/1 450V | " " |
| C12 | N5 | " CE17069/1 50V | " " |
| C13 | W10 | T.C.C. SM3N | ±5 |
| C14 | Q4 | " CP33N/PVC | |
| C15 | Q3 | Plessey CE811/1 450V | −20, + 50 |
| C16 | S2 | Combined with C11 | |
| C17 + C20 | R2 | Plessey CE820/1 450V | " " |
| C18 | S3 | T.C.C. CP47S/PVC | |
| C19 | T5 | Plessey CE17069/1 50V | −20, + 100 |
| C20 | | Combined with C17 | |
| C21 | U3 | T.C.C. CP37N/PVC | |
| C22 | W4 | Plessey CE809/1 450V | −20, + 50 |
| C23 | W3 | " CE811/1 450V | " " |
| C24 | B10 | Erie N750/K | ± 5 |
| C25 + C28 | D8 | Plessey CE822/1 450V | −20, + 50 |
| C26 | D9 | T.C.C. CSM20N | ± 5 |
| C27 | E11 | " CP33N/PVC | |
| C28 | F8 | Combined with C25 | |
| C29 | F11 | Erie N750/K | " |
| C30 | G9 | " " | " |
| C31 | H8 | " CP33N/PVC | |
| C32 | W16 | " CM20N | |
| C33 + C34 | I8 | Plessey CE822/1 450V | −20, + 50 |
| C34 | H8 | Combined with C33 | |
| C35 | J11 | T.C.C. CP33N/PVC | |
| C36 | K11 | Erie N750/K | ± 5 |
| C37 + C52 | K8 | Plessey CE822/1 450V | −20, + 50 |
| C38 | L9 | T.C.C. CSM20N | ± 5 |
| C39 | N11 | " CP33N/PVC | |
| C40 | M8 | Erie N750/K | " |
| C41 + C44 | N8 | PlesseyCE822/1 450V | −20, + 50 |
| C42 | P9 | T.C.C. CSM20N | ± 5 |
| C43 | Q9 | " CP37N/PVC | |

| Comp. | Loc. | Type | Tolerance Per cent |
|---|---|---|---|
| C44 | I14 | Combined with C41 | |
| C45 | S11 | T.C.C. CP37N/PVC | |
| C46 | O5 | " " | |
| C47 | C17 | Erie N750/K | ±5 |
| C48 | D17 | " CP32N/PVC | |
| C49 | D14 | Plessey CE809/1 450V | −20, + 50 |
| C50 | E15 | T.C.C. CSM20N | ± 5 |
| C51 | F14 | " CP33N/PVC | |
| C52 | G14 | Combined with C37 | |
| C53 | H17 | T.C.C. CP33N/PVC | |
| C55 | V9 | " SM3N | " |
| C56 | L19 | " " | " |
| C57 + C59 | X14 | Plessey CE911/1 450V | −20, + 50 |
| C58 | X15 | T.C.C. CP47S/PVC | |
| C59 | V14 | Combined with C57 | |
| C60 + C61 | U14 | Plessey CE911/1 450V | " " |
| C61 | V14 | Combined with C60 | |
| C62 | T15 | T.C.C. CP32N/PVC | |
| C63 | S17 | Mullard E.7876 | |
| C64 | J15 | T.C.C. CSM20N | |
| C65 | K15 | " " | |
| C66 | L14 | " CP37N/PVC | |
| C67 | I15 | " " | |
| C68 + C83 | M14 | Plessey CE822/1 450V | " " |
| C69 | N14 | T.C.C. CP37N/PVC | |
| C70 | K14 | " " | |
| C71 | Q17 | " CP33N/PVC | |
| C72 | P17 | Hunt A315 | |
| C73 | V15 | T.C.C. CP47S/PVC | |
| C74 | B13 | Erie N750/K | ± 5 |
| C75 | B14 | " " | " |
| C76 | B14 | " " | " |
| C77 | B15 | " " | " |
| C78 | B16 | " " | " |
| C79 | B16 | " " | " |
| C80 | S13 | " CP56X 2kV | |
| C81 | S14 | " " " | |
| C82 | T13 | " " " | |
| C83 | X9 | Combined with C68 | |
| C84 | B9 | T.C.C. CP33N/PVC | |
| C85 | J9 | " " | |
| C86 | L8 | " " | |
| C87 | P8 | " " | |
| C88 | S8 | " " | |
| C89 | W7 | " CP35N/PVC | |
| C90 | F14 | " CP33N/PVC | |
| C91 | H14 | " " | |

# COMPONENT TABLE: FIG 9—*contd.*

| Comp. | Loc. | Type | Tolerance Per cent | Comp. | Loc. | Type | Tolerance Per cent |
|---|---|---|---|---|---|---|---|
| C92 | H3 | T.C.C. CP33N/PVC | ± 5 | R41 | T1 | Dubilier BTB 1W | ± 10 |
| C93 | L15 | „ CP35N/PVC | | R42 | U4 | Erie 9 0·25W | „ |
| C94 | E9 | Mullard E.7876 | | R43 | U4 | „ „ „ | „ |
| C95 | T17 | T.C.C. CSM20N | „ | R44 | V2 | Painton P301 4·5W | ± 5 |
| | | | | R45 | W5 | Erie 108 0·5W | „ |
| L1 | I2 | BBC EB8488 DET. 67 | | R46 | W5 | „ „ „ | „ |
| L2 | C13 | „ RA8107/7 | | R47 | V1 | „ 100 1W | ± 21 |
| L3 | C14 | „ „ | | R48 | X5 | „ 108 0·5W | ± 5 |
| L4 | C15 | „ „ | | R49 | B8 | „ 9 0·25W | ± 10 |
| L5 | C15 | „ „ | | R50 | B11 | „ „ „ | „ |
| L6 | C16 | „ „ | | R51 | C7 | Dubilier BTB 1W | „ |
| | | | | R52 | C8 | Morganite LHNAR | |
| R1 | A4 | Erie 108 0·5W | „ | | | 10250 32800 | |
| R2 | B4 | Reliance TW/1/8S/W | „ | R53 | D11 | Erie 9 0·25W | ± 10 |
| R3 | C4 | Erie 9 0·25W | ± 10 | R54 | B9 | „ „ „ | „ |
| R4 | C2 | „ 109 „ | ± 5 | R55 | E8 | „ 109 „ | ± 2 |
| R5 | C1 | Painton P302 6W | „ | R56 | E7 | Morganite LHNAR | |
| R6 | D5 | Erie 109 0·25W | „ | | | 10550 32800 | |
| R7 | C2 | Dubilier BTB 1W | ± 10 | R57 | G7 | Dubilier BTB 1W | ± 10 |
| R8 | D4 | Erie 9 0·25W | „ | R58 | E7 | Erie 108 0·5W | ± 5 |
| R9 | F5 | „ „ „ | „ | R59 | E11 | „ 109 0·25W | „ |
| R10 | E2 | Painton P301 4·5W | ± 5 | R60 | F9 | „ 9 „ | ± 10 |
| R11 | H5 | Erie 9 0·25W | ± 10 | R61 | F8 | „ „ „ | „ |
| R12 | E2 | Dubilier BTB 1W | „ | R62 | G8 | „ „ „ | „ |
| R13 | H4 | Erie 9 0·25W | „ | R63 | G11 | „ „ „ | „ |
| R14 | I2 | Dubilier BTB 1W | „ | R64 | G11 | „ „ „ | „ |
| R15 | I2 | Painton MV1 1·5W | ± 5 | R65 | H11 | „ „ „ | „ |
| R16 | I4 | Erie 108 0·5W | „ | R66 | I7 | Painton P302 6W | ± 5 |
| R17 | I5 | „ „ „ | „ | R67 | I8 | Erie 9 0·25W | ± 10 |
| R18 | F5 | „ 9 0·25W | ± 10 | R68 | I11 | „ „ „ | „ |
| R19 | F2 | Colvern CLR 1106/15S | „ | R69 | H7 | „ „ „ | „ |
| R20 | J5 | Erie 9 0·25W | „ | R70 | J7 | „ 108 0·5W | ± 5 |
| R21 | L5 | „ „ „ | „ | R71 | J11 | „ 109 0·25W | „ |
| R22 | L5 | Morganite LHNAR | | R72 | K9 | „ „ „ | „ |
| | | 10550 32800 | | R73 | K7 | Dubilier BTB 1W | ± 10 |
| R23 | L2 | Erie 9 0·25W | „ | R74 | K8 | Erie 9 0·25W | „ |
| R24 | M5 | „ „ „ | „ | R75 | L8 | „ „ „ | „ |
| R24 | M5 | „ „ „ | „ | R76 | K11 | „ „ „ | „ |
| R25 | M2 | „ „ „ | „ | R77 | M10 | „ „ „ | „ |
| R26 | M2 | „ „ „ | „ | R78 | M11 | Morganite LHNAR | |
| R27 | N5 | „ 109 „ | ± 5 | | | 50450 32800 | |
| R28 | N2 | „ 108 0·5W | „ | R79 | N7 | Erie 108 0·5W | ± 5 |
| R29 | O5 | Colvern CLR 1106/15S | ± 10 | R80 | N10 | „ 109 0·25W | „ |
| R30 | Q2 | Painton P302 6W | ± 5 | R81 | N9 | „ 9 „ | ± 10 |
| R31 | S5 | Erie 9 0·25W | ± 10 | R82 | O7 | Painton P301 4·5W | ± 5 |
| R32 | P5 | Colvern CLR 1106/15S | „ | R83 | O8 | Erie 9 0·25W | ± 10 |
| R33 | Q5 | Erie 9 0·25W | „ | R84 | O11 | „ „ „ | „ |
| R34 | R5 | „ „ „ | „ | R85 | P8 | „ „ „ | „ |
| R35 | S1 | Painton P302 6W | ± 5 | R86 | P10 | „ „ „ | „ |
| R36 | S2 | Erie 109 0·25W | „ | R87 | P11 | Morganite LHNAR | |
| R37 | R1 | Dubilier BTB 1W | ± 10 | | | 25450 32800 | |
| R38 | T4 | Erie 0·25W | „ | R88 | R8 | Erie 108 0·5W | ± 5 |
| R39 | U5 | „ „ „ | „ | R89 | R11 | „ 109 0·25W | „ |
| R40 | T2 | Painton P301 4·5W | ± 5 | R90 | R9 | „ 9 „ | ± 10 |

## COMPONENT TABLE FIG. 9—*contd.*

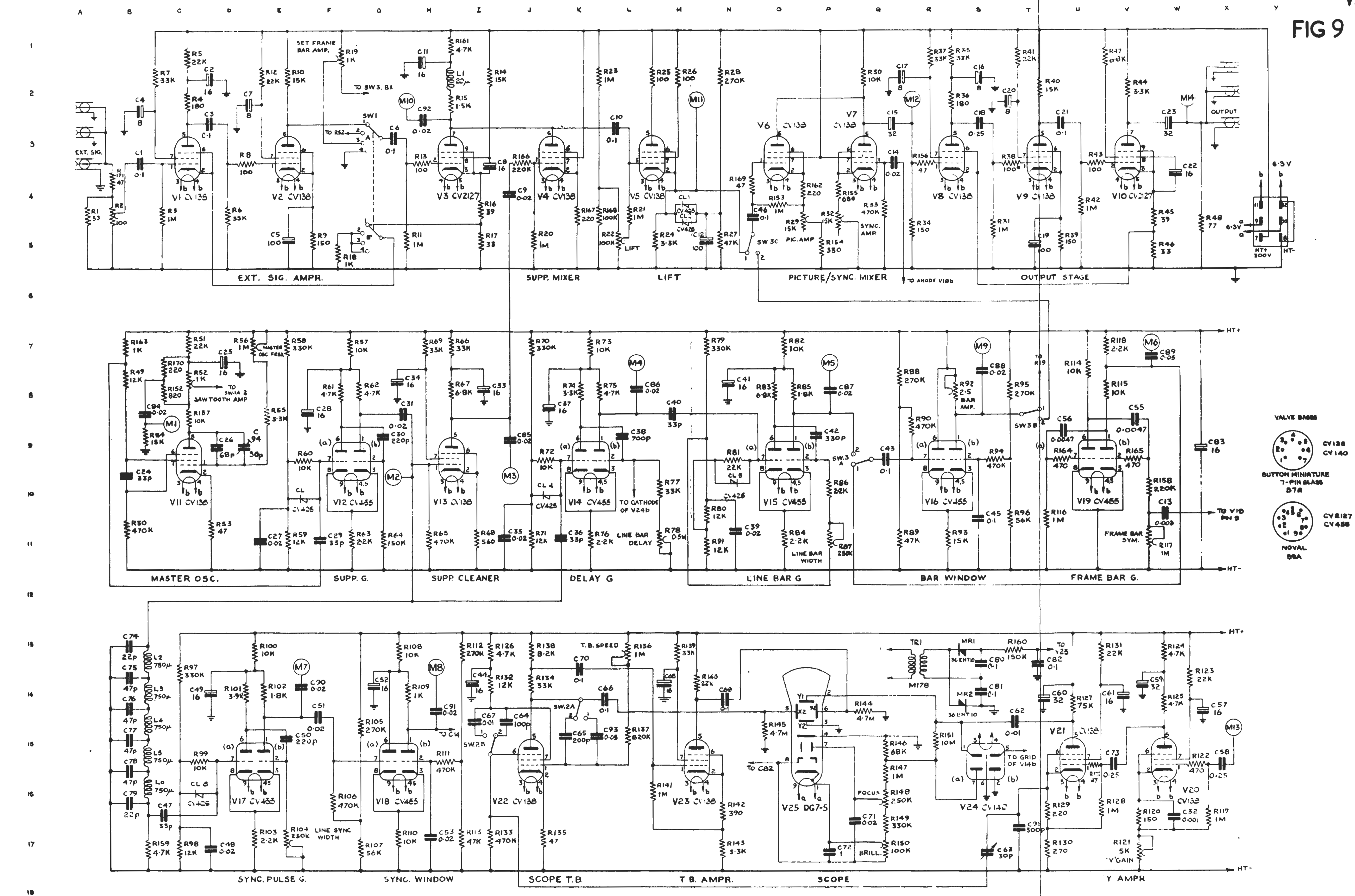
| Comp. | Loc. | Type | Tolerance Per cent | Comp. | Loc. | Type | Tolerance Per cent |
|---|---|---|---|---|---|---|---|
| R91 | N11 | Erie 109 0·25W | ± 5 | R134 | J14 | Dubilier BTB 1W | ± 10 |
| R92 | S8 | Colvern CLR 1106/15S | ± 10 | R135 | K17 | Erie 9 0·25W | „ |
| R93 | S11 | Dubilier BTB 1W | „ | R136 | L13 | Morganite LHNAR | |
| R94 | S9 | Erie 9 0·25W | „ | | | 10550 32800 | |
| R95 | T8 | „ 108 0·5W | ± 5 | R137 | L15 | Erie 9 0·25W | „ |
| R96 | T11 | „ 109 0·25W | „ | R138 | J13 | „ „ „ | „ |
| R97 | C14 | „ „ „ | „ | R139 | M13 | „ „ „ | „ |
| R98 | C17 | „ „ „ | „ | R140 | N14 | Dubilier BTB 1W | „ |
| R99 | D15 | „ „ „ | ± 10 | R141 | M16 | Erie 9 0·25W | „ |
| R100 | E13 | Dubilier BTB 1W | „ | R142 | N16 | „ „ „ | „ |
| R101 | D14 | Erie 9 0·25W | „ | R143 | N17 | „ „ „ | „ |
| R102 | E14 | „ „ „ | „ | R144 | Q14 | „ „ „ | „ |
| R103 | E17 | „ „ „ | „ | R145 | O15 | „ „ „ | „ |
| R104 | E17 | Morganite LHNAR | | R146 | Q15 | „ „ „ | „ |
| | | 25450 32800 | | R147 | Q16 | Dubilier BTB 1W | „ |
| R105 | G15 | Erie 108 0·5W | ± 5 | R148 | Q16 | Morganite LHNAR | |
| R106 | F16 | „ 9 0·25W | ± 10 | | | 25450 32800 | |
| R107 | G17 | „ 109 „ | ± 5 | R149 | Q17 | Erie 9 0·25W | „ |
| R108 | H13 | Dubilier BTB 1W | ± 10 | R150 | Q17 | Morganite LHNAR | |
| R109 | H14 | Erie 9 0·25W | „ | | | 10450 32800 | |
| R110 | H17 | Dubilier BTB 1W | „ | R151 | R15 | Erie 9 0·25W | „ |
| R111 | H15 | Erie 9 0·25W | „ | R152 | C8 | „ 109 „ | ± 5 |
| R112 | I13 | „ 108 0·5W | ± 5 | R153 | O4 | „ 9 „ | ± 10 |
| R113 | I17 | „ 109 0·25W | „ | R154 | P5 | „ „ „ | „ |
| R114 | U8 | Dubilier BTB 1W | ± 10 | R155 | P4 | „ „ „ | „ |
| R115 | V8 | „ „ „ | „ | R156 | R3 | „ „ „ | „ |
| R116 | U11 | Erie 9 0·25W | „ | R157 | C9 | Dubilier BTB 1W | „ |
| R117 | W11 | Morganite LHNAR | | R158 | W10 | Erie 9 0·25W | „ |
| | | 10550 32800 | | R159 | C17 | „ 109 „ | ± 5 |
| R118 | V7 | Erie 9 0·25W | „ | R160 | T13 | „ 9 „ | ± 10 |
| R119 | X17 | „ „ „ | „ | R161 | I1 | Painton P301 4·5W | ± 5 |
| R120 | W16 | „ „ „ | „ | R162 | P4 | Erie 9 0·25W | ± 10 |
| R121 | V17 | Colvern CLR 1106/15S | „ | R163 | B7 | „ „ „ | „ |
| R122 | X16 | Erie 9 0·25W | „ | R164 | U9 | „ „ „ | „ |
| R123 | X14 | „ „ „ | „ | R165 | V9 | „ „ „ | „ |
| R124 | W13 | Dubilier BTB 1W | „ | R166 | U3 | „ „ „ | „ |
| R125 | W14 | „ „ „ | „ | R167 | K4 | „ „ „ | „ |
| R126 | J13 | Erie 9 0·25W | „ | R168 | K4 | „ „ „ | „ |
| R127 | U14 | Painton ~~P302 6W~~ MXL 1·5W | ± 5 | R169 | N4 | „ „ „ | „ |
| R128 | V16 | Erie 9 0·25W | ± 10 | R170 | C7 | „ 109 „ | ± 5 |
| R129 | U16 | „ „ „ | „ | R171 | B4 | „ 108 0·5W | „ |
| R130 | U17 | „ „ „ | „ | R172 | U16 | „ 9 0·25W | ± 10 |
| R131 | V13 | „ „ „ | „ | | | | |
| R132 | J14 | „ „ „ | „ | | | | |
| R133 | J17 | „ „ „ | „ | TR1 | R14 | BBC M178 | |

55/GGJ/010
DJ1243



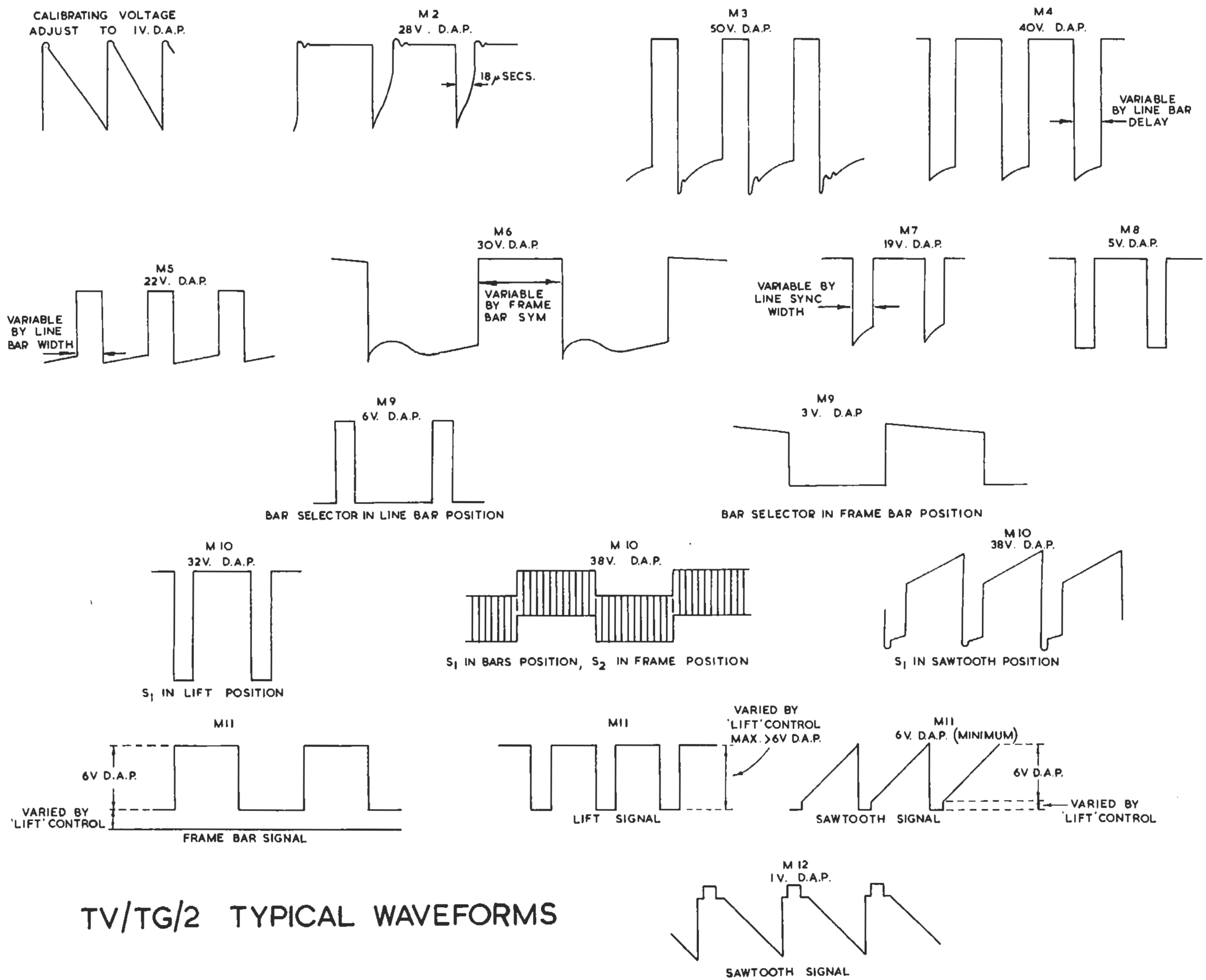
V3

FIG 9




# TELEVISION TEST GENERATOR TV/TG/2 CIRCUIT

55/GG.J/011/DFE
DSKA 1970
DSKA 1971




# TV/TG/2 TYPICAL WAVEFORMS

FIG 10

V3