SECTION 7

BAR AND SAWTOOTH GENERATORS GE1/508 AND GE1/508A

Introduction

Generator GE1/508A is the current version of a unit which forms part of the Test Generator Outfit OT1/503, used in mobile controls to check camera-channel gains and gamma correction, as well as serving as a source for sending test signals to line. The front aspect of the generator is shown in Fig. 7.1.

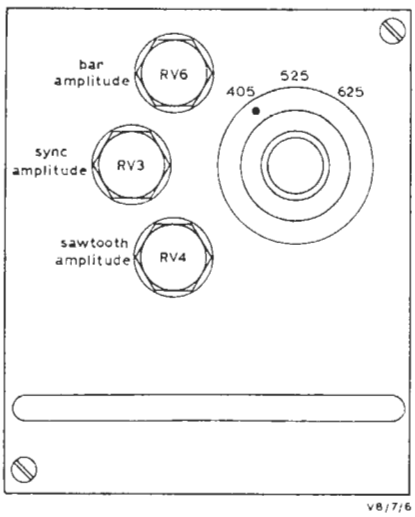


Fig. 7.1. GE1/508 and GE1/508A: Front View of Unit

Two outputs of fully-blanked television test signal are provided, one composite and the other non-composite. Two test waveforms are generated, one a peak-white line bar and the other a peak-white line sawtooth, and they appear on alternate lines. This adjacent-line positioning enables the adjustment of level and detection of undesirable limiting effects to be made simultaneously. There is provision for operation on 405, 525, and 625 line standards.

All components are distributed between three printed-wiring cards mounted on a modified CH1/12B chassis. Those on an upper board are relevant to a blanking amplifier, trigger, divider and bar generator, and components on a lower board are associated with a sync generator and a sawtooth generator. To one side of these is a board carrying components of the composite and non-composite amplifiers. The separate operating supply is obtained from a PS2/12 stabilised supplier; details of this are in Section 12, Part 2 of Instruction G.2.

The few GE1/508 units in service differ from the current type in having Veroboard where the GE1/508A employs printed-wiring cards. The two versions differ also in their chassis-indexing pins, which are 7 and 22 for the GE1/508 and 7 and 11 for the GE1/508A.

General Specification

Input Signals

Mixed sync pulses (2 volts p-p).

Mixed blanking pulses (2 volts p-p).

Line Standards

405, 525 and 625.

Input Impedance

Approximately 10 kilohms at 10 kc/s (with unit switched on).

Output Impedance

75 ohms approximately.

Output Rise and Fall Times of Bar

0·25 μsec to 0·5 μsec (405 lines).

0·2 μsec to 0·4 μsec (625 lines).

Output Fall Time of Sawtooth

2·5 μsec (adjusted to this value).

Frequency Response

3 dB down at 1 Mc/s.

Current Consumption

63 mA (±3 mA) in 12-volt positive lead.

42 mA (±2 mA) in 12-volt negative lead.

Stability

Within ±2 per cent; normally ±1 per cent.

Note: It is advisable to check and adjust the waveform amplitude at approximately three-monthly intervals.

General Operation

Fig. 7.2 is a block schematic of the equipment. Mixed synchronising pulses are fed to a sync generator in which they are stabilised in amplitude

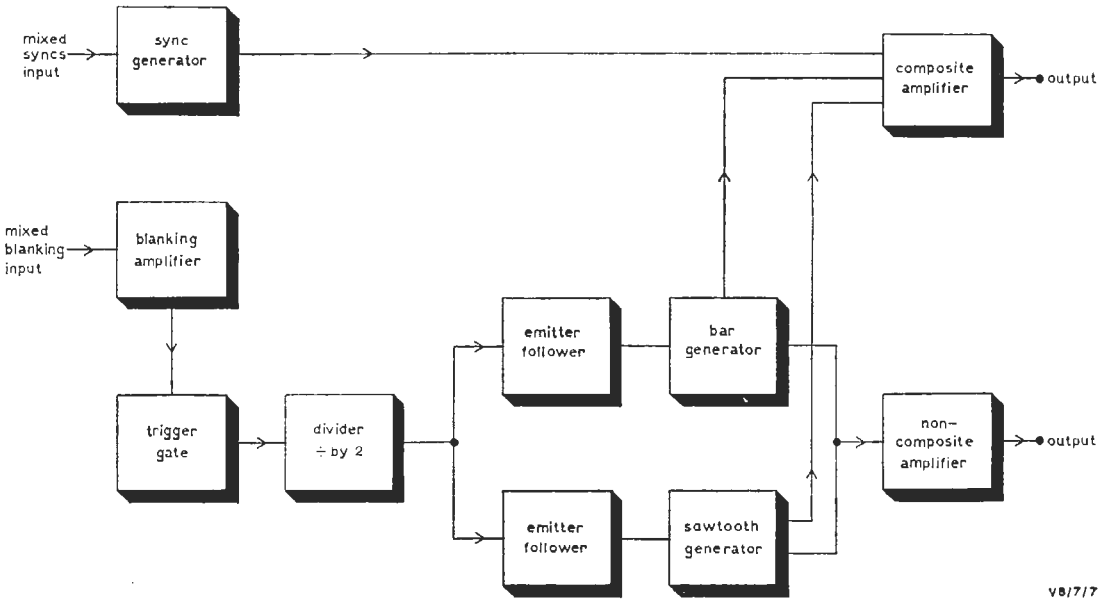


Fig. 7.2. GE1/508 and GE1/508A: Block Diagram

and processed to remove distortion, before application to the composite amplifier.

The mixed blanking pulses also are amplitude-stabilised before use in triggering a divider. For clarity the schematic omits a branch taken from the blanking amplifier to the bar and sawtooth generators, to ensure that they are switched off at the ends of those fields containing one half of an active line period. This feature provides a suppressive action by preventing part of the generator output, either bar or sawtooth, from appearing in the first broad-pulse (or equalising-pulse) period.

The divider produces two outputs of trigger pulses at half line-frequency and they are displaced from one another by a period equal to the duration of one line. One set of these pulses is used to initiate the bar waveform, and the other to trigger the sawtooth generator. The outputs of the two generators are taken to both the composite and non-composite amplifiers.

Circuit Description (Fig. 12)

The complete circuit diagram in Fig. 12 includes details of a supplementary arrangement which has to be used with the generator, namely two external capacitors wired across the panel socket.

Waveforms at various points in the circuit are shown in Figs. 7.3 and 7.4.

Sync Pulse Generator

The action of this circuit is such that a portion from the centre of the input-waveform amplitude is selected and stabilised.

In the quiescent condition the transistor TR11 is biased near cut-off and takes current determined by the base potential and R38. The collector potential is held at approximately −9 volts by ZD3, which draws a small current through the collector load R37. Also connected to ZD3 is the base of TR12. The current taken by this transistor is determined by R42 and the difference between the potentials existing at (a) the TR12 base, and (b) the junction of R42 and C22. This difference of potential, and hence the TR12 current, can be controlled by RV8.

Application of an input signal causes the TR11 current to increase, but there is no increase in collector voltage until the value reaches about 3 milliamperes, corresponding to an input voltage of 0·5 volt. As the input voltage increases negatively, the collector current increases and the collector potential moves positively. This movement is communicated to the base of TR12 and that transistor is cut off, with the collector at −12 volts. Thus the signal excursion at TR11 collector is constrained between the potentials stabilised by ZD3 and MR9; limiting by MR9 avoids undesir-

able break-through effects between the base and collector of TR12. The amplitude of the output signal, which has the same polarity as the input signal, is determined by the quiescent-condition voltage drop across R41, and is adjusted by RV8. The degree of local negative feedback makes circuit operation largely independent of variations in the characteristics of TR11 and TR12.

Blanking Amplifier

Negative-going mixed blanking pulses cause a heavy flow of current in TR13, but the voltage swing at the collector is limited by ZD5. This zener diode stabilises at 5 volts, and thus the collector excursion is 7 volts, as can be seen in Fig. 7.3. The inverted signal at TR13 collector is differentiated in the C25, R47 combination, the derived negative-going pulses being amplified and inverted in TR14 to obtain positive-going pulses for triggering the divider.

Divider

TR15 and TR16 form a bistable multivibrator producing two rectangular waveforms, one applied to the bar generator and the other to the sawtooth generator. The transistors have their emitters strapped in connection with a common bias resistor, which ensures that the emitter current of the transistor that happens to be conductive provides a bias keeping the other transistor in the cut-off condition.

To consider the action, assume that TR15 is conducting and TR16 is cut off. Thus the TR15 collector voltage is low (−2 volts), almost equal to the emitter voltage, whereas the TR16 collector potential is high (−10 volts), as set by the voltage-divider R56, R52 and R53. It is arranged that the potentials to either side of MR10 differ very little for the assumed state, so this diode is ready to conduct when a positive pulse is applied. MR11 is reverse-biased because, with TR15 conducting, the cathode is positive to the anode.

An incoming positive pulse (from TR14) makes MR10 conductive and is able to pass through speed-up circuit C28, R52 to the TR15 base. This pulse is unable to reach the TR16 base because MR11 is reverse-biased, but it is applied to the TR16 collector and, by counteracting the existing high negative potential at that point, accelerates the regenerative multivibrator action. This is initiated as the TR15 collector current is reduced by the positive pulse at the base, the resultant rise of TR15 collector voltage being communicated to the base of TR16, causing that transistor to conduct. The rapid change of state ends with a reversal of the original condition, leaving TR16 conductive and ready to respond to the next positive pulse by initiating another cycle returning the circuit to the initial state. Thus two triggering pulses are needed for one complete rectangular waveform and the pulse repetition frequency is halved.

The circuit has a symmetrical arrangement of identical coupling components, so the TR15 output for the sawtooth generator is similar to the TR16 output for the bar generator, subject to the time displacement of the two waveforms. These outputs are applied through emitter-followers TR27 and TR17 respectively.

Bar Generator

The 5-kc/s pulses from the divider are differentiated at the base of the isolating transistor TR17 and the derived negative-going edges are employed to trigger the monostable multivibrator circuit of TR19 and TR20.

The circuit action can be considered from the stable state, in which TR19 is cut off and TR20 is conductive. When a negative-going edge arrives at its base, TR19 becomes conductive and its collector-current increase gives a rise of potential which cuts off TR20; this positive excursion is communicated also to the output circuit via R67, which controls the amount of current through ZD6. As TR20 is cut off, C36 begins to discharge through R69 and RV9 (bar width adjustment) and the TR20 base potential moves negatively until it reaches a value at which this transistor again becomes conductive. The resultant rise of TR20 collector voltage cuts off TR19 and the circuit returns to the stable condition having delivered one rectangular pulse under the action of one triggering pulse. Output-pulse amplitude is kept constant by means of ZD6.

To achieve the proportionately shorter bar-widths appropriate to shorter active-line periods on 525- and 625-line standards, switch SA1 is used to place R88 in parallel with R69 and RV9.

During odd fields there are half-line periods in which half-line signals are liable to be generated after the start of field sync intervals. To prevent this intrusion the mixed blanking pulses are applied to TR18 for the purpose of obtaining positive-going edges to stop the bar-generator action at the end of each odd-field half-line preceding the field sync interval; the bar generated is therefore of

shorter duration than in the rest of the active field period.

Sawtooth Generator

The functioning of the circuit comprised of TR25, TR26, TR27, TR28 and their associated networks is identical with that already described for the bar generator. The waveform generated across ZD7 has a time displacement of one line from that developed across ZD6, and it is applied through R77 to TR24.

TR24, TR23, TR22 and associated components form a bootstrap circuit. In the quiescent condition, TR24 conducts heavily due to the negative potential on ZD7, and therefore the collector voltage is low (approximately 0·3 volt). When a triggering pulse is applied through TR27, the multivibrator (TR25 and TR26) begins a complete double transition which produces a positive bar waveform across ZD7. The leading edge of this waveform cuts off TR24, and C41 starts to charge through R75. The voltage across C41 is applied through emitter-followers TR23 and TR22 to the base of output transistor TR21, from which there is connection through bootstrap capacitor C40 to the MR13, R75 junction. Through voltage change applied via C40, MR13 cut-off and the voltage across R75 remains constant, so C41 undergoes constant-current charging. This linearising process applies also to the quick discharge of C41 when TR24 again becomes conductive at the end of the positive pulse.

The sawtooth duration is equal to the duration of the bar waveform across ZD7. The amplitude of sawtooth waveform depends on the value of C41 and the charge duration and rate, the latter being determined by the operating voltage and R75. The shorter-duration bar for 525- and 625-line standards is obtained by increasing the charging rate, for which purpose RV11 and R90 are added in parallel with R75.

The sawtooth waveform is amplified and inverted in TR21, before application through C38 and RV4 to both the composite and non-composite amplifiers.

Composite and Non-composite Amplifiers

These two amplifiers have almost identical circuits. The differences are in (a) provision to mix the synchronising pulses at the composite amplifier, and (b) incorporation of RV5 and RV7 to enable the amplifier gains to be made equal.

Each amplifier has two stages with negative feedback taken from the second-stage emitter to the first-stage base. This gives a very low input impedance, enabling the parts of the output signal to be mixed with negligible interaction by means of a resistive matrix. C9 and C16 are compensating capacitors to trim the amplitude/frequency responses of the individual amplifiers.

Test Schedule

Apparatus Required

Avometer Model 8.
Oscilloscope (Tektronix type 545, with plug-in unit type 53/54G and a probe unit (10x) type P6000.)
Signal Measuring Unit, type UN1/511.
Non-linearity Test Signal Generator (405 lines), type GE4/505.

Also needed are supplies of mixed sync pulses and mixed blanking pulses for both 405 and 625 lines, each at 2 volts p-p across 75 ohms; line standards to be those on which the generator is to be operated.

Preliminary

Set all controls to their centre positions and ensure that two 250-µF capacitors are wired to the panel socket, as indicated at the top-left corner of Fig. 12.

Sync Pulse Generator

1. Set switch SWA on the front panel of the GE1/508A to the *405* position.
2. Connect a 2-volt p-p supply of mixed sync pulses (405 lines) to PLB10, with the input terminated in 75 ohms.
3. With the 10x probe and the oscilloscope, check that the waveforms correspond with those shown in Fig. 7.3.
4. With the probe connected to the TR12 collector, adjust RV8 to obtain a pulse amplitude of 1·5 volts p-p.

Trigger Amplifier

1. Feed mixed blanking pulses at 2 volts p.p. into PLB2, with the parallel input plug terminated in 75 ohms.
2. Using the 10x probe, check that waveform at the TR13 collector is as in Fig. 7.3.

Divider

1. Trigger the oscilloscope externally from the mixed sync pulses.
2. Using the 10x probe, check that the waveforms at the TR15 and TR16 collectors are as in Fig. 7.3.

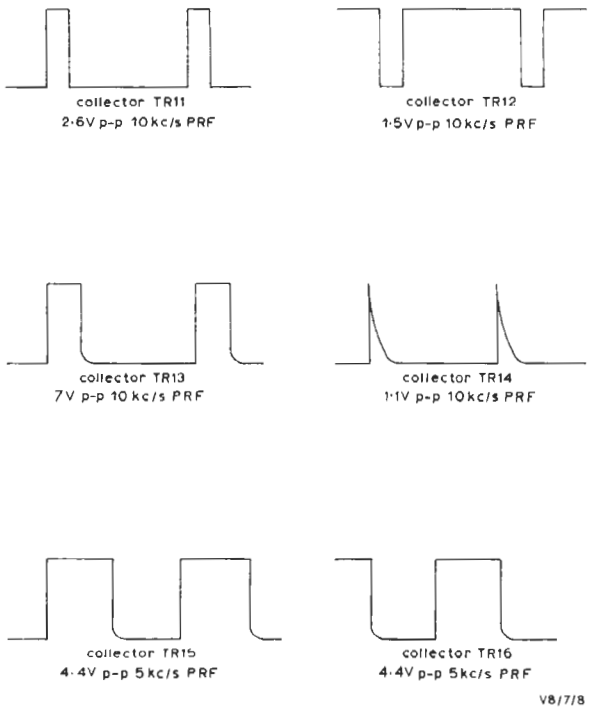


Fig. 7.3. GE1/501 and GE1/508A: Waveforms at Collectors of TR11 to TR16

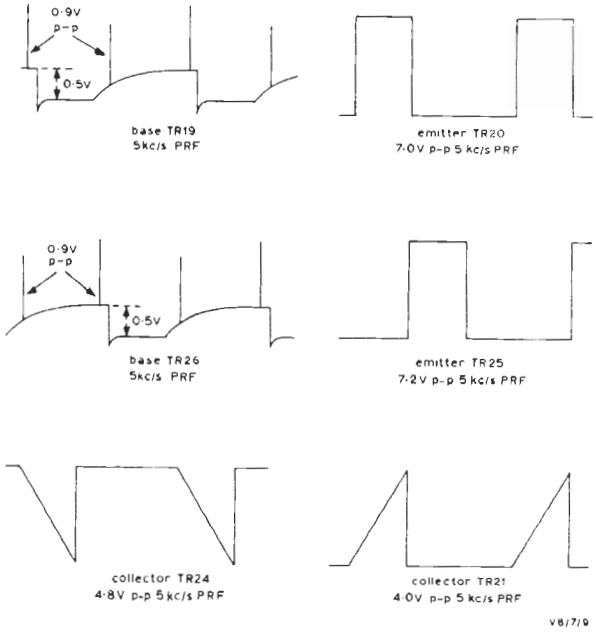


Fig. 7.4. GE1/508 and GE1/508A: Waveforms in Bar and Sawtooth Generators

Bar and Sawtooth Generators

Using the 10x probe, check that the waveforms correspond to those shown in Fig. 7.4.

Note: When either a component or transistor in the sawtooth generator is changed, the sawtooth recovery time must be checked. If necessary, the recovery time should be restored to 2·5 µsec by selecting a suitable value for C44; the value lies in the range 270-560 pF.

Setting-up Procedure

Sync Pulse Stabiliser

1. Use the mixed sync pulses for external triggering of the oscilloscope, and connect this unit (terminated in 75 ohms) to the *Output* plug of the UN1/511. Connect PLB12 (GE1/508A) to the *Signal Input* plug of the UN1/511, set for the *Measure Sync* condition and with the dial at 0 dB.
2. Adjust RV3 (GE1/508A) until the balance condition is obtained. Check that (a) the rise and fall times of the sync pulse are not greater than 0·2 µsec, and (b) any overshoot present is not greater than 5 per cent of the sync amplitude. Select C9 to obtain these conditions.

Bar Generator

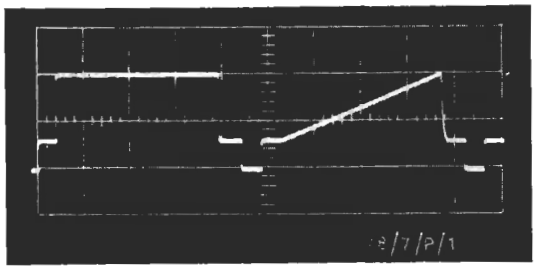
3. Switch the UN1/511 to the *Signal* position. Adjust the oscilloscope timebase speed to 2 µsec/cm.
4. Adjust RV9 (GE1/508A) to obtain a pre-sync blanking time, after the bar waveform, of 10 µsec.
5. Switch the UN1/511 to *Measure Pic*, leaving the dial at 0 dB.
6. Adjust RV6 (GE1/508A) until the balance condition is obtained.
7. Connect PLB8 (GE1/508A) to the *Signal Input* of the UN1/511, leaving this unit as in item 5.
8. Adjust RV7 (GE1/508A) until the balance condition is obtained. Select C16 to obtain minimum overshoot consistent with a bar rise-time of between 0·25 µsec and 0·5 µsec.

Note: RV6 and RV7 interact, and it is necessary to repeat the adjustment of these controls to obtain correct signal amplitude simultaneously from both amplifier outputs.

9. Check that the top of the bar is flat to within 0·5 per cent of the bar amplitude.

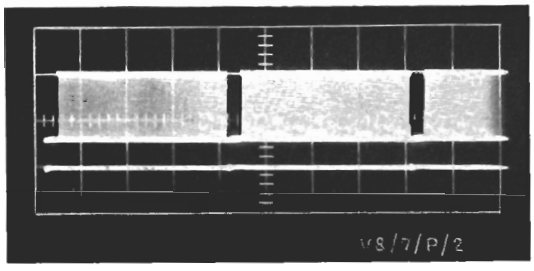
Sawtooth Generator

10. Trigger the oscilloscope externally from the



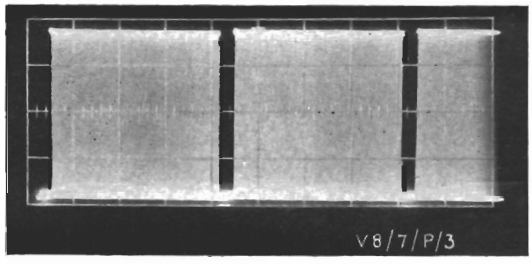
(a) Output PLB12

Vertical scale: 0·5 volt per square
Horizontal scale: 20 μsec per square



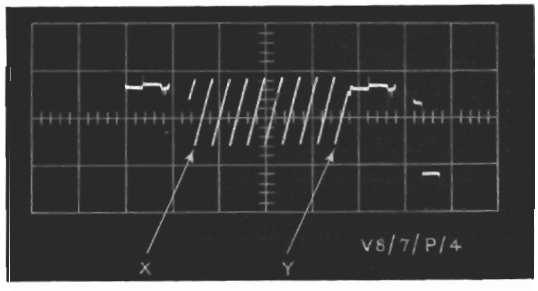
(b) Output PLB12 (D.C. coupled)

Vertical scale: 0·5 volt per square
Horizontal scale: 5 msec per square



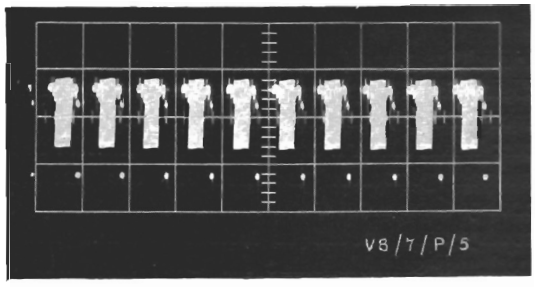
(c) Output PLB8 (D.C. coupled)

Vertical scale: 0·2 volt per square
Horizontal scale: 5 msec per square



(d) Check of Sawtooth Linearity

Vertical scale: 0·05 volt per square
Horizontal scale: 20 μsec per square



(e) Check of Sawtooth Linearity

Vertical scale: 0·05 volt per square
Horizontal scale: 200 μsec per square

Fig. 7.5. GE1/508 and GE1/508A: Output and Linearity-check Waveforms

mixed sync pulses. Switch the UN1/511 to *Signal* and connect the *Signal Input* to PLB12 (GE1/508A).

11. Adjust RV10 (GE1/508A) to obtain a pre-sync blanking time, after the sawtooth waveform, of 10 μsec.
12. Alter the UN1/511 to the *Measure Pic* setting, with the dial at 0 dB.
13. Adjust RV4 (GE1/508A) to obtain the balance condition.
14. Transfer the *Signal Input* of the UN1/511 to PLB8 of the GE1/508A.
15. Adjust RV5 (GE1/508A) to obtain the balance condition.

Note: RV4 and RV5 interact, and it is necessary to repeat the adjustment of these controls to obtain

the correct signal amplitude simultaneously from both amplifier outputs.

Measurement of Sawtooth Linearity

16. Using the type-545 oscilloscope with the type-53/54G pre-amplifier, feed the PLB12 output of the GE1/508A to input A of the pre-amplifier, terminated in 75 ohms.
17. Connect a 2-volt supply of 405-line triggering pulses to the *Sync Input* of the GE4/505, and adjust the controls to obtain a repetitive 10-step waveform at the output of the unit. Connect this output to input B of the pre-amplifier, terminated in 75 ohms.
    Set the function switch to A-B (a.c. coupled) and use the maximum gain of the pre-amplifier.

Note: Adjust the amplitude of the step waveform so that the first sawtooth appears at the same level as the final one. This is illustrated by Fig. 7.5(d) in which points X and Y appear at the same level.

18. Check that the variation in level, from the mean of peaks in the displayed series of sawtooth waveforms, is less than 7 mV.

Output Signals

Observe the output signals and check that waveforms correspond with those of Fig. 7.5.

Adjustments for 625-line Working

1. Prepare the GE1/508A by setting SWA to *625* and connecting signals, to the 625-line standard, as follows:
   Mixed sync pulses at 2 volts p-p to PLB10,
   Mixed blanking pulses at 2 volts p-p to PLB2.
2. Set the UN1/511 to *Signal* and connect it to PLB12 of the GE1/508A.
3. Check that the pre-sync blanking time is 10 µsec (±1 µsec).
4. Switch the UN1/511 to *Measure Pic* and see that the dial is at 0 dB.
5. Adjust the sawtooth amplitude by means of RV11 (GE1/508A) so that the balance condition is obtained.
6. Check that the rise and fall times of the sync pulse are not greater than 0·25 µsec, and observe that the output signals are as shown in Fig. 7.5.

D.C. Measurements

The table gives typical voltages, as measured by a Model-8 Avometer and with no signal input.

Transistor	*Voltages to earth*		
	Emitter	*Collector*	*Base*
TR7	+6·3	+4·9	+6·0
TR8	+11·3	+6·0	+11·0
TR9	+11·3	+6·6	+11·0
TR10	+6·9	+4·4	+6·6
TR11	−0·37	−9·0	−0·45
TR12	−8·9	−10·6	−9·0
TR13	0	−10·2	+0·3
TR14	0	−6·3	0
TR15	−0·94	−0·72	−3·3
TR16	−0·94	−0·72	−3·1
TR17	0	−12	0
TR18	0	+12	0
TR19	+12	+3·6	+12
TR20	+1·65	−4·1	+1·67
TR21	−1·8	−10·4	−1·96
TR22	−1·5	−12·0	−0·85
TR23	−0·75	−12·0	−0·85
TR24	0	−0·85	−0·05
TR25	+1·6	−4·0	+1·6
TR26	+12	+3·5	+12
TR27	−0·02	−12·0	0
TR28	+0·02	+12·0	0

WJP/1165

From DH11065 iss.5
Parts List DA11066

Previously issued as Fig.12 in Instruction V8, Section 7

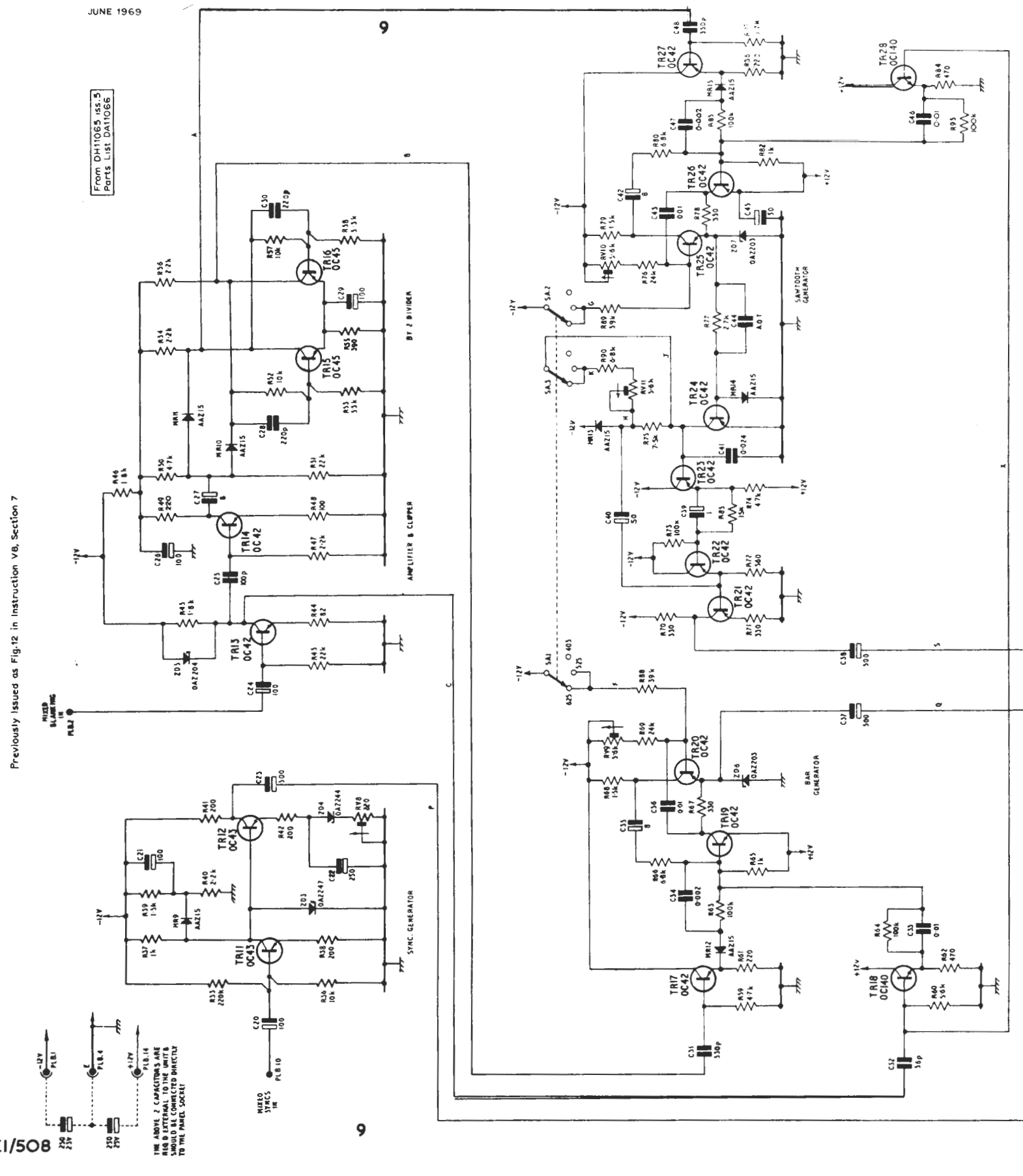


Fig. 6 Circuit of the Bar and Sawtooth Generator GEI/ 508A