GRILLE GENERATOR GE4/513

Introduction

The Grille Generator GE4/513 provides an output signal which produces a pattern of fine vertical and horizontal bars when displayed on a picture monitor. It has been designed to serve the two functions of providing (a) a pattern of 25 vertical and 25 horizontal bars for setting scan linearity, and (b) a pattern of 18 vertical and 18 horizontal bars for setting-up colour monitor convergence circuits. The input signals required are mixed synchronising pulses, mixed blanking pulses, and field trigger pulses. The generator operates on three line standards (405, 525 and 625 lines), the line standard and pattern being selected by a switch on the front panel.

Three printed-wiring boards are used, mounted on a CH1/12C plug-in chassis. The generator contains its own power supply unit and operates from 50-Hz mains.

General Data

Output Signal	1 volt peak-to-peak composite video signal into 75 ohms.
Input Signals	2 volts p-p (±2 dB) mixed synchronising pulses 2 volts p-p (±2 dB) mixed blanking pulses 2 volts p-p (±2 dB) field trigger pulses.
Line Standard	Switchable to 405, 525 and 625 lines.
Input Impedance	3 kilohms for each signal.
Output Impedance	75 ohms (±2 per cent) up to 5·5 MHz
Output Rise and Fall Times	
Synchronising pulses	Less than 0·1 μs
Vertical bar	Less than 0·1 μs
Pulse Duration	
Vertical bar	0·25 μs
Horizontal bar	82·5 μs (405 lines) 53·5 μs (525 and 625 lines).
Number of Bars	
Vertical convergence	18.
Vertical Linearity	25
Horizontal convergence	18 (405 lines). 17·5 (525 and 625 lines).
Horizontal linearity	23·5 (405 lines). 24·5 (525 and 625 lines).
Operating Temperature Range	0 to 45 degrees C.
Temperature Stability	
Output Level	Less than 0·02 dB/degree C.
Number of vertical bars	0·01 per cent/degree C.
Number of horizontal bars	Independent of temperature.
Mains Variation	Variation in output level is less than 0·025 dB for voltage change of 7½ per cent.
Mains Hum	0·01 volt p-p on output signal
Mains Voltage	200 to 250 volts, 50 Hz
Power Consumption	15 mA at 240 volts.
Weight	3 lb 9 oz.

Circuit Description

General

A block schematic of the generator is shown in Fig. 2, and the complete circuit diagram in Fig. 1. The upper part of both diagrams refers to the production of the vertical bars, and the lower part to the horizontal bars.

The generator is supplied with standard mixed synchronising pulses, mixed blanking pulses, and field trigger pulses. The vertical and horizontal bars forming the grille are all derived from the line component of the mixed blanking pulses. The production of the vertical bars is described first.

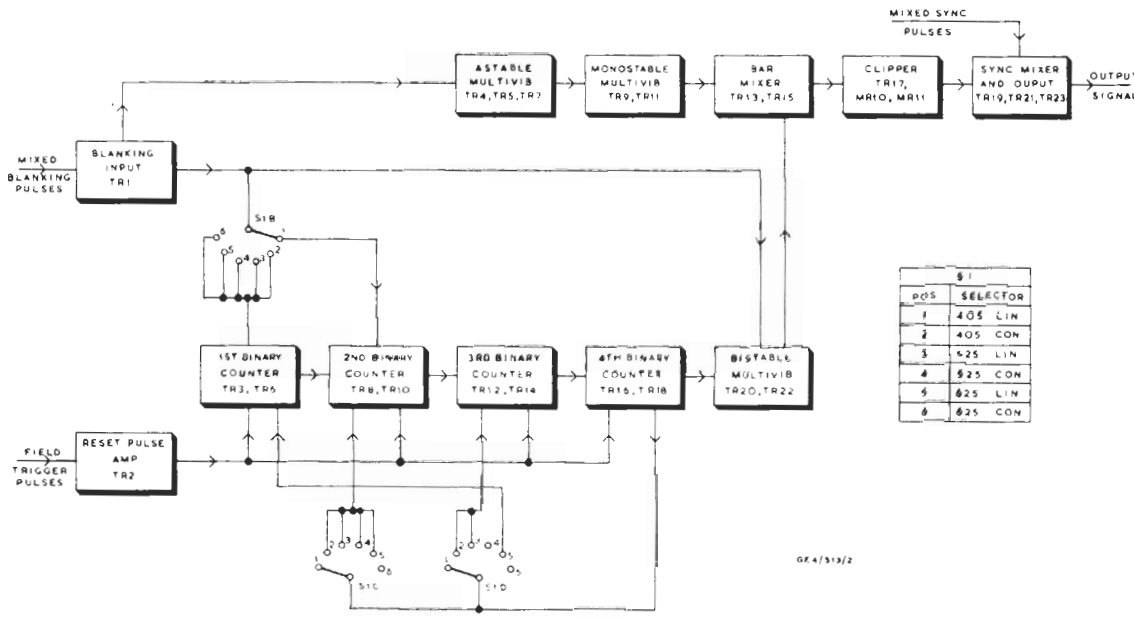

Fig. 2 Grille Generator GE4/513: Block Diagram

A train of pulses with a frequency appropriate to the required number of vertical bars is developed by the astable multivibrator formed by transistors TR5 and TR7, synchronised either every 18th or every 25th cycle of the multivibrator by the line component of the mixed blanking pulses from the blanking input stage TR1. The pulses from the multivibrator are modified to the required pulse duration of 25 μs by the monostable multivibrator formed by TR9 and TR11. From this multivibrator the vertical bar pulses are fed to the bar mixer stage, TR13 and TR15.

To produce the horizontal bars, the mixed blanking pulses are taken from the input stage TR1 to the chain of four binary counters, using transistors TR3 and TR6, TR8 and TR10, TR12 and TR14, and TR16 and TR18 respectively. The counters perform the frequency division necessary to produce pulses at the appropriate frequency for the number of horizontal bars required. They use knock-back circuits which are switched to obtain the number of bars and line standard required. The leading edge of the horizontal bar pulse from the binary counter chain, which corresponds in time with the trailing edge of the original line blanking pulse, is used to switch the bistable multivibrator formed by TR20 and TR22. The mixed blanking pulse restores the bistable multivibrator to its original state so that a pulse of one-line duration is produced either 18 or 25 times per field. The horizontal bar pulses are fed to the bar mixer stage where they are mixed with the vertical bar pulses. The resulting grille signal is clipped, amplified and inverted before passing to the sync mixer and output stage (TR19, TR21 and TR23) where the mixed synchronising pulses are added.

The trigger pulses for the binary counter chain, the line-forming bistable multivibrator, and the vertical bar generator are derived from the appropriate edge of the mixed blanking pulses, the three trigger points being fed from a common emitter-follower stage TR1. As the generators are suppressed during the field and line blanking-pulses, there is no need for further blanking of the output waveform.

Vertical Bar Generator

The vertical bars are produced by two multivibrators, the first being an astable circuit which determines the periodic time of the pulse train, and the second a monostable circuit which determines the pulse duration. The astable multivibrator is formed by transistors TR5 and TR7, and the duration of the quasi-stable state is determined by the variable resistors RV1 to RV5 to give the required number of bars for the various functions. If TR5 is cut off and TR7 is conducting, the potential at which the base of TR5 is held depends on the charge developed across capacitor C8. This potential is approximately equal to that of the emitter rail, the voltage excursion at the base of TR5 having been caught at this potential during the previous period of conduction. The positive pulse developed across resistor R31 on the conduction of TR7 appears at the base of TR5, the amplitude being such that the base potential becomes equal to that of the positive rail. Capacitor C8 discharges through R23 so that the base of TR5 becomes negative. Transistor TR5 starts to conduct, regenerative switching occurs, cutting off TR7 and leaving TR5 conducting. Similarly, when the base of TR7 becomes positive, C7 discharges through R24 so that the base of TR7 becomes negative and the transistor conducts. Regenerative switching occurs again and a new cycle starts.

To synchronise this form of multivibrator and to ensure that the cycle starts from the trailing edge of the blanking pulse, mixed blanking pulses are applied to the base of TR4 which, when bottomed, takes the collector potential of TR5 to that of the positive rail. In this state TR5 is reverse-biased, C8 charges, holding the base of TR5 to the positive-rail potential on the cessation of the blanking pulse, which is the condition existing at the start of a cycle under normal operation. However, the period of the first half-cycle at the start of the pulse train is dependent on the potential of the emitter rail. To set the spacing between the first and second bars equal to the normal bar spacing, the potential of the emitter rail can be adjusted by the pre-set control RV6. The thermistor TH1 is included in the collector circuit of TR7 to

stabilise the number of vertical bars by compensating for variations in base current with temperature.

The output of the astable multivibrator (shown in Fig. 3) is taken from the junction of R17 and R18 in the collector circuit of TR5, differentiated by C6, and applied to the monostable multivibrator, TR9 and TR11. These transistors are biased so that TR11 normally conducts, the common emitter rail being made negative so that TR9 is cut off. When the negative trigger pulse from the astable multivibrator is applied to the base of TR9, the transistor conducts and makes the collector of TR9 and the base of TR11 positive, thereby cutting off TR11. Capacitor C14 discharges through R48, making the base of TR11 negative and so returning TR11 to its normal state of conduction.

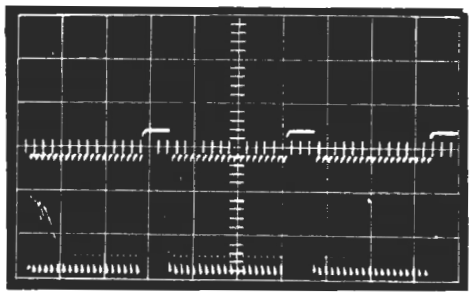

Fig. 3 GE4/513: Output Waveform of Astable Multivibrator, at Junction of R17 and R18 in TR5 Collector Circuit

Vertical scale: 1 volt per square
Horizontal scale: 20 μsec per square

The output of the monostable multivibrator is taken from the collector of TR11 and fed by C19 to the bar mixer stage, TR13 and TR15.

Horizontal Bar Generator

The horizontal bar repetition-rate is determined by the binary counter chain which is fed with the mixed blanking pulses from the input stage TR1.

The trigger pulses to TR3 and TR6 are applied through diodes MR2 and MR3, which are controlled by the collector potentials. The diodes are biased by the potential divider R6 and R7 so that they are on the point of conduction when the associated transistor is cut off and reverse-biased when the transistor is conducting. The action of the diodes, therefore, is to supply sequentially the positive-going trigger pulses to the base of the conducting transistor through the coupling components R19/C10 and R22/C11. The diodes also remove the negative-going edge of the differentiated pulse. The output of the counter is taken from the collector of TR6, and consists of one pulse for every two positive-going trigger pulses.

The binary counter chain consists of four counters. Switch S1 enables knock-back pulses to be applied to the appropriate counter which, together with the bypassing of the first counter, enables five division ratios to be obtained. The switch positions and the corresponding division ratios and functions are listed in the table below.

Switch Position	*Number of Bars*	*Line Standard*	*Division Ratio*	*Circuit Condition*
1	23·5	405	8	First counter inoperative
2	18·8	405	10	Knock-back pulses to 2nd and 3rd counters
3	24·5	525	10	Knock-back pulses to 2nd and 3rd counters
4	17·5	525	14	Knock-back pulses to 2nd counter
5	24·5	625	12	Knock-back pulses to 1st and 2nd counters
6	18·2	625	16	Knock-back pulses to no counter

The knock-back pulses are obtained from the collector of TR16, and passed through the delay network of L1, R63, and C23 to switches S1C and S1D. The pulses are passed to the second and third counters as required, through the hold-off resistors R45, R52 and R111. Bypassing of the first counter is effected with switch C1B, one setting of which connects the trigger pulses from the blanking input stage to the second, instead of the first, counter.

To ensure that the count starts correctly from the end of the field blanking pulse, the counters must be reset to a common state. Failure to reset the counter would result in a travelling bar pattern. A reset pulse in the form of an inverted field-trigger pulse if therefore applied by TR2 to a rail from which base-circuit resistors R21, R37, R61, and R77 are taken. When the reset pulse is applied, transistors TR6, TR10, TR14, and TR18 are, if not already, cut off and TR3, TR8, TR12, and TR16 conduct. Waveforms in the binary counter chain are shown in Fig. 4.

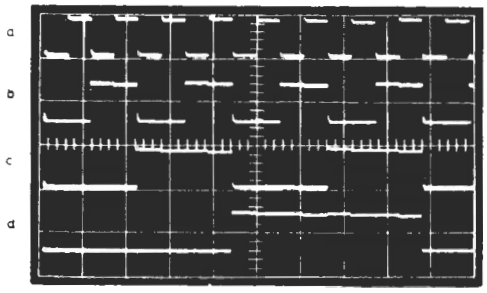

Fig. 4 GE4/513: Waveforms in Binary Counter Chain, at Collectors of (a) TR6, (b) TR10, (c) TR14 and (d) TR20

Vertical scale: 2 volts per square
Horizontal scale: 100 μsec per square

The output of the binary counter chain is taken from the collector of TR18 and fed through C30 to the bistable multivibrator, TR20 and TR22. This multivibrator generates a pulse of one-line duration for each positive edge supplied by the binary counter chain. This positive edge corresponds to the trailing edge of the line blanking pulse, and forms one timed edge, the other being taken from the leading edge of the inverted mixed blanking pulses.

The circuit of the bistable multivibrator is the same as that of the binary counter; the action differs only in the method of triggering. The output of the binary counter chain is applied to the collector of TR20. Mixed blanking pulses, inverted by TR24, are applied to the collector of TR22 by the diode MR17 which is biased to be inoperative when TR22 is conducting. A positive pulse applied to the collector of TR20 cuts off TR22. Diode MR17 is biased on, and the first positive edge from the inverted mixed blanking pulses (the leading edge) makes the base of TR20 positive, so cutting off TR20. Transistor TR22 conducts, and consequently MR17 is again biased off. The circuit remains in this state until the next positive edge is received from the counter chain.

The output of the bistable multivibrator, shown in Fig. 5, is taken from the voltage divider (R95 and R96) in the collector circuit of TR22, and fed through C24 to the bar mixer stage, TR13 and TR15.

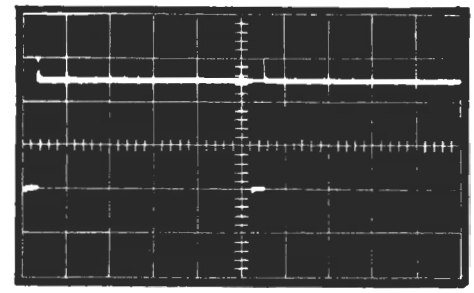

Fig. 5 GE4/513: Output Waveform of Horizontal Bar Generator, at Collector of TR22

Vertical scale: 0·5 volt per square
Horizontal scale: 200 μsec per square

Bar Mixer and Clipper Stages

The outputs of the vertical and horizontal bar-generators are applied to the bases of TR13 and TR15 respectively, and a combined output is developed across the common collector-load resistor R58. As each transistor is bottomed when pulses are applied to the base, the collector signal contains only a very small vertical bar pulse during the horizontal bar period, and so only a small amount of clipping is required to produce the final bar signal.

The positive excursion of the combined vertical and horizontal bar signal is clipped to a predetermined level by diode MR11. The negative excursion is clipped by MR10, and the clipping level can be adjusted by RV7 *(Bar Amp.)* to provide a bar amplitude control. The clipped signal is amplified by TR17, and fed through C29 to the sync mixer stage, TR19, TR21 and TR23.

Sync Mixer Stage

Mixed synchronising pulses are applied to the base of TR23, and cause the transistor to bottom. Because the collector of TR23 is connected directly to the base of TR21, this transistor is cut off for the duration of the pulse. The negative excursion of the base, and hence the period of conduction of TR21, is set by the voltage-divider chain R93, RV8, and R94. The variable resistor RV8 *(Sync. Amp.)* provides a synchronising pulse amplitude control. The composite grille signal is developed across R91, which is the common collector-load resistor of TR19 and TR21. This gives the generator an output impedance of 75 ohms.

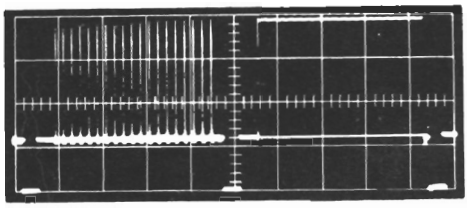

Fig. 6 GE4/513: Line Output Waveform
Vertical scale: 0·25 volt per square
Horizontal scale: 10 μsec per square

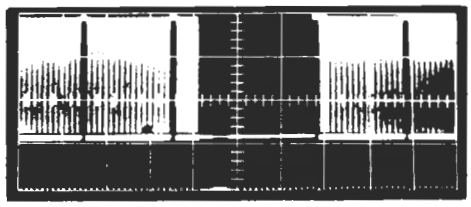

Fig. 7 GE4/513: Field Output Waveform
Vertical scale: 0·25 volt per square
Horizontal scale: 500 μsec per square

The line output waveform of the generator is shown in Fig. 6. and the field output waveform in Fig. 7.

Power Supply Unit

The mains transformer T1 provides a current of 120 mA at 13·8 volts which is applied to the diode bridge consisting of MR13, MR14, MR15, and MR16. The output of the bridge is smoothed by the RC circuit of C23, R86, and C31. The output voltage is stabilised at 6·25 volts by the zener diode MR12. The negative side of the supply is earthed.

Setting-up Procedure

1. Connect the mixed synchronising pulses, mixed blanking pulses and field trigger pulses to the appropriate inputs, and terminate the equipment correctly.
2. Switch on.
3. Place the *Select* switch (S1) to either the linearity setting *(Lin)* or convergence setting *(Con.)* for the line standard of the incoming pulses.
4. Use the *Sync. Amp.* control (RV8) to set the sync level to 0·3 volt.
5. Use the *Bar Amp.* control (RV7) to set the bar amplitude to 0·7 volt.
6. Turn the *Vert. Bar Fine* control (RV5) to mid-position. With the *Select* switch at *Con.* on the required line standard, adjust either RV4 (525 and 625 lines) or RV2 (405 lines) to give 18 bar spaces. Move the *Select* switch to the associated *Lin.* setting and adjust either RV3 (525 and 625 lines) or RV1 (405 lines) to give 25 bar spaces.
7. Use a waveform monitor with time-measuring facilities (for example, marker pips) and adjust RV6 to set the position of the first vertical bar to give bar spacing equal to that of the repetition bar pulse train.
8. Repeat item 6.
9. Select the required pattern. Note: Any day-to-day drift can be corrected by means of the *Vert. Bar Fine* control.

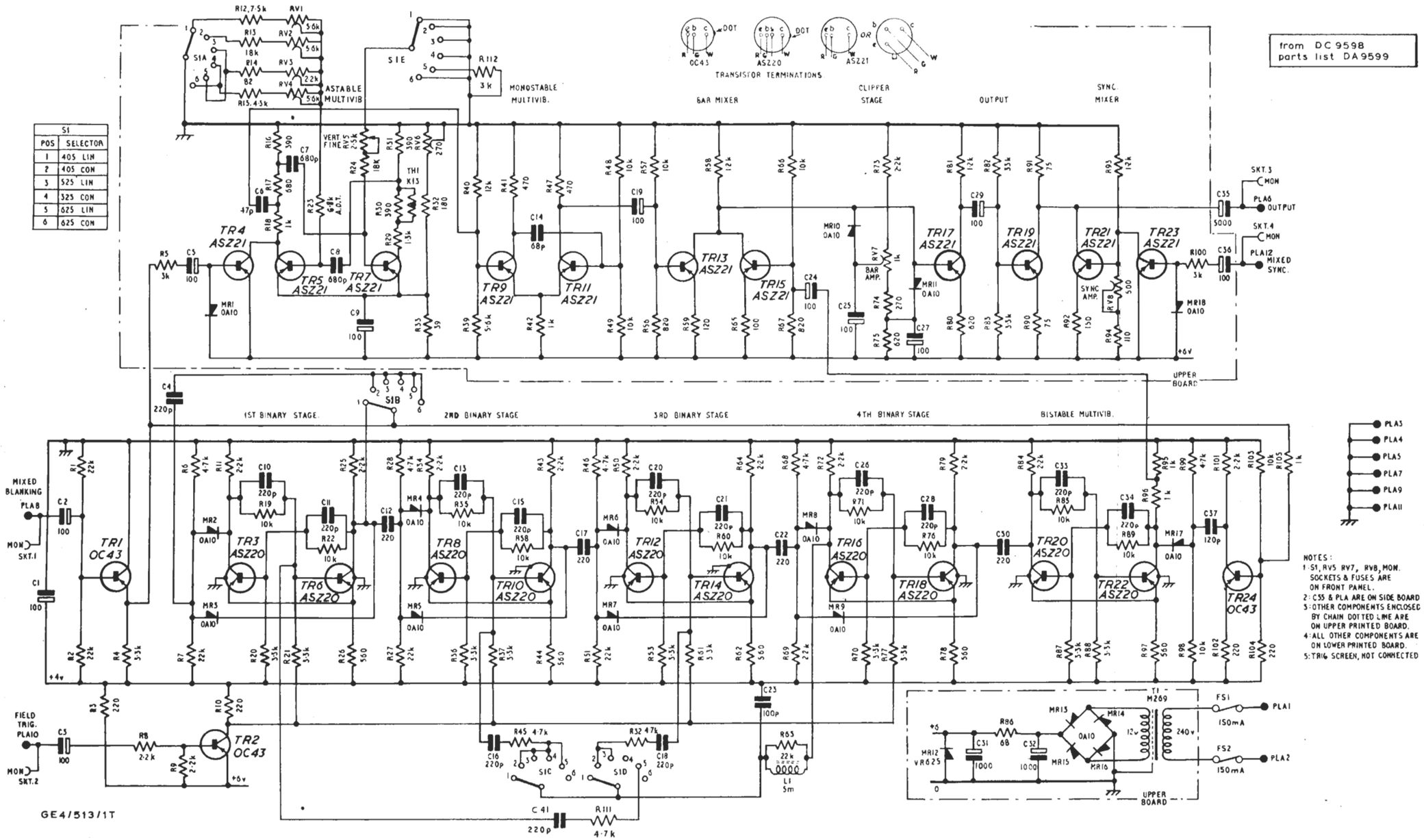

Fig.1. Circuit of Grille Generator GE4/513