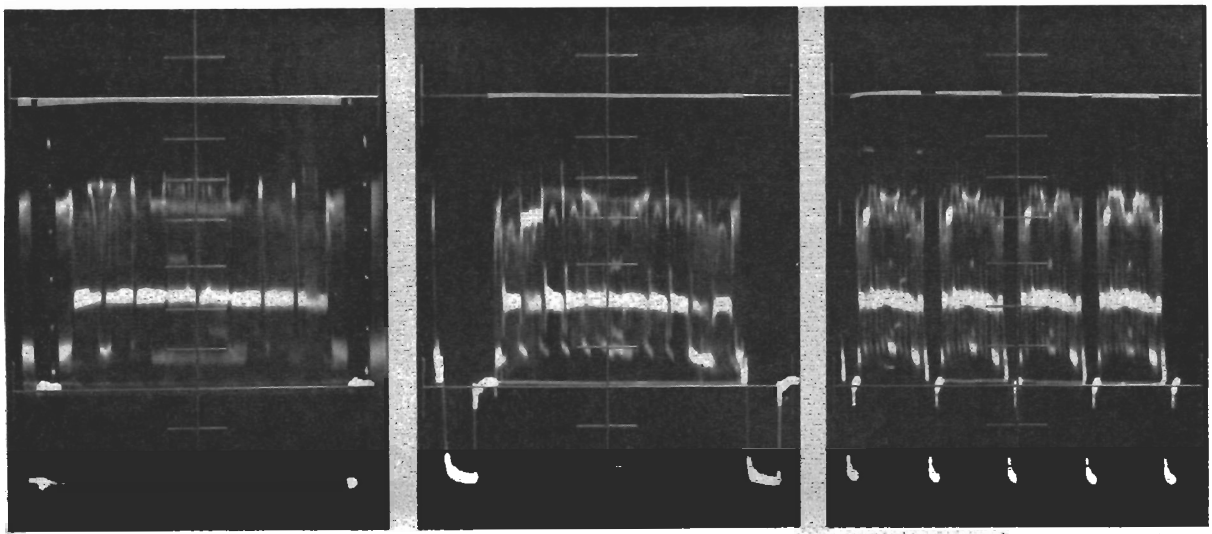
SECTION 3

CHANNEL WAVEFORM MONITOR MN6/503



V11/3P (a) (b) (c)

Fig. 3.1 Display Modes of the MN6/503
(a) Field (b) One line (c) Four lines

Introduction

The MN6/503 is a multi-standard oscilloscope used for monitoring the amplitude of the output of a television channel. There are three display modes, illustrated in Fig. 3.1, in which the full blanking and synchronising periods are shown at both ends of the trace:

(a) either field
(b) one line
(c) four lines

A colour channel can be monitored in the four-line mode by making use of an R.G.B.Y. Switch Unit UN9/544*. The four-line colour display sequentially monitors the red, green, blue and luminance channels as illustrated in Fig. 3.2.

The MN6/503 is constructed in a case, 10 inches high by 5 inches wide by 14½ inches long, which is designed to fit alongside a picture monitor.

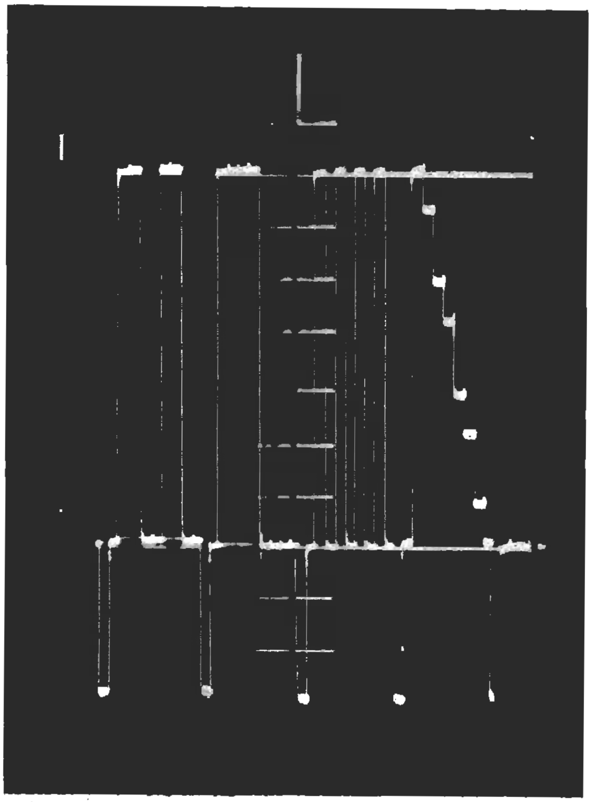
Facilities

The controls of the MN6/503 are shown in Fig. 3.3. The operation of this monitor should be self-evident.

*see Designs Department Technical Memorandum No. 8.227(67)

General Specification

Inputs	
Video, composite or non-composite	0·7 volts p-p picture signal
	0·3 volts ±3 dB sync pulses
Mixed sync pulses	0·5 volts to 2·5 volts
Line Standards	405, 525 and 625
Video Input Impedances	
High	10 kilohms ±20 per cent
75 ohms	75 ohms ±2 per cent
Sync Input Impedance	75 ohms
Maximum Permitted d.c. on Input	1 volt



V11/4P

Fig. 3.2 Four-line Display of a Sequentially-switched Colour Channel

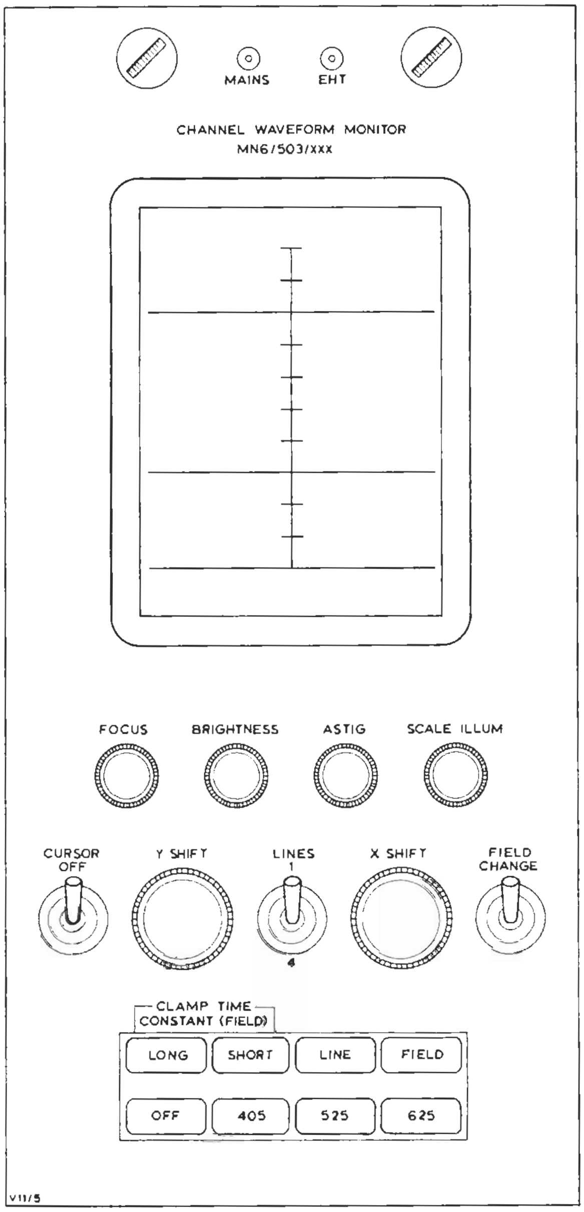


Fig. 3.3 Controls of the MN6/503

Video input frequency response	±0·1 dB at 4·43 MHz with respect to 15 kHz
625-line k-rating	less than 0·5 per cent
Switchable cursor amplitude	0·7 volts above blanking level
Cursor accuracy	
High impedance video input	±0·3 dB
75-ohms video input	±0·1 dB
Mains voltage input	240 volts ±6 per cent, 50 Hz
Power consumption	40 watts approx.
E.H.T. switch-on delay time	90 seconds
Height of display	8 cm
Width of display	6 cm
Vertical deflection sensitivity	0·15 volts per cm
Ambient temperature range	
Working	0°C to 45°C
Storage	0°C to 70°C

General Description

A block diagram of the MN6/503 is shown in Fig. 3.4. The video input signal can be terminated either externally, to permit bridging, or internally in a 75-ohm adder network. In the externally-terminated condition the input signal is fed to the adder network via a high impedance buffer amplifier.

The video signal is fed from the adder network to the cathode-ray tube via an emitter follower and a Y-output amplifier. Stabilisation of blanking level in the display is achieved by feeding a correction signal from a black-level detector to the Y-output amplifier. The detector is fed with the input video signal and with clamping pulses from a timing circuit.

The timing circuit is fed with mixed sync pulses derived either from the video input signal in a sync separator or from a separate input. This circuit produces four outputs:

(a) Cursor pulses are fed to the adder network via an amplifier. These pulses produce a cursor line on the display which is set at 0·7 volts above blanking level. A bridge configuration in the adder network prevents cursor pulses from appearing at the video input.

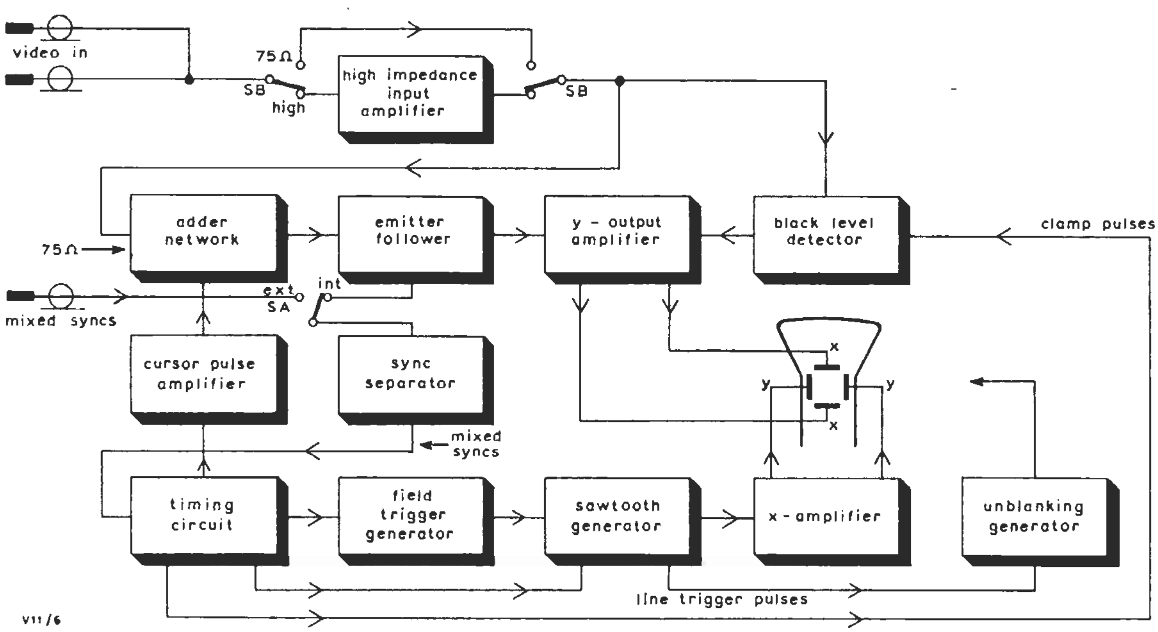


Fig. 3.4 Block Diagram of the MN6/503

(b) Field-frequency pulses are fed to a field-trigger generator. This generator produces picture-frequency pulses on either field and these are fed to a sawtooth generator.
(c) Line-frequency trigger pulses are fed directly to the sawtooth generator.
(d) Clamp pulses are fed to the black-level detector.

The sawtooth generator produces a scanning waveform for the display; this waveform is fed via an X-amplifier to the cathode-ray tube. An output of the sawtooth generator is also fed to an unblanking generator whose output switches on the beam of the tube during the forward sweep of the display.

Circuit Description

The circuit of the MN6/503 is given in Figs. 3.5, 3.9 and 3.12. Fig. 3.5, which is on page 3.5, gives the circuits of the following:

High Impedance Input Amplifier

Transistor TR201 is an input emitter follower. Transistors TR202 and TR203 form a negative-feedback pair in which transistor TR202 is a common-base stage, with feedback applied to the base, and transistor TR203 is an emitter follower. Variable resistor R212 controls the gain of the amplifier.

Adder Network

The adder network, in parallel with the input impedance of the black-level detector, presents 75 ohms resistance to the output of switch SB-3. The input impedance of transistor TR305 in parallel with resistor R309 gives a resistance of 820 ohms. Thus resistors R303, R304, R309 and R310 form a bridge circuit in which cursor pulses, fed from transistors TR301 and TR303, do not appear across resistor R301.

Y-output Amplifier

This amplifier is an elaborate long-tailed pair. Transistors TR502 and TR505 are the normal current-amplifying transistors. Transistors TR501 and TR504 form part of the long tail in which variable resistor R519 sets the total current and variable resistor R1 determines the ratio of the currents in the two halves of the pair.

Transistors TR503 and TR506 are common-base amplifiers used to isolate the output circuit and to increase the bandwidth and power output of the amplifier.

Black Level Detector

The video signal is fed via a subcarrier-frequency rejection circuit to a switching transistor which samples the waveform at times determined by clamp pulses. The sampled waveform is integrated in a capacitor C310. The integrated waveform is partially smoothed and fed to the Y-output amplifier.

In the clamp pulse feed to the switching transistor TR312 the speed-up capacitor C312 provides a greater base current for transistor TR312 thereby allowing for the heavy initial charging current into capacitor C310. Variable resistor R334 compensates for the d.c. loss into transistor TR311. This and transistor TR310 form a directly-coupled complementary negative-feedback amplifier with a very low output impedance (see *Power Supplies*).

Capacitors C308 and C309 together with resistor R330 are switched to give the short and long time constants.

Cursor Pulse Amplifier

Transistors TR301 and TR303 of a long-tailed pair amplifier are fed from a constant current generator. Transistor TR304, operated close to saturation, has its emitter voltage set by Zener diode D302 at +6·2 volts with respect to the −11·2 volt supply. Transistors TR302 and TR304 are both of the same type which ensures that their base-emitter voltage drops are equal over a wide range of ambient temperature thereby maintaining the potential across resistor R312 at 6·2 volts.

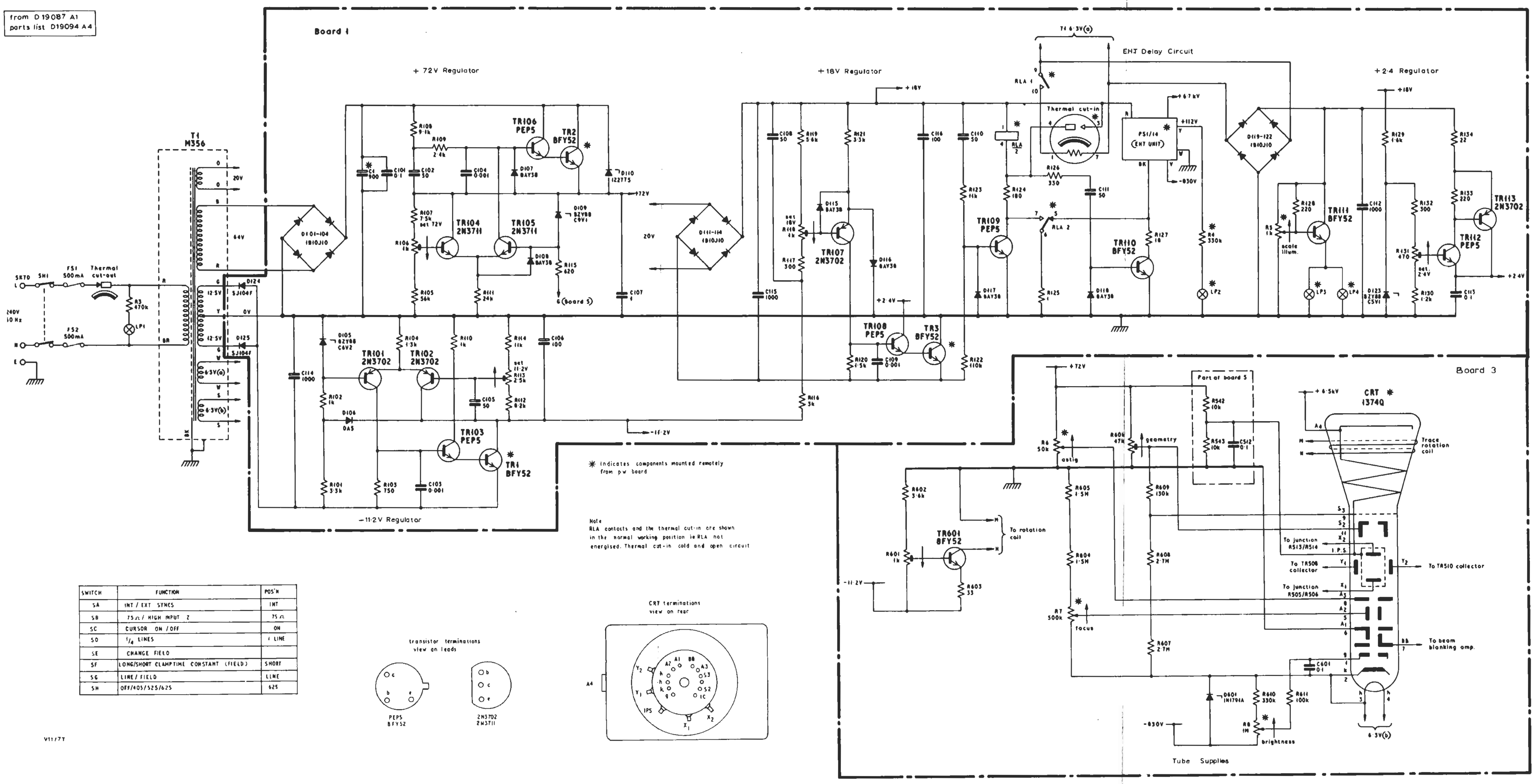
The load, including A.O.T. resistor R305, of the long-tailed pair amplifier sets the gain and hence the amplitude of the cursor pulse.

Sync Separator

The sync separator is a two-stage inverting amplifier followed by a sync-separator stage. Positive-going sync pulses are d.c.-restored at the base of transistor TR308. The output amplitude of this transistor is limited to about 0·8 volts p-p.

Timing Circuit

The timing circuit comprises seven integrated bistable circuits Type MC352G and additional components. These components provide for the input gating and the conversion of six of the integrated circuits from the bistable to the monostable form.



SWITCH	FUNCTION	POS'N
SA	INT / EXT SYNCS	INT
SB	75Ω / HIGH INPUT Z	75Ω
SC	CURSOR ON / OFF	ON
SD	1/4 LINES	1 LINE
SE	CHANGE FIELD	
SF	LONG/SHORT CLAMPTIME CONSTANT (FIELD)	SHORT
SG	LINE / FIELD	LINE
SH	OFF/405/525/625	625

Fig. 3.5 Circuit of the MN6/503 (Diagram 1)

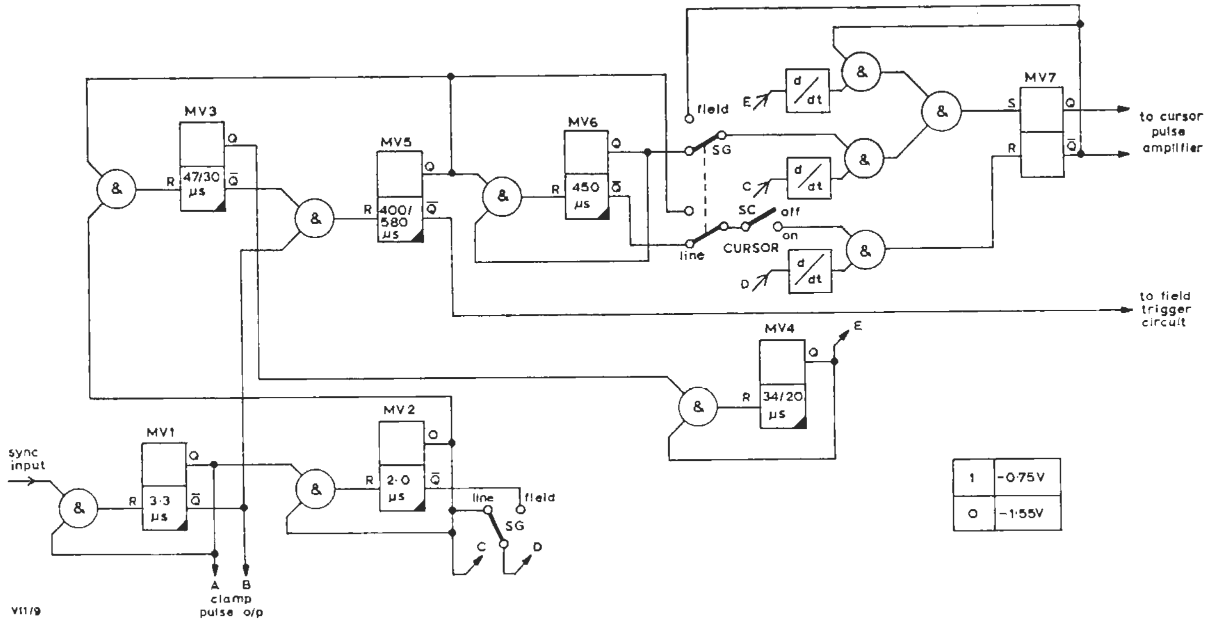


Fig. 3.6 Logic Diagram of the Timing Circuit

A logic diagram of the timing circuit is given in Fig. 3.6 and the waveforms for the start of a 625-line even field are given in Fig. 3.7 on page 3.9.

Field Trigger Generator

Field frequency pulses are fed to bistable circuit IC8 which is connected as a divide-by-two stage. Picture frequency pulses on either field (selected by switch SE) are used to synchronise an astable multivibrator which includes transistors TR402 and TR403. This multivibrator has an approximately unity mark-to-space ratio. Capacitor C406 and resistor R415 differentiate the square wave giving positive-going pulses at the collector of transistor TR404 which have their amplitude limited to 3·5 volts p-p.

Fig. 3.8, on page 3.11, gives circuits of the following:

Sawtooth Generator

The sawtooth generator is fed with either line trigger pulses (0·8 volts p-p) or picture trigger pulses (3·5 volts p-p). These pulses are differentiated and, because of their different rise times, they both produce 0·8-volt p-p pulses at pin 7 of integrated circuit IC9.

A block diagram of the sawtooth generator is shown in Fig. 3.9. Initially both bistable circuits are in the Reset condition (see UN9/528, Instruction V.14), TR410 is conducting and the output waveform (Fig. 3.10) has its most negative value. An input pulse switches the first bistable circuit to the Set condition and, in turn, this switches the second bistable circuit causing TR410 to cut off. Feedback from emitter follower TR407 to the input of the first bistable causes this circuit to latch in the Set condition. Transistor TR411 is a constant-current generator with its current determined by zener diode D404 and its emitter resistor. The constant current charges a timing capacitor (combination taken from C413 to C416) generating a sawtooth waveform at the base of transistor TR412. The capacitors are discharged through resistor R436 and transistor TR410 at the end of each sawtooth.

A small portion of the waveform is fed back from the collector of transistor TR412 to the base of transistor TR411; this improves the linearity of the waveform degraded by the presence of the input resistance of transistor TR412 across the timing capacitor.

The amplitude of the sawtooth and its duration are controlled by a potential divider R443. A fraction of the sawtooth waveform is fed back to the Reset input of the second bistable. At a voltage about midway between its two logic levels this

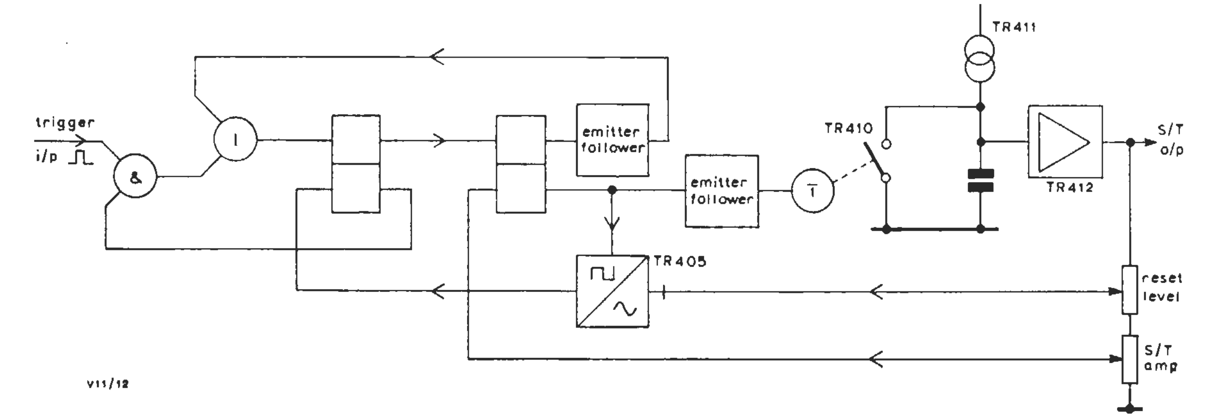


Fig. 3.9 Block Diagram of the Sawtooth Generator

bistable is switched to the Reset condition and TR410 discharges the timing capacitor.

Transistor TR405 is cut off at the start of the sawtooth waveform by having its emitter driven negative by the $\bar{Q}$ output of the second bistable. The emitter returns to its more positive state when the sawtooth waveform is at its most positive excursion. The conduction of transistor TR405 is delayed therefore until the sawtooth waveform at the base of this transistor has fallen to about −2·3 volts. The rise in the collector voltage of TR405 switches the first bistable circuit to the Reset condition thus returning the sawtooth generator to its initial state. This delay prevents the circuit being triggered during the flyback period.

X-amplifier

Transistors TR413 and TR509 form a long-tailed pair amplifier fed from a constant-current generator transistor TR507. Transistors TR508 and TR510 isolate the amplifier from the +72 volts supply, increasing the bandwidth and power output of the amplifier. The base of transistor TR509 is fed via emitter follower TR511 from potential divider R2 which is the *X-shift* control.

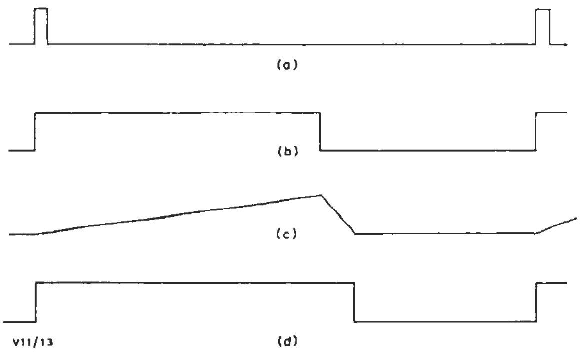


Fig. 3.10 Waveforms in the Sawtooth Generator

(a) input *(b) output IC10*
(c) sawtooth output *(d) output IC9*

Unblanking Amplifier

Transistors TR512 and TR514 form a long-tailed pair amplifier fed with a pulse from emitter followers TR407 and TR406 during the forward sweep of the display. Transistors TR513 and TR515 isolate the amplifier from the +72 volts supply to produce an unblanking pulse which is fed to the cathode-ray tube.

Fig. 3.11, on page 3.13, shows circuits of the following:

Power Supplies

(a) General

The power supply circuits provide stabilised outputs at:

+6·7 kV
+112 volts
+72 volts
+18 volts
+2·4 volts
−11·2 volts
−830 volts

The 6·7-kV, 112-volt and 830-volt supplies are derived from a PS1/14 (see Instruction G.2) which is not a stabilised power supplier but which is fed from the stabilised 18-volt supply.

The power supply circuits also provide unstabilised outputs at:

0 to +6 volts
6·3 volts, 50Hz

The 11·2-volt, 18-volt and 2·4-volt circuits use a

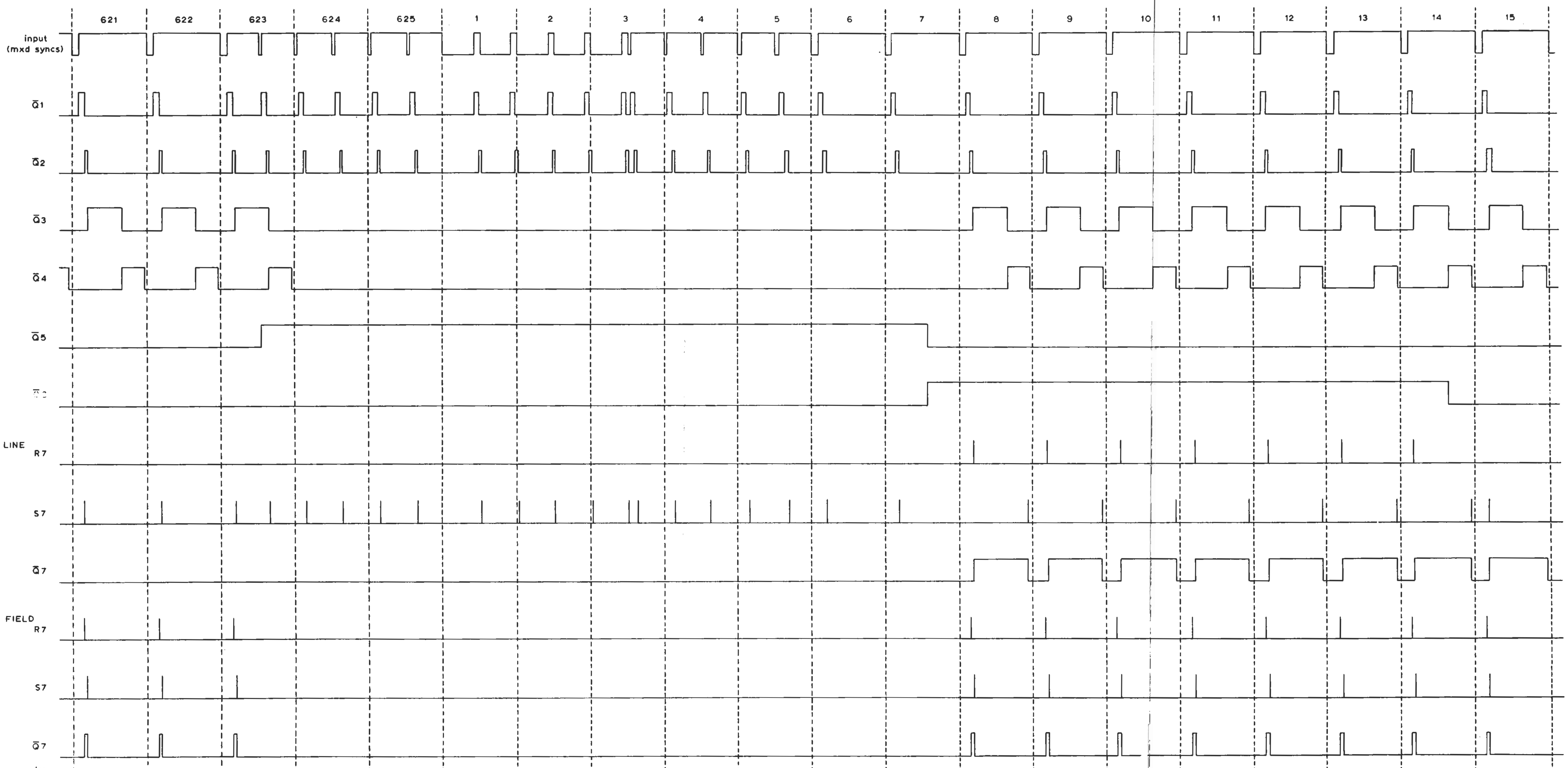


Fig. 3.7 Timing-circuit Waveforms

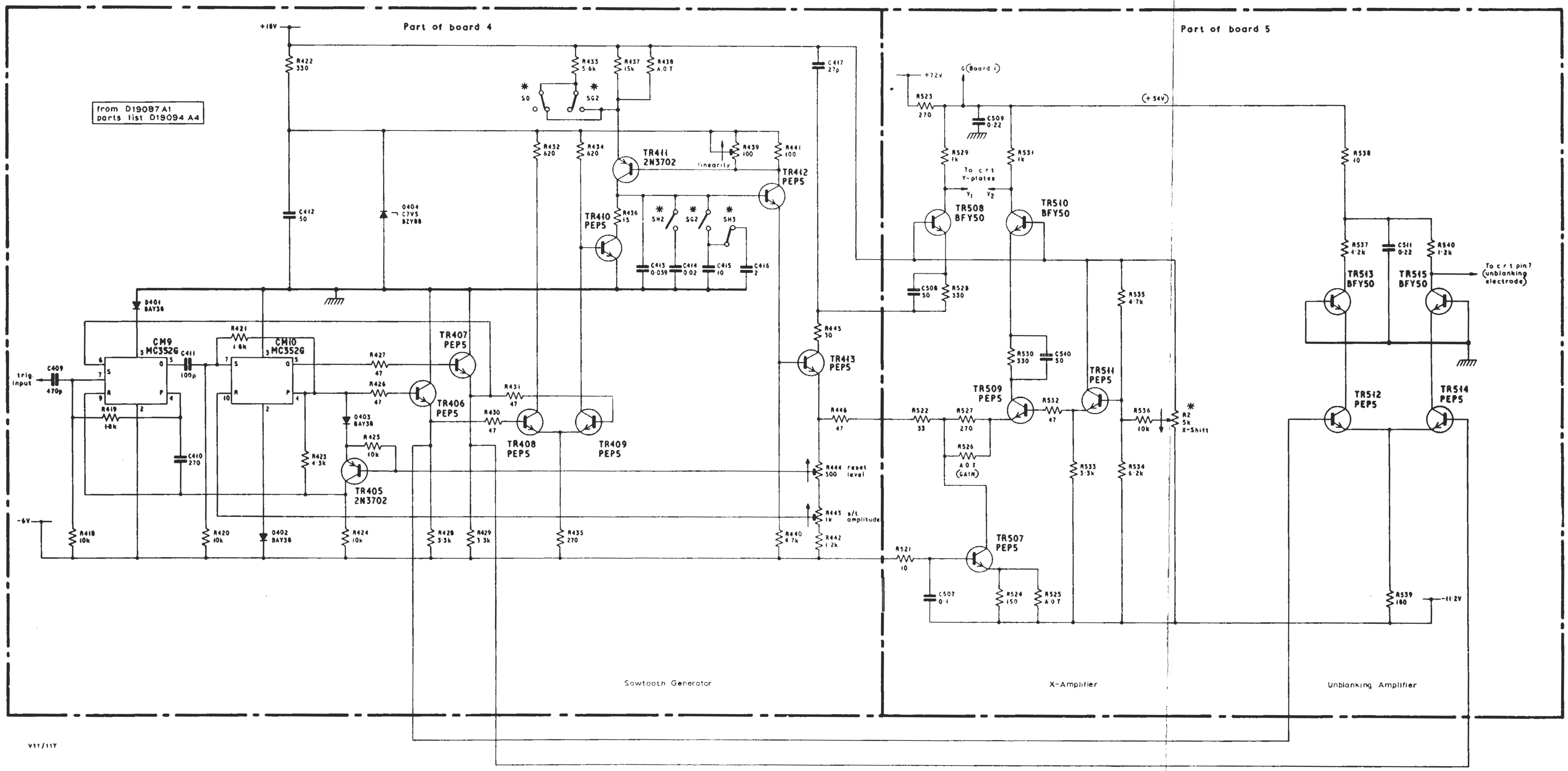


Fig. 3.8 Circuit of the MN6/503 (Diagram 2)

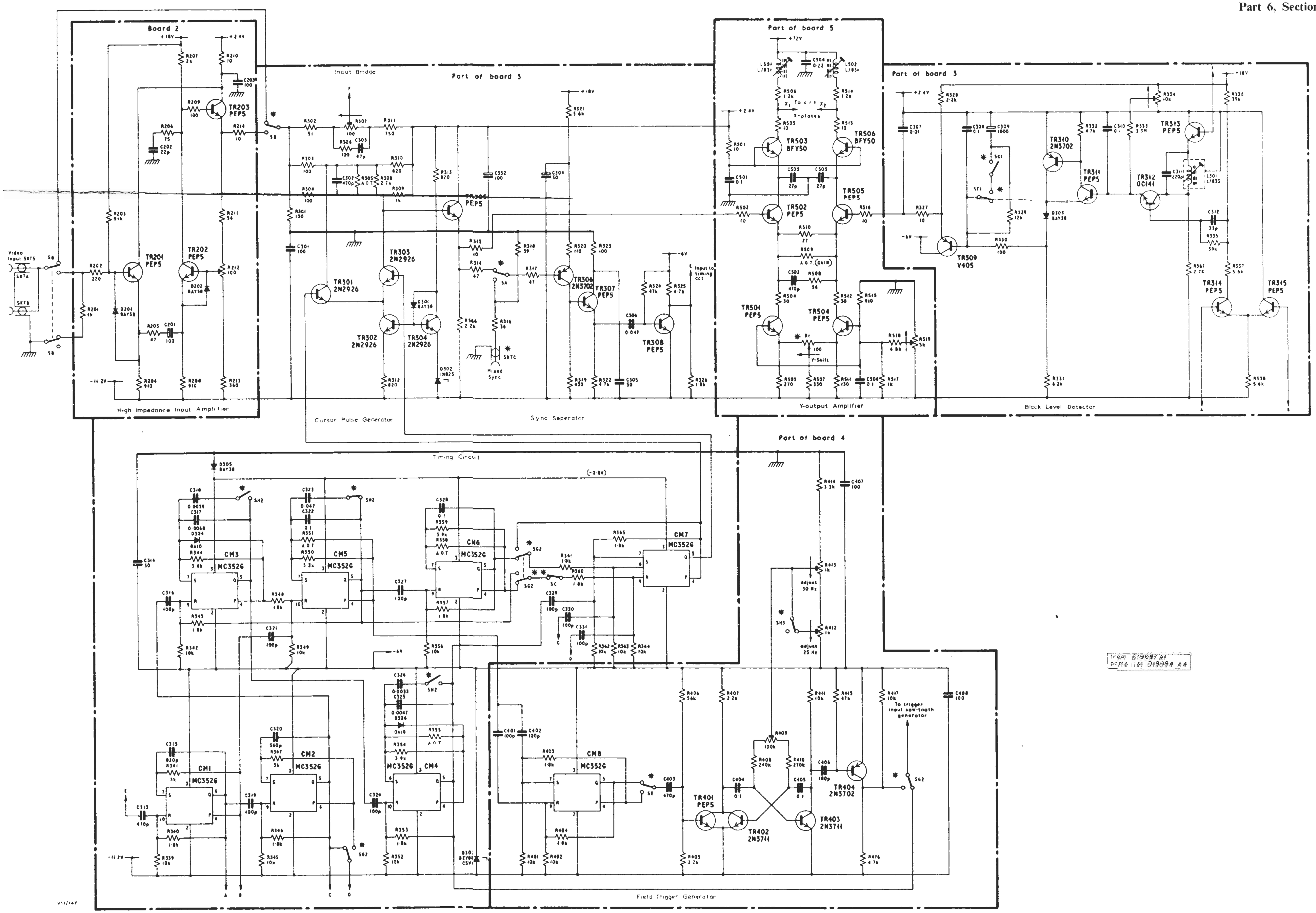


Fig. 3.11 Circuit of the MN6/503 (Diagram 3)

common-emitter output stage instead of the more usual emitter-follower output stage. Such a circuit is derived from a two-stage negative-feedback amplifier shown in Fig. 3.12(a). A similar circuit, using a complementary output stage, is shown in Fig. 3.12(b). This circuit is shown also in Fig. 3.12 (c) used as a voltage stabiliser. Compare it with the more usual emitter-follower output circuit shown in Fig. 3.12(d). In Fig. 3.12(e) the first stage is changed to a long-tailed pair amplifier and an emitter-follower precedes the output stage.

(*b*) *Mains Input Circuit*
A thermal cut-out in the mains input circuit is set to cut out at a temperature of 55°C and to cut in at a temperature of 40°C. The MN6/503 is not to be used in an ambient temperature greater than 45°C under normal conditions of ventilation.

A neon lamp across the mains transformer primary winding indicates that the mains input circuit is functioning normally.

(*c*) *72-volt Circuit*
This is a conventional emitter-follower output-stage circuit. The amplifier load resistor R109 is decoupled, not to earth but to the +72 volt supply rail. A 9·1-volt zener diode is connected via resistor R115 to the +54 volts (approx) supply which feeds the X-amplifier and the unblanking amplifier. In addition diodes D107, D108 and D110 protect their respective transistors against excessive transient voltages that may occur when the mains supply is switched.

(*d*) *11·2-volt Circuit*
This circuit closely resembles the basic circuit shown in Fig. 3.12(e). Resistor R101 provides current to zener diode D105 when the supply is switched on. When the circuit is operating, the current to the zener diode is fed from the stabilised output via diode D106.

The collector of transistor TR103 is connected via resistor R110 to earth rather than to the −11·2 volt rail to extend the stabilisation range and to provide current limitation under overload conditions.

(*e*) *18-volt Circuit*
This circuit resembles the basic circuit of Fig. 3.12(c) with the addition of an emitter-follower TR108 preceding the output transistor TR3. The feedback is taken from the collector of transistor TR3 to the emitter of transistor TR107 via diode D116 which prevents transistor TR107 bottoming when the input voltage is low. The collector of transistor TR108 is taken to the +2·4 volt supply rail rather than to earth to increase the regulation range.

(*f*) *E.H.T. Delay Circuit*
As the 18-volt supply is switched on transistor TR109 passes a pulse of current while capacitor C110 charges. This current pulse operates relay RLA which holds on via contact RLA-2. Contact RLA-1 connects 6·3 volts a.c. to the thermal cut-in which operates after about 90 seconds. Operation of the cut-in short-circuits relay RLA and produces a positive-going pulse at the base of transistor TR110. This transistor conducts charging a capacitor in the input of the PS1/14. Resistor R127 limits this charging current to 1 amp maximum. The release of relay RLA is delayed by the inductive decay of the current in the relay. With relay RLA released the PS1/14 is fed via resistor R125.

A neon lamp LP2 indicates that the PS1/14 is switched on.

(*g*) *Graticule Illumination*
Graticule illumination lamps LP3 and LP4 are fed with unstabilised d.c. via an emitter follower TR111. Resistor R128 modifies the law of dimmer resistor R5.

(*h*) *2·4-volt Circuit*
This circuit is the basic circuit shown in Fig. 3.12 (c) with the feedback fraction increased to unity. The zener diode D123 is fed from the 18-volt supply rather than from capacitor C112 to reduce the hum level in the output.

Tube Supplies
The cathode-ray tube supplies are conventional though there are some points to be noted.

The tube, being rectangular, cannot be rotated to give a level display. Such rotation is carried out electromagnetically by feeding a current from transistor TR601 through a rotation coil.

An inter-plate screen IPS used to reduce X-Y crosstalk is connected to a decoupled d.c. source which is at the mean potential of the plates (+36 volts).

A 68-volt zener diode D601 makes the tube-electrode potential-divider chains independent of the loading of the beam current.

The internal connection shown between anode A4 and the interplate screen is a high-resistance spiral coating (100 megohm minimum) on the inside

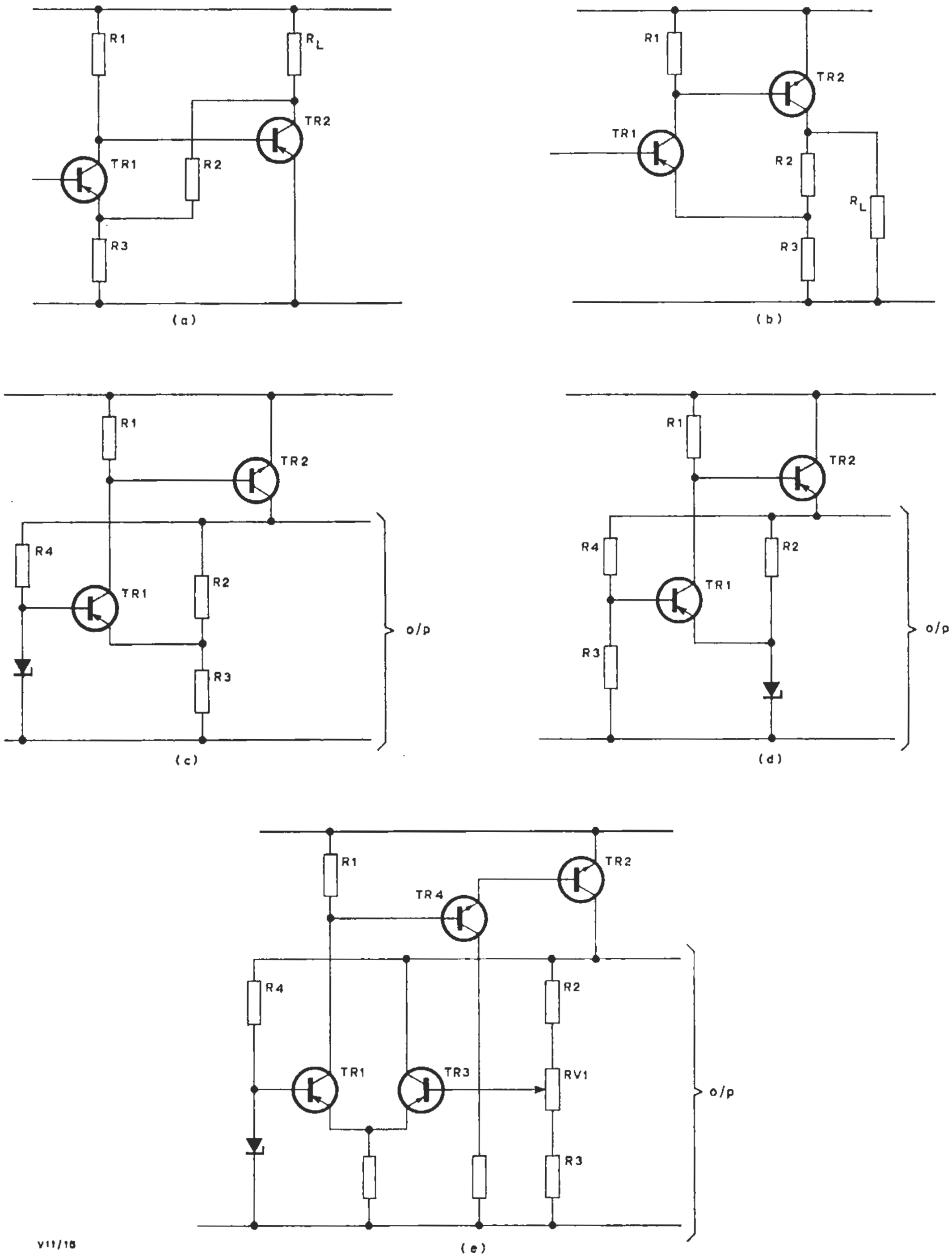


Fig. 3.12 Derivation of a Complementary Stabilising Circuit

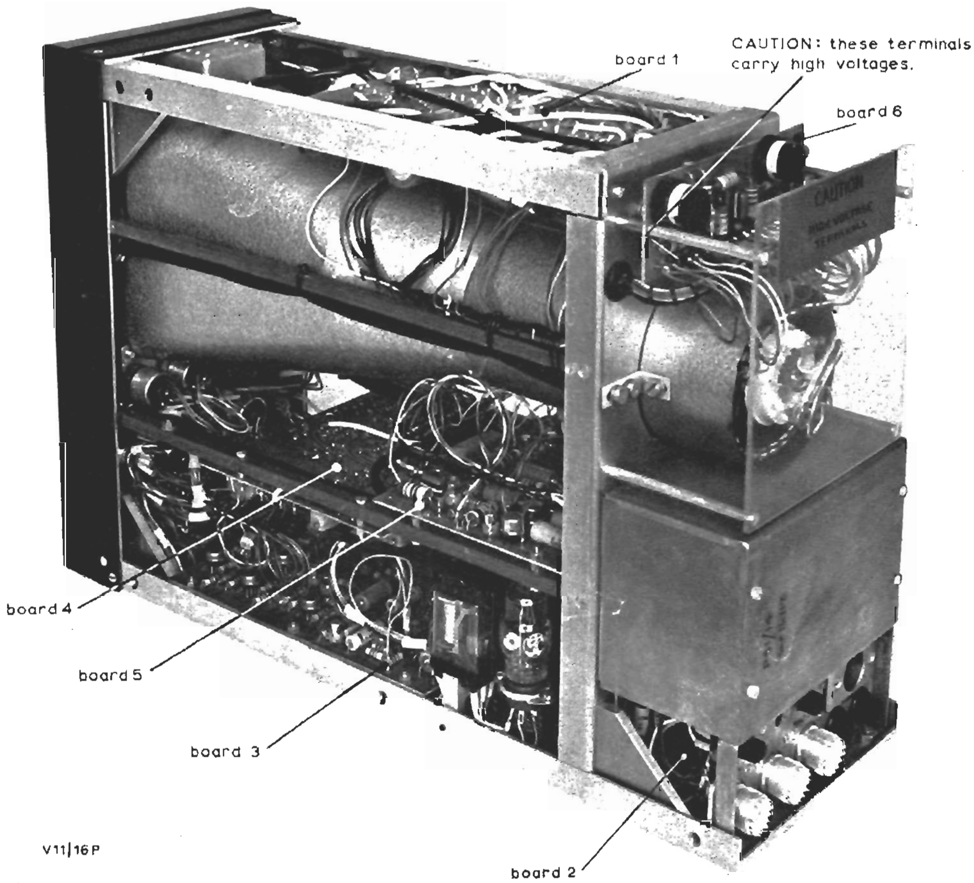


Fig. 3.13 Layout of the MN6/503

surface of the tube to provide a post-deflection accelerating field.

Test Procedure

This procedure, set out in Table 1, outlines the adjustments required for the preset controls.

Fig. 3.13 shows the physical layout of the MN6/503 and indicates the high-voltage points. If the mains-switch insulation is removed it should be replaced according to Designs Department Specification No. 9.75(66). The MN6/503 can be tested according to the following schedule or it can be returned to Equipment Department.

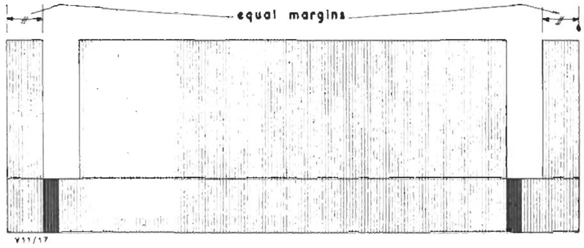


Fig. 3.14 Display for the Correct Adjustment of R409

TABLE 1

Control	*Adjustment*
R106	Adjust for +72 volts supply.
R113	Adjust for −11·2 volts supply.
R118	Adjust for +18 volts supply.
R131	Adjust for +2·4 volts supply.
R212	Feed a 625-line white-level bar composite video signal to the MN6/503. Connect a switched accurate 75-ohm termination to the parallel input of the MN6/503. Switch between external and internal terminations. Adjust R212 until there is no change in the amplitude of the display on switching.
R307	Switch the white-level bar on and off leaving the sync pulses on. Adjust R307 so that there is no change in the blanking level of the display.
R334	Switch to *Int Syncs* and to *Field.* Disconnect the input signal. Adjust R334 to keep the trace on the tube face.
R439	Reconnect the input signal using a 625-line sawtooth composite video waveform. Switch to *Line.* Adjust R439 for sawtooth linearity.
R443	Adjust R443 for a 5-volt p-p sawtooth waveform at the base of transistor TR412. Check that the width of the display is about 6 cm. If necessary change the AOT resistor R526 to vary the width of the display.
R444	Turn R444 clockwise until the trace disappears. Turn R444 anti-clockwise until a stable trace just appears.
R409	Switch to *Field.* Adjust R409 to give equal margins as shown in Fig. 3.14.
R413	Switch to *525* and change the input signal for 525-line signal. Switch to *Ext Syncs* with no external sync input. Adjust R413 to give a drift rate from right to left of about 1 field per second.
R412	Switch to *625* and change the input signal for a 625-line signal. Adjust R412 to give a drift rate from right to left of about 1 field per second. Recheck the adjustment of R409.
R519	Disconnect the input signal. Use an Avometer Model 8 to check the voltages at the collectors of transistors TR503 and TR506. Adjust R519 to make the sum of these voltages 72 volts.
R601	Adjust R601 to rotate the trace until it is level. If necessary reverse the connections to the rotation coil.
R606	Feed in a white-level bar composite video waveform. Switch to *Field.* Adjust R606 to give the best compromise between pincushion and barrel distortions.

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