A three-channel electronic switch

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ABSTRACT

Three different transient audio frequencies, ranging up to 1,500 cycles per second, can be displayed simultaneously on a single beam oscilloscope. A linear sweep is applied to the cathode-ray tube and is displaced in turn to three adjustable levels, 7,500 times a second, thus effectively producing three linear sweeps. The audio inputs are sampled in sequence at the same rate so that a given audio signal appears on one trace only. Circuit diagrams and sample photographs of the cathode-ray tube presentation are included.

CONTENTS

FIGURES

A THREE-CHANNEL ELECTRONIC SWITCH

Introduction

The three-channel electronic switch was developed to display three different audio signals simultaneously on a cathode-ray oscilloscope for recording on a single film. Frequencies up to 1,500 cycles per second can be displayed. A linear sweep is applied to the X-plates of a cathode-ray tube, and an adjustable, three-step separation voltage is directly connected to one of the Y-plates, effectively providing three simultaneous sweeps, each at a recurrence frequency of 7,500 cycles per second. As the three audio signals are gated at the same rate as the step separation voltage, and are mixed and directly connected to the remaining Y-plate of the cathode-ray tube, any one signal appears only on one of the three simultaneous sweeps. The phase relationship between the input, output, and any intermediate stage of an audio amplifier can be checked simultaneously with the three-channel electronic switch.

The step voltage is generated by three cathode-coupled multivibrators in a ring circuit. The pulses from the multivibrators are of equal width and follow in sequence. The three pulses are coupled to three audio gate tubes with a common load and the output is directly coupled to one Y-plate of the cathode-ray tube. Two of the pulses from the cathode-coupled multivibrators are squared and mixed, giving a three-step voltage, of which two of the steps are variable. The mixed output is directly connected to the remaining Y-plate of the cathode-ray tube.

Description

In the circuit diagram, Fig.1, the ring multivibrator circuit consists of V_1, $V_2(A)$, V_3, V_4 and V_5. The starter button is pushed momentarily, thus putting a positive pulse on the grid of the non-conducting section of V_1 to start the multivibrator. The positive pulse from V_1 is differentiated by C_5 and R_9, producing a positive pulse at the start of the pulse from V_1 and a negative pulse at the end. Only the negative pulse is allowed to pass through $V_2(A)$ to the grid of the normally-conducting section of V_3. This pulse triggers V_3 at the end of the pulse from V_1. The pulse from V_3 is differentiated in the same manner as the pulse from V_1, and the negative pulse is allowed to pass through $V_4(A)$ to the grid of the normally conducting section of V_5, thus triggering V_5 immediately

after V_3. The pulse from V_5 is again differentiated and the negative pulse allowed to pass through $V_4(B)$ to the grid of the normally conducting section of V_1. V_1 is thus triggered after V_5 and the circuit continues this sequence 7,500 times per second. Fig.2 illustrates the waveforms in the ring multivibrator circuit and the duration of the pulses.

The positive pulse from V_1 is coupled to the two-stage squaring amplifier, V_6. The positive pulse from V_6 is coupled by C_{13} to one cathode and one plate of the dual diode, V_7. The other plate of V_7 is grounded and the remaining cathode is connected to the center tap of P_1 and to C_{14}. The potential on this cathode may be varied from 0 to 100 volts by means of P_1, which allows the amplitude of the pulse to be pre-set, and, by clipping the pulse, further improves the square waveform. The positive pulse from V_3, which follows immediately after the pulse from V_1, is coupled by C_{18} to V_8, another two-stage amplifier which performs the same function as V_6. The positive pulse from V_8 is coupled by C_{16} to V_9. The dual diode, V_9, is wired in the same way as V_7 and performs the same function. The clipped pulse from V_7 is directly coupled to one plate of V_{10}, a dual diode, and the clipped pulse from V_9 is directly coupled to the other plate. Between the pulse from V_9 and the pulse from V_7 there is a time lapse equal to the duration of the pulse from either V_9 or V_7. This is due to the absence of the pulse from V_5. With the potentiometers P_1 and P_2 set at different voltages above ground a three-step voltage is obtained at the cathodes of V_{10}. Since the lowest of these step voltages was not quite flat, a potential of 10 volts through $V_2(B)$ is applied to the cathodes of V_{10}. Because the voltage divider R_{10}, R_{11} and R_{12}, in the plate of $V_2(B)$, has a small resistance to ground (1.5 K), the lowest step voltage is satisfactorily flattened. The step voltage is brought to a terminal post on the chassis to be applied directly to one Y-plate of the cathode-ray tube. The step voltages have a maximum separation of 80 volts, each step having a duration of 42 microseconds, with 2 microseconds switching time. Fig.3 is a photograph of the step-voltage waveforms.

The audio gate circuit uses three type-6BN6 tubes. The control grid of this tube has a very slight effect on plate current after reaching a small positive voltage, as can be seen from the tube characteristics shown in Fig.7. The positive pulses from the multivibrator tubes are applied to the control grids of the type-6BN6 tubes (V_{14}, V_{15}, V_{16}) through cathode-follower stages V_{11},

V_{12}, and V_{13}. The potentiometers P_3, P_4, and P_5 are adjusted so that the peak square-wave voltages do not exceed the control grid peak voltage rating of the type-6BN6 tube. The pulses from V_1, V_3, and V_5 follow each other as previously shown; therefore each type-6BN6 tube is turned on in the same sequence, the on-off ratio being 1 to 2. The audio signals to be examined are introduced on the suppressor grids of the type-6BN6 tubes and the amplitudes are adjusted, as desired, by P_6, P_7, and P_8. The three type-6BN6 tubes have a common plate load, and the mixed output is brought to a terminal post to be attached directly to the remaining Y-plate of the cathode-ray tube. The type-6BN6 stages have a gain of 10 and a maximum undistorted output of 48 volts, peak.

Figs. 4 and 5 are examples of waveform presentation with the three-channel electronic switch. The lowest frequency illustrated is 60 cycles. In Fig.6 the step voltages have been equalized to superimpose the three waveforms.

It may be pointed out that if additional audio channels are required it is a simple matter to add multivibrators to the ring, together with the associated squaring amplifiers and gate tubes.

Photographs of the complete unit appear in Figs. 8 and 9.

COMPONENTS

RESISTORS

R1	1 meg.	1/2 w
R2	6.8 meg.	1 w
R3	47 k	1/2 w
R4	1.5 k	2 w
R5	22 k	2 w
R6	12 k	2 w
R7	1meg.	1/2 w
R8	2.2 meg.	1/2 w
R9	47 k	1/2 w
R10	1.5 k	2 w
R11	68 k	2 w
R12	68 k	2 w
R13	2.2meg.	1/2 w
R14	1.5 k	2 w
R15	1meg.	1/2 w
R16	12 k	2 w
R17	22 k	2 w
R18	47 k	1/2 w
R19	47 k	1/2 w
R20	47 k	1/2 w
R21	2.2 meg.	1/2 w
R22	1meg.	1/2 w
R23	1.5 k	2 w
R24	12 k	2 w
R25	22 k	2 w
R26	47 k	1/2 w
R27	22 k	2 w
R28	22 k	2 w
R29	1meg	1/2 w
R30	20 k	8 w
R31	2.2 k	2 w
R32	22 k	2 w
R33	20 k	8 w
R34	8 k	8 w
R35	1meg.	1/2 w
R36	22 k	2 w
R37	22 k	2 w
R38	1meg.	1/2 w
R39	1meg.	1/2 w
R40	1meg.	1/2 w
R41	1meg.	1/2 w
R42	120 k	1 w
R43	75 Ω	1/2 w
R44	120 k	1 w
R45	75 Ω	1/2 w
R46	120 k	1 w
R47	75 Ω	1/2 w
R48	27 k	2 w
R49	100 Ω	14 w
R50	100 Ω	14 w
R51	100 Ω	14 w
R52	8 k	10 w
R53	1 k	4.8 w
R54	5 k	14 w

CONDENSERS

C1	33 pf	500 v	Mica
C2	.01 mf	500 v	Mica
C3	470 pf	500 v	Mica
C4	120 pf	500 v	Mica
C5	47 pf	500 v	Mica
C6	120 pf	500 v	Mica
C7	470 pf	500 v	Mica
C8	47 pf	500 v	Mica
C9	47 pf	500 v	Mica
C10	120 pf	500 v	Mica

CONDENSERS (CON'T.)

C11	470 pf	500 v	Mica
C12	.01 mf	500 v	Mica
C13	.01 mf	500 v	Mica
C14	10 mf	450 v	Electrolytic
C15	10 mf	450 v	Electrolytic
C16	.01 mf	500 v	Mica
C17	.01 mf	500 v	Mica
C18	.01 mf	500 v	Mica
C19	.01 mf	500 v	Mica
C 20	.01 mf	500 v	Mica
C 21	.01 mf	500 v	Mica
C 22	.1 mf	600 v	Paper
C 23	.1 mf	600 v	Paper
C 24	.1 mf	600 v	Paper
C 25	1 mf	400 v	Paper
C 26	1 mf	400 v	Paper
C 27	1 mf	400 v	Paper
C 28	10 mf	600 v	Oil
C 29	10 mf	600 v	Oil

POTENTIOMETERS

P 1	10 k	4 w
P 2	10 k	4 w
P 3	100 k	2 w
P 4	100 k	2 w
P 5	100 k	2 w
P 6	100 k	2 w
P 7	100 k	2 w
P 8	100 k	2 w

TUBES

V 1	6J6	Cathode coupled multivibrator
V 2a	1/2 6AL5	Positive pulse blocker
V 2b	1/2 6AL5	Pulse clipper
V 3	6J6	Cathode coupled multivibrator
V 4	6AL5	Positive pulse blocker
V 5	6J6	Cathode coupled multivibrator
V 6	6J6	Amplifier
V 7	6AL5	Clipper
V 8	6J6	Amplifier
V 9	6AL5	Clipper
V 10	6AL5	Mixer
V 11	6J6	Cathode follower
V 12	6J6	Cathode follower
V 13	6J6	Cathode follower
V 14	6BN6	Gater
V 15	6BN6	Gater
V 16	6BN6	Gater
V 17	VR150/0D3	Voltage regulator
V 18	VR150/0D3	Voltage regulator
V 19	0B2	Voltage regulator
V 20	VR 75/0A3	Voltage regulator
V 21	5R4GY	Voltage rectifier

MISC.

T 1	Hammond No. 278 Transformer
L 1	Hammond No. 10-200 Choke
Sw1	S.P.S.T. Switch
Sw2	Acro interlock switch – 115v-15 amp.

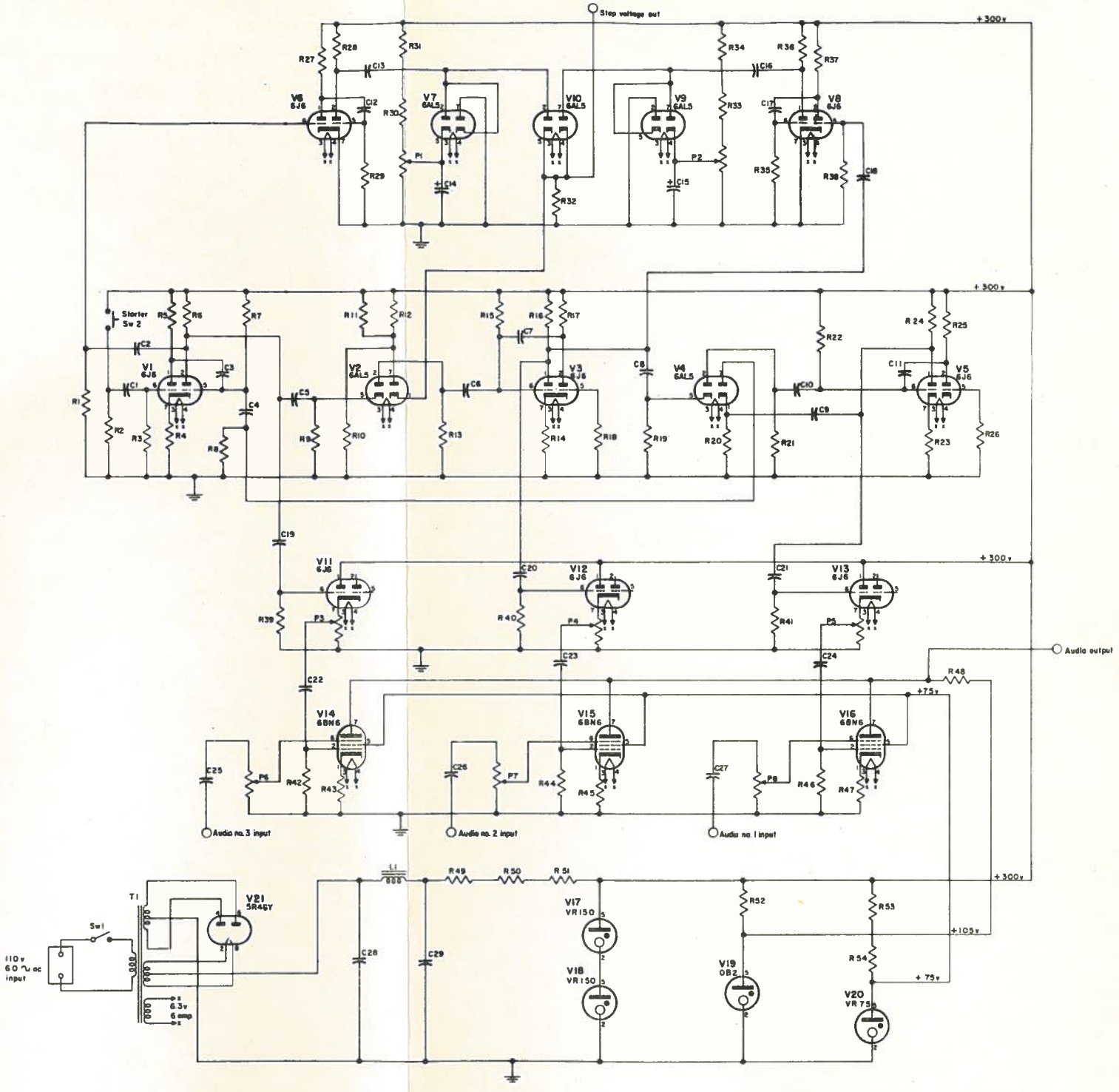

FIG. 1

SCHEMATIC DIAGRAM
OF
THREE-CHANNEL ELECTRONIC SWITCH

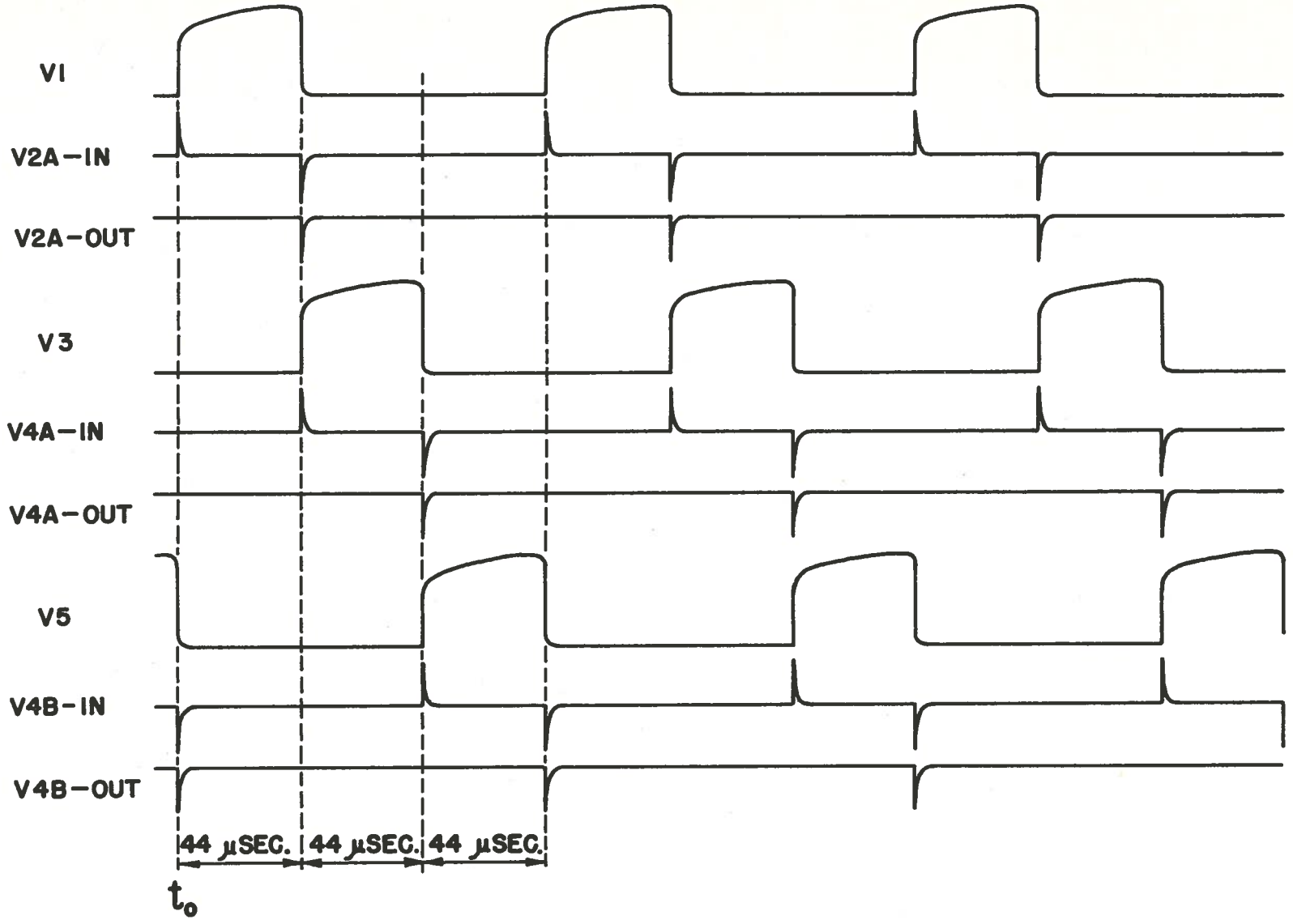

FIG. 2
RING MULTIVIBRATOR WAVEFORMS

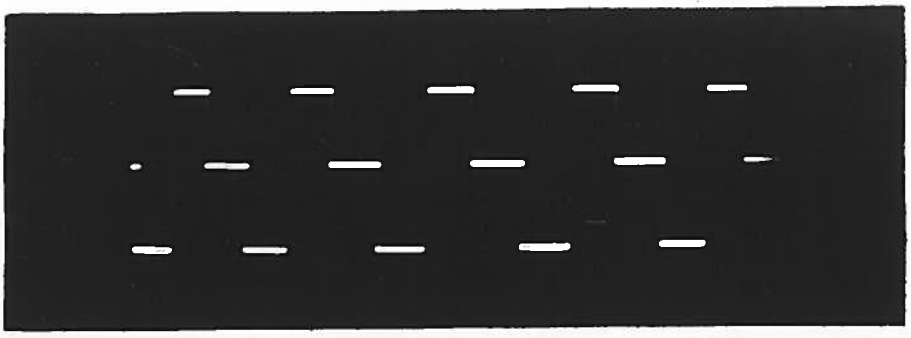

FIG. 3

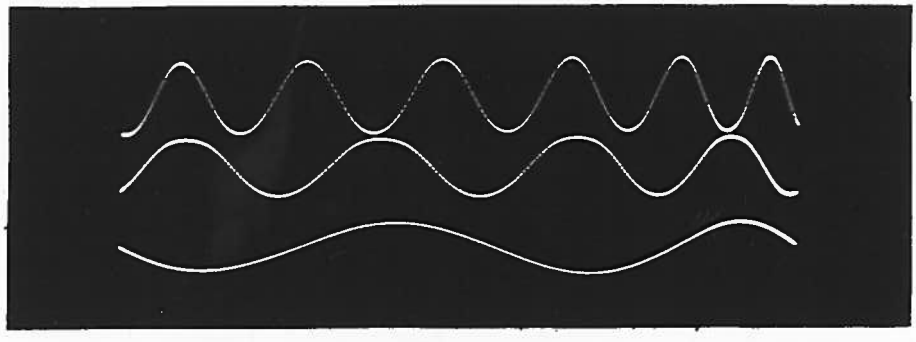

FIG. 4

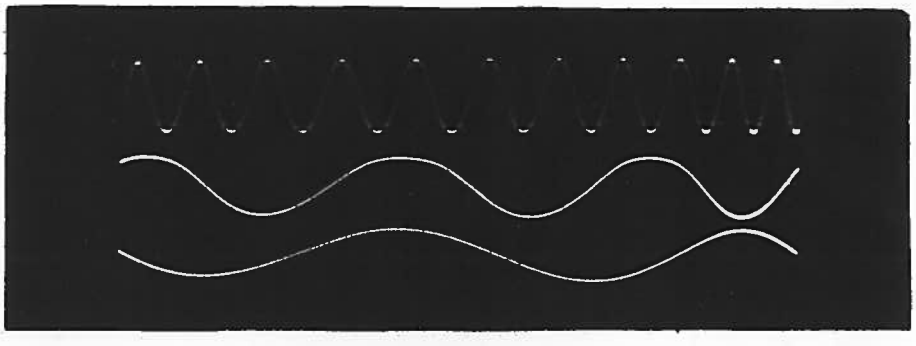

FIG. 5

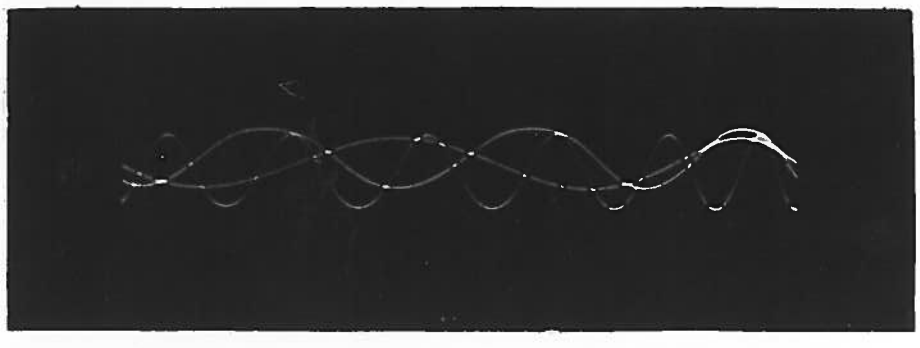

FIG. 6

PHOTOGRAPHS OF WAVEFORMS

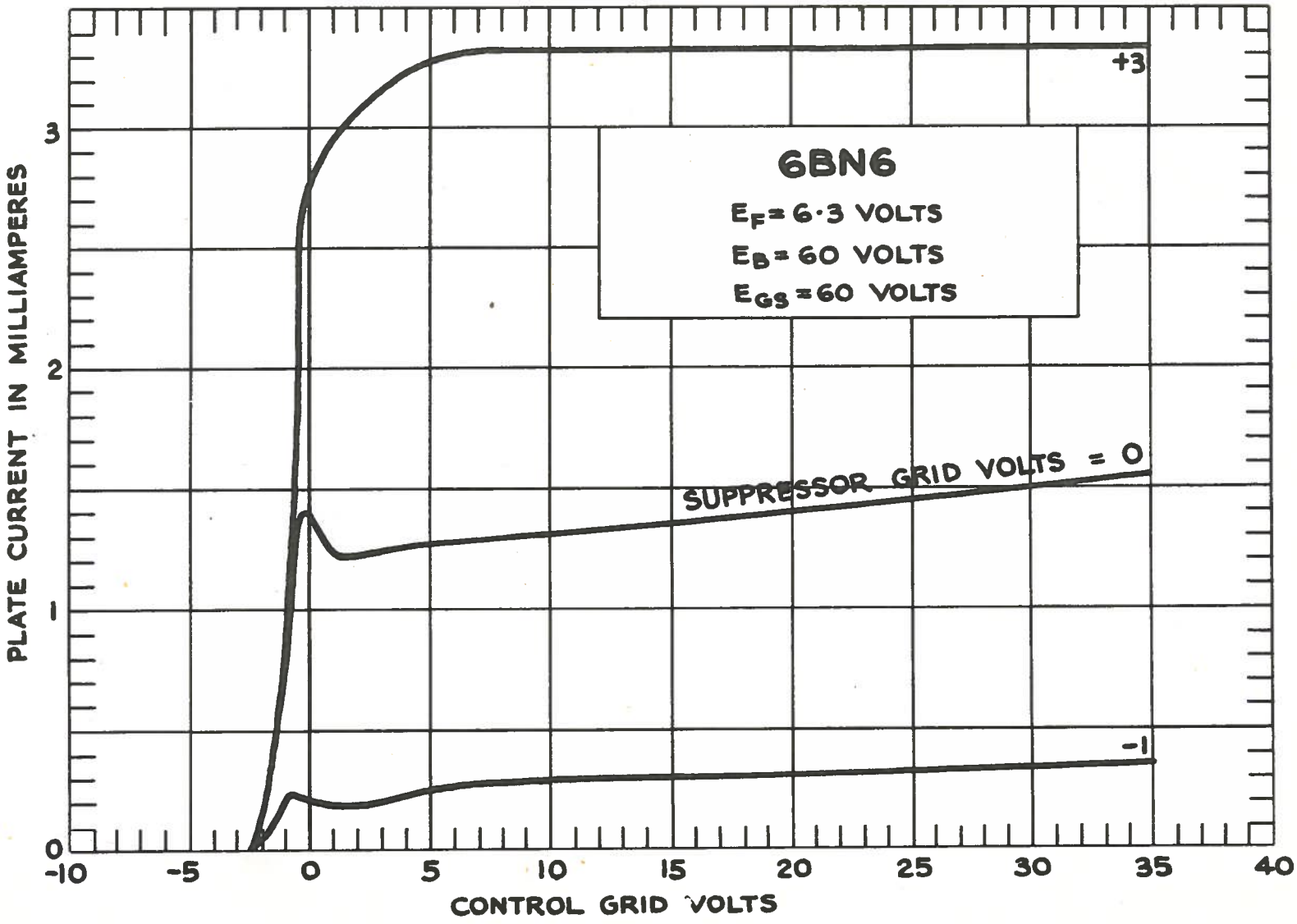

FIG. 7

TYPE-6BN6 OPERATING CHARACTERISTICS

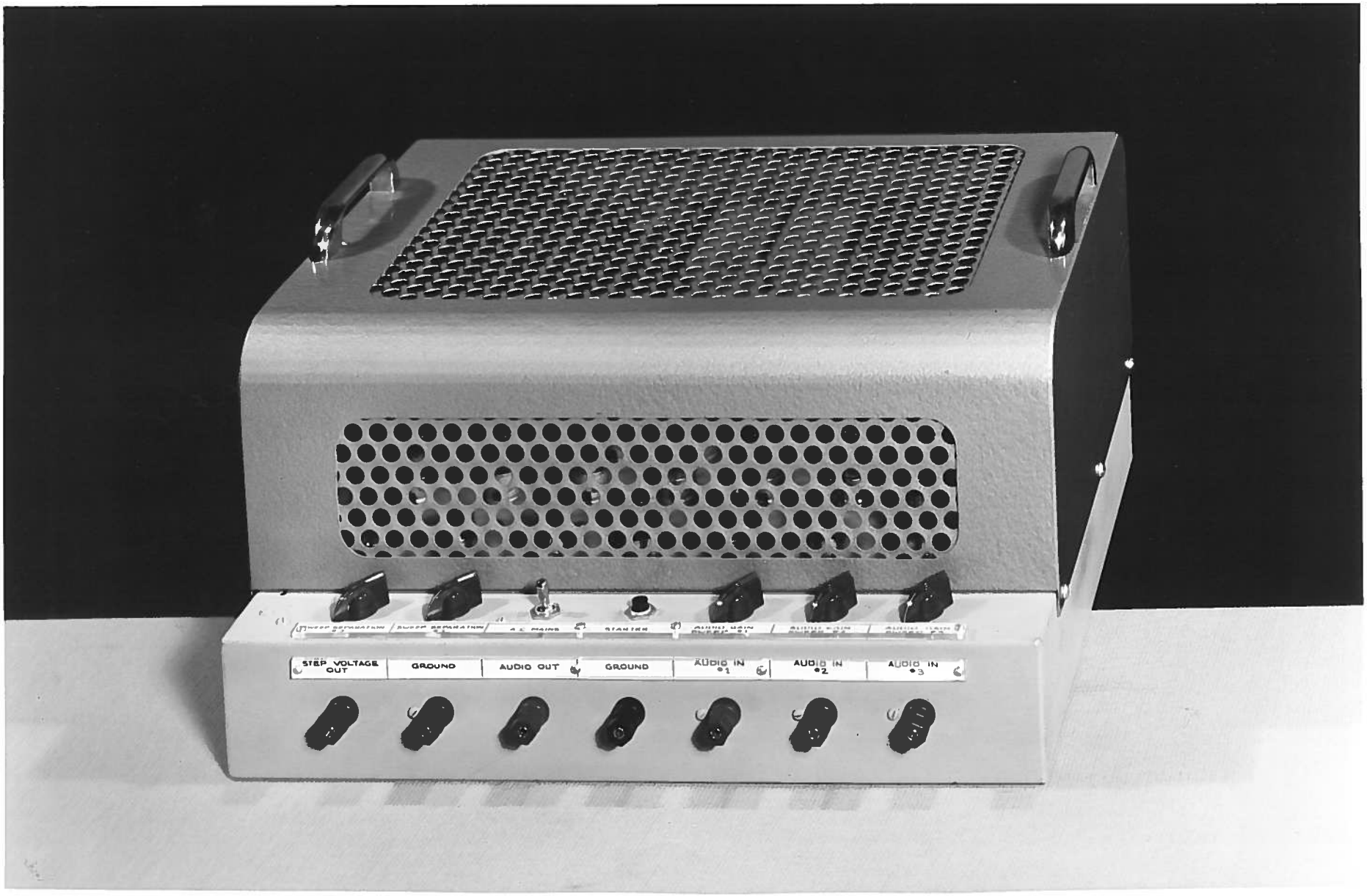

FIG. 8

THREE-CHANNEL ELECTRONIC SWITCH

TOP VIEW

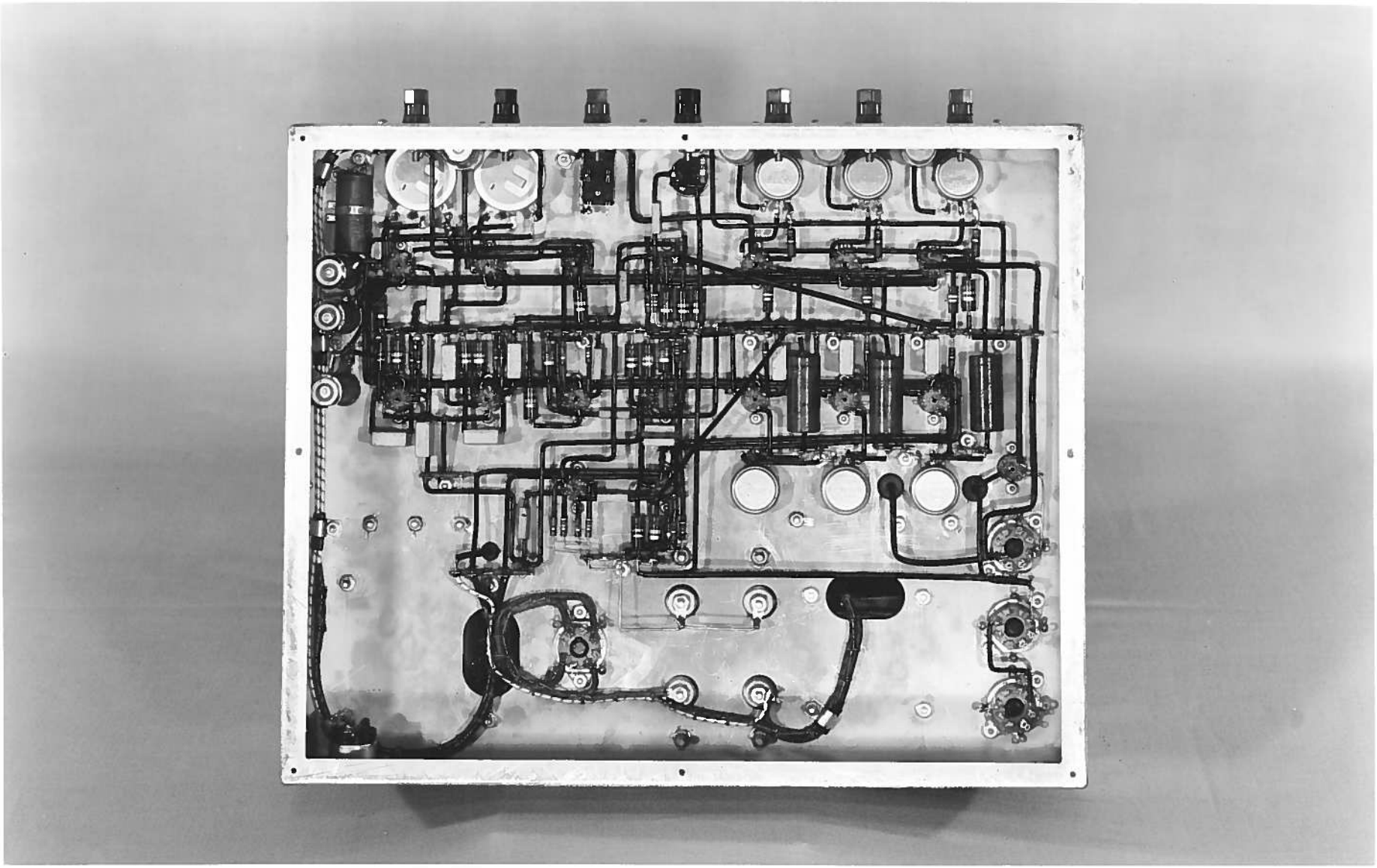

FIG. 9

THREE-CHANNEL ELECTRONIC SWITCH

UNDERSIDE VIEW