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EXPERIMENTAL TELEVISION CIRCUITS

By The Engineering Department, Kenyon Transformer Co., Inc.

SINCE sweep circuits are the foundation on which a television receiver must be built, it is logical to consider what their function is, how they work, and how they may be built, before going into the other details of the receiver.

A characteristic of the human eye termed as the *persistency of vision* is such that if an image is flashed intermittently before it more than a certain minimum times per second the image appears without perceivable flicker. Around this peculiar characteristic is built up the principle of television and also motion pictures.

Now let us suppose it is possible to move the beam of cathode ray tube back and forth in a horizontal direction fast enough, and at the same time move it up and down on the screen sixty times per second, making a series of horizontal lines about a fortieth of an inch apart. This is as though we had laid out a rectangle on a piece of paper and had moved our pencil once across the page for every time we moved it down the page a fortieth of an inch. A series of parallel lines very close together would be the result. Now, if we were to bear down lightly on the pencil every time across until we reached the middle, then heavily for the rest of the lines, a picture would be formed of two rectangles side by side, one light, and the other dark. By varying the pressure of our pencil on the way across the

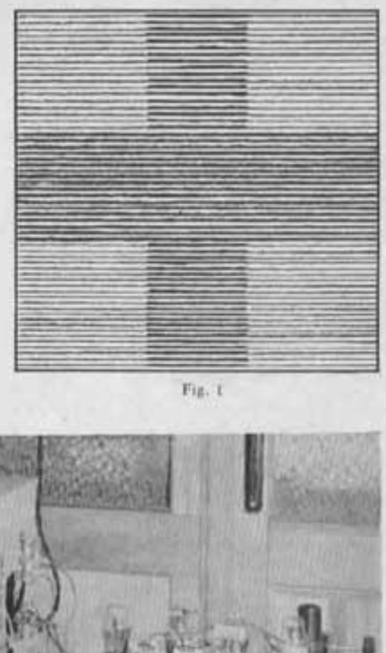


Fig. 1

The complete sweep circuit assemblies and cathode ray tube as set up for experimental use.

VERTICAL LOW FREQUENCY SWEEP CIRCUIT

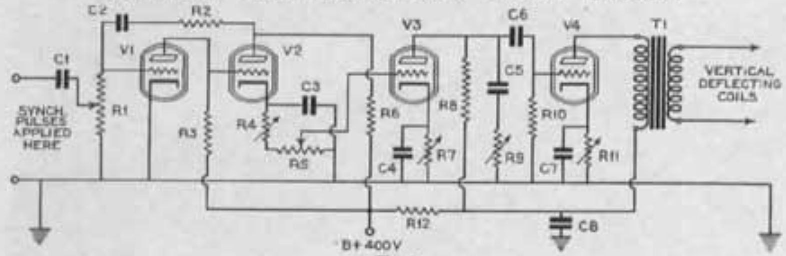


Fig. 2

LIST OF PARTS

R1	1 Meg. Pot.
R2	4,000 ohms—1 watt
R3	100,000 ohms—1 watt
R4	250,000 ohms—Pot. Freq. Control
R5	25,000 ohms—Pot. Size Control
R6	2,000 ohms—5 watt
R7	50,000 ohms—Pot. Bias
R8	500,000 ohms—1 watt
R9	100,000 ohms—Pot. Linearity Control
R10	500,000 ohms—½ watt
R11	10,000 ohms—Pot. Bias
R12	35,000 ohms—1 watt
C1	.1 mfd.—400 v. Paper
C2	.002 mfd.—400 v. Mica
C3	.1 mfd.—400 v. Paper
C4	10 mfd.— 50 v. Elect.
C5	.5 mfd.—400 v. Paper
C6	.1 mfd.—400 v. Paper
C7	20 mfd.— 50 v. Elect.
C8	8 mfd.—450 v. Elect.
V1, V2, V3	76
V4	6C5
T1	Kenyon Type T112

lines, any type of picture desired may be formed. The cross shown in Fig. 1 was made by pressing heavily on our pencil only in the center of the picture for a third of the lines on the way down. The next third of the lines were drawn using a heavy pressure all the way across. The last third of the lines were drawn the same as the first third pressing heavily only in the middle part.

Returning to our cathode ray tube we now see the reason for drawing the closely spaced horizontal lines. By referring to the picture we drew with the pencil, it will be noted that we drew lines starting always from the same side, lifting the pencil from the paper on the return stroke. In order to do this with the cathode ray tube two sweep circuits are used.

The horizontal sweep moves the spot across the screen in one direction at a uniform rate and then jerks it back to the other side very quickly so as to be ready to start its uniform motion across again. At the same time the vertical sweep is moving the spot across the screen in a vertical direction at a much slower, uniform rate of speed. This sweep combination then is controlling the motion of the cathode ray spot in exactly the same manner that we controlled the motion of our pencil. We controlled the lighter and darker tones of the picture by pressure on the pencil. The brilliancy of the cathode ray spot likewise follows the same analogy, and is controlled by the receiver. As this has no immediate bearing on the design of our sweep circuits, we will neglect it for the present. It is sufficient to say that this circuit besides controlling the brilliancy, performs a function similar to lifting the pencil from the paper for the return stroke, so only the uniform motion of the sweep is allowed to appear on the screen.

Thus far, we have followed the development of one-half picture, or frame. In order to make our picture plainer, we went back and put an extra line between each of those we had already drawn. In order to do this, we would go back to the top of the picture, if this is where we started, and draw another set of horizontal lines, shading them by pencil pressure, to conform with those previously drawn. The picture is now finished, and we go on to another picture to be made in exactly the same manner.

The sweep circuits to be described are for standard 441 line scanning, 30 frames per second. This means that there are 220 parallel lines on each tracing of the picture (or half frame) and that it takes 1/60th of a second to trace a half frame. From this we see that the frequency of the vertical sweep is 60 per second and the horizontal sweep is 220 times this or 13,200 per second.

Thus one sweep must generate sixty uniform pulses per second, and the other 13,200 per second. Since these pulses must be uniform with time, the wave form will be a sawtooth with one side a straight slanted line, and the other side almost vertical, indicating a quick return.

The sawtooth generators to be described are designed to meet these requirements by two Englishmen, Bedford and Puckle. They were recommended and described to us by Mr. M. P. Wilder of the National Union Radio Co. Their advantage over some other types is in stability of oscillation, ease of adjustment, and in the low value of voltage necessary to synchronize them.

VERTICAL LOW FREQUENCY SWEEP

The sawtooth generator in this circuit as shown in Fig. 2 consists of V_1 and V_2. Note the connections on these tubes. It is a two stage resistance coupled amplifier with the output fed back into the input. When plate voltage is applied V_2 draws a large amount of current. This causes a

SUGGESTED CENTERING CONTROL

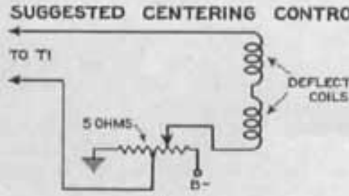


Fig. 2A

HORIZONTAL HIGH FREQUENCY SWEEP CIRCUIT

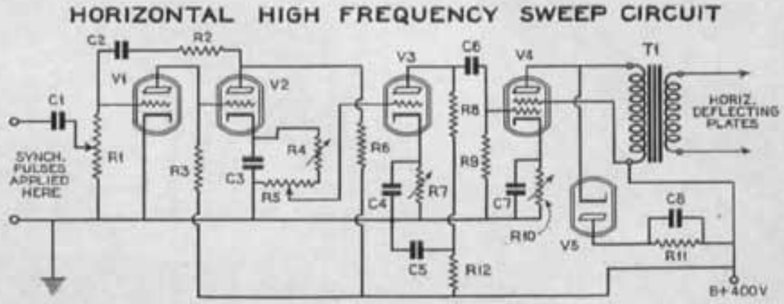


Fig. 3

LIST OF PARTS

R1	1 Meg. Potentiometer
R2	4,000—1 watt
R3	100,000—1 watt
R4	100,000—Pot. Freq. Control
R5	10,000—Pot. Size Control
R6	2,000—1 watt
R7	10,000—Bias Pot.
R8	250,000—1 watt
R9	500,000—½ watt
R10	1,000—Pot. Bias
R11	8,000—5 watt
R12	25,000—1 watt
C1	.005 mfd.—400 v. Paper
C2	.0025 mfd.—400 v. Mica
C3	.001 mfd.—400 Paper
C4	.25 mfd.—400 Paper
C5	8 mfd.—450 v. Elect.
C6	.005 mfd.—400 v. Paper
C7	10 mfd.— 50 v. Elect.
C8	.05 mfd.—600 v. Paper
V1, V2, V3	76
V4	6L6
V5	1V (Filament Insulated from Ground)
T1	Kenyon Type T111

voltage drop in R_6. Since R_6 is coupled to the grid of V_1 it swings the grid negative and V_1 draws no current. At the same time a voltage has been building up across the R_4, R_5, C_3 network. This happens almost instantaneously and the plate current of V_2 reaches a steady value. When the steady state is reached there is no longer a negative voltage applied to the grid of V_1. As soon as the charge leaks off its grid through R_1, V_1 starts to draw plate current. This causes a voltage drop in R_3, swinging the grid of V_2 further negative. This reduces the plate current of V_2 decreasing the voltage drop in R_6, and applying a positive surge to the grid of V_1 through the coupling network R_2, C_2. This causes additional plate current to flow through R_3, biasing V_2 further toward cut-off.

Now when plate current no longer flows in V_2, the charge starts to leak-off C_3 through R_4, R_5. The time necessary for this to occur is determined by the time constant of the RC combination. The voltage drop is then following the exponential discharge curve of a condenser-resistor combination. When this charge has leaked off, the grid of V_2 is again at a positive potential with respect to its cathode so V_2 starts to draw plate current. So the cycle is ready to repeat itself. During this cycle the voltage across R_4, R_5 increases very sharply and decreases at a rate as determined by the values of resistance and capacity chosen. A portion of this voltage is taken off R_5 and fed to the grid of V_3 to be amplified.

Since the voltage fed to the grid of V_3 is that of a condenser discharging through a resistor it is of an exponential curve and not truly linear. In order to correct for this, and also distortion which occurs in the deflecting coils on the cathode ray tube, R_7 and R_{11} are made variable. This makes it possible to operate V_3 and V_4 on the portion of the plate characteristic which is curved in the proper manner to compensate for the unlinearity. The resistor-condenser combination R_8, C_5 form an additional control for the purpose of linearity correction.

T-112, the output transformer, is specially designed to match the impedance of the vertical coils in the Kenyon deflecting yoke T-700.

SUGGESTED METHOD OF CENTERING

In order to center the beam a direct current of the order of 300 M.A. may be necessary in either or both horizontal and vertical deflecting coils. The circuit Fig. 2A shows how to employ the total supply to sweep circuits and receiver for this purpose. No serious voltage drop is involved for the D.C. resistance of the deflecting coils is small.

The resistor shown in circuits, Figs. 2 and 3, have an important bearing on operating characteristics, and are therefore shown as variable type. However, when proper values are determined, fixed type resistors may then be substituted.

POWER SUPPLY FOR RCA 1800 TUBE - ANODE No. 2 - 6000 V.

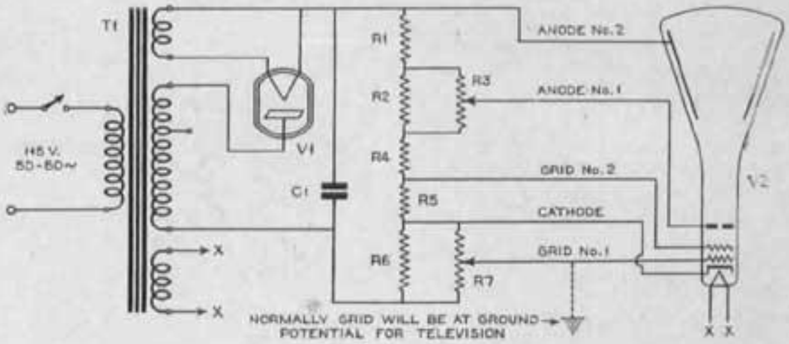


Fig. 4

LIST OF PARTS

- R1 40—25,000 ohm 1 watt carbon on form No. 1
- R2 5—25,000 ohm 1 watt carbon on form No. 2
- R3 500,000 ohm volume control, no taper on form No. 2
- R4 8—20,000 ohm 1 watt carbon, plus 1—5,000 ohm 1 watt carbon on form No. 2
- R5 5—10,000 ohm 1 watt carbon, plus 1—5,000 ohm 1 watt carbon on form No. 2
- R6 2—8,000 ohm 1 watt carbon on form No. 2
- R7 25,000 Pot. no taper, mounted on control panel
- C1 .1-.5 mfd.—6,000 v. D.C.
- V1 878 RCA
- V2 1,800 RCA
- T1 Kenyon Type T204

All resistors series connected except potentiometers which are paralleled.

SUGGESTED BAKELITE FORM FOR 1 MEGOHM RESISTOR FORM No. 1

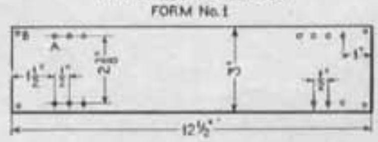


Fig. 5

Material—1/8" or 3/32" Bakelite

Drilling—

Holes "A" spaced as shown—total of 21 holes on each side of strip—1/16" to 1/8" in diameter

Holes "B" for mounting strip to chassis

SUGGESTED BAKELITE FORM FOR REST OF BLEEDER FORM No. 2

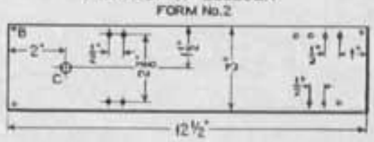


Fig. 5A

Material—1/8" or 3/32" Bakelite

Drilling—

Holes "A" spaced as shown—total of 14 each side

Holes "B" for mounting strip to chassis

Holes "C" 3/8" to take standard volume control shaft

HORIZONTAL HIGH FREQUENCY SWEEP

The sawtooth generator circuit, Fig. 3, is the same type as used in the low frequency sweep. The constants have been changed to give the required frequency of 13,200 cycles.

A higher power level is required to give sufficient amplitude in the horizontal coils so a 6L6 tube is used in the output. (Parallel 42's may also be used.) The rectifier 1-V with its resistor condenser combination serves to damp out spurious oscillations developed by the output tube.

The output transformer T-111 is designed to match the output tube to type T-700 deflecting yoke.

METHOD OF MOUNTING RESISTORS TO STRIP

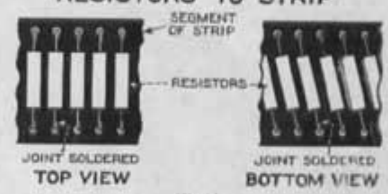
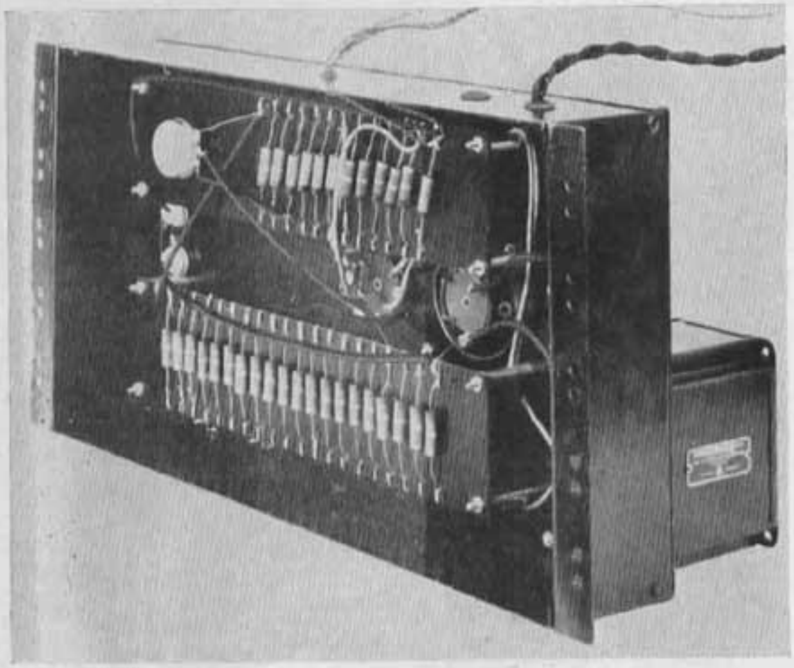


Fig. 6

POWER SUPPLY CONSTRUCTION

The first item which meets the eye in looking over the power supply diagram (Fig. 4) as furnished for the Kinescope, is the fact that the bleeder is made up of a 1 Meg. 25 watts resistor, which is hard to obtain, particularly in the voltage class of this supply, 6000 V. D. C. However, a little thought evolved a suitable system. The bleeder in its entirety was made up of common one watt carbons, of small enough resistance so that when combined in series, their wattage rating would be sufficient. For instance, the megohm bleeder is made up on a bakelite strip, Fig. 5, designated as form No. 1, of forty equal one watt resistors, giving it a wattage rating of 40 which is more than sufficient.



An underneath view of the power supply chassis showing the method of mounting the resistor forms.

The resistors are mounted on the two sides of the strip, as shown in Fig. 6 to make a series connection.

The other resistors are made up in the same manner. For variables, since very little current is drawn by the tube itself, a low wattage rating potentiometer was shunted across a fixed resistor, Form No. 2, (Fig. 5A). This is desirable, since a single unit, 100,000 ohm potentiometer capable of handling 3 watts, as required, is unusual.

It is recommended that all wiring on the high voltage side of the power supply be done with some type of high voltage cable, with at least a 10,000 volt test rating. The socket for the 878 rectifier should either be mounted on a bakelite plate with a minimum of ¾" spacing from ground, or else mounted on ceramic stand off insulators, to withstand the high voltage.

EXPERIMENTAL MOUNTING FOR TUBE

The cathode ray tube comes packed in a carton which makes an excellent mount for experimental purposes, with a little revision. See sketch, Fig. 7. First, cut out handle (a) remove part (b) and remove tube. Remove straps from part (b), cut a suitable mask for the tube screen. (Size is given in tube data).

Now, remove the bottom of the carton by cutting above the wooden bottom at (c) all around the carton. Remove part (d) and reverse directions, so that the flaps point into the box, and replace, bringing it just flush to the line cut at (c).

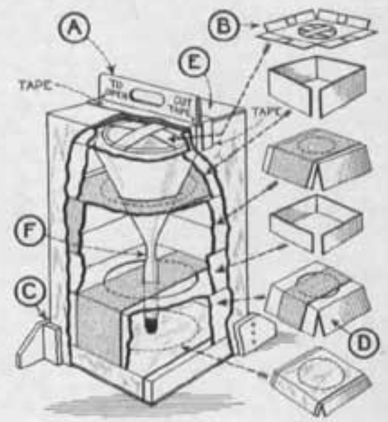


Fig. 7

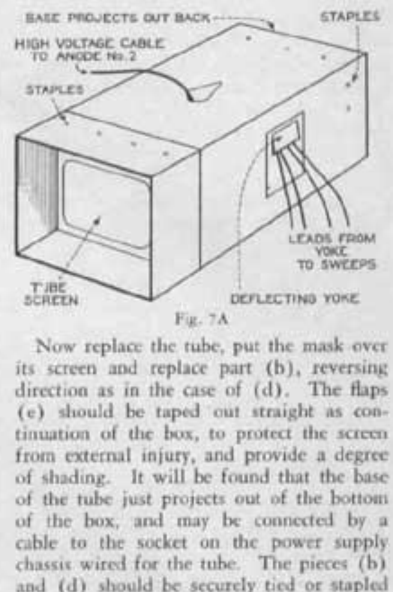


Fig. 7A

Now replace the tube, put the mask over its screen and replace part (b), reversing direction as in the case of (d). The flaps (e) should be taped out straight as continuation of the box, to protect the screen from external injury, and provide a degree of shading. It will be found that the base of the tube just projects out of the bottom of the box, and may be connected by a cable to the socket on the power supply chassis wired for the tube. The pieces (b) and (d) should be securely tied or stapled in place and the tube is locked in position so it cannot shift.

A hole some six inches square is cut in the side of the box opposite the neck (f) for coil adjustment, and a hole cut in the top above the cap for anode No. 2 on the tube, to allow for the high voltage connection, and to keep this lead away from other leads, see Fig. 7A. This leaves the inside of the box free and open, and yet the tube is well protected and securely held, free from danger until ready to be assembled in a final cabinet layout.

NEW KENYON TELEVISION COMPONENTS

Type No.		Case No.	List Price
T-111	To couple single 6L6 or parallel 42's to horizontal coils of Kenyon or RCA deflecting yokes	1A	$ 5.00
T-112	To couple single 6C5, 76, 56, etc., to vertical coils of Kenyon deflecting yoke (When T-112 is used no plate choke is needed)	2A	4.50
T-203	Plate and filament transformer Sec. No. 1—0-1,500-2,000 V RMS (To supply 2,000 or 3,000 V DC) Sec. No. 2—2.5 V-1.75 A (Insulated for use in 3,000 V circuits) Sec. No. 3—2.5 V-2.1 A (Insulated for use in 500 V circuits)	4A	8.00
T-204	Plate and filament transformer Sec. No. 1—0-2,200-4,400 V RMS (To supply 3,000 or 6,000 V DC) Sec. No. 2—2.5 V-6 A (Insulated for use in 6,000 V circuits) Sec. No. 3—2.5 V-2.1 A (Insulated for use in 500 V circuits)	5A	13.00
T-700	Deflecting yoke (constructed to provide maximum amplitude and minimum defocusing control)	—	12.00
T-208	Plate and filament transformer Sec. No. 1—0-850 (To supply 1,200 DC) Sec. No. 2—7.5 V-1.25 A (Insulated for use in 1,200 V circuits) Sec. No. 3—2.5 V-2.1 A (Insulated for use in 1,200 V circuits)	4A	7.50