

July 9, 1940.

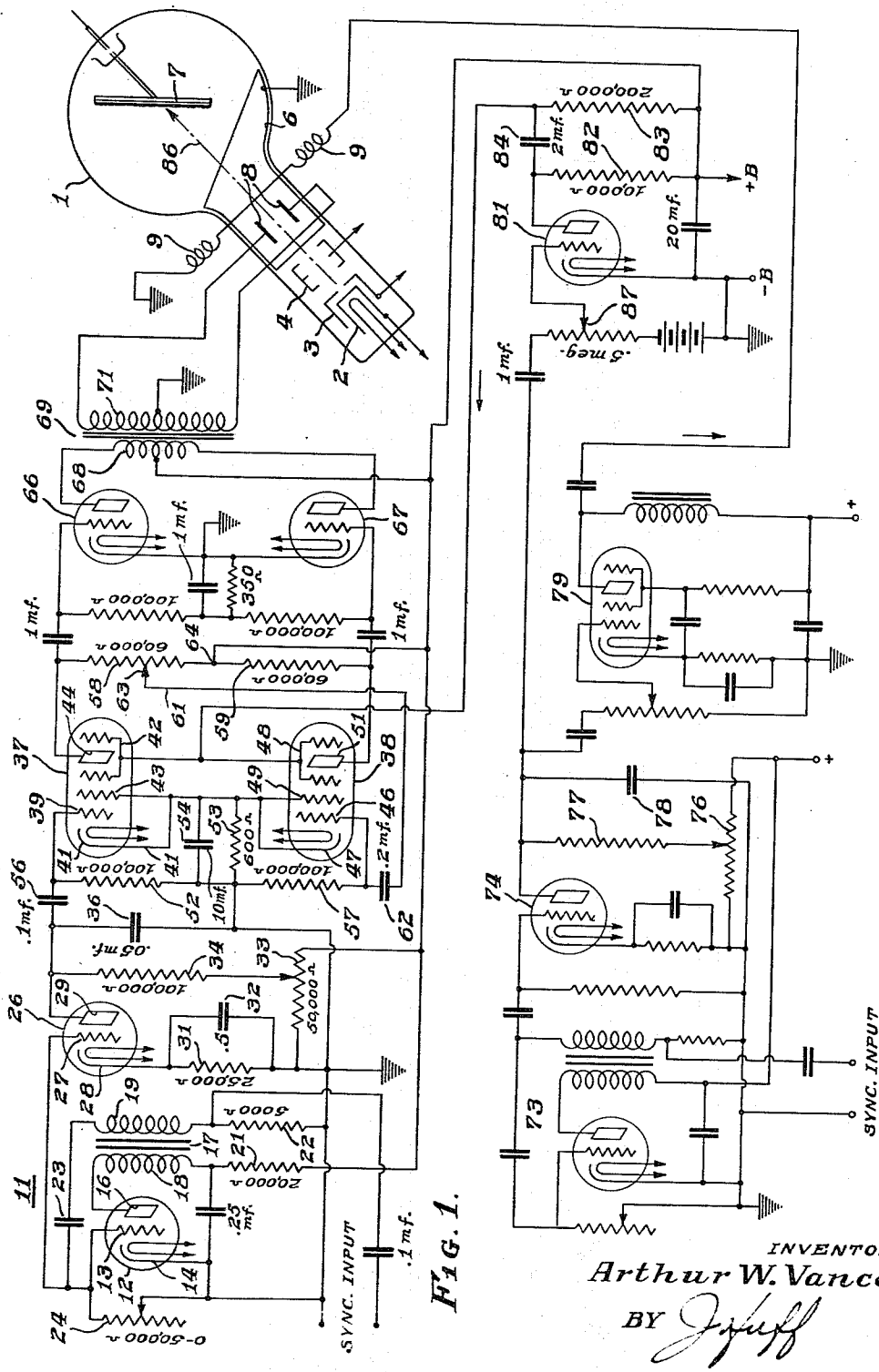
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2,207,499

CATHODE RAY DEFLECTING SYSTEM

Filed June 26, 1936

2 Sheets-Sheet 1



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Fig. 2.

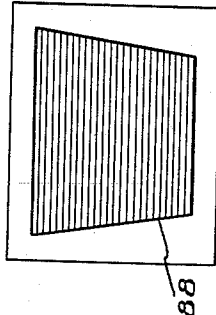


Fig. 3.

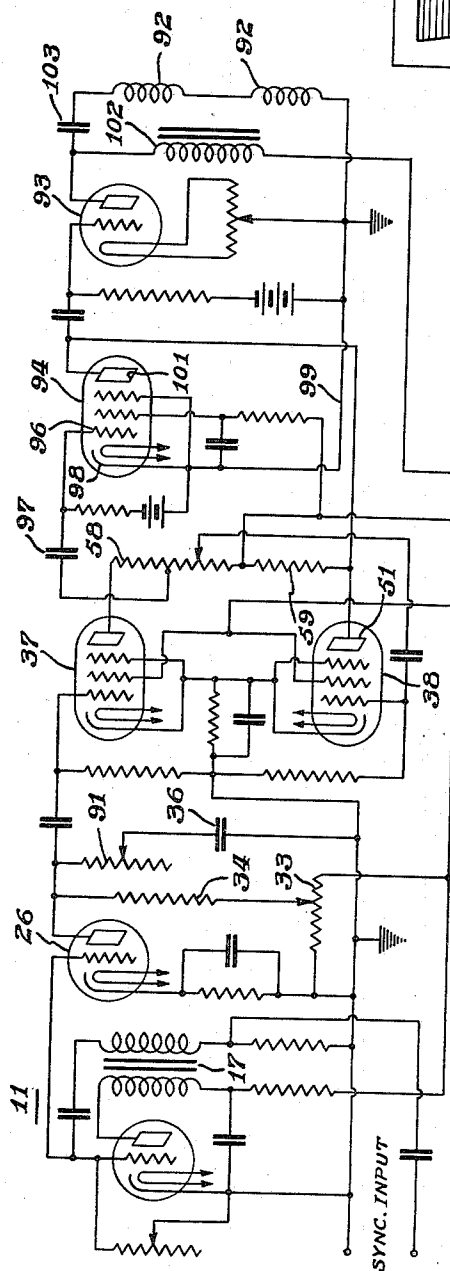
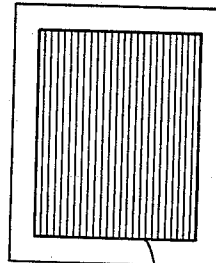
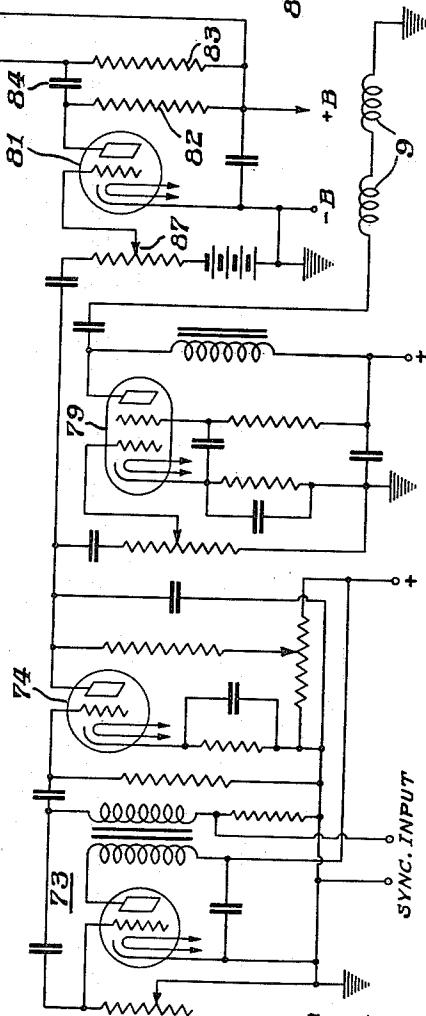


Fig. 4.



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CATHODE RAY DEFLECTING SYSTEM

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1 Claim. (Cl. 178—7.7)

My invention relates to cathode ray tube deflecting systems, and particularly to deflecting systems which are employed with a cathode ray tube of the type having a screen structure inclined at an acute angle with respect to the axis of the tube.

In cathode ray transmitter tubes of the type commonly employed in television transmitters, the tube includes a mosaic of light sensitive elements, which is positioned at an acute angle to the axis of the electron gun whereby the same side of the mosaic which has an optical image projected thereon may be scanned by the cathode ray. In cathode ray receiver tubes of a common type, the fluorescent screen is positioned at an acute angle to the electron gun, whereby an observer may view a picture on the same side of the screen that is being scanned by the cathode ray.

In the preferred television systems, at both the transmitter and receiver a cathode ray is deflected horizontally at a comparatively high frequency by means of saw-tooth waves, while it is being deflected vertically at a comparatively low frequency by means of other saw-tooth waves.

If the screen structure of the cathode ray tube were located normal to the electron gun axis, such deflection of the cathode ray would cause it to scan a rectangular pattern on the screen. Where the screen structure is positioned at an acute angle to the electron gun axis, however, the scanning pattern produced by such deflection has a keystone shape. Various apparatus and circuits have been proposed for correcting this keystone error, but they have involved certain objectionable features.

It is, accordingly, an object of my invention to provide an improved method of and means for correcting keystone error in cathode ray tubes of the above mentioned type.

It is a further object of my invention to provide an improved deflecting system for cathode ray tubes of the above mentioned type, which is comparatively simple in design and which will produce a substantially rectangular scanning pattern on the tube's screen structure.

In practicing my invention, I modulate the horizontal saw-tooth waves with the lower frequency vertical saw-tooth waves in a balanced circuit, whereby the modulating vertical saw-tooth waves are balanced out and prevented from appearing in the output of the horizontal deflecting circuit. Therefore, the only deflecting waves supplied to the horizontal deflecting plates

or deflecting coils are the modulated horizontal saw-tooth waves, these waves gradually increasing in amplitude as the cathode ray is deflected vertically towards the edge of the screen which is nearer the electron gun. It is very important that the vertical saw-tooth component be prevented from appearing in the output of the horizontal deflecting circuit, as such a component distorts the scanning pattern on the screen by making the vertical edges of the pattern appear at an angle with respect to the vertical to produce a slanted pattern.

Other objects, features and advantages of my invention will appear from the following description, taken in connection with the accompanying drawing, in which:

Figure 1 is a circuit diagram of a saw-tooth deflecting circuit embodying my invention, this circuit being designed to supply saw-tooth voltage waves to a pair of deflecting plates;

Fig. 2 is a diagram showing a scanning pattern containing keystone error;

Fig. 3 is a diagram showing the scanning pattern produced by a deflecting circuit such as the one illustrated in Fig. 1; and

Fig. 4 is a circuit diagram of another embodiment of my invention.

Referring to Fig. 1, my invention is shown applied to a deflecting circuit for a cathode ray transmitting tube of a well known type. This tube, which is indicated at 1, comprises an evacuated envelope having therein an indirectly heated cathode 2, a control grid 3, a first anode 4, and a second anode 6. It also includes a screen structure 7 comprising a mosaic of light sensitive elements, this screen structure being positioned at an acute angle to the axis of the electron gun comprising the cathode, the control grid, and first anode. The cathode ray tube 1 is also provided with a pair of deflecting plates 8 and a pair of deflecting coils 9.

The horizontal deflecting circuit includes an oscillator 11 for producing electrical impulses at the frequency at which it is desired to produce saw-tooth deflecting waves. In the preferred embodiment of the invention, this oscillator is of the blocking oscillator type, comprising a three-element tube 12 having a grid 13, a cathode 14, and a plate 16. The plate circuit is coupled to the grid circuit through a transformer 17 having a primary 18 and a secondary 19, voltage being supplied to the plate 16 through a voltage reducing resistor 21 and the transformer primary 18. The transformer secondary 19 is con-

nected at one end through a resistor 22 to ground, and at the other end through a grid condenser 23 to the control grid 13.

A grid resistor 24 is connected between the grid 13 and the cathode 14. The relative values of the grid condenser 23 and grid resistor 24 are such that voltage fed back through transformer 17 blocks the tube 12 for a certain period. At the end of this period another cycle of operation of the oscillator is begun. Each cycle of operation produces a positive voltage impulse of large magnitude, which is supplied to the grid of a discharge tube 26.

The discharge tube includes a control grid 27, a cathode 28, and a plate 29. The tube 26 is biased substantially to cut-off by suitable biasing means such as a self-biasing resistor 31 connected between the cathode 28 and ground, this resistor being shunted by a suitable condenser 32. The plate 29 of the discharge tube is supplied with a suitable operating potential through a potentiometer 33 and a plate resistor 34.

A condenser 36 is connected between the plate 29 and ground, whereby it is charged comparatively slowly from the plate supply through the plate resistor 34. Since a positive impulse is being applied to the grid 27 of a discharge tube periodically, the condenser 36 discharges suddenly through the discharge tube, after having been charged up to a certain value. This slow charge and sudden discharge of the condenser produces the desired saw-tooth wave, the saw-tooth wave occurring at the frequency at which the condenser 36 is discharged by the oscillator impulses.

In accordance with my invention, the saw-tooth wave appearing across the condenser 36 is supplied to a balanced modulator circuit. This modulator circuit includes a pair of screen grid tubes 37 and 38 the tube 37 having a control grid 39, a cathode 41, a screen grid 42, a suppressor grid 43, and a plate 44. The tube 38 likewise includes a control grid 45, a cathode 47, a screen grid 48, a suppressor grid 49, and a plate 51.

The input circuit of the tube 37 includes a grid resistor 52 and a self-biasing resistor 53, the self-biasing resistor being shunted by a suitable condenser 54. The saw-tooth condenser 36 is connected across the grid resistor 52 through a coupling condenser 55. The input circuit of the tube 38 includes a grid resistor 57 and the biasing resistor 53.

The plates of the tubes 37 and 38 are supplied with the proper operating voltage through resistors 58 and 59, respectively, from a common voltage source. It will be apparent that the tubes 37 and 38 are connected in push-pull or balanced relationship both in their grid circuits and in their plate circuits.

In order to couple the single-sided discharge tube amplifier 26 to the double sided push-pull modulator 37—38, a connection is taken from a point on the plate resistor 58 of the tube 37 to the grid 46 of the tube 38, through a conductor 61 and a coupling condenser 62. The connection to the resistor 58 preferably is through a variable tap 63 which is adjusted to a point where the gain of the amplifier 37 is unity, that is, the voltage appearing between the tap 63 and the voltage supply point 64 is equal to the voltage impressed upon the control grid 39 of the tube 37.

The output of the balanced modulator 37—38 is supplied to a conventional push-pull amplifier including amplifier tubes 66 and 67 having the

primary 68 of a step-up transformer 69 in their plate circuits. The secondary 71 of this transformer is connected across the deflecting plates 8, the mid-point of the transformer secondary being connected through ground to the second anode 6 of the cathode ray tube.

The modulating voltage which is supplied to the balanced modulator 37—38 is derived from the vertical deflecting circuit. The vertical deflecting circuit preferably comprises a blocking oscillator 73 similar to the one in the horizontal deflecting circuit, this oscillator being adjusted to produce positive voltage impulses occurring at the comparatively low picture frame frequency. These impulses are impressed upon the grid of a discharge tube 74 corresponding to the tube 26 in the horizontal deflecting circuit.

Voltage is supplied to the plate of the discharge tube 74 through a potentiometer 76 and a plate resistor 77 having high resistance. A condenser 78, across which the vertical saw-tooth voltage wave is produced, is connected between the plate of tube 74 and ground. The vertical saw-tooth voltage wave is produced in the same way that the horizontal saw-tooth wave is produced, the condenser 78 being charged slowly through the plate resistor 77, and being discharged rapidly through the discharge tube 74 each time a positive impulse is applied to the grid of the discharge tube.

The vertical saw-tooth wave is supplied through a screen grid output tube 79 to the vertical deflecting coils 9, or to a pair of deflecting plates, if preferred.

In accordance with my invention, the saw-tooth waves appearing across the condenser 78 are also impressed upon the screen grids 42 and 48 of the balanced modulator 37—38 in the horizontal deflecting circuit, whereby they modulate the horizontal saw-tooth waves. The modulating waves are supplied to the screen grids 42 and 48 through a linear amplifier 81 which has voltage applied to its plate through a plate resistor 82. The screen grids 42 and 48 may be supplied through a screen grid resistor 83 with voltage from the same source (not shown) as that supplying the plates of the tubes. The low frequency saw-tooth voltage is impressed upon the resistor 83 and thus upon the screen grids 42 and 48 through a coupling condenser 84.

The adjustment of the circuit is such that if the cathode ray, indicated at 86, is deflected downwardly, the modulating saw-tooth voltage on the screen grids 42 and 48 increases in amplitude, whereby the amplitude of the horizontal saw-tooth waves gradually increases during downward deflection of the beam. By adjusting a variable tap 87 on the input resistor of the linear amplifier 81, the magnitude of the modulating voltage may be made just sufficient to compensate for the keystone effect.

The result of the keystone correction will be seen by referring to Figs. 2 and 3. Before the correction, the scanning pattern on the mosaic 7 of the cathode ray tube is of the keystone shape indicated at 88 in Fig. 2. By properly adjusting the value of the low frequency modulating voltage, the scanning pattern on the mosaic is made substantially rectangular, as indicated at 89 in Fig. 3.

In order to obtain good keystone correction, it is necessary that the balanced modulator 37—38 have a substantially linear characteristic. It may be pointed out that when a saw-tooth wave is modulated by another saw-tooth wave, a wide

band of frequencies is produced, the highest of which is the highest harmonic of the "carrier saw-tooth wave" plus the highest harmonic of the modulating saw-tooth wave. The lowest frequency is the fundamental of the "carrier saw-tooth wave" minus the highest harmonic of the modulating saw-tooth wave. Thus, in order to transmit a modulated horizontal saw-tooth wave, a circuit with a lower frequency cut-off is required than would be necessary for an unmodulated saw-tooth wave. For this reason, the values of the coupling condensers and bypass condensers are made extra high in order to pass these lower side band frequencies.

In Fig. 4 there is shown an embodiment of my invention in which the horizontal deflecting circuit supplies saw-tooth voltage to deflecting coils instead of saw-tooth voltage to deflecting plates, as in Fig. 1. In the two figures, like parts are indicated by the same reference numerals. Up to and including the plate circuit of the balanced modulator, the circuits in Figs. 1 and 4 are substantially the same. Preferably, however, a "peaking" resistor 31 is included in series with the saw-tooth condenser 36 in order to provide the impulse component which is desired when deflecting coils are fed from a low impedance output tube. The deflecting coils and output tube are indicated at 92 and 93, respectively. It may be noted that in some cases, especially when the tube 93 has a very low plate impedance, it will be desired to impress voltage impulses only upon the balanced modulator whereby impulses occurring at the horizontal frequency are modulated by the vertical saw-tooth waves.

Since it is desirable to feed the deflecting coils 92 from a single-sided output amplifier, instead of from a push-pull amplifier, an amplifier tube 94 is included between the balanced modulator 37-38 and the output tube 93 for connecting from a balanced or double-sided circuit to a single-sided circuit. The control grid 96 of tube 94 is connected through a coupling condenser 97 to a point on the plate resistor 58, and the cathode 98 is connected to the grounded conductor 99. The plate 101 of the tube 94 is connected directly to the plate 51 of the balanced modulator tube 38, both of these plates being supplied with voltage through the plate resistor 59.

The plate circuit of the tube 94 is connected to the input circuit of the output tube 93, which may be of the three-element type having a fairly low plate impedance. The deflecting coils 92 are coupled to the output circuit of the tube 93 through the usual choke coil 102 and coupling condenser 103.

It will be noted that in this embodiment of my invention the horizontal saw-tooth waves are modulated by the vertical saw-tooth wave in the way previously described, in order to obtain the desired keystone correction.

It will be apparent that in the circuits described above, the vertical saw-tooth wave does not ap-

pear in the output circuit of the balanced modulator, since such a modulator balances out the modulating signal, as is well known in the art. As previously mentioned, this is very important if an undistorted deflecting pattern is to be obtained on the screen of the cathode ray tube.

It may be pointed out that in most radio circuits, where a radio frequency is modulated by an audio signal, it is possible to filter out the modulating frequencies if they appear in the modulator output. In the present case, however, where a horizontal saw-tooth wave is modulated by a vertical saw-tooth wave, some of the modulated frequencies are higher than some of the "carrier" frequencies, and obviously such filtering is impossible.

In Fig. 1 the values of certain resistors and condensers have been indicated in ohms and microfarads merely by way of example. Also, the types of vacuum tubes have been indicated by way of example. It should be understood that, if preferred, substantially different circuit constants may be employed in practicing my invention.

Since the deflecting circuits of a transmitter are usually operated in synchronism with impulses supplied from a synchronizing generator, the points at which these impulses are supplied to the blocking oscillators are indicated in Figs. 1 and 4 by the legend "Sync. input."

It will be apparent from the foregoing description that various modifications may be made in my invention without departing from the spirit and scope thereof, and I desire, therefore, that only such limitations shall be imposed thereon as are necessitated by the prior art and set forth in the appended claim.

I claim as my invention:

In combination, a cathode ray tube having a screen structure positioned at an acute angle with respect to the axis of its electron gun, horizontal deflecting means for deflecting the cathode ray at right angles to the plane of said acute angle, vertical deflecting means for deflecting the cathode ray in the plane of said acute angle, a horizontal deflecting circuit including a pair of electric discharge tubes connected in balanced relation to form a balanced modulator, means for producing saw-tooth voltage waves at a comparatively high frequency, means for supplying said waves to said horizontal deflecting means through said modulator, means for producing saw-tooth waves occurring at a comparatively low frequency and supplying them to said vertical deflecting means, and means for impressing said low frequency waves upon said balanced modulator for modulating said high frequency waves, the constants of said horizontal deflecting circuit being such that it passes substantially all the frequency components of both the upper side band and the lower side band of the modulated high frequency waves.

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