CATHODE RAY MODULATOR
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My invention relates to cathode ray modulators and more specifically to a method of and apparatus for simultaneously applying modulating potentials to grid, cathode and anode electrodes of a cathode ray tube.

The cathode ray in a cathode ray tube is generally deflected by deflecting coils or electrodes, focused by applying bias voltages to one or more anode electrodes and modulated or varied in intensity by applying modulating voltages between grid and cathode electrodes. If modulation voltages of improperly related amplitudes are applied to the anode electrodes, defocusing usually accompanies the modulation, and thereby an unsatisfactory trace results. I have found that if the potentials applied to the first and second anodes are suitably varied, a properly focused modulated trace may be secured.

If the best focus is obtained by a given ratio of voltages applied between first anode and cathode, and between second anode and cathode, anode modulation potentials may be applied in substantially the same ratio. Therefore an object of my invention is to provide means for applying modulation voltages to the anodes of a cathode ray tube in the ratio which results in maintenance of proper focus. Another object is to provide means whereby modulation voltages may be applied to anode, cathode and control electrodes of a cathode ray tube. An additional object is to provide means whereby a fixed and a variable pattern may be obtained on a cathode ray screen.

In describing the invention reference will be made to the accompanying drawings in which

Figure 1 is a schematic diagram of one application of the invention;

Figures 2 and 3 are illustrative cathode ray traces;

Figure 4 is a circuit diagram of a preferred embodiment of the invention; and

Figure 5 is a circuit diagram of a modification of the invention.

Although my invention is not limited to any particular form of modulation, for purposes of illustration, a complete schematic diagram of a cathode ray modulation circuit is shown in Fig. 1. This circuit, which is partly of the type shown in U. S. Patent No. 2,121,559 issued June 21, 1938, on an application Serial No. 134,074, filed on March 31, 1937, by David G. C. Luck and Lowell E. Norton, shows a cathode ray tube on which a marking scale and impulse of a phase to be determined by reference to the scale are impressed on the cathode ray tube in accordance with my invention. A standard frequency generator 1 provides a source of alternating current of a frequency of 15 kilocycles per second. This alternating current is impressed on three frequency divider stages 3, 5, 7 which provide alternating currents of the following frequencies: 3000 C. P. S., 1000 C. P. S. and 333 1/3 C. P. S. The output of the last frequency divider stage 7 is applied to a multivibrator 9, having a ratio of 6 to 1. The flat top wave 11 produced by the multivibrator is applied to a filter and wave shaper 13 to produce a sine wave 15, which is applied to a phase splitter 17. The output of the phase splitter is a two phase current 19 which is impressed on the deflecting coils 21 of the cathode ray tube 23.

The output of the several frequency divider stages 3, 5, 7 are applied to attenuators 25, 27, 29 and from the attenuator to an amplifier 31. The output of the amplifier 31 is impressed between the grid 33 and cathode 35 electrodes of the cathode ray tube, and upon a modulator 37. The modulator and cathode ray tube are supplied with power from a common source 39. The first 41 and second 43 anode electrodes of the cathode ray tube are connected to a voltage divider which, in turn, is connected to the modulator tube so that its potential variations follow those of the modulator. The signal of unknown frequency, phase, or the like, from a source 45 may be impressed through an impulse amplifier 45 on either the amplifier or the modulator.

The details of a preferred embodiment of amplifier, modulator and cathode ray tube circuit are illustrated in Fig. 4. The terminals A—B are connected to the input of a thermionic amplifier T. The amplifier T may also include an input terminal Y which is connected to a grid G0. The amplifier output circuit includes a potentiometer R0 and a source of current 51. The output circuit is coupled through a capacitor C to the control electrode G of the cathode ray tube. The cathode electrode K is connected to ground terminal 3 by a self-bias resistor R3. The first and second anode electrodes A1, A2 are connected to the cathode K by a resistor R2 which includes an adjustable tap 53. A capacitor 55 may be shunted across either the upper or lower portion of the resistor R2 to maintain their impedance ratio independent of frequency. The anode A3 is connected through a resistor R to an anode voltage source 57.

A modulator tube T3 is connected as follows: The cathode K1 is connected through a self bias resistor R1 to ground. The first grid G1 is connected to the output of the amplifier T by a connection between the capacitor C and the grid G.
The anode P is connected to the junction of the resistor R and the second anode A2. The second grid G2 is connected to a bleeder network 59, 61 which shunts the anode voltage source 57. The third grid G3 is connected to ground through a resistor 63. The source of potential of unknown frequency, or phase or desired modulation may be connected to the terminal T and grid G1 in the amplifier T, or the third grid G3 of the modulator T3.

The adjustment and operation are as follows: The currents in the deflecting coils are adjusted to produce a circular pattern which may be adjusted in intensity by R3 so that the circular trace 67 appears as in Fig. 2 or disappears as in Fig. 3. The cathode ray beam focus is adjusted by varying the tap 53 on resistor R4. The modulator T3 is adjusted to approximately cut-off its anode current by regulating the self bias R1. The fixed scale or markers 69 are obtained by applying negative impulse potentials, from the attenuators 25, 27, 29 to the grid of the amplifier T. The negative impulse voltages applied to the grid appear as positive impulse voltages on the output resistor R4. These positive impulse voltages are simultaneously applied to the grid G of the cathode ray tube and the grid G3 of the modulator tube T3.

The simultaneous application of the positive impulse voltages to the grids G and G3 increases the brightness of the cathode ray traces (Figs. 2 and 3) during the application of the impulse. Since the positive impulse voltage on G3 makes the modulator T3 more conductive, this increases the voltage drop in the resistor R3, and diminishes the potentials applied to the first and second anodes A1, A2 which thereby deflect the trace outwardly during the impulse. While the potentials applied to the anodes A1, A2 vary as described, the ratio of the potentials being applied between K and A1, and between K and A2 through the potentiometer R2 remains fixed and thereby the focus is maintained. Thus, a fixed pattern or trace is obtained. The unknown modulation impulse may be applied to the grid G3 of the modulator T3 and will be observed as a trace 71 whose position indicates its phase with respect to the fixed scale. The several traces may be extended from the circular trace toward the center instead of away from the center by applying positive instead of negative impulse voltages, or may be extended on both sides of the circular trace by application of negative and positive impulses.

Thus a cathode ray modulator including a modulator tube connected in shunt to a potentiometer, from which modulation voltages are applied to the first and second anodes of the cathode ray tube has been described. In some installations it may be desirable to apply the modulation potentials by including the modulator tube in series with the cathode circuit of the cathode ray tube as shown in Fig. 5. In this arrangement, the tube V is arranged as an oscillator, which is modulated by imitating the modulating potentials across the terminals AB. The output circuit 73 of the oscillator is coupled to a rectifier V2. The rectifier output is applied to the cathode Ks and control electrode Gs of the cathode ray tube. The modulation potentials from the source of unknown phase may be applied to the terminals AB and grid G1 of the modulator tube V3. The modulation potential from the source of unknown phase may also be applied to the terminals KB. The cathode-anode circuit of the modulator tube V3 is connected in series with the self bias resistor R3 of the cathode ray tube.

The anode potential for the cathode ray tube and the modulator V4 is supplied from any suitable source 75. The first Gs and second Gs anode electrodes are connected to the slider and upper terminal of a potentiometer 71, which is connected from the cathode Ks to the positive terminal of the source 75. Either the upper or lower portion of the potentiometer may be shunted by a capacitor 19 to maintain the proper ratio of impedance independent of frequency. After the slider of the potentiometer 71 has been adjusted to properly focus the cathode ray, the focus will be maintained because the modulation potential applied through the modulator tube will not alter the ratio.

In the instant circuit the modulating potentials are simultaneously applied to the control grid and first and second anode electrodes of the cathode ray tube. The operation of the modulator is essentially the same as the modulator circuit of Fig. 4. In the instant circuit, the modulation potentials of either the fixed pattern or the fixed pattern and the variable or unknown pattern are applied to the modulator V3 and to the oscillator and, after rectification, are applied to the control grid Gs and the cathode electrode Ks. The modulator V3, being suitably biased, varies the potential between Ks and Gs, and between Ks and Gs, of the cathode ray tube to thereby vary its trace.

Thus I have described a cathode-ray tube modulation system in which the cathode-ray beam is modulated without defocusing. The focus is adjusted and maintained by applying potentials in the proper ratio to the first and second anodes. While two phase currents have been applied to deflect the beam in a circular trace, currents of saw-tooth or any suitable waveform may be applied to deflect the beam in any desired pattern.

I claim as my invention:

1. In a cathode ray tube modulation device, a cathode-ray tube including cathode and anode electrodes, means for applying steady potentials to said first and second anode electrodes, means for applying modulation potentials to said anode electrodes, means for applying modulation potentials to said anode electrodes and maintaining constant the ratio of the cathode to the first anode potential to the cathode to the second anode potential during the said applications of said modulation potentials.

2. In a cathode ray tube modulation device, a cathode-ray tube including cathode and control electrodes, control and first and second anode electrodes, means for applying steady potentials to said first and second anode electrodes, means for applying modulation potentials to said control electrodes, means for applying modulation potentials to said anode electrodes and maintaining constant the ratio of the cathode to the first anode potential to the cathode to the second anode potential during the said applications of said modulation potentials.

3. In a cathode ray tube modulation device, a cathode-ray tube including cathode, control and first and second anode electrodes, means for applying steady potentials to said first and second anode electrodes, means for applying modulation potentials to said first and second anode electrodes, means for applying modulation potentials to said anode electrodes and maintaining constant the ratio of the cathode to the first anode potential to the cathode to the second anode potential during the said applications of said modulation potentials.
for simultaneously applying modulation potentials to said control and first and second anode electrodes and maintaining constant the ratio of the cathode to the control electrode potential to the cathode to first anode potential and the ratio of the cathode to first anode potential to the cathode to second anode potential during the said application of modulation potentials.

4. In a cathode ray tube modulation system, a cathode ray tube including control grid and first and second anode electrodes, a first source of modulation potentials, means for simultaneously applying potentials from said first source to said control grid and first and second anode electrodes, a second source of potentials, means for simultaneously applying potentials from said second source to said electrodes, and means for maintaining a constant ratio of resultant potentials applied to said first and second anode electrodes so that focuses of the resultant cathode ray traces are maintained over a range of said applied potentials.

5. In a cathode ray tube modulation system, a cathode ray tube including control grid, first and second anode electrodes, an amplifier, a vacuum tube having an input and an output, connections from the output of said amplifier to said control grid and to the input of said vacuum tube, connections from the output of said vacuum tube to said first and second anode electrodes, means for adjusting and maintaining a ratio of potentials for focusing said cathode ray, means for applying said potentials to said first and second anode electrodes insuring focusing of said cathode ray, and means for applying modulation potentials through said amplifier and said vacuum tube connections to said cathode ray tube electrodes.

6. In a cathode ray tube modulation system a cathode ray tube including control grid, first and second anode electrodes, an oscillator, a rectifier, a thermionic tube having an input and an output, connections from the output of said oscillator to said rectifier and to the input of said thermionic tube, means for effectively connecting the output of said thermionic tube in the anode current paths of said cathode ray tube, means for applying and maintaining potentials of a known ratio to said first and second anodes insuring focusing of said cathode ray, and means for applying modulation potentials to said oscillator and said thermionic tube so that said cathode ray is modulated.

7. The method of modulating a cathode ray tube having first and second anode electrodes which includes the steps of establishing a cathode ray beam in said tube, focusing said beam by adjusting the ratio of steady potentials applied to said first and second anodes, modulating said beam by varying potentials by applying said varying potentials to said anode electrodes and at the same time maintaining constant the ratio of the varying potential applied to the first anode to the varying potential applied to the second anode.

8. The method of modulating a cathode ray tube having control, first and second anode electrodes which includes the steps of establishing a cathode ray beam in said tube, focusing said beam by adjusting the ratio of steady potentials applied to said first and second anodes, modulating said beam by varying potentials by applying said varying potentials to said anode electrodes and at the same time maintaining constant the ratio of the varying potential applied to the first anode to the varying potential applied to the second anode.

9. The method of modulating a cathode ray tube having control, first and second anode electrodes which includes the steps of establishing a cathode ray beam in said tube, focusing said beam by adjusting the ratio of steady potentials applied to said first and second anodes, modulating said beam by varying potentials by applying said varying potentials to said control electrode and to said anode electrodes and at the same time maintaining constant the ratio of the varying potential applied to the first anode to the varying potential applied to the second anode and maintaining constant the ratio of the varying potential applied to the first anode to the varying potential applied to the control electrode.

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