

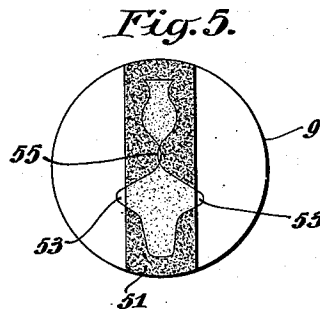
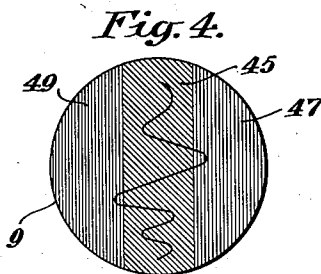
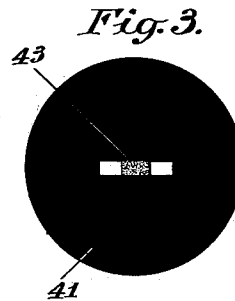
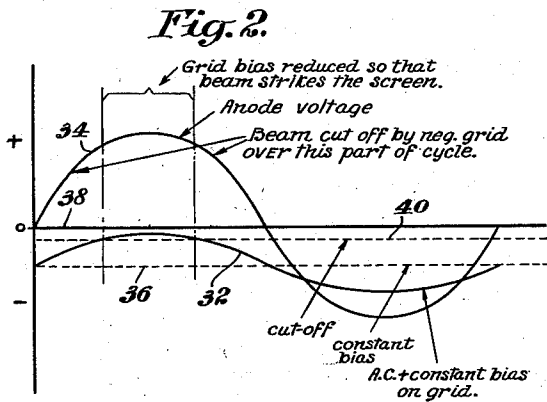
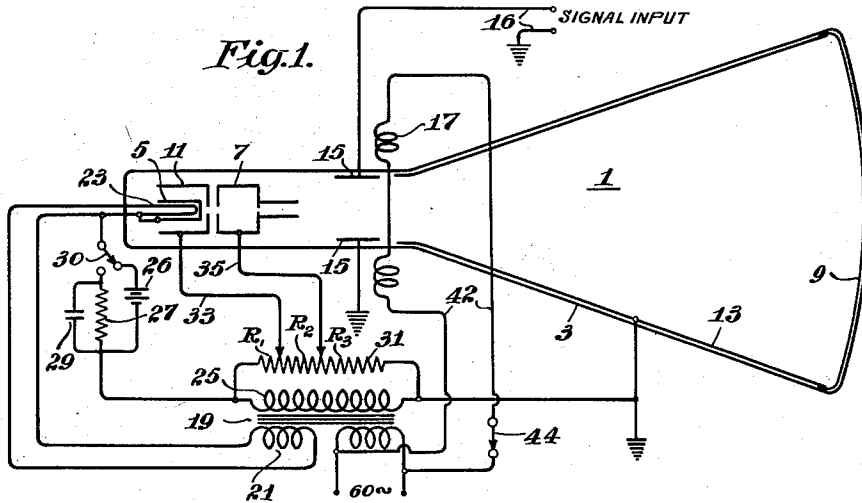
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CATHODE RAY MODULATION INDICATOR

Filed June 29, 1933



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CATHODE RAY MODULATION INDICATOR

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My invention relates to electrical indicating systems and has for its primary object to provide an electrical indicating system wherein a cathode-ray tube and an associated circuit for
5 operating the tube directly from alternating current with alternating supply potentials applied to the electrodes thereof may be utilized to advantage.

When using cathode-ray tubes, especially those
10 of the general type disclosed in Zworykin British Patent 384,094, it is the present practice to supply the anodes of such tubes with steady potentials such as those provided by direct current sources. This has been considered necessary for all uses
15 of cathode-ray tubes of this type since the focusing of the cathode-ray and the amount the ray is deflected depend upon the magnitude of the anode voltages. Direct current supply has, therefore, heretofore been considered desirable
20 because of the steady potentials provided thereby.

I have found that for certain applications, it is possible to apply alternating voltages to the electrodes of a tube of the above-mentioned type in such a way that the operation of the tube will
25 be highly satisfactory.

One specific application of my invention is the use of a cathode-ray tube as a peak volume indicator in broadcast studios for indicating when over-modulation occurs.

The peak volume indicators or modulation meters which are now in general use are not entirely satisfactory because they do not follow the signal wave rapidly enough to give a true indication of the percentage modulation and,
35 therefore, of a condition of operation in which over-modulation may be occurring. Because of this, a transmitter must often be operated considerably below its rated power to be certain that over-modulation does not occur, or if operated at
40 full power, is often over-modulated on peak signals for an appreciable portion of the time in which it is in operation.

Although an ordinary cathode-ray oscillograph having direct current or direct voltages on its electrodes might be utilized, such oscillographs are ordinarily not used in broadcast stations since among other things, the rectifying and the filtering system for the direct current supply system therefore is relatively costly.

It is, therefore, an object of my invention to provide an alternating current circuit for a cathode-ray tube of the above-mentioned type that shall make feasible the application of alternating voltages to the tube electrodes.

A further object of my invention is to provide

an electron discharge device and associated alternating current circuit so designed that the electron flow is sharply reduced when the anode voltage of the device falls below a predetermined value whereby such device and circuit may readily
5 be employed in signal amplitude or modulation indicator systems.

A still further object of my invention is to provide a modulation meter which will be inexpensive and which will give a true indication of the percentage or amount of modulation.

A still further object of my invention is to provide a modulation meter having an indicating screen that shall emphasize over-modulation.

In practicing my invention I provide the control-electrode of a cathode-ray tube with a negative bias such that the electron beam is normally prevented from reaching the fluorescent screen. Alternating voltages are applied in phase to the anodes and the control-electrode of the tube and the alternating voltage applied to the control-electrode is given such a value that the negative bias is periodically reduced sufficiently to permit the passage of the electron beam through the tube.

Other 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 schematic diagram of an electrical indicating system, including a cathode-ray tube and an associated electrical circuit, embodying my invention;

Fig. 2 is a view showing curves which are referred to in describing the operation of the apparatus shown in Fig. 1;

Fig. 3 is a view, on a reduced scale, of a mask arrangement for the fluorescent screen end of the cathode-ray tube shown in Fig. 1; and

Figs. 4 and 5 are similar end views, and on the same scale as Fig. 3, showing modifications of the mask arrangement shown in Fig. 3.

Referring to Fig. 1, the cathode-ray tube 1 is of the well known type which is commonly used as a receiving tube in television systems. It comprises a glass envelope 3 which has been pumped to a high vacuum so that a pure electron discharge can be obtained between an indirectly heated cathode 5 and a first anode 7.

The cathode 5 and anode 7 form an electron gun which will cause a beam of electrons to move down the axis of the tube 1 and strike a fluorescent screen 9 when the proper voltages are applied. A cup-shaped control-electrode 11 is positioned near the cathode 5 for controlling the

number of electrons reaching the fluorescent screen 9.

The inner surface of the large end of the envelope 3 is coated with metal or conducting material to form a second electrode or anode 13 for accelerating and focusing the beam of electrons.

The customary beam deflecting plates 15 and deflecting coils 17 are provided. The coils may be supplied with alternating current as will hereinafter be described. The plates represent suitable beam deflecting means for signals, the amplitude of which is to be indicated and, in the present example, are connected with a suitable signal input circuit 16. This may be a source of the modulation signals for a transmitter as indicated.

A change in voltage on the anodes 7 and 13 will have another detrimental effect, since the amount that the electron beam is deflected depends upon the speed of the electrons in the beam. For example, if there is a steady potential impressed upon the deflecting plates 15 so that the electron beam is deflected to a certain point on the fluorescent screen, the beam will be deflected still more if the voltages on the anodes 7 and 13 are reduced in value.

It is apparent, therefore, that if an alternating voltage were applied to the deflecting plates 15 with an alternating voltage applied to the anodes 7 and 13, there would be no distinct maximum deflection shown on the fluorescent screen 9. The operation with alternating voltages is helped somewhat by two factors, however. In the first place, the alternating anode potential remains in the neighborhood of its maximum value much longer than it remains in the neighborhood of any other value; and in the second place, the intensity of the spot on the fluorescent screen 9 decreases rapidly with a decrease in anode potential.

I have found by experiments, however, that the effect of the above mentioned factors alone is not great enough to permit the operation of a cathode-ray tube by means of alternating voltages. However, I have succeeded in providing an improved circuit which permits the use of alternating current on such tubes.

As shown in Fig. 1, my improved circuit includes a transformer 19 which supplies alternating voltages to all the tube electrodes. A low potential secondary winding 21 supplies current to the heater 23 of cathode 5. A high potential secondary winding 25 is connected at one end to the accelerating and focusing anode 13 which is preferably connected to ground as indicated. The other end of the high potential winding 25 is connected to the cathode 5 through either a biasing battery 26 or a resistor 27 which is shunted by a condenser 29. A suitable switch 30 may be provided for this purpose. The resistor-condenser combination comprising units 27 and 29 is the equivalent of the battery 26 and causes a negative bias potential to be established on the control electrode as will be explained hereinafter, this bias potential being obtained by the rectifier action of the cathode-ray tube.

The secondary winding 25 is shunted by a tapped potentiometer device 31 which supplies the proper alternating voltages to the control electrode 11 and the first anode through conductors 33 and 35, respectively, and corresponding spaced taps on the device 31.

The control-electrode 11 is given a negative bias by means of the condenser-resistor combination such that it never becomes positive, this being necessary to prevent injury to the cathode.

It is preferable that the control-electrode 11 be biased to cut-off except during a certain period when it is the least negative. The expression "biased to cut-off" is used in the sense that the control-electrode is made so negative that the electron beam is normally prevented from reaching the fluorescent screen 9.

The above described circuit supplies a comparatively low value of alternating voltage to the control-electrode 11 which voltage is in phase with the alternating voltage supplied to the anodes 7 and 13. Therefore, the control electrode 11 will reach its least negative value with respect to the cathode, at the same time that the anodes 7 and 13 are most positive.

The operation of the circuit will best be understood by referring to the curve shown in Fig. 2. Although the curves in this figure have been shown for a complete cycle, it will be apparent that the tube 1 may be operative only during the period that the anodes 7 and 13 are positive. The anode voltage curve indicated at 34 represents the voltage applied to either the anode 7 or the anode 13.

The second dotted line 36 below the zero axis 38 represents the value of the constant negative bias applied to the control-electrode by means of the biasing battery or condenser-resistor combination. The first dotted line 40 below the zero axis represents the cut-off point. If the control-electrode 11 is more negative than this value, the electron beam is prevented from reaching the fluorescent screen 9. If the control-electrode is less negative than this value, the electron beam will pass down the axis of the tube 1 and strike the fluorescent screen 9.

The sine curve 32 shown below the zero axis represents the actual voltage on the control-electrode 11, this voltage being the sum of the bias voltage supplied by the condenser-resistor combination (or the battery 26) and the alternating voltage supplied by the potentiometer 31 through the conductor 33.

As shown by the curves, the control-electrode voltage is given a value such that it is less negative than the cut-off value during the period that the anode voltage is in the region of its maximum value. It is, of course, also during this period that the rate of change of the anode voltage has a minimum value.

The curves in Fig. 2 show that as soon as the anode voltage becomes less than a predetermined value, the electron beam is cut-off so that, in effect, the tube is inoperative until the region of the maximum voltage is reached in the next positive half cycle. In this way the electron beam is permitted to reach the fluorescent screen 9 only during the period that it is sharply focussed and during which it would be deflected a substantially constant amount by a deflecting voltage of constant value.

In order to obtain the proper bias for the control-electrode when using the resistor-condenser combination, the condenser 29 should be large enough to have a small impedance for the 60 cycle supply current in comparison with the other impedances in the circuit, and the resistor 27 should be chosen to give a time constant for the condenser-resistor combination which is fairly long compared with one-sixtieth of a second.

The resistor section R_1 of the potentiometer 31 is chosen to give the proper alternating voltage bias for extinguishing the spot on the fluorescent screen 9 rapidly as the anode voltage decreases.

In a preferred embodiment of the invention the

potentiometer sections R_2 and R_3 may be provided by a material which changes its resistance so as to decrease in resistance value in response to the application of higher potentials, a resistance unit such as R_1 having a constant value remaining in series therewith and the secondary 25. For example, the resistor sections R_2 and R_3 may be made of a material commercially known as Thyrite. The effect of such resistance elements circuit will be to make the anode voltage flatter-topped than it would be normally for a sine wave and to prolong the time interval during which the spot can be used effectively.

The cathode-ray tube 1 may be made most effective as a peak volume indicator or modulation meter by placing a mask over the fluorescent screen 9. Several mask arrangements are shown in Figs. 3, 4, and 5.

In the arrangement shown in Fig. 3 an opaque mask 41 having a slit therein covers the fluorescent screen end of the cathode-ray tube 1. The slit extends in the direction in which the cathode-ray or electron beam is to be deflected. This arrangement is designed to be used when the deflecting plates 15 are connected to the audio frequency circuit of a transmitter or other source of modulation signal. The deflecting coils 17 may be deenergized by opening the alternating current supply circuit 42 therefore by a suitable switch 44, and consequently the cathode-ray will then be deflected in only one plane.

A translucent grey or partially absorbing mask 43 is placed in the middle of the slit and given a width such that the cathode-ray spot will always be behind the mask 43 unless over-modulation occurs. In the event of over-modulation, a line of light will extend beyond the mask 43, and because of the mask arrangement the occurrence of over-modulation will immediately be apparent to the operator.

Another arrangement for use with audio frequency signals is shown in Fig. 4. With this arrangement the audio frequency signals are applied to the deflecting plates 15, while the 60 cycle current is applied to the deflecting coils 17, the circuit 42 being energized by closing the switch 44. The current through the coils 17 is so phased that when the anode voltage is a maximum, the electron beam is striking the middle of the screen 9. This requires a 90 degree phase relation between deflecting current and anode voltage which relation will be obtained by the circuit shown since coils 17 have a high inductance value. The fluorescent screen 9 is made in three sections, the middle section 45 being made of a material which will fluoresce with a different color than the outside sections 47 and 49.

In the example illustrated, the middle section 45 is of a material which fluoresces green and the outside sections 47 and 49 are of a material which fluoresces red. So long as there is no over-modulation, the curve will appear green. The instant over-modulation does occur, the peaks of the curve will extend beyond the green section 45 and appear red and thus instantly call the attention of the operator to the over-modulation.

If it is desired to use a modulation meter at the output end of a transmitter, the screen shown in Fig. 5 may be employed. When using the cathode-ray tube 1 in this way, the deflecting plates 15 have the modulated carrier wave voltage impressed thereon. The deflecting coils 17 are supplied with a 60 cycle current.

A partially absorbing screen 51 is placed in the middle of the fluorescent screen 9 and given a

width such that, so long as there is no over-modulation, the curve of the modulated carrier wave remains entirely behind the absorbing screen. As soon as over-modulation occurs, however, the peaks of the curve extend beyond the absorbing screen 51, as indicated at 53, and appear much brighter than the rest of the curve since they are being seen directly upon the fluorescent screen 9.

In the case of negative over-modulation, a bright line appears in the middle of the curve, as indicated at 55. The partially absorbing screen 51 is preferably made to absorb such a percentage of light that the curve will appear to be approximately the same brilliancy at both the negatively over-modulated and the positively over-modulated portions.

The screen 51 may be made of various materials such as a partially developed photographic plate or a half-silvered plate.

It will be understood that, if desired, my modulation meter may be operated with a potential on the control-electrode such that the beam is never completely cut off. In this case, the intensity of the spot of light on the screen caused by the impact of the electrons will increase very rapidly as the control-electrode becomes less negative so that more electrons can reach the screen. Consequently, the operation may be nearly as satisfactory as with the cut-off adjustment.

Various other 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 placed thereon as are necessitated by the prior art and are set forth in the appended claims.

I claim as my invention:

1. In combination, a highly evacuated cathode-ray tube having a cathode, an anode and a control electrode, a current path between said cathode and anode, means for applying an alternating voltage to said anode means for biasing said control electrode, and means for applying an alternating voltage to said control electrode to normally block said current path and to unblock said path when the instantaneous value of said voltage becomes greater than a predetermined positive value.

2. In combination, a highly evacuated cathode-ray tube having a cathode, an anode and a control electrode, means for applying an alternating voltage to said anode, means for applying a biasing voltage to said control electrode, said biasing voltage having a steady component sufficient to bias said control electrode to cut-off said cathode ray during part of the positive cycle of alternating voltage, and means for applying an alternating voltage to said control electrode in phase with said anode voltage.

3. In combination, a cathode-ray tube having a cathode, an anode and a control electrode, means for applying an alternating voltage to said anode, means for negatively biasing said control electrode and means for applying an alternating voltage to said control electrode such that the intensity of the cathode-ray discharge is sharply reduced when the instantaneous voltage on said anode falls below a predetermined positive value.

4. In a cathode-ray tube having means including a cathode, control electrode, an anode for producing a beam of electrons and a receiving surface for said beam, means for applying an alternating voltage to said anode and means including means for applying an alternating voltage to said control electrode for preventing the major

portion of said beam from reaching said receiving surface when the instantaneous voltage on said anode falls below a predetermined positive value.

5 In a cathode-ray tube having means for producing a beam of electrons, a control electrode, an anode and a fluorescent screen, means for applying an alternating voltage to said anode and means including means for applying an alternating voltage to said control electrode for so
10 biasing said control electrode that the major portion of said beam is prevented from reaching said screen when the instantaneous voltage on said anode falls below a predetermined positive value.

6. In combination, a cathode-ray tube of the
15 type having means for producing a beam of electrons, a control electrode therefor, an anode, a fluorescent screen and means for focusing said beam upon said screen, an alternating current source, means for applying an alternating voltage
20 age derived from said source to said anode, whereby said beam is properly focused only while said voltage is in the region of maximum instantaneous value, and means for applying a voltage derived from said alternating current source to said control
25 electrode such that said beam is prevented from reaching said screen when the instantaneous value on said anode is less than a predetermined positive value.

7. In combination, a cathode-ray device including means for producing a beam of electrons, a screen fluorescent to impingement of said
30 electrons thereon, an anode and a control electrode, means for applying an alternating voltage to said anode and means for applying both a constant biasing voltage component and an alternating voltage component to said control electrode, said alternating voltage biasing component
35 being in phase with said anode voltage.

8. In combination, a cathode-ray tube having
40 means for producing a beam of electrons, a control electrode, an anode and a fluorescent screen, means for applying an alternating voltage to said anode and means for applying an alternating voltage to said control electrode such that it
45 prevents said beam from reaching said screen except during the period that said alternating voltage is positive and its rate of change comparatively small.

9. In combination, a cathode-ray tube having
50 means including an anode for producing a beam of electrons, a cathode and a control electrode, a fluorescent screen positioned in the path of said beam and means for deflecting said beam, means for applying an alternating voltage to
55 said anode whereby the deflection of said beam will be affected by said varying anode voltage, and means including means for applying an alternating voltage to said control electrode for preventing said beam from reaching said screen
60 while said anode voltage has an instantaneous value less than a predetermined value.

10. In a cathode-ray tube, a fluorescent screen, an electronic beam, means for deflecting said
65 beam, and a partially light absorbing mask, positioned over only a middle portion of said screen, which masks normal deflections of said beam.

11. In a cathode-ray tube, a fluorescent screen, an electronic beam, means for deflecting said
70 beam, a mask having a slit therein positioned over said screen, the dimensions of said slit being smaller than those of said screen, and a partially absorbing mask, positioned over said screen in line with said slit, which partially masks normal deflections of said beam.

75 12. A modulation indicator constituted by a

cathode-ray tube having means for deflecting said cathode ray, a fluorescent screen, said screen including one portion which is responsive to deflections of said cathode-ray when deflected by a modulating voltage below a certain value, and
5 two other portions, one on each side of said one portion, which are responsive to deflections of said cathode-ray when deflected by a modulating voltage above said certain value, said one portion
10 fluorescing in one color and said two portions fluorescing in a color differing from the color of the one portion.

13. In combination, a cathode ray tube having a cathode and a fluorescent screen arranged in spaced relation to each other, an anode electrode
15 adjacent to the cathode, a control electrode interposed between said anode and cathode and an accelerating anode adjacent to the fluorescent screen, means for deflecting said electron beam, a signal input circuit connected with said deflecting
20 means, a potentiometer device, means for supplying alternating current to the terminals of said device, a circuit connection between one terminal of said device and the cathode and between the control electrode and a first tap point
25 adjacent to said terminal on said potentiometer device, means in circuit between the control electrode and the cathode for establishing on said control electrode a predetermined negative bias potential, a circuit connection between the first
30 anode and a second tap point on the potentiometer device, and a third circuit connection with the said potentiometer device for the accelerating anode whereby said anodes and the control electrode receive alternating potentials
35 in phase.

14. In combination, a cathode ray tube having a cathode and a fluorescent screen arranged in spaced relation to each other, an anode electrode
40 adjacent to the cathode, a control electrode interposed between said anode and cathode, an accelerating anode adjacent to the fluorescent screen, and means for deflecting said electron beam, a signal input circuit connected with said
45 deflecting means, a potentiometer device, means for supplying alternating current to the terminals of said device, a circuit connection between one terminal of said device and the cathode and between the control electrode and a first tap
50 point adjacent to said terminal on said potentiometer device, means in circuit between the control electrode and the cathode for establishing on said control electrode a negative bias potential sufficient normally in the absence of signals
55 to prevent the application of the electron beam to the fluorescent screen, a circuit connection between the first anode and a second tap point on the potentiometer device, and a third circuit connection with the said potentiometer device for the accelerating anode, whereby said
60 anodes and the control electrode receive alternating potentials in phase, a mask having a slit therein positioned adjacent to the fluorescent screen whereby said screen may be observed through said slit, and a light absorbing mask positioned adjacent to said screen in alignment
65 with said slit.

15. In combination, a cathode ray tube having a cathode, an anode, a control electrode and a
70 fluorescent screen, means for applying an alternating potential to said anode, means for applying a substantially constant biasing potential to said control electrode, means for applying an alternating potential to said control electrode in
75 phase with said anode potential, means provid-

ing a light absorbing mask over a portion of said fluorescent screen, beam deflecting means in said tube, and a signal circuit connected therewith.

16. In combination, a cathode ray tube having
5 a cathode, an anode, a control electrode and a fluorescent screen, means for applying an alternating potential to said anode, means for applying a substantially constant biasing potential
10 to said control electrode, means for applying an alternating potential to said control electrode in phase with said anode potential, means providing a light absorbing mask over a portion of said fluorescent screen, said mask having an area
15 through which movement of the electron beam may be observed with altered intensity, beam

deflecting means in said tube, and a signal circuit connected therewith.

17. A modulation indicator constituted by a cathode-ray tube provided with a fluorescent screen, said tube including means for producing
5 a beam of electrons which strike said screen, means for deflecting said beam between certain boundaries on said screen so long as the modulation has the desired value and for deflecting said
10 beam outside of said boundaries when said modulation exceeds the desired value, means for giving the fluorescence caused by the impact of said electrons on said screen one light appearance
15 between said boundaries and a second light appearance outside of said boundaries.

IRVING WOLFF.