Aug. 25, 1964 R. B. FERTIG 3,146,372

SWEEP-FAILURE PROTECTION CIRCUIT FOR CATHODE-RAY TUBES

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Fig. 1.

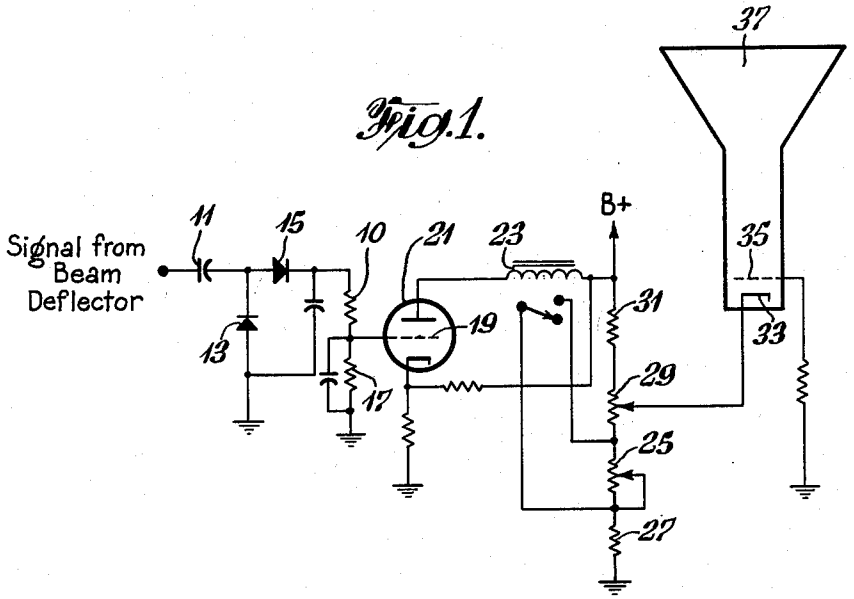
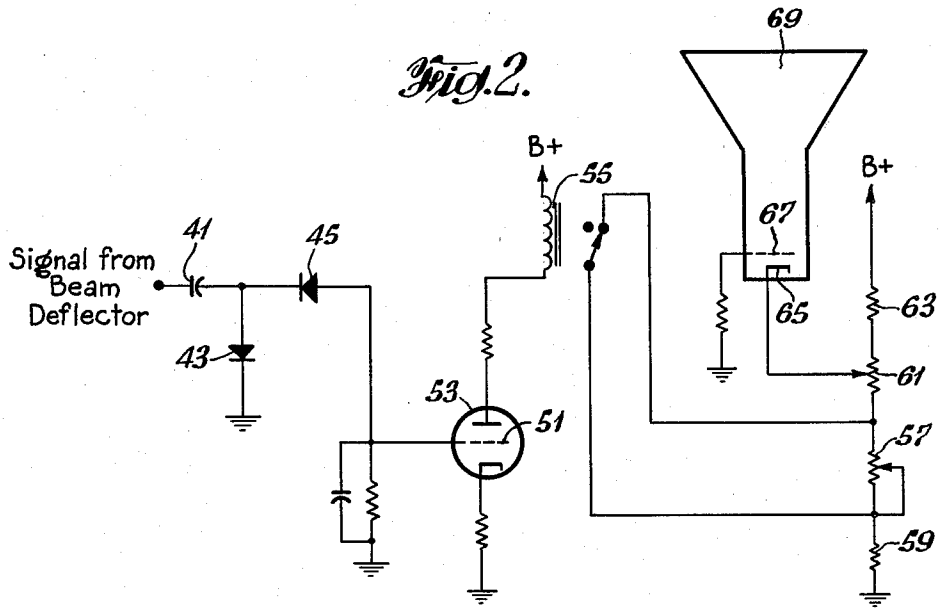


Fig. 2.



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Fig. 3.

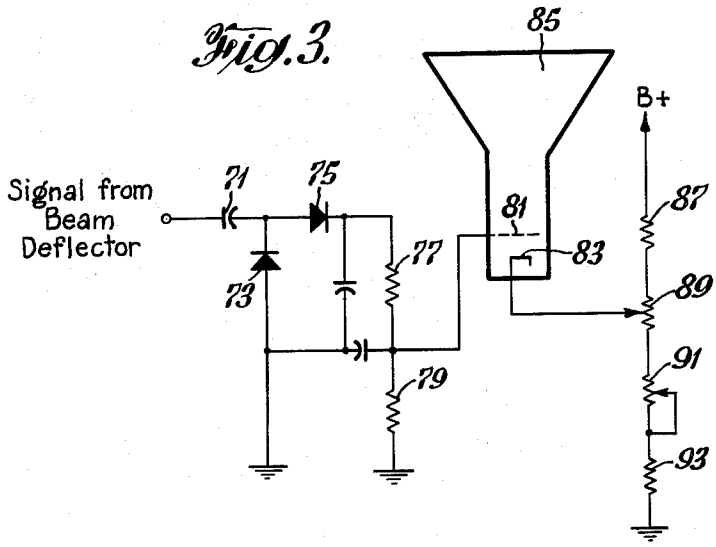
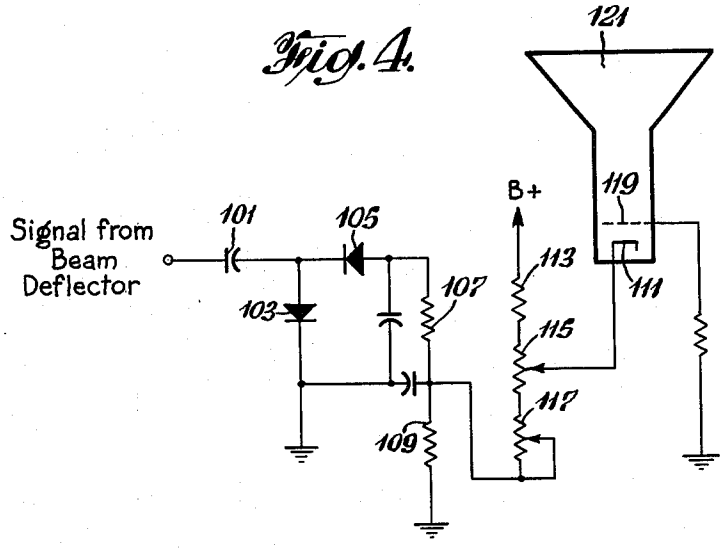


Fig. 4.



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SWEEP-FAILURE PROTECTION CIRCUIT FOR CATHODE-RAY TUBES

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The present invention relates to a method of and apparatus for controlling the intensity of an electron beam impinging on a sensitized screen of a cathode-ray tube and more particularly to such method and apparatus adapted to decrease automatically the intensity of such an electron beam on said screen when a varying signal impressed on an electron beam deflecting means of said cathode-ray tube decreases in amplitude to a condition in which the electron beam will define a singular point on the screen. Burns on the sensitized coating of the screen of the cathode-ray tube, due to the concentration of the electron beam on a singular point, are thus eliminated.

Essentially, the cathode-ray tube is an electronic device for converting the energy of a beam of electrons into photonic energy and for utilizing light thus generated as an indication of the motion of the electron beam. Such tubes have been aptly called indicators having pointers of negligible inertia, the pointers being the electron beams. In addition to being used as a measuring instrument, the tube is also used as an oscillograph for examining alternating wave forms, as an image-producing device in television reception and as a reflected signal timing device in certain types of radar equipment. A cathode-ray tube, in addition to a glass envelope forming the tube body, has at least five essential component parts, comprising an electron-emitting cathode, an anode or plate to attract and transmit an electron beam emitted from said cathode, a sensitized screen which is luminescently responsive to an electron beam emitted from said cathode, an electron beam intensity control electrode or grid and an electron beam deflecting means to make the electron beam emitted from the cathode traverse the sensitized screen according to signals applied to said deflecting means. When a deflection signal is not present on the electron beam deflecting means, the electron beam impinges on an extremely small area of the sensitized screen, defining a bright spot which, in time, permanently alters the composition of the screen sensitizing material causing a spot having a burned-out appearance, necessitating cathode-ray tube replacement with the difficulties and expense attendant thereon.

Known methods adapted by those skilled in the art to prevent the above-described phenomenon, generally involve deflecting the electron beam off the sensitized screen by a secondary electrostatic or magnetic means when no signal is present on the electron beam deflecting means of the tube. The presence of these secondary deflecting means necessitates delicate adjustment of external circuit parameters affecting tube performance to insure against aberrative effects during dynamic operation of the tube. The apparatus of the present invention, by utilizing a rectified beam-deflecting signal to effect changes in the relative bias between the cathode and the grid of the cathode-ray tube, decreases the electron beam intensity to a harmless level when no deflecting signal is present and permits desired intensity when a signal is imposed on the tube's beam deflecting means, making intensity control adjustments dependent only on the standard parameters of the tube. Those skilled in the art will recognize that the apparatus and method of the present invention represent an outstanding contribution to the art and offer a valuable contribution to the techniques of beam intensity control in cathode-ray tube operation.

The invention also comprises novel details of construction and novel combinations of components, together with other features and results which will be more apparent from the description given in detail below and as defined in the appended claims and as illustrated in preferred embodiment in the accompanying drawings, in which:

FIGURE 1 is a schematic diagram of a first embodiment of apparatus according to the present invention;

FIGURE 2 is a schematic diagram of a second embodiment of apparatus according to the present invention;

FIGURE 3 is a schematic diagram of third embodiment of apparatus according to the present invention and

FIGURE 4 is a schematic diagram of a fourth embodiment of apparatus according to the present invention.

FIGURE 1 of the drawings presents a schematic diagram of the first of the several embodiments of apparatus, according to my invention, to eliminate burning of a cathode-ray tube screen. Referring to FIGURE 1, a signal input from a beam deflecting means for a cathode-ray tube 37, or from some convenient point at the source of said signal, such as a deflection plate amplifier stage, is applied to a capacitor 11, which is part of a coupling network between the apparatus shown in FIGURE 1 of the drawings and other components of a cathode-ray tube system, said other components not being shown. This signal, which is normally pulsating or varying cyclically, is rectified by rectifiers 13 and 15, shown in a conventional arrangement, to provide positive (with respect to ground) rectification and is applied through a voltage divider network comprising resistors 10 and 17 to grid 19 of a vacuum tube 21, which, in the discrete embodiment shown, is a triode. Tube 21 is statically grid-biased (with respect to the tube 21 cathode) to cutoff or below cutoff and when the rectified deflection signal is imposed on grid 19, the grid bias is raised to a condition at which tube 21 conducts, causing plate current flow. A relay 23, having normally open contacts, i.e., open when the relay coil is deenergized, is in circuit with the plate of tube 21 and responds to plate current flow by closing its contacts. The contacts of relay 23 are arranged in parallel connection with a resistor 25 in an array of resistors 25, 27, 29 and 31 which are connected to establish a biasing potential on a cathode 33 of cathode-ray tube 37. An electron beam intensity control electrode 35 of cathode-ray tube 37 is statically biased to a condition with respect to the cathode 33 which effects low electron beam intensity on the screen of the cathode-ray tube when the cathode is biased by the four resistors 25, 27, 29 and 31 but which effects relatively high beam intensity on the screen when the cathode is biased by resistors 27, 29 and 31. At least one of the resistors 27 and 29 is variable, e.g., resistor 29, and can be adjusted to allow for desired image brightness on the cathode-ray tube screen.

When the cathode-ray tube beam deflecting signal is lost or reduced in amplitude to a point where an undesirable concentrated light spot would appear on the cathode-ray tube screen, the rectified signal either drops to zero or to a level at which it is ineffective in overcoming the relative grid-cathode bias of vacuum tube 21, resulting in cut-off of tube 21 in either case. At cut-off condition, vacuum tube 21 stops conducting and plate current drops to zero, deenergizing plate circuit relay 23, the contacts of which then assume their normally open position. Open the relay 23 contacts interrupts the shunt path around resistor 25 and effects introduction of this resistor into the cathode biasing resistor circuit of cathode 33 of the cathode-ray tube 37. Adding resistor 25 to the biasing circuit increases the cathode 33 potential positively with respect to the beam intensity control electrode 35 and establishes a condition which, in a relative sense, is similar to imposing greater negative biasing potential on the

intensity control electrode. This causes a decrease in intensity of the electron beam impinging on the screen of cathode-ray tube 37 and results in a dim screen spot which will not cause damage to the screen sensitized coating. It will be obvious to persons skilled in the art that the circuit parameters shown can be selectively adjusted to eliminate quiescent screen spots completely.

FIGURE 2 of the drawings represents a schematic diagram of a second embodiment of apparatus according to my invention. Referring to FIGURE 2, a signal input from a beam deflecting means for a cathode-ray tube 69, or from some convenient point at the source of said signal, such as a deflection plate amplifier stage, is applied to a capacitor 41, which is part of a coupling network between the apparatus shown in FIGURE 2 of the drawings and other components of a cathode-ray tube system, said other components not being shown. This signal, which is normally pulsating or varying cyclically, is rectified by rectifiers 43 and 45, shown connected in an arrangement to provide negative rectification, and is applied to grid 51 of a vacuum tube 53, which, in the illustrated embodiment, is a triode. Vacuum tube 53 is statically grid biased (with respect to the tube 53 cathode) above cut-off and when the negatively rectified deflection signal is imposed on grid 51, the grid bias is reduced to a condition at which tube 53 cuts off, causing cessation of plate current flow. A relay 55, having normally closed contacts, i.e., closed when the relay coil is deenergized, is in circuit with the plate of tube 53 and responds to the cessation of plate current flow by closing its contacts. The contacts of relay 55 are arranged in parallel connection with a resistor 57 in an array of resistors, 57, 59, 61 and 63 which are connected to establish a biasing potential on a cathode 65 of cathode-ray tube 69. An electron beam intensity control electrode 67 of cathode-ray tube 69 is statically biased to a condition with respect to the cathode 65 which effects low electron beam intensity on the screen of the cathode-ray tube when the cathode is biased by the four resistors 57, 59, 61 and 63 but which effects relatively high beam intensity on the screen when the cathode is biased by resistors 59, 61 and 63. At least one of the resistors 59 and 61 is variable, e.g., resistor 61, and can be adjusted to allow for desired image brightness on the cathode-ray tube screen.

When the cathode-ray tube beam deflecting signal is lost or reduced in amplitude to a point where an undesirable concentrated light spot would appear on the cathode-ray tube screen, the rectified signal either drops to zero or to a level at which it is ineffective in overcoming with negative bias the above cut-off bias imposed on grid 51 of vacuum tube 53, resulting in tube conductance and plate current flow in either case. At the above-cut-off condition, vacuum tube 53 conducts and plate current flows, energizing plate circuit relay 55, the contacts of which then assume an open position. Opening the relay 55 contacts interrupts the shunt path around resistor 57 and effects introduction of this resistor into the cathode biasing resistor circuit of cathode 65 of cathode-ray tube 69. Adding resistor 57 to the biasing circuit increases the cathode 65 potential positively with respect to the beam intensity control electrode 67 and establishes a condition which, in a relative sense, is similar to imposing greater negative biasing potential on the intensity control electrode. This causes a decrease in intensity of the electron beam impinging on the screen of cathode-ray tube 69 and results in a dim screen spot which will not cause damage to the screen sensitized coating. As mentioned hereinabove with respect to the first-described embodiment of my invention, it will be obvious to persons skilled in the art that the circuit parameters shown can be selectively adjusted to eliminate quiescent screen spots completely.

A third embodiment of apparatus according to the present invention is shown schematically in FIGURE 3 of the drawings. Referring to FIGURE 3, a signal from a beam deflecting means for a cathode-ray tube 85, or from some convenient point at the source of said signal, such as a deflection plate amplifier stage, is applied to a capacitor 71, which is part of a coupling network between the apparatus shown in FIGURE 3 and other components of a cathode-ray tube system, said other components not being shown. This signal, which is normally pulsating or varying cyclically, is rectified by rectifiers 73 and 75, shown in a conventional arrangement, and is applied through a voltage divider network comprising resistors 77 and 79, to an electron beam intensity control electrode 81 of a cathode-ray tube 85. Cathode-ray tube 85 is statically biased to a condition of cut-off or slightly above cut-off and when the rectified deflection signal is imposed on the intensity control electrode, the potential is raised positively to a bias at which electron beam intensity is increased, causing image brightness on the cathode-ray tube screen. Resistors 87, 89, 91 and 93 are connected to establish a biasing potential on cathode 83 of cathode-ray tube 85. At least one of the group consisting of resistors 89, 91 and 93, for example resistor 89, is variable and can be adjusted to allow for desired image brightness on the cathode-ray tube screen.

Whenever the cathode-ray tube beam deflecting signal is lost or reduced in amplitude to a point where an undesirable concentrated light spot would appear on the cathode-ray tube screen, the rectified signal either drops to zero or to a level at which it is ineffective in overcoming the cut-off or near cut-off biasing potential statically imposed on electron beam intensity control electrode 81, resulting in either cathode-ray tube cut-off or a decrease in beam intensity to a harmless level.

FIGURE 4 of the drawings represents schematically a fourth embodiment of apparatus according to my invention. Referring to FIGURE 4, a signal input from a beam deflecting means for a cathode-ray tube 121, or from some convenient point at the source of said signal, such as a deflection plate amplifier stage, is applied to a capacitor 101, which is part of a coupling network between the apparatus shown in FIGURE 4 and other components of a cathode-ray tube system, said other components not being shown. This signal, which is normally pulsating or varying cyclically, is rectified by rectifiers 103 and 105, shown connected in an arrangement to provide negative rectification, and is applied as negative bias through a voltage divider network comprising resistors 107 and 109 to a biasing network in circuit with a cathode 111 of cathode-ray tube 121. Resistor 109 is connected in a series arrangement of resistors 113, 115 and 117 (in addition to resistor 109) which establish a biasing potential on a cathode 111 of cathode-ray tube 121. An electron beam intensity control electrode 119 of cathode-ray tube 121 is statically biased to a condition with respect to the cathode 111 which effects low electron beam intensity on the screen of the cathode-ray tube when the cathode is biased without a rectified signal negative biasing contribution but which effects relatively high beam intensity on the screen when the cathode is biased with a rectified signal negative biasing contribution. The ohmic values of resistors 107 and 109 are, of course, selected to accomplish the desired cathode bias change. At least one of the resistors 115 and 117, e.g., resistor 115, is variable and can be adjusted to allow for desired image brightness on the cathode-ray tube screen.

When the cathode-ray tube beam deflecting signal is lost or reduced in amplitude to a point where an undesirable concentrated light spot would appear on the cathode-ray tube screen, the rectified signal either drops to zero or to a level at which its negative biasing contribution to the cathode 111 biasing network is ineffective in overcoming the static biasing conditions of the cathode-ray tube. This causes a decrease in intensity of the electron beam impinging on the screen of cathode-ray tube 121 and results in a dim screen spot which will not cause damage to the screen sensitized coating. As with the

other embodiments, the circuit parameters shown in FIGURE 4 of the drawings can be selectively adjusted to eliminate quiescent screen spots completely.

While, in all of the above-described embodiments of apparatus according to my invention, the presence of a varying beam deflecting signal on an electron beam deflecting means is used to effect changes in the relative bias between a cathode and an electron beam intensity control electrode of a cathode-ray tube, and the absence of diminution of said varying beam deflecting signal effects a decrease in the intensity of an electron beam impinging on the sensitized screen of the cathode-ray tube, it will be apparent to those skilled in the art that my invention operates equally well to diminish or eliminate concentrated light spots on a cathode-ray tube screen caused by a non-varying electron beam deflecting signal such as a constant value D.C. potential. In such circumstances, the electron beam impinging on the screen would be deflected to a point off screen center but would still result in an undesirable concentrated light spot. Due to the coupling capacitors described in the various embodiments of my invention, however, such a deflecting signal will be blocked from the rectifiers and the net result will be a decrease in electron beam intensity in the same manner as when no deflecting signal is present on the beam deflecting means of the cathode-ray tube.

Those skilled in the art will see many possible modifications to my invention. For example, the apparatus comprising the first and second described embodiments are readily adaptable to switch resistances in and out of biasing circuits for grids or electron beam intensity control electrodes rather than for cathodes of cathode-ray tubes. Many forms of coupling are adaptable to the method comprising my invention as well as many art recognized rectification means for the deflecting signal. Various known biasing arrangements are also adaptable to the basic function of my invention. The selection and application of many equivalents, which, combined, will comprise the apparatus of the present invention will undoubtedly be suggested by my descriptions to persons familiar with the art.

It will therefore be obvious that, while in the foregoing description, certain specific details and operative steps have been set forth, together with certain suggested modifications, additional variations may be made in these without departing from the spirit of the present invention. The foregoing description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom.

What is claimed is:

1. In a cathode-ray tube system which includes a cathode-ray tube having an electron-emitting cathode, a sensitized screen which is luminescently responsive to an electron beam emitted from said cathode, an electron beam intensity control electrode which is biased relative to said cathode and at least one electron beam deflecting means, apparatus for controlling the intensity of said electron beam on said sensitized screen, comprising, in combination, a rectifier in circuit with said beam deflecting means adapted to rectify a varying signal imposed on said beam deflecting means; a vacuum tube which is statically biased to substantially cut-off condition and having a grid in circuit with said rectifier; a plate in said vacuum tube; a plate circuit relay in circuit with said plate of said vacuum tube, said relay having at least one set of contacts which are open when the relay is deenergized and a resistor in parallel connection with said contacts, said resistor being a resistor comprised in a biasing circuit for the cathode of said cathode-ray tube.

2. In a cathode-ray tube system which includes a cathode-ray tube having an electron-emitting cathode, a sensitized screen which is luminescently responsive to an electron beam emitted from said cathode, an electron beam intensity control electrode which is biased relative to said cathode and at least one electron beam deflecting means, apparatus for controlling the intensity of said electron beam on said sensitized screen, comprising, in combination, a rectifier in circuit with said beam deflecting means adapted to negatively rectify a varying signal imposed on said beam deflecting means; a vacuum tube which is statically biased to an above-cut-off condition and having a grid in circuit with said rectifier; a plate in said vacuum tube; a plate circuit relay in circuit with said plate of said vacuum tube, said relay having at least one set of contacts which are closed when the relay is deenergized and a resistor in parallel connection with said contacts, said resistor being a resistor comprised in a biasing circuit for the cathode of said cathode-ray tube.

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