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CATHODE-RAY TUBE FOCUSING CIRCUIT

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Fig. 1.

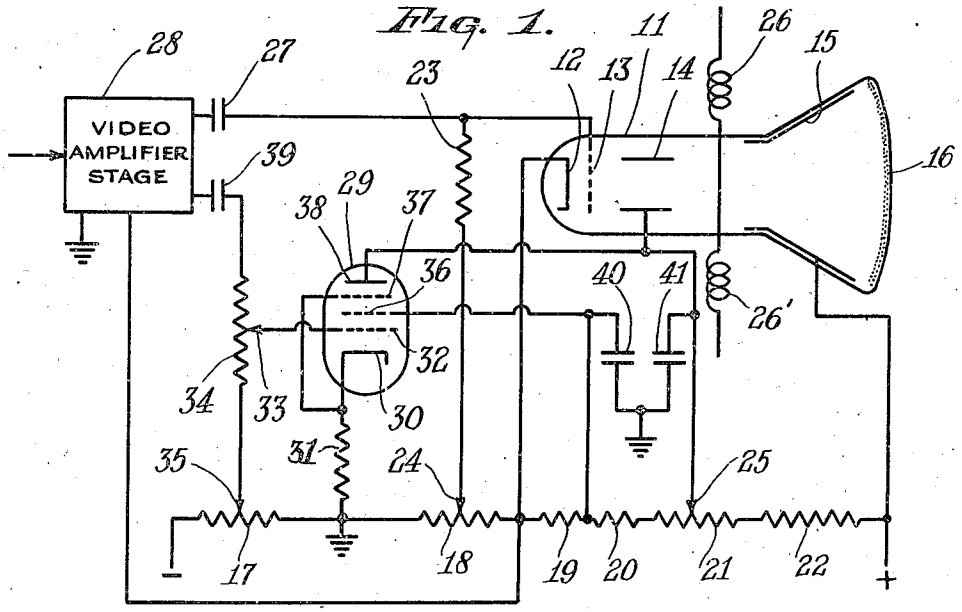
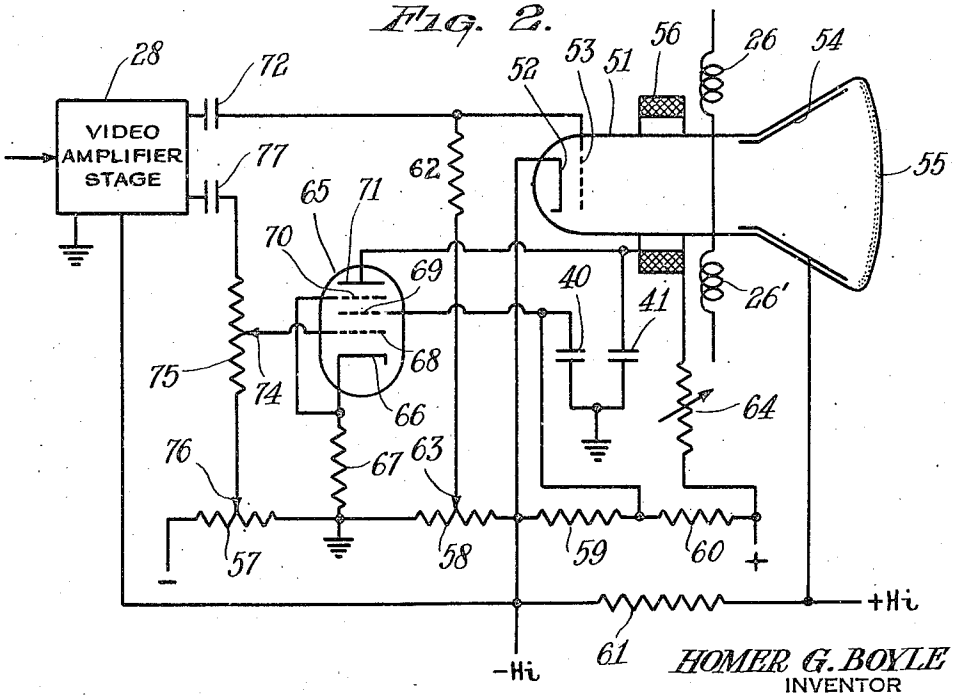


Fig. 2.



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CATHODE-RAY TUBE FOCUSING CIRCUIT

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6 Claims. (Cl. 315—31)

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The invention relates to circuit arrangements for cathode ray tubes and particularly pertains to circuit arrangements for ensuring stability of the focusing of cathode ray tubes throughout variations of the operating potentials thereof.

In employing cathode ray tubes, i. e. television receiving apparatus, it has been found that the image produced on the screen of the cathode ray tube becomes distorted due to defocusing of the cathode ray beam with a change in the demand made upon the power supply thereof by the complex and abruptly changing signal received. While this defocusing effect may in part be corrected by the use of a power supply of good voltage regulation, i. e. by the use of a heavy duty power supply, this solution to the problem is not a satisfactory one because of the inherent weight and bulk and attendant high cost of such a power supply.

It is an object of the invention to provide a circuit arrangement whereby defocusing of the cathode ray beam in a television receiver is substantially eliminated.

It is another object of the invention to provide a circuit arrangement for stably maintaining the focus of a cathode ray beam in equipment embodying a power supply of poor regulation.

It is a further object of the invention to provide a circuit arrangement to eliminate defocusing of the cathode ray beam which is applicable to inexpensive television receivers.

These and other objects of the invention will appear as the specification progresses.

According to the invention, changes in the focus of a cathode ray tube due to variations in its operating potential brought about by variations in the demands made on the power supply by changes in the intensity of the beam current are corrected by adjusting the focusing potential proportionally to the voltage which produces the changes in the cathode ray beam intensity.

More particularly, in an image system for television receivers, the focusing potential of the cathode ray tube is made proportional to the video signal applied to the beam intensity controlling electrode of the cathode ray tube.

The invention will be described in greater detail with reference to the accompanying drawing forming a part of the specification and which:

Fig. 1 is a schematic diagram of a circuit arrangement according to the invention as applied to an electrostatically focused cathode ray tube, and

Fig. 2 is a schematic diagram of a circuit arrangement according to the invention as applied to an electromagnetically focused cathode ray tube.

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Referring to Fig. 1 there is shown an electrostatically focused cathode ray tube 11, which comprises a cathode 12, a grid 13, a focusing electrode 14, an accelerating anode 15 and a luminescent screen 16. The various potentials required for energizing the tube are provided by tapping across a resistor network comprising resistors 17, 18, 19, 20, 21 and 22 connected in series across a source of direct current potential (not shown); one end of resistor 17 being connected to the negative terminal of said source and the remote end of resistor 22 being connected to the positive terminal. The interconnection of resistors 17 and 18 is connected to ground. Cathode 12 is connected to the interconnection of resistors 18 and 19. Grid 13 is biased by means of resistor 23 connected to an adjustable tap 24 on resistor 18. Focusing electrode 14 is energized by means of an adjustable tap 25 on resistor 21. The accelerating anode 15 is connected directly to the positive terminal of the potential source. Suitable means to deflect the cathode ray beam are provided in the form of coils 26 and 26' which are coupled to circuits suitable for controlling the beam in a predetermined manner. These circuits may be entirely conventional and are therefore not shown. For simplicity only one set of coils is shown. Operating voltages to intensity modulate the cathode ray beam are provided by coupling grid 13 by means of a capacitor 27 to the output circuit of a video amplifier 28 which is shown in block form. Video amplifier 28 is entirely conventional and is energized by potential obtained from the interconnection of resistors 18 and 19. In operation, adjustable tap 24 on resistor 18 is set to provide the desired degree of modulation and the potential on focusing electrode 14 is set by means of tap 25 on resistor 21 to provide the desired definition on screen 16. An abrupt change of signal voltage produces an abrupt demand on the potential supply source which adversely affects the potential on the focusing electrode 14. For example, an increase of video frequency voltage from amplifier 28 makes grid 13 more positive with respect to cathode 12, causing an increase in beam current, which in turn imposes an increased current demand on the potential source. This increased demand brings about a lowering of potential available due to the increased potential drop in the power supply circuit, which effect is well known to the art.

The lowering of available potential also lowers the focusing potential, but since the focusing electrode draws little current the ratio of focusing potential to accelerating and potential is changed thereby causing the spot displayed on screen 16 to lose its normal definition and become large and fuzzy, an action which is usually termed "blooming" by those familiar with the art. In the circuit arrangement shown in Fig. 1, however, "blooming" is eliminated by the action of an electron discharge tube 29, which is preferably a pentode but which may be of almost any other type of grid controlled tube. Tube 29 comprises a cathode 30 connected to ground by means of resistor 31, a grid 32 connected to the adjustable tap 33 of a resistor 34, one end of which is connected to an adjustable tap 35 on resistor 17 thereby providing bias for grid 32, screen grid 36 energized by potential taken from the interconnection of resistor 19 and 20, suppressor grid 37 connected to cathode 30, and an anode 38 connected to the cathode ray tube focusing electrode 14 and energized by the potential applied thereto. Capacitors 40 and 41 connecting screen 36 and anode 38 respectively to ground serves to bi-pass video frequency currents to ground; capacitor 41 being of low capacity in order that video frequency currents are not unduly suppressed and prevented from affecting the focus of the cathode ray beam. The end of resistor 34 remote from tap 35 is coupled by means of a capacitor 39 to the output circuit of video amplifier 28 in any known manner so that the voltage applied to grid 32 of tube 29 is in the proper phase relationship with that applied to grid 13 of cathode ray tube 11. Hence, for an increase in voltage on cathode ray tube grid 13, an anti-phase input voltage to tube 29 makes grid 32 less positive with respect to cathode 30, thereby reducing the current flow in the anode circuit and increasing the potential across the tube. Thus in turn the potential drop between the cathode 12 and the focusing element 14 of cathode ray tube 11 is increased. Correspondingly, an inphase input voltage to tube 29 will result in a decrease of potential between cathode 12 and focusing element 14. The type of correction to be applied depends of course upon the characteristics of the cathode ray tube employed. By adjusting the input voltage and the bias on tube 29 by means of adjustable taps 33 and 35 respectively, the potential applied to focusing electrode 14 can be maintained at the value corresponding to correct focus of the cathode ray beam.

Referring to Fig. 2, there is shown an electromagnetically focused cathode ray tube 51, which comprises a cathode 52, a grid 53, an accelerating anode 54 and a luminescent screen 55. Mounted externally to and surrounding the neck of the cathode ray tube is a solenoid 56 which forms the focusing element for cathode ray tube 51. The various potentials required for energizing the tube are provided by tapping across a resistor network comprising resistors 57, 58, 59 and 60 connected in series a cross a source of direct current low potential (not shown); one end of resistor 57 being connected to the negative terminal of said source and the remote end of resistor 60 being connected to the positive terminal thereof. The interconnection of resistors 57 and 58 is connected to ground. Cathode 52 is connected to the interconnection of resistors 58 and 59. Grid 53 is biased by means of resistor 62 connected to an adjustable tap 63 on resistor 58. The accelerating anode 54 is connected directly to the positive terminal of a high potential source (not shown), which source is shunted by a bleeder resistor 61. As in the arrangement shown in Fig. 1 means for deflecting the cathode ray beam are shown in the form of coils 26 and 26' which are coupled to circuits suitable for controlling the beam in desired manner. Focusing coil 56 is energized by means of this circuit comprising a variable resistor 64 connected directly to the low potential source and an electron discharge tube 65 whose cathode 66 is connected to ground by means of resistor 67. Tube 65 comprises cathode 66, previously mentioned, control grid 68, screen grid 69 energized by potential taken from the interconnection of resistors 59 and 60, suppressor grid 70 connected to the cathode 66, and anode 71 directly connected to focusing coil 56. Grid 53 is biased by means of resistor 62 connected to an adjustable tap 63 on resistor 58. Operating voltages to intensity modulate the cathode ray beam are provided by coupling said grid by means of capacitor 72 to a video amplifier 28, which amplifier is identical to that shown in the arrangement of Fig. 1. Video amplifier 28 is energized by potential obtained from the interconnection of resistors 58 and 59. Grid 68 of tube 65 is connected to an adjustable top 74 on a resistor 75, one end of which is connected to an adjustable bias for said tube. The end of resistor 75 remote from tap 76 is coupled by means of capacitor 77 to the output circuit of video amplifier 28 in the same manner as described in the foregoing paragraphs relating to the embodiment illustrated in Fig. 1. As in the previously described embodiment capacitors 40 and 41 connecting screen 69 and anode 71 respectively serve to bi-pass video frequency currents to ground.

The operation of the circuit arrangement shown in Fig. 2 is similar to that of circuit arrangement shown in Fig. 1 except that the correction of the focus of the cathode ray tube is obtained by the change of current flowing through coil 56. By adjusting the input voltage and the bias on tube 65 by means of adjustable taps 74 and 76 respectively, the current passing through focusing coil 56 can be maintained at the value corresponding to correct focus of the cathode ray beam.

While, for the purpose of simplification the invention has been described as applied to circuit having but one source of potential applied across a resistor network, it is to be understood that any of the various power supply arrangements known to the art may be used with equal success, and it is to be further understood that the invention is not limited to those specific embodiments described but that various modifications may be made in the invention without departing from one spirit and scope thereof.

I claim:

1. An electronic circuit arrangement comprising a cathode ray tube having an electron beam generating cathode electrode, a grid electrode, an anode electrode and a focusing element, a direct current potential source connected between said cathode electrode and said anode electrode, means to apply a first voltage of variable amplitude to the grid electrode of said cathode ray tube to intensity modulate the electron beam thereof, said potential source being responsive to the modulation of said beam to produce in the output thereof voltage fluctuations inversely proportional to changes in the intensity of said beam and thereby normally produce a defocusing of said beam, an electron discharge tube having a

cathode electrode, a control electrode and an anode electrode, means to apply operating potentials to the electrodes of said discharge tube, means to apply a second voltage proportional to said first variable amplitude voltage to the control electrode of said discharge tube, and means to couple the anode-cathode circuit of said discharge tube to said focusing element to thereby maintain said electron beam in focus independently of said voltage fluctuations of said potential source.

2. An electronic circuit arrangement comprising a cathode ray tube having an electron beam generating cathode electrode, a grid electrode, an anode electrode and a focusing element, a direct current potential source connected between said cathode electrode and said anode electrode, means to apply a first voltage of variable amplitude to the grid electrode of said cathode ray tube to intensity modulate the electron beam thereof, said potential source being responsive to the modulation of said beam to produce in the output thereof voltage fluctuations inversely proportional to changes in the intensity of said beam and thereby normally produce a defocusing of said beam, an electron discharge tube having a cathode electrode, a control electrode and an anode electrode, means to apply operating potentials to the electrodes of said discharge tube, means to apply a second voltage inversely proportional to said first variable amplitude voltage to the control electrode of said discharge tube, and means to couple the anode-cathode circuit of said discharge tube to said focusing element to thereby maintain said electron beam in focus independently of said voltage fluctuations of said potential source.

3. An electronic circuit arrangement comprising a cathode ray tube having an electron beam generating cathode electrode, a grid electrode, an anode electrode and a focusing electrode, a direct current potential source connected between said cathode electrode and said anode electrode, means to apply a first voltage of variable amplitude to the grid electrode of said cathode ray tube to intensity modulate the electron beam thereof, said potential source being responsive to the modulation of said beam to produce in the output thereof voltage fluctuations inversely proportional to changes in the intensity of said beam and thereby normally produce a defocusing of said beam, means to apply a potential to said focusing electrode to thereby produce focusing of said beam at a given current intensity thereof, an electron discharge tube having a cathode electrode, a control electrode and an anode electrode, means to apply operating potentials to the electrodes of said discharge tube, means to apply a second voltage proportional to said first variable amplitude voltage to the control electrode of said discharge tube, and means to couple the anode-cathode circuit of said discharge tube to said focusing electrode to vary the potential thereof proportionally to the current intensity of said beam and thereby maintain said electron beam in focus independently of said voltage fluctuations of said potential source.

4. An electronic circuit arrangement comprising a cathode ray tube having an electron beam generating cathode electrode, a grid electrode, an anode electrode and a focusing coil, a direct current potential source connected between said cathode electrode and said anode electrode, means to apply a first voltage of variable amplitude to the grid electrode of said cathode ray

tube to intensity modulate the electron beam thereof, said potential source being responsive to the modulation of said beam to produce in the output thereof voltage fluctuations inversely proportional to changes in the intensity of said beam and thereby normally produce a defocusing of said beam, means to apply a potential across said focusing coil to thereby produce focusing of said beam at a given current intensity thereof, an electron discharge tube having a cathode electrode, a control electrode and an anode electrode, means to apply operating potentials to the electrodes of said discharge tube, means to apply a second voltage proportional to said first variable amplitude voltage to the control electrode of said discharge tube, and means to couple the anode-cathode circuit of said discharge tube to said focusing coil to vary the current flowing therethrough proportionally to the current intensity of said beam and thereby maintain said electron beam in focus independently of said voltage fluctuations of said potential source.

5. An electronic circuit arrangement comprising a cathode ray tube having an electron beam generating cathode electrode, a grid electrode, an anode electrode and a focusing electrode, a direct current potential source, a series resistor network connected across said source, means to connect said cathode electrode of said cathode ray tube to said resistor network, means to connect said anode of said cathode ray tube to the positive pole of said source, means comprising an adjustable tap on said resistor network to bias the grid electrode of said cathode ray tube, means comprising an adjustable tap on said network to apply a potential to said focusing electrode to thereby produce focusing of said beam at a given intensity thereof, an electron discharge tube having a cathode, a control grid and an anode, means comprising a tap on said resistor network to apply a biasing potential to said control grid of said discharge tube, means to connect said anode of said discharge tube to said focusing electrode, means to apply a first voltage of variable amplitude to the grid electrode of said cathode ray tube to intensity modulate the electron beam thereof, said potential source being responsive to the modulation of said beam to produce in the output thereof voltage fluctuations inversely proportional to changes in the intensity of said beam and thereby normally produce a defocusing of said beam, and means to apply a second voltage inversely proportional to said first variable amplitude voltage to the control grid of said discharge tube to thereby maintain said electron beam in focus independently of said voltage fluctuations of said potential source.

6. An electronic circuit arrangement comprising a cathode ray tube having an electron beam generating cathode, a grid electrode, an anode electrode and a focusing coil, means to connect a direct current potential source between said cathode electrode and said anode electrode, means to energize said focusing coil, an electron discharge tube having a cathode, a control grid and an anode connected in series with said coil and said coil energizing means to apply a biasing potential to said control grid to vary the steady state current through said coil, means to apply a first voltage of variable amplitude to the grid of said cathode ray tube to intensity modulate the electron beam thereof, said potential source being responsive to the modulation of said beam to produce in the output thereof voltage fluctuations inversely proportional to changes in the intensity of said

beam and thereby produce a defocusing of said beam, and means to apply a second voltage inversely proportional to said first variable amplitude voltage to the control grid of said discharge tube to thereby maintain said electron beam in focus independently of said voltage fluctuations of said potential source.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,116,671	Dowsett et al.	May 10, 1938
2,255,485	Dome	Sept. 9, 1941
2,291,682	Blumlein et al.	Aug. 4, 1942