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CATHODE RAY TUBE PROTECTION CIRCUITS

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2 Sheets-Sheet 1

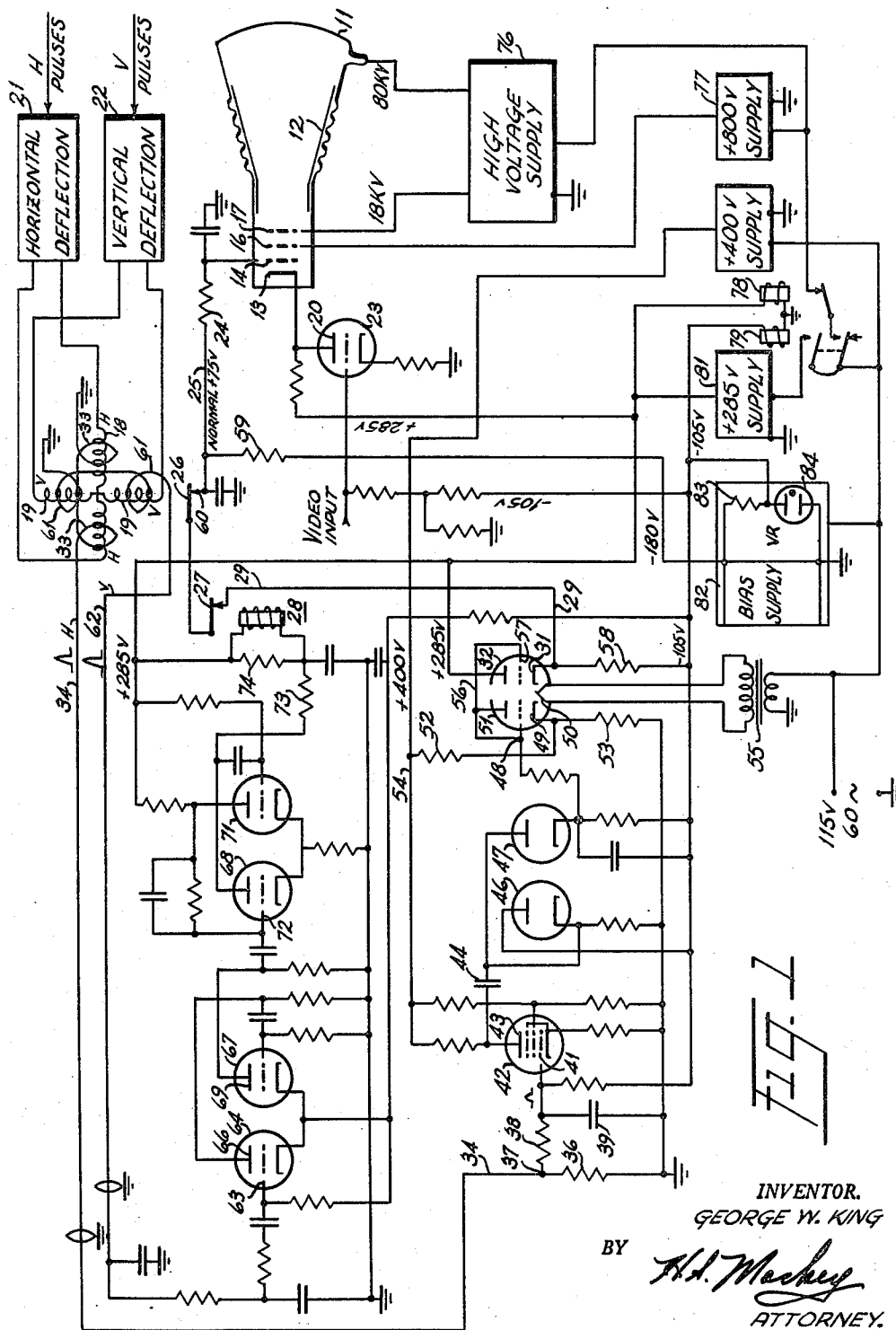


FIG. 1

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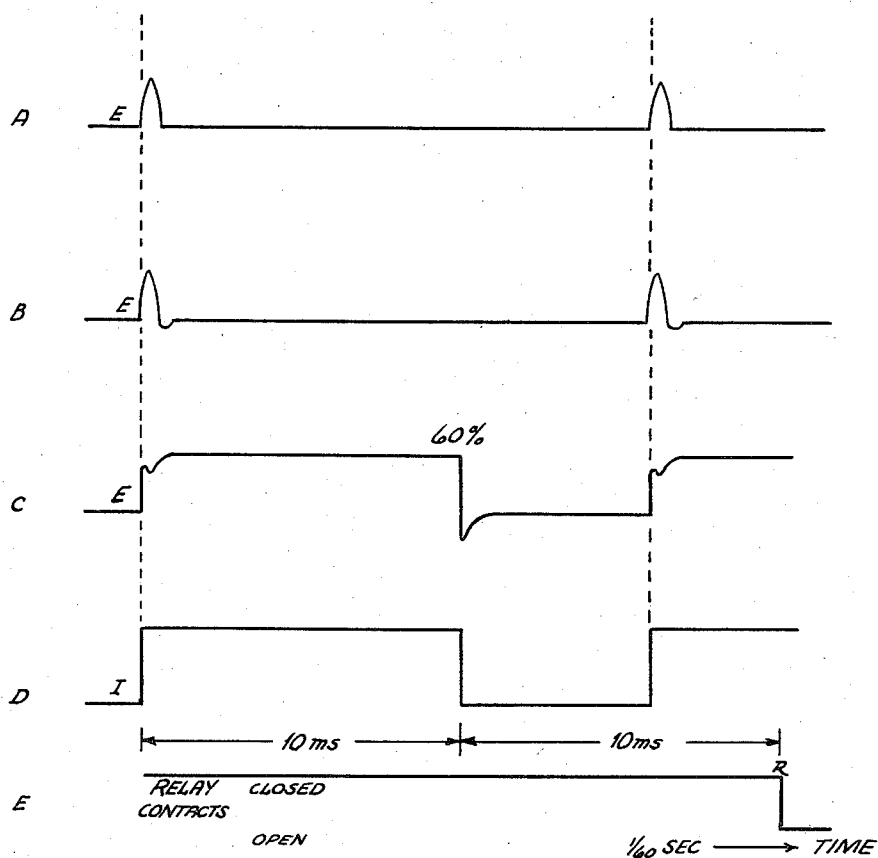


Fig. 2

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CATHODE RAY TUBE PROTECTION CIRCUITS

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13 Claims. (Cl. 315—20)

This invention relates to a protective circuit for use in connection with cathode ray, or other discharge tubes. In particular, the invention relates to a circuit for preventing damage to a discharge tube consequent upon the failure of any portion of its circuit or associated circuits. The invention is particularly adapted to the prevention of "beam burns" on the fluorescent screen of a cathode ray tube having normally continuous horizontal and vertical scansion. Such beam burns are caused by the absence of, or the reduction of either the horizontal or vertical scanning velocity.

This invention is applicable to any magnetically deflected cathode ray tube, but is particularly adapted to the type having a fluorescent screen target for the cathode ray, although it is also applicable to the Lenard tube to prevent damage to the external target thereof. The invention is also applicable to any other type of discharge tube associated with a sweep circuit, to prevent damage due to loss of the sweep voltage.

Although the instant invention has many applications in discharge tube circuits where protection is desirable, the most important application is in circuits of such type that protection against any possible loss of scansion is necessary. In this class are high voltage kinescopes for use in large screen projection television receivers. For example, in order to secure enough light from a kinescope to project onto a theatre screen it is necessary to employ a very intense cathode ray beam. In the event of the cessation of either the vertical or horizontal scan a line will be burned on the fluorescent screen in much less than a second, and the loss of both horizontal and vertical scan will burn a spot on the screen in a period measured in microseconds.

In order to protect the tube from any fault that is at all likely to occur that might result in excessive instantaneous beam current being applied to the screen, the protective circuit must protect the tube against damage in the event anything happens which seriously reduces the effective area over which the beam scans and also must protect against loss of bias potential. Protection against loss of scansion must protect against this loss from any cause, including opening, short-circuiting or grounding of the deflection yoke itself, and complete protection must include protection in turn against failure of any part of the protective circuit itself, and against failure of all power supplies to that circuit. Protection must also extend to the occurrence of any or all of these types of fault at the same time.

The instant invention provides this type of protective circuit, including appropriate components for protection against failures of both horizontal and vertical scanning circuits. These protective components are energized by special windings incorporated in the deflection yoke, one such winding being closely coupled magnetically to the horizontal deflection winding therein, and another such winding being similarly coupled to the vertical deflection winding therein. In addition to the usual overvoltage relay cutout in the high voltage supply, and a control

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grid positive current limiter, the power supply circuits include relays actuated by loss of any of the several voltages to open selected primary windings of the power transformers, with the effect of reducing the kinescope beam current to zero.

The portion of the protective circuit associated with the horizontal deflection yoke winding comprises a detector or demodulator having circuits with appropriately short time constants. In the vertical scan protective circuit, however, such a circuit cannot be employed with success to sense the loss of the vertical scansion, because the sensing must be accomplished in a fraction of one vertical time period, for which the usual detection circuits are unsuitable. A triggered multivibrator circuit is therefore employed in conjunction with an electromagnetic relay to safeguard the circuit within a few milliseconds after the loss of one vertical scan sawtooth pulse. This speed is ample for protection because the time constants of the conventional vertical deflection circuit are great enough to prevent complete collapse of vertical scansion within this time.

One object of the present invention, therefore, is to provide a circuit for the prevention of damage in a cathode ray tube having a moving cathode ray beam due to failure of the beam to move in its normal manner.

Another object is to provide a circuit for the prevention of beam burns in the fluorescent screen of a cathode ray tube.

Another object is to provide a circuit adaptable to the protection of any discharge tube.

Still another object is to provide a circuit for the reduction of the cathode ray beam of a cathode ray tube to a harmless intensity upon failure of either or both horizontal or vertical scanning circuits associated with the tube.

Still another object is to provide a circuit for protecting cathode ray tubes in the event of simultaneous failure of both the scanning circuit, and the protective circuit itself.

A further understanding of the invention may be secured from the detailed description and the accompanying drawings in which:

Figure 1 is a schematic diagram of the circuit of the invention.

Figure 2 graphically indicates the operation of the circuit of the invention.

Referring now to Fig. 1, a cathode ray tube of the type employed for theatre television projection is indicated at 11. This tube may be, for example, of the type 7NP4 designed for the application of an 80 kv. supply to its accelerating anode 12. The maximum instantaneous beam current may be greater than 6 milliamperes, so that the maximum beam energy at the screen is more than 480 watts. At this rate the beam power concentrated at a small spot on the screen upon the failure of both scanning circuits attains the extremely high beam density of 6400 kw. per square inch of screen surface, which will cause the destruction of the screen in a time measured in microseconds. The beam power that is concentrated in a line on the screen by the failure of either scanning circuit is 8 kw. per square inch, sufficient to ruin the tube within milliseconds.

At these power rates it is obvious that in order to preserve the tube from instantaneous destruction the continuity of both scans must be maintained, or in the event of interruption of either scan the tube beam current must be cut off almost instantaneously.

The tube 11 is provided with a cathode 13, control grid 14, No. 2 grid 16, and a focusing grid No. 3 indicated at 17. The tube neck is surrounded by a deflecting yoke containing a horizontal deflection winding 18 and a vertical deflection winding 19, these windings being drawn

schematically and separate from the tube for clarity. The horizontal winding 18 is connected to a conventional horizontal deflection or scanning circuit 21 which energizes it with a varying potential having a period of $63\frac{1}{2}$ microseconds. A conventional vertical deflection or scanning circuit 22 energizes the winding 19 with a varying potential having a period of $\frac{1}{60}$ of a second. These circuits are timed, respectively, by horizontal and vertical synchronizing pulses from a composite television signal through a synchronization signal separator (not shown), this signal being received by radio or cable from the television transmitter.

The video component of the television signal is amplified in an amplifier, the final stage of which comprises the tube 23 having an output black level of +200 volts and an extreme white level value of +75 volts which is applied from the plate 20 of tube 23 to the cathode 13 of the cathode ray tube.

The control grid 14 is normally biased at +75 volts corresponding to a black level bias of -125 volts relative to the cathode 13, which at picture black normally reduces the beam current to zero.

The voltage on grid 14 is supplied through a 100 K. resistor 24 to prevent excessive current flow if the grid should become positive. The voltage is supplied through conductor 25, a conventional manual on-off switch 26, contacts 27 of relay 28, conductor 29, cathode 31 of a triode section 32 and cathode resistor 58. The relay 28 is normally closed during picture reception, and the cathode resistor 58 is connected to the -105 volt point on a source of direct current potential 82.

This cathode 31 is maintained at +75 volts in the following manner. A pick-up winding 33, having a total of six turns, is wound around the horizontal deflection winding 18 of the deflection yoke so as to have very close magnetic coupling thereto while electrically insulated from it. A voltage is induced in this pick-up coil 33 by any change of current in the winding 18 and, being proportional to the rate of change of current, is much greater during flyback than during the forward scan. The polarity is such that the pulse produced during flyback is positive. This positive pulse is supplied through a shielded conductor 34 and a 200 ohm resistor 36, which constitutes the input for tube 42. The pulse potential at the junction 37 of resistor 36 is applied to an integrating circuit composed of a 100 K. resistor 38 and a 100 mmf. condenser 39, the resulting integrated voltage being of such reduced peak value and reduced rate of decay as to be suitable for energization of the control grid 41 of a pentode amplifier 42 within each horizontal line period. The output is coupled from plate 43 through a condenser 44 to a rectifier comprising two diodes 46 and 47. The relatively continuous direct current output is applied between the anode connection 48 and the cathode 49 of a triode section 51 connected as a diode limiter, the anode connection 48 being at a positive potential. The cathode 49 of the limiter 51 is maintained at +65 volts by its connection to a voltage divider composed of series resistors 52 and 53 connected between the plus 400 voltage supply bus 54 and ground. The potential of the anode of this limiter may therefore drop below plus 65 volts but cannot rise above it. However, component magnitudes of the associated circuit are such that with normal horizontal scan current flowing the integrated anode voltage is fully maintained at plus 65 volts at all times. This value of positive voltage is applied through conductor 56 to the control grid 57 of a cathode follower section 32, and results in such current flow as to cause the cathode 31 to set itself at a potential about 10 volts above the grid 57, or at plus 75 volts. This voltage may also be considered as the drop in resistor 53 due to the tube current, and is applied as described through conductor 29, closed relay contacts 27, closed switch 26, conductor 25, and resistor 24 to the No. 1 grid 14 of cathode ray tube 11.

The twin triode having sections 32 and 51, has its heater 50 energized from an insulating transformer 55 in order to prevent cathode ray tube failure consequent upon breakdown of the insulation between heater and cathode in this twin triode.

A negative bias potential of minus 180 volts is connected through 100 K. resistor 59 to the fixed contact 60 of switch 26. This potential has no effect upon the cathode ray tube 11 when the plus 75 volt bias is applied, but if the plus 75 volt circuit is opened the voltage of the control grid 14 immediately drops from plus 75 volts to minus 180 volts. For example, opening of the on-off switch 26 causes the control grid 14 to go to minus 180 volts, applying cut-off bias to the cathode ray tube and thereby interrupting its cathode ray beam. Opening of the relay contact 27 has the same effect.

The relay 28 is kept in its normal operating condition with its contacts 27 closed in the following manner. A winding 61, having a total of 12 turns, surrounds the vertical deflection winding 19, and is closely coupled to the latter but insulated therefrom. This pick-up coil 61 therefore has a potential induced in its proportional to the rate of change of vertical deflection current, so that a sharp positive pulse is produced at the time of each vertical flyback. This positive pulse is graphically depicted at A in Fig. 2. It is transmitted through conductor 62 to the control grid 63 of a triode amplifier 64, from the plate 66 of which the pulse is further amplified in triode 67. If the succeeding tube 68 be removed from its socket the pulse at plate 69 of triode 67 has the appearance shown at B, Fig. 2, the series capacitances in this two-stage amplifying circuit being so large as to exert very little differentiating effect.

The tube 68 together with tube 71 comprises a monostable, or one-shot multivibrator, the tube 71 being normally conducting and tube 68 normally non-conducting. Upon application of the positive pulse shown in B, Fig. 2, to the grid 72, the tube 68 becomes conducting and the tube 71 non-conducting. This unstable state persists for approximately 60% of one vertical scan period, or 10 milliseconds, when the multivibrator spontaneously returns to its normal state. This cycle is indicated by the curve C, indicating the change of potential at the grid 72 with time. During the time that grid 72 is positive, plate current flows through tube 68, the current-time curve being indicated at D. This current flows through resistor 73 and relay 28 from the plus 285 volt supply, the relay being shunted by a resistor 74 to reduce its release time. This release time is designed so that the contacts 27 open about 10 milliseconds after the relay winding current has been interrupted. This release time therefore is greater than the no-current interval in graph D, but is less than one vertical scan period, and will occur at the point R in curve E, 10 milliseconds after the end of any multivibrator unstable state period when the next following vertical pulse is omitted. Accordingly, since the period of the vertical sweep is less than the period of the multivibrator plus the release interval, the winding 28 remains energized and switch 27 closed as long as the vertical sweep pulses are not interrupted or the frequency thereof is not appreciably decreased.

The power supply for the video tube 11 includes a conventional high voltage supply 76 which is independent of the deflection circuits. The power supply furnishes 80 kv. for the cathode ray tube accelerating anode 12 and 18 kv. for the focusing grid 17. Conventional overload protection is included. An 800-volt supply 77 is directly connected to supply positive potential to the No. 2 grid 16, and its input power terminals are effectively connected in parallel with those of the 80 kv. supply. Power is applied to these two supply circuits through series connected contacts of two undervoltage protective relays 78 and 79. The winding of relay 78 is connected across the plus 285-volt output terminals of power source 81 which supplies the final video amplifier tube 23 and also the protective cir-

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cuits. The winding of relay 79 is connected across the minus 105-volt output of the power supply unit 82, which supplies bias voltage to the final video tube 23 and to the protective circuits. This supply unit 82 also supplies minus 180 volts to the cathode ray tube 11 as a cut-off voltage, and at the same time energizes the protective circuits. Thus any interruption of the plus 285-volt supply circuit 81 output opens the 800-volt, 18 kv., and 80 kv. power supply circuits, and any interruption of the minus 180/105-volt supply unit 82 does the same and in addition opens the plus 285-volt power supply circuit 81. The protective circuits described protect against probable faults occurring singly or in any possible combination as may be seen from the subsequent description.

The loss of, or material reduction in the magnitude of the horizontal scanning magnetic field may be caused by a fault in the horizontal deflection circuit 21, in loss of horizontal synchronizing pulses thereto, or by an open circuit, short circuit, ground or cross in the deflection yoke itself. Loss or serious reduction of horizontal scanion due to any cause is sensed by the pick-up coil 33, and causes such loss or reduction of the signal pulse voltage in conductor 34 that the potential of junction 37 falls to ground, or nearly to ground. The integrated pulse output of amplifier 42 therefore disappears, and because of loss of input, the bias on the control grid 41 drops below cut-off negative potential. The rectified potential at the cathode of tube 47 disappears and the potential at junction 48 falls to minus 105, causing the triode 51 to become almost cut-off. The connection 56 therefore applies the minus 105-volt potential to the control grid 57 of cathode follower 32, so that its cathode 31 assumes a potential of about minus 90 volts. This potential is applied through conductor 29, closed contacts 27 of relay 28, closed switch 26, conductor 25, and resistor 24 to the control grid 14 of the video tube 11, reducing the beam current of the latter to zero. This occurs for the reason that since the cathode 13 is at plus 200 volts, the grid bias relative to cathode becomes minus 300 volts, which is far below the cut-off value of minus 125 volts for this tube.

The circuit parameters are so chosen that this entire cut-off action, from the time of loss of the first horizontal signal pulse to reduction of beam current in the video tube 11 to zero, takes no more than the time of five or six horizontal periods, or not over 400 microseconds. Such speed is adequate for protection of the cathode ray tube 11 under all conditions involving loss of horizontal scanning.

A fault in any of these five tubes and tube sections causing zero tube current or even materially reduced tube current causes the cathode ray tube beam current to become zero. The same action occurs upon failure of the plus 400-volt supply.

In a similar manner, loss of or substantial reduction in the magnitude of the vertical scanning magnetic field may be caused by a fault in the vertical deflection circuit or by loss of the vertical synchronizing pulses, or by an open-circuit, short-circuit, ground or cross in the deflection yoke itself. Loss or substantial reduction of vertical scanion due to any cause is sensed by pick-up coil 61, and results in such loss or reduction of the pulses applied through conductor 62 to the amplifier 64 that the multi-vibrator energized therefrom is not triggered. The multi-vibrator tube 68 therefore remains continuously non-conducting, starting at the end of its last non-stable state. The relay 28 connected thereto opens about 4 milliseconds after the time of beginning of the first omitted or weak vertical deflection signal pulse, causing minus 180 volts to be applied through resistors 59 and 24 to the control grid 14 of the video tube 11 thus applying a relative negative bias of minus 380 volts to the tube, and reducing its beam current to zero. Any tube or other component fault which causes current through the winding of relay 28 to be interrupted causes the opening of contacts 27 thus applying a high negative bias on control grid 14 thus making video tube 11 inop-

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erative and insuring against any injury to the latter. Loss of the plus 285-volt supply or of the minus 105-volt supply would cause the failure of the protective circuit, which is responsive to the vertical sweep pulses, and the opening of relay 28, thus again applying cut-off bias potential to the video tube 11.

In the event, however, of loss of the minus 180-volt supply simultaneously with loss of either deflection supply or with opening of switch 26, the control grid 14 would fall only to ground potential. This will ordinarily result merely in the production of a very dim picture on the fluorescent screen of the video tube 11 and only in the event of a high resistance leak between the control grid 14 and a source of positive potential, either within or outside of the video tube will the beam current rise dangerously. To protect against this contingency the relay 79 is provided. It is also necessary to protect against loss of the minus 105-volt supply because this supply is used to bias the final video tube 23. Bias loss would cause such high current in this tube as to reduce the potential of cathode 13 causing a dangerous rise in beam current. However, loss of the minus 105 bias voltage is protected against by the provision of the same protective relay 79, since the minus 105-volt supply is derived from the minus 180-volt supply. The contacts are connected to open the primary power supply to the plus 285-volt, plus 800-volt, 18 kv. and 80 kv. supply circuits. Upon opening these circuits, no beam current whatever can flow.

Loss of the plus 285-volt supply to the video tube 11 would cause the cathode 13 to go to ground potential, causing an excessively high beam current. The relay 78 is therefore shunted across the output of this supply, so that failure causes opening of the plus 800-volt 18 kv. and 80 kv. supplies, again preventing any beam current flow.

Therefore, this circuit, consisting of protective sections cooperating with the video supply and horizontal and vertical deflection yoke supplies, is arranged to cut off the cathode ray beam current upon the occurrence of any probable type of failure, and "fails safe" upon the failure of any of its own components.

What is claimed is:

1. In a circuit for energizing a cathode ray tube having a plurality of electrodes including a cathode, an anode, a control electrode, electro-magnetic means for deflecting said electron beam in an oscillatory manner in response to a pulsing electrical potential, means magnetically coupled with said electro-magnetic deflecting means for cooperatively controlling the energization of said respective electrodes of said tube in response to the energization of said deflecting means.

2. In a circuit for energizing a cathode ray tube having a plurality of electrodes including a beam-generating cathode, an anode and a control electrode, deflecting means for oscillating an electron beam along orthogonal axes in response to respective pulsating electrical potentials, a source of biasing potential for said control electrode, means including conjointly acting protecting circuits for applying a normal biasing potential to said control electrode in response to predetermined normal energization of said deflecting means and for immediately applying a cut-off bias potential to said control electrode in the event of substantial deviation in the energization of the means for oscillating the electron beam along either orthogonal axis, one of said protecting circuits being responsive to a train of electrical pulses for applying the normal biasing potential to said control electrode, the other of said protecting circuits being responsive to a single pulse of the respective energization potential for applying the normal biasing potential to said control electrode.

3. The combination as set forth in claim 2 in which said deflecting means comprises an electromagnetic deflection yoke having two deflection coils the axes of

which are disposed in orthogonal relation and in which said protective circuits include two pick-up coils respectively coupled magnetically to said deflection coils, one of said protection circuits including an integrating network which is responsive to a continuous train of impulses for establishing a normal biasing potential for said control electrode, the other of said protective circuits including a multivibrator having a periodicity which is less than the periodicity of the pulses normally supplying its associated deflection coil.

4. The combination as set forth in claim 2 in which said other protection circuit includes a multivibrator having a periodicity less than the periodicity of the pulses normally supplying its associated deflection coil, a relay, energized by said multivibrator, having a release time of such value that when added to the periodicity of said multivibrator the total period is greater than the period of the pulses normally energizing the associated deflection coil, said relay adapted to control the circuit through which the normal energizing potential is applied to said control electrode.

5. In a circuit for energizing a cathode ray tube having a plurality of electrodes including a beam-generating cathode, an anode, a first control electrode and a second control electrode, an electromagnetic deflection yoke having a horizontal deflection coil arranged for energization by sawtooth current pulses and a vertical deflection coil adapted to be energized by sawtooth current pulses at a frequency less than that of the frequency of the pulses energizing said horizontal deflection coil, modulator amplifier means for applying video signals between said first control electrode and the cathode of said video tube, respective sources of power supply for supplying a normal biasing voltage between said electrodes, means including conjointly acting protecting circuits for establishing circuits for applying said normal operating potentials to said electrodes, said protective circuits including respective pick-up coils magnetically coupled to said deflection coils and means responsive to the normal energization of said deflection means for establishing and maintaining circuits for applying a normal biasing potential to said electrodes and for immediately applying a cut-off bias to said first control electrode in the event of substantial deviation in the energization of either of said deflecting coils and means responsive to the failure of either of said protective circuits for interrupting the bias potential on said second grid, said protective circuits including electrical interlock means for causing a protective bias to be established between the cathode of said video tube and said first control grid in the event of failure of the power supply to either of said protective circuits.

6. A cathode ray tube circuit comprising, a cathode ray tube including a fluorescent screen, a beam-generating cathode, a control grid, an anode and an electromagnetic deflection yoke having at least a horizontal deflection coil arranged for energization by sawtooth deflection voltage pulses, power supply means for supplying bias voltages to said cathode and said control grid, and a protective circuit including a pick-up coil magnetically coupled to said horizontal deflection coil for reception of voltage pulses during horizontal flyback time, integrating circuit means connected to said pick-up coil to integrate said voltage pulses, a discharge tube amplifier connected to said integrating circuit means for energization thereby, a rectifier in the output of said amplifier, a positive voltage limiter in said rectifier output, output discharge tube means for applying said positive limited voltage to said control grid to maintain it at a selected negative voltage level relative to the zero modulation cathode voltage level, whereby the failure or substantial reduction of said horizontal voltage pulses causes the bias voltage on said control grid to go below cut-off voltage level cutting off said beam, and automatic means for cutting off said beam upon failure of any part of said protective circuit.

7. A cathode ray tube circuit comprising, a cathode

ray tube including a fluorescent screen, a beam-generating cathode, a control grid, an anode and an electromagnetic deflection yoke having at least a vertical deflection coil arranged for energization by sawtooth deflection voltage pulses, bias power supply means for supplying bias voltages to said cathode and control grid, and a protective circuit including a pick-up coil magnetically coupled to said vertical deflection coil for reception of voltage pulses during vertical flyback time, a discharge tube amplifier connected to said pick-up coil for actuation thereby to produce amplified voltage pulses, a multivibrator monostable multivibrator having a stable and an unstable state, one of the tubes of said multivibrator being non-conductive in the stable state, electrical connection means from the output of said amplifier to said multivibrator for causing conduction through a selected tube by said amplified voltage pulses whereby the multivibrator is maintained in its unstable state at least 40% of the time, an electromagnetic relay, the winding thereof being connected for energization by the plate current of said selected tube and the normally-open contacts thereof being connected to apply normally operative voltage to said control grid, an electrical connection from said bias power supply means to said control grid whereby upon the omission of a single vertical pulse said electromagnetic relay contacts are released and cut-off biasing voltage from said bias supply means effects cut-off of said beam, and means for cutting off said beam upon failure of any part of said protective circuit.

8. A cathode ray tube circuit comprising, a cathode ray tube having a plurality of electrodes including a beam-generating cathode, a control electrode, an anode and a deflection yoke including a horizontal deflection coil and a vertical deflection coil, means for energizing said vertical deflection coil with periodic voltage pulses to move said cathode ray vertically, means for energizing said horizontal deflection coil with periodic voltage pulses to move said cathode ray horizontally, modulating amplifier means for applying amplified modulating video signals between said control electrode and said cathode, power supply means for applying bias voltages to said electrodes, a pick-up coil magnetically associated with said vertical deflection coil, a second pick-up coil magnetically associated with said horizontal deflection coil, and a protection circuit normally continuously actuated from said horizontal and vertical pick-up coils, said protection circuit being connected to said power supply and to said cathode ray tube for control of the application of said bias voltages, whereby cessation or reduction of the energization of either said horizontal or vertical coils or of any bias potential or failure of any part of said protection circuit reduces the cathode ray beam to a harmless magnitude.

9. A protective circuit for a cathode ray tube comprising, a deflection circuit adapted to operate cyclically, means for developing a direct voltage pulse once during each cycle of operation of said deflection circuit, a monostable multivibrator which when triggered remains in its unstable state for a period of time less than the duration of one cycle of said deflection circuit, means for applying each developed pulse to said multivibrator, a relay including an operating winding and a set of normally open contacts, said relay being one which releases a short time after deenergization of its operating winding, means for energizing said winding while said multivibrator is in its unstable state, and means for supplying an electrode of said cathode ray tube with operating potential through said contacts.

10. In a circuit for energizing a cathode ray tube having a plurality of electrodes including a cathode, an anode and a control electrode, a protective circuit comprising a source of negative bias voltage connected to said control electrode, a source of anode voltage, and means responsive to failure of said source of bias voltage for disabling said source of anode voltage.

11. In a circuit for energizing a cathode-ray tube hav-

ing a plurality of electrodes including a cathode, an anode, and a control electrode and having deflecting means for causing the electron beam to scan the face of the tube, a protective circuit comprising a source of negative bias voltage connected to said control electrode, a source of anode voltage, means responsive to the energization of said deflecting means for overcoming said bias voltage, and means responsive to failure of said source of bias voltage for disabling said source of anode voltage.

12. In a circuit for energizing a cathode ray tube having a plurality of electrodes including a cathode, an anode, and a control electrode, a protective circuit comprising, a source of low voltage for applying a positive potential to said cathode, a source of high voltage for applying a higher positive potential to said anode, and means responsive to the failure of said low voltage source for disabling said high voltage source.

13. In a circuit for energizing a cathode ray tube having a plurality of electrodes including a cathode, an anode, and a control electrode and having deflecting means for

causing the electron beam to scan the face of the tube, a protective circuit comprising, a source of negative bias voltage connected to said control electrode, circuit means responsive to the energization of said deflecting means for overcoming said bias voltage, a source of positive voltage for operating said circuit means, and means responsive to the failure of said source of negative bias voltage for disabling said source of positive voltage.

References Cited in the file of this patent

UNITED STATES PATENTS

2,098,384	Goodrich	Nov. 9, 1937
2,119,372	Wendt	May 31, 1938
2,202,171	Stocker	May 28, 1940
2,261,645	Delvaux	Nov. 4, 1941
2,261,776	Poch	Nov. 4, 1941
2,577,848	Greenleaf et al.	Dec. 11, 1951
2,584,932	Snyder et al.	Feb. 5, 1952
2,635,208	Cage	Apr. 14, 1953