

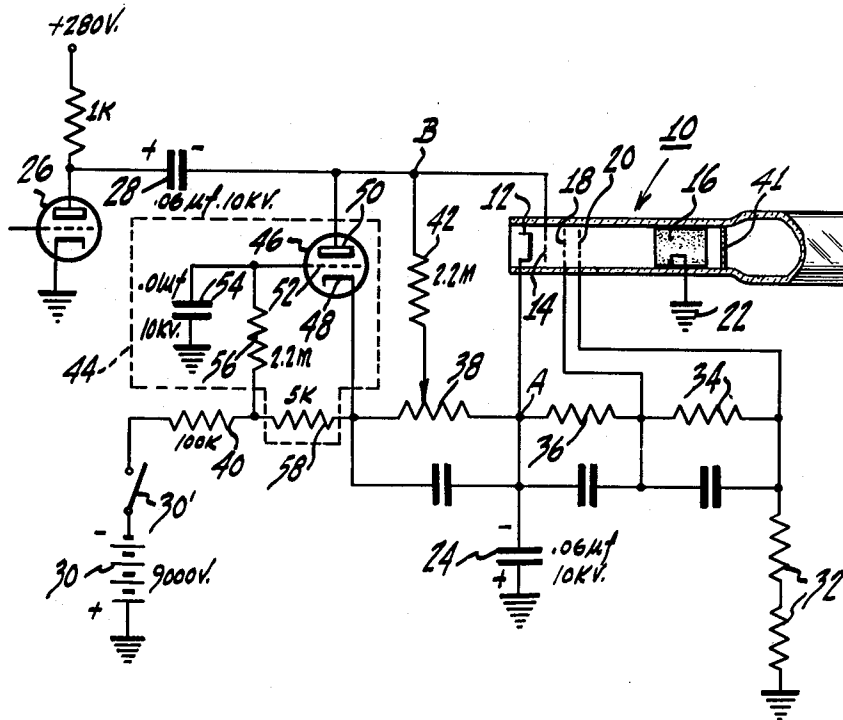
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PROTECTIVE CIRCUIT

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2,756,378

PROTECTIVE CIRCUIT

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The present invention relates to electrical protective circuits and, more particularly, although not necessarily exclusively, to circuitry for use in conjunction with cathode ray tube devices for the prevention of excessive beam current under certain operational conditions.

In the case of certain cathode ray tubes, the cathode is operated at a high negative potential with respect to the anode, the latter electrode being maintained at ground potential. One such device is the Graphecon which is described in an article by L. Pensak entitled "Picture storage tube" and appearing in the July 1949 issue of Electronics at page 84, et seq. Another article by L. Pensak on this tube, namely, "The Graphecon—a picture storage tube" may be found in the March 1949 issue of "RCA Review," a publication of the Radio Corporation of America. In the Graphecon, as in some cathode ray tubes, excessive beam current for more than a few milliseconds may well cause permanent damage to the target or screen. Thus, if excessive beam current flows in a Graphecon when the accelerating potential is applied to its "writing gun," the center of its target is quickly punctured, thereby rendering it useless insofar as its storage properties are concerned.

In applying the accelerating potential to the writing gun of a Graphecon or to the gun of a kinescope which is being operated with its cathode at a high negative potential (an example of which is described in U. S. Patent No. 2,261,787, granted to K. R. Wendt on November 4, 1941, for "Amplifier"), there exists the problem of charging the various capacitors in the circuit to their stable conditions at a proper and inter-related rate, for otherwise the cathode might be brought to its negative potential more rapidly than the control electrode. The result of such action would be a high beam current with its attendant damage to the target.

It is, therefore, a primary object of the present invention to provide means for preventing excessive beam current in a cathode ray tube during the application of operating potentials to its electrodes.

Another object hereof is the provision of means effective in preventing excessive beam current in the event of surges of potential in the power supply.

In the prior art, attempts have been made to overcome the problem presented by time constants inherent in the operating circuits of cathode ray tubes and the like, including proposals for introducing additional time delays of even greater magnitude than those necessarily present in the circuitry. The instant invention, however, differs from such proposals in that it decreases appreciably the time normally required for the cathode ray tube circuits to reach their stabilized charged condition. Moreover, as will appear more fully hereinafter, although the apparatus of the present invention is made a physical part of the circuitry, it is operative only when its services are required, as during the period immediately following the closing of the service switch to the power supply or in the event of abnormal voltage surges.

In general, the present invention contemplates the pro-

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vision of a low resistance charging path for a capacitor in lieu of a high resistance path required by the circuit for other reasons. In accordance with a specific embodiment of the invention, a protective circuit is afforded a

- 5 Graphecon whose cathode is connected to a large capacitor adapted to be charged to a high negative potential and whose control electrode is coupled to a preceding video amplifier stage via a blocking capacitor. Normally, a large resistor connected between the control electrode and cathode constituted the charging path for such blocking capacitor, so that the first-named capacitor would be charged negatively in a very short time thereby producing a great potential difference between cathode and control electrode for an appreciable time until the blocking capacitor reached its stabilized condition of charge. Such time relations, however, resulted in high writing gun current for a period sufficient to produce ruinous effects on the tube target. Hence, the present invention includes a control tube in parallel with the Graphecon grid resistor to provide a relatively low resistance path for charging the blocking capacitor simultaneously with the capacitor in the cathode circuit. Means are further included for insuring during starting periods that the Graphecon grid is maintained slightly negative with respect to its cathode during such intervals, thereby preventing the flow of any beam current. A time constant circuit between the control tube's cathode and control grid automatically biases that tube to cutoff after both large capacitors have become stabilized, thus permitting normal operation of the Graphecon.
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It is a further object of the invention to provide means for effecting rapid stabilization of capacitors in a cathode ray tube circuit in order to avoid periods of abnormal cathode-to-control electrode negative potential.

- 35 A still further object is that of providing a protective circuit as set forth supra which insures a negatively biased control electrode of a cathode ray device during "starting periods" (i. e., the intervals following closing of the power switch).
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Yet another object is the provision of means as described comprising a shunt path of low resistance to afford more rapid charging of a capacitor than can otherwise be realized.

- Another object hereof is to provide means for automatically removing the protective circuit set forth above from its electrical environment as soon as stable conditions have been attained by its associated elements.
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Additional objects and advantages of the present invention will become apparent to persons skilled in the art from a study of the accompanying drawing which illustrates, by way of schematic diagram, a circuit embodying its principles.

- Referring to the drawing, reference numeral 10 indicates generally a cathode ray tube device such as a Graphecon having the usual cathode 12, control electrode 14 and final anode 16. Also illustrated, in the interest of completeness of description, are accelerating electrodes 18 and 20 whose operation does not constitute a part of the invention. The final anode 16 is shown as connected to ground potential at 22, in accordance with the usual operation of this type of tube.
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The cathode 12 is connected to one end of a large capacitor 24, the other end of the latter element being connected to ground. Control electrode 14 of the Graphecon is illustrated as deriving its electron beam intensity modulating signals from a video amplifier 26 via a D. C. blocking capacitor 28, in a conventional manner. A source of high negative potential of, for example, 9000 volts indicated diagrammatically by battery 30 comprises the power supply for the Graphecon 10 and further includes bleeder resistances 32, 34 and 36 for supplying desired potentials to the accelerating electrodes 20 and 18

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in a well-known manner. Additional voltage drops are furnished by way of resistors 38 and 40. A resistor 42 is connected between the Graphecon electrode 14 and a point on resistor 38.

As thus far described, the circuit is in accordance with conventional operating techniques, as will be appreciated by those familiar with the art, the values of the various circuit components indicated on the drawing being illustrative of typical constants. According to the conventional operation of the circuit as set forth, the voltage at point B (Graphecon control electrode) is normally set by resistor 38 with respect to point A (Graphecon cathode) to cut off beam current within the tube, so that only positive picture signals from tube 26 cause the control electrode 14 to permit electrons to flow toward the Graphecon target 41. Since the picture signals are of short duration they do not injure the target. This, however, presupposes stabilized conditions for the Graphecon's associated circuits.

When, on the other hand, the power supply battery 30 is initially connected into the circuit by the closing of switch 30', capacitor 24 must charge to its normal value through resistance 40 and resistance 38, the latter being so small in relation to the value of the former as to be considered negligible, for present purposes. The blocking capacitor 28 must charge through resistor 40 and grid resistor 42 or it may find a path through the Graphecon grid-cathode conductance if the Graphecon grid were to become positive. It will be noted that the time constant of resistor 40 and capacitor 24 is small in comparison to the time constant of capacitor 28 and resistor 42, the result of this disparity being that the voltage across capacitor 24 (i. e., Graphecon cathode) rises to a high negative value rather quickly, while the blocking capacitor 28 is charging slowly through resistor 42 or the tube's grid-cathode conductance. Since the control electrode 14 of the Graphecon is connected to capacitor 28 and its cathode is connected to capacitor 24, it will be apparent that during the charging interval, the Graphecon grid (point B) will go far above its normal cutoff point or even positive before capacitor 28 reaches its normal operating potential and such action, moreover, will obtain for several time constants of resistor 40 and capacitor 28 before it decreases in a generally exponential manner, by reason of the fact that the two capacitors in question must attain almost their full charge before the Graphecon's grid-cathode voltage can approach normal. With the voltage between points B and A near zero or even positive during this charging time of the capacitors, extremely high beam currents from the Graphecon writing gun will strike the target 41 with a damaging effect sufficient to puncture the center of the target, thereby rendering it inoperative for the storage of picture information.

The present invention, as has been stated briefly above, precludes the dangers inherent in the conventional circuits, as discussed, by means of the elements contained within the dotted line area 44. More specifically, a control tube 46 which may be one half of a type 5751 high-mu triode having a cathode 48, anode 50 and control electrode 52 is connected in parallel with the Graphecon's grid resistance 42 in the manner shown. The control electrode 52 is additionally connected to a time constant circuit including capacitor 54 and resistor 56, the former being connected to ground and the latter being connected to a point between resistor 40 and a relatively smaller resistor 58. As will appear, the control tube 46 and its associated time constant circuit and resistor 58 (all of which are added to conventional circuitry according to this embodiment of the invention) serve to prevent damaging beam current in the Graphecon when the high voltage 30 is applied to the circuit by the closing of switch 30'. When the switch 30' is closed, capacitor 24 begins to charge negatively such that the cathode 48 of control tube 46 as well as the Graphecon cathode 12 will go

negative. Since the time constant of resistor 56 and capacitor 54 is rather large, the control grid 52 is kept from biasing the tube to cutoff for an appreciable period, thus permitting the control tube to conduct. With tube 46 conducting, capacitor 28 is permitted to charge directly through resistor 40 and the tube 46 simultaneously with capacitor 24. Such simultaneity results from the fact that both capacitors 24 and 28 are charging through resistor 40 and the relatively negligible additional resistances afforded by elements 58 and 38 in the case of capacitor 24 and the resistance of tube 46 in the case of capacitor 28. It should also be noted at this point that the blocking capacitor 28 charges to a point more negative than that of point A because for the voltage drop produced across resistor 38, thus maintaining the Graphecon control grid 14 more negative than its cathode 12 or, in other words, biasing the Graphecon to cutoff. The time constant of capacitor 54 and resistor 56 is, in view of the values of these elements, of course, greater than that of capacitors 24 and 28 in parallel charging through resistor 40, so that control tube 46 remains conductive until after capacitors 24 and 28 have attained their stable state. When capacitor 54 has completed its charge through resistor 56, the biasing voltage across resistor 58 produces cutoff of tube 46. It may be mentioned here that, by virtue of the values of the various circuit elements present, the drop across resistor 58 will be in the neighborhood of 5 volts D. C. which is sufficient to maintain tube 46 non-conductive until such time as its plate voltage might exceed 225 volts D. C. Since the picture signal from tube 26 ordinarily does not exceed 100 volts peak to peak, the control tube 46 is normally open during normal operation of the system.

Hence, the primary function of tube 46 may be characterized as that of serving, in conjunction with its associated circuit elements 54, 56 and 58, to prevent excessive flow of Graphecon beam current when the high voltage source 30 is applied to the circuit by closing of switch 30'.

Of additional value is the fact that the circuitry of the present invention (within the dotted line area 44) will react, in a manner similar to that described above, to any large negative surge of the high voltage supply which would otherwise cause excessive beam current in the Graphecon. Its action, in this respect, would be analogous to that explained in conjunction with the initial application of the power source to the circuit.

While the invention has been described, by way of illustration, in accordance with a specific operative embodiment, it should be borne in mind that various changes and modifications within its scope will suggest themselves to persons skilled in the art and, for that reason, the illustrative examples should not be construed as in any way limiting.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Electrical protective apparatus which comprises: a circuit including a capacitor to be charged to a predetermined potential; resistive means in series with and affording a charging path for said capacitor; means including an electron tube whose anode-cathode path is in parallel with said resistive means for providing a low resistance, short time constant charging path for said capacitor upon the application to said circuit of a source of charging potential.

2. Electrical protective apparatus which comprises: a circuit including a capacitor to be charged to a predetermined potential; resistive means in series with and affording a charging path for said capacitor; means including an electron tube in parallel with said resistive means for providing a low resistance, short time constant charging path for said capacitor upon the application to said circuit of a source of charging potential; and means for rendering said electron tube conductive for a predetermined period of time.

3. Electrical protective apparatus which comprises: a circuit including a capacitor to be charged to a predetermined potential; resistive means in series with and affording a charging path for said capacitor; means including an electron tube in parallel with said resistive means for providing a low resistance, short time constant charging path for said capacitor upon the application to said circuit of a source of charging potential; and means for automatically rendering said electron tube non-conductive at a time no sooner than the attainment of said capacitor of said predetermined potential.

4. Electrical protective apparatus which comprises: a circuit including a capacitor to be charged to a predetermined potential; resistive means in series with and affording a charging path for said capacitor; means including an electron tube in parallel with said resistive means for providing a low resistance, short time constant charging path for said capacitor upon the application to said circuit of a source of charging potential; and a time constant circuit for controlling the period of conductivity of said tube.

5. Electrical protective apparatus which comprises: a circuit including a capacitor to be charged to a predetermined potential; resistive means in series with and affording a charging path for said capacitor; means including an electron tube in parallel with said resistive means for providing a low resistance, short time constant charging path for said capacitor upon the application to said circuit of a source of charging potential; and said electron tube includes a control electrode and a resistor-capacitor combination associated therewith for rendering said tube conductive for a predetermined time.

6. Protective apparatus comprising a first capacitor and means providing a resistive charging path therefor, such that the combination of said capacitor and path is of a predetermined time constant; a second capacitor; resistive means in circuit with said second capacitor and affording a charging path therefor, such that the time constant of said second capacitor and its charging path is greater than that of said first-named time constant, said capacitors being arranged so that they determine the relative voltages at different points in an electrical circuit; and means including an electronic tube in circuit with said second capacitor for affording a low impedance charging path therefor, such that said second capacitor is adapted to attain its predetermined charge substantially simultaneously with said first capacitor.

7. Apparatus as set forth in claim 6 wherein said last-named means is in parallel with said second-named resistive means.

8. Apparatus as set forth in claim 6 including means for rendering said last-named means conductive for a limited period at least as long as the time required for charging said first capacitor through its resistive path.

9. A protective circuit for electronic apparatus having a first terminal and a second terminal adapted to be maintained at generally the same potential, which comprises: a first capacitor connected to said first terminal; a first resistive path for charging said capacitor to a predetermined potential, said capacitor and path having a predetermined time constant; a second capacitor connected to said second terminal; a resistance in circuit with said second capacitor to afford a charging path therefor, said second resistor-capacitor combination having a longer time constant than said first time constant, said capacitors being arranged so that they determine the relative voltages at said first and second terminals; and means including an electron tube in circuit with said second capacitor for decreasing the time constant of the charging path of said second capacitor, thereby causing it to charge at substantially the same rate as said first capacitor.

10. A protective circuit for electronic apparatus having a first terminal and a second terminal adapted to be maintained at generally the same potential, which com-

prises: a first capacitor connected to said first terminal; a first resistive path for charging said capacitor to a predetermined potential, said capacitor and path having a predetermined time constant; a second capacitor connected to said second terminal; a resistance in series with said second capacitor to afford a charging path therefor, said second resistor-capacitor combination having a long time constant as compared to said first time constant, said capacitors being arranged so that they determine the relative voltages at said first and second terminals; and means including an electron tube in parallel with said second resistor for decreasing the time constant of the charging path for said second capacitor, thereby causing said second capacitor to charge at a rate no slower than that of said first capacitor.

11. A protective circuit for electronic apparatus having a first terminal and a second terminal adapted to be maintained at generally the same potential, which comprises: a first capacitor connected to said first terminal; a first resistive path for charging said capacitor to a predetermined potential, said capacitor and path having a predetermined time constant; a second capacitor connected to said second terminal; a resistance in circuit with said second capacitor to afford a charging path therefor, said second resistor-capacitor combination having a longer time constant than said first time constant, said capacitors being arranged so that they determine the relative voltages at said first and second terminals; and means including an electron tube in circuit with said second capacitor for decreasing the time constant of the charging path for said second capacitor, thereby causing it to charge at a rate no slower than that of said first capacitor.

12. A protective circuit as defined by claim 11 which includes means for effectively removing said electron tube from said circuit after said capacitors have been charged to their predetermined potentials.

13. A protective circuit for a cathode ray tube having a first electrode and a second electrode which comprises: a first capacitor connected to said first electrode; a first resistive path for charging said capacitor to a predetermined potential, said capacitor and path having a predetermined time constant; a second capacitor connected to said second electrode; a resistance in circuit with said second capacitor to afford a charging path therefor, said second resistor-capacitor combination having a longer time constant than said first time constant, said capacitors being arranged so that they determine the relative voltages on said first and second electrodes; and means including an electron tube in circuit with said second capacitor for causing it to charge at a rate no slower than that of said first capacitor.

14. A protective circuit for a cathode ray tube having a first electrode and a second electrode adapted to be maintained at generally the same potential in the absence of signal, which comprises: a first capacitor connected to said first electrode; a first resistive path for charging said capacitor to a predetermined potential, said capacitor and path having a predetermined time constant; a second capacitor connected to said second electrode; a resistance in circuit with said second capacitor to afford a charging path therefor, said second resistor-capacitor combination having a longer time constant than said first time constant, said capacitors being arranged so that they determine the relative voltages at said first and second electrodes; and means including an electron tube in circuit with said second capacitor for decreasing said second time constant, thereby causing said capacitor to charge at a rate no slower than that of said first capacitor, whereby said capacitors are charged to their respective potentials at generally the same rate upon the application of charging potential to said electrodes.

15. A protective circuit for electronic apparatus having a first terminal and a second terminal adapted to be maintained at generally the same potential, which com-

prises: a first capacitor connected to said first terminal; a first resistive path for charging said capacitor to a predetermined potential, said capacitor and path having a predetermined time constant; a second capacitor connected to said second terminal; a resistance in circuit with said second capacitor to afford a charging path therefor, said second resistor-capacitor combination having a longer time constant than said first time constant, said capacitors being arranged so that they determine the relative voltages at said first and second terminals; means for applying a potential source to said paths; and means including an electron tube in circuit with said second capacitor for decreasing the time constant of said second resistor-capacitor combination, thereby causing said second capacitor to charge at a rate no slower than that of said first capacitor, when said source of potential is applied to said paths.

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