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[54] SURGE VOLTAGE PROTECTION FOR CATHODE RAY TUBE DRIVERS

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[58] **Field of Search** .....178/DIG. 12, 7.5 R, 7.5 DC; 315/91, 93, 107; 317/DIG. 6, 11 R; 330/207 P; 328/8, 9, 171; 307/93, 100, 202

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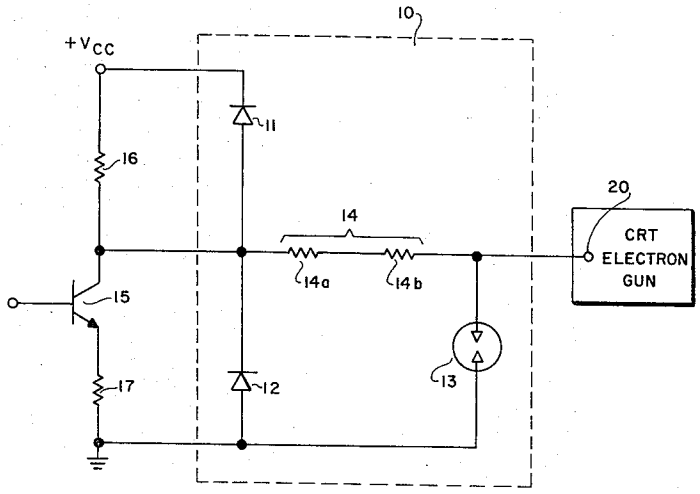
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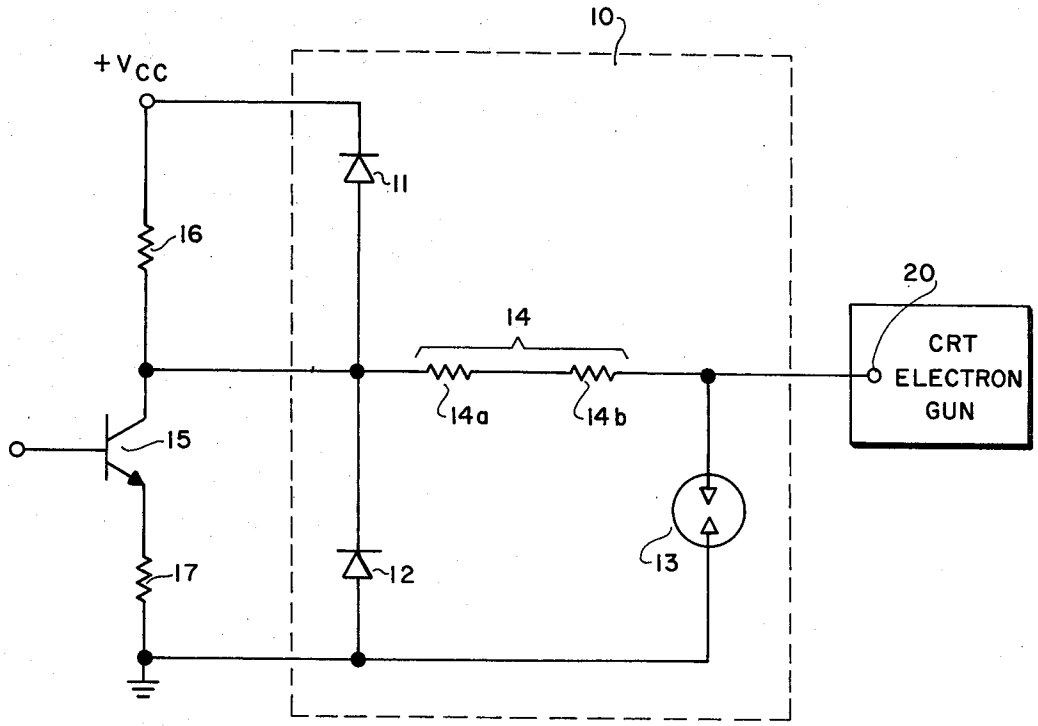
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[57] **ABSTRACT**

Disclosed in a transient voltage protective network for protecting the transistor of a video amplifier coupled to one of the input terminals of a CRT electron gun from the arcing voltages appearing at this input terminal, the protective network including a pair of diodes respectively connected to the output of the transistor and the collector supply voltage and ground terminals thereof, as well as surge voltage protective device coupled through resistive means across one of the diodes.

7 Claims, 1 Drawing Figure





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SURGE VOLTAGE PROTECTION FOR CATHODE RAY TUBE DRIVERS

This invention pertains to surge voltage protective networks, more particularly to surge voltage protective networks for solid state devices, and even more particularly to protective networks for transistorized video amplifiers driving cathode ray tube displays.

Cathode ray tubes have long been used to provide visual representation of electrical effects, these cathode ray tubes generally consisting of three fundamental sub-systems: (1) an electron gun for producing and focusing an electron beam; (2) a deflection system for diverting the electron beam in accordance with the information to be displayed; and (3) a fluorescent screen upon which the so-deflected electron beam is focused. The electron gun basically includes cathode, anode, and grid electrodes which, in combination, determine the production and focusing of the electron beam which is subsequently deflected upon the screen. In practice, the control effected by the electron gun is achieved by driving either the cathode or one of the grid electrodes from the output of a video amplifier, all as conventionally known in the art.

Modern day requirements have resulted in cathode ray tube systems being developed which have increased structural complexity as well as excessively high voltages associated therewith. As a result of these developments, the present day high performance cathode ray tube is increasingly prone to high voltage transients or arcing during its operation. With the corresponding development of solid state (semiconductor) networks as the video amplifier driving stage, this arcing within the cathode ray tube has presented severe problems to the effective operation of the overall system in view of the resultant damage to these solid state devices. In particular, since the output of video amplifier is normally coupled directly to the cathode or grid electrode of the electron gun portion of the CRT, any arcing that occurs within the CRT severely damages the transistor forming the output stage of the amplifier, thus causing a failure in the whole system.

In an attempt to overcome this difficulty, various techniques have been thought of to protect the video amplifier from the deleterious effects of these arcing voltage transients, all of these techniques in themselves having substantial disadvantages. For example, the placing of a protective diode across the output of the transistor amplifier where the diode has a sufficiently high current carrying capacity to handle the excessively large arcing currents consequently result in impeding the performance of the video amplifier due to the correspondingly high capacitance associated therewith. Alternatively, the placement of a high value impedance device, such as a resistor, between the output of the video amplifier and the input to the CRT electron gun substantially impedes the overall performance of the CRT due to the substantial reduction in the output signal from the amplifier.

It is therefore a primary object of the invention to provide a new and improved protective network for devices subjected to excessively high surge or transient voltages.

It is another object of the invention to provide a new and improved surge voltage protective network for solid state devices.

It is an even further object of the invention to provide protection for a transistorized video amplifier driving the cathode or grid electrode of a CRT electron gun without substantially impairing the performance of the video amplifier.

In accordance with these and other objects, the present invention is directed to a protective network comprising a pair of diodes respectively connected to the output of a transistor amplifier and the collector supply voltage and ground terminals thereof, and a surge voltage protective device coupled through resistive means across one of the diodes. As a specific feature of the invention, the protective network is coupled at the intersection of the diodes from the output from a transistorized video amplifier to the input to the cathode or grid electrode of the electron gun portion of a CRT. As subsequently described, the diodes provide protection for the amplifier against excessive voltage transients appearing at the cathode or grid electrode, as the case may be, prior to the ignition of the surge voltage protective device, the protective device thereafter effecting isolation of the amplifier from the arcing voltages.

For a more complete understanding of the invention, and for further objects, advantages and features thereof, reference may now be had to the following detailed description when taken in conjunction with the sole FIGURE of the accompanying drawing illustrating a circuit schematic of a preferred embodiment of the protective network of the invention.

Referring now to the sole FIGURE of the drawing, there is depicted the protective network **10** of the present invention. Accordingly, the network **10** includes a pair of diodes **11** and **12**, and a voltage discharge device **13** connected across the diode **12** by way of resistive means **14** comprising resistors **14***a* and **14***b*. The device **13** is of the type which will conduct when a D.C. ignition voltage of predetermined value appears across its terminals, thus providing discharge path to ground upon this ignition. These devices are generally referred to in the art as "spark gap" devices, Siemens Corporation being one manufacturer and distributor of same.

As a specific feature of the present invention, the protective network **10** is coupled between the output stage of a video amplifier and the input terminal **20** to the cathode or grid electrode of a CRT electron gun. Specifically, the video amplifier output stage includes the common emitter transistor amplifier **15** having collector load resistor **16** connected to the positive collector supply voltage V_{cc} and an emitter bias resistor **17** connected to ground, all as conventionally known in the art. Diode **11** is connected as illustrated from the output of the transistor **15** to the supply voltage V_{cc}, and the diode **12** is connected as illustrated from the output of the transistor **15** to ground. The output of the transistor **15** is also coupled through the resistors **14***a* and **14***b* to the input terminal **20**. During normal operation, the diodes **11** and **12** (being reverse-biased), and the "spark gap" device **13** are not conducting, the cathode or grid of the electron gun being driven in a normal manner by the video amplifier. If, however, an excessive voltage transient occurs at the terminal **20** as a result of arcing within the CRT electron gun, and this voltage transient exceeds the ignition or striking voltage of the device **13**, the device **13** will conduct and, in combination with the resistive means **14**, will provide an essentially short circuit discharge path to ground, thus protecting the transistor **15** from these damaging surge voltages. Once the excessive surge current has thus been bypassed, the device **13** will resume its normal non-conducting mode.

As an additional specific feature of the invention, the diodes **11** and **12** provide additional voltage protection for the transistor **15** until the "spark gap" device **13** is ignited. Since the device **13** must have a sufficiently high ignition voltage to avoid its triggering from the supply voltage V_{cc}, and furthermore, since there is an inherent time lag from the time when the damaging voltage transient occurs at terminal **20** until the device **13** conducts, preliminary protection must be provided the transistor **15** against these excessive voltage transients until the device **13** conducts. This preliminary protection is provided by diodes **11** and **12** which serve to respectively clamp the output of the transistor **15** at essentially either the supply voltage value V_{cc} or ground, depending upon the polarity of the arcing voltage at terminal **20**. For example, assuming the presence of a negative voltage transient at the terminal **20** prior to ignition of the device **13**, this negative voltage will cause diode **12** to become forward biased and conduct (diode **11** remaining reverse-biased) thus clamping the output of the transistor **15** (and the terminal **20** through the resistive means **14**) to the ground. Alternatively, if the surge voltage transient at the terminal **20** is positive, the diode **11** will become forward biased and conduct, and the output of the transistor **15** will therefore essentially be clamped to the supply voltage V_{cc}. Thus, it can be observed that the transistor amplifier **15** is always protected against the damaging voltage

transients that may occur at the terminal **20** as a result of arcing within the electron gun.

Various types and values of circuit components may be utilized in the network **10** to effect the previously described operation. Generally, however, the ignition voltage of the "spark gap" device **13** should be as low as possible to protect against the voltage transients occurring at the terminal **20**, but must be sufficiently high to avoid being triggered from the collector supply voltage V_{cc}. Diodes **11** and **12** should have a short switching time while also having a minimum capacitance associated therewith. The resistors **14***a* and **14***b* must have resistance values large enough to limit the current through diodes **11** and **12**, while at the same time not being excessively large so as to disadvantageously affect the bandwidth capability of the video amplifier. In accordance with one specific example, the following circuit components were advantageously utilized:

Transistor **15**	2N3499
Resistor **16**	500 ohms
Resistor **17**	100 ohm
V_{cc}	+40 volts
Diodes **11** and **12**	1N4148
Resistors **14***a* and **14***b*	68 ohms, ½ watt
Spark gap device **13**	Siemens surge voltage protector B1–A230

Various modifications to the disclosed preferred embodiment, as well as alternate embodiments, may become apparent to one skilled in the art without departing from the scope and spirit of the invention as defined by the appended claims.

What is claimed is:

1. A cathode ray tube system, comprising:

a. electron gun means having an input terminal thereto;

b. a video amplifier for providing a driving signal to said input terminal, said video amplifier including a transistor in the output stage, and

c. a transient voltage protection network coupled intermediate the output of said video amplifier and said input terminal, said protection network comprising a pair of diodes, each having respective terminals coupled to the output of said transistor, the other terminals of said diodes respectively coupled to a first and second potential source; and a voltage discharge device adapted to conduct solely upon the occurrence of a predetermined minimum voltage appearing across its terminals having one end coupled to the output of said transistor and the said input terminal, the other end of said discharge device being coupled to said second potential source, whereby a transient voltage at said input terminal having a value in excess of said predetermined minimum voltage will initially cause one of said diodes to conduct, thereby clamping the output of said transistor to one of said potential sources, and thereafter triggering said voltage discharge device into conduction, thereby to limit the voltage at the output of said transistor.

2. The system as described in claim **1** wherein one of said diodes has its cathode connected to the transistor output and its anode connected to a source of ground potential, and the other of said diodes has its anode connected to the transistor output and its cathode connected to a supply voltage source, the voltage discharge device being coupled in series with resistive means across said one diode.

3. The system as described in claim **2** wherein said voltage discharge device is a spark gap.

4. The system as described in claim **3** wherein said transistor has its emitter coupled through a bias resistor to ground potential, and said supply voltage source is positive.

5. A surge voltage protection network, comprising:

a. a common emitter connected transistor having its emitter coupled through a bias resistor to ground potential and its collector coupled through a bias resistor to a positive supply voltage, said collector also being coupled through resistive means to the output terminal of said network,

b. a first diode in a normally reverse biased condition connected between said collector and said positive supply voltage,

c. a second diode in a normally reverse biased condition connected between said collector and said ground potential, and

d. a voltage discharge device adapted to conduct solely upon the occurrence of a minimum voltage appearing across its terminals coupled between ground and the output terminal of said network.

6. The network as defined by claim **5** wherein said voltage discharge device is a spark gap.

7. The network as defined by claim **5** wherein said resistive means is of a value that the voltage at said output terminal is substantially identical to the voltage at the collector of said transistor during the conduction of said voltage discharge device.

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