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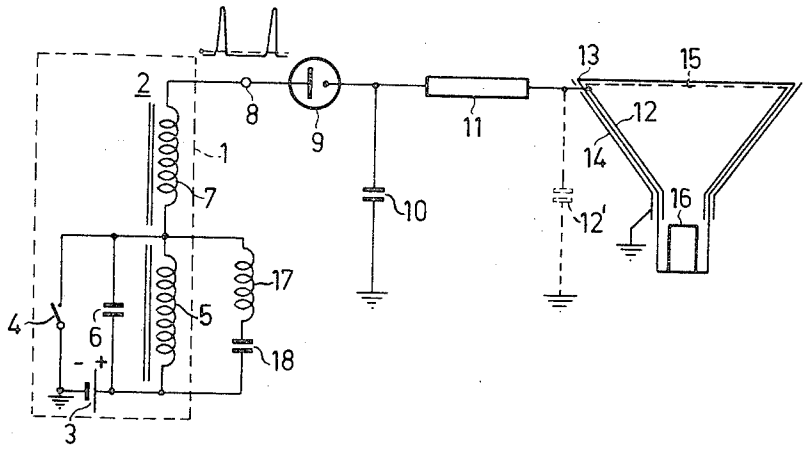

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NTC RESISTOR IN THE HIGH VOLTAGE SUPPLY

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ABSTRACT OF THE DISCLOSURE

A NTC resistor is connected between rectifying circuit and a high voltage electrode to thereby provide a constant high DC voltage.

This invention relates to a device for continuously supplying a high DC voltage to an electrode of a cathode ray tube. The device comprises a high-voltage generator having an output terminal at which a periodically occurring pulsatory high voltage is produced. The output terminal is connected to the said electrode through a rectifying and a smoothing circuit.

Devices of this type are used in many fields of application of cathode ray tubes, such as, for example, in electron microscopy, radiology, radar and television. The design of the cathode ray tubes and the value of the required high DC voltage vary greatly for different fields of application. A great variation also occurs in any one field, such as may be illustrated in television by monochrome, colour or projection television in which a high voltage of 15 kv., 25 kv., or 50 kv. to 80 kv. is required for the anode electrode of the differently constructed television display tubes. A general requirement for satisfactory operation of the cathode ray tubes is, however, that the high DC voltage must have a substantially constant value without ripple, which may be obtained with the aid of a satisfactory smoothing circuit. The smoothing circuit is generally formed by a resistor connected between the rectifier circuit and the electrode of the cathode ray tube and by the capacitance relative to ground of the said electrode.

The above-mentioned devices present the following problems which will be described, by way of illustration, for a colour television receiver.

The pulsatory high voltage generated by the high-voltage generator and rectifed by the rectifying circuit should be supplied as a substantially constant high DC voltage to the anode of the colour television display tube through the said smoothing circuit. This may be achieved by means of a proper choice of the time constant of the smoothing circuit relative to the recurrence period of the pulsatory voltage. Since the smoothing capacitance is determined by the capacitance of the anode relative to ground, the smoothing resistor must be properly matched and must have a high value for satisfactory smoothing.

If, however, a flashover occurs, for example, because of an arc discharge between the anode conveying high voltage and ground, then the high voltage supplied by the rectifier is instantaneously set up across the series arrangement of the smoothing resistor and the resistance of the arc discharge, i.e. the arc resistor. Such flashovers frequently occur in the new cathods ray tubes. The cause of the flashover is that, for economic reasons, the metal components in the cathode ray tube are not polished so that they still have burrs which produce local electrical field interruptions, which in turn may cause a flashover. The result of such a flashover is that, on the one hand,

the burr possibly burns away and hence the cause of the flashover is eliminated, but on the other hand the rectified high voltage is set up across the series arrangement of the smoothing resistor and the arc resistor in the form of a step function. As a result a voltage division occurs, while proportionally therewith the power generated by the high-voltage generator is dissipated in the smoothing resistor and the arc resistor. It will be evident from the foregoing that it is desirable for the smoothing resistor to have a small value relative to the arc resistor during flashover. The smoothing resistor would otherwise be destroyed due to the high instantaneous power dissipation and the large high voltage (for colour television the high-voltage generator supplies a nominal power of, for example, 30 w. at 25 kv.).

It is even possible that, for example, during service operations the electrode conveying the high voltage is connected to ground. During the comparatively long short circuit that then occurs, a smoothing resistor of high value would certainly be destroyed.

It is found that the smoothing resistor must have a high value on the one hand for satisfactory smoothing of the rectified high voltage, and on the other hand a low value in case the anode is short-circuited to ground. It is known that this can be realized by placing a spark gap in parallel with the smoothing resistor. Said solution is very unattractive and is inherently dangerous. The reproducibility of the flashover voltage of a spark gap is in fact very poor. Furthermore, the occurrence of a flashover introduces oscillations into the entire device with all the adverse results attended therewith. It is also known to give the smoothing resistor a resistance value which lies between the said high and low values. It is evident that this compromise will result in both a poorly smoothed high voltage for the anode and in an unsafe device. Said solution is very expensive since the smoothing resistor must be considerably overrated.

An object of the device according to the invention is to obviate the above-mentioned drawbacks concerning smoothing and short circuit. The invention is characterized in that in order to obtain a device supplying a substantially constant high DC voltage that is protected against short circuits, the filter circuit comprises a smoothing resistor having a negative temperature coefficient which connects the rectifying circuit to the said electrode.

The invention is based on the concept that the object aimed at can be reached with a smoothing resistor having a non-linear current-voltage characteristic and having a time delay in the resistance variation as a function of the impressed varying voltage. The use of a voltage-dependent resistor (VDR) is thus excluded. The ripple on the rectified high voltage will in fact cause an immediately occurring variation of resistance with a VDR so that a poor smoothing action is obtained. In addition, a VDR across which part of the high voltage is set up during flashover will experience changes in material so that its properties also change.

In order that the invention may be readily carried into effect, it will now be described in detail, by way of example, with reference to the accompanying diagrammatic drawing of one embodiment.

The sole figure shows a high-voltage generator **1** comprising a transformer **2**, a DC voltage source **3** and a switching element **4**. The transformer **2** is constructed with a primary winding **5** to which a possibly parasitic capacitor **6** and a series arrangement of a voltage source **3** and switching element **4** are connected in parallel. For television purposes, the switching element **4** is generally switched at the line deflection frequency. The alternate closing and opening of switching element **4** excites the

oscillatory circuit formed by the capacitor **6** and the primary **5**. The result is that a pulsatory high voltage is induced in the secondary winding **7** of the transformer **2**. This voltage is shown near the output terminal **8** of the high-voltage generator **1**. The output terminal **8** is connected to a smoothing circuit through a rectifying circuit arrangement formed by a rectifier **9** and a capacitor **10**, which is connected to ground at its other end. According to the invention said smoothing circuit comprises a resistor **11** having a negative temperature coefficient (NTC) as the smoothing resistor. The other end of the NTC resistor **11** is connected to an anode **12** of a colour television display tube **13**. The capacitance of the anode **12** relative to ground or the outer coating **14** of the tube **13** is indicated by a capacitor **12'**. Anode **12** is applied as an Aquadag layer on the inner wall of the cone of the display tube **13**, shown as a shadow mask tube. The shadow mask **15** is connected to the anode **12**. The shadow mask tube **13** is provided with means **16** for generating, accelerating and focusing three electron beams, not shown. Further components which are irrelevant for an understanding of the invention, but are required for a satisfactory operation of tube **13**, are not shown in figure since they are well known in the art.

During normal operation, a maximum current of 1.2 ma may flow through the NTC-resistor **11** in the embodiment shown (30 w. at 25 kv.). This resistor is chosen in a manner such that the resistance value is, for example, 33 kΩ at a current of 1 ma. With this resistance value and an anode-ground capacitance **12'** of approximately 2200 pf., a satisfactory smoothing of the rectified high voltage is ensured at a pulse recurrence frequency of 15,625 c./s.

If a flashover in the form of an arc discharge occurs between the anode **12** and, for example, the means **16**, which may be connected through a small spark gap to the outer coating **14**, which in turn is connected to ground, then a large dissipation of short duration occurs in the NTC-resistor **11**. As a result, the resistance value of NTC-resistor **11** radially decreases to a very low value. It was found that although the short-circuit current achieved a higher peak value of short duration on account of the decrease in resistance of NTC-resistor **11**, the power actually dissipated in the resistor **11** had decreased greatly relative to the power which would have been dissipated in a constant resistor of 33 kΩ. According to the invention, a satisfactory smoothing by means of a smoothing resistor **11** having a high value is obtained in the manner described, while said resistor is not destroyed in case of a short circuit of the anode-ground capacitance **12'**. Even if a direct connection between anode **12** and ground is applied, NTC-resistor **11** was found not to be destroyed during the comparatively long short-circuit period, which is determined by a safety circuit (not shown) associated with the high-voltage generator **1**. If a current-dependent short-circuit safety element is used in the device, e.g., a fuse, then it will be possible for said device to be switched off due to the larger short-circuit current that occurs as a result of the NTC-resistor having decreased in value. Without the decrease in resistance of resistor **11**, the short circuit current might be too small to blow the fuse, so that the resistor would finally burn out.

It will be evident that the disclosed embodiments of the high-voltage generator **1** and the rectifying circuit are not decisive of the invention.

High-voltage generator **1** may be constructed both as a pulse and a fly-back driven high-voltage generator. The pulse type is sometimes used when a large high-voltage power must be generated, to which end a special transformer **2** has been placed in, for example, a colour television receiver or projection television apparatus. The fly-back driven type simultaneously generates a saw-tooth deflecting current for the line deflection coils of a television display tube **13**. This is shown in the figure by the series arrangement of a line deflection coil **17** and a capacitor **18** connected in parallel with primary winding **5** of transformer **2**. The flyback driven high-voltage generator may then be provided with a booster or a shunt efficiency diode.

The rectifying circuit arrangement is shown in the figure by a vacuum diode **9** and a capacitor **10**. Diode **9** may also be constructed as a semiconductor diode while capacitor **10** may be a coaxial cable.

It will also be evident that the device according to the invention may be provided with a control circuit which, apart from the ripple, must receive a generated high voltage at a more or less constant value. Voltage multiplication arrangements may also be used.

What is claimed is:

1. Apparatus for continuously supplying a substantially constant high DC voltage to an electrode of a cathode ray tube comprising, a high voltage generator having an output terminal at which periodically occurring high voltage pulses are produced, rectifying means including a capacitor for developing said high DC voltage, means connecting said rectifying means to said output terminal, and a filter circuit coupled between said rectifying means and said tube electrode and including a resistor having a negative temperature coefficient of resistance, said resistor having a given time delay in its resistance variation as a function of applied voltage such that the resistance remains substantially constant at the ripple frequency of said high voltage but rapidly decreases to a very low value in the event said electrode is short-circuited.

2. Apparatus as claimed in claim **1** wherein said rectifying means comprises a diode connected in series with said capacitor across said high voltage generator, and said negative temperature coefficient resistor is connected in series with said diode between the output terminal and the tube electrode.

3. Apparatus as claimed in claim **1** wherein said high voltage generator comprises a transformer connected to said output terminal, and a DC voltage source and a switching element coupled to said transformer.

4. Apparatus as claimed in claim **1** wherein said rectifying means comprises a diode and said capacitor comprises a coaxial cable.

5. Apparatus as claimed in claim **1** wherein said high voltage generator comprises a flyback driven high voltage generator that simultaneously generates a deflection current for the line deflection coils of said cathode ray tube.

6. In a display system including a cathode ray tube having a cathode and at least one electrode that requires a substantially constant high DC voltage relative to the cathode, the improvement comprising, a source of high voltage pulses, a rectifier circuit comprising a diode and a capacitor connected across said pulse voltage source, and a filter circuit connected between the output of said rectifier circuit and said tube electrode, said filter circuit including a series connected negative tempertaure coefficient resistor that exhibits a predetermined time delay in its resistance variation as a function of applied voltage so that said resistor does not respond to the normally occurring frequency components of the voltage supplied by said pulse voltage source.

7. A display system as claimed in claim **6** wherein said pulse voltage source comprises the horizontal deflection transformer of a magnetic beam deflection system for said cathode ray tube.

8. A circuit for supplying a high DC voltage to an electrode of a cathode ray tube comprising, a source of high voltage, a rectifier circuit comprising a diode and a capacitor connected across said voltage source, and a filter circuit connected between the output of said rectifier circuit and said tube electrode, said filter circuit including a series connected negative temperature coefficient resistor having a negative resistance region in its V-I characteristic.

9. A circuit as claimed in claim **8** further comprising means directly connecting said negative temperature co-

efficient resistor between the output electrode of said diode and said tube electrode.

References Cited

UNITED STATES PATENTS

2,628,326 2/1953 Bridges ..... 315—27

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U.S. Cl. X.R.

321—11; 317—41