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HIGH VOLTAGE POWER SUPPLY SYSTEM FOR CATHODE RAY TUBES EMPLOYING PROTECTIVE TIME DELAY MEANS

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Fig. 1

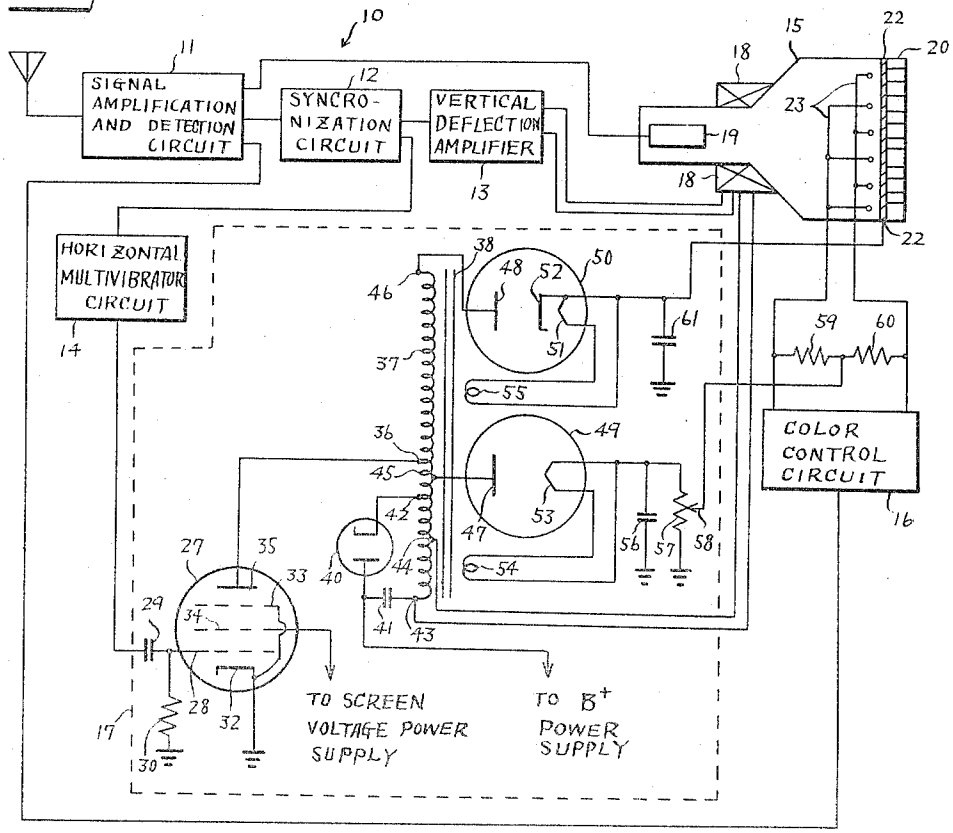


Fig. 2

PRIOR ART

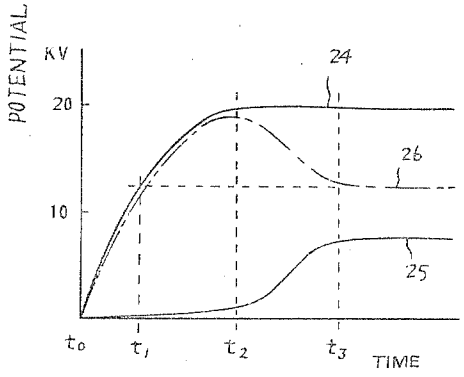
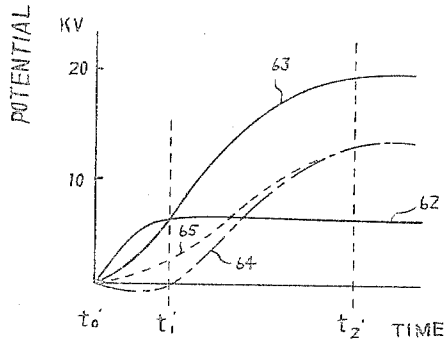


Fig. 3



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HIGH VOLTAGE POWER SUPPLY SYSTEM FOR CATHODE RAY TUBES EMPLOYING PROTECTIVE TIME DELAY MEANS

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This invention was evolved with the general object of increasing the efficiency and prolonging the life of post-acceleration or focusing type cathode ray tubes, such as Chromatron tubes, although it will be understood that various features of the invention have other applications.

This invention is based in part upon the discovery that power supply systems of the prior art tend to cause premature failure of such cathode ray tubes because they allow excessive potentials to develop between closely spaced electrodes during the starting period. In a Chromatron tube, the back of a layer of phosphors making up the screen is covered with a metallic film which is electrified to a high potential, approximately 20,000 volts, during operation. A pair of fine grids of conducting wire, which serve to deflect the electron beam according to the color signals received, is placed behind and in close proximity to the metallic film covering the phosphors on the tube face. A potential of between ⅕ to ⅓ of that applied to the metallic film is applied to these grids under normal operating conditions. The difference in potential, ⅔ to ⅘ of that applied to the metallic film, between the grids and the metallic film will not damage the tube under normal steady state operation.

It has been found that Chromatron tubes connected to a circuit designed according to the prior art may be damaged during the transient starting up period because the prior circuits allowed the metallic film to reach its operating potential, approximately 20,000 volts, while the grids remained at a relatively low potential. The resultant electrostatic forces were strong ennough to cause the metallic film to be pulled from the face and accelerated into the grid where it could cause breakage or become an obstacle in the path of the electron beam. In some cases it caused the phosphorescent screen to come off the face of the tube.

According to this invention, the potentials applied to the closely spaced electrodes of an electron tube such as a Chromatron are derived from circuits whose starting time constants are so matched that an excessive voltage difference between closely spaced electrodes cannot be realized during the transient start up periods.

Specific features of the invention reside in circuits which are comparatively simple and economical in construction and operation while providing the proper starting time characteristics in a highly reliable and efficient manner.

This invention contemplates other objects, features and advantages which will become more fully apparent from the following detailed description taken in conjunction with the accompanying drawings which illustrate a preferred embodiment and in which:

FIGURE 1 is a schematic electrical diagram illustrating a color television reproducing system constructed according to the principles of this invention;

FIGURE 2 is a graph of the potentials appearing at and between the metallic film and grids of a Chromatron connected to the circuit utilizing the prior art during the starting period; and

FIGURE 3 is a graph of the potentials appearing at and between the metallic film and grids of a Chromatron connected to the circuit utilizing this invention during the starting period.

FIGURE 1 illustrates a color television reproducing system generally designated by the reference numeral **10**. The system **10** comprises a signal amplification and detection circuit **11**, a synchronization circuit **12**, a vertical deflection circuit **13**, a horizontal multivibrator circuit **14**, and a Chromatron type cathode ray viewing tube **15**, all of which are well known in the art. The system **10** also contains a color control circuit **16**, preferably of the type disclosed in my application for patent, Ser. No. 284,679, and a high voltage power supply and horizontal deflection circuit **17** which is the subject of this invention.

The Chromatron tube **15**, which is encircled by a deflection coil **18**, contains an electron gun **19** and has a phosphorescent face **20** of the type required for reproduction of color television signals. Coated to the back of the phosphorescent face **20** is a metallic film **22**. In close proximity to the metallic film is a pair of wire grids **23** which serve to control deflection of the electron beam toward the proper phosphors on the face **20** in accordance with the commands of the color control circuit **16**.

When a high voltage power supply and horizontal deflection circuit of the prior art is substituted for the circuit **17** of this invention, the voltages as a function of time after start-up appearing upon the metallic film **22** and the grids **23** are shown by curves **24** and **25**, respectively, of FIGURE 2. The voltage applied to the metallic film **22** reaches its steady state value at a time t_2 but the voltage at the grids **23** does not reach its steady state value until a time t_3 which is longer than time t_2. The voltage difference between the metallic film **22** and the grids **23**, shown as a function of time by curve **26** of FIGURE 2, exceeds its steady state value after time t_1 and reaches a maximum of nearly full anode potential at time t_2 before dropping to its steady state value after time t_3. The strong electrostatic forces caused by the high difference in potential between the electrodes at time t_2 are the cause of tube damage.

The circuit **17** solves the problem of excessive interelectrode potentials by exploiting the difference in warm-up characteristics of two different high voltage diode rectifiers, but other means can of course be utilized.

The circuit **17** contains a power amplifier vacuum tube **27** which has its control grid **28** connected to the horizontal multivibrator circuit **14** through a DC blocking capacitor **29**, a resistor **30** being connected between the grid **28** and ground. A cathode **32** is grounded. The preferred embodiment utilizes a beam power pentode in which a pair of beam forming plates **33**, diagrammatically illustrated as a grid, are connected to the cathode. A positive potential of about 150 volts is applied to a screen grid **34**. Other amplification devices may be substituted without deviating from the scope and purpose of this invention. A plate **35** of the amplifier tube **27** is connected to a tap **36** of a primary winding **37** of a transformer **38**, known in the art as a horizontal flyback transformer. The circuit is connected to a power supply of approximately 350 volts potential through a diode **40** which also serves, along with a capacitor **41**, to damp out excessive oscillations. The cathode of the diode **40**, which diode may be any type of electrical rectifying device but which is illustrated here as a vacuum tube diode, is connected to a tap **42** on the primary winding **37**. Terminal **43** and a tap **44** are connected to the horizontal deflection coils of the deflection coil assembly **18** on the Chromatron tube **15**. Tap **45** and terminal **46** are connected to anodes **47** and **48**, respectively, of two specially chosen rectifiers **49** and **50**, respectively, in a manner to be described. The location and connection of all the taps on the transformer **38** is made in a manner well known in the art.

In this embodiment, the transformer **38** is constructed so that the potential appearing between the tap **46** and

ground during the flyback interval is upwards of 20,000 volts. Similarly, the tap **45** is so placed that the potential between it and ground is upwards of 8,000 volts.

Rectifier **49** is preferably a directly heated cathode type of high voltage vacuum diode rectifier such as a 1X2A, having a comparatively fast warm-up time. A semiconductor diode or the like having a fast warm-up time may also be employed. Rectifier **50** is preferably an indirectly heated cathode or heater cathode type of high voltage vacuum diode rectifier such as a 3A3. It has a filament **51** which is encased in a cathode **52**, a metallic sleeve fitted around the filament and treated so as to have a high electron emission at operating temperatures.

The filament **53** of the rectifier **49** is connected to a secondary winding **54** on the transformer **38**. Similarly, the filament **51** of the rectifier **50** is connected to a secondary winding **55** on the transformer **38**. The cathode **52** is connected to the filament **51**.

The filament **53** of the rectifier **49** is connected to one end of a filter capacitor **56** and one end of a potentiometer **57** which can be adjusted to set the voltage at the grid **23** to the desired level. The other ends of the capacitor **56** and potentiometer **57** are connected to ground. A movable tap **58** of the potentiometer **57** is connected to a pair of balancing resistors **59** and **60** which couple the high voltage to the color control circuit **16** and the color control grids **23**.

The cathode **52** of the rectifier **50** is connected to a filter capacitor **61** which is connected between the metallic film **22** and ground. The values of the capacitors **56** and **61** may be chosen to control the time required for the electrodes, here the metallic film **22** and the grids **23**, to reach their steady state operating potential.

When the receiver **10** is turned on, the horizontal multivibrator circuit **14** transmits a saw-tooth signal to the grid **28** of the amplifier tube **27** which in turn causes currents to flow in the primary winding **37** of the transformer **38** in the manner well known in the art. The taps **45** and **46** reach operating potential almost immediately after the start-up period of the amplifier tube **27** and the diode **40** by reason of the autotransformer effect of the primary winding **37**. The voltages appearing across the secondary windings **54** and **55** cause currents to flow in the filaments **53** and **51** respectively. The filament temperatures start to rise to operating levels, but because the filament **53** is smaller and lighter than the filament **51** and cathode **52**, its instantaneous electron emission as a fraction of its steady state electron emission is higher than the comparative electron emission of the indirectly heated cathode **52** at all times during start-up. In other words, at any given time during the starting period, rectifier **49** conducts a higher percentage of its steady state current than does rectifier **50**. This causes the capacitor **56** to charge up to operating potential at a faster rate than the capacitor **61**, other factors being equal. The result is that the grids **23** of the Chromatron tube **15** reach operating potential before the metallic film **22**.

In the preferred embodiment shown here, the control grids **23** reach operating potential, shown as a function of time in curve **62** of FIGURE 3, at a time t_1' while the metallic film reaches its operating potential at time t_2', shown as a function of time by curve **63** of FIGURE 3. Because the voltage on the metallic film **22** is less than

the voltage on grids **23** before time t_1' the maximum allowable interelectrode voltage is never exceeded and the tube is not subjected to excessive forces which cause premature failure. The potential between the metallic film **22** and the grids **23** as a function of time is shown by broken line curve **64** of FIGURE 3. As illustrated, a negative potential is applied from time t_0' to time t_1' which ordinarily has no effect. However, if desired, the starting characteristics may be adjusted to obtain a potential which gradually rises to the steady state value as shown by the dotted line curve **65**.

It will be apparent that the invention may be applied to electron tubes other than the Chromatron and to other devices which require protection from excessive interelectrode voltages during starting periods, and that other circuit arrangements and components may be employed to obtain starting characteristics such as to provide such protection.

It will be understood that many other modifications and variations may be effected without departing from the spirit and scope of the novel concepts of this invention.

What I claim is:

1. Apparatus for supplying a first potential and a higher second potential to a first and second electrode of a post-acceleration type cathode ray tube comprising first and second power supplies connected to a source of electrical energy of predetermined maximum potential for supplying the first and second potentials, respectively, said first and second power supplies having respectively associated therewith first and second time delay circuits, said two time delay circuits having time constants selected such that when said two power supplies are connected to said energy source the potential difference between said two electrodes is controlled and said apparatus may be operated without damage.

2. Apparatus as recited in claim **1**, wherein the time delay of said second time delay circuit is at least equal to that of said first time delay circuit.

3. Apparatus as recited in claim **1**, wherein said two power supply circuits contain a first and second rectifier, respectively, said second rectifier having an indirectly heated cathode.

4. Apparatus as recited in claim **3**, wherein said first rectifier has a directly heated cathode.

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