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HIGH VOLTAGE SLEWING OF PENETRATION TUBE GUN

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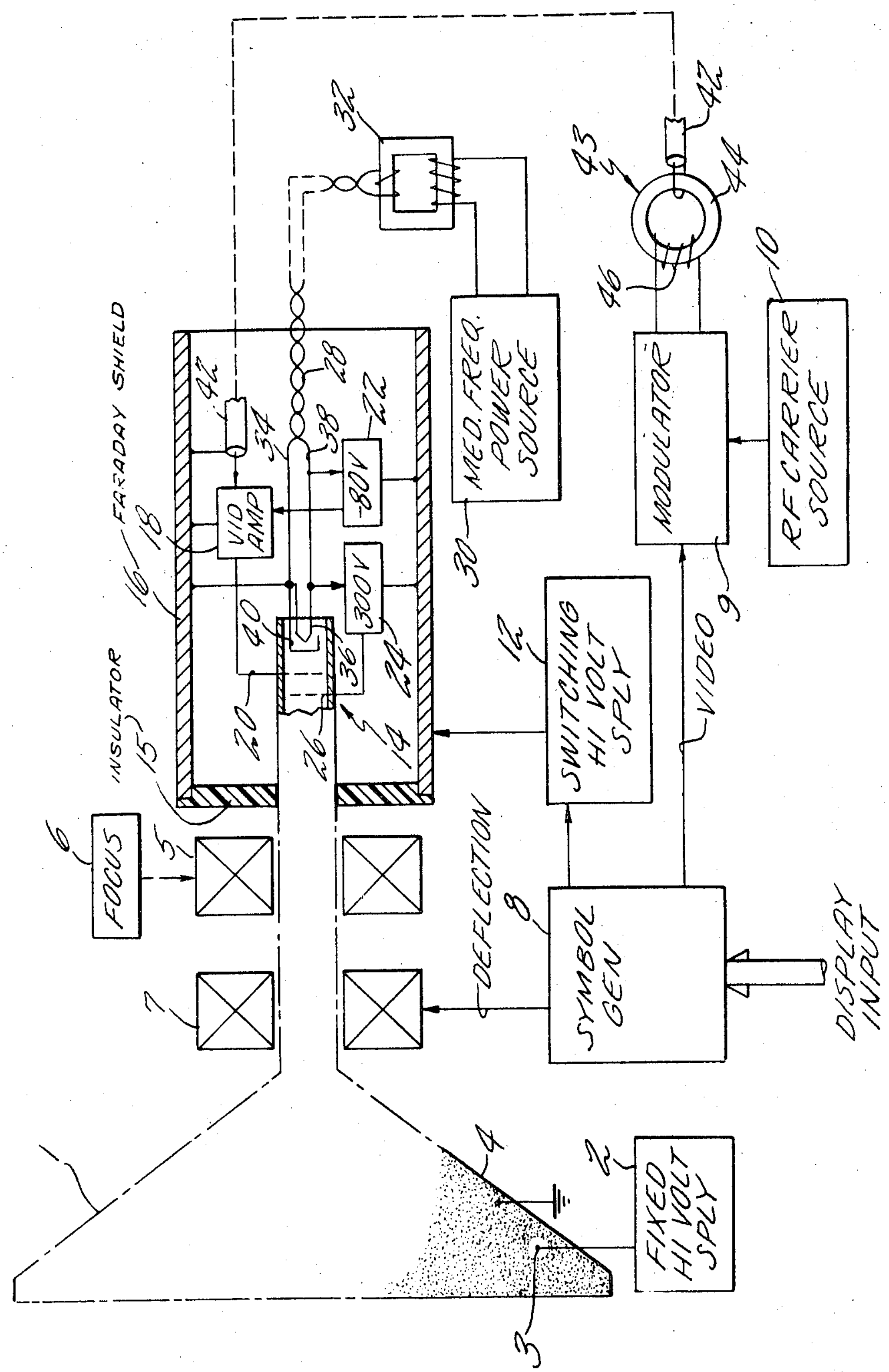

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HIGH VOLTAGE SLEWING OF PENETRATION TUBE GUN

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ABSTRACT OF THE DISCLOSURE

The electron gun of a multiple penetration type cathode ray tube is completely surrounded by a shield which houses circuitry for operating the gun with potentials referenced to the shield. The circuitry is coupled through high voltage isolation to external circuitry such as power sources and a source of video. The anode of the CRT is maintained at a constant high voltage potential, whereas the shield and the gun are slewed many kilovolts between high voltages so as to provide variable to penetration of the CRT beam in order to excite selected phosphors.

BACKGROUND OF THE INVENTION

Field of invention

This invention relates to improvements in arrangements of high voltage in multiple phosphor penetration cathode ray tube circuitry.

DESCRIPTION OF THE PRIOR ART

As is known in the art, a cathode ray tube comprises an evacuated glass bulb, necked down at one end wherein an electron beam gun is situated. Various focusing electrodes, grids and sweep generating coils or plates and other apparatus are also located along the necked down portion. The working element of the electron beam gun is the cathode which is nominally held at a low potential. To accelerate the electrons rapidly into a beam which has a substantially constant velocity throughout most of the length of the tube as the electrons flow toward the screen of the tube, a conductive coating is utilized throughout substantially the entire internal surface of the tube, except immediately adjacent to the gun. In addition, a thin aluminum layer (or the equivalent) covers the entire inner surface of the screen (the front face of the tube) and a high voltage (5 kv. to 20 kv. is typical) is applied to this inner conductive layer, and to the conductive coating, which operates to accelerate the electrons to the proper velocity to impact the particles of the phosphor in a fashion to create the light image as desired. The high voltage on this coating, however, creates problems with metal surfaces and circuitry external to the tube; that is to say the coating on the inside of the tube forms a capacitor with any conductive element adjacent the outside of the tube. To isolate the high voltage in the tube from circuitry surrounding the tube, it is very common to employ a conductive coating on the outside of the tube which is typically a carbon wash of some sort. This outer coating is grounded so as to provide the desired isolation. However, the outer and inner coatings, separated by a dielectric (the glass of the tube wall), form a capacitor.

Multiple phosphor penetration type cathode ray tubes have additional problems. A multiple phospor penetration type tube is one which either has composite phosphors in which an inner phosphor is one color (green or blue), completely surrounded by a different phosphor (such as red), all of these particles together forming the phosphor surface on the screen. If the electron beam impacts the screen with a very high velocity, the inner

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phosphor will be excited and the light generated will be the color of the inner phosphor; if however the beam impacts the phosphor with a lesser velocity, then only the outer layer is excited and so the other color (such as red) will emanate. Another type of multiple phosphor penetration type tube employs two separate layers of phosphor separated by an energy sensitive barrier layer. Other penetration CRT's, similar to the multi-color penetration CRT's, may employ phosphors of different persistence or other characteristics rather than only of different colors. Although general knowledge is limited as to the method of manufacture of tubes of this type, of high quality, with a high contrast between the effect of the selectable phosphors as a function of control of the voltage which accelerates the beam, tubes of the type described hereinbefore are readily available in commerce from companies such as RCA, Sylvania, and others.

The key to operation of a multiple phosphor penetration type CRT is to provide a beam of the correct energy on a point by point basis as a picture is being developed on the screen of the CRT. In order to alter the intensity of the beam from point to point as necessary to excite the desired phosphor in the generation of the picture, it becomes necessary to switch the high voltage at video rates. Thus, once the high voltage starts switching at high frequency, the entire system acts much the same as an antenna, creating strong fields about the tube. For instance, switching from 6 to 12,000 volts at video rates, comprising a square wave, provides significant frequency components as high, perhaps, a 50 kHz. If one were to approach the front of the screen one would have extreme discomforture and perhaps even feel a significant shock as a result of this high voltage field. In order to overcome this problem in penetration type tubes, an RF shield is placed in front of the screen, which is grounded so as to isolate persons and objects in the vicinity of the front of the screen from the RF field generated by switching of the high voltage. This in turn provides another significant capacitance between ground and the high voltage acceleration layer within the tube.

The total capacitance of the high voltage acceleration layer or anode inside of the tube to ground (represented by the shielding coating on the outside of the tube and the RF shield at the front of the tube) renders it difficult to change the high voltage by large amounts at a rapid rate. For instance, to change from an acceleration voltage on the order of 6,000 volts to an acceleration voltage on the order of 14,000 volts (which may obtain in a typical large screen application), may require driving as much as several thousand pico farads, which could in turn require as much as two or three amperes. This can be seen to require a power supply capable of delivering on the order of 10 to 20 thousand watts peak.

Assuming that one has a suitable power supply to handle the aforementioned difficulties, there is nonetheless an additional associated problem. Because of the difficulties of connecting the anode coating inside of the tube with a power supply, through the tube wall, anode voltages are typically applied at one electrode only. However, in a large screen CRT (which may be as much as 24 inches in diameter), it is obvious that all of the capacitance described hereinbefore is distributed about a large area of tube surface. Thus the voltage may change more quickly at points immediately adjacent the anode terminal than would occur on the opposite sides of the tube, which are some distance away, due to the resistance of the conductive coating. The tube must therefore be blanked out once a voltage change is initiated until steady state conditions can be established with an equipotential layer throughout the screen of the tube. This slows down the rate at which the video can be changed in the tube; otherwise, defocusing and errors in deflection and other picture degradation will result.

SUMMARY OF INVENTION

The object of the present invention is to provide improvements in multiple phosphor penetration CRT systems, and particularly in the high voltage arrangements therein.

According to the present invention, the anode of a multiple phosphor penetration cathode ray tube is held at a constant potential, and the gun of the cathode ray tube, including the immediate circuitry for operating it, are all slewed upward and downward by the desired voltage differential.

In further accord with the present invention, the gun and its associated equipment are located within a Faraday shield, whereby the slewing of the high voltage has no effect on the circuitry within the Faraday shield. In still further accord with the present invention, essentially only two connections are made between the circuitry within the Faraday shield and the outside world; these comprise an alternating current source of power which may conveniently be supplied thereto by a twisted pair fed through a high voltage isolation transformer, and video superimposed on an RF carrier supplied over a coaxial line through a high voltage isolation transformer.

The present invention provides significant reduction in the capacitance which has to be driven in a high voltage voltage-switching multiple phosphor penetration cathode ray tube. In addition, the present invention avoids the necessity of an RF shield since the high voltage at the screen remains constant. The present invention, by keeping the screen at the same potential at all times, completely eliminates the necessity of establishing steady state conditions each time that the high voltage is switched in order to avoid focus and deflection ambiguities and the resulting degradation of the picture quality.

The present invention is readily implementable using standard technology without significant penalties in cost, weight or size.

Other objects, features and advantages of the present invention will become more apparent in the light of the following detailed description of a preferred embodiment thereof, as illustrated in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The sole figure herein comprises a simplified, illustrative schematic block diagram of a preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, a typical embodiment of the present invention is shown as it may be implemented in a video display unit. A cathode ray tube **1** is provided with a fixed high voltage supply **2** which is connected to an anode electrode **3** on the CRT to provide the acceleration voltage to the anode of the CRT. The CRT **1** may be provided with an external conductive coating **4** which is grounded to isolate structure external of the tube **1** from the high voltage on the anode, as is known in the art. The CRT is also provided with a focus coil **5** which is driven by suitable focus circuitry **6** which may be of the type well known in the art and which is not described further herein. A deflection coil **7** is driven by a symbol generator **8** which may in turn receive signals from apparatus, such as a computer, a radar system or other apparatus, the data output of which is to be displayed. The symbol generator **8** also provides video to a modulator **9** which modulates the video on an RF carrier provided thereto from an RF carrier source **10**.

In accordance with the invention, a high voltage switching power supply **12** is controlled by the symbol generator **8** so as to provide a swing in high voltage applied to the gun **14** of the CRT **1**. The high voltage supply **12** is connected to a Faraday shield structure **16**, which completely surrounds the gun **14** and circuitry utilized to operate the gun **14**. The Faraday shield **16** may take the form of a hollow aluminum cylinder, or other shapes of other conductive materials as may be desired in any given utilization of the present invention. As shown in the figure, the Faraday shield **16** is supported by an insulating disc **15** which slips over the neck of the tube. Additional support may be provided by similar insulating discs located midway within the shield (but eliminated herefrom for simplicity) which may conveniently have the CRT tube socket (not shown) fastened thereto, whereby the shield **16** will derive support from the base (not shown) of the tube; however, the Faraday shield **16** may be supported by external structure or in any other way found suitable.

Located within the Faraday shield **16** is a detector and amplifier **18** of a common type which is utilized to drive the control grid **20** of the CRT. Also, a suitable power supply for the video amplifier is included within the Faraday shield **16**; this may typically comprise a −80 volts supply **22**. A 300-volt supply **24** is provided to maintain the potential of the screen grid **26** of the CRT. Power for the power supplies **22**, **24** is provided by a twisted pair of leads **28** which is connected externally of the Faraday shield **16** to a medium frequency power supply **30**, which may typically supply 6.3 volts (to match the heater voltage of the CRT) at about 50 kHz. The power supply **30** is coupled to the twisted pair **28** by a high voltage isolating transformer **32** which may comprise a ferrite core with suitable insulation and a proper assemblage of windings in accordance with well known teachings of the art. Within the Faraday shield **16**, one wire **34** of the twisted pair comprises ground and is connected to the Faraday shield **16**. One side of the heater is similarly grounded to the shield **16**, and the other side of the heater is connected directly to the other wire **38** of the twisted pair **28** along with the power supplies **22**, **24**. The cathode **40** of the CRT is connected directly to the shield **16** so that it is slewed between upper and lower DC voltages applied thereto by the switching high voltage supply **12**. The video detector and amplifier **18** derives the video input from a coaxial line **42** which is coupled through a single turn to a high voltage isolating transformer which may typically comprise an iron dust core (or it may be an air core) which is coupled to a primary **46** driven by the modulator **9**. The transformer **43** may be designed in any desired fashion so as to satisfy the requirements of the carrier (which may typically be 80 mHz.) provided by the source **10**.

In operation, in accordance with the color of a given symbol to be written on the face of the CRT **1**, the symbol generator **8** causes the high voltage switching supply **12** to change from one voltage to another so that the total acceleration voltage between the cathode **40** and the anode **3** of the CRT changes from one voltage to another. As an example, the fixed high voltage supply **2** might be at a potential of positive 9 kv. and, in a two-level penetration type application, the switching high voltage supply **12** may typically provide minus 4 kv. and plus 4 kv. Thus the total acceleration voltage would vary from 5 kv. to 13 kv. However, depending on the type of CRT being driven, more than two voltage levels may be supplied by the switching high voltage power supply **12**; for instance, in a tube capable of generating four different colors, four different voltages may be provided by the switching high voltage supply **12**.

The use of a medium frequency power supply to introduce power to the circuitry within the Faraday shield **16** is convenient since the size, weight and cost of the transformer can be lower at a higher frequency than for standard power frequencies. Of course, other frequencies could be utilized if desired in any given implementation of the present invention.

It should be appreciated that the magnetic coupling provided by the high voltage isolation transformer **43** in coupling the video from the outside world into the Faraday shield **16** is essential in order to isolate the high voltage DC of the Faraday shield **16** from the circuitry outside thereof. In contrast, if one attempted to use capacitive coupling for the video, the video signal would be superimposed on the high voltage, and it would be impossible to isolate the circuitry within the Faraday shield **16** from the high voltage. The shield **16** should be sufficient to provide substantially complete RF shield of the components **14, 18, 22** and **24** from the outside world, so that they can function together in their own world which is many volts elevated from the surrounding structure outside the shield **16.**

Thus, although the invention has been shown and described with respect to a preferred embodiment thereof, it should be understood by those skilled in the art that the foregoing and various other changes and omissions in the form and detail thereof may be made therein without departing from the spirit and the scope of the invention.

Having thus described typical embodiments of my invention, that which I claim as new and desire to secure by Letters Patent of the United States is:

1. A multiple penetration cathode ray tube apparatus adapted to provide significant rapid alteration of the cathode ray beam accelerating voltage, comprising:

a multiple penetration cathode ray tube having an anode and an electron gun including a cathode;

a Faraday shield surrounding said electron gun sufficiently to provide substantially complete RF shielding thereof;

high voltage isolation means;

external circuit means disposed outside of said shield for supplying power and video signals for the operation of said gun;

shielded circuit means disposed within said shield, said shield providing substantially complete RF shielding of said shielded circuit means, said shielded circuit means providing operating potentials and signals referenced to said shield for operating said electron gun in response to signals applied thereto by said external circuit means through said high voltage isolation means;

a fixed high voltage supply connected to the anode of said cathode ray tube; and

a switching high voltage supply capable of providing at least two different voltages connected at least to said shield and to said cathode.

2. Apparatus according to claim **1** wherein:

said external circuit means includes video means providing a video signal modulated on an RF carrier;

said shielded circuit means includes a video detector and amplifier disposed in said shield and operating with the potential of said shield as a reference potential; and

said isolation means includes a high voltage isolation RF transformer having a primary coupled to said video means and a single turn secondary coupled through the central conductor of a coaxial cable to said video detector and amplifier, the outer conductor of said coaxial cable being connected to said shield.

3. Apparatus according to claim **2** wherein:

said external circuit means includes a medium frequency power source; and

said isolation means includes a high voltage isolation transformer having a primary coupled to said medium frequency power source, and connection means comprising a twisted pair connected to a secondary of said transformer and applying the voltage therefrom between said shield and said shielded circuit means.

4. Apparatus according to claim **1** wherein:

said external circuit means includes a medium frequency power source; and

said isolation means includes a high voltage isolation transformer having a primary coupled to said medium frequency power source, and connection means comprising a twisted pair connected to a secondary of said transformer and applying the voltage therefrom between said shield and said shielded circuit means.

5. Apparatus according to claim **4** wherein said electron gun includes a screen grid and said shielded circuit means further includes a power supply for said screen grid powered by said twisted pair.

6. Apparatus according to claim **4** wherein said electron gun includes a cathode heater element connected to said twisted pair.

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