

Feb. 21, 1961

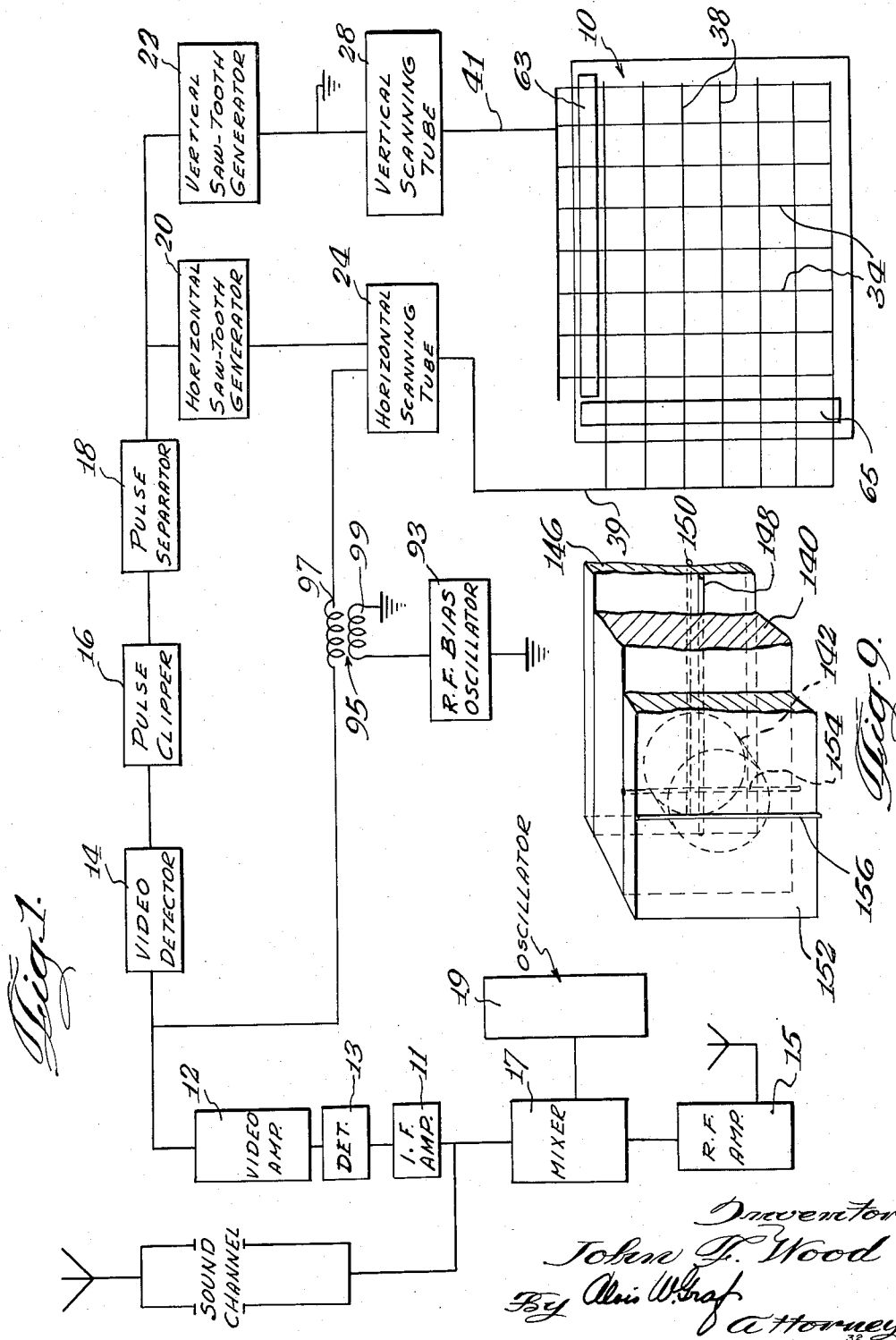
J. F. WOOD

2,972,707

IMAGE REPRODUCING DEVICE

Filed Oct. 18, 1954

3 Sheets-Sheet 1



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IMAGE REPRODUCING DEVICE

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3 Sheets-Sheet 2

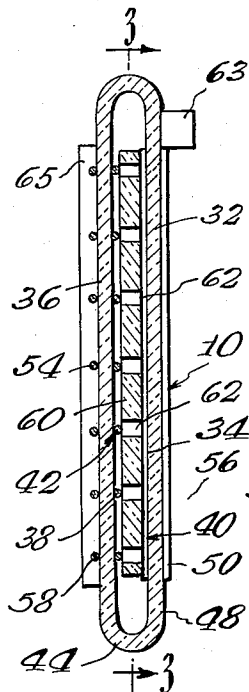


Fig. 2.

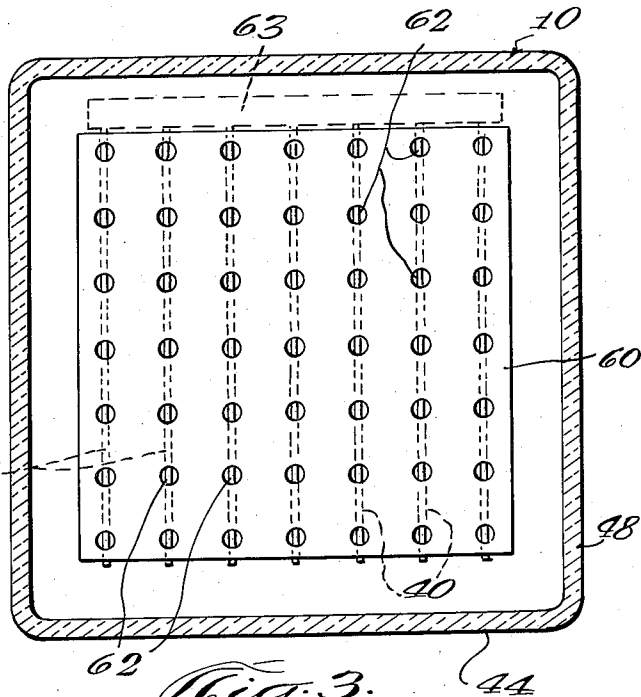


Fig. 3.

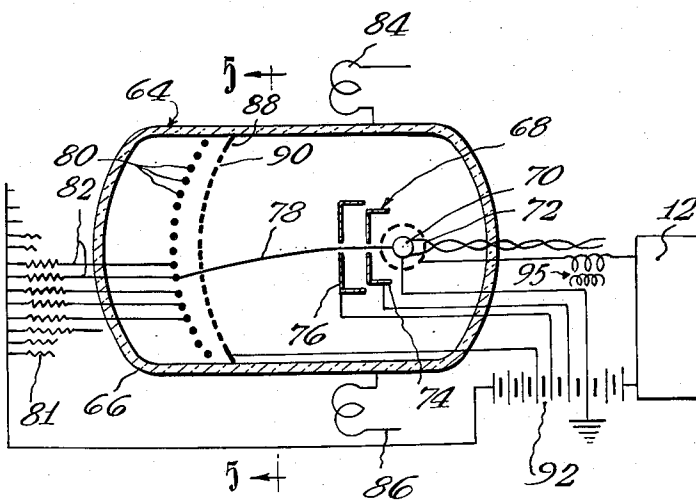
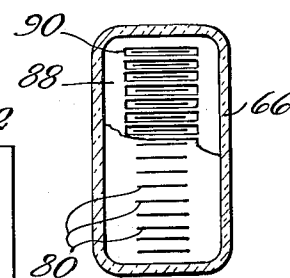


Fig. 4.

Fig. 5.



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IMAGE REPRODUCING DEVICE

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3 Sheets-Sheet 3

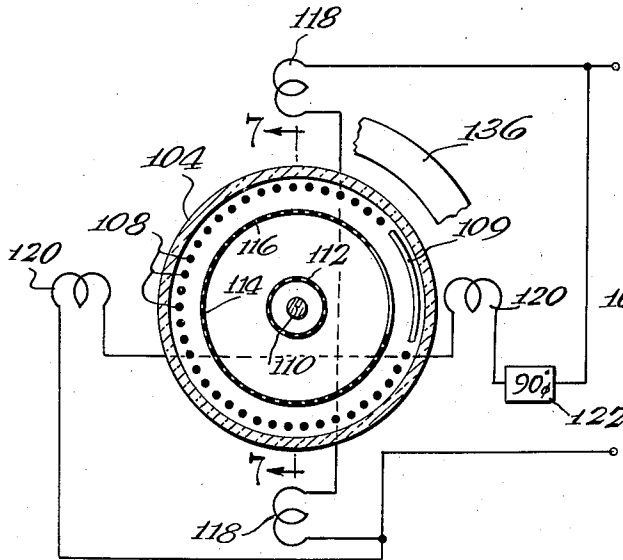


Fig. 6.

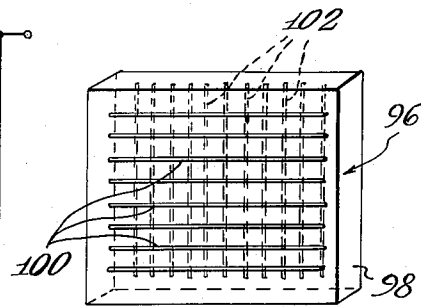


Fig. 8.

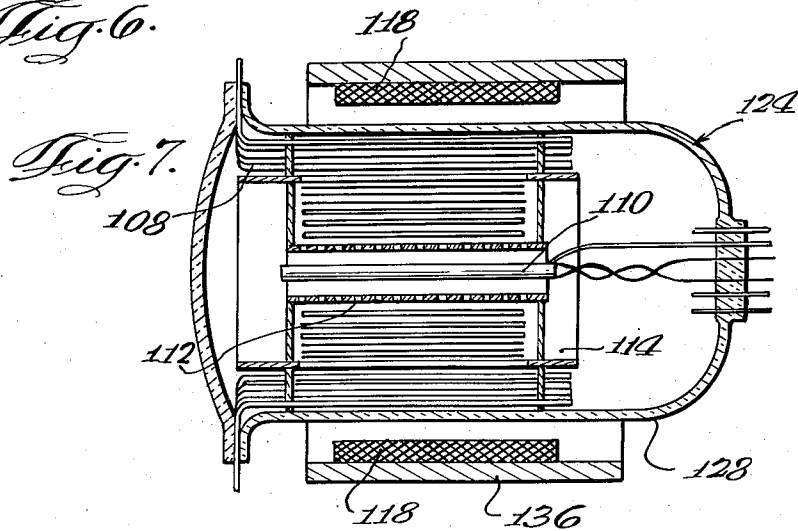


Fig. 7.

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IMAGE REPRODUCING DEVICE

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8 Claims. (Cl. 315—362)

The present invention relates to devices for reproducing images, and more particularly to non-recording image reproduction devices and image tubes suitable for use in such devices.

The non-recording image reproduction devices heretofore commonly used utilize a screen having a relatively large number of spaced picture elements. The picture elements are excited by a beam of electrons which impinges upon the screen, and the magnitude of the electron current determines the intensity of the light emitted by each of the picture elements. The electron beam is made to scan the picture elements, and the intensity of the beam is controlled for each picture element during the period of time the beam is impinging upon that element to provide the proper light emission for that particular point on the screen.

Since beams of electrons will not traverse a gaseous atmosphere, it is necessary to provide an evacuated region between the screen and the electron source for bombarding the picture elements of the screen. Generally, the light emitting properties of the screen are provided by a fluorescent coating disposed upon an inner relatively flat surface of an evacuated envelope constructed of light permeable material, and an electron gun is mounted within the envelope confronting the fluorescent coating. The larger the screen is constructed, the larger the evacuated envelope must be, and the larger the envelope the greater is the difficulty in maintaining a vacuum. Also, the electron gun must be disposed further away from the screen as the size of the screen is increased, since there is a limitation upon the angle through which an electron beam may be deflected. As a result of this construction, picture tubes with substantial screen areas require relatively large depths. Also, high potentials are required to accelerate electrons from the electron source to the screen. Further, the maximum luminosity of the picture elements in the screen is directly related to the accelerating potential of the electron beam. As a result, very large potential power supplies are required for image reproducing devices of this type.

It is an object of the present invention to provide an image producing screen which utilizes picture elements which are electro-luminescent rather than cathode-luminescent, i.e., picture elements which emit light by electrical excitation rather than excitation directly by an electron beam.

It is a further object of the present invention to provide, as one embodiment of the invention, a picture tube with a screen consisting of a plurality of gaseous discharge picture elements, and as a second embodiment of the invention, a picture tube with a screen consisting of a plurality of electro-luminescent picture elements.

It is a further object of the present invention to provide means for scanning the picture elements of a gaseous discharge picture element screen and an electro-luminescent picture element screen.

The man skilled in the art will readily perceive many advantages and objects of the present invention in addi-

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tion to those stated from a further reading of the specification, particularly when viewed in the light of the drawings, in which:

Figure 1 is a schematic circuit diagram of a television receiver constructed according to the present invention;

Figure 2 is a vertical section view of the image screen illustrated in Figure 1;

Figure 3 is a vertical sectional view of the image screen on a plane normal to that of Figure 2;

Figure 4 is a view of a scanning tube, partly schematic, and a schematic diagram of a circuit utilizing the scanning tube;

Figure 5 is a sectional view of the scanning tube taken along line 5—5 of Figure 4;

Figure 6 is a schematic circuit diagram of another embodiment of a scanning tube illustrating the scanning tube in vertical section;

Figure 7 is a horizontal sectional view taken along line 7—7 of the scanning tube illustrated in Figure 6;

Figure 8 is an elevational view of another embodiment of an image reproducing screen constructed according to the teachings of the present invention; and

Figure 9 is a fragmentary vertical sectional view of another embodiment of an image screen constructed according to the teachings of the present invention.

Figure 1 illustrates the present invention incorporated in a television receiver, although it is to be understood that the invention may be incorporated in any image producing device. As illustrated, an image reproducing screen 10, which will be described in detail hereafter, is connected to a video amplifier 12 of a television receiver. A video detector 14, a pulse clipper 16, a pulse separator 18, horizontal saw-tooth generator 20, and a vertical saw-tooth generator 22 of conventional design are interposed between the video amplifier 12 and the image screen 10 in the conventional construction. Also as in conventional television receivers, the video amplifier 12 is driven by an intermediate amplifier system having an I.F. amplifier 11 and detector 13, and an R.F. amplifier system including an R.F. amplifier 15, mixer 17 and oscillator 19. A horizontal scanning tube 24 is connected between the horizontal saw-tooth generator 20 and a plurality of horizontal electrodes 38 which form a part of the image screen 10 by means of a multiconductor cable 39. Also, a vertical scanning tube 28 is connected between the vertical saw-tooth generator 22 and a plurality of vertical electrodes 34, which are also a part of the image screen 10, through a multiconductor cable 41. The video amplifier 12, video detector 14, pulse clipper 16 and pulse separator 18 are conventional circuits and are used to key the horizontal saw-tooth generator 20 and the vertical saw-tooth generator 22 to the television signal emitted by a conventional television transmitter, and it is to be understood that these elements may be replaced by other circuits performing this function.

One embodiment of the image screen 10 is illustrated in Figures 2 and 3, and utilizes the phenomenon of gaseous discharge. A flat plate 32 is provided with a plurality of spaced parallel insulated electrical conductors 34 which are vertically disposed, as illustrated in Figures 2 and 3. A second plate 36 is also provided with a plurality of spaced parallel insulated conductors 38 which are normal to and confront the conductors 34. Collectively the conductors 34 constitute a grid 40 of parallel vertical electrodes and the conductors 38 constitute a confronting second grid 42 of parallel conductors which are normally disposed relative to the conductors 34 in the first grid 40. The ends of the plates 32 and 36 are sealed together by a wall 44 to provide a gas tight envelope 48 which is filled with a gas capable of maintaining a glow discharge when subjected to a potential gradient. An example of a suitable gas for maintaining a glow discharge is neon

at a pressure of approximately 5 centimeters of mercury, and an ignition voltage of between 55 and 75 volts will establish a glow discharge in neon of this pressure which will be sustained by a potential of approximately 15 volts lower.

In order to make electrical contact with the grids 40 and 42, counter-grids 50 and 54 are disposed on the outer surfaces of the plates 32 and 36, the electrical conductors 56 and 58 of these grids 50 and 54 being parallel to and confronting the conductors 34 and 38 in the grids 40 and 42. Direct electrical connection is made to the conductors 56 and 58 of the counter-grids 50 and 54, as will be hereinafter explained, and the capacity between the conductors 56 and 58 of the counter-grids 50 and 54 and the conductors 34 and 38 of the grids 40 and 42 is utilized to conduct a radio frequency signal to the grids 40 and 42. A plate 60 is disposed between the grids 40 and 42, and the plate 60 is provided with perforations 62 adjacent to each point of adjacency of the conductors in the grids 40 and 42, a point of adjacency being defined as the nearest point on any conductor in grid 40 to a conductor in grid 42. The envelope 48 contains an atmosphere consisting of argon at a pressure of 5 centimeters of mercury. Other suitable atmospheres for the envelope 48 are the other noble gases at a pressure of less than 15 centimeters of mercury. The atmosphere within the envelope 48 is selected to produce the desired color of glow and proper physical characteristics including luminous efficiency, transient ionization, response time (including deionization) and stability.

Each of the conductors 56 in counter-grid 50 is connected to the vertical scanning tube 28, and each of the conductors 58 in counter-grid 54 is connected to the horizontal scanning tube 24. Electrical connections to the grids 50 and 54 are made by a pressure fitting 63 adjacent to the periphery of grid 50 and a pressure fitting 65 adjacent to the periphery of grid 54. The envelope 48 is constructed of light permeable material, such as glass, and the perforated plate 60 is also constructed of light permeable material, such as a thin sheet of mica. As a result of this construction, the image screen 10 is essentially light permeable and a plurality of image screens of this construction may be disposed adjacent to each other, or stacked, for the purpose of providing depth perception or color, as will be hereinafter described. Because of the large number of connectors in the grids 40 and 42 and counter-grids 50 and 54, it is convenient to construct these grids by placing grooves in the plates 32 and 36 and spraying electrically conducting material on the surfaces of the plates 32 and 36. The electrically conducting material may then be scraped from the surfaces of the plates 32 and 36, leaving only a conducting layer in the grooves. Other methods of construction may also be employed, such as printed circuit techniques.

A suitable scanning tube for the horizontal scanning tube 24 is illustrated in Figures 4 and 5, it being understood that this scanning tube may also be used for vertical scanning tube 28. The scanning tube, designated 64, is provided with a gas-tight envelope 66 which contains an electron gun 68 adjacent to one end of the envelope 66. The electron gun 68 has a filament 70 surrounded by a cathode 72 and two pairs of beam focusing plates 74 and 76 in a manner conventional to electron guns presently used in the art. The electron gun 68 ejects an electron beam, illustrated at 78, in the form of a flat ribbon. A plurality of electrical contacts 80 are mounted on the interior surface of the envelope 66 confronting the electron gun 68, the electrical contacts 80 being electrically insulated from each other and provided with conductors 82 which extend through the envelope 66. Each of the contacts 80 is connected to the positive terminal of a power source 92 through plate resistor 81, and connected to one of the conductors of the multiconductor cable 39, or 41 if the tube is used as the vertical scanning tube. Thus when used as the horizontal scanning tube 24, each

of the contacts 80 is electrically connected to one of the conductors 58 of the horizontal counter-grid 54 of the image screen 10 through the pressure fitting 59 and the multiconductor cable 39, and when used as the vertical scanning tube 28, each one of the electrical contacts 80 is connected by the pressure fitting 63 and cable 41 to one of the conductors 56 of the vertical counter-grid 50.

A pair of magnetic deflection coils 84 and 86 are disposed adjacent to the exterior surface of the envelope 66 and aligned with the contacts 80 to deflect the electron beam 78 in a manner conventional in the art. When used as the horizontal scanning tube 24, as illustrated in Figure 4, the magnetic deflection coils 84 and 86 are connected to the output of the horizontal saw-tooth generator 24, so that the beam 78 will sweep all of the contacts 80 within the tube for each pulse generated by the generator 24. When used for the vertical scanning tube 28, the tube is connected to the vertical saw-tooth generator 22, rather than as illustrated in Figure 4. A plate 88 is disposed adjacent to the contacts 80 and is provided with an aperture 90 confronting each of the contacts 80 to permit the electron beam 78 to pass through the plate 88 to impinge upon the adjacent contact 80. The plate 88 is constructed of electrical conducting material and is connected to power source 92 which provides a positive potential thereon relative to the cathode 72 of the scanning tube 64 for the purpose of preventing the large positive potentials applied to the contacts 80 from diverting the electron beam 78. The deflecting electrodes 74 and 76 are also connected to the power source 92 and are maintained at a positive potential relative to the cathode 72. A positive potential of several hundred volts is connected to the contacts 80, as is illustrated in Figure 4.

The picture element is selected by the action of the horizontal scanning tube 24 and the vertical scanning tube 28. As indicated in Figures 1 and 4, the video signal with superimposed R.F. bias is introduced from the video amplifier 12 upon the cathode 72 of the horizontal scanning tube 24, and the vertical electrode 34 of the image screen 10 which completes the circuit is selected by the vertical scanning tube 28. The horizontal scanning tube 24 selects which of the horizontal electrodes 38 is to be connected to the R.F. signal appearing at the output of the video amplifier 12. In this manner, the combined video signal and R.F. bias is placed across the conductors 34 and 38 of the image screen 10, and produces the luminescence called for by the amplitude of the video signal appearing at the output of the video amplifier 12. It will be noted that both the horizontal counter-grid 54 and vertical counter-grid 50 of the image screen 10 are maintained at a relatively high positive D.C. potential, but relative to each other, there is only an R.F. bias potential.

The R.F. bias potential is supplied by an R.F. oscillator 93 which is coupled to the image screen 10 through the horizontal scanning tube 24 and a transformer 95 having a coil 97 connected between the horizontal scanning tube 24 and the video amplifier 12, as illustrated in Figure 1. The transformer 95 has a second winding 99 connected to the oscillator 93. The magnitude of the R.F. bias establishes the magnitude of video signal required to ignite and control the glow discharge of the picture elements. The R.F. bias also improves the linearity of the relation between light output and video signal.

Figure 8 illustrates another embodiment of the image reproducing screen constructed according to the teachings of the present invention and suitable for use in the circuit illustrated in Figure 1. This image reproducing screen, designated 96, comprises a plate 98 of electro-luminescent material, a plurality of parallel conductors 100 on one face of the plate 98 and a plurality of parallel conductors 102 which are normal to the conductors 100 on the opposite face of the plate 98. Again the conductors 100 and 102 may be constructed by forming grooves in the plate 98 and spraying electrically conductive material in

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the grooves, as was described with regard to the construction of image reproducing screen 10. It will be noted that there is no need for an inert atmosphere between the conductors 100 and 102, and that the only requirement is that the plate 98 have dielectric properties suitable for supporting electro-luminescence, these properties being well known.

Another type of scanning tube for horizontally scanning tube 24 or vertically scanning tube 28 is illustrated in Figures 6 and 7, Figure 6 showing a portion of the electrical circuit schematically. In this embodiment of the scanning tube, an evacuated sealed cylindrical tube 104 constructed of non-magnetic material, such as glass, is provided with a plurality of spaced insulated electrical conductors 108 disposed about the inner periphery of the tube 104 parallel to its axis. A gap is disposed between the conductors 108 at one side of the tube 104 providing a blanking interval 109, as will hereinafter be explained. An elongated filament 110 is disposed axially within the tube 104, and a cathode 112 with an electron emitting surface surrounds the filament 110. A shielding electrode 114 is interposed between the cathode 112 and the electrical conductors 108, and a slot 116 is disposed between each of the conductors 108 and the cathode 112.

A first pair of deflecting coils 118 are disposed upon opposite sides of the tube 104, and a second pair of deflecting coils 120 are also disposed upon opposite sides of the tube 104 and spaced midway between the deflecting coils 118. The deflecting coils 120 are connected in parallel with the deflecting coils 118 through a 90 degree phase shifting network 122. When used in the image reproducing device illustrated in Figure 1, the deflecting coils 118 are connected to the output of the horizontal saw-tooth generator 20, or the vertical saw-tooth generator 22, depending upon whether the scanning tube is used as the horizontal or vertical scanning tube. A magnet 136 in the form of a hollow cylindrical sleeve is disposed about the cylindrical tube 104 and is provided with permanent magnetic poles at its ends, thus providing an axial magnetic flux within the tube 104.

The filament 110 of the scanning tube emits electrons which assume trochoidal paths due to the presence of the axial magnetic field provided by the magnet 136. The saw-tooth pulses from the saw-tooth generator 20 or 22 cause the electrons moving in trochoidal paths to rotate as a beam about the axis of the scanning tube and to strike the conductors 108 successively. Which one of the conductors 108 that is to be bombarded by the beam of electrons is determined by the portion of the pulse which excites the deflecting coils 118 and 120 at the particular point of time, the beam contacting all of the conductors 108 responsive to each pulse. As the beam of electrons sweeps the blanking interval 109, no electrical contact is formed with a picture element for the period of time required for the electrons to sweep this portion of the tube 104, and hence the scanning tube 104 is properly keyed to the transmitted signal.

Figure 9 illustrates fragmentarily another embodiment of the image reproducing screen constructed according to the teachings of the present invention. It also may be used in the circuit illustrated in Figure 1 and is a modification of the image screen illustrated in Figure 2. In this embodiment, a plate 140 is provided with cylindrical apertures 142 and a phosphor coating 144 is disposed upon the surfaces of the apertures. A rear plate 146 provided with an electrically conducting strip 148 abuts the plate 140, the strip 148 passing centrally over each of the apertures 142 in the horizontal plane. The rear plate 146 is also provided with an electrically conducting strip 150 on the side opposite to the strip 148 and parallel with the strip 148. A front plate 152 is also disposed adjacent to the plate 140 and is provided with parallel electrically conducting strips 154 and 156 on opposite surfaces thereof passing centrally over each of the apertures in the plate 140. The front plate 152 and the back plate 146 may

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be sealed to the plate 140 to provide a gas-tight region within the apertures 142 of the plate 140 and retain any desired atmosphere therein. The atmosphere may consist of any noble gas but preferably produces ultra violet radiation when electrically excited to permit a choice of phosphors which will produce illumination throughout the spectrum. Hence, argon and mercury vapor atmospheres are most desirable. An image reproducing screen constructed in this manner takes advantage of the range of colors provided by phosphor coatings, exhibits greater luminous efficiency, and minimizes the obstruction to light caused by the phosphor coating.

An image may be produced in color by combining three image tubes 10 or 96. In the case of image tube 10, the color of the glow from each of the picture elements can be controlled by selection of the atmosphere within the tube 10. As presently used for color television, the primary colors red, green and blue, are used to produce full color images. In the case of the image tube 10, the cells are preferably provided with an atmosphere producing ultraviolet light when excited. Argon or mercury vapor atmospheres are thus very suitable. With such an atmosphere, a phosphor can be selected and mixed with the atmosphere to produce any desired color.

Also a third dimension can be provided by stacking up image screens 10 or 96 to provide a third coordinate. Other uses and advantages of the present invention will be readily devised by the man skilled in the art which are within the intended scope of the invention. Therefore, it is intended that the scope of the present invention be not limited by the foregoing disclosure, but only the appended claims.

What is claimed is:

1. A screen adapted for use in an image reproducing device comprising an airtight housing including a first plate transparent to visible light and a spaced parallel second plate, a plurality of spaced electrically insulated electrical conductors forming a first grid supported upon one surface of the first plate, a plurality of spaced electrically insulated electrical conductors parallel to the conductors in the first grid supported on the opposite surface of said plate forming a first counter-grid, a plurality of spaced electrically insulated electrical conductors forming a second grid supported upon the surface of the second plate confronting the first plate, the second grid being electrically insulated from the first grid and each conductor in said second grid being approximately normal to the confronting conductor in the first grid at each point of adjacency between the two grids, a plurality of spaced electrically insulated electrical conductors supported on the opposite surface of the second plate parallel to the conductors in the second grid forming a second counter-grid, an atmosphere consisting of a noble gas at a pressure of less than 15 centimeters of Hg disposed between the plates, a radio frequency generator and means electrically connected to the generator and to each of the electrical conductors in the first counter-grid and the second counter-grid to impress the output of the generator on the first and second counter-grids.

2. A screen adapted for use in an image reproducing device comprising the elements of claim 1 in combination with a perforated plate disposed between the first and second plates and abutting the first and second grids, said perforated plate having a perforation at each point of adjacency of the first and second grids.

3. A screen adapted for use in an image reproducing device comprising an airtight housing including a first plate transparent to visible light and a second plate spaced therefrom, a plurality of spaced electrically insulated electrical conductors forming a first grid supported upon the surface of the first plate confronting the second plate, a plurality of spaced parallel electrically insulated electrical conductors confronting the conductors of the first

grid and supported on the opposite surface of the first plate forming a first counter-grid, a plurality of spaced electrically insulated electrical conductors forming a second grid supported upon the surface of the second plate confronting the first grid, the second grid being electrically insulated from the first grid and each conductor in said second grid being approximately normal to the conductors of the first grid, a plurality of spaced parallel electrically insulated electrical conductors supported on the opposite face of the second plate confronting the conductors of the second grid forming a second counter-grid, a luminous cell disposed between each point of adjacency between the first and second grids, the luminosity of each of said cells being a function of electrical excitation, and radio frequency excitation means electrically connected to the first and second counter-grids whereby a radio frequency potential is applied to the luminous cells.

4. A screen adapted for use in an image reproducing device comprising the elements of claim 1 wherein the atmosphere disposed between the plates consists of argon at a pressure of approximately 5 centimeters of Hg.

5. A screen adapted for use in an image reproducing device comprising the elements of claim 2 wherein the atmosphere disposed between the plates consists of argon at a pressure of approximately 5 centimeters of Hg.

6. A screen adapted for use in an image reproducing device comprising an airtight housing including a first plate transparent to visible light and a second plate parallel to the first plate, a plurality of spaced electrically insulated electrical conductors forming a first grid supported upon the surface of the first plate confronting the second plate, a plurality of spaced electrically insulated electrical conductors parallel to the conductors in the first grid support on the opposite surface of said plate forming a first counter-grid, a plurality of spaced electrically insulated electrical conductors forming a second grid supported upon the surface of the second plate confronting the first plate, the second grid being electrically insulated from the first grid and the conductors in said second grid being approximately normal to the conductors in the first grid, a plurality of spaced electrically insulated electrical conductors supported on the opposite surface of the second plate parallel to the conductors in the second grid forming a second counter-grid, a perforated third plate disposed between the first and second grids having a perforation therein aligned with each point of adjacency between the two grids, and a phosphor coating on the surface of the perforations in the plate, whereby an electrical potential applied to the counter-grids will cause the phosphor to emit light.

7. A screen adapted for use in an image reproducing device comprising an airtight housing including a first plate transparent to visible light and a second plate parallel to the first plate and spaced therefrom, a plurality of spaced electrically insulated electrical conductors forming a first counter-grid supported upon the surface

of the first plate opposite the second plate, a plurality of spaced parallel electrically insulating electrical conductors forming a second counter-grid supported upon the surface of the second plate opposite the first plate, the conductors of the second counter-grid being approximately normal to the conductors of the first counter-grid, an electrode disposed on the surface of the first plate confronting the second plate at each point of adjacency between the first and second grids, and an electrode disposed on the surface of the second plate confronting the first plate at each point of adjacency between the first and second grids, a luminous cell disposed between each electrode on the first plate and the confronting electrode on the second plate, the luminosity of each cell being a function of electrical excitation.

8. A screen adapted for use in an image reproducing device comprising an airtight housing including a first plate transparent to visible light and a second plate spaced therefrom, a plurality of spaced electrically insulated electrical conductors forming a first grid supported upon the surface of the first plate confronting the second plate, a plurality of spaced parallel electrically insulated electrical conductors confronting the conductors of the first grid and supported on the opposite surface of the first plate forming a first counter-grid, a plurality of spaced electrically insulated electrical conductors forming a second grid supported upon the surface of the second plate confronting the first grid, the second grid being electrically insulated from the first grid and each conductor in said second grid being approximately normal to the conductors of the first grid, a plurality of spaced parallel electrically insulated electrical conductors supported on the opposite face of the second plate confronting the conductors of the second grid forming a second counter-grid, a third plate of electrically insulating material disposed between the first and second grids, said third plate having a perforation confronting each point of adjacency between the conductors of the first and second grids, a coating of phosphor disposed on the surface of each of the perforations, an atmosphere of a noble gas disposed within the housing, radio frequency generating means, and switching means connected to the radio frequency generating means and the first and second counter-grids, whereby a radio frequency potential may be placed between one conductor of each of the counter-grids.

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