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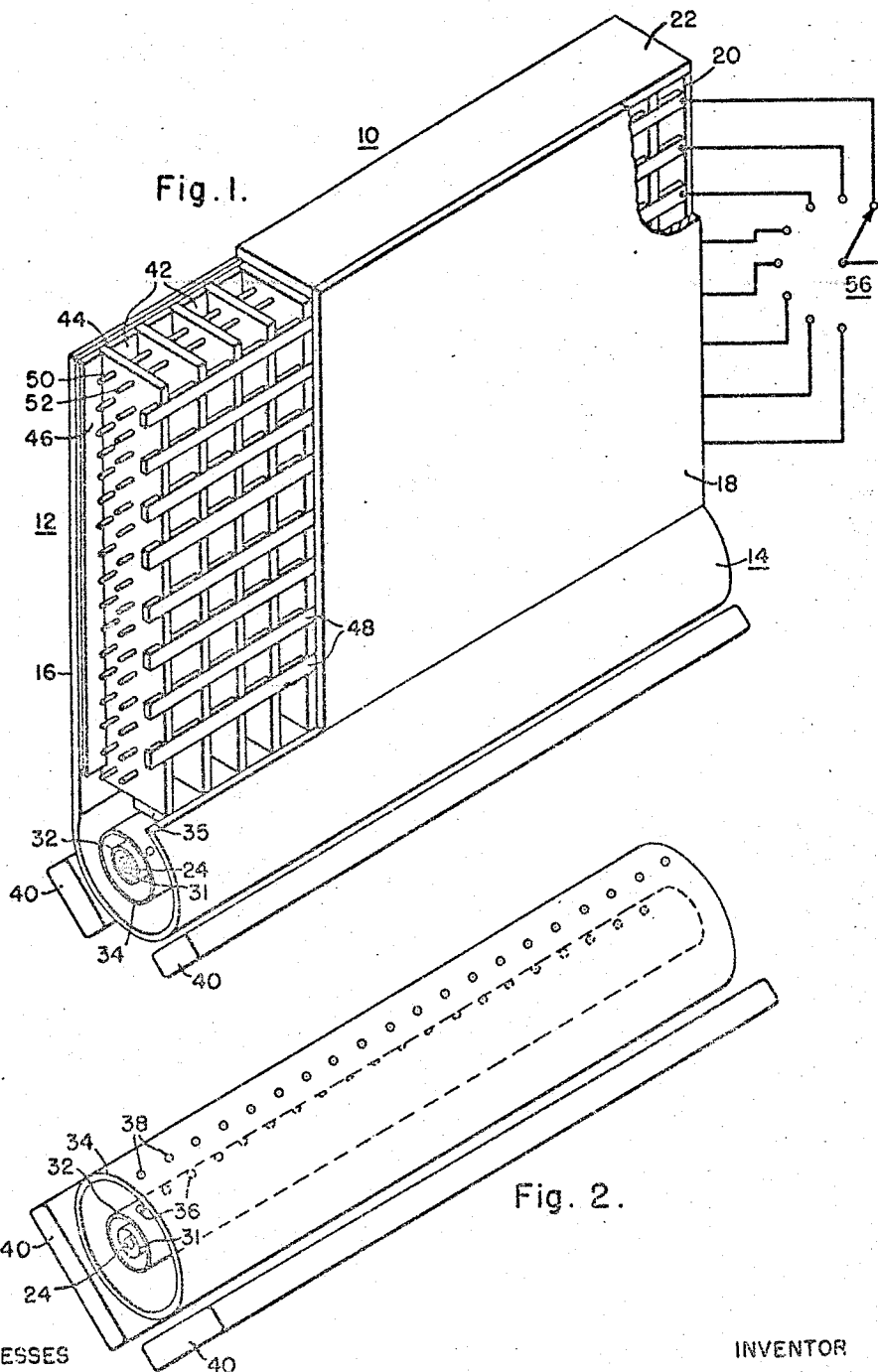
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W. L. ROBERTS
CATHODE RAY TUBE

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2 Sheets-Sheet 1



WITNESSES

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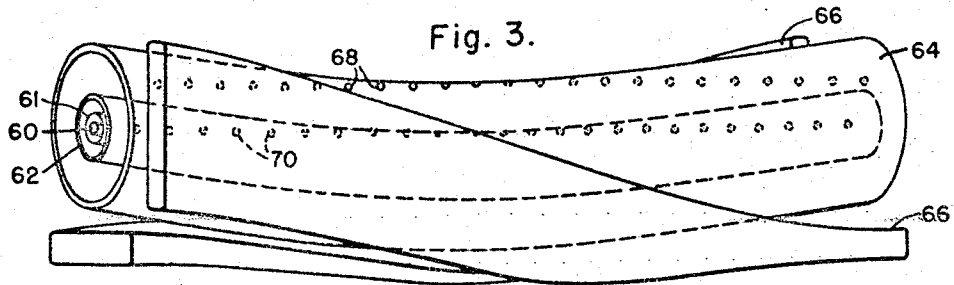
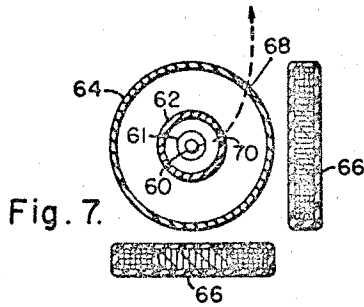
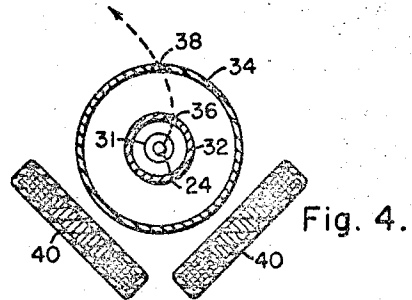
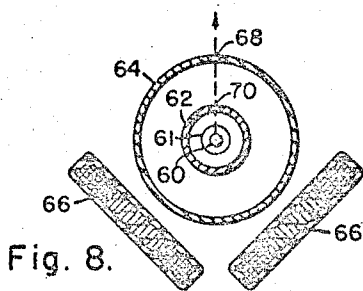
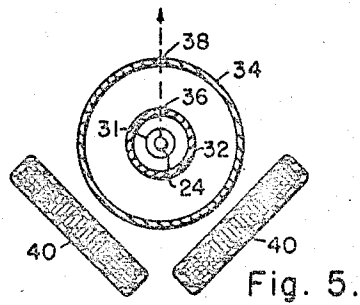
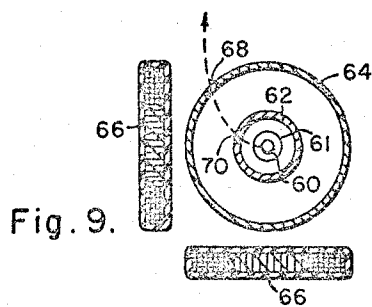
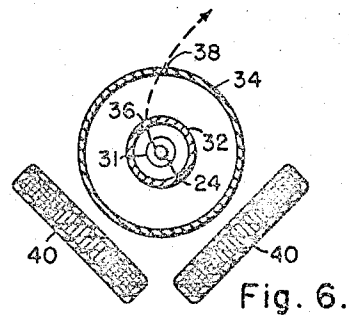
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2,858,464

CATHODE RAY TUBE

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6 Claims. (Cl. 313—69)

This invention relates to electron discharge devices and more particularly to those devices in which an electron beam is used to scan a target.

In image reproduction tubes utilized in television, many attempts have been made to reduce the depth of the cathode ray tube in that this is the primary limitation in reducing the depth of the television set. It would be desirable if the image reproduction tube be of a flat type structure which might possibly be hung on a wall similar to a picture frame. It is to this type of structure that the present invention is directed and this type of tube structure may be referred to as a luminograph. One specific type structure is described in a copending application, Serial No. 433,988, filed April 18, 1954, now abandoned, by A. P. Kruper et al., entitled "Television System" and assigned to the same assignee. In the structure described in the above-mentioned application, a large planar type cathode is utilized which is difficult to construct and normally of large power consumption. It is also necessary, with the use of planar type cathodes, to resort to unconventional type scanning systems in that the large cathode requires no beam deflection, but rather a means of selectively controlling the electron flow to reach a selected portion of the screen at any given instance. The resolution utilized in commercial television requires a very high speed switching device in which a satisfactory device has not been developed at this time.

It is therefore an object of my invention to provide an improved type cathode ray tube.

It is another object to provide an improved method of scanning an electron beam across a large area screen.

It is another object to provide an improved linear type cathode and associated grid structure for producing sequentially a small electron beam along a line.

It is another object to provide an improved line type cathode structure so that an electron beam may be generated selectively along the length of a line cathode structure with the electrons leaving the structure along one plane.

These and other objects are effected by my invention as will be apparent from the following description taken in accordance with the accompanying drawings throughout which like reference characters indicate like parts, and in which:

Figure 1 is a perspective view of an image reproduction tube partly cut away embodying my invention;

Fig. 2 is a perspective view of the cathode and associated electron beam forming structure embodied in Fig. 1;

Fig. 3 is a perspective view illustrating a modified linear electron gun structure embodying my invention;

Fig. 4 is a cross sectional view near one end of the structure shown in Fig. 2 illustrating the path of the electron beam;

Fig. 5 is a cross sectional view taken near the middle of the structure shown in Fig. 2 illustrating the path of the electron beam;

2

Fig. 6 is a cross sectional view near the opposite end of the structure shown in Fig. 2 with respect to Fig. 4 illustrating the path of the electron beam;

Fig. 7 is a cross sectional view near one end of the structure shown in Fig. 3 illustrating the path of the electron beam;

Fig. 8 is a cross sectional view taken near the middle of the structure shown in Fig. 3 for purposes of illustrating the path of the electron beam; and

Fig. 9 is a cross sectional view near the opposite end of the structure shown in Fig. 3 with respect to Fig. 4 illustrating the path of the electron beam.

Referring in detail to Figs. 1 and 2 of the drawings, there is shown an image reproduction tube embodying my invention. The tube structure is enclosed in an evacuated envelope 10. The envelope 10 may be broken down into two sections, a large area display section 12 and an electron gun section 14. The display section 12 of the envelope 10 is substantially a flat rectangular box of a suitable material such as glass. The display section consists of a large area viewing screen plate 16 forming one of the large area wall members and the other large area wall member 18 may be referred to as the backing plate. These two walls or plates 16 and 18 should be equally spaced along their surfaces and may be of a planar type surface or any other suitable curved or spherical surface. The dimensions of the faceplate 16 and backplate 18 may be of the order of the conventional television tubes, while the spacing between the backplate 18 and faceplate 16 may be of the order of 1 to 2 inches. Three of the edge portions of the volume confined between the backplate and faceplate may be closed off by suitable side plates 20 and a top plate 22 while the lower edge portion is provided with the electron gun enclosure section 14. The electron gun section 14 may be of any suitable cross section and in this case is circular to conform with the electron gun structure.

Positioned within this electron gun section 14 is an elongated linear cathode 24 extending from one side of the tube envelope 10 to the other. The cathode 24 may be of any suitable type and normally is an indirectly heated thermionic type in which the cathode 24 consists of a long cylindrical metallic sleeve with a heating element positioned therein. An electron emissive coating is deposited on the exterior surface of the sleeve member such as barium or strontium oxides.

Positioned around the cathode 24 are three concentric cylindrical grid members 31, 32 and 34. The inner grid 31 may be of mesh material and used as the control grid. The middle and outer grid may be used in some applications and omit the grid 31. The middle grid member 32 has a number of openings 36 perforated in the upper portion so as to form a helical line turning approximately 90° along the length thereof. The number of holes 36 within the member 32 should correspond to the number of horizontal picture elements desired in the image reproduction tube. It may be desirable in some structures to utilize a long slit rather than the plurality of apertures 36. The outer cylinder 34 has a similar number of holes 38 as the middle cylinder 32 provided in a straight line extending along the entire length of the outer cylinder 34. The alignment of the openings 36 and 38 provided in the middle and outer cylindrical members 32 and 34 are more clearly shown in Figs. 4, 5 and 6. It should be noted that the aperture 36 located on one end of the middle cylinder 32 is positioned on one side of a straight line passing between the aperture 38 in the outer member 34 and cathode 24 as shown in Fig. 4. The aperture 36 on the other end is positioned on the opposite side of the line as shown in Fig. 6. In the center portion of the structure as shown in Fig. 5, the aperture 36 in the middle

member 32 and the aperture 38 in the outer member 34 are located along a straight line passing through the cathode 24. It should also be noted that this straight line, if extended, would be parallel to an intermediate backing plate 18 and the face plate 16 of the display portion 12 of the envelope 10. The lines passing through the centers of the two rows of apertures are skewed with respect to each other.

Two magnetic deflection coils 40 are provided on the exterior of the envelope 10 adjacent the gun section 14 and extending along the length to enable a magnetic field to be set up perpendicular to the axis of the gun assembly. The two coils provide a resulting magnetic field capable of being rotated through 90°. The cylindrical grids 31, 32 and 34 and the cathode 24 should be of a non-magnetic material.

The display portion 12 of the tube consists of a large number of fluted vertical channels 42 provided between the faceplate 16 and the backplate 18. A channel 42 should be provided for each horizontal picture element desired and an aperture 38 in the outer cylindrical grid 34 should be positioned substantially in the center of each of these fluted channels 42. The internal surface of the faceplate 16 is coated with a suitable conductive coating 44 such as Nesa or stannic oxide with a coating 46 of a suitable electron sensitive material thereon. In the case of a display tube, a phosphor material such as a P-4 phosphor would be utilized to produce light for black and white television. The Nesa coating 44 should be continuous to serve as an electrode while the phosphor may be placed on in strips within each channel 42. The structure could be modified for use in color television by depositing phosphor capable of emission of red, green and blue light in alternating channels across the entire structure. To obtain similar resolutions as that of black and white three times the number of channels would be required. Alternatively, the colored phosphors may be deposited sequentially in a vertical manner in each channel. The phosphor areas of the same color would then appear like parallel lines.

On the opposite side of the display portion of the envelope 10 near or on the backplate 18 are placed horizontal conductive strips or wires 48 transverse to the channels 42. The number of the conductive elements 48 would primarily be determined by the amount of resolution desired in the resulting image in the vertical direction. Suitable switching means 56 should be provided on the exterior portion of the tube 10 and connected to each of the conductive strips 48 so as to provide means of sequentially applying a given voltage to conductive electrode 48 to give the conventional vertical scanning action. A "Dekatron" or other suitable switching tube may be utilized for this slow speed vertical switching. It may be also desirable to coat the inner surface of the backplate 18 with a semiconductive material to prevent any charging of the wall. Two unipotential grids 50 and 52 are also provided more or less centrally located between the backplate 18 and the faceplate 16 at a potential close to the normal potential scanning electrodes. The purpose of these unipotential grids 50 and 52 is to provide a substantially uniform potential field for the electrons within the display portion 12 of the tube 10.

In the operation of the structure described, with respect to Figs. 1 and 2, a suitable current waveform is passed through the right hand coil 40 to set up a magnetic field to deflect the electrons along the path as shown in Fig. 4. Therefore substantially all the electrons emitted from the cathode 24 will be intercepted by the middle grid 32 except those passing through the apertures 36. However, as shown in Fig. 4, an aperture 36 in middle grid 32 and an aperture 38 in the outer grid 34 at one end are positioned to allow the electrons having the trajectory shown in Fig. 4 to pass. The other electron beams passing through the apertures 36 are intercepted by the

outer grid 34. This provides an elemental electron beam for the end channel 42 of the structure.

In the illustration shown in Fig. 4, currents of approximately equal amplitudes flow through both coils 40 and the resulting magnetic fields causes the electrons to follow substantially a straight line trajectory and pass through an aperture 36 and an aperture 38 near the center of the structure.

In the illustration shown in Fig. 6, the electron path must be as shown in Fig. 6 to permit electrons to emerge from an aperture at the opposite end with respect to Fig. 4. This electron trajectory may be obtained by applying current to only the left hand coil 40. It is therefore apparent that by application of suitable current waveforms and phase relation to the coils 40, the electrons will emerge successively from the apertures 38 in grid 34. In this manner the structure provides a horizontal scanning electron beam. In the case of the structure shown in Figs. 1 and 2, the electrons do not leave the outer cylindrical grid member 34 normal to the surface except at the center as shown in Fig. 5, and it is therefore necessary to use a beam straightener. One possible method of doing this is by use of a transmissive secondary electron multiplying dynode structure 35 such as described in a copending application Serial No. 434,467 entitled "Electron Discharge Device" by E. J. Sternglass, filed June 4, 1954, and assigned to the same assignee. Suitable operating voltages would place the cathode 24 at ground potential with a positive potential of the order of 25 volts on the inner cylindrical grid 32 and a positive potential of the order of 50 volts on the outer cylindrical grid 34. The transmissive dynode may be operated at potential of the order of 200 volts.

The video signal on a suitable television receiver may be applied to either the middle or outer cylindrical grids 32 or 34 in order to impress the video intelligence on the electron beam. It may be preferable, however, to use the inner grid 31. Otherwise, if a large video signal is applied to grids 32 and 34, the beam could be positive rather than intensity modulated. The conductive members 48 on the backplate 18 of the display portion 12 would have a normal voltage applied of the order of 350 volts with the nearer unipotential grid of the order of 350 volts and the other unipotential grid of a slightly higher potential of the order of 400 volts. The phosphor screen is at a potential of the order of 18 kilovolts by means of application of voltage to the Nesa or stannic oxide conductive coating. By means of the cathode 24 and associated grids 31, 32 and 34, electrons will be projected into one of the channels 42 at a time. The beam is directed into the field-free region between the unipotential grid 52 and the backplate 18 where the conductive elements 48 are positioned applying voltage to the selected conduction strips 48 by means of the switch 56 of sufficient positive polarity in order to 25 to 100 volts. The electron beam will be deflected into incidence with the phosphor 46 with resulting light emission.

It may be desirable to reduce the number of strips 48 and switching contacts while still retaining the same vertical resolution. This may be accomplished by application of a stair-step voltage to each strip and thereby vary the angle of deflection of the electron beam. In this manner, a number of vertically displaced lines could be obtained on screen from each strip.

In the conventional type linear scanning device a saw tooth current waveform would be applied to the coils 40. The electron gun structure lends itself to other use. For example, the video signal might be applied to the inner grid 31 and apply a voltage difference between the middle and outer grids 32 and 34. This voltage would provide means of obtaining a fine positioning control of the electron beam between apertures. Another example would be to use a stair-step current waveform in the coils 40 and use a voltage difference

between the grids 32 and 34 to electrostatically position the electron beam between steps. This type scan might be used in a color reproduction tube where phosphor lines are vertical. The stair-step scan would move the beam between color groups and the voltage difference between the grids 32 and 34 could be used to determine the color. Also the vertical location could be changed by velocity modulation of the electron beam.

In Fig. 3 there is shown a modified electron beam generating structure which is constructed by twisting the cathode 24, inner cylindrical member 31, middle cylindrical member 32, outer cylindrical member 34 and associated deflecting coils 40 in a helical fashion. The resulting structure comprised of cathode 60, inner grid 61, middle grid 62, outer grid 64 and deflection coils 66, allows the electrons to leave the outer cylindrical member 64 through the apertures 68 provided in the outer cylindrical grid 64 along the paths lying in one plane. The electron trajectories are illustrated in Figs. 7, 8 and 9 by the cross sectional views on opposite ends of the structure and a center sectional view. The effect of the twisting action on the structure shown in Fig. 2 resulting in the structure shown in Fig. 3 is to give the entire structure a helical configuration with the geometric center of the helix being a straight line passing through the line of apertures 68 provided in the outer cylindrical grid member 64. The structure as shown in Fig. 3 results in that no beam straightening mechanism is required within the tube structure. The apertures 70 provided in inner grid 62 are in a helical line. The operation is similar to that described with respect to Fig. 2.

It is therefore seen that the described device provides an image reproduction tube of small depth with thin large area walls capable of withstanding atmospheric pressure when the tube is evacuated by means of the channel support walls. The electron gun structure including the line type cathode provides the horizontal deflection system for the tube resulting in far less power demands and the structure of the gun is of utmost simplicity.

While I have shown my invention in only two forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible to various other changes in modifications without departing from the spirit and scope thereof.

I claim as my invention:

1. A line type electron gun structure comprising an elongated cathode capable of emission of electrons along its entire length, a first cylindrical surface surrounding said cathode, said first cylindrical surface having a plurality of openings therein, said openings positioned in a fractional pitch helical line from one end of said surface to the other, a second cylindrical surface surrounding said first surface having a plurality of openings therein, said openings positioned in a straight line parallel to said cathode, said first and second cylindrical surfaces positioned so that the centrally located openings of said surfaces and said cathode are in a straight line.

2. A linear electron gun structure comprising an elongated cathode capable of the emission of electrons along its entire length, a first surface enclosing said cathode, said first surface having a plurality of openings therein, said openings positioned in a fractional pitch helical line from one end of said first surface to the other end, a second closed surface surrounding said first surface having a plurality of openings therein positioned in a straight line parallel to said cathode, said first and second surfaces positioned so that the center openings of said first and

second surfaces and said cathode are in a straight line, said structure including said first and second surfaces and said cathode in a form of a helix with the geometric center in the form of a straight line passing through the centers of the openings of said second surface.

3. An electron tube comprising a large electron sensitive target area, an electron gun positioned along one edge of said target for generating an electron beam substantially parallel to said area, said electron gun comprising an elongated electron emissive element, a first grid of similar length as said emissive element, said first grid having a row of apertures disposed in a line along its entire length, said apertures disposed with respect to said electron emissive element so that the lines perpendicular to the electron emissive element and passing through the centers of the apertures are angularly disposed with respect to said other apertures and a second grid positioned on the opposite side of said first grid with respect to said cathode having a row of apertures disposed in a straight line parallel to said electron emissive element.

4. An electron tube comprising a large area electron sensitive target area and a similar dimensioned parallel backing plate, an electron gun positioned along one edge of said target for generating and directing an electron beam between said target area and said backing plate, said electron gun comprised of an elongated electron emissive element, means for focusing a portion of the electrons emitted from said electron emissive element into a ribbon skewed with respect to said electron emissive element and means for selecting elemental lengths of said electron ribbon beam for sequentially generating an electron beam along the entire length of said electron gun.

5. A line type electron gun adapted to produce sequentially along its length a plurality of electron beams, said gun comprising an elongated electron emissive element, a first tubular member surrounding said electron emissive element, said first member having a row of apertures disposed along its length and skewed with respect to said electron emissive element and a second tubular member surrounding said first member having a row of apertures disposed therein parallel to said electron emissive element.

6. A line type electron gun adapted to produce sequentially along its length a plurality of electron beams, said gun comprising an elongated electron emissive element, a first tubular member surrounding said electron emissive element and having a row of apertures disposed therein along its length, a second tubular member surrounding said first tubular member and having a row of apertures disposed along its length, the rows of apertures in said first and second tubular members disposed at an angle with respect to each other and means for deflecting the electrons generated by said electron emissive element to provide passage of electrons from said second member sequentially along the entire row of apertures.

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