Nov. 26, 1968 B. J. HART ET AL 3,413,505

DARK TRACE CATHODE-RAY TUBE WITH IMPROVED ERASING MEANS

Filed May 31, 1966

2 Sheets-Sheet 1

Fig. 1.

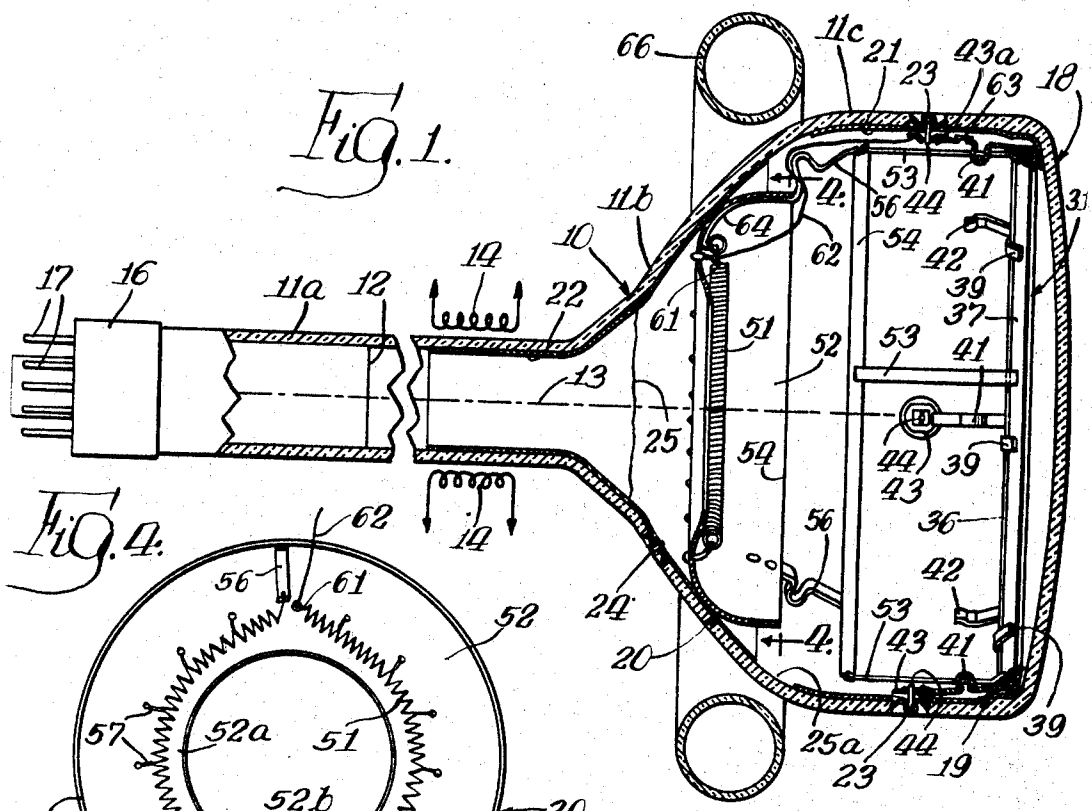


Fig. 4.

Fig. 2.

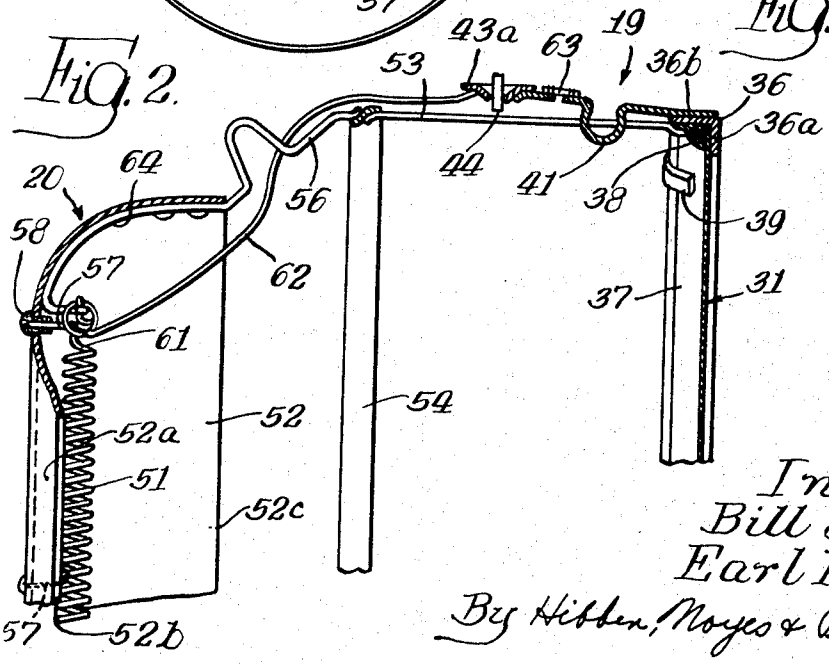
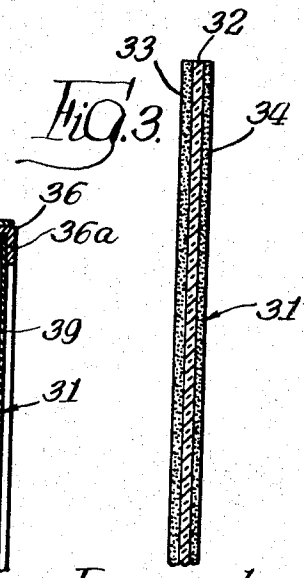


Fig. 3.



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Fig. 5.

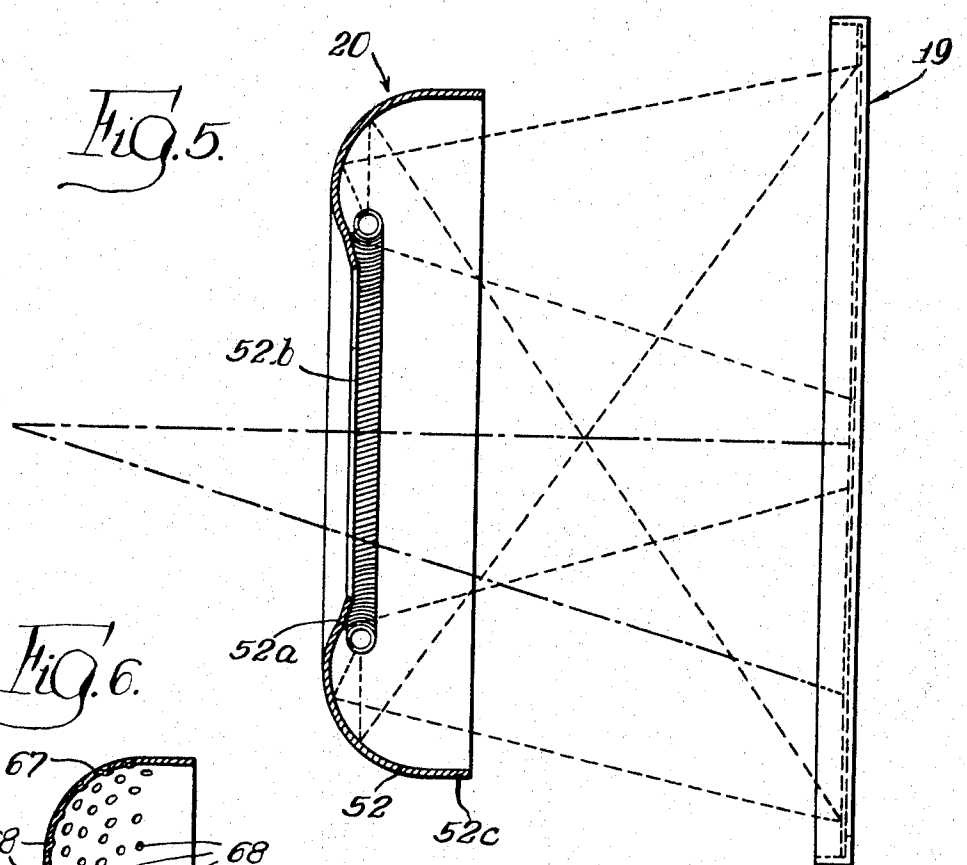


Fig. 6.

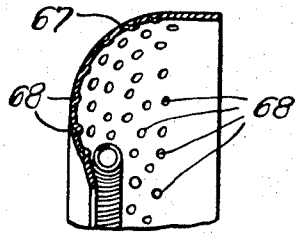
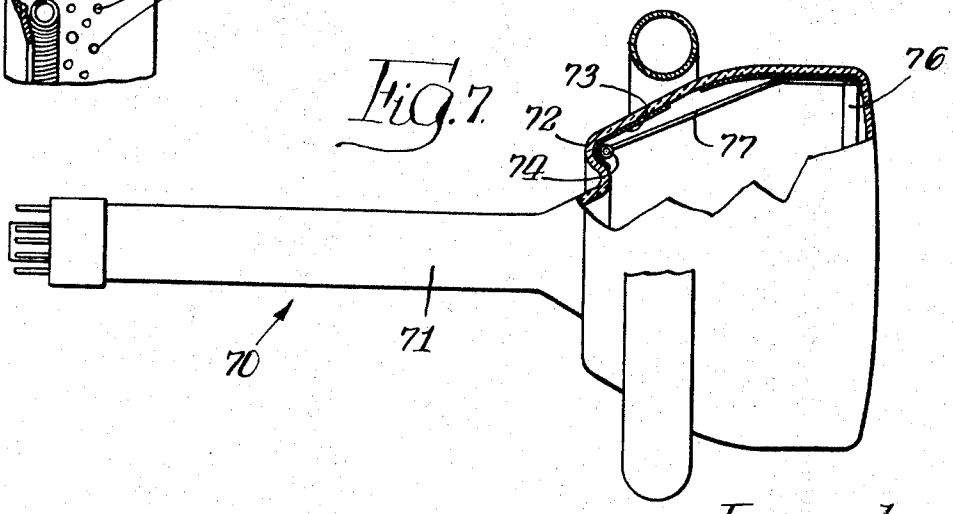


Fig. 7.



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DARK TRACE CATHODE-RAY TUBE WITH IMPROVED ERASING MEANS

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10 Claims. (Cl. 313—91)

ABSTRACT OF THE DISCLOSURE

This disclosure deals with a dark trace cathode-ray tube including a scotophor screen and improved means for erasing an image from the screen. The erasing means is located behind the screen and includes an annular heating coil and an annular generally parabolic reflector. The coil is located approximately at the focal line of the reflector, and heat generated by the coil is reflected by the reflector to the screen to erase an image from the screen.

Disclosure

A dark trace cathode-ray tube includes a bulb which forms a sealed enclosure, an electron gun within the enclosure, and a screen, also within the enclosure, which has a trace or image formed thereon when electrons from the gun impinge upon it. The screen retains the image until the image is erased in some manner, erasure usually being accomplished by heating the screen. One apparatus for heating the screen to obtain erasure has included a tungsten filament mounted within the enclosure adjacent the screen, the filament generating heat when energized and heating the screen.

It is an object of this invention to provide a dark trace cathode-ray tube of the foregoing character, including improved means for rapidly heating the screen to obtain erasure.

Another object is to provide a tube of the foregoing character, wherein the screen is rapidly and uniformly heated.

Still another object is to provide a tube of the foregoing character, wherein the heating means does not interfere either with the electron beam which forms a trace on the screen or with a light source which illuminates the trace on the screen.

Other objects and advantages of the invention will become apparent from the following description taken in conjunction with the accompanying figures of the drawings, in which:

FIG. 1 is a sectional view of a tube embodying the invention;

FIG. 2 is an enlarged fragmentary view of a portion of the tube;

FIG. 3 is a still further enlarged fragmentary view of another portion of the tube;

FIG. 4 is a sectional view taken on the line 4—4 of FIG. 1;

FIG. 5 is an enlarged fragmentary view illustrating the operation of the tube;

FIG. 6 is a fragmentary view showing an alternative form of a portion of the tube; and

FIG. 7 is a view partially in section of still another alternative form.

In general, a dark trace cathode-ray tube in accordance with the invention comprises a bulb which forms a sealed enclosure, the bulb including an elongated neck portion and a relatively large front face portion. An electron gun is mounted within the neck of the bulb and a scotophor screen is mounted within the bulb adjacent the face, in the path of electrons emitted by the electron gun. A conventional electron beam deflector is also provided for

deflecting the beam in order to form a trace or image on the screen, the trace being visible from the face of the bulb when the screen is illuminated by a light source.

To erase a trace from the screen, a toroidal heating coil or winding is positioned within the enclosure, coaxially with the bulb and between the electron gun and the screen. Behind the coil is provided an annular reflector which reflects heat generated by the coil toward the screen. The reflector and the coil are so constructed and are located relative to each other and to the screen such that the screen is substantially uniformly heated at a rapid rate, and they are located radially outside of the path of the electron beam.

The screen is preferably illuminated from its rearward side by an annular lamp positioned outside the bulb, and the heating coil and the reflector are also located out of the path of light rays leaving the lamp and striking the screen.

Since the heating coil and the reflector are out of the path of both the electron beam and the light rays, they do not leave a shadow on the screen either when a trace is being formed or when the trace is being viewed.

In FIGS. 1 to 4, a dark trace tube embodying the invention comprises a sealed envelope **10** which may be a glass bulb of the character commonly used in cathode-ray tubes. The envelope **10** comprises a relatively long, cylindrical neck portion **11***a*, an enlarged, cylindrical front portion **11***c*, and a funnel portion **11***b* connecting the portions **11***a* and **11***c*. The front of the envelope forms a face **18**, through which an image may be viewed as will be described later.

For purposes well known in the art, a coating **21** of an electrically conductive reflective material such as aluminum is preferably formed on the interior surface of the envelope, extending from the face **18** to approximately the midway point of the funnel **11***b*, and another coating **22** of an electrically conductive material such as colloidal graphite is preferably formed on the interior surface of the envelope extending from the coating **21** into the neck **11***a*. The coatings **21** and **22** meet along a line indicated by the numeral **25** (FIG. 1). At approximately the juncture of the funnel and front portions of the envelope, an annular portion of the envelope is left uncoated, thus forming a window **25***a*, the purpose of which will be explained hereinafter.

Mounted within the envelope are an electron gun **12** for developing a focused electron beam **13**, a scotophor screen assembly **19**, and an erase assembly **20** which includes a source of infra-red radiation. The gun **12** is located in the neck portion **11***a* while the screen assembly **19** is positioned in the front portion **11***c* such that it may be viewed through the face **18** of the envelope. Conventional beam deflecting apparatus is also provided which may comprise either electrostatic means or electromagnetic means. In the present instance, coils **14** of an electromagnetic deflection system are shown. At the rear or base **16** of the envelope **10** a plurality of prongs **17** are provided for the purpose of making electrical connections with some of the electrical components within the envelope **10**, such as the electron gun **12**. To electrically connect the coatings **21** and **22** to an external circuit, a plurality of conventional electrical connectors are provided which extend through and are hermetically sealed to the wall of the envelope. In the present instance, four connectors **23** are provided at the front portion **11***c* of the envelope and one connector **24** is provided in the funnel portion **11***b* of the envelope. The connector **24** is forward of the line **25** and is electrically connected to the coating **22** by extending a portion of the coating **22** up to the connector **24** and forming the coating over the portion of the connector **24** within the envelope. One of the four connectors **23** is similarly connected to the coat-

ing 21 and to the frame of the screen assembly 19 while the other connectors 23 are insulated from the coating 21 and the screen assembly. In addition to making electrical connections between the external circuit and the screen assembly 19 and the erase assembly 20, the connectors 23 also serve to support the assemblies 19 and 20. The external circuit suitably interconnects the coatings 21 and 22 and the other components of the tube.

With reference to FIG. 2, the screen assembly 19 comprises a disk shaped screen 31 which is illustrated in detail in FIG. 3. The screen 31 comprises a transparent layer 32 of a material such as mica which serves as a support, a layer 33 of a scotophor material, and a layer 34 of a heat radiation absorption material such as carbon black. Since the absorption layer 34 is at the front side of the screen and the screen is viewed from the front of the tube, the layer 34 must of course be sufficiently thin that a trace on the layer 33 may be viewed through the face 18.

The screen 31 is positioned in a plane which is normal to the axis of the envelope 10, and is supported by an annular frame 36 which is L-shaped in cross section. One arm 36*a* (FIG. 2) of the L extends substantially in the plane of the screen 31 and over the front side of the screen 31 adjacent its edge, while the other arm 36*b* of the L extends rearwardly across the edge of the screen 31. The screen 31 is held in place against the arm 36*a* by an annular support member 37 which extends into the opening of the L-shaped frame and over the back side of the screen 31 adjacent its edge. Between the members 36 and 37 is positioned an annular cushion 38 of a compressible material such as a crumpled sheet of aluminum. Where the construction of the screen 31 is such that it includes an electrically conductive material, the aluminum cushion 38 also serves to make an electrical connection between the screen 31 and the frame member 36. The members 36 and 37, the screen 31, and the cushion 38 are held in assembled relation by, for example, a plurality of circumferentially spaced clips 39 which are secured to the outer surface of the arm 36*b* as by welding, and are bent inwardly over the back side of the member 37.

The frame member 36 of the screen assembly 19 is supported within the envelope 10 by four contact fingers 41 and a plurality of spring fingers 42, the fingers 41 and 42 being secured as by welding to the outer surface of the arm 36*b* and extending rearwardly therefrom. The contact fingers 41 include clips or clamps 43 at the rearward ends thereof, which are fastened to the connectors 23. At their inner ends, the connectors 23 include inwardly extending prong-like members 44 which are engaged by the clips 43. The spring fingers 42 engage the inner surface of the envelope 10 and hold the screen assembly centered within the envelope, and they also electrically connect the screen assembly with the coating 21.

As is well known in the art, when the electron beam 13 strikes the screen 31, opacity centers are formed in the scotophor layer 33. To erase these centers, the erase assembly 20 includes a heating coil 51 for generating heat and a reflector 52 for reflecting the heat to the screen assembly 31. The coil 51 is toroidal in shape and is located generally at the focal line of the reflector 52, which is annular and generally parabolic in cross section. The reflector 52 includes a radially inner wall 52*a*, the inner edge of which forms a circular opening 52*b*, and a radially outer wall 52*c* (FIGS. 4 and 5).

The reflector 52 and the coil 51 are supported by the screen assembly 31. To this end, a plurality of circumferentially spaced metal rods 53 are secured, as by welding, to the member 37 and extend rearwardly therefrom. At their rearward ends, the rods 53 are secured together by an annular metal brace 54, and a plurality of circumferentially spaced rearwardly extending metal arms 56 secure the reflector 52 to the brace 54. The foregoing connections may be made as by welding or rivets.

The coil 51 is fastened to the metal reflector 52 by a plurality of circumferentially spaced support wires 57. Each wire 57 is secured to the bottom portion of the reflector 52 by forming a hole through the reflector 52, positioning one end of the wire 57 through the hole with the wire out of contact with the reflector 52, and bonding the wire to the reflector 52 with an electrical insulating material 58. The other end of the wire 57 is twisted around a loop of the coil 51.

To pass current through the coil 51, one end 61 of the coil 51 is insulated from the reflector 52 but is connected by a wire 62 to one of the clips 43, this particular clip being indicated by the numeral 43*a*. The clip 43*a* is fastened to its associated contact finger 41 by a strip 63 of insulating material, whereby the clip 43*a*, the wire 62 and the associated end of the coil 51 are electrically insulated from the frames of the screen and erase assemblies and from the coatings 21 and 22 but are electrically connected to the connector 23 associated with the clip 43*a*. This particular connector is not the one which is connected to the coating 21 and the frame of the screen assembly.

The other end of the coil 51 is electrically connected to the erase and screen frames by an extension 64 of one of the arms 56 and through the frames to the connectors 43 other than the connector 43*a*. Thus, current may flow from the connector 43*a*, the wire 62, through the coil 51, the extension 64, the frame of the screen assembly, and the connectors 43, in order to energize the coil and thereby heat the screen 31, the external power circuit preferably being such that the coil 51 may be energized only when an image or trace is not being formed on the screen.

The reflector 52 is provided to increase the rate at which the screen is heated and to insure that the screen is uniformly heated. As shown in FIG. 5, each section of the reflector directs heat to substantially all portions of the screen 31. While the coil 51 is at substantially the focal line of the parabolic reflector 52, the coil 51 has considerable thickness and consequently it extends around the focal line. The heat rays emitted by the coil are therefore spread uniformly over the screen, resulting in rapid and uniform heating of the screen.

Since the screen 31 does not produce light, some lighting means must be provided to light the screen for viewing purposes, and it is preferred that a back lighting arrangement be used. In the present instance, a circular fluorescent lamp 66 (FIG. 1) is positioned coaxially with the envelope around the funnel portion 11*b*. The lamp 66 is located adjacent the window 25*a*, and consequently light shines through the window 25*a*, and illuminates the screen 31. If it is desired to decrease the amount of light entering the window 25*a*, a portion of the window 25*a* may be blocked out by paint on the outer surface of the envelope. From FIG. 1 it will be noted that the reflector 52 is located rearwardly to a sufficient extent relative to the window that the reflector does not cast a shadow on the screen. Further, from FIGS. 1 and 5 it will be noted that the electron beam 13 passes through the center of the reflector 52 and that the center opening 52*b* of the reflector is sufficiently large that it does not interfere with the beam 13 even under maximum deflection conditions.

The radially outer side portion 52*c* of the reflector may be made considerably longer than the radially inner side 52*a* and the outer side helps to spread the heat across the screen.

To increase the tendency of the reflector of the erase means to spread the heat rays uniformly over the screen, a tube may be provided including a reflector 67 (FIG. 6) having a plurality of dimples 68 on its inner surface, the dimples tending to scatter light.

The funnel portion of the glass envelope may be molded and coated to form a parabolic reflector. With reference to FIG. 7, a tube 70 is shown including an envelope 71 wherein a portion of the funnel of the envelope is molded to form a parabola 72. A highly reflective coating 73 is

formed on the inner surface of the parabola, and a heating coil **74** is mounted substantially at the center of the parabola. A screen assembly **76** is provided which may be similar to the assembly **19**, and the coil **74** is supported by arms **77** which extend from the screen assembly **76** to the coil **74**. Again the coil **74** and the reflector are designed to rapidly and uniformly heat the screen **76**. In this form of the invention, the coating **73** forms a reflector which is parabolic because of the shape of the envelope.

It will be apparent from the foregoing that a novel and useful dark trace cathode-ray tube has been provided. The construction and location of the erase assembly improve the performance and life of the screen of the tube. The reflector directs substantially all of the heat to the screen, and is far more efficient than a tube wherein any reflection of the heat is from the tube walls and is therefore scattered throughout the tube. The erasure time of a tube embodying the invention is less than one-half that of a conventional tube.

The inner surface of the reflector should of course be bright and shiny to improve the reflection characteristics. While the reflector will ordinarily be silver colored, it could be plated with gold, if the preferred reflection is in the yellow region of the spectrum.

The construction of the scotophor screen is described in greater detail in the copending application of E. R. Ewald et al., Ser. No. 554,024, filed May 31, 1966, now abandoned.

We claim:

1. A dark trace cathode-ray tube comprising an envelope, an electron gun in said envelope for developing a beam of electrons, a screen in said envelope extending substantially normal to and in the path of said electron beam, said screen including a layer of scotophor material which develops opacity centers when said electron beam impinges thereon, and means for erasing said centers, said erasing means comprising a generally annular source of infrared radiation positioned within said envelope rearwardly of said screen, and an annular generally parabolic reflector located adjacent to and generally rearwardly of said source of radiation, said source of radiation and said parabolic reflector being generally coaxial with said envelope and having a relatively large center opening through which said electron beam passes, said source of radiation being located generally at the focal point of said reflector, whereby rearwardly emitted heat radiation from said source is reflected towards said screen and consequently substantially all of the heat radiation emitted by said source is spread uniformly over said screen.

2. Apparatus as in claim **1**, and further including a light source for illuminating said screen, said light source being positioned adjacent to but out of the path of light from said light source to said screen, whereby said erasing means does not cast a shadow on said screen.

3. Apparatus as in claim **1**, wherein said source of radiation and said reflector are positioned between said electron gun and said screen but out of the path of said electron beam, said reflector being separate from and mounted within the inner periphery of said envelope.

4. Apparatus as in claim **1**, wherein said reflector is dimpled in order to more uniformly spread the heat over said screen.

5. Apparatus as in claim **3**, wherein said reflector and said source of radiation are substantially annular, said reflector comprising a reflective coating on a parabolically shaped portion of said envelope.

6. A dark trace cathode-ray tube comprising an envelope having neck, funnel, and front portions, an electron gun mounted in said neck portion for emitting a beam of electrons, a plurality of fingers secured to said front portion on the inside of said envelope, a frame fastened to said fingers within said envelope, a screen assembly mounted on said frame in said front portion and extending substantially transversely of the axis of said envelope, said screen assembly including a layer of scotophor material which develops opacity centers when said electron beam impinges thereon, and erase means mounted on said frame within said envelope adjacent said funnel portion, said erase means comprising an annular heater and an annular reflector located generally coaxially within said envelope, said reflector being generally parabolic and located relative to said heater and to said screen assembly to reflect heat from said heater toward said screen assembly.

7. Apparatus as in claim **6**, wherein said reflector comprises a metal member, and said heater comprises a coil which is mounted generally at the focal line of said reflector.

8. Apparatus as in claim **7**, wherein the circuit path for electric current flowing through said coil includes said reflector.

9. Apparatus as in claim **7**, wherein the radially outer side of said reflector is relatively long and extends forwardly adjacent the inner surface of said envelope.

10. A dark trace cathode-ray tube comprising an envelope having neck, funnel and front portions, an electron gun mounted in said neck portion for emitting a beam of electrons, a screen assembly mounted in said front portion and extending substantially transversely of the axis of said envelope, said screen assembly including a layer of scotophor material which develops opacity centers when said electron beam impinges thereon, and erase means within said envelope adjacent said funnel portion, said erase means comprising an annular heater and an annular reflector located generally coaxially within said envelope, said reflector being generally parabolic and located relative to said heater and to said screen assembly to reflect heat from said heater toward said screen assembly, said reflector comprising a metal member which is supported within said envelope, and said heater comprises a coil which is mounted generally at the focal line of said reflector, the inner periphery of said envelope adjacent said reflector being coated with a reflective material, an annular portion of said envelope being uncoated and thereby forming an annular window, and a circular lamp positioned outside of said envelope adjacent said window, said reflector being located sufficiently away from said window that light may shine through said window and illuminate said screen assembly and said reflector does not cast a shadow.

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