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PICK UP TUBE WITH INFRA-RED SENSITIVE THERMIONIC CATHODE WITH COOLING MEANS SPACED FROM THE THERMIONIC CATHODE

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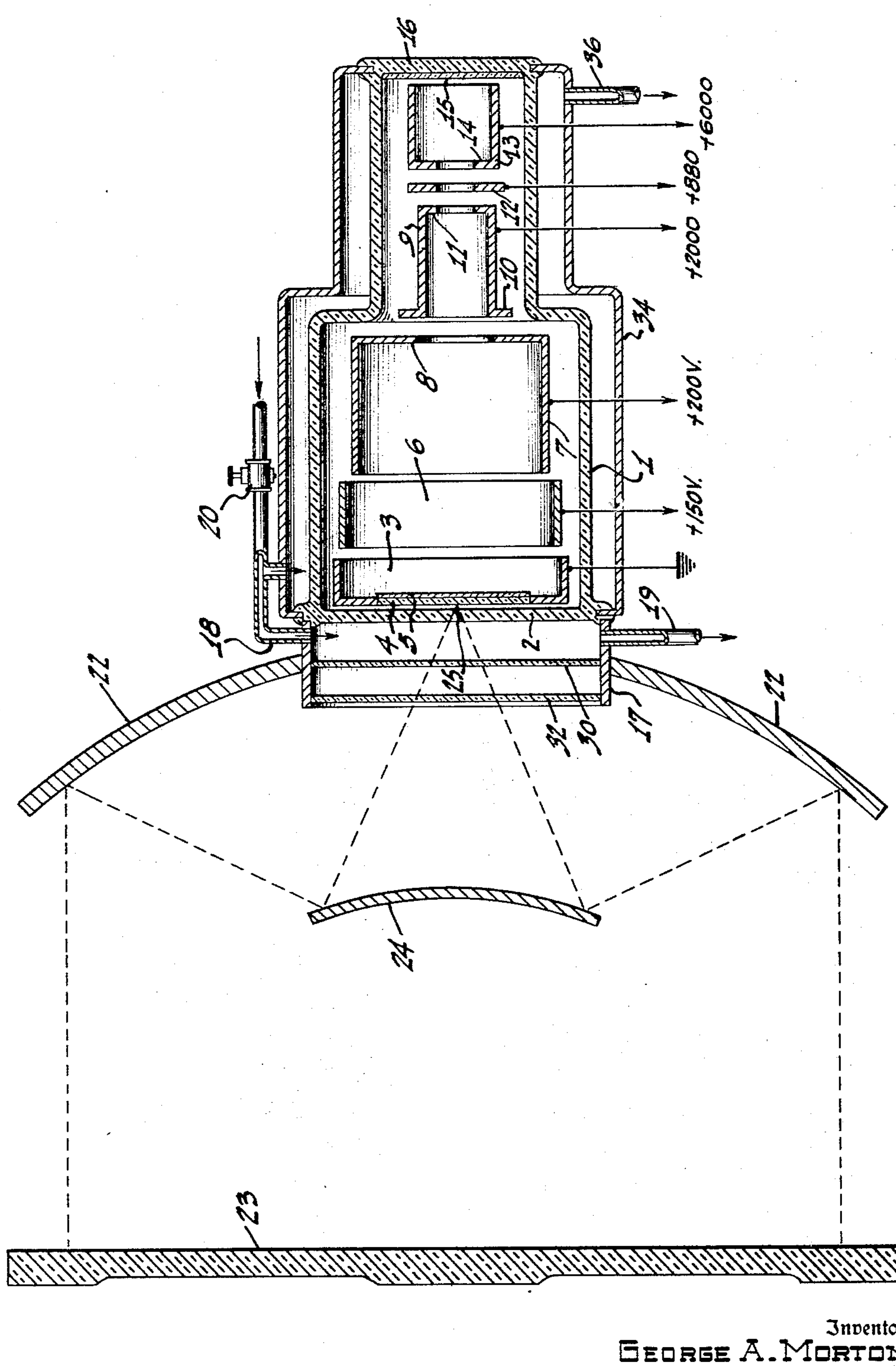

Inventors
GEORGE A. MORTON
& GARDNER L. KRIEGER
By William A. Zalesak
Attorney

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PICK UP TUBE WITH INFRA-RED SENSITIVE THERMIONIC CATHODE WITH COOLING MEANS SPACED FROM THE THERMIONIC CATHODE

George A. Morton and Gardner L. Krieger, Princeton, N.J., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army

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This invention relates to devices for observing objects in the dark by means of infra-red radiant energy particularly in the wave spectrum 8 to 13 microns called far infra-red.

In prior art image devices it has been the practice to use a photo-cathode that is from time to time sensitized by ultra violet light to store energy. This is stimulated by near infra-red energy to emit visible light. The infra-red energy does not in this type of cathode produce the light by direct action on the atomic structure of the phosphor but indirectly through release of energy previously stored in the cathode by the energy of shorter wave lengths.

It is an object of this invention to provide an image device that produces an electron image by producing thermal changes in the cathode.

Another object of the invention is to produce an image device having a thermionic cathode acted upon by far infra-red energy to release electrons which are in turn imaged to form a greatly demagnified electron image on a fluorescent screen in order to increase the intrinsic brightness.

Another object of the invention is to bias the thermionic cathode of an image device to relatively low temperature to increase the effect of far infra-red energy in relation to that of the ambient temperature.

Other objects of the invention will appear in the following specification, reference being had to the drawing in which:

The single figure is a sectional elevation of an image device embodying the invention.

This invention relates to a heat sensitive image tube in which the photocathode is provided on a very thin low-heat inertia transparent foundation, such as a thin sheet of glass so that thermionic emission from the cathode develops the electron image which is utilized in a conventional manner upon a fluorescent screen.

The thermionic properties of photocathodes of the type described below are well known. The tube of the invention is dependent upon the heating of elemental areas of the cathode with an infra-red image while maintaining the photocathode of the tube cooled to provide normal thermionic emission at a low thermal level relative to ambient temperature. By this means, then, the effect of far infra-red energy in relation to that of ambient temperature is detectable.

Referring to the drawing, the image device comprises an evacuated tube envelope **1** of glass or other suitable material which has a window **2** of some material such as rock salt transparent to far infra-red energy. A metal cathode cylinder **3** has a very thin film or sheet of glass **4**, of other suitable material, secured across one end of the cylinder adjacent the window **2**. The glass film **4** has a layer or coating **5** of thermionic emitting material such as caesiated silver-silver oxide, well known in the art. Other materials may, however, be used. The glass film and coating absorb infra-red energy to produce a rise in temperature at points illuminated by the infra-red radiations and cause the thermionic coating **5** to emit electrons by thermal action. The number of electrons emitted vary with the impinging infra-red energy so that an electron image will be produced corresponding to any infra-red image focused on the film **5**. Various voltages and dimensions may be used for the cathode cylinder **3**, but, as an example, suitable values will be given for this and the other electrodes in the tube shown.

The cathode cylinder **3** may have a diameter of 1.3 inches and a length of 0.25 inch. It is connected to the negative terminal of the voltage supply. Spaced about 0.0625 inch from the end of cylinder **3**, is anode cylinder **6** having a diameter of about 1.2 inches and a length 0.375 inch. This anode may be connected to a terminal of the voltage supply which is 150 volts positive with respect to the cathode cylinder **3**. Tubular anode **7** is spaced about 0.0625 inch from anode **6** and may have a diameter of about 1.1 inches at the end adjacent anode **6** and a flanged other end **8** having an opening of 0.375 inch. This anode may be 0.875 inch in length and is connected to a terminal of the supply which is 200 volts positive with respect to the cathode **3**. Anode **9** is spaced about 0.125 inch from flanged end **8**. The diameter of this anode at the end facing the anode, is about 0.375 inch. Also, this end of anode **9** may have an external flange **10** and the other end an internal flange or diaphragm **11** having an aperture of about 0.15 inch. This anode may be connected to a terminal 2000 volts positive relative to the cathode **3**. A diaphragm **12** having an aperture of about 0.15 inch is spaced about .0625 inch from the diaphragm **11** and may be connected to the 880 volt terminal. Anode **13** has a diaphragm **14** at the end spaced about 0.0625 inch from diaphragm **12** and also has an aperture of about 0.15 inch. The other end of anode **13** is open and may be spaced about 0.0625 inch from a phosphor screen **15** on the transparent end plate **16** of the tube envelope. Anode **13** may be connected to a terminal of the voltage supply which is 6000 volts positive relative to cathode **3**. The screen **15** may be of any appropriate phosphor material such as zinc sulphide or zinc silicate.

To cool the cathode to a low temperature of about −20° C. to −100° C., or lower, the cathode end of the tube envelope is surrounded by a jacket **17** connected by an inlet **18** to a tank (not shown) containing liquid air or carbon dioxide gas under high pressure. The jacket **17** is vented at **19** to the atmosphere. Upon adjustment of the expansion of the CO_2 gas by needle valve **20**, the temperature of the thermionic cathode **5** may be regulated. The cooling jacket **17** may be closed by a pair of glass or plastic plates **30** and **32** which are transparent to infra-red. Plates **30** and **32** are spaced apart and prevent fogging of the tube window **2** when cooling gas is passed into the jacket **17**. Plates **30** and **32** may be of any appropriate material which will transmit the desired infra-red radiation. The tube envelope **1** may also be surrounded, except for end **16**, by another cooling jacket **34** connected to the intake **18** and having an outlet **36** for maintaining the envelope **1** at a relatively low temperature. Jackets **17** and **34** may be combined to form a single cooling chamber.

The image tube may be used with the well known Schmidt optical system having a spherical mirror **22**, a corrector plate **23**, made of infra-red transmitting material, and a mirror **24**. The far infra-red energy is focused as at **25** on the thermionic cathode **5** and electrons are emitted from each elemental area of surface **5** in proportion to radiant energy focused on the area element. The electrons are then focused on the phosphor screen **15** by the electrostatic lens system of anodes **6**, **7**, **9**, **12** and **13** to produce a demagnified image of about one tenth the size of the image formed on cathode **5**. The image may be reduced to any desired size by suitably altering the dimensions of the electrodes and voltages applied thereto. The reduction of the image in this way proportionally increases the intrinsic brightness and the image on screen **15** may be in turn optically magnified.

The supports for the various electrodes are not shown as these are well known in the art and are shown in my application filed jointly with Flory and Reudy, Oct. 5, 1946, Ser. No. 701,588 which is now Patent No. 2,506,018, granted May 2, 1950.

Various modifications may be made of the invention without departing from the spirit thereof.

What we claim as new is:

1. An electron image tube comprising an evacuated envelope including at one end thereof a window transparent to infra-red radiant energy, a tubular cathode within said envelope having one end adjacent said window, a film substantially transparent to said infra-red energy mounted across said one end of said tubular cathode, a phosphor screen mounted at the other end of said envelope, a thermionic cathode on the side of said transparent film facing said phosphor, a plurality of anode electrodes positioned between said thermionic cathode and said phosphor screen for focusing electrons from said thermionic cathode, and means spaced from said transparent film to cool said thermionic cathode on said phosphor screen below ambient temperature.

2. An electron image tube comprising an evacuated envelope including a window transparent to infra-red radiant energy, a cathode cylinder within said envelope having one end adjacent said window, a sheet of material substantially transparent to said infra-red energy mounted across said cathode cylinder, a phosphor screen at the other end of the envelope intercepting the axis of said cathode cylinder, a thermionic cathode on the side of said sheet facing said phosphor screen, a plurality of anode electrodes positioned between the thermionic cathode and said phosphor screen, for electrostatically focusing an electron emission from said thermionic cathode on said phosphor screen, and means spaced from said thermionic cathode to cool portions of said tube adajacent said thermionic cathode below the temperature of the ambient atmosphere.

3. An electron image tube comprising an evacuated envelope having a portion thereof transparent to infra-red radiations, a thermionic cathode electrode mounted within said envelope spaced from and adjacent said transparent envelope portion, a phosphor screen within said envelope spaced from said cathode electrode, means between said cathode electrode and said phosphor screen for accelerating and focusing an electron emission from

cathode electrode onto a reduced portion of said screen, and a cooling chamber including said transparent envelope portion for maintaining the thermionic cathode below the temperature of the ambient atmosphere.

4. An electron image tube comprising an evacuated tubular envelope having each end thereof closed by a transparent wall portion, a thermionic cathode electrode mounted at one end of said tubular envelope spaced from and adjacent to said wall portion closing said one end of said envelope, a phosphor material coating said wall portion closing the other end of said tubular envelope, means between said thermionic cathode and said phosphor coating for focusing an electron emission from said cathode on said phosphor film, a cooling chamber including said wall portion at said one end of said envelope for maintaining said one end of said envelope below the temperature of the ambient atmosphere, said chamber including a window comprising a pair of thin plates transparent to infra-red radiations.

5. An electron image tube comprising an evacuated tubular envelope having each end thereof closed by a transparent wall portion, a thermionic cathode electrode mounted within one end of said tubular envelope spaced from and adjacent to said wall portion closing said one end of said envelope, a phosphor material coating said wall portion closing the other end of said tubular envelope, means between said thermionic cathode and said phosphor coating for focusing an electron emission from said cathode on said phosphor film, a cooling chamber enclosing said tubular envelope for maintaining said image tube below the temperature of the ambient atmosphere, said chamber including a window extending over said one end of said envelope, said window comprising a pair of thin plates transparent to infra-red radiations.

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JAMES W. LAWRENCE, *Primary Examiner.*

JAMES L. BREWRINK, *Examiner.*

VINCENT LAFRANCHI, *Assistant Examiner.*