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LUMINOSCOPE

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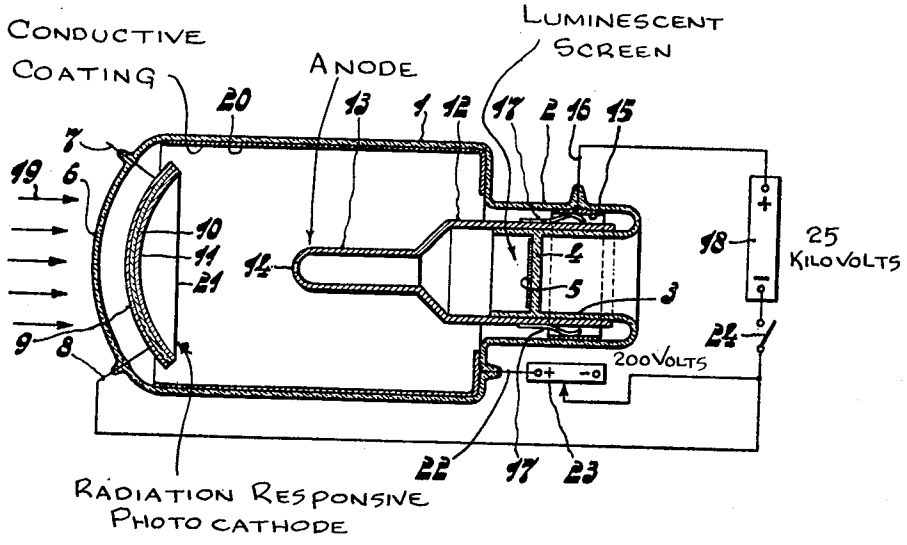

INVENTORS

MARTEN CORNELIS TEVES
TAEKE TOL

BY Fred M Vogel

AGENT

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LUMINOSCOPE

Marten Cornelis Teves and Taeke Tol, Eindhoven, Netherlands, assignors to Hartford National Bank and Trust Company, Hartford, Conn., as trustee

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This invention relates to "luminoscopes," i. e., a device for converting an infra-red or X-ray image into a luminescent image having a different wavelength or a higher degree of brightness.

Conventional luminoscopes generally comprise an electron-optical system constituted by a photo-electric cathode in the form of an arcuate body and a thimble-shaped anode having an aperture for the passage of the electrons emitted by the cathode to a luminescent or collecting screen. Luminoscopes of the foregoing type have also been provided with a conductive surface electrically at the same potential as the cathode and enclosing the path of the electrons between the cathode and the anode. Such tubes, however, have the great disadvantage that in order to obtain a sharply defined image on the collecting or luminescent screen, the spacing between the cathode and the anode must be held to extremely close tolerances, not more than ±0.1 mm. It is obvious that the manufacture of glass-envelope luminoscopes fulfilling the above requirement is extremely difficult and time consuming.

The present invention is directed to an improvement in the luminoscope described above whereby the spacing between the anode and cathode is no longer critical and whereby other advantages over the luminoscopes heretofore known are obtainable as will be more fully explained hereinafter.

According to the invention, a luminoscope, comprising a photo-electric cathode shaped in the form of a sphere segment and a thimble-shaped anode having its axis arranged at right angles to a collecting or luminescent screen and to the concave cathode surface and having a central aperture in the path of the electron beam whose diameter is smaller than that of the collecting screen, is provided with a conductive surface which encloses the entire path of the electrons between the cathode and the anode and which is electrically insulated from the cathode. Means are also provided for maintaining this conductive surface at a variable potential which differs from the potential applied to the cathode. By altering the potential difference between the conductive surface and the cathode, the quality of the image on the collecting screen may be varied.

The polarity and magnitude of the potential difference between the conductive screen and the cathode will depend upon whether the spacing between the anode and the cathode is greater or less than the critical spacing, i. e., the spacing at which, with zero potential difference between the conductive surface and the cathode, a sharply defined image is produced on the collecting screen. So, for example, if the spacing is greater than the critical spacing, the potential applied to the conductive screen must be positive with respect to the cathode. Where the spacing is less than the critical spacing, the surface must be negative relative to the cathode. The magnitude of the potential difference required to be applied for the production of a sharply defined image is a linear function of the difference between the actual

spacing and the critical spacing, and, with conventional size tubes is about 20 volts per mm. It is preferable that the actual spacing be greater than the critical spacing.

In a preferred embodiment, the photo cathode is not integral with the wall of the tube but is arranged in the tube as a separate body and the conductive surface which surrounds the electron path is cylindrically shaped. This arrangement has the advantage that a reduction in the diameter of the tube is obtainable. Furthermore, the positive potential applied to the conductive surface relative to the cathode completely avoids, or at least greatly reduces, the reduction in definition which previously occurred at the edge of the image. A further advantage obtainable with a positive potential on the conductive surface is that a larger part of the cathode, per surface unit, is projected on to the collecting or luminescent screen so that both a larger image and a brighter image is observed.

The conductive surface may be formed by a metal wall portion of the glass envelope or by a conductive coating on the inner surface of the glass wall. A suitable material for this conductive coating is aluminum.

The invention will now be described in detail with reference to the accompanying drawing in which the sole figure is a view, in cross section, of a luminoscope according to the invention for amplifying X-ray images.

The luminoscope shown in the figure comprises a narrowed part 2 including a re-entrant part 3. This re-entrant part 3 is closed by a transverse wall 4 which is coated on its inner side with a film 5 of a substance which fluoresces on being struck by electrons, the wall 4 and the film 5 constituting a luminescent collecting screen. This film is shown in the figure in lines which are of exaggerated thickness.

Suspended from an arcuate part 6 of the tube wall, which serves as a radiation-transparent window, by means of small metal wires 7 and 8 sealed in the glass is a metal bowl 9, for example, of aluminum. The hollow side of this bowl contains the photo-electric layer or cathode 11. However, since such a cathode absorbs very few X-rays and, consequently, under the influence of these rays alone would emit very few electrons, provision is made in the bowl 9 of a layer 10 of a substance which fluoresces under the influence of X-rays. The light of this primary luminescent screen 10 causes the photo-electric layer 11, which is arranged to coat the layer 10 with a current supplying substratum, to emit electrons.

A metal cylinder 12 is arranged to grip the re-entrant part 3. The portion of the cylinder 12 adjacent the cathode is narrowed and terminates in a thimble-shaped top 13 which serves as the anode of the tube. This top 13 has formed in it a circular bore or aperture 14, the diameter of which is, for example, 5 mms. On the collecting screen 5, a circular surface having a diameter of from 15 to 20 mms. is occupied by the image. The narrowed part 2 of the tube wall is provided on its inner side with an annular coating 15 of silver or other suitable conducting material and a wire 16 sealed in the wall of the part 2 for making contact therewith. The cylinder 12 is provided externally with a pair of contact springs 17 which engage the coating 15. Current is supplied to the anode via the wire 16, the coating 15 and the springs 17 and is supplied to the photo cathode 11 by way of the wire 8.

By means of a suitable source of potential 18, the positive terminal of which is connected to the wire 16 and the negative terminal of which is connected to the wire 8 through a switch 24, the anode is given a sufficiently high positive potential in relation to the cathode

(an adequate voltage is, for example, 25 kv.). The electrons emerging from any point of the cathode surface **11** are conducted to the anode **13** in the form of a beam and, in the case of correct focussing, all of them strike the collecting screen **5** at the same point which is the image point of the point of the cathode from which the electron beam has issued. Thus, every emitting point of the cathode finds an image point on the luminescent screen. The beams of electrons intersect in the vicinity of the aperture **14**. The extent to which the points of the photo-electric cathode **11** emit electrons varies in accordance with the degree of brightness of the primary screen **10**, which, in turn, depends on the intensity of the X-rays, denoted in the figure by arrows **19** penetrating through the front part of the tube wall **6** and the metal bowl **9** into the fluorescent layer **10**. Thus, a true image of the radioscopic image is produced on the luminescent screen **5**.

The inner surface of the wall **1** is coated with a conductive layer **20**. A suitable substance for this layer is aluminum, because aluminum does not remove the caesium introduced into the tube by the manufacture of the photo-electric cathode **11**. The layer **20** extends from the center of the cathode **11** slightly beyond the marginal surface **21** thereof and towards the anode side of the tube as far as almost the narrowed part **2**.

The supply conductor for the coating **20** is constituted by a wire **22** sealed in the wall.

Connected between the negative terminal of the source of potential **18** and the supply wire **22** is a second source of potential **23** having a variable voltage. This source **23** gives the coating **20** a positive potential in relation to the cathode **11** which may be varied, for example, between 0 and 200 v. The distance between the top of the anode **13** and the cathode **11** is made larger than that at which a sharply defined image would be formed without any voltage between the coating **20** and the cathode **11**. Consequently, the application of a potential to the coating **20** permits sharp focussing of the image on the collecting screen **5**. Correct adjustment is obtained by varying the voltage provided by the source of potential **23** while viewing the collecting screen **5** through a magnifying lens (not shown) in the re-entrant part **3**.

While we have thus described our invention with specific examples and embodiments thereof, other modifications will be readily apparent to those skilled in the art without departing from the spirit and the scope of the invention as defined in the appended claims.

What we claim is:

1. A luminoscope comprising an envelope, a radiation-transparent window in said envelope, a photo-electric cathode having a spherical segmental shape disposed adjacent said window for forming beams of electrons corresponding to radiation impinging on said photo-cathode, a luminescent collecting screen having a given diameter disposed within said envelope and serving as a target for said electron beams, a thimble-shaped anode disposed between said cathode and said collecting screen and having its axis arranged at right angles to the screen and to the cathode surface, said anode having a centrally-disposed aperture having a diameter smaller than said given diameter, a conductive surface enclosing the entire path of the electron beams between the cathode and the anode, said conductive surface being electrically insulated from said cathode, means for applying a potential between said anode and said cathode, and means for applying a a potential between said cathode and said conductive surface.

2. A luminoscope comprising an envelope, a radiation-transparent window in said envelope, a photo electric cathode having a spherical segmental shape disposed adjacent said window for forming beams of electrons corresponding to radiation impinging on said photo-cathode, a luminescent collecting screen having a given diameter disposed within said envelope and serving as a target for said electron beams, a thimble-shaped anode disposed between said cathode and said collecting screen and having its axis arranged at right angles to the screen and to the cathode surface, said anode having a centrally-disposed aperture having a diameter smaller than said given diameter, a single cylindrically-shaped conductive surface enclosing the entire path of the electron beams between the cathode and the anode, said conductive surface being electrically insulated from said cathode, means for applying a potential between said anode and said cathode, and means for applying a positive potential between said cathode and said conductive surface.

3. A luminoscope comprising a glass envelope, a radiation-transparent window in said envelope, a photo electric cathode having a spherical segmental shape disposed adjacent said window and spaced therefrom for forming beams of electrons corresponding to radiation impinging on said photo-cathode, a luminescent collecting screen having a given diameter disposed within said envelope and serving as a target for said electron beams, a thimble-shaped anode disposed between said cathode and said collecting screen and having its axis arranged at right angles to the screen and to the cathode surface, said anode having a centrally-disposed aperture having a diameter smaller than said given diameter and being spaced from said cathode a distance exceeding the distance at which a sharply defined image is produced on the collecting screen, a single cylindrically-shaped conductive surface enclosing the entire path of the electron beams between the marginal surface of the cathode and anode, said conductive surface being electrically insulated from said cathode, means for applying a potential between said anode and said cathode, and means for applying a positive potential between said cathode and said conductive surface.

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