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DRUM TARGET IMAGE ORTHICON

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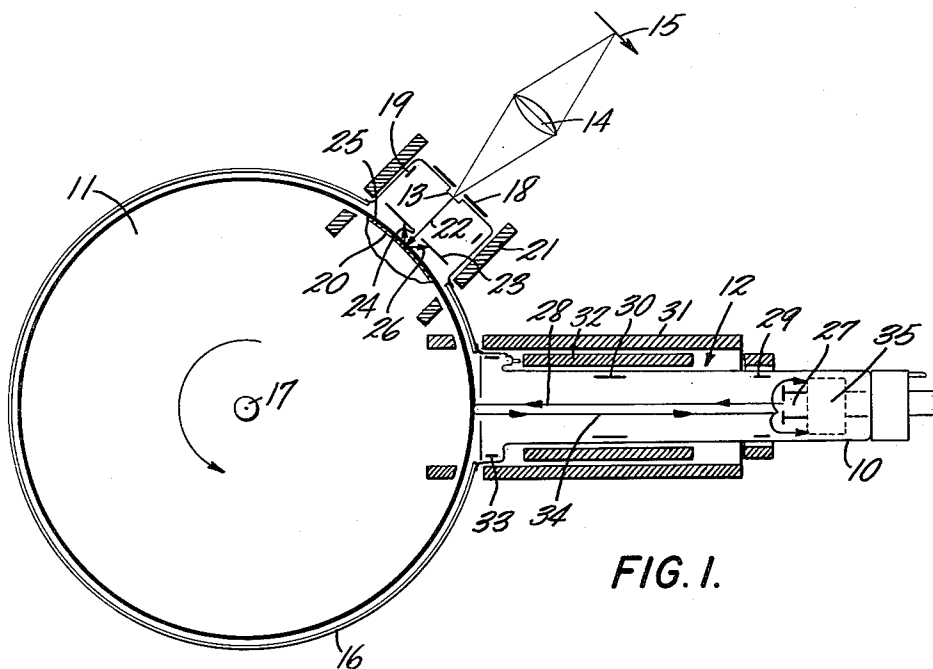


FIG. 1.

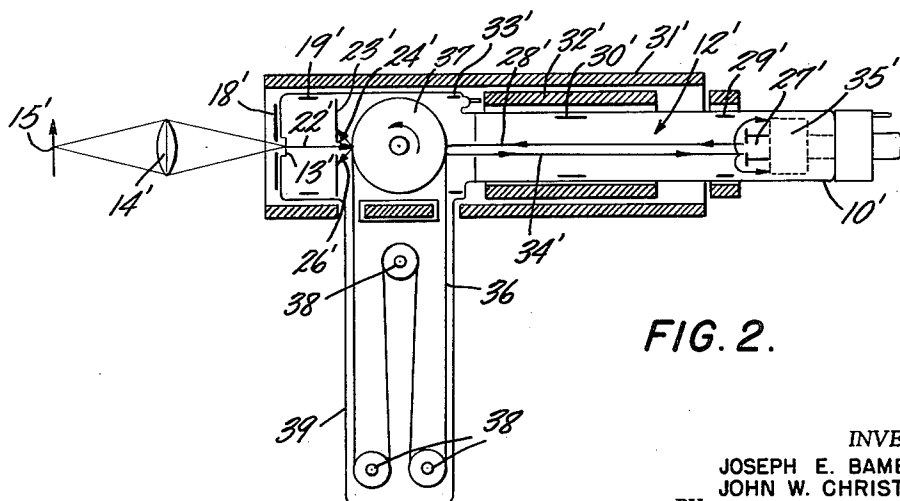


FIG. 2.

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1

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DRUM TARGET IMAGE ORTHICON

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This invention relates to orthicon type electron image tubes and, more particularly, to a new and improved image orthicon especially adapted for aerial reconnaissance.

Generally, aerial reconnaissance systems arranged to provide a photographic record of a scene such as the terrain below an airplane do not permit immediate visual observation of the photographic record. Conventional television recording systems, on the other hand, while allowing simultaneous visual observation, are incapable of the high image resolution obtainable photographically. Furthermore, inasmuch as the photosensitive element in the usual image orthicon is held in fixed position with respect to the viewing lens, relative motion of a scene with respect to this element, produced by the forward motion of an aircraft, for example, further degrades the quality of the image being recorded.

Accordingly it is an object of this invention to provide a new and improved electron image tube for aerial reconnaissance eliminating the above disadvantages of conventional systems.

Another object of the invention is to provide an image orthicon capable of substantially improved image resolution.

A further object of the invention is to provide an image orthicon incorporating image motion compensation to prevent blurring caused by a moving scene.

Still another object of the invention is to eliminate image retention, burn-in, and microphonic image degradation in image orthicons.

These and other objects of the invention are attained by providing an image orthicon with a movable charge storage target layer. In one position the charge storage layer receives electrons from a photocathode element illuminated by a moving image, and in a second position the charge image resulting therefrom is read out from the layer by a line scanner, the rate and direction of motion of the layer corresponding to that of the image in the photocathode element. A slit electrode between the photocathode and the charge storing layer confines the electrons emitted by the photocathode to a narrow band transverse to the direction of motion of the layer and also traps secondary electrons released from the layer. In one embodiment of the invention, the charge storing layer is mounted on the periphery of a drum which rotates past the photocathode and the line scanner while another embodiment of the invention utilizes a moving belt to carry this layer.

Further objects and advantages of the invention will be apparent from a reading of the following description in conjunction with the accompanying drawings in which:

FIG. 1 is a sectional view illustrating one form of image orthicon arranged according to the invention; and

FIG. 2 is a sectional view illustrating another embodiment of the invention.

In the embodiment of the invention shown in FIG. 1, the image orthicon comprises an evacuated envelope 10 enclosing a rotatably mounted cylindrical drum 11 and a conventional electron beam line scanner 12. Adjacent the periphery of the drum 11, a photocathode 13 is positioned in the image plane of a lens 14 directed toward a scene moving relatively to the image orthicon in the direction of the arrow 15, the portion 16 of the

2

envelope 10 surrounding the drum being opaque to provide a light tight enclosure therefor.

The photocathode 13 is of the usual type adapted to emit electrons in proportion to the intensity of incident light and is preferably oblong in shape with its length extending parallel to the axis 17 of the drum 11. In order to restrict the portion of the scene image falling on to the photocathode to a narrow band, an optical slit 18 is mounted adjacent the photocathode with its length extending parallel thereto. This slit is made adjustable in width so that the exposure of a moving image falling on the photocathode can be varied.

Within the envelope 10 an accelerator grid 19, maintained at a positive potential with respect to the photocathode 13, accelerates electrons therefrom toward the periphery 20 of the drum 11, while a focusing coil 21 confines these electrons to a limited path 22. In close proximity to the periphery 20 of the drum, a slit electrode 23 having an aperture 24 extending parallel to the optical slit 18 and to the photocathode 13 restricts the electrons in the path 22 to a narrow band parallel to the axis of the drum.

The periphery 20 of the drum comprises a highly polished metal surface and carries a thin coating 25 of electrically insulative charge storing target material, such as glass, for example. Inasmuch as electric charges are induced in and read out from the same side of this charge storing layer in the manner described below, the layer need not be capable of conducting electricity to any extent, as is required in conventional image orthicon tubes, and preferably has substantially zero conductivity. For this reason, a charge storing material having high resolution and tonal range characteristics can be selected without requiring a specific electrical conductivity.

Substantially improved image resolution is also obtained in electron image tubes arranged according to the invention by the elimination of the mesh screen utilized in conventional image orthicons between the photocathode and the charge storing layer to trap secondary electrons. In addition, the image charge storage capacity is increased with the charge storing target arrangement utilized in the invention since the entire backing surface for the storage layer 25 is highly conductive and the layer can be made as thin as desired without introducing microphonic effects. Furthermore, since the charge storing material has substantially zero conductivity, no lateral charge leakage occurs and charge images can be stored for a relatively long time. Another advantage of the arrangement described herein is that no burn-in and image-sticking effects are encountered since the charge image is induced and read-out from the same side of the charge storing target layer.

As in conventional image orthicons, electrons emitted from the photocathode 13 are accelerated by the electrode 19 to strike the charge storing layer 25 at an energy above the secondary electron emission threshold, thereby releasing secondary electrons 26 to accomplish image charge amplification. Secondary electrons released in this manner are collected by the slit electrode 23 which is maintained at a positive potential with respect to the periphery 20 of the drum 11, while the drum periphery is held at a potential corresponding to that of the target mesh in conventional orthicon tubes.

In order to eliminate the smearing effect of relative motion of the scene and the electron image tube as produced, for example, by the motion of the aircraft passing over the scene to be observed, the drum 11 is rotated in the same direction and at the same peripheral speed as the resultant motion of the optical image on the photocathode 13. Thus, with a scene moving relatively in the direction of the arrow 15, the image formed by the lens 14 at the photocathode 13 moves in the opposite direction

and the drum 11 is rotated counterclockwise as indicated in the drawing by the arrow. Rotation of the drum 11, which is mounted in suitable bearings (not shown) within the envelope 10, may be accomplished by rotating a magnetic field outside the envelope and providing appropriate magnetic elements attached to the drum within the envelope in the manner described in United States Patent No. 2,330,682, for example.

It will be readily apparent that the optical exposure of the photocathode 13, and therefore the exposure of the charge storing layer 25 to electrons accelerated therefrom, varies inversely with the speed of the image and directly with the width of the slit 18. Accordingly, the adjustable slit 18 may be narrowed at low image speeds or widened at high image speeds to maintain a constant exposure time. Also, inasmuch as the layer 25 and the optical image at the photocathode 13 move in unison, the image motion is compensated and a charge image representing the moving scene is continuously registered on the layer 25 without blurring or smearing.

In order to read out the charge image placed on the layer 25 in the manner described above, an electron gun 27 in the line-scanner 12 generates a scanning beam 28 which is accelerated toward the drum by electrodes 29 and 30 and focused on the periphery of the drum by a focusing coil 31, as in conventional image orthicons. In this case, however, the scanning beam 28 is deflected only in a direction parallel to the axis 17 of the drum by a deflection coil 32, since the rotation of the drum provides motion in the perpendicular direction. As in the usual orthicon tube, a decelerator grid electrode 33 slows the electrons in the beam 28 as they approach the layer 25 and, where no positive charges are deposited on the layer, the electrons are accelerated back toward the electron gun in a return beam 34. Inasmuch as electrons approaching positive charges on the layer 25 are trapped thereby to neutralize the charges, the return beam 34 possesses a signal component corresponding to the image brightness of the scanned area of the scene. A suitable electron multiplier 35 amplifies this signal in the usual manner to provide an output signal having a high signal-to-noise ratio.

By making the angular travel of the drum 11 between the photocathode 13 and the line scanner 12 large and by utilizing a large diameter drum, read out of the charge image may be delayed for any reasonable length of time, dependent only on the leakage characteristics of the storage layer 25. Furthermore, the separation of the photocathode portion of the tube from the line scanner eliminates undesirable cross-talk effects frequently caused by the line scanner beam deflection field in the usual form of image orthicon.

In operation, the drum 11 is rotated in the same direction and at the same speed as an image falling on the photocathode. Electrons emitted from each exposed point in the photocathode in proportion to the light intensity incident thereon are accelerated toward the corresponding point in the charge storing layer 25 of the drum 11 and release secondary electrons 26 therefrom to form a charge image, the secondary electrons being captured by the relatively positive slit electrode 23. When the drum has turned far enough to expose the charge image to the scanning beam 28 of the line scanner 12, the beam reads out the image line by line as the drum rotates, generating a return beam 34. This beam carries a signal component representing the scene brightness information to the electron multiplier for amplification and the amplified signal may be recorded by suitable equipment and simultaneously applied to viewing equipment for visual observation.

In the embodiment of the invention shown in FIG. 2, substantially increased time delay between the optical image exposure and the line scanner read out is obtained without increasing the size of the envelope by providing

a belt 36 coated with a layer of charge storing material in the same manner as the drum 11 of FIG. 1. Inasmuch as the image receiving section and the electron beam line scanner of this embodiment of the invention are identical to those described above with respect to FIG. 1, these portions of the embodiment shown in FIG. 2 are not described in detail, primed reference numerals being utilized to indicate the corresponding elements in FIG. 2.

With the belt 36, which may be up to 25 feet long, for example, providing the charge storage layer, a substantially smaller drive drum 37 is utilized in this embodiment and the belt 36 is carried over rollers 38 mounted in a cassette portion 39 of the envelope 10'. The operation of this embodiment of the invention is identical to that described above with reference to FIG. 1, the drum 37 being driven in the direction of the arrow to move the belt 36 adjacent the slit electrode 23' through the cassette 39 and past the scanning beam 28'.

Although the invention has been described herein with reference to specific embodiments thereof, many modifications and variations therein will readily occur to those skilled in the art. Accordingly, all such variations and modifications are included within the intended scope of the invention as defined by the following claims.

We claim:

1. An electron image tube comprising an evacuated enclosure, photocathode means adapted to emit electrons in response to illumination from a scene, movable electric charge storage means within the enclosure arranged to receive electrons from the photocathode means on a first surface spaced at a distance from the photocathode means and store corresponding electric charges, and means for reading out the charges stored in the storage means directly from said first surface at a position spaced from the photocathode means.

2. An electron image tube comprising an evacuated enclosure, photocathode means adapted to emit electrons in response to illumination from a scene, movable electric charge storage means within the enclosure having substantially zero conductivity arranged to receive electrons from the photocathode means on a first surface spaced at a distance from the photocathode means and store corresponding electric charges, and means for reading out the charges stored in the storage means directly from said first surface at a position spaced from the photocathode means.

3. An electron image tube comprising an evacuated enclosure, photocathode means adapted to emit electrons in response to illumination from a scene, slit means defining a narrow band of electrons from the photocathode means, movable electric charge storage means within the enclosure arranged to receive the band of electrons at one position and store corresponding electric charges, and means for reading out the charges stored in the storage means directly from said first surface at a position spaced from the photocathode means.

4. An electron image tube comprising an evacuated enclosure, photocathode means adapted to emit electrons in response to illumination from a scene, movable electric charge storage means within the enclosure arranged to receive electrons from the photocathode means on a first surface spaced at a distance from the photocathode means and store corresponding electric charges, accelerator means for accelerating electrons from the photocathode means toward the storage means, slit means between the photocathode means and the storage means defining a narrow band of electrons from the photocathode means and having a more positive potential than the storage means to trap secondary electrons emitted thereby, and means for reading out the charges stored in the storage means directly from said first surface at a position spaced from the photocathode means.

5. An electron image tube comprising an evacuated enclosure, fixed photocathode means adapted to emit electrons in response to illumination by an image of a

moving scene, electric charge storage means within the enclosure movable in the same direction as the image of the scene arranged to receive electrons from the photocathode means on a first surface spaced at a distance from the photocathode means and store corresponding electric charges, slit means defining a narrow band of electrons from the photocathode means extending transversely to the direction of motion of the scene, and means for reading out the charges stored in the storage means directly from said first surface at a position spaced from the photocathode means.

6. An electron image tube comprising an evacuated enclosure, fixed photocathode means adapted to emit electrons in response to illumination by an image of a moving scene including slit means restricting the image falling on the photocathode means to a narrow band extending transversely to the direction of motion of the image, electric charge storage means within the enclosure movable in the same direction as the image of the scene having substantially zero conductivity arranged to receive electrons from the photocathode means on a first surface spaced at a distance from the photocathode means and store corresponding electric charges, and means for reading out the charges stored in the storage means directly from said first surface at a position spaced from the photocathode means.

7. An electron image tube comprising an evacuated enclosure, fixed photocathode means adapted to emit electrons in response to illumination by an image of a moving scene including slit means restricting the image falling on the photocathode means to a narrow band extending transversely to the direction of motion of the image, electric charge storage means within the enclosure movable in the same direction and at the same rate as the image of the scene having substantially zero conductivity arranged to receive electrons from the photocathode means on a first surface spaced at a distance from the photocathode means and store corresponding electric charges, accelerator means for accelerating electrons from the photocathode means toward the storage means, slit electrode means between the photocathode means and the storage means defining a narrow band of electrons from the photocathode means and having a more positive potential than the storage means to trap secondary electrons emitted thereby, and means for reading out the charges stored in the storage means directly from said first surface at a position spaced from the photocathode means.

8. An electron image tube comprising an evacuated enclosure, fixed photocathode means adapted to emit electrons in response to illumination by an image of a moving scene, electric charge storage means within the enclosure movable in the same direction as the image of the scene arranged to receive electrons from the photocathode means on a first surface spaced at a distance from the photocathode means and store corresponding electric charges, slit means defining a narrow band of electrons from the photocathode means extending transversely to the direction of motion of the scene, and electron beam line scanning means at a position spaced from the photocathode means adapted to scan the storage means on a line extending transversely to the direction of motion

thereof to read out directly from said first surface the charges stored therein.

9. An electron image tube, comprising an evacuated enclosure, a rotatable drum within the enclosure, electric charge storage means at the periphery of the drum, fixed photocathode means at one angular position spaced from the drum adapted to emit electrons toward the drum periphery in response to illumination from a scene, and means for reading out directly from the periphery of the drum the charges stored in the storage means at an angular position spaced from the photocathode means.

10. An electron image tube comprising an evacuated enclosure, a rotatable drum within the enclosure, electric charge storage means affixed to the periphery of the drum having substantially zero conductivity, fixed photocathode means at one angular position spaced from the drum adapted to emit electrons toward the drum periphery in response to illumination from a scene, and means for reading out directly from the periphery of the drum the charges stored in the storage means at an angular position spaced from the photocathode means.

11. An electron image tube comprising an evacuated enclosure, fixed photocathode means adapted to emit electrons in response to illumination from a scene, belt means within the enclosure movable adjacent the photocathode means to receive electrons therefrom on a surface spaced from the photocathode means, electric charge storage means on the first surface of the belt means arranged to store electric charges in response to the electrons, and means for reading out the charges stored in the storage means directly from said first surface at a position in the path of the belt means spaced from the photocathode means.

12. An electron image tube comprising an evacuated enclosure, fixed photocathode means adapted to emit electrons in response to illumination by the image of a moving scene, belt means within the enclosure having a first surface spaced from and movable adjacent the photocathode means in the same direction and at the same speed as the image of the scene, electric charge storage means on the first surface of the belt means having substantially zero conductivity arranged to store electric charges in response to electrons from the photocathode means, slit means restricting the electrons from the photocathode means to a narrow beam extending transversely to the direction of motion of the belt means, and line scanning beam means for reading out the charges stored in the storage means directly from said first surface of the belt means at a position in the path of the belt means spaced from the photocathode means.

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