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[56]

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[54] DIRECT RECORD IMAGE DISCHARGE TUBE
10 Claims, 3 Drawing Figs.

[52] U.S. Cl. 346/74,

313/67, 313/74, 313/84, 346/110

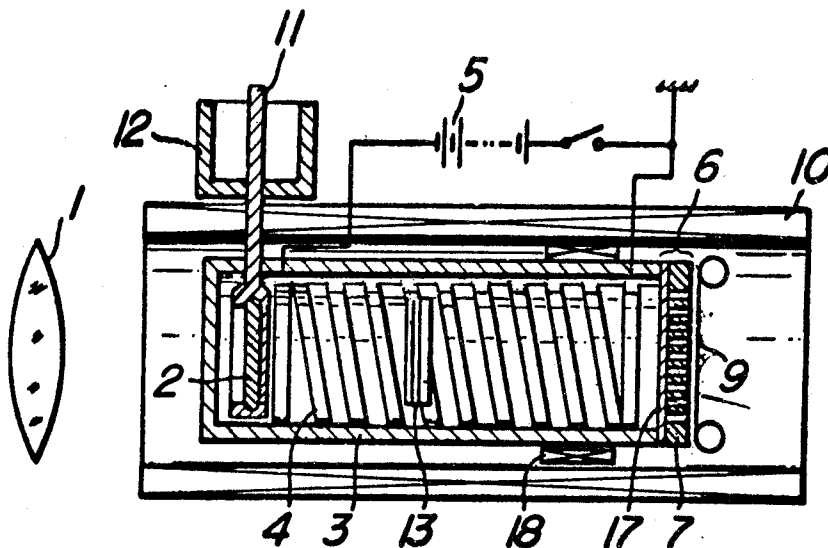
[51] Int. Cl. G01d 15/06,

H01j 31/26, H01j 33/00

[50] Field of Search..... 346/74,

110; 313/33, 36; 313/74, 73, 83, 67

ABSTRACT: A device for directly recording an optical image on a recording medium, first by converting the optical image to an electron beam image, then directly recording the electron beam image on a recording medium sensitive to electron beams.



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FIG. 1

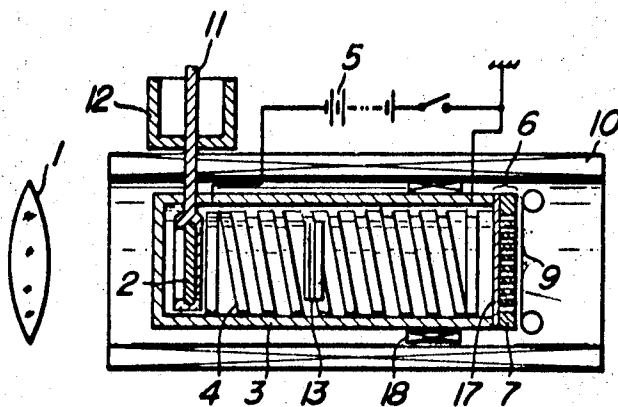


FIG. 2

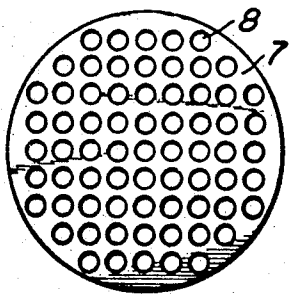
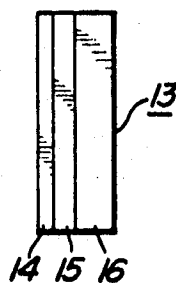


FIG. 3



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DIRECT RECORD IMAGE DISCHARGE TUBE

This invention relates to a direct record image discharge tube, in which an optical image is converted into an electron image which, being taken out of the tube, is directly recorded on a recording medium which is sensitive to electrons.

In ordinary image tubes, the recording of an image is performed by first converting the image to an electron image, then converting the electron image again to an optical image by a fluorescent substance, and finally recording the optical image on a photographic film. If the step of photoelectric conversion by the fluorescent substance can be omitted and if the electron beams can directly act on a recording medium, many advantages will be obtained. In such direct recording, the sensitivity of the system will be about ten thousand times as high as that of the conventional image tubes, if a film of silver salt-type is used. Other recording media present very economical recording in the direct recording medium. However, in the known direct record image tube, it is necessary that the recording medium is put into the high vacuum tube for each recording. This requires a costly evacuating apparatus and much operation time. A direct record tube which dispenses with the evacuating apparatus has been proposed, using a mica film as an electron beam pervious window. However, that one is limited only to small tube, from the strand point of physical strength, and the electron pervious window tends to be concaved, thus making the movement of the recording medium impossible.

The present invention overcomes the above-mentioned disadvantages encountered by the known image tubes, and provides a unique image tube for direct recording which is high in sensitivity and low in noise.

For a fuller understanding of the nature and objects of the invention, reference should be made to the following detailed description of the embodiments of the invention taken in connection with the accompanying drawings, in which:

FIG. 1 is a sectional view of a direct record image tube embodying the present invention;

FIG. 2 is the front view of electron beam pervious window of the image discharge tube shown in FIG. 1; and

FIG. 3 shows the constitution of a penetration-type secondary electron emitting element.

Referring now to FIG. 1, there is shown a direct record image discharge tube which generally comprises an optical lens system 1, an evacuated envelope 3 having a photoelectric element 2 positioned close to the faceplate thereof, a resistive helical electrode 4 positioned within the envelope 3, an electron beam pervious window 6 positioned at the end of the envelope 3 opposite to the faceplate, a recording medium 9 positioned outside of the evacuated envelope 3 in opposed relationship to the electron beam pervious window 6, and a field coil 10 positioned outside of the envelope 3. The optical lens system 1 focuses a light image upon the photoelectric element 2 which emits electrons in accordance with the light image. The electrons thus emitted are accelerated towards the electron beam pervious window 6 by the action of an electric field established by the resistive helical electrode 4. The resistive helical electrode 4 is connected to an electric source 5 in such a manner that the end of the resistive helical electrode 4 which is close to the electron beam pervious window 6 has a higher potential than at the opposite end thereof. The electron beam pervious window 6 consists of an electron beam pervious film 17 made of, for example, aluminum and its support member 7 having a plurality of fine apertures 8 formed therein. The electron beam pervious film 17 covers the fine apertures 8 but allows high velocity electrons to penetrate therethrough. Thus, the electrons emitted from the photoelectric element 2, when they are accelerated by the action of the high electric field, penetrate through the electron beam pervious film 17 and pass through the fine apertures of the support member 7.

The recording medium 9 is placed in opposed relationship to the electron beam pervious window 6 so that the electrons which have passed through the window 6 may act on the

recording medium 9. The recording medium 9 may be a photographic film of either silver halide, polymer, dye stuff or electrostatic photographic material. Outside of the evacuated envelope 3 there is a field coil 10 which functions to focus an electron beam upon the recording medium 9. The field coil 10 may be replaced with a field magnet, if desired, though not shown in this drawing.

The photoelectric element 2 positioned close to the faceplate of the envelope 3 is supported by a heat conductive support 11 which is cooled by a coolant such as liquid nitrogen. The coolant is contained in a container such as a dewar flask 12.

It is preferable for increased sensitivity of the device to provide a penetration-type secondary electron emitting element 13 between the photoelectric element 2 and the electron beam penetrative window 6. The number of the electrons emitted from the photoelectric element 2 is multiplied through the penetration-type secondary electron emitting element 13. FIG. 2 shows the construction of the penetration-type secondary electron emitting element comprising an Al thin film 14, an Al_2O_3 film 15 and a porous layer of KC1 16. The photoelectrons thus multiplied are accelerated by the helical electrode to 10 to 50 KeV and reach the electron beam penetrative window 6 without diffusion by the action of the magnetic field caused by the field coil 10 thus to be focused on the beam penetrative window 6. The electron beam image focused on the window 6 acts on the recording medium 9 through the thin film constituting the window 6, to produce an electron beam image corresponding to the incident optical image on the recording medium 9.

The heat conductive support 11 which supports the photoelectric element 2 and is cooled to a low temperature of, for example, nearly -196°C . if liquid nitrogen is used as the coolant, conveys this low temperature to the photoelectric element 2 to cool it, in order to suppress the emission of thermal electrons from the photoelectric element 2, thus to improve the signal-to-noise ratio. It will be understood that instead of the helical electrode 4 as an electrode for accelerating the electron beams, divided electrodes can be used, steppedly higher voltages being applied successively to the respective divided electrodes.

Thus, according to this invention, the incident optical image is directly recorded on the recording medium as an electron beam image, the electron beams projected from the photoelectric element being accelerated and transmitted through the electron beam penetrative window, to directly act on the recording medium.

Further, according to this invention, the small apertures on the electron beam penetrative window are arranged along one line, the image being moved, by the deflecting coil 18, transversely to the column of the small apertures, and the recording medium being shifted in synchronism with (but not necessarily at the same speed with) and in the direction of or opposite to the above-mentioned movement of the image, thus to attain the desired recording.

I claim:

1. A direct record image discharge tube comprising an evacuated envelope having a faceplate formed at one end thereof, a photoelectric element positioned within said envelope close to the faceplate thereof, a lens system for permitting an image of external objects to be projected upon said photoelectric element, an electron beam pervious window positioned at the end of the envelope opposite to said faceplate, said electron beam pervious window comprising an electron beam pervious film which seals the envelope in a gastight manner and a support member having a plurality of fine apertures formed over its entire surface thereof, said electron beam pervious film being mounted on the vacuum side of said support member, a recording medium placed outside of said evacuated tube in opposed relationship to said electron beam pervious window, means positioned within said envelope for accelerating electrons released from said photoelectric element towards the electron beam pervious

window so as to penetrate therethrough and means positioned outside of said envelope and extending around the recording medium for focusing said electrons so as to form an electron image on said recording medium.

2. A direct record image discharge tube as claimed in claim 1, wherein said electron accelerating means comprises a resistive helical electrode.

3. A direct record image discharge tube as claimed in claim 1, wherein said electron accelerating means comprises a divided-type electrode.

4. A direct record image discharge tube as claimed in claim 1, wherein said electron focusing means comprises a field coil.

5. A direct record image discharge tube as claimed in claim 1, wherein said electron focusing means comprises a field magnet.

6. A direct record image discharge tube as claimed in claim 1 further comprising a penetration-type secondary electron

emitting element positioned within said envelope between said photoelectric element and electron beam pervious window.

7. A direct record image discharge tube as claimed in claim 6, wherein said penetration-type secondary electron emitting element comprises an aluminum film, an aluminum oxide film and porous potassium chloride layer.

8. A direct record image discharge tube as claimed in claim 1 further comprising means to cool said photoelectric element.

9. A direct record image discharge tube as claimed in claim 8, wherein said cooling means comprises a heat conductive support which supports said photoelectric element and a container for coolant such as a liquid nitrogen.

10. A direct record image discharge tube as claimed in claim 1, wherein said electron pervious film is composed of aluminum.

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