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G. FRIES

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METHOD OF AND APPARATUS FOR RECORDING PICTURES

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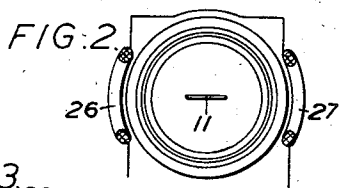
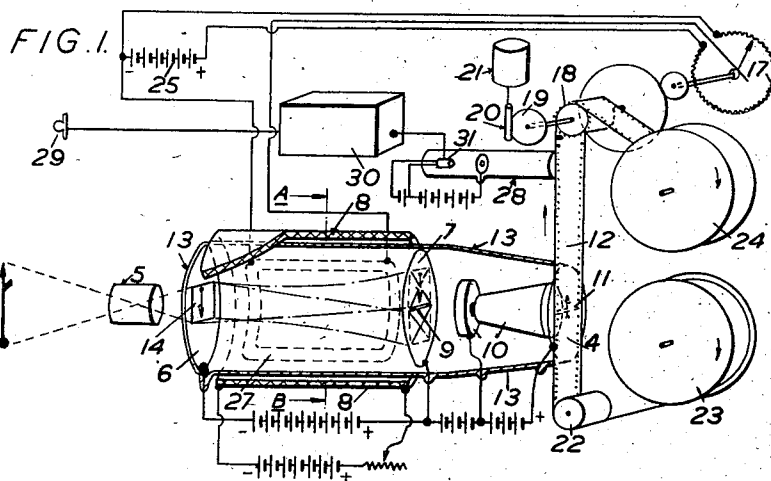


FIG. 3.

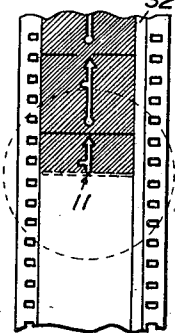


FIG. 4.

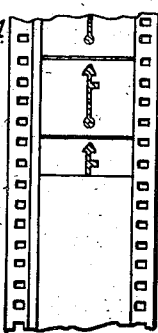


FIG. 5.

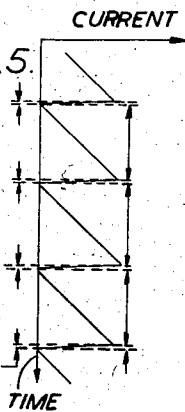


FIG. 6.

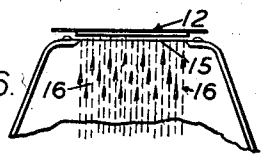
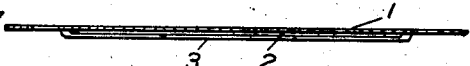


FIG. 7.



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METHOD OF AND APPARATUS FOR RECORDING PICTURES

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Application October 9, 1951, Serial No. 250,471

14 Claims. (Cl. 178—6.7)

This invention relates to the recording of pictures through the intermediary of cathode-ray images and has for an object to make it possible for two-dimensional cathode-ray pictures, as distinct from linear curves, to be recorded without the necessity of introducing the record carrier into a vacuum or of introducing a raster and thereby limiting the resolution of the recorded images. Another object is to record pictures which are available in the form of non-corpuscular radiation by transforming them into images formed by cathode rays and recording the resulting cathode-ray images without the necessity of introducing the record carrier into a vacuum or of introducing a raster and thus limiting the resolution of the recorded images. It has long been known that cathode rays are capable of producing photographic records, when, for example, a photographic plate is brought into the vacuum of a cathode-ray tube, and this phenomenon is being practically used, for example in order to obtain so-called electron micrograms by means of electron microscopes. It is however inconvenient and often impracticable to have to introduce the photographic material into the vacuum of a cathode-ray tube, more particularly when it is desired to produce cinematographic records of pictures or television images by the direct action of cathode rays.

It is on the other hand known that it is possible to cause cathode rays to leave the evacuated envelope of the tube through a so-called Lenard window, but these windows essentially consist of minutely thin material, and are, therefore, self-supporting only over extremely small areas so that Lenard windows corresponding in area to a whole image must be provided with a supporting grid structure the shadow of which is visible in the cathode-ray image obtained. It is an object of the present invention to permit images of appreciable area to be recorded by cathode-rays outside the evacuated envelope of the cathode-ray tube without the use of such supporting grid. In one aspect, the present invention consists in a method of recording pictures which consists in projecting the picture as an electron image on to a slot-like window, moving the electron image transversely with respect to said window, and causing the electrons passing through said window to record corresponding elements of the picture upon a record carrier which is moved synchronously with said movement of the electron image.

The invention also consists in a method of recording pictures which consists in projecting the pictures as electron images through a slot-like Lenard window in the wall of the envelope in which the electron images are generated, and on to a carrier which is sensitive to electrons, and is arranged outside the said envelope and is continuously moved in a direction transverse to said slot-like window, and imparting periodic sweep movements to the electron images in a direction transverse to said slot-like window and in synchronism with the movement of the record carrier.

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The invention further consists in apparatus for recording pictures comprising an image converter tube having a photo-cathode surface within an evacuated envelope, a slot-like Lenard window in the wall of said envelope, means for focussing the picture on to said photo-cathode to produce a corresponding electron image within the tube, an electron sensitive film disposed outside the tube envelope and opposite said window, means for continuously moving said film in a direction transverse to the longitudinal direction of said window, means for focussing the electron image on said window, means for deflecting said electron image transversely to the longitudinal direction of said window, and means for applying a sawtooth deflecting waveform to said deflecting means.

The recording may, with particular advantage, be effected on the film or other sensitized material described and claimed in the specification of my Patent No. 2,707,162 dated April 26, 1955.

In order that the invention may be more readily understood, an embodiment thereof will now be described with reference to the accompanying drawing, in which

Fig. 1 is a diagrammatic section of one form of image recording apparatus according to the invention;

Fig. 2 is a section on line A—B of Fig. 1;

Fig. 3 shows a film negative obtained by means of the apparatus of Fig. 1;

Fig. 4 shows a corresponding positive and

Fig. 5 shows a current diagram for a suitable sweep current;

Fig. 6 shows part of the apparatus of Fig. 1 on a larger scale, and

Fig. 7 is an enlarged diagrammatic cross-section of a suitable film having an ionic crystal layer.

In the apparatus as shown in Fig. 1, the images, which are to be recorded cinematographically at point 4 on a suitably sensitized film, are projected optically through lenses 5 upon a photo-cathode 6 provided in an evacuated envelope 13 of an image-converter tube. The electron image 14 thus produced is accelerated by means of an anode 7, and a sharply defined image thereof is produced upon the anode by means of the focussing coil 8. A slot 9 is provided in the anode 7 through which the electrons forming the part of the electron image corresponding to the area of this slot can pass. The electron beam which passes through the slot 9 and corresponds to an image element of the size of the area of the slot, is further accelerated by means of an electron optical system 10, and arrives, sharply focussed, at slot-like gap 11 in the wall of the envelope, which is closed by a Lenard window 15 (Fig. 6). The sensitized film 12 is made as more fully described in the specification of my co-pending application Serial No. 250,472 filed herewith, and as shown in Fig. 7 comprises a film carrier 1 on which is applied, preferably by vapour deposition, an ionic crystal layer 2 which is sensitive to cathode rays, this layer 2 being covered by a protective layer 3. The layers 2 and 3 are applied to the carrier 1 in a high vacuum so that the layer 2 is, when the complete film is in use under atmospheric conditions, protected and isolated from the atmosphere by the air-tight protective layer 3. The protective layer 3 is pervious to cathode rays so that the ionic crystal layer 2 will be activated by the cathode rays passing through the Lenard window 11 and impinging upon the film 12. The film 12 is moved continuously past the Lenard window by means of the toothed drum 13 which is driven by the motor 21 through the worm 20 and worm wheel 19. The film 12 is withdrawn from the supply spool 23, passes over the roller 22 and drum 18, and is wound up on the take-up spool 24.

The cathode rays 16 (see Fig. 6) penetrate through

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the Lenard window 15 and, also penetrating the protective layer 3 of the film, impinge upon the ionic-crystal layer 2 where they record the image in accordance with their intensity. In order that the images will be recorded in cinematographic sequence one after another upon the continuously moving film 12, a sweep movement of the electron image in front of and across the slot 9 is produced in synchronism with the movement of the film.

This is attained with the help of the rotating potentiometer 17 which is arranged to rotate, for example, at four times the rate of revolution of the toothed drum 18, which produces the film-feed movement, assuming that the toothed drum 18 feeds the film 12 by four frames at each revolution. The sweep current for sweeping the electron image is supplied by the battery 25 and is fed, under the control of the potentiometer 17, to the deflector coils 26 and 27 (see Fig. 2).

Fig. 5 shows the saw-tooth form of the sweep current as a function of the image sequence and time.

By means of a second cathode-ray tube 28 the sound coming from the microphone 25 through amplifier 30 may be recorded on the film 12 in addition to and simultaneously with the image recording. The sound may be recorded as a variable density record by the sound signals modulating the intensity of the cathode beam from the Wehnelt cylinder 31. The cathode beam of the tube 28 likewise passes through a Lenard window to impinge upon the film 12 and record thereon the sound in the sound track 32 (Fig. 3).

Figure 3 shows a film bearing an image recording (negative image on ionic-crystal layer); after transforming this image into a positive by photographic copying on to a conventional photographic film (Fig. 4), the images and also the sound recorded on the electron-sensitive film may be erased in order that this film may be again used to make a new record.

If it be desired to reproduce an image and sound recording thus obtained, within very short time, as positive images for example through any normal sound film projector, a positive image may be produced on an electron-sensitive film by passing the negative image film, if desired as it is being recorded, through a second apparatus similar to that above described, the images of the negative film being projected through the lens system 5 upon the photo-cathode 6, so that due to reversal inherent in the method, positive images are produced on the film 12 of the second apparatus. In the case of the second apparatus, a sweep movement of the electron image is not necessary if the negative film is moved continuously in front of the photo-cathode synchronously with the film on which the positive image is to be recorded.

I claim:

1. Apparatus for recording pictures, comprising an image-converter tube equipped with a slot-like Lenard window in a wall surface of its evacuated envelope and with a photo-cathode facing said window, means for producing images on said photocathode to cause said photo-cathode to produce cathode-ray images in said tube and for focussing said cathode-ray images and accelerating them towards said wall surface, means for moving an electron-sensitive record carrier past the outer side of said window transversely to the longitudinal direction of the window, and means for producing a sweep movement of the cathode-ray images in the same direction as and in synchronism with the movement of said carrier.

2. Apparatus as claimed in claim 1, comprising electron-optical deflecting means for producing periodic sweep movement of the cathode-ray image and means for supplying to said deflecting means a saw-tooth voltage or current.

3. Apparatus for recording pictures comprising an image converter tube having a photo-cathode surface within an evacuated envelope, a slot-like Lenard window in the wall of said envelope, means for focussing the pic-

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ture on to said photo-cathode to produce a corresponding electron image within the tube, an electron sensitive film disposed outside the tube envelope and opposite said window, means for continuously moving said film in a direction transverse to the longitudinal direction of said window, means for focussing the electron image on said window, means for deflecting said electron image transversely to the longitudinal direction of said window, and means for applying a sawtooth deflecting waveform to said deflecting means.

4. Apparatus as claimed in claim 3, comprising means for focussing the electron image released from the photo-cathode on to an anode having a slot therein, means for deflecting the electron image transversely with respect to the longitudinal direction of said slot, means for applying the sawtooth deflecting waveform to said deflecting means, and electron-optical means for focussing the electrons passing through said slot on to the slot-like Lenard window.

5. An arrangement for recording picture images comprising an image converter tube having a large-area photo-cathode, an electron-permeable window opposite said photo-cathode, means for projecting an optical image on to said photo-cathode to produce thereon an electron image, an anode in said tube, means for focussing said electron image on to said anode, and means for transferring said picture from said anode through said window on to an electron-sensitive film located outside said tube.

6. Apparatus for recording pictures comprising an image converter tube having a large-area photocathode surface within an evacuated envelope, a slot-like Lenard window in one wall of said envelope, means for focusing a picture on to said photo-cathode to produce a corresponding electron image within said tube, an electron-sensitive film disposed outside said tube envelope and opposite said Lenard window, means for continuously moving said film in a direction transverse to the longitudinal direction of said window, means for focusing the electron image on said window, deflection coils on said tube located about the longitudinal axis thereof between said photocathode and said Lenard window, and means for applying a saw-tooth deflection waveform to said deflection coils.

7. Apparatus as claimed in claim 6, comprising a drum for moving said film, means for rotating said drum at a predetermined speed, a potentiometer having a rotary wiper, means for rotating said wiper at a speed four times greater than said film drum, and a source of potential between said potentiometer and said deflection coils.

8. An arrangement for recording picture images comprising a vacuum-sealed tube, means in said tube for receiving an optical image, means for converting said optical image into an electron image, an electron-permeable window in said tube opposite said image conversion means, an electron-sensitive record carrier outside said tube, and means for focussing said electron image through said window and on to said carrier.

9. An arrangement for recording picture images comprising an image converter tube having a large-area photocathode, an electron-permeable window opposite said photo-cathode, a record-carrier positioned outside said tube and including an ionic crystal layer which is sensitive to cathode rays, and means for focussing electron images passing through said window on to said record-carrier.

10. An arrangement for recording picture images comprising a vacuum-sealed tube, means in said tube for receiving an optical image, means for converting said optical image into an electron image, an electron-permeable window in said tube opposite said image conversion means, an electron-sensitive record carrier outside said tube, and means for focussing said electron image through said window and on to said carrier, said carrier including an ionic crystal layer which is sensitive to cathode rays.

11. An arrangement for recording picture images, com-

prising an image-converter tube having a large-area photocathode, an electron-permeable window in the wall of said tube opposite said photocathode, means for focussing electrons emitted from said photocathode to pass through said window and form outside the tube an electron image of said picture image, and means for supporting an electron-sensitive carrier so that said electron image is formed thereon.

12. Apparatus for recording pictures by means of cathode rays, comprising an image converter tube having an evacuated envelope provided with a photocathode at one end and a Lenard window at the opposite end, means for imaging the picture on the photocathode to release electrons therefrom in a pattern corresponding to the picture, means for accelerating and focussing electrons released from said photocathode so as to pass through said window and form outside the envelope a clearly defined electron image of the picture, and means for supporting a cathode-ray sensitive record carrier outside said envelope and in a position where said electron image is formed on said carrier.

13. An arrangement for recording pictures on an electron-sensitive carrier, comprising an evacuated envelope having a transparent wall, a photocathode surface within said envelope and facing said wall, a narrow, strip-like electron-permeable window in the wall of said envelope

opposite said photocathode surface, means for accelerating and focussing electrons emitted by said photocathode so as to pass through said window and form outside the tube an electron image of a strip-like area of the photocathode.

14. An arrangement as claimed in claim 13, further comprising carrier means for supporting a record carrier outside the envelope so that said electron image is formed thereon, means for integrally forming on said strip-like area of the photocathode, an image of a strip-like picture portion, and means for producing simultaneous and synchronised relative sweep movements transversely to the longitudinal direction of said strip-like portion and between said electron image and said carrier and between said strip-like area of the photocathode and the picture to be recorded.

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