Jan. 14, 1947. H. C. MILHOLLAND 2,414,319

DEVICE FOR RECORDING TELEVISION PROGRAMS

Filed May 19, 1945 2 Sheets-Sheet 1

Fig. 1

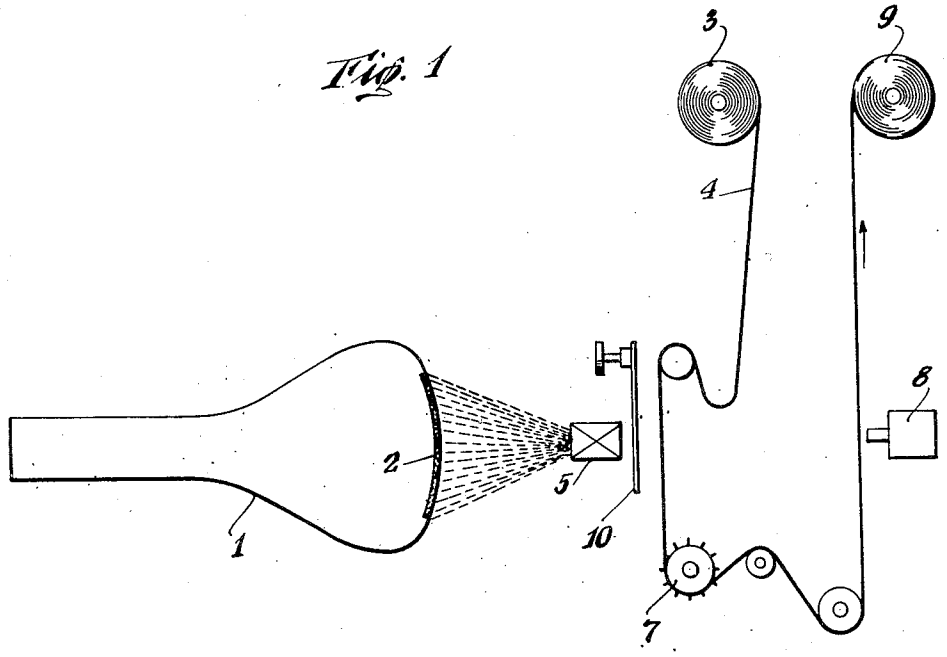
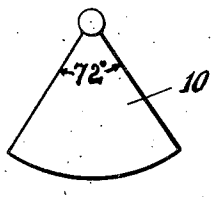


Fig. 2



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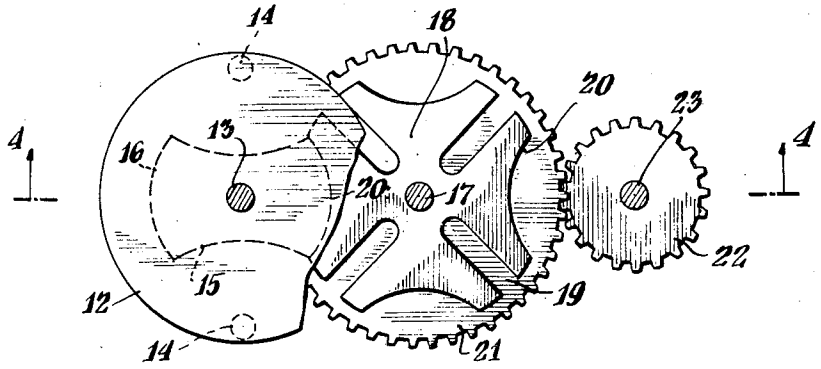
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Fig. 3



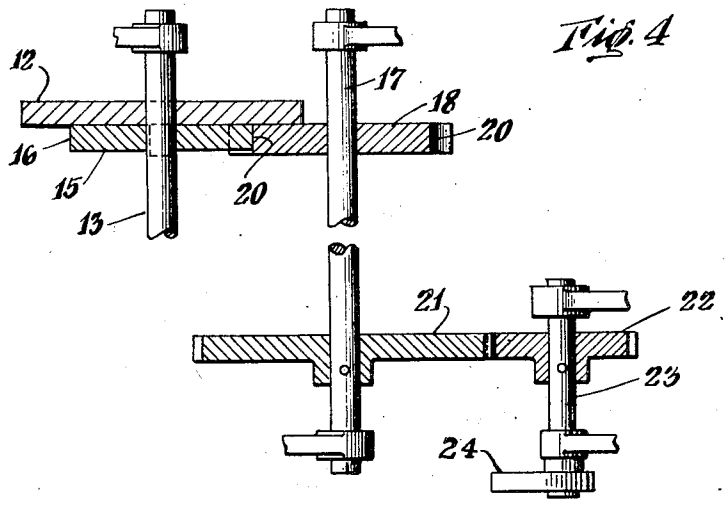


Fig. 4

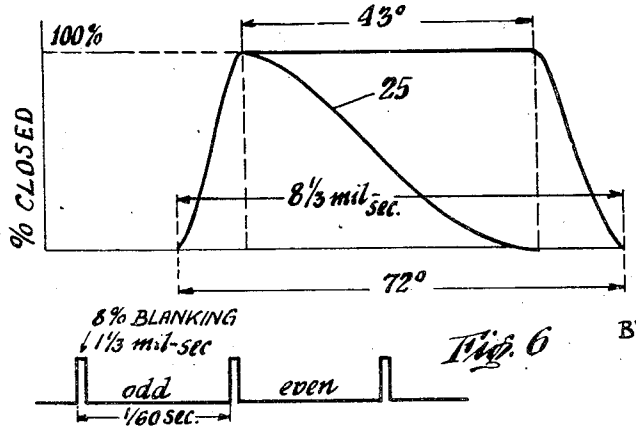


Fig. 5

Fig. 6

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UNITED STATES PATENT OFFICE

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DEVICE FOR RECORDING TELEVISION PROGRAMS

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Application May 19, 1945, Serial No. 594,615

13 Claims. (Cl. 178—6.7)

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This invention relates to a device for sight and sound recording of television programs on moving picture film. In carrying out the invention the pictures or scenes that are caused to appear upon the screen of a television receiver are recorded at 24 frames per second upon a moving picture film. At the same time the accompanying sound is recorded at a 24 frames per second rate upon the sound track of the film. The film is then developed in the usual way to produce a negative which is used to produce one or more positive films.

Or, by receiving the picture upon the television screen in negative polarity in any of the known ways, a positive film can be obtained directly from the television screen in accordance with this invention.

With the present invention both the sight and sound of a cathode-ray tube television receiver can be recorded at 24 frames upon motion picture film such as the 16 mm. or 35 mm. film, for example.

The picture which is formed on the screen of the cathode-ray tube in a television receiver appears to the eye to be similar to any other observed picture or scene. However, when successive scenes from the picture on the cathode-ray tube are photographed by a movie camera the film must move during certain intervals of time, and must remain at rest for the exposure. Numerous problems arise due to the fact that the image on the cathode-ray tube screen is physically different from any other image or scene that is to be observed or recorded.

While ordinary pictures or scenes are being photographed, light is emanating from every point on the picture at all times during the exposure of the film in the camera. Consequently, when the film is at rest, every point of exposure on the film will be continuously exposed during the exposure interval. In order to obtain proper exposure of the film one need only to have the proper light, speed of film and aperture of the camera lens.

In the case of a picture on the cathode-ray screen of a television receiver, light is not being emitted continuously from any one point of the picture. The light emanating from the picture comes from luminous points on the cathode-ray tube screen that are illuminated in succession. These points are in lines that are very rapidly traced and the sequence of these rapidly traced lines give the appearance to the eye of a continuous picture. However, since the sequence of lines is traced in a finite period of time, which is one-thirtieth of a second under present standards, provision is made in a camera in

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accordance with the present invention so that the stationary period of the film will contain the entire interval of time which is necessary for tracing the total number of lines on the cathode-ray screen that is needed for a complete picture. Also, the interval of time during which the film is stationary is accurately synchronized with the interval of time that is required for tracing the sequence of lines on the cathode-ray tube screen.

Ordinary motion picture cameras as now used are not suitable for photographing television pictures directly from the screens of the cathode-ray tubes.

The lines on a cathode-ray tube screen are traced or scanned usually from the top of the picture downwardly. If the moving picture film were pulled down and the shutter closed while the scanning was proceeding from the top portion of the picture down to the middle portion, and repeated during each pull-down of the film, the resultant exposure on the film would record only the lower half of the picture. Or, if the film exposure should occur only when there was no line scanning taking place, the film would have no picture whatever on it. It will therefore be clear that a camera for recording television pictures that appear upon the screen of a cathode-ray tube must be considerably different from those used for recording a continuously light-emitting scene, because in the latter case, at all times while the film is at rest it is being exposed to light from every point on the object that is being photographed.

With the present standard television transmission and reception the lines mentioned above are traced out or scanned at what is known as 60 fields per second or 30 frames per second. A complete scanning from the top to the bottom of the picture occurs during each field interval, and alternate fields produce lines which fit between the lines of the preceding field to form what is called an interlace. The lines formed during two such fields accordingly produce a raster containing a standard 525 line picture. The lines produced by these two fields produce what is called a "frame." Consequently, a complete interlace scanning of a screen is produced during each frame, and there are 30 of these frames per second. There were various reasons for selecting a 30 frame per second television standard in this country, such as ease of synchronizing the fields with the standard 60 cycle power sources, and maintaining a sufficiently high repetition rate of scanning to prevent flicker. The 30 frames per second rate is freer from flicker than a lower rate would be.

In standard motion picture photography provision is made for 24 frames per second. In photographing an ordinary scene with a motion picture camera it is permissible to use approximately as much time for pulling down the film as is used for exposure of the film. If this were done to photograph television pictures produced on cathode-ray tube screens, it would be necessary to operate the camera at either 30 frames per second or 15 frames per second in order to permit synchronization of the exposure interval of the film with the scanning interval of the cathode-ray tube.

This is not suitable for recording television pictures. If an attempt were made to make the pull-down time of the film approximately equal to the exposure time, a large portion of the scanning on the cathode-ray tube screen would be lost. Pictures of moving objects would be so recorded that they would lack continuity. This is especially noticeable when the picture is one of a rapidly moving body.

Recording at 15 frames per second, for example, results in a picture which is impaired by a very large increase in observable flicker along with this discontinuity in the motion of the moving object. This also has an added disadvantage as to sound recording because poor frequency response is shown in the sound recording. The high frequencies do not come through satisfactorily because of the slow motion of the film and the lack of resolution necessary to record high frequencies of sound on moving film.

If the television picture were recorded on a motion picture film at 15 or 30 frames per second, there would be the problem of projecting pictures on this film on to a screen. However, if the picture were recorded at 24 frames per second, then a standard projector could be used for projecting the picture on to a screen. If either 30 frames per second or 15 frames per second were used, a special projector would have to be provided.

With the present invention the 30 frames per second, 60 fields per second television pictures that are received on a cathode-ray tube screen can be recorded on film and projected by standard moving picture projectors at 24 frames per second, while at the same time synchronization defects are absent.

The way in which received television programs may be recorded upon standard motion picture film in accordance with this invention and afterwards projected in the usual way may be understood from the description in connection with the accompanying drawings, in which:

Fig. 1 is a somewhat diagrammatic drawing of an arrangement of apparatus for carrying out the invention;

Fig. 2 is a side view of one of the details;

Fig. 3 is a side view of a device for pulling down the film when the shutter is closed;

Fig. 4 is a section along the line 4—4 of Fig. 3;

Fig. 5 is a diagram showing the rate at which the shutter is opened and closed and the length of time it remains open; and

Fig. 6 is a diagram showing the relation between blanking intervals and scanning or field intervals.

In the drawings, reference character 1 indicates a television receiver tube upon the fluorescent screen 2 of which the televised picture is caused to appear by the modulated cathode-ray beam of this tube being caused to scan the screen at the rate of sixty fields or scannings per second. Since each frame of the television picture consists of two fields of interlaced lines, each frame requires one-thirtieth of a second.

The parts indicated somewhat diagrammatically by reference characters 3 to 8 are well known parts of standard moving picture recorders.

Reference character 3 indicates a reel which carries a sensitized film 4 which is unwound therefrom in the usual way and exposed to the light from screen 2 which is focussed by lens 5 upon the film 4. This film after being exposed to the television picture is then passed in the usual way at a constant speed in proximity to the sound recording device 6 to record the sound upon the sound track of the film. The film is then wound upon the reel 9 and afterwards developed. Pull-down mechanism for the film is indicated diagrammatically at 7 and is described later. A shutter 10 is driven at a constant speed of 24 revolutions per second which is the standard speed for sound film recording.

Due to the fact that the standard speed of moving picture film is 24 frames per second while the standard television picture production is 30 frames per second, provision is made in accordance with this invention for cutting off the light from screen 2 to the film 4 by means of the shutter 10 at the right moments and for the proper lengths of time to enable the television picture to be recorded at standard speed so that it can be projected by the standard projector in the usual way.

For this purpose the shutter 10 is provided with an arcuate portion occupying a space of 72° as indicated in Fig. 2. This shutter is driven at a constant speed which is determined by the frame rate of the film 4. The frame rate of moving picture sound films has been standardized for projection at 24 frames per second both for the 16 mm. film and for the 35 mm. film.

With the 72° shutter 10 and a film running at the standard rate of 24 frames per second the time during which the shutter 10 shuts off the light from film 4 per revolution of this shutter is therefore $\frac{72}{360}$ of $\frac{1}{24}$ of a second, or $8\frac{1}{3}$ thousandths of a second. This film is then exposed to light from the tube 1, $\frac{288}{360}$ of $\frac{1}{24}$ of a second or $33\frac{1}{3}$ thousandths of a second, and so on repeatedly while the program is being recorded on the film 4.

Each pulldown of the film 4 must occur while the shutter 10 is cutting off the light that comes from screen 2 and preventing it from reaching the film 4, otherwise the recorded picture on the film would be blurred. The pulldown time of the film 4 while the shutter 10 is cutting off the light must not be too short or sudden because of danger of injuring or tearing the film, so that a sufficiently long time must be allowed for film pull-down. The 72° shutter 10 running at 24 revolutions per second has been found to give sufficient time for this purpose.

The drive mechanism for pulling down the film while the shutter 10 is cutting off the light from the television screen 2 without injuring the film is shown in Figs. 3 and 4.

Reference character 12 indicates a disc mounted on shaft 13 that is held in fixed bearings and is driven, by means not shown, at the speed at which the film is pulled down. This disc is provided with diagonally opposite pins 14 and a stop 15 having convex arcuate ends 16

Shaft 17 which is parallel with shaft 13 is also journalled in fixed bearings It carries a disc 18

that is provided with radial slots 19 and concave arcuate edge portions 20 that have the same curvature as the arcuate ends 16 The shafts 13 and 17 are spaced so that the ends 16 can enter the portions 20 and prevent the disc 18 from turning for predetermined intervals of time.

Shaft 17 carries a gear 21 that meshes with a gear 22 half its size on shaft 23. Shaft 23 also carries an eccentric 24 that operates the pull-down mechanism for moving picture film in the known usual way.

The shutter 10 is completely closed for 43° as shown in the diagram, Fig. 5. The time elapsing from the beginning of the closing movement to the end of the opening of the shutter is that elapsing during 72° of turning of disc 12, which is 8⅓ thousandths of a second. The curve 25 in Fig. 5 shows vertical displacement of the film during the 43° time interval during which the shutter is completely closed. This diagram also shows that the beginning and stopping of the movement of the film is gradual. This is due to the fact that when the pin 14 enters and leaves the slots 19 it is moving radially with respect to the disc 18.

With the standard scanning rate of 60 fields per second on the television screen 2 and with the film 4 running at the standard rate of 24 frames per second each film frame will have recorded thereon two field scannings of 1/60 of a second, or 16⅔ thousands of a second each on the screen 2. One of these scannings is a scanning of the odd lines of the screen 2 by the cathode-ray beam of tube 1 and the other is a scanning of the even lines of this screen.

Since the shutter 10 is 72° wide or extends over one-fifth of the circumference, light from the screen 2 will be cut off partially or totally from the film 4 by the shutter 10 one-fifth of the time or during one scanning period out of every five scanning periods. Film exposures occur during four-fifths of the time or during four scanning periods out of every five. The partial or total cut-off time is 8⅓ thousandths of a second and the exposure time is 33⅓ thousandths of a second so that the sum of a cut-off time and an exposure time is one twenty-fourth of a second, or, there are twenty-four exposures per second. 33⅓ thousandths of a second is the time required for two complete television scanning fields or one complete television frame. Therefore, during two frames of film at twenty-four frames per second, four television scannings will be recorded and one will be cut off or lost with the standard scanning rate of sixty fields per second. The four that are recorded on the film 4 are sufficient to enable the film to be projected satisfactorily upon a moving picture screen in the usual way. Since there are 24 complete television frames recorded on the film 4 each second in this way, no change in the 60 fields per second of television scanning of the screen 2 of tube 1 and no change of 24 frames per second of the frame rate of the film 4 is required.

It will be understood from the description above that with the film 4 running at the standard rate of 24 frames per second two television field scannings produced at the rate of 60 field scannings per second, one of which is even and one is odd, will be recorded on each frame of the film. These are close together in time. Therefore, they are exactly or almost exactly alike even when the televised scene includes objects that are moving rapidly. Also, although the shutter 10 cuts off one-fifth of the fields that appear upon the screen 2 the other fields are bright enough to make the record or pictures on the film 4. Also, the brightness of the pictures upon television screens can be easily increased in known ways for cases where the four fields of each five fields do not ordinarily yield sufficient light for proper recording on the film.

It will be obvious from the above description that this device can be used for recording television sight and sound programs at 24 frames per second on moving picture film with either a single or a double system of film recording.

What is claimed is:

1. The process of recording television pictures received at a predetermined frame rate upon moving picture film at a different frame rate, which comprises cutting off the light periodically from said screen to said film during time intervals which are equal to that fraction of the total time represented by unity minus the ratio of the recording frame frequency to the received frame frequency, the time during which the light is entirely cut off from said film being approximately 43/72 of the time during which any of the light is cut off therefrom.

2. The process of claim 1, in which the exposure time of the moving picture film is that fraction of the total recording time represented by the ratio of the recording frame frequency to the received frequency.

3. The process of claim 1, in which the light is periodically cut off one-fifth of the total recording time.

4. The process of claim 1, in which the film is exposed four-fifths of the total recording time.

5. In a device for recording a television picture on a film, means for moving said film periodically in front of a television picture receiving tube, and a shutter between said tube and said film adapted to shut off the light from said tube to said film at a predetermined rate with respect to the rate of scanning of said television picture, said shutter being adapted to cut off all of the light from said film approximately 43/72 as long a time as it cuts off any of said light.

6. The device of claim 5, in which said shutter is adapted to shut off the light each time said film is moved.

7. The device of claim 5, in which said shutter shuts off at least some of the light from said television tube one-fifth of the time.

8. The device of claim 5, in which said shutter subtends an arc of approximately 72°.

9. The device of claim 5, in which said television picture is of the interlaced scanning type.

10. The device of claim 5, in which said television picture is of the interlaced scanning type and each frame is scanned in one-thirtieth of a second.

11. The device of claim 5, in which said television picture is of the interlaced scanning type and each field is scanned in one-sixtieth of a second.

12. The device of claim 5, in which said television picture is of the interlaced scanning type and each field is scanned in one-sixtieth of a second, and said film is moved at a predetermined rate.

13. The device of claim 5, in which said television picture is of the interlaced scanning type, each field is scanned in one-sixtieth of a second, and said film is moved at a rate of 24 frames per second.

HARRY CARTER MILHOLLAND.