March 21, 1944. A. N. GOLDSMITH 2,344,695

TELEVISION TRANSMITTING SYSTEM

Filed May 29, 1942

Fig. 1.

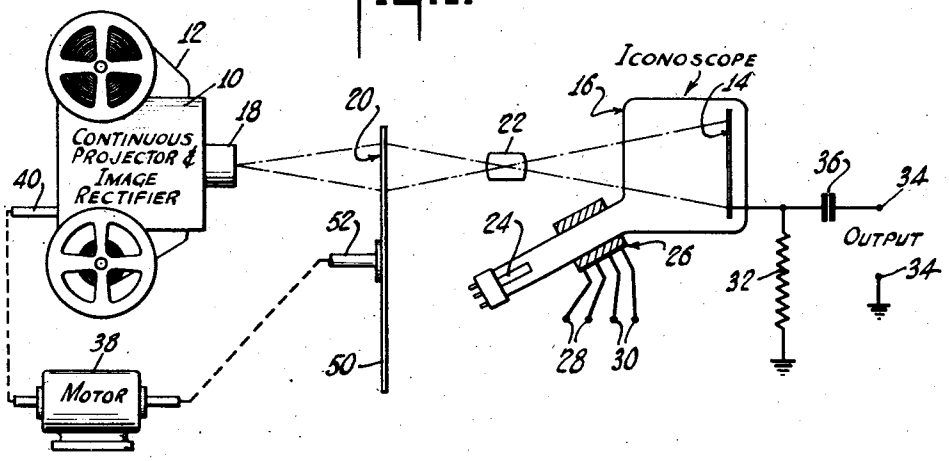


Fig. 2.

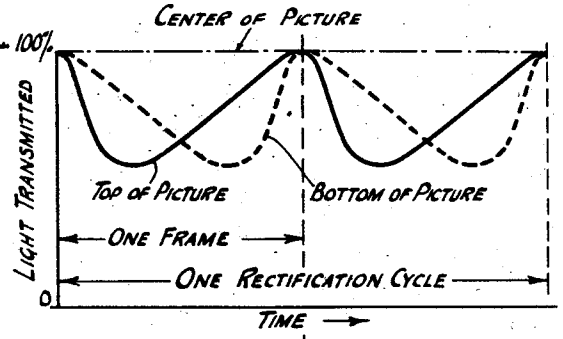


Fig. 3.

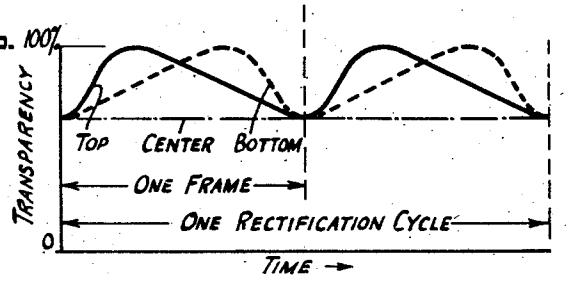


Fig. 4.



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TELEVISION TRANSMITTING SYSTEM

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9 Claims. (Cl. 88—16.8)

This invention relates to an improvement in television transmitters, and more particularly to transmitters wherein the subject matter is derived from a moving picture film.

In the transmission of television programs it is frequently desirable or necessary to derive some of the material transmitted from a motion picture film, particularly where the subject matter is difficult to derive from the television studio or, for example, under conditions where the action transpired some time previously and was recorded on a standard film. If the film frame speed of the film bearing the subject matter to be transmitted were exactly the same as the television field or frame frequency, transmission of subject matter from moving picture film would be greatly simplified. This condition does not exist under the present standards of motion picture recording and television picture transmission. Standard 35 mm. moving picture film is generally photographed and projected at the rate of 24 frames per second, whereas standard black and white television programs are transmitted at the rate of 60 fields per second interlaced so as to form 30 frames per second. Naturally, the apparent movement would be accelerated to a point where it would seem unnatural if the moving picture film were projected at a rate of 30 frames per second and the accompanying sound as recorded on the film would be unacceptably raised in pitch, so that some means is necessary to permit the moving picture projector to operate at 24 frames per second, while the television transmitting system operates at 30 frames per second. Various methods have been devised for permitting this operation, one method being the use of an intermittent projector in which alternate frames supply two television images for two successive television fields, whereas the remaining film frames supply three television images for three television fields. An example of such a system and apparatus is shown and described in Bedford Patent No. 2,227,054, issued December 31, 1940, and a different system is shown and described in Seeley application Serial No. 291,309 filed August 22, 1939. The use of intermittent projectors, however, is not wholly satisfactory when used with television pick-up tubes of the non-storage type and when pick-up tubes of that type are used it is desirable to employ a continuous film projector. The use of a continuous film projector also affords other inherent advantages.

It is therefore desirable to be able to use moving picture projectors that operate continuously so that the rate of movement of the film through the projector is uniform and the film is not moved intermittently. However, when continuous projectors are employed, naturally the projector must also include some type of image rectification. The image rectifier performs the function of causing the images of the individual film frames to be projected in a stationary manner upon a screen electrode or surface. This is accomplished even though the film moves continuously at a constant rate of speed, and in such image rectifiers a dissolve from one individual film frame to the next is accomplished through the operation of the image rectifier. Various types of image rectifiers have been used in the prior art, some of which constitute the use of a spiral disc of transparent material which constitutes a light prism, the effective angle of which is varied gradually and cyclically in accordance with the speed of operation of the continuous projector. Another type of image rectifier consists in the use of a plurality of separate lenses positioned about the periphery of the disc, the lenses being so located as to perform the desired image rectification. Still another form of image rectifier that is known in the prior art is in the form of a rocking or oscillating mirror, which causes the moving images to be projected in stationary manner upon a projection screen. Still other types of image rectifiers use rotating or oscillating plates on polygonal prisms. Various types of image rectifiers to be used with continuous moving picture film projectors are, for example, shown and described in the United States patents to Mechau, No. 1,543,224, issued June 23, 1925; No. 1,584,317, issued May 11, 1926; and No. 1,893,374, issued January 3, 1933.

In the described types of continuous or non-intermittent variable brightness projection the film is advanced at a uniform velocity through the film gate of the projector. At least parts of at least two film frames are within the illuminated portion of the image projection system at all times, and by one of the above referred to optical rectifiers images of successive frames are projected in superposition and the effects of film motion are neutralized. Further, the optical arrangements are such that as one film frame is faded out the next film frame is gradually brought in. Unfortunately, however, in this type of projection the fading out of one film at any given point of the field does not occur at the same rate as the bringing in of the next picture at the same part of the field. Thus, there are inherently brightness variations at all parts of the field or

object area throughout the projection cycle, and the law governing the amplitude variation and phase of the illumination cycle varies from one part of the field to another. In general, these variations in brightness are considerably less than 100%. However, in all presently known continuous projectors wherein image rectifiers are used, the variations are finite and usually of sufficient magnitude to be noticeable, particularly in those portions toward the edge of the picture where vignetting effects during the cycle or other optical effects conspire to produce maximum brightness variations. Regardless of the particular type of optical rectification used, whether it be mirrors, polygonal glass prisms, plates, lens wheels or drums, some variation in average brightness is present, and it is highly desirable that this variation in brightness (irrespective, of course, of changes in the picture content itself) be eliminated to reduce the apparent flicker in the produced television image.

One purpose of the present invention, therefore, resides in the provision of means whereby brightness variations in the projected image from a continuous film projector may be compensated for to remove the effects of the brightness variations on the screen or area upon which the images are projected.

Another purpose of the present invention resides in the provision of an apparatus operated in synchronism with the continuous projector for compensating for changes in the average brightness of the projected image, as well as brightness changes in each part thereof, to eliminate thereby flicker effects on the screen that would otherwise be apparent when a continuous film projector and image rectifier is employed.

A still further purpose of the present invention resides in the provision of a cyclically variable translucent filter device interposed in the optical axis of a continuous film projector and image rectifier to eliminate the inherent brightness variations in any and all parts of the field that are associated with the usual operation results from a continuous projector.

Still another purpose of the present invention resides in the use of a continuous film projector and image rectifier for projecting film images onto a light responsive electrode in a television transmitting tube, together with means interposed in the optical path for compensating for the inherent brightness variations associated with continuous film projectors, whereby substantially flickerless television images may be produced at a television receiver.

Various other purposes and advantages of the present invention will become apparent to those skilled in the art from the following detailed description, particularly when considered in connection with the drawing, wherein:

Figure 1 represents a portion of a television transmitting system.

Figure 2 shows a curve representing the brightness variations at three different parts of the projected image.

Figure 3 shows curves representing the variation in transparency of the filter means, and

Figure 4 shows in detail a section or portion of the equalizer or compensating filter for nullifying the effects of the brightness variations.

Referring now to the drawing, and more particularly to Figure 1, wherein there is shown a continuous film projector 10 which includes an image rectifier, the film 12 is passed through the continuous projector at a uniform rate, and stationary optical images of the separate film frames on the film 12 are projected on the mosaic electrode 14 of a television transmitting tube 16. By means of the lens system 18 associated with the continuous projector the images are first focused to form an aerial image at the plane indicated at 20, while the lens system 22 re-focuses the aerial images onto the light responsive electrode 14 of the transmitting tube.

The transmitting tube shown in Figure 1 is, for example, of the "iconoscope" type, which includes an electron gun structure 24 for producing a focused cathode ray beam, and a deflection yoke 26 for causing horizontal and vertical deflection of the cathode ray beam in order that the mosaic or light responsive electrode 14 may be scanned by the cathode ray beam. In order to perform the scanning operation horizontal deflection voltage variations may be applied to the terminals 28, while vertical deflection voltage variations may be applied to the terminals 30 in order that the deflection yoke 26 may produce the desired and necessary electromagnetic field. The picture signals developed by the scanning operation are applied across the output load resistance 32 of the transmitting tube, and these same picture signals are available from the output terminals 34 by way of coupling condenser 36. The picture signals as derived from the output terminals 34 may then be subjected to the desired amplification in order that their intensity may be increased, and thereafter synchronizing signals and blanking signals may be added in a manner well known in the prior art, so that the resultant composite series of signals may then be used to modulate a radio frequency carrier.

For driving the continuous projector a motor 38 is provided which is mechanically coupled to the driving shaft 40 of the continuous projector. This motor operates the projector at a rate such that the film will be transported through the projector at a rate of approximately 24 film frames per second in order that the proper apparent motion will be attributed to the subject matter contained on the film.

In the system as so far described optical images will be projected on the light responsive electrode 14 of the television transmitting tube, but these optical images will vary in brightness irrespective of the picture content of the film, the variations occurring in synchronism with the operation of the continuous projector, and particularly in synchronism with the image rectifier associated therewith. In some continuous projectors and image rectifiers this variation in brightness may be as much as 40% at some particular portions of the image area.

There are shown in Figure 2 of the drawing three curves representing the variation in brightness at three particular portions of the image area. The solid line curve might, for example, represent the variation in brightness at the top of the picture, in which case the brightness would diminish quite rapidly after the beginning of one film frame cycle, then increase gradually to a maximum at the termination of each film frame cycle. The curve represented by the dot and dash line might, for example, represent the light intensity at the center of the picture, and at this portion of the picture there might be no variation in brightness, in which case the curve is represented as a horizontal line at approximately 100% brilliance (disregarding picture content). As a third example, a dotted line is shown in Figure 2 representing, for example,

the variations in brightness at the bottom of the picture. Associated with the curve is shown the distance represented by one film frame in point of time.

In order to compensate for these variations in brightness a disc **50** is provided, which is preferably located at the plane **20** of the aerial image. This disc is driven by shaft **52**, which in turn is connected directly or by means of appropriate gearing to the driving motor **38**. Inasmuch as the disc **50** and the continuous projector **10** are both driven by the motor **38**, they necessarily operate in synchronism and in proper phase with each other.

In order to compensate for the undesired brightness variations introduced by reason of the image rectifier the periphery of the disc **50** is so constructed as to have varying light transmitting qualities. In order that the variations in brightness may be compensated for, the transparency of the peripheral turn of the disc is made such that light will be absorbed by the disc in inverse relation to the brightness variation at all parts of the optical image. In other words, all parts of the image projected on the screen electrode **14** of the television transmitting tube are reduced to correspond to the lowest, yet finite, intensity of any portion of the optical image. The equalizer disc **50**, therefore, may well be in the form of a variable density, movable filter covering the entire aerial image area **20**, and having at all points and at all times a density or light absorption capacity such that it neutralizes all brightnesses of the image above a fixed minimum or datum amount. Thus, if the darkest part of the aerial image at any time has a brightness of, say 60% of the maximum brightness, then the density or absorption of the equalizer at that part of the image and at that instant for the darkest part of the picture must be zero, while the density or absorption of the filter of the brightest part of the picture at the corresponding time must be such that 40% of the light is absorbed, thus equalizing the picture brightness. It is also necessary that the equalizer or filter disc **50** be moved relative to the aerial image in such fashion that it is synchronized with the brightness variations thereof, which is readily and conveniently accomplished by directly connecting the equalizing disc **50** to the motor **38** that drives the continuous projector.

The equalizer disc **50** may make one revolution for each cycle of operation of the image rectifier, or a single revolution of the equalizer disc may represent a plurality of integer cycles of operation of the image rectifier. If the equalizing disc **50** makes one revolution per rectification cycle, the density band thereon, which will be circular, must correspond to one rectification cycle. If the equalizer makes one half revolution per rectification cycle, the density band thereon must correspond to two rectification cycles, etc.

Figure 3 shows a series of three curves representing the transparency of particular portions of the equalizer disc **50** as related to the corresponding portions of the image and the brightness variations represented by the curves shown in Figure 2. The solid line curve of Figure 3, therefore, corresponds to the variation in transparency as a function of time for exactly compensating for brightness variations in the top of the picture when the variation in light is such as that represented by the solid line curve shown in Figure 2. The dot and dash line and the dotted line of Figure 3 similarly correspond to the similarly represented curves in Figure 2.

In Figure 4 there is shown a portion of the periphery of the equalizer disc **50**, the density band, however, being shown straight rather than curved for the sake of clarity. One cycle of the density band is indicated in Figure 4, and by comparing the curves shown in Figure 3 with the density at the top, center, and bottom of the density band, the relationship is at once apparent.

When an equalizer disc **50**, having the proper variation in density or light absorption, is used with a continuous film projector and image rectifier, all variations in brightness as a result of the operation of the image rectifier may be completely compensated for. When this is the case any relationship of film frame and television frame frequency may be present, and the television pictures may be transmitted at any particular desired frequency irrespective of the speed of operation of the continuous projector. The variations in brightness of the images projected by the continuous projector, disregarding subject matter contained on the film, is entirely a function of the operation of the image rectifier associated with the projector, and once the proper density band has been determined, that density band will exactly correct for light intensity variations for the particular image rectifier. It is not necessary to alter the equalizer disc **50** in any way when the film is changed in the projector, or when the subject matter contained on the film is altered. In accordance with this invention the equalizer disc may be used with any type of continuous projector regardless of the type of image rectification employed.

There are various methods by which an equalizer disc may be made which will exactly match the inherent brightness variations for a particular image rectifier. One of these methods is to employ an unexposed photographic plate of optical glass coated with an emulsion of very fine grain. This photographic plate, which preferably could be in the form of a disc such as shown at **50** in Figure 1, is positioned in the normal operating position of the equalizer disc, and the projector is operated for one or more cycles, during which time the disc is synchronously rotated through one revolution. This is done with a blank field or completely transparent film in the projector. Naturally, no extraneous light is permitted to strike the plate, the only light permitted to fall on the photographic plate being that of the aerial image produced by the continuous projector per se. The plate, after exposure, is then removed and developed as a photographic negative until its density or light transmission in all parts corresponds to the values required as set forth above. Such an equalizer made as a photographic negative may then be cemented to a circular plate of optical glass so as to protect it from deterioration. The resultant equalizer will then exactly match the inherent light variations of the associated continuous projector.

It will also be possible to make an equalizer disc by actually measuring variations in light intensity by a photometer or other equivalent apparatus, and subsequent to such measurements construct a variable translucency band which would have the desired light absorbing properties and variations. Such a method, however, would

be quite tedious and costly, particularly as compared with the method above described wherein an unexposed light sensitive film or plate is employed.

It is not necessary that the equalizer disc **50** be in the form of a disc as shown in Figure 1, since it is entirely feasible that the equalizer could be in the form of an endless film or band which could be moved through the aerial image plane **20**. The equalizer disc or variable translucency band could also be constructed in various other manners.

Furthermore, in the system shown in Figure 1, a conventional iconoscope is shown. However, it is to be understood that various other transmitting tubes such as the orthicon could as well be employed.

Various other alterations and modifications may be made in the present invention without departing from the spirit and scope, and it is desired that all such modifications be considered within the purview of the present invention except as limited by the herein appended claims.

What I claim is:

1. A continuous moving picture projector including an image rectifying system for producing substantially stationary images of the separate film frames, the operation of the continuous projector inherently causing undesired cyclic brightness variations in the produced images, a lens system associated with the projector for producing an aerial image of the subject matter contained on the film frames, an equalizer disc positioned substantially in the plane of the aerial image, means for rotating said disc in synchronism and in phase with the operation of the continuous projector and image rectifier, said equalizer disc being provided with a peripheral band of variable transparency, the variations in transparency extending both radially and circumferentially and corresponding to the undesired brightness variations of each portion of the image during each rectification cycle, and a further lens system for projecting the aerial image onto an image receiving surface, whereby the images projected on the surface will be free from objectionable variations in picture brightness.

2. A continuous moving picture projector including an image rectifying system and a lens system for producing substantially stationary aerial images of the separate film frames of the continuously moving film, the operation of the continuous projector inherently causing unequal undesired brightness variations in various portions of the produced images, an equalizer disc having a portion of its periphery positioned in the aerial image plane, said equalizer disc being provided with a peripheral band of variable translucency, the translucency variations corresponding to the undesired brightness variations occurring in the various portions of the images during each image rectification cycle, means to rotate said disc in synchronism and in phase with the operation of the continuous projector and image rectifier, and a further lens system for projecting the aerial image onto an image receiving screen, whereby the optical images projected on the screen will be free from objectionable brightness variations.

3. A continuous moving picture projector including an image rectifying device, a lens system associated with the continuous projector for producing substantially stationary aerial images of the subject matter contained on the film frames, the operation of the continuous projector inherently causing undesired cyclic brightness variations in the produced images, an equalizer disc positioned in the aerial image plane, means for rotating said disc in synchronism with the projector and in proper phase with the operation of the image rectifying device, said equalizer disc being provided with a peripheral band of bidimensionally variable light transparency corresponding to the undesired cyclic variations in brightness of all portions of the image occurring during each image rectification cycle, and a further lens system for projecting the aerial image onto an image receiving surface, whereby the images projected on the surface will be free from the undesired objectionable brightness variations.

4. A continuous film projector including an image rectifier, lens means for producing aerial images at a predetermined image plane, means for focusing the aerial images onto the light image receiving surface, said continuous projector and image rectifier causing different undesired cyclical variations in picture brilliance for different portions of each image rectification cycle, a brilliance correction disc positioned substantially in the plane of the aerial image, the periphery of said disc being provided with a variable density band chosen in accordance with the undesired variable brilliance of the different portions of the images during each rectification cycle, and means for rotating said disc in synchronism and in proper phase relationship with the operation of the continuous projector and image rectifier, whereby the undesired variations in the brilliance of the images projected on the surface will be eliminated.

5. A continuous film projector including an image rectifier, lens means for producing substantially stationary aerial images of the film frames at a predetermined plane, means for focusing the aerial images onto a light image receiving screen, said continuous projector and image rectifier causing undesired cyclical variations in picture brilliance over substantially the entire image area during each image rectification cycle, a brilliance correction device positioned substantially in the plane of the produced aerial images, said correction device being provided with a variable transparency band, the variations in transparency extending in substantially all directions throughout the effective portion of the band and determined, in accordance with the undesired variable brilliance during each rectification cycle, and means for moving said device in synchronism with the projector and in proper phase relationship with respect to the image rectifier, whereby the undesired variations in the brilliance of the images projected on the light screen will be substantially eliminated.

6. An optical image projection system for use with a motion picture film comprising a continuous film projector including an image rectifier, lens means for producing substantially stationary aerial images of the film frames at a predetermined image plane, means for focusing the aerial images onto an image screen, said continuous projector and image rectifier causing undesired cyclical variations in picture brilliance during each image rectification cycle, a brilliance correction disc positioned substantially in said predetermined image plane, the periphery of said

disc being provided with a variable density band having both radial and circumferential variations in density chosen in accordance with the undesired variable brilliance of each portion of the image during each rectification cycle, and means for rotating said disc in synchronism and in proper phase relationship with the operation of the continuous projector and image rectifier, whereby the undesired variations in the brilliance will be eliminated from the images projected on the image screen.

7. A motion picture projecting system for projecting images of the separate frames of a moving picture film comprising a continuous projector including an image rectifier, means including a lens system for producing aerial images of the film frames, a further lens system for focusing the aerial images onto an image receiving screen, said continuous projector and image rectifier inherently producing undesired cyclical variations in brilliance of the images, a translucent equalizer member positioned substantially in the plane of the aerial images, said translucent equalizer member cyclically varying in translucency in all directions over its effective area in accordance with the cyclical variations in brilliance of all portions of the images, and means for moving said equalizing member through the optical path of the projector at the plane of the aerial images in synchronism and in phase with the operation of the continuous projector and image rectifier.

8. A motion picture projecting system for projecting substantially stationary images of the separate frames of a moving picture film comprising a continuous projector including an image rectifier, means including a lens system for producing substantially stationary aerial images of the film frames, a further lens system for focusing the aerial images onto an image receiving screen, said continuous projector and image rectifier inherently producing undesired cyclical variations in brilliance of the images, a translucent equalizer member positioned substantially in the aerial image plane, said translucent equalizer member having a portion thereof cyclically varying in transparency in accordance with the undesired cyclical variations in brilliance of each portion of the produced images, and means for moving the variable transparency portion of said equalizing member through the optical path at the aerial image plane in synchronism with the speed of operation of the projector and in phase with the operation of the image rectifier to thereby eliminate the undesired brilliance variations.

9. A motion picture projecting system for projecting optical images of the separate frames of a moving picture film comprising a continuous motion picture film projector including an image rectifying device, means including a lens system for producing substantially stationary aerial images of the film frames at a predetermined plane, a further lens system for focusing the aerial images onto an image receiving screen, said continuous projector and image rectifying device inherently producing different undesired cyclical brightness variations in different portions of the produced images, an image brightness equalizer member positioned substantially in the said predetermined plane, said equalizer member including a cyclically varying light translucency portion, the translucency variation being determined in accordance with the different cyclical variations in brightness of each different portion of the optical images, and means for moving the variable light translucency portion of said equalizing member through the optical light path of the projector at the aerial image plane in synchronism and in proper phase with the operation of the continuous projector and image rectifier to thereby produce optical images substantially devoid of undesired brightness variations on the image receiving screen.

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