Dec. 31, 1940. A. V. BEDFORD 2,227,054

FILM PROJECTOR FOR TELEVISION

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Fig. 1

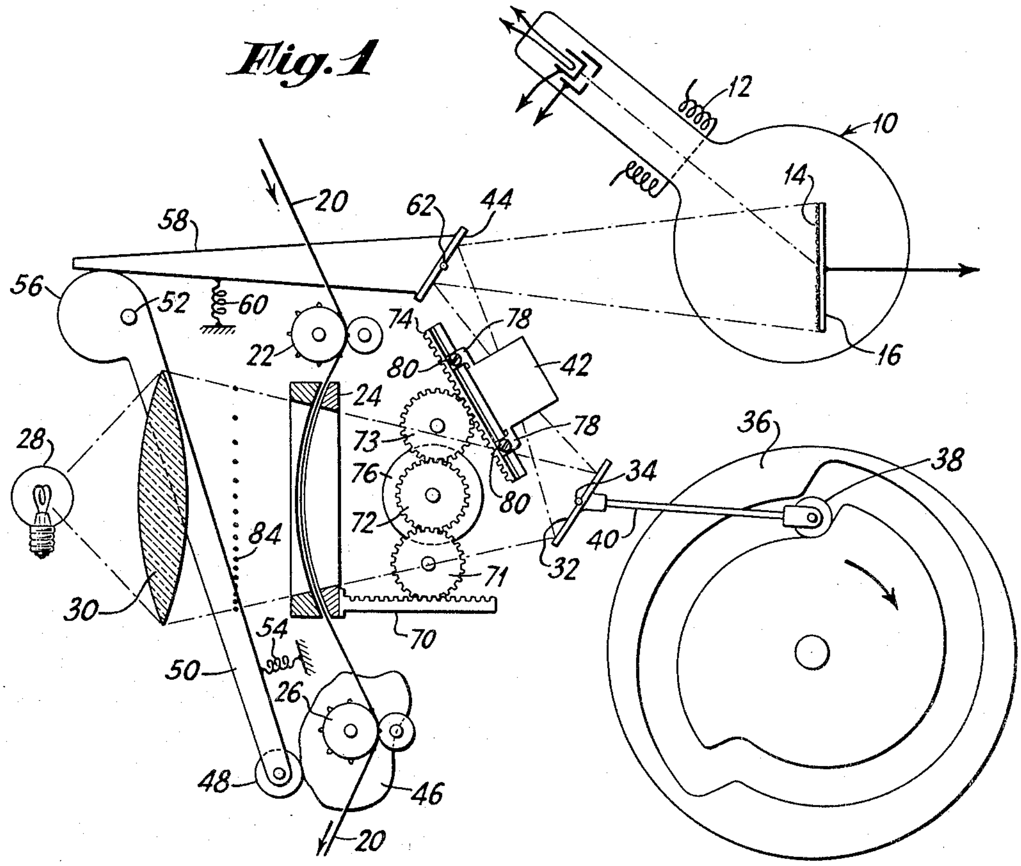


Fig. 2

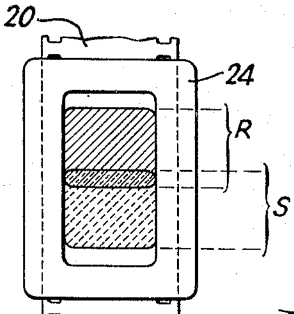


Fig. 3

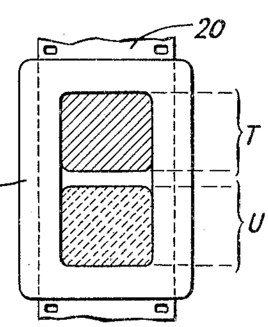
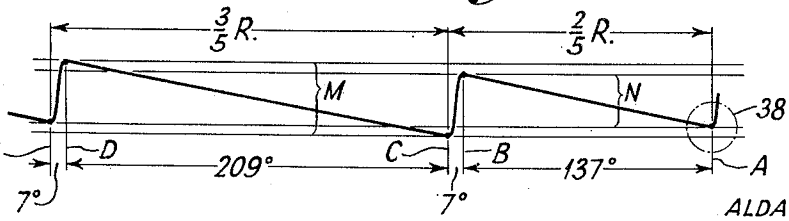


Fig. 4



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FILM PROJECTOR FOR TELEVISION

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14 Claims. (Cl. 88—16.8)

This invention relates to a new and improved method of and means for transmitting the photographic images on a moving picture film by television. More specifically, the invention relates to a device wherein it is possible to transmit the material contained on an ordinary cinema film by television without the necessity of intermittently moving the film through the transmitting device.

In known and previously used film scanning devices, an intermittent motion of the film has been employed, the film being moved intermittently by an appropriate Geneva movement. During the intervals when the film is stationary, light is projected through a particular film frame in order that the image on the film may be brought to focus on the mosaic or light responsive electrode of a television transmitting tube. Insofar as this operation is concerned, it is quite similar to the method used in theatres for projecting cinema films, and could be used very satisfactorily in television transmitting systems if the rate at which the separate television pictures transmitted was the same as the proper showing speed of the film, and if the ratio of the time required to transmit a frame to the time elapse of an entire cycle was the same as that normally used in projection of moving picture films.

In the operation of a television system, however, only about 10% of the entire scanning cycle is utilized for returning the scanning beam to another starting point, and the remaining $\frac{9}{10}$ths of the cycle is employed in the actual transmission of video signals representative of the image projected upon the television transmitting tube. In order to maintain an image of one frame of the cinema film on the light sensitive electrode of a television transmitting tube during the full time that the picture signals are being transmitted, it would, therefore, be necessary to maintain the film stationary during $\frac{9}{10}$ths of a cycle of operation, the film being moved from one frame position to the next succeeding frame position during $\frac{1}{10}$th of the cycle. This ratio of movement is materially in excess of the rate normally employed in the projection of cinema films in a theatre, and the necessarily high accelerating rate associated with such rapid movement would materially affect the film and in many instances cause a breakage thereof.

Furthermore, an ordinary Geneva movement or some similar movement such as is conventionally used for the projection of cinema films in a theatre could not be used to control the movement of a film in a television transmitting system, since the rate at which separate fields are transmitted in a television system is materially in excess of the normal frame showing speed of a cinema film. The standard rate at which a cinema film should be run in order that the rate of movement will appear normal, is 24 frames per second. In a television system, 60 separate fields are transmitted per second, and if the film were shown at a rate of 60 frames per second, the apparent movement of film subject matter would be entirely too rapid. Furthermore, if the film were maintained stationary during the showing of two television fields, the rate of movement of the film would then be 30 frames per second, which would still not be proper and would cause movement to be increased by 25%. In order that the film may be moved at its appropriate rate of 24 frames per second, the film must be maintained stationary during the showing of one film frame for the length of time consumed by the transmission of two television fields, the film being maintained stationary during the showing of the next succeeding film frame for the length of time required to transmit three separate television fields. Alternate film frames are, therefore, transmitted respectively at rates corresponding to 2 and 3 television fields. When this is done, and when an appropriate Geneva movement or similar mechanism is employed to produce such an intermittent film movement, the length of time required to show two adjacent film frames equals $\frac{2}{60}$ths plus $\frac{3}{60}$ths or $\frac{5}{60}$ths of a second, which is identical with the proper showing speed for the film, namely 24 frames per second.

In the present invention provision is made whereby intermittent movement of the film is entirely unnecessary and the film may be moved through the television scanning device in a continuous and uniform manner. In order that an image of the separate frames of the continuously moving film may be projected upon the mosaic or light responsive electrode of the television transmitting tube, some means must be provided for creating a stationary image. In the present invention a mirror is used, the mirror being oscillated in synchronism with the operation of the scanning device and in accordance with the movement of the film through the device.

The present invention also provides means whereby slight changes in the physical dimensions of the film due to atmospheric conditions and ageing may be compensated for in a very simple and convenient manner. The present invention provides, in addition, means whereby errors in the construction of the means for maintaining a stationary image may be compensated for.

It is, therefore, one of the purposes of the present invention to provide a television scanning device wherein a cinema film may be scanned to produce a series of signals representative of the separate images on the film, the film being moved through the scanning device in a continuous and uniform manner.

Another purpose of the present invention resides in the provision of means whereby a stationary optical image of each frame of the moving film may be created and made to persist for a definite length of time even though the film movement is continuous.

A still further purpose of the present invention resides in the provision of means whereby proper operation and optical adjustments of the scanning device may be maintained, and whereby changes in the physical dimensions of the film may be compensated for.

Still another purpose of the invention resides in the provision of means whereby errors in the construction of the means for maintaining a stationary optical image may be compensated for in a convenient manner.

Still other purposes and advantages of the present invention will become apparent to those skilled in the art from a reading of the following specification particularly when considered with the drawings wherein like reference characters represent like parts, and wherein

Figure 1 shows, by way of example, one form of the scanning device constructed in accordance with the present invention;

Figures 2 and 3 show the progression of the film through the scanning device for successive scanning operations; and

Figure 4 shows diagrammatically the movement and cycle of operation of a portion of the apparatus shown in Figure 1.

Referring now to Figure 1 wherein a television transmitting tube **10** is shown which includes means for producing an electron beam and means for deflecting the beam in mutually perpendicular directions. The deflecting means are shown schematically as electromagnetic coils **12** but, it is to be understood that any appropriate beam deflecting means may be used. Included within the transmitting tube is a mosaic or light sensitive electrode **14** on which an optical image is projected and across the surface of which the beam of electrons produced within the tube is caused to move in a systematic manner. Associated with the mosaic is a signal plate **16** from which electrical signals corresponding to light values projected upon the photoelectric mosaic may be derived. Further explanation of the television transmitting tube per se is believed to be unnecessary since the present invention is not specifically concerned with the particular tube used inasmuch as any appropriate television transmitting tube may be used with the present invention.

The film **20**, the frame images of which are to be transmitted by television, is pulled from a reel (not shown) by a sprocket wheel **22** at a uniform rate. The film is then passed through a film gate **24**, and a second sprocket wheel **26** is provided for further moving the film in the direction shown by the arrow, the film being finally wound on a take-up reel (not shown).

For projecting light through the film, a source of light **28** is provided and in order to increase the efficiency of the light and to cause the rays to be projected in the proper direction through the film, a condensing lens **30** is utilized.

Since it is necessary to maintain a stationary optical image upon the mosaic **14** of the transmitting tube **10**, and since the film **20** is moved uniformly and continuously at a rate of 24 frames per second through the film gate **24**, a movable mirror **32** is provided which may be oscillated about an axis of rotation **34**. For oscillating the mirror **32**, a cam wheel **36** is provided with which cooperates a cam follower **38**. The follower is attached to the mirror **32** by means of the rod **40**. A second lens system **42** is provided for properly focusing an image of a frame of the film upon the light responsive electrode **14**. The light is not transmitted directly from the lens system **42** to the mosaic **14**, but is reflected from a second mirror **44**, the purpose of which will be explained more fully later.

Since the speed at which the film is moved through the scanning device must, for proper showing, be maintained at 24 frames per second, and since television pictures or fields are normally sent at the rate of 60 fields per second, some means must be provided for compensating for this difference in film frame speed and television field speed. This is done by properly constructing the cam wheel **36**. This cam rotates in the direction indicated by the arrow at the speed of 12 revolutions per second. Due to the construction of the cam, during one complete revolution of the cam wheel **36** the mirror is rotated in a clockwise direction very rapidly and moved in a counter-clockwise direction relatively slowly during $\frac{2}{5}$ths of one revolution. As the cam wheel **36** continues to rotate, the mirror **32** is again moved clockwise rapidly and then rotated counter-clockwise relatively slowly during the remaining $\frac{3}{5}$ths of a revolution of the cam wheel **36**.

For a clearer explanation of a cycle of operation of the device, a graph of the movement of the cam follower **38** with respect to the center of the cam wheel **36** is shown in Figure 4. Movement of the follower **38** toward the left in Figure 4 corresponds to a rotation of the cam **36** in a clockwise direction in Figure 1. By inspecting Figure 4, it may be seen that the cam follower **38** in moving from point A to point B is raised vertically by an amount N. The next movement of the cam follower **38** from point B to point C causes the follower to be very rapidly lowered in position. The movement of the follower from A to C corresponds to $\frac{2}{5}$ths of one revolution of the cam wheel **36** or 144° of rotation. With the cam wheel rotating at 12 revolutions per second, and with the television field scanning cycles occurring at a rate of 60 per second, it follows that five television fields are scanned and transmitted for each revolution of the cam wheel **36** and accordingly, during $\frac{2}{5}$ths of one revolution of the cam wheel two television fields are scanned and transmitted, each of the image of the same film picture frame.

In order that the mirror **32** may be returned to a new starting position in a period of time corresponding to $\frac{1}{10}$th of the time cycle for transmitting one television field, the mirror must be moved to the new starting position in $\frac{1}{600}$th of a second and with the cam wheel rotating at 12 revolutions per second the mirror **32** must undergo the necessary clockwise rotation during approximately 7 degrees rotation of the cam wheel. The distance from point B to point C in Figure 4 must, therefore, correspond to about 7 degrees rotation of the cam wheel 36.

In moving the cam follower from point C to point D the follower is raised an amount indicated at M in Figure 4, during which time three television fields are scanned and transmitted, all being of the one film frame. It will be noticed that this vertical movement of the cam follower 38, that is, the distance M is somewhat greater than the distance N in view of the fact that during the movement of the cam from point A to point B only two television fields are transmitted while the image from a particular film frame is projected upon the television transmitting tube electrode, whereas, during movement of the follower from point C to point D three separate television fields are transmitted while the image of the next succeeding film frame is projected upon the light sensitive electrode of the television transmitting tube. The vertical movement of the cam follower 38, and accordingly the amount of counter-clockwise rotation of the mirror 32, is 50% greater during movement of the cam follower from point C to point D than from point A to point B.

When the cam follower moves from point D to point A, the follower is accordingly lowered in position so that a new cycle of operation may take place. The amount of rotation of the cam wheel during a corresponding movement of the follower from point D to point A is again approximately 7 degrees for the reasons given above.

In order to more clearly indicate the relative movement of the film with respect to the mirror 32 and with respect to the transmission of the separate television fields, Figures 2 and 3 are provided. In these figures, the film gate 24 is shown, together with a portion of the film 20. Figure 2 shows the amount of movement which the film 20 undergoes during the movement of the cam wheel through ⅖ths of one revolution which corresponds to the transmission of two television fields. It must be remembered that, during one revolution of the cam wheel 36, two film frames pass through the film gate and five television fields are transmitted; two of one film frame and three of the other film frame. Accordingly, the shaded area R may correspond to the particular film frame being transmitted at a particular instant, and the position of the shaded area within the film gate indicates the position of the particular film frame when the cam follower is at point A. The mirror 32 is then rotated in a counter-clockwise direction during ⅖ths of one revolution of the cam 36 and, accordingly, the film 20 moves through the film gate ⅖ths of the distance occupied by two film frames or, in other words, ⅘ths of one film frame. The position that the particular film frame will occupy at the expiration of the transmission of that particular frame is indicated by the shaded portion S shown in Figure 2. At this time, the mirror 32 is then quickly rotated in a clockwise direction and is so positioned that light from the next succeeding frame, which is then in a position indicated by the shaded portion T in Figure 3, may be projected upon the light responsive element 14. A projection of an image of this film frame continues through ⅗ths of one revolution of the cam wheel 36, which corresponds to the transmission of three television fields. The film, during this expiration of time, will have moved through the film gate a distance which corresponds to ⅗ths of two film frames or 1⅕th film frames and the cam follower will have reached a point corresponding to D in Figure 4. When this has transpired, the particular film frame in question will have reached a position indicated by the shaded portion U shown in Figure 3. In the above the ⅖ths and ⅗ths revolutions of the cam 36 each include not only the gradual rise of the follower 38 but also the following rapid fall which produces the quick clockwise rotation of the mirror.

It may be seen therefore that as each film frame is followed in movement by a corresponding rotation of the mirror 32, the mirror is rotated an equal amount on each side of the optical axis of the system regardless of whether an image of the frame is projected for the shorter or the longer period of time, so that substantially no distortion of the image projected upon the mosaic will result. Furthermore it will be noticed that because of such an arrangement, the distance traveled by the follower 38 and accordingly the angular movement that the mirror 32 is subjected to during the rigid return period is the same regardless of whether it follows the ⅖ths or the ⅗ths rotation of the cam wheel. Also, this arrangement requires that the opening in the film gate have a length at least equal to 2⅕th film frames.

From the above description it will be apparent that when light from the source 28 is projected through the film 20 and the film is moved continuously and uniformly in the direction indicated by the arrows, a stationary image of each film frame is projected on the light responsive electrode 14 of the television transmitting tube 10 by reason of the oscillation of the mirror 32 about its center of rotation 34. Furthermore, in view of the proportionate lengths of the two portions of the cam wheel 36, alternate film frames are projected upon the light responsive electrode of the television transmitting tube for a period corresponding to the time required to transmit two television fields, whereas the intermediate film frames are projected upon the electrode for a period corresponding to the time required to transmit three television fields. The lens system 42 is utilized to maintain proper focal conditions between the film 20 and the electrode 14.

In order that the optical arrangement may not be disturbed and in order that proper focus may be maintained, the film gate 24 is curved with its center of curvature lying at the axis of rotation 34 of the mirror 32. When the mirror 32 is rotated counter-clockwise in order to follow the continuous movement of each successive film frame through the gate, the effective optical distance from the lens 42 to the particular film frame being projected remains constant irrespective of its position in the film gate.

It has been found to be rather difficult to construct a cam such as shown at 36 with sufficient accuracy to produce a result which would be desirable. Due to slight imperfections in the cam 36, the image projected upon the mosaic may move even very slightly which would, of course, cause a distortion of the picture signals transmitted by the television transmitting system. Such distortion causes a loss of vertical detail in the picture at the receiver. In order to compensate for any errors which may be present in the cam wheel 36, a second cam wheel 46 is provided with which the follower 48 cooperates. The cam wheel 46 is attached to and rotates with the sprocket wheel 26 which is arranged to complete one revolution for each two film frames. The speed of the cam wheel 46 is therefore twelve revolutions per second, which is the same as the speed of rotation of the cam wheel 36.

The follower 48 is attached to a rod 50 which is pivoted to rotate or oscillate about a point 52. The follower 48 is urged against and maintained in contact with the cam 46 by the tension spring 54. At the pivot end of the rod 50 is a cam surface 56 cooperating with which is a second arm 58 which is held in contact with the cam surface 56 by reason of the tension spring 60. The arm 58 is attached to the mirror 44, the latter being pivoted for rotation about the pivot point 62. The movement of the end of the rod 58 therefore causes the mirror 44 to be turned about the pivot point 62 in order to alter the position of the optical image upon the mosaic electrode 14.

In view of the fact that considerable mechanical advantage exists between the cam 46 and the mirror 44, comparatively large movements of the cam follower 48 are permissible even though relatively very small movements of the mirror 44 result thereby. This construction is desirable in view of the fact that the slight errors in the construction of the cam wheel 36 will necessitate only very small movements of the mirror 44 in order to compensate for these inaccuracies and through the use of such high mechanical advantage it is, therefore, possible to easily provide a cam such as 46 for controlling the movements of the mirror 44 in order to compensate for whatever errors may be present in the cam wheel 36.

Furthermore, if by reason of the movement of the mirror 32 any disturbance or alteration in the optical arrangement results, this disturbance can be compensated for by movement of the mirror 44 through proper design of the cam 46.

Inasmuch as the physical dimensions of a film vary to a measurable degree in accordance with ambient temperature, age and humidity conditions, some provisions must be made for compensating for this variation since, if the film has changed in length slightly, the movement of the mirror 32 will not exactly follow the film frames even though the movement of the film through the gate still remains at exactly 24 frames per second. If the film gate 24 is moved toward or from the mirror 32, this change in physical dimension of the film 20 may be compensated for. For example, if the film has shrunk a slight amount, moving the film gate 24 toward the mirror 32 will permit a slightly smaller physical movement of the film for the same mirror movement to still produce a stationary image of the film frame on the electrode 14. Conversely, movement of the film gate 24 away from the mirror 32 will permit a slightly longer film (per frame) to be used even though the same mirror movement continues. Slight changes in the physical dimensions of the film may, therefore, be compensated for successfully by simply changing the position of the film gate 24 with respect to the mirror 32.

Such a movement of the film gate 24 would, of course, disturb the optical system and would alter the focal condition of the optical image upon the mosaic 14. In order to prevent any disturbance in the optical system, and in order to maintain the image in focus upon the mosaic regardless of the position of the film gate 24, a rack 70 is attached to the film gate 24 and a plurality of gears 71, 72 and 73 are provided, the latter of which meshes with a second rack 74, to which is attached the lens system 42. For altering the position of the film gate 24, a hand wheel 76 is attached to the gear wheel 72 so that, by rotating this hand wheel, the film gate may be moved closer to or farther from the mirror 32 while at the same time the lens system 42 may be moved so as to maintain the distance between the optical center of the lens system 42 and the film 20 constant. This distance is, of course, the distance between the film and the surface of the mirror 32 plus the distance from the optical center of the lens 42 to the surface of the mirror 32.

In order to initially focus the optical system, the lens system 42 is not permanently secured to the rack 74 but is attached thereto by means of a plurality of lugs 78 which slidably engage the edge portion of the rack 74. The lens system may therefore be moved independently of the rack 74 and when a focused condition is reached, the screws 80 are tightened in order to clamp the supports 78 firmly to the rack 74 in order that further movement of the lens system with respect to the rack is rendered impossible. Therefore, once this adjustment is made the optical image on the mosaic can always be maintained even though provisions are made for compensating for smaller changes in the physical dimension of the film.

Since it is incumbent that the intensity of light projected upon the film 20 be constant and uniform throughout the entire area of the film gate so as to prevent any change in the intensity of the image projected upon the mosaic during film movement and a corresponding flicker or change in intensity of the picture transmitted, a grating 84 of a plurality of fine wires is positioned between the lens 30 and the film gate 24. These wires may be of sufficiently reduced diameter and so positioned in the optical system that no shadows or images of the wires will be present on the mosaic 14, and the distribution of the wires may be so arranged that the final amount of light which is projected upon the entire opening on the film gate is uniform. These wires may be supported at any logical place in the optical system (preferably as shown) and by any appropriate means.

It is to be understood that since each cam 36 will have its own peculiarities and irregularities, a separate cam 46 must be constructed in accordance with these particular irregularities, and in view of the fact that the cam 46 is of such magnified size, it is not difficult to quickly and accurately make a cam which will compensate for all irregularities in the cam 36, and in fact, for the system as a whole. Furthermore, through the use of this system, any change in the contour of the cam 36 as a result of wear through usage of the mechanism for extended periods may be compensated for simply by slightly altering the contour of the cam 46 (which for convenience of manipulation may be made of a material which is readily carved or machined), and without the necessity of constructing a new cam 36.

It is to be understood that although a more or less specific form of television transmitting tube is shown schematically in the drawing, any other transmitting tube in which optical images are translated into electrical signals may as well be used. Furthermore, any means other than the system of gears shown and described may be utilized for connecting the optical system 42 and the lens gate 24.

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

I claim:

1. In a motion picture film projection apparatus of the class wherein the film is moved continuously and a compensating optical device is employed whereby stationary images of the individual film frames may be maintained on a screen for predetermined lengths of time comprising a lens system located between the film and the screen, a mirror positioned between the film and the lens system, means for cyclically oscillating said mirror at a rate commensurate with the film speed to produce a substantially stationary image of each film frame on the screen, a second mirror positioned between the lens system and the screen, and means for cyclically shifting said second mirror within predetermined small limits to compensate for errors in the oscillations of the first mentioned mirror, the direction and amount of movement of said second mirror being determined by the inaccuracies in the movement of said first mirror.

2. In a motion picture film projection apparatus of the class wherein the film is moved continuously and a compensating optical device is employed in order that stationary images of the individual film frames may be maintained on a screen for predetermined lengths of time comprising a lens system located in the optical system between the film and the screen, means for projecting light through the film and the lens system onto the screen, a mirror positioned in the path of the projected light between the film and the lens system, means for cyclically oscillating said mirror at a rate commensurate with the film speed to produce a substantially stationary image of each of the individual film frames on the screen, a second mirror positioned in the path of the projected light, and means including an irregularly shaped cam for cyclically shifting said second mirror within predetermined small limits to compensate for inaccuracies in the operation of the means for cyclically oscillating the first mentioned mirror, each cycle of operation of said second mirror occupying a time interval equivalent to two oscillations of the first mentioned mirror.

3. In a motion picture film projection apparatus of the class wherein the film is transported at a constant rate of speed and wherein a compensating device is employed to produce stationary images on the individual film frames of a screen comprising a lens system located between the film and the screen, a light reflecting surface positioned between the film and the lens system, means for cyclically oscillating said reflecting surface at a rate commensurate with the film speed to produce successively substantially stationary images of each individual film frame on the screen, a second light reflecting surface positioned in the optical system, and means for cyclically manipulating said second light reflecting surface within predetermined small limits and in such directions and amounts as will compensate for the inaccuracies of operation of the means for cyclically oscillating the first mentioned reflecting surface.

4. In a motion picture film projection apparatus of the type wherein the film is moved continuously and a compensating device is employed whereby individual images of each of the film frames may be maintained on a screen comprising a lens system for focusing the images on the screen, a first and a second reflecting surface positioned in the optical system, means for cyclically manipulating the first of said reflecting surfaces to produce in succession a substantially stationary image of each film frame on the screen, and means including an irregularly shaped cam operated in synchronism with said first means for manipulating the second of said reflecting surfaces within predetermined small limits to compensate for inaccuracies in operation of the means for cyclically manipulating the first of said reflecting surfaces, each cycle of operation of said second reflecting surface occupying a time interval equivalent to two successive manipulations of the first of said reflecting surfaces.

5. In a motion picture film projection apparatus of the type wherein the film is moved at a constant rate of speed and a compensating device is employed whereby individual images of each of the individual film frames may be maintained on the screen comprising a lens system positioned between the film and the screen for focusing the images on the screen, a first and a second mirror positioned in the optical path of the lens system, means for intermittently and cyclically oscillating the first of said mirrors to produce in succession a substantially stationary image of each film frame on the screen, the degree of oscillation of the first of said mirrors being different for alternate oscillations thereof, and means for cyclically moving the second of said mirrors within predetermined small limits in synchronism with the operation of said first means to compensate for errors in the oscillations of the first mirror, the direction and amount of movement imparted to the second of said mirrors being dependent upon the inaccuracies of operation of said first named means, the time occupied for each cycle of operation of each of said means corresponding to the time that two successive film frames are projected on the screen.

6. In a motion picture film projection apparatus of the class wherein the film is moved continuously, and wherein a device is employed whereby stationary images of each of the individual film frames may be maintained on a screen comprising a source of light positioned on one side of the film, a lens system located between the film and the screen, a first and a second device positioned in the optical system for altering the path of the light rays, means for cyclically manipulating the first of said devices to produce in succession a substantially stationary image of each film frame on the screen, and synchronously operated means including an irregularly shaped cam for manipulating the second of said devices by very small amounts in such directions and by such amounts as will compensate for the inaccuracies in the operation of said first mentioned means.

7. In a motion picture film projection apparatus of the class wherein the film is moved at a constant rate of speed and a compensating device is employed whereby stationary images of the separate film frames may be individually maintained on a screen comprising a lens system located between the film and the screen, means including a source of light for projecting

light rays through the film and lens system onto the screen, a first and a second device for altering the path of the light rays, means for positioning said devices in the path of the projected light rays, means for cyclically manipulating the first of said devices to produce in succession a substantially stationary image of each individual film frame on the screen, and means including an irregularly shaped cam and follower for simultaneously and synchronously manipulating the second of said devices within predetermined small limits to compensate for mechanical inaccuracies in the operation of the means for manipulating the first of said devices.

8. In a motion picture film projection apparatus of the class wherein the film is moved at a constant rate of speed and a compensating device is employed whereby stationary images of the individual film frames may be individually maintained on a screen comprising a lens system located between the film and the screen, means including a source of light for projecting light rays through the film and lens system onto the screen, a first and a second device for altering the path of the light rays, means for positioning the first said devices between the film and the lens system, means for cyclically and intermittently manipulating said first device to successively produce a substantially stationary image of each individual film frame on the screen, means for positioning the second of said devices between the lens system and the screen, synchronously operated means for cyclically manipulating said second device to compensate for errors in the movements of the first device, and means for adjustably varying the relative spacing of the film and said first device.

9. A moving picture film projection apparatus comprising a source of light, a film, a film gate through which said film may be passed, a lens system and a screen upon which images of the film frames may be projected, means for moving said film continuously through said film gate, a first mirror positioned between the film gate and the lens system, means for cyclically and intermittently moving said mirror at a rate commensurate with the film frame speed in order to compensate for film movement whereby a substantially stationary image may be formed upon the screen, a second mirror positioned between the lens system and the screen, means operated in synchronism with said last named means for simultaneously moving said second mirror to compensate for errors in the movements of said first mirror, and means to adjust the spacing of said film gate with respect to said first mentioned mirror to compensate for changes in the physical dimensions of the film.

10. A moving picture film projection apparatus comprising a source of light, a film, a film gate through which said film may be passed, a lens system and a screen upon which images of the film frames may be projected, means for moving the film through said film gate continuously and at a uniform rate of speed, a mirror positioned in the optical system between the film gate and the lens system, means for cyclically and intermittently moving said mirror at a rate commensurate with the film frame speed in order to compensate for film movement whereby a substantially stationary individual image of each film frame may be formed upon the screen, and means to adjust the spacing of said film gate with respect to said first mentioned mirror to compensate for film shrinkage and expansion.

11. A moving picture film projection apparatus comprising a source of light, a film, a film gate through which said film may be passed, a lens system and a screen upon which successive images of the film frames may be projected, means for transporting said film in a continuous manner at a uniform rate of speed, a device positioned in the optical system between the film gate and the lens system for altering the path of the light rays, means for cyclically moving said device at a rate commensurate with the film frame speed in order to compensate for film movement whereby a substantially stationary image may be formed upon the screen, means to manually adjust the spacing of said film gate with respect to said first mentioned mirror to compensate for changes in the physical dimensions of the film, and means to simultaneously alter the position of the lens system to maintain a fixed focal condition.

12. A motion picture film projection device comprising a source of light, a condensing lens, a film gate, a lens system and a screen, means for moving the film through said film gate in a continuous manner, a first mirror positioned between said film gate and said lens system, means including a cam for continuously oscillating said mirror in accordance with film frame speed whereby images of film frames may be made to appear substantially stationary on said screen, a second mirror positioned between said lens system and said screen, means for cyclically oscillating said second mirror to compensate for inaccuracies in the oscillations of said first mirror, means for altering the position of said film gate with respect to said first mirror along the axis of the optical system in order to compensate for slight variations in film size, means for simultaneously altering the position of the lens system in order to maintain the images in focus on said screen, and means positioned between said condensing lens and said film gate whereby the light distribution over said film gate may be made uniform.

13. A motion picture film projection device comprising a source of light, a condensing lens, a film gate, a lens system and a screen, means for moving the film through said film gate in a continuous manner, a mirror positioned between said film gate and said lens system, means including a cam for intermittently oscillating said mirror in accordance with film frame speed whereby images of film frames may be made to appear substantially stationary on said screen, means for altering the position of said film gate with respect to said mirror along the axis of the optical system in order to compensate for slight variations in film size, means for simultaneously altering the position of the lens system in order to maintain the image in focus on said screen, and means positioned between said condensing lens and said film gate whereby the light distribution over said film gate may be made uniform.

14. A motion picture film projection device comprising a source of light, a condensing lens, a curved film gate, a lens system and a screen, means for moving the film through said film gate in a continuous manner, a first mirror positioned between said film gate and said lens system, means including a cam for oscillating said mirror in accordance with film frame speed whereby images of film frames may be made to appear substantially stationary on said screen, the center of curvature of the film gate coinciding with the center of oscillation of the mirror, a second

mirror positioned between said lens system and said screen, means for simultaneously cyclically oscillating said second mirror to compensate for inaccuracies in the oscillations of said first mirror, means for altering the position of said film gate with respect to said first mirror along the axis of the optical system in order to compensate for slight variations in film size, means for simultaneously altering the position of the lens system in order to maintain the image in focus on said screen, and means positioned between said condensing lens and said film gate whereby the light distribution over said film gate may be made uniform.

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