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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Cine Film Feeding Mechanism

We, EASTMAN KODAK COMPANY, a Company organized under the Laws of the State of New Jersey, United States of America of 343 State Street, Rochester 4, New York, United States of America (Assignees of ROBERT JUSTIN ROMAN and VICTOR JOSEPH WITKOWSKI) do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an intermittent pulldown system for motion picture apparatus, and particularly to an intermittent claw pulldown mechanism for motion picture projectors by the use of which fast motion, normal motion, slow motion and still projection can be achieved in both forward and reverse operation of the projector without a significant loss of light or increase in flicker. The mechanism also provides for reverse projection of any rate of motion, as well as still projection without stopping the shutter.

A common procedure used for obtaining slow motion effects in motion pictures has been to expose them at a rate in excess of that at which they are to be projected, i.e., 16—18 frames per second for silent pictures and 24 frames per second for sound pictures. Some attempts have been made to vary selectively the rate of film pulldown in projectors in order to obtain slow motion and rapid motion effects in the projection of films exposed at normal speed. Such attempts, however, have generally involved varying the rate of pulldown by changing the speed of the motor driving the projector by the use of a rheostat in the motor circuit and have not been particularly successful because this mode of altering the rate of projection, particularly when slowing projection down for achieving slow motion effects, also necessarily slowed down the shutter and introduced a flicker condition or a significant loss of light on the screen.

While some known projectors also provided

means for reversing the intermittent film advancing mechanism to obtain reverse projection, such reversing generally required that the prime move for the pulldown claw be stopped and then reversed in its direction of operation. All of this requires time during which the shutter stops and reverses so that there is a period when the screen is dark and undesirable flicker results. In the projection of "stills" it has been customary to stop the pulldown mechanism and stop the shutter in an open position. This procedure not only involves a strain on the mechanism by reason of abruptly stopping the shutter and its associated driving mechanism, but involves a delay in subsequent resumption of projection by reason of the parts having to resume their normal operating speed from a standstill condition.

An object of the present invention is to provide an improved variable rate pulldown system for motion picture projectors by the use of which fast motion, normal motion, slow motion, as well as still projection, can be achieved almost instantly without having to stop or change the speed or direction of operation of the drive means for the pulldown mechanism and/or shutter.

A further object is to provide a pulldown system which can be reversed almost instantly without changing the direction of, or stopping, the drive means therefor.

According to the present invention, there is provided a motion picture projector comprising a film claw for intermittently transporting a film through a gate having a projection aperture, first cam means for reciprocating the film claw in the direction of film transport, only at a given frequency, a driven member carrying second cam means for reciprocating the film claw into engagement with the film, the second cam means being operable to reciprocate the claw at a frequency which is selectively variable between a maximum, equal to the given frequency, and a lower frequency which is a fraction of the given frequency.

In the accompanying drawings:—

Fig. 1 is a perspective view showing an intermittent pulldown system for a motion picture projector constructed in accordance with a preferred embodiment of the present invention,

Fig. 2 is a partial front elevational view of a face cam of the mechanism which provides in and out movements of a film pulldown claw,

Fig. 3 is an enlarged sectional detail showing the manner in which in and out motion is transmitted to the pulldown claw by the in and out face cam,

Fig. 4 is an enlarged sectional detail view taken through a shutter shaft, just ahead of the shutter, and showing how a modified form of up and down cam is connected to a drive shaft so that it can be rotated 180° relative thereto to reverse the direction of film advance without stopping or changing the direction of rotation of the drive shaft, and

Fig. 5 is a sectional view taken substantially on line 5—5 of Fig. 4.

Referring now to the drawings, for purposes of clarity and simplification, only those parts of a motion picture projector which are essential to an understanding of the present invention have been shown. These parts include an apertured film gate 10, the aperture 12 of which is illuminated by a lamp 14 located behind the gate. A motion picture film F is adapted to be intermittently moved through this gate by an improved pulldown claw mechanism to be described hereinafter, and, as each frame of the film is moved into alignment with the aperture in the gate and is illuminated by the lamp 14, it is projected by a lens 16 onto a screen not shown.

A prime mover of the projector comprises an electric motor M, a drive shaft 18 of which extends to one side of, and substantially parallel to, the optical axis of the projector. Under normal load conditions, the drive shaft 18 will rotate at approximately 3250 rpm. or 54 cycles/sec. which is the normal operating speed of certain commercially available small electric motors. The light beam is repeatedly cut off from the projection aperture of the gate by a rotating sector shutter 20 fixed to the drive shaft 18. Since this shutter has but a single cut-off blade it will intercept the light beam at 54 cycles per second and is arranged to do this only during the interval of time in which the film is being advanced through the gate, as is well known in the art.

Coming now to the intermittent film feeding mechanism, this includes a rigid claw arm 22 extending laterally of the film to be fed and having turned-over perforated ears slidably and pivotally engaging a fixed rod 23 which extends substantially parallel to the film gate and to one side thereof. One end of the claw arm is turned at right angles to the body of the arm and is provided with one or more

claws or teeth 24 which are adapted to engage the perforations of the film F to advance the same. As is well known, the claw will reciprocate up and down the rod 23 to effect the film advance and will pivot about said rod to move the claws or teeth 24 into and out of engagement with the film, the gate being provided with an elongated slot 25 to accommodate the pulldown claws and allow the up and down movement of the claw arm while the claws are in engagement with the film.

In the arrangement shown, the up and down reciprocal movement of the claw arm for feeding the film is under the control of an up and down cam 26 fixed to the drive shaft. This cam is embraced by a pair of followers 28 fixed to the claw arm and extending substantially at right angles to the rod 23 to an extent sufficient always to embrace the cam 26 irrespective of the pivotal movement of the claw 22. Since each revolution of the up and down cam produces one complete reciprocal stroke of the film claw, and the drive shaft is rotating at 54 rps., it follows that the claw will be reciprocated vertically at a rate of 54 strokes per second.

The in and out movement of the pulldown claw relative to the film gate is produced by a novel mechanism which will now be described. A spring 30, one end 32 of which is fastened to a wall portion of the projector indicated at 31 in Fig. 3, bears against one surface of the end 34 of the claw arm remote from the film engaging claws, causing the claw arm normally to be pivoted about the rod 23 in a direction to withdraw the claw from engagement with the film in the gate. At the same time the spring 30 urges the other surface of the end 34 of the claw arm against a follower pin 36 which is free to slide in a bushing 38, see Fig. 3. Also secured to the drive shaft 18 is a worm gear 40 which engages complementary gear teeth on the periphery of a wheel or face cam 42 rotating about an axis 44 which is parallel to the drive shaft.

The inner face of the face cam or wheel 42 has a series of cam lobes 47 arranged in three concentric circles. The outer circle has nine evenly spaced cam lobes; the next inner circle has three evenly spaced cam lobes; and the next circle has one cam lobe. Finally, within the innermost circle containing a single cam lobe there is a circle which contains no lobe. The bushing 38 is fixed to a lever 50 which pivots about a stud shaft 52 fixed to the projector housing, not shown, and said lever includes a shaft handle 54 which will extend through the top of the projector housing to be accessible to the operator. When the lever 50 is rotated by means of the shaft handle 54. The follower pin 36 can be moved radially of the face cam 42 and along the end 34 of the claw arm 22 to be positioned in alignment with any of the aforementioned circles on the face cam. The flat surface of the face cam

is so disposed that, when the follower pin 36 engages it, the spring 30 can pivot the claw arm by a sufficient amount to swing the claw out of engagement with the film in the gate.

5 All of the cam lobes 47 have the same rise or throw end which is of such dimension that when the follower pin engages the top thereof the claw arm is pivoted about the rod 23 against the action of the spring 30 by an
10 amount which will move the film claw into engagement with the film to advance the same. Obviously, each of the cam lobes is of sufficient length as to hold the claw in engagement with the film long enough to produce the advancing
15 stroke of the film. Accordingly, each circular series of the lobes 47, in combination with the face of the wheel 42, will constitute a circular in and out face cam for controlling the in and out movement of the claw with respect to the
20 film path at the gate. Whilst the innermost circle described has no lobes 47, the face of the wheel allows the claw to be spring held out of engagement with the film for the projection of "stills" and, in reality, constitutes an
25 in and out cam despite the fact that it possesses no lobes.

The reduction ratio between worm gear 40 and wheel or face cam 42 is nine to one (9:1). Since there are nine lobes 47 on the outer circular series of lobes, when the follower pin 36 is positioned to engage this series of lobes, it will produce an in and out stroke per revolution of the up and down cam 26. This means that the film F will be pulled down one frame
30 per revolution of the cam 26 i.e., at a rate of 54 frames per second. When the follower pin 36 is moved inwardly of the face cam to the next circular series of the lobes 47 i.e., that circle containing three lobes, it produces
40 one in and out stroke of the claw for every three revolutions of the up and down cam 26, i.e., 18 frames per second. When the follower pin 36 is moved inwardly to the circle containing one lobe it produces one in and out stroke
45 of the claw for every nine revolutions of the up and down cam 26, i.e., six frames per second.

If the follower pin 36 is moved in on the face cam to a portion where there are no lobes,
50 there will be no in and out stroke of the claw but the claw teeth will be held out of engagement with the film by the spring 30. This will produce a desirable condition of still projection in which the shutter continues to run. It is
55 also pointed out that, for all three film speeds described, as well as during still projection, the light beam interruption rate by the shutter, and hence the flicker, has remained constant at 54 frames per second. Furthermore, the
60 amount of light transmitted remains constant and independent of the rate of projection.

As will be noted in Fig. 3, the cam lobes 47 as well as the end of the follower pin 36 engaging the face cam 42 are shaped to allow
65 the shifting of the follower pin 36 from one

circular face cam to the next concentric one without stopping the mechanism. As is most clearly shown in Fig. 3, this involves tapering the long sides of each lobe 47 as shown at 60 and rounding the end of the follower pin engaging the same. This produces an apparently instant change of frame rate which is highly desirable. In addition, there is little difference in mechanism noise from fast to slow film speeds. It goes without saying that the leading and trailing edges of each cam lobe 47 are tapered to allow the end of the follower pin 36 to move up onto and down off of each lobe as the face cam rotates relative thereto.

The variable intermittent pulldown mechanism described up to this point can feed the film at 54, 18 or 6 frames per second with instant shift from one rate to another. This means that the film is travelling through the projector at 8,1, 2.7 or 0.9 inches per second, respectively. With a sprocketless projector of the well known type, i.e., where the film is pulled directly from a supply reel and fed to a takeup reel by the pulldown claw, this difference in film rate is absorbed easily by the takeup and supply reels which are generally tendency driven i.e. a light friction clutch or the like. If this pulldown system were used on a conventional sprocket-type projector, however, means would have to be provided to alter the sprocket feed rate in exact synchronism with a change in rate of the pulldown mechanism in order to avoid loss of the film loop ahead of the pulldown claw. This would probably involve such a complicated and expensive sprocket driving mechanism as to take such a projector out of the price range of amateur projection equipment.

While we have mentioned certain rates of projection in describing our invention, it will be appreciated that a greater or lesser number of speed changes could be provided. Likewise, while we have shown one arrangement of parts by which the desired change in frequency between the up and down and in and out movements of the claw can be achieved almost instantly while the prime mover is operating at one speed, it is pointed out that the present invention is not limited to the particular arrangement of parts disclosed to accomplish this end, but is intended to cover all arrangements for achieving the same result, i.e., the use of a plurality of separate in and out cams operating at different frequencies relative to that of the up and down cam and means for selectively connecting any one of these in and out cams to the pulldown claw for use in combination with the up and down cam.

In order to achieve reverse projection with this variable rate pulldown system without having to stop or reverse the direction of drive of the motor M, an arrangement of parts has been devised for rotating the up and down cam 26 through 180° so that the claw teeth are pivoted into engagement with the film perfora-
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tions at the end of the pulldown stroke of the claw and are moved out of engagement with the film at the end of the upward stroke of the claw instead of *vice versa* as is the case for forward projection.

To this end, referring to Figs. 4 and 5, an up and down cam 26¹ instead of the above described cam 26 is rotatably mounted on the drive shaft 18 and has a radial arm 70 secured thereto by a pin 71. This arm 70 is adapted to be engaged alternatively and driven by either of the two drive pins 72 and 73 located 180° apart and slidably extending through holes in a hub portion of the shutter 20. One drive pin 72 is notched at 75 to allow the arm 70 to pass through it, while the other drive pin 73 has a length corresponding to the shortest part of the notch 75. Axially shifting both the drive pins 72 and 73 relative to the plane of movement of the arm 70 gives the choice of driving the arm 70 and the up and down cam 26¹ secured thereto by either of the pins 72 or 73. To enable the pins 72 and 73 to be shifted between their two positions, they are each fixed at one end to a disk 80 which is, in turn, secured to a bushing 82 slidably mounted on a hollow shaft 84 of a bearing 85, which is secured to the drive shaft 18 by a set screw 86 and which has a key portion 87 engaging a keyway 88 in the hub portion of the shutter 20 to connect the shutter to the drive shaft. Whilst the drive shaft and the shutter are rotating, the drive pins 72 and 73 can be slid axially between their two operating positions by means of a shift lever 90, one end of which has a yoke 91 engaging a groove in the bushing 82. The other end of the shift lever 90 extends through the top of the projector to be engaged manually by an operator. The drive pins 72 and 73 can be maintained in either position of adjustment by a detent action formed by a spring-loaded ball 93 carried by bushing 82 snapping into one or the other of two grooves 94 and 95 formed in and spaced axially of the bushing 82. A stop ring 97 is fixed to the drive shaft 18 to limit the motion of the bushing 82 in a direction away from the shutter and to prevent the drive pins 72 and 73 from being withdrawn from driving engagement with the shutter should the shift lever 90 be moved far enough to shift the bushing 82 to a point beyond which the spring-loaded ball 93 might tend to move out of, and beyond, the groove 95.

The subject matter of the present application is closely related to that of its divisional patent application No. 29371/66 (Serial No. 1,054,106) in which the above described mechanism for reversing the direction of film drive is claimed.

WHAT WE CLAIM IS:—

1. A motion picture projector comprising a film claw for intermittently transporting a film through a gate having a projection aperture, first cam means for reciprocating the film claw

in the direction of film transport, only at a given frequency, a driven member carrying second cam means for reciprocating the film claw into engagement with the film, the second cam means being operable to reciprocate the claw at a frequency which is selectively variable between a maximum, equal to the given frequency, and a lower frequency which is a fraction of the given frequency.

2. A projector as claimed in Claim 1 wherein a shutter is driven by a drive means of the first cam means at the given frequency.

3. A projector as claimed in Claim 1 or 2 wherein means for the selective variation of the frequency of reciprocation of the second cam means, is adjustable without change in or interruption of the given frequency.

4. A projector as claimed in Claim 1, 2 or 3 wherein the film claw is normally urged out of engagement with the film.

5. A projector as claimed in any preceding claim wherein the second cam means comprises a plurality of cams, the cams being effective at frequencies less than or equal to the given frequency.

6. A projector as claimed in Claim 5 wherein the cams are in the form of lobes on one surface of a face cam constituting the driven member rotatable about an axis parallel to the optical axis of the projector.

7. A projector as claimed in Claim 6 wherein the lobes are arranged in groups concentric about the axis of rotation of the face cam and the lobes in each group being circumferentially equi-spaced of the respective concentric circle.

8. A projector as claimed in Claim 6 or 7 wherein the face cam is driven through gears at a reduction ratio equal to the number of lobes in the largest of the group.

9. A projector as claimed in Claim 6, 7 or 8 wherein a cam follower extends between the film claw and the lobes for engagement with none, one or more thereof.

10. A projector as claimed in Claim 7 and 9 wherein the cam follower is slidably arranged in a bushing in one end of a pivoted manually operable two-armed lever whereby movement of the lever causes the cam follower to engage, selectively, a group of the lobes.

11. A projector as claimed in claim 2 or any claim appended thereto wherein the drive means comprises a drive shaft driven in one direction at the given frequency.

12. A projector as claimed in Claim 8 and 11 wherein a pinion on the drive shaft engages gear teeth on the circumference of the face cam thereby to drive the latter at a frequency which is equal to a fraction of the given frequency, the fraction being the reciprocal of the number of lobes in the largest group.

13. A projector as claimed in Claim 2 and 11 or Claim 12 wherein the shutter and the first cam means are fixed onto the drive shaft for rotation therewith.

14. A projector as claimed in Claims 2 and



tions at the end of the pulldown stroke of the claw and are moved out of engagement with the film at the end of the upward stroke of the claw instead of *vice versa* as is the case for forward projection.

To this end, referring to Figs. 4 and 5, an up and down cam 26¹ instead of the above described cam 26 is rotatably mounted on the drive shaft 18 and has a radial arm 70 secured thereto by a pin 71. This arm 70 is adapted to be engaged alternatively and driven by either of the two drive pins 72 and 73 located 180° apart and slidably extending through holes in a hub portion of the shutter 20. One drive pin 72 is notched at 75 to allow the arm 70 to pass through it, while the other drive pin 72 has a length corresponding to the shortest part of the notch 75. Axially shifting both the drive pins 72 and 73 relative to the plane of movement of the arm 70 gives the choice of driving the arm 70 and the up and down cam 26¹ secured thereto by either of the pins 72 or 73. To enable the pins 72 and 73 to be shifted between their two positions, they are each fixed at one end to a disk 80 which is, in turn, secured to a bushing 82 slidably mounted on a hollow shaft 84 of a bearing 85, which is secured to the drive shaft 18 by a set screw 86 and which has a key portion 87 engaging a keyway 88 in the hub portion of the shutter 20 to connect the shutter to the drive shaft. Whilst the drive shaft and the shutter are rotating, the drive pins 72 and 73 can be slid axially between their two operating positions by means of a shift lever 90, one end of which has a yoke 91 engaging a groove in the bushing 82. The other end of the shift lever 90 extends through the top of the projector to be engaged manually by an operator. The drive pins 72 and 73 can be maintained in either position of adjustment by a detent action formed by a spring-loaded ball 93 carried by bushing 82 snapping into one or the other of two grooves 94 and 95 formed in and spaced axially of the bushing 82. A stop ring 97 is fixed to the drive shaft 18 to limit the motion of the bushing 82 in a direction away from the shutter and to prevent the drive pins 72 and 73 from being withdrawn from driving engagement with the shutter should the shift lever 90 be moved far enough to shift the bushing 82 to a point beyond which the spring-loaded ball 93 might tend to move out of, and beyond, the groove 95.

The subject matter of the present application is closely related to that of its divisional patent application No. 29371/66 (Serial No. 1,054,106) in which the above described mechanism for reversing the direction of film drive is claimed.

WHAT WE CLAIM IS:—

1. A motion picture projector comprising a film claw for intermittently transporting a film through a gate having a projection aperture, first cam means for reciprocating the film claw

in the direction of film transport, only at a given frequency, a driven member carrying second cam means for reciprocating the film claw into engagement with the film, the second cam means being operable to reciprocate the claw at a frequency which is selectively variable between a maximum, equal to the given frequency, and a lower frequency which is a fraction of the given frequency.

2. A projector as claimed in Claim 1 wherein a shutter is driven by a drive means of the first cam means at the given frequency.

3. A projector as claimed in Claim 1 or 2 wherein means for the selective variation of the frequency of reciprocation of the second cam means, is adjustable without change in or interruption of the given frequency.

4. A projector as claimed in Claim 1, 2 or 3 wherein the film claw is normally urged out of engagement with the film.

5. A projector as claimed in any preceeding claim wherein the second cam means comprises a plurality of cams, the cams being effective at frequencies less than or equal to the given frequency.

6. A projector as claimed in Claim 5 wherein the cams are in the form of lobes on one surface of a face cam constituting the driven member rotatable about an axis parallel to the optical axis of the projector.

7. A projector as claimed in Claim 6 wherein the lobes are arranged in groups concentric about the axis of rotation of the face cam and the lobes in each group being circumferentially equi-spaced of the respective concentric circle.

8. A projector as claimed in Claim 6 or 7 wherein the face cam is driven through gears at a reduction ratio equal to the number of lobes in the largest of the group.

9. A projector as claimed in Claim 6, 7 or 8 wherein a cam follower extends between the film claw and the lobes for engagement with none, one or more thereof.

10. A projector as claimed in Claim 7 and 9 wherein the cam follower is slidably arranged in a bushing in one end of a pivoted manually operable two-armed lever whereby movement of the lever causes the cam follower to engage, selectively, a group of the lobes.

11. A projector as claimed in claim 2 or any claim appended thereto wherein the drive means comprises a drive shaft driven in one direction at the given frequency.

12. A projector as claimed in Claim 8 and 11 wherein a pinion on the drive shaft engages gear teeth on the circumference of the face cam thereby to drive the latter at a frequency which is equal to a fraction of the given frequency, the fraction being the reciprocal of the number of lobes in the largest group.

13. A projector as claimed in Claim 2 and 11 or Claim 12 wherein the shutter and the first cam means are fixed onto the drive shaft for rotation therewith.

14. A projector as claimed in Claims 2 and

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11* or Claim 12 wherein the shutter is fixed on the drive shaft for rotation therewith and the first cam means is mounted on the drive shaft for rotation therewith but is adjustable relative thereto between two positions 180° apart for effecting reverse of the direction of film transport through the gate.

15. A projector, as claimed in Claim 14 wherein the means for adjusting the first cam means between its two positions comprises a radial arm secured to the first cam means, a pair of axially displaceable pins disposed parallel to the drive shaft and on opposite sides thereof, and an axially displaceable sleeve carrying the pins so that the radial arm may be selectively engaged by one of the pins whereby

the first cam means can be drivingly connected to the drive shaft, in either of two positions spaced by 180°

16. A projector as claimed in Claim 15 wherein the pins are axially displaceable through diametrically disposed apertures in a disc secured to the drive shaft.

17. A projector as claimed in Claim 16 wherein the disc also constitutes the shutter.

18. A motion picture projector substantially as hereinbefore described with reference to and as illustrated in Figs. 1, 2 and 3, or Figs. 1, 2 and 3 as modified by Figs 4 and 5,

L. E. T. BRANCH, B.Sc., F.R.I.C.,
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of the accompanying
drawings

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