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## (54) CARTRIDGE LOADING PROJECTOR

(71) 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, New York 14650, United States of America, 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:—

This invention relates to a cartridge loading motion picture projector having a spindle for supporting in operational position on the projector a reel which is loosely enclosed in a cartridge.

Many spindles used for supporting a supply reel in a motion picture projector are mounted so that the axis of rotation thereof is substantially fixed. This may produce undesirable results during operation of a cartridge-loading motion picture projector because rigid support of the supply reel within a cartridge may cause the reel flanges to engage the cartridge walls and produce undesirably high frictional forces. Theoretically, the construction and mounting of the spindle, reel and cartridge should locate the reel within the cartridge so that such friction is not produced, but in practice optimum conditions may not be achieved due to difficulties in the construction of and mounting of the spindle, reel and cartridge. More specifically, the spindle may not rotate about an axis or rotation exactly perpendicular to the plane within the cartridge in which the reel should rotate. Also, the reel flanges or the cartridge walls may become warped or otherwise distorted during manufacture, particularly when the reel or cartridge is thin and manufactured from plastics materials. In addition, it is known to provide clutch mechanisms for projector supply spindles which deflect in response to a predetermined load imposed by a vertically positioned reel. When the spindle is so deflected, it can produce (or increase) undesirable friction between the reel and the cartridge.

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According to the present invention there is provided a cartridge loading motion picture projector having a spindle for supporting in operational position on the projector a reel which is loosely enclosed in a cartridge, comprising means for locating the cartridge in predetermined position on the projector, a hub of the spindle arranged to extend into a cartridge as located on the projector and to support for rotation about the hub axis a reel within the cartridge, a shaft of the spindle carried by the projector and mounted for rotation about the shaft axis, the hub being mounted at one end of the shaft by a coupling which permits the hub to pivot about the intersection of the axes of the hub and the shaft such that frictional contact between the rotating reel and the cartridge can be minimised and which causes rotation of one shaft to be transmitted to the hub.

The invention permits a desired relative movement between the reel and the walls of a cartridge in which the reel is loosely enclosed by allowing the reel to wobble about a pivot point, and also provides a spindle construction that precisely locates the pivot point of the reel during such movement. In one embodiment of the invention the spindle axis is substantially vertical and the hub rests on a suitable portion of the inner spindle part. In another embodiment of the invention the spindle axis is horizontal, and means are provided for holding the outer spindle part on the inner spindle part. Another feature of the present invention comprises improved means for locating a cartridge on a projector so that the cartridge is free to move in one direction with respect to the spindle in response to high frictional forces exerted on the cartridge by the reel during rotation of the reel within the cartridge.

The two embodiments will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of a fragmentary portion of a cartridge-loading motion

picture projector showing a reel-containing cartridge adjacent to the projector;

Fig. 2 is an enlarged view, mainly in cross section, illustrating the first embodiment of reel mounting assembly of this invention and showing the manner in which it supports a reel for rotation within a cartridge located on the projector;

Fig. 3 is an exploded view, partly in section, of the spindle construction shown in Fig. 2;

Fig. 4 is an enlarged fragmentary section illustrating the second embodiment; and

Fig. 5 is a view similar to Fig. 2 showing the spindle of Fig. 4 and its relation to a reel and cartridge.

Because motion picture projectors are well known, the present description will be directed in particular to elements forming part of, or co-operating more directly with, the present invention.

The present invention may be used in connection with various machines adapted to receive and transport an elongate strip of web material from a reel. As illustrated in Figure 1 of the drawings to which reference should now be made the machine is a motion picture projector having a plate 10 with a recess or well 12 for receiving a cartridge. The spindle construction is generally designated 14 and it projects upwardly through an elongate slot 16 in the bottom wall 18 of the well. The projector receives a cartridge 20 containing a reel 22 on which an elongate strip of film F is wound. The reel comprises a pair of spaced and generally parallel flanges 24 and 26 which project radially outwardly from a centrally located hub portion 28. There is an opening 29 in the reel hub for receiving a portion of spindle 14 and the walls of the hub defining the reel opening may be tapered as illustrated in Fig. 2.

The cartridge 20 has a pair of spaced side walls 30 and 32 and an edge wall 34 which jointly enclose the reel 22. Wall 32 has a centrally located opening 36 and wall 30 has a somewhat larger centrally located opening 38 through which a portion of spindle 14 is adapted to project when the cartridge and reel are properly located on the projector in the manner described more fully hereinafter. Reel 28 preferably includes an annular flange 40 which projects axially from hub 28. Flange 40 has a diameter which is larger than the diameter of opening 36 but smaller than the diameter of opening 38 so that the reel cannot be improperly positioned within the cartridge.

The cartridge includes structure for locating or orienting the cartridge at a predetermined location with respect to projector plate 10. The orienting structure comprises a pair of spaced and generally parallel ribs 42 and 44 of substantially equal length. Each of these ribs has a discontinuity intermediate its ends to provide a gap as shown at 46. Other locating or orienting structure important for the purpose of this discussion includes a pair of spaced openings 48 and 50 positioned at opposite sides of the opening 38 in cartridge wall 30 and notches 52 and 54 located in the lower edge of cartridge walls 30 and 32, respectively. Film F is unwound from the cartridge through an opening 55 (Fig. 1) at the bottom of the cartridge.

The co-operating locating or orienting structure on the projector comprises an island or raised portion 56 at one end of the well 12 and having spaced and generally parallel side edge surfaces 58 and 60 and an upper edge 62 having straight end portions and a curved centre portion. Edge surfaces 58 and 60 are engaged by the inner edges of ribs 42 and 44 to locate the cartridge and to prevent its movement in either of two opposite directions in the plane of the well, i.e., in directions extending generally toward the lower left and the upper right as viewed in Fig. 1. Two spaced abutments 64 and 66 located at the upper ends of edge surfaces 58 and 60 are positioned and dimensioned so that they are received within the gaps 46 of ribs 42 and 44, respectively. These abutments establish the position of the cartridge and limit its movement in two opposite directions in the plane of the well, i.e., in directions extending generally toward the upper left and lower right as viewed in Fig. 1. In addition, a pair of spaced pins or circular abutments 68 and 70 in the well 12 are adapted to enter openings 48 and 50, respectively, in the cartridge. Co-operation between the latter abutments and openings 48 and 50 establishes the location of the cartridge within the plane of the well. A projection 72 at the lower edge of the well is adapted to enter cartridge notches 52 and 54 when the cartridge is positioned into the well. Projection 72 is asymmetrically located to prevent insertion of the cartridge into the well with cartridge wall 32 facing the bottom wall 18 of the well. Surface 62 is adapted to co-operate with a mating surface on cartridges of other sizes or configurations, such as the cartridge construction disclosed in Patent Specification No. 1,261,525.

In the embodiment shown the well 12 is located in a substantially horizontal plane and, accordingly, there is no need to latch or fasten the cartridge to prevent its movement in a vertical direction since the force of gravity acting on the cartridge is normally sufficient to hold it in its mounted position in the well. Because of the absence of latching means, the cartridge is free to move upwardly in response to forces that may be encountered during operation of the projec-

tor as will be described more fully hereinafter.

For the reasons mentioned above, during rotation of the reel within the cartridge, one or both of the heel flanges may tends to rotate in the paths shown in phantom in Fig. 2, thereby creating considerable friction between the reel flanges and the cartridge, particularly when the reel is adapted to carry long lengths of film, e.g. 400 foot lengths of film. The spindle construction of the present invention and the mounting of the cartridge on the projector in accordance with the present invention minimizes this undesirable frictional contact and permits relief in the event that abnormal high frictional forces are encountered.

Referring now to Figs. 2 and 3, spindle 14 comprises a first spindle part illustrated in the form of a shaft 80 rotatable about an axis A, and a second spindle part shown in the form of a hub 82 which is mounted on the shaft 80 for pivotal movement with respect to the shaft 80. More specifically, the shaft 80 is carried by a lever 81 and is adjustable by movement of the lever to various positions along the length of slot 16. This adjustment may be effected in the manner disclosed in Patent Specification No. 1,261,189. The upper end of shaft 80 has a pair of spaced, upwardly projecting, generally arcuate teeth 84 which extend approximately one quarter of the way around of the circumference of the shaft. Positioned between the teeth is a socket comprising a mounting or pivot surface 86. Surface 86 is preferably in the shape of a segment of a sphere having a centre of curvature located along the axis of rotation A. Shaft 80 is adapted to be rotated about axis A from a suitable power source, such as a driving mechanism (not shown) forming part of the motion picture projector.

Hub 82 is hollow and has stepped interior and exterior surfaces. The interior of the hub includes an inner substantially cylindrical recess formed by a wall 88 and a somewhat larger outer recess formed by a wall 90. A pair of spaced, generally arcuate teeth 92 on wall 88 project into the inner recess. Each of the teeth 92 extends for slightly less than one quarter of the circumference of wall 88 and they are dimensioned so that they fit between teeth 84 on the upper end of shaft 80, thereby establishing a driving connection between the shaft and the hub so that when the parts are assembled as illustrated in Fig. 2, rotation of shaft 80 simultaneously effects rotation of hub 82. Secured to the hub and projecting downwardly into the inner recess is a pin 94 which carries at its lower end a ball 96 or other member having a generally spherical surface. The radius of curvature of the surface of the ball 96 is substantially equal to the radius of curvature of the spherical surface 86 on the shaft. The ball 96 and surface 86 are located on their respective spindle parts so that the ball rests on surface 86 and is adapted to pivot with respect to surface 86 about a pivot point located at the centre of the spherical surface of the ball and also located on the axis of rotation A of the shaft. The extent of this pivotal movement of the hub with respect to the shaft is limited by a plurality of ribs 98 projecting inwardly from 90. As will be observed from Fig. 2, the inner edges of ribs 98 and the wall 88 are dimensioned with respect to the shaft 80 so that there is adequate space around the portion of shaft 80 located within the hub 82 to permit wobbling or pivotal movement of the hub substantially in one plane relative to the shaft as illustrated by the phantom lines in Fig. 2.

The outer surface of hub 82 comprises a cylindrical upper surface portion 100 positionable within opening 29 in the reel hub. A key 101 projecting from surface 82 is positionable in any one of several keyways conventionally provided in the hub of the reel to lock the spindle and reel together for rotation. The outer surface of hub 82 also includes a larger lower cylindrical surface portion 102 that projects downwardly from the reel through slot 16 in the projector wall. Surface portion 102 is smaller in diameter than the width of the slot 16 so that the limited pivotal movement of the spindle hub on the shaft is not restricted by engagement of the surface portion with the wall defining the slot. An annular shoulder 104 between surface portions 100 and 102 is engaged by the lower portion of the reel hub 28 for supporting the reel in the desired horizontal plane. An outwardly projecting annular flange 106 at the lower end of hub 82 and adjacent to the projector wall 18 preferably has a diameter which excends the width of slot 16, thereby preventing inadvertent disassembly of the spindle parts by upward movement of the hub with respect to the shaft. This flange is desirable when, as in the present embodiment, only the force of gravity holds hub 82 on shaft 80, and there is no means provided or necessary for fastening the spindle hub onto the shaft.

As will be observed from Fig. 2, the centre of curvature of the spherical surface of ball 96 is located substantially at the centre of the rotating mass (i.e. the reed and film) supported by the spindle. This location of the pivot is preferred since this allows the reel to pivot most freely and easily about the pivot point.

As will be observed from Fig. 2, the reel hub rests on shoulder 104, and this serves to locate the reel accurately relative to the cartridge and wall 18.

In operation, a cartridge 20 with a reel

22 therein containing film F is positioned over wall 18 with cartridge wall 30 facing wall 18 of the well, with the opening 29 in the reel aligned with the axis of spindle 14, and with the cartridge locating or orienting structure including ribs 42, 44 and notches 52, 54 located over the co-operating structure on projector plate 10. Then the cartridge is moved downwardly until the cartridge is seated in well 12. During such movement, the opening in the reel hub receives spindle 14. When this downward movement occurs the locating and orienting structures on the cartridge and projector locate the cartridge in the desired position on the projector. Then the projector drive can be coupled to the spindle to rotate the reel within the cartridge. As will be apparent to those skilled in the art, during such rotation of the reel the film is extracted from the cartridge through opening 55 for delivery through the projector to a take-up reel.

In the event that the reel flanges engage the cartridge walls 30 and 32 during rotation of the reel within the cartridge, the spindle construction of this invention permits the reel flanges to pivot about a point located at the centre of curvature of ball 96 and thereby move (within predetermined limits) away from the cartridge walls, thus minimizing the frictional contact between the reel and cartridge. Because the pivot is located at the centre of the rotating mass, very little force is required to produce any necessary pivotal movement of the reel. As a result of the pivoting of the hub 82, the axis of rotation of the spindle hub and reel during rotation of the reel may move along a substantially conical path. The maximum extent of pivotal movement of the hub relative to the shaft 80 is determined by the ribs 98 on the hub which will contact the shaft after the hub has tilted or wobbled through a predetermined arc.

In some cases it may be possible that the reel flange 26 will engage cartridge wall 32 even after the spindle has been tilted through its maximum angle of inclination, and that the force exerted by the reel flange against the cartridge wall will be great enough to lift the cartridge from the bottom wall 18 of well 12. This is permissible in accordance with the present invention due to the novel locating or orienting structure for the cartridge which eliminates the need for latching of the cartridge to the projector, and due to the presence of studs 68 and 70 which serve to guide the cartridge through limited movement in a vertical direction, i.e., in a direction substantially parallel to the axis of spindle 14. While the resulting frictional forces may be high under these abnormal conditions, the permissible movement of the cartridge does reduce the total frictional force to a level that permits satisfactory operation of the projector.

Another embodiment of the spindle construction of the invention is illustrated in Figs. 4 and 5. The construction of the cartridge 20 and reel 22 illustrated in Fig. 5 may be the same as that previously described, and the location and latching of the cartridge to the projector may be accomplished in the manner described in Patent Specification No. 1,261,527. In this instance, the cartridge is latched in place against a wall 110 of a projector, and this wall is illustrated as being in a substantially vertical plane, thereby locating the cartridge and reel in a substantially vertical plane. The axis of rotation of the spindle is substantially horizontal, and it is desirable that some means be provided to prevent separation of the ball and socket which pivotally couple the spindle parts together.

The spindle construction shown in Figs. 4 and 5 is generally designated 112 and it comprises a hub which may be identical to the previously described hub 82, therefore, the same reference numerals have been used to designate the various parts of the hub. Spindle 112 has a shaft 114 having at its outer end a socket generally designated 116 which comprises a plurality of fingers 118 located in spaced relation to each other and extending generally in a direction parallel to the axis of rotation A of the shaft. Each of the fingers has an inner surface 120 defining a segment of a sphere, and these surfaces are positioned around a surface 122 which also defines a segment of a sphere. Surface 122 is somewhat similar to the previously described socket surface 86. The surfaces 120 and 122 are located with respect to each other so that they bound a substantially spherical space having a radius of curvature substantially equal to the radius of curvature of ball 96. Thus, when the ball is in engagement with surfaces 120 and 122, the fingers pivotally mount the ball and retain it against inadvertent removal from shaft 114. Fingers 118 are preferably flexible so that they may be deflected outwardly away from each other to permit insertion and removal of the ball from the socket. Insertion of the ball is facilitated by the provision of a bevelled upper edge 124 on each finger that is inclined downwardly and inwardly toward the centre of the socket so that the ball acting against edges 124 produces a component of force which acts against the fingers to urge them outwardly and away from each other to permit the ball to be seated in the socket. The flexible fingers then snap back towards each other to capture the ball between the fingers and in pivotal engagement with surfaces 120 and 122.

Shaft 114 further comprises a pair of axially extending teeth 126 which are adapted

to co-operate with the teeth 92 of the spindle hub for effecting rotation of the hub and the reel when shaft 114 is driven.

During operation, ball 96 is free to pivot within the socket formed by fingers 118 and surface 122 to permit the wobbling action or correcting motion of spindle hub 82 in response to forces generated by rotation of the reel within the cartridge. This movement is illustrated in Fig. 4 by the solid and phantom positions for shaft 94. Thus the spindle depicted in Figs. 4 and 5 is essentially identical in operation to the previously described spindle. While spindle 112 has been described in connection with the horizontal positioning of the spindle, it will be understood that it also can be positioned vertically (as illustrated for spindle 14) or in other attitudes.

WHAT WE CLAIM IS:—

1. A cartridge loading motion picture projector having a spindle for supporting in operational position on the projector a reel which is loosely enclosed in a cartridge, comprising means for locating the cartridge in predetermined position on the projector, a hub of the spindle arranged to extend into a cartridge so located on the projector and to support for rotation about the hub axis a reel within the cartridge, a shaft of the spindle carried by the projector and mounted for rotation about the shaft axis, the hub being mounted at one end of the shaft by a coupling which permits the hub to pivot about the intersection of the axes of the hub and the shaft such that frictional contact between the rotating reel and the cartridge can be minimised and which causes rotation of one shaft to be transmitted to the hub.

2. A projector as claimed in Claim 1, wherein the pivotal mounting between the hub and shaft comprises a ball and socket.

3. A projector as claimed in Claim 2, wherein the shaft provides the socket, and the hub provides the ball.

4. A projector as claimed in Claim 2 or Claim 3, wherein a part of the hub surrounds the shaft and is arranged to contact the shaft to determine the maximum extent of the relative movement about the said point.

5. A projector as claimed in Claim 2 or Claim 3, wherein the socket is formed by a plurality of fingers located in spaced relation to each other, each of the fingers having a surface defining a segment of a sphere, this surface being engageable with the ball and being located with respect to the other surfaces for retaining the ball between the fingers during relative pivotal movement between the spindle parts, and each of the fingers being flexible to permit insertion of the ball between the fingers and removal of the ball from between the fingers.

6. A projector as claimed in Claim 1, 2 and 3, wherein the said co-operating means comprises axially extending teeth formed on the shaft and the hub radially outwardly of the ball and socket and arranged to interlock.

7. A projector as claimed in any preceding claim, wherein the hub includes a flange which can co-operate with the apparatus to limit movement of the hub away from the shaft.

8. A projector as claimed in Claim 1, wherein the cartridge is arranged to be positioned generally horizontally with the spindle extending substantially vertically.

9. A projector as claimed in Claim 8, including positioning means permitting vertical guided movement of the cartridge during operation in response to frictional forces exerted on the cartridge by the rotating reel.

10. A projector as claimed in Claim 9 and including a reel mounting assembly as claimed in Claim 2, wherein the ball of the pivotal mounting is held in contact with the socket thereof only by gravity during operation.

11. A projector as claimed in Claim 1, wherein the cartridge is arranged to be positioned generally vertically with the spindle extending substantially horizontally.

12. A projector as claimed in Claim 1 and including a reel mounting assembly as claimed in Claim 7, wherein the projector includes a wall extending perpendicularly of the spindle and behind which the flange of the hub is disposed to limit movement of the hub away from the shaft.

13. A projector as claimed in Claim 14, wherein the said wall defines a slot through which the spindle extends, the position of the spindle along this slot being adjustable.

14. A reel mounting assembly substantially as hereinbefore described with reference to Figure 1, to Figures 2 and 3, or to Figures 4 and 5.

15. A motion picture projector substantially as hereinbefore described with reference to Figures 1, 2 and 3, or to Figures 1, 4 and 5.

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to co-operate with the teeth 92 of the spindle hub for effecting rotation of the hub and the reel when shaft 114 is driven.

During operation, ball 96 is free to pivot within the socket formed by fingers 118 and surface 122 to permit the wobbling action or correcting motion of spindle hub 82 in response to forces generated by rotation of the reel within the cartridge. This movement is illustrated in Fig. 4 by the solid and phantom positions for shaft 94. Thus the spindle depicted in Figs. 4 and 5 is essentially identical in operation to the previously described spindle. While spindle 112 has been described in connection with the horizontal positioning of the spindle, it will be understood that it also can be positioned vertically (as illustrated for spindle 14) or in other attitudes.

WHAT WE CLAIM IS:—

1. A cartridge loading motion picture projector having a spindle for supporting in operational position on the projector a reel which is loosely enclosed in a cartridge, comprising means for locating the cartridge in predetermined position on the projector, a hub of the spindle arranged to extend into a cartridge so located on the projector and to support for rotation about the hub axis a reel within the cartridge, a shaft of the spindle carried by the projector and mounted for rotation about the shaft axis, the hub being mounted at one end of the shaft by a coupling which permits the hub to pivot about the intersection of the axes of the hub and the shaft such that frictional contact between the rotating reel and the cartridge can be minimised and which causes rotation of one shaft to be transmitted to the hub.

2. A projector as claimed in Claim 1, wherein the pivotal mounting between the hub and shaft comprises a ball and socket.

3. A projector as claimed in Claim 2, wherein the shaft provides the socket, and the hub provides the ball.

4. A projector as claimed in Claim 2 or Claim 3, wherein a part of the hub surrounds the shaft and is arranged to contact the shaft to determine the maximum extent of the relative movement about the said point.

5. A projector as claimed in Claim 2 or Claim 3, wherein the socket is formed by a plurality of fingers located in spaced relation to each other, each of the fingers having a surface defining a segment of a sphere, this surface being engageable with the ball and being located with respect to the other surfaces for retaining the ball between the fingers during relative pivotal movement between the spindle parts, and each of the fingers being flexible to permit insertion of the ball between the fingers and removal of the ball from between the fingers.

6. A projector as claimed in Claim 1, 2 and 3, wherein the said co-operating means comprises axially extending teeth formed on the shaft and the hub radially outwardly of the ball and socket and arranged to interlock.

7. A projector as claimed in any preceding claim, wherein the hub includes a flange which can co-operate with the apparatus to limit movement of the hub away from the shaft.

8. A projector as claimed in Claim 1, wherein the cartridge is arranged to be positioned generally horizontally with the spindle extending substantially vertically.

9. A projector as claimed in Claim 8, including positioning means permitting vertical guided movement of the cartridge during operation in response to frictional forces exerted on the cartridge by the rotating reel.

10. A projector as claimed in Claim 9 and including a reel mounting assembly as claimed in Claim 2, wherein the ball of the pivotal mounting is held in contact with the socket thereof only by gravity during operation.

11. A projector as claimed in Claim 1, wherein the cartridge is arranged to be positioned generally vertically with the spindle extending substantially horizontally.

12. A projector as claimed in Claim 1 and including a reel mounting assembly as claimed in Claim 7, wherein the projector includes a wall extending perpendicularly of the spindle and behind which the flange of the hub is disposed to limit movement of the hub away from the shaft.

13. A projector as claimed in Claim 14, wherein the said wall defines a slot through which the spindle extends, the position of the spindle along this slot being adjustable.

14. A reel mounting assembly substantially as hereinbefore described with reference to Figure 1, to Figures 2 and 3, or to Figures 4 and 5.

15. A motion picture projector substantially as hereinbefore described with reference to Figures 1, 2 and 3, or to Figures 1, 4 and 5.

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