

PATENT SPECIFICATION

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(54) WEB HANDLING APPARATUS

(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 web handling apparatus and more particularly, but not exclusively, to a motion picture projector.

In the advancing of webs in various apparatus, one problem encountered is the control of tension in the web at various points between a web supply and a web take-up. This control is desirable in the advancing of various types of webs or web-like members, such as film, magnetic tapes, belts, chains and the like (all of which will hereinafter be referred to as "webs"). However, this problem is particularly troublesome in connection with a web advancing mechanism that intermittently advances a thin, flexible web, e.g., in a motion picture projector, wherein it is important for projection of a steady image that the film while in a projector film gate be held stationary. In order for the film to be stationary in the gate it should be isolated from those film tensions and tension fluctuations produced by normal operation of the projector. Motion picture projectors produce undesirable film tensions on film at the film gate in various ways. For example, the film take-up reel is usually constantly driven in a take-up direction through a friction or so-called tendency drive even when the film is being held stationary in the gate. The film supply reel also may be driven in a take-up direction by a friction or tendency drive even when film is being forceably withdrawn from the supply reel by operation of the claw. Even if the supply reel is free-wheeling,

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tension fluctuations are produced by the mass of the reel and film wound thereon opposing advancement of the film by the pull-down claw. Tension fluctuations attributable to the mass of the reel and film are particularly acute when large film rolls (eg 400' of film) are to be handled by the projector. Thus, a strip of film being projected by a motion picture projector is constantly subjected to tension forces that tend to produce undesirable unsteady projected images due to slight film movement at the gate when the film should be held stationary. In addition, these tension forces adversely affect film life.

In accordance with the present invention there is provided a web handling apparatus comprising a rotatably mounted member about which a web is partially wrapped in its passage from a web supply to a web take-up, said rotatably mounted member including a driven portion of the rotatably mounted member outside the web passage area so as not to interfere therewith, drive means associated with the driven portion of the rotatably mounted member and arranged to be driven at a speed which is sufficiently high that slippage occurs continuously between the drive means and the said driven portion when they are in contact, and means responsive to a variation in tension forces acting on said web partially wrapped about the rotatably mounted member for controlling the coupling of the drive means to the driven portion of the rotatably mounted member so that sliding friction between the drive means and the said driven portion is one of the factors tending to maintain constant the ratio of the web tension on each side of the rotatably mounted member.

In accordance with the present invention there is also provided a motion picture projector comprising a rotatably mounted member about which a film is partially wrapped

in its passage from a film supply to a film take-up, said rotatably mounted member including a driven portion of the rotatably mounted member outside the film passage area so as not to interfere therewith, drive means associated with the driven portion of the rotatably mounted member and arranged to be driven at a speed which is sufficiently high that slippage occurs continuously between the drive means and the said driven portion when they are in contact, and means responsive to a variation in tension forces acting on said film partially wrapped about the rotatably mounted member for controlling the coupling of the drive means to the driven portion of the rotatably mounted member so that sliding friction between the drive means and the said driven portion is one of the factors tending to maintain constant the ratio of the film tension on each side of the rotatably mounted member.

In the accompanying drawings:—

Fig 1 is a schematic view of one form of web tension isolator constructed in accordance with the present invention;

Fig. 2 is an elevation of one form of pulley suitable for use with the web tension isolator shown in Fig. 1;

Fig 3 is a schematic view of part of a motion picture projector constructed in accordance with the present invention;

Fig 4 is a schematic view of a modification of the isolator shown in Fig 1 having an internal friction disc driver;

Fig 4a is a section through the pulley shown in Fig. 4;

Fig 5 is a schematic view of a modification of the isolator shown in Fig 1 wherein the arm for the pulley is utilised to impart additional torque and increase the overall gain of the system;

Fig. 6 is a schematic view of a modification of the isolator shown in Fig. 5, having a differently shaped pivoted arm;

Fig. 7 is a schematic view of a modification of the isolator shown in Fig. 4, wherein the pivoted arm has been eliminated; and

Fig. 8 is a view of a modification of the isolator shown in Fig. 1, wherein a drive belt is used.

Because web handling apparatus is well known, the present description will be directed in particular to elements forming part of, or cooperating more directly with, the present invention, elements not specifically shown or described herein being understood to be selectable from those known in the art.

Referring now to the drawings and first particularly to Fig. 1, a tension isolator comprises a freely rotatable pulley 11 mounted at one end of an arm 12. A web 17 is engageable with an angular portion of pulley 11 as explained later. The arm 12 is

mounted at its other end on a support 13 for pivotal movement of the arm 12 and pulley 11 in both directions about axis X. A driver pulley 14 is continuously rotated about a fixed axis by suitable power means (not shown in Fig. 1). The pulleys 11 and 14 are mounted with respect to each other so that the outer surface of pulley 11 at a radius R_1 can be brought into engagement with the surface of pulley 14 to permit pulley 11 to be driven by pulley 14. The driver pulley 14 is preferably driven at a speed which is sufficiently high so that slippage continuously occurs between the surfaces of the driver and the driven pulleys when they are in contact. The driving torque on the pulley 11 depends, in part, on the force urging the pulley 11 against the pulley 14 and this, in turn, is a function of the tension in the web portion trained around the pulley 11. The pulley 11 has a second surface located at a radius R_2 . The web 17 to be advanced, hereinafter described by way of example as a length of motion picture film, is wrapped or looped around the pulley 11 and engages a circumferential portion of the pulley at radius R_2 . The film should not slip with respect to the pulley 11. Film slip will not occur provided the film tension ratio, defined hereinafter, required for slip always remains greater than the tension ratio produced by the pulley system.

Under the influence of the forces or vectors T_1 and T_2 acting on the high tension side and low tension side, respectively, of the film 17, the pivoted arm 12 may be swung about its axis X until the surface of the pulley 11 at radius R_1 is brought into contact with the driving surface of the pulley 14. The contact force between the two pulleys can increase in response to increases in vectors T_1 and/or T_2 until equilibrium is reached between the forces acting on the mechanism. In Fig. 1 the forces acting on the pulley 11 when the system is in equilibrium are as represented by vectors A, B and C. Vector A is the resultant of the radial and tangential forces imposed on the pulley 11 by the pulley 14. The direction of vector A, referred to herein as the driver line of action, is determined by the coefficient of sliding friction μ between the driver pulley 14 and the driven surface of the pulley 11 at the point at which the pulley 11 contacts the pulley 14. Vector B represents the force exerted on the pulley 11 by the pivoted arm 12, which force acts along the common centre line of the pulley and the arm when the geometrical relation between the parts is as shown in Fig. 1. Vector C represents the resultant line of action of the total forces (the tension forces T_1 and T_2) exerted by

the film 17 on the pulley 11. From the foregoing it will be apparent that an increase in the film tension (vector C) produces an increase in the driving force (vector A) applied to the pulley 11 by the pulley 14, and that such increase must be balanced by vectors A and B for the system to remain in equilibrium.

From the preceding discussion, it follows that the location and direction of the total film force line of action (vector C) is established solely by the geometry of the mechanism and the driver coefficient of friction. The ratio T_1/T_2 comprises the film tension ratio or "gain" of the mechanism. Since the direction of vector C is established, the ratio T_1/T_2 also is established for a given position of the two film strands or portions at opposite sides of the pulley 11.

When the pulley 11 is in translational equilibrium, the A and B forces adjust themselves so that vectors A, B and C add vectorially to zero. Thus, any increase in film tension (vector C) increases the vector forces designated A and B but does not change the T_1/T_2 ratio. This tension ratio remains constant regardless of the magnitude of the film tension or speed of pulley rotation as long as the coefficient of sliding friction between the pulley 11 and the pulley 14 does not change. Also, a change in the direction of the line of action of any of vectors A, B and C can be compensated for by changes in the other vector(s) to provide an equilibrium condition.

In general the tension ratio T_1/T_2 or "gain" of the tension isolator is determined by:

- (a) The coefficient of sliding friction μ ;
- (b) The ratio R_1/R_2 ;
- (c) The angle formed by a line from axis X to the centre of the pulley 11 and a line through the point of contact between the pulley 11 and the pulley 14 and the centre of the pulley 11; and
- (d) The location of the film wrap arc, i.e., the location of that portion of the pulley 11 at radius R_2 that is contacted by the film 17.

By various arrangements and combinations of the basic elements discussed above, the operating characteristics of the tension isolator may be varied.

As previously mentioned, during operation the web or film 17 should not slip with respect to the driven pulley 11. This no-slip condition is easily achieved in a number of different ways. For example, a V-groove type pulley generally designated 21 (Fig. 2) may be used as the driven pulley. As shown in Fig. 2, the pulley may have a generally cylindrical surface 22 that comprises a root support. The support 22 is positioned between two spaced and oppositely tapered frusto-conical surfaces 23a and 23b. These surfaces

are contacted by the side edges of the film 17 throughout the extent of the wrap angle of the film 17 about the driven pulley 11. The surfaces 23a and 23b are inclined at equal angles α and β to the face of the pulley 11, and these angles are preferably sufficiently small so that no slippage will occur between them and the side edges of the film 17. Ordinarily the root support 22 is not contacted by the film, but it is preferably closely adjacent to the inner surface of the film 17 so that it can be contacted by the film in the event the film buckles in an inward direction, thereby eliminating excessive tensions that otherwise might be encountered above the normal operating range of the mechanism of the invention. Normally the diameter of the root support 22 is selected so that the clearance between the root support 22 and the film 17 is the minimum required to ensure contact between the edges of the film 17 and the surfaces 23a and 23b. Since the film 17 normally contacts the pulley 21 only along its side edges, undesirable scratching and wear of the image areas of the film is avoided.

Various other means may be utilized for preventing slip between the driven pulley 11 and the film 17. For example, when perforated film is being handled then the driven pulley 11 can be a sprocket having teeth adapted to enter the film perforations. For either perforated film or unperforated film the pulley 11 may be provided with a high friction surface. For example, a coating of rubber or other elastomeric material may be provided on the surface of the pulley contacted by the film. Of course, when film or similar webs are to be handled by the mechanism, surfaces contacted by such webs should not be unduly abrasive. Other constructions of the driven member may be used depending upon the particular application of the tension isolator, the nature of the web or other material being handled, etc.

Fig. 3 illustrates schematically a motion picture projector comprising a film gate 24 located along a film path between a roll of film on a film supply reel 27 and a take-up reel 28. The projector has two substantially identical film tension isolators 40 and 50 of the type hereinbefore described, arranged symmetrically on opposite sides of the gate 24. Each tension isolator has its respective low tension side toward the film gate 24 and its respective high tension side toward the supply reel 27 and the take-up reel 28, respectively.

The tension isolators 40 and 50 are the same basic mechanisms and have the same basic operating theory as previously described in connection with Figs. 1 and 2. The supply isolator 40 comprises a rotatable pulley 41 mounted for free rotation

in both forward or reverse directions on an arm 42 which is pivotally supported on a base 43. The arm 42 extends beyond its pivotal mounting on the base 43, and the extension is coupled to a tension spring 44. A driver pulley 47 is rotatably supported on a fixed support 48 and is continuously rotated in the direction indicated, by suitable power means, such as a motor M, coupled thereto. The spring 44 is preferably a weak spring and it biases the pulley 41 away from the pulley 47.

The take-up isolator 50 comprises a rotatable pulley 51 mounted for rotation in both directions on an arm 52 which is pivotally mounted on a base 53. An extension of the arm 52 is coupled to a weak biasing tension spring 54 that urges the pulley 51 away from the driver pulley 55. The pulley 55 is rotatably supported on a fixed base 56 and is continuously rotated in the direction indicated by suitable power means such as the motor M. The pulleys 41 and 51 can be constructed in the manner shown in Fig. 2 for the pulley 21. The pulleys 47 and 55 are both driven at speeds that ensure slippage between them and their respective driven pulleys 41 and 51, and each pulley 47 and 55 is driven in a direction for feeding the film 17 toward the gate 24. The film 17 is wrapped partially around the pulleys 41 and 51. There should be no slippage between the film 17 and the pulleys 41 and 51.

A film claw 58 comprises part of a conventional intermittent drive mechanism for advancing the film 17 through the film gate 24 one frame at a time. In the usual manner light from a light source 71 is directed through an image frame on the film 17 when the frame is properly located in the film gate 24, and then to a lens assembly 72 for projection of an image on to a suitable screen (not shown).

During advancement of the film 17 from the reel 27 to the reel 28, the take-up reel 28 is driven through a friction clutch or so-called "tendency drive", that is, the reel 28 is driven through a friction clutch or the like at a rate higher than the rate that the film 17 is delivered to the reel 28 so that a "pull" is constantly maintained on the film 17. The clutching mechanism included in the drive assembly permits the drive to be constantly applied to the reel 28 even when no film is being taken up by the reel 28. Similarly, the supply reel 27 may be tendency driven in a film take-up direction during unwinding of the film 17 therefrom. The reels 27 and 28 are driven by spindles 27a, 28a, respectively, that are coupled to the motor M, as shown diagrammatically in Fig. 3.

A pair of lightly biased spring arms 73 and 74 are provided at the low tension

sides of the film tension isolators 40 and 50 between the film gate 24 and driven pulleys 41 and 51, respectively. The spring arms 73 and 74 are each pivotally mounted on stationary portion of the projector for pivotal movement in the directions indicated by the arrows in Fig. 3. Each arm 73 and 74 has a finger portion shown at 73a and 74a, respectively, which engages and supports a portion of the film 17 between the respective driven pulley 41 or 51 and the film gate 24. The arms 73 and 74 are spring biased away from the gate 24, as illustrated diagrammatically, so that a small tension or force is exerted on the film 17. This tension is inversely related to the size of the film loop produced by the arms 73 and 74. Preferably, the spring force acting on each arm 73, 74 has a natural frequency appreciably higher than the maximum pull-down frequency of the claw 58 so that the finger portions 73a and 74a of the arms 73 and 74, respectively, remain in contact with the film 17 at all times. The spring force acting on the arms 73 and 74 is preferably obtained by making these arms of a spring material; however, separate spring members can be used if desired.

During operation of the projector for feeding film from the supply reel 27 to the take-up reel 28, the claw 58 effects intermittent motion of the film through the film gate 24. As a length of film 17 is pulled from the supply loop of film around the finger 73a and added to the take-up loop around the finger 74a, the film loop supported by the arm 73 becomes smaller and the film loop supported by the arm 74 becomes larger. The arms 73 and 74 are both deflected to the left (as viewed in Fig. 3) in response to the changes in the size of the film loops engaged by these arms. Film advancement therefore increases the force on the film 17 between the reel 27 and the gate 24 and correspondingly decreases the film tension in the loop between the gate 24 and the reel 28. The tension isolators 40 and 50 are effective to maintain a constant film tension ratio (T_1/T_2) of 10 to 1, for example, in the film loops around the pulleys 41 and 51, respectively. Thus as the film tension in the loop of the supply isolator 40 increases, driving torque on the pulley 41 increases as the increased film tension forces the pulley 41 against the pulley 47 with a greater force and thereby increases the effectiveness of the drive on the pulley 41 from the pulley 47. The film 17 is driven toward the gate 24 and into the loop around the arm 73 until the tension in that loop returns to the design or equilibrium value. When such equilibrium condition is reached, the pulley 47 is ineffective to rotate the pulley 41. Conversely, the film tension in the loop of the take-up ten-

sion isolator 50 first decreases due to the length of film 17 fed toward the pulley 51 by the claw 58, and driving torque on the pulley 51 is decreased as pressure between the rollers 51 and 55 is decreased, thus permitting the take-up reel 28 to pull film from the loop and restore the design or equilibrium film tension in the portion of the film around the pulley 51, thereby maintaining the ratio T_1/T_2 constant. The above cycle of operation is repeated each time film is advanced toward the take-up reel.

The moment of inertia of each pulley 41, 51 and the compliance of the associated spring arm 73 or 74 constitute a mechanical filter that effectively isolates the reels 27 and 28 from the energy pulses generated in the film by the pulldown claw 58. Also, reel load fluctuations are isolated from film at the gate 24 by this filter mechanism. As a result, film transport at the supply and take-up reels 27 and 28 is at an essentially uniform speed. Also, tension transients originating at the reels 27 and 28 are highly attenuated at the film gate 24, thereby providing a steadier projected image and increasing film life.

It will be noted that the overall arrangement of the projector parts controlling film handling along the film path is fully symmetrical, and that each tension isolator 40 and 50 tends to drive film toward the film gate 24. Thus forward and reverse projection of film is basically the same although, of course, in opposite directions. The two tension isolators 40 and 50 are fully symmetrical and the action of each is basically the same regardless of the direction of film movement. Thus the reels 27 and 28 have been arbitrarily designated as supply and take-up reels, respectively.

As previously noted, the arm 42 is biased counter-clockwise by the spring 44 and the arm 52 is biased clockwise by the spring 54. The biasing force of each spring is relatively light, preferably being just enough to move the arm and disengage the supported pulley from the associated driver pulley at times when the reel film tension is extremely low. At such times as the pulley 51 or the pulley 41 is so disengaged from its associated driver, it then acts simply as a freely rotatable idler pulley. By suitable location of the pulleys 41 and 51 the force of gravity may be used to effect the biasing function of the springs 44 and 54.

Means may be provided for declutching or disengaging one or both of the pulleys 41 and 51 from their respective driver pulleys. This may be desirable during rewind, for example, so that one or both of these pulleys act as free idlers. As shown in Fig. 3, this may be accomplished by providing clutch levers 77 and 78 that can be swung in the directions indicated to move arms 42 and 52

in directions that cause the respective driven pulleys supported by the arms to be disengaged from the pulleys 47 and 55, respectively. If desired, one pulley can be declutched while the other pulley is driven in the normal way. Thus only the pulley 41 need be declutched to produce automatic rewinding of film on to the reel 27 without further clutching of either the reel 27 or the reel 28. With the pulley 41 acting as an idler, the full tension produced by the reel 27 acts to the right (as viewed in Fig. 3) on the film at the gate. However, the pulley 51 still being engaged causes, for example, only one tenth of the tension produced by the reel 28 to act toward the left on the film at the gate. This difference in film tension causes the film to accelerate in a direction towards the reel 27. This acceleration will continue until the motor drive speed of the reel 27 or the driver 55 is attained. The film can be brought to a gentle stop by re-engagement of the pulley 41 with the driver 47 which restores the tension balance. Correspondingly, the pulley 51 may be disengaged from the driver 55 which will produce the same rewind action but in the opposite direction. When rewinding or slowing the film at high speeds, the gate pressure pad, claw and any other film restraining devices are normally retracted to allow unimpeded motion of the film. The described mechanism therefore can be seen to provide a very simple means for control of all modes of film motion at high and low speeds in either direction.

By way of further example, both clutch levers may be moved simultaneously by means of a control lever 79 pivotal about an axis 79a and connected to both clutch levers by coupling means illustrated diagrammatically in Fig. 3 at 79b and 79c in which case the reels 27 and 28 may be suitably clutched for high speed film motion in either direction.

Figs. 4-7 illustrate forms of tension isolators that are basically similar in construction and theory of operation to the form shown in Fig. 1, previously described. In the form shown in Figs. 4 and 4a, a pulley 81 is driven by an internal friction disc driver or pulley 82. The pulley 82 is engageable with a generally cylindrical inner surface 85 that opens to at least one end of the pulley 81. The diameter of surface 85 is substantially larger than the diameter of the pulley 82 so that the pulley 81 is movable into and out of engagement with the pulley 82. The pulley 81 is rotatably mounted on an arm 83 which is pivoted on a support 84. In this instance the film 17 is wrapped on the outer surface of the pulley 81, and suitable provision is made for a no-slip wrap. The pulley 82 is mounted for rotation about a fixed axis and the

pulley 81 is brought into engagement there-with in response to the tension in the external paths of the film 17. The vectors and lines of action for the various forces involved can be plotted in the manner described in connection with Fig. 1. The external configuration of the pulley 81 may be the same as that described for the pulley 21 (Fig. 2) and the pulley 81 can be urged in an anticlockwise direction (as viewed in Fig. 4) out of contact with the pulley 82 by the force of gravity or by spring means as described in connection with Fig. 3.

In the form of the invention shown in Fig. 5 a pulley 101 (which may be similar to pulley 21) is driven by a driver pulley 102 in a manner generally similar to that described in the form shown in Fig. 1. However, the pulley 101 is rotatably mounted on one end of a shorter portion 107a of an L-shaped arm or bell crank 107. An idler roller 104 is rotatably mounted on the end of longer portion 107b of the arm 107. The film 17 is wrapped partially around the roller 104 and the roller 101. The arm 107 is pivoted on a support 108 at the intersection of the arm portions 107a and 107b.

When used in a motion picture projector such as shown in Fig. 3, the arm 107 is arranged so that the roller 104 is located between the film gate and the pulley 101. The L-shaped arm 107 and the film wrap around part of the roller 104 in the manner shown provides a mechanical advantage that imparts an additional torque to the pivoted arm which increases the overall tension amplification or gain of the apparatus. Also, it reduces the effective inertia of the apparatus which raises the frequency response of the tension isolator system. This method of increased amplification tends to render the apparatus less sensitive to changes in geometry and coefficient of friction although the enhanced frequency response amplifies the tension pulses produced during film pull-down.

Fig. 6 shows a further form of the invention that is generally similar to that shown in Fig. 5. In Fig. 6, a pulley 111 is rotatably mounted on an arm 112 between the ends thereof. The arm 112 is pivotally mounted at one end on a support 113. The film 17 is partially wrapped around a freely rotatable roller 117 which is mounted at the free end of the arm 112. The pulley 111 is driven by a driver pulley 118 in the manner previously described in relation to the form shown in Fig. 5. In the Fig. 6 form, tension gain of the apparatus results only from the pivoted arm extension whereas in the form shown in Fig. 5 the gain results both from the arm extension and from the film tension situation.

In the embodiments of Figs. 5 and 6 just

described, the arm portions supporting the rollers 104 and 117 may be made of spring material. Also, in both of these forms the effective inertia and hence the system frequency response is a function of the length and position of the arm relative to other parts of the mechanism.

In the form of the invention in Fig. 7, the pivotally mounted arm shown in Figs. 1, 4, 5 and 6 has been eliminated. A pulley 131 surrounds and is driven by an internal driver disc 132 in a manner similar to that discussed in connection with Fig. 4. The driver 132 is driven about a fixed axis, and suitable retainers (not shown) may be provided for limiting axial movement of the pulley 131. The pulley 131 seeks a position of equilibrium wherein the line of action of the driver force on the pulley coincides with the line of action of the total film force on the pulley, and wherein the driver force vector A is equal and opposite to the total film force vector C. Since the location of the point of contact between the driver 132 and the pulley 131 is not rigidly fixed, the gain of the system depends only on the R_1/R_2 ratio and the value of the coefficient of friction.

In the forms described hereinbefore, a separate disc or pulley driver member has been disclosed for driving the pulley about which the film or other web is wrapped. Fig. 8 shows a form of the invention wherein the driver member comprises a driver belt 140 which is trained about a driven pulley member 142 at a radius R_1 . The belt 140 has a slip type drive with respect to the pulley 142 and is driven at a speed that tends to drive the pulley 142 faster than the maximum speed required for advancing the film 17. The pulley 142 is provided with a web supporting surface 144 at a radius R_2 . The belt and web engaging portions of the pulley are offset axially from each other. The film 17 is wrapped about the pulley and engages the surface 144. The pulley 142 is rotatably mounted at the free end of an arm 146, the other end of which is pivoted at 148 on a fixed support 150. In operation, the force of the engagement between the belt 140 and the pulley 142 is determined by the tension in the film 17 and this, in turn, governs the driving force imparted by the belt 140 to the pulley 142.

The preceding discussion has been directed primarily to the use of the invention for maintaining a particularly low tension force (T_2); however, the invention is equally applicable to maintenance of a high tension force (T_1) as, for example, in winding a tight roll of web material. Irrespective of the application, simple and efficient means have been provided whereby the ratio of the tensions of the web portions on oppo-

site sides of the driven pulley is maintained substantially constant by fully automatic means that are responsive to variations in tension in the web portions themselves. This tension ratio and the magnitude of the tension forces designated T_1 and T_2 may be varied over a wide range, as desired, by different geometrical arrangements and combinations of the basic elements, and by changing the coefficient of friction between the driver and driven pulley members. It is also noted that the absence of film lubricant ensures a high coefficient of friction between the film and the driven pulley (which is desirable) while the absence of lubricant is normally undesirable with prior film handling devices.

Reference is directed to our British patent specification no. 1341758 in which there is described and claimed:

Web handling apparatus for moving a web past a station arranged between a web supply and a web take-up, the apparatus having a drive member for selectively advancing the web in forward or reverse directions past the station and two capstan drive means positioned at opposite sides of the drive member, each of the capstan drive means comprising a rotatable member engageable with the web, and means coupled to each of the rotatable members for simultaneously rotating these rotatable members respectively at a speed in excess of the maximum forward speed, and at a speed in excess of the maximum reverse speed, of the web produced by the drive member, both rotatable members tending to drive the web towards the drive member.

WHAT WE CLAIM IS:

1. A web handling apparatus comprising a rotatably mounted member about which a web is partially wrapped in its passage from a web supply to a web take-up, said rotatably mounted member including a driven portion of the rotatably mounted member outside the web passage area so as not to interfere therewith, drive means associated with the driven portion of the rotatably mounted member and arranged to be driven at a speed which is sufficiently high that slippage occurs continuously between the drive means and the said driven portion when they are in contact, and means responsive to a variation in tension forces acting on said web partially wrapped about the rotatably mounted member for controlling the coupling of the drive means to the driven portion of the rotatably mounted member so that sliding friction between the drive means and the said driven portion is one of the factors tending to maintain constant the ratio of the web tension on each side of the rotatably mounted member.

2. A web handling apparatus according

to claim 1 wherein the drive means comprises a drive member mounted for rotation about a fixed axis and wherein the means for controlling coupling of the drive means to the driven portion of the rotatably mounted member comprises a pivotally mounted arm which carries the rotatably mounted member and is movable about a fixed axis in an arc toward or away from the drive member, whereby the rotatably mounted member is movable into or out of engagement with the drive member for rotation therewith or release therefrom, respectively.

3. A web handling apparatus according to claim 1 wherein the drive means comprises an endless drive belt trained around a portion of the rotatably mounted member.

4. A web handling apparatus according to claim 1 wherein the rotatably mounted member has a cylindrical opening therein and the drive means comprises a drive member positioned at least partially within the opening and engageable with the cylindrical surface thereof for driving the rotatably mounted member.

5. A motion picture projector comprising a rotatably mounted member about which a film is partially wrapped in its passage from a film supply to a film take-up, said rotatably mounted member including a driven portion of the rotatably mounted member outside the film passage area so as not to interfere therewith, drive means associated with the driven portion of the rotatably mounted member and arranged to be driven at a speed which is sufficiently high that slippage occurs continuously between the drive means and the said driven portion when they are in contact, and means responsive to a variation in tension forces acting on said film partially wrapped about the rotatably mounted member for controlling the coupling of the drive means to the driven portion of the rotatably mounted member so that sliding friction between the drive means and the said driven portion is one of the factors tending to maintain constant the ratio of the film tension on each side of the rotatably mounted member.

6. A motion picture projector according to claim 5 wherein the drive means comprises a pulley which is mounted for rotation about a stationary axis.

7. A motion picture projector according to claim 5 wherein the drive means comprises a drive belt frictionally engageable with the driven portion of the rotatably mounted member.

8. A motion picture projector according to claim 5 or 6 wherein the means for controlling the coupling of the drive means to the driven portion of the rotatably mounted member comprises an arm supporting the rotatably mounted member, the

site sides of the driven pulley is maintained substantially constant by fully automatic means that are responsive to variations in tension in the web portions themselves. This tension ratio and the magnitude of the tension forces designated T_1 and T_2 may be varied over a wide range, as desired, by different geometrical arrangements and combinations of the basic elements, and by changing the coefficient of friction between the driver and driven pulley members. It is also noted that the absence of film lubricant ensures a high coefficient of friction between the film and the driven pulley (which is desirable) while the absence of lubricant is normally undesirable with prior film handling devices.

Reference is directed to our British patent specification no. 1341758 in which there is described and claimed:

Web handling apparatus for moving a web past a station arranged between a web supply and a web take-up, the apparatus having a drive member for selectively advancing the web in forward or reverse directions past the station and two capstan drive means positioned at opposite sides of the drive member, each of the capstan drive means comprising a rotatable member engageable with the web, and means coupled to each of the rotatable members for simultaneously rotating these rotatable members respectively at a speed in excess of the maximum forward speed, and at a speed in excess of the maximum reverse speed, of the web produced by the drive member, both rotatable members tending to drive the web towards the drive member.

WHAT WE CLAIM IS:

1. A web handling apparatus comprising a rotatably mounted member about which a web is partially wrapped in its passage from a web supply to a web take-up, said rotatably mounted member including a driven portion of the rotatably mounted member outside the web passage area so as not to interfere therewith, drive means associated with the driven portion of the rotatably mounted member and arranged to be driven at a speed which is sufficiently high that slippage occurs continuously between the drive means and the said driven portion when they are in contact, and means responsive to a variation in tension forces acting on said web partially wrapped about the rotatably mounted member for controlling the coupling of the drive means to the driven portion of the rotatably mounted member so that sliding friction between the drive means and the said driven portion is one of the factors tending to maintain constant the ratio of the web tension on each side of the rotatably mounted member.

2. A web handling apparatus according

to claim 1 wherein the drive means comprises a drive member mounted for rotation about a fixed axis and wherein the means for controlling coupling of the drive means to the driven portion of the rotatably mounted member comprises a pivotally mounted arm which carries the rotatably mounted member and is movable about a fixed axis in an arc toward or away from the drive member, whereby the rotatably mounted member is movable into or out of engagement with the drive member for rotation therewith or release therefrom, respectively.

3. A web handling apparatus according to claim 1 wherein the drive means comprises an endless drive belt trained around a portion of the rotatably mounted member.

4. A web handling apparatus according to claim 1 wherein the rotatably mounted member has a cylindrical opening therein and the drive means comprises a drive member positioned at least partially within the opening and engageable with the cylindrical surface thereof for driving the rotatably mounted member.

5. A motion picture projector comprising a rotatably mounted member about which a film is partially wrapped in its passage from a film supply to a film take-up, said rotatably mounted member including a driven portion of the rotatably mounted member outside the film passage area so as not to interfere therewith, drive means associated with the driven portion of the rotatably mounted member and arranged to be driven at a speed which is sufficiently high that slippage occurs continuously between the drive means and the said driven portion when they are in contact, and means responsive to a variation in tension forces acting on said film partially wrapped about the rotatably mounted member for controlling the coupling of the drive means to the driven portion of the rotatably mounted member so that sliding friction between the drive means and the said driven portion is one of the factors tending to maintain constant the ratio of the film tension on each side of the rotatably mounted member.

6. A motion picture projector according to claim 5 wherein the drive means comprises a pulley which is mounted for rotation about a stationary axis.

7. A motion picture projector according to claim 5 wherein the drive means comprises a drive belt frictionally engageable with the driven portion of the rotatably mounted member.

8. A motion picture projector according to claim 5 or 6 wherein the means for controlling the coupling of the drive means to the driven portion of the rotatably mounted member comprises an arm supporting the rotatably mounted member, the



arm being mounted for pivotal movement about a point spaced from the rotatably mounted member so as to allow movement of the rotatably mounted member into and out of frictional driving engagement with the drive means.

9. A motion picture projector according to claim 8 wherein the arm comprises two arm portions arranged substantially in an L-shaped and is pivotally mounted at the intersection of the said arm portions, one of which carries the rotatably mounted member and the other of which carries a film guide member to guide the film along the film path adjacent the rotatably mounted member.

10. A motion picture projector according to Claim 8 wherein the rotatably mounted member is pivotally mounted on an intermediate portion of the arm, which is mounted for pivotal movement about one of its end portions, and carries a film guide member on its other end portion to guide film along the film path adjacent to the rotatably mounted member.

11. A motion picture projector according to Claim 5 wherein the drive means comprises a rotatable disc mounted for rotation about a fixed axis, and the rotatably mounted member has an opening therein bounded by a cylindrical driving surface, the disc being positioned within the opening and engageable with said driving surface.

12. A motion picture projector according to Claim 11 wherein an arm which is mounted for pivotal movement about an

axis supports the rotatably mounted member for movement into and out of engagement with the disc.

13. A motion picture projector according to Claim 8 including means coupled to the arm for biasing the arm about its pivotal mounting in a direction for terminating the driving connection between the rotatably mounted member and the drive means.

14. A motion picture projector according to Claim 5 or 6 further comprising clutch means coupled to the rotatably mounted member for terminating the driving connection between the drive means and the rotatably mounted member.

15. A motion picture projector according to any one of the preceding claims 6-14 wherein the rotatably mounted member comprises a pulley having a pair of flanges the inner surfaces of which are tapered defining the film driving surface.

16. A motion picture projector according to any one of the preceding claims 5-15, wherein the rotatably mounted member and its drive means are located on one side of the film gate and a similar rotatably mounted member and drive means are located on the other side of the film gate.

17. A motion picture projector having film tension controlling means substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

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