

[54] LINKAGE

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[58] Field of Search74/128, 142, 575, 577;
353/117, 107, 68

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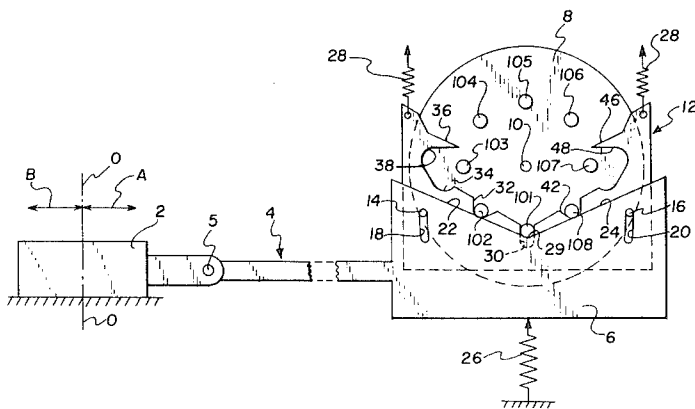
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[57] ABSTRACT

A mechanism for converting reciprocating linear motion to rotary motion comprises an escape wheel rotatable in equal angular increments about an axis, a pallet for rotating the wheel, and a ramp member for actuating the pallet and controlling the displacement of the wheel. The escape wheel is rotated by the sequential application of torque by the pallet to pins extending from the face of the escape wheel, and displaced radially from the axis and angularly from each other. The direction of rotation of the escape wheel can be reversed in response to a change in the path of reciprocation of the input member, and the pallet limits rotation of the wheel to the equal angular increments regardless of overtravel of the input member.

9 Claims, 4 Drawing Figures



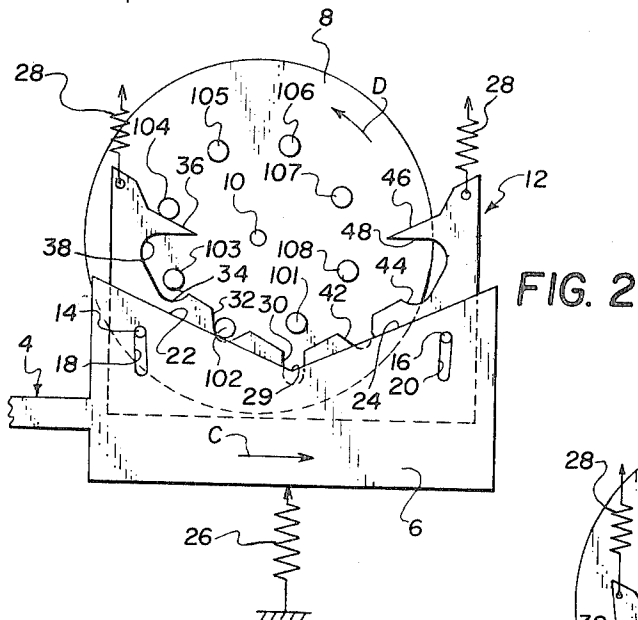
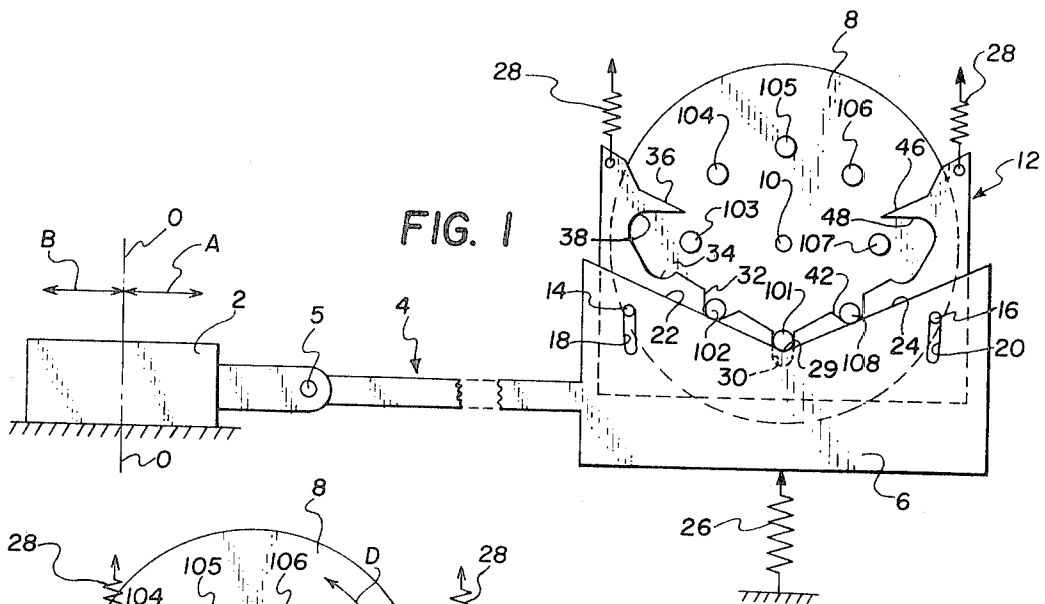
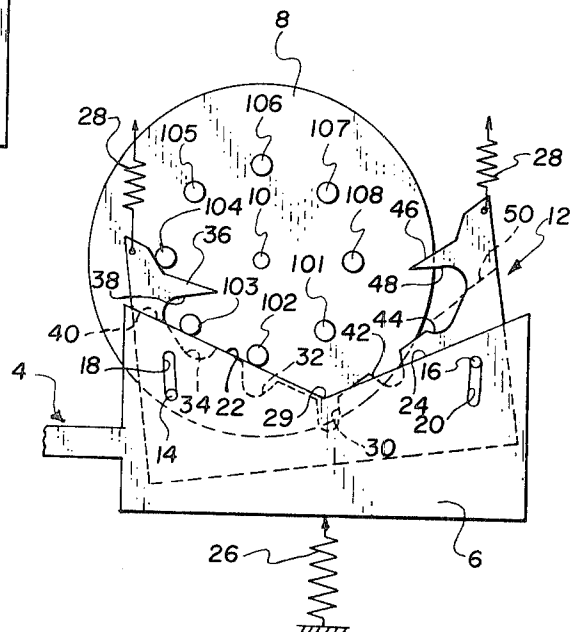


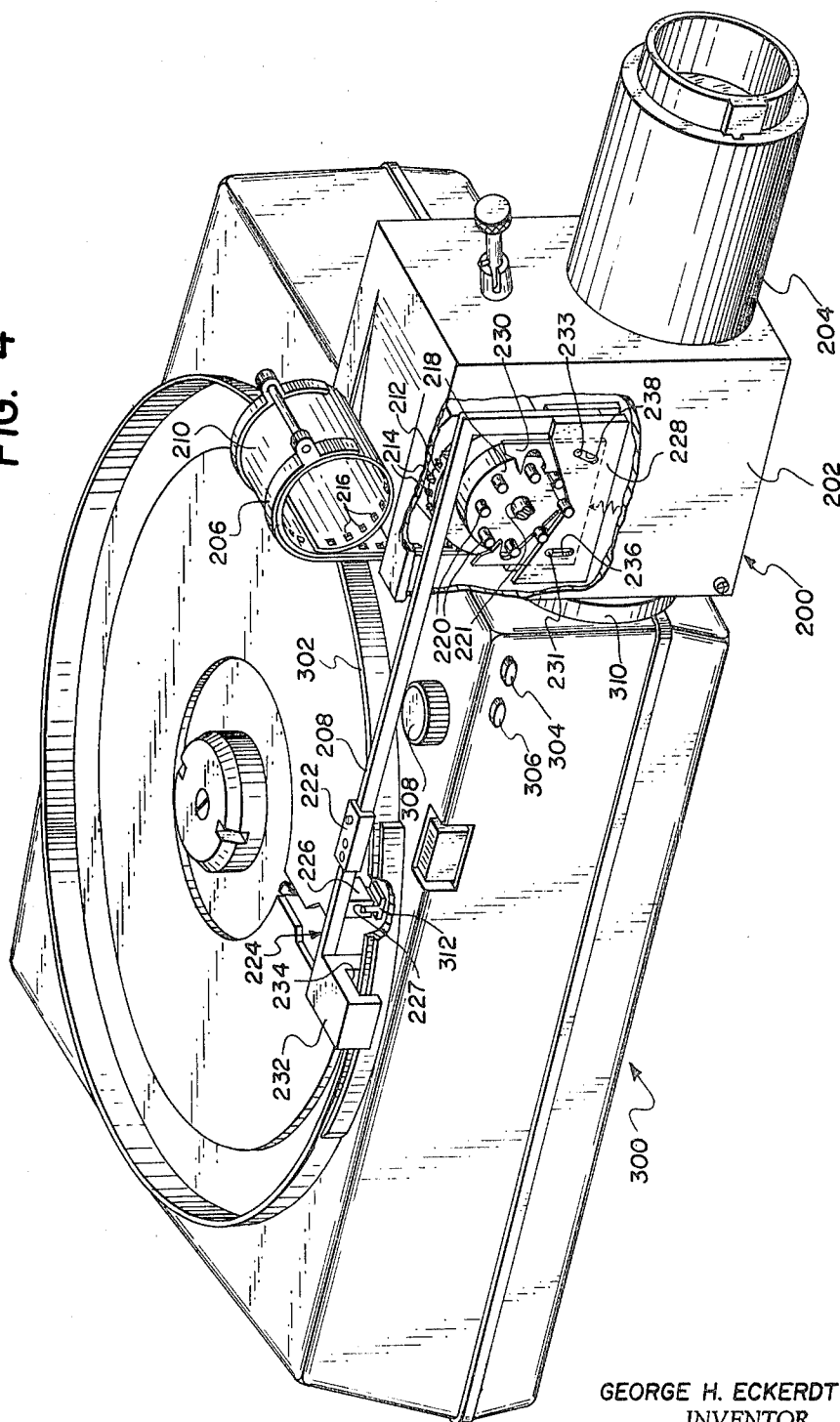
FIG. 3



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FIG. 4



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LINKAGE

CROSS-REFERENCE TO RELATED APPLICATION

U.S. Ser. No. 27,519, entitled "Filmstrip Adapter to Slide Projector," filed on even date herewith by George H. Eckerdt.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to mechanisms for converting reciprocating linear motion to rotary motion of equal angular increments. The invention further relates to devices for converting linear motion to rotary motion wherein an output member is alternatively rotated in clockwise and counterclockwise directions depending on the direction of displacement of a linear input member.

2. Description of the Prior Art

A common expedient for the conversion of linear motion to rotary motion involves the use of pawl or claw type members which move in response to a linear input for successively engaging the teeth of a ratchet wheel to rotate the wheel. Examples of the latter devices are disclosed in U.S. Pat. Nos. 2,299,030 to Peebles, and 3,231,059 to Hall. Other devices, such as that taught by U.S. Pat. No. 3,411,685 to De Gennaro disclose rotary elements having cogs or pins extending from the face thereof and engageable by drive members for rotating the member. U.S. Pat. No. 3,156,400 to Rigby discloses a reciprocal plunger carrying a claw for successively engaging the pins extending from the face of a rotatable disk for rotating the disk in uniform angular increments. Other devices well known in the art for converting reciprocating linear motion to rotary motion include slider-crank mechanisms, drag links, the Whitmore mechanism, the crank shaper, the offset slider crank, and the toggle mechanism.

Each of the foregoing mechanisms known in the prior art has one or more of the following disadvantages: (a) high friction, such as results from constant rubbing contact between different elements in the mechanism; (b) the rotational output varies with the linear input, thus making it impossible to achieve uniform angular displacement of the output member when the linear input member is displaced by varying amounts with successive operations of the device; (c) the displacement of the rotary output member is unidirectional, making it impossible or difficult to reverse the direction of rotation when the direction of displacement of the input member is reversed; and (d) difficulty in varying the angular displacement of the output member.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an improved linkage for converting linear motion into rotary motion which avoids the aforementioned disadvantages of the prior art.

A more specific object of the present invention is to provide a mechanism having a rotary output member which is displaceable in uniform angular increments in response to the displacement of a reciprocating linear input member, with the angular displacement of the output member being unaffected by at least limited overstroke of the linear input member.

Another object of the present invention is the provision of a linkage having an escape wheel displaceable in uniform angular increments, and in clockwise or counterclockwise directions, in response to the displacement of an input member in forward and reverse directions respectively.

Another object is the provision of a linkage having low friction losses.

Still another object of the invention is to provide means for rotating an output member by predetermined angular increments in response to the displacement of a reciprocating linear input member, the device being of simple construction and operation, and economical to manufacture.

Further objects will be apparent from the description to follow and the appended claims.

The objects mentioned above are accomplished by means of a mechanism including a reciprocating input member displaceable in a linear path, and an output member, referred to herein as an escape wheel, mounted for rotation about a central axis and having a series of discontinuities such as drive pins extending from the face thereof. A pallet for driving the pins on the output member is coupled to a control member, which is in turn actuated by the input member. With each displacement of the input member in a driving direction, the pallet sequentially engages several of the drive pins to rotate the escape wheel, and a plurality of the pins engages a specially contoured surface on the control member to limit the rotation of the escape wheel. Upon further displacement of the input member in the driving direction, another pin on the escape wheel engages the pallet and rotates the pallet relative to the control member to disengage the engaged pins therefrom, and maintains the escapement in this disengaged condition while the input member is further displaced in the driving direction until it has returned to its initial position. By providing the pallet and the control member with allochiral configurations, the escape wheel can be made to rotate in opposite directions in response to the displacement of the input member in forward or reverse directions.

The invention, and its objects and advantages, will become more apparent in the detailed description of the preferred embodiment presented below.

BRIEF DESCRIPTION OF THE DRAWINGS

In the detailed description of the preferred embodiment of the invention presented below, reference is made to the accompanying drawings in which:

FIGS. 1-3 depict a linkage according to the invention in three sequential stages in the operation thereof; and

FIG. 4 shows a pictorial of the invention as incorporated in a filmstrip adapter mounted on a slide projector, with portions of the adapter cut away to reveal the operative components thereof.

DETAILED DESCRIPTION OF THE INVENTION

Because slide projectors are well known, the present description will be directed in particular to elements of slide projectors and filmstrip adapters therefor, forming part of, or cooperating more directly with, apparatus in accordance with the present invention. Specifically, the present invention will be described as incorporated in an adapter of the type disclosed in previously cited Ser. No. 27,519. That adapter is intended for use with an indexing mechanism of the type disclosed in U.S. Pat. Re. No. 26,789 and incorporated in a slide projector of the type disclosed in U.S. Pat. No. 3,276,314. This slide projector receives and indexes a circular slide tray for sequentially presenting slide transparencies to a projection position, and the aforementioned adapter enables the projector to receive filmstrip and sequentially present frames of film thereon to a projection position. The present invention is intended to convert a linear input from the preceding type of indexing mechanism to a rotary output for operating a filmstrip advancing mechanism. It is to be understood that slide projector and filmstrip adapter elements not specifically shown or described may take various forms well known to those skilled in the art. The following description will first be directed to the basic structure of the preferred embodiment, with the various elements shown in schematic form. The adaptation of the invention to the above-mentioned apparatus will be described thereafter. The various elements of the present invention have been ascribed appellations taken from the horological art because of the similarity of structure or function of these elements with elements common to that art.

Referring to the linkage illustrated in FIG. 1, an input member 2 is shown as being displaceable in a linear path on a fixed plane and reciprocal in the directions indicated by the arrows A and B from a rest position indicated by the line 0-0. A control member 4 is coupled to input member 2 at pivot 5,

and is displaceable angularly and linearly in response to the linear displacement of input member 2. Control member 4 comprises a double ramp portion 6 to be described below. The output member of the linkage comprises an escape wheel 8 mounted for rotation about axis 10, and has extending therefrom a plurality of pins designated by the sequence of numerals from 101 through 108. The pins are displaced radially from axis 10 of escape wheel 8 by a common distance. Moreover, the pins are displaced from each other by equal angular amounts. A pallet 12 is coupled to control member 4 by means of pins 14 and 16 which extend through arcuate slots 18 and 20 in control member 4. Arcuate slots 18 and 20 are segments of a circle. Pallet 12 has an allochiral configuration, and includes adjacent sets of surfaces specially contoured for engaging the pins extending from escape wheel 8 to rotate escape wheel 8 by equal angular increments with each reciprocation of input member 2, in a manner to be described below.

Double ramp portion 6 also has an allochiral configuration, and comprises ramp surfaces 22 and 24, which are urged into engagement with the pins extending from escape wheel 8 by means of a spring 26. Pallet 12 is biased upwardly relative control member 4 by means of springs 28. The description of the invention can best be continued by way of a description of the operation thereof.

Initially, input member 2 is in the rest position at the line 0-0, and a drive pin 101 is located in notch 29 defined by ramp surfaces 22 and 24 of ramp portions 6, and positioned in notch 30 on pallet 12. Control member 4 is biased in a counterclockwise direction about pivot 5 by spring 26, whereby pin 101 is rendered under the influence of spring 26. The influence of springs 28 on pallet 12 urges that element upwardly so that pins 14 and 16 engage the uppermost portions of slots 18 and 20 in control member 4.

It should be understood at this point that escape wheel 8 can be rotated in either a clockwise or counterclockwise direction, depending on whether input member 2 is reciprocated in the directions B or A respectively, from the line 0-0. For the purposes of this description, the direction A will be termed forward direction and the direction B will be termed the reverse direction. When input member 2 is displaced away from the line 0-0 in either of the directions A or B, that direction of displacement will be termed the driving direction because it is this displacement which effects the rotation of escape wheel 8. Displacement of input member 2 towards the line 0-0 will be termed the return direction.

Upon the forward displacement of input member 2 in the driving direction, control member 4 is displaced to the right as shown by arrow C, and pallet 12, coupled to control member 4 by pins 14, 16, exerts a sidewise force on pin 101 causing escape wheel 8 to rotate about axis 10 as shown by arrow D. Upon the continued displacement of input member 2 in the driving direction, pin 101 proceeds in a counterclockwise direction and eventually, as indicated in FIG. 2, disengages from notch 30 in pallet 12 with which it has been in driving engagement. When pin 101 leaves driving engagement with notch 30, pin 102, which has been traveling with notch 32 in pallet 12, becomes engaged with the left hand surface thereof, and the driving force on pallet 12 is now exerted to escape wheel 8 through pin 102. During this sequence, the full force of control member 4 is exerted on escape wheel 8 since pins 14 and 16 have remained in the upper portions of slots 18 and 20 of control member 4.

As escape wheel 8 rotates with the continued displacement of input member 2, pin 104 engages the surface 36 on pallet 12 and pin 103 is received by the recess defined by surface 34. In response to the subsequent displacement of input member 2 in the driving direction, pin 103 travels towards ramp 22, and pin 104 engages surface 36 of pallet 12 and proceeds to drive that surface towards ramp 22. Pin 104 thus rotates pallet 12 about pin 16 in the uppermost portion of slot 20, and pin 14 in slot 18 begins to travel downwardly. The angular displacement of escape wheel 8 is arrested when pin 103 engages ramp 22.

At this time, escape wheel 8 has been rotated by the predetermined number of degrees.

Even though escape wheel 8 has been rotated by the desired amount, input member 2 is still permitted a certain amount of overtravel in the driving direction. Thus, as control member 4 moves to the right, pin 104 imparts torque to pallet 12, and the latter rotates about pin 16 causing pin 14 to travel to the lowermost portion of slot 18. Eventually, the mechanism achieves the condition shown in FIG. 3. In this condition, pin 104 has rotated pallet 12 to such an extent that pin 102 has become completely disengaged from notch 32. Overtravel is now possible despite the arresting of the rotation of escape wheel 8 because pin 104 holds pallet 12 down and out of engagement with pin 102. Thus, input member 2 is able to proceed in the forward direction with ramp surface 22 in engagement with pins 102 and 103. However, when pin 103 reaches abutting surface 38 in notch 34 of pallet 12, further displacement of the control member 4 in the forward direction is prevented.

An alternate embodiment of the invention permits unlimited overtravel of input member 2 without rotation of escape wheel 8 beyond the prescribed amount. Referring to FIG. 3, it is apparent that displacement of input member 2 is limited by the location of abutting surface 38, since that surface engages pin 103 to preclude continued displacement of input member 2. However, by removing surface 34 and by in effect "cutting off" a portion of pallet 12 along a plane parallel with ramp surface 22 when pallet 12 rotated by its maximum amount relative to ramp portion 6 (as in FIG. 3) at surface 40 (which is aligned with surface 22 and hence not visible in FIG. 3), continued displacement of pallet 12 causes pin 103 to ride along surface 40. Hence, pin 103 holds pallet 12 in its rotated position and escape wheel 8 rotates no further than the prescribed angular amount, so that the continued displacement of input member 2 in the driving direction after the initial engagement of pin 103 with ramp 22 causes pin 103 to travel in engagement with surface 40 the full length thereof. Surface 40 can be of any length, and virtual unlimited overtravel is possible.

Upon completion of the displacement of input member 2 in the driving direction, it becomes necessary to return the input member to the rest position, and to maintain escape wheel 8 in its new position with pin 102 having assumed the initial position of pin 101. This result is achieved by the continued engagement of pin 104 with surface 36 (or 40) to keep pallet 12 in the position in which it is disengaged from the pins extending from the escape wheel 8 (of course, excluding pin 104). Thus, while the device returns to the rest position, pins 102 and 103 ride along ramp 22 towards notch 29 of the ramp. When input member 2 reaches the rest position 0-0, pin 104 becomes disengaged from surface 36 on pallet 12, and springs 26 and 28 return pallet 12 and control member 6 to their initial positions.

The embodiment illustrated in FIGS. 1-3 is displaced in for clockwise and counterclockwise rotation of escape wheel 8 in response to the linear displacement of input member 2 in the directions A and B as mentioned previously. Accordingly, allochiral pallet 12 is provided with notch 42, surface 44, surface 46 and surface 48, which surfaces correspond with those designated by the numerals 32, 34, 36, and 38 mentioned above. Similarly, surface 50 (shown in dotted lines) corresponds to the surface 40 mentioned earlier as an alternative embodiment of the invention. Ramp 24 corresponds in operation with ramp 22, also mentioned before. Therefore, when input member 2 is displaced in driving direction in the reverse direction B and thereafter returned to the rest position at plane 0-0, the operational characteristics of the device are the same as those described previously, except that escape wheel 8 rotates clockwise in predetermined angular increments with each reciprocation of input member 2.

If only unilateral rotation of the escape wheel 8 is desired, one-half of the upper contoured surface of pallet 12, excluding notch 30, can be dispensed with. In such an embodiment,

both pins 14 and 16 would be required, since each serves a function regardless of the rotational output of escape wheel 8.

Other variations falling within the scope of the invention can be envisioned. The linear input member 2 has been shown in schematic form but of course it could comprise any number of equivalent arrangements. Control member 4 is shown as being angularly displaceable relative to input member 2, but practically speaking, a mechanical joint often is unnecessary. For example, if the member connecting ramp portion 6 and input member 2 is long enough, and there is sufficient play in input member 2 in the direction transverse to the plane of movement, the slight angular displacement required of control member 4 could be achieved. Control member 4 could be connected to the linear input member in any number of ways, and is shown in the drawings as merely being connected by a straight member for the sake of simplicity. Likewise, springs 26 and 28 are shown schematically, and they also could take a variety of forms. The functions of springs 26 and 28 could be accomplished by the use of leaf springs or coil springs or the like, and their respective function could be divided among a plurality of springs. The angular displacement of escape wheel 8 depends on the number of drive pins on the surface thereof. For example, to decrease the incremental displacement of the member 8, additional pins would be added, and pallet 12 and ramp surfaces 22 and 24 would be altered accordingly. It might also be noted that the functions of the input and output members can be reversed, so that drive force would be applied directly to escape wheel 8, and the output would be the resulting reciprocating motion of member 2.

As explained earlier, the present invention is particularly suitable for incorporation in an adapter for enabling circular slide tray projector to receive and advance filmstrip. FIG. 4 illustrates a filmstrip adapter 200 of the type described in Ser. No. 27,519 mounted on a slide projector 300, the latter being representative of the projector disclosed in U.S. Pat. No. 3,276,314 and incorporating an indexing mechanism of the type disclosed in U.S. Pat. Re. No. 26,789.

Adapter 200 includes a housing 202, a lens holder 204, a filmstrip holder 206, and sprocket wheels 212. Filmstrip 210 is shown loaded in adapter 200 for advancement therethrough. The advancement of filmstrip 210 is accomplished by means of the rotation of sprocket wheels 212 and the successive engagement of sprockets 214 extending from sprocket wheels 212 with perforations 216 located along the opposite lateral edges of filmstrip 210.

The rotation of sprocket wheels 212 is accomplished through a linkage according to the present invention. This linkage includes an arm 208 coupled by a coupling 222 to an input member 224, and fastened to a ramp portion 228. A pallet 230 is coupled to ramp portion 228 by means of pins 231 and 233 extending through slots 236 and 238. Pallet 230 is further coupled to an escape wheel 218 by means of the engagement of the contoured surfaces of the pallet with pins 220 extending from the forward surface of escape wheel 218. Escape wheel 218 and sprocket wheels 212 are mounted for rotation on a common axle 221, and are coupled together so that the angular displacement of escape wheel 218 results in a like angular displacement of sprocket wheels 212. It should be apparent at this point that pins 220 can be spaced from one another by an amount such that the rotation of the escape wheel 218 by that amount causes sprocket wheels 212 to advance filmstrip by a distance equal to the length of one frame of film.

Projector 300 comprises an annular lip 302 in which a circular slide tray is normally received by the projector, buttons 304 and 306 for effecting the forward and reverse indexing of a slide tray mounted on the projector, a focusing knob 308 for adjusting the lens system of the projector, a lens mount 310 by means of which adapter 200 is mounted on projector 300, and an indexing mechanism including drive member 312. Drive member 312 reciprocates in radial and curved paths for normally engaging lugs extending downwardly from the bottom a received circular slide tray and indexing the tray to present slides to a projector film gate.

Input member 224 includes a guide member 232 having a slot 234 therein for engaging lip 302 of projector 300 to maintain member 224 and arm 208 in position, and a connecting member 226 extending therefrom. Connecting member 226 includes a slot 227 contoured to receive drive member 312 when guide member 232 is mounted on lip 302, so that when drive member 312 is driven along its indexing path, member 226 will be displaced thereby. Because of the combined length of input member 224 and arm 208, the play in coupling 222, and the short path of travel of drive member 312, the movement of arm 208 in response to the indexing displacement of member 312 is substantially linear, so that element 224 is equivalent to input member 2 described earlier. In fact, the curved path of drive member 312 is short enough to be considered linear for present purposes, and that member could be considered equivalent to previously discussed member 2.

The tolerance limits for the path of movement of drive member 312 of projector 300 are quite large, and the displacement of member 312 can accordingly vary by relatively large amounts without hindering the normal operation of the projector. However, it is important that filmstrip 210 be advanced in film frame length increments for the proper projection of the frames. The particular advantages of the linkage according to the invention as incorporated in the adapter now become apparent.

The dimensions of the various components of adapter 200 are selected so that sprocket wheels 212 will necessarily be rotated by an amount sufficient to advance filmstrip 210 a distance equal to a frame length when drive element 312 moves along its minimum path of travel. And, as a result of the overtravel feature of the invention, whenever indexing member 312 moves along a path having a distance greater than the minimum distance, the sprocket wheels will be rotated by the prescribed amount and no more.

In light of the discussion relating to the schematic representation of the invention shown in FIGS. 1-3, the operation of invention as utilized in the apparatus shown in FIG. 4 is apparent, and will be mentioned only briefly. Assuming forward advancement of filmstrip 210 through adapter 200 is desired, button 304 is depressed. Drive member 312 follows its normal prescribed path, and in so doing urges input member 224 and arm 208 in the forward, driving direction. Arm 208, and ramp portion 228 integral therewith, move pallet 230 and escape wheel 218 in their prescribed paths, thereby rotating sprocket wheels 212 by the proper angular increment in the clockwise direction to advance filmstrip 210 by a distance equal to the length of a frame of film. Depression of button 306 to effect the movement of drive member 312 in the path for reverse indexing similarly causes the counterclockwise rotation of sprocket wheels 212. The previous discussion of the invention fully describes the detailed operation of the above-mentioned linkage. Reference is made to U.S. Ser. No. 27,519 and U.S. Pat. No. 3,276,314 and U.S. Pat. Re. No. 26,789 for complete descriptions of adapter 200, projector 300, and the indexing mechanism, respectively.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

I claim:

1. A device for converting reciprocating linear motion into rotary motion, said device comprising:
 - an input member reciprocally displaceable in a substantially linear path in driving and return directions;
 - an output member comprising a first member having an axis of rotation and a forward surface, and rotatable in uniform angular increments about said axis in response to successive reciprocations of said input member;
 - a plurality of discontinuities arranged sequentially on said forward surface of said first member, said discontinuities displaced radially from said axis of rotation, and uniformly spaced from each other by angular amounts equal to said uniform angular increments;

a second member coupled to said input member and displaceable in driving and return directions in response to like displacements of said input member, said second member including a control surface engageable by said discontinuities for limiting the rotation of said first member with each operation of said device;

a third member coupled to said second member and movable in at least one arcuate path relative to said second member, said third member comprising:

driving surfaces for engaging and exerting force on said discontinuities to rotate said first member; and

at least one abutting surface engageable by said discontinuities for moving said third member in said arcuate path to disengage said discontinuities from said driving surfaces in response to the rotation of said first member by the predetermined amount, and for keeping said driving surfaces disengaged from said discontinuities when said input member is further displaced in the driving direction, and when said input member is displaced in the return direction;

means for urging said third member in a predetermined path relative to said first member and into engagement with one of said discontinuities in said path; and

means for urging said second member in a predetermined direction relative to said first member;

wherein in response to displacement of said second member in the driving direction, said driving surfaces on said third member successively engage the discontinuity in said path and the next discontinuity in the sequence on said first member to rotate said first member about the axis of rotation; and

wherein said control surface on said second member engages said next discontinuity to limit the rotation of said first member to said uniform angular increment.

2. A device according to claim 1 wherein said third member further comprises blocking means for limiting the displacement of said input member in the driving direction after the disengagement of said discontinuities from said driving surfaces.

3. A device according to claim 2 wherein said blocking means comprises at least one surface on said third member for engaging a discontinuity engaged by said control surface on said second member, after the disengagement of said discontinuities from said driving surfaces.

4. A device according to claim 1 further comprising:

first pin and slot means for coupling said third member and said second member, wherein said slot means defines said arcuate path of said third member; and

second pin and slot means about which said third member is pivotal for movement in said arcuate path in response to engagement of said abutting surface on said third member by said discontinuities.

5. A device according to claim 1 wherein said input member is reciprocally displaceable in forward and reverse directions, each of said directions having corresponding driving and return directions, said first member being rotatable in clockwise and counterclockwise directions in response to the displacement of said input member in the forward and reverse directions respectively;

wherein said second member includes first and second allochiral control surfaces, said surfaces being engageable by said discontinuities in response to the displacement of said input member in the forward and reverse directions respectively, to limit the rotation of said first member to said uniform angular increments;

wherein said third member comprises first and second allochiral driving surfaces for engaging and exerting force on said discontinuities, in response to the displacement of said input member in the forward or reverse directions respectively;

wherein said abutting surface on said third member comprises first and second allochiral abutting surfaces engageable by said discontinuities to limit the displacement of said input member in the driving directions, in response to the displacement of said input member in the forward or reverse directions respectively; and

wherein said at least one arcuate path comprises first and second allochiral arcuate paths, said third member being displaceable in one of said paths in response to the engagement of said continuities with a corresponding abutting surface on said third member.

6. A device according to claim 5 further comprising:

first and second allochiral pin and slot means for coupling said third member to said second member, wherein said slot means define said first and second arcuate paths of movement of said third member, and wherein said second and first pin means are pivots about which said third member is movable in said first and second arcuate paths respectively.

7. A device according to claim 6 wherein said first and second abutting surfaces on said second member comprise allochiral ramps meeting at the lowermost ends thereof, and inclined respectively to engage the second discontinuity from said discontinuity in said path, to limit the rotation of said first member to said uniform angular increment.

8. A device for converting reciprocating linear motion into rotary motion of predetermined, uniform angular increments, said device comprising:

input means movable in a driving direction in a linear path in response to the exertion of force thereon;

a first member having an axis of rotation and being mounted for rotation about said axis;

a plurality of discontinuities located on said first member, said discontinuities being spaced radially from said axis of rotation by equal distances, and spaced from each other by equal angular amounts;

a second member coupled to said input means and movable in a path transverse to said linear path and into engagement with said discontinuities, said second member comprising:

driving means engageable with one of said discontinuities for effecting the rotation of said first member in response to the movement of said input means in the driving direction; and

abutment means engageable with another of said discontinuities in response to the rotation of said first member by said predetermined angular increment, for preventing the further rotation of said second member in response to the further movement of said input means in the driving direction; and

means for urging said second member in said transverse path into engagement with said discontinuities.

9. A device according to claim 8 wherein:

said input means is movable in forward and reverse directions in said linear path;

said driving means of said second member is engageable with one of said discontinuities for effecting the rotation of said first member in a first direction in response to movement of said input means in the forward direction, and for effecting the rotation of said first member in a second direction in response to movement of said input means in the reverse direction; and

said abutment means includes first and second surfaces, each of said surfaces being engageable with another of said discontinuities in response to the rotation of said first member by said predetermined angular increment in said first and second directions, respectively, for preventing the further rotation of said second member in response to the further movement of said input means in the driving direction.

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