Dec. 17, 1940. E. E. FRANZ 2,224,905

MECHANICAL MOTION

Filed Sept. 7, 1939

FIG. 1

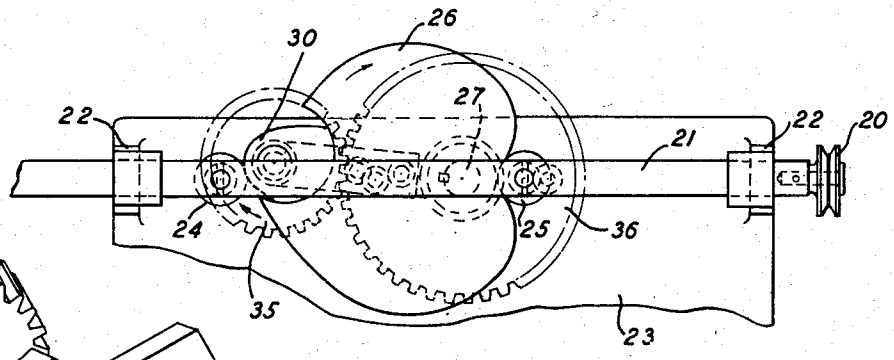


FIG. 4

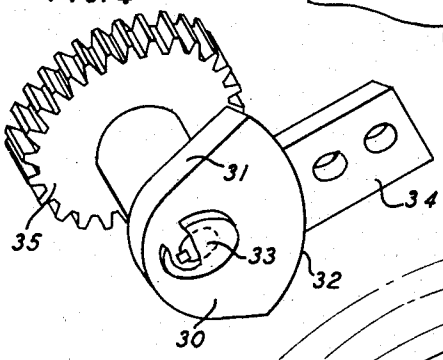


FIG. 3

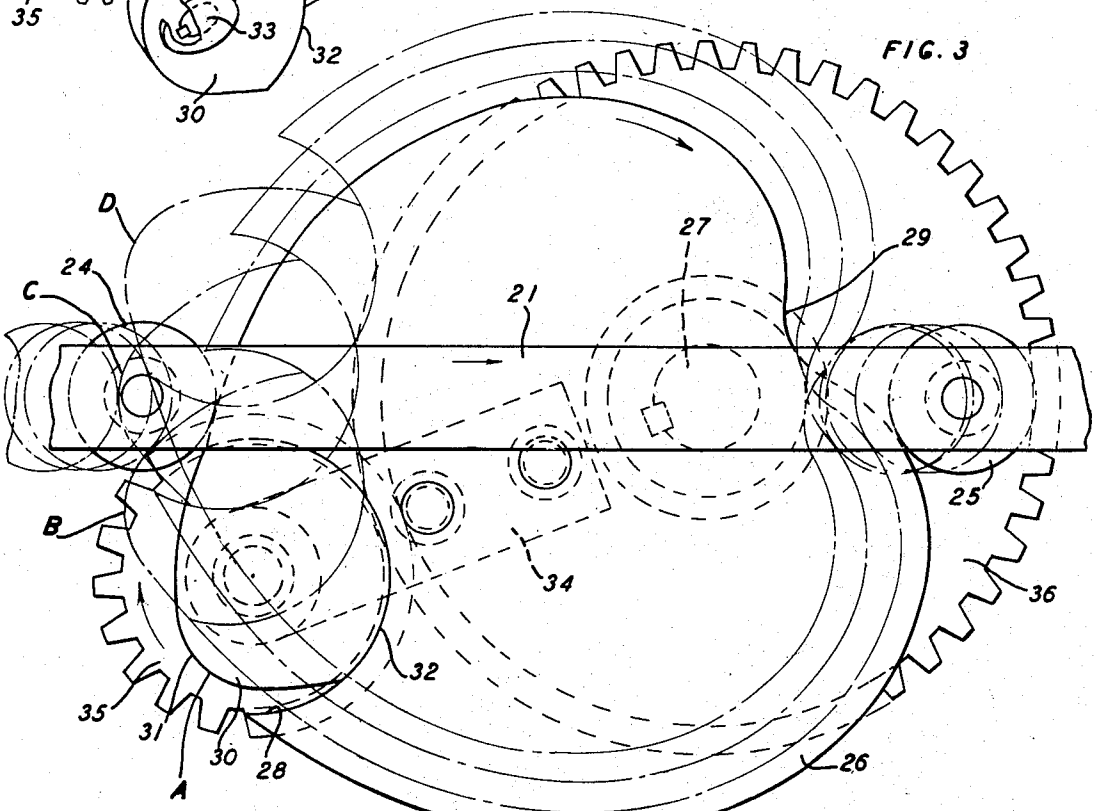
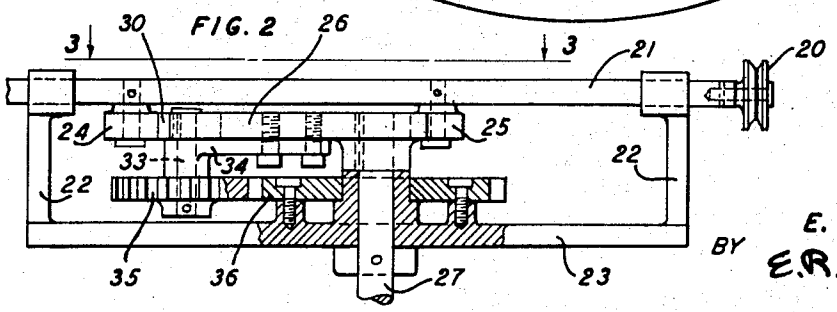


FIG. 2



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MECHANICAL MOTION

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10 Claims. (Cl. 74—55)

This invention relates to a mechanical motion, and more particularly to a cam mechanism for converting uniform rotary motion into reciprocating motion of as uniform a character as practically possible.

In many kinds of strand handling apparatus, a wire thread, line or other kind of strand is wound upon some kind of core, spool, reel, or the like which is rotated about its own axis to wind the strand thereon while a guide member for the strand is reciprocated parallel to the axis of the rotating core to distribute the strand thereon in uniform turns.

An object of the present invention is to provide means to drive such a reciprocating member with the least possible waste of time and space at each reversal of its motion and the greatest possible uniformity, from a rotary driving member running at uniform rotary speed.

With this and other objects in view, one embodiment of the invention may be presented by a reciprocable member having one or more cam rollers thereon, in combination with a rotary cam of a form ordinarily having in theory a salient angle thereon and in which the portion of the cam ordinarily having such salient is replaced by a secondary cam mounted on the first cam and rotatable with respect thereto.

Other objects and features of the invention will appear from the following detailed description of an embodiment thereof in a device for reciprocating a strand distributing member, taken in connection with the accompanying drawing in which the same reference numerals are applied to identical parts in the several figures, and in which

Fig. 1 is a broken plan view of a distributor device constructed in accordance with the invention;

Fig. 2 is a view thereof in side elevation;

Fig. 3 is an enlarged plan view of the cam mechanism; and

Fig. 4 is a similar detached perspective view of the secondary cam member.

In the embodiment of the invention herein disclosed, a strand distributor guide sheave 20, shown in Figs. 1 and 2 in its extreme leftward position, is to be reciprocated from left to right and back with the utmost possible uniformity of motion and especially with the least practicable loss of motion at the reversals. The sheave 20 is rotatably mounted on the end of a bar 21 mounted in standards 22 on a base member 23, to be freely reciprocable in the standards. On the under side of the bar 21 is fixedly mounted a pair of freely rotatable cam rollers 24 and 25, spaced to run on and be driven by a generally heart-shaped cam 26. The cam 26 is rigidly mounted on a drive shaft 27 which is driven in uniform rotation by any suitable power means (not shown).

Theoretically, the uniform rotary motion of the shaft 27 can be converted into uniform reciprocatory motion of the bar 21 by a simple properly shaped and proportioned, heart-shaped cam. Such a cam will have a sharp reentrant angle and a sharp salient angle at opposite ends of a common diameter representing the points of the cam surface which effect reversal of motion in the cam follower. Furthermore, it is, in theory, necessary that the follower touch the cam only along a single geometric line perpendicular to the plane of rotation of the cam. Each follower will have to present to the cam the edge of a wedge whose solid angle is no greater than the reentrant angle of the cam; and this edge will slide continuously along the cam face. Such a structure is obviously impracticable, as the edge would not endure the friction and the battering consequent upon service.

Generally speaking, such difficulties in cam applications are overcome by substituting a cam roller of sensible diameter whose axis replaces the contact edge or line of the follower, and modifying the face of the cam to represent the geometric envelope of the positions of the roller as its axis follows the path of the former edge. Any reentrant angle on the cam then becomes a rounded reentrant lobe whose inmost and most sharply curved portion is substantially a circular arc congruent to the circle of the roller and which replaces the apex point of the former reentrant angle. This is mechanically possible and occasions no difficulty, for no point of the roller has a path necessarily invading the geometric volume of the modified cam.

However, a salient sharp angle on the theoretically proper cam presents a different problem, and one not heretofore solved and seemingly incapable of solution heretofore. At the moment when the axis of the roller following the path of the form of the ideal cam stands at the apex of the salient angle, the trailing portion of the roller still overhangs that part of the dihedral angle on which the roller has just rolled into its momentary position, and which is necessary to bring the roller to that position. For the axis to proceed now along the side of the ideal dihedral

leading away from the apex, parts of the trailing side of the roller must follow paths which pass through the substance of the cam inside of the dihedral face leading to the apex. Thus the portion of the cam leading to the salient must be present to force the roller axis out to the apex, and must be absent to permit the roller to leave the apex with its axis following the desired path. This and other analogous considerations prove that it is not possible to shape a single rotating cam so that the axis of a cam roller moving on the cam will be forced to follow a path having a salient angle with a sharp apex.

In the present invention this object is achieved by cutting away a portion of the cam, preferably a portion bounded by a circular arc 28, and positioning an auxiliary cam therein, generally indicated at 30. The cam 30 is formed in two integral parts, one bounded by a cam surface 31, the other by a circularly arcuate face 32 adapted to slide on and be supported by the arc 28 of the main cam and coaxial with a shaft 33. The cam 30 is keyed to the shaft 33, which is journalled in a bracket 34 rigidly secured to the main cam 26.

A planetary pinion 35, also keyed to the shaft 33, meshes with a sun gear 36 stationarily secured to the base 23 and coaxial with the shaft 27. Thus as the main cam 26 is rotated by the shaft 27, the planetary pinion 35 is rotated about the sun gear 36 and rolls thereon, thus rotating the auxiliary cam 30 in the main cam and with respect to the main cam.

In the embodiment illustrated, the planetary pinion rotates with respect to the main cam one full turn in each half turn of the main cam or one and a half turns in each half revolution of the pinion around the sun gear. Hence the pinion assumes identical positions with respect to the main cam or positions 180° apart with respect to the slide bar, at each half rotation of the main cam. Hence the sequence of events as the auxiliary cam passes under the roller 24, as illustrated in Fig. 3, is repeated as between the auxiliary cam and the roller 25 when the main cam has made a half turn from its position in Fig. 3.

In Fig. 3, the full line position of the auxiliary cam, indicated at A, shows the status just before the roller 24 is transferred from the main cam to the auxiliary. The auxiliary is moving bodily upwardly with the clockwise rotation of the main cam and is also rotating clockwise on its own axis; and the other positions, shown in dot and dash and indicated at B, C and D, show successive stages in the progress of the auxiliary cam past the roller 24.

The surface 31 of the auxiliary cam is so shaped and proportioned that the roller 24 is forced to move leftward, reversed and allowed to follow rightward as if the motion were controlled by a theoretically correct heart cam acting on a line follower located in the axis of the roller 24. The pressure of the roller 24 against the cam face 31 is always normal to the face 31 and therefore radial to the shaft 33. Hence, if necessary, this pressure can be resisted not only by the shaft 33 but also by the support of the arc 28 of the main cam upon which the face 32 of the auxiliary cam slides.

From just after the position shown at A to the position shown at C, the auxiliary cam is driving the roller 24 to the left while the roller 25 is following the main cam down into the reentrant curve at 29. At this instant, C, the reversal takes place; and the main cam begins to drive the roller 25 to the left, while the roller 24 follows the auxiliary cam until the roller 24 is transferred back from the auxiliary cam to the main cam.

No mathematical investigation has been made of the relations or forms involved. The cams shown have been developed and laid out by a geometrical procedure analogous to that suggested by Fig. 3, to give the rollers 24 and 25 the same motion as that effected by a theoretical constant increment heart cam for an edge follower. The form of the cam 30 shown is further conditioned by the relative sizes of the pinion 35 and sun gear 36. Other proportions of these would call for modified forms of the cam 30, especially as to its face 31. As shown face 31 of the auxiliary cam runs ahead of the main cam under the roller 24. Were a ring gear with the pinion inside substituted for the sun gear with the pinion outside, the auxiliary cam would run behind the main cam instead of it.

It is not necessary that the two cams be so formed that the face 32 of the auxiliary cam be supported by sliding on the face 28 of the main cam. This was thought preferable in the illustrative device to relieve side stresses on the shaft 33 and bracket 34. If the latter be sufficiently stiff and strong, there can as well be frictionless clearance between the two cams.

As shown, and since the auxiliary rotates once with respect to the main cam while the latter makes a half turn, the auxiliary is a single lobed cam. Were the auxiliary to rotate half as fast, i. e. were to make one half rotation with respect to the main cam while the latter makes a half turn, the auxiliary would be formed with two diametrically opposite, identically similar cam faces.

The invention is herein illustrated as applied to a heart cam having one salience and one reentrance. Obviously, the invention is equally applicable to a multi-salient cam by providing auxiliary cam mechanism, as illustrated, at each salience of a main cam. Hence while the invention is herein illustrated as applied in a strand distributor, it is not so limited but is applicable wherever it would be desirable to use a cam having a sharp angled salience and an edge follower.

In the particular embodiment illustrated, all the members, except the slide bar 21 and its sheave 20, are either stationary, as 23 and 36, or are in uniform, unaccelerated rotary motion, e. g. 26, 35, 30 etc. If the bar 21 and sheave 20 be made as low in mass as possible, e. g. of a suitable alloy of aluminum or magnesium or the like, and if the other parts be made as massive as may conveniently and reasonably be done, the motion of the bar and sheave will be substantially uniform reciprocation with practically, though not actually, instantaneous reversals.

Various modifications and applications of the invention will readily occur to those skilled in the art in addition to the particular form and application herein disclosed, and the invention is not limited to the particular embodiment herein illustrated, but only by the appended claims.

What is claimed is:

1. A mechanical movement, comprising a movable main cam, and an auxiliary cam mounted on the main cam to be carried thereby and to be movable thereon during the motion thereof, in combination with a cam follower member to

be driven in sequence by the main cam and by the auxiliary cam.

2. A mechanical movement, comprising a movable main cam, an auxiliary cam mounted on the main cam to be carried thereby and to be rotatable thereon, and means to rotate the auxiliary cam by the motion of the main cam, in combination with a cam follower member to be driven in sequence by the main cam and by the auxiliary cam.

3. A mechanical movement, comprising a rotatable main cam, an auxiliary cam mounted on the main cam to be carried in revolution thereby and to be rotatable thereon, and means to rotate the auxiliary cam by the motion of the main cam, in combination with a cam follower member to be driven in sequence by the main cam and by the auxiliary cam.

4. A mechanical movement, comprising a main cam of a form normally having a salience and formed with a recess at the apex of such salience, an auxiliary cam mounted on the main cam in the recess, and means to move the auxiliary cam in the recess with respect to the main cam, in combination with a cam follower member to be driven in sequence by the main cam and by the auxiliary cam, the main cam and the follower being movable one with respect to the other.

5. A mechanical movement, comprising a rotatable heart cam having the salience cut away to form a recess, an auxiliary cam mounted in the recess to be rotatable therein and bodily revoluble with the heart cam, a stationary gear, and a pinion on the auxiliary cam and meshing with the stationary gear to drive the auxiliary cam in rotation when the heart cam is rotated, in combination with a cam roller to be driven alternately by the heart cam and by the auxiliary cam.

6. In a strand handling apparatus, strand distributor means including a rotary drive shaft, a reciprocable distributor member and means to drive the distributor member in substantially uniform reciprocation from the drive shaft, the said means comprising a main cam mounted on the shaft to be driven thereby, an auxiliary cam mounted on the main cam to be carried in revolution thereby and to be rotatable thereon, and means to rotate the auxiliary cam by the motion of the main cam, in combination with a cam follower mounted on the distributor member to be driven in sequence by the main cam and by the auxiliary cam.

7. In a strand handling apparatus, strand distributor means including a rotary drive shaft, a reciprocable distributor member, and means to drive the distributor member in substantially uniform reciprocation from the drive shaft, the said means comprising a heart cam mounted on the shaft to be driven in rotation thereby and having the salience of the cam cut away to form a recess, an auxiliary cam mounted in the recess to be rotatable therein and bodily revoluble with the heart cam, a stationary gear, and a pinion on the auxiliary cam and meshing with the stationary gear to drive the auxiliary cam in rotation when the heart cam is rotated, in combination with a cam roller mounted on the distributor member to be driven in sequence by the heart cam and by the auxiliary cam.

8. A mechanical movement, comprising a movable main cam, an auxiliary cam mounted on the main cam to be movable on the main cam and to be carried thereby, and means to move the main cam and the auxiliary cam therewith and to move the auxiliary cam on the main cam during the motion of the main cam, in combination with a cam follower member to be driven in sequence by the main cam and by the auxiliary cam.

9. A mechanical movement, comprising a rotatable main cam, an auxiliary cam mounted on the main cam to be rotatable on the main cam and to be carried thereby, and means to rotate the main cam and the auxiliary cam therewith and to rotate the auxiliary cam on the main cam during the rotation of the main cam, in combination with a cam follower member to be driven in sequence by the main cam and by the auxiliary cam.

10. A mechanical movement, comprising a movable main cam, an auxiliary cam mounted on the main cam to be carried by the main cam and to be movable thereon, and means to move the auxiliary cam on the main cam by the motion of the main cam, in combination with a cam follower member to be driven in sequence by the main cam and by the auxiliary cam.

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