United States Patent [19]

Eminger

[11] **3,785,212**

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[54] **MOTION ALTERING APPARATUS**

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[73] Assignee: **Windamatic Systems, Inc.,** Ft. Wayne, Ind.

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[52] **U.S. Cl.** ..... **74/23,** 242/1.1 R

[51] **Int. Cl.** **F16h 21/00**

[58] **Field of Search** ..... 74/117, 22, 23; 242/1.1 R

[56] **References Cited**

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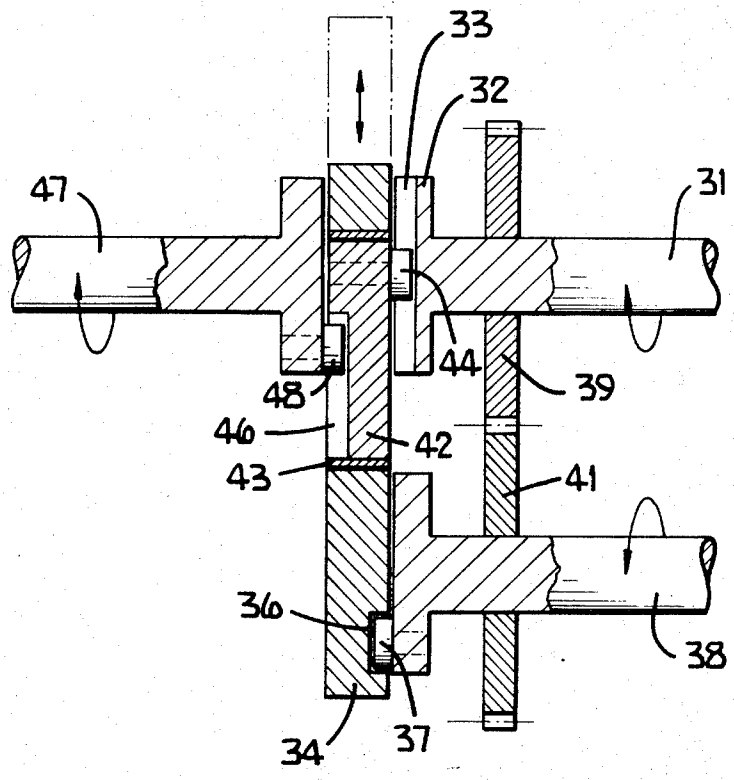
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Assistant Examiner—Wesley S. Ratliff, Jr.
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[57] **ABSTRACT**

Disclosed is an apparatus for changing rotary driving motion of uniform velocity into driven rotary motion whose velocity varies in a uniformly recurring pattern. The length of and number of minimum velocity or "dwell" periods is adjustable over a wide range. The apparatus can be utilized in actuating the movement of a winding head for winding wire on electric stators, or the like. An offset driving crank drives a Scotch yoke slide, the slide carrying a freely rotatable member. The rotatable member has a pin and slot connection to the driving or input shaft and this input shaft also drives the offset driving crank. The freely rotatable member has a pin and slot connection to the output or driven shaft.

6 Claims, 4 Drawing Figures



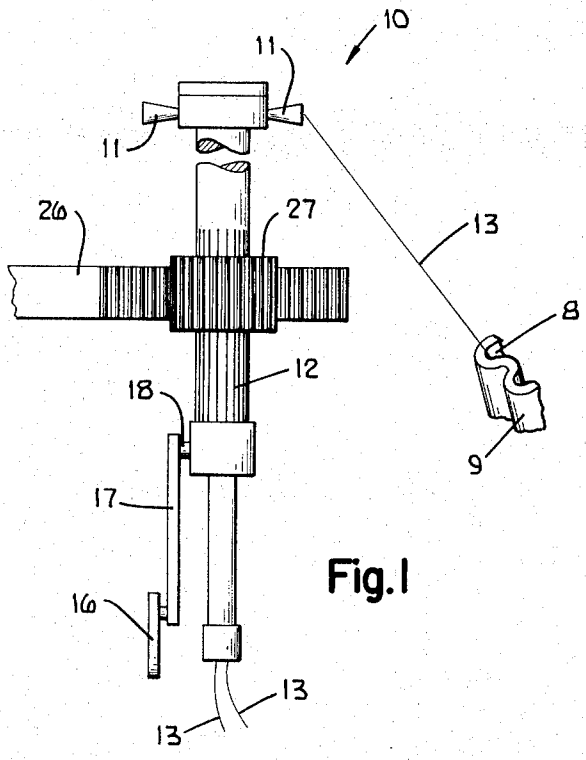


Fig.1

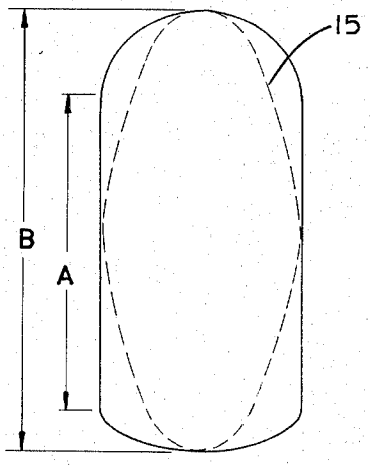


Fig.2

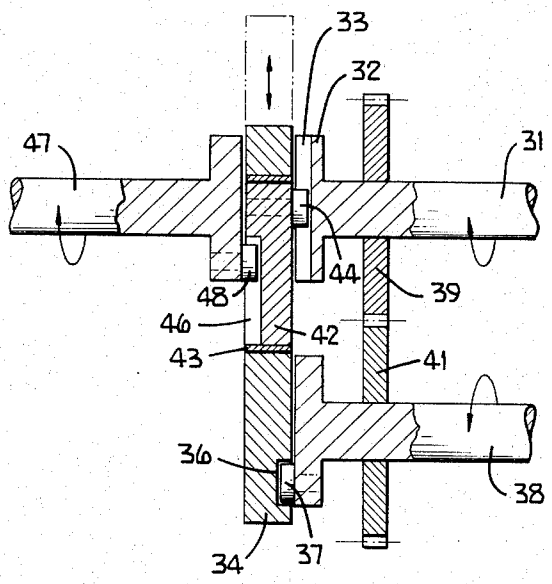


Fig.3

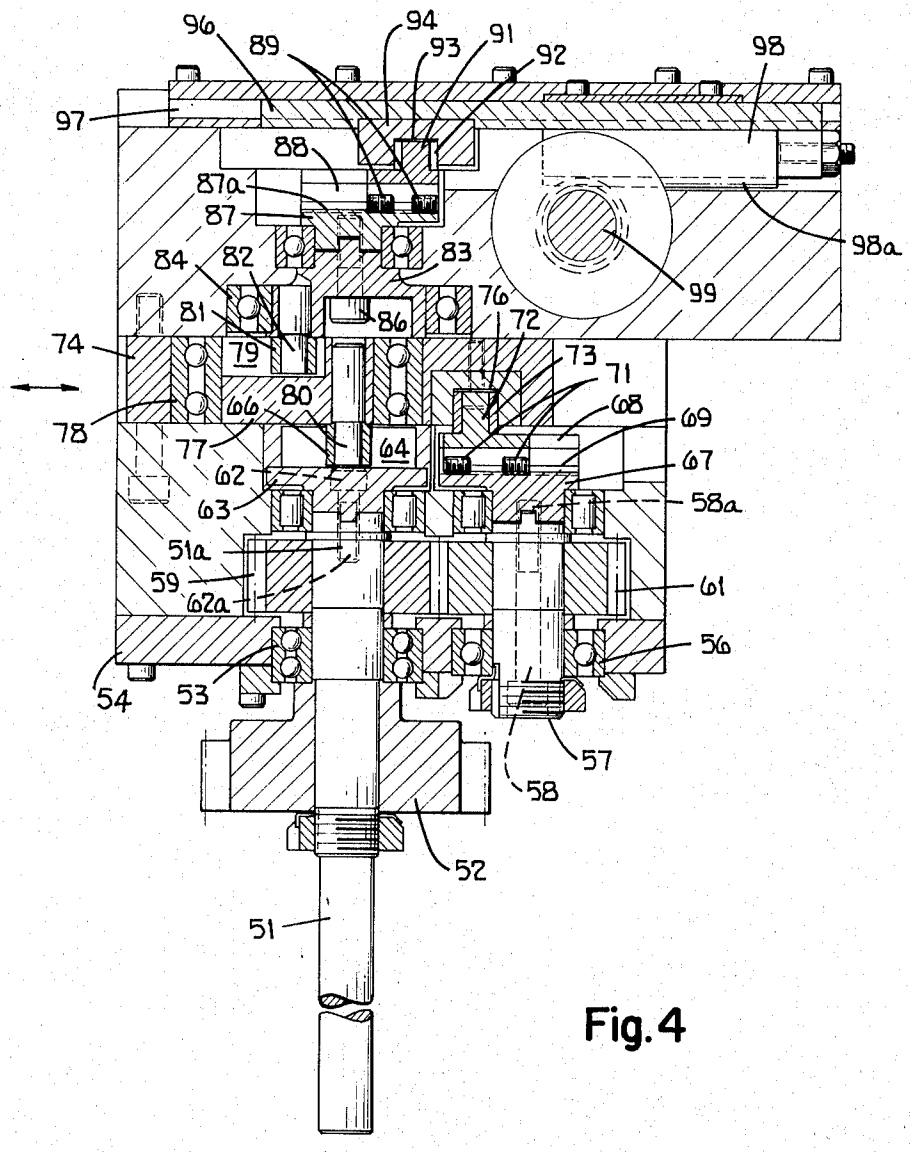

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Fig.4

MOTION ALTERING APPARATUS

BACKGROUND OF THE INVENTION

In my U. S. Pat. No. 2,949,789 there is disclosed a motion altering or converting apparatus for producing the linear, reciprocating motion required for the winding head of a high speed stator winding apparatus. The present inventive concept concerns an apparatus for providing the oscillating, angular motion of the winding head. As indicated in my previously mentioned patent, one conventional means for obtaining this reciprocating angular motion utilizes a slotted barrel cam to produce the required rectilinear reciprocating motion of the toothed rack which angularly swings the winding head. This conventional arrangement is beset with difficulties in high speed winding operations because of cam wear, difficulty in adjustment, etc.

The motion altering apparatus of the present invention provides the required angular reciprocal motion for a winding head in a manner characterized by adjustability of both the duration and number of occurences, in unit time, of the periods of dwell, or minimum velocity, of the winding head and this function is accomplished by parts having relatively small mass, thereby particularly accommodating the apparatus to high speed operation with minimum wear.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic, fragmentary view illustrating a winding head during a stator winding operation.

FIG. 2 is a diagram illustrating the path of motion of the winding head and illustrating various types of motion which can be imparted to the winding head.

FIG. 3 is a side sectional view illustrating in simplified, schematic form the structure of the present invention.

FIG. 4 is a sectional view illustrating in detail thee structure of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring initially to FIG. 1, there is shown at 10 a winding head having extending from it the wire dispensing elements 11. The winding head is mounted upon a splined shaft 12 through which a supply of wire 13 is fed for dispensing through the elements 11. Coordinated vertical reciprocating motion and oscillating angular motion of the head 10, by means to be subsequently described, functions to wind wire in the slots 8 of the stator fragmentarily shown at 9. The splined shaft 12 is slidable within but is rotationally locked to a pinion gear 27. The pinion gear meshes with the toothed portion of a rack 26, rectilinear, reciprocating motion of the rack producing reciprocating angular motion of the shaft 12 and of the head 10. A means is provided for imparting vertical reciprocating motion to the head and this means includes a disc fragmentarily illustrated at 16 which is rotated by a power source not shown, the disc carrying a crank arm 17 which is pivotally supported on it. The crank arm 17 has a pivotal connection with the shaft 12 as indicated schematically at 18. It will be apparent from the foregoing that, as the disc 16 is rotated the crank arm will linearly reciprocate, vertically, the winding head. It will be understood that this schematically indicated means for providing the required vertical reciprocating motion of the winding head forms no part of the present invention which

is directed specifically to a means for obtaining the desired motion of the rack 26 and, thus, the required angular oscillation of the winding head 10. FIG. 2 illustrates the path in which the winding head moves both vertically and horizontally during a single cycel of the apparatus. The oscillating, angular motion of the head produced by the rack 26 is illustrated by the curved lines at the top and base of the diagram. During the vertical portion of the motion, the angular movement of the head ceases, this producing the vertical dwell portion of the cycle, and during this dwell period the major portion of the vertical movement of the head produced by the crank 17 occurs. The diagram has a more peaked configuration at its top and this occurs because of the conventional, non-symmetrical motion produced by the crank 17, this discrepancy in crank drive being well known and produced because the relative motion between the cross-head and crank during the first half of the crank stroke is different from that of the second half of the stroke. This occurs for the reason that one-half of the crank pin circle curves toward the cross-head, whereas during the other half of the cycle one-half of the crank pin circle curves away from the cross-head. Where a means is utilized for producing the vertical motion of the shaft 12 and head 10 other than the crank and cross-head drive illustrated in FIG. 1, the trace of the movement of the head 10 would be symmetrical. The apparatus of the present invention, shown in detail in FIG. 4, is concerned with producing the horizontal, angular oscillation of the head 10 and is characterized by adjustability of the duration of the dwell period of the head over a wide range. As illustrated in FIG. 2 the dwell, indicated by the dimension identified at A is at a maximum, that is, approximately 78 percent of the total vertical stroke (identified at B) of the winding head. When the period of dwell or horizontal immobility of the winding head is zero, the winding head then takes the generally oval path illustrated by the broken line 15. It will be understood that between these two extremes, the apparatus of FIG. 4 may be adjusted to produce varying winding head paths, thus making the apparatus adaptable to winding of various types of stators and permitting the apparatus to be utilized in various applications.

A simplified form of the structure of FIG. 4 is illustrated in FIG. 3 and is here described to simplify and clarify the description of the structure and operation of FIG. 4. Referring to FIG. 3, an input or drive shaft 31 carries at its end a drive disc 32, the disc 32 has a radial slot 33 extending across its face. A slide member 34 is capable of reciprocating vertical movement. The slide member is provided with an elongated slot 36 extending transverse to the direction of the motion of the slide and a crank member, taking the form of the roller 37 which extends into the slot 36. A crank drive shaft 38, extending parallel to the shaft 31, carries the crank member 37 which, as will be seen in FIG. 3, is offset from the axis of rotation of the shaft 38. The crank 37 and slot 36 form a Scotch yoke drive between the crank drive shaft 38 and the slide 34, producing vertical reciprocating motion of the slide as the shaft 38 is rotated. Identically sized meshing gears 39 and 41 are rigidly attached to and rotate with the shafts 31 and 38, respectively. A circular element 42 is supported in the slide by a suitable bearing 43, the circular element having an abutment in the form of roller 44 offset from the center of the element and extending from one face of

the circular element into the radial slot 33 in the drive shaft disc 32. The opposite face of the circular element 42 is provided with a radial slot 46. An output shaft 47, mounted for rotation adjacent the slide member 34 carries a crank abutment in the form of roller 48, which is offset from the axis of rotation of the shaft 47, and extends into the radial slot 46 in the circular element 42.

As the input shaft 31 is rotated, as indicated in FIG. 3, the shaft 38 will also be rotated in opposite direction starting the slide 34 on its upward motion. This displaces the roller 44 away from the axis of rotation of the shaft 31 producing rotation of the circular element 42 within its bearing 43 and thereby moving the roller 48 away from its alignment with the center line of the circular element 42. This produces rotation of the output shaft 47, however, the character of this rotation is quite different from the uniform velocity rotation provided the input shaft 31. In FIG. 3 the ratio between the gears 39 and 41 is one to one and the amount of offset of the roller 37 from the axis of rotation of the shaft 38 and the offset between the rollers 44 and 48 are identical. Under these adjustment conditions, although the shaft 31 is rotated continuously at uniform velocity, the output shaft 47 will pass through a dwell period, in which its rotation substantially ceases, each time the rollers 44, and 48 are aligned with the axis of rotation of the shaft 31 and the center of the circular element 42, respectively. Since, as will be evident from FIG. 3, this occurs each time the slide member 34 is at the lower extreme of its stroke (shown in solid lines in FIG. 3) and at the upper extreme of its vertical stroke (shown in broken lines in FIG. 3), this dwell of the shaft 47 will occur twice in each 360° rotation of the shaft 31, the dwells being separated by 180°. By positioning the slide off center, the two dwell points can be displaced from the position just described in the cycle, and, by shortening the offset of the roller 37 from the axis of shaft 38, the stroke of the slide member 42 may be decreased so that the rollers 48 and 44 are at the center of their respective driving elements at only one extreme of the slide movement or stroke, thereby providing only one dwell for the shaft 47 in each 360° of rotation of the input shaft 31. Increasing the offset of the roller 37 from the axis of the shaft 38 increases the duration of the dwell period for the shaft 47.

Referring now to FIG. 4, the apparatus of the present invention will be described in further detail. An input or drive shaft is identified at 51 and is comparable to the input shaft 31 of FIG. 3. The shaft 51 has keyed to it an input drive sprocket 52 which may be driven by means of a chain or by other suitable means from a source of power not shown. A bearing 53 supports the shaft for rotation in the plate 54. The plate 54 also carries a bearing 56 which supports for rotation a stub shaft 57. The shaft 57 is centrally apertured and threaded to receive the cap screw 58. The cap screw tip 58a protrudes from the end of the shaft 57. The shaft 51 has rigidly attached to it a gear 59 (comparable to the gear 39 of FIG. 3) and meshing with gear 59 is an indentical gear 61 rigidly carried on the shaft 57, the gear 61 being comparable to the gear 41 of FIG. 3. The end of the shaft 51 is provided with a threaded aperture 51a into which extends the end 62*a* of a stud 62 which extends from a disc shaped member 63, the disc shaped member thus being rigidly joined to the end of the shaft 51. The member 63 is provided with a radially extending slot 64 into which extends the roller 66. The disc-shaped member 63 corresponds to the member 32 of FIG. 3, the slot 64 corresponds to the slot 33 of FIG. 3 and the roller 66 corresponds to the roller 44 of FIG. 3. The tip 58a of the cap screw 58 extends into the threaded recess provided in the member 67. The member 67 has a radial slot 68 and a threaded portion 69 which cooperates with the threaded members 71 providing an adjustable positioning for the stud 72 which carries a roller 73. It will be understood that the member 67 is analogous to the member 32 of FIG. 3 and the roller 73 corresponds to the abutment 44 of FIG. 3, the threaded members 71 providing a means for adjustably positioning, or determining the offset of, the roller 73 with respect to the axis of rotation of the shaft 57.

A slide member 74 is supported for rectilinear, reciprocating motion in the direction indicated by the arrow in FIG. 4, this reciprocating motion being produced by the crank action of the roller 73 as it moves within the transverse slot 76 in the slide member. The transverse slot 76 and the roller 73 form a Scotch yoke drive between the shaft 57 and the slide 74. It will be understood that the slide 74 is the counterpart of the slide 42 of FIG. 3 and, as shown in FIG. 4, is in its extreme leftward position. Supported for free rotation in the slide member 74 is a circular or disc shaped element 77. The bearing 78 supports the element 77 and the element is provided with a radial slot 79 in one face and, extending from the other face is a rigid stud 80 which carries the roller 66 adapted to ride within the slot 64, as previously mentioned. The slot 79 corresponds to the slot 46 in the element 42 of FIG. 3.

Extending into the slot 79 is a roller 81 carried by a stud 82 which is rigidly secured in an element 83 supported for rotation by the bearing 84. The element 83 is rigidly coupled, by means of the stud 86, to the member 87 which is provided with a slot 88. The member 87 is threaded as indicated at 87a and accommodates the threaded elements 89 (identical to threaded elements 71) which permit adjustable positioning of the stud 91 which carries the roller 92. The members 89 permit adjustment of the degree of offset of the roller 92 with respect to the axis of the member 83 (the center line of the stud 86). The member 87 corresponds to the output shaft 47 of FIG. 3 and the roller 92, together with the rack structure to be described functions to transform the rotating motion of the member 87 into reciprocating rectilinear motion.

The roller 92 moves within a transverse slot 93 in a member 94 which is a part of a rack slide 96. The rack slide is adapted to reciprocate, with rectilinear motion in the track 97 and the slide is provided with a rigidly attached toothed rack element 98. The teeth 98*a* of the rack element mesh with the shank of the splined shaft 99. The splined shaft 99 corresponds to the shaft 12 of FIG. 1 and carries the winding head (not shown in FIG. 4).

In operation, the structure of FIG. 4 functions the same as that of FIG. 3. The uniform rotation of input shaft 51 produces, through the shaft 57, a rectilinear reciprocation of the slide 74. As this occurs, rotation of shaft 51 also functions to rotate the element 77 within the slide 74 producing, through the crank stud 82, rotary motion of the member 87 with the velocity of that motion varying in a uniformly recurring pattern and, with the apparatus adjusted as it appears in FIG. 4, producing two dwell periods for each complete rotation of

the shaft **51**, during which dwell periods the member **87** is substantially at rest. Rotation of member **87**, through the stud **91** reciprocates rectilinearly the rack **98** reproducing the pattern of velocity variation in a uniformly recurring manner in the splined shaft **99**.

Adjustment of the offset of the stud **91** by means of the elements **89** permits variation in the throw of the rack. Adjustment of the offset of the roller **73** with respect to the axis of rotation of the shaft **57** by means of the members **71** varies the throw of the slide member **74**. As shown in FIG. **4**, the central axis of the roller **73** is offset from the rotational axis of the shaft **57** by the same distance that the roller **81** is offset from the axis of rotation of the shaft **51** and, under these conditions, the central axis of the roller **81** is centered on the central axis of the member **77** and the roller **66** is centered on the rotational axis of the shaft **51** at each extreme of the throw of the slide **74**. When such centering occurs the member **87**, and consequently the rack **98** and shaft **99** will be substantially stationary for a dwell period. If the throw of the slide is adjusted so that the rollers do not center with their driving elements during a complete motion cycle of the slide **74**, then the duration of the dwell will be reduced to zero and the path of motion of the winding head will assume the elongated oval configuration identified at **15** in FIG. **2**.

I claim:

1. An apparatus for converting rotary driving motion of uniform velocity into rotary driven motion whose velocity varies in a uniformly recurring pattern as the driving motion proceeds, said apparatus comprising a drive shaft adapted to rotate at a constant velocity and a drive disc rigidly secured to the drive shaft and rotating concentrically therewith, a radial slot in the face of said disc, a slide member mounted for reciprocating rectilinear motion adjacent said slotted disc face and normal to the axis of rotation of the disc, an elongated slot formed in said slide member extending transverse to the direction of motion of the slide, a crank member extending into said slot, a crank drive shaft mounted for rotation adjacent said drive shaft, said crank member being attached to but offset from the axis of rotation of said crank drive shaft and with said slot forming a Scotch yoke drive between said crank drive shaft and said slide, motion transmission means between said drive shaft and said crank drive shaft to rotate the latter with the former but in opposite direction, a circular element supported for free rotation of said slide member, said circular element having an abutment offset from the center of the element and extending from one face of the circular element into said radial slot in the drive shaft disc, the opposite face of said circular element having a radial slot, an output shaft mounted for rotation adjacent said slide member, a crank abutment carried by said output shaft offset from the axis of rotation thereof and extending into said radial slot in the circular element whereby upon uniform rotation of said drive shaft the simple harmonic motion of said slide member is superimposed on the cranking motion imparted to said output shaft to produce a recurring pattern of varying velocity of rotation in the output shaft.

2. An apparatus as claimed in claim **1** in which the offset of said crank member from said axis of rotation of the crank drive shaft is adjustable to vary the throw of the Scotch yoke drive.

3. An apparatus as claimed in claim **1** in which said motion transmission means between said drive shaft and said crank drive shaft comprises meshing gears having a one-to-one ratio.

4. An apparatus as claimed in claim **1** in which said drive shaft and said output shaft are axially aligned.

5. An apparatus as claimed in claim **1** in which said output shaft carries a crank member offset from the axis of rotation of the output shaft, a rack member mounted for rectilinear reciprocal motion adjacent said output crank member and having an elongated transverse slot into which said output shaft crank member extends whereby rotation of the output shaft is transformed into rectilinear motion of said rack member.

6. An apparatus as claimed in claim **5** in which the offset of said output shaft crank member from the axis of rotation of the output shaft is adjustable to vary the throw of said rack member.

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