

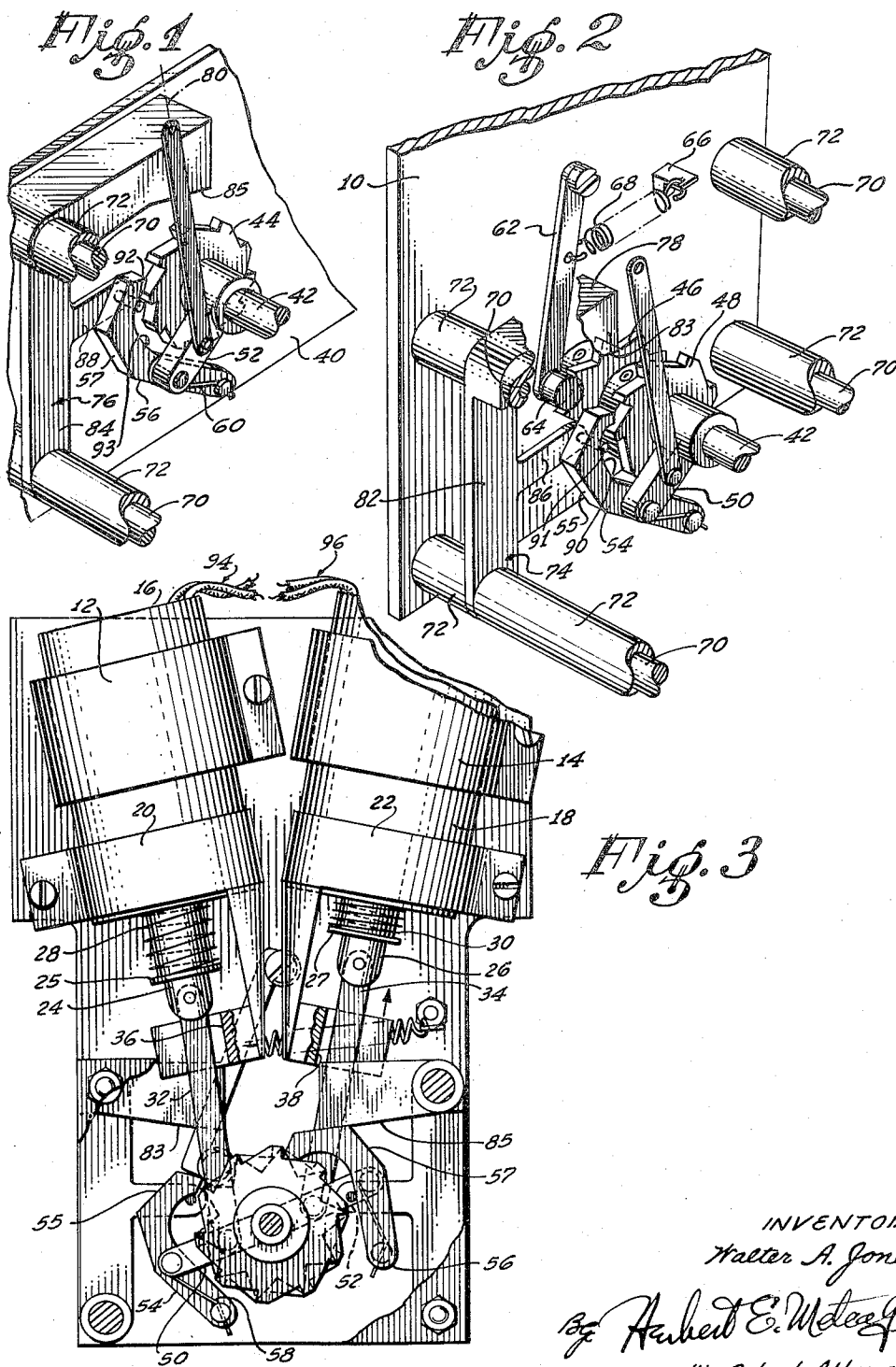
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PAWL-TYPE INCREMENTAL MOTOR

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PAWL-TYPE INCREMENTAL MOTOR

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This invention has to do with electrically energized instruments and more particularly with incremental or stepper motors.

Some stepper motors require structure that rotates a shaft through a limited but accurately defined path of travel, and an electrical signal may not be immediately or subsequently transmitted unless the defined distance of travel is completed.

Stepper motors are used to control accurately functioning mechanisms such as computing devices, servo systems, and electrical relay systems that may be found in communication equipment and similar applicable structures.

Devices of the kind to which this invention relates should operate on the electrical power provided, be so constructed that they may be readily incorporated in place of other previously used devices in a wide variety of equipment and should be readily adapted to the special needs of whatever type of equipment the device is to be used.

Therefore, the principal object of this invention is to provide an electrical pulse actuated stepper motor that will operate very accurately for an extended period of time without missing any pulses.

Another object of this invention is to provide an electrical pulse actuated stepper motor capable of use in a variety of equipment, that may be readily actuated in one or the other direction or alternately in one direction and then the other or in any combination thereof.

Figure 1 is a fragmentary, perspective view illustrating a pawl, sprocket wheel and related structure embodied in the present invention.

Figure 2 is a view similar to Figure 1 but illustrating another pawl, related structure and additional elements for restraining rotative movement of a shaft.

Figure 3 is a fragmentary, cross-sectional view of the stepper motor having embodied therein the present invention and illustrating the entire assembly, with one solenoid energized and one de-energized.

Referring to the drawings, 10 designates a panel having a pair of screw clamps 12 and 14 secured thereto for holding electrically energized solenoid coils 16 and 18 at an inclined from the vertical position whereby the upper end of the coils are spaced further apart than the lower; and to each solenoid coil 16 and 18 is clamped a guard 20 and 22. Actuated by each of the solenoid coils 16 and 18 is a plunger 24 and 26 having an annular flange 25 and 27 thereon. Disposed between the flanges 25 and 27 and the bottom of each solenoid coil is a spring 28 and 30 that urges the respective plunger to the extended position when the solenoid coils 16 and 18 are de-energized.

Pivotally connected to each plunger 24 and 26 is an elongated rod 32 and 34 which is guided in a reciprocating path of travel by notched guides 36 and 38 on the lower end of guards 20 and 22 respectively as viewed in Figure 3 of the drawings.

Supported in panel 10 and plate 40 is in elongated

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shaft 42 which has secured thereto, adjacent plate 40 and panel 10, a multi-toothed sprocket 44 and star wheel 46, respectively. Between sprocket wheel 44, spaced therefrom and adjacent star wheel 46 is a second sprocket wheel 48.

Freely rotatable on shaft 42 between sprocket wheels 44 and 48 are elongated links 50 and 52; the latter, intermediate their ends, being pivotally secured to rods 32 and 34. Pivotally secured to links 50 and 52 in opposed relationship to that end rotatable about shaft 42 are sprocket wheel engaging pawls 54 and 56. Secured to each pawl and corresponding link is a spring 58 and 60 that urges the pawls 54 and 56 into engagement with sprocket wheels 44 and 48.

Pivotally secured to panel 10 is an arm 62 having a roller 64 on one end thereof that engages star wheel 46. Urging the roller 64 into engagement with star wheel 46 is a compression spring 68 which is secured to arm 62 and a bracket 66 that is in turn secured to panel 10.

Plate 40 is secured to panel 10 by a plurality of elongated screws 70. Secured in a spaced relationship from panel 10 and plate 40 by a pair of screws having spacers 72 thereon are L-shaped arms 74 and 76 respectively. The short leg 78 and 80 of the arms have a thickness greater than the long legs 82 and 84 which results in a face 83 and 85 being formed thereon that functions as a stop to limit the path of travel of the pawls 54 and 56 in one direction when the solenoid coils 16 and 18 are energized. Pawls 54 and 56 each have a flat surface 55 and 57 thereon which abuts the faces 83 and 85 in the manner illustrated by the pawl shown on the right side in Figure 3. Integral with the long legs 82 and 84 of arms 74 and 76, extending toward pawls 54 and 56 and parallel with legs 78 and 80, are projections 86 and 88 which have pins 91 and 92 thereon that are contacted by arcuate cam surfaces 90 and 93 on pawls 54 and 56, when the coils 16 and 18 are de-energized, to urge the pawls out of engagement with the sprocket wheels 44 and 48. The legs 78 and 80, pins 90 and 92, pawls 54 and 56 all lie in the same plane as their respective sprocket wheels 44 and 48.

The operation of the stepper motor is as follows. One of the two solenoid coils 16 and 18 illustrated is energized through electrical leads 94 and 96. Both cannot be energized simultaneously for the reason that one functions to rotate shaft 42 clockwise and the other functions to rotate shaft 42 counterclockwise. It is to be understood that the description of operation of one solenoid coil assembly is also applicable to the other and that one may be operated entirely independent of or in the absence of the other. Assume coil 16, and all related structure to be energized. The magnetic field created by the imposed electrical pulse pulls plunger 24 into the field and coil which in turn results in pulling rod 32 in the identical direction. The link 50 being pivotally connected to rod 32 is in turn actuated to pull the pawl 54 from the position illustrated in Figure 3 to the position of pawl 56 as it is viewed. The pawl 54 engages one of the teeth of sprocket wheel 44 which results in the rotating of shaft 42. The path of travel of pawl 54 is restricted by surface 55 contacting face 83 on leg 78. The roller 64 on arm 62 is in continuous engagement with star wheel 46 and the magnetic field created must be sufficient to overcome the inertia of the roller being urged into the aforementioned engagement by the spring 68. When the coil 16 is de-energized the spring 28 urges the plunger 24, rod 32, link 50 and pawl 54 into the extended and disengaged position illustrated in Figure 3. Immediately before pawl 54 reaches its aforementioned disengaged position the cam surface 91 contacts pin 90 which urges the pawl against the impetus of

spring 58 from engagement with the sprocket wheel 44. This disengagement is of sufficient clearance to permit the sprocket wheel to rotate in either of two directions depending on which pawl is actuating the shaft 42.

When the pawl 54 is disengaged from sprocket wheel 44, the roller 64 is urged between two teeth on star wheel 46 which restrains the shaft from creeping due to such vibration as may be present.

It is to be further understood that the coils 16 and 18 can be alternately energized to impose a rotation in one and then the other direction on shaft 42.

While in order to comply with the statute, the invention has been described in language more or less specific as to structural features, it is to be understood that the invention is not limited to the specific features shown, but that the means and construction herein disclosed comprise a preferred form of putting the invention into effect, and the invention is therefore claimed in any of its forms or modifications within the legitimate and valid scope of the appended claims.

What is claimed is:

1. An incremental motor comprising a housing; at least one electrically energized solenoid coil secured to said housing; a plunger in said coil and actuated by the same when an electrical pulse is transmitted thereto; a rod pivotally connected to said plunger; a shaft; at least one toothed sprocket wheel on said shaft; a star wheel on said shaft; a link pivotally connected to said rod, and rotatable about said shaft; a pawl pivotally connected to said link and engaging said sprocket wheel when said solenoid coil is energized for rotating said shaft; an L-shaped arm secured to said housing; one leg of said arm being a stop to limit the path of travel of said pawl in one direction; a projection on said arm; a pin on said projection for disengaging said pawl from said sprocket wheel when the solenoid coil is de-energized; and resilient means on said housing and engaging said star wheel for restraining rotative movement of said shaft when said solenoid coil is de-energized.

2. An incremental motor comprising a housing; at least one solenoid coil on said housing; a reciprocable plunger in said coil and actuated by the same when an electrical pulse is transmitted thereto; a rod pivotally connected to said plunger; a driven assembly; said assembly including a shaft; a link pivotally connected to same rod and rotatable about said shaft; an arcuate pawl, pivotally connected to said link, that engages said driven assembly when said solenoid coil is energized; a cam surface on the concave side and a flat surface on the convex side of said pawl; an L-shaped arm secured to said housing; one leg of said arm being a stop, engaged by said flat surface, that limits the path of travel of said pawl and driven assembly in one direction; a projection on said arm; a pin on said projection that is engaged by said cam surface to disengage said pawl from said driven assembly when the solenoid coil is de-energized; and means on said housing that restrains rotative movement of said driven assembly when said solenoid coil is de-energized.

3. An incremental motor comprising a housing; at least one reciprocable, plunger type solenoid on said housing; means pivotally connected to said plunger; a driven assembly; said assembly including a shaft; an element pivotally connected to said means and rotatable about said shaft; an arcuate pawl, pivotally connected to said element, that engages said driven assembly when said solenoid is energized; a cam surface on the concave side and a flat surface on the convex side of said pawl; an L-shaped arm secured to said housing; one leg of said arm being a stop, engaged by said flat surface, that limits the path of travel of said pawl and driven assembly in one direction; structure on said arm; a means on said structure that is engaged by said cam surface to disengage said pawl from said driven assembly when

the solenoid is de-energized; and means on said housing that restrains rotative movement of said driven assembly when said solenoid is de-energized.

4. An incremental motor comprising a housing; at least one reciprocable, plunger type solenoid on said housing; means pivotally connected to said plunger; a driven assembly; said assembly including a shaft; an element pivotally connected to said means and rotatable about said shaft; an arcuate pawl, pivotally connected to said element, that engages said driven assembly when said solenoid is energized; a cam surface on the concave side and a flat surface on the convex side of said pawl; an L-shaped arm secured to said housing; one leg of said arm being a stop, engaged by said flat surface, that limits the path of travel of said pawl and driven assembly in one direction; structure on said arm; a means on said structure that is engaged by said cam surface to disengage said pawl from said driven assembly when the solenoid is de-energized; and means on said housing that restrains rotative movement of said driven assembly when said solenoid is de-energized; said first mentioned means being a rod.

5. An incremental motor comprising a housing; at least one reciprocable, plunger type solenoid on said housing; means pivotally connected to said plunger; a driven assembly; said assembly including a shaft; an element pivotally connected to said means and rotatable about said shaft; an arcuate pawl, pivotally connected to said element, that engages said driven assembly when said solenoid is energized; a cam surface on the concave side and a flat surface on the convex side of said pawl; an L-shaped arm secured to said housing; one leg of said arm being a stop, engaged by said flat surface, that limits the path of travel of said pawl and driven assembly in one direction; structure on said arm; a means on said structure that is engaged by said cam surface to disengage said pawl from said driven assembly when the solenoid is de-energized; and means on said housing that restrains rotative movement of said driven assembly when said solenoid is de-energized; said element being a link.

6. An incremental motor comprising a housing; at least one reciprocable, plunger type solenoid on said housing; means pivotally connected to said plunger; a driven assembly; said assembly including a shaft; an element pivotally connected to said means and rotatable about said shaft; an arcuate pawl, pivotally connected to said element, that engages said driven assembly when said solenoid is energized; a cam surface on the concave side and a flat surface on the convex side of said pawl; an L-shaped arm secured to said housing; one leg of said arm being a stop, engaged by said flat surface, that limits the path of travel of said pawl and driven assembly in one direction; structure on said arm; a means on said structure that is engaged by said cam surface to disengage said pawl from said driven assembly when the solenoid is de-energized; and means on said housing that restrains rotative movement of said driven assembly when said solenoid is de-energized; said structure being a projection.

7. An incremental motor comprising a housing; at least one reciprocable, plunger type solenoid on said housing; means pivotally connected to said plunger; a driven assembly; said assembly including a shaft; an element pivotally connected to said means and rotatable about said shaft; an arcuate pawl, pivotally connected to said element, that engages said driven assembly when said solenoid is energized; a cam surface on the concave side and a flat surface on the convex side of said pawl; an L-shaped arm secured to said housing; one leg of said arm being a stop, engaged by said flat surface, that limits the path of travel of said pawl and driven assembly in one direction; structure on said arm; a means on said structure that is engaged by said cam surface to disengage said pawl from said driven assembly when the solenoid is de-energized; and means on said housing that restrains

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rotative movement of said driven assembly when said solenoid is de-energized; said second mentioned means being a pin.

8. An incremental motor comprising a housing; at least one reciprocable, plunger type solenoid on said housing; means pivotally connected to said plunger; a driven assembly; said assembly including a shaft; an element pivotally connected to said means and rotatable about said shaft; an arcuate pawl, pivotally connected to said element, that engages said driven assembly when said solenoid is energized; a cam surface on the concave side and a flat surface on the convex side of said pawl; an L-shaped arm secured to said housing; one leg of said arm being a stop, engaged by said flat surface, that limits the path of travel of said pawl and driven assembly in one direction; structure on said arm; a means on said structure that is engaged by said cam surface to disengage said pawl from said driven assembly when the solenoid is de-energized; and means on said housing that restrains rotative movement of said driven assembly when said solenoid is de-energized; said third mentioned means being a spring loaded arm with a roller on the free end.

9. An incremental motor comprising a housing; at least one reciprocable, plunger type solenoid so said housing; means pivotally connected to said plunger; a driven assembly; said assembly including a shaft; an element

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pivotally connected to said means and rotatable about said shaft; an arcuate pawl, pivotally connected to said element, that engages said driven assembly when said solenoid is energized; a cam surface on the concave side and a flat surface on the convex side of said pawl; an L-shaped arm secured to said housing; one leg of said arm being a stop, engaged by said flat surface, that limits the path of travel of said pawl and driven assembly in one direction; structure on said arm; a means on said structure that is engaged by said cam surface to disengage said pawl from said driven assembly when the solenoid is de-energized; and means on said housing that restrains rotative movement of said driven assembly when said solenoid is de-energized; said first, second, and third mentioned means being a rod, a pin, and a spring loaded arm with a roller on the free end, respectively.

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