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J. F. MULLER
ELECTROMAGNETIC DRIVE MECHANISM

3,080,492

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FIG. 3

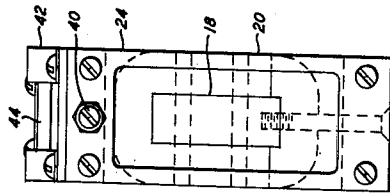


FIG. 2

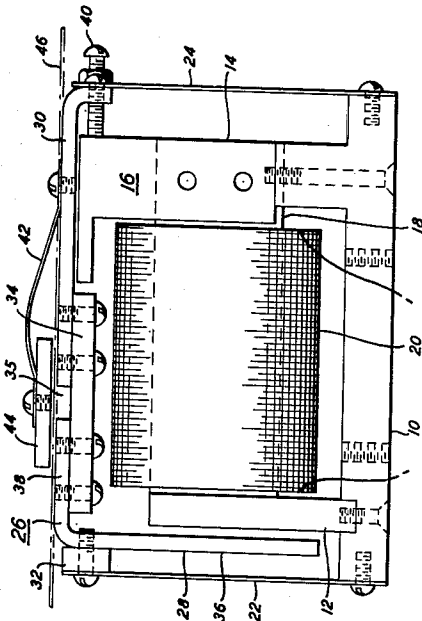


FIG. 1

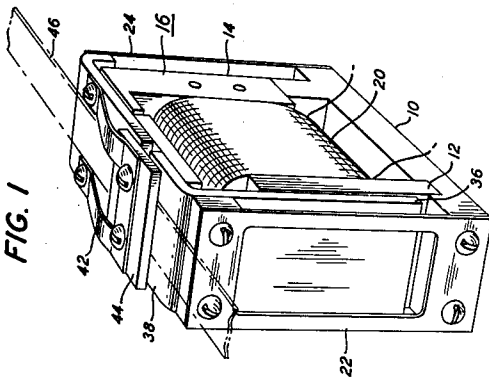


FIG. 4

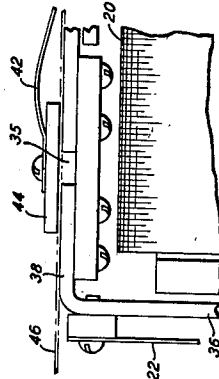


FIG. 6

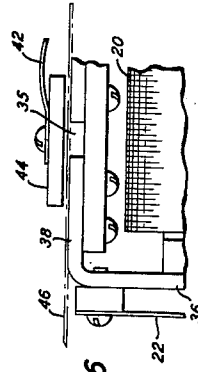
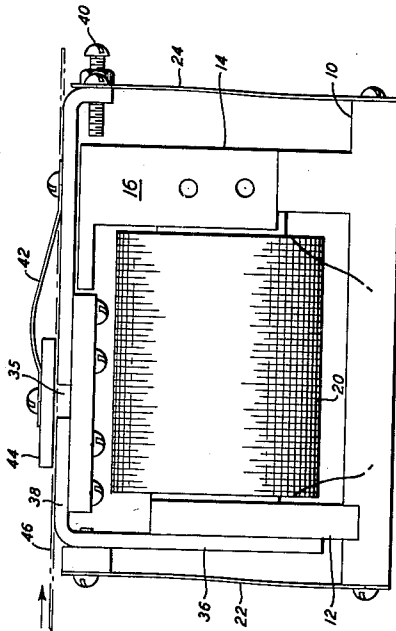


FIG. 5



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1

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ELECTROMAGNETIC DRIVE MECHANISM
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This relates to electromagnetic devices and particularly to step-by-step drive mechanisms.

It is often desirable in electromechanical systems to move a component small increments of distance in response to electrical pulses. One way of accomplishing the desired movement is by means of an electromagnetic device that operates in conjunction with a tape to produce relative motion between the tape and itself, either the tape or the electromagnetic device being secured to the component to be moved. Heretofore, most mechanisms of this type have utilized a reciprocating toothed or forked element and a perforated tape. The toothed element moves into the holes in the tape, advances the tape relative to the device or the device relative to the tape, moves out of the holes in the tape, and returns to its original position. With this type of mechanism there is the problem of properly registering the toothed element in and out of the holes in the tape. In addition, there is the limitation of being unable to change the amount of movement obtained with each energization of the mechanism without having to change the stroke of the toothed element and change the spacing between the holes in the tape.

An object of this invention is to provide an improved electromagnetic step-by-step drive mechanism.

Specifically, an object of this invention is to provide an electromagnetic drive mechanism that operates in conjunction with a tape but utilizes no toothed or forked elements and requires no perforation of the tape.

Another object of this invention is to provide an electromagnetic drive mechanism that with each energization thereof moves itself through a small accurate distance with respect to a tape or moves the tape through a small accurate distance with respect to itself.

A further object of this invention is to provide an electromagnetic drive mechanism in which the distance moved with each energization thereof may be easily changed.

A still further object of this invention is to provide an electromagnetic drive mechanism that is comparatively inexpensive to manufacture, simple in construction and operation, and reliable in performance.

These and other objects of the invention are realized in an illustrative embodiment thereof wherein the drive mechanism comprises a core, a coil disposed about the core, and an armature movable between a first and a second position along a predetermined path. Biasing means normally maintains the armature in the first position while energization of the coil moves the armature to the second position. The armature has a low permeability gap therein, and a magnetic shunt member is mounted on the armature adjacent to the gap. The shunt member is mounted so that it is normally spaced from the armature, but upon energization of the coil, the shunt member moves against the armature to form a magnetic bridge for the gap. Positioned between the shunt member and the armature is a tape that extends along the path of movement of the armature. When the coil is energized, first the shunt member moves against the armature, clamping the tape against the armature, and then the armature moves along its predetermined path, moving the tape therewith. When the coil is de-energized, first the shunt member moves from the armature, freeing the tape, and then the biasing means returns the armature to its original position. Each energization of the coil thereby produces relative motion between the armature and the tape.

2

A feature of the invention resides in providing a means for varying the amount of travel of the armature so that the amount of movement obtained with each energization of the coil can be accurately preselected.

A complete understanding of the invention and of these and other features and advantages thereof may be gained from consideration of the following detailed description taken in conjunction with the accompanying drawing wherein one embodiment of the invention is illustrated. It is to be expressly understood, however, that the drawing is for the purposes of illustration and description and is not to be construed as defining the limits of the invention.

In the drawing:

FIG. 1 is a perspective view of the electromagnetic step-by-step drive mechanism of this invention;

FIG. 2 is a front elevation of the drive mechanism in a de-energized condition;

FIG. 3 is a side elevation of FIG. 2;

FIG. 4 is a front elevation of a portion of the drive mechanism showing the first of the sequence of movements upon the energization of the coil wherein the shunt member moves against the armature, thereby bridging the low permeability gap therein and clamping the tape thereagainst;

FIG. 5 is a front elevation of the drive mechanism showing the second of the sequence of movements upon the energization of the coil wherein the armature moves against the core along a predetermined path; and

FIG. 6 is a front elevation of a portion of the drive mechanism showing the first of the sequence of movements upon the de-energization of the coil wherein the shunt member moves away from the armature, thereby freeing the tape while the armature is still positioned against the core.

Referring now to the drawings and particularly to FIGS. 1, 2, and 3, the drive mechanism comprises a base 10 having arm portions 12 and 14 of a core 16 fastened thereto and extending approximately perpendicularly therefrom. A body portion 18 of the core extends between the arm portions a spaced distance from the base, and a coil 20 is disposed about the body portion. The base is formed from a non-magnetic material, such as aluminum, and the core is formed from a magnetic material having high permeability and low hysteresis loss, such as permalloy. The coil is wrapped with a suitable insulating wrapping material, such as cellulose acetate.

Leaf springs 22 and 24 are respectively fastened to the ends of the base 10 and extend approximately perpendicularly therefrom. The leaf springs are preferably made of a material having a high degree of resiliency, high tensile strength, and good resistance to fatigue, such as Phosphor bronze. Suspended between the leaf springs is an armature assembly 26 comprising a first section 28, a second section 30, and spacers 32 and 34. The first section 28 is fastened to the leaf spring 22 through the spacer 32 while the second section 30 is fastened directly to the leaf spring 24. The spacer 34 joins the two sections and holds the facing ends thereof a spaced distance apart. The two sections are made of a magnetic material having high permeability and low hysteresis loss, such as permalloy, and the spacers are made of a nonmagnetic material, such as aluminum. Thus the space between the facing ends of the sections forms a low permeability gap 35 in the armature assembly.

The two sections 28 and 30 of the armature assembly 26 combine to form an L-shaped member, a leg 36 of which extends approximately parallel to the leaf springs 22 and 24 and a leg 38 of which extends approximately perpendicular to the leaf springs. The leaf springs permit the armature assembly to move, and they guide the movement of the assembly along a path that is approximately parallel to the plane of the leg 38, maintaining

the leg 38 a small distance from the arm portion 14 of the core 16. In addition, the leaf springs bias the armature assembly so that normally the leg 36 is a predetermined distance from the arm portion 12 of the core.

The magnitude of the distance between the leg 36 and the arm portion 12 is determined by a screw 40 mounted in the leg 38. The bias of the leaf springs 22 and 24 brings the screw to bear against the arm portion 14 of the core, and so, by moving the screw to the left as viewed in FIG. 2, the distance between the leg 36 and the arm portion 12 is decreased; and by moving the screw to the right, the distance between the leg 36 and the arm portion 12 is increased. The distance between the leg 36 and the arm portion 12 is the distance moved by the electromagnetic drive mechanism with each energization of the coil 20, and therefore the screw is the means by which this distance can be varied. Although a simple screw is shown, a barrel type micrometer screw or any other type of positioning means could be used to provide a more accurate means of selecting the amount of movement of the drive mechanism. The screw is advantageously made of a nonmagnetic material, such as aluminum.

The arms of a U-shaped spring member 42, most clearly shown in FIG. 1, are fastened to the leg 38 of the armature assembly 26, and the closed end of the spring is fastened to a shunt member 44. The spring positions the shunt parallel to the leg 38 and adjacent to the low permeability gap 35 in the leg. Furthermore, the spring allows the shunt to move normal to the leg and normally biases the shunt a predetermined distance from the leg. The biasing force exerted by the spring is the same as, or smaller than, the biasing force exerted by the leaf springs 22 and 24, and the distance between the shunt 44 and the leg 38 is substantially smaller than the distance between the armature leg 36 and the arm portion 14 of the core 16. The size of the shunt is such that the ends thereof overlap the magnetic gap and are in juxtaposition with portions of the leg on both sides of the gap, and the mass of the shunt is substantially smaller than the mass of the armature assembly. Positioned between the shunt and the armature leg 38 is a tape 46 (shown in phantom) that extends between the arms of the spring and along the plane of the leg. The shunt is made from a magnetic material having high permeability and low hysteresis loss, such as permalloy, and the spring is made from a material having a high degree of resiliency, high tensile strength, and good resistance to fatigue, such as Phosphor bronze. The tape may be made of any material having a fair degree of tensile strength.

In the operation of the drive mechanism, when the coil 20 is energized, the shunt member 44 moves against the armature leg 38, as shown in FIG. 4, thereby clamping the tape 46 between it and the leg, and then, as shown in FIG. 5, the armature leg 36 moves against the arm portion 12 of the core 16, moving the armature assembly 26 and thereby the tape a predetermined distance to the right. When the coil is de-energized, the spring member 42 moves the shunt away from the armature leg 38, as shown in FIG. 6, freeing the tape, and then, as shown in FIG. 2, the leaf springs 22 and 24 move the armature assembly back to its original position. Repeated pulsing of the coil causes step-by-step relative motion between the drive mechanism and the tape.

Although the armature shown moves along an approximately rectilinear path, the guide means of the armature assembly could be modified to direct the armature along any predetermined path. In addition, although the drive mechanism disclosed utilizes both a core and an armature, a solenoid type of arrangement, wherein a single member functions as both, could be used. These and other changes may be made in the design and arrangement of the various elements of the electromagnetic drive mechanism without departing from the spirit and scope of the accompanying claims.

What is claimed is:

1. An electromagnetic drive mechanism comprising an armature movable between a first and a second position, said armature having a low permeability gap therein, means for biasing said armature toward said first position, a magnetic shunt member for bridging said low permeability gap in said armature, said shunt member being of larger size than said gap and overlying the gap and a surface of said armature adjacent to said gap, said shunt member further being coupled to the armature and moving therewith, means for biasing said shunt member to a position a spaced distance from said armature surface, a driven member extending between the shunt member and the armature, and a coil mounted in a magnetically energizing relationship to said armature, said coil when energized sequentially moving said shunt member against the armature, clamping the driven member therebetween, and then moving the armature to said second position, and said coil when de-energized permitting said shunt biasing means to return said shunt member to said spaced position, freeing said driven member, and then permitting said armature biasing means to return said armature to said first position.

2. The electromagnetic drive mechanism as in claim 1 wherein the driven member is a tape.

3. An electromagnetic drive mechanism comprising an armature movable between a first and a second position, said armature having a low permeability gap therein, means for biasing said armature toward said first position, a magnetic shunt member for bridging the low permeability gap in said armature, said shunt member being of larger size than said gap and overlying the gap and a surface of said armature adjacent to the gap, means for biasing said shunt member to a position a spaced distance from said armature surface, and a coil mounted in a magnetically energizing relationship to said armature, said coil when energized sequentially moving said shunt member against said armature surface and then moving the armature to said second position, and said coil when de-energized permitting said shunt biasing means and said armature biasing means to respectively sequentially return said shunt member to said spaced position and said armature to said first position.

4. An electromagnetic drive mechanism comprising an armature movable between a first and a second position, said armature having a low permeability gap therein, means for biasing said armature toward said first position, a magnetic shunt member for bridging the low permeability gap in said armature, said shunt member being of larger size than said gap and overlying the gap and a surface of said armature adjacent to the gap, means for biasing said shunt member to a position a spaced distance from said armature surface, and a coil mounted in a magnetically energizing relationship to said armature, said coil when energized sequentially moving said shunt member against said armature surface and then moving the armature to said second position, the movement of said shunt member being generally normal to the movement of said armature.

5. An electromagnetic drive mechanism comprising an armature movable between a first and a second position, said armature having a low permeability gap therein, means for biasing said armature toward said first position, a magnetic shunt member for bridging the low permeability gap in said armature, said shunt member being of larger size than said gap and overlying the gap and a surface of said armature adjacent to the gap, means for biasing said shunt member to a position a spaced distance from said armature surface, and a coil mounted in a magnetically energizing relationship to said armature, said coil when energized sequentially moving said shunt member against said armature surface and then moving the armature to said second position.

6. An electromagnetic drive mechanism comprising an armature movable between a first and a second position,

5

tion, said armature having a low permeability gap therein, means for biasing said armature toward said first position, a magnetic shunt member for bridging the low permeability gap in said armature, said shunt member being of larger size than said gap and overlying the gap and a surface of said armature adjacent to the gap, means for biasing said shunt member to a position a spaced distance from said armature surface, and a coil mounted in a magnetically energizing relationship to said armature, said coil when energized moving said armature to said second position and moving said shunt member toward said armature surface, the movement of said shunt member being generally normal to the movement of said armature.

7. An electromagnetic drive mechanism comprising an armature movable between a first and a second position, said armature having a low permeability gap therein, means for biasing said armature toward said first position, means for bridging said low permeability gap in said armature, said bridging means being in juxtaposition with said gap, means for directing the movement of said bridging means along a path that is generally normal to the path of movement of said armature and for biasing said bridging means to a position a spaced distance from said armature, and a coil mounted in magnetically energizing relationship to said armature, said coil when energized moving said armature to said second position and moving said bridging means against said armature.

8. An electromagnetic drive mechanism comprising an armature movable between a first and a second position, said armature having a low permeability gap therein, means for biasing said armature toward said first position, means for bridging said low permeability gap in said armature, said bridging means being in juxtaposition with said gap, means for directing the movement of said bridging means along a path that is generally normal to the path of movement of said armature and for biasing said bridging means away from said gap, a driven member extending between said bridging means and said armature, and a coil mounted in magnetically energizing relationship to said armature, said coil when energized sequentially moving said bridging means against the armature, clamping the driven member therebetween, and then moving the armature to said second position, and said coil when de-energized permitting said biasing means acting upon said bridging means to move said bridging means away from said armature, freeing said driven member, and then permitting said armature biasing means to return said armature to said first position.

9. An electromagnetic drive mechanism comprising an armature movable between a first and a second position, said armature having a low permeability gap therein, means for biasing said armature toward said first position, means for bridging said low permeability gap in said armature, said bridging means being in juxtaposition with said gap, means for biasing said bridging means away from said armature, a driven member extending between said bridging means and said armature, and a coil mounted in magnetically energizing relationship to said armature, said coil when energized sequentially moving

6

said bridging means against the armature, clamping the driven member therebetween, and then moving the armature to said second position, and said coil when de-energized permitting said biasing means acting upon said bridging means to move said bridging means away from said armature, freeing said driven member, and then permitting said armature biasing means to return said armature to said first position.

10. An electromagnetic drive mechanism as in claim 9 wherein the bridging means is secured to the armature and moves therewith.

11. An electromagnetic drive mechanism comprising a core, a coil mounted in a magnetically energizing relationship to said core, an armature positioned to generally define in combination with said core a magnetic circuit structure, said armature being movable between a first and a second position and said armature having a low permeability gap therein, means for biasing said armature toward said first position, a magnetic shunt member for bridging the low permeability gap in said armature, said shunt member being of larger size than said gap and overlying the gap and a surface of said armature adjacent to the gap, means for biasing said shunt member to a position a spaced distance from said armature surface, and a driven member extending between said shunt member and said armature, said coil when energized sequentially moving said shunt member against said armature, clamping said driven member therebetween, and then moving said armature to said second position, and said coil when de-energized permitting said shunt biasing means to return said shunt member to said spaced position, freeing said driven member, and then permitting said armature biasing means to return said armature to said first position.

12. An electromagnetic drive mechanism as in claim 11 further including means for varying the distance moved by the armature when the coil is energized.

13. An electromagnetic drive mechanism as in claim 12 wherein the distance moved by said armature is substantially greater than the distance moved by the shunt member.

14. An electromagnetic drive mechanism as in claim 13 wherein the shunt member has a mass substantially less than the mass of the armature.

15. An electromagnetic drive mechanism as in claim 14 wherein the biasing force exerted by the armature biasing means is equal to or greater than the biasing force exerted by the shunt biasing means.

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