Jan. 19, 1937. C. T. BLUME 2,068,531

ELECTROMAGNETIC MOTOR MECHANISM

Filed Oct. 16, 1935 2 Sheets-Sheet 1

Fig.1.

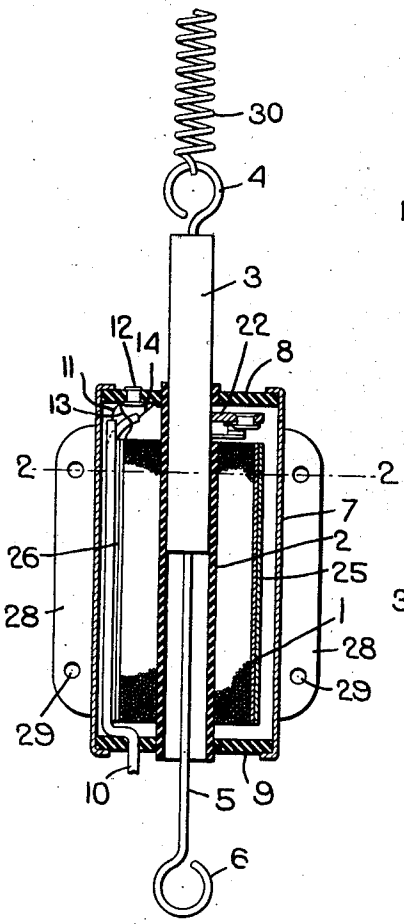


Fig.3.

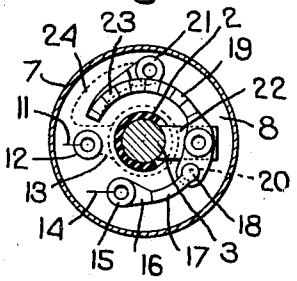


Fig.5.

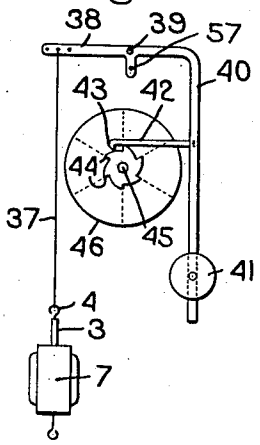


Fig 4

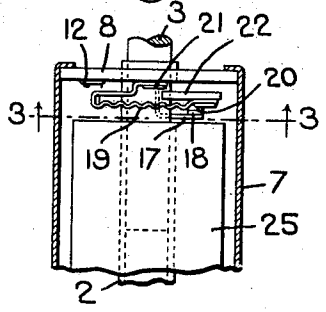


Fig.2.

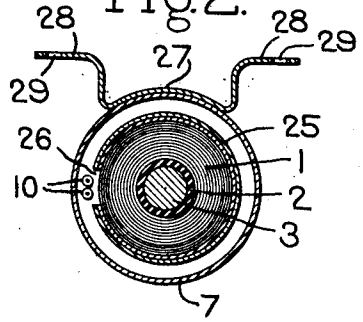


Fig.6.

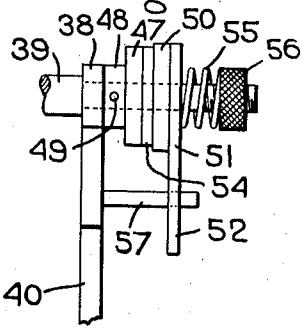
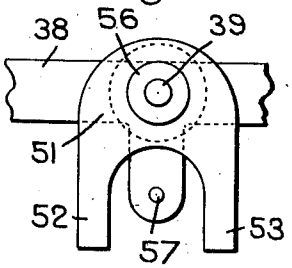


Fig.7.



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Fig.8.

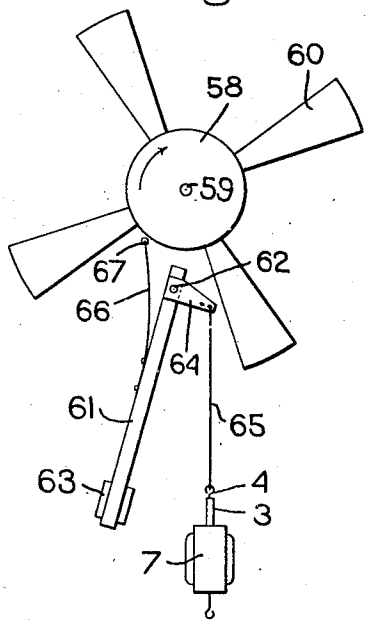


Fig.9.

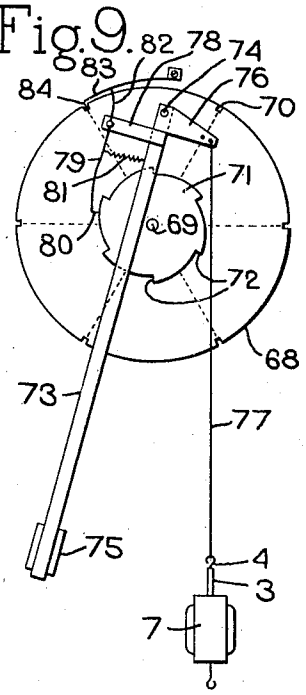


Fig.10.

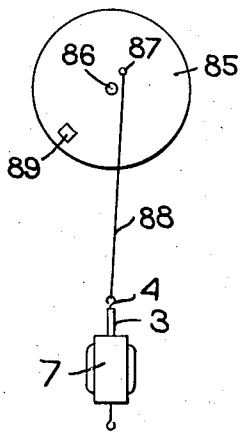


Fig.11.

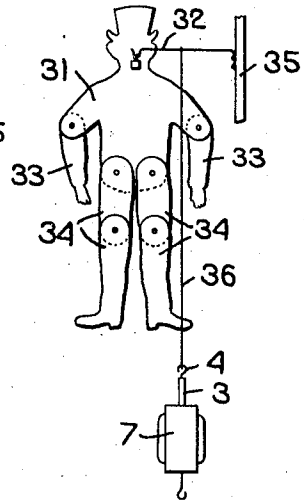
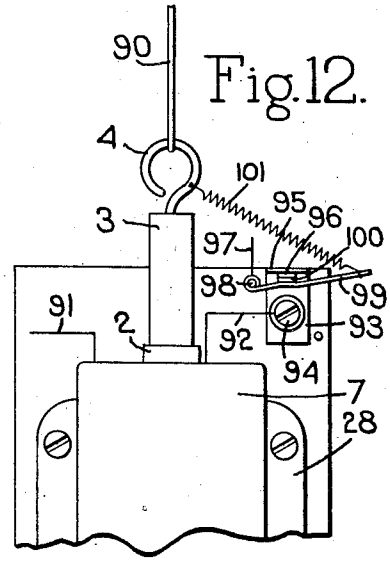


Fig.12.



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UNITED STATES PATENT OFFICE

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ELECTROMAGNETIC MOTOR MECHANISM

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Application October 16, 1935, Serial No. 45,262

13 Claims. (Cl. 172—126)

This invention relates to improvements in electromagnetic motors and the general object of the invention is to provide a motor of this type of compact construction and which can be selectively adapted to impart a reciprocatory, oscillating, rotary, or intermittent movement to suitable mechanism to be actuated thereby.

More particularly the invention relates to an electromagnetic motor unit comprising a solenoid having a coil in an electric circuit, a core reciprocable axially of said coil, a switch in said electric circuit having relatively movable contact members with yieldable means operable by the movements of the core in reverse directions to move one of the contact members into and out of engagement with the other without restricting to any considerable extent the freedom of movement of the core, thereby enabling the core to have reciprocating movements with different amplitudes.

A further object of the invention is to provide a solenoid motor having a reciprocating core with yieldable switch mechanism operated by the movement of the core so constructed that the contact members of the switch will be moved into or out of engagement with each other after the reversal of movement of the core and will be maintained in engagement or disengagement until the next reversal of movement of the core. By reason of this construction proper making and breaking of the circuit will be accomplished irrespective of the amplitude of movement of the core.

Another object of the invention is to provide a solenoid motor having a reciprocating core and switch mechanism operable by the reciprocating movements of the core which will cause progressively increasing amplitude of such reciprocating movements until a maximum is attained.

A further object of the invention is to provide means for limiting the reciprocation of the core substantially to a predetermined amplitude of movement.

Another object of the invention is to provide display devices and the like operable by an electromagnetic motor of the character described with a reciprocating movement, an intermittently rotary movement, or a continuous rotary movement.

These and other objects and features of the invention will more fully appear from the following description and the accompanying drawings and will be particularly pointed out in the claims.

In the drawings:

Fig. 1 is a detail view, mainly in vertical section, of an electromagnetic motor unit embodying the invention;

Fig. 2 is a transverse sectional view on line 2—2 Fig. 1;

Fig. 3 is a horizontal sectional view on line 3—3 Fig. 4, viewed in the direction indicated by the arrows;

Fig. 4 is a detail view, mainly in elevation, illustrating the relative positions of the switch members;

Fig. 5 is a diagrammatic view showing the application of the electromagnetic motor embodying the present invention to a pendulum mechanism for intermittently rotating a display device, or the like;

Fig. 6 is an enlarged detail view illustrating a frictional device for limiting the amplitude of reciprocation of the pendulum which is actuated by the electromagnetic motor of the present invention;

Fig. 7 is a detail view of the mechanism shown in Fig. 6, viewed from the right toward the left;

Fig. 8 is a graphic illustration of the electromagnetic motor employed to oscillate a pendulum which in turn imparts rotation to a display device, such as a wind mill, and in which continuous rotary motion is imparted to the rotating device by force intermittently transmitted by the pendulum;

Fig. 9 is a graphic illustration of a pendulum-actuated device in which intermittent rotary movement is imparted to the display device by the oscillations of the pendulum;

Fig. 10 is a graphic illustration of a continuously rotating member actuated by the electromagnetic motor;

Fig. 11 is a graphic illustration of a display device in the form of an articulated figure supported by a spring and actuated by the electromagnetic motor; and,

Fig. 12 is a view of a modified form of switch mechanism actuated by the reciprocating movements of the core of the solenoid motor.

The electromagnetic motor of the present invention comprises a solenoid coil in an electric circuit, a core mounted to reciprocate axially of said coil, means for applying to said core a force tending to withdraw the core from the solenoid coil and of sufficiently increasing intensity to overcome the magnetic force produced by the coil after the core has been drawn inwardly, with switch mechanism actuated by the movement of the core, after the reversal of direction of movement of the core, to break the circuit and main-

tain the circuit in open condition during the outward movement of the core until said force is overcome and a reversal of the movement of the direction of the core produced, and thereafter by such reverse movement of the core to close said circuit, energize the coil and maintain the same in closed condition during the movement of the solenoid inwardly of the coil until again overcome by the force applied to the core.

In the preferred construction illustrated the electromagnetic motor comprises a solenoid coil 1 surrounding a central tube 2 of insulating material and having a core 3 slidably mounted in said tube and reciprocable axially thereof. The core 3 is provided at one end with means, such as an eye 4, to which a force-applying device, tending to withdraw the core from the coil, may be applied. The eye 4 desirably is of sufficient size to prevent the core from being withdrawn from the tube 2. A rod 5 desirably is secured to the core and extends axially therefrom and is provided at its end with a loop or eye 6 of greater diameter than the tube 2 to prevent the complete withdrawal of the core from the tube.

The solenoid coil 1 is mounted in a suitable casing preferably comprising a metallic cylinder 7 with heads 8 and 9 of insulating material secured to the tube 2, the edges of the metallic cylindrical casing desirably being flanged or spun over the heads as illustrated. An insulated electric conduit 10 for the conductors of an electric circuit extends through the head 9 and alongside the coil 1 and terminates in proximity to the head 8. One of the conductors 11 of said circuit is connected to an anchoring member, such as an eyelet 12, and one end 13 of the coil is also connected to said eyelet. The other conductor 14 of the electric circuit is connected to an eyelet or binding post 15 which is mounted in the head 8 and a switch member 16 is also secured to said head by the eyelet 15. The switch member 16 has an offset resilient portion the end of which is provided with a contact member 18. By thus providing a slightly resilient support for the contact 18, chattering, which might be produced by the engagement of the contact members of the switch, is practically eliminated.

The complementary switch member comprises a spring 19, preferably of arcuate form, having at its end a contact member 20 superimposed over the contact member 18 and anchored at its end to the head by a suitable eyelet 21. A friction member 22, preferably of rawhide, is secured to the switch member or spring 19 preferably at approximately ninety-degrees from the eyelet or anchorage of the spring to the head 8 and frictionally engages the solenoid core 3.

In the preferred construction illustrated the spring 19 is of flat resilient material and corrugated and is connected to the eyelet 21 by a reversely bent and offset end portion 23, thereby increasing the flexibility of the spring with respect to movements in the direction of movement of the core. The corrugations of the spring also increase its resilience in holding the frictional member 22 in engagement with the solenoid core. The other end 24 of the coil is connected to the spring 19 or to the eyelet or binding post which secures the spring to the head 8.

In order to reduce eddy current losses in the outer container a split iron magnetic shield 25 embraces the coil within the metal casing and the conduit 10 desirably extends along the space 26 between the ends of the shield. The casing 7 may be secured to a suitable plate or bracket 27 in any suitable manner and the plate provided with flanges 28 having suitable screw holes 29 by means of which it may be mounted upon any suitable support.

Any suitable means may be employed for applying to the core a progressively increasing force tending to withdraw the core from the coil in opposition to the electromagnetic force produced by the coil when energized and which will overcome the electromagnetic force after the core has passed beyond the range of said maximum electromagnetic force.

As illustrated in Fig. 1 a helical spring 30 is employed which may be attached to a device adapted to be actuated by the reciprocation of the core.

When the parts are in the position illustrated in Fig. 1, the solenoid core has been drawn upwardly by the spring 30 to the limit of its movement and has then moved downwardly a sufficient distance to cause the frictional engagement of the friction member 22 with the solenoid core to force the contact member 20 carried by the spring 19 into engagement with the contact 18, thereby completing the circuit through the solenoid coil and energizing the same. The electromagnetic force thus created by the solenoid draws the core inwardly of the coil, thereby imposing a tension upon the spring 30 which progressively increases until the force of the spring overcomes the electromagnetic force produced by the coil. The force of the spring thereupon causes a reversal of movement of the core 3 and immediately upon such reversal of movement the friction member 22 of the spring 19 causes the movable switch member to be raised, thereby separating the contact 20 from engagement with the contact, 18, thus breaking the circuit and eliminating the electromagnetic force and permitting the solenoid to be drawn upwardly by the spring.

The frictional engagement of the member 22 of the movable switch arm with the core causes alternate making and breaking of the electric circuit upon each reversal of movement of the core irrespective of the amplitude of such movement and without substantially mechanically restricting the freedom of movement of the core.

By means of the frictional engagement of the member 22 with the core of the solenoid during its upward or outward movement, the separation of the contact members is maintained until the decreasing force of the spring is overcome by the weight of the core, whereupon the core begins to descend and immediately causes the friction member 22 to force the contact 20 into engagement with the contact member 18, thus again completing the circuit through the solenoid coil and energizing the same. By reason of the fact that the solenoid core is of considerable mass or weight, the initial reciprocation caused by the alternate action of the electromagnetic force and the spring is relatively small, but by reason of the gradually increasing momentum of the core and its load during its reciprocation the amplitude of reciprocation progressively increases to a maximum so that when such maximum is attained the solenoid core will continue to reciprocate with substantially uniform amplitude of movement.

An illustrative application of the electromagnet motor thus described to produce reciprocation of an object, such as an articulated figure of a man, is illustrated in Fig. 11 which illustrates a figure 31 suspended upon a spring 32 and pro-

vided with articulated arms 33 and articulated legs 34. In this construction the spring 32 is anchored at its opposite end to a suitable rigid support 35 and is connected by a suitable cord or cable 36 to the eye 4 of the solenoid core 3. In the operation of this device when once the spring is drawn down and released the solenoid core 3 will be rapidly reciprocated by the alternation forces of the spring and the electromagnetic force of the solenoid and will cause the figure to dance continuously.

The application of the electromagnetic motor to a pendulum is illustrated in other figures of the drawings. In Fig. 5 the eye 4 of the core is connected by suitable means, such as a rod or cord 37 to one arm 38 of a bell crank lever which is fulcrumed upon a pivot 39. The other arm 40 of the bell crank lever is offset vertically downwardly and provided with an adjustable weight 41 thereby forming a pendulum. When the pendulum is at rest the core of the solenoid will be in raised or partially raised position with the contact members 18 and 20 in engagement. When the main electric circuit is completed the coil will be energized, thereby causing the core to be drawn inwardly of the coil and causing the pendulum weight to swing upwardly in one direction until the force exerted by the weight reverses its direction of movement, thereby causing the core to move upwardly. Such upward movement of the core will disengage the contact members 18 and 20 of the switch, thus interrupting the current so that the momentum of the descending weight will again raise the core during the upward swinging movement of the pendulum. Upon the following downward movement of the pendulum the switch members will be again moved into contact and the solenoid core energized as before, thus drawing the same downwardly and applying to the pendulum a force tending to increase the amplitude of its swinging movement.

The actuation of the pendulum in the manner above described may be employed for various purposes. As illustrated in Fig. 5 a pawl 42, which is pivotally connected to the pendulum, is provided with a hook-shaped end 43 adapted to engage the teeth 44 of a ratchet which is secured to the shaft 45 of a device to be rotated. If the teeth 44 of the ratchet are spaced a sufficient distance apart, several actuations of the pendulum by the electromagnetic motor will be required to produce sufficient amplitude of vibration of the pendulum to cause the hook 43 of the pawl to engage a tooth 44 of the ratchet. Upon such engagement the device, which may be in the form of a display device 46 presenting a series of segments corresponding in number to the teeth of the ratchet, will be rotated one step. The power required thus to rotate the display device will partially overcome the force transmitted by the pendulum to the solenoid core and will therefore decrease the amplitude of oscillation of the pendulum so that several more oscillations will be required before the pendulum will have sufficient amplitude of movement to cause engagement of the hook 43 of the pawl with the next tooth of the ratchet. By reason therefore of this construction the display device will be rotated intermittently to present the successive segments to such open space which may be provided in the casing therefor as may be desired.

In certain instances it may be desirable to restrict the amplitude of oscillation of the pendulum and to accomplish this purpose suitable dampening means may be provided, a preferred form of which is illustrated in Figs. 6 and 7. This mechanism comprises a collar or disk 47 having a hub 48 fixedly secured by a pin or set screw 49 to the pivotal shaft 39 upon which the pendulum oscillates and a collar 50 rotatably mounted upon the shaft 39 having rigid therewith a plate 51 having extensions 52 and 53. A friction disk 54 is interposed between the adjacent face of the collars 47 and 50 and is held in frictional engagement with both of said faces by a helical spring 55 encircling the shaft and abutting at one end against the plate 53 and at its opposite end against a knurled nut 56 the adjustment of which upon the end of the shaft 39 will determine the pressure of the spring upon the plate 51. The pendulum is provided with a pin or stud 57 which extends between the arms or extensions 52 and 53 of the plate 51.

In the operation of the device the pendulum may swing freely so long as the pin 57 does not engage either the extension 52 or 53 of the plate 51. When however the oscillation of the pendulum exceeds such free amplitude of vibration the pin 57 will engage the arm 52, thereby rotating the plate 51 about the shaft 39 against the frictional force exerted between the collars 47 and 50 by the frictional member 54, thus dampening the movement of the pendulum in one direction. Upon oscillation of the pendulum in the other direction the pin 57 will engage the extension 53 of the plate 51 which will then have been somewhat displaced and by the frictional resistance to the movement of the plate in the opposite direction will still further dampen the oscillating movement of the pendulum until the desired amplitude of vibration is reached which may be determined by adjustment of the nut 56 and the consequent amount of frictional resistance offered to the pendulum by the pivotally mounted plate 57.

Another application of the electromagnetic motor to a continuously rotating device, such as a wind mill, is illustrated in Fig. 8. In this construction the rotating device comprises a cylindrical hub 58 which is rotatably mounted upon a shaft 59 and is provided with vanes 60 simulating those of a wind mill. The pendulum 61 is pivotally mounted upon a shaft or stud 62 and is provided at its lower end with a suitable weight 63 which may be adjustably secured to the pendulum. The pendulum is provided with an arm 64 desirably extending at right angles from the pivot thereof and the end of the arm 64 is connected by a suitable means, such as a rod 65, to the eye 4 of the core 3 of the solenoid motor. The pendulum 61 has secured to it a spring 66 having at its end a frictional member 67 adapted to engage the cylindrical surface of the hub 58. When the pendulum is once started its oscillation is maintained by the alternate force applied to the core by the electromagnetic motor and the movement of the pendulum. The spring arm 66, which engages the periphery of the hub, is therefore reciprocated into and out of engagement with the periphery of the hub, the engagement with the periphery of the hub being maintained during the swinging of the pendulum in one direction sufficiently to impart rotation to the hub and consequently to the vanes of the wind mill.

Another application of the pendulum mechanism, which cooperates with the solenoid motor, is illustrated in Fig. 9. In this construction a circular display device 68 is mounted upon a shaft 69 and is divided into a plurality of sectors defined by notches 70 in the periphery of the

device. The device 68 has secured to it a ratchet 71 having teeth 7 located midway between the radii of the edges of the segments of the display device. The pendulum 73 is pivotally mounted upon a shaft or stud 74 and is provided at its lower end with a weight 75. The pendulum is provided with a rigid arm 76, which is flexibly connected by a rod 77 to the eye 4 of the solenoid core 3. The pendulum is also provided with another arm 78 extending in the opposite direction to which is pivotally connected a pawl 79 having a hook-shaped end 80 adapted to engage the teeth of the ratchet 71. A light spring 81 tends to hold the pawl 79 in engagement with the ratchet. Desirably the pawl 79 is provided with an extension 82 beyond its pivot which is adapted to engage a detent 83 having a hooked end 84 adapted to engage the notches 70 in the periphery of the display device.

In the operation of this device the electromagnetic force exerted by the electromagnetic motor causes the pendulum to swing with progressively increasing amplitude of oscillation, as above described, until the end of the pawl engages one of the teeth of the ratchet. Just prior to such engagement the end of the extension 82 of the pawl will lift the detent sufficiently to release the hooked end 84 from the notch 70 in the display device, so that upon the swinging of the pendulum in the opposite direction the engaged end of the pawl with the tooth of the ratchet will rotate the display device until the detent engages the next notch in the periphery thereof. The power absorbed in such rotation of the display device will again slow down the pendulum so that several progressively increasing oscillations will be required before the pawl 79 of the pendulum will again release the detent and engage the next tooth of the ratchet.

Another adaptation of the invention to propel a continuously rotatable device is illustrated in Fig. 10. In this construction the rotatable device, which is graphically illustrated as a disk 85, is rotatably mounted upon a stud or shaft 86. A stud 87 is secured to said disk at suitable radial distance from the center thereof and is connected by a rod 88 to the eye 4 of the solenoid 3. The disk has secured to it or formed integral therewith a counterweight 89 located approximately diametrically opposite the stud 87. In the operation of the device, when the rotatable member is given an initial impulse, the electromagnetic force of the coil will draw the core inwardly thereby rotating the disk 85 and imparting sufficient momentum to it to carry the counterweight across the vertical plane of the pivotal shaft 86. The momentum of the disk and downward movement of the counterweight will then move the core upwardly thereby disengaging the contact members of the switch until the core again moves downwardly and completes the circuit, thus again energizing the coil. By alternate making and breaking of the circuit continuous rotation of the disk will be effected.

It will be understood that the graphic illustrations of several methods in which the electromagnetic motor forming the subject matter of the present invention may be employed are merely examples of various devices which may be propelled by said motor. The invention is particularly applicable to display devices in which animated objects are given a reciprocatory, rotary, or intermittent movement, but it is obvious that the motor may be employed in various other relations within the knowledge of those skilled in the mechanical or electrical art.

A modified form of switch mechanism is illustrated in Fig. 12. In this construction the solenoid coil enclosed in the casing 7 and the flanges 28 of which are secured by screws to a suitable base may be and are the same as heretofore described, as is also the core 3 which is reciprocable within the tube 2 which extends axially through the core of the solenoid. In this construction the hook 4 of the core 3 is connected to a rod 90, the opposite end of which in turn may be connected to a pendulum, spring, or other device, to be actuated by the solenoid. In this construction one of the conductors 91 of the electric circuit is directly connected to one end of the coil and the other end of the coil is connected by a conductor 92 to a conducting plate 93 which is suitably secured to the base by a screw 94. The plate 93 is provided with a laterally bent upper end 95 having a terminal contact 96. The return branch 97 of the electric circuit is connected to a stud 98 having pivotally mounted thereon a switch arm 99 provided with a contact member 100 complementary to the contact member 96. A very light spring 101 is connected at one end to the solenoid core or preferably to the eye 4 and at its opposite end to the switch arm 99 at approximately the end thereof. The switch arm 99 is so located that during the reciprocation of the solenoid core 3 the point of its attachment to the eye 4 of the solenoid core will be alternately raised above the horizontal plane of the pivot 98 of the arm 99 and depressed below said horizontal plane. By reason of this construction the contact member 100 will be maintained in engagement with the stationary contact member 96 during the upward or outward movement of the solenoid core 3 after the spring is raised above the horizontal plane of the pivot 98 and will be removed from and retained out of engagement with the stationary contact member 96 when the spring is below the horizontal plane of the pivot 98. The action of the switch in this construction is substantially identical with that heretofore described in respect to the construction shown in Figs. 1, 2, and 3. Inasmuch as the spring 101 is a light spring, no substantial resistance is offered to the free movement of the core whether impelled by the electromagentic force of the coil or by the counteracting force of the spring, pendulum, or other power applying device.

It will therefore be obvious that other specific forms of switch-actuating mechanism, which permit varying amplitudes of reciprocation of the solenoid core, may be employed within the scope of the invention.

It will be understood that the embodiments of the invention disclosed herein are of an illustrative character and not restrictive of the scope and meaning of the following claims.

Having thus described the invention, what is claimed as new, and desired to be secured by Letters Patent, is:

1. An electromagnetic motor unit comprising a solenoid coil in an electric circuit, a core reciprocable axially of said coil and having no positive limitation of movement, yieldable means normally suspending said core partially within said coil, a switch in said circuit having relatively movable contact members, and yieldable means operable by movements of said core in reverse directions to move one of said contact members into and out of engagement with the other without substantially mechanically restricting the free-

dom of movement of said core whereby successive energizations of said coil will cause progressively increasing amplitudes of movement of said core until limited to a maximum amplitude of reciprocation by said yieldable supporting means.

2. An electromagnetic motor unit comprising a solenoid coil in an electric circuit, a core reciprocable axially of said coil and having no positive limitation of movement, yieldable means normally suspending said core partially within said coil, a switch in said circuit having a fixed contact member and a relatively movable contact member, and resilient means connected to said movable contact member operable by the reciprocating axial movements of said core to move said movable contact member into and out of engagement with said fixed contact member and adapted to yield in response to continued movement of said core in the same direction after engagement of said contact members has been effected whereby successive energizations of said coil will cause progressively increasing amplitudes of movement of said core until limited to a maximum amplitude of reciprocation by said yieldable supporting means.

3. An electromagnetic motor comprising a solenoid coil in an electric circuit, a core reciprocable axially of said coil and having no positive limitation of movement, yieldable means normally suspending said core partially within said coil, a switch in said circuit having a stationary contact member and a spring-supported contact member having means slidably engaging said core with light friction and operable by the axial movement thereof in reverse directions to move said movable contact member into and out of engagement with said stationary contact member and to permit progressively increasing amplitudes of reciprocation of said core until limited to a maximum amplitude of reciprocation by said yieldable supporting means.

4. An electromagnetic motor comprising a metallic casing having a head of insulating material, a solenoid coil in an electric circuit mounted within said casing, a core reciprocable axially of said coil and having no positive limitation of movement, yieldable means normally suspending said core partially within said coil, a switch in said circuit comprising a stationary contact member connected to said coil and a movable contact member carried by a light spring mounted on said insulated head and connected in said circuit, means on said spring slidably engaging said core with light friction and operable during the movement of said core in one direction to close said circuit and during the movement of said core in the opposite direction to open said circuit without effectively restraining the movement of said core whereby successive energizations of said coil will cause progressively increasing amplitudes of movement of said core until limited to a maximum amplitude of reciprocation by said yieldable supporting means.

5. An electromagnetic motor comprising a metallic casing having a head of insulating material, a solenoid coil in an electric circuit mounted within said casing, a core reciprocable axially of said coil and having no positive limitation of movement, yieldable means normally suspending said core partially within said coil, a switch in said circuit comprising a stationary contact member connected to said coil, a light spring connected in said circuit mounted upon said insulated head and of arcuate form substantially concentric with said core having a contact member complementary to said stationary contact member and a frictional member connected to said spring lightly engaging said core and operable to close said circuit and retain said circuit closed during the movement of the core in one direction and to open said circuit and retain said circuit open during the movement of the core in the opposite direction whereby successive energizations of said coil will cause progressively increasing amplitudes of movement of said core until limited to a maximum amplitude of reciprocation by said yieldable supporting means.

6. An electromagnetic motor comprising a metallic casing having a head of insulating material, a solenoid coil in an electric circuit mounted within said casing, a core reciprocable axially of said coil and having no positive limitation of movement, yieldable means normally suspending said core partially within said coil, a switch in said circuit comprising a stationary contact member connected to said coil, a light spring in said circuit mounted upon said insulated head having a section engaging said head and an offset reversely extending arcuate corrugated section concentric with said core having a contact complementary to said stationary contact and provided with frictional means engaging said core approximately ninety-degrees from the point of anchorage of said spring to said head and operable to close said circuit and retain said circuit closed during the movement of the core in one direction and to open said circuit and retain said circuit open during the movement of the core in the opposite direction whereby successive energizations of said coil will cause progressively increasing amplitudes of movement of said core until limited to a maximum amplitude of reciprocation by said yieldable supporting means.

7. An electromagnetic motor comprising a solenoid coil in an electric circuit, a core reciprocable axially of said coil with no positive limitation of its movement and movable inwardly of said coil by the electromagnetic force of said coil when energized, yieldable means suspending said core operable with increasing intensity upon said core during the inward movement thereof sufficiently to overcome said electromagnetic force and to reverse the direction of movement of said core, a switch in said circuit, means actuated by said core during its inward movement to close said switch and retain it closed and during its outward movement to open said switch and retain it open, thereby alternately energizing and deenergizing said coil and causing said core to reciprocate with progressively increasing amplitude of reciprocation until limited to a maximum amplitude of reciprocation by said yieldable suspending means.

8. An electromagnetic motor comprising a solenoid coil in an electric circuit, a core reciprocable axially of said coil with no positive limitation of its movement and movable inwardly of said coil by the electromagnetic force of said coil when energized, a spring suspending said core operable upon inward movement of said core to apply a progressively increasing force adapted to overcome said electromagnetic force and reverse the direction of movement of said core, a switch in said circuit, means actuated by said core during its inward movement to close said switch and retain it closed and during its outward movement to open said switch and retain it open, thereby alternately energizing and de-energizing said coil and causing said core to reciprocate with progressively increasing amplitude until limited to a maximum

amplitude of reciprocation by the action of said spring.

9. An electromagnetic motor comprising a solenoid coil in an electric circuit, a core reciprocably mounted in said coil and movable inwardly of said coil by the electromagnetic force of said coil when energized, a pendulum having means flexibly connected to said core and movable substantially in the direction of the axis thereof operable by a swinging movement to overcome the electromagnetic force and reverse the direction of movement of said core, a switch in said circuit having a movable contact member provided with means engaging said core and actuated by said core during its inward movement to close said switch and retain it closed and during its outward movement to open said switch and retain it open, thereby alternately energizing and de-energizing said coil thus causing said core to reciprocate and the oscillation of said pendulum to be maintained with progressively increasing amplitude of oscillation until a maximum amplitude is attained after which the oscillation will remain constant.

10. An electromagnetic motor comprising a solenoid coil in an electric circuit, a core reciprocably mounted in said coil and movable inwardly of said coil by the electromagnetic force of said coil when energized, a pendulum having means flexibly connected to said core and movable substantially in the direction of the axis thereof operable by a swinging movement to overcome the electromagnetic force and reverse the direction of movement of said core, a switch in said circuit having a movable contact member provided with means engaging said core and actuated by said core during its inward movement to close said switch and retain it closed and during its outward movement to open said switch and retain it open, thereby alternately energizing and de-energizing said coil thus causing said core to reciprocate and the oscillation of said pendulum to be maintained with progressively increasing amplitude of oscillation, and frictional means acting upon said pendulum operable to maintain substantial uniformity in the amplitude of oscillation.

11. An electromagnetic motor comprising a solenoid coil in an electric circuit, a core reciprocably mounted in said coil and movable inwardly of said coil by the electromagnetic force of said coil when energized, a rotatable member having a crank pin offset from its center of rotation, means flexibly connecting said crank pin to said solenoid movable substantially in the direction of the axis, of said solenoid, and a counterweight on said rotatable member substantially diametrically opposite to said crank pin operable by the rotation of said rotatable member to exert a force upon said core adapted to overcome said electromagnetic force and reverse the direction of movement of said core, a switch in said circuit, means actuated by said core during its inward movement to close said switch and retain it closed and during its outward movement to open said switch and retain it open, thereby alternately energizing and de-energizing said coil thus causing said core to reciprocate and rotation of said rotatable member to be maintained.

12. A display device comprising a solenoid in an electric circuit, a core reciprocably mounted in said coil and movable inwardly of said coil by the magnetic force of said coil when energized, an animated device having a spring flexibly connected to the core of said solenoid, said spring being of such strength that the increased tension thereof, produced by the inward movement of the core, will overcome the electromagnetic force of said coil and cause a reversal of movement of said core, a switch in said circuit, means actuated by said core during its inward movement to close said switch and retain it closed and during its outward movement to open said switch and retain it open, thereby alternately energizing and de-energizing said coil thus causing actuation of said animated device.

13. An intermittently rotatable display device comprising a rotatable display member having a hub, a pendulum supported upon a pivot located in proximity to said hub, means carried by said pendulum engaging said hub and operable to rotate the same, when the pendulum is swinging in one direction, an electromagnetic motor comprising a solenoid coil in an electric circuit, a core flexibly connected to an arm of said pendulum and reciprocably mounted in said coil and movable inwardly of said coil by the electromagnetic force of said coil when energized, means for intermittently energizing said coil comprising a switch in said circuit, means actuated by said core during its inward movement to close said switch and retain it closed and during its outward movement to open said switch and retain it open, whereby alternate energization and de-energization of said coil will maintain reciprocation of said pendulum and intermittent rotation of said display device.

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