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Aug. 4, 1931. H. I. MORRIS 1,817,638

POWER MECHANISM

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FIG. 1.

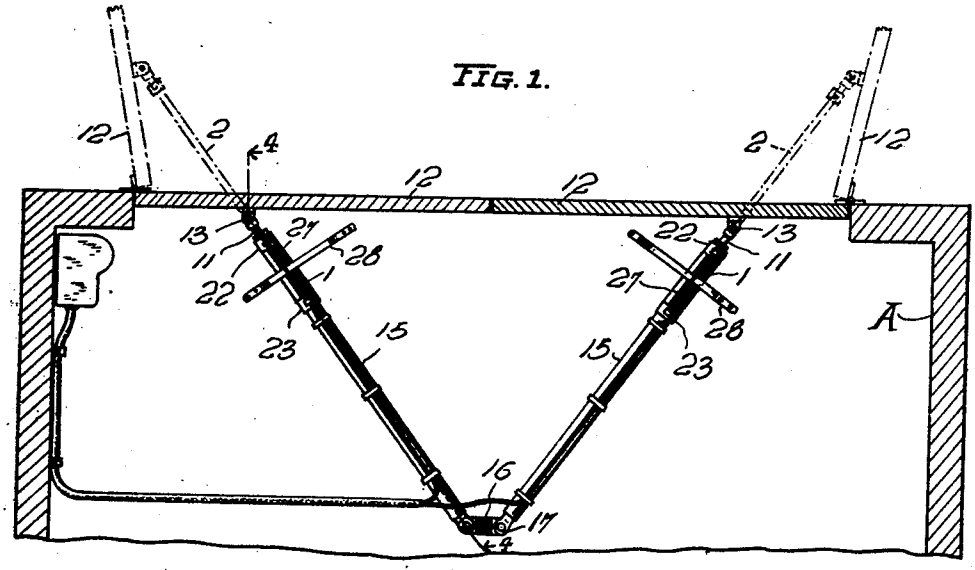


FIG. 2.

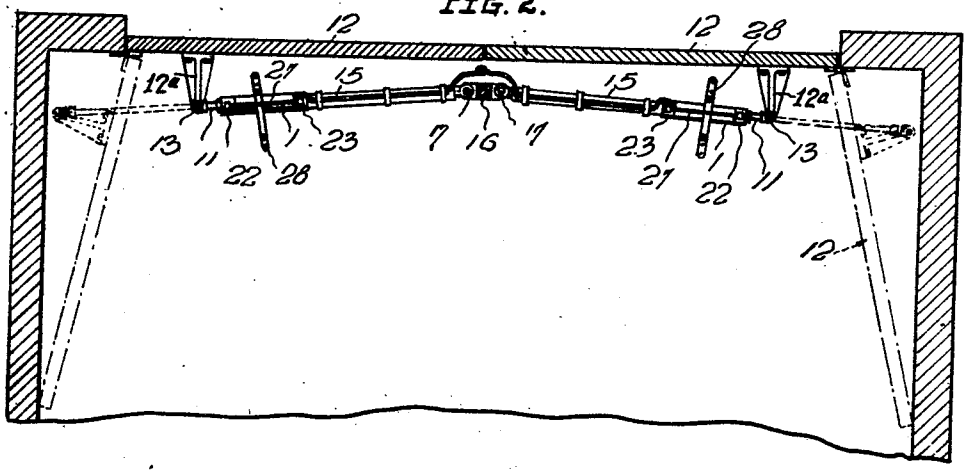
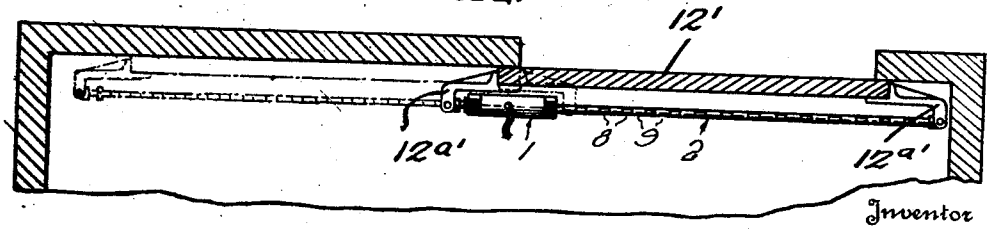


FIG. 3.



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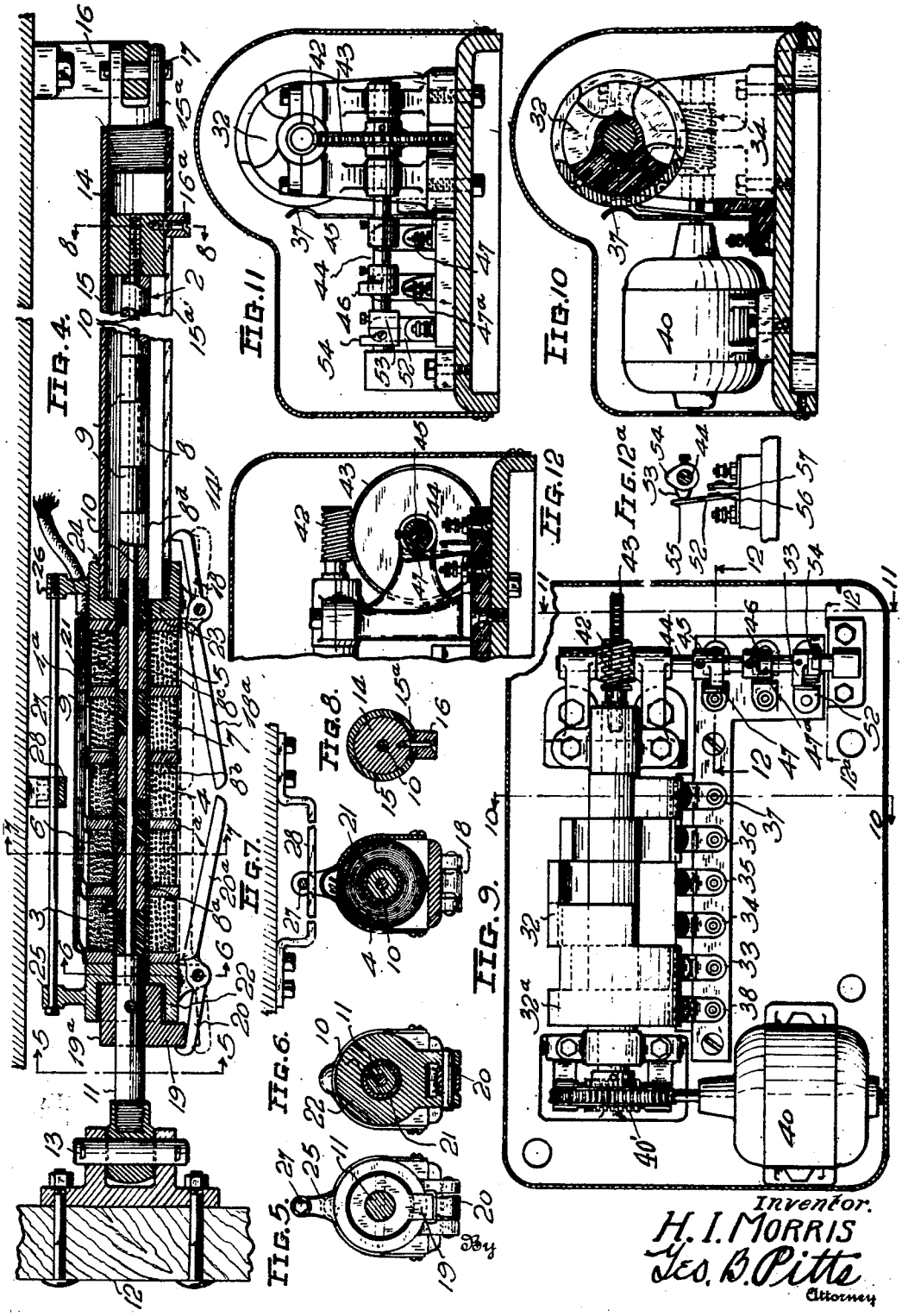
Attorney

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POWER MECHANISM

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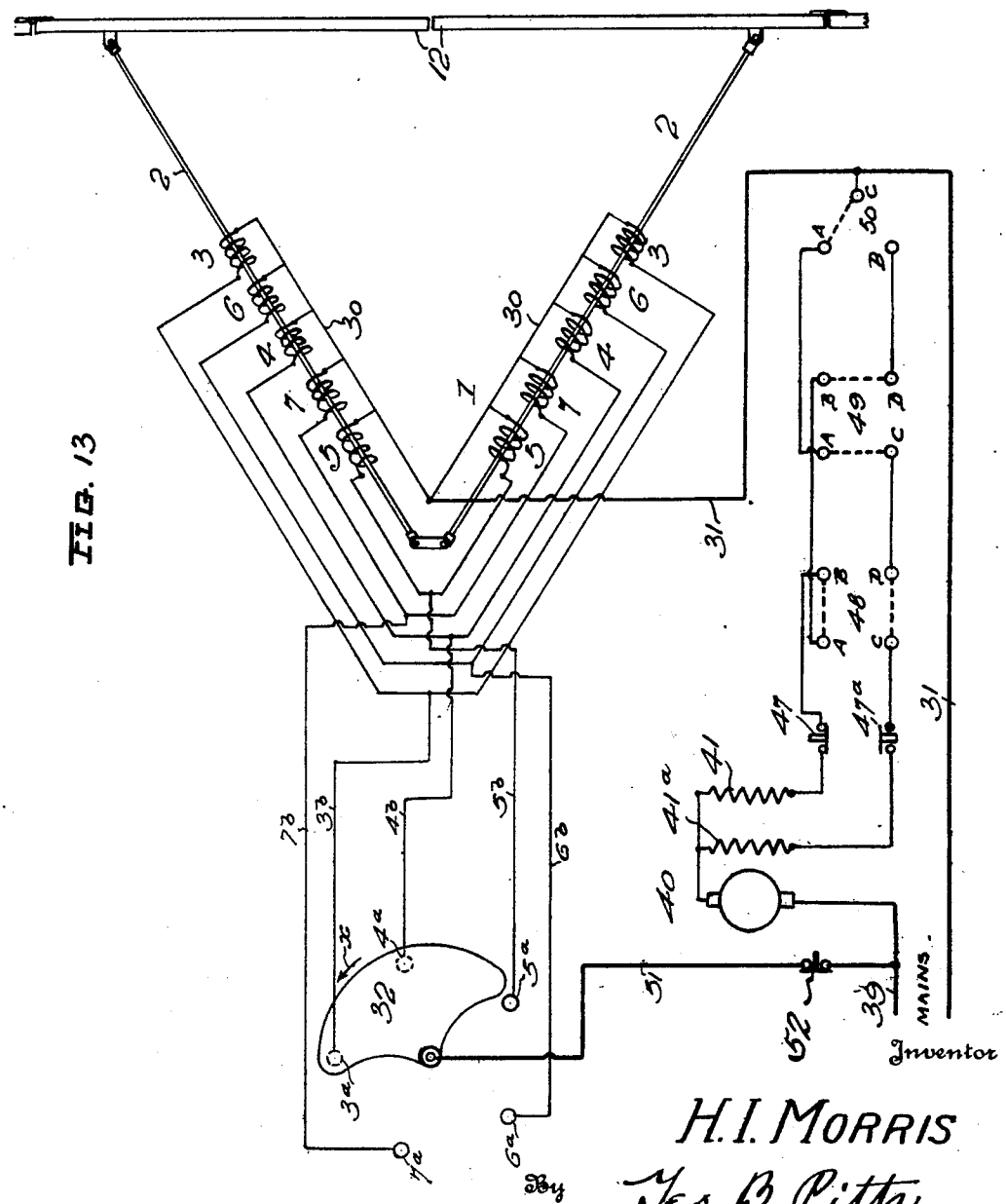
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POWER MECHANISM

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FIG. 13



Patented Aug. 4, 1931 1,817,638

UNITED STATES PATENT OFFICE

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POWER MECHANISM

Application filed March 3, 1928. Serial No. 258,874.

The present invention has reference to power applying and controlling mechanism and more particularly to that type of mechanism in which power is applied or utilized through proper control thereof to actuate a movable element.

The invention has for its object the provision of a power applying and controlling mechanism in which electrical energy is utilized to actuate a movable element to any one of a plurality of positions.

Another object of the present invention is to provide a structure of this type which is particularly adaptable to the operation of one or more movable members and in which the control for the structure may be located at any convenient point or at a plurality of points more or less remote from the structure and from each other.

Another object of the invention is to provide a device actuating or operating mechanism in which the force to move or operate the device is yieldingly applied thereto.

A further object of the invention is to provide a mechanism wherein a movable member may be yieldingly actuated and which mechanism functions in addition to positively lock the member in a selected one of a plurality of predetermined positions.

A still further object of the invention is to provide mechanism of the class described in which the member to be moved is operated by a direct magnetic application of power.

Other objects of the invention will be apparent to those skilled in the art to which my invention relates from the following description taken in connection with the accompanying drawings, wherein

Fig. 1 is a top plan view of the power applying and controlling mechanism as utilized in conjunction with a pair of outwardly swinging doors for a building, the doors and building being shown in section.

Fig. 2 is another plan view, but showing the mechanism as utilized in conjunction with a pair of doors for a building swingable inwardly, the doors and building being shown in section.

Fig. 3 is another plan view, but showing the mechanism as utilized in conjunction with a sliding door for a building, the door and building being shown in section.

Fig. 4 is a sectional detail view of the power applying and controlling mechanism on the line 4—4 of Fig 1.

Fig. 5 is a view along the section line 5—5 of Fig. 4.

Fig. 6 is a view along the section line 6—6 of Fig. 4.

Fig. 7 is a view along the line 7—7 of Fig. 4.

Fig. 8 is a view along the section line 8—8 of Fig. 4.

Fig. 9 is a top plan view of the circuit controlling mechanism for controlling the energization of the solenoid illustrated in Fig. 4.

Fig. 10 is a detailed section view of the mechanism shown in Fig. 9 along the section line 10—10 thereof.

Fig. 11 is a detailed view partly in section on the line 11—11 of Fig. 9.

Fig. 12 is a detailed section on the line 12—12 of Fig. 9.

Fig. 12*a* is a section on the line 12*a*—12*a* of Fig. 9.

Fig. 13 is a diagrammatic illustration of one arrangement of circuits which may be utilized in connection with the specific embodiment disclosed in the previous figures.

In the illustrated embodiment shown, the application of power to operate one or more movable members, such as the door or doors of a building, is obtained by means of a solenoid 1 co-operating with a core or plunger member 2. The solenoid 1 comprises a plurality of independent windings 3, 4, 5, 6 and 7 arranged along a common axis, which windings are adapted to be energized in the proper or predetermined sequence to produce a continuous pull on the core or plunger 2 which in turn is composed of a plurality of magnetic segments or sections 8, alternating with a plurality of non-magnetic segments or sections 9, and having certain spaced relationship to the solenoid windings. Each of the non-magnetic sections 9 is preferably of less length than the respective magnetic sections 8. 1*a* indicates pole pieces disposed upon or at the opposite

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sides of each winding; these pole pieces preferably comprising annular steel plates. The sections 8 and 9 are assembled in end to end relation upon a relatively long rod or member 10 of non-magnetic material, the length of which and the number of magnetic sections thereon being dependent upon the distance traversed by the member to be operated. One end of the member 10 is fixed, preferably in end to end relation to a rod 11 which is pivotally connected to the door 12 by means of the pivot 13, according to the arrangement shown in Fig. 1. The other end of the member 10 is threaded and a suitable block 14 is applied thereto for the dual purpose of compressing and holding rigid the assembly of core sections 8 and 9 and at the same time acting as a support and guide for the outer end of the core or plunger member 2.

In order to accomplish this latter purpose, the block 14 is adapted to slide in a guide member 15, the extreme end of which is adjustably connected to a connecting element 15*a* pivoted by means of a pivot 17 to a suitable support 16, preferably carried by the ceiling of the building A.

In the arrangement shown in Fig. 2, the rod 11 is pivoted to a bracket 12*a* carried by the door 12 and operates therethrough to swing the doors inwardly to the position shown in dotted lines.

In Fig. 3 the device is shown in connection with a door 12′ of the sliding type. In this arrangement it is not necessary to utilize a guide member 15 such as is shown in Figs. 1, 2 and 4, since the core or plunger 2 of the solenoid is directly connected at its opposite ends to the door by arms 12*a*′.

In the arrangements shown in Figs. 1 and 2 I have shown two swingable doors each operated by a power applying mechanism, but by preference, the corresponding windings of the solenoids of both mechanisms are energized and de-energized by a single controlling means, so that both doors are operated and stopped simultaneously, as will be understood from Fig. 13. As the power applying mechanisms are similar in construction, only one will be described.

14′ indicates as an entirety means for holding or locking the core 2 and through it the door 12 in its open or closed position. In the illustrated form of construction one element of the locking means 14′ comprises a projection 16*a* fixed to the lower portion of the block 14, which projection operates through a slot 15*a*′ formed in the lower portion of the guide member 15.

This projection cooperates with a locking detent 18 for locking or holding the door in an open position in a manner to be later described.

Another element of the locking means comprises a similar projection 19 on the lower portion of a block 19*a* preferably fixed to the rod 11, which projection cooperates with a locking detent 20 to lock the door in closed position in a manner to be later described. Each of the projections 16*a*, 19, may be adjustably mounted on its supporting block.

Referring now to the detailed structure of the solenoid itself, the windings or coils 3, 4, 5, 6 and 7 are mounted coaxially on a tubular member 21 formed of brass or other non-magnetic material, through which the core 2 moves. End pieces 22 and 23 are threaded upon or otherwise connected to the member 21 and function to hold the windings of the solenoid and their pole pieces 1*a* assembled in rigid relationship thereon, the end piece 23 being internally threaded as at 24 so that the entire solenoid structure may be suitably mounted upon and connected to the outer end of the guide member 15.

In the arrangements shown in Figs. 1 and 2, the solenoid structure is movably mounted so that it may accommodate itself to the swing of the adjacent door. In the illustrated form of mounting the end pieces 22 and 23 are provided with upwardly extending lugs 25 and 26, respectively, in which a rod 27 is mounted. This rod cooperates with a flat guide or saddle member 28 which is mounted on the ceiling or other support, thereby providing a support capable of carrying the weight of the solenoid and permitting it to have a certain amount of movement with respect to the pivotal point of support at 17 as the door opens and closes.

The manner in which the solenoid cooperates with its core or plunger through the sequential energization of its several windings in cooperation with the magnetic portions 8 of the core or plunger 2, will now be described. The magnetic portions 8 of the core or plunger are of approximately the same length as the individual solenoid windings while the non-magnetic portions 9 are about two-thirds the length of the individual windings. In the embodiment shown three magnetic segments together with three non-magnetic segments are equivalent in length to the five windings of the solenoid, although of course it is to be understood that other relative lengths may be used. Their assembly therefore produces what might be termed a progressive spacing of the magnetic portions of the core with respect to the individual solenoid windings as illustrated in the sectional view in Fig. 4, in which the magnetic sections immediately adjacent the windings have been further identified for the purposes of illustration by the reference characters 8*a*, 8*b*, 8*c* and 8*d*. One side of the solenoid windings are connected through common leads

30 to one of the mains 31. The other side of the windings are connected to a rotary member, preferably a motor actuated multiple contact controller switch whose structure is shown in detail in Figs. 9 to 12, inclusive.

The switch comprises a rotary circuit controlling member 32, to which rotation is imparted by an electric motor 40 and worm drive 40', the member 32 being cut away to form a plurality of angularly displaced substantially semi-circular contact surfaces co-operating with a plurality of contact spring fingers 33, 34, 35, 36 and 37, respectively, as shown in Fig. 9, to energize the solenoid windings in a predetermined sequence (as will later appear), with the exception that the portion 32*a* is completely cylindrical and thus co-operates with the spring contact 38 to connect rotary circuit controlling member 32 at all times to the power supply main 39 through the lead 51. Where the solenoid structure comprises a relatively large number of windings, they may be energized and de-energized in groups of two or more to more effectively operate the core 2. Where the solenoid structure comprises five windings, as shown, the contacting surfaces of the controlling member 32 are shaped and constructed to at all times complete the circuit to two of the windings; and to insure this result these surfaces are arranged to energize a third winding before de-energizing one of the other windings. This will be understood from Fig. 13 where the controller 32 in moving counterclockwise will make contact with terminal 7*a* before it breaks contact with terminal 4*a*.

The motor 40 is reversible so as to operate the rotary controller in either direction, this reversibility being obtained in the present instance by the use of oppositely wound fields 41 and 41*a* either of which may be selected to function as a series field with the motor armature. The construction of motor shown is not claimed herein as it will form the subject-matter of a separate application. This reversibility is accomplished by connecting one of the brushes of the motor to the main 39 and supplying energy to the armature thereof through either of the fields 41*a* or 41 from the main 31. The revolving contact member 32 carries at its end remote from the motor drive, a worm 42 which cooperates with a worm wheel 43 to operate or rotate a supplemental shaft 44. This shaft carries upon it adjustable cams 45, 46, which operate or actuate limit switches 47, 47*a*, respectively.

These limit switches are in the respective circuits of the fields 41 and 41*a* and function to open the motor circuit after the circuit control member 32 has made a specified number of revolutions which will be determined by the ratio between the worm 42 and gear 43 together with the position of the cams 45 and 46. Upon the energization of the motor 40 for rotation in a given direction by a closing of its circuit in a manner to be later described, the same will operate the rotary circuit controller 32 a predetermined number of revolutions and then will actuate the limit switch in the field circuit, which has been energized, to open the motor circuit and stop its operation.

If now the circuit through the other field is closed a reverse operation or rotation of the rotary circuit controller 32 will result until the predetermined number of revolutions have been accomplished when the other limit switch will be opened, leaving the apparatus in readiness to repeat the cycle of operation.

The actuating motor 40 with its two oppositely wound fields is connected to a remote control circuit so that the motor may be controlled from a plurality of independent positions or stations. In the circuit arrangement shown diagrammatically in Fig. 13 three stations or three points of operation are shown, two four-way switches 48 and 49 being utilized together with a three-way switch 50. With the arrangement of field windings and circuits shown, any number of remote control stations may be added to the three illustrated by inserting in the two leads from the fields four-way switches similar to 48 and 49.

With the switches in the position shown, the motor has been actuated into a position in which the limit switch 47*a* has opened the circuit through field 41*a*. If now the three-way switch 50 should be manipulated so that the circuit should be closed from C to B, field 41 would be energized together with the motor armature through the closed limit switch 47 and rotation would result. Similarly, if the four-way switch 49 were operated so that circuits were closed from A and B and C and D, respectively, the motor would be similarly actuated and this would also be the case were the four-way switch 48 actuated so that circuits were closed from B to D and A to C, respectively.

Operation of the motor 40 after being initiated would then continue rotation of the rotary circuit controller 32 until the limit switch 47 was opened, the limit switch 47*a* in the meantime closing, whereupon the motor would stop; but as the limit switch 47*a* is closed the motor 40 would be in readiness to respond in the reverse direction upon manipulation of any one of the switches 48, 49 or 50.

It will therefore be seen that by means of the motor circuit with its pair of opposed field windings in conjunction with the arrangement of switches described, the motor and the rotary circuit controller 32 may be actuated from any one of a plurality of re-

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motely located stations, independently of the previous position that a control switch has been left in and with a minimum of electrical circuits.

Rotation of the circuit controller 32 acts to cause sequential energization of the solenoid windings 3, 4, 5, 6 and 7, the circuit through one winding being closed before being broken through one of the previously energized windings. This sequential energization of the windings will be understood by reference to Fig. 13 which shows a diagrammatic arrangement of the circuits. In this arrangement the contact points 3*a*, 4*a*, 5*a*, 6*a* and 7*a* are connected with the solenoid windings 3, 4, 5, 6 and 7 by the circuits 3*b*, 4*b*, 5*b*, 6*b* and 7*b*, respectively.

With the circuit controller 32 in the position shown in full lines in Fig. 13, coils 3 and 4 will first be energized when the main circuit is closed, as the circuit controller is adapted for rotation in a counter-clockwise direction (as indicated by the arrow *x*) to open the doors, when the motor 40 is energized by any one of the switches 48, 49, 50. For this functioning the sequence of coil energization will be first coils 4—3; then coils 3—7; then coils 7—6; then coils 6—5; and then coils 5—4; this sequence being repeated and the magnetic sections being progressively acted upon until the core 2 has traversed its full movement or until one of the limit switches has been opened.

Referring now to Fig. 4, it will be noted that upon energization of coils 4 and 3, the magnetic portions 8*b*, 8*a*, of the core will be drawn to the left and will tend to take up a position in the centers of coils 4 and 3, respectively, the armatures 18*a* and 20*a* of the locking latches 18 and 20 will be raised into the dotted line position shown in Fig. 4, thereby releasing the projection 19*a* from the detent 20 and permitting the rod 11 pivoted to the door 12 to move to the left under the influence of these solenoid windings.

By further rotation of controller 32 in counter-clockwise direction which cuts out winding 4, winding 7 will be energized and this winding and winding 3 will exert a magnetic pull upon the segments 8*c*, 8*a*, respectively; by further rotation of the controller 32, which cuts out winding 3, winding 6 will be energized and this winding and winding 7 will exert a magnetic pull on segments 8*b*, 8*c*, respectively; by further rotation of the controller 32, which cuts out winding 7, winding 5 will be energized and this winding and winding 6 will exert a magnetic pull on segments 8*b*, 8*d*, respectively; by further rotation of the controller 32, which cuts out winding 6, winding 4 will be energized and this winding and winding 5 will exert a magnetic pull on the segments 8*c*, 8*d*, respectively; and by further rotation of the controller 32, which cuts out winding 5, winding 3 will be energizing and this winding and winding 4 will exert a magnetic pull on the segments 8*b* and 8*c*, respectively; this progressive action or pull upon the iron segments of the core produced by the sequential energization of the solenoid windings will thus continue to manifest itself until the entire extent of the core or plunger has been traversed. At that time the door will assume an open position as shown in dotted lines in Figs. 1, 2 and 3, the cam 45 or 46 being so set with reference to the shaft 44 upon which it is mounted, that the limit switch controlled thereby will open the circuit to the motor 40 and cause it to stop.

De-energization of the solenoid windings, as will later appear, will cause the latch 18 to engage with the lug 16*a* thus holding the door or doors in open position.

Upon subsequent operation of any of the switches 48, 49 and 50 the motor 40 will be energized so as to produce a reverse rotation or clockwise rotation of the circuit controller 32. This causes a sequential energization of the solenoid windings represented by the following sequence 3—4, 4—5, 5—6, 6—7 and 7—3, thereby causing the core to traverse the solenoid structure in the opposite direction and effecting a closing of the door or doors connected thereto. Upon final de-energization of the solenoid winding, as later set forth, the latch 20 will cooperate with the detent or block 19 to lock the door or doors closed.

For the purpose of de-energizing the solenoid windings to release the armatures 18*a*, 20*a*, whereby they will gravitate to the position shown in Fig. 4, when the door has reached its full open or full closed position, I provide in the lead 51 an automatically operated switch 52, which preferably operates simultaneously with each of the operated limit switches 47, 47*a*, or immediately thereafter.

The operation of the switch 52 may be effected by making each of the cams 45, 46, wider, so that they may operate a switch similar to the switch 47 shown in Fig. 12 to open the circuit; but by preference I provide on the shaft 44 cams 53, 54, each adjustable thereon and each adapted to engage the spring finger 55 (Fig. 12*a*) to break the circuit through the switch 52 (comprising contacts 56, 57) at the desired time, thus de-energizing all of the windings through which at the time the cam 53 or 54 operates, the circuit is completed by the controller 32. Upon the breaking of the circuit by the switch 52, the armatures 18*a*, 20*a*, will be released, allowing the locking detents to swing upwardly, one of which will engage the adjacent projection 19 or 16*a*, according to the position of the door to lock the core and through it the door against movement in the reverse direction,

except by operation of one of the switches 48, 49 and 50, and the energization of the windings as above set forth.

It is of course to be understood that the present device may be utilized for the operation of structures or movable members other than closure devices or doors and that the same is applicable wherever it is desired to cause operation of an element in either direction.

To those skilled in the art to which my invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. My disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

What I claim is:

1. In a power applying and controlling mechanism including a solenoid having a plurality of separate windings adapted to be progressively energized in a predetermined sequence, the combination of a circuit controller movable in either direction for connecting said windings to a common energizing circuit, a core having a plurality of spaced segments of magnetic material and movable endwise through said windings, and a reversible electric motor for operating said circuit controller.

2. In a power applying and controlling mechanism including a solenoid having a plurality of separate windings adapted to be sequentially energized, the combination of a circuit controller for sequentially connecting said units to a common energizing circuit in a sequence dependent upon the direction of movement of said circuit controller, means for operating said circuit controller in either direction comprising a reversible electric motor, and circuit controlling means for said motor for initiating its operation in either direction.

3. In a power applying and controlling mechanism including a solenoid having a plurality of separate windings adapted to be sequentially energized, the combination with a circuit controller for sequentially connecting said units to a common energizing circuit in a sequence dependent upon the direction of movement of said circuit controller, means for operating said circuit controller in either direction comprising an electric motor having separate sets of field windings, one set being connected reversely with respect to the other set, and circuit controlling means for energizing said electric motor and selecting either field winding for initiating the operation of the circuit controller in either direction.

4. In a power applying and controlling mechanism, a solenoid having a plurality of separate windings, a core having a plurality of segments of magnetic material movable endwise through said windings, means comprising a circuit controller for sequentially energizing said windings to effect movement of said core, means for operating said circuit controller comprising an electric motor, a circuit for initiating operation of said electric motor, and automatic limit means for stopping said motor after a predetermined operation thereof.

5. In a power applying and controlling mechanism, a solenoid having a plurality of separate windings, means comprising a rotary circuit controller for controlling the energizing of said windings in a sequence dependent upon its rotation, means for operating said circuit controller in either direction comprising a reversible electric motor, circuits for initiating operation of said electric motor in either direction, and a plurality of automatic limit switches operated by said circuit controller each arranged to stop said motor after a predetermined operation thereof.

6. In a power applying and controlling mechanism, including a solenoid having a plurality of separate windings adapted to be progressively energized in any one of a plurality of predetermined sequences, and a core having a plurality of segments of magnetic material movable endwise through said windings, the combination of a circuit controller for connecting said units to a common energizing circuit, means for operating said circuit controller for connecting said units in any one of a plurality of predetermined sequences and means comprising an electric circuit with switches for controlling the operation of said circuit controller and selecting the predetermined sequence of operation desired.

7. In a power applying, controlling and locking mechanism for operating a movable member, the combination of a solenoid having a plurality of windings, a core member cooperating therewith to produce a relative movement with respect thereto upon energization of said windings, means for applying the relative movement to a movable member including a rod adapted for pivotal attachment to the same, and magnetic latch mechanism for locking said core member against relative movement with respect to said solenoid except when one of said windings of said solenoid is energized.

8. A power applying, controlling and locking mechanism for operating a movable member comprising, in combination, a solenoid, a core member cooperating therewith to produce a relative movement with respect thereto upon energization of said solenoid, means for applying the relative movement to a movable member, and magnetic latch mechanism for locking said core member against relative movement with respect to

said solenoid except when said solenoid is energized.

9. In apparatus of the class described, the combination of a plurality of related windings, a core movable through said windings, and means for progressively energizing and progressively de-energizing said windings in a predetermined sequence to effect a substantially continuous pull on said core, and means for locking said windings and core against relative movement following the termination of its movement in one direction.

10. In apparatus of the class described, the combination of a plurality of related windings, a core movable through said windings, and means for progressively energizing and progressively de-energizing said windings in a predetermined sequence to effect a substantially continuous pull on said core, and means for locking said windings and core against relative movement following the termination of its movement in one direction, said locking means including devices for opening the circuit to said winding.

11. In apparatus of the class described, the combination of a plurality of related windings, a core movable through said windings, and means for progressively energizing and progressively de-energizing said windings in a predetermined sequence to effect a substantially continuous pull on said core, and means for locking said windings and core against relative movement following the termination of its movement in one direction, said locking means being automatically released when said energizing and de-energizing means is set in operation.

12. In apparatus of the class described, the combination of a set of related windings, a core movable through said windings, means for energizing and de-energizing alternate windings in a predetermined sequence, whereby said set of windings and core move relative to each other, and for de-energizing all of said windings at a predetermined position of said set of windings and core relative to each other.

13. In apparatus of the class described, the combination of a set of related windings, a core movable through said windings, means for energizing and de-energizing said windings in a predetermined sequence, whereby said set of windings and core move relative to each other, and for de-energizing all of said windings at a predetermined position of said set of windings and core relative to each other, and an armature associated with certain of said windings and provided with a locking element maintained in an in-operative position so long as any of the adjacent windings are energized but when said armature is released to engage said core.

14. In apparatus of the class described, the combination with a pair of relatively movable members, of a set of windings carried by one member and a core carried by the other member comprising a series of spaced segments, co-acting elements mounted on said members, respectively, and arranged to lock them against movement in one direction, a portion of the element mounted on the winding carrying member serving as an armature, whereby the windings when energized will operate said element and disengage it from the element mounted on the other member, and means for energizing and de-energizing alternate windings in a predetermined progressive sequence to effect relative movement between said windings and core in one direction, said means being movable in the opposite direction, whereby the predetermined sequence is reversed to effect relative movement between said windings and core in the opposite direction.

15. In apparatus of the class described, the combination of a set of windings, a core movable endwise through said windings in either direction, means operable in one direction to energize and de-energize said windings in a predetermined sequence to move said core in one direction and operable in the opposite direction to energize and de-energize said windings in a predetermined sequence to move said core in the other direction, and devices at opposite ends of said set of windings, each arranged to engage a portion of the core when the latter moves to a predetermined position.

16. In apparatus of the class described, the combination of a set of windings, a core movable endwise through said windings in either direction, means operable in one direction to energize and de-energize said windings in a predetermined sequence to move said core in one direction and operable in the opposite direction to energize and de-energize said windings in a predetermined sequence to move said core in the other direction, and means for automatically stopping said operating means at a predetermined position when moving in one direction.

17. In apparatus of the class described, the combination of a set of windings, a core movable endwise through said windings in either direction, means operable in one direction to energize and de-energize said windings in a predetermined sequence to move said core in one direction and operable in the opposite direction to energize and de-energize said windings in a predetermined sequence to move said core in the other direction, and means for automatically stopping said operating means at a predetermined position when moving in one direction, and breaking the circuit to all of said windings.

18. In apparatus of the class described, the combination of a set of windings, a core comprising spaced segments of magnetic material, supply mains for electric current, one of said mains being connected to all of said windings and a switch device connected to the other main and movable to complete the circuit through alternate windings in a predetermined sequence, and means for breaking the connection between said switch device and the adjacent main when said core has moved through a predetermined distance.

19. In apparatus of the class described, the combination of a set of windings, supply mains for electric current, one of said mains being connected to all of said windings and a switch device connected to the other main and movable to complete the circuit through said windings in a predetermined sequence, an electric motor for operating said device, and means for stopping said motor and for breaking the connection between said switch device and the adjacent main when said device has moved through a predetermined cycle.

In testimony whereof, I have hereunto subscribed my name.

HOWARD I. MORRIS.