

June 3, 1952

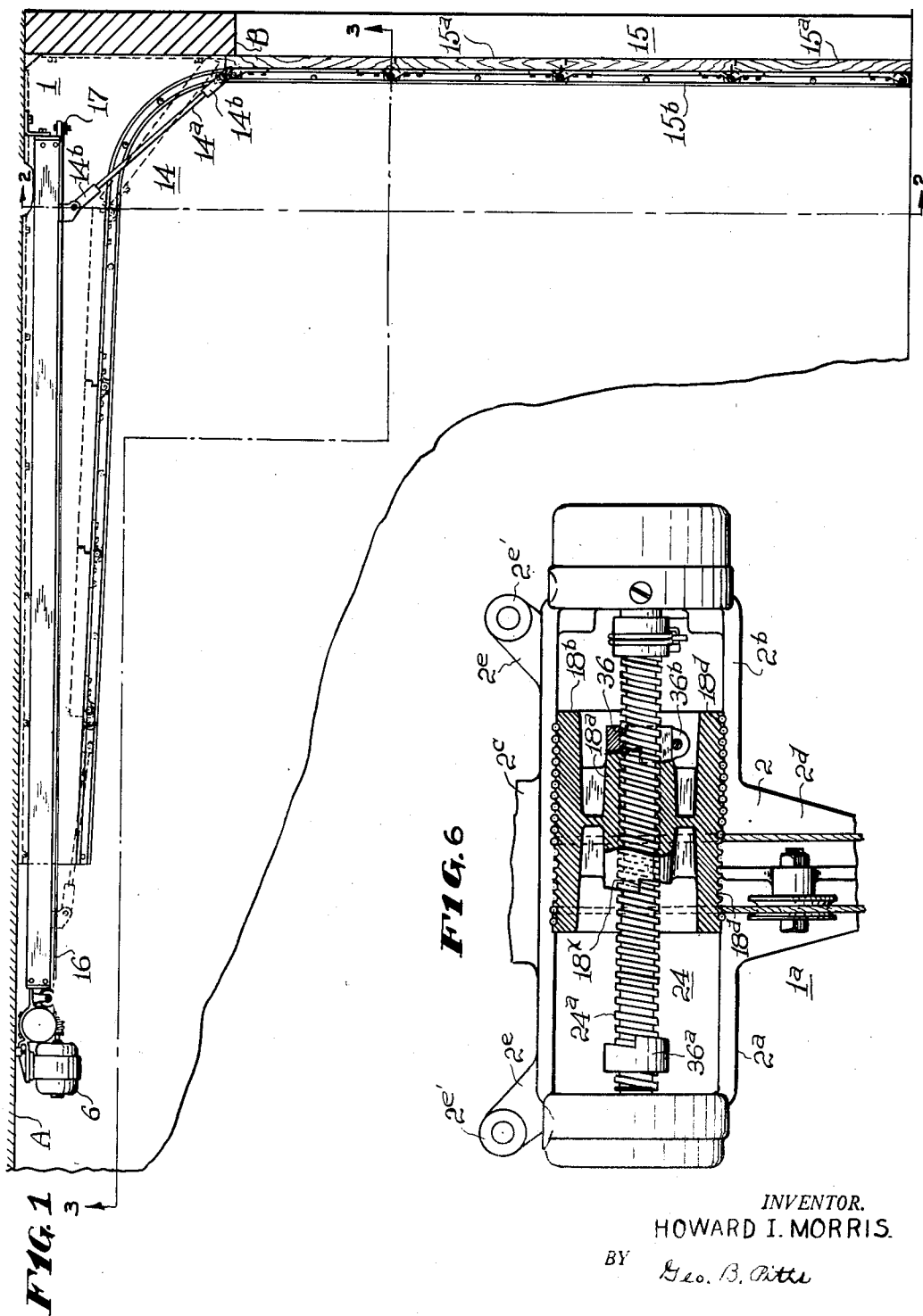
H. I. MORRIS

2,598,709

MECHANISM FOR OPERATING A CLOSURE FOR AN OPENING

Filed Jan. 5, 1950

10 Sheets-Sheet 1



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MECHANISM FOR OPERATING A CLOSURE FOR AN OPENING

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10 Sheets-Sheet 2

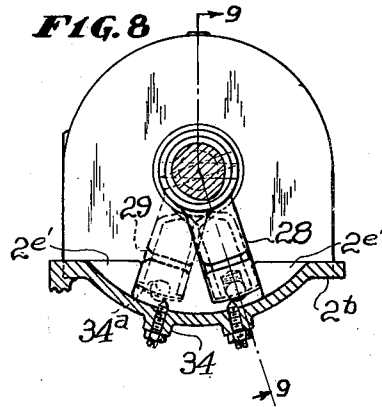
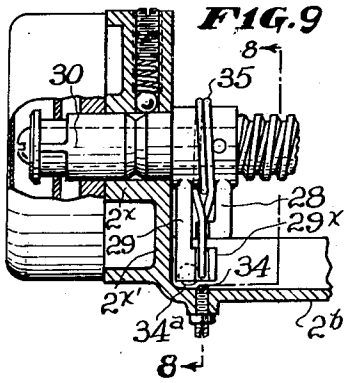
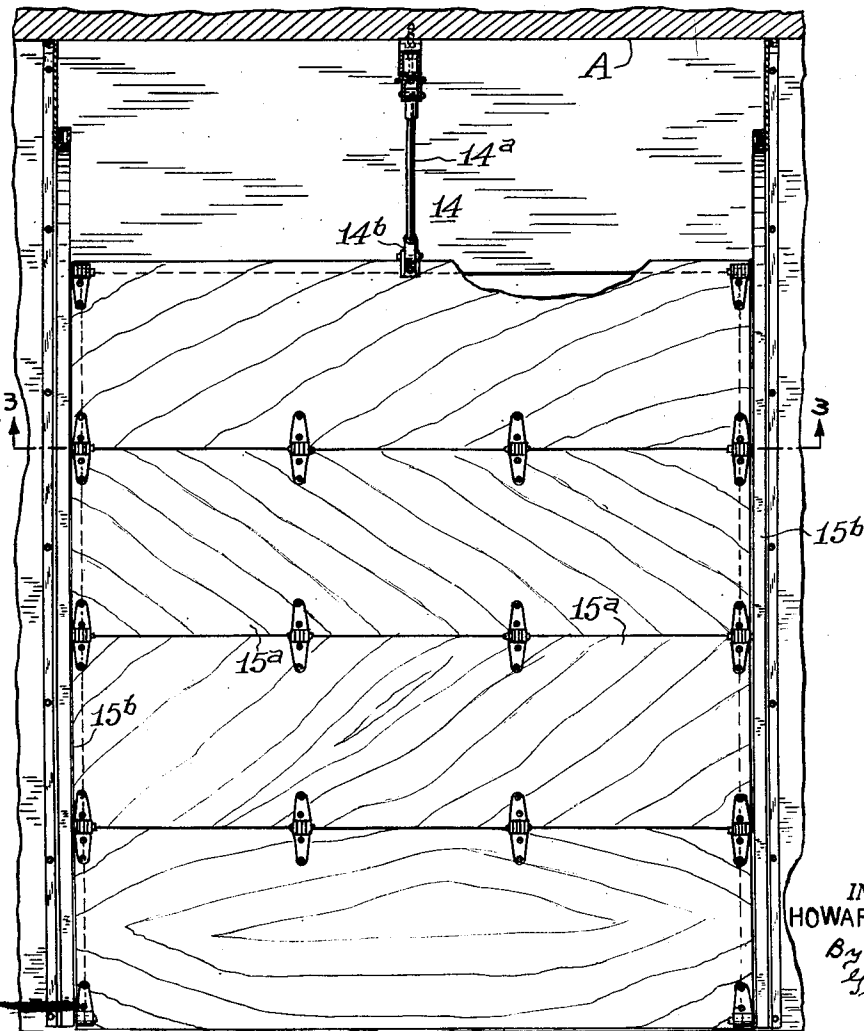


FIG. 2



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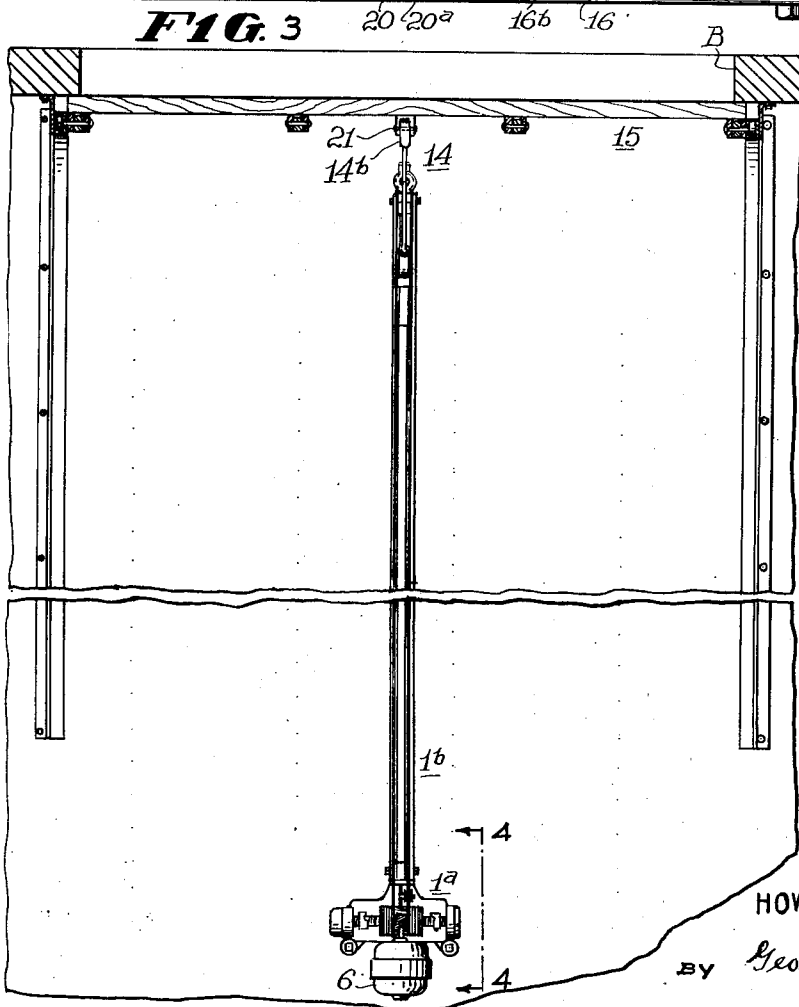
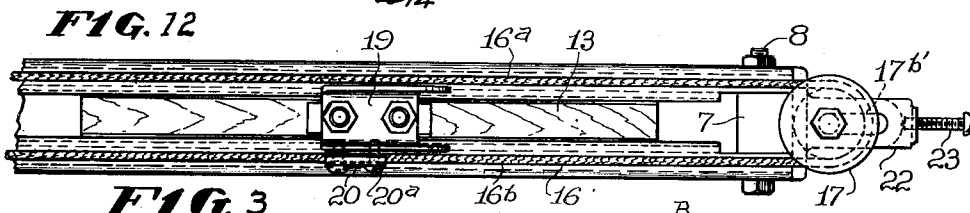
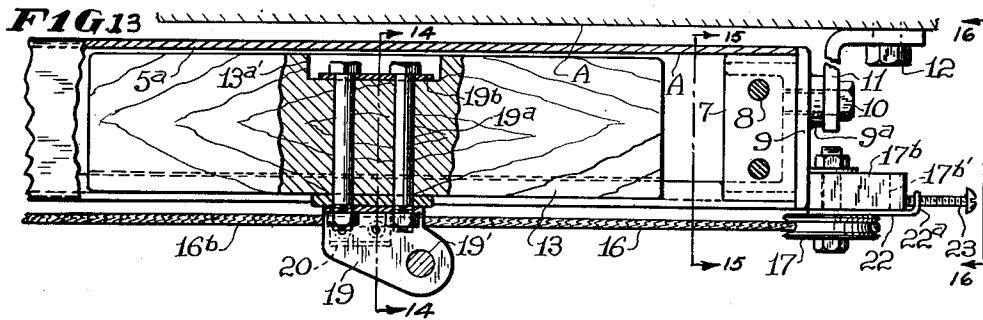
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10 Sheets-Sheet 3



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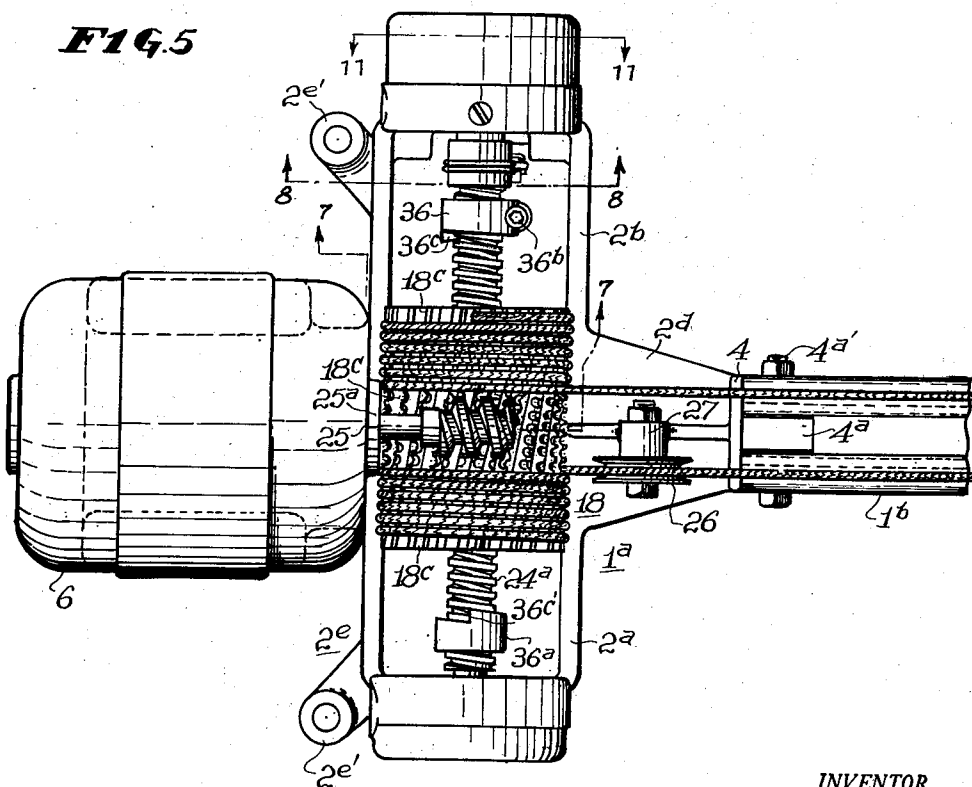
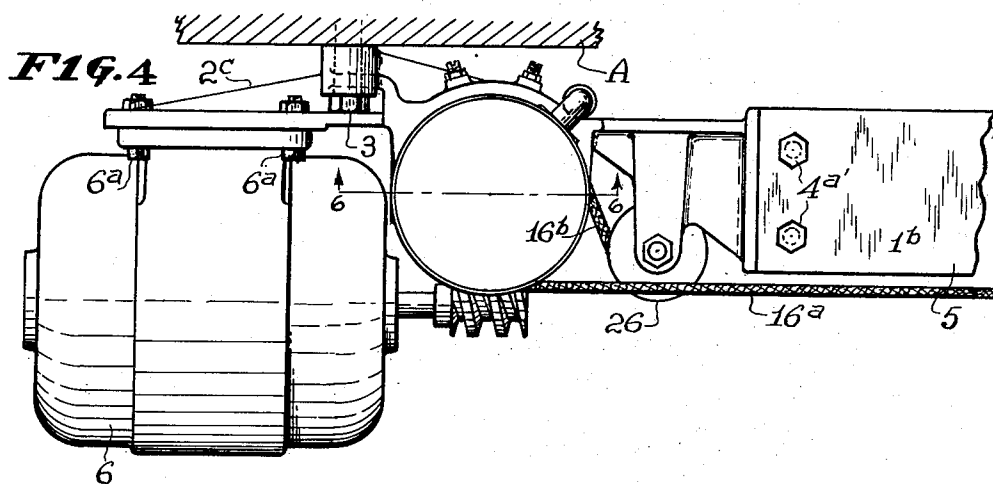
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MECHANISM FOR OPERATING A CLOSURE FOR AN OPENING

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10 Sheets-Sheet 4



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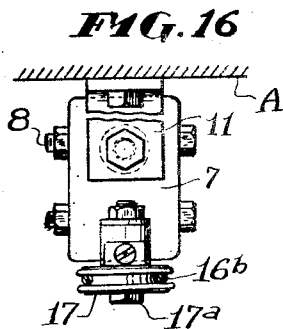
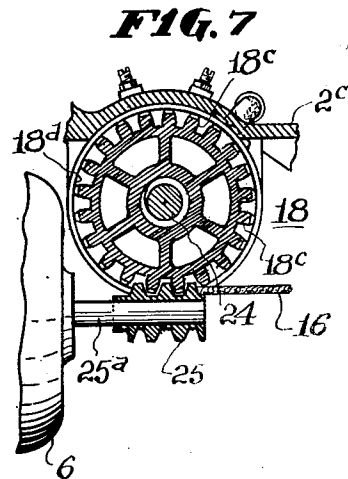
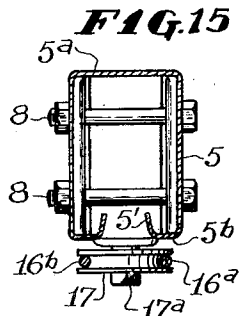
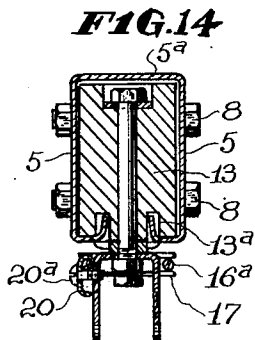
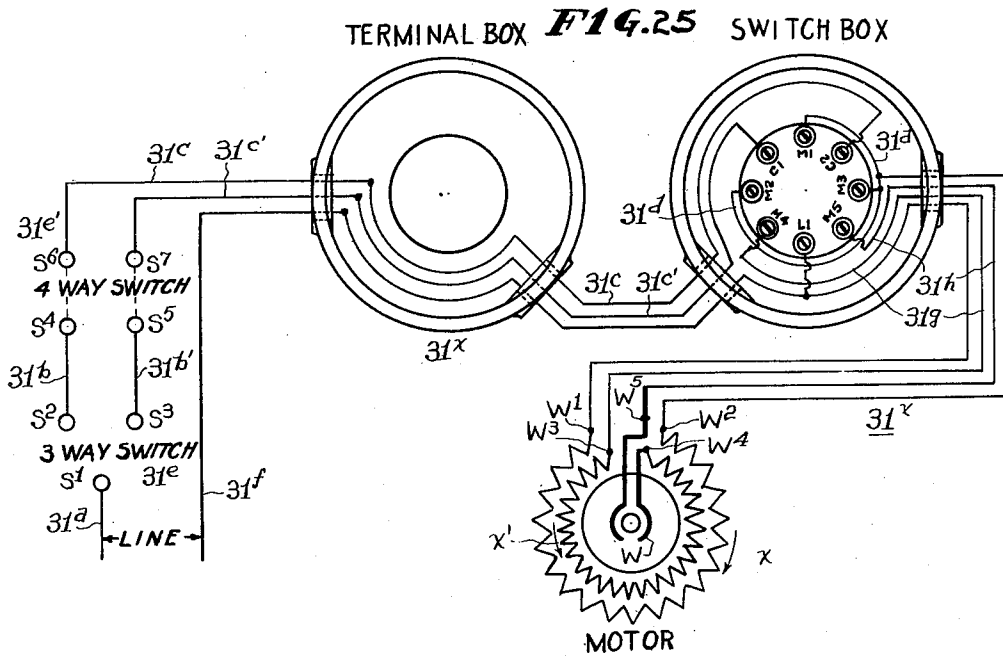
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MECHANISM FOR OPERATING A CLOSURE FOR AN OPENING

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10 Sheets-Sheet 5



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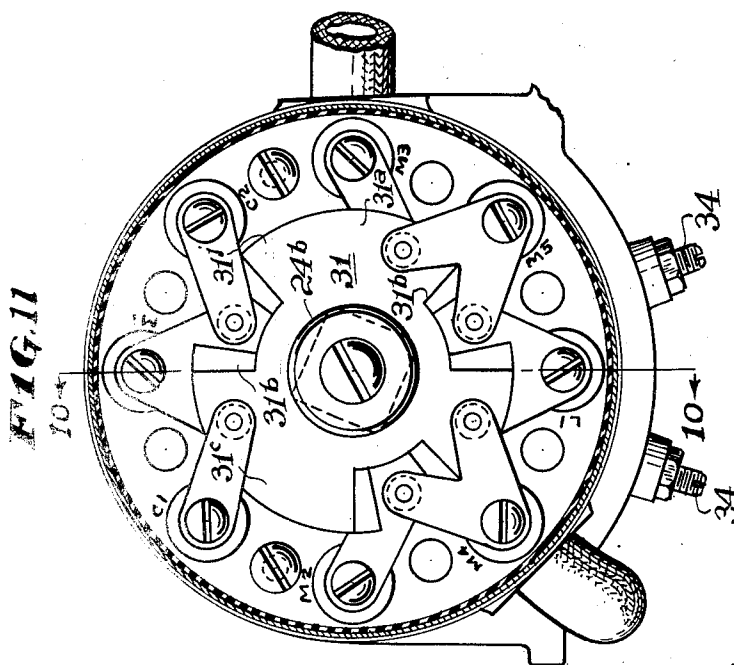
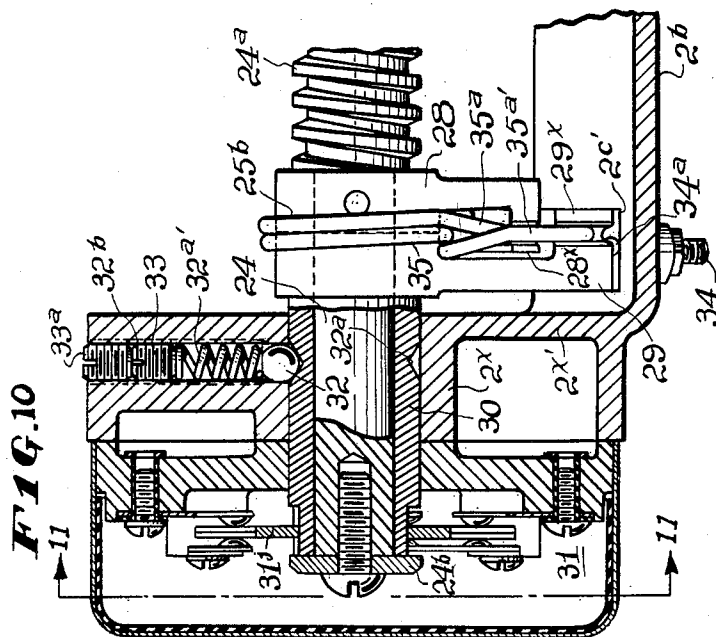
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MECHANISM FOR OPERATING A CLOSURE FOR AN OPENING

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10 Sheets-Sheet 6



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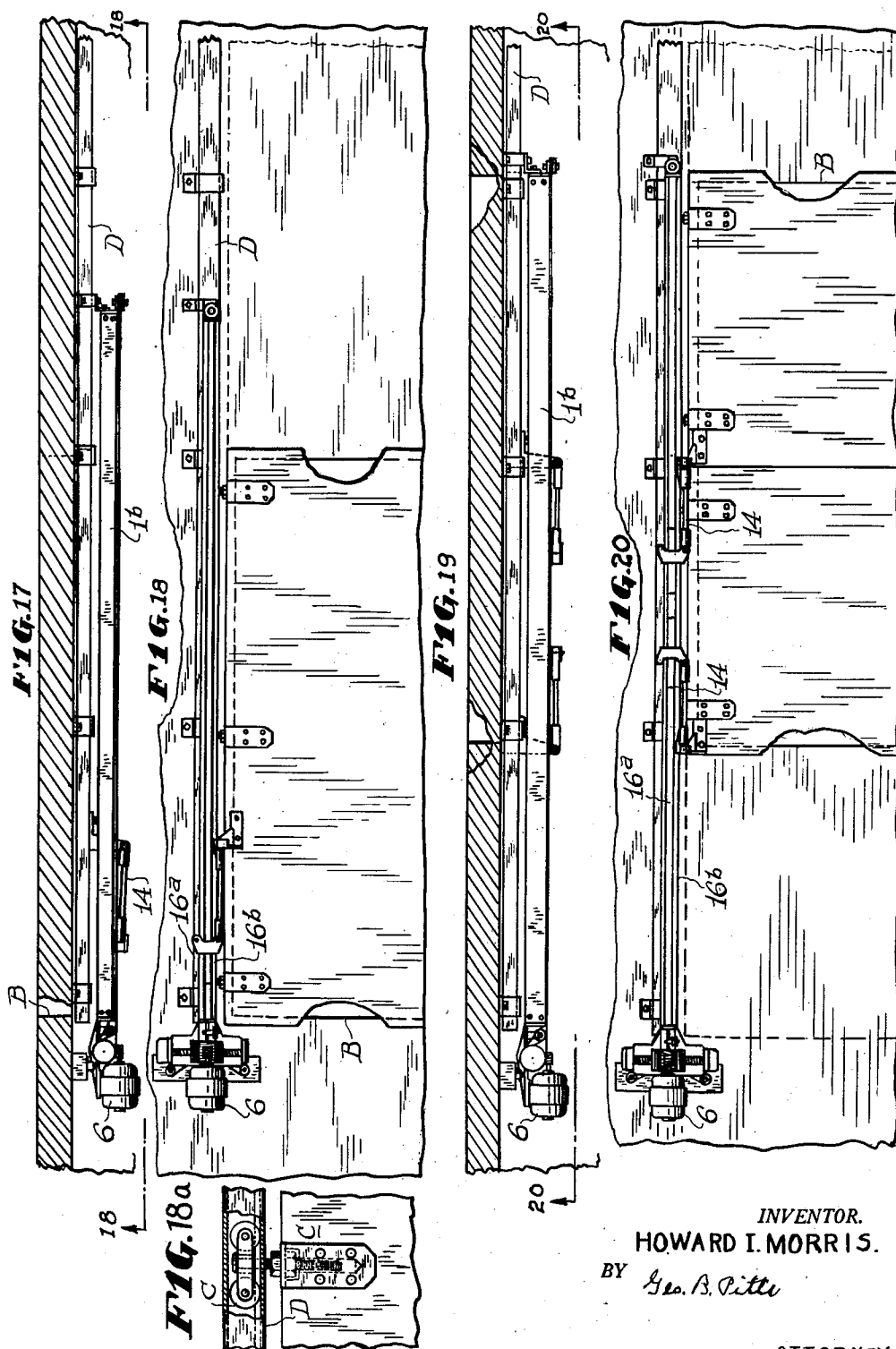
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MECHANISM FOR OPERATING A CLOSURE FOR AN OPENING

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10 Sheets-Sheet 7



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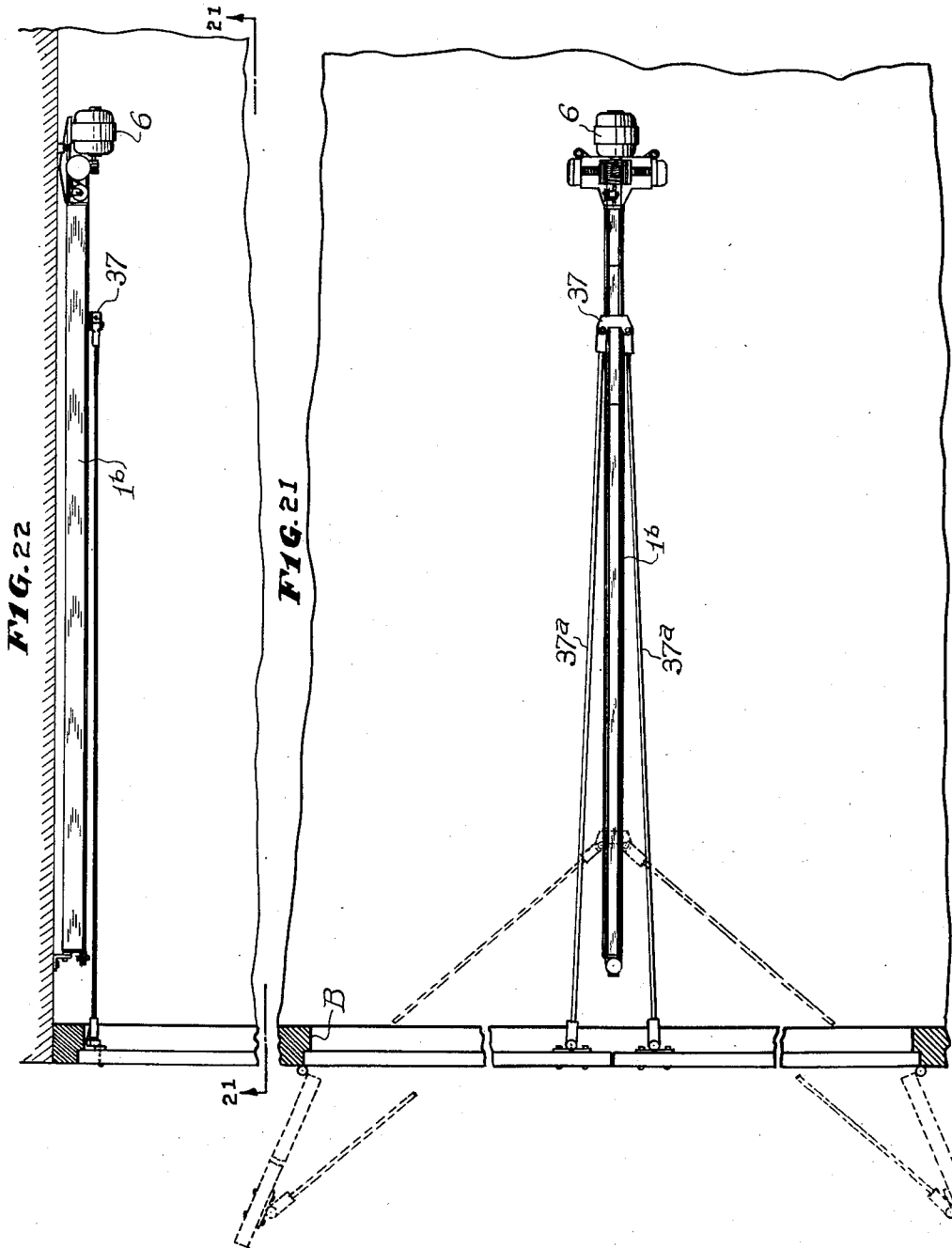
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10 Sheets-Sheet 8



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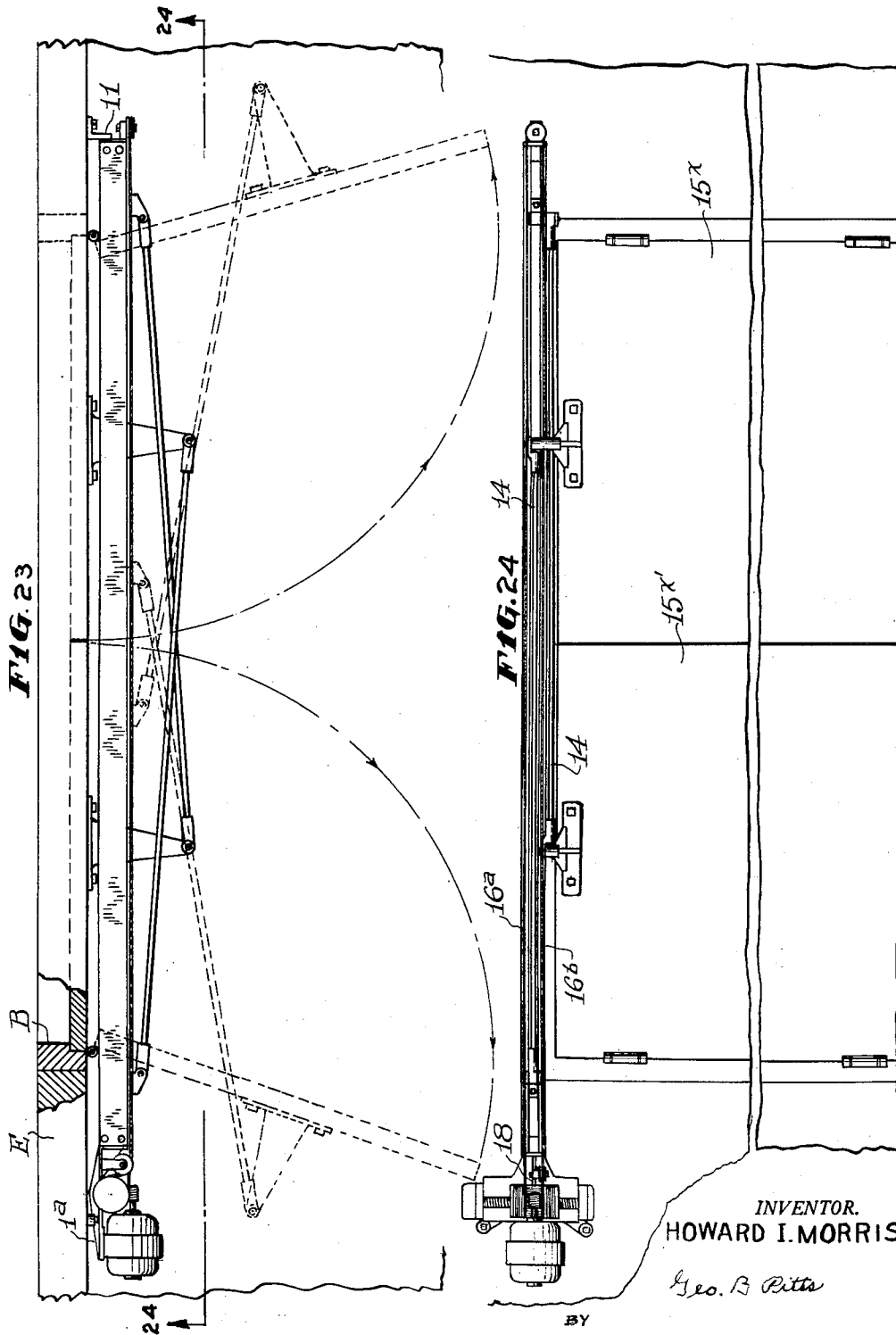
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FIG. 26

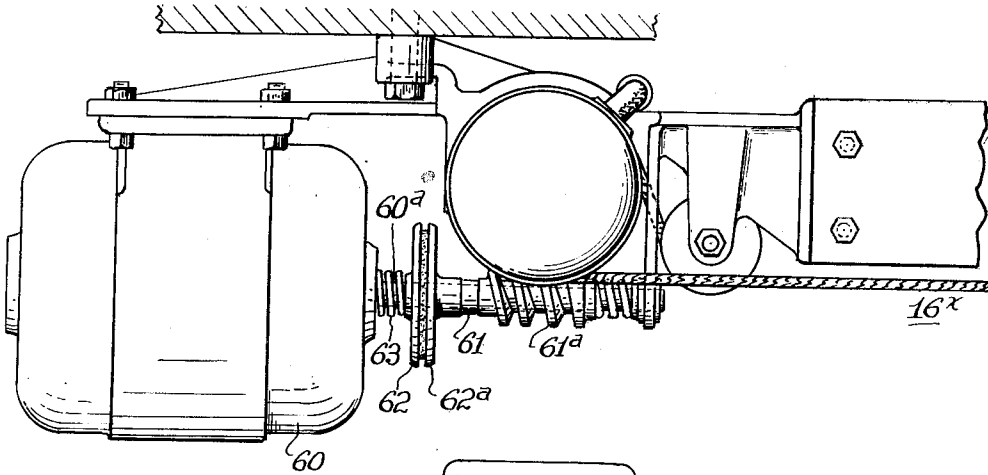


FIG. 27

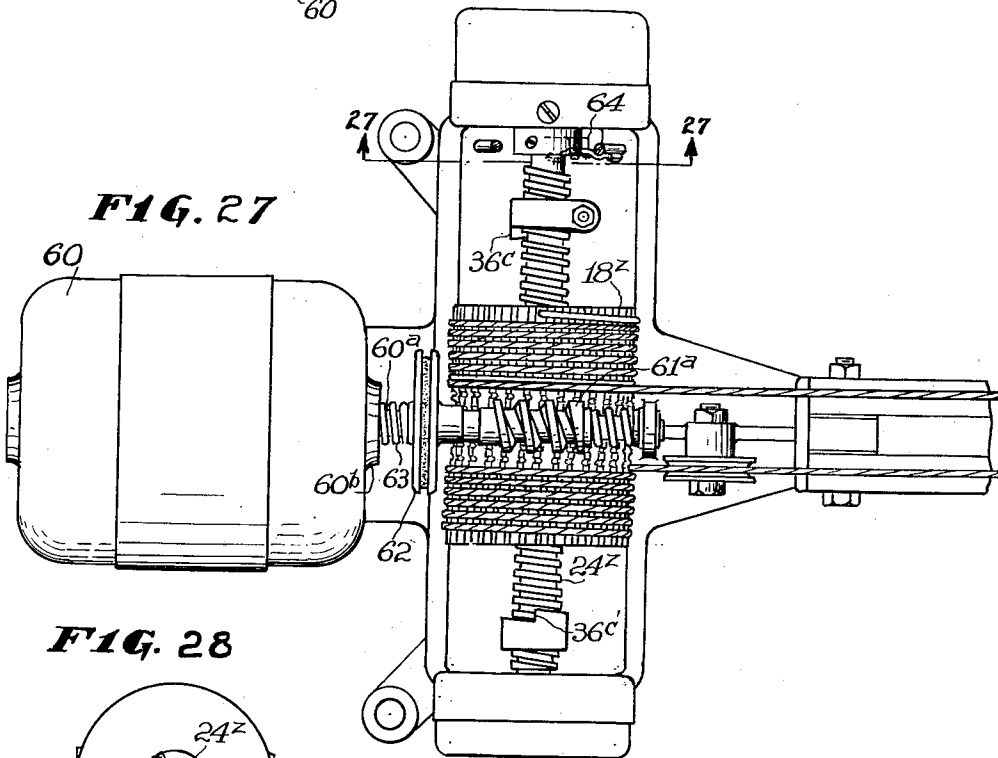
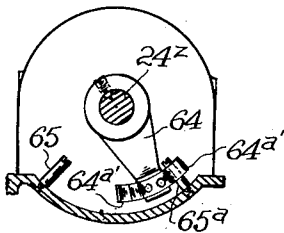


FIG. 28



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UNITED STATES PATENT OFFICE

2,598,709

MECHANISM FOR OPERATING A
CLOSURE FOR AN OPENING

Howard I. Morris, San Marcos, Calif.

Application January 5, 1950, Serial No. 136,940

16 Claims. (Cl. 268—59)

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This invention relates to a mechanism for operating a member which is mounted to move from one position to another position and back to its first position. For the purpose of illustrating one application of the invention, it is illustrated as applied to the operation of a closure for an opening, for example, a closure consisting of one or more members, referred to herein as a door or doors. The invention lends itself for application for various types of doors, namely, a vertically slidable door, a vertically slidable door consisting of connected together sections, a single or double horizontally slidable doors or a single or double swingable doors.

The mechanism includes a trolley connected to the door or doors and a flexible member having runs which are driven in one direction to effect movement of the door or doors to open position and in the opposite direction to close the door or doors. The mechanism also includes a flexible member connected to the door or doors, a motor and a combined power transmitting element and drum on which the runs of the flexible member simultaneously wind and unwind to effect movement of the door or doors in either direction. The mechanism also includes a track supported trolley connected to the door or doors, a flexible member, a motor and a drum-like member incorporated between the runs of the flexible member and the motor and drivingly connected to the latter and operating to take up and pay out the respective runs of the flexible member, the member being automatically moved axially relative to the motor and flexible member runs in either direction in coordinated relation to its rotative movement, whereby the runs of the flexible member are maintained in position to exert pull in a predetermined plane.

One object of the invention is to provide an improved operating mechanism applicable for connection to various types of slidable and hinge mounted doors.

Another object of the invention is to provide an improved mechanism for operating a movable member consisting of a simplified assembly including a motor and driving or operating means, adapted to be readily mounted in position and connected to the member with minimum labor and expense.

Another object of the invention is to provide in a power operated mechanism for moving a member to and from a predetermined position, an improved operating means between the motor and the connection with the member, consisting of a flexible member having runs one of which is connected to the member and a rotatable element between the runs of the flexible member and the motor, drivingly connected to the latter, and arranged to take up and pay out the flexible member, when the element is driven in either direction.

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Another object of the invention is to provide in a motor operated mechanism for moving a door or doors to open and closed positions, an improved operating means between the motor and the connection with the door or doors, consisting of a flexible member connected to the door or doors, and an elongated element rotatable about and movable on an axis at right angles to the motor shaft, the element consisting of a drum on which the runs of the flexible member wind and unwind and having peripheral gear elements in mesh with complementary gear elements on the motor shaft.

Another object of the invention is to provide in a motor operated mechanism for moving a door or doors to open and closed positions, an improved operating means consisting of circuit control devices for the motor, a flexible member, having a connection with the door or doors and a rotatable member on which the runs of the flexible member wind and unwind, disposed at right angles to and driven by the shaft of the motor, the rotatable member being provided axially with a nut engaging a screw, whereby the rotatable member, when driven, moves endwise to operate said control devices.

Another object of the invention is to provide in a motor operated mechanism for moving a door or doors to open and closed positions, an improved operating means between the motor and door or doors and having a track supported trolley connected to the door or doors, a flexible member and a power member on which the runs of the flexible member wind and unwind, rotatable on an axis at right angles to the motor shaft and having driving connection with the latter, said power member being mounted to float endwise during rotation while maintaining driving connection with the motor shaft to effect spirally related convolutions of the flexible member on the power member as either run of the flexible member winds on the latter.

Another object of the invention is to provide an improved means of simplified construction including a driven drum on which the end portions of a flexible member simultaneously wind and unwind, the direction of rotation of the drum being reversible to effect the operation of a movable member to and from a predetermined position.

A further object of the invention is to provide an improved drive mechanism for the runs of a flexible member having a rotatable dual functional device provided with power transmitting elements in mesh with complementary elements on the motor shaft and peripheral guide elements for the runs of the flexible member when each run winds on the device.

A still further object of the invention is to provide an improved motor driven mechanism for the runs of a flexible member consisting of a

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feed screw, a nut engaging the screw and provided with an outer wall having helically shaped elements providing a worm gear in mesh with a worm on the shaft of the motor, each helically shaped element being formed with side by side transverse recesses related to the recesses of adjoining elements, to provide seats for the convolutions of the flexible member, the driving of said nut by the motor serving to feed the nut endwise of the screw to maintain the seats in winding and unwinding relation to the runs as the latter wind on and off of the annular wall.

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 fragmentary sectional view of a house or garage showing a mechanism embodying my invention installed therein and connected to a vertically slidable door consisting of connected together panels;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is a section on the line 3—3 of Figs. 1 and 2;

Fig. 4 is a fragmentary section on the line 4—4 of Fig. 3, enlarged;

Fig. 5 is a bottom plan view of the parts shown in Fig. 4;

Fig. 6 is a fragmentary bottom plan view of parts shown in Fig. 4, partly in section on the line 6—6 thereof;

Fig. 7 is a fragmentary section on the line 7—7 of Fig. 5;

Fig. 8 is a section on the line 8—8 of Figs. 5 and 9;

Fig. 9 is a section on the line 9—9 of Fig. 8;

Fig. 10 is a fragmentary view partly in section (enlarged) on the line 10—10 of Figs. 5 and 11;

Fig. 11 is a section on the line 11—11 of Fig. 10;

Fig. 12 is a fragmentary bottom plan view of parts shown in Figs. 1, 3 and 13;

Fig. 13 is a fragmentary section on the line 13—13 of Fig. 14;

Figs. 14 and 15 are sections on the lines 14—14 and 15—15, respectively, of Fig. 13;

Fig. 16 is an elevational view on the line 16—16 of Fig. 13;

Fig. 17 is a plan view showing the mechanism connected to a horizontally slidable door;

Fig. 18 is a fragmentary view on the line 18—18 of Fig. 17;

Fig. 18a is a fragmentary view of parts shown in Figs. 17 and 18, portions being broken away;

Fig. 19 is a plan view similar to Fig. 17 but showing the mechanism connected to two horizontally slidable doors;

Fig. 20 is a fragmentary view on the line 20—20 of Fig. 19;

Fig. 21 is a bottom plan view on the line 21—21 of Fig. 22, showing the mechanism connected to doors mounted to swing outwardly;

Fig. 22 is a side elevation of parts shown in Fig. 21;

Figs. 23 and 24 are views similar to Figs. 21 and 22, respectively, but wherein the doors swing inwardly;

Fig. 25 is a diagram of the motor circuit;

Fig. 26 is a view similar to Fig. 4 but embodying a modification;

Fig. 27 is a bottom plan view of parts shown in Fig. 26; and

Fig. 28 is a section on the line 28—28 of Fig. 27.

In the drawings, 1 indicates as an entirety

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means for supporting the various parts (except the manually operated switch) for operating a door or doors. In the arrangement shown, referring particularly to Figs. 1 to 25, inclusive, the means 1 consist of a casting 1a and a channel member 1b rigidly secured at its inner end to the casting 1a. This arrangement provides for a unitary assembly of the driving and operating means, so that shipment of the complete mechanism and mounting thereof on the ceiling A, rafters or other overhead members, within a building, are facilitated.

The casting 1a is shaped to form a body 2 having oppositely extending wings 2a, 2b, and oppositely extending supporting arms 2c, 2d, disposed at right angles to the wings 2a, 2b. The inner sides of the wings 2a, 2b, adjacent their outer ends, are provided with brackets 2e, which terminate in hollow bosses 2e'. The bosses 2e' accommodate suitable bolts or screws 3 to secure the casting to the ceiling A. The arm 2d is provided with a vertical wall 4 having an extension 4a on its outer side. The extension 4a telescopes into the inner end of the channel member 1b to form a spacer between its side walls 5, so that by means of a plurality of bolts 4a' the channel member 1b is rigidly secured to the arm 2d of the casting 1a. The other arm 2c, which is preferably aligned with the arm 2d, provides a base to which a suitable motor 6 is rigidly secured by bolts 6a. The outer end of the channel member 1b is connected to the ceiling A by the following instrumentalities (particular reference being made to Figs. 12, 13, 14, 15 and 16): 7 indicates a cup-shaped member telescoped within the outer end of the channel member 1b. The member 7 is of a size to closely fit the inner walls of the channel member 1b, to prevent distortion thereof and to enable its side walls 5 to be rigidly secured to the cup-shaped member 7 by suitable devices, such as bolts 8. The bottom wall of the member 7 is provided with a rim 9, which engages the end wall of the member 1b, and a boss 9a on its outer face. A cap screw 10, which extends through an opening formed in one end portion of an angle 11, is threaded into an opening formed in the boss 9a and bottom wall of the member 7 to rigidly secure the angle 11 to the latter. The opposite end portion of the angle 11 is secured to the ceiling A by a bolt or screw 12, and co-operates with the brackets 2e and screws 3 to mount the unitary assembly on the ceiling A.

The channel member 1b consists of a top wall 5a and side walls 5 (already referred to) having intumed bottom walls 5b terminating in upwardly extending flanges 5' (see Figs. 14 and 15), which are spacedly related to form an opening extending longitudinally of the channel member 1b, preferably from end to end thereof, for a purpose later apparent. The walls 5, 5a, 5b, form a track-way or guide for a trolley 13. The trolley 13 consists of an elongated member, preferably formed of wood, the bottom wall of the trolley being formed with recesses 13a extending from end to end thereof, to accommodate the flanges 5'. If desired, rollers mounted in the bottom wall of the trolley may be employed to reduce friction between the trolley and walls of the guide 1b. The trolley 13 is connected by a linkage, indicated as an entirety at 14, to a door 15 in the manner later set forth, the door in the form of construction being described consisting of a series of hingedly connected sections 15a slidably mounted in spaced, parallelly related channels

15b preferably similarly to that shown in my Letters Patent No. 1,954,825, dated April 17, 1934, for movement endwise of the channels. The trackway 1b may be of any desired length dependent upon the length of movement of the door or doors to and from their open position. By preference, the trackway 1b is of sufficient length to accommodate a trolley employed for operating doors for various sizes of openings, but may be of a lesser length, when found desirable, dependent on the travel of the door to be operated. As shown, the trolley 13 is operated endwise of the trackway 1b by a flexible member 16, preferably a wire cable or rope, the trolley being anchored to the cable 16, as later set forth, and the latter being operated in one direction to effect movement of trolley 13 in a direction to open the door 15 and in the opposite direction to close the door 15. In employing this form of reciprocating means to open and close the door or doors, the trolley 13 is preferably elongated to insure a large sliding area between it and the walls of the trackway or guide 1b to reduce or eliminate danger of vibrations being set up in the cable 16 and affecting the movement of the adjacent door. The cable 16 is reeved around a pulley 17 mounted at the outer end of the trackway 1b to provide two parallelly related runs 16a, 16b, disposed adjacent to the trackway or guide 1b and extending toward the casting 1a, the end portions of the cable 16 being arranged to simultaneously wind on and off a rotatable and endwise movable member, indicated as an entirety at 18, the member, by preference, being positively moved endwise during its rotation, as later set forth.

In the arrangement being described, the door opening B is provided with a single door, so that an operating connection is provided between one of the runs of the cable 16 and the door, but as later set forth, in some installations employing two doors, it may be desirable to connect each run of the cable to one of the doors.

The anchor between one run of the cable 16 (run 16b) and the trolley 13 preferably consists of a U-member 19 the bottom wall of which is secured to the bottom of the trolley 13 by a pair of bolts 19a. The bolts 19a extend through the trolley, the heads of the bolts engaging a plate 19b seated in a recess 13a' formed in the upper side of the trolley 13 (see Fig. 13). The end portions of the legs of the U-member 19 are formed with alined openings to receive and support the opposite ends of a pivot 19', to which the adjacent end of the linkage 14 is connected, as shown in Figs. 1 and 2. As shown in the Figs. 12 and 14, the runs 16a, 16b, are disposed at opposite sides of the U-member 19, so that either run may be connected thereto, this connection consisting of a plate 20 one end portion of which engages the run 16a, whereas its other end portion is bent inwardly and engages the adjacent U-member leg, so that by means of one or more screws 20a extending through openings in the intermediate portion of the plate 20 and threaded into the adjacent U-member leg, the adjacent cable run is secured to the latter.

The linkage 14 preferably consists of a rod 14a, provided with a connector 14b at each end, the connector at the inner end of the rod 14a being connected to the pivot 19' and the connector 14b at the outer end of the rod being connected to a pin mounted in a U-member 21 fixed to the upper end door panel or section 15a of the door intermediate its ends, as shown in Fig. 3.

Where the door 15 consists of a series of panels

or sections 15a, as shown in Figs. 1, 2 and 3, the trackway 1b extends at right angles to the plane of the opening or doorway B and is disposed midway between and parallel to the guides for the door panels, as shown in Fig. 3.

The pulley 17 is mounted on a shaft 17a supported on a bracket 17b which is suitably fixed to the plate 9 adjacent its lower end. The shaft 17a preferably consists of a bolt extending through an elongated opening 17b' formed in the bracket 17b. The outer portion of the bolt shank is reduced to form a shoulder arranged to engage the bottom wall of the bracket when the nut 17c is tightened in position. As shown, the opening 17b' is elongated along an axis co-incident with the axis of the trackway or guide 1b, so that by loosening the nut 17c, the bolt 17a can be adjusted to take up slack in the cable runs 16a, 16b.

By preference, I provide a plate 22 movably supported between the hub of the pulley 17 and bracket 17b, the plate being formed with an opening through which the bolt 17a extends. The plate 22 extends outwardly beyond the bracket 17b and is bent upwardly to form a flange 22a, which mounts a screw 23. As shown in Fig. 13, the screw 23 may be operated to engage the outer end of the bracket 17b, so that if the nut 17c is loosened and the screw 23 is turned to apply pressure on the bracket 17b, the flange 22a will operate as a nut and operate through the plate 22 to adjust the bolt 17a outwardly, whereby the cable run 16a, 16b will be tensioned between the pulley 17 and the member 18.

The member 18 is mounted on a shaft 24 extending at right angles to and laterally to either side of the trackway. The opposite ends of the shaft 24 are mounted in suitable bearings 2x provided on the end walls 2x' for the wings 2a, 2b (one bearing only being shown in Fig. 10), whereby the shaft may be oscillated an angular distance for a purpose later set forth.

In the form of construction shown, the shaft 24 is provided between the end walls 2x' with screw threads 24a and the inner wall of the hub 18a of the member 18 is provided with screw threads, as shown in Fig. 6, the hub serving as a nut, so that when the member 18 is rotated it is positively moved endwise for purposes later set forth. The annular wall 18b of the member 18 is elongated axially and its outer surface is provided circumferentially with power transmitting elements 18c extending from end to end of the wall 18b (see Fig. 5). The power transmitting elements are preferably of helical form, thereby constituting a worm gear. As shown in Figs. 5 and 7, the power transmitting elements 18c have meshing relation with a worm 25 fixed to the shaft 25a of the motor 6. Also, as shown in Figs. 5 and 7, the face or land of each of the power transmitting elements 18c throughout its length is provided with a plurality of recesses 18d, preferably of curvilinear shape in cross section corresponding to the diameter of the cable or rope 16. As shown in Fig. 5, the axes of the recesses 18d in each element 18c are disposed at an angle to an imaginary plane extending at an angle to the axis of the member 18, so that the respective recesses 18d in each element 18c form with corresponding recesses 18d, in adjoining elements 18c, throughout the circumference of the wall 18b, a series of helically disposed seats, for the wire rope runs, as either thereof winds on the member 18 during rotation of the latter in either direction. The pitch of the helically related seats 18d corresponds to the hand and pitch of the

screw threads 24a on the shaft 24, so that in each revolution of the member 18 it is moved endwise, according to the direction of its rotation, one pitch. As a result of this endwise movement, when the member 18 is being rotated, one run of the flexible member 16 is winding on the member 18 and the other run thereof is unwinding from the member 18, but as the latter simultaneously moves endwise at a right angle to the runs in co-ordinated relation to its rate of angular or rotational movement, the runs remain in parallel relation to the trackway and move rectilinearly to avoid side or lateral pull on the trolley during movement thereof endwise of the trackway 1b in either direction.

The reason for the threaded shaft and the helical groove, also the necessity of them being the same pitch and hand, is this; if the member 18 did not travel endwise while the cable was winding on and off the member, the cable runs would travel sidewise, but because the member 18 travels sidewise as fast as the number of the convolutions of the cable runs increase and decrease sidewise and in the opposite direction, the cable runs remain in fixed positions relative to the trackway at all times, regardless of which way the member may be rotated. This fixed position of the cable runs relative to the trackway is necessary in order that the cable runs, which travel along the bottom side of the trackway, may always be in alignment with the latter, as the function of the cable is to pull the trolley along the track and it is not desirable that the cable should pull sidewise on the trolley, as this would set up excessive friction.

This form of drive mechanism between the motor shaft and the cable runs is advantageous since the worm 25 in rotating the member 18 in either direction does not make contact with any point or spot on the power transmitting elements or helical teeth 18c of the member 18 but once. Thus, the wear on the teeth 18c is reduced to a minimum, because the wear is distributed over a large amount of surface, the same as though the gear were large in diameter and had a large number of teeth.

In the mechanism heretofore built and operated by me, the member 18 is provided with 21 teeth 18c and makes 18 revolutions in each complete operation in either direction, the equivalent of a gear having 378 teeth; or in other words, the member 18 herein will have a life 18 times longer than an ordinary worm gear having the same number of teeth.

As shown in Fig. 5, the end portions of the runs 16a, 16b, are wound on the opposite end portions of the member 18 and the worm 25 engages the teeth 18c in the space between these wound portions of the runs 16a, 16b. However, from the foregoing description it is to be noted that in rotating the member 18 in either direction, whereby one run winds on the member and the other run unwinds therefrom, it moves endwise in each revolution a distance equal to the width of a convolution of each run, so that while the number of convolutions of one run are increasing on one end portion of the member 18, an equal number of convolutions of the other run is decreasing on the other end portion of the member, the result being that the width of the space between the run convolutions remains the same and the worm 25 has continuous driving relation with the teeth 18c in this space.

As shown in Fig. 4, the run 16a of the rope 16 leads to and from the lower side of the mem-

ber 18, whereas the other run 16b leads to and from the upper portion of the member 18. To support the run 16b below and in operative relation to the trackway 1b, I provide a pulley 26 in alignment with the run 16b, the shaft 26a for the pulley being mounted in a boss 27 integrally connected to the arm 2d between the member 18 and the inner end of the trackway 1b.

Suitable limit mechanism may be provided for stopping the motor 6 when the door approaches or reaches its open position and its closed position, such mechanism preferably being constructed to reverse the direction of rotation of the motor, so that a simplified switch for the motor circuit may be employed. One form of limit mechanism is shown in Figs. 6, 10, 11 and 25.

In this form of construction the shaft 24 is arranged to oscillate and also move endwise in the bearings 2x for a purpose later set forth. Referring to these views, the shaft 24 is extended beyond its bearing 2x on the end wall 2x' for the wing 2b, for a purpose later apparent. 28 indicates an arm having a hub suitably keyed to the shaft 24 inwardly of the end wall 2x' for the wing 2b. 29 indicates a separate arm somewhat longer than the arm 28 and having a hub 29a free to rotate on the shaft 24. As shown in Fig. 10, the arm 29 is mounted between the arm 28 and the adjacent end wall 2x' and its hub 29a is suitably connected to the inner end of a sleeve 30 extending outwardly and surrounding the shaft between it and the adjacent bearing 2x to operate a switch mechanism indicated as an entirety at 31. The outer end of the shaft 24 has fixed to it a disk 24b engaged by the outer end of the sleeve 30; as the sleeve 30 and the hub 29a of the arm 29 have a combined length equal to the space between the hub of the arm 28 and disk 24b, it will be observed that the shaft 24 and sleeve will move endwise as a unit, but such movement in either direction is yieldably resisted by means of a spring biased ball 32 normally seated in an annular substantially V-shaped recess 32a formed in the outer surface of the sleeve 30, but permits the shaft 24 to move endwise, as later set forth. As shown in Fig. 10, the spring 32a' for biasing the ball is mounted in an inwardly radially extending opening 32b formed in the adjacent end wall 2x' and bearing 2x and its outer end is engaged by a screw 33 (engaging an inner threaded portion of the opening 32b), whereby the tension of the spring may be adjusted to increase or decrease the pressure on the ball 32. The screw 33 is locked by an outer screw 33a threaded into the outer portion of the opening 32b. The shaft 24 is oscillated in the manner later set forth. The movement of the arm 29 is limited in either direction by lugs 2c' (Figs. 6 and 10) spaced approximately 45 degrees and formed integrally on the inner wall of the wing 2b and yieldably locked in each position by spring operated latch means, shown in Figs. 8 and 9. The latch means consist of the following: 34 indicates inwardly extending latch elements mounted on the wing 2b between the limiting lugs 2c' and in alignment with the path of movement of the off-set 29x on the arm 29. Each element 34 preferably consists of a threaded member endwise adjustably mounted in a screw threaded opening formed in the wing 2b, the axis of the opening being disposed radially of the shaft 24. The inner end of each element 34 is arranged to be engaged by a spring operated ball 34a mounted in a recess formed in the end of the arm 29, whereby the arm 29 is yieldably

locked in either position by the adjacent element 34; the ball 34 being arranged to yield against the tension of its operating spring, when pressure or tension exerted on the arm in a direction to move it to its other position is sufficient to overcome that applied to the ball 34a, so that the arm 29 may be moved to its other position and yieldably locked by the other latch element 34. As will be observed, when the arm 29 is moved from either position to the other position the ball 34a rides the adjacent element 34 so as to engage its outer side.

The arms 28, 29, are connected together by a spring 35 having intermediate its end portions 35a, 35a', loops 35b which surround one or both hubs of the arms 28, 29. The terminating end portions 35a, 35a' of the loops extend outwardly and are bent laterally in opposite directions, one relative to the other, so as to respectively engage the opposite outer sides of off-sets 28x, 29x, provided on the opposed faces of the arms 28, 29, respectively, adjacent their outer ends. Thus, the arms 28, 29, are connected together in side by side relation, but when the arm 28 is operated in either direction, due to the rotative movement of the shaft, the end portion 35a of the spring 35 moves with the arm and establishes a tension on the other end portion 35a' and when the tension between the spring arms 35a, 35a', is sufficient to overcome that on the ball 34a, the arm 29 is released from the adjacent element 34 and moves to its other position with a snap action.

The means for oscillating the shaft 24 to effect movement of the arm 28 in either direction consist of the following: 35, 35a, indicate collars adjustably fixed to the shaft 24 inwardly of the arm 28 and the end wall 2x' for the wing 2a. The collars 36, 36a, are preferably internally threaded and mesh with the screw threads 24a, so that rotation of each collar will effect its adjustment longitudinally of the shaft 24. However, the inner diameter of each collar 36, 36a, may be of a size to slidably fit the screw threads 24a to permit its adjustment longitudinally of the shaft 24. Each collar 36, 36a, is preferably of the split type and clamped to the screw threads by a bolt 36b. The inner faces of the collars are provided with shoulders 36c, 36c', respectively. As the collars 36, 36a, are independently adjustable longitudinally and rotatively of the shaft 24, the shoulder on each collar may be set to stop the motor at a predetermined position of the door. As shown in Fig. 6, each end of the nut 18a is provided with a tooth 18x arranged to engage the adjacent shoulder (36c or 36c'), when the member 18 moves endwise, as already set forth, and effect rotative movement of the shaft 24, whereby the arms 28, 29, are operated as above described and the latter arm, through the sleeve 30 operates the switch mechanism 31 to stop the motor 6 and reverse the circuit connections therefor, so that upon closing of the circuit to operate the door in the opposite direction, the direction of rotation and endwise movement of the member 18 will be reversed.

As will be observed, the collars 36, 36a, are spacedly fixed to the shaft 24 so that the shoulder on one collar is engaged by the tooth 18x on the adjacent end of the nut 18a when the door moves to its open position and the shoulder on the other collar is engaged by the tooth 18x on the adjacent end of the nut 18a when the door moves to its closed position. Accordingly, (a) when the member 18 reaches the end of its travel endwise of the

shaft 24 in one direction, it rotates the latter in one direction and when the member 18 reaches the end of its endwise movement in the other direction it rotates the shaft 24 in the opposite direction and (b) such rotation of the shaft in either direction serves to operate the arms 28, 29, as already set forth.

The switch mechanism 31 consists of the following: 31a indicates a disk formed of fiber the marginal portion of which is formed with substantially uniformly spaced recesses 31b, the latter forming lands 31c therebetween disposed in a plane between sets of electrical contacts. The disk 31a is formed axially with a non-circular opening the wall of which slidably fits a complementary shaped portion on the outer end of the sleeve 30, whereby the disk rotates with the latter when the arm 29 is operated in either direction as already set forth. When the disk 31a is in either rotated position, the opposite sides of the lands 31c are disposed between the contacts of one circuit, so that the disk is held against movement with the sleeve 30 and shaft 24 when the latter is moved endwise, as later set forth.

The switch mechanism serves to close the circuit to the motor to rotate the motor shaft 25a, the rotative movement of the disk 31a with the sleeve serving to open the motor circuit and reverse its connections to the motor at the end of the movement of the door in either direction.

The circuit 31x for the motor 6 is shown as provided with a three-way switch 31e and a four-way switch 31e' so that the circuit may be closed at more than one control station. The switch mechanism (see Figs. 10 and 11) is provided with pairs of contacts, each pair being connected to a lead, as shown in Fig. 10, but to facilitate the illustration only one contact of each pair is shown. When the disk 31j is moved to one position the contacts of certain pairs are disengaged and the contacts of the other pairs are in engagement, whereas in the other position of the disk 31j the contacts of the other pairs are engaged and the contacts of the first pairs are disengaged, the movement of the disk in either direction serving to open the motor circuit and reverse the connections thereof to the motor 6, so that in a succeeding operation of the switch the direction of rotation of the motor shaft is reversed.

The motor circuit 31x may be traced as follows: starting with lead 31a, from source of current, and supposing the three-way and the four-way switches to be in the position indicated by the dotted lines, the current passes from the terminal S¹ to terminal S² through the three-way switch to lead 31b and then to terminal S⁴ of the four-way switch. From terminal S⁴ to terminal S⁵ through the four-way switch to lead 31c, thence along lead 31c to terminal C² of the motor switch 31'. The motor switch 31' is provided with terminals M¹, C¹ and C² constituting a mechanical operated three-way switch which in co-operation with the manually operated switches above referred to, controls the starting and stopping of the motor. The manually operated switches start the motor while the mechanically operated three-way switch stops the motor.

In the position of the switch shown in Fig. 11, terminal C² is in contact with terminal M¹, so that the current passes through these terminals to lead 31d. Lead 31d divides, one part is connected to terminal W² at one end of the running winding of motor 6, whereas another part of lead 31d is connected to terminal M³ on the motor switch and a third part is connected to terminal

M² on the motor switch. The part of the current reaching terminal W² on the motor, passes through the running winding, in the direction of the arrow *x*, to terminal W¹, then through lead 31*f* back to the source of current, thus energizing the running winding of the motor. Part of the current from lead 31*d* passes through terminal M² to terminal M⁴, (they being connected together as shown in Fig. 11) then through lead 31*g* to terminal W³ at one end of the starting winding of the motor. From terminal W³ the current passes through the starting winding, in the direction of the arrow, to terminal W⁴, then through the centrifugal cutout switch *w* to terminal W⁵. The current passing through the respective windings, in the directions indicated by the arrows *x*, *x'*, determines the direction in which the motor will rotate. From terminal W⁵, the current will flow through lead 31*h* to terminal M⁵ on the motor switch. Terminal M⁵ being connected to terminal L¹, as shown in Fig. 11, current will flow to through the contacts and to lead 31*f* and back to the source of current, thus completing the circuit.

As will be observed, the terminals M², M⁴, L¹, M⁵ and M³, in reality constitute a pole changing switch, the function of which is to reverse the current flow through the starting winding of the motor, but not to reverse the current through the running winding, thus causing the motor to reverse its direction of rotation.

When the door has reached the end of its travel in one direction and the cable drum 18 has completed its cycle of rotation and endwise movement, the shoulder on the end of the hub engages the shoulder on the adjacent collar, which causes the shaft 24 to be rotated and in turn causes the motor switch to move to its opposite position. This movement causes the fiber disk 31*j* to open the contacts between terminals C² and M¹, thus breaking the path of current to the motor and causing the motor to stop. This same movement of the motor switch causes the contacts between terminals C¹ and M¹ to make contact, but, because terminal C¹ is connected to lead 31*c'* and through the four-way switch to lead 31*b'*, there is no current flow to the motor since the circuit is broken between terminals S¹ and S³ in the three-way switch 31*e*, so in order to start the motor again it will be necessary to manually operate either the three-way switch or the four-way switch to establish a path for the current to flow to terminal C¹ on the motor switch. The said movement of the motor switch likewise breaks the contacts between terminals M² and M⁴ also between L¹ and M⁵, and establishes contact between terminals M⁴ and L¹ also between M³ and M⁵. The motor switch is now in proper position for the next operation of the door operator in the reverse direction.

If the three-way switch 31*e* is operated to its opposite position, establishing contact between terminals S¹ and S³ to start the door operator, beginning at lead 31*a*, from the source of current, the current passes from terminal S¹ to terminal S³ through the three-way switch to lead 31*b'* and then to terminal S⁵ of the four-way switch. From terminal S⁵ to terminal S² through the four-way switch to lead 31*c'*, thence along 31*c'* to terminal C¹ of the motor switch. From the terminal C¹ the current passes through the contacts to terminal M¹ and then to lead 31*d*. Part of the current in lead 31*d* goes to terminal W² at one end of the running winding of the motor, then through the winding in the same direction as before to termi-

nal W¹, then through lead 31*f* back to the source of current, thus energizing the running winding in the same direction as before. The other part of the current in lead 31*d* passes through terminal M² to terminal M⁵ (as they are now connected together), then through lead 31*h* to terminal W⁵ and then through the centrifugal cutout switch *w* to terminal W⁴ at one end of the starting winding of the motor. From terminal W⁴ the current passes through the starting winding in the opposite direction to that indicated by the arrow to terminal W³. The current passing through the respective windings, one of which being reversed to what it was in the previous operation, causes the motor to rotate in a direction opposite to its previous direction. From terminal W³ the current will pass through lead 31*g* to terminal M⁴ on the motor switch. Terminal M⁴ being connected to terminal L¹ current will flow through 31*f* back to the source of current, thus completing the circuit.

When the door has reached the end of its travel in this direction and the shoulder on the end of the cable drum hub 18*a* has engaged the shoulder on the other collar, then the motor switch will move to its first position, this movement causing the contact between terminals C¹ and M¹ to be broken and thus breaking the path of the current to the motor. This path of current can not again be established until either the three-way or the four-way switch be manually operated.

If it is desired to stop the motor before the door has reached the end of its travel, either the three-way or the four-way switch may be operated manually, which will break the path of current to the motor. If either switch is again operated, the path of current will again be established and the motor will again start in the same direction as before, continuing until it has completed its cycle.

Operation.—When one of the three- or four-way control switches (Fig. 25) is manually operated, the current passes through them, then through the motor switch on the operator, to actuate the motor to rotate the member 18 in one certain direction, say for example, to open the door. The rotation of the gear pulls on one of the cable runs which in turn pulls on the trolley 13 connected to the door and opens the latter. During this movement, the threaded shaft 24 remains stationary, but as the member 18 rotates, to open the door, it also travels longitudinally along the shaft until the tooth 18*x* on the advancing end of the nut 18*a* engages the adjacent shoulder on the adjacent collar 36 or 36*a*, the collar having been adjusted on the shaft 24 so that this engagement takes place at the moment the door reaches its full open position. This engagement of the tooth 18*x* with the shoulder of the adjacent collar serves to rotate the shaft 24, which in turn swings the arm 28 therewith. The arm 29 is not immediately operated because the latch ball 34*a* prevents its movement, but as the shaft 24 continues to rotate, increased tension is built up in the torsional spring 35, which connects the arm 28 with the arm 29, until the tension is great enough to overcome the resistance of the ball 34*a*, then the arm 29 moves with a sudden snap to its opposite position, through an arc of 45 degrees. When the arm 29 snaps, it operates the switch mechanism 31, as above set forth cutting off the current to the motor and also reversing the motor connections for the next operation. The motor remains stationary until one of the switches is manually operated again.

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When one of the control switches is again operated, the motor is actuated in the opposite direction, or in the direction to close the door. There being a certain amount of torsional tension still remaining in the torsional spring 35, between the arms 28, 29, the shaft will rotate a small amount in reverse, with the member 18, but will stop when the torsional spring reaches its neutral position and thereafter the shaft will remain stationary while the member 18 continues to rotate. No action takes place in the motor switch until the member 18 has progressed along the shaft far enough for its other tooth 18x to engage the shoulder on the other collar. When the member 18 engages the latter shoulder, it rotates the shaft 24 in the reverse direction, causing tension to be set up in the torsional spring in the reverse direction, and this in turn causes the arm 29 to snap to the opposite side and operate the switch to cut off the current to the motor and reverses the circuit connections for the next operation.

It will be observed that when the tooth 18x on either end of the hub or nut 18a engages the shoulder on the adjacent collar to rotate the shaft 24, the resulting rotative movement of the latter gradually builds up tension between the end portions 35a, 35a', of the spring 35 due to movement of the arm 28 with the shaft 24 relative to the arm 29, until the latter is released and snaps to its other position. However, this tension in the spring 35 acts as a brake on the motor shaft and tends to stop its rotation after the current to the motor is cut off.

Figs. 17, 17a and 18 show a modified arrangement wherein the closure for the opening B consists of a horizontally slidable door suitably connected to a plurality of supports C each mounted on rollers c which traverse an overhead track D fixed to the wall above the opening B. The operating mechanism for the door is so mounted on the wall adjacent to the opening B that the trackway 1b is disposed on the outer side of the track D and parallel thereto. One of the runs 16a, 16b, of the flexible member is connected to the trolley and also connected through the linkage 14 to the door, so as to slide it endwise.

Figs. 19 and 20 show an arrangement similar to that in Figs. 17 and 18, except that two slidable doors are provided for the opening B and each run 16a, 16b, is connected through a linkage 14 to one of the doors. As shown, the two doors are in engagement to close the opening B and when the mechanism is operated to drive the flexible member the doors simultaneously move outwardly as shown in dotted lines and are simultaneously moved toward each other to close the opening.

Figs. 21 and 22 show another modified arrangement wherein the closure for the opening B consists of two doors mounted on hinges the axes of which are disposed vertically and the doors swing outwardly. In this arrangement the trackway 1b extends at right angles to the opening B and the trolley 13 is connected through a yoke 37 to the inner ends of separate linkages 37a, one run of the flexible member being connected to the trolley.

Figs. 23 and 24 show another arrangement wherein the closure for the opening B consists of two doors mounted on hinges the axes of which are disposed vertically and the doors swing inwardly. Also, in this arrangement the mechanism is mounted parallel to the opening B and the supports for the mechanism mount the latter on the front wall E at opposite sides of the opening B. As shown, in this arrangement the axis of the

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shaft 24 is disposed vertically and the runs 16a, 16b, of the flexible member 16 are disposed one above the other, so that one linkage 14 is connected to the run 16a and the door 15x remote from the member 18, whereas a separate linkage 14 is disposed in a plane below the other linkage and connected to the run 16b and the adjacent door 15x'.

In the event the door or either door, where two doors are employed is stopped due to an obstruction in its path of movement, such stoppage is effective to stop rotation of the member 18. As the worm shaft driven by the motor is disposed at 90 degrees to the shaft 24, stoppage of the member 18 will cause the torque of the motor shaft to exert an increased end thrust on the member 18 and the latter in turn will effect an endwise movement on the shaft 24 and operate the switch to open the motor circuit 31x and thus stop the motor and prevent damage to the mechanism or the body forming the obstruction.

Figs. 26, 27 and 28 show a modification of the driving mechanism and automatic circuit controlling switch. In this form of construction, 60 indicates the motor having a shaft 60a which drives the shaft 61 carrying the worm 61a meshing with the power transmitting elements on the member 18z, which is mounted and operates similar to the member 18 as already set forth to operate the flexible member 16x. The adjacent ends of the shafts 60a, 61, are provided with disks 62, 62a, respectively, one or both of which are provided with suitable friction material, and one of the disks (preferably the disk 62) is biased by an expansion spring 63 toward the other disk. The spring biased disk 62 is keyed to but slidably engages the shaft 60a. As shown, the spring 63 is interposed between the hub of the disk 62 and the boss 60b on the motor casing. The purpose of the slip clutch is to permit the motor shaft 60a to continue running in the event the operated member, that is, the door in the present disclosure, meets with an obstruction when it is being moved in either direction and thus stops the movement of the flexible member 16x, which in turn stops the member 18z. Such stoppage operation serves to prevent damage to the doors and/or any of the parts of the mechanism. However, where the motor 60 is provided with an automatic cut-off (such as a thermostatically operated switch) operable when the motor becomes heated, it will be observed that when a stoppage of the character above referred to occurs, the motor will run for a limited period and then stop due to the cut-off controlled by the rise of temperature of the motor. Motors constructed to operate in this manner are of standard construction so that illustration thereof is not deemed necessary.

As already pointed out the shaft 24x, which is mounted similar to shaft 24, is rotated when either tooth 18x on the hub of the member 18z engages the shoulder 35c or 35c' on the adjacent collar, whereby the switch mechanism 31 is operated. As shown in Fig. 27, the shaft 24x is provided with an arm 64 provided at its outer end with a connector 64a preferably consisting of laterally extending resilient elements 64a' each arranged to engage one of the spaced stops 65, 65a, suitably mounted in the wall of the adjacent wing. Each of the elements 64a' is shaped to ride the adjacent stop to effect a yieldable locking relation therewith, so that when the arm 64 is moved in either direction it is locked to the adjacent stop and maintains the shaft 24x and disk 31c of the switch mechanism 31 in operated posi-

tion until the shaft 24x is rotated or oscillated in the opposite direction and builds up sufficient tension in the element to release it from the adjacent stop. The stops 65, 65a, are disposed in the path of movement of the arm 64 in either direction to limit the movement of the shaft 24x.

As shown in Figs. 4 and 26, a cable carries the leads for the motor circuit and switch contacts.

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 mechanism of the class described, the combination with supporting means, of a motor on said supporting means, a shaft supported at its opposite ends on said supporting means, the intermediate portion of said shaft being provided with screw threads, a drum having a hollow hub the inner wall of which is provided with screw threads engaging the threads on said shaft and the exterior surface of said drum being provided with worm teeth formed with seats, corresponding seats in adjacent teeth being in spiral relation, a guide disposed at right angles to said drum, a pulley on said guide remote from said drum, a flexible member reeved around said pulley and providing runs extending therefrom parallel to said guide, the opposite end portions of said flexible member engaging said seats in reversely wound relation to simultaneously wind on and unwind from said drum during rotation of the latter, a device fixed to one run of said flexible member and slidably engaging said guide for movement endwise thereof in opposite directions and adapted to be connected to a movable member for operating it to and from a predetermined position, and a worm on the shaft of said motor in mesh with the worm teeth on said drum for rotating the latter, whereby said shaft moves said drum endwise to maintain the run of the flexible member connected to the adjacent end of said device in alignment therewith during movement of the latter along said guide.

2. A mechanism as claimed in claim 1 wherein said gearing consists of a gear driven by said motor and helical teeth on the outer wall of said drum in mesh with said gear, the land of each tooth being recessed from end to end thereof, corresponding recesses between each land and adjoining lands extending on an imaginary helix throughout the circumference of the drum.

3. In mechanism for moving a member to and from a selected position, the combination with a support, of an electric motor mounted thereon, electric current supply leads for said motor adapted to be connected with a source of current supply, a switch mechanism interposed in said leads, a flexible member, a device fixed to said flexible member and operatively connected to the movable member, and power mechanism for operating said flexible member consisting of a shaft disposed at right angles to the shaft of said motor, a worm drivingly connected with the shaft of said motor, an elongated annular member mounted to rotate and move axially on said first mentioned shaft, the outer wall of said annular member being provided with gear teeth extending helically substantially from end to end thereof in meshing relation with said worm, the end portions of said flexible member leading from opposite ends of said device being arranged to simultaneously wind

on and off the lands of said helical teeth, during rotative and slidable movement of said annular member.

4. A mechanism as claimed in claim 3 wherein said first mentioned shaft is provided at opposite sides of said annular member with stops in the path of said annular member axially to limit its movement in either direction.

5. A mechanism as claimed in claim 3 wherein means are provided between said switch mechanism and said shaft and actuated by the rotative movement of the latter to cut off current supply to said motor due to the engagement of said annular member with one of said stops.

6. A mechanism for reciprocating a movable member, comprising, in combination, a motor, a pulley, supporting means for the motor and pulley, a worm on the shaft of said motor, a separate shaft mounted on said supporting means disposed at substantially right angles to the motor shaft, a drum rotatable and endwise movably supported on said separate shaft, and a flexible member reeved around said pulley, the end portions of said member being wound on said drum and arranged to simultaneously wind on and off said drum during rotation thereof, said drum being provided with helical teeth in mesh with said worm, whereby the latter drives said drum in either direction.

7. A mechanism for reciprocating a movable member, comprising, in combination, a motor, a pulley, means for supporting said motor and pulley, a power element driven by said motor, a separate shaft mounted at its opposite ends on said supporting means and provided throughout its length with screw threads, a drum having a hub the inner wall of which is provided with screw threads engaging the screw threads on said separate shaft, and a flexible member reeved around said pulley, the opposite end portions of said flexible member being wound on said drum and arranged to simultaneously wind on and off said drum during rotation thereof, the outer wall of said drum being provided throughout its circumference with gear teeth extending substantially from end to end thereof in mesh with said power element whereby said drum, when driven, moves endwise of said separate shaft.

8. A mechanism as claimed in claim 7 wherein each tooth on said drum is formed with substantially transverse recesses, the recesses in each of said teeth being related to corresponding recesses, respectively, in adjoining teeth throughout the circumference of said drum to form seats for said flexible member disposed along an imaginary helix from end to end of said drum having a pitch corresponding to that of the screw threads on said separate shaft.

9. A mechanism for reciprocating a movable member, comprising, in combination, a motor, a switch controlled electric circuit for the motor, a pulley, means for supporting said motor and pulley, a shaft mounted in bearings at its opposite ends on said supporting means and provided throughout its length between its bearings with screw threads, stops adjustably fixed in predetermined positions on said separate shaft inwardly of its bearings, a drum having a hub the inner wall of which is provided with screw threads engaging the screw threads on said separate shaft, a flexible member reeved around said pulley, the opposite end portions of said flexible member being wound on the end portions of said drum and arranged to simultaneously wind on and off said drum during rotation thereof, the outer wall of said drum being provided throughout its circum-

ference with gear teeth extending substantially from end to end thereof having driving connection with the motor shaft, whereby said drum, when driven, moves endwise of said separate shaft, devices on the opposite ends of the drum hub, each arranged to engage one of said stops when the drum moves endwise in either direction and rotate said separate shaft, and a separate switch mechanism controlled by the rotation of said separate shaft for stopping said motor.

10. A mechanism for reciprocating a movable member, comprising, in combination, a motor, a pulley, means for supporting said motor and pulley, a separate shaft mounted at its opposite ends on said supporting means and provided throughout its length with screw threads, a drum having a hub the inner wall of which is provided with screw threads engaging the screw threads on said separate shaft, a flexible member reeved around said pulley, the opposite end portions of said flexible member being wound on the opposite end portions of said drum and arranged to simultaneously wind on and off said drum during rotation thereof, the outer wall of said drum being provided throughout its circumference with gear teeth extending substantially from end to end thereof, and a gear driven by said motor shaft and having meshing relation with the teeth on said drum between the windings of said flexible member on the latter to rotate said drum, the rotation of the drum serving to move it endwise on said separate shaft, in relation to the increase and decrease of the windings on said drum, whereby said gear maintains meshing relation with the teeth on the drum as the latter moves endwise in either direction.

11. A mechanism as claimed in claim 3 wherein said first mentioned shaft is rotatably supported, and includes operating connections between said switch mechanism and said first mentioned shaft controlled by the rotation of the latter, to stop said motor, limiting stops on said first mentioned shaft in the path of said annular member, the engagement of said annular member with either of said stops serving to rotate the first mentioned shaft.

12. A mechanism as claimed in claim 11 wherein said operating connections include a pair of relatively movable spring connected elements, one of which is fixed to said first mentioned shaft and tensions said spring when the latter is rotated, the tension of said spring serving to cushion the impact of said annular member against each of said stops.

13. A mechanism for moving a member to and from predetermined positions, having, in combination, a support, a motor, an elongated guide disposed in endwise relation to the shaft of said motor, a slide movable longitudinally of said guide, a linkage between said slide and the movable member, a pulley mounted on said guide remote from said motor, a separate shaft disposed at right angles to and extending to either side of said motor shaft and mounted at its opposite ends on said support, a member rotatably and slidably mounted on said separate shaft, a flexible member engaging said pulley intermediate its ends to provide runs extending therefrom parallel to said guide, the opposite end portions of

said runs being reversely wound on said rotatable member and arranged to simultaneously wind on and off the latter when said member is rotated, means between said rotatable member and said separate shaft for moving said rotatable member endwise in either direction during its rotation, and a gear fixed to the shaft of said motor and meshing with gear elements on the outer surface of said rotatable member for rotating the latter.

14. A mechanism as claimed in claim 13 wherein each of the gear elements on said rotatable member is formed with seats for the flexible member, the seats in each element and correspondingly related seats in adjoining elements being disposed in an imaginary helix circumferentially of said rotatable member.

15. A mechanism as claimed in claim 7 wherein the motor shaft consists of inner and outer sections the adjoining ends of which are provided with disks, one disk being keyed to and slidable on the adjacent shaft section and one of said disks being provided on its face with friction material, and a spring coiled around the shaft section carrying the slidable disk and engaging the latter to bias it toward the other disk.

16. In mechanism for moving a member to and from selected positions, the combination with a support, of an elongated guide thereon, a device slidably mounted on said guide and adapted to be operatively connected to the member for moving it, a support disposed adjacent one end of said guide, a shaft provided with screw threads mounted on said support, a drum formed with an axial opening through which said shaft extends and provided with screw threads engaging the threads on said shaft, a reeving element mounted adjacent the opposite end of said guide, a flexible member reeved around said element to provide runs leading therefrom the end portions of which simultaneously wind on and off of said drum when the latter is rotated, one of said runs being connected to said device for moving it in either direction, and power mechanism for rotating said drum, the outer wall of said drum substantially from end to end thereof being formed with seats for the runs of said flexible member disposed in helical relation and having a pitch coinciding with the pitch of the threads on said shaft and provided with gear teeth complementary to the teeth of the driven element of said power mechanism.

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