March 10, 1942. G. I. HOLMES 2,276,195

MOTORIZED VALVE

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Fig. 1

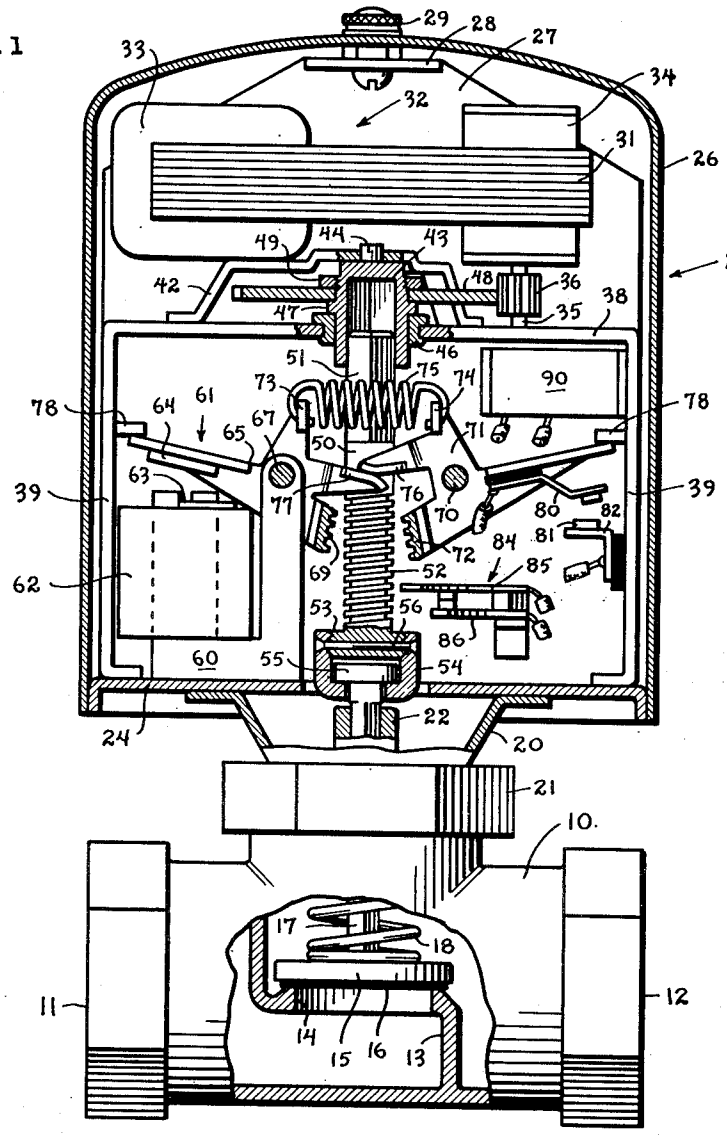
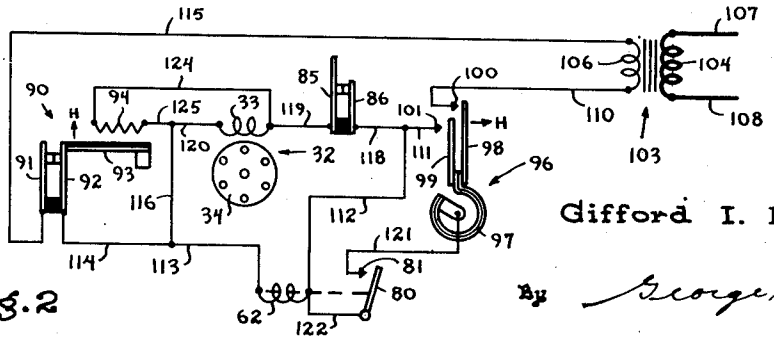


Fig. 2



Inventor

Gifford I. Holmes

By George H. Fisher

Attorney

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MOTORIZED VALVE

Gifford I. Holmes, Minneapolis, Minn., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

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11 Claims. (Cl. 137—139)

The present invention is concerned with a motorized valve and more particularly one of the type which is biased to one flow controlling position, usually closed position.

In many types of apparatuses, particularly motorized valves controlling the flow of a temperature changing medium, it is desirable that the valve or controlling device be biased to a safe position so that in the event of power failure, the valve is automatically moved to this safe position. A typical case is that of a motorized valve controlling the flow of gas to a gas burning furnace. Such a motorized valve is usually provided with a rotary motor which lifts the valve to its valve open position wherein it is either maintained by continued energization of the motor itself or by some auxiliary holding means. The present invention is particularly concerned with the type of arrangement wherein auxiliary holding means is employed for maintaining the valve in its open position. The general principles of the invention are applicable to any motor positioned element which is movable from a first safe position, to which it is biased, to a second active position.

An object of the invention is to provide a motor operated fluid flow controlling member wherein the transmission means between the motor and the controlling member includes two threaded elements, one of which is rotated by the motor and the other of which is non-rotatable so as to cause relative longitudinal movement of the elements with releasable means for maintaining the threaded connection between the elements.

A further object of the invention is to provide such a motorized mechanism in which one of the transmission elements comprises a plurality of relatively movable portions and wherein the releasable means for maintaining the threaded connection between the transmission elements maintains these portions so disposed as to maintain the threaded connection.

A further object of the invention is to provide such an arrangement in which one of the elements is a threaded shaft rotated by the motor.

A further object of the invention is to provide such an arrangement in which the other element is a divided nut, the sections of which are biased apart and are held together by the releasable means.

A further object of the invention is to provide a novel means for holding the sections of the threaded nut together for simultaneously moving them apart upon the maintaining means being no longer effective.

A further object of the present invention is to provide a motorized device in which the motor moves the positioned device to its active position and is thereupon deenergized and in which the device is held in its active position by a holding means, wherein means are provided for rendering the holding means ineffective if the motor does not move the device to the active position within a predetermined period of time.

Other objects of the invention will be apparent from a consideration of the accompanying specification, claims and drawing in which:

Figure 1 is an elevational view, with portions in section, of my improved motorized valve, and

Figure 2 is a schematic wiring diagram showing the controlling circuit for the motor.

Referring to the drawing for a more detailed understanding of the invention, a valve body is generally designated by the reference numeral 10. This valve body has an inlet 11 and an outlet 12. Extending across the valve body is a transverse partition wall 13 which is apertured at 14, the aperture 14 providing a valve seat. A valve disc 15, provided with suitable facing material 16, seats upon the valve seat. Secured to the valve disc 15 is a valve stem 17. This valve stem is shown as being of square cross-section although it can be provided with any other non-circular cross-section. A spring 18 surrounds the valve stem 17 and urges the valve disc 15 into engagement with its seat. Secured to the upper end of the valve body 10 is an inverted frusto-conical supporting member 20. Member 20 is secured to the valve body by a clamping nut 21. Formed integrally with the supporting member 20 is a valve guide sleeve 22 which is provided with a square aperture so as to restrain stem 17 from rotary movement but to permit longitudinal movement thereof.

Supported by the member 20 is a base plate 24 of a housing 25 for the operating mechanism. Fitting over the base plate 24 is a housing cover 26. Extending upwardly from the base plate 24 are supporting plates, only plate 27 of which is shown. These plates are provided for supporting the various elements of the operating mechanism. The upper end of the plate 27 is provided with a horizontal flange 28 and secured to this flange is a releasable clamping means 29 for retaining the housing cover 26 in position.

Suitably supported from the upright plates including the plate 27 is a stator frame 31 of an induction motor 32. The induction motor may take any suitable form and since the details of such as motor are well known, these details are not shown. As will be apparent from the drawing, the frame 31 is disposed horizontally. This frame is a rectangular frame having a field winding 33 in one cross leg and having an opening in the other cross leg for a rotor 34. This rotor 34 will normally be of the conventional squirrel cage type. Secured to the rotor 34 is a shaft 35 carrying a pinion gear 36. The lower end of the pinion shaft 35 has a bearing in a supporting

plate 38 which plate is provided with down turned legs 39 secured at their lower ends to the base plate 24. Secured to the supporting plate 38 is a three legged spider bracket 42. The legs of the spider are secured to the plate 38 and the central portion thereof is apertured to provide a bearing for a collar 43. The collar 43 has an aperture of square cross-section extending substantially the full length thereof and terminating just below the upper end of the collar. The upper end of the collar is thus closed. Projecting from this upper end is a reduced cylindrical shaft 44 which extends through the aperture in the spider 42 to form one journal for the collar 43. A bearing sleeve 46 extends through and is secured to the plate 38. The lower end of the collar 43 extends through this bearing sleeve and is journalled therein. The collar 43 is provided with a flange 47 which rests on the upper end of the bearing sleeve 46. Secured to the collar 43 is a gear 48 which gear meshes with the pinion gear 36. The gear 48 is clamped between the flange 47 and a clamping nut 49. It will be readily seen that upon energization of the motor and rotation of rotor 34, the collar 43 will be rotated at a lesser speed due to the speed reducing effect of gears 36 and 48. The collar 43 is adapted to connect the gear 48 to a rotatable shaft 50. The upper end 51 of this shaft is of a square cross-section conforming with the cross-section of the aperture of collar 43. It can readily be seen that the collar 43 and the square end of shaft 50 cooperate to provide a driving connection for rotating shaft 50, which connection permits longitudinal movement of shaft 50 with respect to the nut 43. The lower portion of the shaft 50 is threaded as at 52. At its extreme lower end, the shaft is provided with a threaded flange 53 to which is threadedly secured an apertured cup 54. A rivet 56 maintains the cup 54 in assembled relation with the threaded flange 53. Disposed in the enclosure provided by the cup and flange 53 is a flange 55 on the upper end of valve stem 17, the stem proper extending through the aperture of cup 54. The stem 17, cup 54, and flange 53 thus form a connection between the shaft 50 and the stem 17 providing for longitudinal movement of the stem 17 by the shaft 50 and permitting relative rotation between these two members.

A U-shaped core 60 of an electromagnet 61 is secured to the base plate 24. Surrounding the outer leg of this core 60 is a winding 62. The upper end of the core leg containing the winding 62 is split in the conventional manner to provide for a conventional shading ring 63 surrounding one of the split portions. An armature 64 cooperates with the upper end of the core 60 and is secured to a lever 65 pivotally mounted at 67 to the core 60. The extreme right-hand end of the lever 65 is formed as a section of a nut, as indicated by the reference numeral 69. Pivotally mounted on a pivot pin 70 is a second lever 71. This second lever is formed at its left-hand end as a section of a nut, as indicated by the reference numeral 72. The nut sections 69 and 72 are provided with threads of the same pitch as the threads of the threaded portion 52 of shaft 50 so that when the lower inner ends of levers 65 and 71 are moved together, they mesh with the threaded portion 52 of the shaft 50. The lever 65 is provided with an upstanding ear 73 and the second lever 71 with a similar ear 74. A spring 75 is connected to the two ears 73 and 74 and tends to urge these two ears together. The effect of this spring 75 is to tend to cause the levers 65 and 70 to swing in a direction to move the thread engaging faces 69 and 72 apart and out of engagement with the threaded portion 52 of the shaft 50. The levers 65 and 71 are provided with cooperating cam faces 76 and 77, these cam faces being so formed that upon rotation of the lever 65, the second lever 71 is moved in an equal amount in the opposite direction. Projecting inwardly from the supporting legs 39 are lugs 78 which engage the outer ends of the lever 65 to limit the movement caused by the biasing means 75. The electromagnet 61 when energized rotates the lever 65 in a counter-clockwise direction due to the attraction of the armature 64 towards the core 60. Upon such counter-clockwise movement of the lever 65, the cooperating cam surfaces 76 and 77 cause a clockwise movement of the second lever 71. The result is that the nut sections 69 and 72 are moved into engagement with the threaded portion 52 of the shaft 50 upon such energization of the electromagnet 61.

Secured to the lever 71 is a contact blade 80. This contact blade cooperates with a fixed contact 81 secured to a supporting bracket 82. The supporting bracket 82 is in turn supported from the leg 39. Upon energization of the electromagnet 61 with the resultant movement of the levers 65 and 71 into shaft engaging position, the switch blade 80 is moved into contact making position with the contact 81.

When the nut sections 69 and 76 are in engagement with the threaded portion 52 of the shaft 50 and the shaft 50 is rotated by the motor 32, it will be obvious that such rotation of the shaft 50 results in an upward movement thereof and consequently an upward movement of the valve disc 15 towards valve open position. Due to the small pitch of the threaded portion 52, the longitudinal movement of shaft 50 will be relatively small compared with the rotative movement thereof. The energization of the motor 32 is controlled by a cycling switch 84 comprising a pair of switch blades 85 and 86. The two switch blades 85 and 86 are biased into contact making engagement. The switch blade 85 is provided with a portion projecting into the path of the flange 53 of the shaft 50 so that upon the valve disc 15 being moved to the valve open position, the flange 53 engages the left-hand end of the switch blade 85 and moves this switch blade out of contact making engagement with the switch blade 86.

A thermal safety switch is indicated by the reference numeral 90. This switch may be of any suitable type which is so designed that upon continual energization for a predetermined period of time, the switch will be opened in such a manner as to require manual operation to reclose the same. Such a switch is shown in the patent to Frederick S. Denison No. 1,985,081 issued May 8, 1934. The switch is shown in schematic form for purposes of illustration in Figure 2. The switch comprises two switch blades 91 and 92 which are normally in engagement. The switch blade 92 is biased away from the switch blade 91 but is held in engagement therewith by the bimetallic element 93 which in its cold position lies in the path of movement of the upper end of the switch blade 92. Associated with the bimetallic element is an electric heater 94. This heater when energized serves to heat the bimetallic element 93 thus tending to flex the left-hand end of the bimetallic element upwardly out of the path of movement of the switch blade 92. If this heat continues suffi-

ciently long, it will be obvious that the switch blade 92 will be free to move away from the switch blade 91 and that thereafter, it will be necessary for the switch blades to be normally reclosed.

A thermostat 96 is shown as the main control switch in Figure 2. It is to be understood that other types of control switches can be employed depending upon the particular application of the motorized valve. As illustrated, the thermostat 96 comprises a bimetallic element 97 provided with contact blades 98 and 99 which are adapted to engage contacts 100 and 101. The bimetallic element 97 is so disposed that upon a temperature fall the contacts 98 and 99 are moved to the left. The spacing of the contact arm 98 from the contact 100 is less than the spacing of the contact arm 99 from the contact 101 so that upon a temperature fall the contact blade 98 is first engaged with the contact 100 and contact blade 99 is engaged secondly with contact 101.

Low voltage power for operation of the system is supplied by a step-down transformer 103. This transformer comprises a line voltage primary 104 and a low voltage secondary 106. The line voltage primary 104 is connected to line wires 107 and 108 leading to any suitable source of power (not shown).

Operation

In the following operation it will be assumed that the valve is employed for controlling the flow of a heat producing fluid such as gas to a gas furnace or steam to a radiating system. It will be assumed that the thermostat 96 is responsive to the temperature of the space at a suitable point of control. Upon the space temperature falling, the contact blade 98 will first engage the contact 100. This will not result in the establishment of an energizing circuit, however. Upon a further fall in temperature so as to cause engagement of contact blade 99 with contact 100, the following energizing circuit will be established to the magnet winding 62: from the lower terminal of the transformer secondary 106 through conductor 110, contact 100, contact blades 98 and 99, contact 101, conductors 111 and 112, magnet winding 62, conductors 113 and 114, switch blades 92 and 91, and conductor 115 to the other terminal of transformer secondary 106. At the same time an energizing circuit will be established to the field winding 33 of motor 32 as follows: from the lower terminal of the transformer secondary 106 through conductor 110, contact 100, contact blades 98 and 99, conductors 111 and 118, switch blades 86 and 85, conductor 119, field winding 33, conductors 120, 116 and 114, switch blades 92 and 91, and conductor 115 to the other terminal of the secondary 106.

As soon as the magnet winding 62 is energized, the nut sections 69 and 72 are moved inwardly into engagement with the threaded portion 52 of the shaft 50. The energization of the field winding 33 of motor 32 causes rotation of the rotor 34 to in turn cause rotation of shaft 50. The resultant rotation of shaft 50 causes longitudinal movement of the shaft by reason of the engagement of the non-rotatable nut sections 69 and 72. As pointed out previously, this causes the valve disc 15 to be moved towards valve open position.

The energization of the magnet winding 62 and the resultant movement of the levers 65 and 71 in counter-clockwise and clockwise directions, respectively, not only causes engagement of nut sections 69 and 72 with the shaft 50 but also causes the switch blade 80 to be moved into engagement with the contact 81. As soon as this takes place, a circuit is established to the magnet winding as follows: from the lower terminal of the secondary 106 through conductor 110, contact 100, contact blade 98, bimetallic element 97, conductor 121, contact 81, switch blade 80, conductor 122, magnet winding 62, conductors 113 and 114, switch blades 92 and 91, and conductor 115 to the other terminal of the secondary 106. It will be noted that the new energizing circuit is independent of contact 101 so that even though separation of contact blade 99 from 101 takes place, due to a slight fluctuation in the temperature, the magnet winding 62 will remain energized. The possibility of any chattering action of the magnet 61 is thus eliminated. The engagement of the switch blade 80 with the contact 81 also results in the following maintaining circuit for the motor field winding 33: from the lower terminal of the secondary 106 through conductor 110, contact 100, contact blade 98, bimetallic element 97, conductor 121, contact 81, switch blade 80, conductors 122, 112 and 118, switch blades 86 and 85, conductor 119, field winding 33, conductors 120, 116 and 114, switch blades 92 and 91, and conductor 115 to the other terminal of secondary winding 106. It will be noted that this new circuit, like the maintaining circuit traced for the magnet winding 62, is independent of the contact 101. It is thus assured that both the motor and the magnet will remain energized in spite of any fluttering condition that might exist between the contact blade 99 and the contact 101.

The heating element 94 of the safety switch is connected in parallel with the field winding 33 at all times. It is believed necessary to trace only the maintaining circuit for this heating element although it is to be understood that since it is connected in parallel with the field winding 33, it is energized even before engagement of switch blade 80 with contact 81 in the same manner as field winding 33. The maintaining circuit for this heating element 94 is as follows: from the lower terminal of the secondary 106 through conductor 110, contact 100, contact blade 98, bimetal element 97, conductor 121, contact 81, switch blade 80, conductors 122, 112 and 118, switch blades 86 and 85, conductors 119 and 124, heating element 94, conductors 125, 116 and 114, switch blades 92 and 91, and conductor 115 to the other terminal of secondary 106.

During normal operation, the valve is moved upwardly by the operation previously described until the flange 53 engages the left-hand end of the switch blade 85 to cause separation of the switch blades 85 and 86. When this happens, the circuits to both the motor field winding 33 and the heating element 94 are interrupted as will be clearly evident from Figure 2. The valve is, nevertheless, maintained in open position against the action of the biasing spring 18 as long as the nut sections 69 and 72 remain in engagement with threads 52. This is the case because the pitch of the threads 52 is relatively small and it would obviously be impossible for the spring 18 to cause the necessary rotation of shaft 52 to permit movement of valve disc 15 to its closed position. The valve will thus normally be maintained in open position until the temperature in the space has risen as a result of the flow of the heating medium through the valve until the switch blade 98 has disengaged from

the contact 100. When this happens, the energizing circuit to the magnet winding 62 is interrupted permitting the spring 75 to swing levers 65 and 71 to the position shown in Figure 1. With the levers in this position, the spring 18 is free to move the shaft 50 downwardly to close the valve 15. The action of the spring 18 by the fact that the area of engagement of the nut sections 69 and 72 is below the pivot points 67 and 70 is such that the biasing effect of spring 18 tends to swing levers 65 and 71 to their biased position.

If for some reason or other, the valve does not move to open position so that the motor remains energized, provision is made for insuring the return of valve disc 15 to its closed position. In many types of heating equipment for example, it is undesirable to maintain a valve in a partially open position. Thus in the case of a gas burning furnace, if the valve is only partially open, the flow of gas to the burner may be insufficient to purge the air from the burner with the result that a minor explosion occurs to cause combustion to take place in the mixing chamber. This is known as "pop back" in the mixer. Similarly, in the case of steam, a certain minimum flow is necessary to insure adequate distribution of the steam in the heating equipment. It is possible that the valve might conceivably be stopped in the partially open position due, for example, to foreign matter becoming lodged in the threads 52 thus preventing the motor 32 from moving the valve to open position. In such event, the field winding 33 would not be deenergized and current would continue to flow not only through the field winding 33 but also through the heating element 94. After a predetermined period of time, this heating action would have sufficient effect on the bimetallic element 93 to cause the left-hand end thereof to move upwardly over the end of switch blade 92 permitting this blade to move away from switch blade 91. As previously explained, opening of the switch blades 92 and 93 requires a manual operation before the blades can be reset. This insures that an operator must inspect the valve to determine the cause of the failure of the motor to open the valve within the required time.

It will be seen that I have provided an extremely simple and highly effective arrangement whereby the motor of a motorized valve is deenergized when the valve is moved to open position and wherein auxiliary holding means is employed for holding the valve in open position as long as it is desired to maintain the valve in such position. While the apparatus has been shown in connection with a motorized valve, it is understood that a number of the features thereof are applicable to any motorized mechanism of the type wherein an element is moved from a normal safe position to an active second position against the action of some biasing means. While a simple reduction gear train has been shown between the motor and the shaft, this can in many cases be entirely eliminated, the motor rotor being directly connected to the shaft. This is possible because of the pronounced gear reduction effect of the cooperating threaded shaft and split nut. In general, while I have shown a specific embodiment of my invention for purposes of illustration, it is to be understood that the invention is limited only by the scope of the appended claims.

I claim as my invention:

1. In combination, a fluid flow controlling member, movable between first and second controlling positions, a threaded shaft rotatably connected to said member, electrical motor means for rotating said shaft, a nut secured to a fixed support and adapted to engage said shaft so that upon rotation of said shaft, the shaft is moved longitudinally to move said flow controlling member to said controlling position, electrically operated means for releasably maintaining said nut in engagement with said shaft, means for energizing both said motor means and said engagement maintaining means, and means automatically operable upon said member reaching said second position to terminate the energization of said motor.

2. In combination, a control member biased to a first safe position and movable to a second active position, motor means for moving said member to said second position against its bias, transmission means between said motor means and said member, said transmission means comprising a threaded shaft rotated by said motor and a non-rotatable element adapted to engage the threads of said shaft, one of said transmission elements being longitudinally stationary and the other being longitudinally movable upon rotation of said shaft, and electrically operated means for releasably maintaining said non-rotatable element in engagement with the threads of said shaft.

3. In combination, a control member biased to a first safe position and movable to a second active position, electrical motor means for moving said member to said second position against its bias, transmission means between said motor means and said member, said transmission means comprising a threaded shaft rotated by said motor and a non-rotatable element adapted to engage the threads of said shaft, one of said transmission elements being longitudinally stationary and the other being longitudinally movable upon rotation of said shaft, electrically operated means for releasably maintaining said non-rotatable element in engagement with the threads of said shaft, means for simultaneously energizing said motor means and said engagement maintaining means, and means automatically operable upon said member reaching said second position to terminate the energization of said motor.

4. In combination, a control member biased to a first safe position and movable to an active second position, electrical motor means for moving said flow controlling member to a second position against its bias, electrically controlled holding means for releasably retaining said member in said second position against its bias and independently of said motor, means automatically operable upon said member reaching said second position to terminate the energization of said motor, and means automatically operable at the expiration of a predetermined period of time following the energization of said motor to terminate the energization of both said motor and said holding means if said member has not reached said second position.

5. In combination, a control member biased to a first safe position and movable to a second active position, electrical motor means for moving said member to said second position against its bias, transmission means between said motor means and said member, said transmission means comprising a threaded shaft rotated by said motor and a non-rotatable element adapted to engage the threads of said shaft, one of said

transmission elements being longitudinally stationary and the other being longitudinally movable upon rotation of said shaft, electrically operated means for releasably maintaining said non-rotatable element in engagement with the threads of said shaft, means for simultaneously energizing said motor means and said engagement maintaining means, means automatically operable upon said member reaching said second position to terminate the energization of said motor, and means operative at the expiration of a predetermined period of time following the energization of both said motor and said engagement maintaining means if said member has not reached said second position.

6. In combination, a control member biased to a first safe position and movable to a second active position, motor means for moving said member to said second position against its bias, a longitudinally movable threaded shaft rotatably connected to said member, a connection between said motor means and said shaft for imparting rotation to said shaft but permitting longitudinal movement thereof independently of said motor, an element pivoted to a fixed support so as to be movable along an arcuate path substantially tangential to said shaft and adapted to engage the threads of said shaft so as to cause longitudinal movement of said shaft upon rotation thereof by said motor, and means for releasably maintaining said element in engagement with the threads of the shaft.

7. In combination, a control member biased to a first safe position and movable to a second active position, motor means for moving said member to said second position against its bias, a longitudinally movable threaded shaft rotatably connected to said member, a connection between said motor means and said shaft for imparting rotation to said shaft but permitting longitudinal movement thereof independently of said motor, an element pivoted to a fixed support and adapted to engage the threads of said shaft so as to cause longitudinal movement of said shaft upon rotation thereof by said motor, and electrically operated means for releasably maintaining said element in engagement with the threads of the shaft, the region of engagement of said element with said shaft being located closer to the first position of said member than said pivot point so that the bias of said control member tends to move said element out of engagement with the threads of said shaft.

8. In combination, a control member biased to a first safe position and movable to a second active position, motor means for moving said member to said second position against its bias, a longitudinally movable shaft rotatably connected to said member, a connection between said motor means and said shaft for imparting rotation to said shaft but permitting longitudinal movement thereof independently of said motor, a pair of elements each pivoted to a fixed support so as to be movable along an arcuate path substantially tangential to said shaft and adapted to engage the threads of said shaft so as to cause longitudinal movement of said shaft upon rotation thereof by said motor, means biasing said elements apart and out of engagement with said shaft, electromagnetic means for holding one of said elements in engagement with said shaft, and cam means associated with said one element for causing simultaneous movement of the other element.

9. In combination, a control member movable between a first safe position and a second active position, means biasing said member to its first position, motor means for moving said member to its second position against said biasing means, and transmission means between said motor means and said member, said transmission means comprising a threaded shaft rotated by said motor and a threaded nut having a plurality of sections each pivotally mounted on a fixed support for movement along a path substantially tangential to said shaft, and electrical means effective when energized to move said sections along said paths to a position where they threadedly engage said shaft, said biasing means being effective when said member is not in safe position and said electrical means is deenergized to move said shaft longitudinally thereby moving said nut sections away from said engaging position.

10. In combination, a control member movable between a first safe position and a second active position, means biasing said member to its first position, motor means for moving said member to its second position against said biasing means, transmission means between said motor means and said member, said transmission means comprising a threaded shaft rotated by said motor and a threaded nut having a plurality of sections each pivotally mounted on a fixed support for movement along a path substantially tangential to said shaft, and electrical means effective when energized to move said sections along said paths to a position where they threadedly engage said shaft, said biasing means being effective when said member is not in safe position and said electrical means is deenergized to move said shaft longitudinally thereby moving said nut sections away from said engaging position, and further biasing means tending to hold said sections at points on said paths where they are spaced from said shaft.

11. In combination, a control member movable between a first safe position and a second active position, means biasing said member to its first position, motor means for moving said member to its second position against said biasing means, a threaded shaft, a connection between said motor means and said shaft for rotating said shaft while permitting longitudinal movement thereof independently of said motor, a connection between said shaft and said control member for moving said member upon longitudinal movement of said shaft, a threaded nut having a plurality of sections each pivotally mounted on a fixed support for movement along an arcuate path to which said shaft is substantially tangential, electrical means effective when energized to move said sections along said paths to a position where they threadedly engage said shaft so as to cause longitudinal movement of said shaft upon rotation thereof by said motor, said biasing means being effective when said member is not in safe position and said electrical means is deenergized to move said shaft longitudinally thereby moving said nut sections away from said engaging position.

GIFFORD I. HOLMES.