This invention relates to devices for effecting remotely controlled displacement of a movable member between two predetermined positions. More particularly, the invention pertains to remotely controlled solenoid operated electrical switches.

An important object of the present invention is to provide an actuating device subject to remote control and operative not only to displace a movable member from one to the other of two predetermined positions each time the actuating device is energized, such displacement being effected independently of the length of time the actuating device is energized, but also operative to retain said movable member in the final position assumed at the end of each displacement.

A more specific object of this invention is to provide a solenoid operated primary switch subject to remote control by a secondary switch, the solenoid being energized by a low intensity current so as to eliminate the need for heavy insulated wire or conduit in the solenoid circuit.

Another object of this invention is to provide a solenoid operated actuating device subject to remote control by a switch and so constructed that each time the switch is closed, no matter whether for a short time or for a long time, the actuating device will be displaced from one to the other of two predetermined positions and retained in its final position after the actuating movement has been completed and the solenoid circuit has been opened.

Other and further objects and features of this invention will become apparent from the following description and appended claims, as illustrated by the accompanying drawings showing, by way of examples, a number of devices according to the present invention. More particularly:

Figure 11 is a greatly enlarged fragmentary cross sectional view taken along the line 11—11 of Figure 6; Figure 12 is an enlarged cross sectional view, with parts shown in elevation, taken along the line 12—12 of Figure 13 and showing a third solenoid operated switch according to this invention in closed position; Figure 13 is a fragmentary cross sectional view, with parts shown in elevation, taken along the line 13—13 of Figure 12; Figure 14 is a fragmentary cross sectional view, with parts shown in elevation, taken along the line 14—14 of Figure 13 and showing the switch in closed position; Figure 15 is a view similar to Figure 14 but showing the switch in open position; Figure 16 is a view similar to Figure 14 but showing the switch in a position intermediate the positions shown in Figures 14 and 15; Figure 17 is an enlarged cross sectional view, with parts shown in elevation, of a fourth solenoid operated switch according to this invention in closed position; Figure 18 is a fragmentary view similar to Figure 17 but showing the switch in open position; Figure 19 is a view similar to Figure 17 but showing the switch in a position intermediate between the two positions shown in Figures 17 and 18; Figure 20 is an enlarged longitudinal cross sectional view, with parts shown in elevation, taken along the line 20—20 of Figure 21, of a fifth solenoid operated switch according to this invention in closed position; Figure 21 is a view similar to Figure 20 but showing the switch in a position intermediate between the two positions shown in Figures 20 and 22; Figure 22 is a view similar to Figure 20 but showing the switch in closed position; Figure 23 is a cross sectional view, with parts shown in elevation, taken along the line 23—23 of Figure 22; Figure 24 is an enlarged longitudinal cross sectional view, with parts shown in elevation, taken along the line 24—24 of Figure 26, of a sixth solenoid operated switch according to this invention in closed position; Figure 25 is a side elevational view of the switch of Figure 24, with parts shown in cross section along the line 25—25 of Figure 26; Figure 26 is another side elevational view of a switch of Figure 24, with parts shown in cross section along the line 26—26 of Figure 24; and Figure 27 is a fragmentary view similar to Figure 25 but showing the switch in a position intermediate between fully closed and fully open positions.

Referring now to the wiring diagram of Figure 1, a solenoid operated switch generally indicated by the reference numeral 10 (shown in greater detail in Figures 2 through 5), is interposed, as at terminals a, a, in a normal voltage circuit including a wire 11 and a grounded wire 12 both connected to a load 13 (indicated in the drawing by a light bulb). This normal voltage circuit may be connected to a suitable source of power, for instance, 110 volts, at a pair of terminals b, b. A high resistance solenoid coil made up of two windings 14a and 14b is connected in parallel across the power source, through a low resistance wire 15 connected to the grounded wire 12 and another low resistance wire 16 including a fuse 16a connected to the wire 11, the solenoid coil being connected to the wires 15 and 16 at terminals c, c. A push button switch for making and breaking the solenoid circuit is indicated generally at 17 and is connected to the solenoid windings at terminal d, d. A resilient contact arm 18 forming part of the switch 10 is operative to make and break the normal voltage circuit. Solenoid operated contacts for actuating the contact arm 18 are described in detail hereinbelow.

In the system illustrated by the wiring diagram of Figure 1, the high resistance of the solenoid coil windings 14a and 14b serves to reduce substantially the amperage in the solenoid circuit when the latter is closed, for instance, to less than about one ampere, thus rendering unnecessary the use of a transformer to step down the voltage for this purpose. The 14a will function to interrupt the flow of any excessive current, as when the wiring may accidentally be grounded. Further, at the low voltage indicated, there is no need for having the wires
The action of the springs 40 transmitted through the actuating arm 39 and the pin 43 causes the solenoid core 42 to move downwardly. The core 42 is free to rotate and therefore when moving downwardly, it will rotate so that the pin 44 will lodge in one of the vertices d, e, d' or e'. Further downward core movement is thereby arrested, and the action of the springs 40 thereafter consists in holding the solenoid core 42 in the position assumed at the end of its downward stroke since then core rotation can be effected only against the resistance of the springs 40. As shown in Figure 2, the deflecting arm 37 at this time holds the contact arm 41 away from the contact arm 32, so that then the switch is held in open position.

If it is assumed that the position of the solenoid core 43 (with respect to the fixed pin 44) shown in Figure 2 corresponds to the position of the pin e indicated in Figure 5, the further actuation of the switch may be described as follows: When the coil 20 is energized and the core 42 thereby moved upwardly, the core will be rotated in the direction shown in Figure 5 and the actuating arm 40 will follow downwardly. When the coil 20 is again energized, the core 42 is pulled down and rotated to bring the pin 44 from the position e' shown in Figure 5 to f', where the core is held until the core is deenergized. At this time the actuator 40 will again press and rotate the core to bring the same into position d'.

The right side indentations of the vertices in the track 45 serve to position the pin 44 so that on movement of the core 42, the pin 44 will move to the right in the track 45. It will be noted that in order to make this actuation possible, the action of the springs 40 must be sufficiently strong to overcome the reluctance of the coils 20 and 50, and the force exerted jointly by the resilient arm 34 and the solenoid coil 20 (when energized) must be sufficiently strong to overcome the force exerted by the springs 40.

It will also be noted that whenever the solenoid core 42 is moved by the coil 20 (which movement is always in the same direction), such movement serves to bring the core 42 to a position where the springs 40 will next move the core into either a switch closing or a switch opening position. Such switch closing and switch opening movements of the core are effected alternately. Thus, displacement of the actuating arm 40 at the end of the actuation of the switch may be subdivided into an initial step effected by energizing the solenoid coil and a second step effected by the springs 40 when the solenoid coil is deenergized. When extending from the coil 20, with no switch actuating movement, the springs 40 serve to hold the switch actuating means in the position assumed at the end of the switch actuating movement.

Another angle of the arcuate solenoid operated switch carried by being inserted in the wiring diagram of Figure 1 in the face of switch 10 is illustrated in Figures 6 through 11 as including an annular solenoid coil 50 mounted in a tubular casing 51, described and shown in Figure 11 and connected to a pair of terminal 53 at the bottom of the casing 51. The terminals 53 correspond to the terminals a, d of Figure 1. A solenoid plunger 54 is movable within the coil 50, being drawn down or retracted into the bore of the coil 50 when the latter is energized.
A generally U-shaped strip 55 extends over the top of the casing 51. The legs 56 of this strip have their ends 57 bent over the top of the casing 51. An insulating strip 58 affixed thereto as by means of screws 59. Terminals 60 and 61 are attached to the upper edge of the strip 58. These terminals correspond to the terminals a, b of the wiring diagram of Figure 1. A lead 62 connects the terminal 60 to a resilient contact arm 63 extending below the plate 58 and biased into contact with a second contact arm 64 connected to the terminal 61 by a lead 65.

A mounting strip 66 has one end hinged on a pin 67 mounted on the left strip leg 56 and extends under the contact arms 63 past the center of the solenoid core 54. A metal fin 68 forms a continuation of the upper edge of the strip 66 and is threaded through an insulating link 69 of generally T-shaped configuration extending through a suitable aperture in the contact arm 63, as best shown in Figure 10. A coil spring 70 is mounted on the under side of the strip 66 below the finger 65 and has a long finger 71 extending to the right through a window shown in Figure 11, extending thence into a labyrinth generally indicated at 73. The spring 70 is arranged to bias the finger 71 toward the right side of the coil spring 70, and another wire 74 attached to the end of the solenoid core 54 passes over the strip 66, as best shown in Figure 10.

When the solenoid coil 50 is energized, the solenoid core 54 is pulled downward and the pin 10 whereby the switch is opened and closed. A metal strip 78 forms a continuation of the upper edge of the arm 71 and causes the finger 71 to become lodged in the angle 82, as shown in Figure 9. When next the solenoid coil 50 is energized and the finger 71 retracted by the solenoid core 54, the finger 71 moves downwardly past the lowermost part 90b of the coil spring 70 and the pin 10 is moved upwardly by the angle formed by the strip 78 and the plate 55. When the coil is next deenergized, the resiliency of the arm 63 raises the finger 71 and causes the latter to slide along the strip 78 into the position shown in full lines in Figure 9 and also illustrated in Figure 6, the switch then being closed.

The switch is shown in Figure 7, where the switch is closed by the projecting portions of the shoulders 109 and 110, and the projecting portions of the shoulders 109 and 110 serve to hold the two pins 106 in position. The switch of Figures 12 to 16 is therefore opened and closed simply by rotation of the shaft 100. The switch actuating mechanism includes a solenoid core 102 retracted into the solenoid coil 90 when the latter is energized and having attached to its upper end a pin 106 having an inwardly deflected portion 108. When the solenoid core 102 is retracted, engaging the upper side of that one of the pins 106 located in the upper right quadrant of the pin 106 partially. The wiring number 103 is also formed with a left shoulder 109 and a right shoulder 110 coming to a point at the middle of the plate 103. The right shoulder 110 extends downwardly at a relatively steep angle while the left shoulder 109 extends downwardly from said point at a relatively gentle slope. When the actuating plate 103 has been retracted by energizing the solenoid, and when thereafter the solenoid is deenergized and the springs 104 move the plate upwardly, the shoulder 109 engages the pin 106 in the lower left-hand quadrant to move this pin upwardly and thereby to rotate the discs 105 further. Thus, the downward movement of the actuating plate 103, and the upward movement of the energized solenoid followed by subsequent upward movement under the influence of the springs 104 has been shown to effect rotary movements of the discs 105 which may total 90°. Figures 14 to 16 illustrate the different positions assumed during such rotary movement by the pin 101 whereby the switch is opened and closed. It will also be noted that the projecting portions of the shoulders 109 and 110 serve to hold the two pins 106...
in the lower two quadrants against movement when the switch is not being actuated. For this purpose the relative
turning of the shoulder 170a to form an angle 111 extending horizontally a vertically extended plate edge 111 extending
between the lower end of the shoulder 110 and the arm 107. An arm 111a may extend upwardly on the left
hand side of the actuating plate edge 111. This arm 111a and the arm 107 may slide over the inside of the casing
91 and thereby serve to keep the plate 103 in proper vertical alignment within the casing 91.

In this manner the movement of the switch mechanism of Figures 12 through 16, the same cyclical succession of
two step movements is effected as in the previously de-
scribed switches. In other words, energizing the solen
doid causes movement of the switch actuating member
as shown in Figures 24 and 25, one of the star wheel arms 157a to
by the actuated end of another erect arm 159 extending upwardly from the right solenoid core arm 155.

When the coil 140 is energized to retract the solenoid core arm 154 as shown in Figures 24 and 25, one of the star wheel arms 157a to
its upper side contact by the free end of the arm 159. When the solenoid core 140 is next energized
to retract the solenoid core arm 154, the rightward arms 158a to cause partial rotation of the discs to the position shown in
Figure 27. During this partial rotation, the other arm
160 slides over one arm 158a of the other star wheel. When next this coil 140 is deenergized, the solenoid core
154 is pulled upwardly and the arm 160 engages the underside of a star wheel arm 158a to further rotate the
star wheels. During this second rotary movement, the arm 159 slides over another star wheel arm 157a to
return the arms 159 and 160 to the same relative position with respect to the star wheels as that shown in
Figures 24 and 25. The two rotating movements may total 90° for moving the switch from a closed to an
open position or vice versa. After each switch closing or
opening movement, the arms 159 and 160, acting under the force exerted by the springs 156, serve to
retain the switch in a position assumed at the end of
such switch opening or switch closing movement.

The above described solenoid operated switches are
given merely by way of examples of devices according to
the present invention. It will be understood that
instead of electrically actuated solenoids, hydraulically
actuated or pneumatically actuated pistons may be used.

The device of the present invention offers a number of advantages over conventional
assistance of switches and the like. Such conventional devices require three wires because the solenoid operating the switch has two separate windings, one being energized
to close the switch and the other to open the switch.
The two solenoid circuits are controlled, respectively, by an “on” push button switch and by an “off” push button switch. Our solenoid operated
switch, on the other hand, requires only two wires and
single push button switch.

Conventional devices for remote solenoid control of
switches are ordinarily operated by using a separate
24 volt potential obtained from a separate source for each device to be so operated, our device can also be
more conveniently and economically operated from the
110 volt power present in each ordinary outlet box by the use of our solenoid coil armatures, each
armature being coupled with a fuse limiting the amperage to a predetermined maximum value. For instance, the
canoloid coil resistance can be predetermined to limit the amperage to 0.5 ampere, and the fuse used is
0.7 ampere. Such an arrangement will conform to the
National Electric Code requirements for remote control systems.

At the low current intensity required by our device, a paired conductor of No. 18 or 20 gauge solid or
stranded wire with fairly rugged moisture proof insulation will ordinarily be satisfactory. Where considerable
wear is anticipated, armored cable may be used. The
solenoid and the switch controlled thereby may conveniently be provided as a complete unit with wires
brought out as pigtailed for easy connection to wiring within the outlet box where the switch is to be used. The push button switches or other finger control switches may be quite small, and may easily be provided in various
numbers distributed over various locations. There is no particular fire hazard or danger of severe shock at
the switches when using the low current intensities made possible by the devices disclosed hereinabove.

Many details of construction may be varied within a wide range without departing from the principles of
this invention. It is, therefore, not our purpose to limit the
patent granted on this invention otherwise than necessitated
by the scope of the appended claim.

We claim:

A solenoid switch for an electrical circuit comprising

a solenoid arm, a reciprocable solenoid plunger, said
coil being operative for actuating the solenoid plunger
at one end and two spring members for actuating the
solenoid plunger in the opposite direction, said coil and
said spring members cooperating successively to actuate
the solenoid plunger through a reciprocating cycle, a pair
of contacts interposed in one side of said circuit, and
switching means actuated during one reciprocating cycle
of said solenoid plunger whereby the pair of contactors are electrically connected during one reciprocating cycle of said solenoid plunger and electrically disconnected during the following reciprocating cycle, said switching means comprising a rotatably mounted disc formed with spaced axial projections distributed symmetrically around the margin of said disc, means rigidly secured to said plunger for engaging said disc projections and comprising a first actuating member for engaging a projection on one side of said disc to rotate said disc as said plunger is moved under the influence of said coil and a second actuating member for engaging another projection on the diametrically opposed side of said disc to continue the rotation of said disc as said plunger is moved in said opposite direction under the influence of said spring members, said second actuating member being shaped to engage, at the end of said movement of said plunger in said opposite direction, one projection on each of the two diametrically opposed sides of said disc whereby said disc is held against further rotation until said plunger is again moved under the influence of said coil, said switch further comprising means carried by said disc for establishing and disestablishing electrical contact between said contactors.

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