Nov. 7, 1950 S. I. LINDELL 2,529,032

ELECTRIC SWITCH

Filed April 6, 1945 5 Sheets-Sheet 1

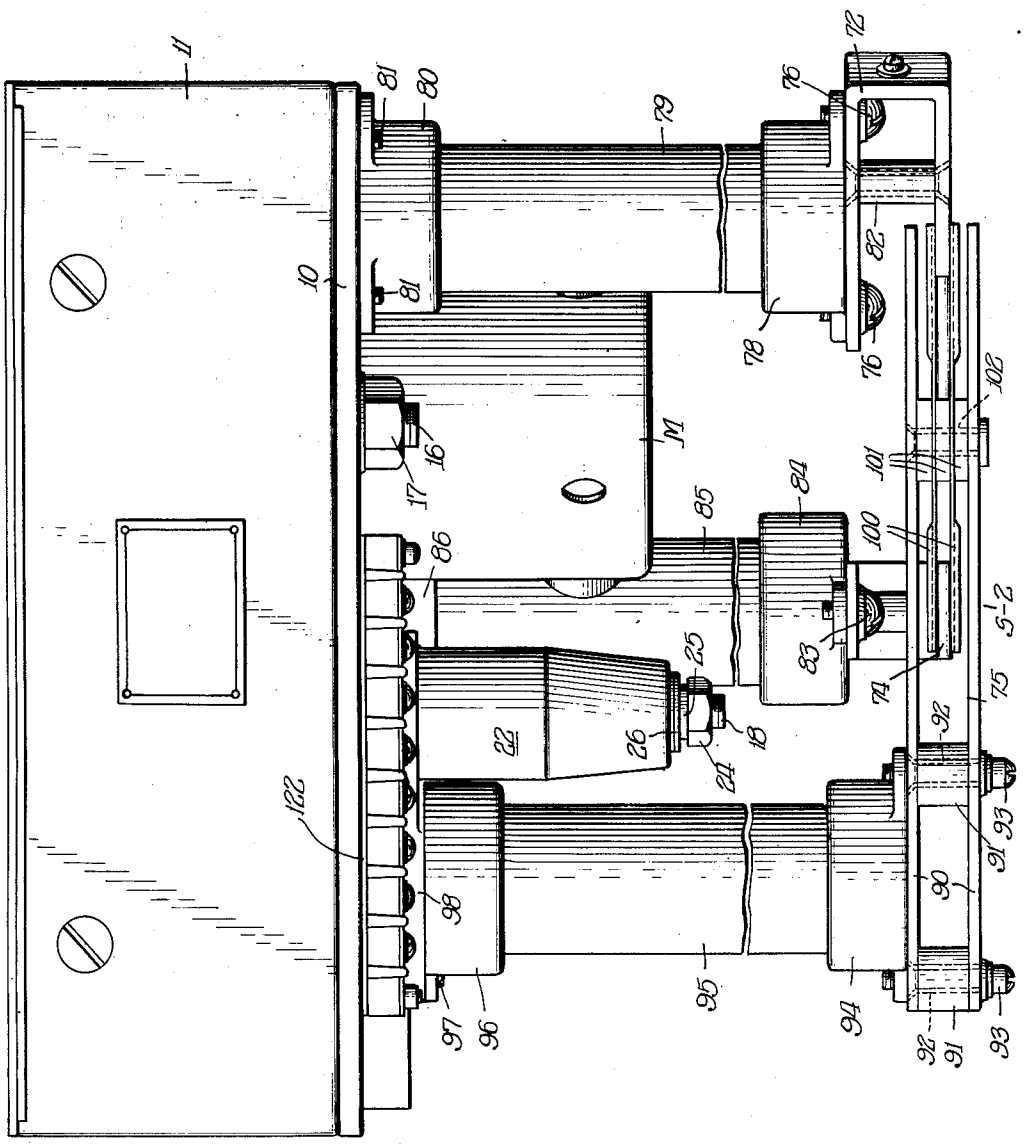


Fig. 1

INVENTOR.
Sigurd I. Lindell.
BY
Brown, Jackson, Boettcher & Dienner
attys.

Nov. 7, 1950 S. I. LINDELL 2,529,032

ELECTRIC SWITCH

Filed April 6, 1945 5 Sheets-Sheet 2

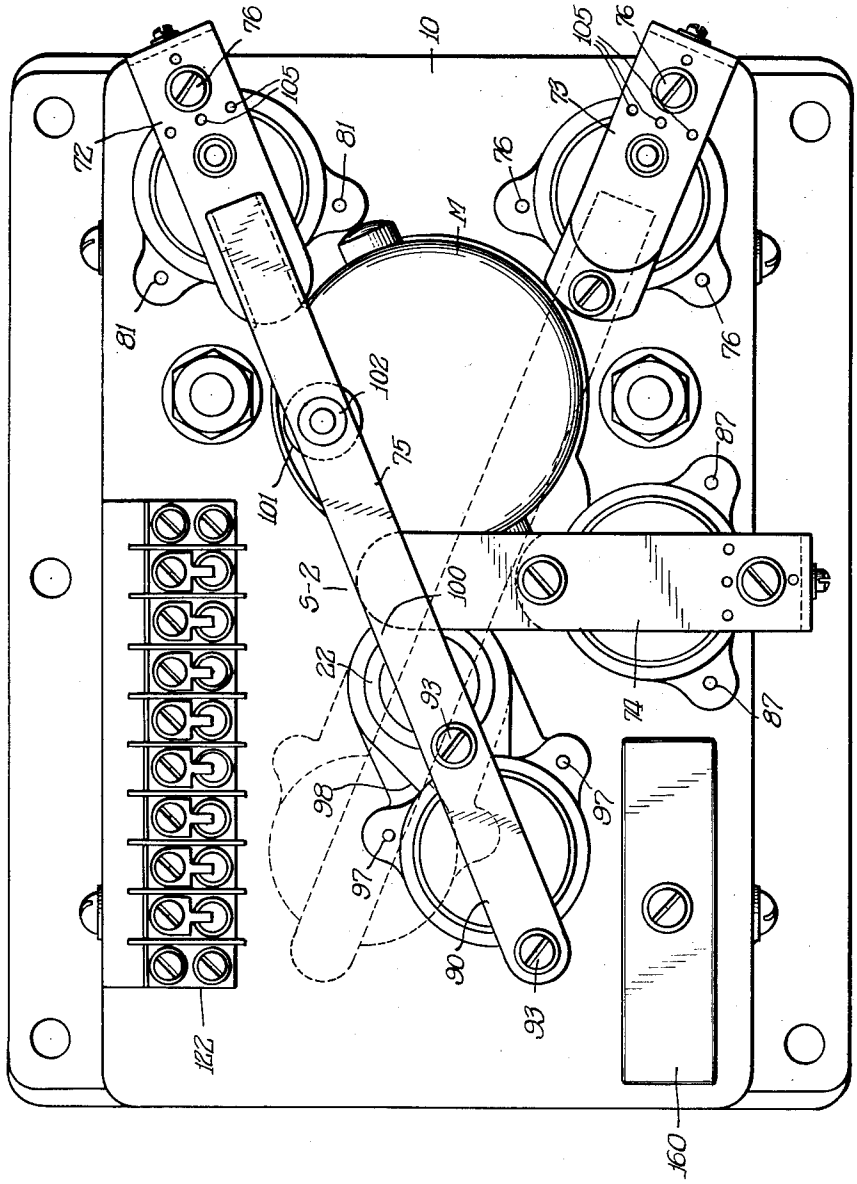


Fig. 2.

INVENTOR.
Sigurd I. Lindell,
BY
Brown, Jackson, Boettcher & Dienner
Attys.

Nov. 7, 1950 S. I. LINDELL 2,529,032

ELECTRIC SWITCH

Filed April 6, 1945 5 Sheets-Sheet 3

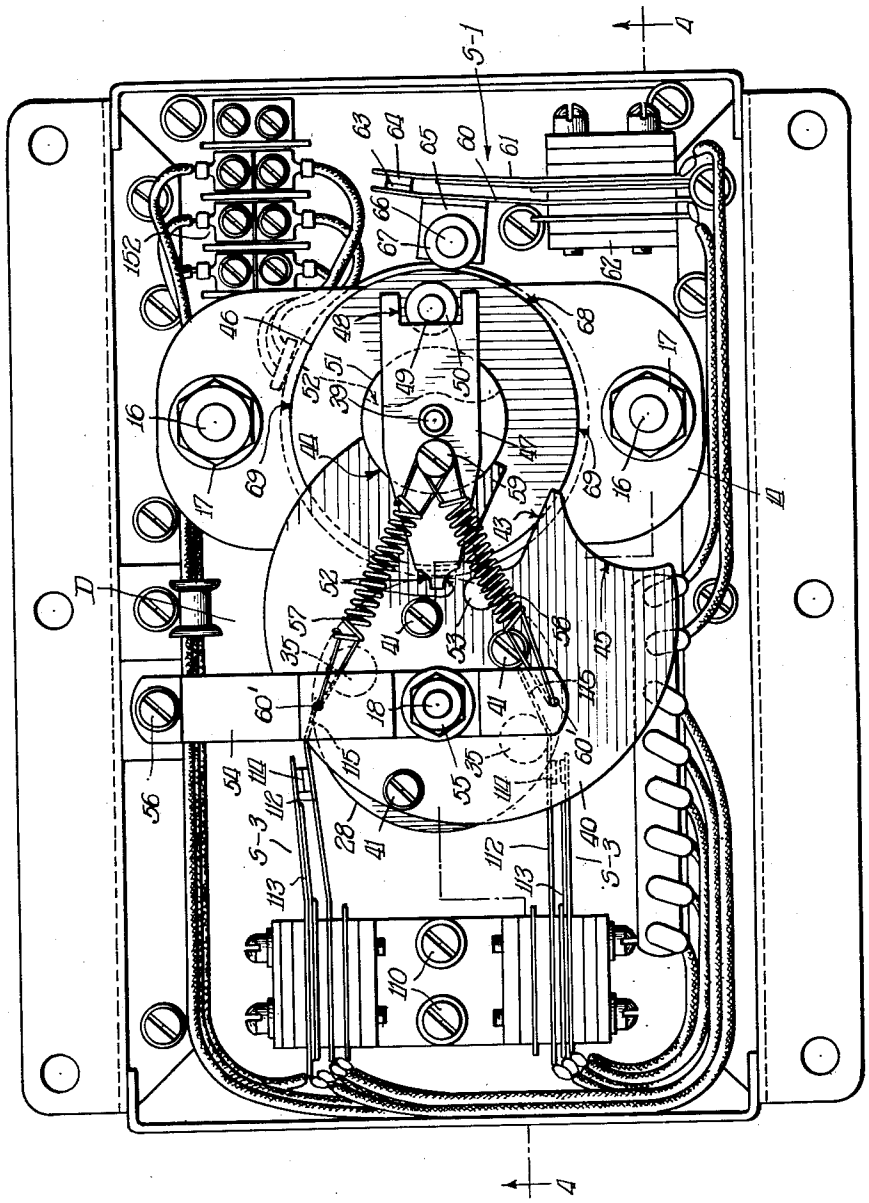


Fig. 3

INVENTOR.
Sigurd I. Lindell.
BY
Brown, Jackson, Boettcher & Dienner
attys.

Nov. 7, 1950 S. I. LINDELL 2,529,032

ELECTRIC SWITCH

Filed April 6, 1945 5 Sheets-Sheet 4

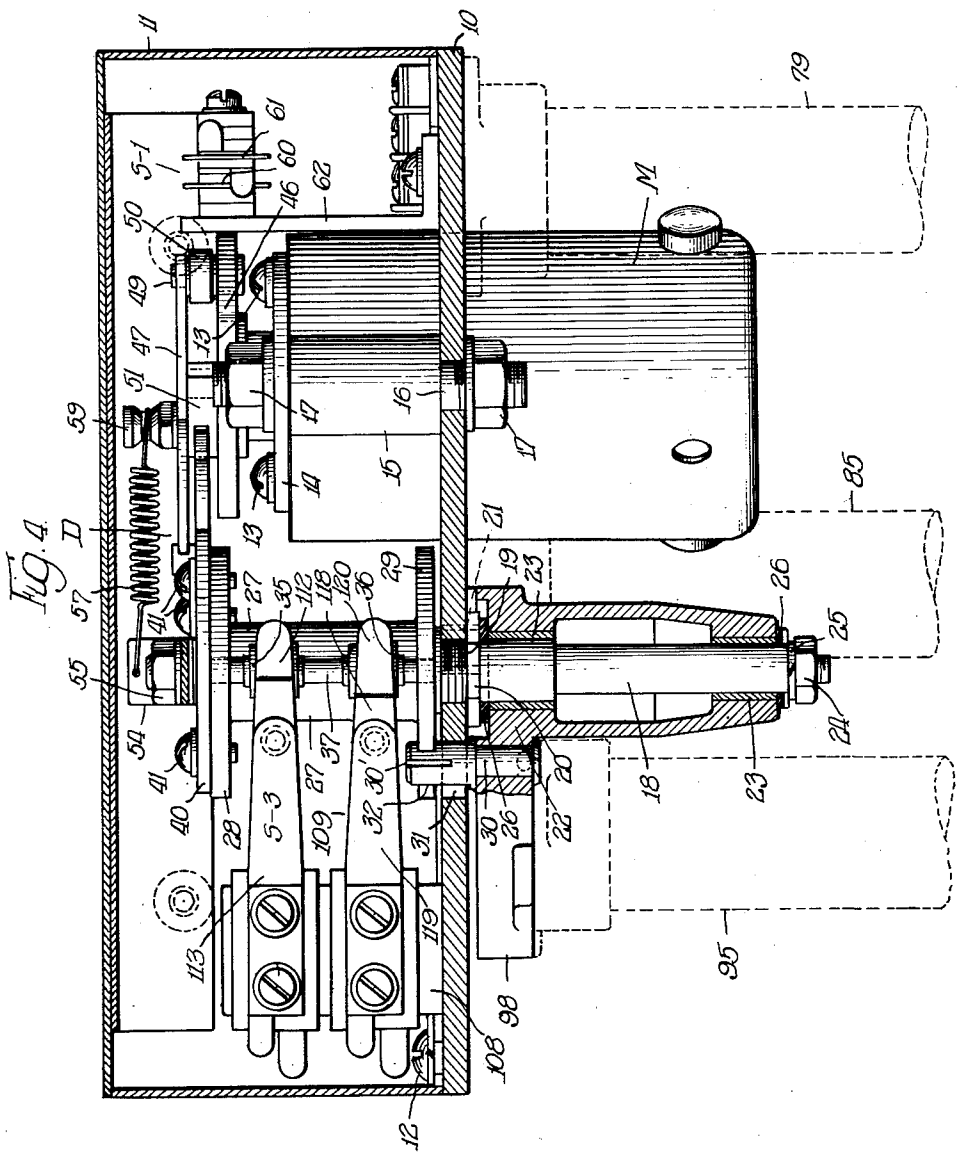


Fig. 4

INVENTOR.
Sigurd I. Lindell
BY
Brown, Jackson, Boettcher & Dienner
attys.

Nov. 7, 1950 S. I. LINDELL 2,529,032

ELECTRIC SWITCH

Filed April 6, 1945 5 Sheets-Sheet 5

Fig. 5

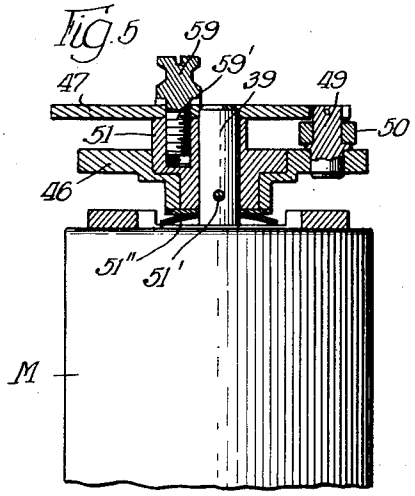


Fig. 6

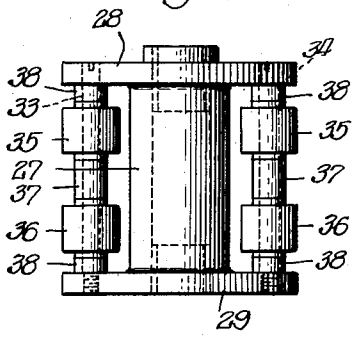
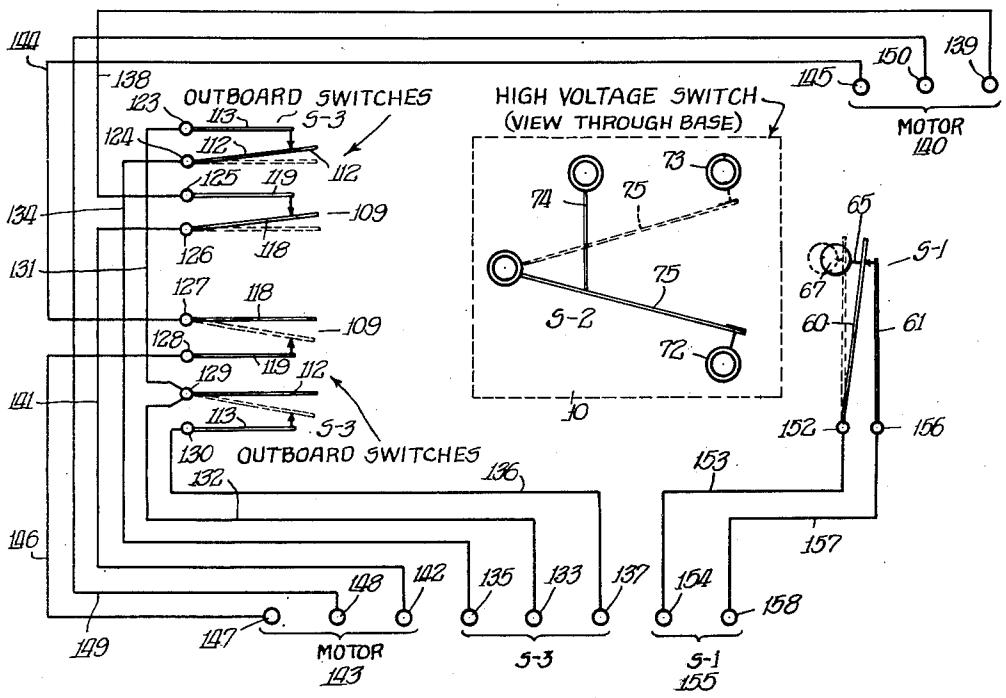


Fig. 7



INVENTOR.

Sigurd I. Lindell,

BY

Brown, Jackson, Boettcher & Dienner

Attys.

Patented Nov. 7, 1950 2,529,032

UNITED STATES PATENT OFFICE

2,529,032

ELECTRIC SWITCH

Sigurd I. Lindell, Chicago, Ill., assignor to S & C Electric Company, a corporation of Delaware

Application April 6, 1945, Serial No. 586,850

6 Claims. (Cl. 318—15)

1

This invention relates, in general, to electric switches, and has particular relation to improvements in switches for interrupting small high-voltage currents.

While the particular switch which I shall describe hereinafter in connection with the drawings is a high voltage switch adapted for use in connection with microwave transmission lines and in places where the switch is or may be subject to shock, vibration, high humidity and high temperature conditions, and other deleterious conditions, it is to be understood that the invention is not limited to such use but may be employed for other purposes and under other conditions, as suitable and desired.

The problem of interrupting small high-voltage currents under the conditions which the switch of my present invention is particularly adapted to withstand has not, prior to my invention, been met satisfactorily. Prior switches of which I am aware have not been shock-proof with respect to mechanical strength, nor have they had the ability to operate unhampered while subjected to shock of specified direction and intensity. They have also been unable to withstand the vibration which the switch of my present invention is able to withstand, particularly in combination with shock, without undue wear, rattle, misalignment, or interference with mechanical operation.

Prior switches have likewise not approached the switch of my present invention in simplicity and compactness, nor have they had in combination with the other features positive and quick break actions suitable for use, particularly under the conditions which the switch of my present invention is adapted to withstand.

I am aware of prior rotary type tap changing switches employing so-called Geneva gear drives for use with step voltage regulators. The drive mechanisms of such switches do not operate directly from the motor shaft, nor do they have the shock-proof and vibration-proof characteristics as provided in the switch of the present invention, particularly during the switching operations. Instead, the prior switches above mentioned employ gear trains and other mechanism which preclude the advantages which the switch of the present invention provides. Moreover, these prior switches are not simple and compact in construction, and could not be installed where space is very limited.

One of the main objects of the present invention is to provide a switch of the character described having various features of novelty and advantages.

2

Another object of the invention is to provide a switch which is simple and compact in construction so that it may be installed, for example, with other equipment in a cabinet where space is very limited.

Another object of the invention is to provide a switch which will withstand shock with respect to mechanical strength and operate unhampered while subjected to shock of specified direction and intensity.

Another object of the invention is to provide a switch which will withstand vibration over a wide range, in combination with shock, without undue wear, rattle, misalignment or interference with mechanical operation.

Another object of the invention is to provide in a switch of the class described a quick break action secured simply and directly from the motor shaft or other rotary operating means to facilitate interruption of the high voltage circuit, and, more particularly, a high speed drive which provides quick break operation of conventional auxiliary switch contacts.

Another object of the invention is to provide a switch of the class described which is operable effectively under conditions of high humidity and high temperature; also where the atmosphere is salty, and under other deleterious conditions.

Another object of the invention is to provide improved mechanism for operating the switch, for example, from a high speed reversible motor of high starting torque, whereby the motor is permitted to gain speed before engaging the switch rotor to open the high voltage contacts, maximum mechanical advantage is obtained to separate the wiping high voltage contacts, and quick opening is provided upon separation of the contacts; also quick closing.

Another object of the invention is to provide a substantially balanced strong assembly driven by a motor or other reversible rotary operating means with a flywheel, which makes the entire assembly substantially balanced to resist linear shock without pronounced interference with the operation of the switch assembly.

Another object of the invention is to provide a switch operating mechanism with a lost motion flywheel and stop arranged to dissipate the excess energy at the end of an operation through impact, for example, first between a stop member secured to the armature and a cooperating stop member, and then between the first mentioned stop member and the lost motion flywheel as the direction of the former is reversed; also a control of the low voltage auxiliary switch by a cam face

on the flywheel to provide time in this positive manner for operation of the contactors to interrupt the main load before the high voltage contacts are separated.

Another object of the invention is to provide in one replaceable assembly a quick-break high-voltage switch for interruption of small high voltage currents complete with electrical remotely controlled operating mechanism, including position indicating switches and limit switches.

Another object of the invention is to provide in a switch of the class described leakage-proof high-voltage insulation obtained by the use, for example, of porcelain insulators having leakage distance equal to approximately twice the striking distance through air between live parts of the switch, or between live parts and grounded parts.

Another object of the invention is to provide for securing the features and advantages set forth in a single pole, double throw selector switch, or in a two pole, single throw, double break switch or other form of switch.

Another object of the invention is to provide a switch of the class described having the features and advantages set forth, and which is effective in use, economical in manufacture, and adapted for application in a wide range of installations.

Another object of the invention is to provide an improved pole arrangement and movable contact assembly for a single pole, double throw selector switch; also an improved pole arrangement and movable contact assembly for a two pole, single throw, double break switch.

Other objects and advantages of the invention will appear from the following detailed description, taken in connection with the accompanying drawings in which:

Figure 1 is a front elevational view of a switch embodying the present invention;

Figure 2 is a bottom plan view of the switch shown in Figure 1;

Figure 3 is a top plan view of the switch shown in Figure 1, with the housing for the switch operating mechanism removed;

Figure 4 is a fragmentary sectional view taken substantially on the line 4—4 of Figure 3;

Figure 5 is a fragmentary detailed view, partially in section, of the operating disc assembly;

Figure 6 is a detailed elevational view of the drinving hub for the rotating insulator base, showing the auxiliary switch operating rollers carried by this hub; and

Figure 7 is a wiring diagram for the switch shown in Figures 1 to 6, inclusive.

Referring now to the drawings, the switch shown in Figures 1 to 7, inclusive, comprises, in general, a driving motor M, main switch mechanism S—2, and drive mechanism D for operating the switch directly from the motor shaft in the improved manner and with the advantageous results which will herein appear.

In the particular embodiment of the invention selected for illustration, the motor M is a 115-volt 60-cycle split series wound reversible ball-bearing motor, with the windings having an anodized black and tropicalized finish, but this, of course, may vary.

The embodiment of the invention illustrated in Figures 1 to 7 comprises a base plate 10 formed, for example, of steel, suitably enameled. A housing 11, also formed, for example, of steel, suitably enameled, is mounted on one side of the base plate 10 and secured thereto, for example, by screws 12.

The driving motor M is enclosed within a suitable housing and secured by screws 13 to a motor mounting plate 14. The plate 14 is supported within the housing 11 and in spaced relation to the plate 10 by posts 15. Studs 16 extend through the base plate 10, posts 15 and plate 14, and have nuts 17 screwed on the ends thereof, preferably with underlying lock washers for securing the motor in place on the base plate 10 with its inner end disposed within the housing 11 and its outer end extending outside the housing. The brushes for the motor, where used, are preferably located outside the housing 11 where they will be conveniently accessible.

The main shaft, indicated at 18, is threaded at 19 between its ends, and has a polygonal flange 20 by means of which the threaded portion 19 is screwed into the base plate 10 until the flange 20 abuts the outer side of the base plate 10, with the outer end of the shaft 18 extending outwardly from the base plate 10 and the inner end of the shaft disposed within the housing 11. A pin 21 is engaged in the flange 20 and in the base plate 10 for locking the shaft 18 in place.

A rotating insulator base 22, which may be in the form of a brass casting suitably enameled, is journaled to turn on the outer end of the shaft 18. Hardened stainless steel bearing sleeves 23 are preferably interposed between the insulator base 22 and the shaft 18 which is non-hardened stainless steel, although, of course, these details and the materials employed may vary widely within the scope of the present invention. A nut 24, screwed on the outer end of the shaft 18 and preferably provided with a lock washer 25, secures the insulator base 22 against outward axial displacement from the shaft 18. Washers 26, of Bakelite or other suitable material, are preferably interposed between the inner end of the base 22 and the flange 20, and between the outer end of the base 22 and the lock washer underlying the nut 24.

The inner end of the shaft 18 has a driving hub 27 journaled for rotation thereon within the housing 11. The hub 27 has, at its upper end as the device is viewed in Figure 4, an integral flange 28, and, at its lower or opposite end, an integral flange 29. A coupling pin 30 secured in the insulator base 22 extends through an opening 31 in the base plate 10 and, within the housing 11, engages relatively tightly in a notch 32 in the flange 29. The upper end of the pin 30 is shown as being split at 30' to provide the desired tightness of engagement of the flattened sides of the upper end of the pin with the sides of the notch 32. The coupling pin 30 serves to rotate or turn the insulator base about the outer end of the shaft 18 upon rotating or turning the hub 27 about the inner end of the shaft, as will hereinafter appear.

A pair of diametrically opposite shafts 33 and 34 (Figure 6) for auxiliary switch operating rollers extend between and are carried at opposite ends by the flanges 28 and 29 of the hub 27. Each shaft 33 and 34 carries a pair of rollers 35 and 36 formed, for example, of molded insulation or other suitable material. The rollers 35 and 36 are spaced from each other by spacers 37, and from the flanges 28 and 29 by spacers 38. These spacers 37 and 38 may be formed, for example of stainless steel or other suitable material.

For the purpose of imparting rotary or turning movement to the hub 27 and thereby to the insulating base 22 alternately in opposite directions and directly from the shaft 39 of the motor

M, a key disc 40 is secured in eccentric relation on the adjacent flange 28 by screws 41, preferably with lock washers, as illustrated in the drawings. The disc 40, which is disposed within the housing 11, has a generally radially extending and peripherally opening slot 43 and a pair of arcuate peripheral concavities 44 and 45, one on each of the opposite sides of the slot 43.

An operating disc 46 is loose on the motor shaft 39, and is disposed within the housing 11 in position underlying the adjacent portion of the disc 40. An operating arm or lever 47 is fixed on the motor shaft 39 in position overlying the adjacent portion of the disc 40. One end of the arm 47 has a notch or slot 48 into which the adjacent end of a driving stud 49 extends. The stud 49 is secured, at its lower end, in the operative disc 46 to rotate this disc by movement of the stud, as will hereinafter appear. A roller 50, mounted on the stud 49 between the disc 46 and arm 47, is adapted to enter the slot 43 in the disc 40 to impart rotation in opposite directions to the disc 40 upon rotation of the motor shaft 39 in opposition directions, as will hereinafter appear.

A lock disc 51 on the motor shaft 39 engages in one or the other of the concavities 44 and 45 in the periphery of the disc 40. The off-center or eccentric positioning of the disc 40 relative to the axis of the hub 27 with the other features set forth provides a substantially balanced strong assembly which operates directly from the shaft of the motor M or other reversible rotary operating means, and the relatively heavy disc 46 functions as a flywheel for the motor M or other reversible rotary operating means. The switch is shockproof with respect to mechanical strength and has the ability to operate unhampered while subjected to shock of specified direction and intensity. It will also withstand vibration, particularly in the range of 0 to 2500 cycles per second, in combination with shock without undue wear, rattle, misalignment or interference with mechanical operation. The lock disc 51 is formed at 52' to permit rotation of the disc 40 relative thereto in the operation of the switch.

As shown in detail in Figure 5, the lock disc 51 has a portion thereof fitting within the operating disc 46 for rotation relative to the disc 46, which, as previously mentioned, is relatively heavy, to serve as a flywheel for the motor. An integral hub on the lock disc 51 extends downwardly into an integral hub on the operating disc for rotation relative thereto. The hub on the lock disc 51 is fixed, for example, by a pin 51' to the motor shaft 39 for rotation therewith. The operating arm or lever 47 is fixed to the motor shaft 39, for example, by screwing the threaded shank 59' of the anchor stud 59, which passes through the arm 47, into the upwardly extending portion of the lock disc 51. A cupped spring disc 51'' urges the disc 46 yieldingly upwardly to hold same in relatively tight cooperation with the lock disc 51, as shown in Figure 6.

Lock disc 51 is preferably formed of hardened stainless steel, and the key disc 40, against which it operates, is preferably formed of non-hardened stainless steel. The roller 50 is preferably formed of hardened stainless steel for operation against the non-hardened stainless steel disc 40. These features may, of course, vary within the scope of the present invention.

The opposite end of the arm 47 has concavities 52 for cooperation with a stop pin 53 carried by the disc 40. A spring bracket 54 is secured beneath the nut 55 screwed on the adjacent end of

the shaft 18 and, at 56, to the housing 11. Two helical springs 57, 58, formed, for example, of stainless steel spring wire, are anchored or connected in spaced relation at 60', 60', respectively, to raised or offset portions of the bracket 54. The springs 57 and 58 converge toward their opposite ends and are anchored or connected to the anchor stud 59.

The lost motion connection between the cam face flywheel or disc 46 and the operating arm 47 through the stud and notch driving connection at 49, 48 leaves the armature of the motor and the flywheel as unrestrained as possible, and the helical springs free and unhampered, to bring the cam face flywheel into proper alignment. As will hereinafter more fully appear, excess energy at the end of an operation is dissipated through impact, first, between the stop bar or arm 47 secured to the armature and the stop pin 53, and then, between the stop bar and the lost motion flywheel as the direction of the former is reversed. A series of impacts may result.

The action just described results in a rebound which is limited mainly by the angle of lost motion (usually limited to about one-half of this angle, or less), and which is practically independent of the resilient properties of the various parts as well as the speed of the armature assembly at the time when the main switching action has been completed. This permits the use of a motor with ample torque and operation direct from the motor shaft to secure positive operation under adverse conditions, particularly adverse conditions of the character previously set forth. The drive mechanism of this embodiment of the present invention avoids oscillation and overswinging of the flywheel at the end of an operation such as would result if the flywheel were rigidly attached to the motor shaft and would cause the auxiliary switch S—I, to be next described, to open and close repeatedly before coming to rest with an objectionable opening and closing of the circuit controlled by this auxiliary switch.

If, for example, the auxiliary switch S—I is omitted, the flywheel 46 may be attached directly to the shaft of the motor M and the lost motion connection, as above described, may be omitted.

In the illustrated embodiment of the invention, the auxiliary switch S—I is a low voltage switch which opens approximately two cycles before the high voltage contacts separate, to initiate, for example, the interruption of a low voltage circuit by means of a contactor. The switch S—I comprises a pair of contact springs 60 and 61, insulated from each other at one end and having insulated support on a mounting bracket 62 mounted on the base plate 10. The free ends of the contact spring 60 and 61 have cooperating contacts 63 and 64, respectively. Secured, for example, to the spring 60 is a roller bracket 65 which carries a pin 66 on which a roller 67 is free to turn.

The roller 67 cooperates with the cam face periphery of the flywheel or disc 46. It may be formed of Bakelite or otherwise insulated from the other parts of the switch. The high portion 68 of the peripheral cam face, by cooperation with the roller 67, closes the contacts 63 and 64 and holds them closed. The low portion 69 of the cam face at the ends of the high portion 68 releases the switch closing action on the roller 67 and permits the spring 60 to spring away from the spring 61, thus separating the contact 63

from the contact 64 and opening the auxiliary circuit.

It is to be understood that the auxiliary switch S—1, and any of the other auxiliary switches, may be modified to open auxiliary circuits instead of operating to close the same as herein described.

In the illustrated embodiment of the invention the total operating time from one position of the main switch to another is approximately six cycles. To provide the time element of two cycles for opening of the auxiliary switch S—1 before the high voltage contacts separate, the angular width of the cam face is limited substantially as illustrated.

The main switch S—2, illustrated in Figures 1 to 6, inclusive, is a single-pole double-throw selector switch. It is to be understood, however, that the present invention, in its broader aspects, may be embodied in switches of the two-pole, single throw, double break type, and in switches of other types and for use for other purposes and under other conditions than those herein set forth.

The switch S—2 comprises a pair of stationary contacts 72 and 73, a third stationary contact 74, and a movable contact assembly 75. The contacts 72 and 73, formed, for example, of red brass silver-plated, are generally U-shaped in form and have inner legs secured, for example, by screws 76 to insulator ferrules 78 which may be in the form of silver-plated brass castings fixedly mounted on the outer ends of porcelain insulators 79. Similar insulator ferrules 80, which likewise may be in the form of silver-plated brass castings, are fixedly mounted on the inner ends of the insulators 79. The inner insulator ferrules 80 are secured, for example, by screws 81 to the outer side of the base plate 10. The outer contact making and breaking legs of the contacts 72 and 73 are maintained in parallel spaced relation with respect to the inner legs of the contacts by struts or spacers 82 interposed therebetween and secured in place, for example, by hollow rivets. The struts or spacers 82 may be formed of silver-plated rolled brass or other suitable material.

The third stationary contact 74 is of a form similar to the contacts 72 and 73. Its inner leg is secured by screws 83 to an insulator ferrule 84 fixedly mounted on the outer end of a porcelain insulator 85. A similar ferrule 86 is fixedly mounted on the inner end of the insulator 85 and secured by screws 87 to the outer side of the base plate 10. The outer contact leg of the contact 74 is longer than the corresponding legs of the contacts 72 and 73, for reasons which will presently appear.

The movable main contact assembly comprises a pair of spaced outer contact guards or bars 90 which may be formed, for example, of silver-plated phosphor bronze spring tempered. The guards 90 are spaced by spacers 91 and secured together as a unitary assembly, for example, by hollow rivets 92. Threaded studs or screws 93 pass through the guards 90, spacers 91 and rivets 92 and are screwed into integral lugs on the adjacent insulator ferrule 94 to secure one end of the movable contact assembly fixedly on the ferrule 94. The ferrule 94 is fixedly mounted on the outer end of a porcelain insulator 95. A similar ferrule 96 is fixedly mounted on the inner end of the insulator 95 and secured by screws 97 to a laterally extending integral arm 98 on the rotating insulator base 22.

The procelain insulators, which are preferably formed of wet process porcelain, provide a high voltage leakage-proof insulation. The porcelain insulators preferably have leakage distances equal to approximately twice the striking distance through air between the live parts, or between live parts and grounded parts. By making the insulators of porcelain of the character described I avoid carbonization such as would tend to occur if the insulators were made of Bakelite and other organic materials.

Contact springs 100 are mounted in spaced relation intermediate their ends between the guard bars 90 by spacers 101 and a hollow rivet 102. The twin fingers thus presented at one end of the contact springs 100 are held under self-compression and have constant wiping contact with the contact leg of the contact 74. The twin fingers at the opposite end of the contact springs 100 are held under self-compression, and move over and from the contact fingers of the contacts 72 and 73 with a strong spring-wiping action in the operation of the switch.

When the rotating insulator base 22 is rotated in a clockwise direction as viewed in Figure 2, through the driving mechanism described by the eccentric engagement of the coupling pin 30 in the base 22, the movable contact assembly is rotated from the full line position (Figure 2), connecting the contacts 72 and 74, to the dotted line position connecting the contacts 73 and 74. Conversely, when the base 22 is rotated in a counterclockwise direction (Figure 2) from the position in which the movable contact assembly is in its dotted line position, the movable contact assembly is rotated from the dotted line position connecting the contacts 73 and 74 to the full line position connecting the contacts 72 and 74. The stationary contacts 72, 73, and 74 have tapped holes 105 for connecting thereto the terminals of the conductors of the main circuit in which the switch is connected.

The length of the movable main contact assembly 75 from the axis of the shaft 18 to the outer free end of the movable contact assembly is greater than the length of the movable assembly 75 from the axis of the shaft 18 to the mounted end of the movable main contact assembly. This provides an overhang which, with the overhang of the disc 40 and the other features, provides a unit which is substantially dynamically balanced.

Mounted on the base plate 10 to the left of the hub 27, as the switch is viewed in Figure 4, is an auxiliary switch mounting bracket 108. This bracket 108 supports, in insulated relation, the contact springs of a pair of upper auxiliary switches S—3, S—3, and the contact springs of a pair of motor limit switches 109, one motor limit switch 109 being positioned beneath each of the upper auxiliary switches S—3. The bracket 108 is secured in place on the base plate 10, for example, by screws 110 which are preferably provided with lock washers.

Each switch S—3 comprises a pair of contact springs 112, 113 extending generally horizontally from the bracket 108 toward and in the horizontal plane of the upper rollers 35 carried by the hub 27 as the switch is viewed in Figure 4. The springs 112, 113 have contacts 114 near their free ends which are normally separated or held in open circuit position and are returned to such position by the inherent resilience of the springs 112, 113. The free ends of the inner springs 112 have angular ends 115 which are positioned to

be engaged by the rollers 35 in the rotation of the hub 27 alternately in opposite directions. Engagement of one roller 35 with the angular end 115 of the spring 112 of one switch S—3 closes the contacts 114 of this switch. Engagement of the other roller 35 with the angular end 115 of the spring 112 of the other switch S—3 closes the contacts 114 of this switch. Upon release of the rollers 35 from their auxiliary switch closing engagement with the angular ends of the respective springs 112 the auxiliary switches S—3 are opened by the inherent resilience of the spring contacts.

Each motor limit switch 109 comprises a pair of contact springs 118, 119 which extend generally horizontally from the bracket 108 toward and in the horizontal plane of the lower rollers 36. The springs 118, 119 have contacts which are normally separated and held in open circuit position, and are returned to such position by the inherent resilience of the springs. The free ends of the inner springs 118 have angular ends 120 which are positioned to be engaged by the rollers 36 in the rotation of the hub 27 alternately in opposite directions. Engagement of one roller 36 with the angular end 120 of the spring 118 of one of the motor limit switches closes the contacts of this switch. Engagement of the other roller 36 with the angular end 120 of the spring 118 of the other motor limit switch closes the contacts of this switch. Upon release of the rollers 36 from the auxiliary switch closing engagement with the angular ends of the respective springs 118, the motor limit switches 109 are opened by the inherent resilience of the spring contacts.

Mounted upon the bottom of the base plate 10 is a terminal block 122 having eight terminals 123, 124, 125, 126, 127, 128, 129, and 130. As shown in the wiring diagram (Figure 7), the contact spring 113 of one auxiliary switch S—3 is connected to the terminal 123 which is connected by a conductor 131 to the terminal 129 of the other auxiliary switch S—3. The contact spring 112 of this other auxiliary switch S—3 is connected to the terminal 129 which is connected by a conductor 132 to the terminal 133 of a terminal assembly S—3. The other contact spring 112 of the first mentioned auxiliary switch S—3 is connected to the terminal 124 which is connected by a conductor 134 to the terminal 135 of the terminal assembly S—3. The other contact spring 113 of the other auxiliary switch S—3 is connected to the terminal 130 which is connected by a conductor 136 to the third terminal 137 of the terminal assembly S—3.

The contact spring 119 of one motor limit switch 109 is connected to the terminal 125 which is connected by a conductor 138 to the terminal 139 of the motor terminal assembly 140. The other contact spring 118 of the switch 109 is connected to the terminal 126 which is connected by a conductor 141 to the terminal 142 of the motor terminal assembly 143. The contact spring 118 of the other motor limit switch 109 is connected to the terminal 127 which is connected by a conductor 144 to the terminal 145 of the motor terminal assembly 140. The other contact spring 119 of the last mentioned motor limit switch 109 is connected to the terminal 128 which is connected by a conductor 146 to the terminal 147 of the motor terminal assembly 143. The terminal 148 of the motor terminal assembly 143 is connected by a conductor 149 to the terminal 150 of the motor terminal assembly 140.

The motor terminals 139, 145, and 150 of the motor terminal assembly 140, and the motor terminals 142, 147, and 148 of the motor assembly 143 are carried by the terminal block 152 mounted upon the top of the base plate 10 near the upper right hand corner of the base plate as it is viewed in Figure 3.

As shown more or less diagrammatically in the wiring diagram (Figure 7), the contact spring 60 of the auxiliary switch S—1 is connected to a terminal 152 which is connected by a conductor 153 to the terminal 154 of a terminal assembly 155. The other contact spring 61 of the auxiliary switch S—1 is connected to a terminal 156 which is connected by a conductor 157 to a terminal 158 of the terminal assembly 155. The terminals 154 and 158 of the terminal assembly may be carried by a terminal block which may be mounted upon the base plate 10 or otherwise as desired.

A spare brush container 160, mounted on the bottom of the base plate 10, for example as shown in Figure 2, carries one or more pairs of spare brushes and brush caps for the motor M.

With the movable contact assembly 75 of the main switch in position connecting the stationary contacts 72 and 74 as shown in Figures 2 and 7, the operation of the switch shown in Figures 1 to 7, inclusive, follows the following sequence.

The circuit for the motor M is closed, for example, from remote position to rotate the motor shaft 39 in a clockwise direction from the position as viewed in Figure 3. The motor shaft 39 operating directly through the pin connection 51' (Figure 5), lock disc 51, and anchor stud 59, rotates the operating arm 47 in a clockwise direction with the motor shaft 39. Upon taking up the lost motion between the slot 48 and the driving stud 49, the arm 47 at the upper end of the slot 48 (Figure 3) engages the stud 49 and turns the operating disc 46 in a clockwise direction with the motor shaft 39.

As the stud 49 rotates in a clockwise direction with the disc 46, the roller 50 on the stud 49 enters the slot 43 in the disc 40 with maximum mechanical advantage, and rotates the disc 40 in a counterclockwise direction (Figure 3). This counterclockwise rotation of the disc 40 rotates the attached or connected hub 27 in the same direction. Rotation of the hub 27 operates directly through the coupling pin 30, and the lateral flange of the insulator base 22, to rotate the base 22 about the axis of the main shaft 18 in a direction to swing the insulator 95 and the movable contact assembly 75 from the position connecting the contacts 72 and 74, as shown in Figures 2 and 7, to the dotted line position, disconnecting the contacts 72 and 74 and connecting the contacts 74 and 73.

It will be noted that the movable contact assembly 75, and particularly the contact springs 100 thereof, have a firm spring wiping contact with the contact flange of the contact 74 at all times, and that the opposite ends of the contact springs 100 move alternately into and out of firm spring-wiping contact with the contacts 72 and 73 as the movable contact assembly 75 is swung alternately in opposite directions by the reversible motor M or other suitable rotary driving or operating means.

It will also be noted that there is no appreciable load on the motor in starting. Until the roller 50 enters into driving engagement with the disc 40 through the slot 43 the motor is permitted freely to gain speed or accelerate. Then as the roller 50 enters the slot 43 and into driving engagement with the disc 40, it does so with

maximum mechanical advantage to break the static friction, whereupon the speed is accelerated to move the movable contact assembly quickly from one position to the other. Likewise, quick movement in the opposite direction is provided. The roller 50 also leaves the slot 43 with maximum mechanical advantage.

The limit switch 109, which is operative in the direction of operation being described, opens at the point where the roller 50 leaves the slot 43 to cut the power to the motor M. This is accomplished by movement of the corresponding roller 36 out of engagement with the corresponding contact spring 118 to permit the limit switch to open by the resilience of the spring 118. The switch rotor is attempting to return energy to the motor, and the helical springs 57 serve to bring the driving arm 47, and thereby the flywheel 46 with its pin 49, to predetermined locking position substantially as shown in Figure 3, and to maintain such position.

The switch described will withstand shock with respect to mechanical strength and operate unhampered while subjected to shock of specified direction and intensity. It will also withstand vibration in the range of 0 to 2500 cycles per second, in combination with shock, without undue wear, rattle, misalignment, or interference with mechanical operation. These conditions are met by the rigid mounting of the contacts, the absence of loose linkages, loose couplings, gear trains and the like, the provision of a direct simple drive, the balanced arrangement and the positive spring restrained self-aligning lock which secures the switch in alignment in each position.

The particular switch mechanism described provides a unitary assembly containing a single-pole, double-throw selector switch in combination with quick break auxiliary switches which operate in positive sequence. As already pointed out and as will hereinafter appear, it is to be understood, however, that the present invention, in its broader aspects, may be embodied in switches of the two pole, single-throw, double-break type and in switches of other types.

In the illustrated embodiment of the invention, the low voltage switch S—1, controlled by the cam face of the disc or flywheel 46, opens, as previously stated, approximately two cycles before the high voltage contacts separate, to initiate the interruption of a low voltage circuit by means of a contactor. This opening of the switch S—1 is accomplished by movement of the low portion 69 at one or the other of the ends of the high portion 68 of the cam face of the flywheel, depending upon the direction of rotation into position adjacent the roller 67. When either of the low portions 69 of the cam face is positioned adjacent the roller 67, the closing operation of the high cam portion 68 is released and the contact spring 60 snaps to open position to open the switch S—1. The time element above referred to is provided by limiting the angular width of the cam face of the flywheel, so that the desired time elapses after opening of the auxiliary switch S—1 before opening of the high voltage switch S—2. The more the angular width of the cam face of the flywheel can be reduced, the greater the time available between functioning of the two switches. With the present invention, the only limitation on the amount the angular width of the cam face of the flywheel can be reduced is the oscillation of the flywheel at the end of each switching cycle, which is effectively limited by the lost motion impact stop arrangement.

The operation in the opposite direction is obtained by reversing the motor M or other rotary driving or operating means, and follows, for the reverse operation, the sequence above described. The auxiliary switches S—3 are operated by the rollers 35 on the hub 27. Upon operation in one direction, one switch S—3 is closed by one of the rollers 35, and upon operation in the opposite direction this switch S—3 is released and snaps to open position, and the other switch S—3 is closed.

Referring to the wiring diagram (Figure 7), the operating sequence of the main and auxiliary switches is as follows:

(1) S—1 opens;
(2) S—2 opens from one position;
(3) S—3 opens from one position; ;
(4) S—3 closes in opposite position;
(5) S—2 closes in opposite position;
(6) S—1 closes in original position.

The wiring diagram shows the position of the switches after the terminals 147, 148 have been energized and the switching cycle is completed.

The switching arrangement of the present invention may be modified to include several notches 43 with their associated concavities 44 and 45, to provide for stepped operation of multi-position switches selective as to their direction and choice of position.

The switch of the present invention is capable of intermittent operation without lubrication.

The embodiments of the invention shown in the drawings are for illustrative purposes only, and it is to be expressly understood that said drawings and the accompanying specification are not to be construed as a definition of the limits or scope of the invention, reference being had to the appended claims for that purpose.

I claim:

1. An operating mechanism for a device, such as a switch, having a member to be moved from one position to another comprising, in combination, a reversible driving motor, an operating disc loose on the motor shaft, an operating arm fixed on the motor shaft and having a notch in one end thereof, a driving stud carried by the operating disc and extending into said notch for lost motion driving connection between said arm and said disc, a key disc mounted to turn about an axis parallel with and spaced laterally of the axis of the motor shaft, a roller on said driving stud, said key disc having a slot which said roller is adapted to enter and leave with maximum mechanical advantage to turn the key disc, and a drive connection between said key disc and said movable member for moving said movable member from one position to another.

2. An operating mechanism for a device, such as a switch, having a member to be moved from one position to another comprising, in combination, a reversible driving motor, an operating disc loose on the motor shaft, an operating arm fixed on the motor shaft and having a notch in one end thereof, a driving stud carried by the operating disc and extending into said notch for lost motion driving connection between said arm and said disc, a key disc mounted to turn about an axis parallel with and spaced laterally of the axis of the motor shaft, a roller on said driving stud, said key disc having a slot which said roller is adapted to enter and leave with maximum mechanical advantage to turn the key disc, a drive connection between said key disc and said movable member for moving said movable mem-

ber from one position to another, an anchor stud on said operating arm, a spring bracket, and a pair of helical springs anchored at one end to said bracket in spaced relation and converging toward the opposite ends and anchored to said stud.

3. An operating mechanism for a device, such as a switch, having a member to be moved from one position to another comprising, in combination, a reversible driving motor, an operating disc loose on the motor shaft, an operating arm fixed on the motor shaft and having a notch in one end thereof, a driving stud carried by the operating disc and extending into said notch for lost motion driving connection between said arm and said disc, a key disc mounted to turn about an axis parallel with and spaced laterally of the axis of the motor shaft, a roller on said driving stud, said key disc having a slot which said roller is adapted to enter and leave with maximum mechanical advantage to turn the key disc, a drive connection between said key disc and said movable member for moving said movable member from one position to another, and a stop pin on said key disc for cooperation with said operating arm whereby excess energy at the end of an operation is dissipated through impact first between said arm and said pin and then between the arm and the lost motion disc as the direction of the former is reversed.

4. An operating mechanism for a device, such as a switch, having a member to be moved from one position to another comprising, in combination, a reversible driving motor, an operating disc loose on the motor shaft, an operating arm fixed on the motor shaft and having a notch in one end thereof, a driving stud carried by the operating disc and extending into said notch for lost motion driving connection between said arm and said disc, a key disc mounted to turn about an axis parallel with and spaced laterally of the axis of the motor shaft, a roller on said driving stud, said key disc having a slot which said roller is adapted to enter and leave with maximum mechanical advantage to turn the key disc, a drive connection between said key disc and said movable member for moving said movable member from one position to another, a stop pin on said key disc for cooperation with said operating arm whereby excess energy at the end of an operation is dissipated through impact first between said arm and said pin and then between the arm and the lost motion disc as the direction of the former is reversed, said key disc having a pair of arcuate peripheral concavities one on each of the opposite sides of said slot, and a lock disc fixed on the motor shaft for engagement alternately in said concavities at the ends of the operations of said device.

5. An operating mechanism for a device, such as a switch, having a member to be moved from one position to another comprising, in combination, a reversible motor including a rotor rotatable through one revolution, a shaft carrying said rotor, a Geneva pinion carried by said shaft and rotatable therewith through said one revolution, a Geneva gear directly connected to said movable member and operatively related to said Geneva pinion whereby the rotation of the latter through one complete revolution unlocks said Geneva gear, moves the same and said movable member from one position to the other, and then locks them in said other position, and spring means cooperating with said Geneva pinion to bias it and said rotor to the same starting position.

6. An operating mechanism for a device, such as a switch, having a member to be moved from one position to another comprising, in combination, a reversible electric motor including a rotor rotatable through one revolution, a shaft carrying said rotor, a Geneva pinion carried by said shaft and rotatable therewith through said one revolution, a Geneva gear directly connected to said movable member and operatively related to said Geneva pinion whereby the rotation of the latter through one complete revolution unlocks said Geneva gear, moves the same and said movable member from one position to the other, and then locks them in said other position, a pair of limit switches operated by said Geneva gear and connected to control the operation of said motor, one limit switch being closed when said Geneva gear occupies one position to provide a circuit for energizing said motor to operate said Geneva gear to the alternate position and the other limit switch being opened as said Geneva pinion moves out of driving engagement with said Geneva gear and vice versa whereby said motor is deenergized in advance of the completion of said one revolution in either direction in sufficient time to dissipate the kinetic energy of the rotating parts and bring the same to rest when said one revolution is completed, and spring means cooperating with said Geneva pinion and acting to dissipate said kinetic energy and to bias said Geneva pinion and said rotor to the same starting position.

SIGURD I. LINDELL.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,047,463	Thompson	Dec. 17, 1912
1,099,421	Burke	June 9, 1914
1,109,586	Hewlett	Sept. 1, 1914
1,517,061	Hart	Nov. 25, 1924
1,685,069	Dilks	Sept. 18, 1928
1,740,436	Kimball	Dec. 17, 1929
1,856,121	Austin	May 3, 1932
1,896,850	Perry	Feb. 7, 1933
2,095,796	Crabbs	Oct. 12, 1937
2,200,989	Lennox et al.	May 14, 1940
2,349,682	Snyder	May 23, 1944

FOREIGN PATENTS

Number	Country	Date
357,287	Great Britain	Sept. 24, 1931