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[54] **PUSH-PULL SWITCH HAVING SELF-BIASING ELASTOMERIC MATERIAL CONTACTS WITH DISCRETE CONDUCTIVE PARTICLES DISPERSED THEREIN**

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Related U.S. Application Data

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[52] **U.S. Cl.** ..... **200/161,** 200/16 B, 200/166 C

[51] **Int. Cl.** **H01h 15/24,** H01h 1/02

[58] **Field of Search** ..... 200/161, 166 C, 153 K, 200/153 V, 16 A, 16 B, 82 D, 153 LA, 153 W, 159 R; 338/114, 99, 100, 101

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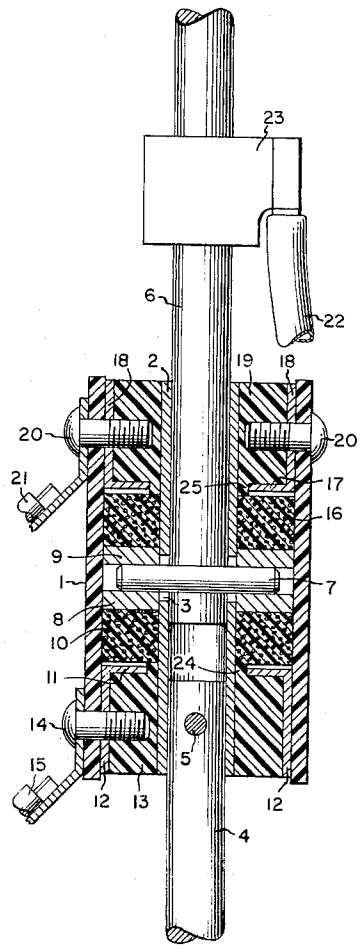
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[57] **ABSTRACT**

A push-pull switch having a pair of axially aligned, extensible and retractable links and a pair of resilient, normally non-conductive switching members one of which may be compressed and rendered conductive in response to extension of the links and the other of which may be compressed and rendered conductive in response to retraction of the links. The resilience of the compressible switching members normally maintains the links in such positions that neither of the switching members is conductive.

8 Claims, 3 Drawing Figures



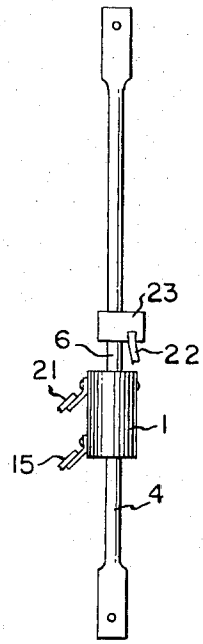


FIG. 1

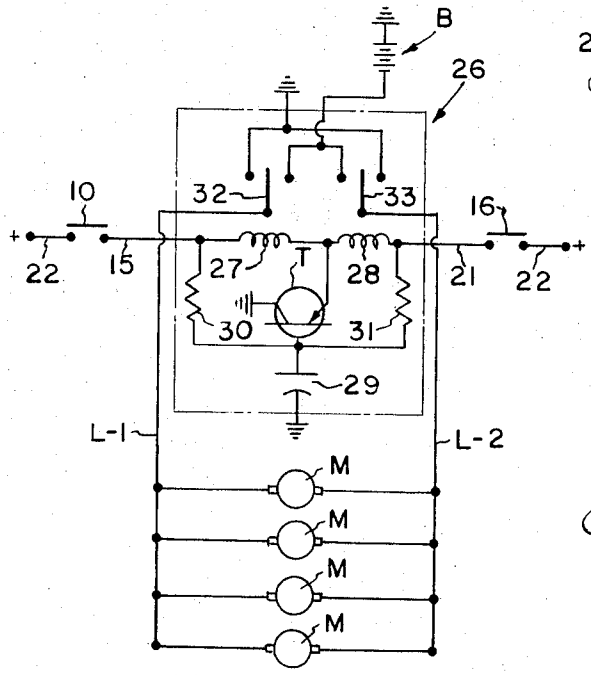


FIG. 3

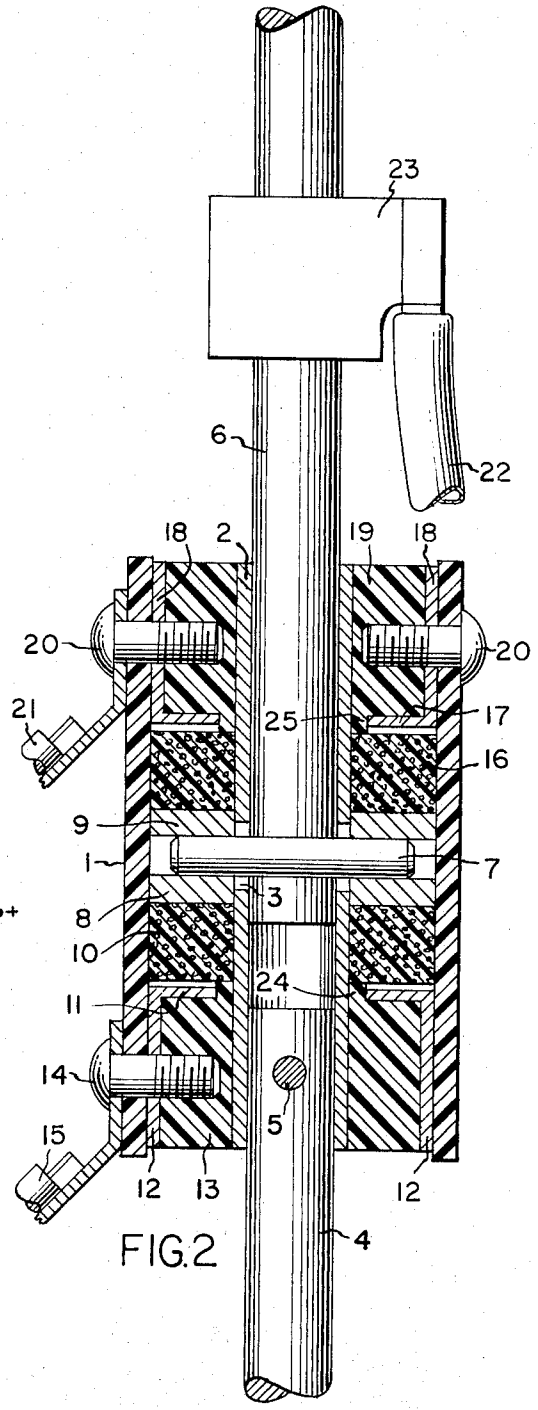


FIG. 2

PUSH-PULL SWITCH HAVING SELF-BIASING ELASTOMERIC MATERIAL CONTACTS WITH DISCRETE CONDUCTIVE PARTICLES DISPERSED THEREIN

RELATED APPLICATION

This application is a division of application Ser. No. 851,343, filed Aug. 19, 1969, now U.S. Pat. No. 3,653,237.

The invention disclosed herewith relates to a switch construction of the pull-push type for operating electrical devices such as reversible D.C. motors and includes a pair of compressible, resilient, normally non-conductive switching members. The switching members are so arranged with relation to the remaining switch structure that one of them is compressed and rendered conductive when the switch structure is subjected to a pulling force and the other of the switching members is compressed and rendered conductive when the switch structure is subjected to a pushing force. The arrangement is such that it is not possible to render both switching members conductive simultaneously.

A switch of the kind disclosed herein is particularly well adapted for controlling power apparatus for locking and unlocking the door latching means of vehicles, but has many other uses.

An object of this invention is to provide an improved switch construction for controlling the operation of power apparatus such as reversible electric motors.

Another object of the invention is to provide a switch construction of the kind referred to which precludes energization of a reversible motor or the like in more than one direction at any one time.

Other objects and advantages of the invention will be pointed out specifically or will become apparent from the following description when it is considered in conjunction with the appended claims and the accompanying drawings, wherein:

FIG. 1 is an elevational view of a switch constructed in accordance with the invention;

FIG. 2 is a vertical sectional view on a greatly enlarged scale of the switch; and

FIG. 3 is a schematic wiring diagram of a typical circuit with which the switch may be used.

Apparatus constructed in accordance with the invention comprises a hollow, cylindrical casing **1** formed of insulating material such as nylon or the like and within which is a concentric, electrically conductive sleeve **2** constituting a contact of a circuit yet to be described. The sleeve has an axially elongated, diametral, lost motion slot **3** between its ends. The upper end of a link **4** extends into the sleeve **2** and is fixed to the latter by means of a pin **5**. The lower end of a link **6** also extends into the sleeve **2** and is connected to the latter by means of a force transmitting pin **7** which passes through the slot **3** so as to permit limited lost motion between the link **6** and the sleeve **2** and between the links **4** and **6**. The links **4** and **6**, together with the pin **7**, constitute switch operating means as will be pointed out hereinafter.

Encircling the sleeve **2** and arranged on opposite sides of the pin **7** is a pair of electrically conductive washers **8** and **9**. In face to face engagement with the washer **8** is an annular, pressure sensitive switching member **10** and in axially spaced, confronting relation with the member **10** is an annular conductor **11** having

a pair of axially extending contact legs **12** which parallel the inner wall of the housing **1**. Fitted within the legs **12** is a rigid, annular plug **13** formed of insulating material such as nylon and which is fixed with respect to the casing **1** by the pin **5** and by an electrically conductive screw **14** which extends through the casing **1** and through one leg **12** of the conductor **11** so as to connect to the latter an electrically conductive wire **15**.

In face to face engagement with the conductive washer **9** is a pressure sensitive switching member **16** similar in all respects to the member **10**. In axially spaced relation to the switch **16** is an annular conductor **17** corresponding to the conductor **11** and from which extends a pair of contact legs **18** which parallel the wall of the casing **1**. An insulating plug **19** similar to the plug **13** is accommodated between the legs **18** and is fixed with respect to the casing **1** by a pair of screws **20** corresponding to the screw **14**. One of the screws **20** connects a wire **21** to one of the legs **18** of the conductor **17**. A wire **22** is coupled by means of a conductive clamp **23** to the link **6**.

The central opening in each of the annular conductors **11** and **17** is larger than the outside diameter of the sleeve **2**, thereby providing an annular space between each of the annular conductors and the sleeve. The plugs **13** and **19**, however, include axially extending, annular projections **24** and **25**, respectively, which occupy the annular spaces and bear against the associated switches **10** and **11**. The projections **24** and **25** thus perform the function of providing axial spacing between the switches and their respective conductors **11** and **17**, and the projections also provide concentrated force applying means in a manner and for a purpose presently to be described.

Each of the switches **10** and **16** may correspond to one of those disclosed in application Ser. No. 857,941, filed Sept. 15, 1969, and to which reference may be had for a more detailed disclosure of the manner of constructing the switches. Briefly, however, each switch **10** and **16** comprises an annular pad of resilient, deformable, non-conductive, synthetic rubber material such as that produced by combining Dow Corning silicone 3120 with Dow Corning catalyst S or F and throughout which is dispersed a large number of electrically conductive particles such as commercially available, silver coated, copper particles. The body of each switch is completely moisture impervious and may be formed by mixing the silicone resin and catalyst and stirring the conductive particles therein, following which the mixture may be cast in a mold and cured. The dispersion, the size and the quantity of particles are such that when the body is in its normal, unstressed condition the electrical resistance of the body is infinite and the body is non-conductive. When the body is subjected to compressive force of sufficient magnitude, however, the particles are forced to move relatively to one another into particle-to-particle engagement. The resistance of the body changes to that of the metal particles and the body becomes electrically conductive. Upon release of the compressive force, the inherent resilience of the body restores it to its normal, unstressed condition whereupon the particles again move relatively to one another, but in this instance in such manner as to disengage one another and render the body non-conductive. The two pads constituting the switches yieldably maintain the links **4** and **6** in their normal po-

sitions in which neither of the switches is conductive.

Only one of the switches **10** and **16** may be rendered conductive at one time. If the switch **10** is to be rendered conductive, a compressive force of sufficient magnitude must be applied to it to establish a conductive path via the conductive particles between the conductors **8** and **11.** This may be accomplished by applying a downward force on the link **6** of sufficient magnitude to take up the lost motion between the pin **7** in the slot **3** in the sleeve **2** and to cause the pin **7** to bear against the conductor **11** so as to compress the pad **10** between the conductor **11** and the conductor **8.** The projection **24** will provide a concentration of force adjacent the conductor **11** so as to assure establishing a conductive path through the switch **10.**

To render the switch **16** conductive the pin **7** must be moved upwardly so as to compress the switch **16** between the conductors **9** and **17.** Such movement of the pin **7** may be accomplished by upward movement of the link **6** a distance sufficient to take up the lost motion between the pin **7** and the sleeve **2** and effect compression of the switch **16** between the parts **9** and **17.** The projection **25** will provide a high concentration of force adjacent the conductor **17** so as to assure the establishing of a conductive path through the switch **16.**

Although the foregoing description refers to upward and downward movements of the link **6** to effect compression of the respective switches **16** and **10,** it will be understood that the application of a pulling force on the links **4** and **6** simultaneously, so as to extend the links, will effect compression of the switch **16,** whereas the application of pushing forces on the links **4** and **6** simultaneously, so as to cause retraction of the links, will effect compression of the switch **10.**

FIG. **3** discloses schematically one arrangement for operating electric motors by means of switches constructed according to the invention. As shown, there are four reversible D.C. motors M, the armatures of all of which are connected in parallel circuit relation between power lines L-**1** and L-**2.** The switch **10** is shown connected between the wires **15** and **22** and connected to a battery B by the line **22.** The switch **16** is shown connected between the wires **21** and **22** and connected to the battery by the line **22.**

The apparatus includes a double pole, double throw relay **26** having two similarly wound windings **27** and **28.** One end of each winding is adapted to be connected to the battery B through the switches **10** and **16,** respectively. The opposite ends of the relay windings are joined and are connected to the emitter of a PNP transistor T having its collector grounded. A capacitor **29** is connected between ground and the base of the transistor T. The junction of the capacitor and the base of the transistor is connected through resistors **30** and **31** to the lines **15** and **21,** respectively. The relay **26** has two switching contacts **32** and **33** which are adapted to connect the four motors M to the battery B.

When the switch **10** is rendered conductive the relay **27** is energized and effects movement of the switching contacts **32** and **33** to the left so as to connect the battery B to the armatures of all of the motors M via the lines L-**1** and L-**2.** The polarity of the battery should be such as to effect driving of the motors M in one direction.

When the switch **16** is rendered conductive, the winding **28** is energized to effect movement of the switching contacts **32** and **33** to the right, thus connecting the armatures of the motor M to the battery B with a reverse polarity. The motors thus will be driven in the opposite direction.

Regardless of which switch is rendered conductive, the emitter of the transistor T will be connected to the positive side of the battery B through the appropriate winding **27** or **28** so as to bias the transistor forwardly into conduction. Simultaneously, the capacitor **29** will begin to charge and within a very short time, such as one second, the charge of the capacitor will be sufficient to decrease the forward bias on the base-emitter junction to render the transistor T non-conductive. When the transistor is rendered non-conductive, the current through the winding **27** or **28** ceases and the switch contacts **32** and **33** return to their neutral positions as shown in FIG. **3,** whereupon the motors M will be disconnected from the power source. In essence, therefore, each of the motors is energized by a current pulse of short duration.

Although the transistor T is rendered non-conductive shortly after energization of the motors M in either direction of operation, the capacitor **29** will maintain its reverse biasing charge through the resistor **30** or **31** until such time as the actuated switch is rendered non-conductive and opens the circuit to the capacitor **29,** at which time the capacitor will discharge through the transistor T. The discharge of the capacitor is at a slower rate than its charging rate, however, so as to require two or more seconds before the transistor can be rendered conductive. Thus, the apparatus has a time delay characteristic which prevents rapid motor reversing operations such as may be attempted by a child and which would be harmful to the apparatus.

The relative sensitivities of the switches **10** and **16** may be varied in any one of several ways. For example, the switch **10** could have incorporated in it a larger number of conductive particles than are included in the switch **16.** Alternatively, the switch **10** could be made much thinner than the switch **16,** thereby requiring less travel of the links **4** and **6** toward one another to render the switch **10** conductive.

The disclosed embodiment is representative of the presently preferred form of the invention, but is intended to be illustrative rather than definitive thereof.

What is claimed is:

1. A switch construction comprising a pair of normally non-conductive switching members each of which is composed of a resilient, compressible body of non-conductive, elastomeric material having a plurality of electrically conductive, discrete particles dispersed therein, the quantity and size of said particles being such that each of said switching members is non-conductive until a sufficient compressive force is applied thereto to compress said body and effect movement of a sufficient number of said particles into engagement to establish through said body an electrically conductive path having a resistance corresponding substantially to the resistance of the engaged particles; electrically conductive force applying means interposed between said switching members in a position to bear against either of said switching members to apply a compressive force thereto; and operating means for moving said electrically conductive force applying

means into and out of force applying relation with a selected one of either of said switching members to apply a compressive force sufficient to render it electrically conductive, said operating means being capable of applying such force to one only of said switching members at any one time.

2. The construction set forth in claim 1 wherein said switching members are arranged in spaced relation and wherein said operating means includes a force applying member interposed between said switching members.

3. The construction set forth in claim 1 including means associated with said switching members and operable to concentrate the force applied by said force applying means to said selected one of said switching members.

4. The construction set forth in claim 1 including a casing in which said switching members are contained in spaced apart relation.

5. The construction set forth in claim 5 wherein said operating means comprises a pair of relatively movable links extending into said casing from opposite ends of the latter, and a force applying member carried by one of said links and interposed between said switching members.

6. A switch construction for connecting an input circuit line to either of a pair of coutput circuit lines comprising a pair of normally non-conductive switching members each of which is composed of a resilient, compressible body of non-conductive, elastomeric material having a plurality of electrically conductive, discrete particles being such that each of said switching members is nonconductive until a sufficient compressive force is applied thereto to compress said body and effect movement of a sufficient number of said particles into engagement to establish through said body an electrically conductive path having a resistance corresponding substantially to the resistance of the engaged particles, each one of said switching members being adapted to be connected to a different one of said output lines; electrically conductive force applying means interposed between said switching members in a position to bear against either of said switching members to apply a compressive force thereto; and electrically conductive operating means, adapted to be connected to said input circuit line, for moving said force applying means into and out of force applying relation with a selected one of said switching members to connect said input line to one of said output lines via a path including said operating means and said one of said switching members.

7. The construction set forth in claim 6 wherein at least one of said switching members has an opening therein through which said operating means extends.

8. The construction set forth in claim 6 wherein each of said switching members has an opening therein through which said operating means extends, said operating means comprising a pair of links axially extensible and retractable relative to said casing.

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