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McCloskey et al.

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[54] SWITCHING DEVICES

[72] Inventors: **Fenimore G. McCloskey; William Robert Jordan**, Columbus, Ohio

[73] Assignee: **Columbus Electric Manufacturing Co.**, Columbus, Ohio

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[52] **U.S. Cl.** **335/164**, 335/179, 335/229

[51] **Int. Cl.** **H01h 9/20**

[58] **Field of Search**.....335/164, 170, 174, 179, 229, 335/230, 232, 188, 79

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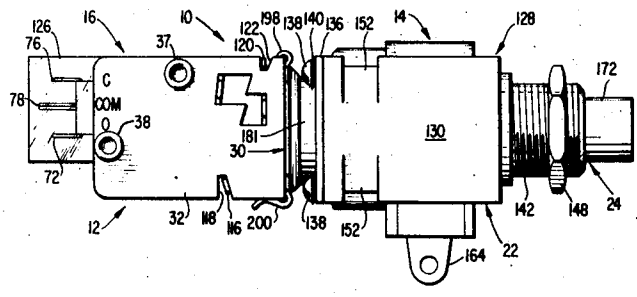
Primary Examiner—Harold Broome

Attorney—Strauch, Nolan, Neale, Nies & Kurz

[57] **ABSTRACT**

A switching device of the electromechanical type including a push button actuator, a permanent magnet for keeping the actuator in the operated position, and an electromagnet which is energizable to neutralize the permanent magnet field and allow the actuator to return to its unoperated position.

11 Claims, 7 Drawing Figures



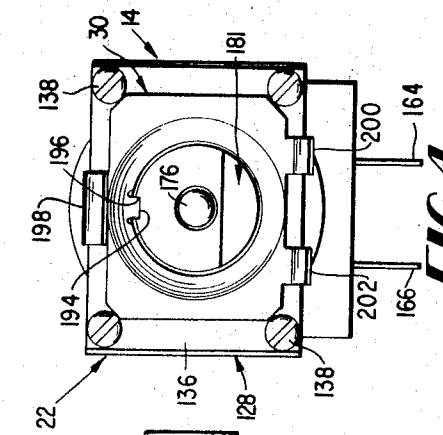


FIG. 4

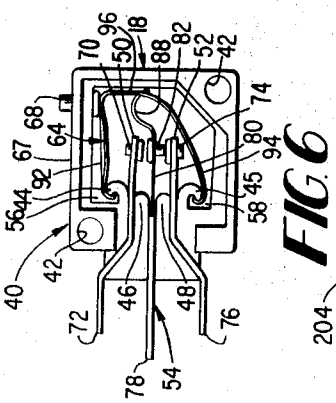


FIG. 6

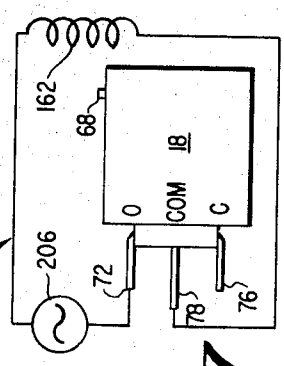


FIG. 7

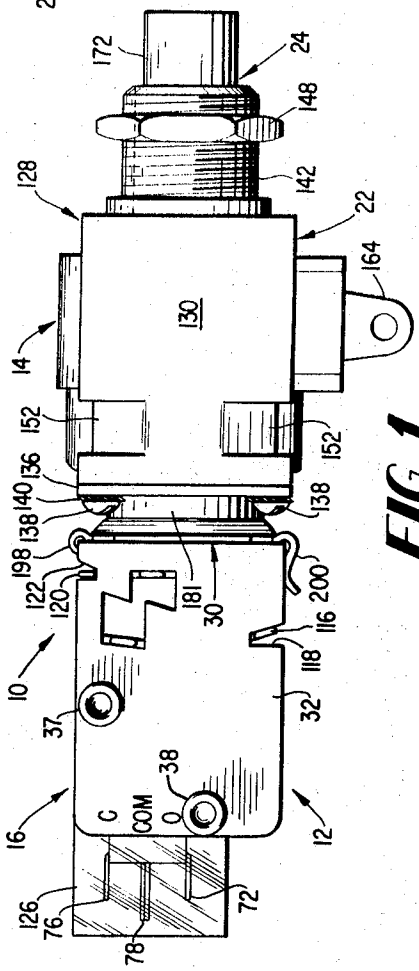


FIG. 1

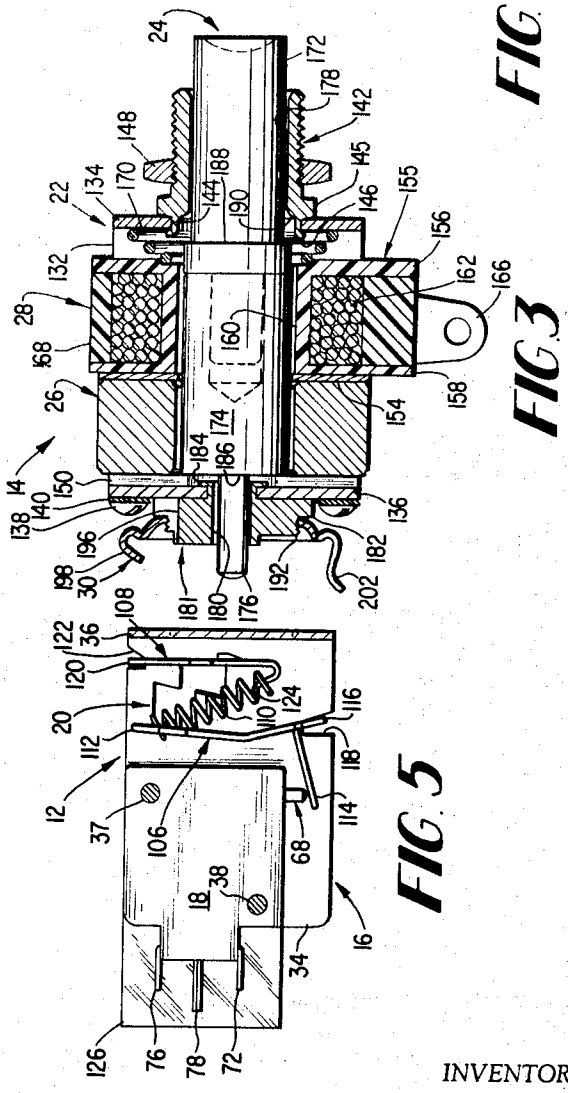


FIG. 3

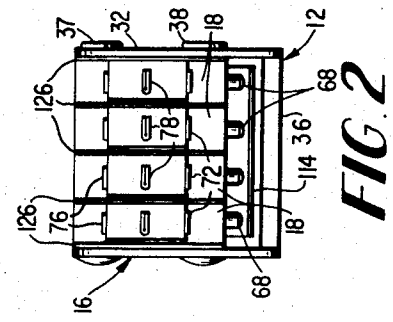


FIG. 2

FIG. 5

INVENTORS
FENIMORE G. MC CLOSKEY
WILLIAM ROBERT JORDAN

BY Strauch, Nolan, Neale, Nies & Kurz
ATTORNEYS

SWITCHING DEVICES

This invention relates to switches and, more particularly, to novel, improved switching devices of electromechanical type.

The primary object of the present invention is the provision of novel, improved switching devices of the character described in the preceding paragraph.

Generally speaking, the novel switching devices of the present invention, by which the foregoing and other objects are achieved, include a switch module and an operator module. The switch module includes one or more switches and a spring loaded, snap-acting operator for actuating the switch or effecting simultaneous actuation of all switches if multiple switches are employed.

The operator module includes a push button actuator for transferring the spring loaded operator in the switch module from a rest position to an operated position to actuate the switch or switches in the switch module. This module also includes a permanent magnet for maintaining the push button actuator and the spring loaded operator in their operated positions and an electromagnet which is energizable to neutralize the field of the permanent magnet. This allows the spring loaded operator in the switch module to return to its unoperated position, which restores the push button actuator to its rest position and deactuates the switch or switches in the switch module.

The principle object of the invention has been identified above. Other important objects as well as the important features and the advantages of the invention will become apparent from the appended claims and as the ensuing detailed description and discussion proceeds in conjunction with the accompanying drawing in which:

FIG. 1 is a side view of a switching device constructed in accord with the principles of the present invention;

FIG. 2 is a left-hand end view of the switching device of FIG. 1;

FIG. 3 is a section through an operator module employed in the switching device of FIG. 1;

FIG. 4 is a left-hand end view of the operator module;

FIG. 5 is a side view of a switch module employed in the switching device of FIG. 1, part of the casing of the module being broken away to show its internal components;

FIG. 6 is a side view of one type of switch which may be employed in the switch module, part of the switch casing being broken away to show its internal components; and

FIG. 7 is an electrical schematic for a second form of the invention.

Referring now to the drawing, FIG. 1 depicts a novel electromechanical switching device 10 constructed in accord with the principles of the present invention. The major components of switching device 10 are a switch module 12 and an operator module 14.

Switch module 12 includes a frame 16 supporting a plurality of switches 18 and a spring loaded, snap-acting type switch operator 20. The operator module includes a frame 22 of magnetic material housing a push button type actuator or plunger 24 also of magnetic material, a permanent magnet 26, and an electromagnet 28. Switch module 12 is detachably connected to operator module 14 by a retainer 30 incorporated in the latter.

Referring now to FIGS. 1 and 5, the frame 16 of switch module 12 is a U-shaped member having side walls 32 and 34 and an end wall 36. Switches 18 (four in the illustrated embodiment of the invention) are supported between the side walls 32 and 34 of frame 16 as by rivets 37 and 38, which extend through the switches and the side walls of the frame.

Different types of switches may be employed in electromechanical switching devices constructed in accord with the principles of the present invention. The switch identified by reference character 18 in the drawing and shown in detail in FIG. 6 is typical.

Turning now to the latter figure, switch 18 consists generally of a substantially rectangular housing or base 40 provided with apertures 42 at its corners through which rivets 37 and 38 extend. A cover (not shown in FIG. 6) is secured to base 40.

Housing 40 includes an upper contact support portion 44 and a lower contact support portion 45. A central projecting nose comprising bosses or backing portions 46 and 48 is disposed between upper and lower contact support portions 44 and 45 to define channels which receive upper and lower fixed contact arms 50 and 52. A similar channel is provided between bosses 46 and 48 to receive a central, movable contact arm assembly 54.

Inside of the housing cavity, further upper and lower channels 56 and 58, which are symmetrical about the horizontal centerline of the switch housing, are provided for receiving the ends of the switch actuating member 64. A vertical through bore (not shown) is provided in the upper housing wall 67 to receive a slidably mounted, push button type actuator 68.

Upper fixed contact arm 50 is rigid and has a contact 70 at its inner end and a terminal 72 at its outer end. Lower contact arm 52 is formed in the same manner as upper contact arm 50 and has a contact 74 and a terminal 76.

Movable contact arm assembly 54 includes a terminal 78 and a flexible contact arm 80 which is formed from a suitable resilient metal such as beryllium copper. A contact 82 extending through and secured to the free end of the contact arm is engageable with fixed contact 74 when actuator 68 is in the illustrated rest position and with fixed contact 70 when the actuator is depressed.

At the right side of contact 82 an abrupt deformation or bend is formed in contact arm 80 to provide an arched or arcuate portion 88. Since arcuate portion 88 is made of a resilient material, the force at the bend always urges contact 82 into engagement with one of the associated fixed contacts 70 or 74. Which contact is engaged by the associated movable contact depends upon whether the free end of arcuate contact arm portion 88 is below or above the horizontal centerline of the switch between fixed contacts 70 and 74.

Actuating member 64, which is substantially U-shaped, has an upper leg 92 and a lower leg 94 connected by an end section 96. The free ends of these legs are bent at right angles to secure actuating member 64 in channels 56 and 58. Sufficient clearance is provided so that the only contact which actuating member 64 has with housing 40 is in these channels. The free end of arcuate contact arm portion 88 is positioned at the bottom of a depression forming a stiffening ridge (not shown) in actuator end section 96. A simple frictional connection is thus provided which retains the contact arm section 88 in the desired arched form and which causes its free end to move up and down with the central section of switch actuating member 64. When push button actuator 68 is pressed downwardly (as shown in FIG. 6), the legs 92 and 94 of main actuating member 64 are flexed with bending occuring in the upper and lower legs near the fixed points in channels 58 and 60 and flexing occurring in its curved sections.

Switches of the type described above and illustrated in FIG. 6 are described in more detail in U.S. Pat. Nos. 3,248,496 issued Apr. 26, 1966 and 3,234,343 issued Feb. 8, 1966, which are hereby incorporated by reference.

Snap-acting switch operator 20 is movable between the illustrated rest position and an operated position. Upon movement to the operated position, operator 20 depresses switch actuators 68, transferring the movable contacts 82 of switches 18 from fixed contacts 74 to fixed contacts 70. As the operator returns to the rest position, actuators 68 are released, and the internal actuating members 64 of the switches transfer movable contacts 82 from fixed contacts 70 back to fixed contacts 74.

Referring now specifically to FIG. 5, snap-acting operator 20 includes a pivotally mounted actuator member 106, a second pivotally mounted operator member 108 engageable by push button actuator or plunger 24 of electromechanical switching device 10, and a compression spring 110. The pivotal actuator member 106 has a main body portion 112 ex-

tending in a generally vertical direction with switch module 12 oriented as shown in FIG. 5, an integral actuator portion 114, and laterally extending ears 116 (only one of which is shown). Ears 116 are disposed in and extend through notches 118 in the lower edges of the side walls 32 and 34 of switch module frame 16, pivotally supporting the member from the side walls of the frame.

Push button actuator operated member 108 of the snap-acting mechanism is supported in switch module frame 16 in generally parallel spaced relationship to member 106 by laterally extending integral ears 120, which are disposed in and extend through recesses 122 at the upper edges of frame side walls 32 and 34 adjacent the rear or end wall 36 of the frame.

At its upper end, spring 110 of the snap-acting mechanism is hooked through an aperture (not shown) adjacent the upper end of pivotal actuator member 106. The lower end of the spring is hooked through a similar aperture (likewise not shown) formed in an upturned, integral portion 124 of snap-acting operator member 108.

Also included in switch module 12 are sheets or strips of electrical insulation 126. As shown in FIG. 2, these strips are located between adjacent switches 18 and between the outermost switches 18 and side walls 32 and 34 of switch module frame 16. Insulator strips 126 eliminate inadvertent electrical contact between leads (not shown) attached to switch terminals 72, 76, and 78.

Referring now to FIGS. 1, 3, and 4, the frame 22 of operator module 14 includes a generally U-shaped member 128 having side walls 130 and 132 and an end wall 134 together with an end plate 136 fixed to member 128 as by screws 138 and lock washers 140. At the right-hand end of the operator module (oriented as shown in FIGS. 1 and 3), a threaded mount 142 extends through an aperture 144 of frame end wall 134. Annular flanges 145 and 146 formed on mount 142 engage opposite sides of the end wall to secure the mount in place. Mount 142 is adapted to be inserted through an aperture in a support member (not shown). A nut 148 is then threaded on the mount to secure switching device 10 to the supporting member.

Located at the opposite end of frame member 128 adjacent inturned integral flanges 150 (only one of which is shown) is the permanent magnet 26 referred to above. Magnet 26 has a cylindrical configuration and is secured in place by tabs 152 bent from the side walls 130 and 132 of operator module frame member 128.

Electromagnet 28 is disposed adjacent permanent magnet 26 and is separated from it by a washer 154 of a magnetic material.

As shown in FIG. 3, electromagnet 28 includes a spool-like coil support 155 having parallel flanges 156 and 158 and a hub 160. Wound on hub 160 between flanges 156 and 158 is a coil 162, the opposite ends of which are connected to terminals 164 and 166. Coil 162 is surrounded by or potted in insulating material identified generally by reference character 168.

Electromagnet 28 is maintained in juxtaposition to permanent magnet 26 by a compression spring 170 disposed between end wall 134 of operator module frame member 128 and flange 156 of electromagnet coil support 155. This spring biases electromagnet 28 to the left as shown in FIG. 3 to maintain it in engagement with magnetic washer 154 and the washer in engagement with the permanent magnet.

Actuator 24 includes a push button portion 172 accessible from the exterior of operator module 14. Push button 172 is attached to a cylindrical member 174 of magnetic material, which constitutes the armature of electromagnet 28. Integral with the left-hand end of armature 174 and extending through the left-hand end of the operator module casing is a pin 176 dimensioned to engage the pivotal member 108 of the snap-acting operator 20 in switch module 12.

Plunger 24 is supported for rectilinear, back and forth movement in a bore 178 in mount 142, and in a bore 180 formed in a bushing 181 of magnetic material at the left-hand end of operator module 14. Radially extending flange portions 182 and 184 on the bushing engage opposite sides of operator module end plate 136, securing the bushing to this member.

Movement of actuator 24 to the left as shown in FIG. 3 is limited by the engagement of the left-hand end 186 of armature 174 with the flange 184 on bushing 181. Movement of the actuator to the right as shown in this figure is limited by the engagement between an annular shoulder 188 on push button 172 and a cooperating internal shoulder 190 in mount 142.

Referring now to FIGS. 3 and 4, the retainer 30 by which switch module 12 is detachably connected to operator module 14 is fixed to bushing 181 as by staking it onto the reduced diameter portion 192 of the bushing. A tab 194 on the retainer as shown in FIG. 4 projects into a notch 196 in the bushing and prevents relative rotation between these two components.

A hook-like portion 198 is formed at the upper edge of retainer 30. As shown in FIG. 1, this portion of the retainer fits over the upper edge of the rear wall 36 of switch module frame 16 to secure this edge of the frame to operator module 14. Two spaced apart, integral clip portions 200 and 202 are formed at the lower side of the retainer. As is also shown in FIG. 1, these are configured to snap over the lower edge of rear wall 36 of frame 16 to secure the lower edge of the frame to the operator module.

The switch module can be readily attached to the operator module by inserting the upper edge of wall member 36 in retainer portion 198 and rotating the module in a counterclockwise direction to snap the retainer portions 200 and 202 over the lower edge of wall 36. Conversely, the switch module can be readily separated from the operator module by reversing this sequence of steps.

Plunger 24 is shown in its rest or unoperated position in FIG. 1. From this position, the plunger may be depressed, moving it to the left (with respect to FIGS. 1 and 3) to the operative position shown in FIG. 3. As plunger 24 moves to the left, the pin 176 at its left-hand end pivots input member 108 of snap-acting operator 20 in a clockwise direction. As this pivotal movement continues, the actuator member 106 of the mechanism pivots in a clockwise direction, this occuring with a snap action because of the manner in which spring 110 is connected between the two pivotal members of mechanism 20. As member 106 pivots, actuator portion 114 moves upwardly, depressing (moving upward as shown in FIG. 5) the actuators 68 of switches 18. As explained above, this transfers the movable contacts of the switches from engagement with fixed contacts 74 into engagement with fixed contacts 70. This interrupts the circuit continuity between switch terminals 76 and 78 and establishes continuity between switch terminals 72 and 78.

Plunger 24 is retained in the operated position shown in FIG. 3 by permanent magnet 26 against the restoring force of spring 110, the magnetic flux following a path through operater module frame 22, washer 154, armature 174, and bushing 181 which are all made from magnetic materials as discussed above. To restore the plunger to the rest position of FIG. 1 and allow the movable switch contacts 82 to transfer back into engagement with fixed contacts 74 in switches 18, the coil 162 of electromagnet 28 is energized by connecting terminals 164 and 166 of the operator module across a source of DC operating voltage. Coil 162 is so wound and the DC voltage so applied that, when the coil is energized, the poles of the electromagnet will oppose those of the permanent magnet, neutralizing the field of the latter. When this occurs, spring 110 causes snap acting mechanism members 106 and 108 to rotate in a counterclockwise direction, moving plunger 24 to the right to its rest position, where it is held by the bias exerted by spring 110.

In a typical embodiment of the present invention, the magnetic field of electromagnet 28 will be greater than that of the permanent magnet. As a result, there will be an imbalance of magnetic forces to aid in returning the plunger to the rest position.

In a variant of the above-described mode of operation, the coil **162** of the electromagnet is energized as plunger **24** is depressed. In these circumstances, the permanent magnet is not capable of keeping the plunger in the operated position since its magnetic field is neutralized by that of the electromagnet. In this type of operation, therefore, pressure must be maintained on plunger **24** to keep it in the operated position.

For the mode of operation just described, the wiring arrangement **204** illustrated in FIG. **7** may be employed. Referring now to this Figure, the coil **162** of electromagnet **28** is connected in series with terminals **72** and **78** of one of the switches **18** in module **12** and in series with a source of operating voltage **206**, which will typically be AC in this case. In electromagnetic switching arrangement **204**, coil **162** is not energized until plunger **24** is depressed to transfer the movable contact **82** of the switch into engagement with its fixed contact **70** in the manner described above. This arrangement has several advantages. First, it eliminates the need for a DC power supply and also the continuous current drain through the electromagnet coil, which may amount to 2 to 3 watts per unit. Furthermore, since less current flows through the coil over a given period, the generation of heat is reduced, which can be a decided advantage in many applications of the present invention. Finally, if an AC source is employed, a 60 cycle vibration will be set up in the push button **172** of the plunger. This makes the operator aware that the plunger is in the operated position.

As discussed above, the electromechanical switching devices of the present invention may use switches other than the type illustrated in FIG. **6**. Also, one as opposed to a bank of switches may be employed. Other modifications will readily occur to those conversant with the arts to which the present invention relates. To the extent that these are not expressly excluded from the appended claims, they are fully intended to be covered therein.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by Letters Patent is:

1. An electromechanical switching device comprising at least one switch having a contact and an actuator displaceable to transfer the contact from one to the other of two positions; a switch operator which is distinct from said switch and is movable from a rest position to an operated position to displace said switch actuator and thereby effect a transfer of said contact; a push button actuator which is distinct from said switch operator and is movable between rest and operated positions, said push button actuator including means comprising an armature for moving said switch operator to the operated position thereof as said push button actuator is moved to its operated position; a permanent magnet cooperable with said armature to maintain said push button actuator in the operated position and thereby maintain the switch operator in its operated position; and an electromagnet energizable to neutralize the permanent magnet field and thereby allow said push button actuator and said switch operator to return to the rest positions thereof.

2. The electromechanical switching device of claim **1**, wherein there are a plurality of switches as aforesaid disposed in side-by-side relationship, said switch operator being dimensioned to engage the actuators of all of said switches and thereby concurrently effect the transfer of the contacts of the several switches.

3. The electromechanical switching device of claim **1**, wherein said switch operator is physically and operationally located between said push button actuator and said switch actuator and wherein said switch operator includes biasing means for displacing the switch operator and the push button actuator to their rest positions upon neutralization of the permanent magnet field.

4. The electromechanical switching device of claim **2**, wherein there are means in at least one of said switches for completing a circuit between two terminals thereof when the switch contact is transferred by displacement of the switch actuator and including circuit means for connecting the coil of the electromagnet in series with said terminals of said one switch and a source of operating voltage, whereby said electromagnet is energized when said actuator is in the actuated position thereof.

5. An electromechanical switching device comprising at least one switch having a contact and an actuator displaceable to transfer the contact from one to the other of two positions; a switch operator which is distinct from said switch and is movable from a rest position to an operated position to displace said switch actuator and thereby effect a transfer of said contact; a first frame housing said switch and said switch operator; a push button actuator movable between rest and operated positions, said push button actuator including means comprising an armature for moving said switch operator to the operated position thereof as said push button actuator is moved to its operated position; a permanent magnet surrounding said armature for maintaining said push button actuator in the operated position thereof to thereby maintain the switch operator in its operated position; an electromagnet surrounding said armature, said electromagnet being energizable to neutralize the permanent magnet field and thereby allow said push button actuator and said switch operator to return to the rest positions thereof; and a second frame housing said push button actuator, said permanent magnet, and said electromagnet.

6. The electromechanical switching device of claim **5**, wherein said second frame has an end wall and including means between said end wall and said electromagnet for biasing said electromagnet against said permanent magnet.

7. An electromechanical switching device comprising at least one switch having a contact and an actuator displaceable to transfer the contact from one to the other of two positions; a switch operator which is distinct from said switch movable from a rest position to an operated position to displace said switch actuator and thereby effect a transfer of said contact; a push button actuator movable between rest and operated positions, said push button actuator including means comprising an armature for moving said switch operator to the operated position thereof as said push button actuator is moved to its operated position; a permanent magnet cooperable with said armature to maintain said push button actuator in the operated position thereof and thereby maintain the switch operator in its operated position; and an electromagnet energizable to neutralize the permanent magnet field and thereby allow said push button actuator and said switch operator to return to the rest positions thereof, said switch operator being of the snap-acting type and comprising a first pivotally mounted member having a portion thereof engageable with said switch actuator; a second member mounted for pivotal movement about an axis located in parallel, spaced relationship to the pivot axis of said first member; and a spring connected between said first and second members at locations removed from the pivot axes of said members and said push button actuator being positioned to engage and pivot said second member as said actuator is moved from its rest position to its operated position.

8. The electromechanical switching device of claim **7**, wherein said switch comprises a housing having top, bottom, and end walls; a pair of elongated, spaced, substantially rigid, cantilevered contact arms secured to one of said end walls and extending toward the other end wall; fixed contacts on the facing surfaces of said rigid contact arms at the free ends thereof; a resilient, elongated contact arm extending between said rigid arms and secured to said one end wall; contact means on the

opposite surfaces of said resilient contact arm positioned to alternatively engage one or the other of said fixed contacts; said actuator including an actuator member mounted for movement in a direction generally perpendicular to the centerline of said resilient arm for controlling movement thereof, said actuator member having an upper leg; means coupling the resilient contact arm to the actuator member at a position between the actuator member and the movable contacts for effecting a snap movement of the resilient arm to move the disengaged movable contact into engagement with the associated fixed contact; and integral backing portions extending from said one end wall between said resilient contact arm and each of the rigid contact arms toward the other end wall.

9. An electromechanical switching device comprising a switch module which includes a frame, a switch disposed in said frame, and a spring loaded mechanism distinct from said switch for actuating the switch; an operator module comprising a frame, a push button type actuator in said frame for operating the actuating mechanism in the switch module, means comprising said push button actuator and a permanent magnet for maintaining the push button actuator in the operated position, and an electromagnet energizable to neutralize the permanent magnet field and allow the push button actuator and the switch actuating mechanism to return to rest positions, said permanent magnet and said electromagnet being housed in said operator module frame; and means for detachably fixing the frame of said switch module to the frame of the operator module comprising a retainer fixed to the frame of said operator module, said retainer having means at one end thereof for receiving one edge of the switch module frame and at least one resilient finger means at the opposite end thereof for engaging an opposite edge of said switch module frame.

10. An electromechanical switching device comprising a switch module which includes a frame, a switch disposed in said frame, and a switch operator movable from a rest position to an operated position to displace said switch actuator and thereby effect a transfer of said contact, said switch operator comprising a first member pivotally supported by said frame and having a portion thereof engageable with said switch actuator, a second member pivotally supported by said frame for pivotal movement about an axis located in parallel, spaced relationship to the pivot axis of said first member, and a spring connected between said first and second members at locations removed from the pivot axes of said members; and an operator module distinct from said switch module comprising a frame, a push button type actuator in said frame movable between rest and operated positions, said push button actuator having means including an armature for moving the switch operator to the operated position thereof as said push button actuator is moved to its operated position, a permanent magnet which surrounds and is cooperable with said armature to maintain said push button actuator in the operated position thereof and thereby maintain the switch operator in its operated position, and an electromagnet adjacent the permanent magnet and surrounding said armature which is energizable to neutralize the permanent magnet field and thereby allow said push button actuator and said switch operator to be returned to the rest positions thereof by the spring in said switch operator.

11. The electromechanical switching device of claim 10, together with means for detachably fixing the frame of said switch module to the frame of the operator module which comprises a retainer fixed to the frame of said operator module, said retainer having means at one end thereof for receiving one edge of the switch module frame and at least one resilient finger means at the opposite end thereof for engaging an opposite edge of said switch module frame.

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