US006737598B1

(12) **United States Patent**
Allen et al.

(10) **Patent No.: US 6,737,598 B1**
(45) **Date of Patent: May 18, 2004**

(54) **ELECTRICAL SWITCH WITH LIMITED CONTACT ARCING**

(75) Inventors: **David G. Allen**, Toronto (CA); **Mehmet U. Sayman**, Scarborough (CA); **Liviu N. Dan**, Kitchener (CA)

(73) Assignee: **Tyco Electronics Canada, Ltd.**, Markham (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/316,757**

(22) Filed: **Dec. 11, 2002**

(51) **Int. Cl.**[7] **H01H 15/00**
(52) **U.S. Cl.** **200/537**; 200/538; 200/548
(58) **Field of Search** 200/537, 538, 200/539, 540, 541, 542, 547, 548, 549, 550, 303, 383

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,169,099 A * 1/1916 Wilcox et al.
5,369,237 A 11/1994 Mejerl et al.
5,426,274 A * 6/1995 Briiggemann et al. 200/447
5,798,584 A 8/1998 Schaeffeler et al.
6,104,105 A 8/2000 Schaeffeler et al.

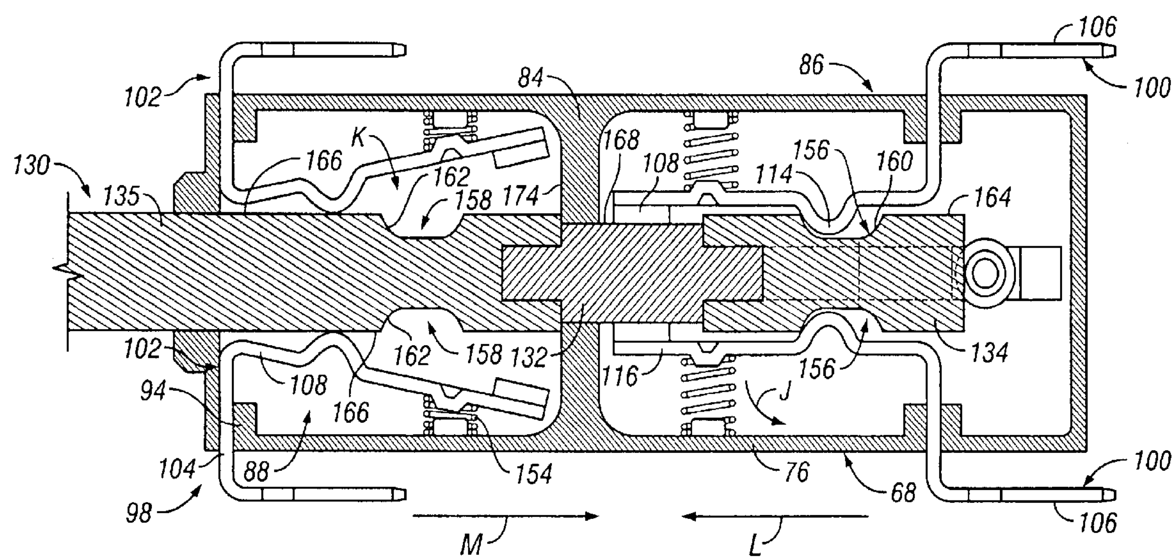
* cited by examiner

Primary Examiner—Lincoln Donovan
Assistant Examiner—K. Lee

(57) **ABSTRACT**

An electrical switch is provided that includes a housing having at least one contact retention chamber formed therein. The housing includes an opening in one wall of the contact retention chamber through which an actuator is extended. A contact assembly is movably mounted within the contact retention chamber of the housing. The contact assembly has at least one contact that is movable along an arcuate path aligned at an angle to the longitudinal axis of the housing. The actuator includes an insulated over-molded portion that retains a conductive member therein. The conductive member is configured to engage the contact. The housing slidably retains the actuator to permit movement of the actuator and the conductive member along the longitudinal axis of the housing. The actuator drives the contacts along the arcuate path between engaged and disengaged positions with the conductive member as the actuator moves along the longitudinal axis of the housing.

20 Claims, 7 Drawing Sheets



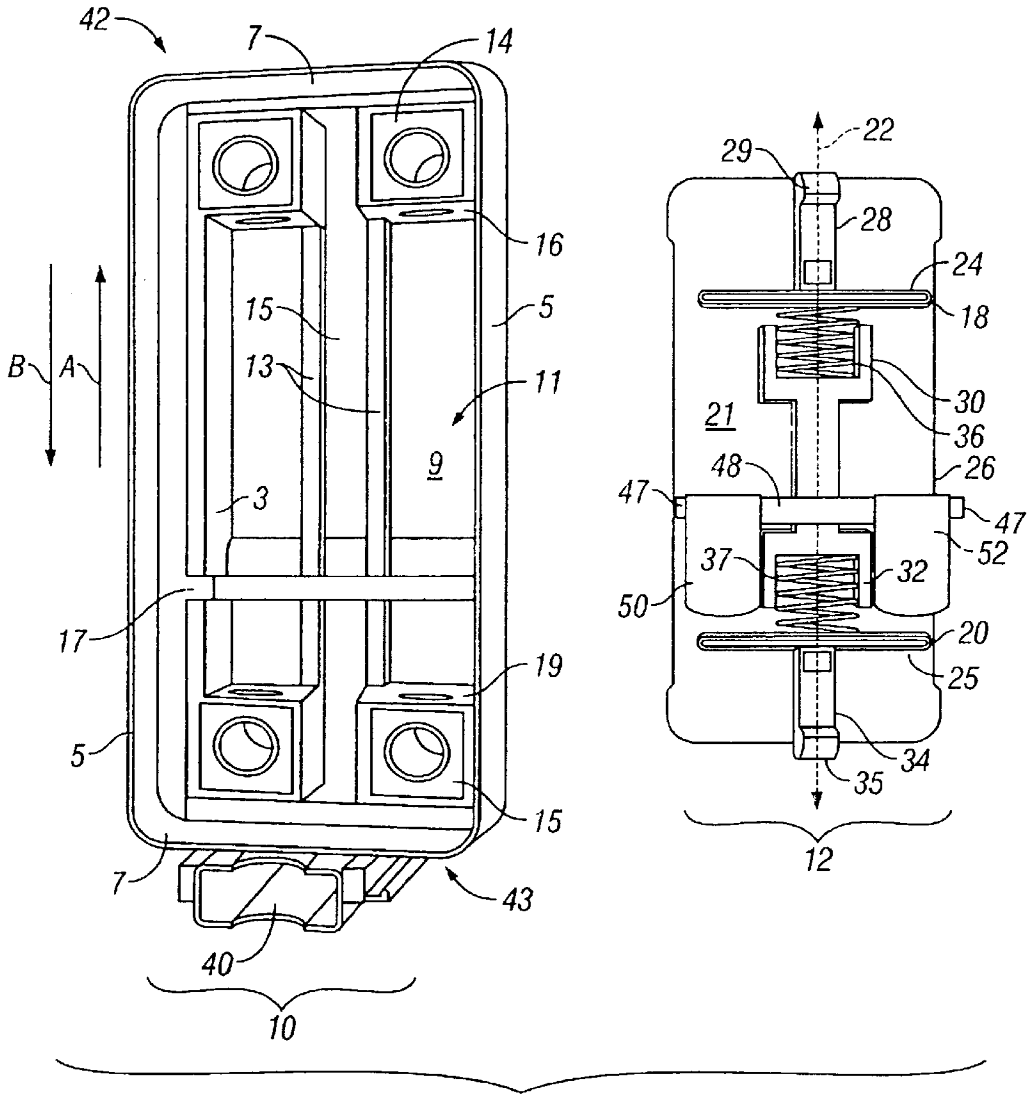


FIG. 1
(Prior Art)

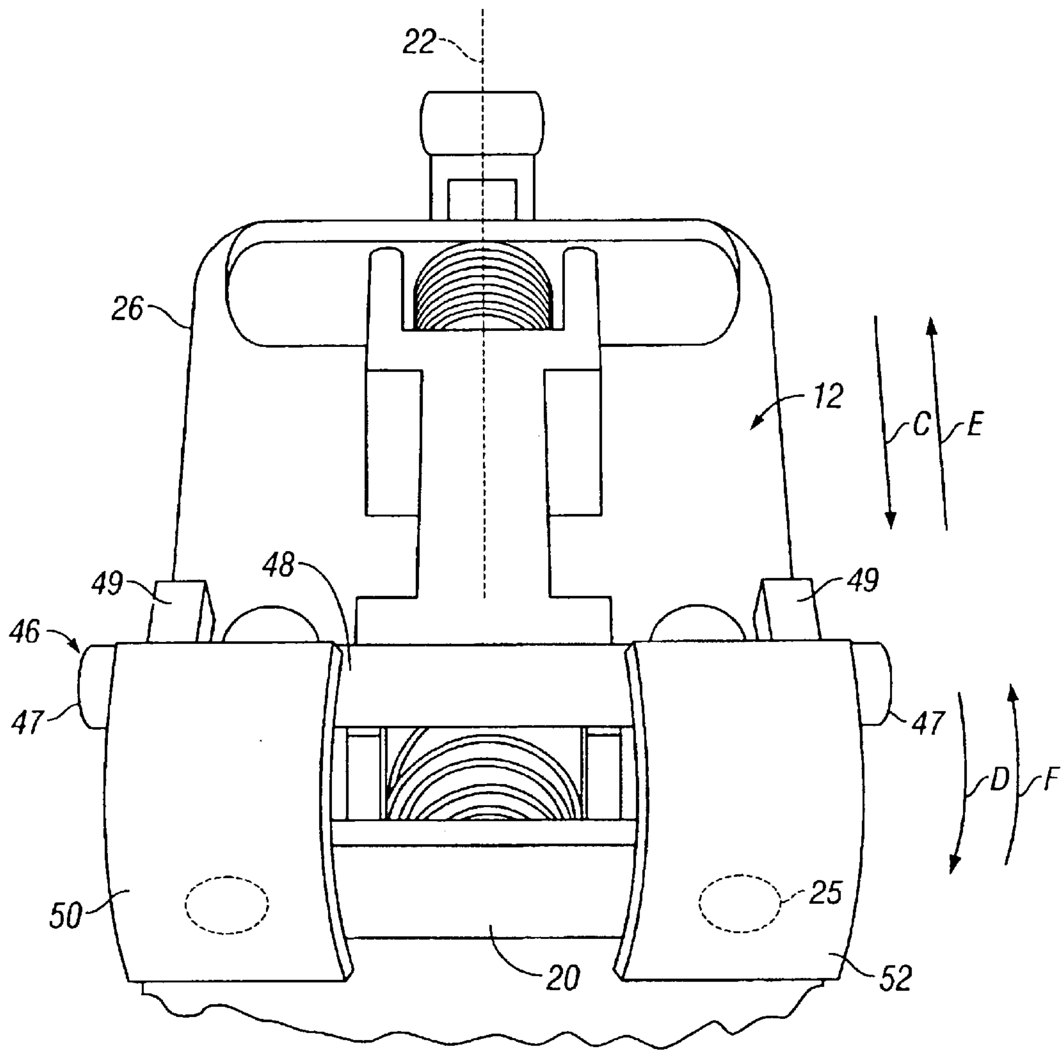


FIG. 2
(Prior Art)

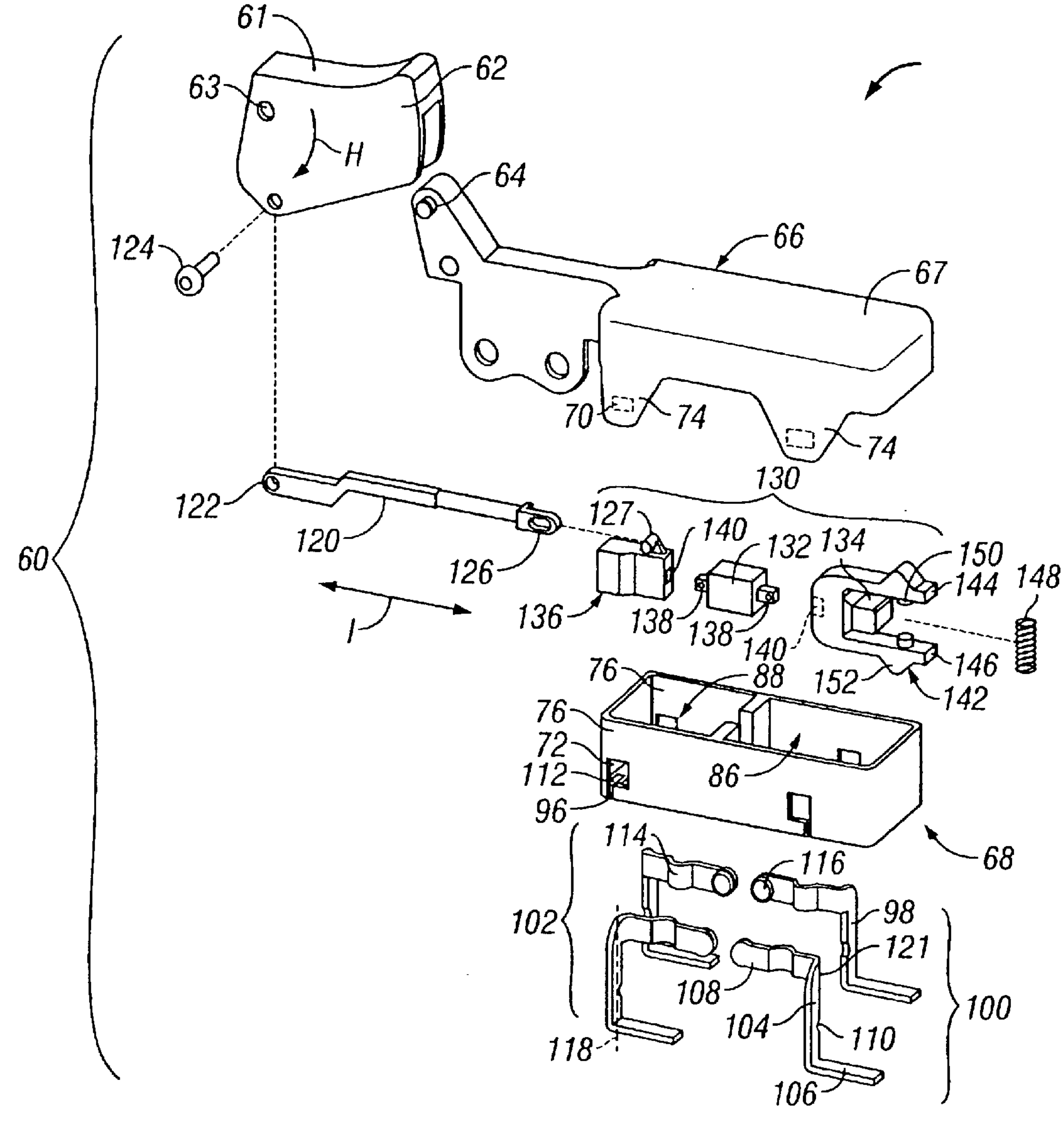

61
62
63
H
64
66
67
124
70
74
74
130
122
127
140
132
134
150
144
148
120
126
60
136
138
138
140
146
142
152
76
88
76
72
112
86
96
68
114
116
102
98
121
108
100
104
110
118
106

FIG. 3

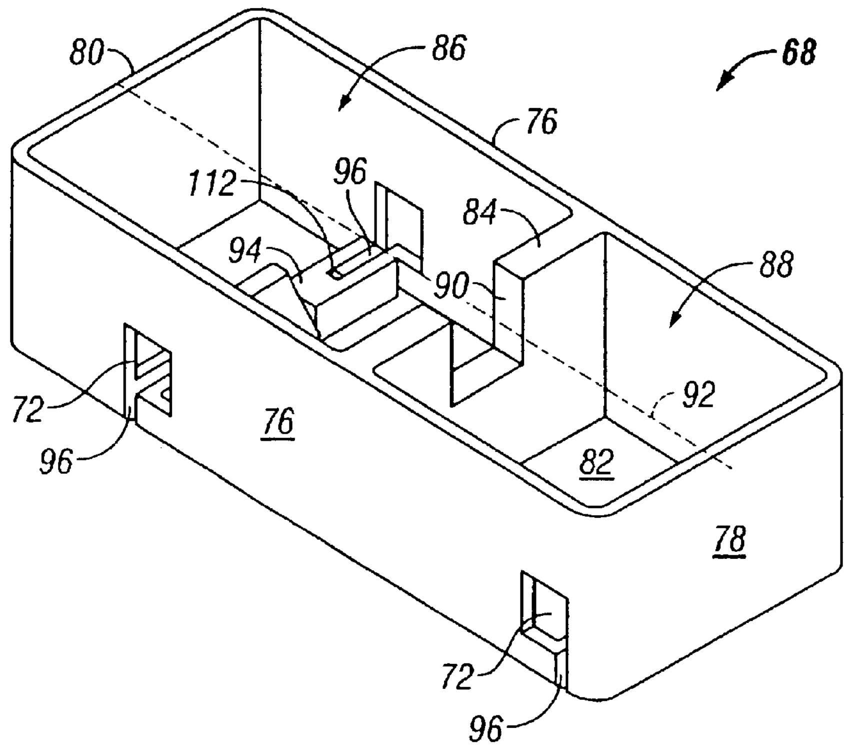

80
86
68
76
112
96
84
94
90
88
72
76
92
96
82
78
72
96

FIG. 4

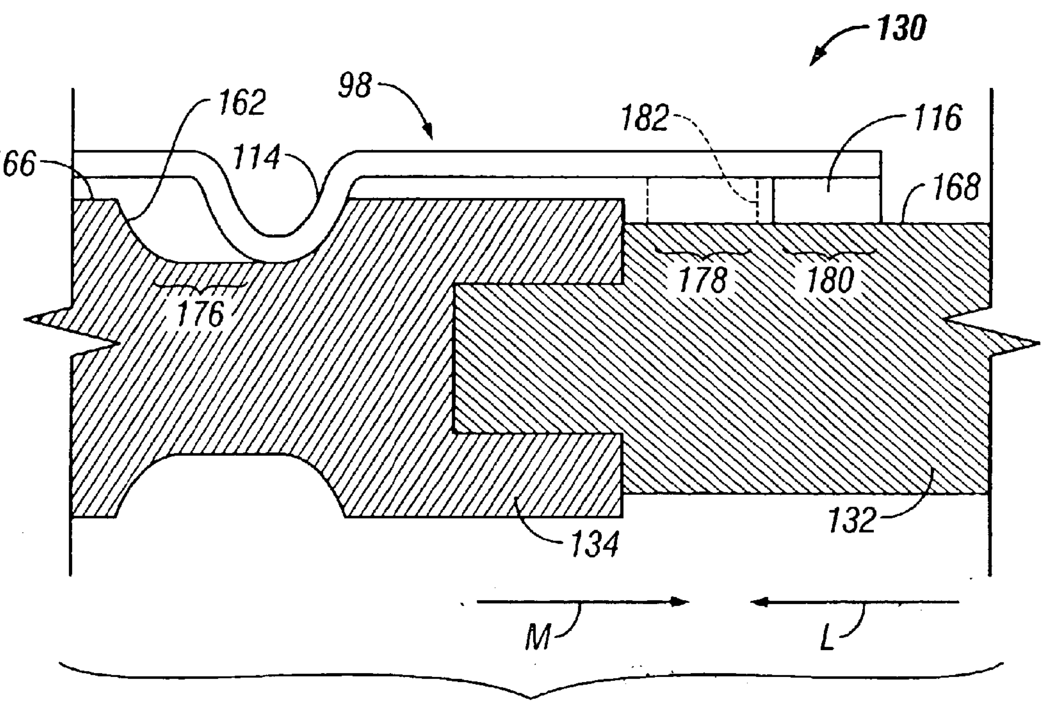

130
162
98
182
116
166
114
168
178
180
176
134
132
M
L

FIG. 7

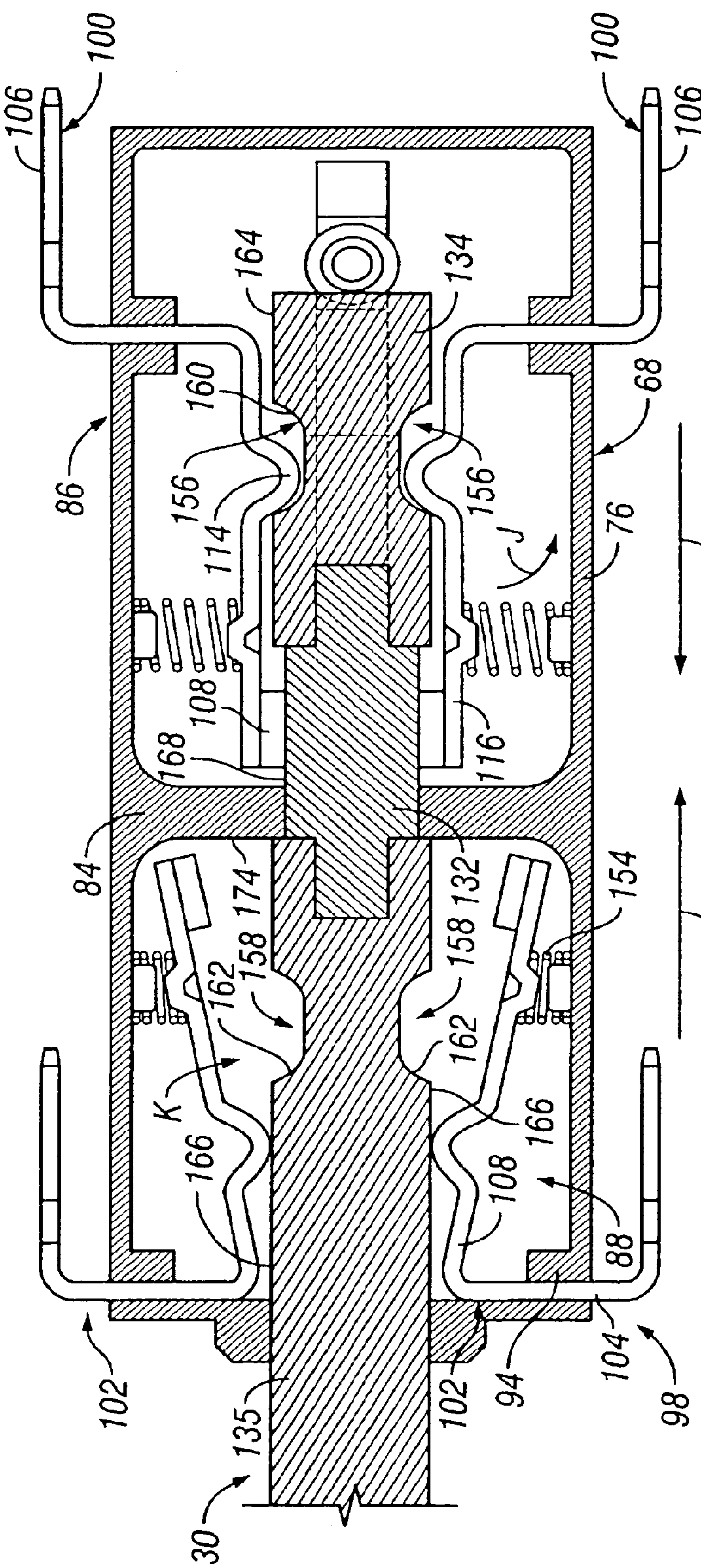

100
106
100
106
164
134
68
160
86
156
156
114
156
76
J
L
108
116
168
116
84
132
174
154
158
158
M
162
162
K
166
166
108
166
88
102
94
104
98
102
135
130

FIG. 5

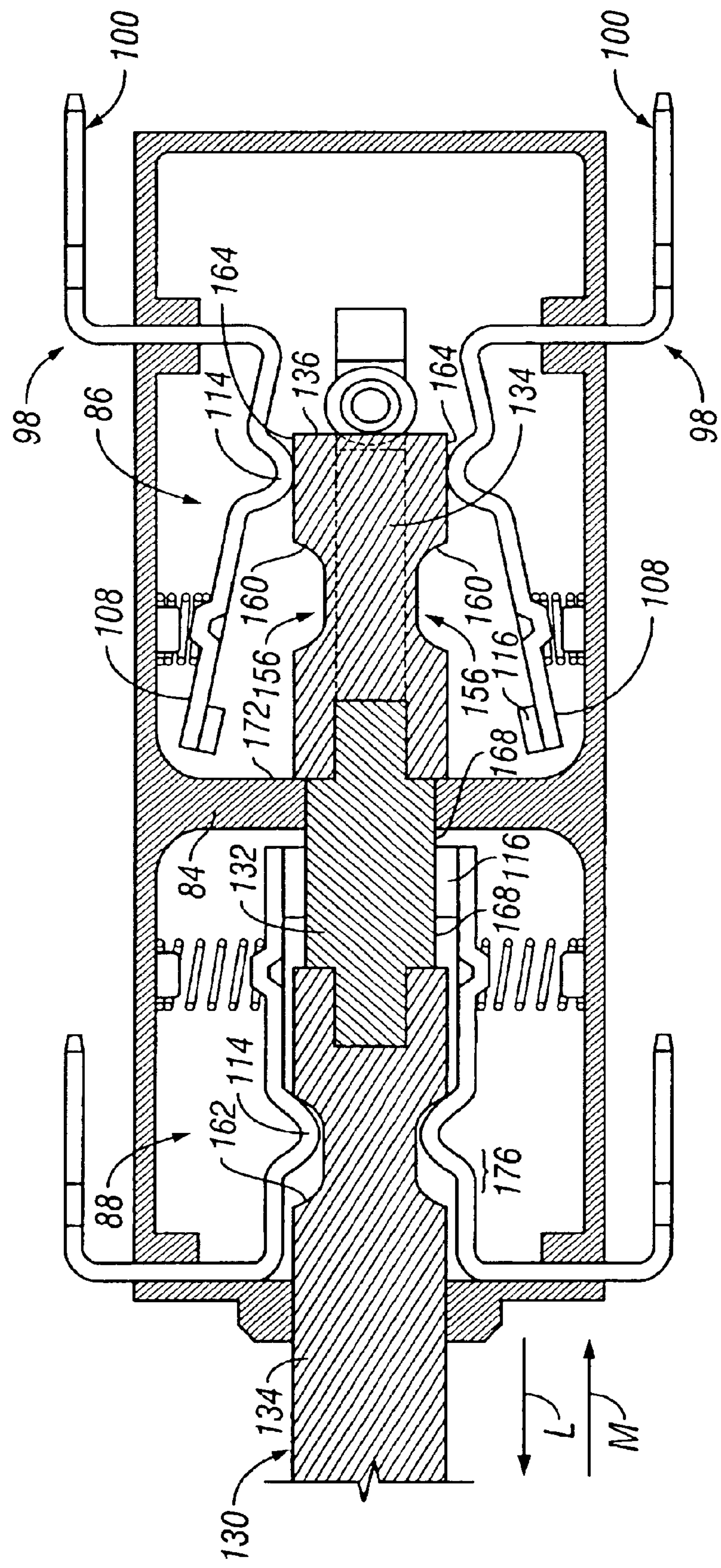

100
100
164
98
86
114
136
164
134
98
108
160
160
108
156
172
116
156
168
84
132
116
168
114
162
88
176
134
L
M
130

FIG. 6

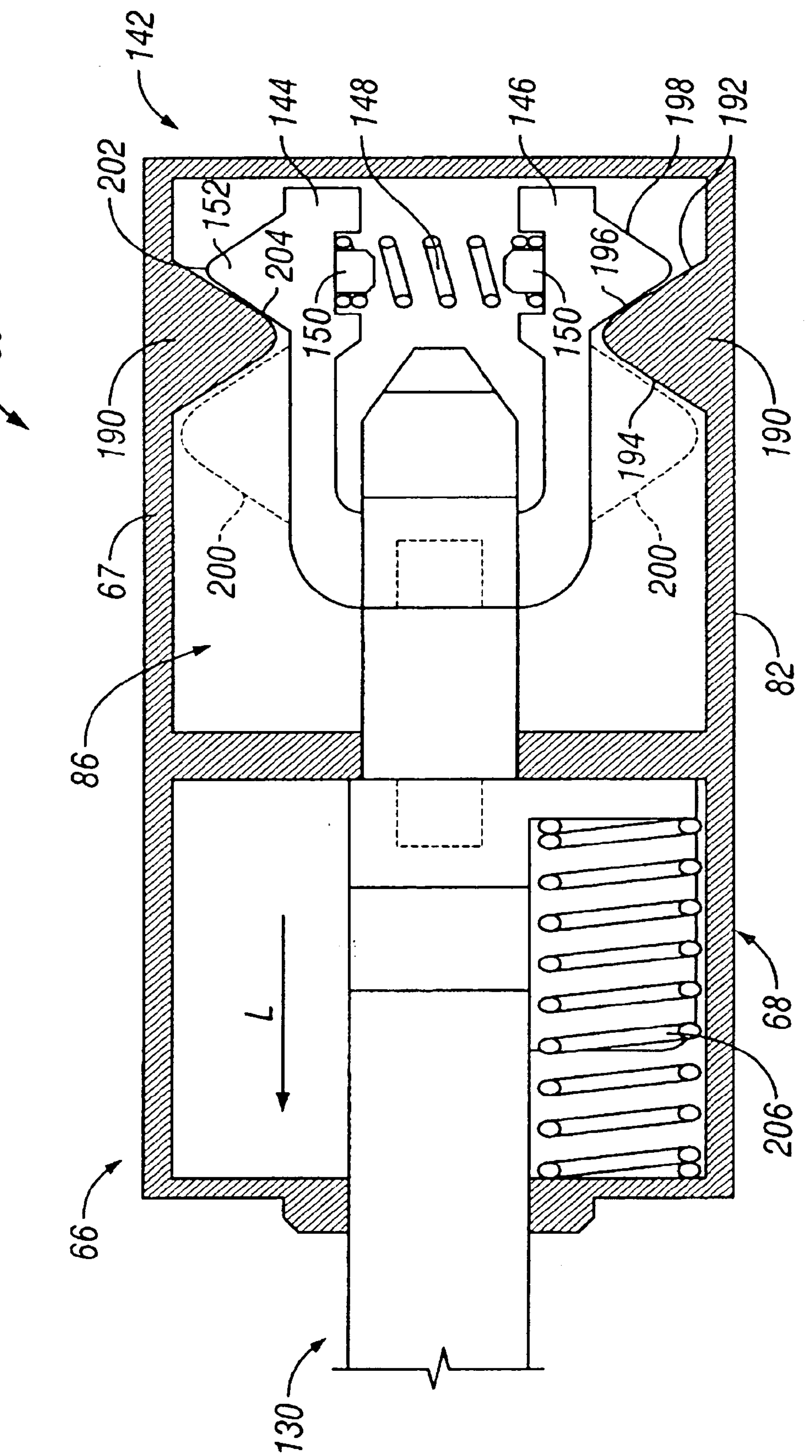

142
144
148
146
198
192
202
152
204
196
150
150
60
190
190
194
67
200
200
82
86
L
68
206
66
130

FIG. 8

ELECTRICAL SWITCH WITH LIMITED CONTACT ARCING

BACKGROUND OF THE INVENTION

The present invention generally relates to an electrical switch for use in high current and high voltage applications. More particularly, certain embodiments of the present invention relate to an electrical switch that reduces arcing when contacts make and break connections.

A wide variety of electrical switches have been proposed for various industrial and commercial applications. Some examples of industrial and commercial applications relate to power tools, electric motors, heating and air conditioning systems, and the like. These varied electrical switches are adapted to operate in high current and/or high voltage applications, as well as with AC and/or DC power supplies.

In general, electrical switches used in high current and high voltage applications include a contact carriage that is moveable within a switch housing. The contact carriage carries contacts that make and break electric connections with associated contacts mounted in the switch housing. FIG. **1** illustrates a top isometric view of a conventional switch housing **10** and a contact carriage **12** removed therefrom. The contact carriage **12** is configured to be moveably mounted within the switch housing **10**. The switch housing **10** includes side walls **5**, end walls **7** and a bottom **9** that collectively define an interior chamber **11**. The switch housing **10** includes contact posts **14** and **15** that are rigidly mounted within the chamber **11** and located proximate front and rear ends **42** and **43**, respectively, of the switch housing **10**. The contact posts **14** and **15** include faces **16** and **19**, respectively, directed toward one another. The bottom **9** of the switch housing **10** is formed with parallel ribs **13** extending between the front and rear ends **42** and **43** of the switch housing **10**. A space between the ribs **13** forms a channel **15** that similarly extends between the front and rear ends **42** and **43**. The side walls **5** include stepped interior surfaces **3** that are cut by a notch **17** which extends laterally across the interior chamber **11**. The notch **17** extends through the ribs **13** and through the channel **15**.

The contact carriage **12** includes a body **26** that extends along a longitudinal axis **22**. The body **26** includes a front face **21**. The contact carriage **12** is configured to be inserted into the chamber **11** of the switch housing **10** with the front face **21** of the contact carriage **12** turned to face the bottom **9** of the switch housing **10**. With reference to FIG. **1**, before insertion into the switch housing **10**, the contact carriage **12** as shown FIG. **1** is rotated 180 degrees about the longitudinal axis **22** until the front face **21** of the contact carriage **12** faces the bottom **9** of the switch housing **10**.

The body **26** of the contact carriage **12** includes support posts **28** and **34** formed on the front face **21** proximate opposite ends of the body **26**. A pair of C-shaped supports **30** and **32** are also provided on the front face **21** of the body **26** and arranged to face in opposite directions along the longitudinal axis **22**. The C-shaped supports **30** and **32** are positioned near corresponding support posts **28** and **34**. The support post **28** and the C-shaped support **30** are separated by a gap that receives a contact bridge **18**. The support post **34** and C-shaped support **32** are separated by a gap that receives contact bridge **20**. Contact bridges **18** and **20** are oriented parallel to one another and transverse to the longitudinal axis **22**. The C-shaped supports **30** and **32** receive springs **36** and **37**, respectively, that bias contact bridges **18** and **20**, respectively, outward against support posts **28** and **34**. The contact bridges **18** and **20** include contact pads **24** and **25**, respectively, facing outward in opposite directions. The contact bridges **18** and **20** are permitted to move along the longitudinal axis **22** within a limited range of motion.

The support posts **28** and **34** include tip portions **29** and **35**, respectively, extending upward away from the front face **21**. When the contact carriage **12** is loaded into the chamber **11**, the contact tips **29** and **35** are turned down to rest in, and slide along, the channel **15** formed between the ribs **13**. Hence, ribs **13** and tip portions **29** and **35** cooperate to control the direction of motion of the contact carriage **12** with respect to the switch housing **10** during operation. Once the contact carriage **12** is loaded into the chamber **11**, the contact bridges **18** and **20** are aligned with contact posts **14** and **15**, respectively, such that pads **24** on contact bridge **18** align with faces **16** on contact posts **14**. Similarly, pads **25** on contact bridge **20** align with faces **19** on contact posts **15**. As the contact carriage **12** is slid in the direction of arrow A, pads **24** engage faces **16** to form an electrical connection through contact bridge **18** and between contact posts **14**. When the contact carriage **12** is slid in the direction of arrow B, pads **25** engage faces **19** to afford an electrical connection through contact bridge **20** between contact posts **15**. Only one of contact bridges **18** and **20** is electrically connected with the corresponding contact posts **14** and **15**, respectively, at any single point in time. Hence, when contact bridge **18** engages contact posts **14**, contact bridge **20** is disengaged from contact posts **15**, and vice versa.

FIG. **2** illustrates a partial end isometric view of the contact carriage **12** to better illustrate a dielectric hood **46** mounted on the body **26**. The dielectric hood **46** is configured to reduce arcing by separating the contact bridge **20** from the contact posts **15** when the contact carriage **12** is moved in the direction of arrow A. The dielectric hood **46** includes a central beam **48** located above, and extending parallel to, the contact bridge **20**. Opposite ends **47** of the central beam **48** are held within notch **17** (FIG. **1**) in the stepped interior surfaces **3** of the side walls **5**. The central beam **48** is slidably mounted to legs **49** provided on the body **26**. The notch **17** holds the central beam **48** at a fixed position in the chamber **11**. Hence, when the contact carriage **12** moves within chamber **11**, the dielectric hood **46** moves relative to the body **26**.

A pair of isolation flaps **50** and **52** are mounted on opposite ends of the central beam **48** proximate the pads **25** (shown in dashed lines in FIG. **2**) on opposite ends of the contact bridge **20**. The isolation flaps **50** and **52** are curved in an L-shape as shown in FIG. **2** to extend forwardly from the central beam **48** and to curve downward toward the body **26**. When the central beam **48** is moved in the direction of arrow C with respect to the body **26**, the central beam **48** rotates in the direction of arrow D until the isolation flaps **50** and **52** cover the pads **25** on the front of the contact bridge **28**. When the central beam **48** is moved in the direction of arrow E with respect to the body **26**, the central beam **48** is rotated in the direction of arrow F, causing the isolation flaps **50** and **52** to pivot upward to expose the pads **25** on the contact bridge **20**. FIG. **1** illustrates the dielectric hood **46** moved to a position at which the contact bridge **20** and the pads **25** are entirely exposed to faces **19** on the contact posts **15**.

Returning to FIG. **1**, when the contact carriage **12** is loaded into the switch housing **10**, opposite ends **47** of the central beam **48** are received within the notch **17**. As the contact carriage **12** is moved in the direction of arrow A, the notch **17** holds the central beam **48** in a fixed position relative to the switch housing **10**, thereby causing the relative motion between the dielectric hood **46** and the body **26** of the contact carriage **12** in the direction of arrow C (FIG. **2**) which in turn causes the central beam **48** to rotate in the direction of arrow D to cover pads **25** on the contact bridge **20** with the isolation flaps **50** and **52**. In reverse, when the contact carriage **12** is moved in the direction of arrow B (FIG. **1**), the notches **17** continue to retain the central beam **48** at a fixed location relative to the switch housing **10**. As the contact carriage **12** is moved in the direction of arrow B, the body **26** and dielectric hood **46** experience relative motion therebetween in the direction of arrow E which in turn causes the central beam **48** to rotate in the direction of arrow F. Rotating the central beam **48** in the direction of arrow F moves the isolation **50** and **52** upward away from the contact bridge **20** to expose the pads **25** to the faces **19**.

The foregoing conventional structure provides a high current and/or high voltage switching mechanism.

However, conventional switches, such as the switch shown in FIGS. **1** and **2**, have met with limited success. In particular, conventional electrical switches continue to experience an unduly large amount of arcing in high current and/or high voltage applications. There remains a tendency for arcing to occur during making and breaking of connections between the contact pads **24** and **25** and faces **16** and **17** on contact posts **14** and **15**, respectively. Each time an arc occurs, a carbon residue is left on the faces **16** and **17** of the contact posts **14** and **15** and upon the contact pads **24** and **25**. In addition, each time an arc occurs, the risk exists that small divots may be burned or chipped into the faces **16** and **17** and/or contact pads **24** and **25**. Carbon buildup and divots create a rough interface between the contact pads **24** and **25** and faces **16** and **17**. As this interface becomes more uneven and as more carbon builds up, the electrical switch exhibits higher internal resistance which causes the switch to heat up during operation. Undue heating of the electrical switch may damage the switch and detract from its useful life.

A need remains for an improved electrical switch that reduces carbon buildup and surface divots at the contact interface, in order to extend the overall operating life and current/voltage carrying capacity of the electrical switch.

BRIEF SUMMARY OF THE INVENTION

An electrical switch is provided that includes a housing having at least one contact retention chamber formed therein. The housing includes an opening through one wall of the contact retention chamber through which an actuator extends. A contact assembly is movably mounted within the contact retention chamber of the housing. The contact assembly includes contacts that are movable along an arcuate path aligned at an angle to a longitudinal axis of the housing. The actuator includes an insulated over-molded portion that retains a conductive member therein. The conductive member is configured to engage the contacts. The housing slidably retains the actuator to permit movement of the actuator and the conductive member along the longitudinal axis of the housing. The actuator drives the contacts along the arcuate path between engaged and disengaged positions with the conductive member as the actuator moves along the longitudinal axis of the housing drives.

Optionally, the contact assembly may include first and second sets of contacts that are configured such that the first set of contacts is normally open, while the second set of contacts is closed when the switch is an OFF position. When either set of contacts is closed, it engages opposite sides of the conductive member to convey power through the conductive member between the closed set of contacts.

Optionally, the housing may include first and second contact retention chambers separated by an insulated divider. The insulated divider includes an opening therethrough that slidably receives the conductive member. The conductive member moves back and forth through the divider between the first and second contact chambers to engage one of the first and second sets of contacts. When the conductive member is located in the first contact chamber, the contacts in the second contact chamber are open and electrically isolated from one another by an intervening dielectric member, and vice versa.

The actuator may include one or more grooves cut in its exterior and aligned with corresponding elbows bent into the bodies of the contacts. The grooves and elbows cooperate to bias the contacts outward away from the actuator along the arcuate path as the actuator is slidably moved along the longitudinal axis of the housing. The contacts travel along the arcuate path at a first instantaneous rate of movement and the actuator moves along the longitudinal axis of the housing at a different second instantaneous rate of movement. By using different first and second instantaneous rates, the actuator increases the rate at which the contacts are moved toward and away from the conductive member with respect to the rate at which the actuator is moved along the housing.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

FIG. **1** illustrates a top isometric view of a conventional switch housing and contact carriage.

FIG. **2** illustrates a partial end isometric view of a conventional contact carriage.

FIG. **3** illustrates an exploded isometric view of an electrical switch formed in accordance with an embodiment of the present invention.

FIG. **4** illustrates a top isometric view of a housing base formed in accordance with an embodiment of the present invention.

FIG. **5** illustrates a top sectional view of an electrical switch formed in accordance with an embodiment of the present invention when in a rest/disengaged position or state.

FIG. **6** illustrates a top sectional view of an electrical switch formed in accordance with an embodiment of the present invention when in an ON/engaged position or state.

FIG. **7** illustrates a partial view of a contact and actuator mechanism formed in accordance with an embodiment of the present invention.

FIG. **8** illustrates a top sectional view of an electrical switch and the trigger assist mechanism therein formed in accordance with an embodiment of the present invention.

The foregoing summary, as well as the following detailed description of certain embodiments of the present invention, will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, there is shown in the drawings, certain embodiments. It should be understood, however, that the present invention is not limited to the arrangements and instrumentality shown in the attached drawings.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **3** illustrates an exploded view of an electrical switch **60** formed in accordance with an embodiment of the present invention. The electrical switch **60** includes a trigger **62** having a hole **63** that is rotatably mounted at hinge pin **64** to an upper shell **66** of the electrical switch **60**. A user squeezes the trigger **62** at surface **61** to rotate the trigger **62** in the direction of arrow H. The upper shell **66** is mounted over a housing base **68** and snapably retained thereon by latch projections **70** that are securely received within openings **72** in the housing base **68**. In the illustration of FIG. **3**, one side of the upper shell **66** is illustrated to include a pair of limbs **74** extending downward therefrom. Each limb **74** includes one of the latching projections **70** on its interior surface (denoted in dashed lines). It is to be understood that a similar pair of limbs **74** are formed on the back side of the upper shell **66** (although not shown). The housing base **68** includes multiple openings **72** arranged along opposite sides **76** and positioned to align with the latch projections **70**.

As shown in FIG. **4**, the housing base **68** includes front and rear end walls **78** and **80** and a bottom wall **82**. The housing base **68** also includes a central divider **84** separating the housing base **68** into first and second chambers **86** and **88**. The divider **84** includes a notched opening **90** cut therein to afford a path of communication between the first and second chambers **86** and **88**. The housing base **68** has a longitudinal axis **92**. The bottom wall **82** is molded with block portions **94** on the interior surface thereof. The block portions **94** are formed proximate to, and extend laterally inward from, the openings **72** into the first and second chambers **86** and **88**. Each opening **72** is joined by a slot **96** cut downward through the block portions **94** and bottom wall **82**. As explained below in more detail, the openings **72** enable contacts to be loaded into the first and second chambers **86** and **88**, while slots **96** securely retain the contacts once loaded.

Returning to FIG. **3**, the electrical switch **60** also includes a plurality of contacts **98** arranged in first and second contact sets **100** and **102**. Each contact **98** includes a base portion **104** joined at a right angle on one end, with a contact tail **106** and on the opposite end by a contact arm **108**. The base **104**, contact tail **106**, and contact arm **108** are joined in a stepped manner at right angles in the preferred embodiment. However, alternative contact designs may be utilized. The base portion **104** of each contact **98** includes a notch **110** formed in a side thereof. The contacts **98** may be loaded in through the exterior of openings **72** or outward from the interior of openings **72**. Once the contacts **98** are inserted through the openings **72**, the base portions **104** are firmly pressed into slots **96** until notches **110** seat against the interior end **112** of the corresponding slot **96**. In this manner, the contacts **98** are firmly and frictionally held within the first and second chambers **86** and **88**.

The contact arms **108** each include an intermediate elbow **114** bent to be directed inward toward the center or longitudinal axis **92** (FIG. **4**) of the housing base **68**. The outer ends of the contact arms **108** include contact pads **116** that are aligned to face inward toward the longitudinal axis **92** (FIG. **4**). The contact pads **116** and elbows **114** on contacts **98** in the first contact set **100** align with and face one another as do the contact pads **116** and elbows **114** in the second contact set **102**.

The base portions **104** may be flexible such that when held firmly within notches **96**, the base portions **104** define axes of rotation **118** about which the contact arms **108** may pivot. The contact tails **106** are configured to be connected to external wires that supply power to the electrical switch **60** and draw power from the electrical switch **60**. The contact **98** permits rotation of each contact arm **108** along an arcuate path about rotational axis **118** by twisting the base portion **104** and/or a limited amount of flex at corner **121** where the contact arm **108** and base portion **104** intersect.

The electrical switch **60** also includes a plunger **120** having a hole **122** through one end thereof. The plunger **120** is pivotally mounted by a pin **124** to the trigger **62**. The plunger **120** includes an elongated hole **126** in an end opposite to the hole **122**. The elongated hole **126** receives a pin **127** formed on an actuator assembly **130**. As the trigger **62** is depressed in the direction of arrow H or released in the opposite direction, the trigger **62** pivots about hinge pin **64** which in turn drives the plunger **120** in directions denoted by arrow I.

The actuator assembly **130** includes a conductive member **132** centrally located between lead and trailing dielectric members **134** and **136**. The conductive member **132** includes pins **138** extending from opposite ends thereof that are configured to be received in holes **140** formed in adjacent faces of the lead and trailing dielectric members **134** and **136**. The hole **140** in the lead dielectric member **134** is denoted in dashed lines. The lead dielectric member **134** is provided with a trigger advancing mechanism **142** (integrally or separately). The structure and operation of the trigger advancing mechanism is discussed below in more detail in connection with FIG. **8**. The trigger advancing mechanism **142** facilitates and increases the speed with which the actuator assembly **130** is moved along the longitudinal axis **92** between on and off switch positions or states once the trigger **62** is squeezed to an intermediate transition point along the range of motion for the trigger **62**.

FIGS. **5** and **6** illustrate top sectional views of the electrical switch **60** when in an OFF position (FIG. **5**) and in an ON position (FIG. **6**). The electrical switch **60** is configured such that the first contact set **100** operates in a normally closed position in which the first contact set **100** engages the conductive member **132** when the trigger **62** is in the OFF position. The second contact set **102** operates in a normally open position (as shown in FIG. **5**) (e.g., disengaged from the conductive member **132**) when the trigger **62** is in the OFF position (e.g., not pressed). When the trigger **62** is pressed, the first and second contact sets **100** and **102** change states (as shown in FIG. **6**).

With reference to FIG. **5**, each base portion **104** is securely held within a corresponding block portion **94**. The contact arms **108** may be biased inward along an arcuate path as denoted by arrow J through the use of springs **154** provided between the contact arms **108** and the sides **76** of the housing base **68**. Optionally, the springs **154** may be removed entirely and the internal normal forces created with the contact **98** solely relied upon to bias the contact arms **108** inward.

The lead and trailing dielectric members **134** and **136** have sides **164** and **166** with grooves **156** and **158** formed therein, respectively. In the example of FIG. **5**, the lead and trailing dielectric members **134** and **136** each include a pair of grooves **156** and **158**, respectively, aligned across from one another on opposite sides of the lead and trailing dielectric members **134** and **136**. Each of grooves **156** and **158** includes at least one ramped surface **160** and **162**, respectively, that forms a transition region between the deepest portion of the corresponding groove **156** and **158** and sides **164** and **166**, respectively. More specifically, with reference to the first chamber **86**, the ramped surface **160** forms a transition area between the side **164** of the lead dielectric member **134** and the bottom portion of the groove **156**. As the actuator assembly **130** is moved in the direction of arrow L, the elbow **114** on the corresponding contact **98** rides from the depth of the groove **156**, along ramped surface **160** onto side **164**. Grooves **156** and elbows **114** cooperate to rotate the contact arm **108** along an arcuate path (denoted by arrow J) outward away from the sides **168** of the conductive member **132**.

Similarly, the trailing dielectric member **136** includes grooves **158** having at least one ramped surface **162** forming a transition between each groove **158** and corresponding sides **166** of the trailing dielectric member **136**. As the actuator assembly **130** moves in the direction of arrow L, the elbows **114** on corresponding contacts **98** ride along sides **166** and downward along ramped surfaces **162** into groove **158**, thereby permitting the contact **98** to rotate inward along arrow K.

FIG. **6** illustrates a top sectional view of the electrical switch **60**, in which the actuator assembly **130** has been moved in the direction of arrow L to the ON position (corresponding to when the trigger **62** is fully squeezed). When the lead and trailing dielectric members **134** and **136** are moved to the ON position, elbows **114** on the first contact set **100** rest on sides **164**, thereby causing the contact arms **108** to pivot outward along an arcuate path away from the conductive member **132**. The elbows **114**, grooves **156** and ramped surfaces **160** may be dimensioned such that the speed or rate of motion at which the contact arms **108** pivot outward is greater than the speed or rate of motion at which the actuator assembly **130** moves linearly in the direction of arrow L. This enables the contact pads **116** to be quickly moved away from the sides **168** of the conductive member **132** in order to minimize the time during which the potential for arcing exists. In addition, as the contacts **98** in the first chamber **86** are disengaged from the conductive member **132**, the conductive member **132** is moved through the divider **84** into the second chamber **88** until the lead dielectric member **134** abuts against the surface **172** of the divider **84**. By abutting the lead dielectric member **134** against the surface **172** of the divider **84**the conductive member **132** is entirely electrically isolated from the contacts **98** in the first chamber **86**.

Returning to FIG. **5**, when the trigger **62** is released, the actuator assembly **130** moves in the direction of arrow M. The conductive member **132** is moved through divider **84** into the first contact chamber **86** until the trailing dielectric member **136** abuts against the surface **174** of the divider **84** thereby entirely electrically isolating the contacts **98** in the second chamber **88** from the conductive member **132** and from one another. By utilizing lead and trailing dielectric members **134** and **136**, the contacts **98** are more efficiently and completely isolated to remove any potential for arcing therebetween or with the conductive member **132**.

Returning to FIG. **6**, when the actuator assembly **130** is in the ON position, a leading portion of the elbows **114** of the contacts **98** in the second chamber **88** are spaced a distance **176** from the beginning of the ramped surfaces **162**. The distance **176** defines a travel range through which the actuator assembly **130** moves in the direction of arrow L before the elbows **114** engage the ramped surfaces **162**. As the actuator assembly **130** travels along the travel range defined by distance **176**, the contact pads **116** slide along the sides **168** of the conductive member **132**. Sliding the contact pads **116** along the sides **168** facilitates removal of carbon and debris that may otherwise build up on the contact pads **116** and conductive member **132**. In addition, the travel range defined by distance **176** defines the point at which the contact pads **116** begin to separate from the sides **168** of the conductive member **132**.

FIG. **7** illustrates a partial top view of the conductive member **132** and one contact **98**. In the position shown in FIG. **7**, the actuator assembly **130** is moved to the final engaged position such that the contact pad **116** is located in an operating region **180** on the side **168** of the conductive member **132**. When the actuator assembly **130** is advanced toward the rest state, the trailing dielectric member **136** moves in the direction of arrow M and the ramped surface **162** engages elbow **114**. At the point where ramped surface **162** initially begins to engage elbow **114**, the contact pad **116** has already slid along side **168** to the position **182** denoted in dashed lines which corresponds to a separation region **178** upon the side **168** of the conductive member **132**. Once moved to the separation region **178**, the contact pad **116** begins to pivot outward away from the sides **168** since the elbow **114** begins to ride up over ramped surface **162** onto the side **166** of the lead dielectric member **134**. To the extent that arcing may still occur, the arcing will occur within separation region **178** which is located remote from the operating region **180** on the side **168**, thereby further reducing the detrimental effects of arcing upon the final connection made between contact **98** and the conductive member **132**. Optionally, the separation region **178** and operating region **180** may partially overlap. Optionally, the lead and trailing dielectric members **134** and **136** may be formed with elbows (not grooves), and the contacts **98** may be formed with grooves (not elbows).

It is understood that the operation described in connection with FIG. **7** occurs at each contact **98** illustrated in FIGS. **5** and **6** within the first and second chambers **86** and **88**.

When the electrical switch **60** is in the position shown in FIG. **5**, the second contact set **102** is open and the first contact set **100** is closed. A current path is established from the contact tails **106** on the first contact set **100** through the contact pads **116** and the conductive member **132**. The contact pads **116** in the second contact set **102** are separated by an air gap and by the trailing dielectric member **136**, thereby preventing arcing. When the electrical switch **60** is moved to the position shown in FIG. **6**, the switch is in an ON state at which the first and second contact sets **100** and **102** have transitioned between open and closed positions. As the contact pads **116** are wiped along the sides **168** of the conductive member **132**, the wiping action cleans any oxides or other non-conductive material and reduces contact resistance. As the contact elbows **114** follow the contour of the sloped surfaces **160** and **162** the contact pads **116** are forced apart thereby quickly increasing the distance between the contact pads **116** and the conductive member **132**. The leading and trailing dielectric members **134** and **136** continue along the direction of motion until abutting against corresponding surfaces **172** and **174** (depending upon the direction of motion) of the divider **84** to further interrupt arcing.

FIG. **8** illustrates a partial side sectional view of the electrical switch **60** to better illustrate the trigger advancing mechanism **142** within the first chamber **86**. The trigger advancing mechanism **142** includes upper and lower beams **144** and **146** that are joined in a vertical plane and aligned in a U-shape. A spring **148** is compressably held between and retained on posts **150** formed on facing sides of the upper and lower beams **144** and **146**. Exterior sides of the upper and lower beams **144** and **146** include raised projections **152** extending outward in opposite directions therefrom. The bottom wall **82** of the housing base **68** and the upper wall **67** of the upper shell **66** are configured with raised projections **190** that face inward towards one another across the first chamber **86**. The projections **190** have sloped lead and trailing surfaces **192** and **194** that act upon corresponding lead and trailing surfaces **196** and **198** on the raised projections **152**.

The trigger advancing mechanism **142**, as shown in FIG. **8**, is in a rest position (corresponding to the contact state shown in FIG. **5**). When the trigger **62** (FIG. **3**) is squeezed, the actuator assembly **130** is moved in the direction of arrow L which causes the raised projections **152** to be biased inward towards one another in order to move past the raised projections **190**. The projections **152** are advanced until resting against the trailing sloped surfaces **194** (as shown by dashed lines **200**). As the raised projections **152** are advanced from their rest state (as shown in FIG. **8**) to their fully engaged state (as shown by shadow line at reference number **200**) the leading sloped surfaces **196** of raised projections **152** slide upward along the leading sloped surfaces **192** on the raised projections **190**.

When the peaks **202** and **204** of the raised projections **152** and **190**, respectively, directly coincide with one another, the upper and lower beams **144** and **146** are fully flexed inward toward one another and the spring **148** is in a fully compressed state. The upper and lower beams **144** and **146** and spring **148** exert a substantial outward force at the point where peaks **202** and **204** align which creates an unstable state within the action of the trigger **62**. As the peaks **202** and **204** are advanced beyond this unstable state further in the direction of arrow L the outward forces exerted by the upper and lower. beams **144** and **146** and the spring **148** force the raised projections **152** outward along the trailing sloped surfaces **194** of the projections **190**. As the trailing sloped surfaces **198** and **194** of the raised projections **152** and **190** slide along one another, the trigger advancing mechanism **142** pushes the actuator assembly **130** in the direction of arrow L at a very rapid speed. Hence, the trigger advancing mechanism **142** introduces a snapping action into the motion of the trigger **62** (FIG. **3**) such that once the actuator assembly **130** is advanced to the unstable state (where peaks **202** and **204** align) the actuator assembly **130** is quickly driven to the final engaged position.

The geometry of the actuator assembly **130**, and the elbows **114** and grooves **156** and **158** substantially reduce the potential time for arcing, thereby lengthening the switch life.

While the invention has been described with reference to certain embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from its scope. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

What is claimed is:

1. An electrical switch, comprising:

a housing having a chamber therein;

a contact assembly movably mounted within said chamber, said contact assembly having an intermediate portion located at an intermediate position along said contact assembly and having at least one contact portion proximate an end of said contact assembly; and

an insulated actuator including a conductive member configured to engage said contact portion, said housing slidably retaining said actuator to permit movement of said actuator and conductive member along an actuation path, said actuator engaging said intermediate portion to pivot said contact portion along said arcuate path between engaged and disengaged positions with said conductive member as said actuator moves along said actuation path.

2. The electrical switch of claim **1**, wherein said actuator includes an outer dielectric portion overmolded about said conductive member, said outer dielectric portion exposing at least one surface on said conductive member that said contact portion engages.

3. The electrical switch of claim **1**, wherein said intermediate portion includes an elbow bent to be directed inward toward said conductive member.

4. The electrical switch of claim l, wherein said contact assembly includes at least two contact arms joined with base portions held firmly in said housing, said contact arms extending along opposed sides of said conductive member, said base portions biasing said contact arms toward said opposed sides of said conductive member.

5. The electrical switch of claim **1**, wherein said housing includes first and second contact chambers separated by an insulated divider, said conductive member being movable through said divider between said first and second contact chambers to engage first and second sets of contact arms held in said first and second contact chambers, respectively.

6. The electrical switch of claim **1**, wherein said chamber in said housing includes at least one wall with an opening therein, said conductive member being slidable in and out of said opening when said actuator is moved along said actuation path.

7. The electrical switch of claim **1**, wherein said contact assembly includes a set of contact arms and said actuator includes an outer dielectric portion that is moved to a position between said contact arms when said set of contact arms disengages said conductive member.

8. The electrical switch of claim **1**, wherein said arcuate path is aligned within a contact plane oriented perpendicular to said actuation path.

9. The electrical switch of claim **1**, wherein one of said intermediate portion and actuator includes an elbow formed therein and another of said intermediate portion and said actuator includes a groove, said elbow movable in and out of said groove to drive said contact portion along said arcuate path.

10. The electrical switch of claim **1**, wherein said actuator includes a groove formed in a side of said actuator proximate said conductive member, said groove engaging said intermediate portion on said contact assembly to pivot said contact portion toward and away from said conductive member as said actuator moves along said actuation path.

11. The electrical switch of claim **1**, further comprising:

a switch driver connected to said actuator, said switch driver having a U-shaped body with at least one actuator ramped projection extending outward therefrom, said ramped projection moving along an engagement path aligned with a corresponding mating housing ramped projection provided on said housing; and

a spring disposed between legs of said U-shaped body to bias said actuator ramped projection against said housing ramped projection to facilitate movement between said engaged and disengaged positions.

12. The electrical switch of claim **1**, wherein said actuator drives said contact along said arcuate path at a first instantaneous rate while said actuator moves simultaneously along said actuator path at a second instantaneous rate that differs from said first instantaneous rate.

13. An electrical switch comprising:

a housing having a chamber therein;

a contact assembly movably mounted within said chamber, said contact assembly having an intermediate portion located at an intermediate position along said contact assembly and having at least one contact portion proximate an end of said contact assembly;

an insulated actuator including a conductive member configured to engage said contact portion, said housing slidably retaining said actuator to permit movement of said actuator and conductive member along an actuation path, said actuator engaging said intermediate portion to pivot said contact portion along said arcuate path between engaged and disengaged positions with said conductive member as said actuator moves along said actuation path; and

a U-shaped driver provided on an end of said actuator and a spring disposed between legs of said U-shaped driver, said spring biasing said legs outward against said housing to create a snap action as said contact moves between said engaged and disengaged positions.

14. An electrical switch, comprising:

a housing having a chamber oriented along a longitudinal axis of said housing;

at least one set of contacts pivotally mounted to said housing within said chamber; and

an actuator including a conductive member joined with a dielectric member, said contacts having contact ends that are configured to engage said conductive member, said actuator being slidably mounted in said housing to move along said longitudinal axis, said actuator engaging intermediate portions of said contact to rotate said contact ends outward away and disengaged from said conductive member when said actuator slides along said longitudinal axis.

15. The electrical switch of claim **14**, wherein said actuator includes lead and trailing dielectric members joined to opposite ends of said conductive member, said lead and trailing dielectric members isolating said conductive member from first and second sets of contacts, respectively, when corresponding first and second sets of contacts are disengaged from said conductive member.

16. The electrical switch of claim **14**, wherein said intermediate portions include elbows bent toward said actuator and said dielectric member includes ramped surfaces that engage said elbows remote from said contact ends to rotate said contact ends outward away from said conductive member.

17. The electrical switch of claim **14**, wherein each of said contacts includes a body portion firmly secured to said housing and an arm extending along said chamber, said arms including said intermediate portions and said contact ends, said arms being biased inward toward one another to engage said conductive member when said conductive member is positioned between said arms.

18. An electrical switch, comprising:

a housing having a chamber oriented along a longitudinal axis of said housing;

a contact pivotally mounted to said housing within said chamber;

an actuator including a conductive member joined with a dielectric member, said actuator being slidably mounted in said housing to move along said longitudinal axis, wherein said contact includes an intermediate elbow formed therein and remote from an end of said contact, said dielectric member including a groove positioned to align with said elbow when said dielectric member is in a first position, said groove driving said elbow outward when said dielectric member is moved to a second position to pivot said end of said contact outward away from said conductive member.

19. An electrical switch, comprising:

a housing having a chamber oriented along a longitudinal axis of said housing;

at least one set of contacts pivotally mounted to said housing within said chamber;

an actuator including a conductive member joined with a dielectric member, said contacts having contact ends that are configured to engage said conductive member, said actuator being slidably mounted in said housing to move along said longitudinal axis, said actuator engaging intermediate portions of said contacts to rotate said contact ends outward away and disengaged from said conductive member when said actuator slides along said longitudinal axis; and

an actuator including lead and trailing dielectric members joined to opposite ends of said conductive member, said lead and trailing dielectric members isolating said conductive member from first and second sets of contacts, respectively, when corresponding first and second sets of contacts are disengaged from said conductive member.

20. An electrical switch comprising:

a housing having a chamber therein;

a contact assembly movably mounted within said chamber, said contact assembly having an intermediate portion located at an intermediate position along said contact assembly and having at least one contact portion proximate an end of said contact assembly;

an insulated actuator including a conductive member configured to engage said contact portion, said housing slidably retaining said actuator to permit movement of said actuator and conductive member along an actuation path, said actuator engaging said intermediate portion to pivot said contact portion along said arcuate path between engaged and disengaged positions with said conductive member as said actuator moves along said actuation path;

a U-shaped driver provided on an end of said actuator and a spring disposed between legs of said U-shaped driver, said spring biasing said legs outward against said housing to create a snap action as said contact moves between said engaged and disengaged positions; and

a U-shaped driver provided on an end of said actuator and a spring disposed between legs of said U-shaped driver, said spring biasing said legs outward against said housing to create a snap action as said contact moves between said engaged and disengaged positions.

* * * * *