Aug. 11, 1964 R. P. BRIDGES ETAL 3,144,536

INTERRUPTER ATTACHMENT FOR DISCONNECT SWITCH

Filed March 22, 1961 5 Sheets-Sheet 1

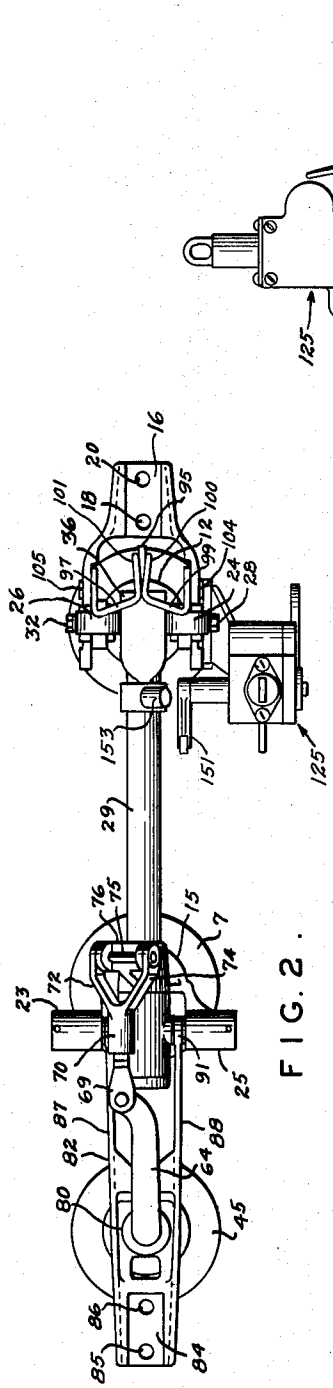


FIG. 2.

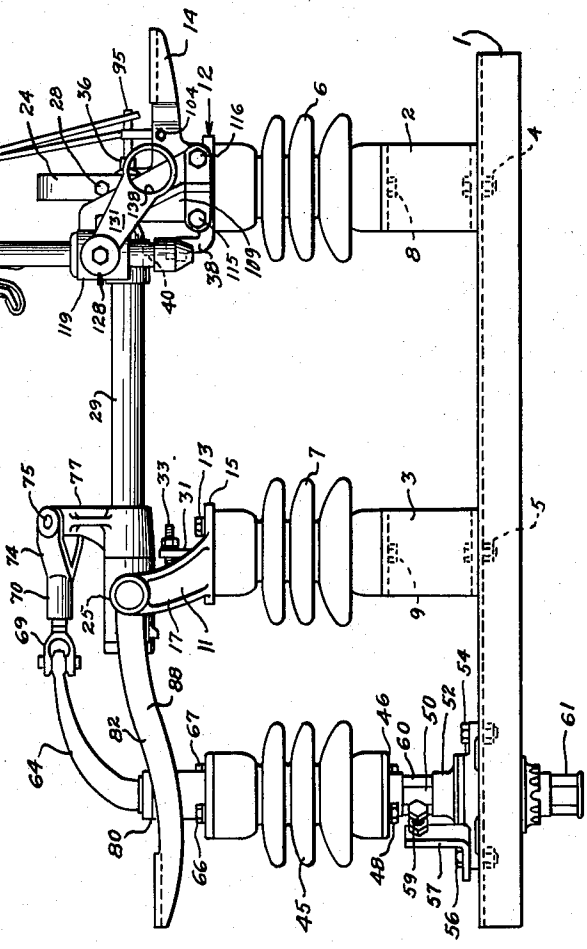


FIG. 1.

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INTERRUPTER ATTACHMENT FOR DISCONNECT SWITCH

Filed March 22, 1961 5 Sheets-Sheet 2

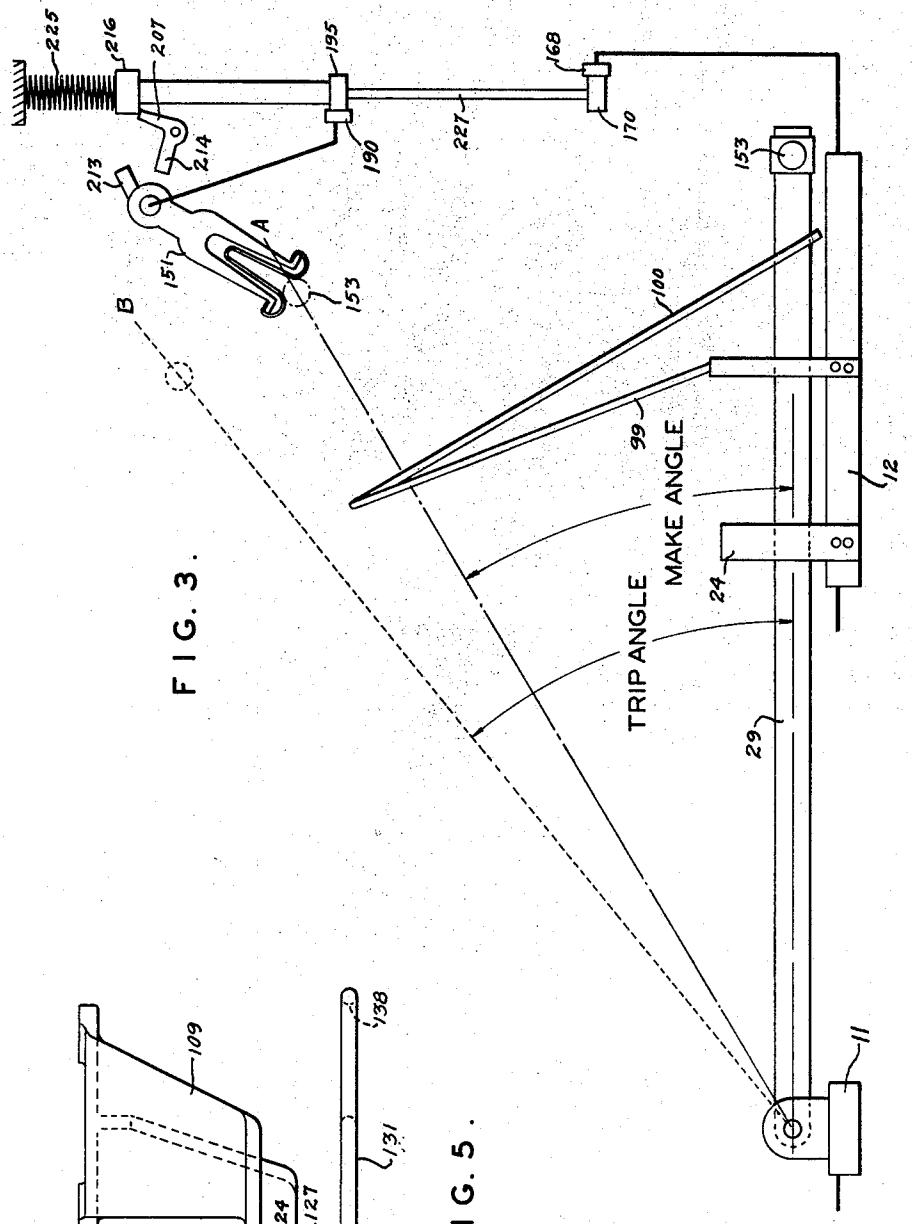


FIG. 3.

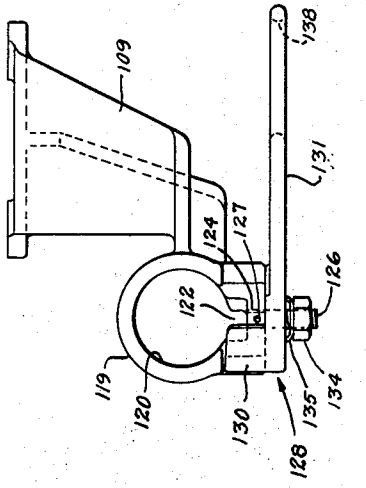


FIG. 5.

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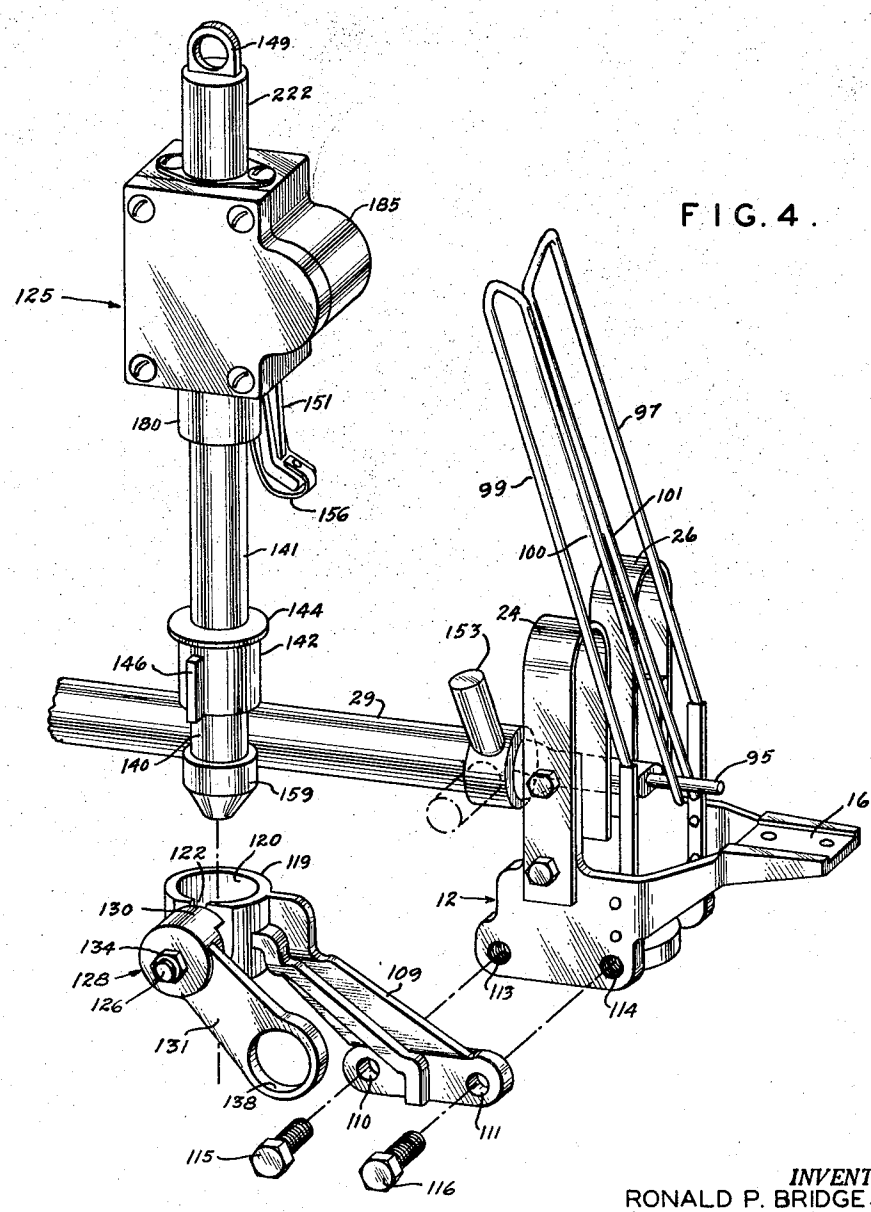
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FIG. 4.



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INTERRUPTER ATTACHMENT FOR DISCONNECT SWITCH

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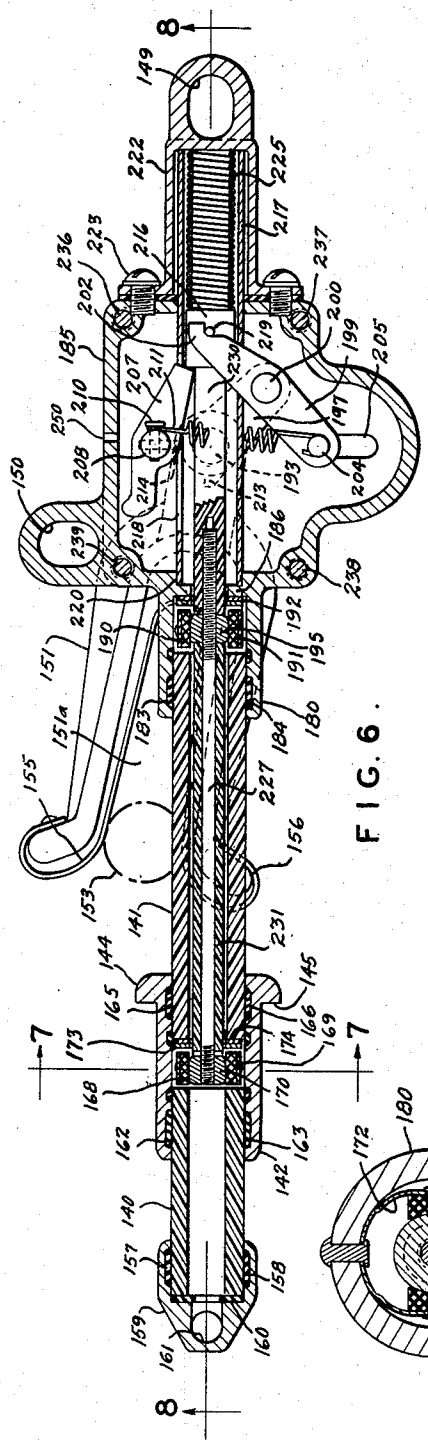


FIG. 6.

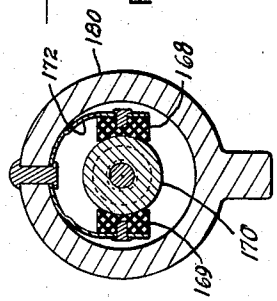


FIG. 7.

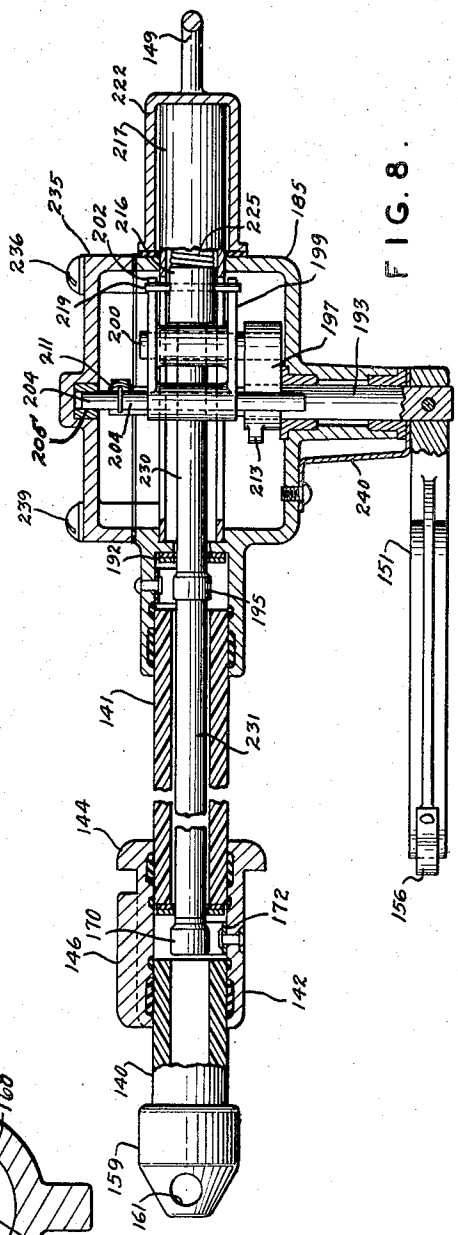


FIG. 8.

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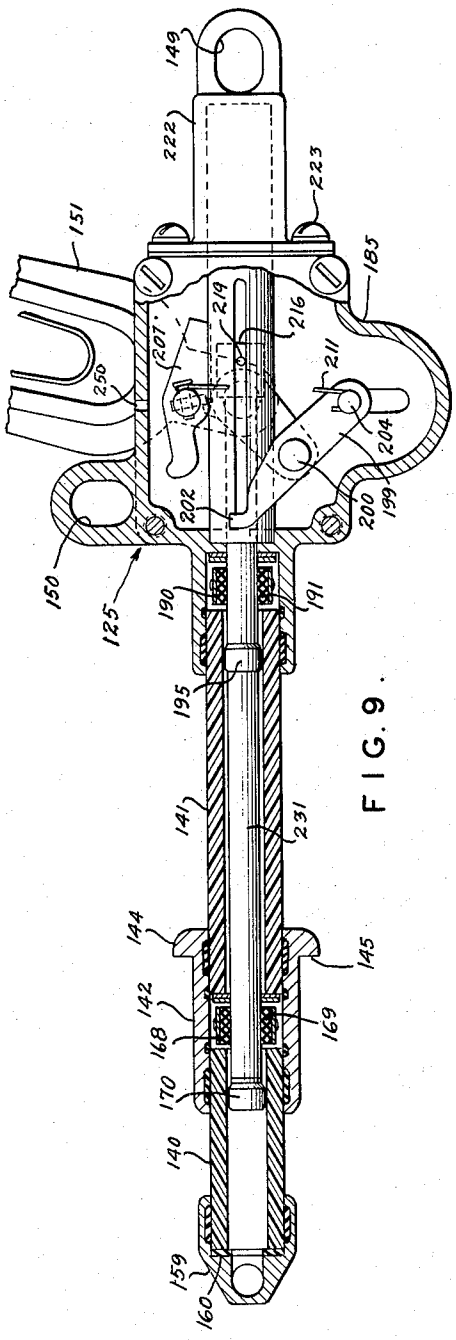


FIG. 9.

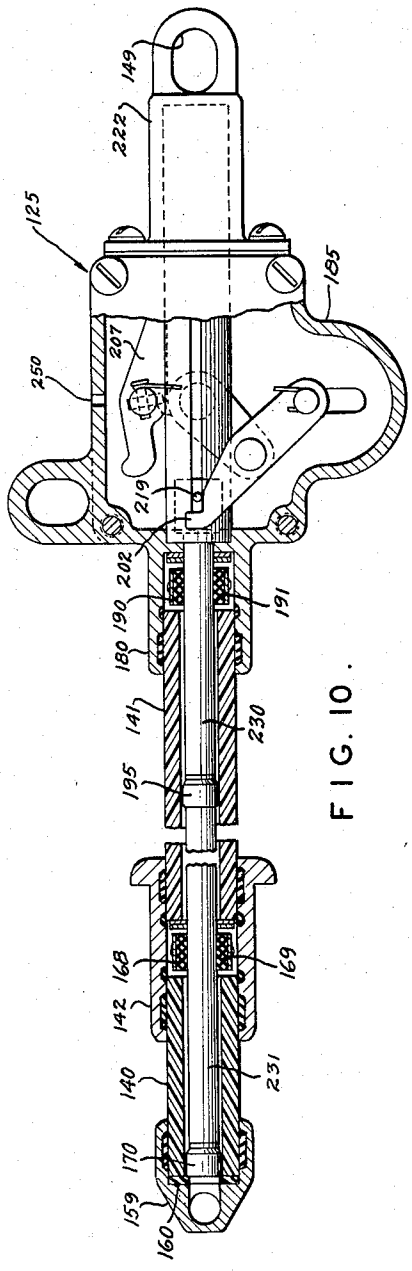


FIG. 10.

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United States Patent Office 3,144,536 Patented Aug. 11, 1964

3,144,536

INTERRUPTER ATTACHMENT FOR DISCONNECT SWITCH

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Filed Mar. 22, 1961, Ser. No. 97,627
11 Claims. (Cl. 200—146)

This invention relates to electric switches for use in high voltage electric distribution systems wherein operation of the switch, while under load, may result in damage to various current carrying switch elements by arcing and more specifically to an improved electric switch constructed with an arc-breaking device to minimize such damage and make possible ready replacement of such elements as are damaged by simply performed service operations while the switch is in service. Although switches of this general description have been proposed heretofore, as an example, see the patent to Froland 2,434,315 of January 13, 1948, this invention relates to certain improvements which enhance the marketability, utility and operation of this kind of switch.

According to this invention, a high potential switch of the kind adapted to be operated remotely is modified in a way to readily accept a fitting, which is operable by an ordinary switch stick to clamp or release a compact arc-breaking device of special construction. The fittings clamp the arc-breaking device in operative position on the switch and the arc-breaking device will operate in this position to protect the switch parts from damage due to arcing when the switch is subsequently opened under load. This arc-breaking device is adapted by its construction to be readily placed in, or removed from, this fitting by an ordinary switch stick.

The switch, the fitting, and the arc-breaking device are separate articles of manufacture and may be sold separately or assembled. This provides for many different contingencies. Suppose that in a proposed electric distribution system, it is contemplated that some of the switches to be installed may be frequently operated under load, others very seldom, or only under very light loads, and still others will be present only in a stand-by capacity when installed. No matter which of these situations could exist, no increase in cost would be involved in installing a switch according to this invention which can be suitably modified to mount the fittings to accommodate an arc-breaking device. For if the need for switch operation is frequent, then the switch with fittings and arc-breaking devices can be assembled before installation. In other cases, the fittings only would be assembled with the switch before installation. In still others, only the bare switch need be purchased for installation. Anytime service demanded an arc-breaking device in the last two instances or examples, it would be purchased and installed on the switch with the fittings, or by purchasing and installing the fittings on the switch, it could be adapted to receive the arc-breaking device. The fittings can readily be constructed to mount arc-breaking devices to match the capacity of the particular switch or switches, which means that a spare can be installed quickly on any switch of this kind when equipped with fittings before or after the switch is opened by using only an ordinary switch stick available to every lineman. It is also possible to speedily replace one arc-breaking device by a spare if the one installed becomes faulty in long service.

From what has been stated so far, it will be apparent to those familiar with electrical equipment problems that the utility of the switch itself (without fittings) is enhanced by its adaption to changing conditions to receive an arc-breaking device, especially one that can be readily replaced without taking the switch itself out of service.

This invention, however, includes not only the switch alone, or the switch and its novel fittings, to make the multi-duty switch a real possibility, but also the arc-breaking device as a separate manufacture and when combined with the switch. Not only does the arc-breaking device have its own novel features, but it is so constructed, mounted and arranged with the switch parts that it is not in shunt relation with the switch when the switch is either closed or fully open. It is, therefore, possible to replace the same with either the switch open or closed without drawing any arc between the parts. The switch parts including the arc-breaking device are so arranged, as will be later described in detail, that the arc-breaking device carries the current during only a brief interval after the switch is opened, but not as the switch is opened, and this feature increases its effectiveness and service life. In this respect, it differs from all prior devices of this kind whether permanent installations, such as in Froland, or portable devices which are used by the lineman and are equally well-known in the art.

It is one of the objects of this invention to provide an electric switch of basic design permitting the addition of certain components which will enhance its value as a switch and improve its operation to perform its function as a disconnect.

It is another object of this invention to provide a basic switch construction to which additions can be made for improving its function as changes in conditions occur in the electrical system in which it is connected.

It is another object of this invention to provide an improved construction in a switch to suppress the arc formed during its operation.

It is still another object of this invention to provide a switch with an arc suppressing device which may be readily replaced without putting the switch out of service.

It is another object of this invention to provide fittings attachable to a basic electric switch incorporating a mechanism for locking or unlocking an arc suppressing device in position thereon which can be operated by the ordinary switch stick.

It is still another object of this invention to provide a novel arc suppressing device for a switch.

Further objects and advantages of this invention will appear from the following detailed description which is in such clear, concise and exact terms as to enable any one skilled in the art to make and use the invention when taken in conjunction with the disclosure in the accompanying drawings forming a part thereof and in which:

FIG. 1 is a side elevational view of a switch constructed in accordance with this invention;

FIG. 2 is a top plan view of the switch shown in FIG. 1;

FIG. 3 is a schematic representation of the same switch illustrating the sequence of operational events;

FIG. 4 is an exploded view on a larger scale illustrating parts of the switch device in perspective;

FIG. 5 is a top plan view of the fitting on an enlarged scale;

FIG. 6 is a view in vertical section through the arc-break device;

FIG. 7 is a sectional view on the line 7—7 of FIG. 6;

FIG. 8 is a sectional view on the line 8—8 of FIG. 6; and

FIGS. 9 and 10 are operational views in section similar to FIG. 6.

Turning now to FIG. 1 of the drawings, the disconnect switch elements include a base 1 of channel iron of suitable dimensions. Bolted to the channel iron 1 at spaced points are a pair of brackets 2 and 3 secured to the channel iron 1 by the bolts 4 and 5, respectively. Each of these brackets in turn supports an insulator member, such as 6 and 7, secured to the brackets 2 and 3, respectively,

by bolts 8 and 9. At the top end of the insulator 6 is a fitting 12 secured thereto by suitable bolts, not shown. This fitting includes an extension 14, the upper side of which is recessed at 16 and provided with spaced holes 18 and 20 for bolts which are used to secure a conductor between a clamping plate and the terminal 14. The fitting 12 also has bolted thereto a pair of spaced spring type of fixed contacts 24 and 26 secured by pairs of bolts, such as 28 and 32, respectively. Both contacts are preferably identical and their free ends are bent upon themselves in a form of a U so as to provide a slot in which the end 36 of the movable arm 29 is wedgingly engaged. The fitting 12 also carries a small extension 38 mounting a stop screw 40 which limits the movement of the end 36 of the movable arm of the switch in a switch closing direction.

The insulator 7 carries a bracket 11 secured to the top of the insulator 7 by suitable bolts, such as 13, one of which is shown in FIG. 1. Bracket 11 has a circular base 15 which seats on top of the end of the insulator 7. Divergent arms 17 carry spaced hollow boss members 23 and 25, respectively, shown in FIG. 2. From this view, it will be apparent that bracket 11 forms the main support for the hinge contact arm 29 of the disconnect switch mechanism. Returning now to FIG. 1, the bracket 11 also carries a small extension 31 projecting vertically therefrom, which in turn is apertured to receive a stop screw 33 locked in position in the aperture by suitable stop nuts. Whereas the two insulators 6 and 7, heretofore described, are mounted on fixed mountings in fixed position with respect to the base 1, nevertheless, they are reversible in position if it is desired to mount the switch disconnect in an inverted position. This is likewise true of the insulator 45 which is supported on a flange 46 rotatable with the vertically mounted shaft 50. Bolts 46 and 48 attach the insulator to the flange. Shaft 50 is rotatably mounted in a bearing support 52 secured to the channel member 1 by bolts 54 and 56, respectively. Bolt 56 also anchors in position a bracket 57 carrying an adjustable stop nut 59. The stop nut 59 is aligned with the end of a short arm 60 turning with the shaft 50 and limits the rotative motion of the shaft 50 in one direction. One end of the shaft 50 projects below the base 1 and may be provided with a fitting, such as 61, secured thereto against rotation, and upon which may be mounted a suitable arm for connection with a linkage to turn the shaft 50.

Supported at the top of the insulator 45 is a crank 64 suitably secured by a plurality of bolts, such as 66 and 67. The end of the crank 64 is pinned to a clevis 69 which is rotatable within a boss of the forked bracket 70. The branched arms of the bracket 70, indicated as 72 and 74, straddle the upper end 76 of a control arm 77 rigidly secured to the contact arm 29 of the switch. A pin 75 forms the rotatable connector between the spaced arms 72 and 74 of the bracket 70 and the control arm 77.

The crank 64 has a bearing part, indicated generally as 80, journalled in an aperture within a bracket 82. On the upper surface of the bracket 82 is a recess 84 with two bolt holes 85 and 86. This forms the terminal to receive another conductor which can be secured in the recess 84 by a suitable bracket or clamping plate held against the conductor by bolts passing through the apertures 85 and 86.

The hinge construction between the blade or arm 29 and its supports, bracket 11 and yoke 82, will not be described here since it forms a part of the invention disclosed in an application of Joseph Bernatt, Serial No. 88,543, filed February 10, 1961, title: Conductive Hinge Structure for Electric Switch. This description so far has been confined to the basic elements of a known type of switch, such as described in the above application of Joseph Bernatt. For a further detailed description, reference should be made to this disclosure. In the basic switch mechanism heretofore described, the contact arm

29 can pivot both on its axis and on the aforesaid hinge mechanism during its opening and closing action. Assuming the parts to be in the position indicated and it is desired to open the switch, the shaft 50 is rotated clockwise by a suitable linkage mechanism which causes the crank 64 to rotate in the same direction as the insulator 45 turns with the shaft 50. The motion of the crank 64 in turn is transmitted to the movable contact arm 29 through clevis 69, bracket 70 and control arm 77 to twist the arm 29 on its axis thereby turning the paddle end 36 of the contact arm from a position generally horizontal as shown in FIG. 2 to a more nearly vertical position. This frees the contact pressure between the fixed contact springs 24 and 26 and further rotation of the crank 64 then swings the contact arm 29 toward a vertical position as shown in the dotted lines, FIG. 3. The closing action of the switch is the reverse of that just described.

The invention here is concerned with protecting the switch contacts 36 and 24 and 26 from damage due to arcing when the switch is opened or when the switch is closed. Of course, their protection afforded by the construction hereinafter described is applicable to most any switch by suitable modifications, but it is contemplated that its action will be the same regardless of the type of switch to which applied.

The protection of the switch from damage due to arcing preferably includes two shunt circuits between the switch contacts, which circuits are operated sequentially to open during movement of the movable contact arm 29 from the fixed contacts 24 and 26. One of these shunt circuits is established by contact between pin 95 in the end of the movable contact arm 29 and the stationary contacts 100 and 101 over which the pin 95 travels during opening of the switch contacts. The fixed contacts 100 and 101 are disposed on opposite sides of the pin 95 and biased toward one another to maintain this contact with the pin 95 by portions 99 and 97, respectively, which are co-extensive with the portions 100 and 101 and are respectively secured to the fixed contact carrying bracket 12 by the bolts 104 and 105. So long as the switch is closed, there will be a shunt circuit established between the pin 95 and the contacts 100 and 101. As the switch is opened, this shunt circuit will continue to conduct the current from the contact arm 29 after the contact 36 has left the contacts 24 and 26. Thus, the shunt circuit between the pin 95 and the contacts 100 and 101 will continue during blade opening to substantially the angular position of the contact arm 29, as indicated by the line A on FIG. 3.

Before the blade 29 reaches the angular position A, however, it has made contact with a second shunt circuit between the movable contact 29 and the fixed contact carrying bracket 12, as will be hereinafter pointed out. The bracket 12, just mentioned, is provided to receive a detachable fititng 109 shown in FIGS. 1, 2, 4 and 5. The fitting 109 has suitable holes 110 and 111 which mate with holes 113 and 114 provided for that purpose in the bracket 12. The holes 113 and 114 are tapped to receive cap screws 115 and 116 by which the fitting 109 may be secured in fixed relation to the bracket 12. Integral with the fitting 109 and suitably offset from its attaching point with the bracket 12 is a socket 119 which is in effect a tubular sleeve formed integrally as a part of the fitting 109. The tubular passage 120 in the socket 119 is opened at both top and bottom and arranged so that it will receive and support an arc-breaking device 125 in a position substantially parallel with the insulator 6. One side of the socket 119 has a key way 122, and aligned with the key way 122 and opening thereinto is a cylindrical tapped hole 124. The hole 124 receives a stud 126 in turn pinned at 127 in place in fixed position within the hole 124. Stud 126 supports a latching device 128 which includes an arcuate swinging latch 130 and a latch lever 131. The latch 130 and the lever 131 swing together around the stud 126 and are held in place on the socket 119 by a nut 134 threaded on the stud 126 and bearing against a

spring washer 135. The end of the latch lever has an eye 138 which may be engaged by an ordinary switch stick so as to swing the latch lever and thereby the swinging latch 130 from an open position, such as shown in FIG. 5 to a closed position in which it obstructs the upper end of the open key way 122. When the latch lever 138 is moved to open position, the socket 119 is adapted in this condition to receive the arc-breaking device 125. On the lower end of the arc-breaking device 125 is lower arcing chamber housing 140 which forms in effect a continuation of the arcing chamber housing 141. These two housings are interconnected by a contact housing 142 which is dimensioned to be received in the socket 119. At the top of the contact housing 142 is a flange 144 having a downwardly facing shoulder 145 which will seat against the upper face of the socket 119. Contact housing 142 also has a rib 146 extending vertically thereof to a point spaced from the shoulder 145 by a distance substantially the thickness of the swinging latch 130. At the upper end of the arc-breaking device 125 is in integral eye 149 by which the arc-breaking device 125 may be lifted to a position where its lower end will be received in the socket 119. The rib 146 of the contact housing 142 locates the arc-breaking device at the proper angle, and the shoulder 145 will then seat on the upper end of the socket 119. The arc-breaking device 125 and the eye 149 are so arranged that an ordinary switch stick may be used to hoist the arc-breaking device into position when the switch is vertical so that its lower end can seat in the socket. If the switch is in a position other than vertical, the switch stick can be placed in the eye 150 which balances the arc-breaking device in a horizontal position so as to be inserted in a socket of a vertically located switch. After the device is positioned in the socket in this manner, the switch stick is removed from the eye 149 or the eye 150 and inserted in the eye 138. A pull on the latch lever by using the switch stick will move the latching device 130 into latching position with the rib 146 of the contact housing 142 thereby locking the arc-breaking device 125 in fixed position within the socket 119 of the fitting 109. The rib 146 is so located on the contact housing 142 as to properly position a trip arm 151 on the arc-breaking device 125 to be engaged by a lug 153 on the contact arm 29 (see FIG. 2). Thus, as the arm 29 is rotated to disengage its paddle shaped end 36 from the fixed contacts, the lug 153 in turn assumes a position to be received between the spring contacts 155 and 156 within the fork-shaped opening 151*a* of the trip arm 151. Spring contacts 155 and 156 are so dimensioned that the lug 153 is snugly engaged forming the electrical connection between the movable contact arm 29 and the forked opening 151*a* of the trip arm 151.

As will be later explained, the arc-breaking device 125 has separable contacts which complete the circuit established with the lug 153 in the contact arm 151 to the contact housing 142 within the socket 119 and, thence, to the bracket 12 for the fixed contacts of the switch. As soon as the lug 153 makes firm engagement during the switch opening movement, the second shunt circuit, heretofore mentioned, is thereby completed from the arm 29, lug 153, trip arm 151, arc-breaking device 125, to contact housing 142, socket 119 and to the bracket 12 carrying the fixed contacts. The lug 153 and the arc-breaking device 125 are so positioned by the fitting 109 that a firm contact is established through the shunt circuit before the pin 95 leaves the contacts 100 and 101. Of course, the contact between arm 29 and fixed contacts 24 and 26 has long since opened when this occurs, so that the current is being shunted through the pin 95 to the stationary contacts 100 and 101 before the second shunt contact is completed between the lug 153 and the trip arm 151.

Enough has been said so far so that it will be quite apparent that by the use of an ordinary switch stick, the latch 130 can be operated to secure or release the arc-breaking device 125. The same stick, if desired, can be then used to engage either the eye 149 or the eye 150 to lift an arc-breaking device 125 into or out of the socket. There is no circuit through the arc-breaking device until the switch has opened far enough to engage the lug 153 in the trip arm 151. On the other hand, if the switch is fully open, there is no circuit which is closed through the arc-breaking device because the contacts therein would normally be open. In either case, this has inherent advantages obvious to those skilled in the art. From what has been said so far it will become now obvious that since the switch structure itself and the fitting 109 are detachably connected and that the arc-breaking device 125 is likewise detachably connected with the fitting, the switch may be sold independently of the fitting, the fitting independently of the switch or arc-breaking device, and the latter independent of the others so that the instant needs of the purchaser of electrical equipment can be satisfied by the purchase of the desired parts. If at first, but one or two are purchased, he can add to these parts so as to have the complete combination.

Arc-Breaking Device

As heretofore stated, the arc-breaking device has a lower housing 140 and a main housing 141, these could also be termed an exhaust tube 140 and a main barrel 141 which are interconnected by the contact housing 142. The exhaust tube 140 has its lower end closed by a vent cap 159 in which is a vent opening 161. The exhaust tube 140 is preferably formed of fiber glass laminate with a lining of acrylic resin, and the vent cap 159 is secured to the lower end thereof by a suitable cement filling 157 in the interior annular groove 158, as shown in FIGS. 6 and 8. Between the vent cap 159 and lower end of the exhaust tube 140 is a sealing washer 160 which also performs the function of a valve seat as will be lated pointed out.

The contact housing 142 is secured to the upper end of the exhaust tube 140 by cement 162 filling the internal annular groove 163 in the contact housing. The upper end of the contact housing 142 in turn is secured to the main barrel 141 by cement 165 filling the internal annular groove 166 in the upper end of the contact housing. The upper end of the exhaust 140 and the lower end of the main housing 141 are spaced apart within the contact housing 142, and within this annular space are a pair of brushes 168 and 169 with arcuate contact faces. With reference to FIG. 7, the brushes are in turn held in straddling relation clamped to the outside of the contact 170 by a resilient conducting metal U-shaped spring 172 with its ends riveted to each brush. This spring in turn is riveted or otherwise secured to the inner wall of the contact housing 142. The brushes 168 and 169 are preferably tungsten-silver contacts. Between these brushes and the end of the main barrel 141 are a pair of washers 173 and 174 which form a valve means with a gas restriction, the function of which will be later described.

The opposite end of the main barrel 141 is secured in a contact housing part 180 of an actuating housing 185. This actuating housing contains a load and fire mechanism. The upper contact housing 180 is secured to the end of the main barrel 141 by cement 183 filling the internal annular groove 184. The main barrel 141 is also constructed of fiber glass laminate lined with acrylic resin, and its upper end terminates within the contact housing 180 but spaced from an annular flange 186 therein. In this space is disposed a pair of brushes 190 and 191 which are constructed in the same manner as the brushes 168 and 169. Brushes 190, 191 are preferably of tungsten-silver and interconnected by a spring mounting which is in turn riveted to the inner wall of the contact housing 180. This spring holds the brushes firmly in engagement with a contact 195, the same as spring 172 holds brushes 168 and 169 on contact 170.

One wall of the actuating housing 185 has a hollow boss with bushings to form a suitable bearing for stub

shaft **193**. One end of shaft **193** is fixed within the trip arm **151** and is rotated thereby. The end of the stub shaft **193** within the actuating housing **185** is fixed within an aperture in lever **197** so that lever **197** swings with the trip arm **151**. As the lever **197** swings, it carries with it a spring reloader lever **199** to which it is pivoted at **200** by a pin. The connection between arm **197** and lever **199** is substantially intermediate the hooked end **202** at one end of the lever **199** and the opposite end of the lever which carries a pin **204**. The pin **204** rides in grooves **205** and **205'** in opposite sides of housing **185** as the arm **197** swings from one extreme position to another. The pin **204** is retained in the groove **205** and in a similar groove **205'** on the opposite side of the housing. Inside the actuating housing **185** is a trip latch **207** carried on a pivot pin **208** to which it is fixed. The pin is received in a suitable socket in one side of the housing **185** and retained in the socket by the opposite side of the housing. The pin **208** in turn carries a spring anchor pin **210** to which one end of the latch spring **211** is connected. The opposite end of the latch spring **211** is anchored around pin **204**. This spring normally biases the trip latch in a clockwise direction, and it is moved against spring pressure by the action of the latch release **213**, which, as it rotates in a clockwise direction, engages a trip pin **214** anchored in the trip latch pivot pin **208**. The engagement of the latch release **213** with the trip pin **214** causes the latch to rotate in a counterclockwise direction or into its released position from its latched position. In its latched position, however, it engages beneath a shoulder of a head **216** which is slidable within a slotted sleeve **217**.

Latch spring **211** has a dual function in this described construction. It holds the latch and also is the operating force in a spring powered snap action toggle formed by the pivoted connection of lever **197** to spring reloader lever **199**.

The head **216** carries a pin **219** projecting through slots in the sleeve **217** into engagement with the hooked ends **202** of the spring reloader lever **199**. The tube **217** is also slotted at **218** so as to allow the end of the trip latch **207** to engage beneath the head **216**. This sleeve terminates in a socket **220** at one end of the housing **185**, the other end of the sleeve **217** projects through the opposite side of the housing **185** and is enclosed and secured in position by a cap **222** carrying the eye **149**. Cap **222** is suitably flanged and has apertures in the flange for receiving the attaching screws **223** which secure the cap firmly to the side of the housing. Within the housing is a firing spring **225** compressed between the top surface of the head **216** and the end of the cap **222**.

The head **216** is formed on one end of a nylon trailer **230** which has a threaded socket receiving a threaded end of a bronze spacer rod **227** extending to and through contact **195** to contact **170**. Each of the contacts **195** and **170** are suitably secured by internal threads to the threaded exterior of bronze spacer rod **227**. Surrounding the bronze spacer rod **227** between the contacts **170** and **195** is an acrylic resin sleeve **231**. The lower face of the contact **170** acts as a valve to close the vent **156** when it moves to the position in contact with the washer **160** under the influence of the spring **225**. The cavity in the housing **185** is enclosed by a plate **235** and secured in position by suitable screws **236**, **237**, **238** and **239**.

The housing **185** is electrically connected to arm **151** by a brush **240** of bronze mounted on the housing by a screw, as shown in FIG. 8. This brush bypasses the electric path from the actuating mechanism which is from arm **151**, brush **240**, contact housing part **180**, brushes **190**, **191**, contact **195**, spacer rod **227**, contact **170**, brushes **168**, **169** and contact housing **142**.

From the construction of the arc-break device, so far described, it will be apparent that when the lug **153** forms a positive contact with the spring contacts **155** and **156** of the trip arm **151**, a circuit is completed when the arc-break contacts are closed. This circuit includes the movable contacts **170** and **195** in series relation. As the lug **153** is moved in a counterclockwise direction by the contact arm **29** of the switch, the trip arm **151** moves in a clockwise direction. As the trip lever **151** continues to rotate in a clockwise direction, the hooked end **202** of the spring reloader lever **199** is withdrawn toward the other side of the casing. During this motion, the pin **204** slides up the slots **205** and **205'** to permit the rotary motion of both arm **197** and spring reloader lever **199**. After the toggle (levers **197** and **199**) pass dead center, spring **211** provides sufficient force to move hook **202** to a full retracted position causing latch release **213** to engage trip pin **214**, tripping the latch **207** and releasing head **216**. Spring **225** then drives the head and plunger assembly toward the opposite side of the casing where pin **217** is positioned to be engaged by the end of the hook **202** in spring reloader lever **199**. When the trip lever **151** is released from the lug **153**, spring **211** will index the position of trip arm **151** to again engage with lug **153**, after the switch is opened or after it has closed. Since the head **216** and contacts **170** and **195** are interconnected mechanically by being part of a plunger assembly, the contacts are separated from their respective brush connections to break the shunt circuit. The fact that there are two of these contacts means that the effective gap will be developed twice as fast as with a single contact, and this multiples the rapid action produced mechanically by the spring **225**. As contacts **170** and **195** separate from their respective pairs of brushes, a pair of arcs will develop between the edges of the brushes adjacent the contacts as they recede in a direction away from these brushes (see FIG. 9) and move rapidly to a fully displaced position as shown in FIG. 10. As shown in FIG. 10, the arcs developed will be rapidly elongated into the narrow space between the acrylic resin sleeve of the inner surface of the barrel **141** and the outer surface of the nylon trailer sleeve **230**. At the opposite end, the arc will be drawn between the inner surface of the exhaust tube **140** and the outer surface of the acrylic resin sleeve **231**. The arc formation will develop a gas pressure due to heating of the acrylic resin linings in the barrel and on the trailer and sleeve. This produces in turn a gas pressure which will tend to expand both ways from the contact **195** and both ways from the contact **170**. However, the gas pressure developed about the contact **170** and about the contact **195** will actuate the washers **173** and **192** respectively so as to force them to act as valve means causing the gas to blow in the direction of the vent **161**. The gas pressure developed near the contacts **170** and **195** will be restricted in its passage by the restricted clearance between the washers **173** and **192** and the plunger assembly. This causes the gases first to flow in a direction from the housing toward the vent **161**. Ordinarily, turbulence created by the passage of gases will be enough to suppress the arcs developing about the contacts **170** and **195** long before the contact **170** seals the vent opening **161** by seating on the washer **160**. If either arc is blown out, the circuit is broken because they are in series. However, not only is the operational life of these devices limited by the total gap produced between the contacts and brushes, but also by the fact that carbon deposits accumulate after each operation. These carbon deposits form a path for electrical leakage within the barrel and within the exhaust tube between each contact and its set of brushes. Of course, when this happens, the useful life of the arc-breaking device is terminated. This is true simply because the device can no longer break the circuit completely. Generally, this occurs without warning and causes the arc to be restruck. To prevent this from happening without warning, the instant device is constructed so that if both arcs continue after contact **170** has seated and vent **161** is closed, the pressure build-

up of gases will increase very rapidly and reverse its direction of flow passing the restriction of the washers **173** and **174** and blasting up the barrel past the restriction of washers **192** into the housing **185**. The fact that the gases begin to escape from the housing **185** through vent holes, such as **250** in its side walls, will indicate what has happened to the lineman, but, in addition, this high pressure due to the closing of the vent will produce extremely high turbulence in the exhaust tube and barrel in a direction to blow out the arcs and, therefore, extinguish the arcs. The trip angle for the latch **207** will be reached when the contact arm **29** has attained the angular position B about the hinge. The distance from A to B indicates approximately the separation which has been obtained between the pin **95** and its stationary contacts **100** and **101** when the arcs are extinguished.

As the switch arm **29** is moved from its fully opened position toward its closed position, lug **153** will again engage the fork and contacts in the trip arm **151** and begin to rotate the arm in a counterclockwise direction. This will rotate the arm **197** in a similar direction and move the hooked end **202** and head **216** by engagement of pin **217** toward a position beyond position A in which trip latch **207** can engage beneath the shoulder on the head **216**. At the time arm **29** reaches to position A, however, pin **95** again re-enters between its contacts **100** and **101** closing the shunt circuit around the switch contacts. Beyond the angle A of arm **29**, contacts **170** and **195** again close and latch **207** snaps under head **216**. As the switch arm **29** continues to close, lug **153** will leave the trip lever and the shunt circuit will be continued solely by contact of pin **95** until the switch is fully closed.

Changes in and modifications of the construction described may be made without departing from the spirit of my invention or sacrificing its advantages.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In an electric switch having a relatively fixed contact and a movable contact engageable with and disengageable from said fixed contact to connect and disconnect a heavy electric load respectively, the combination of means for suppressing the arc formed during switch operation comprising separate means for forming circuits through said movable contact in shunt relation with said fixed and movable contacts operated sequentially to open during movement of said movable contact from said fixed contact to transfer the current path from said switch to one of said shunt circuits and from one of said shunt circuits to another without interruption, a circuit interrupter of the arc suppressing type in said shunt circuit which is last to open, and means to operate said circuit interrupter in response to further opening movement of said movable contact to finally break the circuit between contacts of said switch before disengagement of said means in the shunt circuit last to open.

2. In an electric switch mechanism having a relatively fixed contact and a movable contact engageable with and disengageable from said fixed contact to connect and disconnect a heavy electric load respectively, the combination of means forming a part of said switch mechanism for suppressing the arm formed during switch operation comprising separate means for forming circuits through said movable contact in shunt relation with said fixed and movable contacts operated sequentially to open during movement of said movable contact to open said switch to thereby transfer the current path from said switch to one of said shunt circuits and from one of said shunt circuits to another without interruption, a circuit interrupter of the arc suppressing type in said shunt circuit which is last to open, and means to operate said circuit interrupter in response to further opening movement of said movable contact to finally break the circuit between contacts of said switch before disengagement of said means in the shunt circuit last to open.

3. In an electric switch mechanism having a relatively fixed contact and a movable contact engageable with and disengageable from said fixed contact to connect and disconnect a heavy electric load through said switch respectively, the combination of means forming a part of said switch mechanism for suppressing the arc formed during switch operation comprising separate means for forming circuits through said movable contact in shunt relation with said fixed and movable contacts operated sequentially to close during movement of said movable contact to close said switch to thereby transfer the current path from one or said shunt circuits to another and then to the switch without interruption, a circuit interrupter of the arc suppressing type in said shunt circuit which is last to open, and means to operate said circuit interrupter in response to further opening movement of said movable contact to finally break the circuit between contacts of said switch before disengagement of said means in the shunt circuit last to open.

4. In an electric switch mechanism having a relatively fixed contact and a relatively movable contact engageable with and disengageable from said fixed contact to connect and disconnect a heavy electric load respectively, the combination of means forming a part of said switch mechanism for suppressing the arm formed during switch operation comprising separate means on said switch for forming circuits through said movable contact in shunt relation to said fixed and movable switch contacts, separately operable in uninterruptable sequence during opening movement of said movable contact after said contacts have separated to transfer the current path from one of said shunt circuits to the other, and an arc suppressing device in said other shunt circuit actuated by said movable contact.

5. In an electric switch mechanism having a relatively fixed contact and a relatively movable contact engageable with and disengageable from said fixed contact to connect and disconnect a heavy electric load respectively, the combination of an arc suppressing device removably mounted adjacent to said contacts on said switch and electrically connected through the mounting to one of said switch contacts and comprising a movable trip device engaged by the other of said switch contacts after said switch is opened to form an electrical connection between said other switch contact and said trip device only during engagement therebetween but not when said switch is fully open or partly or fully closed, and separable contacts in said arc suppressing device electrically connected respectively with said one switch contact and said movable trip device to complete a shunt circuit between said switch contacts only when said movable trip device engages the other of said switch contacts so that while the switch is in service the arc suppressing device may be replaced while the switch is either fully opened or closed.

6. In an arc suppressing device for an electric switch having a housing with a barrel, a fixed contact in said housing, a plunger assembly movable in said barrel and defining a restricted space with said barrel, a movable contact on said plunger assembly movable with said plunger assembly from a position in contact with said fixed contact away from the fixed contact into the barrel, the combination of means for biasing said contacts apart, a latch resisting relative contact movement, an actuator, an over-center toggle with a spring actuated snap action and carrying a latch release and connected to and operated by said actuator to a dead center position and beyond dead center position by the spring action to then release said latch by impact of said latch release with said latch, and means on said toggle and on said plunger engaged by reverse movement of said actuator for repositioning said plunger to its latched position.

7. In an arc suppressing device for an electric switch having a housing with a barrel and a vent in the barrel, a fixed contact in said housing, a plunger assembly movable in the barrel and defining a restricted gas passage

with said barrel, a movable contact on said plunger assembly and movable with said plunger assembly from a position in contact with the fixed contact away from the fixed contact into said barrel to draw an arc into the restricted gas passage and generate a gas pressure, the improvement comprising a flow restricting valve means in said barrel closed by gas pressure generated by the arc as the contacts open to cause a gas flow in one direction towards the vent and means actuated by continued movement of said plunger assembly for closing the vent and reversing the gas flow direction.

8. In an arc suppressing device for an electric switch having a housing with a barrel and a vent in the barrel, a fixed contact in said housing, a plunger assembly movable in the barrel and defining a restricted gas passage with said barrel, a movable contact on said plunger assembly and movable with the plunger assembly from a positon in contact with the fixed contact away from the fixed contact into the barrel to draw an arc into the restricted gas passage and generate a gas pressure, the improvement comprising a flow restricting valve means located in said housing on the opposite side of said contacts from the vent in said barrel and arranged to close by gas pressure generated by the arc as the contacts open to cause a gas flow in one direction towards the vent and means actuated by continued movement of said plunger assembly for closing the vent and reversing the gas flow direction toward the valve means and the contacts.

9. In an arc suppressing device for an electric switch having a housing with a barrel and a vent, a fixed contact in said housing, a plunger assembly movable in the barrel and defining a restricted gas passage with the barrel, a movable contact on said plunger assembly and movable with the plunger assembly from a position in contact with the fixed contact away from the fixed contact and into the barrel to draw an arc into the restricted gas passage and generate a gas pressure, the improvement comprising a flow restricting valve means in said barrel on opposite sides of said contacts one of which is closed by gas pressure generated by the arc as the contacts open to cause a gas flow in one direction toward the vent and the other of which is opened by gas pressure, and means actuated by continued movement of said plunger assembly for closing the vent and reversing the gas flow direction so as to close both valve means and build up a high pressure in the barrel.

10. In an arc suppressing device for an electric switch having a housing with a barrel and a vent, a pair of

spaced apart fixed contacts in the housing at opposite ends of the barrel, a plunger assembly movable in the barrel and defining a restricted gas passage with said barrel, a pair of spaced apart electrically connected movable contacts on said plunger assembly and movable with the plunger assembly from a position engaged with said fixed contacts away from said fixed contacts into the barrel to draw an arc into the restricted gas passage and generate a gas pressure, the improvement comprising a flow restricting valve means in said barrel located on the opposite sides of all of said contacts from the vent and arranged to be closed by gas pressure generated by the arc as the contacts open to cause a gas flow in one direction towards the vent and means actuated by continued movement of said plunger assembly for closing the vent and reversing the gas flow direction to increase the pressure in said housing and barrel.

11. In an arc suppressing device for an electric switch having a housing with a barrel and a vent, a pair of fixed spaced apart contacts in said housing and barrel, a plunger assembly movable in the barrel and defining a restricted gas passage with the barrel, a pair of spaced apart electrically interconnected movable contacts on said plunger assembly and movable with said plunger assembly from a position engaging with said fixed contacts respectively away from said fixed contacts into said barrel to draw an arc into the restricted gas passage and generate a gas pressure, the improvement comprising a flow restricting valve means in said barrel on the opposite side of said fixed contacts from the vent and arranged to be closed by gas pressure generated by the arc as the contacts open to cause a gas flow in one direction towards the vent and means actuated by continued movement of said plunger assembly for closing the vents and reversing the gas flow direction to increase the pressure in the barrel.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,144,536 August 11, 1964

Ronald P. Bridges et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 54, for "fititng" read -- fitting --; column 6, line 35, for "lated" read -- later --; column 7, line 16, for "The" read -- This --; column 9, line 62, for "arm" read -- arc --; column 10, line 12, for "or" read -- of --; line 25, for "arm" read -- arc --.

Signed and sealed this 19th day of January 1965.

(SEAL)
Attest:

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EDWARD J. BRENNER
Commissioner of Patents

UNITED STATES PATENT OFFICE

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