United States Patent

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[54] **HIGH VOLTAGE SWITCH WITH PRE-INSERTION RESISTOR**
4 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **200/144AP,** 200/48CB, 200/146
[51] **Int. Cl.** **H01h 33/16**
[50] **Field of Search** ..... 200/144 (APRI), 146, 48 (CB), 48 (SB), 48 (for.), 144 (Cursory); 317/71, 78; 338/204, 215

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Assistant Examiner—Robert A. Vanderhye
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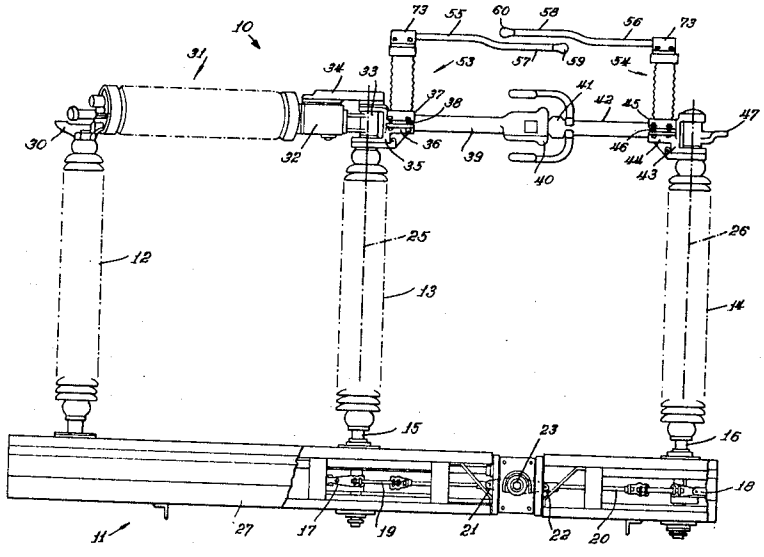
ABSTRACT: A high voltage center break disconnecting switch has a resistor assembly upstandingly mounted on, movable with, and electrically mounted on an insulator pivotable about a vertical axis. A conducting arm extends from the other end of each resistor assembly toward the other arm to complete a conductive path in the atmosphere between their distal ends and through the resistor assemblies in advance of the completion of a conductive path through the switch blades as they are swung into contact engagement at their distal ends.



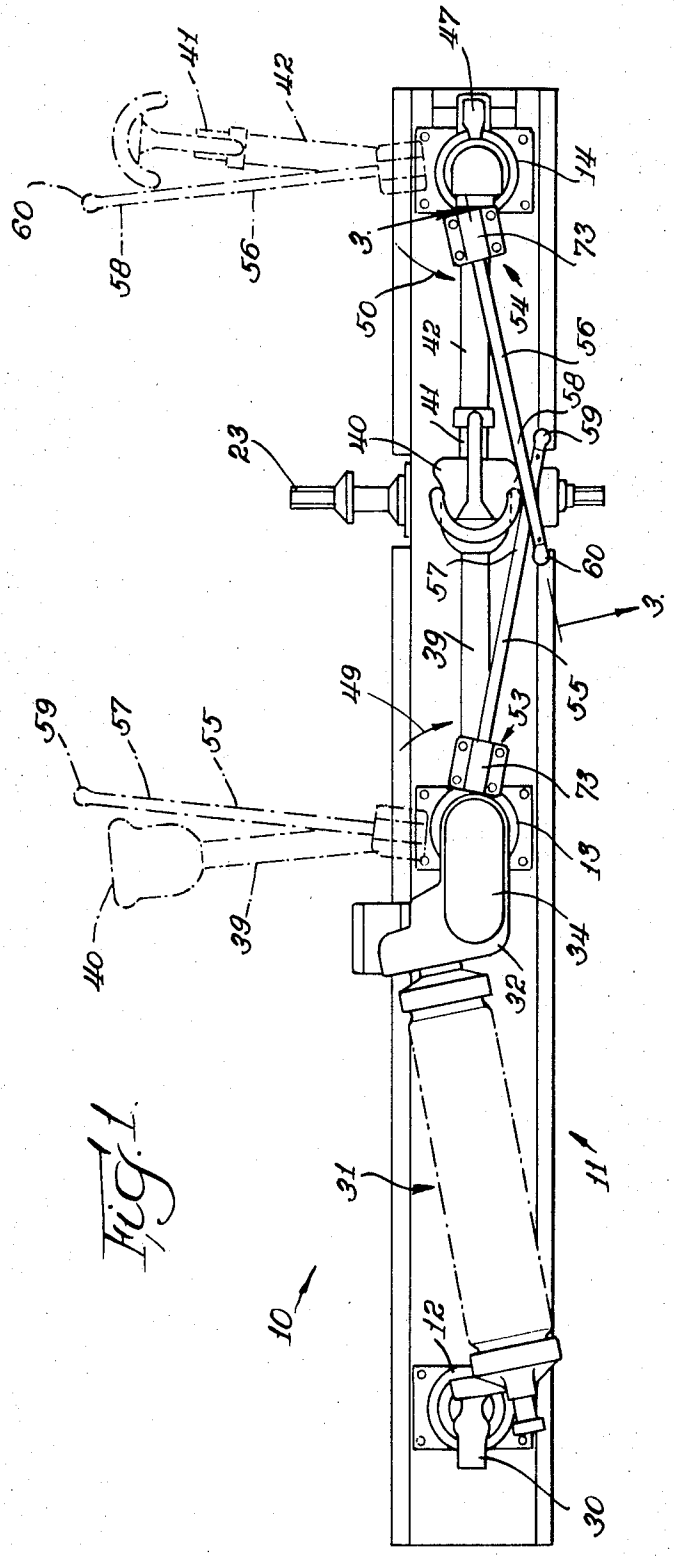

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FIG. 1

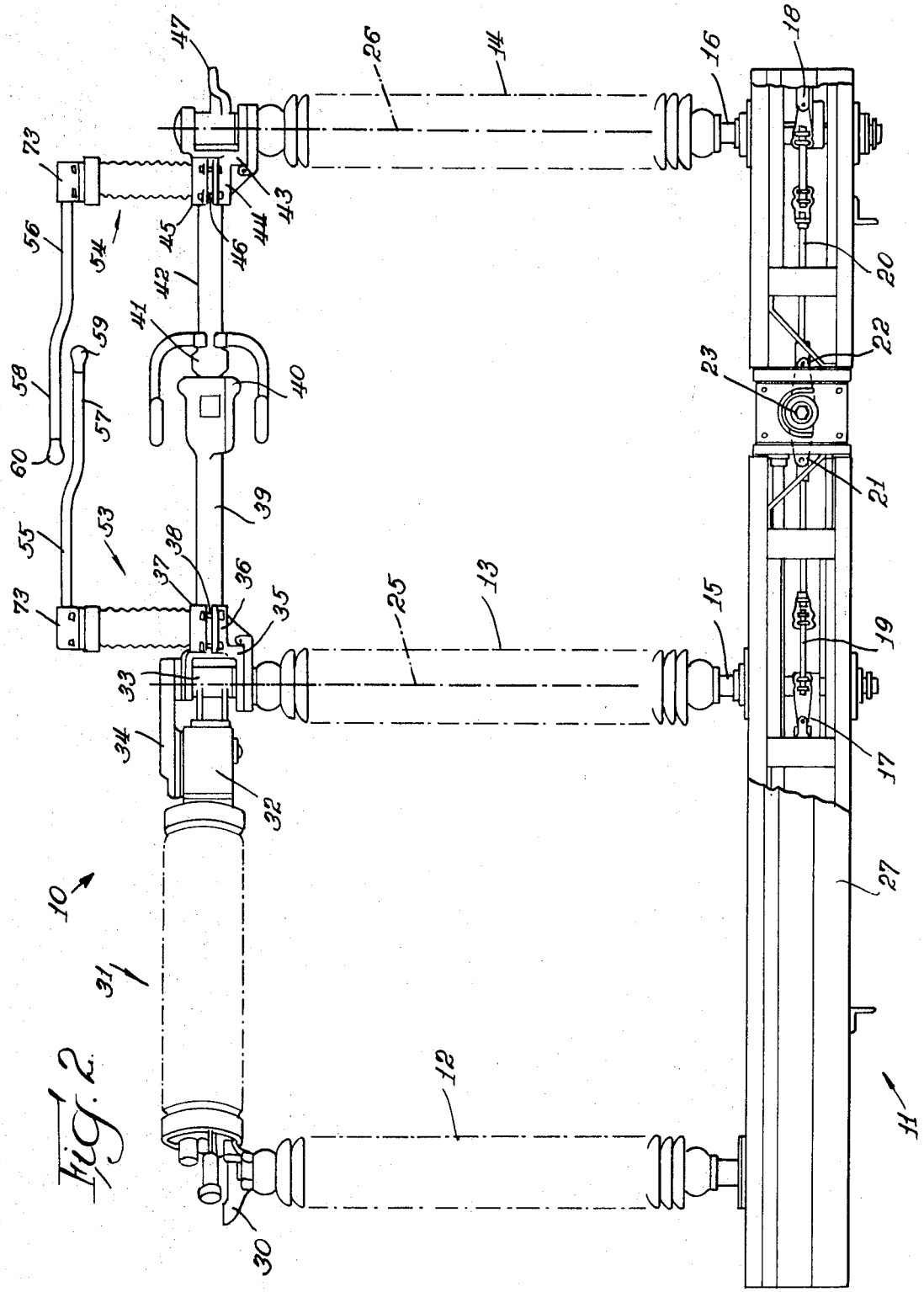
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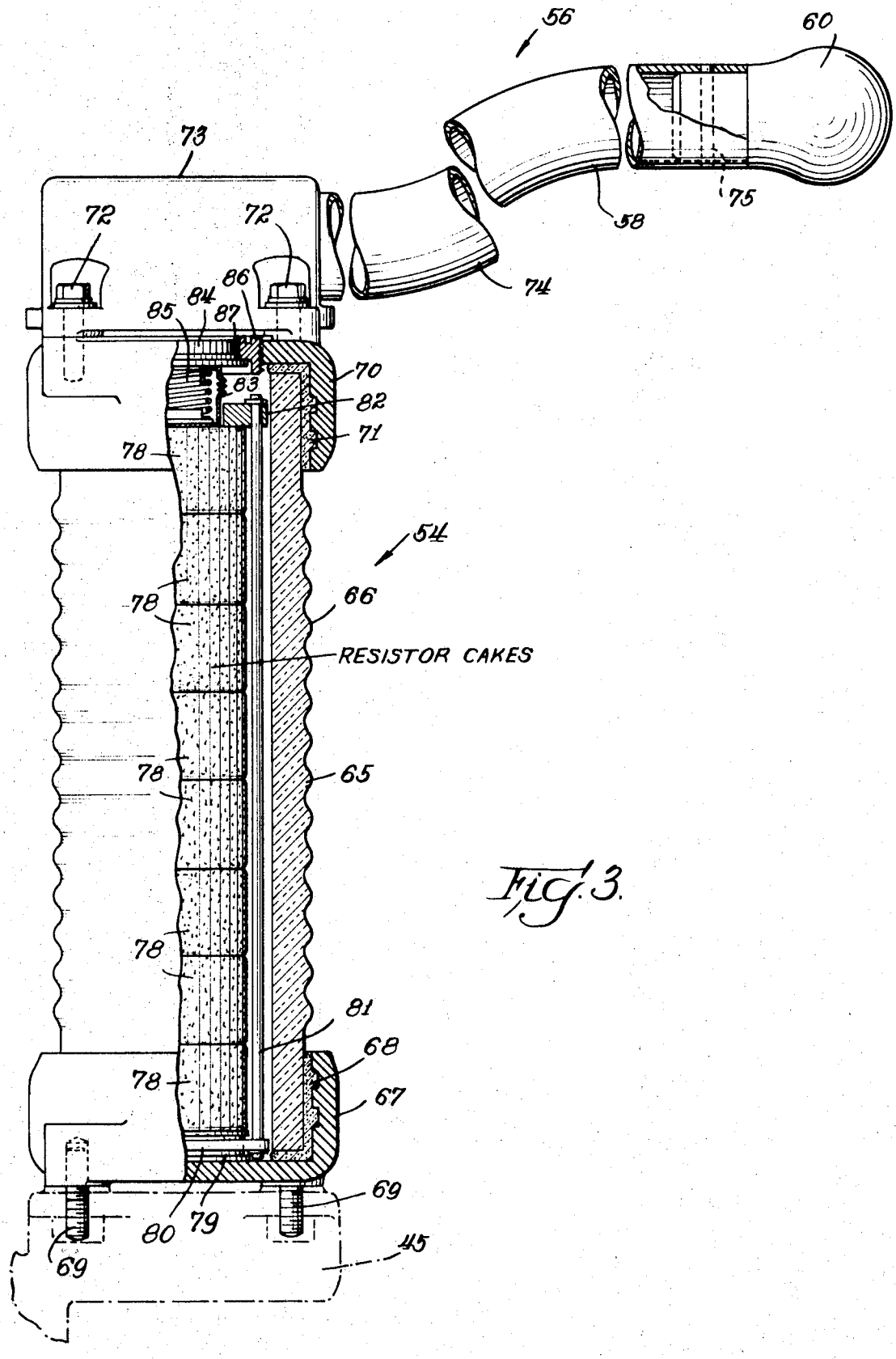
Fig. 2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RESISTOR CAKES
78
65
78
81
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80
79
69
45

Fig. 3.

HIGH VOLTAGE SWITCH WITH PRE-INSERTION RESISTOR

This invention constitutes an improvement over the construction disclosed in U.S. Pat. No. 3,339,037, issued Aug. 29, 1967 to Bernatt et al.

It is desirable to limit the inrush current in a circuit on energization thereof. This is particularly the case when a capacitor bank is energized from a high voltage circuit or a high voltage electric power transmission line having relatively high capacitance is energized. If the inrush current is not limited, transient disturbances in the system may be generated which may cause flashover, insulation breakdown and the like. Further, the closure of the circuit in air may develop objectionable noise incident to formation of arcs on completion of the circuit.

Accordingly, among the objects of this invention are:

To insert one or more resistors in a circuit while it is being energized to limit the inrush current; to keep the resistor inserted in the electric circuit for a definite time to limit the inrush current; to remove the resistor from he electric circuit after the elapsed time period by short circuiting it in order not to exceed the thermal capacity of the resistor; to arrange for inserting the resistor in the circuit in such manner that the magnitude of its resistance is not critical, the insertion time and duration time are not critical, and the fault making capability of the associated switch mechanism is not impaired; to construct the resistor inserting mechanism in such manner that outdoor ambient conditions of rain, ice and sleet do not adversely affect operation of the associated switch mechanism during closing and opening of the electric circuit; to arrange for applying the resistor inserting mechanism to a previously installed switch mechanism not equipped therewith; and to construct the resistor inserting mechanism such that arcing across live parts during insertion of the resistor in the circuit is maintained without undue erosion of arcing parts until the resistor is short circuited out of the circuit.

According to this invention a center break switch construction, such as that disclosed in the above identified patent, is modified to insert a resistor in the circuit while the switch is being closed for limiting the inrush current and to short circuit the resistor when the switch is in the closed position. For this purpose a resistor assembly is mounted in upstanding relation on each switch blade adjacent its pivot axis. A conducting arm extends from the upper end of each resistor assembly toward the other arm with the arrangement being such that a spark gap is formed between the arms during closure of the switch blades in series with the resistor assemblies which is shorter than the gap between the distal ends of the switch blades. When the arms, moved cojointly with the switch blades, reduce the length of the arc gap therebetween sufficiently to permit it to arc over, current begins to flow in the circuit which is limited by the voltage drop across the arc and by the resistor assemblies while the arc is maintained until it is short circuited by engagement of the switch blades at their distal ends. For a balanced construction, two resistor assemblies are used. However, the resistance can be embodied in a single resistor assembly. Each resistor assembly includes a weatherproof housing of porcelain or the like having terminals at its ends interconnected by the enclosed resistance element in the form of cakes of conducting material. The lower terminal includes a clamp section for attachment to the switch blade while the upper terminal has the conducting arm secured thereto. At their distal ends in the switch closed position the resistor inserting arms are spaced from each other. The arms extend angularly from the vertical plane of the respective switch blade on the side facing the direction of closing movement of the switch blades.

In the drawings:

FIG. 1 is a top plan of one pole of a polyphase disconnecting switch and circuit interrupter assembly provided with resistor insertion means embodying the present invention.

FIG. 2 is a view, in side elevation, of the construction shown in FIG. 1, certain parts being broken away in order to illustrate certain internal details of construction.

FIG. 3 is a view, at an enlarged scale, taken generally along the line 3–3 of FIG. 1, certain parts being broken away in order to show the internal details of construction.

Referring now to FIGS. 1 and 2 of the drawings, the reference character 10 designates, generally, one pole of a polyphase switch and interrupter assembly provided with resistance inserting means embodying this invention. For three phase application it will be understood that three poles are employed.

The pole 10 includes a frame base 11 that can be constructed of welded rolled steel angle sections with suitable bracing. At the left there is mounted a stationary insulator stack 12. Also mounted on the frame base 11 are first and second rotatable insulator stacks 13 and 14. Suitable bearings are provided for mounting the lower ends of the insulator stacks 13 and 14 about vertical axes on the frame base 11. The height of the insulator stacks 12, 13 and 14 varies, depending upon the voltage of the system in which the pole 10 is connected. For relatively low voltage application each insulator stack may comprise a single insulator, such as a porcelain insulator. For higher voltages a number of separate insulators having metallic fittings at their ends are bolted together endwise in order to accommodate the voltage used.

As shown in FIG. 2 shafts 15 and 16 extend downwardly from the rotatable insulator stacks 13 and 14 and each carries an operating arm 17 and 18. Mechanism is provided for rotating the operating arms 17 and 18 and thereby shafts 15 and 16 in opposite directions. This mechanism includes links 19 and 20 which are connected at one end to the respective operating arm 17 and 18. At their other ends the links 19 and 20 are connected respectively to crank arms 21 and 22 that extend from a crank shaft 23. On rotation of the crank shaft 23 through slightly more than 180° from the position shown in FIG. 2 the links 19 and 20 are actuated to effect rotation of the shafts 15 and 16 and thereby of the first and second rotatable insulator stacks 13 and 14 respectively. The frame base 11 is suitably enclosed to protect the operating mechanism from the weather. This includes ice shield plates, one of which is indicated at 27.

The stationary insulator stack 12 at its upper end carries a line terminal 30 which one end of a circuit interrupter, indicated generally at 31, is connected. The other end of the circuit interrupter 31 is mounted on a metallic mechanism housing 32 which has a bearing and contact extension 33 extending therefrom and is journaled on the upper end of the first rotatable insulator stack 13. A suitable linkage within a housing 34 mechanically interconnects the first rotatable insulator stack 13 and the mechanism within the metallic housing 32 for operating the circuit interrupter 31. Mounted on the upper end of the first rotatable insulator stack 13, movable therewith and straddling the bearing and contact extension 33, is a bifurcated mounting bracket 35. The mounting bracket 35 includes a bottom clamp fitting 36 having thereabove a cooperating top clamp fitting 37 connected thereto by bolts 38. The clamp fittings 36 and 37 have clamping engagement with a switch blade 39 the distal end 40 of which is arranged to have contact engagement with the distal end 41 of a switch blade 42 which is mounted on and is movable with the second rotatable insulator stack 14. The mounting of the switch blade 42 on the second rotatable insulator stack 14 is similar to the mounting of the switch blade 39 on the first rotatable insulator stack 13. The mounting arrangement for the switch blade 42 includes a bifurcated mounting bracket 43 that is secured to and rotates with the second rotatable insulator stack 14. The mounting bracket 43 includes a bottom clamp fitting 44 and a cooperating top clamp fitting 45 interconnected by bolts 46 for holding the clamp fittings 44 and 45 in clamping engagement with the switch blade 42. A line terminal 47 extends laterally from between the arms of the bifurcated mounting bracket 43 and is suitably journaled therebetween.

In FIG. 1 the switch blades 39 and 42 are shown by broken lines in the switch open position. On rotation of the crank shaft 23 in the manner previously described the switch blades

39 and 42 are swung from the closed position, shown by full lines, to the open position. On reverse rotation of the crank shaft 23 the switch blades 39 and 42 are rotated in the directions indicated by arrows 49 and 50, respectively, to swing the distal ends 40 and 41 into contact engagement with each other to complete a circuit between the line terminals 30 and 47 through the circuit interrupter 31 which, after having opened the circuit during the initial rotation of the crank shaft 23 in a switch opening direction, is reclosed while the switch blades 39 and 42 are being swung to their full open positions as shown by broken lines in FIG. 1.

It is during the final closing movement of the switch blades 39 and 42, while their distal ends 40 and 41 are approaching each other, that an arc is formed between these distal ends which is accompanied by substantial current flow since the resistance otherwise between the line terminals 30 and 47 is relatively low. This current flow, particularly in the case of closing in on a high capacitance load, may be substantial and may be accompanied by objectionable noise.

In accordance with their invention provision is made for momentarily increasing the resistance between the line terminals 30 and 47 during the circuit closing operation of the switch 10. For this purpose, as shown more clearly in FIG. 2, resistor assemblies 53 and 54 are employed. They extend upwardly from the top clamp fittings 37 and 45 and thereby are offset inwardly from the pivot cases 25 and 26 in the direction of the other axis. At their upper ends the resistor assemblies 53 and 54 carry conductor arms 55 and 56 the distal ends 57 and 58 of which are offset so that they overlap with substantial mechanical clearance such that there is little likelihood of their being encased jointly in ice or sleet or, if they are so encased, the ice can be readily ruptured for circuit opening purposes. Corona balls 59 and 60 are carried by the distal ends 57 and 58 at their extremities.

As shown more clearly in FIG. 1 the arms 55 and 56 extend angularly from the vertical plane of the respective switch blade 39 and 42 on the side thereof facing the direction of closing movement. The reason for this arrangement is to provide a shorter spark gap between the distal ends 57 and 58 of the conductor arms 55 and 56 than is present between the distal ends 40 and 41 of the switch blades 39 and 42 as they are pivoted toward the switch closed position. As a result sparking takes place initially between the distal ends 57 and 58 of the conductor arms 55 and 56 and current flow takes place through the resistor assemblies 53 and 54 until they are short circuited on engagement of the distal ends 40 and 41 of the switch blades 39 and 42 as they are pivoted into the switch closed position.

FIG. 3 shows the details of construction of the resistor assembly 54. It will be understood that the details of construction of the resistor assembly 53 are identical. Here a cylindrical insulating housing 65 is shown that may be formed of porcelain. The housing 65 has a corrugated surface 66 to increase the creepage distance between the ends and to provide the necessary voltage withstandability under adverse weather conditions. A lower terminal 67 is secured by cement 68 to the lower end of the insulating housing 65. Depending studs 69 extend into the upper portion of the associated top clamp fitting 45 for the purpose of mounting the resistor assembly 54 to pivot conjointly with the associated switch blade 42. This construction makes it feasible to modify switch constructions, such as that shown in FIGS. 1 and 2 which have been supplied previously without the resistor assemblies 53 and 54 to accommodate such assembly merely by suitable modification of the top clamp fittings 37 and 45. The insulating housing 65 has an upper terminal 70 which is secured thereto by cement 71 and is connected by bolts 72 to a clamp member 73 from which a tubular conductor 74 extends and which comprises the conductor arm 56 previously referred to. The tubular conductor 74 is employed for the purpose of minimizing corona. Preferably the tubular conductor 74 is formed of aluminum alloy to minimize its weight. At the distal end 58 the corona ball 60 is secured in position by a transverse pin 75.

Within the insulating housing 65 there is a stack of cylindrical resistor cakes 78. The number of cakes 78 and their individual resistance are selected in accordance with the characteristics of the circuit in which the switch 10 is connected. Also the resistor cakes 78 are selected with consideration being given to their thermal capacity when subjected to relatively high current flow.

The stack of cylindrical resistor cakes 78 is connected between the lower and upper terminals 68 and 70 in such manner that no sparking takes place at any point therebetween. This top desirable in order to avoid radio interference. At the lower end a bottom contact plate assembly 79 is employed for interconnecting the lowermost cake 78 to the lower terminal 67 which is solidly connected to the top clamp fitting 45 and thereby to the respective switch blade 42. Surrounding the bottom contact plate assembly 79 is a bottom guide rod ring 80 which is connected by guide rods 81, preferably three in number, to a top guide ring 82 which overlies the upper surface of the uppermost resistor cake 78. A flexible shunt 83 interconnects the underside of a top contact plate assembly 84 and the upper end of the uppermost cake 78 while a coil compression spring 85 reacts between the top contact plate assembly 84 and the portion of the flexible shunt 83 overlying the top surface of the uppermost cake 78 to maintain a good conducting path therebetween for the purpose noted above. The upper side of the top contact plate assembly 84 is in good contact engagement with the underside of the clamp member 73 and it extends through an annular plug 86 that is threaded, as indicated, into the upper terminal 70. An O-ring 87 is interposed between the annular plug 86 and the juxtaposed surface of the top contact plate assembly.

In operation, as the first and second insulator stacks 13 and 14 are pivoted about their vertical axes 25 and 26 from the switch open position toward the switch closed position, the distal ends 57 and 58 of the conductor arms 55 and 56 approach within sparking distance of each other and current begins to flow as soon as an arc is drawn but it is limited because of the series connection with the resistor assemblies 53 and 54. As the insulator stacks 13 and 14 continue to be pivoted toward the switch closed positions, current continues to flow but, as indicated, it is limited with the result that a minimum of disturbance in the system results together with a minimum of attendant noise. Because of the circuit that is established through the resistor assemblies 53 and 54 a minimum of arcing takes place between the distal ends 40 and 41 of the switch blades 39 and 42. As a result there is a minumum of erosion thereof. Because the switch blades 39 and 42 and the conductor arms 55 and 56 are pivoted at high speed toward the switch closed position, current flow takes place through the resistor assemblies 53 and 54 only for a correspondingly limited time which is determined by the time that elapses beginning with the initial sparking between the distal ends 57 and 58 of the conductor arms 55 and 56 until they are short circuited by contact engagement between the distal ends 40 and 41 of the switch blades 39 and 42.

While it is preferable to provide the two resistor assemblies 53 and 54 the manner described, it is possible to employ only a single resistor assembly, for example the resistor assembly 54. In such case the conductor arm 55 is employed but, instead of the resistor assembly 53, a solid conductor is substituted. However, such a construction requires more space above the switch 10 to provide equivalent operating characteristics and such space may not be available or desirable to use.

I claim:

1. A resistor inserting switch construction having a pair of parallel spaced apart insulators pivotally mounted at one end about the respective longitudinal axis, each having a switch blade at its other end movable therewith for contact engagement at its distal end with the other switch blade on conjoint pivotal movement of said insulators, said switch construction being characterized by

a first conductor arm mounted on, electrically connected to one of said switch blades, extending therealong and movable unitarily therewith,

a resistor assembly mounted on and electrically connected at one end to the other of said switch blades and movable unitarily therewith, and

a second conductor arm mounted on, movable with, and electrically connected at one end to the other end of said resistor assembly and extending toward said first conductor arm to complete a conductive path in the atmosphere between the distal ends of said arms through said resistor assembly in advance of completion of a conductive path through said switch blades as they are swung toward contact engagement at their distal ends,

said distal ends of said arms being spaced apart in the closed position of said switch blades.

2. The resistor inserting switch construction according to claim 1 wherein said arms extend angularly from the vertical plane of the respective switch blade on the side facing the direction of closing movement thereof.

3. A resistor inserting switch construction having a pair of parallel spaced apart insulators pivotally mounted at one end about the respective longitudinal axis, each having a switch blade at its other end movable therewith for contact engagement at its distal end with the other switch blade on conjoint pivotal movement of said insulators, said switch construction being characterized by

a resistor assembly mounted on and electrically connected at one end to each switch blade and movable unitarily therewith, and

a conductor arm mounted on, movable with, and electrically connected at one end to the other end of each resistor assembly and extending toward the other arm to complete a conductive path in the atmosphere between the distal ends of said arms and through said resistor assemblies in advance of completion of a conductive path through said switch blades as they are swung toward contact engagement at their distal ends,

said distal ends of said arms being vertically spaced apart in the closed position of said switch blades.

4. The resistor inserting switch construction according to claim 3 wherein each arm extends angularly from the vertical plane of the respective switch blade on the side facing the direction of closing movement thereof.