

United States Patent

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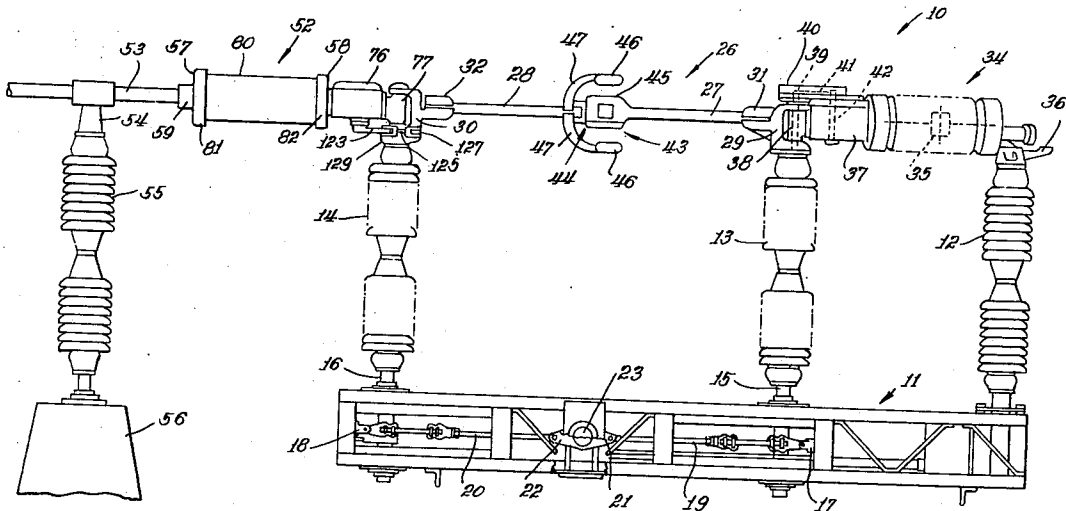
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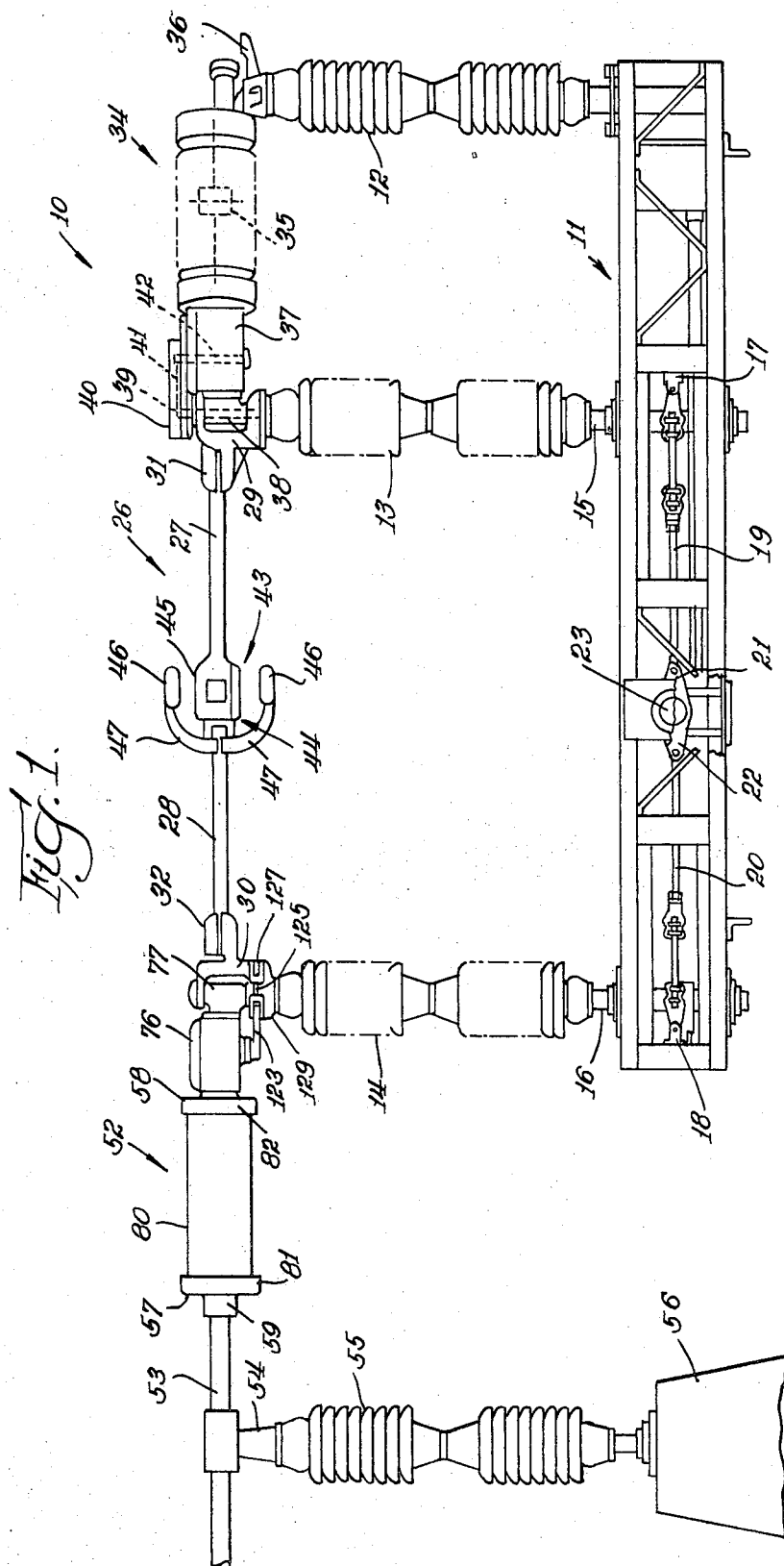
[54] HIGH VOLTAGE SWITCH WITH ENCLOSED PREINSERTION RESISTOR 7 Claims, 5 Drawing Figs.

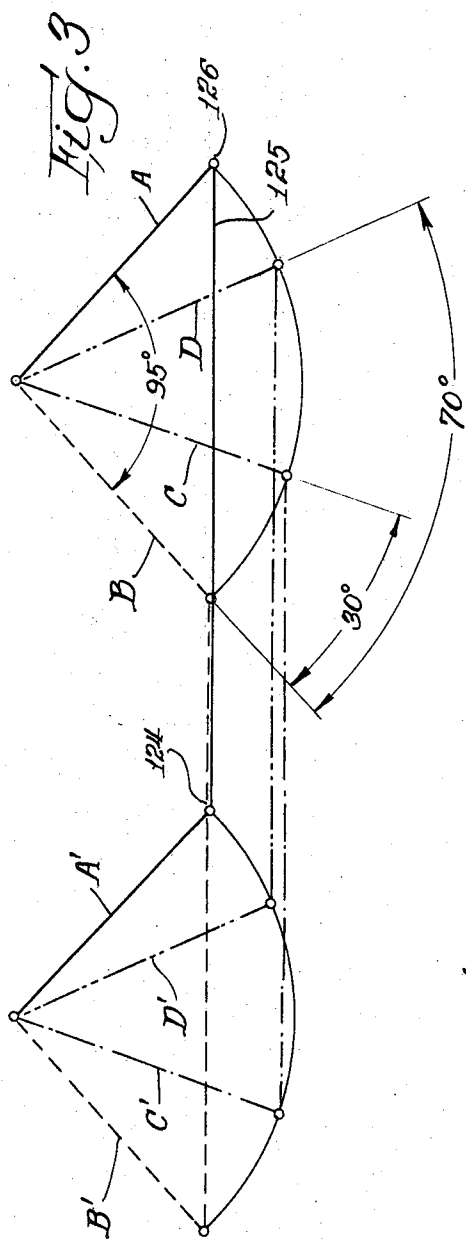
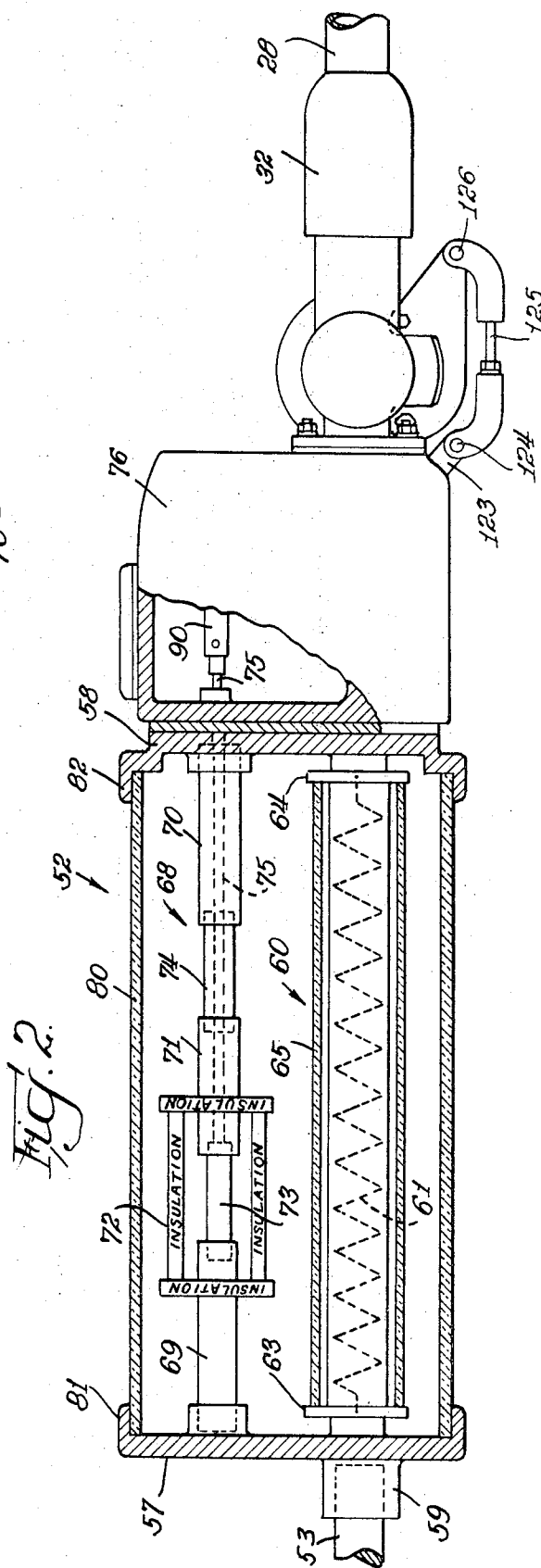
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[56] **References Cited**
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ABSTRACT: A high voltage center-break disconnecting switch has a resistor and short-circuiting contact assembly connected in series circuit relation and mounted in tandem for operation by one of the rotatable insulators in such fashion that the resistor is short circuited except during the closing movement of the switch blades. At that time the contacts are opened and the resistor is connected in the circuit to limit the inrush current. The contacts are closed as the switch blades are swung to the fully closed position to bypass the resistor when the switch is closed. A weatherproof housing encloses the resistor, short-circuiting contacts and operating mechanism therefor to protect them from contamination by the atmosphere and from rain, sleet, ice and snow.







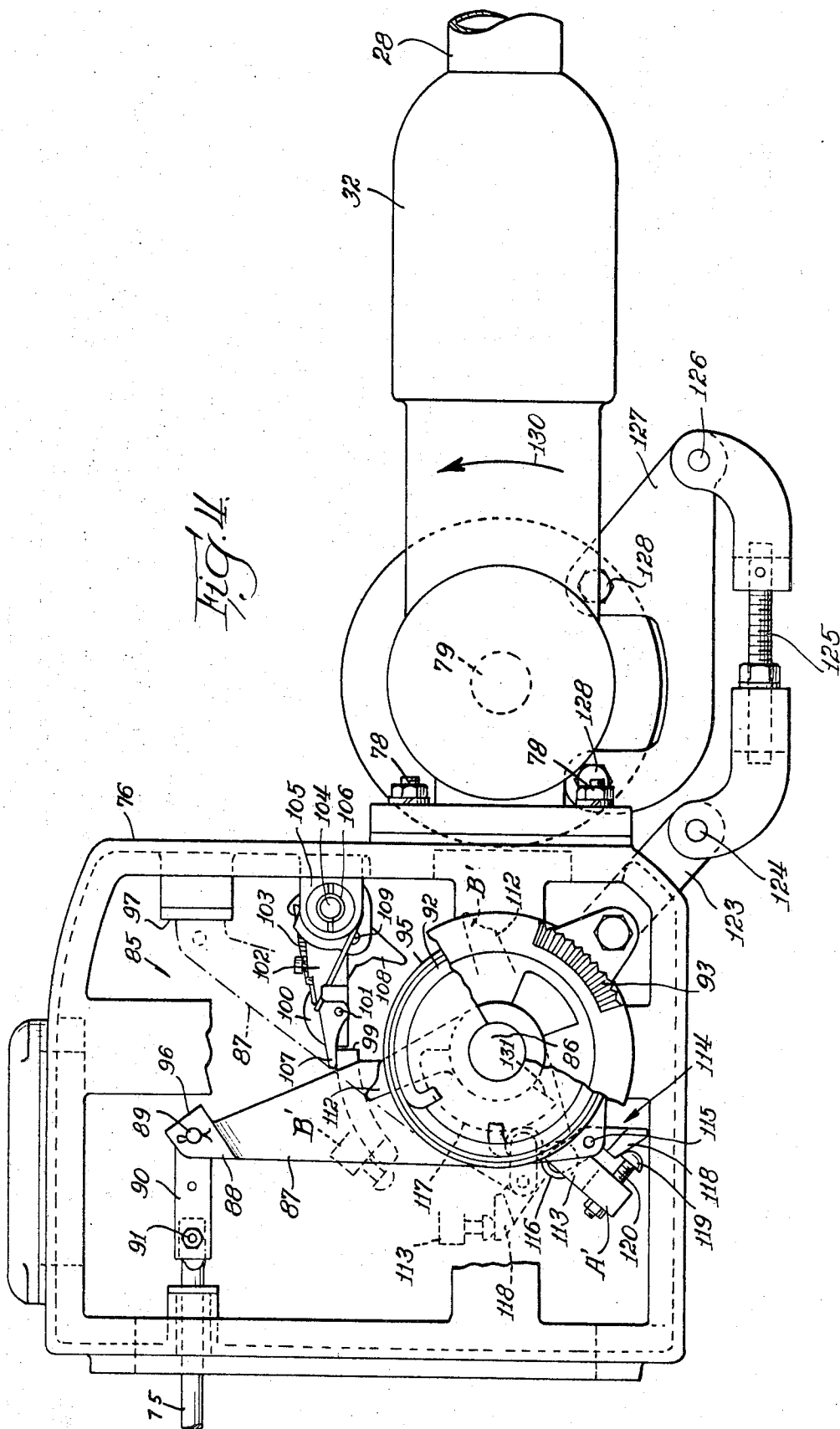
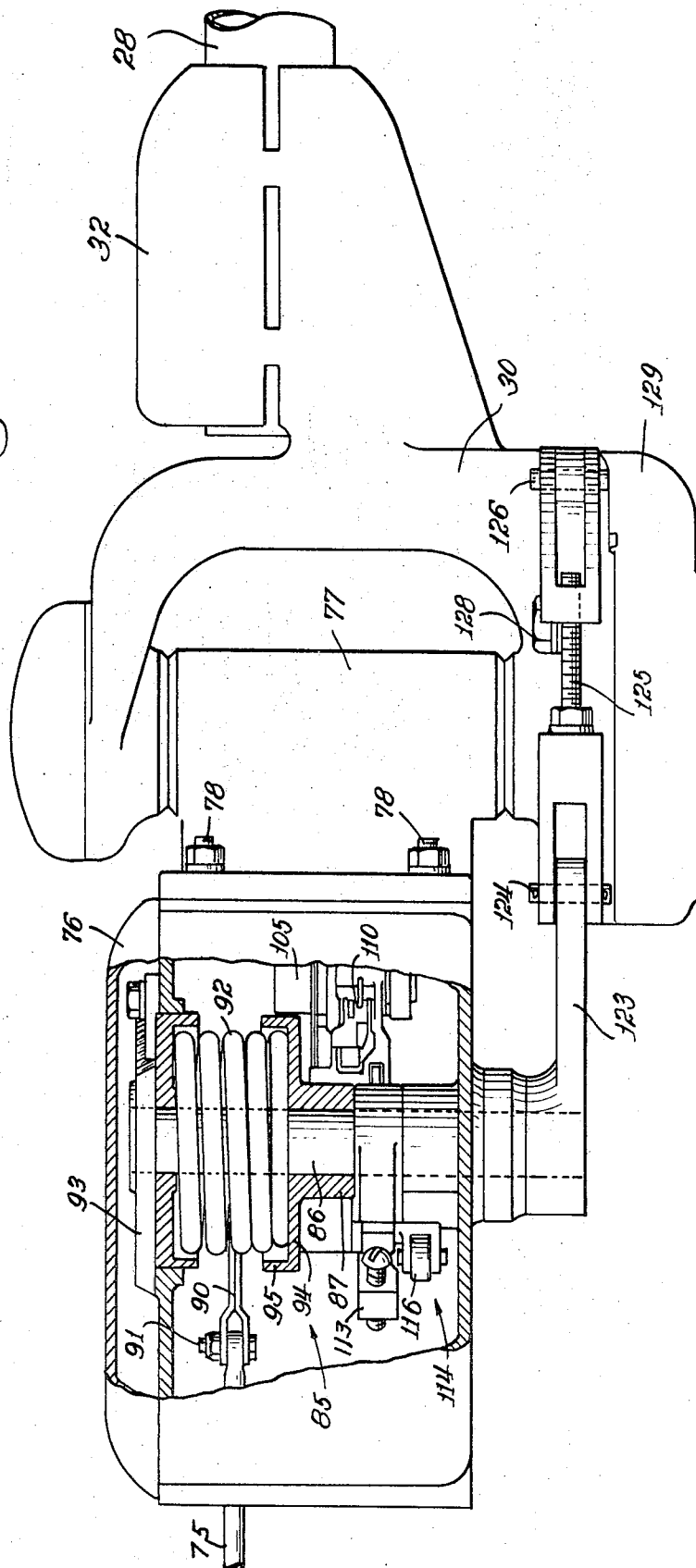


Fig. 5.



HIGH VOLTAGE SWITCH WITH ENCLOSED PREINSERTION RESISTOR

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

It is desirable to limit the inrush current in a circuit on energization thereof. This is particularly the case where 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 a resistor in a high voltage circuit in a new and improved manner in order to limit the inrush current flow when the circuit is completed to energize a load; to connect the resistor permanently in series with a circuit-closing center break switch and to short circuit the resistor at all times except during the circuit-closing operation of the switch; to protect the resistor, short-circuiting contacts and operating mechanism therefor from atmospheric contamination and from rain, sleet, ice and snow; to operate the short-circuiting contacts in timed relation to the closing movement of the switch blades; and to interconnect mechanically the short-circuiting contacts and an adjacent rotatable insulator on which one of the switch blades is mounted in such manner that the contacts remain closed and short circuit the resistor except during the pivotal movement of the rotatable insulator in swinging the associated switch blade to the switch closed position.

According to this invention a center break switch construction, such as that disclosed in the above identified patent, is provided with a resistor that is connected in series with the switch while it is being closed to limit the inrush current. In the closed position of the switch and during the opening of the switch, the resistor is short circuited. In order to protect the resistor, the associated short-circuiting contacts and the operating mechanism therefor they are enclosed in a weather-proof housing, thus rendering them unaffected by rain, ice and sleet. The resistor and short-circuiting contacts are enclosed in an insulating housing which is supported between a metallic mechanism housing carried by a rotatable insulator of the center break switch and a stationary insulator in parallel spaced relation or a section of a bus bar forming a part of the circuit in which the switch is connected. The short-circuiting contacts within the insulating housing are controlled by an operating mechanism in the mechanism housing on pivoting of the rotatable insulator during the closing operation of the center break switch. The sequence of operation is such that the contacts remain closed when the center break switch is closed and while the rotatable insulator is pivoted to the open position. During the reverse pivotal movement of the rotatable insulator and, while the disconnecting switch blades are swinging toward the switch closed position, the mechanism in the mechanism housing operated by the associated rotatable insulator opens the short-circuiting contacts to insert the resistor in the circuit. The swinging movement of the switch blades toward the closed position continues and the circuit is completed with the resistor in series to limit the inrush current in accordance with the resistance of the resistor to an extent depending upon the load on the circuit that is energized when the switch is closed. During the final portion of the pivotal movement of the rotatable insulator to the switch-closed position, the resistor contacts are closed to short circuit the resistor in order to bypass it while the switch is closed and carries the circuit current. When the resistor and short-circuiting contacts are arranged as disclosed, no modification of the center break switch blades is required to provide for operation thereof.

In the drawings:

FIG. 1 is a view, in side elevation, of a high voltage switch construction embodying this invention;

FIG. 2 is a top plan view, at an enlarged scale, of the resistor and contact combination assembly shown in FIG. 1 and the operating mechanism therefor, certain parts being broken away to disclose more clearly the internal details of construction.

FIG. 3 shows diagrammatically the operating sequence of the center break switch and the resistor-inserting assembly;

FIG. 4 is a top plan view of the contact-operating mechanism in the mechanism housing and a portion of the associated switch blade, the showing being at an enlarged scale; and

FIG. 5 is a view, in side elevation, of the construction shown in FIG. 4, a portion of the mechanism housing being broken away to show more clearly certain internal details of construction.

In FIG. 1 the reference character 10 designates, generally, one pole of a polyphase high voltage switch embodying this invention. It will be understood that for conventional three phase operation three duplicate poles 10 are employed in proper spaced relation, depending upon the voltage of the system.

The switch pole 10 includes a frame base that is indicated, generally, at 11 and it may be formed of welded rolled steel angle sections. Mounted on the frame base 11 are a stationary insulator stack 12, and first and second rotatable insulator stacks 13 and 14, these insulator stacks being positioned in parallel spaced relation. The first and second rotatable insulator stacks 13 and 14 extend upwardly from shafts 15 and 16 at their lower ends which are suitably journaled in the frame base 11. Operating arms 17 and 18 extend from the shafts 15 and 16 and they are connected by links 19 and 20 to crank arms 21 and 22 that extend in opposite directions from a crankshaft 23. On rotation of the crankshaft 23, the insulator stacks 13 and 14 are pivoted through the action of the links 19 and 20 and the operating arms 17 and 18.

The switch pole 10 also includes a center break disconnecting switch that is indicated, generally, at 26. It comprises first and second switch blades 27 and 28 having at their ends bifurcated mounting brackets 29 and 30 secured thereto by clamp fittings 31 and 32 and mounted on and for pivotal movement with the first and second rotatable insulator stacks 13 and 14 respectively.

Mounted between the stationary insulator stack 12 and the first rotatable insulator stack 13 is a circuit interrupter that is indicated, generally, at 34 and may be constructed as disclosed in Mikos et al. U.S. Pat. No. 3,163,736, issued Dec. 29, 1964. For illustrative purposes the circuit interrupter 34 is shown as being provided with separable contacts 35 that are arranged to be opened for interrupting the current flow in the circuit in which the switch pole 10 is connected. One connection to the line is provided by a line terminal pad 36 which is carried by the stationary insulator stack 12 and on which one end of the circuit interrupter 34 is mounted. The other end of the circuit interrupter 34 is mounted on a metallic mechanism housing that is indicated, generally, at 37 and it is supported by a laterally extending bearing and contact member 38 in which a shaft 39, extending upwardly from the first rotatable insulator stack 13, extends. A linkage housing 40 overlies the mounting bracket 29 and the metallic mechanism housing 37 for enclosing a link mechanism 41 that is arranged to interconnect the shaft 39 and a shaft 42 in the mechanism housing 37 that is arranged to effect operation of the circuit interrupter operating mechanism within the mechanism housing 37 for opening and closing the contacts 35.

The first and second switch blades 27 and 28 are arranged to be pivoted together with the first and second rotatable insulator stacks 13 and 14 about the longitudinal axes of the latter. At their distal ends the switch blades 27 and 28 have, respectively, a female contact assembly 43 and a male contact assembly 44. A sleet hood 45 encloses the female contact assembly 43. Arcuate corona shields 46, carried by supports 47,

secured to the switch blade 28 overlies the sleet hood 45 in the switch closed position for the purpose of minimizing the effects of corona due to the high voltage at which the center break disconnecting switch 26 is energized.

On rotation of the crankshaft 23 through approximately 180° the first and second rotatable insulator stacks 13 and 14 are pivoted through angles of about 95° to swing the switch blades 27 and 28 through corresponding angles from the switch closed position to the switch open position. Before the contact assemblies 43 and 44 at the distal ends of the switch blades 27 and 28 separate, the contacts 35 in the circuit interrupter 34 are opened as the result of operation of the contact-operating mechanism within the mechanism housing 37 under the control of the first rotatable insulator stack 13. Following opening of the contacts 35 and interruption of the current flow in the circuit and while the insulator stacks 13 and 14 are pivoted to the switch open position, the contacts 35 are reclosed. Now, on rotation of the crankshaft 23 in the opposite direction, the insulator stacks 13 and 14 are pivoted in the opposite directions to swing the switch blades 27 and 28 toward the switch closed position. As the distal ends of the switch blades 27 and 28 approach each other with the circuit energized and a load connected to it, particularly a load having high capacitance, an arc may be drawn between these distal ends while they are approaching each other. Substantial flow of current may take place over the path thus ionized and severe burning of the contact assemblies 43 and 44 may take place. Also objectionable noise may be generated.

In order to limit the flow of current under the circumstances just outlined, a resistor and contact combination indicated, generally, at 52 is provided in series circuit relation with the center break disconnecting switch 26. At one end the resistor and contact combination 52 is carried by the second rotatable insulator stack 14 while the other end may be mounted on a bus section 53 that is carried by a bus support fitting 54 that is mounted on the upper end of a stationary insulator stack 55. The lower end of the insulator stack 55 may be mounted on a suitable support 56 which may be an extension of the frame base 11 or, as shown, a separate support. Alternatively, the resistor and contact combination 52 may be provided with a line terminal pad, such as the line terminal pad 36, and the arrangement mounted on a suitable insulator for connection to a line conductor.

FIG. 2 shows more clearly certain details of construction of the resistor and contact combination 52. It includes metallic end plates 57 and 58. A socket 59 extends outwardly from the end plate 57 for receiving the bus section 53. Connected between the end plates 57 and 58 is a resistor assembly that is indicated, generally, at 60. It includes a resistor that is indicated at 61. Preferably the resistor 61 comprises a stack of cylindrical resistor cakes the number and individual resistance of which are selected in accordance with the characteristics of the circuit in which the center break disconnecting switch 26 is connected. Also, the resistor cakes are selected with consideration being given to their thermal capacity when subjected to relatively high current flow. The resistor 61 interconnects contact plates 63 and 64 that are carried by the end plates 57 and 58, respectively. An insulating sleeve 65 encloses the resistor 61.

Since it is desirable that the resistor 61 be connected in the circuit only during that portion of the closing movement of the switch blades 27 and 28 when arcing might take place therebetween, absent the resistor 61, a resistor-shunting contact assembly, indicated generally at 68, is employed. The contact assembly 68 is arranged to directly interconnect the end plates 57 and 58 and short circuit the resistor 61. The contact assembly 68 includes tubular end stationary contacts 69 and 70 that are mounted on and connected to the end plates 57 and 58 respectively. An intermediate stationary contact 71 is supported from the end stationary contact 69 by a suitable insulating support frame 72. Movable contacts 73 and 74 are arranged to be telescoped with the stationary contacts 59, 70

and 71 for the purpose of interconnecting them and also, when moved to the open position, to provide gaps between the intermediate stationary contact 71 and the end stationary contacts 69 and 70. An insulating contact operating rod 75 mechanically interconnects the movable contacts 73 and 74 and extends into a metallic contact-operating mechanism housing 76 which is connected to and supports the end plate 58 and on the other side has a bearing and contact member 77 which is secured thereto by bolts 78. A shaft 79, extending upwardly from the second rotatable insulator stack 14 and rotatable therewith, extends through the bearing and contact member 77 and thereby provides a support for one end of the resistor and contact combination 52.

In order to protect the resistor assembly 60 and the shunting contact assembly 68 from contamination by the atmosphere and from the weather they are enclosed in an insulating housing 80 which extends between the end plates 57 and 58 with the ends extending into annular flanges 81 and 82 on the end plates 57 and 58.

In FIGS. 4 and 5 the details of construction of a contact-operating mechanism, indicated generally at 85 and mounted within the mechanism housing 76, are shown. The contact operating mechanism 85 includes an operating shaft 86 that is journaled in the mechanism housing 76. Freely pivoted on the operating shaft 86 is an operating arm 87 a distal end 88 of which is connected by a pin 89 to a link 90 which, in turn, is connected by a bolt 91 to the end of the contact-operating rod 75 which extends into the mechanism housing 76. For biasing the insulating rod 75 and thereby the contacts 73 and 74 to the open position is a coil spring 92 which is located around the operating shaft 86 and is connected at its upper end to an adjustment disc 93, carried by the mechanism housing 76, and at its lower end to a spring platform 94 which is integral with the operating arm 87. The platform 94 has a rim 95 for centering the coil spring 92. The distal end 88 of the operating arm 87 has a face 96 that is arranged to engage a stop 97 on the mechanism housing 76 for the purpose of limiting the opening movement of the contact operating arm 75 of the movable contacts 73 and 74.

For holding the contacts 73 and 74 and the operating arm 87 in the contact closed position with the coil spring 92 cocked a latching shoulder 99 is provided on the operating arm 87 and it is held against movement in a clockwise direction, FIG. 4, by a toggle lever 100 which is pivoted at 101 on a latch lever 102. A coil tension spring 103 connected to the toggle lever 100 acts to bias it to the position shown in FIG. 4. The latch lever 102 is pivoted at 104 on a boss 105 that extends inwardly from a sidewall of the mechanism housing 76. A spring 106 acts to bias the latch lever 102 in a counterclockwise direction. The latch lever 102 has a nose portion 107 that overlies the latching shoulder 99 in the latched position for limiting the counterclockwise movement of the latch lever 102. For operating the latch lever 102 to the unlatched position a latch arm 108 is pivotally mounted at 109 on latch lever 102. A spring 110, FIG. 5, biases the latch arm 108 in a clockwise direction to the position shown in FIG. 4.

In order to trip the operating arm 87 and release it for movement under the influence of the coil spring 92 to the contact open position, a tripping finger 112 is employed. It extends radially into the path of the latch arm 108 and is carried by a spring recocking and contact closing arm 113 that is secured to and is movable with the operating shaft 86. The position of the tripping finger 112 and arm 113 shown by full lines in FIG. 4 is the position that they occupy when the switch blades 27 and 28 are in the closed position shown in FIG. 1. For recocking the coil spring 92 and pivoting the operating arm 87 to the full line position shown in FIG. 4 a driving pawl 114 is pivotally mounted at 115 on the operating arm 87. The driving pawl 114 is biased by a spring to pivot in a counterclockwise direction to cause a roller 116 on one end to engage the surface of an arcuate cam 117 that is mounted on the lower wall of the mechanism housing 76. At its other end the driving pawl 114 has a nose portion 118 that is arranged to be

engaged by a head 119 of a bolt 120 that is carried by the arm 113.

For pivoting the operating shaft 86 a driven arm 123 is secured to the lower end which extends downwardly from the mechanism housing 76 and is pivoted at 124 to one end of a link 125 the other end of which is pivoted at 126 to a drive arm 127 which is secured by bolts 128 to a fitting 129 that is secured to and moves with the second rotatable insulator stack 14.

In FIG. 3 the relationship between the position of the second switch blade 28 and of the driven arm 123 or the spring recocking and contact closing arm 113 is shown. The pivotal connections are indicated at 124 and 126 at the ends of the link 125 which is represented by a solid line. In the closed position of the disconnecting switch 26 the position of the second switch blade 28 is indicated at A while the corresponding position of the driven arm 123 or the arm 113 is indicated at A'. When the disconnecting switch 26 is operated to the open position, the circuit is opened by opening of the contacts 35 in the circuit interrupter 34 as described. The full open position of the switch blade 28, after it has swung through an arc of about 95° is indicated at B. The corresponding position of the driven arm 123 and arm 113 is indicated at B'. As the arm 113 is swung to the alternate position from the full line position shown in FIG. 4, the distal end of the tripping finger 112 bypasses the latch arm 108 since it is biased to restore it to the position here shown. The position of the trip finger 112 with the switch blade 28 in the full open position is indicated by the broken line showing thereof in FIG. 3 at B'.

Now it will be assumed that the switch blade 28 is pivoted in the opposite direction or in the direction indicated by arrow 130, FIG. 4. After the switch blade 28 has rotated through about 30° and there has been a corresponding pivotal movement of the arm 113 and tripping finger 112, the latter engages the latch arm 108 and pivots the latch lever 102 in a clockwise direction to swing the nose portion 107 away from overlying relation to the latching shoulder 99 while the toggle lever 100 still bears against the latching shoulder 99 until a center position is passed after which the latching shoulder 99 no longer is restrained and the operating arm 87 then is pivoted by the coil spring 92 in a clockwise direction and the contacts 73 and 74 are moved to the contact open position at which time the face 96 engages the stop 97 and further movement of the operating arm 87 is arrested.

The position of the switch blade 28, when the resistor 61 is inserted in the circuit, is indicated at C in FIG. 3. The corresponding position of the arm 113 is indicated at C'. The contacts 73 and 74 are opened in advance of movement of the distal ends of the switch blades 27 and 28 to within arcing distance of each other. The movement of the contacts 73 and 74 to the open position removes the short circuit across the resistor 61 and it then is effectively inserted in series with the disconnecting switch 26 to limit accordingly the flow of inrush current that takes place when the distal ends of the switch blades 27 and 28 are swung to within arcing distance of each other and before the contact assemblies 43 and 44 engage to short circuit any arc that may be drawn during the switch-closing movement.

The position of the arm 113 in the switch open position is indicated at B' on FIG. 4 which corresponds to the position B' of the tripping finger 112 at this time. As pointed out, movement of the arm 113 through about 30° effects the opening of the movable contacts 73 and 74. Continued movement through about an additional 10° causes the head 119 of the bolt 120 to engage the nose portion 118 of the driving pawl 114 as shown by the broken line position thereof in FIG. 4. Continued pivotal movement of the arm 113 causes the operating arm 87 to pivot from the position shown by broken lines in FIG. 4, corresponding to the open position of the movable contacts 73 and 74, toward the full line position thereof. The driving pawl 114 is held in the position shown because the roller 116 engages the surface of arcuate cam 117. The switch blade 28 continues to move toward the fully

closed position until it reaches the position indicated at D in FIG. 3 at which time the coil spring 92 has been recocked and the operating arm 87 has been returned to the full line position shown in FIG. 4 and latched by the latch lever 102 with the toggle lever 100 in engagement with the latching shoulder 99. In this position the contacts 73 and 74 have been moved back to the closed position shown in FIG. 2 and the resistor 61 has been effectively removed from the circuit. By this time the contact assemblies 43 and 44 at the distal ends of the switch blades 27 and 28 have been moved into contact engagement so that there is no likelihood of arcing therebetween on removal of the resistor 61 from the circuit by its being short circuited on movement of the contacts 73 and 74 to the closed position.

The movement of the switch blade 28 continues in the direction indicated by arrow 130 until it is returned to the position indicated at A in FIG. 3 and the arm 113 is pivoted back to the position indicated at A' or the position shown by full lines in FIG. 4.

After the operating arm 87 has been returned to the contact closed position, the roller 116 rolls off end 131 of the cam 117 and its spring swings it to the position shown by full lines in FIG. 4.

We claim:

1. In a resistor-inserting switch construction having an insulator stack pivotally mounted at one end about a longitudinal axis, a switch blade at the other end of said insulator stack for movement therewith into and out of switch closed position, said switch construction being characterized by:

a resistor assembly mounted on said other end of said insulator stack and connected in series circuit relation with said switch blade;

contacts connected across said resistor; and

operating means interconnecting said contacts and said insulator stack for opening said contacts during a portion of the closing movement of said switch blade to limit the inrush current in a circuit in which the switch construction is connected and then closing said contacts during the final closing movement of said switch blade.

2. The resistor inserting switch construction according to claim 1 wherein:

said operating means includes:

a contact-operating mechanism; and

link means interconnecting said contact-operating mechanism and said insulator stack; and

housing means encloses said resistor, contacts and contact-operating mechanism to protect them from atmospheric contamination and from the weather.

3. The resistor-inserting switch construction according to claim 2 wherein:

said housing means includes:

an insulating housing containing said resistor and contacts; and

a metallic housing containing said contact-operating mechanism and providing a current carrying connection between said switch blade and said contacts and resistor.

4. The resistor-inserting switch construction according to claim 3 wherein:

said contacts include relatively stationary and movable contacts; and

said contact-operating mechanism includes:

a shaft pivoted in said mechanism housing;

an operating arm pivoted on said shaft and connected near its distal end to said movable contact;

spring means connected between said mechanism housing and said operating arm and biasing said movable contact toward open position;

latch means on said mechanism housing for holding said operating arm and said movable contact in closed position;

an unlatching finger movable with said arm for unlatching said latch to permit said springs means to move said movable contact to open position;

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a spring recocking and contact closing arm secured to said shaft and cooperating with said operating arm to recock said spring and reclose said movable contact;
 a driven arm secured to said shaft and connected at its distal end to said link means; and
 a drive arm secured to said insulator stack and connected at its distal end to said link means.
 5. A high voltage center break switch comprising:
 first and second pivotally mounted insulator stacks in parallel spaced relation;
 first and second switch blades mounted on one end of said first and second insulator stacks respectively for contact engagement at their distal ends in circuit closed position;
 a circuit interrupter mounted on said first insulator stack and connected in series circuit relation with said first switch blade;
 operating means interconnecting said circuit interrupter and said first insulator stack for operating said circuit interrupter to open position before said switch blades disengage at their distal ends and to closed position before said switch blades reengage at their distal ends;
 a resistor assembly mounted on said second insulator stack and connected in series circuit relation with said second switch blade;
 contacts connected across said resistor;
 operating means interconnecting said contacts and said second insulating stack for opening said contacts during a portion of the closing movement of said second switch

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blade to limit the inrush current in a circuit in which the switch is connected and then closing said contacts during the final closing movement of said second switch blade; and

driving means connected to the other ends of said first and second insulator stacks for pivoting them between closed and open positions of said first and second switch blades.

6. The high voltage center break switch according to claim 5 wherein:

said operating means interconnecting said contacts and said second insulating stack includes:

a contact-operating mechanism; and

link means interconnecting said contact-operating mechanism and said second insulator stack; and

housing means encloses said resistor, contacts and contact-operating mechanism to protect them from atmospheric contamination and from the weather.

7. The high voltage center break switch according to claim 6 wherein:

said housing means includes:

an insulating housing containing said resistor and contacts; and

a metallic housing containing said contact-operating mechanism and providing a current carrying connection between said second switch blade and said contacts and resistor.

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