

[54] PUFFER TYPE CIRCUIT INTERRUPTER

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 [58] Field of Search. 200/146, 144 B, 145, 148 A, 200/148, 148 C, 150 G

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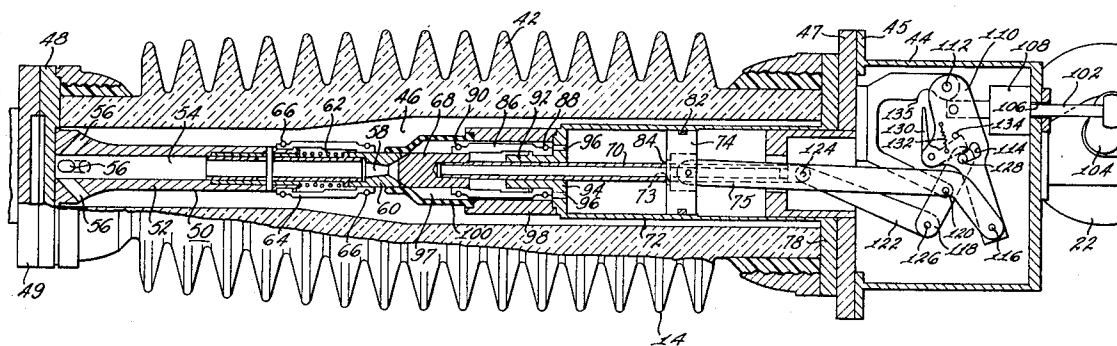
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ABSTRACT

Electrical circuit interrupting apparatus comprises a support at ground potential having three spaced apart upstanding rotatable insulators thereon. Disconnect switch means are supported between a first end column and a second center column and rotation of both of these columns effects operation of the disconnect switch. A puffer type circuit interrupter is connected in series with the disconnect switch and is supported between the second center column and a third end column and rotation of the latter column effects operation of the interrupter.

The interrupter comprises a sealed housing comprising a hollow insulator and a hollow metallic portion containing an arc extinguishing gas and a hollow stationary contact and a solid movable contact are located within the insulated portion of the housing. A stationary cylinder with a piston therein is also located within the insulated portion of the housing. Operating means are located in the metallic portion of the housing and are responsive to rotation of the third end column and effects piston movement in one direction and compression of the gas in the cylinder. Subsequent to compression of the gas in the cylinder, contact separation occurs and gas is forced from the cylinder, through the arc established between the separating contacts, through the hollow stationary contact and back into the housing.

21 Claims, 3 Drawing Figures



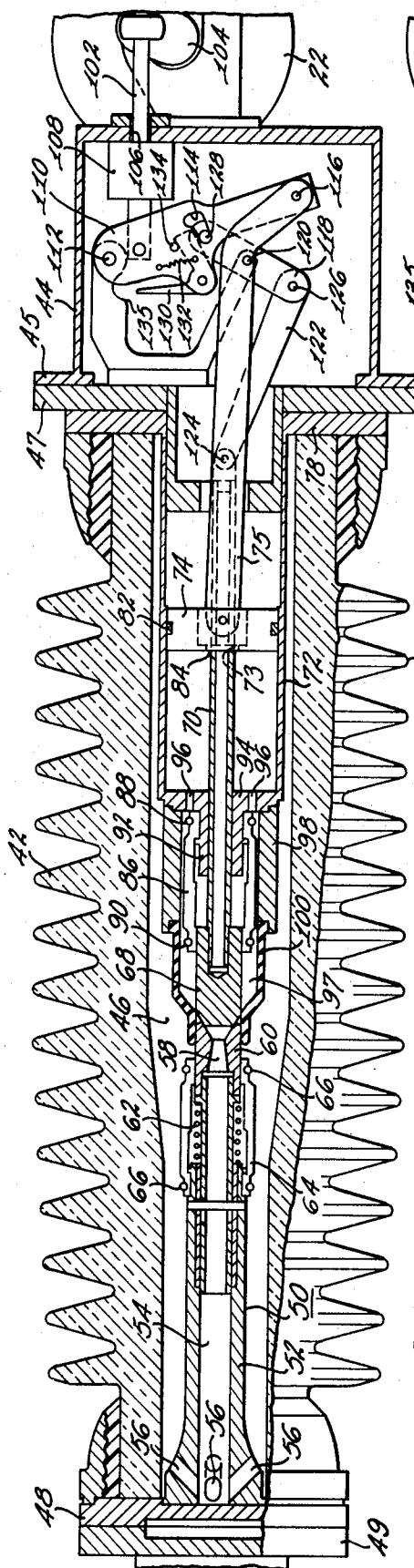


Fig. 1

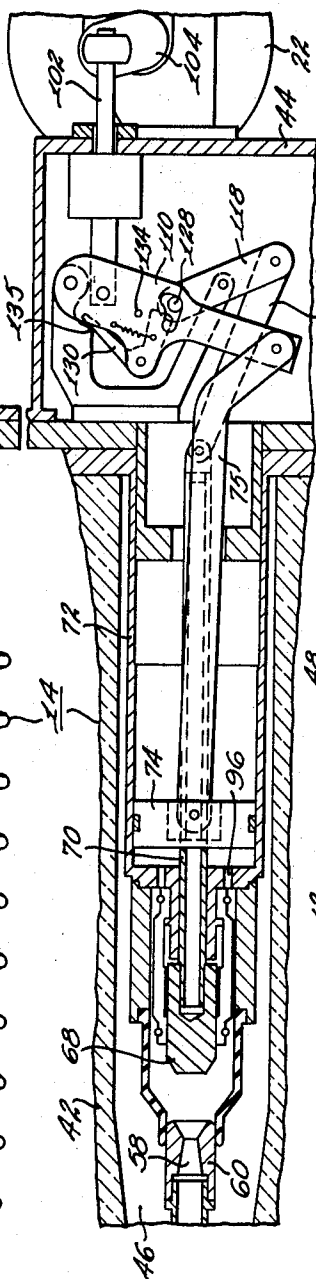


Fig. 2

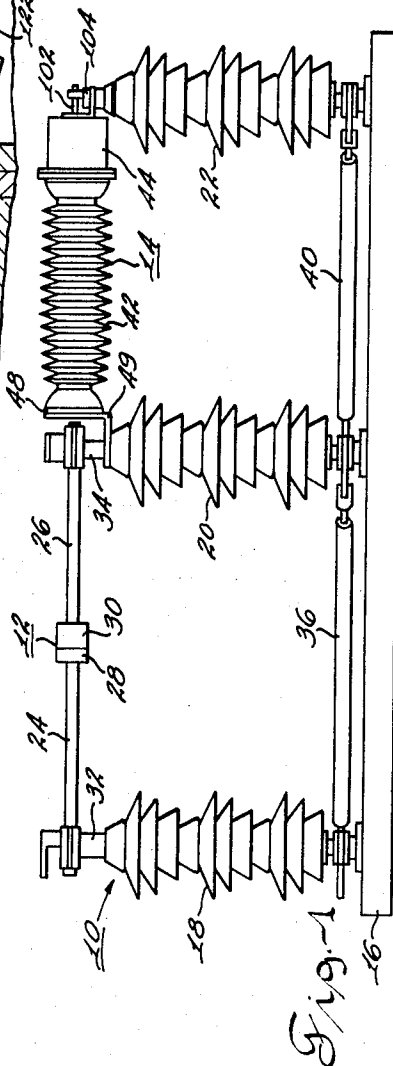


Fig. 3

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PUFFER TYPE CIRCUIT INTERRUPTER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to puffer type circuit interrupters, and particularly to those for use with disconnect switches.

2. Description of the Prior Art

Electrical power transmission and distribution systems employ disconnect switches to isolate portions of the system from one another. Normally, a disconnect switch is opened when no load exists on the system and no arcing occurs across the disconnect switch contacts. In some installations, however, undesirable arcing would occur across these disconnect switch contacts unless a circuit interrupter device is provided in series circuit with the disconnect switch and is opened before the disconnect switch. Presently, for example, such circuit interrupter devices take the form of oil-break switches, vacuum interrupters, or puffer type circuit interrupters containing an arc extinguishing gas. Various puffer type circuit interrupters are available or known. In some, the movable contact and piston are connected and move together in the same direction to effect contact separation and gas compression. In others, the piston is fixed and the movable contact and cylinder move to accomplish the desired objectives. While these prior art devices are generally satisfactory for their intended purposes, it is desirable to improve upon them.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a puffer type circuit interrupter especially adapted for use with disconnect switches which comprises a sealed housing containing an arc extinguishing gas, such as SF_6 . A hollow stationary contact is mounted within an insulated portion of the housing and is provided with two openings which communicate between the interior of the contact and the interior of the housing. A solid movable contact for cooperation with the stationary contact is also disposed within the insulated portion of the housing and, when in closed position, seals one of the openings in the stationary contact. A stationary cylinder is mounted within the insulated portion of housing and a movable piston is located within the cylinder. Passage means including an electrical insulating portion communicate between the discharge end of the cylinder and the sealed opening in the stationary contact. Operating means, responsive to rotation of an insulating support column, are provided to effect movement of the piston in one direction to effect compression of the gas in the cylinder and to effect subsequent opening movement of the movable contact in the opposite direction, unsealing of the opening in the stationary contact and expulsion of the gas between the contacts, through the stationary contact and back into the housing for reuse. The operating means further effect simultaneous movement in opposite directions of the movable contact to closed position and the piston to its starting position.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide an improved puffer type circuit interrupter wherein the gas is precompressed prior to contact separation.

Another object is to provide such an interruption wherein the volume of compressed gas is kept to a minimum without affecting interrupting performance.

Another object is to provide such an interrupter wherein the movable contact and gas pump piston move in opposite directions to each other, differentially during an opening operation and simultaneously during a closing operation.

Another object is to provide such an interrupter which is especially adapted for operation by a rotatable insulating support column and is well suited for use with disconnect switches which are supported on rotatable insulating columns.

Other objects and advantages of the invention will hereinafter appear.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawing illustrates a preferred embodiment of the invention but it is to be understood that the embodiment illustrated is susceptible of modifications with respect to details thereof without departing from the scope of the appended claims.

In the Drawings:

FIG. 1 is a side elevation view of apparatus embodying a disconnect switch and a puffer type circuit interrupter in accordance with the invention;

FIG. 2 is an enlarged sectional view of the puffer type circuit interrupter shown in FIG. 1 and showing it in the contact-closed position; and

FIG. 3 is a view similar to FIG. 2 but showing the circuit interrupter in contact-open position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 of the drawing the numeral 10 designates electrical circuit interrupting apparatus comprising a side break type disconnect switch 12 and a series connected puffer type circuit interrupter 14 in accordance with the present invention. Apparatus 10 comprises a supporting base 16 which is located at ground potential, such as a length of channel iron on which three spaced apart upstanding rotatable insulating columns 18, 20 and 22 are mounted. Disconnect switch 12 comprises a pair of contact arms 24 and 26 which carry cooperating contacts 28 and 30, respectively, at their inner ends and which are connected at their outer ends to suitable mounting means 32 and 34 at the top of the first end column 18 and the second or center column 20, respectively. Disconnect switch 12 is shown in closed position. It is to be understood, for example, that clockwise rotation of column 18 and counterclockwise rotation of column 20 on their vertical axes, effected simultaneously by a tie-rod 36, causes corresponding rotation (in a horizontal plane) of the arms 24 and 26 and separation of the contacts 28 and 30, respectively. Reverse rotation of the columns 18 and 20 causes closure of disconnect switch 12. Puffer type circuit interrupter 14 is mounted between second or center column 20 and the third end column 22 and is connected in series circuit with disconnect switch 12. Clockwise and counterclockwise rotation of column 22 effects closing and opening, respectively, of interrupter 14. A tie-rod 40 connected between the columns 20 and 22 effects rotation of column 22 and coordinated operation of switch 12 and interrupter 14 so that interrupter 14 opens before and closes after disconnect switch 12 opens or closes.

Referring to FIG. 2, it is seen that interrupter 14 comprises a hollow substantially cylindrical ceramic insulator 42 and a hollow substantially cylindrical electrically conductive metal housing 44 which is connected to one end of the insulator and both cooperate to define a sealed chamber 46 which is understood to be filled with an arc extinguishing gas such as SF_6 (sulfur hexafluoride). Housing 44 has a flange 45 which bears against and is secured to a circular end plate 47. The other end of insulator 42 is provided with an electrically conductive end member 48 which serves as an end seal for chamber 46, as a physical mounting means for the end of interrupter 14, and as an electrical connection to one end of the interrupter. End member 48 has an electrically conductive L-shaped mounting bracket 49 connected thereto which adapts it for mounting on column 20.

A stationary contact 50 is provided in chamber 46 and is physically supported by and electrically connected to end member 48. Stationary contact 50 comprises a hollow cylindrical body 52 having a passageway 54 therein which communicates with chamber 46 through a plurality of openings 56 and through an end opening 58. Stationary contact 50 further comprises a hollow cylindrical contact tip 60 which is slidably movable on body 52 and is biased to extended position by a compression spring 62. Tip 60 and spring 62 serve a shock absorbing purpose when the contacts are being closed. A plurality of radially arranged electrically conductive contact fingers

64, held in place by two annular springs 66, ensure good electrical connection between tip 60 and body 52 of stationary contact 50.

Tip 60 of stationary contact 50 cooperates with a solid movable contact 68 which, when in closed position as shown in FIG. 2, engages the tip and is of such a configuration as to close end opening 58 in stationary contact 50 thereby sealing off passageway 54. Movable contact 68 is supported on and moved by a reciprocally movable shaft or rod 70 which extends through an opening 73 in a movable piston 74.

Piston 74 is disposed in a hollow, electrically conductive cylinder 72 which is rigidly secured in chamber 46 by its flange 78 which is sealed to the end of insulator 42. End plate 47 is secured to flange 78. Piston 74 has a first or starting (contact closed) position shown in FIG. 2 and is movable to a second or extended (contact open) position shown in FIG. 3. Piston 74 is provided with a pivotably connected piston rod 75 and is also provided with a seal 82 on its periphery and a seal 84 in its opening 73 to permit gas pressure build-up ahead of the piston as it is moved to the left with respect to FIG. 2.

A plurality of radially arranged electrically conductive contact fingers 86, held in place by two annular springs 88 and 90, slidably engage movable contact 68 and a narrowed neck portion 92 on the end wall 94 of cylinder 72 to provide a good conductive path from the movable contact to the cylinder. End wall 94 is provided with a plurality of openings 96 which permit gas to flow from cylinder 72. Cylinder 72 is provided with means which define a closed passage 97 between the openings 96 in the cylinder and opening 58 in contact tip 60 of stationary contact 50. Such means comprise a tubular member 98 mounted on the end of cylinder 72 and surrounding the openings 96 in end wall 94 of the cylinder. Member 98 is provided with a tubular insulator portion 100 which engages the exterior of contact tip 60 of stationary contact 50 and which is made of heat resistant electrical insulating material such as Teflon or the like. Insulator portion 100 prevents electrical current flow between stationary contact tip 60 and cylinder 72, particularly when the stationary and movable contacts are separated.

Operating means are provided to move piston 74 leftward (with respect to FIG. 2) thereby effecting compression of the gas in cylinder 72 and subsequently to move movable contact 68 in the opposite direction (rightward with respect to FIG. 2) from its closed position shown in FIG. 2 to its open position shown in FIG. 3. Such movement disengages movable contact 68 from stationary contact 50 and effects unsealing of opening 58 in the stationary contact so that compressed gas can flow therethrough from cylinder 72, through the openings 96 and passage 97. The operating means also effect simultaneous movement in opposite directions of movable contact 68 to contact closed position and of piston 74 to its starting position. The operating means comprise a reciprocable movable drive shaft 102 which is connected to a lever arm 104 on top of rotatable insulating column 22. Drive shaft 102 extends into metal housing 44 through an opening 106 therein and the opening is sealed by a bellows 108 which is connected between the shaft 102 and the wall of housing 44. The inner end of shaft 102 is pivotably connected to a main link 110 which is located within housing 44 and has a first pivot point 112 which is pivotally mounted with respect to housing 44. Main link 110 is provided with cam means such as a cam slot 114. Piston rod 75 has one end which is pivotably connected as at point 116 to main link 110. A link 118 is pivotably connected as at point 120 to housing 44. A shaft link 122 is pivotably connected at one end as at point 124 to the end of shaft 70. The other end of shaft link 122 is pivotably connected as at point 126 to one end of link 118. The other end of link 118 is provided with cam means such as a projection 128 which engages the L-shaped cam slot 114 in main link 110. Means such as an L-shaped latch 130 is provided to lock cam pin 128 in a predetermined position in cam slot 114 during operation as hereinafter described. Latch 130 is biased in a counterclockwise direction by a spring 132. A stop pin 134 is provided on main link 110 for cooperation with latch 130.

Interrupter 14 operates as follows. Assume first that interrupter 14 is in the closed position shown in FIG. 2. Counterclockwise rotation of insulator column 22 caused by movement of tie-rod 40 effects inward (leftward) movement of drive shaft 102. This causes clockwise movement of main link 110 which moves piston rod 75 and piston 74 to the left.

As piston 74 leaves its starting position and moves leftward it compresses the gas ahead of it. The gas cannot escape because movable contact 68 is still in closed position and seals opening 58 in stationary contact 50. As main link 110 continues to rotate, the righthand end of cam slot 114 engages cam pin 128 on secondary link 118 and causes counterclockwise rotation of secondary link 118, thereby pulling shaft link 122, shaft 70 and movable contact 68 to the right. As movable contact 68 disengages from tip 60 of stationary contact 50, arcing occurs between the contacts. However, opening 58 is unsealed by rightward movement of movable contact 68 and the gas which was compressed ahead of piston 74 flows from cylinder 72, through the openings 96, through passageway 97, through opening 58, through passageway 54 in stationary contact 50, and through the openings 96 back into chamber 46. This gas flow assists in distinguishing the arc between movable contact 68 and stationary contact 60. It is to be noted that piston 74 and movable contact 68 move in opposite directions during contact opening and, furthermore, that piston movement precedes contact opening so that pressure buildup occurs. In the contact open position shown in FIG. 3 main link 110 has moved sufficiently far in a clockwise direction so that one end of latch 130 engages a point 135 on housing 44 thereby causing latch rotation and the other end of the latch to block cam pin 128 at one end of cam slot 114. When interrupter 14 is in the contact open position shown in FIG. 3, gas pressure within chamber 46 and within cylinder 72 stabilizes at its normal pressure level.

Interrupter 14 is closed in the following manner: Clockwise rotation of column 22 causes rightward movement of drive shaft 102 and counterclockwise movement of main link 110. As main link 110 moves counterclockwise, piston rod 75 and piston 74 move to the right to place the piston in its starting position. Simultaneously shaft link 122 and shaft 70 and movable contact 68 are moved to the left. This simultaneous movement occurs because latch 130 prevents relative movement between cam pin 128 and cam slot 114 at least until main link 110 has moved sufficiently far in a counterclockwise direction to permit latch 130 to be biased back against stop pin 134 by its spring 132. During the contact closing operation the movable contact 68 and piston 74 move in opposite directions, but such motion is initiated simultaneously rather than sequentially as in the case of contact opening. During the closing operation, movable contact 68 again engages contact tip 60 of stationary contact 50 and spring 62 provides for shock absorption as well as for good contact pressure and a good gas-tight seal between the contacts.

As hereinbefore noted in connection with FIG. 1, interrupter 14 opens before and closes after disconnect switch 12 thereby preventing arcing from occurring across the disconnect switch contacts as the latter are opened and closed.

It is apparent that interrupter 14 is well adapted for mounting on rotatable post type insulators such as are used with some disconnect switches because of the manner in which its operating means are constructed and function.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In an electric switch, housing means containing a chamber filled with gas, a hollow stationary contact in said chamber having first and second openings communicating with the interior of said housing means, a movable contact in said chamber which seals said first opening when in contact closed position and which unseals said first opening upon being moved to contact open position, a stationary cylinder in said chamber containing a portion of the gas in said chamber,

a movable piston in said cylinder, said piston having a starting position and a second position, means defining a passage communicating between said cylinder and said first opening and comprising an electrical insulating portion to prevent current flow between said stationary contact and said cylinder, and operating means to effect movement of said piston in one direction from its start position to compress the gas in said cylinder, and means actuated by said piston operating means to effect subsequent opening movement of said movable contact in a direction opposite to said one direction and to unseal said first opening to permit compressed gas to flow from said cylinder, between said stationary and movable contacts, through said first opening, through said hollow stationary contact, and through said second opening back into said chamber, said movable contact opening means being responsive only after a predetermined degree of operation of said piston operating means for initiating movement of said movable contact to contact open position, whereby the gas in said cylinder is precompressed prior to contact opening.

2. In combination, a support at ground potential, first, second and third post type insulators mounted on said support in spaced apart relationship, electrically conductive disconnect switch means supported on the first and second of said insulators, at least one of said first and second insulators being rotatable to effect opening and closing operation of said disconnect switch means, a puffer type circuit interrupter comprising an insulated housing having a pair of separable contacts therein, said interrupter supported on said second and third of said insulators, and a reciprocally movable drive shaft to effect operation of said separable contacts of said interrupter extending outwardly of said housing for cooperation with said third insulator, said third insulator being rotatable effecting reciprocable movement of said drive shaft.

3. A combination according to claim 2 wherein said second insulator is rotatable.

4. A combination according to claim 3 wherein said disconnect switch means comprises two movable arms and wherein each of said three columns is rotatable.

5. An electric switch according to claim 1 wherein said piston operating means includes a mechanical linkage and said movable contact opening means includes cam means actuated by said mechanical linkage after operation of said mechanical linkage to effect a predetermined degree of piston travel.

6. An electric switch according to claim 5 wherein said mechanical linkage and said cam means cooperate to effect the simultaneous movement of said piston to said start position and said movable contact to said contact closed position.

7. An electric switch according to claim 6 wherein said linkage mechanism includes a main link pivotally mounted within said housing means and connected to said piston, said cam means comprising a cam groove on said main link and said contact moving means includes a secondary link pivotally mounted within said housing and having a cam follower in engagement with said cam groove.

8. An electric switch according to claim 7 wherein said cam groove is L-shaped having a portion thereof which permits movement of said main link without imparting contact opening movement to said cam follower and said secondary link until said main link has pivoted through a predetermined arc.

9. An electric switch according to claim 8 including latch means pivotally carried on said main link for latching said cam follower in said cam groove so that pivotal movement of said main link in a direction to return said piston to said start position simultaneously actuates said secondary link to move said movable contact to closed position.

10. An electric switch according to claim 1 wherein said movable contact is movable axially and said stationary cylinder and said piston are coaxial with said stationary and movable contacts.

11. An electric switch according to claim 10 and including a longitudinally reciprocable contact shaft coaxial with and affixed to said movable contact and extending axially through said cylinder.

12. An electric switch according to claim 11 wherein said piston has a central aperture therein which receives said shaft and including sealing means between said shaft and said piston.

13. An electric switch according to claim 11 wherein said insulating portion of said passage means surrounds the portion of said stationary contact defining said first opening and also surrounds said movable contact, and the axial end of said cylinder through which said contact shaft extends is provided with a plurality of openings providing communication between said cylinder and said passage.

14. An electric switch according to claim 13 wherein said cylinder is metallic and is provided with an axially extending neck portion surrounding said contact rod, and there is provided a plurality of contact fingers within said passage and having one end thereof in sliding engagement with said movable contact and the opposite ends in electrical engagement with said neck portion.

15. A circuit interrupter of the fluid-blast type including a stationary contact, a movable contact separable from said stationary contact to establish an arc, puffer means for compressing fluid to effect arc extinction, mechanical linkage means for actuating said puffer means, means for preventing flow of said compressed fluid from said puffer means to effect arc extinction until said movable contact separates from said stationary contact, and cam means actuated by said mechanical linkage means for separating said movable contact from said stationary contact and being actuated thereby to initiate said separation only after compression of said fluid by said puffer means as a result of predetermined movement of said mechanical linkage means.

16. A circuit interrupter of the fluid-blast type including a hollow stationary contact having first and second apertures therein, a movable contact adapted to close said first aperture when engaged with said stationary contact and being separable from said stationary contact to establish an arc, puffer means for compressing fluid to extinguish said arc and including a stationary cylinder, passage means between said cylinder and said first aperture, and a piston movable within said cylinder, said movable contact when closing said first aperture preventing flow of compressed fluid from said cylinder through said first aperture into said hollow contact until said movable contact separates from said stationary contact, mechanical linkage means for actuating said movable piston to compress said fluid within said cylinder, and cam means actuated by said mechanical linkage means for separating said movable contact from said stationary contact to thereby permit said compressed gas to flow through said first aperture into said hollow stationary contact to extinguish said arc and to be exhausted through said second aperture, said cam means only being actuated by said mechanical linkage means to initiate separation of said movable contact from said stationary contact after movement of said piston within said cylinder by said linkage to precompress said fluid.

17. A circuit interrupter according to claim 16 wherein said movable contact is movable axially and said stationary cylinder and said piston are coaxial with said stationary and movable contacts, and including a longitudinally reciprocable contact shaft coaxial with and affixed to said movable contact and extending axially through said cylinder.

18. In an electric switch;

housing means including an elongated hollow ceramic insulator containing a chamber filled with gas;

a hollow stationary contact in said chamber at one end of said ceramic insulator, said hollow stationary contact having a first opening and at least one second opening providing communication between the interior of said hollow stationary contact and the chamber;

a stationary cylinder in said chamber and disposed in coaxial relationship in said ceramic insulator at the end thereof opposite to said stationary contact, said cylinder containing gas;

a piston movably supported in said cylinder and having a first starting position and a second position;

means defining a passageway extending in coaxial relationship between said stationary cylinder and said first opening in said stationary contact and including an electrical insulating portion to prevent current flow between said stationary contact and said stationary cylinder, said passageway means having communication with the interior of said cylinder at one side of said piston and with the interior of said hollow stationary contact through the first opening therein;

a movable contact disposed in said passageway means and operable in contact closed position to seal the first opening in said stationary contact and to establish a current flow path between said stationary contact and said cylinder;

electrical conductive means sealing both ends of said ceramic insulator; and,

operating means extending through one of said sealing means and connected to said piston and to said movable contact and operable to effect the movement of said piston in one direction from its first position for compressing the gas in the end of the cylinder which communicates with said passageway means and to effect the subsequent opening movement of said movable contact in a direction opposite to the direction in which said piston moves to compress the gas, to thereby unseal said first opening in said stationary contact;

whereby the gas in said cylinder is precompressed prior to contact opening and upon the subsequent opening of said contact the precompressed gas is directed through the passageway means and into the first opening of said stationary contact and thence through the interior of said hollow stationary contact and out through the second opening therein back into the chamber of said ceramic insulator.

19. An electric switch according to claim 18 wherein the end seal associated with the end of said ceramic insulator at which said cylinder is disposed is a hollow gas-tight enclosure; wherein said operating means comprising, a drive shaft extends into the interior of said enclosure;

a main link pivotally mounted within said enclosure and being connected to said drive shaft to be actuated thereby;

a first cam means on said main link;

a piston rod connected to said piston and extending outwardly of said cylinder into said enclosure, said piston rod being pivotally connected to said main link;

a contact rod extending through said piston in slidable seated relationship thereto, said contact rod having one end secured to said movable contact and its opposite end extending into said enclosure;

a secondary link pivotally mounted in said enclosure;

a second cam means on said secondary link in position to operatively cooperate with said first cam means; and,

a contact rod link pivotally connected to said contact rod and to said secondary link;

whereby movement of said drive shaft in one direction effects the pivotal movement of said main link to actuate said piston rod for moving said piston to compress the gas in said cylinder, and said first and second cam means cooperate to maintain said secondary link and said contact rod stationary until said piston has moved a distance sufficient to compress the gas in said cylinder and thereafter said main link through said first cam means and said second cam means effects pivotal movement of said secondary link to move said contact rod in a direction opposite to the direction of movement of said piston rod, thereby moving said movable contact to open position to allow the compressed gas to flow out of said cylinder and through said passageway means and thence through the first opening to return to the chamber via said second opening.

20. An electrical switch according to claim 19 wherein said drive shaft is connected to said main link at a point between said pivot point of said main link and said first cam means thereon;

and wherein said pivot point for said secondary link is located between said second cam means thereon and the point at which said contact rod link is pivotally connected thereto.

21. An electrical switch according to claim 20 wherein there is provided a latch mechanism operable to maintain said second cam means in fixed relationship to said first cam means until said main link has pivoted a distance to move said piston in its gas compressing stroke, said latch thereafter releasing said second cam means so that it may change its position relative to said first cam means and thereafter the continued pivotal movement of said main link will also effect pivotal movement of said secondary link to impart a movement to said contact rod to move said movable contact to open position, said latch being operable in a contact closing operation to maintain said second cam means in contact open position relative to said first cam means during a portion of the pivotal movement of said main link in the opposite direction to effect the retracting movement of said piston from its gas compressing second position to its first start position, said latch thereafter releasing said second cam means so that it changes its position relative to said first cam means and the continued pivotal movement of said main link in the opposite direction will operate to move said contact rod in a direction to move said movable contact to a closed position.

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