July 22, 1952 W. E. PAUL 2,604,562

ELECTRIC CIRCUIT INTERRUPTER

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Fig. 1.

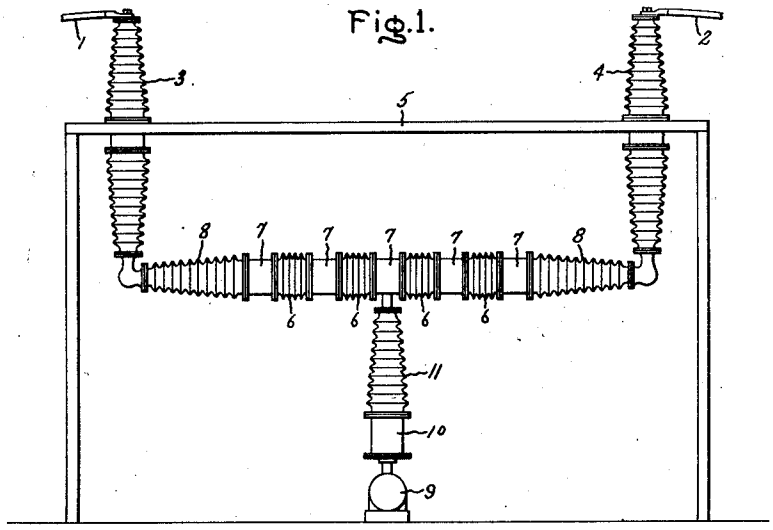


Fig. 2.

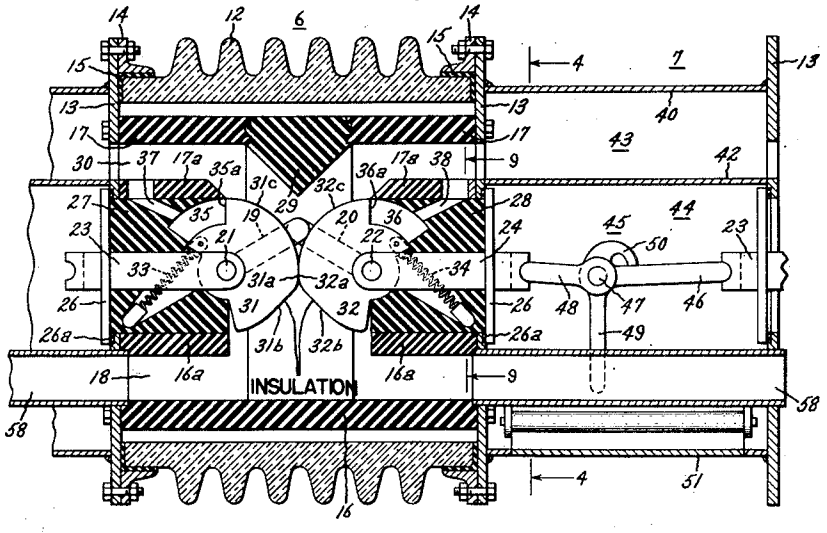
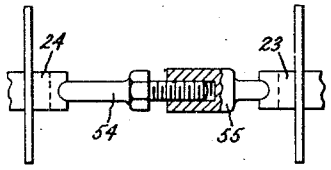


Fig. 3.



Inventor:
William E. Paul,
by Ernest C. Britton
His Attorney.

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Fig.4.

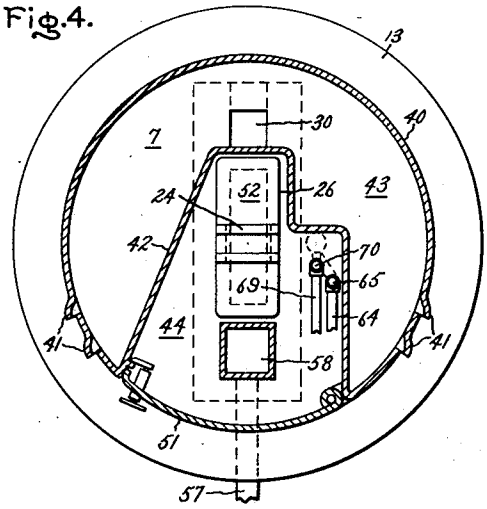


Fig.5.

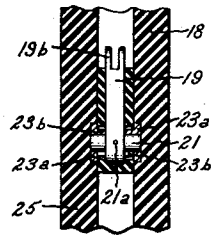


Fig.6.

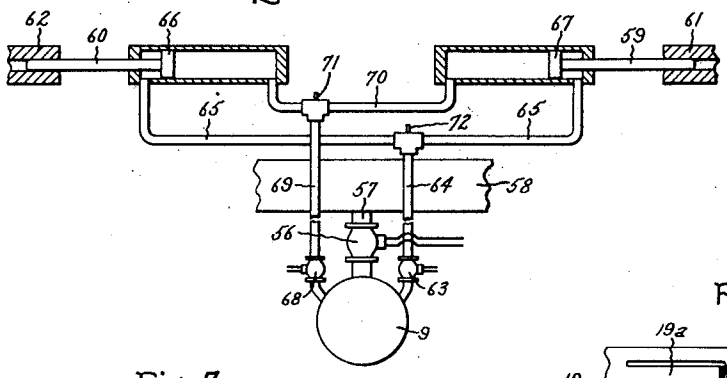


Fig.8.

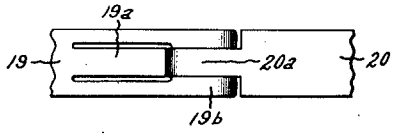


Fig.7.

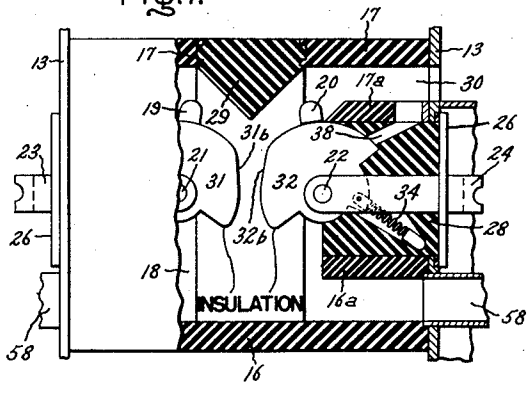
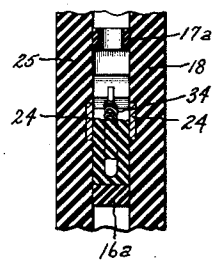


Fig.9.



Inventor:
William E. Paul,
by Ernest C. Britton
His Attorney.

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ELECTRIC CIRCUIT INTERRUPTER

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Fig. 10.

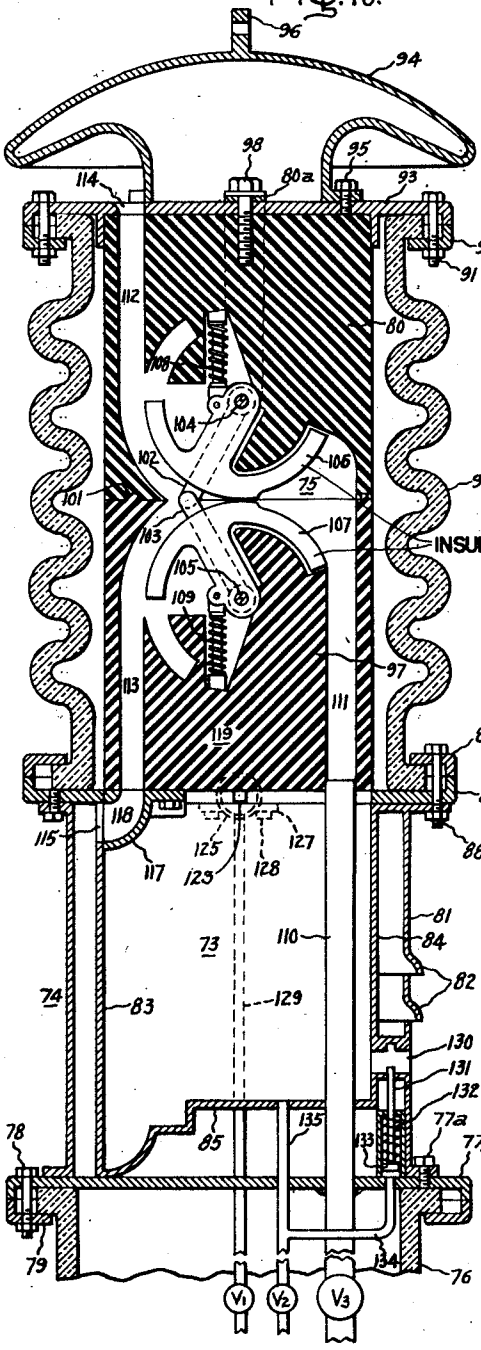
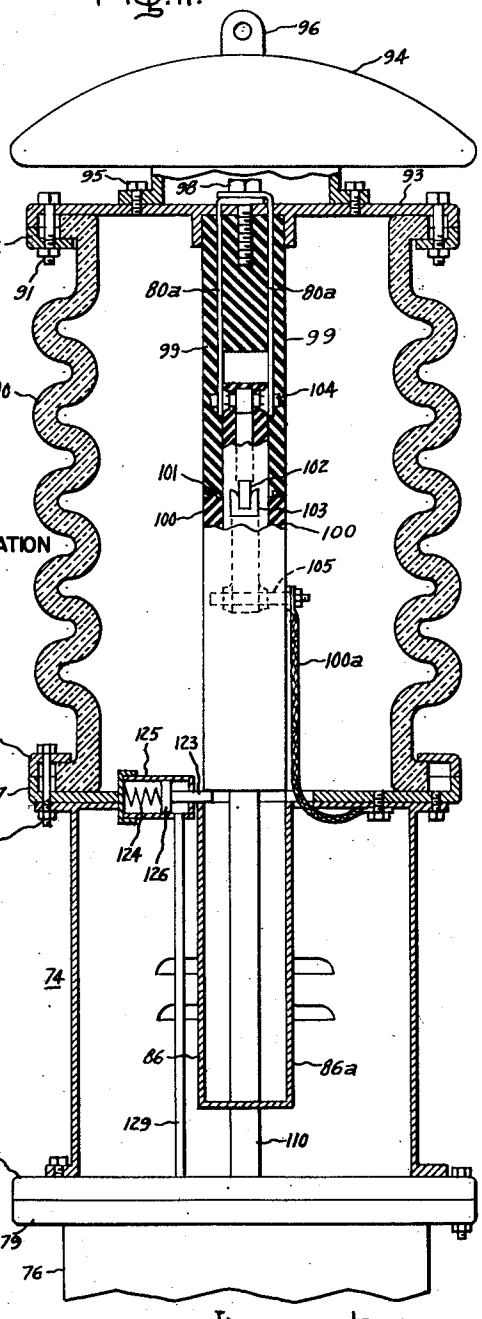


Fig. 11.



Inventor:
William E. Paul,
by Ernest C. Britton
His Attorney.

Patented July 22, 1952 2,604,562

UNITED STATES PATENT OFFICE

2,604,562

ELECTRIC CIRCUIT INTERRUPTER

William E. Paul, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application January 29, 1949, Serial No. 73,614

15 Claims. (Cl. 200—148)

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This invention relates to electric circuit interrupters wherein a gas blast is utilized both as a motive means for operating the contacts and as an arc extinguishing medium.

A principal object of my invention is to provide a circuit interrupter of the gas blast type which is capable of performing very high speed circuit interrupting operations involving large currents at high voltages.

Another object of the invention is the provision of a circuit interrupter having nozzle means adapted automatically to afford desirable gas flow characteristics to aid in interrupting electric circuits.

A further object of my invention is to provide a circuit breaker comprising a pair of cooperating hinged contacts, each of which is provided with nozzle means for controlling the flow of the arc extinguishing gas.

A still further object of the invention is to provide a circuit breaker having hinged contacts which are adapted to draw an arc against an arc divider wherein the gas blast is diverted by the divider in such a way as to cause the ionized products of the circuit interrupting operation to be blown in opposite or diverse directions for the purpose of minimizing the possibility of restrike by the arc following circuit interrupting operations.

Another object of the invention is to provide an improved circuit interrupting and isolating apparatus constructed as an integral unit which may be housed in a suitable enclosing structure so that icing due to weather will not interfere with the operation of the device.

A further object of my invention is the provision of a circuit breaker of the gas blast type which is adapted to perform an efficient circuit interrupting operation with a minimum of heating and resulting expansion of the gas in order to avoid choking of the arcing chamber.

Still another object of the invention is to provide a method for interrupting high currents at high voltages comprising extending an arc to be interrupted by moving its roots simultaneously in two divergent paths while directing a blast of pressure gas along such divergent paths.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention, reference may be had to the accompanying drawings in which Fig. 1 is a side view of a single-pole interrupter embodying my invention; Fig. 2 is a sectional front view of a unitary portion of the structure shown in Fig. 1; Fig. 3 represents an alternative arrangement for a portion of the structure shown in Fig. 2; Fig. 4 is an end view in section taken approximately on the line 4—4 of Fig. 2; Fig. 5 is a fragmentary section showing the details of the supporting structure for the pivotal or hinged contacts incorporated within the interrupter shown in Fig. 2; Fig. 6 is a side view showing in detail the isolating switches and their motors incorporated within the breaker structure shown in Fig. 1; Fig. 7 is a view similar to Fig. 2 showing the arcing contacts in their momentarily open circuit position during interruption; Fig. 8 is a fragmentary top view showing the interrupting contacts in the closed position; Fig. 9 is a cross-sectional view along the line 9—9 of Fig. 2; Fig. 10 is a sectional view of a modified arrangement embodying my invention; and Fig. 11 is a side view in section of the arrangement of Fig. 10.

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While I have shown my invention as being applicable to a single pole only of a circuit interrupter, it will be understood that my invention is equally applicable to circuit breakers having more than one pole.

With reference to Fig. 1, the lines 1 and 2 are shown connected to the terminals of the electrical bushings 3 and 4, which in turn are supported on the supporting structure 5. The bushings 3 and 4 are of conventional construction. A central longitudinally extending metallic conductor is mounted within the insulators 3 and 4 which preferably are constructed of porcelain. Disposed between the lower extremities of the bushings 3 and 4, I have shown a plurality of interrupting units 6 interspersed between a plurality of exhaust chambers 7. The outermost ones of the exhaust chambers 7 are connected to insulators 8, which in turn are supported by the lower ends of the bushings 3 and 4. Suitable conducting means extend through the interrupters 6 and the exhaust chambers 7. Thus, the circuit through the interrupter from left to right comprises the line 1, the conductor within the bushing 3 and insulator 8, the conductors within the exhaust chambers 7, the contacts within the interrupting units 6, and the conductors disposed within the insulator 8, the bushing 4, and line 2.

Fluid under pressure is contained within the reservoir 9. The flow of fluid from the reservoir 9 to the interrupting units 6 is controlled by suit-

able valve members disposed within the housing 10. The insulator 11 contains the fluid conduits from the valves disposed within the housing 10 and also serves as a means for supporting the longitudinally extending structure comprising the interrupting units 6, the exhaust chambers 7, and the insulators 8.

The constructional details of the interrupting units 6 and of the exhaust chambers 7 are shown in Fig. 2. Each interrupting unit 6 is housed within a hollow weather-proof insulator 12 which preferably is constructed of porcelain or other suitable inorganic ceramic material. The insulator 12 is held in position between the two metallic end plates 13 to which are secured the metallic flanged rings 14 which engage the insulating material 15 to hold the insulating tube 12 securely in place. Disposed within the insulator 12 is the interrupter casing comprising a base plate 16 and a top plate 17. Also, a back plate 18, best shown in Fig. 9, and a front plate 25 similar thereto are secured to the plates 16 and 17 to complete the structure for enclosing the interrupting contacts 19 and 20. All these plate-like members are made from some suitable inorganic arc resistant insulating material such as fibre. Contacts 19 and 20 are of the hinged type and are pivotally supported at the fixed pins 21 and 22 to the stationary conducting studs 23 and 24 which may be integral with the two metallic flange plates 26, which in turn are provided with extending edges which engage the insulating gasket 26a. The studs 23 and 24 are normally held in the position shown by means to be described hereinafter. Conducting studs 23 and 24 are embedded within the insulating blocks 27 and 28 which preferably are secured to the metallic plates 26 in any suitable manner. To aid in supporting the blocks 27 and 28 and to afford a partitioning structure for separating the downstream and upstream portions of the interrupting unit 6 from each other, the two lower plates 16a and the two upper plates 17a are appropriately secured to the plates 13 to the back wall 18, and to the front wall 25. Plates 16a and 17a preferably are constructed of insulating material. A wedge-shaped barrier 29 is disposed within a central opening in the top plate 17. The wedge-shaped barrier 29 preferably should be constructed of a homogeneous gas-emitting insulating material, such as polymeric methyl methacrylate or the like, so as to afford good insulation in all directions as well as possessing good arc extinguishing characteristics. Longitudinally extending exhaust passages 30 branch on either side of the wedge-shaped barrier 29. These passages serve to divert exhaust gases from each interrupting unit 6 to the adjoining exhaust or expansion chambers 7. The hinged contacts 19 and 20 are embedded within or otherwise united to the generally semicircular nozzle blocks 31 and 32, which blocks are of appropriate insulating material and are rotatable about the pivots 21 and 22 which are disposed at the geometric center of the arcuate portion of the periphery thereof. For the purpose of biasing contacts 19 and 20 and nozzle blocks 31 and 32 to the contact closed position shown in Fig. 2, the compression springs 33 and 34 are provided.

For the purpose of maintaining good current carrying contact between the contacts 19 and 20 and also for the purpose of allowing a predetermined amount of opening movement of these contacts and of nozzle blocks 31 and 32 to take place before the arc is drawn, the construction shown in Fig. 8 may be used. It will be observed that the contact 20 is provided with a projection 20a which engages the portion 19a of contact 19, thereby affording a somewhat yieldable engagement between the contacts due to resiliency of the portion 19a and of the projection 20a. Long wipe is achieved by constructing contact 19 with two finger-like projections 19b which remain in engagement with the outer surfaces of the projection 20a after contact has been broken between portions 19a and projections 20a thereby maintaining the circuit through the contacts 19 and 20 until a predetermined contact opening movement of the contacts has occurred.

In order to insure resilient electrical contact between the pivotally movable contacts 19 and 20 and their respective stationary conducting studs 23 and 24, the structure shown in Fig. 5 has been found desirable. Both the contacts 19 and 20 are pivotally supported in the same manner, the details of which will be described in connection with contact 19. As shown in Fig. 5, the pivot pin 21 is secured to the conductor 19 by the rivet or pin 21a. The two prongs 23a of the bifurcated conducting stud 23 are provided with aligned openings which form journal supports for the outer ends of the pivot pin 21. Formed integrally with the prongs 23a of conducting stud 23 are a plurality of conducting fingers 23b which are adapted to engage the outer surface of the shaft pin 21 by a relatively high pressure contact. In this way, shaft pin 21 is freely rotatable in response to movement of the contact 19 and at the same time high pressure contact is maintained between the conducting stud 23 and the shaft pin 21 by means of the fingers 23b so that arcing and resulting pitting of the engaging surfaces is avoided.

In order not to impede contact opening rotation of the hinged contacts 19 and 20 and their nozzle blocks 31 and 32, recesses 35 and 36 are respectively formed in the nozzle blocks 31 and 32 which together with corresponding pockets in the supporting blocks 27 and 28 form clearance chambers. Air is not entrapped in these chambers 35 and 36 for it is allowed to escape by way of vents 37 and 38 leading downstream therefrom. However, a small amount of air may be entrapped for contact cushioning by arranging the vents as side ports from the clearance chambers at some appropriate lateral point toward the stroke end as shown. Thus the pockets and the cooperating recesses form dashpot means which is effective after the surfaces 35a and 36a respectively close the vents 37 and 38.

Pressure air or gas admitted through the common supply conduit 58 to the lower portion of each interrupting chamber in the region below the nozzle blocks 31 and 32 will exert a substantially simultaneous contact opening force on the several co-acting pairs of nozzle blocks 31 and 32 which rotate mutually about their respective pivots 21 and 22. The engaging arcuate surfaces 31a and 32a of the nozzle blocks 31 and 32, when the contacts are in the closed position shown in Fig. 2, are so arranged that a predetermined angular rotation of the nozzle blocks 31 and 32 is necessary before such engaging surfaces will be separated. Thus the in-flowing gas blast will build up pressure to accelerate opening movement of the contacts 19 and 20 some time before pressure fluid is allowed to pass between the nozzle blocks 31 and 32. Thus, there is no tendency for pressure fluid to accumulate in the upper portion of the arcing chamber in

the region immediately surrounding the wedge-shaped barrier 29 until after the contacts have achieved a relatively high velocity opening movement. For this reason, the interrupting units are not choked with pressure fluid before interruption of the arc and fluid is not wasted due to premature blasting. While high velocity opening movement of the contacts 19 and 20 is being achieved, the relatively straight cut-away portions 31b and 32b of the nozzle blocks 31 and 32 will rotate to produce eventually a passage for the stream of pressure fluid directed between the nozzle blocks 31 and 32. The space between the portions 31b and 32b is gradually increased as nozzle block 31 rotates counterclockwise and as nozzle block 32 rotates clockwise. After high pressure, high velocity, fluid flow has been established between the nozzle blocks 31 and 32 and outwardly through the widely divergent exhaust passages 30, the arc drawn is blasted by the high velocity fluid against the wedge-like deflector 29 and the products of arcing flow through the exhaust passageways 30 into the expansion space within the chambers 7.

From the above description, it will be understood that I initiate the arc at the point of incidence of the applied fluid blast and then elongate the arc by drawing both roots in generally opposite directions by virtue of the mutually rotational movements of the arcing contacts 19 and 20. It will be appreciated that, while the arc is being elongated as its roots are carried laterally upon the respective arcing contact tips, the arc is virtually deposited or laid along the sloping surfaces of the deflecting gas-emitting barrier 29. Thus, a very effective arc extinguishing process ensues by virtue of the concentrated blast directed toward the mid-portion of the arc which presses the latter forcibly against the gas-emitting surfaces of the deflector 29. Accordingly, the arc is assailed not only by a fresh stream of high-pressure cool uncontaminated air or gas issuing from between the nozzle blocks, but it is also subjected to a secondary gas blast treatment upon its opposite side which is automatically generated from the gas-emitting walls of the deflector 29 along which the arc has been drawn by the arcing contacts and against which it is being immobilized by the force of the fluid blast. As the contacts mutually rotate away from one another to thereby draw an arc of increasing length, the nozzle blocks' inner periphery gradually recede from one another to produce a blast nozzle of increasing cross-sectional area whose final configuration is illustrated in Fig. 7. Accordingly, I have provided means for producing an extinguishing blast, the intensity or magnitude of which varies in accordance with arc length.

Furthermore, it will be observed that the arcing contacts 19 and 20, in their final open position as shown in Fig. 7, lie fairly in the middle of the laterally divergent vent passages 30 so that the full length of the arc, from its central portion to its either extremity at the arcing contacts 19 and 20, is subjected to a blast of high pressure extinguishing gas which has been diverted into two diverging streams in a manner highly effective for preventing re-establishment of the extinguished arc across these separated electrodes following the first current zero.

It will be appreciated that I may choose to make the sloping gas-emitting walls of the deflecting block 29 concave, rather than straight as shown, so as to lie more closely adjacent the arcuate sweep of the arcing tips of the interrupting contacts 19 and 20. In this manner, the arc will become subjected to the direct pressure blast and the reactive emitted blast substantially instantaneously upon its inception.

As the contacts open, the contour of the divergent exhaust passages about the deflecting wedge 29 remains substantially unchanged because of the aforementioned truly arcuate configuration of the upper portions 31c and 32c of the nozzle blocks while, due to the shape of the lower peripheral portions 31b and 32b, the nozzle configuration formed therebetween is of a changing character. It will be understood that any desired flow characteristics for the extinguishing blast stream may be predetermined and produced by selecting an appropriate contour for these lower peripheries of the nozzle blocks. With the semicircular portions of the nozzle blocks in frictional contact as shown, it will be obvious that the initial opening movement of the contacts is mutual so that the contacts move simultaneously away from one another. It will be apparent that they can be interconnected or intermeshed by other well-known means for achieving mutual movement for a part or throughout the whole of the contact travel.

The exhaust chambers 7, best shown in Figs. 2 and 4, comprise an outer metallic weather protective casing 40 which is provided with a plurality of louvers 41 for allowing the escape of exhaust gases. An appropriately configured partition wall 42 segregates the cylindrical casing 40 into a generally U-shaped exhaust or expansion chamber 43 which communicates directly with the passageways 30 and another chamber 44 within the U in which is housed a toggle connector generally designated by the numeral 45. The toggle 45 comprises a longer link 46, a short shaft 47 at the knee of the toggle, and a shorter link 48. Secured to or integral with the shorter link 48 is a handle member 49 which has an extension 50 adapted to engage the link 46 for stopping and holding the toggle in its overset position as shown in Fig. 2. It will be apparent that counterclockwise movement of the handle 49 will break the toggle and relieve the end thrust produced by the toggle when in its overset position shown. Because I make the toggle members of hard copper or other good conducting metal, they constitute an electrical connection as well as an effective thrust member between adjacent units. Thus, good contact making pressure is exerted between the links 46 and 48 and the cooperating conducting studs 23 and 24, and because the plates 26 are secured to the studs 23 and 24, pressure is exerted on gaskets 26a to prevent leakage of fluid from interrupting unit 6 between plates 13 and 26. In order to remove the toggle connection, the handle 49 is rotated in the counterclockwise direction which will collapse the toggle and make possible its ready removal from the chamber 44 through the door 51. After the toggle connector has been removed, the assembly 52 comprising the contact 20 and its nozzle block 32, the conducting stud 24, the contact reclosing spring 34, the supporting block 28, and its plate 26 may readily be withdrawn from the interrupter structure downwardly out through the casing door 51.

In Fig. 3, I have shown an ordinary jack-screw comprising the cooperating members 54 and 55 of good conducting metal which may be used as a thrust type connector instead of the toggle

connector 45 comprising the links 46 and 48. It will be understood that, by means such as these, all the interrupters are electrically connected together in series relationship.

For the purpose of supplying pressure fluid to the interrupting units 6 from the pressure reservoir 9 and also for operating suitable disconnecting switches, the structure shown in Fig. 6 may be used. Pressure fluid for opening the contacts 19 and 20 and for blasting the arc drawn therebetween passes from reservoir 9 through the blast valve 56, conduit 57, into inlet passage 58 which is in communication with the lower portion of the several interrupting units 6. Blast valve 56 may be electromagnetically controlled either manually or automatically in any well-known manner.

Because the contacts 19 and 20 will automatically reclose after the blast valve 56 is closed, due to the action of compression springs 33 and 34, it is necessary to provide suitable isolating switches arranged in series relationship to the interrupter units, the opening of which preferably would be initiated simultaneously with or shortly after the opening of blast valve 56. For example, the isolating switch rods 59 and 60, which cooperate with contacts 61 and 62, are disposed within the insulators 8. Switch rods 59 and 60 are moved inwardly to the open position by pressure fluid passing from reservoir 9 through the opening control valve 63, insulating conduits 64 and 65 and being applied to pistons 66 and 67. Opening valve 63 may be electromagnetically operated and should be arranged to open somewhat after the opening of blast valve 56 in order to insure that the interrupting action will have been completed before permitting the isolating gap to form. Thus pressure fluid admitted through the insulating supply conduit 57 and the distributing conduit 58 will separate the contacts 19 and 20 and blast the arc drawn therebetween to extinction before the isolating switch blades 59 and 60 will have disengaged their cooperating contacts 61 and 62. Because the interrupting contacts 19 and 20 will reclose upon the cessation of the fluid blast under the urge of their return springs 33 and 34, it will be appreciated that the blast valve must be properly timed to reclose so that a safe isolating gap or gaps have been opened up before the interrupting contacts are permitted to reclose.

For the purpose of closing the isolating contacts, a short fluid blast may be supplied through insulating conduits 57 and 58 to the interrupting contacts 19 and 20 so as to separate and blast these contacts momentarily while the isolative contacts 59 and 60 are closing. Therefore, simultaneously with, or just after, the opening of blast valve 56 for this purpose, the closing control valve 68 is opened and pressure fluid is supplied to the right-hand surface of piston 66 and to the left-hand surface of piston 67 to produce closing motion to the contact rods 59 and 60 so as to engage the contacts 61 and 62. As clearly indicated in Fig. 6, the closing valve 68 controls an insulating conduit 69 which branches into an insulating conduit 70 leading to the closing end of the fluid motors. In order to make sure that pressure fluid is not trapped in back of the pistons as they perform contact opening and closing movements, suitable bleed ports may be provided such as those shown at 71 and 72 within the conduits 70 and 65, respectively, or if desired the valves 63 and 68 could be constructed with exhaust ports leading to atmosphere when the valves are closed.

From the above description, it is apparent that each pair of interrupting contacts 19 and 20 disposed within each interrupting unit 6 and the isolating contacts disposed within the insulators 8 are independently operable. By proper adjustment of springs 33 and 34 on all the interrupting units 6, the contacts 19 and 20 of all the interrupting units may be made to operate substantially simultaneously even though pressure within conduit 58 may not be the same throughout its entire length. Due to the particular construction of the nozzle blocks 31 and 32 and the resulting rapid opening of the contacts 19 and 20 and because of the sliding cooperation between the isolating contact rods 59 and 60 and their cooperating contacts 61 and 62 and the resulting relatively slow opening of these contacts, a multiple-break interrupter is provided which will open its independent interrupting contacts substantially simultaneously and almost instantaneously and which will insure that the isolating contacts are opened after all of the interrupting contacts have been separated. Furthermore, the entire mechanism is enclosed and hence free from difficulties due to icing.

It should be noted that rapid reclosures on this breaker may be effected by having the isolating control valve 63 energized through a notching relay, for example, so that the isolating contacts 59 and 60 need not be moved at all, until a given number of automatic reclosures of contacts 19 and 20 have been made by means of the biasing springs 33 and 34 and then reopened by again automatically tripping valve 56 from overcurrent. Valve 56 of course will automatically reseat at cessation of current after each interruption. By this means, the necessary time required for accelerating the isolating switches between operations is eliminated. Only after the desired number of reclosures have been made will the valve 63 be energized and final isolation occur, until the system is again reset.

In accordance with the modification of my invention shown in Figs. 10 and 11, the isolating function is performed by causing the interrupting contacts and the structure associated therewith to separate by an appreciable distance so as to form between the contacts an adequate isolating gap. The interrupter shown in Figs. 10 and 11 comprises the exhaust chamber generally designated by the numeral 74 and the interrupting chamber generally designated by the numeral 75. Support for the interrupter is provided in the form of a hollow insulator 76 which preferably is constructed of ceramic material and which may be generally similar to the insulator 11 of Fig. 1. Metallic foundation disc 77 is secured to the upper flanged end of insulator 76 by means of the bolts 78 and their cooperating clamps 79. The outer wall of exhaust chamber 74 comprises a cylindrical metallic casing 81 provided with exhaust louvers 82. An internal chamber 73 is disposed within the casing 81 and comprises the metallic side walls 83 and 84, the bottom wall 85 as well as front and back walls 86 and 86*a*. Casing 81 is flanged at each end and is secured at its lower end to the foundation plate 77 by means of bolts 77*a*. The plate 87 is secured to the upper flange on the casing 81 by means of bolts 88 and their cooperating clamps 89 which in turn cooperate with the flange on the lower end of the ceramic shell 90 which forms a weather protecting enclosure for the interrupting

chamber 75. The bolts 88 may be utilized as one terminal of the interrupter. As shown, the shell 90 may be corrugated in order to increase the creepage path along the surfaces of the shell so as to prevent flash-over. Disposed at the upper end of the shell 90 and secured thereto by the bolts 91 and the clamps 92 is a metallic disc 93. A cover member constructed of metal and designated by the numeral 94 is secured to the plate 93 by means of bolts 95. If desired, the cover member 94 may be provided with any suitable terminal means such as is indicated at 96 to form another terminal of the interrupter.

The structure disposed within the insulating shell 90 and comprising the interrupter unit is similar to the structure shown in Figs. 2 and 7 except that the lower contact 103 and its associated structure is adapted to move longitudinally downward to perform an isolating action. The upper contact does not move bodily, and hence its associated insulating block 80 is bolted to plate 93 by bolt 98. Insulating plates 99 are fixed in position to block 80 by any suitable means.

Insulating block 97 and plates 100 are secured together to form a unitary movable structure 119. A tongue and groove construction as indicated at 101 is provided to insure a substantially fluid-tight junction between the abutting surfaces of plates 99 and 100 and between blocks 80 and 97. The contacts 102 and 103 are pivoted to the shaft pins 104 and 105, respectively, and are embedded within their corresponding rotatable nozzle blocks 106 and 107. The contacts and their nozzle blocks are biased toward the closed position shown by means fo the compression springs 108 and 109. The shafts 104 and 105 are journally supported by the plates 99 and 100, respectively. The shaft 104 is electrically interconnected with top plate 93 by the conductors 80*a* which are bolted to plate 93 by bolt 98 and which are provided with openings at their lower ends through which shaft pin 104 extends. Shaft pin 105 is connected to middle plate 87 through the flexible conductor 100*a*.

Fluid pressure for operating the contacts 102 and 103 together with their coresponding nozzle blocks is admitted from a source not shown through the valve V_3, the conduit 110 which extends through the plates 77, 85 and 87, and into the lower end of the inlet passage 111 formed in block 97. Fluid from conduit 110 passes through the passageway 111, operates the contacts, and extinguishes the arc. Exhaust passage 112 formed within block 80 serves to convey the products of the interrupting operation through the opening 114 to atmosphere. Exhaust passage 113 leads to the opening 115, thence into the space between the cylindrical casing 81 and the walls of chamber 73. This blast escapes from the shell 81 to atmosphere through the louvers 82. The portion 118 of the exhaust passage between the passage 113 in block 97 and the opening 115 is formed by the metallic member 117 which is bolted to the block 97 and is slidable along the wall 83.

The unitary structure generally designated by the numeral 119 and comprising block 97 and plates 100 together with contact 103 and nozzle block 107 is held in the position shown by the latch 123 which engages the lower surface of the back plate 100. The latch 123 is maintained in the closed position by the action of spring 124 and is movable to the open position by fluid pressure admitted to the cylinder 125 which is effective to operate the piston 126 against the action of spring 124. Cylinder 125 is secured within a recess in the plate 87 by means of the ears 127 and bolts 128 shown dotted in Fig. 10. Ears 127 may be welded to cylinder 125. Fluid pressure for opening the latch 123 is admitted to the cylinder 125 through conduit 129 and valve V_1 from a source of fluid pressure, not shown.

A circuit opening operation of the interrupter of Figs. 10 and 11 is accomplished when valve V_3 is opened in the same manner as interruption is accomplished in the case of the structure shown in Figs. 2 and 7, i. e., fluid pressure rotates the contact 102 and its nozzle block 106 clockwise about the shaft pin 104 and also rotates the contact 103 and its nozzle block 107 in the counterclockwise direction about the shaft pin 105. The arc is then blasted to extinction by the flow of fluid between the contacts and through the exhaust passages 112 and 113. After the arc is extinguished, the unit 119 is caused to move downwardly by the action of the fluid pressure from conduit 110 provided the latch 123 is moved out of engagement with back plate 100 by the action of fluid pressure admitted through valve V_1. It will be obvious that suitable means would be provided for opening valve V_1 an appropriate time after the opening of valve V_3.

For the purpose of preventing the accumulation of substantial pressure below the unit 119 as the unit is moved downwardly, an opening 130 is provided which affords communication from within the chamber 73 to atmosphere so that air within the chamber 73 and above the opening 130 will not be entrapped therein. As the unit 119 moves downwardly, the passage 111 in block 97 telescopically envelopes the conduit 110. When the lower edge of unit 119 covers the opening 130, a certain amount of air will be entrapped between the lower surface of the unit and the wall 85 so as to afford a cushioned stop for the unit. When unit 119 reaches its lowermost position, the latch 123 under the action of the spring 124 engages the upper edge of the back wall 100 of the unit and effectively locks the unit in the down position. In this way, an adequate isolating gap is established between the contacts 102 and 103. It will be obvious that pressure fluid through valve V_1 to operate piston 126 should be shut off after the unit begins its downward travel and before the lowermost position thereof is reached so that the latch can perform its holding function after the unit reaches its lowermost position. It will also be obvious that it is the action of gravity and of the pressure from valve V_3 and conduit 110 which causes downward movement of unit 119 after such pressure has operated to open the interrupting contacts and to extinguish the arc. Valve V_3 should be closed at an appropriate time which would insure that sufficient pressure fluid is available to perform the isolating function without unduly prolonging the fluid blast so as to avoid needless waste of pressure fluid.

When a closing operation is performed, the opening 130 must be closed. To this end, the opening 130 leading from chamber 73 to atmosphere is provided with a normally open gate valve 131 which is biased to the open position by the spring 132. For closing valve 131, a piston 133 and its cooperating cylinder are provided. Fluid pressure for operating piston 133 is supplied from a source, not shown, through the valve V_2 into conduit 134. Conduit 135 is connected with the valve V_2 and is for the purpose of admitting fluid pressure to the chamber 73

so as to cause the unit to move upwardly to the closed position, the unit 119 acting as a piston. The gate valve 131 is merely for the purpose of preventing the escape of fluid to atmosphere during closing operations of the interrupter. Of course, valve V_1 would be opened just prior to or simultaneously with the opening of valve V_2 so as to unlatch the unit. Valve V_1 would be closed before the unit reaches its uppermost position so as to render the latch 123 capable of locking the unit in the upper position as shown in the drawings. It will also be obvious that valve V_2 would be closed after the establishment of sufficient pressure within unit 73 to insure that a closing operation would be completed.

While the arrangement shown in Figs. 10 and 11 provides means for moving the single lower unit such as 119 only, it will be obvious to those skilled in the art that certain changes could be made so as to cause the upper unit comprising block 80, contact 102 and parts associated therewith to move upwardly simultaneously with the downward movement of unit 119. In this way, the isolating gap between the contacts would be made longer, and hence the voltage which the interrupter would withstand immediately following an interrupting operation would be greater.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects and I, therefore, intend in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In an electric circuit interrupter of the fluid blast type, an arcing passage formed of stationary enclosing structure, a pair of relatively movable pivotally mounted long-wipe contacts disposed in said passage and separable in response to a blast of fluid supplied to said passage, and nozzle means of insulating material disposed in said passage upstream of said contacts and operable in response to a blast of pressure fluid to said passage for automatically controlling the magnitude of the blast during a circuit interrupting operation, said nozzle means being effective to prevent blasting of said contacts until after a predetermined contact opening movement is accomplished.

2. In an electric circuit interrupter of the fluid blast type, an arcing passage formed of stationary enclosing structure, a pair of movable long-wipe contacts in said passage, an inlet passage through which a blast of pressure fluid is supplied to said arcing passage for separating said contacts and for extinguishing the arc drawn therebetween upon separation of said contacts, and nozzle means of insulating material movable with said contacts and having engaging surfaces upstream of said contacts for automatically increasing the blast of pressure fluid between said contacts after high velocity opening movement of said contacts is attained and for preventing blasting of said contacts until after a predetermined opening movement of said contacts.

3. In an electric circuit interrupter of the fluid blast type, an arcing passage formed of stationary enclosing structure, a pair of relatively movable long-wipe contacts in said passage, an inlet passage through which a blast of pressure fluid is supplied to said arcing passage for separating said contacts and for extinguishing the arc drawn therebetween upon separation of said contacts, and a nozzle block movable with one of said contacts and having a nozzle surface upstream of said contacts for automatically increasing the blast of pressure fluid between said contacts after high velocity contact opening movement is attained, said nozzle block being effective to increase the fluid blast before the arc is drawn between said contacts.

4. In an electric circuit interrupter of the fluid blast type, an arcing passage formed of stationary enclosing structure, a pair of movable long-wipe contacts in said passage, an inlet passage through which a blast of pressure fluid is supplied to said arcing passage for separating said contacts and for extinguishing the arc drawn therebetween upon separation of said contacts, and a nozzle block secured to each of said contacts and disposed in said passage, said blocks being normally in abutting relationship for closing said passage and being separable for automatically increasing the blast of pressure fluid supplied between said contacts, said nozzle blocks being configured to prevent the flow of fluid between said contacts until after said contacts attain a high speed opening movement.

5. In an electric circuit interrupter of the fluid blast type, an arcing passage formed of stationary enclosing structure, a pair of rotatable contacts in said passage, biasing means for normally holding said contacts in the closed circuit position, means for supplying a blast of pressure fluid to said passage to rotate said contacts to the open position and to blast the arc drawn therebetween to extinction, and a pair of nozzle blocks of insulating material normally in engagement with each other and rotatable with said contacts, said blocks being configured along their abutting surfaces so as to prevent blasting of said contacts until after a predetermined opening movement and thereafter to increase the blast of fluid between said contacts during a circuit interrupting operation.

6. In an electric circuit interrupter of the gas blast type, an arcing passage formed of stationary enclosing structure, a pair of rotatable nozzle blocks of insulating material disposed in said passage, biasing means for normally holding said nozzle blocks in engagement with each other, a pair of interrupting contacts embedded within said nozzle blocks and having projecting portions thereof normally in engagement with each other, the surfaces of said nozzle blocks which are normally in engagement being upstream of said projecting portions of said contacts, an inlet passage through which a blast of gas is supplied to said arcing passage to cause rotation of said nozzle blocks and separation of said contacts and to blast the arc drawn therebetween to extinction.

7. In an electric circuit interrupter of the gas blast type, an arcing passage formed of stationary enclosing structure, a pair of rotatable nozzle blocks of insulating material disposed in said passage, biasing means for normally holding said nozzle blocks in engagement with each other, a pair of interrupting contacts embedded within said nozzle blocks and having projecting portions thereof normally in engagement with each other, and an inlet passage through which a blast of gas is supplied to said passage to cause rotation of said nozzle blocks and separation of said contacts and to blast the arc drawn therebetween to extinction, the cooperating surfaces

of said nozzle blocks which are normally in engagement being arcuate in shape so that the flow of gas through said arcing passage is substantially prevented until after a predetermined relative movement of said contacts has occurred during a circuit interrupting operation.

8. In an electric circuit interrupter of the gas blast type, an arcing passage formed of stationary enclosing structure, a pair of rotatable nozzle blocks of insulating material disposed in said passage, biasing means for normally holding said nozzle blocks closely adjacent each other for closing said passage, a pair of interrupting contacts embedded within said nozzle blocks and having projecting portions thereof normally in engagement with each other, and an inlet passage through which a blast of gas is supplied to said arcing passage to cause rotation of said nozzle blocks and separation of said contacts and to blast the arc drawn therebetween to extinction, the upstream surfaces of each of said nozzle blocks being configured to form a changing nozzle for controlling the flow of gas through said arcing passage only after a predetermined opening movement of said contacts and said adjacent surfaces of said blocks being effective to prevent blasting of said contacts before said predetermined opening movement of said contacts.

9. In an electric circuit interrupter of the gas blast type, an arcing passage, a pair of rotatable nozzle blocks of insulating material having peripheries of generally circular configuration disposed in said passage, biasing means for normally holding said nozzle blocks closely adjacent one another for closing said passage, a pair of interrupting contacts embedded within said nozzle blocks and having projecting portions thereof normally in engagement with each other, and an inlet passage through which a blast of gas is supplied to said passage to cause rotation of said nozzle blocks and separation of said contacts and to blast the arc drawn therebetween to extinction, the upstream peripheral surfaces of each of said nozzle blocks being configured to form a nozzle for automatically increasing the flow of pressure gas through said arcing passage after a predetermined opening movement of said nozzle blocks and the downstream peripheral surfaces of said nozzle blocks being arcuate in shape to maintain a substantially unchanging configuration of said arcing passage in the region thereof downstream from said contacts.

10. In an electric circuit interrupter of the gas blast type, an arcing passage formed of stationary enclosing structure, a pair of rotatable nozzle blocks of insulating material disposed in said passage, biasing means for normally holding said nozzle blocks closely adjacent to each other, a pair of interrupting contacts embedded within said nozzle blocks and having projecting portions thereof normally in engagement with each other, means for supplying a blast of gas to said passage to cause rotation of said nozzle blocks and separation of said contacts and to blast the arc drawn therebetween to extinction, said nozzle blocks being configured to prevent blasting of said contacts until after predetermined opening movement of said contacts, a pair of exhaust passages leading from said arcing passages in divergent directions, and an arc divider of gas emitting insulating material disposed in said arcing passage intermediate said exhaust passages for diverting a portion of the blast through each of said exhaust passages and for supplying a secondary blast of gas to the arc.

11. In an electric circuit interrupter of the fluid blast type, an arcing passage, a pair of movable contacts in said passage, supporting means for said contacts, means for supplying a blast of pressure fluid to said passage for separating said contacts and for extinguishing the arc drawn therebetween upon separation of said contacts, a nozzle block movable with each of said contacts and operable to increase automatically the blast of pressure fluid between said contacts during a circuit interrupting operation, and dashpot means for arresting the opening movement of said nozzle blocks including a recess in said nozzle blocks downstream from said contacts and a pocket in said supporting means, said recess and said pocket being operable to entrap fluid to cushion the opening movement of said nozzle block and said contacts.

12. A circuit interrupting and isolating device comprising an outer weatherproof insulating shell, a pair of complementary insulating units normally disposed in engagement with each other within said shell to define an interrupting chamber, said units being relatively movable with respect to each other in a direction longitudinal with respect to said shell and the complementary surfaces of said units being configured to form a substantially fluid tight junction therebetween, a contact member pivotally supported on each unit, a nozzle block movable with each contact member, said nozzle blocks being in engagement with each other during the initial opening movement of said contacts for preventing blasting of said contacts until after predetermined opening movement of said contacts, means for biasing said contact members toward each other, and means for supplying a blast of fluid to the interrupting chamber to separate said contacts and extinguish the arc drawn therebetween and for separating said units following an interrupting operation.

13. A circuit interrupting and isolating device comprising an outer weatherproof insulating shell, a pair of complementary insulating units normally disposed in engagement with each other within said shell to define an interrupting chamber, said units being relatively movable with respect to each other in a direction longitudinal with respect to said shell, and the complementary surfaces of said units being configured to form a substantially fluid tight junction therebetween, a contact member supported by each unit, means for biasing said contacts toward each other, means for supplying a blast of fluid to the interrupting chamber to separate said contacts and extinguish the arc drawn therebetween and for separating said units following an interrupting operation, and latching means for releasably holding said units in engagement until the arc is extinguished during a circuit opening operation and for holding said units out of engagement upon completion of a circuit isolating operation.

14. An electric circuit interrupter comprising an interrupting chamber, an exhaust chamber disposed adjacent said interrupting chamber and in communication therewith, a pair of relatively movable contacts disposed in said interrupting chamber, each of said contacts being removable from said interrupting chamber, means for supplying a blast of pressure fluid to said interrupting chamber to separate said contacts and extinguish the arc drawn therebetween, another chamber adjacent said interrupting and exhaust chambers for receiving one of said contacts upon

removal thereof from said interrupting chamber, and thrust means disposed in said another chamber for releasably securing said one contact in position in said interrupting chamber, said last mentioned means being constructed of conducting material and being in series with said contacts when arranged to secure said one contact in position within said interrupting chamber.

15. An electric circuit interrupter comprising an interrupting chamber, an exhaust chamber disposed adjacent said interrupting chamber and in communication therewith, a pair of relatively movable contacts disposed in said interrupting chamber, each of said contacts being removable from said interrupting chamber, means for supplying a blast of pressure fluid to said interrupting chamber to separate said contacts and extinguish the arc drawn therebetween, another chamber adjacent said interrupting and exhaust chambers for receiving one of said contacts upon removal thereof from said interrupting chamber, an access door in a wall of said another chamber through which said one contact is removable, and releasable holding means of conducting material disposed in said another chamber and forming a portion of the circuit through the circuit breaker, said holding means being effective normally to secure said one contact in position within said interrupting passage and being arranged so that said one contact may be removed through said another chamber and said door upon release of said holding means.

WILLIAM E. PAUL.

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