May 5, 1942. B. P. BAKER ET AL 2,282,153

CIRCUIT INTERRUPTER

Filed Jan. 25, 1941 4 Sheets-Sheet 1

Fig. 1.

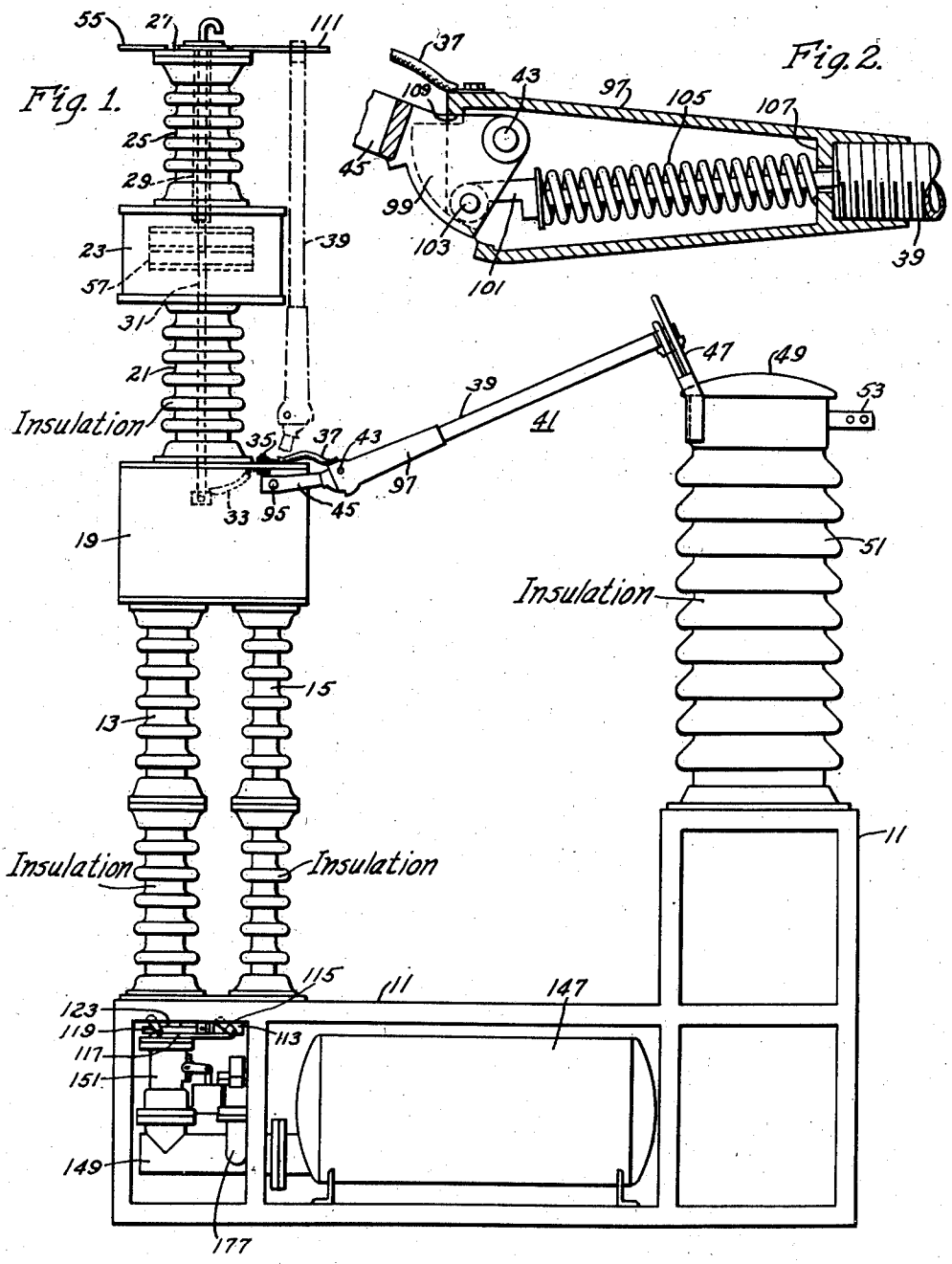

Fig. 2.

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CIRCUIT INTERRUPTER

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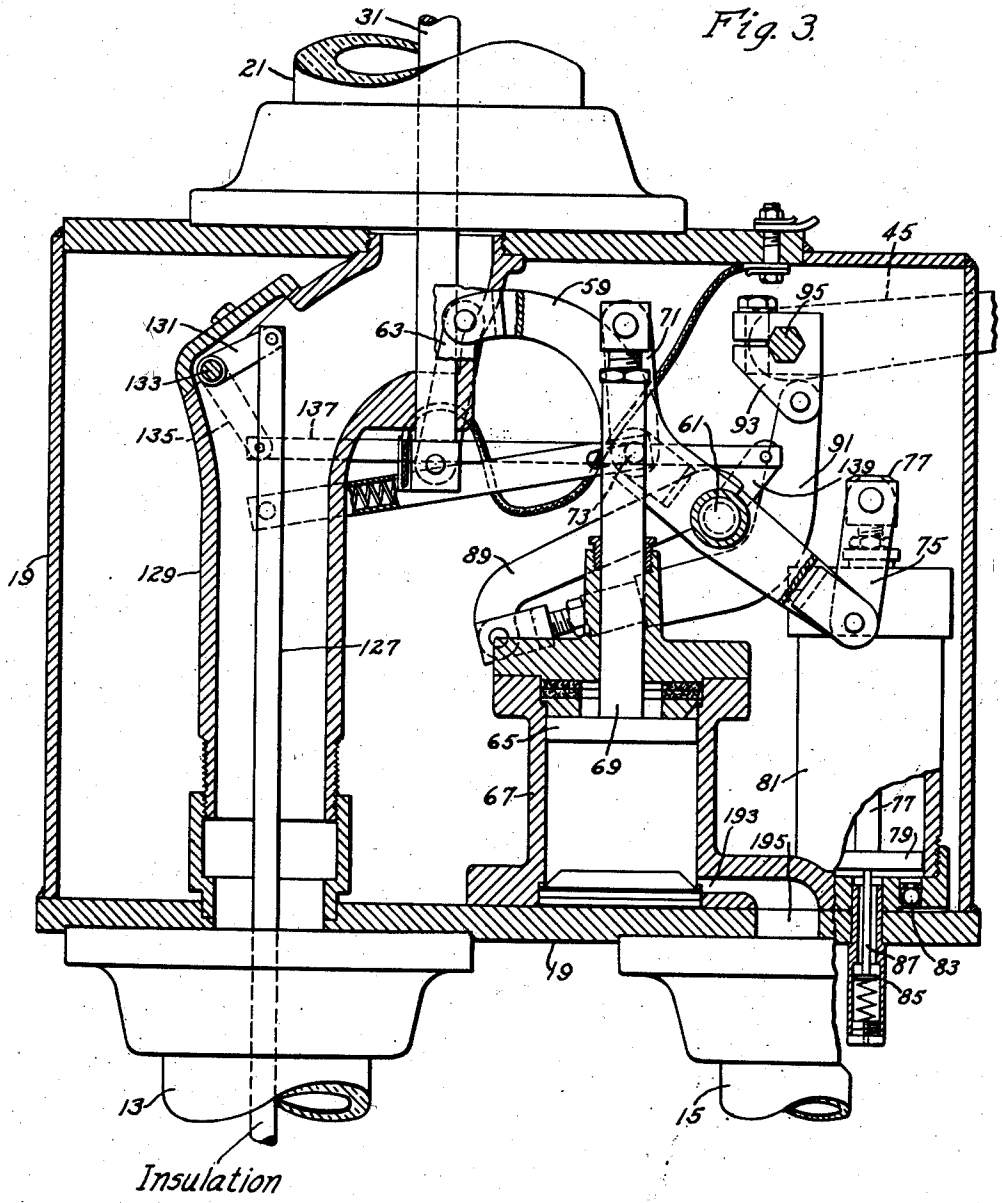
Fig. 3.



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CIRCUIT INTERRUPTER

Filed Jan. 25, 1941 4 Sheets-Sheet 3

Fig. 9.

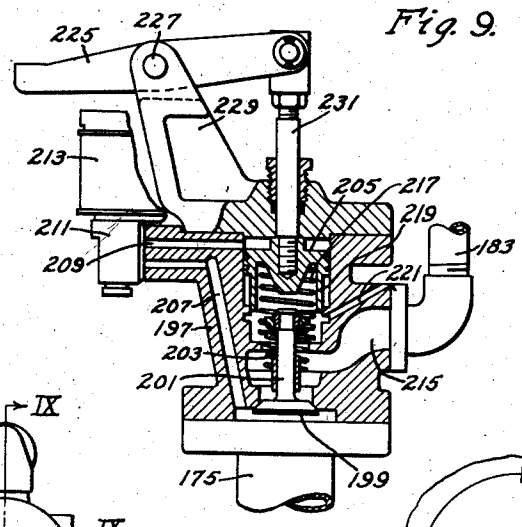

Fig. 8.

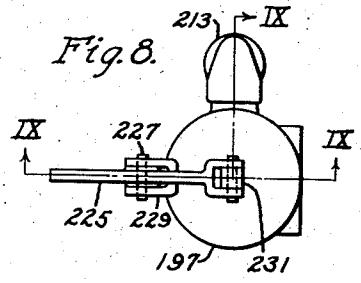

Fig. 4.

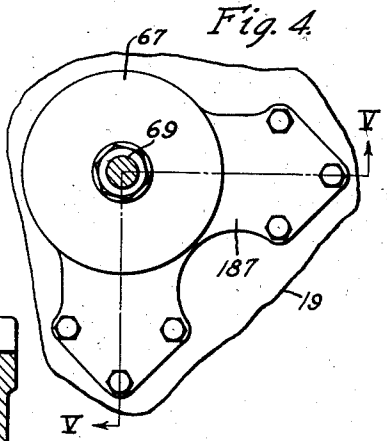

Fig. 5.

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CIRCUIT INTERRUPTER

Filed Jan. 25, 1941 4 Sheets-Sheet 4

Fig. 6.

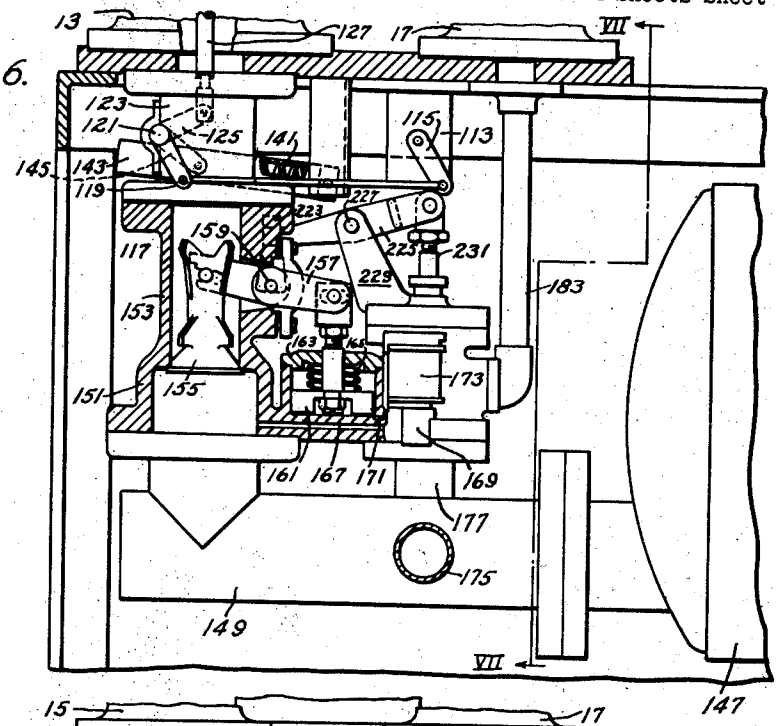
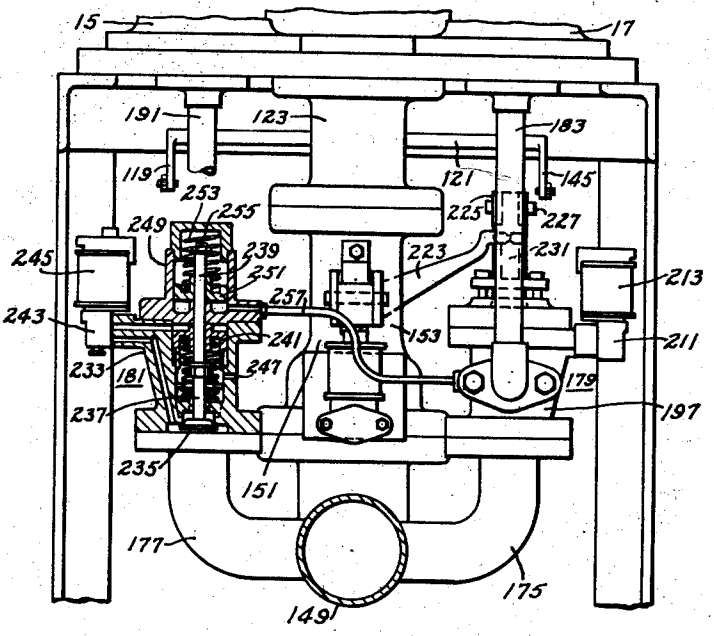


Fig. 7.



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Patented May 5, 1942 2,282,153

UNITED STATES PATENT OFFICE

2,282,153

CIRCUIT INTERRUPTER

Benjamin P. Baker, Turtle Creek, and Andrew H. Bakken, Edgewood, Pa., assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application January 25, 1941, Serial No. 375,968

23 Claims. (Cl. 200—148)

This invention relates to improvements in circuit interrupters, and more particularly to circuit interrupters of the fluid blast type suitable for high-voltage, high-power circuits.

In the extinction of high-voltage, high-power arcs more efficient extinction may be obtained by subjecting a relatively short arc to a fluid blast. Usually the most effective arcing contact separation for arc extinction is too short to provide the necessary insulation following arc extinction and the cessation of the fluid blast.

A series connected disconnect switch, preferably externally arranged, with respect to the interrupting element has been found to provide the extra insulation needed to effectively isolate the two parts of the connected circuit. Even though a disconnect switch provides an effective isolating break, some difficulty has been experienced in maintaining a high dielectric condition in the current interrupting gap without the continuous flow of arc extinguishing fluid on account of sparking across the short interrupting gap.

It is, therefore, an object of our invention to provide a high-voltage, high-power circuit interrupter of the foregoing type employing a series isolating switch and means for removing the potential from across the current interrupting break upon opening of the isolating switch.

A more specific object of the invention is directed to the operating mechanism for current interrupters of the aforesaid type arranged to sequentially open the interrupting contacts and the isolating switch and finally short circuit the circuit interrupting break.

A further feature of our invention is directed to the provision of a fluid actuated operating mechanism of compact design for high-voltage circuit interrupters of the fluid blast type. This feature includes arranging the mechanism for operating the contact structure adjacent to the contacts and maintaining it at line potential, whereas the control apparatus for such mechanism is maintained at ground potential.

Another object of the invention resides in the provision of improved valve means for fluid blast circuit interrupters for controlling the flow of fluid to the current interrupting break and the contact operating mechanism.

A more specific object of the invention contemplates such improvements in valve mechanism for the control of fluid in circuit interrupters of the fluid blast type that opening of the interrupter is prevented in the absence of a fluid blast at the interrupting contact structure. The improved valve mechanism also makes provision for a positive opening operation of the interrupter arcing contact structure in the event that conflicting opening and closing control impulses are applied to the contact operating mechanism.

Other objects and advantages will appear more fully in the following description when read in connection with the accompanying drawings, in which:

Figure 1 is a side elevation view showing a circuit interrupter which illustrates our invention;

Fig. 2 is a fragmentary view in section showing a part of the disconnect switch mechanism of the circuit interrupter;

Fig. 3 is a view partially in section showing the contact operating mechanism of our circuit interrupter;

Fig. 4 is a top view at a reduced scale of the fluid actuated driving means forming a part of the contact operating mechanism shown in Fig. 3;

Fig. 5 is a sectional view of the driving means shown in Fig. 4 taken along the line V—V of that figure;

Fig. 6 is a view partially in section of the fluid control valve assembly of the circuit interrupter;

Fig. 7 is a view partially in section of the valve assembly shown in Fig. 6, as viewed along the line VII—VII of that figure;

Fig. 8 is a top view at a reduced scale of one of the fluid control valve mechanisms; and

Fig. 9 is an enlarged sectional view of the valve mechanism of Fig. 8 taken along the lines IX—IX—IX.

Referring to the drawings, the reference numeral 11 indicates a framework which may be formed of structural steel or other suitable material. Rising from the left-hand side of the framework 11 are a plurality of insulators 13, 15 and 17, only the first two of which are shown in Fig. 1 and the latter two of which are shown in Fig. 5. Supported upon the upper end of the tripod formed by insulators 13, 15 and 17 is a casing 19 for housing an operating mechanism more clearly shown in Fig. 3. The casing 19 supports an insulator 21 which, in turn, supports a circuit interrupting element 23. An insulator 25 similar to insulator 21 extends upwardly from the circuit interrupting element 23 and has a metallic terminal cap 27 on its free end thereof. The insulator 25 is hollow for the purpose of receiving a stationary contact member 29 which extends downwardly from the terminal cap 27 into the circuit interrupting element 23. A movable contact member 31 coacts with the stationary contact member 29 and extends from the

lower end of the stationary contact through the circuit interrupting element 23 and the insulator 21 which also has a passage therethrough. The lower end of the moving contact 31 extends into the casing 19 and is operatively coupled to the operating mechanism as shown in Fig. 3 and which will hereinafter be more fully described. An electrical connection is made from the lower end of the moving contact 31 by means of a flexible conductor 33 to a terminal bolt 35 secured to the upper end of the casing 19. A second flexible connection 37 connects the terminal bolt 35 with the switch blade 39 of a disconnect switch generally indicated at 41. The blade 39 of the disconnect switch 41 is hinged at 43 to the end of an operating arm 45, pivotally mounted upon the casing 19. The right-hand end of the blade 39 makes a high pressure contact with a U-shaped contact jaw 47 supported from a terminal cap 49 forming a covering of a hollow insulator 51.

The insulator 51 may be supported from the right-hand end of the frame 11 and serves as a housing for transformers or other suitable instruments necessary for the control of the circuit interrupter. External circuit connections to the interrupter are made to a terminal 55 carried by the terminal cap 27 and to a terminal 53 carried by terminal cap 49. Thus from the foregoing description, it is apparent that when the interrupter is in the closed circuit position, as shown in Fig. 1, a current flow through the interrupter may proceed from the terminal 55, terminal cap 27, stationary contact 29, moving contact 31, conductor 33, terminal bolt 35, conductor 37, switch blade 39, contact jaw 47, terminal cap 49 to the terminal 53. If the moving contact 31 is operated to the open circuit position while the interrupter is carrying a load, an arc will be drawn between the lower end of the stationary contact 29 and the moving contact.

Extinction of this arc may be accomplished by any suitable arc extinguishing means but preferably by an arc extinguisher of the fluid blast type which, for example, may be of the form more clearly shown and claimed in the copending application of L. R. Ludwig and B. P. Baker, Serial No. 373,856, filed January 9, 1941, and assigned to the assignee of this application. Inasmuch as the instant application is not directed per se to the arc extinguishing structure, it is believed that the general designation of an arc extinguishing unit 57 which is supplied with a blast of arc extinguishing fluid, such as compressed air, for example, will be sufficient for the purpose at hand. Movement of the movable contact member 31 to open and closed circuit positions in this instance is accomplished by an operating mechanism housed within the casing 19 as more clearly shown in Fig. 3.

The operating mechanism comprises a main operating lever or rocker arm 59 fixedly secured intermediate its ends to a shaft 61 which is journaled for rocking movement to the side walls of the casing 19. The left-hand end of the rocker arm 59 is coupled by a link 63 to the lower end of the moving contact member 31. The driving force for actuating the rocker arm 59 is obtained from a fluid driven piston 65 operative within a cylinder 67. A connecting rod 69 secured to the piston 65 extends upwardly through the cylinder 67 and has its upper end coupled by a link 71 to the rocker arm 59 at 73. Thus when piston 65 is moved up and down within the cylinder 67, rocker arm 59 will be alternately rocked in a clockwise and then counterclockwise direction so as to move the contact member 31, respectively, to closed and open positions.

The right-hand end of rocker arm 59 is coupled by a link 75 to the upper end of a connecting rod 77 which, in turn, is coupled to a piston 79. The piston 79 is operated in a cylinder 81 to provide a shock absorbing mechanism for preventing the moving contact 31 from rebounding, particularly during the circuit closing operation.

A ball check valve 83 is provided at the lower end of the cylinder 81, so that as the piston 79 is drawn upwardly during a circuit opening operation a predetermined amount of air will be drawn into the cylinder 81. It will be apparent that movement of the contact structure to the closed position will cause the piston 79 to be moved by the rocker arm 59 in the downward direction against a cushion of air contained within the cylinder 81. Particularly, if high-speed motion is employed in closing the contact 31, considerable inertia of the moving parts would have to be overcome at the end of the closing stroke which would have a tendency to cause the moving contact 31 to rebound toward the open circuit position. The cushion of air under the piston 79 thus cushions the shock of the closing stroke and arrests the motion of the moving contact. This cushion of air, however, if not promptly relieved when the contact 31 has reached its fully closed position, will act as a spring and tend to drive the contact 31 to the open position by acting upwardly on the piston 79.

In order to avoid this action, a release valve 85 is provided in the lower side of the cylinder 81 having a stem 87 extending upwardly into the interior of the cylinder 81, so that when the piston 79 approaches its lowermost position it will engage the stem 87 and open the valve 85 so as to bleed the air compressed under the piston from the cylinder, thereby permitting the contact structure to remain in the closed circuit position.

The operating mechanism within the casing 19 in addition to actuating the moving contact 31 to open and closed circuit positions also operates the switch blade 39 of the disconnect switch 41 in proper sequence. In order to effect operation of the blade 39, the shaft 61 is provided with a crank arm 89, the left-hand end of which is connected to one end of an L-shaped link 91. The other end of the link 91 is pivotally connected to a relatively short crank arm 93 secured to a shaft 95 journaled within the casing 19.

The shaft 95 extends through the opposite sides of the casing 19 and supports the operating arm 45 of the disconnect switch 41. When the piston 65 in the cylinder 67 is moved downwardly so as to rock the shaft 61 in a counterclockwise direction, as viewed in Fig. 3, the crank arm 89 will also be rotated in a counterclockwise direction. Movement of the arm 89 in this manner imparts a translatory motion to the link 91 which acts upon the crank arm 93 causing it to be rotated in a counterclockwise direction, and, in turn, rotating the operating arm 45 in a counterclockwise direction.

The pivotal connection of the blade 39 upon the actuating arm 45 is more clearly illustrated in Fig. 2. As shown in this figure, the left-hand end of blade 39 is provided with a hollow portion 97 into which a quadrant like portion 99 of the actuating arm 45 extends. The portions 97 and

99 are pivoted to each other by the pin 43. The quadrant member 99 has a guide rod 101 pivoted thereto at 103. The guide rod 101 carries a compression spring 105 and extends through a stop wall 107 in the hollow portion 97. The spring 105 thus bears against the guide rod 101 at its left-hand end and against the stop wall 107 at its right-hand end so as to bias the switch blade 39 in a counterclockwise direction about the pivot pin 43 until a stop portion 109 engages the upper edge of the quadrant member 99.

Now, as more clearly shown in Fig. 1, the actuating arm 45 and the blade 39 form a toggle between the shaft 95 and the jaw contact 47, the knee of the toggle being at the pivot pin 43 which is overcenter with respect to a line passing through the shaft 95 and the right-hand contact engaging end of the blade 39. Rotation of the arm 45 in a counterclockwise direction will break the toggle at the pin 43 and cause opening of the switch as follows: The initial rotary movement of the actuating arm 45 in a counterclockwise direction causes the pin 43 to be moved to dead center which in addition to imparting a slight rocking movement to the blade 39 with respect to the contact 47 also causes the blade 39 to move a short distance substantially longitudinally to the right with respect to the contact 47. Immediately after pivot pin 43 passes dead center, translatory motion takes place in the opposite direction, which motion, however, is principally longitudinally of the blade and to the left so as to withdraw the right-hand end of the blade 39 from the jaw contact 47.

As soon as the switch blade 39 has been withdrawn from the jaw contact 47, the spring 105 will cause the switch blade 39 to rotate in a counterclockwise direction causing it to swing upwardly with a snap action. The switch blade 39 will then be maintained against relative movement with respect to the actuating arm 45 at all times when the outer end of the switch blade 39 is free from the contact 47.

In the meantime the actuating arm 45 will have assumed its full open position, as shown by the dotted lines in Fig. 1, in which position switch blade 39 is caused to engage a contact jaw 111 carried by the upper terminal cap 27. In this position of the switch blade 39, an electrical connection is made from the stationary contact member 29, through the jaw contact 111, switch blade 39, flexible conductors 37 and 33 to the movable contact 31, thereby short circuiting the interrupting gap between these contacts. Movement of the actuating arm 45 and the contact operating rocker arm 59 is so related that the moving contact 31 is moved to its full open circuit position just prior to release of the right-hand end of switch blade 39 from the jaw contact 47. In fact, arc extinction within the interrupter 57 is complete prior to the disengagement of the blade 39 from the contact 47. Also, when the switch blade 39 short circuits the current interrupting gap between the contacts 29 and 31 all tendency for break down of this gap due to the applied line voltage between the terminals of the interrupter is removed.

Sparking due to capacity charging current between the arcing contacts is thereby avoided without the continuance of a blast of arc extinguishing fluid. The closing operation of the interrupter is effected by moving the piston 65 upwardly and in all other respects the operation of the mechanism takes place in the reverse manner from that previously described with the exception that the biasing spring 105 of the switch blade 39 causes the blade to move rigidly with the operating arm 45 so that even though the blade 39 disengages from its contact 111 at about the time the moving contact 31 starts its closing movement, the mechanism is so arranged that the contacts 31 and 29 will engage just prior to engagement of the switch blade 39 with the contact jaw 47. The final closing operation of the interrupter then takes place through the disconnect switch 41.

It is desirable to indicate the position of the moving contact 31 as well as the disconnect switch blade 39 at a point remote from the circuit interrupter. For this purpose an auxiliary switch 113 mounted upon the frame 11 is employed. This switch may be of usual construction for controlling a signal light circuit and in addition may contain further control elements for controlling the sequence of operation of the several fluid control valves which will hereinafter be more fully described.

The auxiliary switch 113, as shown more clearly on Figs. 1 and 6, has an operating arm 115 which is coupled by a rod 117 to a crank arm 119. The arm 119 is fixed to a shaft 121 extending through a portion of a hollow conducting member 123 forming part of the gas blast conducting system which will be hereinafter more fully described.

Extending interiorly of the hollow member 123 and also fixed to the shaft 121 is a crank arm 125. The crank arm 125 has pivoted thereto the lower end of a pull rod 127. The pull rod 127 extends upwardly through the hollow support insulator 13 and into the casing 19 where it is surrounded by another hollow conducting member 129 which joins the upper end of the insulator 13 with the lower end of the hollow insulator 21. The upper end of the pull rod 127 is fastened to a crank arm 131 carried by a shaft 133 which extends exteriorly of the hollow member 129 and has a second crank arm 135 thereon. This last named crank arm is coupled by means of a rod 137 to a crank arm 139 rigidly secured to the shaft 61 of the contact operating mechanism. It thus appears that when the rocker arm 59 is rotated in a counterclockwise direction, as viewed in Fig. 3, crank arm 139 will also be rotated in a counterclockwise direction transmitting motion by means of the rod 137 to the crank arms 135 and 131 which will be in the clockwise direction. The clockwise rotation of arm 131 will cause the pull rod 127 to be moved downwardly and effect a clockwise rotation of crank arms 125 and 119 which, in turn, will actuate the switch arm 115.

It will be noted that since the operating mechanism within the housing 19 and the housing itself is maintained at line potential, whereas the auxiliary switch 113 is at ground potential upon the frame 11, the pull rod 127 is of insulating material.

In order to maintain rod 127 of dimensions such that it does not materially obstruct the flow of fluid through the insulator 13 and the hollow member 129, a relatively small rod cross section is employed. Owing to the length of the rod 127, considerable whipping action would take place if it were not maintained in tension. A suitable tensioning device is provided by means of a spring 141 (Fig. 6) operative within a guide tube 143 and operatively coupled to a crank arm 145 fixed to the shaft 121. Thus the shaft 121 is always biased in the clockwise direction, as viewed in

Fig. 6, thereby maintaining the pull rod 127 in tension.

Fluid under pressure for extinguishing the arc and also for operating the piston 65 may be stored in a tank 147 mounted within the framework 11. Extending from the left-hand end of the tank 147 is a conducting pipe 149 which has mounted thereon and in communication therewith a blast valve mechanism generally indicated at 151. The blast valve mechanism 151 communicates with the hollow member 123 previously mentioned and the passage through the hollow support insulator 13. The passage through the insulator 13 communicates by way of the hollow member 129 with the tubular insulator 21 mounted upon the casing 19 and which supports the circuit interrupting unit 23. Thus fluid under pressure from the tank 147 is conducted to the arc extinguisher 57 in the interrupting unit 23 by way of the pipe 149, valve 151, hollow member 123, insulator 13, hollow member 129 and the tubular insulator 21.

The blast valve mechanism 151, as more clearly shown in Fig. 6, comprises a valve housing 153 having a valve 155 therein. The valve 155 is operated to open and closed positions by a rocker arm 157 carried by a shaft 159 and journaled in the side of the casing 153. The rocker arm 157 is actuated by a piston 161 operated within a cylinder 163 secured to the valve housing 153. A spring 165 disposed within the cylinder 163 normally biases the piston 161 downwardly and holds the valve 155 closed.

Fluid under pressure is admitted from the lower side of the housing 153 through a passage 167, through an electromagnetically actuated valve 169 and passage 171 to the cylinder 163 to the lower side of piston 161. This causes the piston 161 to be raised against the action of the spring 165 to rock the shaft 159 in a counterclockwise direction so as to open the valve 155, thereby permitting a blast of fluid under pressure to flow through the passages previously mentioned to the arc extinguisher 57. Valve 169 may be controlled by a solenoid 173 from a suitable control source not shown, but which may be conventional and is generally well known in the art. When the solenoid 173 is deenergized, the control valve 169 is permitted to close, thereby causing the spring 165 to return the piston 161, and consequently the valve 155 to the closed position.

Fluid under pressure from the tank 147 is also utilized to actuate the contact operating piston 65 operative within the cylinder 67. For this purpose, the fluid conducting pipe 149 is provided with two branch pipes 175 and 177 (Fig. 7). The pipe 175 leads to an opening valve mechanism generally indicated at 179, whereas the branch conductor 177 leads to a closing valve mechanism generally indicated at 181.

The fluid under pressure from the valve mechanism 179 is conducted through a pipe 183 which communicates with the lower portion of the tubular insulator 17, as shown in Fig. 7. The casing of the operating cylinder 67 (Fig. 5) is provided with a passage 185 extending from the upper end thereof from a point normally above the uppermost position of the piston 65, and through the flanged portion 187 at the base thereof. The passage 185 also communicates with the passage in the insulator 17 through an opening 189 in the bottom of the casing 19. The closing valve mechanism 181 controls the flow of fluid from the pipe 177, through a pipe 191 which communicates with the passage through the insulator 15. The flanged base portion 187 of the operating cylinder 67 has another passage 193 which communicates with the lower side of the cylinder 67 and also with the passage in the insulator 15, through an opening 195 in the bottom of the casing 19, so as to provide a passage to the lower side of the piston 65 for actuating the piston to the closed circuit position.

Further details of the opening valve mechanism are shown in Fig. 9, in which the reference numeral 197 designates a valve housing having a valve 199 adjacent the lower end thereof. The valve 199 has a stem 201 encircled by a spring 203 for normally holding the valve closed. The valve stem 201 is actuated to the open position by a piston 205 operative within the housing 197 and which has an upper effective pressure reactive area greater than the lower area of the valve 199, so that when the upper side of the piston is subjected to fluid under pressure from the pipe 175, the piston will be moved into engagement with the stem 201 to actuate the valve 199 to the open position.

Fluid under pressure from the pipe 175 is admitted to the upper side of the piston 205, through the passages 207 and 209. Control of the fluid through these passages is obtained by an electromagnetically actuated valve 211, including a solenoid 213. Upon opening of the valve 199 fluid under pressure is permitted to flow from the pipe 175 through a port 215 in the valve housing 197 which communicates with the pipe 183.

Fluid under pressure then proceeds through the pipe 183, through the insulator 17, the passage 185 to the upper side of the piston 65 in the operating cylinder 67 so as to actuate the piston 65 to the open circuit position and cause a separation of the contact structure. When the valve 211 is closed, pressure is relieved on top of the piston 205 and the piston is moved to its upper or normal position by a spring 217. The piston 205 also has a sleeve 219 secured to the lower side thereof which serves to control a bleed passage 221 disposed in the housing 197. When the piston 205 is in the uppermost position, as shown in Fig. 9, the sleeve 219 uncovers the passage 221, thereby connecting the upper side of the operating piston 65 to atmosphere. However, during the initial stages of movement of the piston 205 towards the valve stem 201, the bleed passage 221 is closed by the sleeve 219, thereby preventing loss of pressure to atmosphere when the valve 199 opens to admit pressure to the operating cylinder 67.

In order to prevent actuation of the opening valve mechanism 179 which would produce an opening operation of the interrupter contacts at such times when failure of the electromagnetic control for the blast valve mechanism 151 has occurred, a mechanical interlock is provided between the valve mechanisms 151 and 179. This interlock mechanism is more clearly shown in Figs. 6, 7 and 9.

The shaft 159 carrying the rocker arm 157 has rigidly secured thereto a latch arm 223. This latch arm extends laterally and upwardly with respect to the axis of the shaft 159 and is adapted to engage a rocker arm 225 pivoted about a shaft 227 journaled in a bracket 229 carried by the valve housing 197.

The right-hand end of the rocker arm 225, as viewed in Figs. 6 and 9, is coupled to a connecting rod 231 which extends through the upper end of the valve housing 197 and is secured to the piston 205. Thus when the piston 205 is in its uppermost position and the blast valve 155 is

closed, the left-hand end of the rocker arm 225 engages the lower side of the latch arm 223 so as to hold the piston 205 against movement in the downward direction even though fluid under pressure is admitted to the upper side of the piston. Thus in the event that the solenoid 213 of the control valve 211 receives an impulse tending to actuate the opening valve mechanism 179 when the electromagnetic control mechanism for the blast valve mechanism 151 is inoperative, the opening of valve 199 will be prevented. Consequently, the interrupter contacts and arc extinguishing mechanism will be protected from the burning action of an arc should an attempt be made to open the circuit when the circuit interrupting blast of fluid is not available for interruption.

The closing valve mechanism 181 is generally similar to the opening valve mechanism 179 and is more fully illustrated in Fig. 7. This mechanism includes a valve housing 233 having a valve 235 operative adjacent the lower end thereof. The valve 235 also has a stem 237 that is spring actuated to the closed position. The valve stem 237, however, in this instance has an extension 239, the purpose of which will appear more fully hereinafter. Actuation of the valve 235 to the open position is accomplished by a piston 241 operative within the valve housing 233 and slidable about the extension 239.

Control of fluid under pressure from the pipe 177 to the top of piston 241 is obtained by an electromagnetically controlled valve 243, including a solenoid 245. When a closing impulse is received, that is, when solenoid 245 is energized, valve 243 opens to permit a flow of fluid under pressure from the pipe 177 to the upper side of the piston 241 which actuates the piston downwardly against the stem 237 so as to open the valve 235. Fluid under pressure will then flow from the pipe 177, through a port in the valve housing 233 (not shown) but which is similar to the port 215 in the housing 197 shown in Fig. 9. This port communicates with the pipe 191 so as to direct fluid under pressure through the passage in insulator 15 through the passage 193 and finally to the lower side of the operating piston 65 so as to actuate the interrupter contact mechanism to the closed circuit position. The piston 241 in this instance also controls a bleed passage 247, through the valve housing 233 for the purpose of connecting the lower side of the operating piston 65 to atmosphere at the end of a closing operation.

In order to prevent failure of the operating mechanism which may be caused by conflicting control impulses being impressed upon the solenoids 213 and 245 which would normally tend to produce both opening and closing operations of the interrupter at the same time or in such sequence that one operation would predominate the other, thereby producing the wrong operation, an interlock is provided between the opening and closing valve mechanisms 179 and 181. For this purpose, the upper end of the valve housing 233 is provided with a cylinder 249 into which the extension 239 of the valve stem 237 extends. Operative within the cylinder 249 and slidable about the extension 239 is a piston 251 normally urged to its lowermost position by a spring 253.

The upper end of the extension 239 is provided with a stop such as a nut and washer arrangement 255, as shown, against which the piston 251 may be moved. The lower end of the cylinder 249 communicates by means of a pipe 257 to the valve housing 197 and with the port 215 of that housing. Thus when valve 199 of the opening valve mechanism 179 is opened, fluid under pressure may flow through the pipe 257 to the lower side of the piston 251 so as to raise that piston against the stop 255.

The effective fluid pressure area of the piston 251 is made larger than the effective fluid pressure area of the piston 241, so that if the electromagnetically actuated valve 243 is opened to admit fluid under pressure to the top of piston 241 tending to move the piston downwardly to open the valve 235, the force exerted upon the valve in the downward direction will be less than the force exerted by the piston 251 in the upward direction. Consequently, the valve 235 will remain closed and the valve 199 of the opening mechanism 179 will function in its normal manner to complete the opening operation.

It also follows that in the event the solenoid 245 of the closing valve mechanism 181 is energized to perform a closing operation and during which time the solenoid 213 of the opening valve mechanism 179 becomes energized, the piston 251 will overcome the force exerted by the piston 241 so as to cause the valve 235 to close which immediately permits a fluid pressure on the upper side of the operating piston 65 to dominate and move the contact operating mechanism to the open circuit position.

Although we have not shown a specific control circuit for energizing the valve mechanism solenoids 173, 213 and 245, it will be understood that any conventional means may be employed which in conjunction with the usual auxiliary switch, as shown at 113, will permit operation of the contact operating mechanism to open and closed circuit positions either manually or by full automatic means. It should also be understood that the specific description and illustrations contained herein are merely illustrative of our invention and many changes and modifications may be made by those skilled in the art without departing from the spirit and scope of the appended claims.

We claim as our invention as follows:

1. In a circuit interrupting device, a pair of arcing contacts separable to provide a current interupting break, a pair of switch members connected in series with said arcing contacts and separable to provide an isolating break, and operating means for sequentially moving said arcing contacts and said switch members to the open position, at least one of said switch members being movable into bridging relation with said arcing contacts upon disengagement from the other switch member to electrically connect said arcing contacts with each other.

2. In a circuit interrupting device, a pair of arcing contacts at least one of which is movable to provide a current interrupting break, a pair of switch members at least one of which is movable to provide an isolating break, means connecting said movable arcing contact with said movable switch member, and operating means for first actuating said movable arcing contact and then said movable switch member to the open position, said movable switch member being movable into circuit making relation with said other arcing contact to interconnect said arcing contacts when said movable switch member is in the full open circuit position.

3. The combination with a circuit interrupter

having a line terminal, a pair of arcing contacts one of which is connected to said line terminal and operating means for separating said arcing contacts to provide a current interrupting break, of isolating switch means in series with said arcing contacts, said switch means including a movable blade member and a coacting terminal contact, means for hingedly supporting said blade member upon said circuit interrupter for swinging movement between said terminal contact and said line terminal, and means for operating said blade member in timed sequence with said arcing contacts.

4. In a switching device, a pair of line terminal members, a switch blade arranged for movement to alternately engage one and then the other of said line terminal members, a pair of arcing contacts one of which is connected to the first line terminal member and the other to said switch blade, said arcing contacts and said switch blade normally providing a series connection between said line terminal members when said switch blade is in engagement with the second line terminal member, and operating means for first separating said arcing contacts to introduce a current interrupting break between said line terminal members and thereafter to move said switch blade into engagement with said first line terminal member for introducing an isolating break between the line terminal members and short circuit said arcing contacts.

5. In a circuit interrupter, a support insulator, an arc extinguishing device carried by said insulator, said arc extinguishing device including a line terminal member and a pair of separable contacts one of which is connected to said line terminal member, a switch blade hingedly carried by said arc extinguishing device and connected to the other of said separable contacts, a second support insulator having a second line terminal member thereon, said switch blade normally engaging said second line terminal member and coacting with said separable contacts to provide a series connection between said line terminal members, and operating means for first separating said separable contacts to provide a current interrupting break and thereafter move said switch blade out of engagement with said second line terminal member to the open circuit position to provide an isolating break in the circuit, said first line terminal member being so arranged that said switch blade makes contacting engagement therewith when said switch blade is moved to its full open circuit position so as to remove potential from and then short circuit said arc extinguishing device.

6. In a circuit interrupter, separable contact means, operating mechanism for operating said contact means to open and closed positions, support means including at least one tubular insulator for supporting said contact means and said operating mechanism at a predetermined potential above ground, contact position indicating means maintained at substantially ground potential, and means of insulating material operative within said tubular insulator and actuable by said operating mechanism for actuating said contact position indicating means.

7. In a circuit interrupter, a base, a tubular insulator supported upon said base, an arc extinguishing device carried by said insulator, said arc extinguishing device including separable contact means for establishing a current interrupting break and operating means for actuating said contact means to open and closed positions, said operating means being maintained at line potential, contact position indicating means disposed on said base and maintained at ground potential, and means including a member of insulating material operable within said tubular insulator for operatively connecting said contact operating means and said contact position indicating means.

8. In a circuit interrupter of the fluid blast type, separable contact structure for establishing an arc, fluid pressure actuated means for operating said contact structure, operating valve means controlling the supply of fluid under pressure to said operating means, blast valve means for controlling the supply of arc extinguishing fluid to said contacts, and means dependent upon the position of said blast valve means for controlling the operativeness of said operating valve means controlling the supply of fluid to said operating means.

9. In a circuit interrupter of the fluid blast type, separable contact structure for establishing an arc, operating means for moving said contact structure to open and closed positions, said operating means including a fluid actuated piston, an opening valve for controlling the supply of fluid to one side of said piston for opening said contact structure, a closing valve for controlling the supply of fluid to the other side of said piston to close said contact structure, a blast valve for controlling the supply of an extinguishing fluid to said contact structure, and means interlocking said opening valve and said blast valve for holding said opening valve closed until said blast valve is moved toward its open position.

10. In a circuit interrupter of the fluid blast type, separable contact structure for establishing an arc, operating means for moving said contact structure to open and closed positions, said operating means including a fluid actuated piston, an opening valve for controlling the supply of fluid to one side of said piston for opening said contact structure, a closing valve for controlling the supply of fluid to the other side of said piston to close said contact structure, a blast valve for controlling the supply of an extinguishing fluid to said contact structure, operating mechanism for opening said blast valve including a latch member, and operating mechanism for said opening valve including a linkage arranged to be latched to said latch member when said blast valve is closed for preventing movement of said opening valve operating mechanism to the open position, said latch member being movable in response to movement of said blast valve to the open position to release said linkage to permit opening of said opening valve.

11. In a circuit interrupter, separable contact structure, operating means for moving said contact structure to open and closed positions, said operating means including fluid actuated piston means, opening valve means for controlling the supply of fluid to one side of said piston means for opening said contact structure, closing valve means for controlling the supply of fluid to the other side of said piston means for closing said contact structure, and means responsive to the actuation of said opening valve means to the open position for holding said closing valve means in the closed position.

12. In a circuit interrupter, separable contact structure, operating means for moving said contact structure to open and closed positions, said operating means including fluid actuated piston means, opening valve means for controlling the

supply of fluid to one side of said piston means for opening said contact structure, closing valve means for controlling the supply of fluid to the other side of said piston means for closing said contact structure, and pressure responsive means associated with said closing valve means operating in response to the flow of fluid through said opening valve means for maintaining said closing valve means closed.

13. In a circuit interrupter, separable contact structure, operating means for moving said contact structure to open and closed positions, said operating means including a fluid actuated piston, valve means for controlling the supply of fluid to one side of said piston for opening said contact structure, valve means for controlling the supply of fluid to the other side of said piston for closing said contact structure, pressure actuated means for holding one of said valve means closed, and means operating in response to the flow of fluid through the other of said valve means for supplying fluid to said pressure actuated means.

14. In a circuit interrupter, separable contact structure, operating means for moving said contact structure to open and closed positions, said operating means including a fluid actuated piston, opening and closing valve means for controlling respectively the supply of fluid to opposite sides of said piston for causing said contact structure to be moved to open and closed positions, fluid actuated means for controlling each of said valve means, and a second fluid actuated means for providing an additional control for said closing valve means, said second fluid actuated means being responsive to the flow of fluid through said opening valve means and operative to render said first fluid actuated means for said closing valve means inoperative to open said closing valve means.

15. In a circuit interrupter, a supporting frame, a tank carried by said frame for storing fluid under pressure, a plurality of tubular insulators supported upon said frame, a current interrupting contact structure and operating mechanism therefor supported upon said insulators, said operating mechanism including fluid pressure actuated piston means, at least two of said insulators having a fluid conducting passage therethrough, means including said two insulators for conducting fluid from said tank to opposite sides of said piston means for moving said contact structure to open and closed positions, and valve means disposed at ground potential adjacent said tank for controlling the flow of fluid from said tank into said insulators.

16. In a circuit interrupter, a supporting frame, a tank carried by said frame for storing fluid under pressure, a plurality of insulators supported upon said frame, a current interrupting contact structure and operating mechanism therefor supported upon said insulators, said operating mechanism including fluid pressure actuated piston means, means including said two insulators for conducting fluid from said tank to opposite sides of said piston means for moving said contact structure to open and closed positions, and valve means disposed at ground potential adjacent said tank for controlling the flow of fluid from said tank into said insulators, means for conducting an arc extinguishing blast of fluid from said tank to said contact structure, said last named means including a third of said supporting insulators, and valve means disposed at ground potential between said tank and said third insulator for controlling the arc extinguishing blast of fluid to said contact structure.

17. In a circuit interrupter, a supporting frame, a tank carried by said frame for storing fluid under pressure, a plurality of tubular insulators supported upon said frame, a current interrupting contact structure and operating mechanism therefor supported upon said insulators, one of said insulators having a fluid conducting passage therethrough, means including said one insulator for conducting a blast of arc extinguishing fluid from said tank to said contact structure, an auxiliary switch disposed upon said frame, and a linkage operatively coupling said operating mechanism to said auxiliary switch, said linkage including a member of insulating material operative entirely within the fluid conducting passage in said one insulator.

18. In a compressed gas circuit interrupter, separable contact means, operating mechanism for operating said contact means to open and closed positions, support means including at least one tubular insulator for supporting said contact means and said operating mechanism at a potential above ground, said tubular insulator including a gas passage connected at its end at ground potential to a source of compressed gas for supplying compressed gas to the part of the circuit interrupter at a potential above ground, and means of insulating material extending through said gas passage and connected to be operated upon movement of said contact means to be responsive at its end at ground potential to said movement.

19. In a compressed gas circuit interrupter, separable contact means, operating mechanism for operating said contact means to open and closed positions, support means including at least one tubular insulator for supporting said contact means and said operating mechanism at a potential above ground, said tubular insulator including a gas passage connected at its end at ground potential to a source of compressed gas for supplying compressed gas to the part of the circuit interrupter at a potential above ground, means of insulating material extending through said gas passage and connected to be operated upon movement of said contact means to be responsive at its end at ground potential to said movement, and biasing means maintaining said means of insulating material in tension upon movement of said contact means to both open and closed positions.

20. In a circuit interrupter, a supporting frame, a tank carried by said frame for storing fluid under pressure, a plurality of tubular insulators supported upon said frame, a current interrupting contact structure and a disconnecting switch member and operating mechanism for both said contact structure and disconnecting switch member all supported upon said insulators, said operating mechanism including fluid pressure actuated piston means, at least two of said insulators having a fluid conducting passage therethrough, means including said two insulators for conducting fluid from said tank to opposite sides of said piston means for moving said contact structure and said disconnecting switch member to open and closed positions, and valve means disposed at ground potential adjacent said tank for controlling the flow of fluid from said tank into said insulators.

21. In a circuit interrupter, a supporting frame, a tank carried by said frame for storing fluid under pressure, a plurality of insulators supported

upon said frame, a current interrupting contact structure and a disconnecting switch member and operating mechanism for both said contact structure and said disconnecting switch member all supported upon said insulators, said operating mechanism including fluid pressure actuated piston means, means including said two insulators for conducting fluid from said tank to opposite sides of said piston means for moving said contact structure and said disconnecting switch member to open and closed positions, and valve means disposed at ground potential adjacent said tank for controlling the flow of fluid from said tank into said insulators, means for conducting an arc-extinguishing blast of fluid from said tank to said contact structure, said last-named means including a third of said supporting insulators, and valve means disposed at ground potential between said tank and said third insulator for controlling the arc-extinguishing blast of fluid to said contact structure.

22. In a gas blast circuit interrupter, a supporting frame, an insulator supported upon said frame and carrying a disconnecting contact and one line terminal of the circuit interrupter, a plurality of insulators supported upon said frame and spaced from the first said insulator, a second line terminal and a current interrupting contact structure and a disconnecting switch member all mounted on said plurality of insulators, pneumatic operating means for opening and closing said current interrupting contact structure and for moving said disconnecting switch member into and out of engagement with the disconnecting contact on the first said insulator, a source of compressed gas and a blast valve on said supporting frame at ground potential and connected to one of said plurality of insulators for conducting gas therethrough to extinguish the arc drawn by said current interrupting contact structure, control valve means for said pneumatic operating means also mounted at ground potential, and said plurality of insulators being used for controlling movement of said current interrupting contact structure and said disconnecting switch member upon actuation of said control valve means.

23. In a gas blast circuit interrupter, a supporting frame, an insulator supported upon said frame and carrying a disconnecting contact and one line terminal of the circuit interrupter, a plurality of insulators supported upon said frame and spaced from the first said insulator, a second line terminal and a current interrupting contact structure and a disconnecting switch member all mounted on said plurality of insulators, pneumatic operating means for opening and closing said current interrupting contact structure and for moving said disconnecting switch member into and out of engagement with the disconnecting contact on the first said insulator, a source of compressed gas and a blast valve on said supporting frame at ground potential and connected to one of said plurality of insulators for conducting gas therethrough to extinguish the arc drawn by said current interrupting contact structure, an opening valve mounted at ground potential and connected to a second of said plurality of insulators to control the flow of gas therethrough to said pneumatic operating means for opening both said current interrupting contact structure and said disconnecting switch member, and a closing valve mounted at ground potential and connected to a third of said plurality of insulators to control the flow of gas therethrough to said pneumatic operating means for closing both said current interrupting contact structure and said disconnecting switch member.

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DISCLAIMER

2,282,153.—*Benjamin P. Baker*, Tuitle Creek, and *Andrew H. Bakken*, Edgewood, Pa. CIRCUIT INTERRUPTER. Patent dated May 5, 1942. Disclaimer filed May 27, 1944, by the assignee, *Westinghouse Electric & Manufacturing Company*.

Hereby enters this disclaimer to claims 11, 12, 13, and 14 of said specification.

[*Official Gazette June 27, 1944.*]

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Hereby enters this disclaimer to claims 8 and 9 of said specification.

[*Official Gazette August 15, 1944.*]

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