

Feb. 29, 1944.

L. R. LUDWIG ET AL

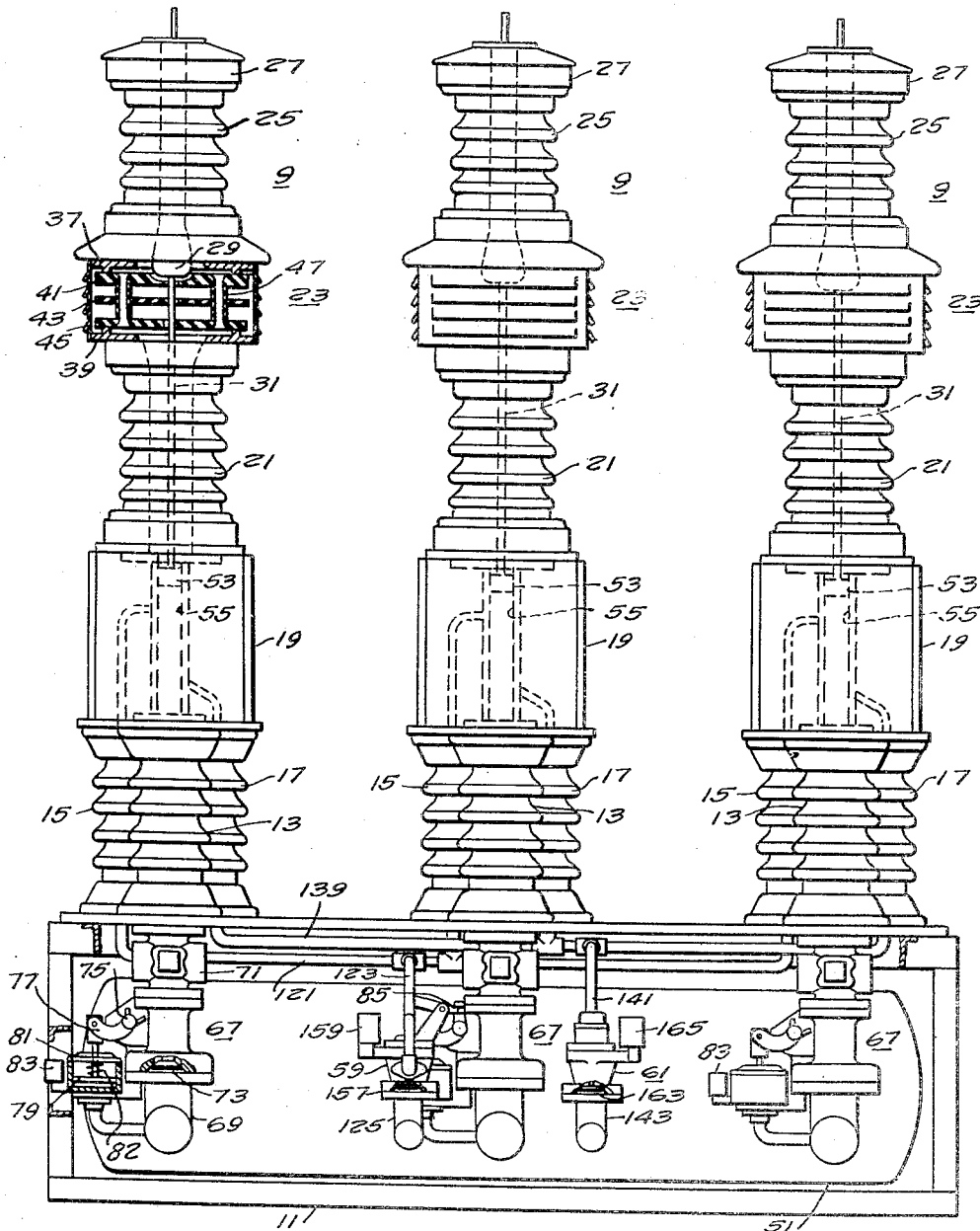
2,342,809

COMPRESSED AIR CIRCUIT BREAKER

Filed March 31, 1942

3 Sheets-Sheet 1

Fig. 1.



WITNESSES:

E. A. McLaughlin
G. S. Parker

INVENTORS

Leon R. Ludwig, Benjamin P. Baker
and James M. Cumming.

BY

Ralph W. Lingle
ATTORNEY

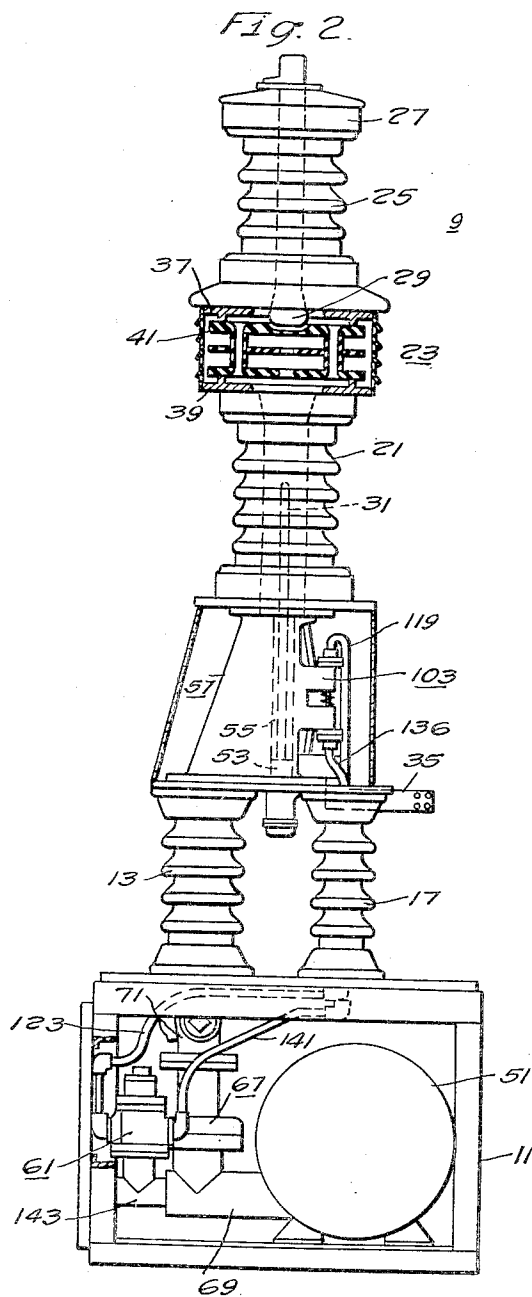
Feb. 29, 1944.

L. R. LUDWIG ET AL
COMPRESSED AIR CIRCUIT BREAKER

2,342,809

Filed March 31, 1942

3 Sheets-Sheet 2



WITNESSES:

E. A. McLoskey.
G. S. Parker

INVENTORS

Leon R. Ludwig, Benjamin F. Baker
and James M. Cumming
BY
Ralph H. Swingle
ATTORNEY

Feb. 29, 1944.

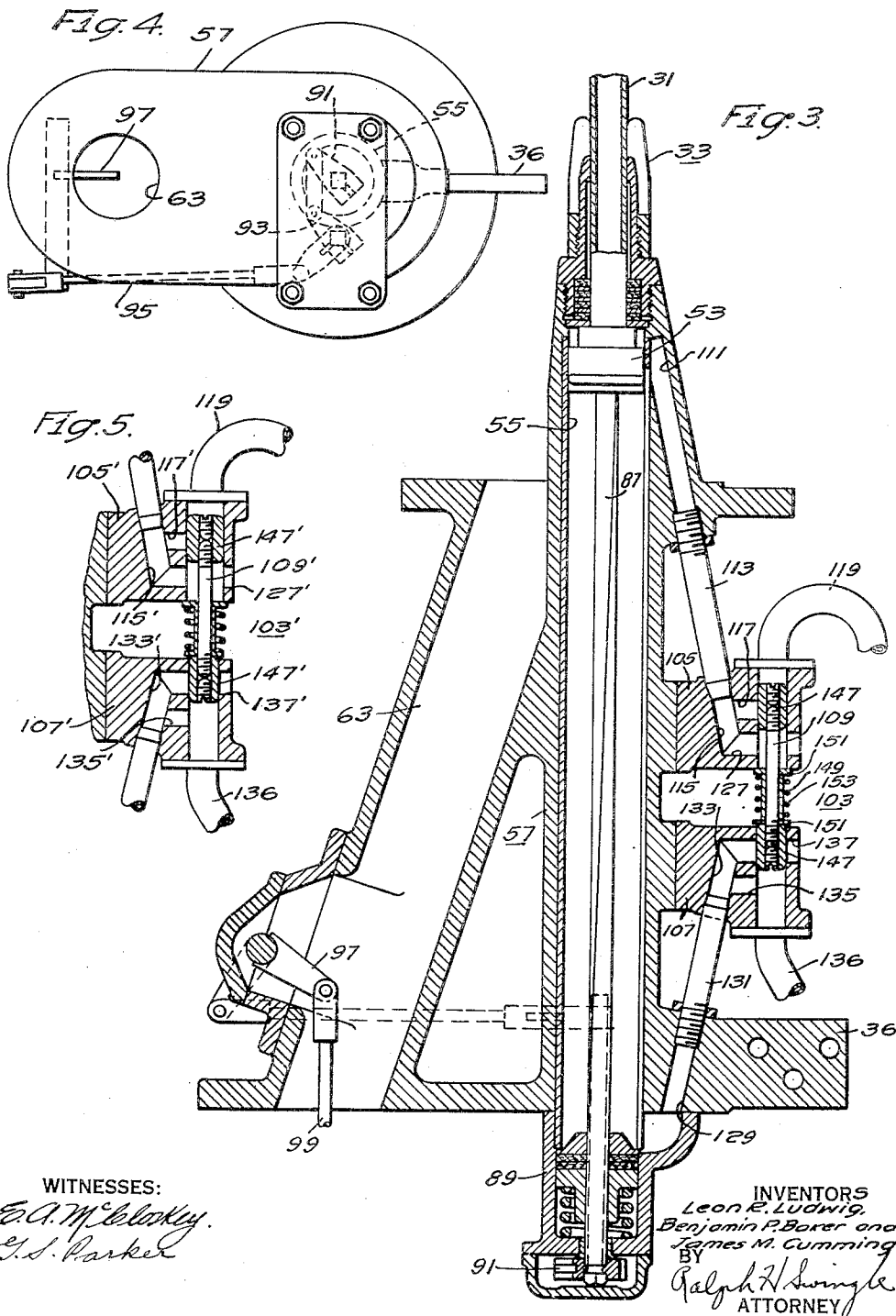
L. R. LUDWIG ET AL

2,342,809

COMPRESSED AIR CIRCUIT BREAKER

Filed March 31, 1942

3 Sheets-Sheet 3



WITNESSES:

E. A. M. C. C. C.
E. L. Parker

INVENTORS
Leon E. Ludwig,
Benjamin P. Baker and
James M. Cumming.
BY
Ralph H. Swingle
ATTORNEY

UNITED STATES PATENT OFFICE

2,342,809

COMPRESSED AIR CIRCUIT BREAKER

Leon R. Ludwig, Forest Hills, and Benjamin P. Baker and James M. Cumming, Turtle Creek, Pa., assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application March 31, 1942, Serial No. 437,010

20 Claims. (Cl. 200—148)

The invention relates to circuit breakers and more particularly to fluid blast circuit breakers of the fluid pressure operated type.

An object of the invention is the provision of an improved porcelain-clad compressed gas operated circuit breaker having a porcelain enclosed movable disconnect contact member.

Another object of the invention is the provision of a porcelain-clad compressed gas operated circuit breaker having an interrupting element and a movable arcing contact member which after arc extinction moves out of the interrupter into a porcelain enclosed disconnect chamber to introduce a disconnecting gap in the circuit.

Another object of the invention is the provision of a circuit breaker as described in the preceding paragraph, wherein the disconnect chamber is formed by a hollow supporting insulator which supports the interrupting element, and the passage or chamber of the insulator serves as a gas blast passage.

Another object of the invention is the provision of a compressed air circuit breaker pole unit having a single operating cylinder and piston for first drawing an arc in the interrupting element and then inserting a porcelain enclosed disconnecting gap in series with the interrupter.

Another object of the invention is the provision of a compressed air circuit breaker pole unit having a simple operating mechanism comprising a single unitary casting formed to provide an operating cylinder, and an air blast passage for the arc extinguishing blast.

Another object of the invention is the provision of a compressed air operated circuit breaker with an air control system including simple dump valve mechanism comprising a single valve member operated by the opening and closing air to dump air from the cylinder in front of the moving operating piston to atmosphere to facilitate high speed closing-opening operation and high speed reclosing operation.

Another object of the invention is the provision of a circuit breaker having a dump valve as described in the preceding paragraph, wherein the single piston type valve element has different pressure reactive areas to cause an opening operation to take precedence over a closing operation in case of conflicting impulses.

Another object of the invention is the provision of a compressed air circuit breaker that is simple, fast and reliable in operation and inexpensive to manufacture.

The novel features that are considered characteristic of the invention are set forth in par-

5 ticular in the appended claims. The invention itself, both as to structure and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description of several embodiments thereof when read in conjunction with the accompanying drawings, in which:

Figure 1 is a front elevational view, partly in section, of a three-pole circuit breaker embodying the features of the present invention;

10 Fig. 2 is a side elevational view, partly in section, of the circuit breaker;

Fig. 3 is a sectional view, on an enlarged scale, of one of the pole unit operating mechanisms and the dump valve thereof;

Fig. 4 is a bottom view of the mechanism shown in Fig. 3; and

Fig. 5 is a sectional view showing a modification of the dump valve mechanism.

Referring to Figure 1 of the drawings, the three-pole circuit breaker has three circuit interrupting pole units 9 which are mounted in spaced relation on a structural supporting frame 11. The three-pole units are of identical construction and each unit comprises three hollow supporting insulators 13, 15 and 17 secured to the frame in triangular spaced relation and rising vertically therefrom. Supported on the upper end of the insulators is a casing 19 for housing the contact operating mechanism more clearly shown in Fig. 3. The casing 19 supports a hollow insulator 21 which, in turn, supports a circuit interrupting element or arc extinguishing structure 23. A hollow insulator 25 extends upwardly from the arc extinguishing structure 23 and has a metallic terminal cap 27 secured on its upper end, and this cap forms the upper terminal of the pole unit. A stationary contact member 29 extends downwardly from the terminal cap 27 into the arc extinguishing structure 23. A cooperating movable contact member 31 coacts with the stationary contact member 29 and extends downwardly through the arc extinguishing structure 23 and through the passage of the hollow supporting insulator 21. The lower end of the contact member 31 extends into the casing 19 and is connected to an operating piston of the operating means as shown in Fig. 3.

The movable contact member 31 functions as the arcing contact and also as a disconnecting contact member as will be described hereinafter. The contact member 31 is electrically connected by means of a resilient multiple finger contact assembly 33 (Fig. 3) and through the operating cylinder casting, which is of conducting mate-

rial, to a terminal 35 which is secured to a projection 36 (Fig. 3) on the lower end of the cylinder casting and projects outwardly from the casing 19.

Extinction of arcs drawn by the movable contact member 31 takes place in the chamber of the arc extinguishing structure 23 and is accomplished by a blast of compressed gas, in this instance compressed air, directed through the passage of the hollow insulator 21 to the arc extinguishing structure 23 and the current arc. The arc extinguishing structure 23 is of the radial blast type generally similar to the structure disclosed in the copending application of L. R. Ludwig and B. P. Baker, Serial No. 373,856, filed January 9, 1941, U. S. Patent 2,313,159 issued March 9, 1943, and assigned to the assignee of the present invention.

The arc extinguishing structure comprises a pair of metallic flanged end members 37 and 39, the lower member 39 being secured to the insulator 21 and provided with an opening through which the contact member 31 extends and also through which gas may flow from the passage of the hollow insulator. The upper flanged end member 37 supports the insulator 25 and has a central opening through which the stationary contact extends. Disposed between the members 37 and 39 are a plurality of baffle members 41, 43 and 45 of insulating material, each of which has a central opening therethrough. The upper baffle member 41 has a central recess adjoining the central opening thereof. This cooperates with an air flow director surrounding the end of the stationary contact to direct the blast of air radially to the arc which plays through the central orifice in the baffle member 41. The space between the flanged end member 37 and the upper baffle member 41 is connected with the chamber formed by the lower flange member 39 by a plurality of tubular members 47 which also serve to space the baffle members apart. Compressed air can thus flow from the passage of the hollow insulator 21 through the tubular members 47 through the chamber provided between the upper flange member 37 and the baffle member 41, where it is then directed radially inwardly toward the central orifice in the upper baffle member 41. This flow of compressed air radially inwardly with high velocity subjects the arc playing within the central orifice to a strong de-ionizing influence as the stream of compressed air is turned from its radially inward direction to a direction parallel with the arc as the discharge takes place through the central orifice. The direction of blast air flow in passing through the orifice changes direction and flows radially outwardly in the space between the upper baffle member 41 and the central baffle member 43. The arc is thus quickly extinguished in the arc extinguishing structure by the deionizing and extinguishing action of the air blast.

Fluid under pressure, in this instance compressed air, for extinguishing the arcs and also for operating the contact members is stored in a common reservoir or tank 51 mounted within the frame 11. Compressed air is stored and maintained at a predetermined pressure in the tank 51 by a suitable motor driven compressor unit (not shown).

Each movable contact 31 of the three-pole breaker is operated to open and closed circuit position by an individual compressed air oper-

ating mechanism comprising a double acting piston 53 (Fig. 3) movable vertically in a relatively long operating cylinder 55 which is formed in a metal casting 57 and compressed air operating piston 53 for each of the three movable contact members 31. Each contact operating mechanism is mounted within its corresponding casing 19, and the three operating pistons 53 are adapted to be operated simultaneously to open or close the breaker by compressed air from the tank 51, the flow of compressed air for opening and closing the three poles of the circuit breaker being controlled by a single opening valve mechanism 59 and a single closing valve mechanism 61 (Fig. 1).

Referring to Fig. 3, the cylinder casting 57 has an air blast tube 63 formed integral therewith communicating at its lower end with the passage through the hollow insulator 13 and communicating at its upper end with the passage of the hollow supporting insulator 21, this tube and the aforementioned passages through the insulators 13 and 21 forming a path for the blast of compressed air which is directed to the arc extinguishing structure during circuit opening operations.

A separate air blast valve, indicated generally at 67 (Figs. 1 and 2), is provided for each of the three pole units of the circuit breaker. Each blast valve 67 includes a housing, the lower end of which is connected by a pipe 69 to the air reservoir tank 51. The upper end of the blast valve housing is connected by a short section of pipe 71 to the passage of the hollow supporting insulator 13 of its corresponding pole unit. The valve element 73 (Fig. 1) within the blast valve housing is connected by means of a rock shaft 75 and a rocker arm 77 to a blast valve operating piston 79 disposed in a blast valve operating cylinder 81. The blast valve is biased to closed position by a spring 82 disposed in the valve operating cylinder 79, and is adapted to be operated to open position by compressed air from the pipe 69 upon opening of a pilot valve controlled by an electromagnet or solenoid 83. The three blast valve controlling solenoids 83 are electrically connected in parallel and arranged to be operated simultaneously with the operation of the opening valve mechanism 59, so that the blast air is directed to the arcs during the opening operation of the breaker. The center pole blast valve mechanism is preferably interlocked with the opening valve mechanism by means of an interlock 85 so as to prevent operation of the opening valve mechanism 59 in the event that the blast valves fail to operate.

In accordance with the present invention, the contact member 31 functions both as an arcing contact and as a disconnecting contact member for inserting a relatively long and safe gap in the circuit after extinction of the arc upon each circuit operating operation. When the piston 53 is moved downwardly by compressed air to open the circuit breaker, it moves through a relatively long stroke. During the initial portion of this stroke an arc is drawn in the upper section of the arc extinguishing structure 23 and is quickly extinguished in the chamber of the arc extinguisher by the blast of compressed air directed to the arc. After arc extinction, the movable contact member 31 continues its downward movement and is moved out of the arc extinguishing structure 23 and a considerable distance down into the passage of the hollow supporting insu-

lator 21 to the open position shown in Fig. 2, thereby inserting a disconnecting gap in series with the interrupting element 23. This disconnecting gap is capable of withstanding high voltages. It will be noted that the disconnecting contact member 31 and the disconnecting gap are totally enclosed by the supporting insulator 21, and thus provides a very desirable feature which makes the circuit breaker particularly suitable and safe for outdoor application.

Referring to Fig. 3, the movable contact member 31 is of tubular construction and the lower end thereof is secured in an opening provided in the operating piston 53. The operating piston is also provided with a substantially square babbitted opening (not shown), in alignment with the tubular contact member 31, for engaging a centrally disposed twisted square rod 87 which is rotatably mounted in a bearing provided in the lower portion of the lower cylinder head 89 secured to the bottom of the casting 57. The twisted square rod extends throughout the entire length of the operating cylinder and the lower end thereof has a crank arm 91 secured thereto which is connected by means of a linkage 93, 95 and 97 (Fig. 4) to a rod 99 (Fig. 3). The rod 99 is suitably connected to a conventional multipole auxiliary switch (not shown). The operating piston 53 and the tubular contact member 31 slide telescopically on the twisted square rod 87 as the piston is moved upwardly and downwardly in the operating cylinder, and this movement, due to the square opening in the piston and the twisted construction of the rod, causes the rod 87 to be rotated upon movement of the piston. This rotary movement of the rod 87 operates the auxiliary switch through the agency of the linkage 93, 95, 97 and 99.

In order to facilitate high speed closing-opening operation and high speed reclosing operation of the circuit breaker, the air in the cylinder ahead of the direction of movement of the piston must be exhausted to atmosphere so that it will not retard movement or reversal of the operating piston. In accordance with the present invention, this is accomplished by means of a simple automatic valve device indicated generally at 103 (Fig. 3). The valve device 103 comprises a housing formed in two separate sections 105 and 107 which are secured to a flattened surface formed on the cylinder portion of the casting 57. A single unitary slide valve member 109 is disposed for vertical sliding movement in aligned vertical passages provided in the valve housing sections 105 and 107. An air passage 111 formed in the upper end of the operating cylinder casting leads to the upper end of the operating cylinder 55 and is connected by a short section of pipe 113 to a passage 115 provided in the valve housing section 105. An inlet port 117 and an atmosphere exhaust port 127 communicate with the passage 115. The inlet port is connected by a pipe 119 and by the passage through the hollow insulator 15 to an opening air manifold pipe 121 (Fig. 1) common to the three pole units of the circuit breaker. The compressed air for producing simultaneous opening operation of the three movable contact members 31 is adapted to flow through the opening air manifold 121 and through the three hollow insulators 15, pipes 119 and inlet ports 117 to the upper ends of the three operating cylinders 55. The opening air manifold 121 is connected by a pipe 123 to the single opening valve mechanism 59, and this valve

mechanism 59 is, in turn, connected by a pipe 125 to the air reservoir tank 51.

An air passage 129 formed in the lower end of the cylinder casting 57 communicates with the lower end of the operating cylinder 55 and is connected through a short section of pipe 131 to a passage 133 formed in the lower section 107 of the automatic valve housing. The passage 133 communicates with an inlet port 135 and also with an exhaust port 137 formed in the section 107 of the valve housing.

The inlet port 135 is connected by a pipe 136 and by the passage through the supporting insulator 17 to a closing air manifold pipe 139 (Fig. 1) common to the three pole units of the circuit breaker. The closing air manifold pipe 139 is connected by a pipe 141 to the closing valve mechanism 61 and this valve mechanism is, in turn, connected by pipe 143 to the air reservoir tank 51.

The single slide valve member 109 is pneumatically operated by the opening and closing air, and functions to automatically control opening and closing of the inlet and exhaust ports for each end of the operating cylinder. The valve member 109 has a piston element 147 threadedly mounted on each end thereof, these piston elements being slidably mounted in the aligned vertical passages of the housing sections 105 and 107. The connecting rod portion of the valve member 109 extends between the valve housing sections 105 and 107 and slides through a sleeve 149 loosely disposed between the two housing sections 105 and 107. Washers 151 are interposed between each end of the sleeve 149 and the corresponding housing sections 105 and 107, the stem or connecting rod of the valve being slidable through the washers. The overall length of the sleeve 149 plus the washers 151 is slightly less than the distance between the opposed portions of the valve housing sections 105 and 107 so that the sleeve and washers are movable vertically a limited amount between the housing sections. A compression spring 153 encircles the sleeve 149 and the opposite ends of the spring bear against the loosely mounted washers 151. The sleeve 149 and washers 151 serve to limit upward and downward movement of the valve member 109 and the spring 153 acts to absorb the kinetic energy of the valve member at the ends of its stroke.

When compressed air flows through the pipe 119 to open the circuit breaker, the pressured air acting on the upper piston element 147 of the automatic valve member 109 pushes the valve member downwardly to its lower position. When the automatic valve member 147 is thus pushed downwardly to its lowermost position, the upper piston element 147 thereof opens the inlet port 117 to admit compressed air to the upper end of the operating cylinder, and closes the corresponding exhaust port 127 of the upper end of the cylinder. At the same time the lower piston element 147 opens the exhaust port 137 of the lower end of the cylinder and closes the inlet port 135 of the lower end of the cylinder. Opening of the exhaust port 137 connects the lower end of the operating cylinder to atmosphere through this port, so that air below the operating piston is exhausted to atmosphere and cannot retard opening movement of the circuit breaker.

Conversely, when compressed air flows through the pipe 136 to close the breaker, the pressure air acting on the lower piston element 147 of the automatic valve member 109 moves the valve member to its uppermost position as shown in

Fig. 3. When the valve member 109 is moved to its uppermost position, the lower piston element 147 thereof opens the inlet port 135 to admit compressed air to the lower end of the operating cylinder, and closes the exhaust port 137 of the lower end of the cylinder. At the same time the upper piston element 147 of the automatic valve member opens the exhaust port 127 for the upper end of the cylinder and closes the inlet port 117 for the upper end of the cylinder. Opening of the exhaust port 127 causes air in the cylinder above the operating piston to be exhausted to atmosphere, so that it will not retard closing movement of the operating piston and breaker.

The opening valve mechanism 59 and the closing valve mechanism 61 are of the same construction as disclosed in the copending application of B. P. Baker and A. H. Bakken, Serial No. 375,968, filed January 25, 1941, U. S. Patent 2,282,153 issued May 5, 1942, and assigned to the assignee of the present invention, and only a brief description thereof will be given in this application as the details of construction of these control valve mechanisms are not necessary to an understanding of the present invention. Referring to Fig. 1, the opening valve mechanism has a valve element 157 which is biased closed and which is caused to be opened by air pressure from the pipe 125 when the pilot valve of the mechanism is operated upon energization of a solenoid 159. Similarly, the closing valve mechanism 61 has a valve element 163 which is biased closed and which is caused to be opened by compressed air from the pipe 143 when the pilot valve of the mechanism is operated in response to energization of a solenoid 165 associated with the valve.

The solenoids 83 of the three blast valves 67 and the solenoid 159 of the opening valve mechanism 59 are adapted to be energized simultaneously upon opening operations of the circuit breaker, and the solenoid 165 of the closing valve mechanism may be energized either alone or simultaneously with the three blast valve solenoids 83 upon closing operation of the breaker.

The operation of the circuit breaker is briefly as follows. Opening operation of the circuit breaker is initiated by simultaneous energization of the blast valve controlling solenoids 83 and the solenoid 159 of the opening valve mechanism 59. Opening of the valve 59 causes compressed air to flow from the tank 51 through the opening air manifold 121, through the three porcelain insulators 15, pipes 119 and inlet ports 117 to the upper ends of the three operating cylinders 55. The pressure of the closing air in the pipes 119 pushes each of the automatic valve members 109 downwardly to its lowermost position thereby causing each automatic valve member 109 to open the inlet port 117 and close the corresponding exhaust port 127 for the upper end of the cylinder and at the same time to open the exhaust port 137 of the lower end of the corresponding cylinder and close the inlet port 135 for the lower end of the operating cylinder. Compressed air thereupon flows into the end of each operating cylinder and moves the operating piston 53 downwardly to open position.

The three blast valves 73 are each opened simultaneously with the opening valve mechanism 59 so that a blast of compressed air flows through the hollow insulators 21 to the arc extinguishing structures 23 to quickly extinguish the current arcs drawn as the movable contact members 31 separate from the stationary contacts 29.

Each movable contact member 31 is moved

downwardly to open position by its operating piston 53. The arc is extinguished by the blast of compressed air in the chamber of the arc extinguishing structure before the movable contact member moves out of the arc extinguishing structure so that the circuit is completely interrupted by this time. Each movable contact member 31 is moved out of the arc extinguishing structure 23 and downwardly for a considerable distance into the corresponding supporting insulator 21 after arc extinction, thus introducing a relatively long safe disconnecting gap in the circuit. By the time the circuit breaker reaches open position, the air blast valves have been returned to closed position, and the solenoid 159 of the opening valve is deenergized and the opening valve returned to closed position, thereby shutting off the opening air.

When the closing valve mechanism 61 is operated to open position, compressed air flows from the tank 51 through the closing air manifold pipe 139, insulators 17, pipes 136, and inlet ports 135 to the lower ends of the three operating cylinders 55. The compressed air in the pipes 136 immediately pushes the three automatic valve members 109 to their upper end positions. When each automatic valve member is thus actuated to its upper position, it opens the inlet port 135 to the lower end of the operating cylinder 55, and closes the corresponding exhaust port 137, and at the same time opens the exhaust port 127 for the upper end of the operating cylinder and closes the inlet port 117 for the upper end of the operating cylinder. Opening of the exhaust ports 127 causes air above the operating pistons to be exhausted to atmosphere. The flow of compressed air to the lower ends of the three operating cylinders through the inlet ports 135 causes the operating pistons 53 to be moved upwardly to the closed position shown in Fig. 3, thereby moving the contact members 31 to closed position in engagement with their corresponding stationary contacts 29. When the breaker reaches closed position, the solenoid 165 of the closing valve mechanism 61 is deenergized, and the closing valve mechanism is returned to closed position, thereby shutting off the closing air. The automatic valves 109 are thereupon returned to neutral position by the springs 153.

A modification of the automatic valve mechanism is shown in Fig. 5. In accordance with this modification of the invention, the automatic valve device is so arranged that a greater actuating force is applied to the movable valve element by the opening air than by the closing air so that an opening operation of the circuit breaker will always take preference over a closing operation in case of conflicting control impulses. Referring to Fig. 5, the automatic valve device 103' is of substantially the same construction as the automatic valve device 103 of the original embodiment of the invention except that the vertical cylindrical passage in the upper valve housing section 105' and the upper piston element 147' of the pneumatically operated valve member 109' are of larger diameter than the lower piston element 147. The remaining structure of the automatic valve device is identical to that of the original embodiment. Since the upper piston element 147' is of larger diameter than the lower piston element 147, the flow of compressed air in the pipe 119 for opening the breaker will exert a greater force on the valve member 109' than the force exerted by the flow of closing compressed air in the pipe 136. Consequently, the automatic

valve member 109' will always be moved to its lowermost position if compressed air is admitted to the pipes 119 and 136 simultaneously. Under these conditions the valve member 109' moves to its lowermost position, maintaining the inlet port 135' for the lower end of the cylinder closed and thereby preventing the flow of compressed air to the lower end of the operating cylinder. Thus, an opening operation will always take precedence over a closing operation in the event of conflicting control impulses.

While the invention has been disclosed in accordance with the provisions of the Patent Statutes, it is to be understood that various changes in the structural details and arrangement of parts thereof may be made without departing from some of the essential features of the invention. It is desired, therefore, that the language of the appended claims be given the broadest reasonable interpretation permissible in the light of the prior art.

We claim as our invention:

1. A gas blast circuit breaker comprising a circuit interrupting element, a hollow member of insulating material supporting said interrupting element, a stationary contact associated with said interrupting element, a cooperating movable contact engageable with said stationary contact, said circuit interrupting element having an arc extinguishing chamber and means for confining the arc within said chamber and preventing the arc from entering the passage of the hollow insulating member, compressed gas operating means for said movable contact operable to move said contact out of the interrupting element after arc extinction and into the chamber of said hollow supporting member to insert a safe enclosed disconnecting gap in series with the interrupting element capable of withstanding high voltages, and means for causing the arc to be extinguished in the interrupting chamber before the moving contact moves into the chamber of the hollow insulator.

2. A gas blast circuit breaker comprising an arc extinguishing structure having an arc extinguishing chamber and means for directing blast gas to the arc, a hollow porcelain insulator supporting said arc extinguishing structure, a stationary contact associated with said arc extinguishing structure, said arc extinguishing structure having means for confining the arc within said chamber and preventing the arc from entering the interior passage of said hollow insulator, a cooperating movable contact, and operating means for moving said movable contact to open and closed position, said operating means being operable to move said movable contact out of said arc extinguishing structure and into the space enclosed by said insulator after extinction of the arc to provide a safe disconnecting gap in the circuit capable of withstanding high voltages.

3. A gas blast circuit breaker comprising an arc extinguishing structure having an arc extinguishing chamber, a hollow porcelain insulator supporting said arc extinguishing structure and having a disconnect chamber communicating with said arc extinguishing chamber, a stationary contact associated with said arc extinguishing structure, said arc extinguishing structure having means for confining the arc within said chamber and preventing the arc

from entering the interior passage of said hollow insulator, a cooperating disconnect contact movable in said chambers into and out of engagement with said stationary contact, operating means for moving said disconnect contact, said operating means being operable to move said disconnect contact out of said arc extinguishing structure and a substantial distance into the disconnect chamber of said insulator after arc extinction to provide a safe disconnecting gap in the circuit, and means for supplying a blast of arc extinguishing gas through the chamber of said insulator to the arc.

4. A gas blast circuit breaker comprising an arc extinguishing structure having an arc extinguishing chamber, a baffle provided with an orifice through which the arc plays and having means for directing blast gas substantially radially toward the arc and out through said orifice, a hollow porcelain insulator supporting said arc extinguishing structure, a stationary contact in said arc extinguishing structure adjacent said orifice, said arc extinguishing structure having means for confining the arc within said chamber and preventing the arc from entering the interior passage of said hollow insulator, a cooperating movable contact engageable with said stationary contact, operating means for moving said movable contact to open and to closed position, said operating means being operable to move said contact out of said arc extinguishing structure after extinction of the arc and a substantial distance into said supporting insulator to provide a safe disconnecting gap in the circuit capable of withstanding high voltages, and means for supplying a blast of arc extinguishing gas through said insulator to said arc extinguishing structure.

5. A compressed gas circuit breaker comprising an arc extinguishing structure having an arc extinguishing chamber, a hollow supporting insulator supporting said arc extinguishing structure, a stationary contact associated with said arc extinguishing structure, said arc extinguishing structure having means for confining the arc within said chamber and preventing the arc from entering the interior passage of said hollow insulator, a cooperating movable contact engageable with said stationary contact, compressed gas operating means for moving said movable contact to open and closed position comprising an operating cylinder and a piston in said cylinder mechanically connected to said movable contact, said operating means being operable to move said contact out of said arc extinguishing structure after arc extinction and a substantial distance into said supporting insulator to provide a safe disconnecting gap in the circuit, and means for supplying a blast of compressed gas through said hollow insulator to said arc extinguishing structure to extinguish the arc.

6. A circuit breaker comprising a movable contact member, compressed gas operating means for moving said contact member to open and to closed position comprising a cylinder, a reciprocally movable piston in said cylinder connected to said contact member, means for supplying compressed gas to said cylinder to move said piston in one direction to close the breaker and to move said piston in the opposite direction to open the breaker, an automatic valve device associated with said cylinder comprising a single movable valve element operated directly by

the operating compressed gas to automatically dump gas from said cylinder in front of the moving piston for both directions of movement of said piston.

7. A circuit breaker having a movable contact member, compressed gas operating means for moving said contact member to open and to closed position comprising a cylinder, a piston reciprocally movable in said cylinder and connected to said contact member, means for supplying compressed gas to said cylinder to move said piston in one direction to close the breaker and in the opposite direction to open the breaker, a valve device associated with said cylinder having a gas inlet passage for admitting compressed gas to one end of said cylinder and having an exhaust port for exhausting gas from said one end of the cylinder, a valve element operated directly by the flow of compressed gas to said inlet passage to close said exhaust port, said valve element also being operated by the flow of compressed gas to the other end of said operating cylinder to close said inlet passage and open the exhaust port.

8. A circuit breaker having a movable contact member, compressed air operating means for moving said contact member to open and to closed position comprising a cylinder, a reciprocally movable piston in said cylinder connected to said contact member, an automatic valve device associated with said cylinder having an inlet port and a corresponding exhaust port communicating with one end of said cylinder and a second inlet port and corresponding exhaust port communicating with the opposite end of said cylinder, valve means pneumatically operated by compressed air in either of said inlet ports to close the corresponding exhaust port and open the exhaust port for the opposite end of said cylinder, and means for supplying compressed air through said inlet ports to said cylinder to operate said piston.

9. A circuit breaker having a movable contact member, compressed gas operating means for moving said contact member to open and to closed position comprising a cylinder and a reciprocally movable piston in said cylinder connected to said contact member, means for supplying compressed gas to the opposite ends of said cylinder to open or to close the breaker, a separate exhaust port for each end of said cylinder, and a single valve member operated directly by the flow of operating compressed gas to either end of said cylinder to close the corresponding exhaust port and open the exhaust port of the opposite end of said cylinder.

10. A circuit breaker having a movable contact member, compressed gas operating means for moving said contact member to open and to closed position comprising a cylinder, a double acting piston in said cylinder connected to said contact member, means including a pair of compressed gas supply lines and a pair of inlet ports for supplying compressed gas to the opposite ends of said cylinder to open or close the breaker, a separate exhaust port for each end of said cylinder, and a single movable valve member pneumatically operated by the flow of operating compressed gas to either end of said cylinder to open the exhaust port of the opposite end of said cylinder and close the inlet port of said opposite end of the cylinder.

11. In a circuit breaker having a movable contact member, compressed gas operating means for moving said contact member to open and

to closed position comprising a cylinder and a piston reciprocally movable in said cylinder connected to said contact member, means for supplying compressed gas to the ends of said cylinder to actuate said contact member to open or to closed position, an automatic valve device associated with said cylinder having an inlet port and a corresponding exhaust port communicating with one end of said cylinder, a second inlet port and corresponding exhaust port communicating with the other end of said cylinder, and movable valve means operated by compressed gas in either of said inlet ports to automatically close the corresponding exhaust port and open the exhaust port of the opposite end of the cylinder and close the inlet port of said opposite end of the cylinder.

12. A circuit breaker having a movable contact member, compressed gas operating means for moving said contact member to open and to closed position comprising a cylinder and a piston reciprocally movable in said cylinder connected to said contact member, means for supplying compressed gas to one end of said cylinder to actuate said contact member to open position and to the other end of said cylinder to actuate said contact member to closed position, an automatic valve device having an inlet port and a corresponding exhaust port communicating with said one end of the cylinder and a second inlet port and corresponding exhaust port communicating with the other end of said cylinder, and a single movable valve member operable by operating compressed gas in either of said inlet ports to automatically close the corresponding exhaust port and open the exhaust port of the opposite end of the cylinder and close the inlet port of said opposite end of the cylinder, said valve member having a pressure reactive surface subject to the closing gas and a pressure reactive surface of larger area subject to the opening gas to cause an opening operation of the breaker to always take preference over a closing operation.

13. A circuit breaker having a movable contact member, compressed gas operating means for moving said contact member to open and to closed position comprising a cylinder and a piston reciprocally movable in said cylinder connected to said contact member, means for supplying compressed gas to one end of said cylinder to actuate said contact member to open position and to the other end of said cylinder to actuate said contact member to closed position, an automatic valve device having an inlet port and a corresponding exhaust port communicating with said one end of the cylinder and a second inlet port and corresponding exhaust port communicating with the other end of said cylinder, and a single movable valve member operable by operating compressed gas in either of said inlet ports to automatically close the corresponding exhaust port and open the exhaust port of the opposite end of the cylinder and close the inlet port of said opposite end of the cylinder, said valve member being subjected to a greater operating force by the circuit breaker opening gas than by the circuit breaker closing gas to thereby cause an opening operation of the breaker to always take preference over a closing operation in case of conflicting operating impulses.

14. A circuit breaker having a movable contact member, compressed air operating means for moving said contact member to open and

to closed position comprising a cylinder, a piston reciprocally movable in said cylinder and connected to said contact member, means including a pair of compressed air supply lines for supplying compressed air to the opposite ends of said cylinder, a valve for controlling opening of the breaker in one of said lines and a valve for controlling closing of the breaker in the other of said lines, and an automatic valve device associated with said cylinder having an inlet port and an exhaust port for each end of said cylinder and a single movable valve member pneumatically actuated by the opening air to automatically open the exhaust port of the closing end of the cylinder and close the inlet supply port for the closing end of the cylinder and pneumatically actuated by the closing air to automatically open the exhaust port of the opening end of said cylinder and close the inlet supply port of the opening end of said cylinder.

15. A circuit breaker having a movable contact member, compressed air operating means for moving said contact member to open and to closed position comprising a cylinder, a piston reciprocally movable in said cylinder and connected to said contact member, means including a pair of compressed air supply lines for supplying compressed air to the opposite ends of said cylinder, a valve for controlling opening of the breaker in one of said lines and a valve for controlling closing of the breaker in the other of said lines, and an automatic valve device associated with said cylinder having an inlet port and an exhaust port for each end of said cylinder and a single movable valve member pneumatically actuated by the opening air to automatically open the exhaust port of the closing end of the cylinder and close the inlet supply port for the closing end of the cylinder and pneumatically actuated by the closing air to automatically open the exhaust port of the opening end of said cylinder and close the inlet supply port of the opening end of said cylinder, said valve member being subjected to a greater actuating force by the opening compressed air than by the closing compressed air to thereby cause an opening operation to always take preference over a closing operation in case of conflicting operating impulses.

16. A gas blast circuit breaker comprising an arc extinguishing structure having an arc extinguishing chamber, a hollow supporting insulator supporting said structure, a stationary contact associated with said arc extinguishing structure, a cooperating movable contact extending within the passage of said insulator and movable into said arc extinguishing structure to closed position in engagement with said stationary contact, compressed gas operating means for moving said contact member to open and to closed position, said contact member when moved to open position being moved out of said arc extinguishing structure after arc extinction and a considerable distance into the passage of said supporting insulator to provide a safe disconnecting gap in the circuit, said operating means comprising a cylinder, a piston in said cylinder connected to said contact member, means for supplying compressed gas to opposite ends of said cylinder to move said piston in one direction to close the breaker and in the opposite direction to open the breaker, an automatic valve device associated with said cylinder comprising a single movable valve element

operated by the operating compressed gas to automatically exhaust gas from said cylinder in front of the moving piston for both directions of movement of said piston to thereby facilitate high speed closing-opening operation and high speed reclosing operation of the movable contact member.

17. A gas blast circuit breaker comprising a plurality of hollow supporting insulators, a single one piece metal casting mounted on said insulators having an operating cylinder formed therein, and having a gas blast conduit formed integral therewith communicating at one end with the passage of one of said supporting insulators, a hollow insulator mounted on said casting having a passage communicating with the other end of said blast conduit, an arc extinguishing structure mounted on the top of said hollow insulator, a stationary contact associated with said arc extinguishing structure, a cooperating movable contact member extending within the passage of said hollow insulator and engageable with said stationary contact, and an operating piston in said cylinder connected to said movable contact.

18. A high voltage compressed gas circuit breaker comprising a plurality of mechanically independent pole units each having means including contact means for interrupting the circuit and for providing an isolating gap in the circuit capable of withstanding high voltages, compressed gas operating means comprising a separate operating cylinder for each of said pole units, a reciprocally movable piston in each cylinder connected to a corresponding one of said contact means, a compressed gas system including a source of compressed gas, a single opening valve mechanism common to all of said cylinders operable to control the flow of compressed gas to one end of all of said cylinders for opening the breaker, and a single closing valve mechanism common to all of said cylinders operable to control the flow of compressed gas to the other end of all of said cylinders for closing the breaker.

19. A compressed air circuit breaker comprising a plurality of mechanically independent pole units each having a movable contact member, compressed air operating means comprising a separate operating cylinder for each of said pole units, a reciprocally movable piston in each cylinder connected to a corresponding one of said contact members, a compressed air system including a source of compressed air, a single opening valve mechanism common to all of said cylinders operable to control the flow of compressed air to one end of all of said cylinders for opening the breaker, and a single closing valve mechanism common to all of said cylinders operable to control the flow of compressed air to the other end of all of said cylinders for closing the breaker, and an automatic valve device associated with each of said cylinders operated by the opening and closing air to automatically dump air from said cylinder ahead of the moving piston to facilitate high speed opening and reclosing operation of the breaker.

20. A compressed air circuit breaker comprising a plurality of mechanically independent pole units each having a movable contact member, compressed air operating means comprising a separate operating cylinder for each of said pole units, a reciprocally movable piston in each cylinder connected to a corresponding one of said contact members, a compressed air system

including a source of compressed air, a single opening valve mechanism common to all of said cylinders operable to control the flow of compressed air to one end of all of said cylinders for opening the breaker, and a single closing valve mechanism common to all of said cylinders operable to control the flow of compressed air to the other end of all of said cylinders for closing the breaker, a separate blast valve for

each pole unit for controlling the flow of arc extinguishing blast air, and means interlocking at least one of said blast valves with said single opening valve mechanism to prevent opening of said opening valve mechanism if said blast valve fails to open.

LEON R. LUDWIG.
BENJAMIN P. BAKER.
JAMES M. CUMMING.