

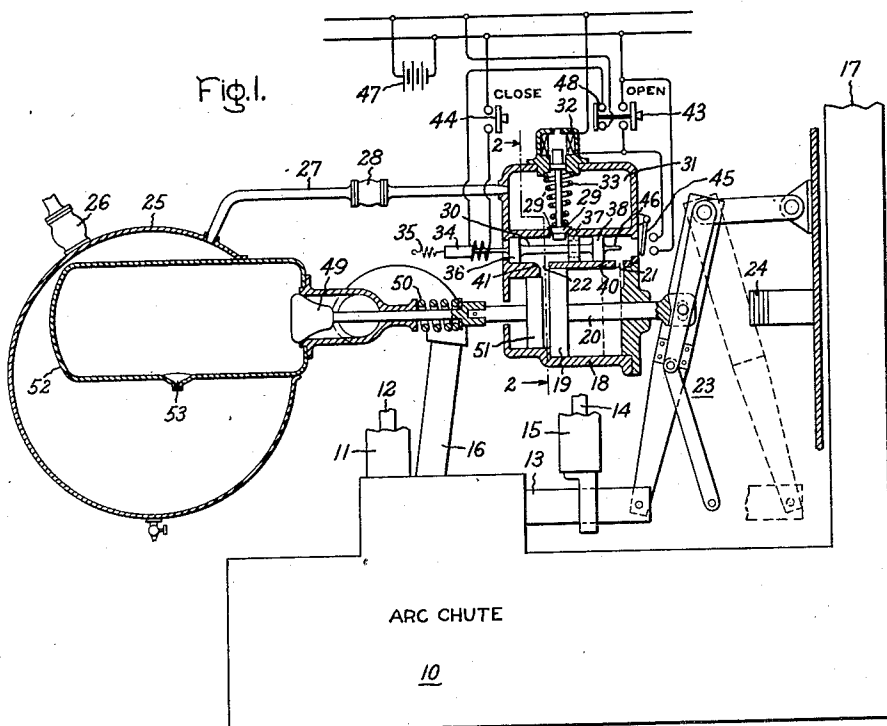
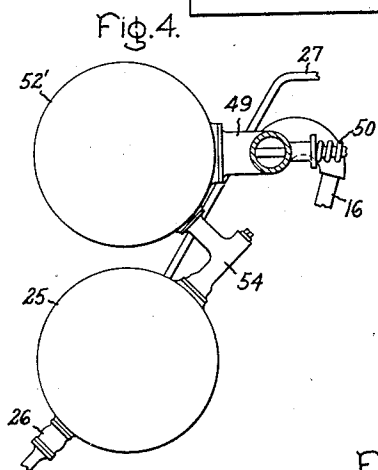
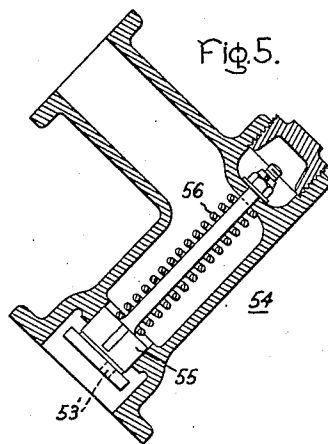
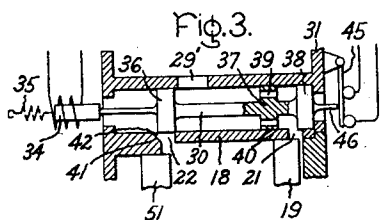
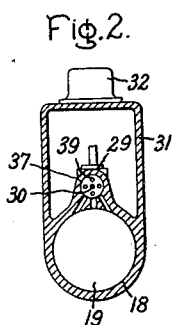
July 21, 1942.

P. BARTLETT

2,290,726

ELECTRIC CIRCUIT BREAKER

Filed Oct. 25, 1940



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UNITED STATES PATENT OFFICE

2,290,726

ELECTRIC CIRCUIT BREAKER

Percy Bartlett, Springfield, Pa., assignor to General Electric Company, a corporation of New York

Application October 25, 1940, Serial No. 362,721

10 Claims. (Cl. 200—148)

My invention relates to electric circuit breakers and more particularly to improvements in electric circuit breakers of the fluid or gas-blast type.

It is an object of my invention to provide a new and improved circuit breaker of the above type which has a high interrupting capacity and, at the same time, is compact, durable, and reliable in operation.

It is another object of my invention to provide an improved pneumatic-operating mechanism for controlling the movement of the relatively movable contacts of the circuit breaker and also the operation of the blast valve.

Still another object of my invention is to provide a new and improved fluid-blast control in which the number of moving parts are minimized and which operates very satisfactorily with respect to the circuit-interrupting operation.

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

For a better understanding of my invention, reference may be had to the accompanying drawing in which Fig. 1 is a schematic diagram partly in section of a circuit breaker embodying my invention, Fig. 2 is a sectional view taken on line 2—2 of Fig. 1, Fig. 3 is an enlarged view of a portion of Fig. 1 to illustrate a specific operating condition of the apparatus, Fig. 4 represents a modification of a portion of the apparatus of Fig. 1, and Fig. 5 is an enlarged sectional view of a portion of the apparatus illustrated in Fig. 4.

Referring now to Fig. 1 of the drawing, I have schematically illustrated an electric circuit breaker embodying my invention. Although only a single phase of the circuit breaker is shown, it will be understood that my invention is equally applicable to polyphase or single-phase circuit breakers and is preferably applicable to an arrangement in which the parts of the circuit breaker are mounted in an enclosed metal framework to form a unit of the type that may readily be installed in a cubicle of metal-clad switchgear of the type now in extensive use.

The circuit breaker of Fig. 1 is illustrated as comprising an arc extinguishing unit or structure generally indicated at 10 in which is suitably mounted a fixed contact, not shown, which is supported by an insulated bushing 11 and connected to a conductor 12. Arc-extinguishing structure 10 also has suitably mounted therein a

movable contact, not shown, supported by a reciprocating blade 13, which is suitably connected to conductor 14 provided with an insulated bushing 15. Conductors 12 and 14 form the terminals of the circuit breaker which are connected to the associated power line controlled thereby. The arc-extinguishing structure generally indicated at 10 comprises an arc chute including an arc-confining chamber, not shown, in which an arc is drawn when the contacts are separated. As is well known by those skilled in the art, suitable baffle structure may preferably be provided in the arc chute and the interruption of the arc is aided by a blast of fluid or gas from conduit 16. The arc products, such as the gases, are cooled in the arc chute and are exhausted to atmosphere through the arc chute exhaust at 17. An electric circuit breaker embodying an arc chute and interrupting unit of the type generally disclosed in Fig. 1 is more fully described and claimed in the copending application of Prince et al., Serial No. 303,126, now Patent 2,284,842, issued June 2, 1942, and assigned to the same assignee as the present application.

In order to produce movement of blade 13, and, consequently, relative movement between the contacts of the circuit breaker, I provide a fluid motor which comprises a cylinder 18 in which is reciprocatingly mounted a piston 19 having an operating rod 20. Cylinder 18 is provided with two fluid pressure inlet ports, namely, a circuit breaker closing inlet port 21 and a circuit breaker opening inlet port 22, which will be described in more detail hereinafter. Operating rod 20 associated with piston 19 is connected with movable blade 13 through a suitable paralleling mechanism generally indicated at 23, a portion of which is preferably constructed of insulating material so as to insulate moving blade 13 from the operating structure of the circuit breaker. A suitable buffer 24 is provided to cushion the operating mechanism of the circuit breaker prior to attaining the position which it assumes when the circuit breaker is open.

In order to operate the fluid motor comprising cylinder 18 and piston 19, I provide a storage reservoir or source 25 of fluid under pressure, which is preferably air or some other gas. Source 25 may be connected through nonreturn valve 26 to a suitable compressor or large storage vessel so as to maintain a substantially constant pressure in source or reservoir 25. I have illustrated source 25 as being interconnected with the fluid motor for operating my circuit breaker through conduit 27, nonreturn valve 28, main valve 29,

main valve port 29', and a diverter valve 30. I have provided a suitable reservoir 31 between the fluid motor comprising cylinder 18, piston 19, and nonreturn valve 28, which reservoir is capable of holding sufficient fluid under pressure for one opening stroke of the circuit breaker. The arrangement of the main valve 29 and diverter valve 30 is substantially the same as that disclosed and claimed in my copending application, Serial No. 307,834, filed jointly with Leonard S. Subber, December 6, 1939, and assigned to the same assignee as the present application.

In order to eliminate delay in the operation of the circuit breaker, I prefer to dispense with all unnecessary piping and, in Fig. 1, I have illustrated reservoir 31, cylinder 18, and the housing for diverter valve 30 as constructed integrally, whereby a minimum delay in operation results and, furthermore, considerable saving in cost and assembly time is accomplished.

Any suitable means for operating main valve 29 and diverter valve 30 may be provided. In Fig. 1, I have illustrated a solenoid 32 for operating main valve 29, which is provided with a spring means 33 normally tending to bias valve 29 to the closed position. Similarly, diverter valve 30, which is illustrated as a piston-type valve, is provided with a solenoid 34 for operating purposes. Suitable spring-biasing means 35 may be provided to cause the diverter valve 30 to assume the position shown in Fig. 1 when solenoid 34 is unenergized. Diverter valve 30 is preferably constructed so as to comprise three piston-like members 36, 37, and 38. When diverter valve 30 is in the position shown in Fig. 1 and main valve 29 is open, fluid is directed through circuit breaker opening inlet port 22 into cylinder 18 and the piston-like member 38 of diverter valve 30 prevents this fluid from entering the circuit breaker closing inlet port 21. On the other hand, when diverter valve 30 is moved to the right upon energization of solenoid 34 to the position shown in Fig. 3, the piston-like member 36 of diverter valve 30 closes the circuit breaker opening inlet port 22 to cylinder 18, and fluid from reservoir 31, upon operation of main valve 29, may enter circuit breaker closing inlet port 21 through openings 39 in the intermediate piston-like member 37 of diverter valve 30.

In order to exhaust the opening end of cylinder 18 to atmosphere at the end of the opening stroke, I have provided a suitable dumping port 40 in cylinder 18 which, when the piston assumes the dotted position shown in Fig. 1, allows the fluid to escape to atmosphere. During the closing operation of the circuit breaker, this port is closed by intermediate piston-like member 37 as shown in Fig. 3. It will be understood that, during the opening stroke of the circuit breaker, fluid on the closing side of piston 19 may escape through port 21 to atmosphere. During the closing stroke of the circuit breaker, on the other hand, it is necessary to provide an escape port for the fluid in cylinder 18 on the opening side of piston 19 and, to this end, I have provided a cutaway portion 41 adjacent circuit breaker opening inlet port 22, best shown in Fig. 3, so as to provide a small opening 42 through which fluid may escape when diverter valve 30 is in the position shown in Fig. 3. This cutaway portion may be so constructed as to provide a predetermined opening 42 to cushion the closing stroke of the circuit breaker by a sort of dashpot action and, furthermore, to operate the blast

valve during the closing stroke as will be described in detail hereinafter.

In order to control the operation of diverter valve 30 and main valve 29 and, consequently, to control the operation of the circuit breaker, I have illustrated a suitable control circuit for solenoids 32 and 34, which include an opening push-button switch 43 and a closing push-button switch 44. A suitable limit switch 45 is also provided which is operated by an extension 46 of diverter valve 30 to cause energization of solenoid 32 during the closing operation of the circuit breaker illustrated in Fig. 1. A suitable source of control potential 47, which is illustrated in Fig. 1 as a battery, may be provided. Opening push-button 43 is provided with an additional set of normally closed contacts 48 which are connected in the circuit for controlling the closing operation of the circuit breaker so that, when an opening operation of the circuit breaker is initiated by push button 43, contacts 48 are opened to preclude the initiation of a closing operation until push button 43 is released.

In order to control the flow of a blast of fluid in the circuit-interrupting structure 10 from conduit 16 during the circuit-interrupting operation and also for an interval during the circuit-closing operation, I provide a suitable blast valve 49 normally biased to the closed position by spring means 50. Any suitable means for operating blast valve 49 may be provided but, as illustrated in Fig. 1, I prefer that blast valve 49 be operated by a suitable fluid motor comprising piston 51 mounted in a suitable cylinder coextensive and integral with cylinder 18. By arranging pistons 19 and 51 in opposing relationship in coaxial cylinders and introducing fluid under pressure between the two, simultaneous operation of the circuit breaker operating mechanism and blast valve 49 will be obtained so that a blast of fluid will be assured adjacent the separating contacts. Furthermore, by this arrangement, a suitable blast of fluid during the closing stroke of the circuit breaker may also be obtained by properly designing the cutaway portion 41 of cylinder 18 so to proportion orifice 42 that the back pressure resulting causes piston 51 to move to the left in Fig. 1 and open blast valve 49.

I have discovered that my circuit breaker will most effectively interrupt a circuit by providing a high initial blast of fluid which may be considerably decreased during the course of the opening stroke of the circuit breaker since, after the initial blast, the arc is interrupted and only a relatively small amount of fluid is necessary to dispose of the gaseous products and prevent re-striking of the arc. While numerous arrangements have been proposed heretofore for varying the flow of fluid during the circuit-interrupting operation, I propose, as illustrated in Fig. 1, to provide a blast valve fluid reservoir 52 interconnected with source of fluid pressure 25 through a suitable metering orifice 53 predetermined size. As shown in Fig. 1, blast valve reservoir 52 may be mounted within reservoir 25. Furthermore, orifice 53 of predetermined size is mounted at the bottom of blast valve reservoir 52 so as also to act as a moisture drain. Blast valve reservoir 52 is preferably constructed so as to provide a predetermined volume commensurate with the desired initial high-velocity blast for circuit-interrupting purposes. After the initial blast, the flow of arc-extinguishing fluid is limited by the metering orifice 53 and

preferably is merely sufficient to dispose of the gaseous products and prevent restriking of the arc which is interrupted by the high initial blast. By this arrangement, it is possible to conserve the arc-extinguishing fluid and, from the standpoint of conserving this fluid under pressure, considerable latitude with respect to the instant of closing of blast valve 49 may be had unaccompanied by large differences in the consumption of air or fluid under pressure. Upon closing of blast valve 49, reservoir 52 refills so as to be in readiness for the next circuit-interrupting operation. Consequently, blast valve 49 controls a high initial fluid blast followed by a beneficial scavenging stream for preventing restriking of the arc.

In view of the detailed description included above, the operation of my circuit breaker will be understood by those skilled in the art and only a very brief discussion will be included hereinafter. Assuming the circuit breaker in the closed position, as shown in Fig. 1, the opening operation may be initiated by depressing opening push button 43. It will, of course, be understood by those skilled in the art that opening operation may also be initiated automatically upon the occurrence of an abnormal electrical condition in the power line associated with conductors 12 and 14 in a manner well understood by those skilled in the art, it simply being necessary to provide means for automatically energizing solenoid 32 under such abnormal conditions. The energization of solenoid 32 will cause opening of main valve 29 and, since diverter valve 30 remains in the position shown in Fig. 1, fluid under pressure from operating reservoir 31 enters cylinder 18 through circuit breaker opening inlet port 22, causing piston 19 to move to the right to the dotted position shown to open the circuit breaker, the opening movement being cushioned near the end of the stroke by buffer means 24. Simultaneously with the movement of piston 19, piston 51 is moved to the left to open blast valve 49 and provide a blast of arc-extinguishing fluid adjacent the separating contacts. By virtue of blast valve reservoir 52 and metering orifice 53, a high initial blast is provided which reduces to a small scavenging stream, whereupon the particular instant of the closing of blast valve 49 from the standpoint of conserving fluid under pressure becomes relatively unimportant. High-speed dumping of the fluid under pressure on the opening side of piston 19 at the end of the opening stroke is accomplished through dumping port 40 so that blast valve 49 may close and so that the fluid motor is ready for instant reclosing of the circuit breaker.

To close the circuit breaker, closing push button 44 is depressed or, if automatic reclosing is desired, suitable means for automatically energizing solenoid 34 may be provided. In either event, upon energization of solenoid 34, diverter valve 30 is moved to the right to assume the position shown in Fig. 3 so that the intermediate piston-like member 37 closes dumping port 40 and communication between the port 29' of main valve 29 and circuit breaker closing inlet port 21 to cylinder 18 is provided through openings 39 in intermediate piston-like member 37. When diverter valve 30 is moved to the right, extension 46 thereof causes limit switch 45 to be closed to energize solenoid 32 from source 47 and open main valve 29, whereupon piston 19 is moved to the left to close the circuit breaker. During the

closing stroke, the fluid trapped in cylinder 18 on the opening side of piston 19 escapes through orifice 42 formed by virtue of the cutaway portion 41 of cylinder 18. However, this orifice is so proportioned that sufficient pressure is built up on the opening side of piston 19 to cushion the closing movement of the circuit breaker by suitable dashpot action. Furthermore, this back pressure is sufficient to move piston 51 to the left and open blast valve 49 to provide a short fluid blast adjacent the contacts of the circuit breaker during the closing operation thereof. Upon the release of closing push button 44, diverter valve 30 assumes the position shown in Fig. 1 by virtue of spring means 35. It will be understood that a suitable limit switch may be provided operable by the closing of the circuit breaker to deenergize solenoid 34 automatically.

From the foregoing description, it will be evident that this arrangement provides for very effective trip-free operation for, during closing of the circuit breaker, fluid pressure is being built up in cylinder 18 on the left-hand side of piston 19 in anticipation of a possible immediate opening response. If, then, during the closing operation of the circuit breaker, opening is initiated by suitable means, the resultant movement of the diverter valve 30 to the left directs additional fluid under pressure between pistons 19 and 51 to effect immediate blast valve opening and reversal of piston 19 irrespective of whether or not piston 19 has completed its closing stroke. Moreover, because the commencement and duration of the fluid blast is not dependent upon predetermined positions in the stroke of the circuit breaker but instead is responsive to the pressure existing between pistons 19 and 51 and the capacity of blast valve reservoir 52, respectively, equally effective blasts are released whether or not piston 19 and the circuit breaker contacts have completed a full closing stroke.

The provision of a relatively small metering orifice 53 between blast valve reservoir 52 and fluid pressure source 25 may cause some delay in the refilling of blast valve reservoir 52 following a circuit-interrupting operation. In order to decrease the duration of the refilling period for blast valve reservoir 52, I have illustrated in Figs. 4 and 5 a modification of the blast valve reservoir 52 and metering orifice 53 of Fig. 1. The corresponding parts of Figs. 4 and 5 are designated by the same reference numerals as in Fig. 1. However, instead of a blast valve reservoir 52 mounted within fluid pressure storage reservoir 25, I have provided a separate blast valve reservoir 52' connected through blast valve 49 to conduit 16. Instead of a metering orifice 53 interconnecting source 25 and blast valve reservoir 53, I have provided a differential valve 54 which interconnects source 25 and blast valve reservoir 52' of Fig. 4. Differential valve 54 is shown in enlarged sectional view in Fig. 5 and includes a metering orifice 53' similar to metering orifice 53 of Fig. 1, which constantly provides a relatively small communication channel between source 25 and blast valve reservoir 52'. Metering orifice 53' is mounted in a valve member 55, normally biased to the open position by spring means 56. In the event that blast valve 49 is operated a considerable reduction in pressure in blast valve reservoir 52' will occur and valve member 55 biased to the open position by spring means 56 of differential valve 54 will be forced to the closed position so that metering orifice 53' is the only means of communication between source 25 and

blast valve reservoir 52', thereby limiting the flow of fluid through blast valve 49 to a small scavenging stream after the high initial blast. However, as soon as the pressure in blast valve reservoir 52' begins to increase upon closing of blast valve 49, valve member 55 is forced to the open position with the aid of spring means 56, thereby greatly increasing the size of the communication channel between source 25 and blast valve pressure reservoir 52' so that refilling of blast valve reservoir 52' can occur at a considerably increased rate than if only metering orifice 53' were provided whereupon the circuit breaker would be better adapted for use in connection with a system where high-speed reclosing is desired. By the arrangement described above, a relatively constant pressure of the fluid for operating pistons 19 and 51 is available so that uniform opening and closing speeds may be obtained regardless of the large drop in fluid pressure in blast valve reservoir 52. This feature, however, is not my invention but is disclosed and claimed in copending application, Serial No. 345,973, of Carl Thumim, filed July 17, 1940 now Patent No. 2,248,593 issued July 8, 1941, and assigned to the same assignee as the present application.

The operation of the modification illustrated in Figs. 4 and 5 will be obvious to those skilled in the art in view of the description included above.

It will be understood by those skilled in the art that, while I have illustrated and described a particular embodiment of my invention, modifications thereof will occur to those skilled in the art. I desire it to be understood, therefore, that my invention is not limited to the particular arrangement disclosed and I intend in the appended claims to cover all modifications which do not depart from the spirit and scope of my invention.

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

1. In an electric circuit breaker of the fluid-blast type comprising relatively movable contacts, means including a first fluid motor for producing relative movement between said contacts, a source of fluid under pressure, means including a blast valve connected to said source for producing a blast of fluid adjacent said relatively movable contacts for arc-extinguishing purposes, a second fluid motor for operating said blast valve, means including a valve interconnecting said source and said first fluid motor for controlling the operation of said first fluid motor, said fluid motors each comprising a piston mounted in opposed relationship in a common cylinder so that said last-mentioned valve simultaneously controls the operation of said blast valve.

2. In an electric circuit breaker of the fluid-blast type comprising relatively movable contacts, means for producing relative movement between said contacts, a source of fluid under pressure, a fluid reservoir connected to said source through a continuously open restricted opening so as normally to be maintained at the same pressure as that of said source of fluid, means including a blast valve connected to said reservoir for controlling a blast of fluid adjacent said relatively movable contacts for arc-extinguishing purposes, said restricted opening being so proportioned relative to the volume of said fluid reservoir that a high initial fluid blast followed by a small scavenging stream is produced adjacent said contacts upon operation of said blast valve.

3. In an electric circuit breaker of the fluid-blast type, a pair of relatively movable contacts, means including a fluid motor for producing rela-

tive movement between said contacts, a source of fluid under pressure, means including a blast valve connected to said source for producing a blast of fluid adjacent said relatively movable contacts for arc-extinguishing purposes, a fluid motor for said blast valve, said fluid motors each comprising a piston mounted in opposed relationship in a common cylinder, and means for introducing fluid from said source between said pistons to produce simultaneous operation of said fluid motors.

4. In a circuit interrupter comprising relatively movable contacts, means including a fluid motor for producing relative movement between said contacts, a source of fluid under pressure, a second fluid motor for operating another portion of said circuit interrupter, said fluid motors each comprising a piston mounted in opposed relationship in a common cylinder, and means for introducing fluid from said source between said pistons to produce simultaneous operation of said fluid motors.

5. In an electric circuit breaker of the fluid-blast type comprising a pair of relatively movable contacts, a source of fluid under pressure, means including a blast valve connected to said source for producing a blast of fluid adjacent said relatively movable contacts for arc-extinguishing purposes, a fluid motor for operating said blast valve, a second fluid motor for operating another portion of said circuit interrupter, said fluid motors each comprising a piston mounted in opposed relationship in a common cylinder, and means for introducing fluid from said source between said pistons to produce simultaneous operation of said fluid motors.

6. In an electric circuit breaker of the fluid-blast type, a pair of relatively movable contacts, means including a fluid motor for producing relative movement between said contacts, a source of fluid under pressure, means including a blast valve connected to said source for producing a blast of fluid adjacent said relatively movable contacts for arc-extinguishing purposes, a fluid motor for said blast valve, said fluid motors each comprising a piston mounted in opposed relationship in a common cylinder, and means for connecting said source with said cylinder including a valve means to control the introduction of fluid under pressure into said cylinder between said pistons to cause simultaneous operation of said blast valve and relative movement between said contacts.

7. In a fluid-operated electric circuit breaker, a fluid motor for operating said circuit breaker, a source of fluid under pressure for operating said motor, means including a main valve and serially connected diverter valve interconnecting said source and said fluid motor, means for selectively operating said diverter valve to determine the operation of said fluid motor when said main valve is open, means including a blast valve connected to said source for producing a blast of fluid in said circuit breaker for arc-extinguishing purposes, a fluid motor for operating said blast valve, said fluid motors each comprising a piston mounted in opposed relationship in a common cylinder so that said main and diverter valves control the operation of both of said fluid motors, said main and diverter valves being so constructed and arranged that only said diverter valve need be operated after said main valve is opened during a circuit-closing operation to permit trip-free operation of said circuit breaker.

8. In an electric circuit breaker of the fluid-

blast type, a pair of relatively movable contacts, means including a fluid motor for producing relative movement between said contacts, a source of fluid under pressure, means including a blast valve connected to said source for producing a blast of fluid adjacent said relatively movable contacts for arc-extinguishing purposes, a fluid motor for said blast valve, said fluid motors each comprising a piston mounted in opposed relationship in a common cylinder, means for connecting said source with said cylinder including valve means to control the introduction of fluid under pressure into said cylinder between said pistons to cause simultaneous operation of said blast valve and relative separation between said contacts, and means for opening said blast valve during the circuit-closing operation by virtue of the back pressure built up between said pistons while the piston of said first-mentioned fluid motor causes closing of said circuit breaker.

9. In an electric circuit breaker of the fluid-blast type comprising relatively movable contacts, means for producing relative movement between said contacts, a source of fluid under pressure, a fluid reservoir, a differential valve interconnecting said source and said fluid reservoir including a permanently open restricted orifice, means in-

cluding a blast valve connected to said reservoir for controlling the flow of a blast of fluid adjacent said relatively movable contacts for arc-extinguishing purposes, said restricted orifice being so proportioned relative to the volume of said fluid reservoir that the flow of arc-extinguishing fluid upon opening of said blast valve comprises a high initial blast followed by a blast of much lower intensity, said differential valve being arranged to close in response to a substantial decrease in pressure so that said restricted orifice alone determines the flow of the lower intensity blast.

10. In a circuit interrupter comprising separable contact members, an arc-extinguishing structure associated therewith and a source of arc-extinguishing fluid confined under pressure, a reservoir normally maintained at the same pressure as said source, means interconnecting said source and said reservoir including a continuously open restricted orifice, the size of said orifice being so proportioned with respect to the volume of said reservoir that said fluid is admitted into said arc-extinguishing structure at a high initial rate and at a substantially decreasing rate as the circuit-interrupting operation progresses.

PERCY BARTLETT.