June 23, 1942. C. THUMIM ET AL 2,287,578

ELECTRIC CIRCUIT BREAKER

Filed Aug. 28, 1940

Fig. 1.

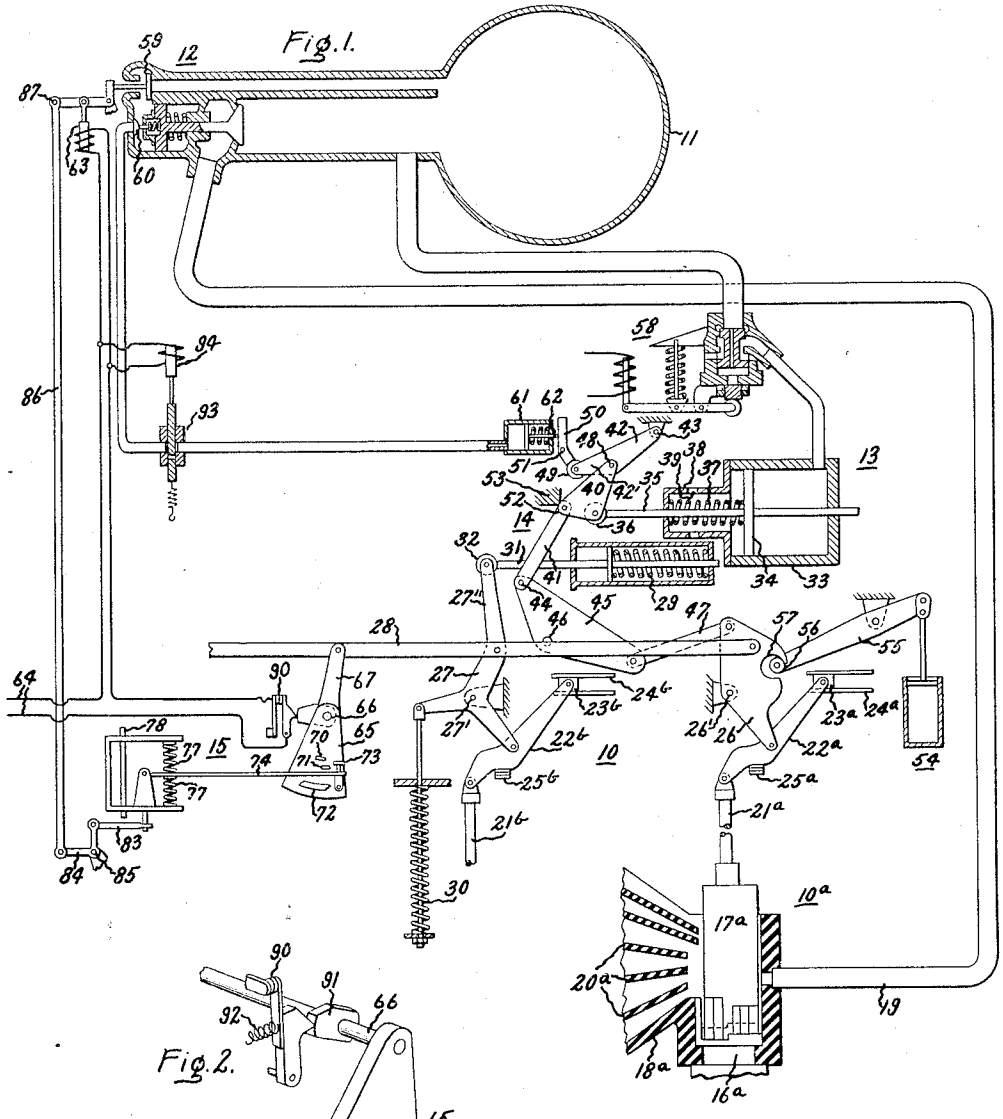
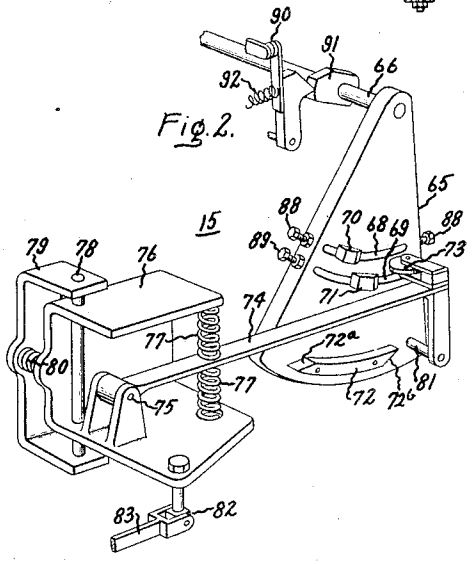


Fig. 2.



Inventors:
Carl Thumim,
John D. Gayer,
by Harry E. Dunham
Their Attorney.

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ELECTRIC CIRCUIT BREAKER

Carl Thumim, Yeadon, and John D. Gayer, Lansdowne, Pa., assignors to General Electric Company, a corporation of New York

Application August 28, 1940, Serial No. 354,608

10 Claims. (Cl. 200—148)

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

In order to eliminate the fire hazard, circuit breakers have been designed which do not utilize oil or other inflammable liquid for arc-extinguishing purposes but instead employ a blast of fluid, such as air or other gas, to extinguish the arc formed both when the circuit is broken between the relatively movable contacts of the circuit breaker and also during the closing operation of the circuit breaker to prevent the formation of any arc at this time. Circuit breakers having independent opening and closing fluid blasts are disclosed and claimed in United States Letters Patent 2,218,797, granted October 22, 1940, on the joint application of Leonard J. Linde and Torild Andersen and in application Serial No. 317,564, filed jointly on behalf of Carl Thumim, Edward J. Frank and Alexander C. Boisseau on February 6, 1940.

It will be understood by those skilled in the art that gas-blast circuit breakers require gas-storage facilities, the size of which is mainly dependent upon the gas used for the gas blast for arc-extinguishing purposes. From a cost standpoint, it would be desirable to limit these facilities to a minimum and this can be accomplished by conserving the gas required for the fluid blast. We have discovered that, during the circuit-opening operation of a gas-blast circuit breaker, the gas blast should exist at the instant the contacts separate and continue for a longer period of time than would be required during the circuit-closing operation where it is merely necessary to prevent the arc from striking and not necessary to extinguish an arc. Due to these desired differences, both in the time of initiation and the duration of the gas blast, a considerable saving of gas under pressure and, consequently, storage facilities and the like results if independently adjustable means are provided for controlling the opening and closing gas blasts of electric circuit breakers of the gas-blast type.

Accordingly, it is an object of our invention to provide an improved circuit breaker of the gas-blast type with independently adjustable means for controlling the gas blast during both the opening and the closing movements of the circuit breaker.

It is a further object of our invention to provide a new and improved circuit breaker of the fluid-blast type in which the initiation and the duration of both the opening and closing fluid blasts are independently and accurately adjustable, whereby an economical consumption of fluid results and the fluid-storage facilities may be maintained within reasonable limits.

Further objects and advantages of our invention will become apparent as the following description proceeds and the features of novelty which characterize our 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 illustrating my invention, and Fig. 2 is an enlarged perspective view of a portion of the apparatus shown in Fig. 1.

Referring now to the drawing, we have illustrated a gas-blast circuit breaker 10 connected to a source of fluid under pressure 11 through a blast valve generally indicated at 12. A fluid motor 13 associated with a trip-free mechanism generally indicated at 14 is provided for producing relative movement between the contacts of circuit breaker 10 and also to charge an energy-storage means for causing high-speed opening of the circuit breaker. A suitable pivoted assembly and associated mechanism generally indicated at 15 and embodying our invention is provided for controlling the operation of blast valve 12 and, consequently, the fluid blast during both the opening and closing movements of the circuit breaker 10.

Although our invention is applicable to polyphase or single-phase circuit breakers, we have illustrated our invention schematically in Fig. 1 as applied to a polyphase circuit breaker 10, only the structure associated with one set of contacts for one pole 10*a* of the circuit breaker being shown since the other poles of the circuit breaker are identical. Where we have illustrated any operating mechanism for the various phases or poles which are identical for each phase or pole, such parts are hereinafter characterized by the same reference numerals with the subscript *a*, *b*, or *c*, depending upon the particular phase or pole of the circuit breaker. Circuit breaker 10 is illustrated as of the cross gas-blast type and the pole 10*a* thereof is illustrated as comprising a stationary contact 16*a* and a movable contact 17*a* arranged to be operated so as to draw an arc in arc chute 18*a*. Contacts 16*a* and 17*a* are arranged to be connected by any suitable means with line terminals, not shown. Upon separation of contacts 16*a* and 17*a*, a blast of fluid from conduit 19 interconnecting the arc-confining chamber, associated

with arc chute 18a, and fluid pressure source 11 drives the arc drawn into the arc chute 18a against the edges of a plurality of baffles or partitions 20a which partitions are traverse to the arc gap and the ends of which extend close to the path of movement of movable contact 17a. The circuit breaker 10, only one pole 10a of which is shown is described and broadly claimed in the joint application of David C. Prince, William K. Rankin, and Wilfred F. Skeats, Serial No. 303,126, filed November 6, 1939, and assigned to the same assignee as the present application, and is illustrated by way of example only.

The mechanism for interconnecting the movable contacts 17a, etc., hereinafter referred to as contacts 17 of the circuit breaker 10, only one pole of which has been shown, with the trip-free mechanism generally indicated at 14 and the fluid motor 13 comprises separate operating rods 21a, 21b, etc., one for each pole of the breaker, and each having one end thereof respectively connected to the corresponding movable contacts 17. These individual operating rods 21a, 21b, etc., are each connected to one end of suitable levers 22a, 22b, etc., each having the other ends thereof provided respectively with crossheads 23a, 22b, etc., arranged to slide in crosshead guides 24a, 24b, etc. Suitable buffers 25a, 25b, etc., respectively are provided for each of the links 22a, 22b, etc., to cushion the closing movement of the operating mechanism and associated circuit breaker 10. Each of the links, such as 22a and 22b, has an intermediate point thereon pivotally connected to one end of bell cranks 26 and 27, respectively, which, in turn, are pivotally mounted on fixed supports 26' and 27'. In order that the movable contacts 17 associated with all the poles of circuit breaker 10 are simultaneously actuated, all the bell cranks such as 26 and 27 are interconnected by a horizontally reciprocating operating rod 28.

As mentioned above, fluid motor 13 is provided for closing circuit breaker 10 and charging the energy-storage means which cause high-speed opening of the circuit breaker. These energy-storage means are illustrated in Fig. 1 as comprising an opening spring 29 and a balancing spring 30. Opening spring 29 is arranged to operate rod 31, which engages with a roller 32 attached to an extension 27'' of bell crank 27. When these springs are charged, as shown in Fig. 1, they tend to cause counterclockwise rotation of bell crank 27 and, consequently, also of bell crank 26 and any other bell cranks which are connected together through horizontally reciprocating operating rod 28 which moves toward the left during opening movement of the circuit breaker 10.

Fluid motor 13 for closing circuit breaker 10 and for charging the energy-storage means is illustrated as comprising a cylinder 33 in which is reciprocatingly mounted a piston 34 operatively connected to a force-transmitting rod 35 arranged to engage with the roller 36 associated with the trip-free thrust-transmitting linkage generally indicated at 14 which is described hereinafter. This thrust-transmitting linkage 14 has one end thereof connected to bell crank 26 so as to cause movement of rod 28 and bell crank 27 and any other bell cranks connected thereto to close the respective contacts 16 and 17 of circuit breaker 10.

The fluid motor 13 is shown in Fig. 1 at the instant when circuit breaker 10 has just been completely closed. Since this fluid motor 13 is used only to close circuit breaker 10 and charge springs 29 and 30, it is desirable to provide suitable means for returning piston 34 to its initial position at the right-hand end of cylinder 33 after the closing operation is completed. Accordingly, I have shown a suitable return spring 37 mounted in a housing 38 supported by cylinder 33. Suitable ports 39 in housing 38 allow air in cylinder 33 to the left of piston 34 to escape when circuit breaker 10 is being closed.

The trip-free thrust-transmitting structure generally indicated at 14 can be of any suitable design, the one shown by way of example comprising a main toggle 40—41 including the roller 36 which coacts with the torque-transmitting rod 35 associated with piston 34. The toggle link 40 is pivotally connected at one end to a lever 42 supported on a fixed pivot 43. The toggle link 41, on the other hand, is connected at 44 to one end of a lever 45 supported on a fixed pivot 46. The other end of lever 45 is connected through a link 47 to bell crank 26. The pivot 48 of toggle link 40 is normally held fixed by a suitable tripping means including an extension 42' on lever 42 supporting a roller 49 which coacts with the tripping latch 50 pivotally mounted at 51. When the toggle 40—41 is straightened at its knee joint 52 by force-transmitting rod 35, the lever 45 is rotated about its fixed pivot 46 in a counterclockwise direction to cause the rod 28 to move toward the right to the position shown in Fig. 1 when the circuit breaker is closed. When the latch 50 is moved out of restraining engagement with respect to roller 49, the lever 42 is free to pivot in a clockwise direction. The toggle 40—41 is then no longer in thrust-transmitting position and is free to collapse, permitting movement toward the left of rod 28 under the bias of the energy-storage means comprising opening spring 29 and balancing spring 30.

In Fig. 1, the trip-free thrust-transmitting linkage 14 is illustrated in the restraining or closed position with respect to rod 28. In this position, the knee joint 52 of toggle 40—41 is overset and engages a stop member 53. The linkage is thereby effectively locked in this position with respect to any opening thrust tending to move rod 28 toward the left as long as the pivot 48 and toggle link 40 are held fixed by the above-described tripping means. When latch 50 of the tripping means no longer restrains link 42 and, hence, also pivot 48, the former rotates in a clockwise direction under the influence of the reacting forces tending to cause opening movement of horizontally reciprocating rod 28. When the toggle 40—41 has collapsed and the lever 45 is rotated in a clockwise direction, opening of circuit breaker 10 results through the upward movement of operating rods 21a, 21b, etc.

Because of the high opening speed of circuit breaker 10, it is desirable to provide cushioning means for retarding the opening movement so as to prevent any damage to the moving parts thereof. Accordingly, we have shown a suitable dashpot 54 connected to a pivotally mounted link 55 having a roller 56 at one end thereof which is arranged to engage with a suitable cam surface 57 provided on bell crank 26. The dashpot 54 and cam surface 57 may be so designed that any desired opening characteristic is obtained. For example, it may be desirable to design cam surface 57 so as to provide an arrangement similar to that disclosed and claimed in United States Letters Patent 1,904,539, granted April 18, 1933, upon an application of Sigwart Ruppel.

In order to operate fluid motor 13, cylinder 33 thereof is connected to source 11 through a solenoid-operated valve 58 which may be of any suitable type and is schematically illustrated as of the balanced-pressure pilot-valve type such as is disclosed in the copending application of Carl Thumim, Serial No. 343,002, filed June 28, 1940.

Blast valve 12 is also schematically illustrated as of the balanced-pressure pilot-valve type comprising pilot valve 59 and, as described and broadly claimed in the above-mentioned copending application, Serial No. 343,002, is so arranged as to be opened to insure a blast of fluid adjacent the contacts of circuit breaker 10 prior to any opening movement thereof. Accordingly, we have illustrated blast valve 12 as controlling a valve 60 for interconnecting the source of fluid under pressure with a pneumatic tripping means generally indicated at 61. It will be observed from Fig. 1 that circuit breaker 10 cannot be opened unless latch 50 is rotated so as to release lever 42. The pneumatic tripping means 61 is provided, as is obvious from the drawing, to cause clockwise rotation of latch 50 at the desired time so that circuit breaker 10 may open after a blast of fluid is assured adjacent the separating contacts thereof. This tripping means comprises a piston-operated plunger 62 arranged to engage an extension on latch 50 whenever fluid under pressure moves plunger 62 toward the right, as shown in Fig. 1. By this arrangement, tripping of circuit breaker 10 cannot occur until blast valve 12 is at least partially open so that valve 60 is open and the condition of the fluid pressure is such as to allow satisfactory interruption of the circuit.

Blast valve 12, as will be understood by those skilled in the art, is caused to open upon opening of pilot valve 59 which may be operated when an abnormal current condition occurs in the electrical circuit associated with circuit breaker 10 requiring the circuit to be interrupted. Accordingly, opening of circuit breaker 10 is initiated by means of a solenoid 63 operatively connected to pilot valve 59, which solenoid is energized for operation in response to abnormal current conditions from source 64 which may, for example, be connected to a current transformer, not shown, connected in the associated power circuit, also not shown. The arrangement described heretofore is not our invention but is described and broadly claimed in copending application Serial No. 343,002 referred to above. Our invention is specifically concerned with the mechanical means, used in conjunction with a gas-blast circuit breaker, operable in response to the position of the contacts of circuit breaker 10 for timing the opening gas blast and initiating and timing the closing gas blast as will be described hereinafter, and is an improvement on the arrangement disclosed in copending application Serial No. 343,002.

In order mechanically to operate pilot valve 59 to time the opening air blast for circuit breaker 10 and to initiate and time the closing air blast, we have provided a pivoted assembly and associated mechanism generally indicated at 15, which is shown in detail in Fig. 2. A suitable pivotally mounted cam supporting plate 65 is provided, which may be rigidly bolted to one of the bell cranks such as 26 or 27 if desired, or, as illustrated in the drawing, may be mounted on shaft 66 which is operatively connected to horizontally reciprocating operating rod 28 through link 67. Cam-supporting plate 65 is provided with arcuate slots 68 and 69 for adjustably supporting closing gas-blast cam 70 and opening gas-blast cam 71, respectively. A suitable guide cam 72 is rigidly attached to cam-supporting plate 65.

A cam follower roller 73 arranged to cooperate with cams 70 and 71, as will be described hereinafter, is suitably supported by a lever 74 which is pivotally supported at 75 by U-shaped crank member 76. A pair of mutually opposing springs 77 are provided to hold lever 74 in a neutral central position between the laterally extending portions of U-shaped crank member 76 which is pivotally mounted at 78 to a supporting member 79. A suitable biasing spring 80 coacting with supporting member 79 and U-shaped crank 76 tends to cause cam follower roller 73 to engage with cam-supporting plate 65.

Cam follower roller 73 coacts with either closing gas-blast cam 70 or opening gas-blast cam 71 depending upon whether roller guide pin 81 attached to lever 74 coacts with the upper cam surface 72*a* or lower cam surface 72*b* respectively of guide cam 72. Pivotal movement of cam-supporting plate 65 in response to the relative movement between the contacts 16 and 17 of circuit breaker 10 will thereby cause cam follower roller 73 to engage with either closing gas-blast cam 70 or opening gas-blast cam 71, whereupon U-shaped crank 76 is caused to rotate about its supporting pivot 78 in a counterclockwise direction with reference to Fig. 2. By means of a suitable linkage comprising universal joint 82, link 83, bell crank 84 pivotally supported at 85, and tension rod 86 operatively connected at 87 to pilot valve 59, the counterclockwise rotation of U-shaped crank 76 about its supporting pivot 78 causes opening of pilot valve 59 and, consequently, opening of blast valve 12.

The point during the opening and closing strokes of circuit breaker 10 at which closing and opening gas-blast cams 70 and 71 become effective may be suitably adjusted by the position of these cams on cam-supporting plate 65. For this purpose, we have provided bolts 88 and 89. The length of the opening and closing air blasts may also be adjusted by using interchangeable cams of various lengths for cams 70 and 71.

As was mentioned above, the opening air blast is initiated by means of solenoid 63, after which the timing thereof is controlled by the pivoted assembly generally indicated at 15 and more specifically by opening gas-blast cam 71. In order to render solenoid 63 ineffective to control pilot valve 59 after mechanical control of pilot valve 59 is obtained by virtue of opening gas-blast cam 71, we have provided a suitable switch 90 connected in series with the energizing circuit of solenoid 63 which is closed when circuit breaker 10 is closed by means of a cam member 91 suitably supported on shaft 66 which is arranged to engage one of the members of switch 90 in this position. After a predetermined opening movement of circuit breaker 10 when mechanical control of pilot valve 59 has been obtained, cam 91 has rotated sufficiently so that spring 92 may cause opening of switch 90 and, consequently, deenergization of solenoid 63.

In view of valve 60, which is opened after blast valve 12 has been opened a predetermined amount, it will be observed that circuit breaker 10 could never be closed without additional means since, as soon as the air blast during the closing stroke thereof was initiated, fluid under pressure would be admitted to pneumatic-tripping means 61 by virtue of the opening of valve

60 and, consequently, tripping latch 50 would release the trip-free mechanism, generally indicated at 14. In order to prevent this, we have provided a suitable valve 93 operable by means of a solenoid 94 the energizing winding of which is connected in parallel with the energizing winding of solenoid 63. Valve 93 is arranged to be connected in the pneumatic circuit between valve 60 and pneumatic-tripping means 61 so that fluid under pressure can reach pneumatic-tripping means 61 to trip circuit breaker 10 only when solenoid 94 is energized. Since switch 90 is connected in this circuit, energization of solenoid 94 can occur only during the closed position of circuit breaker 10, and for a short period during the opening stroke thereof until switch 90 has been opened. During the closing stroke of circuit breaker 10, therefore, when blast valve 12 and, consequently, valve 60 are open valve 93 remains closed and, hence, pneumatic-tripping means 61 is not effective.

The operation of the circuit breaker described above will be obvious to those skilled in the art in view of the detailed description set forth above as well as the description set forth in copending application Serial No. 343,002 referred to above. With the circuit breaker in the closed position shown in Fig. 1, opening thereof is initiated by energization of solenoid 63 and solenoid 94 through switch 90 which is in the closed position. This energization might occur by virtue of an abnormal current condition on the associated power circuit or by suitable manual means, not shown. Energization of solenoid 63 will cause opening of pilot valve 59 and, consequently, opening of blast valve 12 to insure a blast of fluid from source 11 adjacent the contacts 16 and 17 of circuit breaker 10. As soon as blast valve 12 is opened a predetermined amount, valve 60 opens and, since solenoid 94 has opened valve 93, the piston-operated plunger 62 of tripping means 61 is actuated to release the trip-free thrust-transmitting mechanism 14, thereby allowing opening of circuit breaker 10 under the influence of opening spring 29. It will be understood that a blast of fluid under pressure adjacent the contacts must occur prior to opening of circuit breaker 10 by pneumatic-tripping means 61. As the circuit breaker 10 begins to open, horizontally reciprocating rod 28 moves toward the left in Fig. 1 causing rotation of shaft 66 and, consequently, of cam-supporting plate 65 in a counterclockwise direction. Shortly after the beginning of the counterclockwise rotation of cam-supporting plate 65, the beveled right end 72b of cam guide 72 engages guide pin 81 and pulls lever 74 downwardly so that cam follower roller 73 engages opening gas-blast cam 71, causing a clockwise rotation of U-shaped crank 76 about pivot 78 so that pilot valve 95 is held open mechanically by virtue of the linkage comprising members 83 to 86. Cam 91, which is also rotatable with shaft 66, allows switch 90 to break the circuit for energizing solenoids 63 and 94 as soon as mechanical control of pilot valve 59 is obtained. As the opening motion of circuit breaker 10 continues, cam follower roller 73 rolls down the left incline of opening gas-blast cam 71 whereupon spring means 80 forces U-shaped crank 76 to close pilot valve 59 and, consequently, gas-blast valve 12 is closed. Guide pin 81 is thereafter released by guide cam 72 so that lever 74 is restored to its neutral position by mutually opposing springs 77.

If circuit breaker 10 is in the open position, closing thereof may be initiated by energizing the solenoid-operated valve 58, whereupon fluid motor 13 through trip-free thrust-transmitting linkage 14 moves horizontally reciprocating operating rod 28 toward the right which, consequently, also causes movement of cam-supporting plate 65. During this closing operation, guide pin 81 rides up cam surface 72a of guide cam 72 so that cam follower roller 73 engages with closing gas-blast cam 70 at a predetermined point during the closing stroke of circuit breaker 10 to cause opening of pilot valve 59 and, consequently, of gas-blast valve 12 in the same manner as described in connection with opening gas-blast valve 71. The duration of this gas blast is, of course, dependent upon the length of cam 70 and, when the contacts 16 and 17 of circuit breaker 10 engage, pilot valve 59 and, consequently, air-blast valve 12 are closed and lever 74 is restored to its neutral position by means of mutually opposed springs 77. As the circuit breaker approaches the closed position, cam 91 closes switch 90, so that the apparatus is in readiness for the next opening operation.

If, for some unforeseen reason, through failure of some part of the apparatus, circuit breaker 10 should begin to open before solenoid 63 has been energized, pilot valve 59 and, consequently, gas-blast valve 12 will be operated by virtue of opening gas-blast cam 71 in time to extinguish the arc drawn so that even though a greater deterioration of the contact parts might take place under such conditions, the circuit will be interrupted and, hence, an additional factor of safety is provided.

It will be understood that a considerable saving in fluid and, consequently, in fluid-storage facilities may be obtained by the independent adjustment of the opening and closing gas-blast cams so that not only may the point at which the air blast is initiated be controlled but also the duration of the respective air blasts.

It will be apparent to those skilled in the art that our invention is not limited to the particular construction shown but that changes and modifications may be made without departing from the spirit and scope of our invention and we aim in the appended claims to cover all such changes and modifications.

What we 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 a plurality of relatively movable contacts, means for producing relative movement between said contacts, a source of fluid under pressure, means including a valve associated with said source for producing a blast of fluid adjacent said contacts during both the circuit-interrupting and the circuit-closing operations of said circuit breaker, means for causing opening of said valve for a period of time during said circuit-interrupting operation to produce an opening fluid blast, means for causing opening of said valve for a period of time during said circuit-closing operation to produce a closing fluid blast and means including a pivoted assembly having mounted thereon two independently adjustable means for adjusting the duration and time of initiation of said opening and closing fluid blasts.

2. In an electric circuit breaker of the gas-blast type comprising means defining an arc chamber, relatively movable contacts separable to draw an arc in said chamber, a source of gas under pressure for supplying a gas blast to said arc chamber, valve means for controlling the

flow of gas from said source to said arc chamber, means for operating said contacts to open and closed circuit positions, and means including a pivoted assembly having mounted thereon two independently adjustable cams for operating said valve means in accordance with the position of said relatively movable contacts so that said valve means is opened for a period of time during the opening movement of said contacts which is independent of the period of time that said valve means is opened during the closing movement of said contacts.

3. In an electric circuit breaker of the fluid-blast type comprising a plurality of relatively movable contacts, means for producing relative movement between said contacts, a source of fluid under pressure, valve means associated with said source for producing a blast of fluid adjacent said contacts during both the circuit-interrupting and circuit-closing operations of said circuit breaker, a plurality of cam means for controlling said valve means so that the fluid blast during the circuit-interrupting operation is independent of the fluid blast during the circuit-closing operation, and means for determining which of said cam means is effective to control said valve means.

4. In an electric circuit breaker of the gas-blast type comprising means defining an arc chamber, relatively movable contacts separable to draw an arc in said chamber, a source of gas under pressure for supplying a gas blast to said arc chamber, valve means for controlling the flow of gas from said source to said arc chamber, means for operating said contacts to open and closed circuit positions, a plurality of cam means for controlling said valve means in accordance with the position of said relatively movable contacts so that said valve means is operated for a period of time during the opening movement of said contacts which is independent of the period of time that said valve means is operated during the closing movement of said contacts, and means including a guide cam for rendering one of said cam means effective to control said valve means.

5. In an electric circuit breaker of the fluid-blast type comprising means defining an arc chamber, relatively movable contacts separable to draw an arc in said chamber, a source of fluid under pressure for supplying a fluid blast to said arc chamber, valve means for controlling the flow of fluid from said source to said arc chamber, means for operating said contacts to open and closed circuit positions, means including a pivoted assembly operable in response to the relative movement of said contacts, said pivoted assembly including an opening fluid-blast cam and a closing fluid-blast cam, means arranged to engage either said opening or said closing fluid-blast cam to operate said valve means to produce a blast of fluid in said chamber, and means including a guide cam for determining which of said cams is effective to control said valve means.

6. In an electric circuit breaker of the fluid-blast type comprising a plurality of relatively movable contacts, means for producing relative movement between said contacts, a source of fluid under pressure, valve means associated with said source for producing a blast of fluid adjacent said contacts during both the circuit-interrupting and the circuit-closing operations of said circuit breaker, means for preventing said first-mentioned means from operating prior to operation of said valve means, fault responsive means for initiating the operation of said valve means, means including a pivoted assembly interposed between said valve means and said means for producing relative movement between said contacts for timing the opening of said valve means during the circuit-interrupting operation and independent means associated with said pivoted assembly for controlling said valve means during the circuit-closing operation.

7. In an electric circuit breaker of the fluid-blast type comprising a plurality of relatively movable contacts, means for producing relative movement between said contacts, a source of fluid under pressure, valve means associated with said source for controlling the flow of a blast of fluid adjacent said contacts, fault-responsive means for initiating the operation of said valve means to permit a blast of fluid to flow adjacent said contacts during the circuit-interrupting operation, means for controlling the duration of said fluid blast, and means for rendering said fault-responsive means ineffective after said last-mentioned means has taken over control of the duration of said fluid blast.

8. In an electric circuit breaker of the fluid-blast type comprising a plurality of relatively movable contacts, means for producing relative movement between said contacts, a source of fluid under pressure, valve means associated with said source for controlling the flow of a blast of fluid adjacent said contacts during both the circuit-interrupting and the circuit-closing operations of said circuit breaker, fault-responsive means for initiating the operation of said valve means to permit a blast of fluid to flow adjacent said contacts during the circuit-interrupting operation, means including a pair of cams, one for controlling the duration of the fluid blast during the circuit-interrupting operation and the other for controlling said valve means during the circuit-closing operation, and means for rendering said fault-responsive means ineffective after said last-mentioned means has taken over control of the duration of said fluid blast during the circuit-interrupting operation.

9. In an electric circuit breaker of the fluid-blast type comprising a plurality of relatively movable contacts, means for producing relative movement between said contacts, a source of fluid under pressure, valve means associated with said source for producing a blast of fluid adjacent said contacts during both the circuit-interrupting and circuit-closing operations of said circuit breaker, a pair of cam means for controlling said valve means so that the fluid blast during the circuit-interrupting operation is independent of the fluid blast during the circuit-closing operation, means for normally rendering said pair of cam means ineffective, and means responsive to the relative movement between said contacts for determining which of said cam means is effective to control said valve means.

10. In an electric circuit breaker of the fluid-blast type comprising means defining an arc chamber, relatively movable contacts separable to draw an arc in said chamber, a source of fluid under pressure for supplying a fluid blast to said arc chamber, valve means for controlling the flow of fluid from said source to said arc chamber, means for producing relative movement between said contacts, means including a pivoted assembly rotatable in response to the relative movement between said contacts, said pivoted assembly including an opening fluid-blast cam and a

closing fluid-blast cam, means arranged to engage either said opening or said closing fluid-blast cam to operate said valve means to produce a blast of fluid in said chamber, mutually opposing spring means tending to prevent said last-mentioned means from engaging either of said cams, and means including a guide cam for rendering one or the other of said cams effective to control said valve means depending upon the direction of rotation of said pivoted assembly.

CARL THUMIM.
JOHN D. GAYER.