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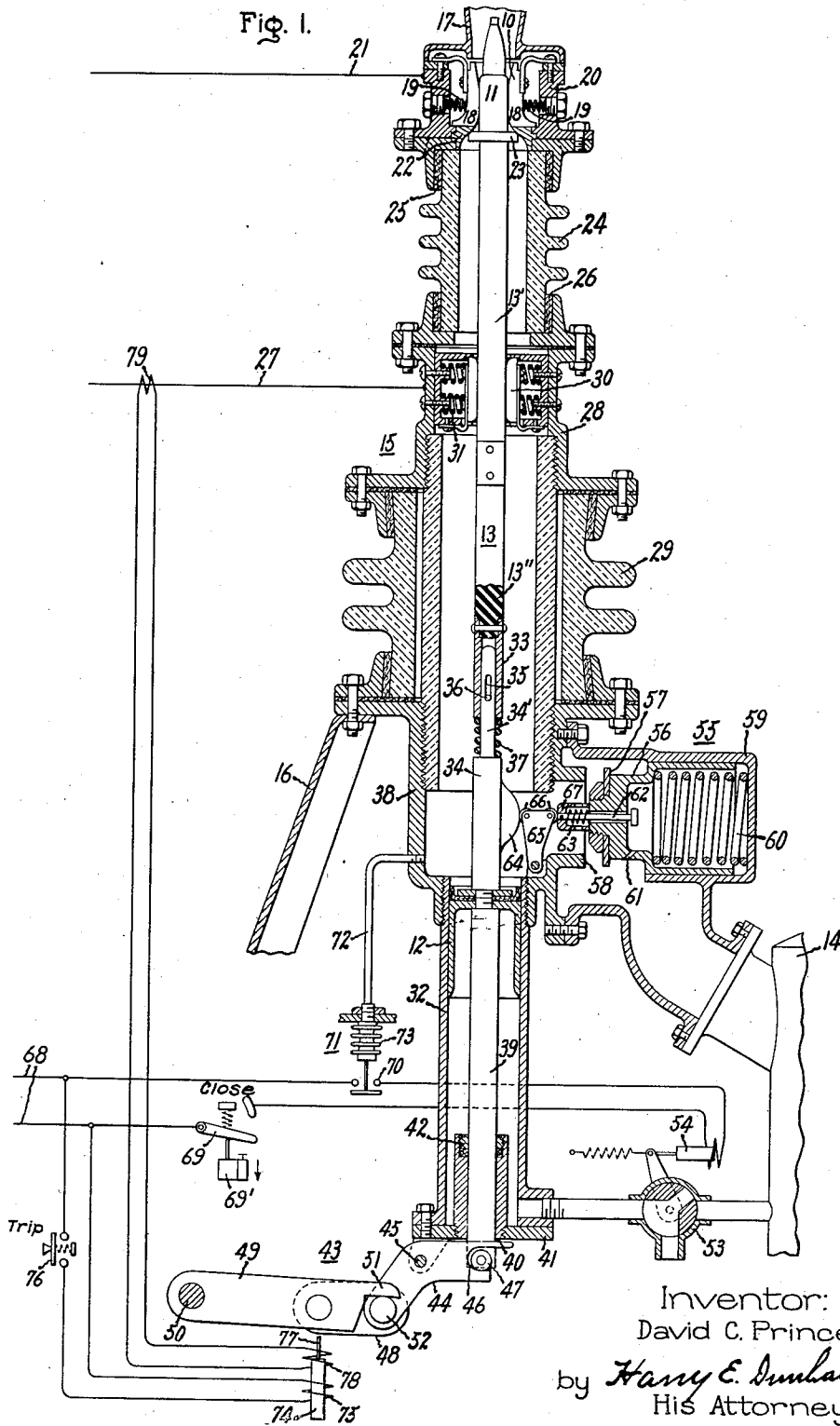
D. C. PRINCE

2,238,567

CIRCUIT BREAKER

Filed Jan. 19, 1940

2 Sheets-Sheet 1



Inventor:
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by *Harry E. Dunham*
His Attorney.

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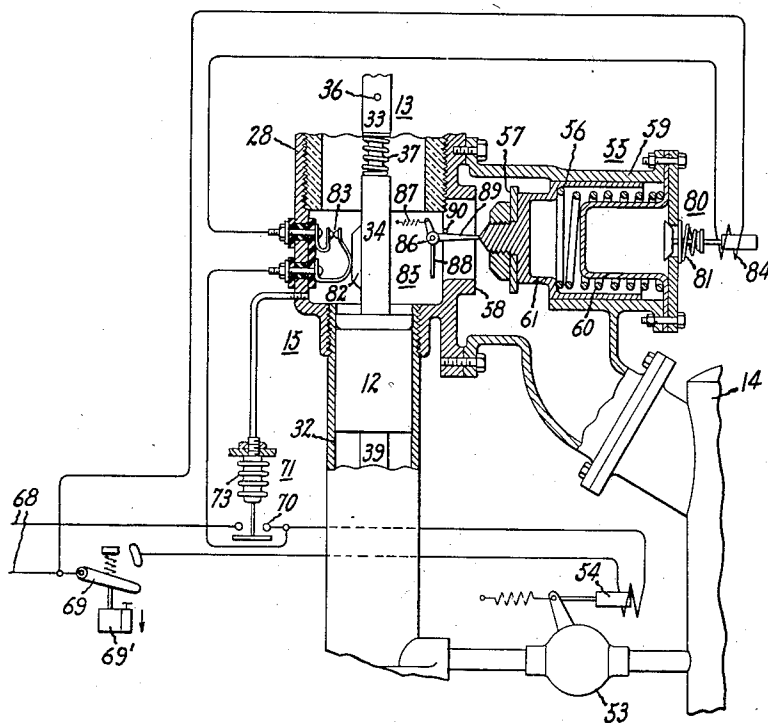
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FIG. 2.



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UNITED STATES PATENT OFFICE

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CIRCUIT BREAKER

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York

Application January 19, 1940, Serial No. 314,613

8 Claims. (Cl. 200—82)

My invention relates to circuit breakers and more particularly to high-speed fluid-operated circuit breakers.

In many high-voltage installations, it is desirable to obtain higher speeds of opening of circuit breakers than has heretofore been possible. Circuit breakers have been designed which operate by spring pressure but, where high-speed tripping is desired, the mass of the springs becomes an important factor both in the amount of energy delivered to the moving parts and the rate of such delivery. In order to deliver sufficient energy, the springs must be heavy and, therefore, the inertia of the actual spring parts prevents any considerable amount of energy from being delivered by the spring in a very short time of the order in which it is desirable to operate a very high-speed circuit breaker. For this reason, air or other fluid under pressure has been suggested as the operating force since it passes a very large amount of energy with a negligible inertia.

In fluid-operated circuit breakers, the fluid under pressure is usually supplied through extended pipes and controlled by a number of small valves. Because of this arrangement, there is a loss of pressure through the extended pipes, causing a delay insofar as high-speed operation is concerned and, furthermore, the time of operating the valve becomes considerable in very high-speed circuit breakers. In accordance with my invention, I provide an arrangement wherein the fluid for operating the circuit breaker is under pressure at the point where it is needed to open the breaker immediately in case of abnormal current conditions or other reasons without the delay caused by pressure loss due to the flow of the fluid through extended pipes as well as the delay coincidental with the operating of various valves. If my invention is applied to a breaker of the fluid-blast type, such as is disclosed and claimed in United States Letters Patent No. 1,898,900 granted February 21, 1933, upon an application of Sigwart Ruppel, the fluid under pressure is also immediately available for the fluid blast for arc-extinguishing purposes.

Furthermore, when the operation of a fluid-controlled circuit breaker is dependent upon the operation of a number of small valves which usually contain passages easily blocked by ice formed in cold weather from the condensation, a material question as to reliability arises. In my invention, on the other hand, these small valves operate only when the circuit breaker is moved to its closed position and the opening of the circuit breaker is in no way dependent upon them but rather is dependent upon fluid under pressure which is always ready at the point of use and which may supply an appreciable amount

of energy in a very short time due to the negligible inertia.

Accordingly, it is an object of my invention to provide a new and improved fluid-operated high-speed circuit breaker.

It is another object of my invention to provide a high-speed fluid-operated circuit breaker in which fluid under pressure for opening the circuit breaker is independent of the operation of valves or other apparatus which are likely to cause appreciable delay.

It is a further object of my invention to provide a fluid-operated circuit breaker of higher speed than has heretofore been possible and which is reliable under all conditions of 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.

My invention will be better understood from the following description taken in connection with the accompanying drawings in which Fig. 1 is a side elevation partly in section of a circuit breaker embodying my invention and Fig. 2 is a cross-sectional view of a portion of the circuit breaker shown in Fig. 1 in order to illustrate a modification thereof.

Referring to Fig. 1, I have illustrated my invention as applied to a circuit breaker of the fluid-blast type although as this description proceeds, it will be apparent to those skilled in the art that my invention is also applicable to other types of circuit breakers. The circuit breaker of Fig. 1 is illustrated as including a pair of relatively movable electrodes or contacts comprising stationary electrode 10 of the female type and movable electrode 11 of the male type. A double acting piston 12, operatively connected by means of connecting rod 13 to movable electrode 11, is arranged to actuate contact 11 when subjected to pressure from fluid pressure source 14. The entire circuit breaker is mounted within a cylindrical fluid-tight container 15, comprising a plurality of individual parts which will be hereinafter described, and is suitably supported on a base, not shown, by means of brackets of the type illustrated at 16.

More specifically, electrode 10 of the female type is mounted at the upper end of cylindrical fluid-tight container 15 which is provided with a nozzle-like opening 17 for the escape of arc products during the opening or closing operations of the circuit breaker. Stationary electrode 10 comprises a cylindrical body built of separate sections 18 biased to form a tight fit with movable electrode 11 by means of suitable springs 19 mounted in a cylindrical conducting chamber 20

forming the upper part of cylindrical casing 15. One of the power lines 21 is suitably connected to cylindrical conducting member 20, and, hence, also to stationary electrode 10. The lower end of cylindrical member 20 is provided with a streamlined portion 22 forming a suitable valve seat for fluid-blast valve 23 carried by movable electrode 11 and connecting rod 13. The entire unit, including stationary electrode 10, cylindrical member 20, and streamlined valve seat 22, is mounted upon a suitable insulator 24 forming another part of cylindrical fluid-tight container 15. Suitable packing material 25 and 26 is provided at either end of insulator 24 to prevent the escape of fluid under pressure contained within fluid-tight container 15. The other power line 27 is connected to a conducting cylindrical member 28 interposed between insulator 24 and insulator 29, all forming part of cylindrical fluid-tight container 15. Electrical connection between movable contact 11 and power line 27 is provided through a conducting portion 13' of connecting rod 13 and a plurality of conducting segments 30 flexibly mounted on springs 31 attached to conducting cylindrical member 28, which provide the necessary contact pressure between segments 30 and conducting portion 13' of connecting rod 13.

The operating mechanism of circuit breaker 10 is insulated from the high-tension portions of the circuit breaker by insulator 29 and an insulating section 13'' of connecting rod 13. Piston 12 is arranged to operate in cylinder 32 and is operatively connected to connecting rod 13 associated with movable contact 11 by means of a sliding joint comprising a tube 33 telescoped with a reduced section 34' of rod 34 including a slot 35 cooperating with pin 36 fixed in tube 33. This sliding joint is included in order to provide suitable sealing of valve 23 in spite of the back lash unavoidably present in the latch mechanism described hereinafter which sealing is produced by virtue of spring 37 mounted between tube 33 and the enlarged portion of rod 24. Rod 34 and the sliding joint all form part of connecting rod 13. Cylinder 32 is connected to insulator 29 by a suitable cylindrical member 38, and members 20, 24, 28, 29, 30, and cylinder 32 together form the cylindrical fluid-tight container 15 for the circuit breaker. Rod 34 forming part of connecting rod 13 is operatively connected to the upper side of double-acting piston 12 while a rod 39 is connected to the lower side of piston 12 and extends beyond the lower end of cylinder 32 through an opening 40 in end cover 41 closing the lower end of fluid-tight cylindrical container 15. A suitable gland 42 is provided for rod 39 to prevent the leakage of any fluid from the lower end of cylinder 32 while still allowing the reciprocation of rod 39 in accordance with the movements of piston 12.

An overcenter device 43 is provided in order to releasably latch the circuit breaker in the closed position and comprises a toggle arrangement including bell crank 44 pivotally mounted at 45 to the lower end of cylindrical fluid-tight casing 15. One end of bell crank 44 is provided with a U-shaped notch 46 which cooperates with roller 47 attached to the end of rod 39 associated with piston 12. The other end of bell crank 44 is pivotally connected to one end of a toggle comprising links 48 and 49, the other end of the toggle being connected to a fixed pivot 50. Link 49 is provided with an extension 51 adapted to cooperate with a pin 52 attached to bell crank

44. In the arrangement shown with extension 51 engaging with pin 52, the toggle comprising links 48 and 49 is in the overcenter position so that circuit breaker 10 is mechanically latched in the closed position and it is necessary to release the toggle comprising links 48 and 49 from the overcenter position, as will be hereinafter described, in order to obtain a tripping or opening operation of the circuit breaker.

The fluid pressure operating means for the circuit breaker comprises a solenoid-operated closing valve 53 including solenoid 54. Closing valve 53 is adapted to interconnect fluid pressure source 14 which may, for example, be a source of air or other suitable gas under pressure with the lower end of cylinder 32 so as to operate against the underside of piston 12. In another operating position of closing valve 53, the lower end of cylinder 32 is vented to atmosphere. A pressure-balanced valve 55 is provided for connecting the upper end of cylinder 32 and the remainder of the cylindrical fluid-tight container 15 with the source of fluid under pressure 14 both for opening the circuit breaker and also for supplying the fluid for the fluid blast when fluid-blast valve 23 is open whereby an arc drawn between contacts 10 and 11 is extinguished. Balanced-pressure valve 55 comprises a piston 56 operatively connected to a valve member 57 which cooperates with valve seat 58. Piston 56 is mounted within a cylinder 59 bolted to the side of cylindrical gas-tight casing 15 adjacent valve seat 58. A spring means 60 biases the balanced-pressure valve 55 to the closed position. Under steady-state conditions, the fluid pressure acting on piston 56 is balanced on both ends of the piston by virtue of a small opening 61, somewhat exaggerated in the drawings for purposes of illustration, which allows an equalization of pressure. In order that balanced-pressure valve 55 may be operated to the open position against the bias of spring means 60, I provide a pilot valve 62 which provides a large opening relative to opening 61 for interconnecting the respective ends of cylinder 59 so that the pressure operating on both ends of piston 56 may be unbalanced. Pilot valve 62 is normally biased to the closed position by means of spring 63.

In order to operate balanced-pressure valve 55 at a predetermined position of movable electrode 11 during the circuit-closing operation, I provide cam 64 associated with connecting rod 13. A pivotally mounted member 65 provided with rollers 66 is engaged by cam 64 just before the closed position of the circuit breaker is reached so as to engage the end of pilot valve 62 and move it to the open position, as shown in Fig. 1. The opening of pilot valve 62 immediately releases the pressure on the right-hand end of piston 56 whereby the pressure on the left-hand end is sufficient to overcome the force of spring means 60 whereby balanced-pressure valve 55 is opened. A cuplike member 67 forming part of pilot valve 62 adjacent pivotally mounted member 65 is provided so that cam 64 maintains balanced-pressure valve 55 in the open position whenever the circuit breaker is in the closed position. By this arrangement, cylindrical fluid-tight casing 15 is maintained under pressure when the circuit breaker is closed so that, whenever overcenter device 43 is released, fluid under pressure is immediately available to move piston 12 downwardly, thereby opening the circuit breaker and, furthermore, fluid under pressure for fluid blast purposes is also available to extinguish the

arc drawn between electrodes 10 and 11 when gas-blast valve 23 is opened.

It will be understood that any well-known control means may be provided for operating the circuit breaker illustrated in Fig. 1. Accordingly, I have illustrated a source of potential 68 for energizing the manually controlled tripping and closing circuits of the circuit breaker. A closing switch 69 is provided for connecting solenoid 54 associated with valve 53 across potential source 68 through contacts 70 of a pressure-operated relay 71. Pressure-operated relay 71 is connected with cylindrical fluid-tight casing 15 above piston 12 through a suitable tube 72 and comprises a bellows 73 which is arranged to expand when fluid under pressure is allowed to enter chamber 15 thereby opening contacts 70 which are normally closed when the pressure within chamber 15 is released. "Close" switch 69 is adapted to be manually operated and is provided with a dashpot 69' in order to delay the opening thereof to insure the closing of the circuit breaker. It will be understood by those skilled in the art that switch 69 could be replaced by the conventional push button switch with seal-in contacts to insure the closing of the circuit breaker. The tripping of the circuit breaker is accomplished by solenoid 74 which has one winding 75 thereof energized from potential source 68 through "trip" button 76. Solenoid 74 has a pin-like extension 77 which is adapted to strike one of the links 48 or 49 of the overcenter device so as to allow tripping of the circuit breaker. A second winding 78 is provided for solenoid 74 which is connected to a current transformer 79 associated with power line 27 so that tripping of the circuit breaker is obtained when abnormal current conditions occur in the power lines.

The operation of my circuit breaker will be considered first with reference to the closed position of the circuit breaker as shown in Fig. 1. Overcenter device 43 is in such a position to mechanically restrain or latch movable contact 11 in current-conducting relation with fixed contact 10 while, at the same time, maintain blast valve 23 against streamlined valve seat 22. Balanced-pressure valve 55 is held open by cam 64 and pivotally mounted member 65 so that fluid under pressure from source 14 completely fills cylindrical fluid-tight casing 15 above piston 12 and below gas-blast valve 23. This fluid, of course, is immediately available independently of the operation of any valves or the like for opening the circuit breaker and providing the arc-extinguishing fluid blast when the mechanical restraining means comprising overcenter device 43 is tripped. Furthermore this fluid under pressure in chamber 15 expands bellows 73 thereby opening contact 70 and preventing the operation of solenoid-operated valve 53 when the circuit breaker is in the closed position. If an overload should occur on the power lines associated with the circuit breaker or if it were desired to manually trip the circuit breaker, solenoid 74 would be energized through coils 78 or 75 respectively, whereby overcenter device 43 would be tripped and the restraining force holding the circuit breaker in the closed position would be removed. As soon as this tripping occurs, the fluid under pressure against the upper side of piston 12 would immediately force piston 12 downwardly and this movement would open blast valve 23. Very high speed operation of the circuit breaker is thereby obtained since the fluid under pressure is available to move piston 12 downwardly and to pro-

vide the necessary fluid blast for arc extinguishment the instant overcenter device 43 is released. Opening of the circuit breaker allows pilot valve 62 to close and furthermore fluid-pressure valve 55 moves to the closed position as soon as the pressures are balanced so that spring 60 again obtains control. Air or other gas or fluid in cylinder 32 below piston 12 is vented to atmosphere through valve 53 during the opening operation of the circuit breaker.

To close the circuit breaker, switch 69 is operated the opening of which is retarded by dashpot 69'. Contact 70 had been closed since the fluid pressure in cylindrical fluid-tight chamber 15 was released through blast valve 23. Therefore, the closing of switch 69 energizes solenoid 54 allowing fluid under pressure from source 14 to enter the lower end of cylinder 32 forcing piston 12 upwardly and moving contact 11 toward stationary contact 10. As soon as cam 64 engages with pivotally mounted member 65 pilot valve 62 is opened and the pressure on the right-hand end of piston 56 is released so that balanced-pressure valve 55 is forced open and held open by cam 64, pivotally mounted member 65, and cup-shaped member 67 associated with pilot valve 62. A blast of fluid or air is allowed to pass through blast valve 23 prior to closing thereof to prevent the formation of an arc before the circuit breaker is closed.

In Fig. 2, I have illustrated a modification of my invention wherein the mechanically operated pilot valve 62 is replaced by an electrically operated pilot valve. The corresponding parts of the circuit breaker illustrated in Fig. 2 are designated by the same reference numerals as in Fig. 1. Balanced-pressure valve 55 is provided with a solenoid-operated pilot valve 80 normally biased to the closed position by means of spring 81. In order that this valve may be operated at a predetermined point in the closing stroke of the circuit breaker, a cam 82 is provided connected with rod 34 of connecting rod 13 for causing the engagement of contacts 83 connected in an electrical circuit for energizing the winding 84 of solenoid-operated pilot valve 80 from source of potential 68. By this arrangement, pilot valve 80 is electrically operated at a predetermined point in the closing stroke of the circuit breaker causing operation of balanced-pressure valve 55 in the same manner as in Fig. 1. In order to hold valve member 57 of balanced-pressure valve 55 in the open position when the circuit breaker is closed, I provide a vane-operated member 85 pivotally mounted at 86 and biased to the position shown in Fig. 2 by spring means 87. This member 85 is provided with a vane 88 arranged to be operated by the flow of fluid through balanced-pressure valve 55. An extension 89 is provided on vane-operated member 85 which engages against stop 90 to hold balanced-pressure valve 55 in the open position after the circuit breaker has been closed. During the circuit-opening operation, the flow of fluid through balanced-pressure valve 55 forces vane 88 to rotate about pivot 86 whereby member 89 releases valve member 57 and allows closure of balanced-pressure valve 55 to take place. Pressure relay 71 is arranged so as to break the circuit of solenoid-operated pilot valve 80 after the circuit breaker has been closed. The operation of the arrangement illustrated in Fig. 2 will be understood by those skilled in the art in view of the detailed description set forth in connection with Fig. 1.

While I have shown particular embodiments of

my invention as applied to a fluid-operated circuit breaker of the gas-blast type, it will be apparent to those skilled in the art that my 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 my invention and I aim in the appended claims to cover all such changes and modifications.

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

1. In a fluid pressure operated circuit breaker, the combination comprising a plurality of relatively movable electrodes, fluid-operated means associated with one of said electrodes for producing relative movement between said electrodes, a source of fluid under pressure, means for connecting said first mentioned means and said source of fluid when said circuit breaker is in the closed position so that said fluid under pressure constantly tends to open said circuit breaker, means for restraining said circuit breaker in said closed position, and means for tripping said last mentioned means, whereby said source of fluid under pressure is released to operate said first mentioned means.

2. In a fluid pressure operated circuit breaker, the combination comprising a plurality of relatively movable electrodes, fluid-operated means associated with one of said electrodes for producing relative movement between said electrodes, a source of fluid under pressure, said source of fluid under pressure constantly tending to produce relative movement between said electrodes when said circuit breaker is in the closed position, means for restraining said circuit breaker in said closed position, and means for tripping said last mentioned means, whereby said source of fluid under pressure is released to operate said first mentioned means.

3. In a fluid pressure operated circuit breaker, the combination comprising a plurality of relatively movable electrodes, fluid-operated means associated with one of said electrodes for producing relative movement between said electrodes, a source of fluid under pressure, means for connecting said first mentioned means and said source of fluid when said circuit breaker is in the closed position so that said fluid under pressure constantly tends to open said circuit breaker, means for restraining said circuit breaker in said closed position, means for tripping said last mentioned means, whereby said source of fluid under pressure is released to operate said first mentioned means, and means for connecting said first mentioned means and said source of fluid to operate said circuit breaker to the closed position.

4. In a fluid pressure operated circuit breaker, a plurality of relatively movable electrodes, fluid-operated means associated with one of said electrodes constantly tending to produce relative movement between said electrodes, means for latching said circuit breaker in the circuit-closing position, and means for tripping said last mentioned means so that said first-mentioned means is caused to operate independently of the operation of valves, thereby producing high-speed opening of said circuit breaker.

5. In a fluid pressure operated circuit breaker, a plurality of relatively movable electrodes, fluid-operated means associated with one of said electrodes for producing relative movement between said electrodes, a source of fluid under pressure, said source of fluid under pressure constantly

tending to produce relative movement between said electrodes when said circuit breaker is in the closed position, means for restraining said circuit breaker in said closed position, means for releasing said last-mentioned means whereby said source of fluid under pressure is released to operate said first-mentioned means, and a blast valve for releasing some of said fluid under pressure to extinguish any arc drawn between said relatively movable electrodes when said restraining means has been tripped.

6. In a fluid pressure operated circuit breaker, the combination comprising a plurality of relatively movable electrodes, a fluid tight casing including a cylinder, a piston reciprocally mounted in said cylinder, a connecting rod interconnecting said piston and one of said electrodes so that relative movement between said electrodes may be obtained, a source of fluid under pressure, a valve for connecting said source of fluid under pressure with said fluid tight casing and one end of said cylinder so that said fluid may operate on said piston to open said circuit breaker, a second valve for connecting said source of fluid with the other end of said cylinder to force said circuit breaker to the closed position, a blast valve operated by said piston, cam means associated with said connecting rod for opening said first-mentioned valve at a predetermined point in the closing stroke of said circuit breaker prior to the closing of said blast valve so a blast of fluid may escape through said blast valve, means for latching said circuit breaker in the closed position, and means for holding said first-mentioned valve in the open position while the circuit breaker is in the closed position so that said source of fluid under pressure is continually ready to open said circuit breaker and provide a fluid blast through said blast valve whenever said latching means is released.

7. In an electric circuit breaker, the combination comprising a plurality of relatively movable electrodes, a connecting rod associated with one of said electrodes, means for operating said connecting rod to produce relative movement between said electrodes, a blast valve mounted on said connecting rod adjacent said electrodes, and a source of fluid under pressure restrained by said blast valve when said circuit breaker is in the closed position, said fluid under pressure being released upon opening of said circuit breaker and consequent opening of said blast valve to produce a fluid blast for arc-extinguishing purposes.

8. In an electric circuit breaker, the combination comprising a plurality of relatively movable electrodes, a casing, a connecting rod associated with one of said electrodes and arranged to operate within said casing, means for operating said connecting rod to produce relative movement between said electrodes, a blast valve operated by said connecting rod for closing one end of said casing, a source of fluid under pressure, and a second valve operated by said connecting rod at a predetermined point in the operating stroke of said circuit breaker for releasing said source of fluid under pressure into said casing, said second valve being mechanically held in the open position whenever said circuit breaker and blast valve are in their closed positions, whereby said blast valve releases said fluid under pressure in said casing to produce an arc-extinguishing blast of fluid upon opening of said circuit breaker.

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