

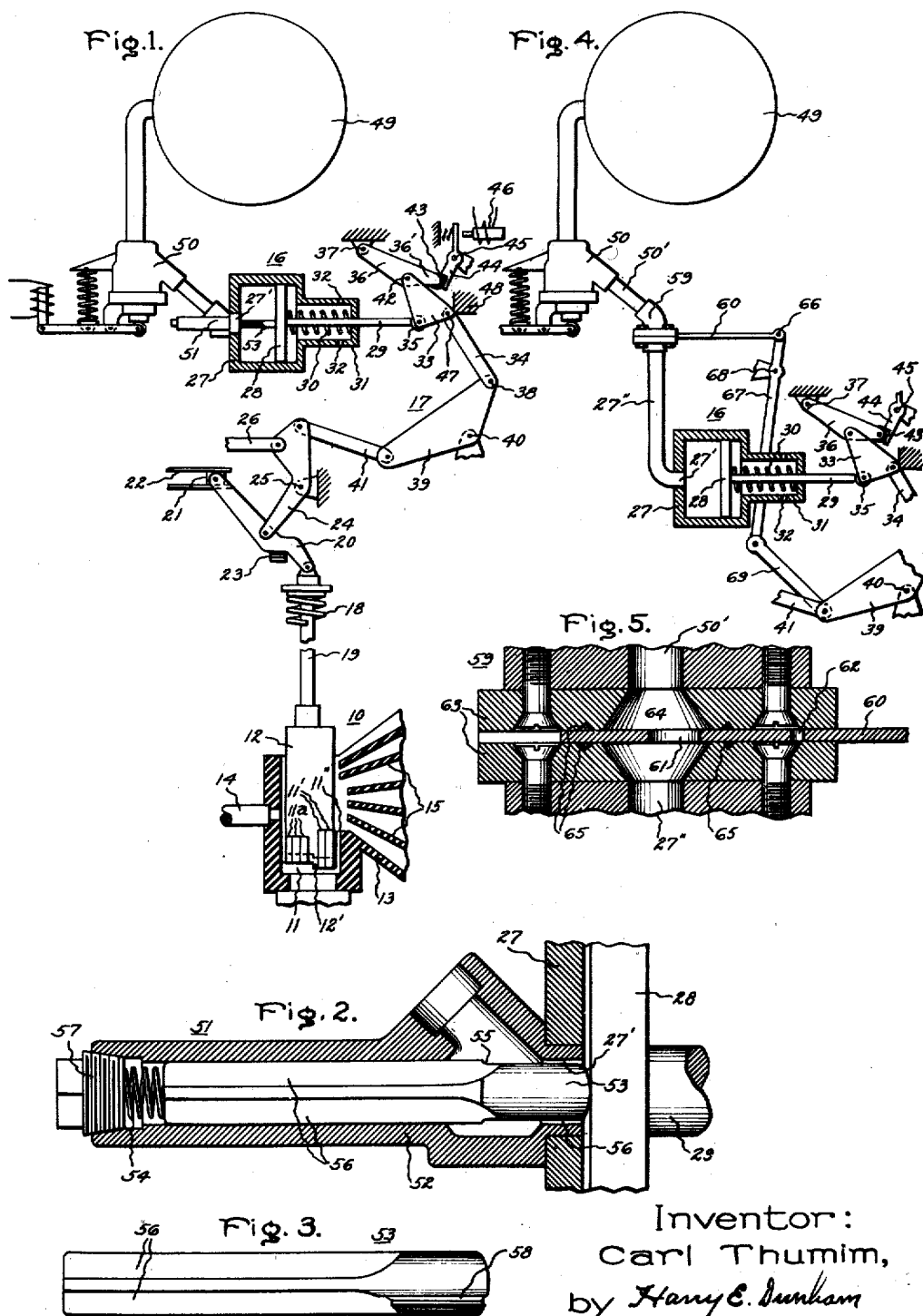
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ELECTRIC CIRCUIT BREAKER

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ELECTRIC CIRCUIT BREAKER

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10 Claims. (Cl. 200—82)

My invention relates to electric circuit breakers and more particularly to circuit breakers wherein relative movement between the contacts is produced by fluid-operated means.

It is a well-known fact that circuit breaker closing loads vary during the closing stroke, as a general rule being comparatively light at the beginning of the stroke and much heavier toward the end of the stroke as the opening springs become charged and the contacts engage one another. Because of this fact, in the case of fluid-operated circuit breakers if the cylinder of the fluid motor is sufficiently large to produce enough operating force near the end of the closing stroke, it will be much too large and produce far too much force at the beginning of the closing stroke. As a result of designing such a cylinder large enough to produce sufficient force at the end of the closing stroke, enormous acceleration of the apparatus will occur at the beginning of the closing stroke which is not only undesirable but may even cause damage to the circuit breaker operating mechanism. It is possible to provide a varying linkage between the fluid motor and the moving contacts of the circuit breaker to compensate for some of this discrepancy in the force applied during the closing stroke. However, circuit breakers are built in many different sizes and it is not practical to provide different mechanisms for each size of breaker. Accordingly, it would be desirable to provide an arrangement for varying the force applied to the closing mechanism of the circuit breaker during the closing stroke which may readily be used on a variety of different circuit breaker sizes without requiring different mechanisms for each breaker size.

It is an object of my invention, therefore, to provide a fluid-operated circuit breaker in which a variable force is applied to the circuit breaker operating mechanism to produce relative movement between the contacts without the use of varying ratio linkages or the like.

It is another object of my invention to provide a new and improved fluid-operated circuit breaker in which the fluid-operated means exerts a variable force during the closing stroke of the circuit breaker.

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 fluid-operated circuit breaker embodying my invention, Fig. 2 is an enlarged cross-sectional view of a portion of the appa-

ratus illustrated in Fig. 1 in a different operating position thereof, Fig. 3 is a modification of a portion of the apparatus illustrated in Fig. 2, Fig. 4 illustrates schematically a portion of an electric circuit breaker embodying a modification of my invention, and Fig. 5 is an enlarged cross-sectional view of a portion of the apparatus illustrated in Fig. 4.

Although my invention is applicable to any fluid-operated circuit breaker, single-phase or polyphase, for purposes of clearness and simplicity in the disclosure, I have illustrated my invention schematically in Fig. 1 as applied to a fluid-operated circuit breaker 10 of the cross gas-blast type comprising a stationary contact 11 and a movable contact 12 arranged to be operated so as to draw an arc in an arc chute 13. It will be understood by those skilled in the art that contacts 11 and 12 are arranged to be connected with suitable line terminals not shown. The stationary or fixed contact 11 is provided with spring-pressed contact fingers 11a and longer arcing contact fingers 11', while movable contact 12 is provided with an arcing tip 12' so that, when the contacts separate, an arc occurs between arcing tips 11' and 12'. Immediately after separation of the contacts, one terminal of the arc is transferred by a blast of fluid, such as air or any other gas issuing from conduit 14, which is suitably connected through a blast valve or the like, not shown, with a source of fluid under pressure, from contact fingers 11' to the contact 11'' which is provided with a tip of arc-resistant metal. The fluid blast from conduit 14, upon the opening of circuit breaker 10, drives the arc into the arc chute 13 against the edges of a plurality of partitions 15, which partitions are mounted in the arc chute 13 transverse to the arc gap and the ends of which extend close to the path of movement of the arcing tip 12' of movable contact 12. This circuit breaker 10 is illustrated by way of example only in order to aid in understanding my invention, which is applied thereto. The circuit breaker described thus far is not my invention but is described and claimed in United States Letters Patent 2,284,842, granted June 2, 1942, upon the joint application of David C. Prince, William K. Rankin, and Wilfred F. Skeats, and assigned to the same assignee as the present application.

It will be understood by those skilled in the art in view of the description following herein-after that my invention is applicable to any fluid-operated circuit breaker whether fluid-operated means are either wholly or partially used to produce relative movement between the circuit breaker contacts. In the specific embodiment disclosed in Fig. 1, I have illustrated fluid-operated means which not only provide the force

necessary to close circuit breaker 10 but also provide the force necessary to charge the energy-storage means which, in turn, provides the force required for opening the circuit breaker at the desired time. Accordingly, in Fig. 1, I have illustrated a fluid motor 16 which, acting through a trip-free thrust-transmitting mechanism generally indicated at 17, is arranged to close circuit breaker 10 and charge an energy-storage means illustrated as an opening spring 18.

The mechanism for interconnecting the movable contact 12 of circuit breaker 10 with fluid motor 16 is illustrated as comprising an operating rod 19, one end of which is operatively connected to movable contact 12 while the other end thereof is pivotally connected to one end of a suitable lever 20 which is provided at the other end thereof with a crosshead 21. This crosshead 21 is arranged to slide in a crosshead guide 22. A buffer 23 may be provided adjacent the lever 20 in order to cushion the closing movement of the operating mechanism associated with circuit breaker 10. Lever 20 has an intermediate point thereon connected to one end of a suitable bell crank 24 which is pivotally mounted on a fixed support 25. A link 26, only a portion of which is shown, may be provided to interconnect bell crank 25 with similar bell cranks, not shown, to operate other poles of the circuit breaker 10 in the event that a polyphase breaker is provided, whereby simultaneous actuation of all the poles of the circuit breaker may be obtained.

The energy-storage means comprising spring 18 is suitably attached to operating rod 19 so as to supply the necessary force for producing uniform high-speed opening movement of circuit breaker 10. Spring 18 is shown in the charged condition in Fig. 1 when the circuit breaker 10 is closed, and is arranged to cause clockwise rotation of bell crank 24 during the opening movement of circuit breaker 10.

Fluid motor 16, which is provided to close the contacts of circuit breaker 10 as well as to charge energy-storage means 18, is illustrated as comprising a suitable cylinder 27 in which is reciprocatingly mounted a piston 28 operatively connected to a force-transmitting rod 29, the latter being arranged to engage with the trip-free thrust-transmitting linkage generally indicated at 17. This thrust-transmitting linkage 17 has one end thereof connected to bell crank 24 so that force may be transmitted from piston 28 to operating rod 19 to close the contacts 11 and 12 of circuit breaker 10.

The fluid motor 16 in Fig. 1 is shown at the instant when circuit breaker 10 has just been completely closed. Since this fluid motor is used only to close circuit breaker 10 and charge opening spring means 18, it is desirable to provide suitable means for returning piston 28 to its initial position at the left-hand end of cylinder 27 after the closing operation is completed. Accordingly, I have shown a suitable return spring 30 mounted in a housing 31 supported by cylinder 27. Suitable ports 32 in housing 31 allow air in cylinder 27 at the right of piston 28 to escape when circuit breaker 10 is being closed.

The trip-free thrust transmitting structure generally indicated at 17 may be of any suitable design, the one shown by way of example comprising a main toggle 33, 34 including a roller 35 which coacts with the torque-transmitting rod 29 associated with piston 28. The toggle link 33 is pivotally connected at one end to a lever 36 supported on a fixed pivot 37. The toggle link

34, on the other hand, is connected at 38 to one end of a lever 39 supported on a fixed pivot 40. The other end of lever 39 is connected through link 41 to bell crank 24. The pivot 42 of toggle link 33 is normally held fixed by a suitable tripping means including an extension 36' on lever 36 supporting a roller 43 which coacts with a tripping latch 44 pivotally mounted at 45. A solenoid-operated plunger 46 is provided to cause counterclockwise rotation of tripping latch 44 and consequent release of the trip-free mechanism generally indicated at 17. When the toggle 33, 34 is straightened at its knee joint 47 by force-transmitting rod 29, the lever 39 is rotated about its fixed pivot 40 in a clockwise direction to cause operating rod 19 to move downwardly to the position shown in Fig. 1 when the circuit breaker 10 is closed. Upon energization of solenoid-operated plunger 46, latch 44 is moved out of restraining engagement with respect to roller 43, and lever 36 is free to rotate in a counterclockwise direction by virtue of the force exerted by opening spring 18. The toggle 33, 34 is then no longer in thrust-transmitting position and is free to collapse, permitting upward movement of operating rod 19 under the bias of the energy-storage means comprising spring 18.

In Fig. 1, the trip-free thrust-transmitting linkage 17 is illustrated in a restraining or closed position with respect to operating rod 19. In this position the knee joint 47 of toggle 33, 34 is overset and engages a stop member 48. The linkage is thereby effectively locked in this position with respect to any opening thrust tending to move operating rod 19 upwardly as long as the pivot 42 of toggle link 33 is held fixed by the above-described tripping means. When latch 44 of the tripping means no longer restrains link 36 and, hence, also pivot 42, the former rotates in a counterclockwise direction under the influence of the forces tending to cause opening movement of circuit breaker 10. When the toggle 33, 34 has collapsed and the lever 39 has rotated in a counterclockwise direction, circuit breaker 10 is opened by virtue of the upward movement of the operating rod 19.

In order to operate fluid motor 16, I provide a source 49 of fluid under pressure which may, for example, be air under pressure. Fluid motor 16 is illustrated as being connected to source 49 through a suitable solenoid-operated valve 50. It will be understood by those skilled in the art that source 49 may also be connected to fluid-blast conduit 14 through a suitable blast valve for supplying the necessary arc-extinguishing fluid in arc chute 13.

The circuit breaker operating mechanism illustrated in Fig. 1 is described in detail in my copending application, Serial No. 343,002, filed June 28, 1940, and assigned to the same assignee as the present application.

In order to obtain a variation in the force applied to the operating mechanism of circuit breaker 10 during the closing stroke, I provide a variable orifice means, generally indicated at 51, at the fluid pressure inlet 27' of cylinder 27. By virtue of this variable orifice means 51, shown in detail in Fig. 2, a relatively small force is applied to the operating mechanism of circuit breaker 10 during the initial portion of the closing stroke so as to avoid excessive acceleration thereof, while a much larger force is applied during the latter part of the closing stroke when the energy-storage means comprising spring 18 is almost fully charged and contacts 11 and 12

begin to engage. The variable orifice means 51 is shown in the initial position in Fig. 2 prior to closure of the circuit breaker 10 while, in Fig. 1, this variable orifice means is shown in the position which a portion thereof assumes at the end of the closing stroke prior to the return of piston 28 to its initial position. The variable orifice means 51 comprises a housing 52 in which is slidably mounted a metering pin 53. Metering pin 53 has one end thereof initially held against piston 28 by light spring 54. This end of metering pin 53 adjacent piston 28 is reduced in diameter as shown at 55 to provide a clearance space 56 between metering pin 53 and the inlet 27' to cylinder 27 so that clearance space 56 provides a restricted area for the flow of fluid under pressure, from source 49 to fluid motor 26, and limits this flow so that a relatively small force, sufficient only to operate piston 28 at the beginning of the closing stroke, is available. By properly proportioning the clearance space 56, the initial forces applied will not be excessive so as to cause damage to the operating mechanism of circuit breaker 10. As the piston 28 moves toward the right of cylinder 27 during the closing stroke of circuit breaker 10, spring 54 initially and later the fluid under pressure cause metering pin 53 to follow the movement of piston 28. A plurality of flutes 58 cut in metering pin 53 greatly increase the area of the inlet 27' to cylinder 27 as the closing stroke of circuit breaker 10 progresses so that a sufficiently increased force for charging the energy-storage means and the like is available. It will be understood that the point at which flutes 58 become effective may be varied by using different metering pins 53 to agree with the required action. This change of metering pins can readily be accomplished by removing plug 57 provided in the end of chamber 52. It will be obvious to those skilled in the art that, in the arrangement just disclosed, no means need be provided for moving the metering pin 53 other than light spring 54 which initiates this movement, after which the fluid pressure continues to cause this metering pin to follow the movement of piston 28.

It will be understood by those skilled in the art that metering pin 53 instead of being provided with a portion of reduced cross section 55 may be provided with a suitable slot 58 (Fig. 3) properly dimensioned to supply the necessary fluid for the initial operation of fluid motor 16. Such an arrangement is disclosed in Fig. 3, which is self-explanatory, the corresponding parts of this metering pin being designated by the same reference numerals as in Fig. 2.

The operation of the apparatus disclosed in Figs. 1 and 2 will be obvious to those skilled in the art in view of the detailed description included above. In order to initiate the closing stroke, solenoid-operated valve 50 interconnects source 49 and cylinder 27 of fluid motor 16. With the metering pin 53 initially in the position indicated in Fig. 2, a minimum force, determined by the design of the metering pin, is applied to piston 28 by virtue of the reduced area 56 through which fluid under pressure may enter cylinder 27. As the closing operation of circuit breaker 10 progresses, the flutes 58 on metering pin 53 become effective and the inlet opening to cylinder 27 increases so that the increased force required for charging spring means 18 and causing engagement of contacts 11 and 12 is available. In the event that energization of solenoid-operated plunger 46 occurs to trip circuit breaker

10 during the closing operation thereof, the trip-free mechanism will collapse and allow high-speed opening of circuit breaker 10. In addition to conserving fluid and preventing initial excessive acceleration, variable orifice means 51 also serves as a means for cushioning the return of piston 28 for, as metering pin 53 is returned to its initial position shown in Fig. 2, the inlet opening to cylinder 27 decreases in size, thereby producing a sort of dashpot effect.

Although I have thus far described a particular type of variable orifice means, it will be obvious that other forms and arrangements may be used. In Fig. 4, for example, I have shown a portion of the circuit breaker and operating mechanism of Fig. 1 with the corresponding parts thereof designated by the same reference numerals, in which a modified variable orifice means is disclosed. Referring now to Fig. 4 and to Fig. 5, where an enlarged cross-sectional view of the variable orifice means of Fig. 4 is shown, I have illustrated a variable orifice means 59 having one end thereof connected by conduit 50' to solenoid-operated valve 50 while the other end is connected by conduit 27'' to the inlet opening 27' of cylinder 27. Variable orifice means 59 of Figs. 4 and 5 comprises a sliding plate 60 including a large opening 61 and a smaller opening 62. Sliding plate 60 is arranged to reciprocate between a pair of members 63 forming the housing of the variable orifice means 59 and each having an enlarged opening 64 therein arranged to be connected with conduits 50' and 27'', respectively. Suitable sealing means 65 may be provided between sliding plate 60 and members 63 to prevent the escape of fluid.

Plate 60 is illustrated in Fig. 4 as being arranged to reciprocate in response to the closing movement of circuit breaker 10 so that, at the initiation of the closing stroke, small orifice 62 is in alignment with openings 64 while, as the closing operation progresses, large opening 61 comes into operation in a manner very similar to the operation of metering pin 53 of Figs. 1 to 3 described heretofore. In order to relate the movement of sliding plate 60 with the movement of circuit breaker 10, sliding plate 60 is pivotally connected at 66 with a lever 67 pivotally mounted at 68. The other end of lever 67 is connected to pivotally mounted lever 39 through link 69.

In Figs. 4 and 5, the apparatus is shown at the instant circuit breaker 10 is completely closed and the large orifice 61 is in the operative position. In the event of trip-free operation of the circuit breaker 10, lever 39 is rotated to return plate 60 immediately to its initial position so that small orifice 62 is in operative position, whereupon the flow of fluid to cylinder 27 is reduced, resulting in a conservation of fluid and, at the same time, providing a dashpot effect to lessen the force with which the unloaded piston returns to its initial position. The operation of the apparatus disclosed in Figs. 4 and 5 will be obvious to those skilled in the art in view of the detailed description included above.

It will be apparent to those skilled in the art that my invention is not limited to the particular constructions 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 an electric circuit breaker comprising a

plurality of relatively movable contacts, a fluid motor including a piston for producing relative movement between said contacts, a source of fluid under pressure, means for interconnecting said source and said fluid motor, and means for varying the flow of fluid between said source and said fluid motor during an operating stroke of said circuit breaker, said fluid motor being so constructed and arranged with reference to said last-mentioned means as to permit said fluid under pressure to act initially on substantially the entire working face of said piston.

2. In an electric circuit breaker comprising a plurality of relatively movable contacts, fluid-operated means for producing relative movement between said contacts, a source of fluid under pressure, means for interconnecting said source and said first-mentioned means, and means for gradually varying the force applied by said fluid under pressure on said first-mentioned means during an operating stroke of said circuit breaker starting with substantially zero force.

3. In a fluid-operated electric circuit breaker comprising a pair of relatively movable contacts, a fluid motor for operating said circuit breaker, a source of fluid under pressure, means for interconnecting said source and said fluid motor for producing relative movement between said contacts, and means permitting the force transmitted from said source of fluid under pressure to said fluid motor to increase after a predetermined closing movement of said circuit breaker has occurred, said last-mentioned means being incapable of transmitting substantially any force from said fluid under pressure acting thereon to said fluid motor.

4. In an electric circuit breaker comprising a pair of relatively movable contacts, a fluid motor for operating said circuit breaker, a source of fluid under pressure, means including a valve for controlling the flow of fluid between said source and said motor to produce relative movement between said contacts, and means interposed between said valve and said fluid motor for varying the amount of fluid supplied during the time said fluid motor produces relative movement between said contacts, said last-mentioned means being incapable of transmitting substantially any force from said fluid under pressure acting thereon to said fluid motor.

5. In an electric circuit breaker comprising a pair of relatively movable contacts, a fluid motor for producing relative movement between said contacts, a source of fluid under pressure, means interconnecting said source and said fluid motor for closing said circuit breaker, and a variable orifice means interposed between said source and said fluid motor to vary the force applied by said fluid motor to said circuit breaker during the closing stroke thereof including a metering pin having a plurality of flutes thereon and having one end thereof cooperating with said fluid motor.

6. In an electric circuit breaker comprising a plurality of relatively movable contacts, a fluid motor including a piston for producing relative movement between said contacts, a source of fluid under pressure, means for interconnecting said source and said fluid motor for closing said circuit breaker, and means interposed between said source and said fluid motor for preventing ex-

cessive acceleration of the movable parts of said circuit breaker during the initial part of the closing operation, said fluid motor being so constructed and arranged with reference to said last-mentioned means as to permit said fluid under pressure to act initially on substantially the entire working face of said piston.

7. In an electric circuit breaker comprising a plurality of relatively movable contacts, a fluid motor for producing relative movement between said contacts, a source of fluid under pressure, means for interconnecting said source and said fluid motor for closing said circuit breaker, and a variable orifice means interposed between said source and said fluid motor to prevent excessive acceleration of the movable parts of said circuit breaker during the closing operation thereof and for conserving fluid under pressure during a trip-free operation of said circuit breaker.

8. In a fluid-actuated electric circuit breaker comprising a plurality of relatively movable contacts, a fluid motor for producing relative movement between said contacts, a source of fluid under pressure, means for interconnecting said source and said fluid motor for closing said circuit breaker, and a variable orifice means interposed between said source and said fluid motor operable in response to the relative movement between said contacts for preventing excessive acceleration of the movable parts of said circuit breaker during the closing operation thereof, said last-mentioned means being incapable of transmitting substantially any force from said fluid under pressure acting thereon to said fluid motor.

9. In a fluid-actuated electric circuit breaker comprising a plurality of relatively movable contacts, a fluid motor for producing relative movement between said contacts, a source of fluid under pressure, means for interconnecting said source and said fluid motor for closing said circuit breaker, and a variable orifice means interposed between said source and said fluid motor to prevent excessive acceleration of the movable parts of said circuit breaker during the closing operation thereof comprising a sliding plate provided with a plurality of openings of different sizes, said plate being movable in response to the relative movement between said contacts so that said different sized openings therein successively become effective during the closing operation of said circuit breaker.

10. In a fluid-actuated electric circuit breaker comprising a plurality of relatively movable contacts, a fluid motor including a piston for producing relative movement between said contacts, a source of fluid under pressure, means including a valve for interconnecting said source and said fluid motor for closing said circuit breaker, and a variable orifice means interposed between said source and said fluid motor to prevent excessive acceleration of the movable parts of said circuit breaker during the closing operation thereof including a metering pin reciprocally mounted and operable in response to the operation of said fluid motor to vary the size of the fluid inlet thereto, said metering pin being constructed so as to transmit a force directly to said piston upon opening of said valve which is insufficient to move said piston.

CARL THUMIM.

DISCLAIMER

2,296,071.—*Carl Thumim*, Yeadon, Pa. **ELECTRIC CIRCUIT BREAKER**. Patent dated September 15, 1942. Disclaimer filed November 27, 1944, by the assignee, *General Electric Company*.

Hereby enters this disclaimer to claims 1, 4, and 6 of said patent.

[*Official Gazette December 26, 1944.*]