April 1, 1952 G. A. MATTHEWS 2,590,989

CIRCUIT BREAKER

Original Filed April 18, 1942

Fig. 1.

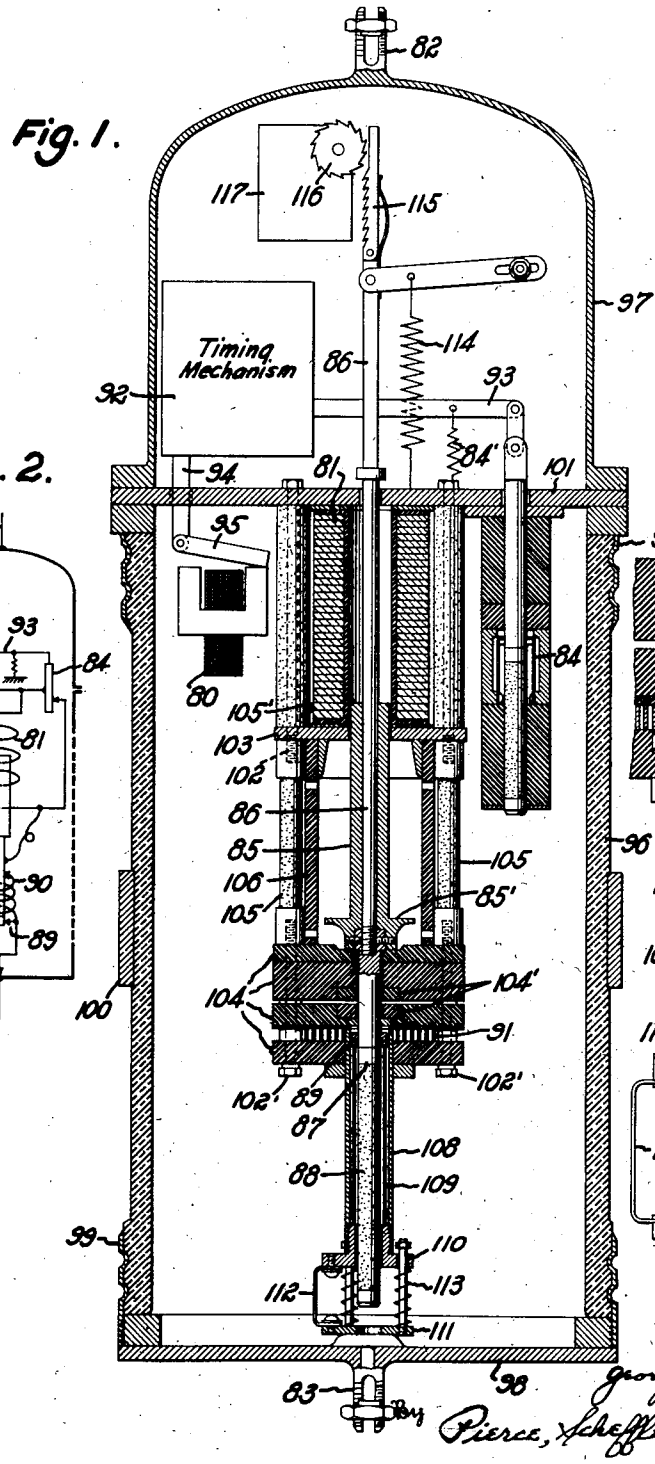


Fig. 2.

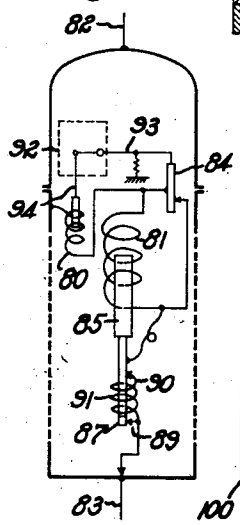
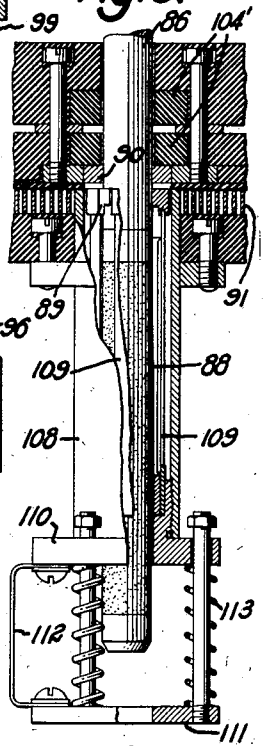


Fig. 3.



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UNITED STATES PATENT OFFICE

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CIRCUIT BREAKER

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Original application April 18, 1942, Serial No. 439,576, now Patent No. 2,443,260, dated June 15, 1948. Divided and this application April 22, 1948, Serial No. 22,620

2 Claims. (Cl. 200—147)

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This invention relates to circuit breakers and particularly to single-pole circuit breakers capable of a quick interruption of relatively heavy currents.

This application is a division of my copending application Serial No. 439,576, filed April 18, 1942, "Circuit Breakers," which matured into Patent No. 2,443,260 on June 29, 1948, which application was a division of application Serial No. 333,875, filed May 7, 1941, "Apparatus for Protecting Power Lines," which matured into Patent No. 2,352,556 on June 27, 1944, and was re-issued under No. 22,872 on April 29, 1947. As stated in the earlier patent, serious damage or complete burn-off of overhead insulated conductors occurs even in the case of transient faults when the protective switch gear is of the prior commercially available types which cannot open the line in less than about ⅙ second. The present invention contemplates a reclosing circuit breaker having an initial opening time substantially lower than that attained or contemplated by the prior workers in this field.

An object of the invention is to provide a single-pole circuit breaker in which insulating material forms a cylindrical arc-extinguishing chamber of restricted annular cross-section in which an arc is drawn upon the separation of the breaker contacts, the movable contact being carried by an operating rod which moves axially in the chamber to open and to close the circuit breaker. A further object is to provide a circuit breaker having the characteristics stated, and which includes an arc-spinning coil for establishing a magnetic field within the arc-extinguishing chamber upon the opening of the breaker contacts, thereby to move the terminals of the arc around on the arcing contacts, thus minimizing the loss of arcing contact metal by not excessively heating the arcing contact metal at any one spot.

These and other objects and advantages of the invention will be apparent from the following specification when taken with the accompanying drawings in which:

Fig. 1 is a central section through a single-pole, oil insulated circuit breaker embodying the invention;

Fig. 2 is a schematic diagram of the same; and

Fig. 3 is an enlarged fragmentary view of the circuit breaker contacts.

The circuit breakers contemplated by this invention, as employed for the protection of the conventional three-phase electrical distribution systems, are light weight, fully automatic, single-pole circuit breakers that each includes its own

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mechanical timing equipment and requires no auxiliary circuits or devices for full automatic operation. As shown in Figs. 1 and 2, the circuit breaker includes a control coil 80 and operating coil 81 in series between terminals 82, 83, the operating coil 81 being normally shunted by the switch 84 that is opened by the control coil 80 against a spring 84'. This switch and the main breaker switch are of the reciprocating rod type as described and claimed in my prior Patent No. 2,167,665, granted August 1, 1939, "Circuit Breaker," in which an annular arc-extinguishing chamber is formed by horn fiber or other organic material.

The core or plunger 85 of coil 81 is secured to a metal rod 86 which carries the movable contact 87 of the circuit breaker and terminates in a rod 88 of horn fiber or the like. The stationary breaker contacts include a main contact 89 that is normally engaged by the rod 86 or its movable contact 87, and an arcing contact 90 above and spaced from the main contacts. The arcing contact 90 is connected to the main contact 89 through a spiral coil 91 coaxial with the rod 86 and the contacts. The function of the coil 91 is to rotate the arc that is drawn between the moving contact 87 and the arcing contact 90 when the breaker opens, and the coil is wound in the sense opposite that of the operating coil 81. The shunt or control switch 84 is of simpler design as the arc drawn across its contacts can be extinguished without the aid of an arc-spinning coil.

Timing mechanism 92 is provided to delay the second and subsequent openings of the breaker, but the first opening takes place with no delay. The timing mechanism is indicated generally by the block diagram overlying the junction of the operating lever 93 of switch 84 and the link 94 that connects lever 93 to the armature 95 of the trip coil 80. Any desired type of mechanism may be employed to delay the opening of the shunt switch 84 for intervals of 60 cycles or upward when the fault is still on the line at the first or subsequent closures of the breaker. The detailed construction is not illustrated since it forms no part of the present invention.

The breaker is housed within a chamber comprising a hollow insulator 96 and end closures 97, 98 of metal that carry the terminals 82, 83, respectively. The insulator is provided with metal sleeves 99 to which the closures are bolted, and is recessed to receive a mounting bracket 100. A plate 101 extends across the upper end of the insulator 96 and constitutes the support for the control switch and the breaker assembly, and

the control mechanism is located in the domed closure 97 above the plate 101. The insulator 96 is preferably filled with oil to approximately the lower face of the plate 101 which supports all of the switch and control mechanism.

The framework of the breaker assembly includes a series of rods 102, a metal plate 103 on which the coil 81 rests, and a plurality of horn fiber plates or disks 104. Insulating rods 105 are threaded upon rods 102 to secure the plate 103 against spacing sleeves 105' on rods 102, and rods 102' are threaded upon the rods 105 to carry the disks 104. A dashpot for arresting the opening movement of the breaker is formed by the enlarged lower end 85' of the core 85 and a cylinder 106 that is mounted between the plate 103 and the upper disk 104. The top portion of the cylinder flares inwardly above vent openings that permit a free escape of oil from within the cylinder during the major part of the opening movement of the rod 86.

The two intermediate plates 104 are separated slightly and are recessed to receive small horn fiber disks 104' that form the outer wall of the arc-suppressing chamber. The small plates may be replaced when the diameter of the chamber has been appreciably increased by the erosion of the horn fiber. The arc-spinning coil 91 is mounted between the two lower disks 104, and connected between arcing contact 90 that is recessed into the lower face of the upper disk of this pair and a flanged brass tube 108 that is bolted to the bottom disk 104 to support the main contact assembly. The main contact 89 includes a plurality of arcuate segments secured to the upper ends of the several sections of a longitudinally slotted tube 109 of resilient metal. The flanged lower end 110 of the tube 109 is electrically connected to a disk 111 by a jumper 112, and the disk 111 is pressed against a boss on the lower closure 98 by springs 113 coiled about guide rods that extend through the flange 110.

The breaker opens against a spring 114, and displaces a ratchet bar 115 into engagement with the wheel 116 of an escapement mechanism. The spring 114 tends to reclose the breaker as soon as the circuit opens but the downward motion of the switch rod 86 is delayed by the escapement mechanism. The escapement may be of known types, including means for locking the breaker in open position after a predetermined number of reclosures if the fault is still on the line and means for resetting from any point in the schedule of reclosures when the breaker closes on a sound line. The time-delay may be of the customary order of from 30 to 60 cycles, but the specific design of the escapement mechanism is not an essential feature of this invention.

The method of operation of the circuit breaker will be apparent from the foregoing description. In the case of a single phase line, a circuit breaker is connected in series with one side of the line at the terminals 82, 83. An ungrounded three-phase circuit can be protected by locating circuit breakers in two of the line conductors.

The tripping value of the circuit breaker may be adjusted as desired but will usually be set up to 200% or more of the rated current capacity of the breaker. The tripping current is determined by the design of the coil 80 and the adjustment of the reclosing spring 84' of the shunting switch 84. The line current does not flow through the operating winding under normal operating conditions, and a heavy and sudden current surge flows through the operating winding 81 when the shunting switch 84 opens. The operating winding 81 may therefore be designed to develop a heavy force for displacing the movable contact 87 at high speed.

The invention is distinguished from prior circuit breakers of the series operating winding type in that the load current is normally by-passed around the operating winding. The prior circuit breakers have been open to the objections of serious overheating and coil damage due to the continuous flow through the operating winding of load currents approximating but somewhat less than the tripping value. This overheating under overloads short of tripping value is eliminated by the present invention as te control coil 80 need develop only a relatively small force to open the shunting switch 84. It is therefore possible, and entirely practical, to design the coil 81 to develop sufficient force for an exceedingly high speed opening of the breaker as the winding 81 is subjected only to a momentary current surge of high magnitude. The reciprocating rod and arc-extinguishing chamber construction also contribute to high speed operations as a 1 to 2 inch movement of the rod, which movement is sufficient to separate the breaker contacts and suppress the arc, is obtained in about 2 to 3 cycles with operating coils 81 of practical design.

The initial opening of the breaker takes place within an interval that depends upon the magnitude of the fault current, as shown graphically by curve B of Fig. 1 of Reissue Patent No. 22,872, but the subsequent openings are delayed by the timing mechanism 92 to supply current to a persistent fault for periods of about 30 cycles and upward at an inverse rate parallel to that for blowing of fuses, thereby to blow sectionalizing fuses or to burn the conductors down if there are no sectionalizing fuses, in the case of a persistent fault or to lock-out the breaker in the open position, if the persistent fault cannot be otherwise cleared from the system.

Time values are stated in cycles on a 60 cycles per second basis since it is the usual practice in this art to measure the operating times of protective switchgear with oscillographs that generate a "timing wave" of the frequency of the electrical distribution system. The novel apparatus has been tested and used on lines supplied with alternating current of a frequency of 60 cycles per second but the protective methods and apparatus may be used on direct current lines or on alternating current lines energized at 25 cycles per second or at other frequencies.

The quick acting circuit breakers are particularly useful in protective systems, as described in the reissue patent, which include line shorting contactors for a substantially instantaneous suppression of fault currents, but may be used to advantage in any protective system where high operating speed is desirable. The high opening speeds of the new circuit breakers are attained by making the operating coil 81 a series element in the line to be protected, whereby a sudden and heavy current surge traverses the coil 81 upon the opening of the control switch 84 which normally by-passes the line current around the operating coil 81. The term "operating coil" is employed in the following claims to identify the element which functions, upon energization as just stated, to operate the circuit breaker to open-circuit condition against the closing force developed by the spring 114. The heavy power surge for effecting a quick opening of the circuit breaker is developed by an operat-

ing coil in series with the line but there is no overheating of the breaker assembly when the line current is maintained for long periods at approximately the preselected breaker-opening value, since the line current is by-passed around the operating coil 81 until the line current reaches that value at which the control coil 89 opens the by-pass switch 84.

It is to be understood that the invention is not restricted to the particular embodiment herein illustrated and described, and that various changes that may occur to those familiar with the design and construction of circuit breakers fall within the spirit of my invention as set forth in the following claims.

I claim:

1. A circuit breaker comprising an axially movable rod carrying a contact, cooperating contact means including a power contact and an arcing contact, means including an operating coil to move said rod to separate the contact thereof from said contact means, insulating material surrounding said rod and defining a cylindrical chamber in which said rod reciprocates upon the opening and closing of the circuit breaker, said insulating material comprising a plurality of disks, each of said disks having a central opening of a diameter just sufficiently larger in diameter than said rod to provide mechanical clearance therefor, a pair of adjacent disks being spaced from each other and a cylindrical extension of insulating material on said rod and movable thereby into said chamber upon an opening movement of the rod, said insulating materials having the property of evolving an arc-extinguishing gas when contacted by an arc, said movable rod, said movable contact and said cylindrical insulating material having the same cross-sectional area and being in axial alignment with each other.

2. In a circuit breaker, stationary contact means including a main contact and an arcing contact, movable contact means including an axially movable metal rod engageable with said stationary contact, means including an operating coil for moving said rod to separate said movable contacts from said stationary contacts, an arc-spinning coil connected between said main contact and arcing contact, insulating means enclosing said contacts, said insulating means comprising a plurality of insulating discs, each of said discs having a central opening of a diameter just sufficiently larger in diameter than said rod to provide mechanical clearance therefor, means for spacing adjacent discs from each other, a rod of insulating material secured to said metal rod and movable therewith into the bore of said insulating means upon an opening movement of said rod, said plurality of superposed discs of insulating material being recessed, and removable discs of insulating material mounted in the recess of each of said insulating discs to define an arc-extinguishing chamber, said arc-spinning coil being mounted between two of said discs, said movable rod, said movable contact and said rod insulating material having the same cross-sectional area and being in axial alignment with each other.

GEORGE AUGUSTUS MATTHEWS.

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