March 17, 1925. 1,530,120

W. HOOPES

CIRCUIT BREAKER

Filed Oct. 4, 1922 2 Sheets-Sheet 1

FIG.1.

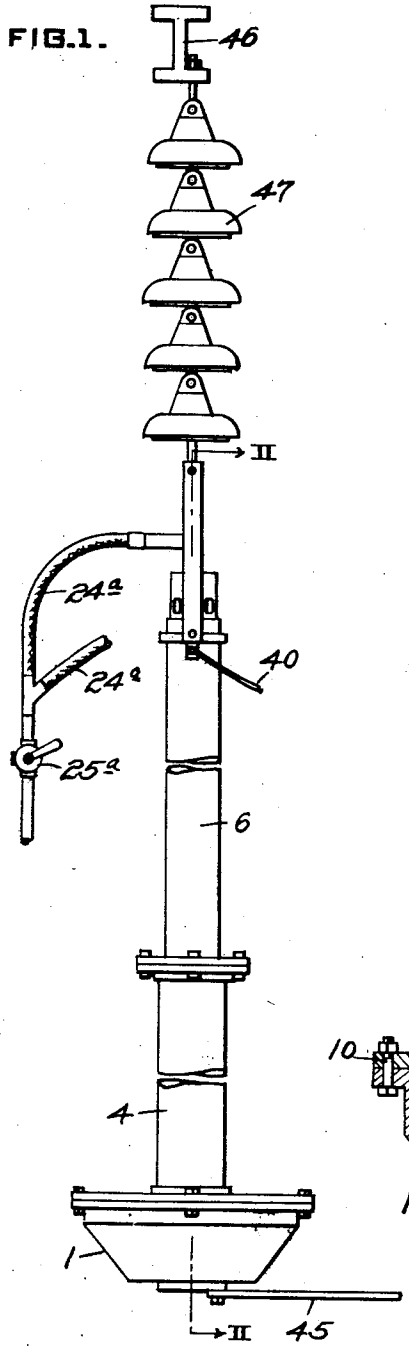
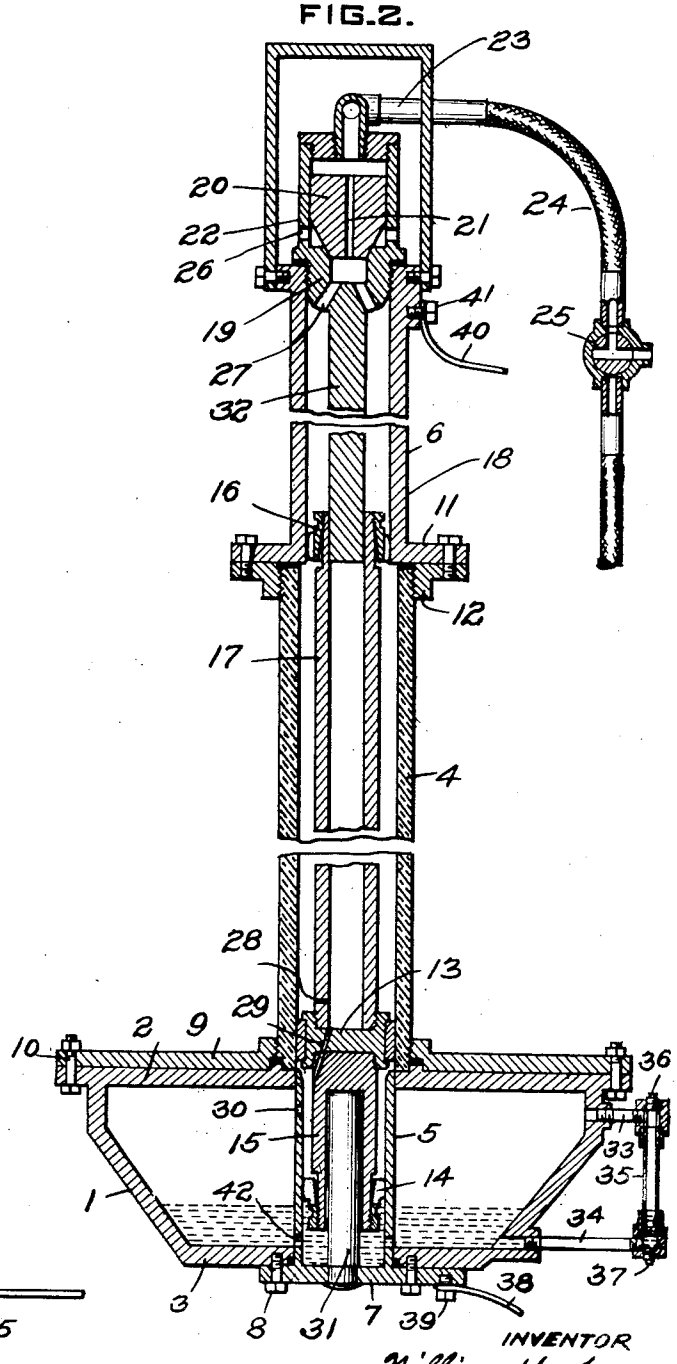


FIG.2.



WITNESSES

J. Herbert Bradley.

INVENTOR

William Hoopes.

by Winter & Brown,

his attorneys.

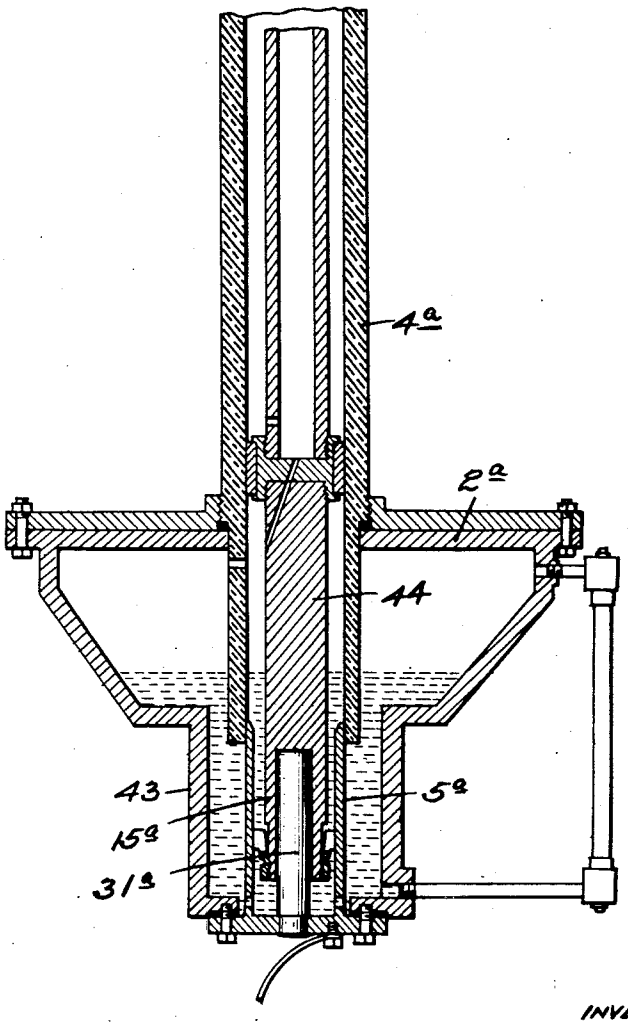
March 17, 1925. 1,530,120

W. HOOPES

CIRCUIT BREAKER

Filed Oct. 4, 1922 2 Sheets-Sheet 2

FIG.3.



WITNESSES

J. Herbert Bradley.

INVENTOR

William Hoopes,
by Winter & Brown,
his attorneys.

Patented Mar. 17, 1925. 1,530,120

UNITED STATES PATENT OFFICE.

WILLIAM HOOPES, OF PITTSBURGH, PENNSYLVANIA, JOHN A. EMERY, EXECUTOR OF SAID WILLIAM HOOPES, DECEASED.

CIRCUIT BREAKER.

Application filed October 4, 1922. Serial No. 592,591.

To all whom it may concern:

Be it known that I, WILLIAM HOOPES, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Circuit Breakers, of which the following is a specification.

The invention relates to circuit breakers for interrupting high voltage circuits, for example those of 10,000 volts and upwards. Such circuits, having high generating capacity and long lines connected to them, are difficult to interrupt without generating large and destructive amounts of energy at the point of interruption, and occasionally the circuit breakers now used fail to open the circuits and the resulting sustained arcs damage the circuit breakers and the buildings and equipment surrounding and connected to them. The usual form of circuit breakers now used for interrupting high voltage circuits includes spring-actuated contactors immersed in large bodies of oil which serve the double purpose of cooling and extinguishing any arc which may be formed when the circuit is broken and of reducing the length of the break necessary to be made in order to interrupt the circuit. Because of their size and of the rather complicated mechanism used for moving the contactors, these circuit breakers are expensive to manufacture as well as to maintain.

The object of this invention is to provide a circuit breaker which may be manufactured at much less expense than those now usually used, and which is certain in its action. A further object is to provide a circuit breaker in which a small body of oil may be properly directed to quickly extinguish an arc as the contactors separate from each other. A still further object is to provide a circuit breaker so constructed that its operating parts may be readily accessible for cleaning, repair and renewal.

The invention is illustrated in the accompanying drawings of which Fig. 1 is an elevation of a single unit of the circuit breaker suspended from a support; Fig. 2 a vertical longitudinal sectional view to enlarged scale taken on the line II—II, Fig. 1; and Fig. 3 a view corresponding to the lower portion of Fig. 2 illustrating a modification of construction.

In the practice of the invention the circuit breaking contactors are caused to move at high speed with relation to each other at the time a circuit is broken, and a stream of oil is directed at high velocity between and transversely to the contactors as they separate from each other. While in its broader aspects the invention contemplates the use of various mechanism for moving one contactor with relation to another for breaking a circuit, the movement is preferably effected by fluid pressure mechanism. The small body of oil required for quenching an arc in the manner explained may be held in the bottom of a reservoir from which there may project upwardly the fluid pressure mechanism for operating the circuit breaker. This mechanism preferably takes the form of a cylinder containing a movable circuit make-and-break member including a piston. The pressure fluid for acting upon the piston to move such member may be a suitable gas stored under pressure in the upper portion of the reservoir, the expansive force of the gas being effective both to move the movable member and to cause the body of oil to flow between the contactors as they separate.

The invention may be further understood, and other features of it explained, by reference to the embodiment illustrated in Fig. 2. The oil and compressed gas reservoir may have a substantially conical side wall 1, a top 2 and bottom 3, the top and bottom being provided centrally with openings. Projecting in part upwardly from the top of the reservoir, and in part through the openings in its top and bottom, there is the cylinder enclosing the movable make-and-break member. The cylinder preferably includes an intermediate portion 4 formed of insulating material, and end tubular portions 5 and 6 formed of electric conducting material. The lower conducting tube 5 may be attached to, or be formed integrally with a plate 7 which may be attached to the bottom 3 of the reservoir by means of machine bolts 8. The intermediate portion 4 of the cylinder may have threaded engagement at its lower end with a centrally flanged plate 9 which may be attached to the top 2 of the reservoir by bolts 10. For attaching the upper conducting tube 6 to the end of the intermediate cylinder section 4, tube 6 may be provided with a flange 11

bolted to a flange ring 12 having screw thread engagement with the section 4.

The movable make-and-break member in the cylinder includes a flanged piston 13 arranged to move in the cylinder section 4 and constructed for attachment at its opposite sides to contactors having sliding engagement with the conducting tubes 5 and 6. The contactor for making contact with tube 5 may be a ring 14 attached to the lower end of a conducting tube 15 having screw thread engagement at its upper end with the lower flange of piston 13, and the upper contactor may take the form of a ring 16 attached to a conducting tube 17 secured to the upper flange of the piston. The upper portion of contact ring 14 is, as shown in Fig. 2, preferably provided with kerfs so that the ring, in effect, forms a plurality of contact fingers which yieldingly press outwardly against conducting tube 5. Contact ring 16 may be formed in a similar manner, except that the outer ends of the fingers are slotted, as at 18, to form gas passages for the purpose presently to be explained.

As stated above, the pressure fluid for moving the movable contact member to break the circuit is preferably gas stored under pressure in the reservoir. During the time a circuit is closed through the circuit breaker, gas under pressure is maintained in the oil reservoir above the small body of oil, and in cylinder 4, 5, 6 both above and below the piston. For this purpose the cylinder containing the movable member is placed in communication with a source of gas under pressure, and means are provided to the end that when communication with such source is interrupted, pressure may be quickly relieved from the top of piston 13, so that the gas stored under pressure below the piston and in the reservoir may act upon the lower side of the piston to raise the movable member.

In the illustrative embodiment of this feature of the invention, the top of contacting tube 6 is provided with a plug 19 forming at its upper end a seat for a relay valve 20 having a small port 21 extending through it. The valve is arranged for vertical sliding movement in a suitable casing 22 from which there extends a pipe 23 adapted to be attached to a conduit 24 formed of rubber or other insulating material. Conduit 24 leads to a source of gas under pressure (not shown), and flow through it is preferably controlled by three-way valve 25, which in one position places the source of gas pressure in communication with the circuit breaker, and in its alternate position places the upper end of valve 20 in communication with the atmosphere. The relay valve is of the unbalanced pressure type having a larger area at its top than at its bottom so that when valve 25 places valve 20 in communication with the source of gas pressure, the same pressure per square inch, acting upon the larger area of the top than of the smaller area of the bottom of the valve, will hold the valve against its seat on plug 19.

Valve casing 22 is provided with ports 26 which serve the double purpose of placing the tapered lower side portion of valve 20 in communication with the atmosphere when the valve is seated, and of permitting the free escape of gas from the cylinder when valve 20 is unseated. Gas from the source of supply flowing through port 21 of plug 20 flows through large ports 27 formed in plug 19 and from thence through the passages 18 formed between the fingers of contactor 16. Tube 17 is provided with a small port 28, piston 13 and tube 15 with a small port 29, and tube 5 with a small port 30 so that gas may flow in a restricted manner from cylinder 4 into tube 5 below the piston and into the upper portion of the oil reservoir.

The upward and downward movements of the movable contact member may be arrested by plungers 31 and 32 arranged within tubular conductors 15 and 17, respectively, the former being attached to closure plate 7 and the latter to plug 19. Attached to side 1 of the oil reservoir by means of pipes 33 and 34 there may be a gage 35 for indicating the level of oil in the reservoir, and such gage may be provided at its upper and lower ends with removable upper and lower plugs 36 and 37. Oil may be supplied to the reservoir by removing upper plug 36, and may be removed from it by removing lower plug 37. To prevent the escape of gas held under pressure in the circuit breaker when the circuit is closed, the several connections of the various parts to each other are provided with packing rings or gaskets which may be of the general types illustrated, or of any other suitable form.

The circuit breaker may be placed in an electric circuit by attaching the closure plate 7 to a conductor 38 by means of a binding post 39, and by attaching conducting tube 6 to a conductor 40 by means of a binding post 41. When the circuit breaker is closed, that is to say when the movable member is in the position indicated in Fig. 2, the circuit is closed between conductors 38 and 40 through closure 7, conducting tube 5, contactor 14, tube 15, piston 13, tube 17, contactor 16 and tube 6.

Assuming that the circuit breaker is in communication through three-way valve 25 with a source of gas under pressure, all that is necessary to do to cause the circuit breaker to break the circuit is to turn valve 25 so that communication with the source of gas under pressure is broken and the upper side of relay valve 20 is open to the atmosphere. Pressure being thus relieved from the upper

side of valve 20, this valve is moved upwardly and held in its upward position by the pressure of gas on its lower side. The gas ports 27 in plug 19 and the passages 18 through contactor 16 being large, gas under pressure above piston 13 quickly flows through these ports and passages and through ports 26 of casing 22 relieving pressure from above piston 13. The expansive force of the gas stored in the reservoir above the body of oil and in tube 5 below the piston acts upon the lower side of the piston and causes the movable contact member to move upwardly. By the time contactor 14 has moved to the upper end of tube 5 the movable member acquires a high velocity so that the break effected when contactor 14 separates from the end of tube 5 is made at high speed.

The pressure of gas upon the top of the body of oil in the reservoir simultaneously forces the oil through openings 42, which place the lower end of tube 5 in communication with the oil reservoir, and the oil thus forced into tube 5 is directed between this tube and plunger 31 transversely between contactor 14 and the end of tube 5, such flow of the oil being through the kerfs in contactor 14. Because of the high pressure on the oil in the reservoir, and because port 30 is so small that gas cannot flow therethrough rapidly enough to prevent it, the oil flows upwardly in tube 5 as rapidly as the movable member moves upwardly, and therefore remains in contact with contactor 14. As soon as contactor 14 separates from tube 5 the oil is projected violently across the rapidly increasing break, so that fresh oil is passed at high velocity across any arc that may be formed and serves to reduce the volume of the arc to small indestructive proportions, the arc being entirely extinguished as soon as the length of the break is equal to the puncture distance through the oil at the voltage momentarily existing across the break. The moving contact member continues its upward movement in the cylinder until near the end of its permissible range of travel, where it is arrested by an air cushion formed in the lower end of tube 17 below the end of plunger 32, the air being able to escape but slowly through port 28 in the lower end of tube 17.

The moving contact member is maintained in its upper position by reason of the outward pressure of the fingers of contactor 16 against tube 6. Therefore the movable contact member does not drop back to close the switch until after the circuit breaker is again placed in communication with the source of gas supply. When the movable contact member has reached its upper position the gas under pressure in the reservoir gradually leaks out through the several ports which place it in communication with the atmosphere, at which time the circuit breaker may be again closed. The circuit breaker shown particularly in Fig. 2 is intended only to break a circuit, there being illustrated in Fig. 3 a modified form of circuit breaker which may be used both to open and close the circuit. In closing a circuit which has been opened by the circuit breaker of Fig. 2, the actual closure of the circuit is made by means of an air disconnecting switch of any suitable or well known construction, before which the circuit breaker shall have been closed by turning the three-way valve 25 to the position in which it places the circuit breaker in communication with the source of gas supply.

When it is desired to examine the movable contact member or to clean or repair it, the small body of oil in the bottom of the reservoir may be withdrawn after removing plug 37 from the bottom of gage 35. Thereafter closure plate 7, together with contact tube 5, may be removed, and the contact member taken out of its cylinder by moving it downwardly through the opening in bottom 3 of the reservoir.

As previously stated, the circuit breaker illustrated in Fig. 3 is intended to be used both for breaking and making the circuit. It differs from the circuit breaker of Fig. 2 chiefly in that the bottom of the oil reservoir is provided with a well 43 so that the upper end of contact tube 5^a may at all times be immersed in oil. The insulating tube 4^a is continued downwardly below the top 2^a of the oil reservoir to a short distance below the top of conducting tube 5^a, and tubular conductor 15^a may have an enlarged solid upper portion 44, or be otherwise formed so that the lower arresting plunger 31^a cooperates with tubular conductor 15^a to act as a dash-pot to arrest the downward movement of the movable contact member when the circuit is being closed.

The compressed gas used for operating the circuit breaker may be air, although it is preferred to use a gas which does not form an explosive mixture with oil vapor. Where there are sufficient circuit breakers installed to justify it, nitrogen, obtained from small air distillation apparatus and stored under proper pressure, is preferably used. Where the number of circuit breakers installed is not large enough to justify the expense of such a nitrogen plant, carbonic acid gas derived from liquid carbonic acid may be used. Both nitrogen and carbonic acid gas obtained in these ways are dry, and when they are used there is no danger from freezing of moisture within the circuit breaker, or contamination of the oil by moisture. In case air is used it should be thoroughly dried.

While a single circuit breaker may be used to break each pole of a circuit, preferably two units are arranged in series for each pole, thus readily adapting the circuit breaker for use with the usual switching station construction. A bus bar 45 (Fig. 1) or other conductor, may be used to electrically connect two circuit breaking units, and a single three-way valve 25ª may place the two units in communication with the source of gas under pressure, there being two conduits 24ª leading from the three-way valve. The number of branch pipes 24ª leading from valve 25ª will of course be multiplied in proportion to the number of units controlled. The circuit breakers may be suspended from a suitable structural support 46 by means of a series of insulators 47, and when used out of doors the exterior surface of insulating cylinder 4 may be provided with insulating petticoats in any well known manner.

According to the provisions of the patent statutes, I have described the principle and operation of my invention together with what I now consider to be the best structural embodiment thereof, however, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced by other forms of construction than that specifically shown and described.

I claim:

1. A circuit breaker comprising a pair of electric conducting elements adapted to contact with each other to close a circuit, means for moving one of said elements with relation to the other to break the circuit, a reservoir provided with a body of oil in communication with said elements, means for maintaining a body of gas under pressure above said oil, and means for utilizing the expansive force of said gas to direct a stream of said oil between said elements as the movable separates from the fixed element.

2. A circuit breaker comprising a fixed and a movable electric-conducting contacting element, a reservoir provided with a body of oil in communication with said elements, means for maintaining a body of gas under pressure above said oil, and means for utilizing the expansive force of said gas to move said movable contacting element and to direct a stream of said oil between said elements as the movable separates from the fixed element.

3. A circuit breaker comprising a closed reservoir partially filled with oil, a tube of conducting material communicating at its lower end with said reservoir, a conductor reciprocable in said tube and contacting therewith, means for maintaining a body of gas under pressure above the oil in said reservoir, and means for utilizing the expansive force of said gas to move said reciprocable conductor beyond the end of said tube and to direct a stream of oil between said conductors as they separate.

4. In a circuit breaker, an oil reservoir, a fixed conductor therein, a movable contactor for completing a circuit through said conductor, fluid pressure actuated means for moving said contactor to break the circuits, and means effective upon the movement of said contactor to direct a stream of oil from said reservoir between said conductor and contactor as the latter separates from the former.

5. In a circuit breaker, the combination of an oil reservoir, a fixed conductor therein, a movable contactor for closing a circuit through said conductor, a cylinder communicating at one end with said reservoir, a piston in said cylinder attached to said contactor, means for maintaining gas under pressure in said reservoir and on the upper and lower sides of said piston, said piston upon the removal of pressure from the gas on its upper side being movable by the expansive force of the gas in the reservoir to cause said contactor to break contact with said conductor.

6. In a circuit breaker, the combination of an oil reservoir, a fixed conductor therein, a movable contactor for closing a circuit through said conductor, a cylinder communicating at one end with said reservoir, a piston in said cylinder attached to said contactor, means for maintaining gas under pressure in said reservoir and on the upper and lower sides of said piston, said piston upon the removal of pressure from the gas on its upper side being movable by the expansive force of the gas in the reservoir to cause said contactor to break contact with said conductor and means for utilizing the expansive force of the gas in the reservoir to direct a stream of oil from the reservoir between the conductor and contactor as they separate.

7. In a circuit breaker, the combination of an oil reservoir, an electric conducting tube projecting upwardly from and communicating with the bottom of the reservoir, a cylinder in alignment with said tube and having a piston therein, a contact ring attached to said piston and contacting with the inner wall of the tube to close a circuit, means for maintaining gas under pressure in said reservoir and above said piston, said piston upon the removal of pressure from the gas on its upper side being movable by the expansive force of the gas in said reservoir to cause said contactor to move beyond said tube to break the circuit, and the expansive force of the gas in said reservoir being simultaneously effective to project oil from said reservoir upwardly through said

tube and in a stream between the upper end of the tube and contact ring when the latter separates from the former.

8. In a circuit breaker, an oil reservoir, a cylinder extending upwardly from the reservoir and comprising an intermediate tube of insulating material and upper and lower electric conducting tubes, adapted to be electrically connected to a circuit, a movable electric conducting member in said cylinder for closing the circuit through said conducting tubes and comprising a piston in the intermediate tube and contactors attached one to each side of the piston and having sliding contact with said conducting tubes, and means for applying fluid pressure to the lower side of said piston to move said movable member upwardly and thereby cause the lower contactor to break contact with the lower conducting tube.

9. In a circuit breaker, an oil reservoir having an opening in its bottom closed by a removable closure, a cylinder extending upwardly from said closure and comprising an intermediate tube of insulating material and upper and lower electric conducting tubes adapted to be electrically connected to a circuit, and a movable circuit make-and-break member in said cylinder including contactors adapted to contact with said conducting tubes, said movable member being removable from the cylinder through said opening in the bottom of the reservoir.

10. In a circuit breaker, an oil reservoir, a cylinder extending upwardly from the reservoir and comprising an intermediate tube of insulating material and upper and lower electric conducting tubes, adapted to be electrically connected to a circuit, a movable electric conducting member in said cylinder for closing the circuit through said conducting tubes and comprising a piston in the intermediate tube and contactors attached one to each side of the piston and having sliding contact with said conducting tubes, said piston having a small gas port through it, and means for placing the upper end of said cylinder in communication with a source of gas under pressure, whereby gas flows through said piston port into said cylinder and becomes effective to move said piston to break the circuit when communication with said source of gas is cut off.

11. In a circuit breaker, an oil reservoir, a cylinder extending upwardly from the reservoir and comprising an intermediate tube of insulating material and upper and lower electric conducting tubes adapted to be electrically connected to a circuit, a movable electric conducting member in said cylinder for closing the circuit through said conducting tubes and comprising a piston in the intermediate tube and contactors attached one to each side of the piston and having sliding contact with said conducting tubes, said piston having a small gas port through it, a relay valve at the top of said cylinder, and a conduit extending from said valve to a source of gas under pressure, said conduit being provided with a valve for alternately placing said relay valve in communication with the source of gas supply and with the atmosphere.

12. In a circuit breaker, an oil reservoir, a cylinder extending upwardly from the reservoir and comprising an intermediate tube of insulating material and upper and lower electric conducting tubes adapted to be electrically connected to a circuit, a movable electric conducting member in said cylinder for closing the circuit through said conducting tubes and comprising a piston in the intermediate tube and tubular electric conductors attached to and extending one from each side of the piston, said tubular conductors being provided with contact rings making sliding contact with said conducting tubes, rods arranged in said tubular conductors for guiding and cushioning the movements of said movable member, and means for applying fluid pressure to the lower side of said piston to break the circuit.

13. In a circuit breaker, the combination of a pair of electric conducting elements adapted to contact with each other to close a circuit, a fluid pressure mechanism including a piston for moving one of said elements with relation to the other for breaking the circuit, means including a control valve for normally maintaining pressure fluid on both sides of said piston, and a relay valve for quickly releasing the pressure fluid on one side of said piston when the control valve is moved to operate the circuit breaker.

14. In a circuit breaker, the combination of an oil reservoir, a fixed conductor, a movable contactor for closing a circuit through said conductor, a cylinder communicating at one end with said reservoir a piston in said cylinder attached to said contactor, means including a control valve for maintaining gas under pressure in said reservoir and on the upper and lower sides of said piston, and a relay valve for quickly releasing the pressure fluid on the upper side of said piston when the control valve is moved to operate the circuit breaker.

15. In a circuit breaker, an oil reservoir, a cylinder extending upwardly from the reservoir, and comprising an intermediate tube of insulating material and upper and lower electric conducting tubes adapted to be held connected to a circuit, a movable electric conducting member in said cylinder for closing the circuit through said conducting tubes and comprising a piston in the inter-

mediate tube and contactors attached one to each side of the piston and having sliding contact with said conducting tubes, a by-pass of constricted area to permit the passage of gas past said piston, a relay valve at the top of said cylinder, and a conduit including a control valve extending from said relay valve to a source of gas under pressure, said relay valve being effected to quickly release the pressure fluid on the upper side of said piston when said control valve is moved to close communication between the circuit breaker and source of gas supply.

In testimony whereof I sign my name.

WILLIAM HOOPES.

Witness:

EDWIN O. JOHNS.