Sept. 1, 1931. W. B. WHITNEY ET AL 1,820,928

CIRCUIT BREAKER

Filed May 15, 1929 2 Sheets-Sheet 1

Fig. 1.

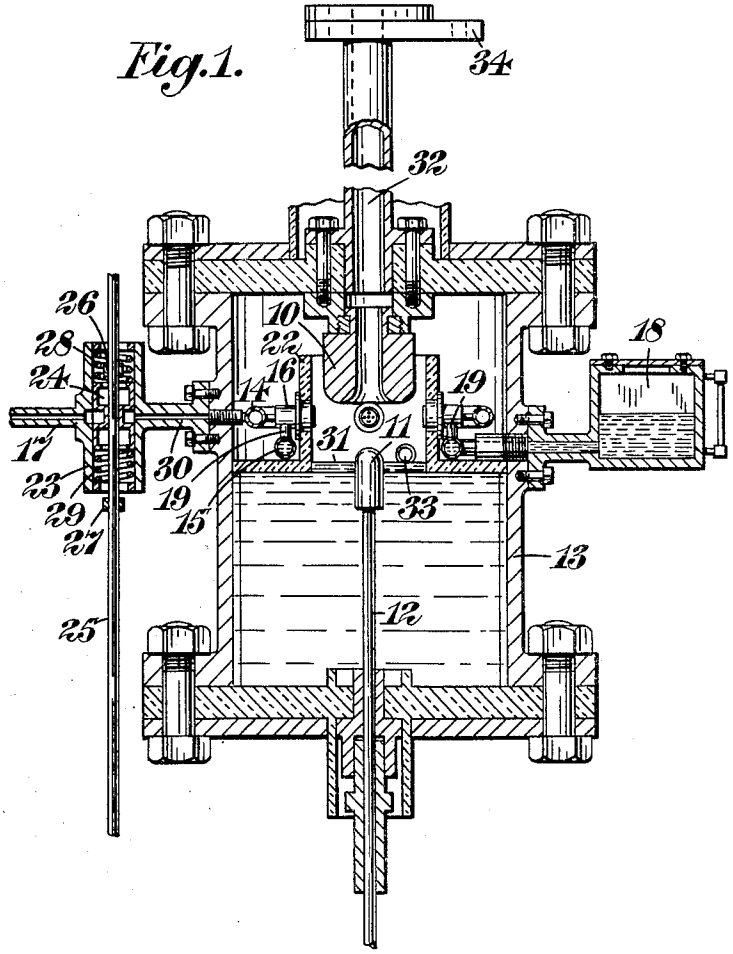
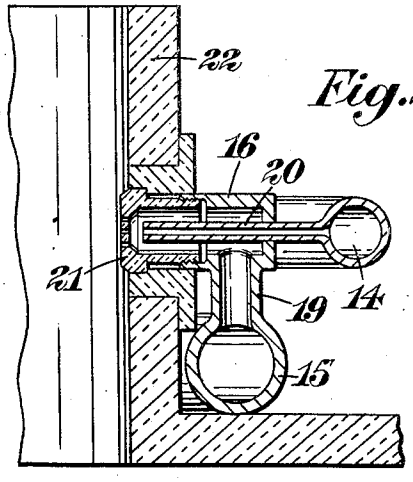


Fig. 2.



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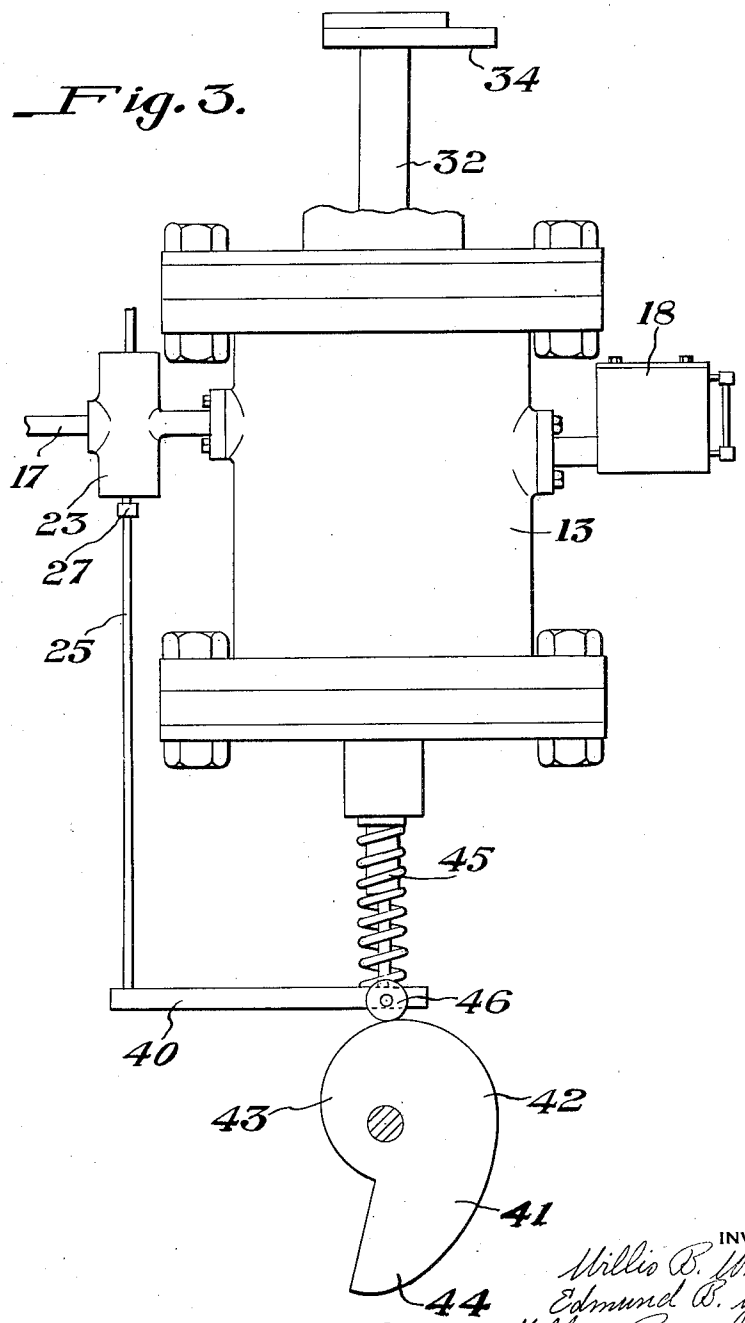
Their attorneys.

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Fig. 3.



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Patented Sept. 1, 1931 1,820,928

UNITED STATES PATENT OFFICE

WILLIS BEVAN WHITNEY AND EDMUND BASIL WEDMORE, OF LONDON, ENGLAND, ASSIGNORS TO THE BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION, OF LONDON, ENGLAND, A BRITISH ASSOCIATION

CIRCUIT-BREAKER

Application filed May 15, 1929, Serial No. 363,344, and in Great Britain June 2, 1928.

This invention consists in improvements in or relating to circuit-breakers or switches, particularly those designed to open electric circuits under heavy loads. The type of circuit-breaker or switch to which the present invention relates has means for projecting a cooling medium into the arc produced between the contacts, or into the space between them. Where reference is made hereinafter to projecting the cooling medium into the arc or arc path, it is to be understood as meaning also the space between the contacts of a circuit-breaker or switch in which an arc may form.

The invention consists broadly in introducing a spray or the like of finely-divided cooling medium into the arc or arc path in such a manner as to secure an intimate mixture of the cooling medium with part or the whole of the arc path through which the arc may restrike, or with even a larger volume than is actually occupied by said path.

In a preferred form of the invention, projecting means is employed that will subdivide fluid or other cooling medium into the requisite fine spray or cloud of particles.

In a modification of the invention and in order to limit the production of gas from the particles of the cooling medium during the arcing stage, means may be employed to hinder or prevent the spray of cooling medium from entering the arc space until the current has reached a relatively small value nearing zero.

Moreover, means may be provided for directing one or more sprays or clouds of separated liquid and/or solid particles at high velocity towards and/or across, and/or along the path of an arc between electrodes which may be initially immersed in gas or liquid or in a vessel containing a gas in contact with a liquid such as may be employed in any type of arc-breaking or sparking device. Such a device includes types covered by our previous British Patents Nos. 222,942, 236,293, 242,318 and 278,764. The spray of cooling medium may contain or be largely composed of liquid particles formed around solid particles or initially mixed with them, as in emulsions. Gases, for example, such as air, carbon di-oxide, hydrogen, nitrogen, etc., may be employed to fill the switch tank and in an atomizer which serves to project the cooling medium, and liquids to be utilized in the atomizer may include oils of suitable viscosities, with or without heating coils for maintaining the requisite viscosity of oil, particularly in cold climates, or the projected cooling medium may contain finely-divided solid particles which may include finely-powdered chalk.

In one form of the invention, spraying means may be controlled by a part of the moving mechanism of a circuit-breaker or switch, such as the cross-bar of the moving contacts or its equivalent part, or by auxiliary means, such as springs, or by gas or liquid under pressure from a storage vessel, or by pumps and the like, or by any selection or combination of the above.

The means for projecting the atomized spray or sprays or cloud or clouds may be situated in or behind, or in any other position relatively to, the contacts, and may be so arranged and/or directed that they prevent bowing of the arc out of the normal straight path between the contacts.

The atomized spray may be in continuous operation from a time just before arcing commences until after it has ceased, or it may be of an intermittent nature and/or arranged so that it is deflected into or from the arc path at such times as it is required.

In one form of the invention in which the arcing contacts are those of, for example, a circuit-breaker separating in gas, the moving contact forms part of or is attached to a piston which sucks gas into a cylinder when the contact is closing and compresses it when it is opening, the pressure being used to drive oil from a reservoir out of a fine pipe or pipes into the stream of gas escaping from a suitable orifice or orifices towards, into or through the arc as above described.

When fluid or fluids are supplied under pressure, the movement of the contact may be used to open or close valves or ports in order to allow said fluid or fluids to be sprayed at the correct times.

A specific example of the invention is illus-

trated in the accompanying drawings, in which—

Figure 1 is a central elevation, in section, of a single-break circuit-breaker,

Figure 2 is a section through one of the spraying devices, and

Figure 3 is a diagrammatic view in elevation of the circuit breaker showing operating mechanism.

Like reference numerals indicate like parts in all the figures of the drawings.

Although Figure 1 shows only a single-break construction, yet multi-break and multi-phase breakers could, for example, be constructed by having two such structures as that illustrated electrically connected in each phase by a conducting cross-bar attached to the bottom of the electrode stem 12, the whole being suitably enclosed and/or supported in an outer casing or framework.

The circuit-breaker illustrated in the accompanying drawings comprises a fixed electrode 10; a movable electrode 11; a rod 12 by which the movable electrode is supported and by which it is guided in its movements and connected with the cross-bar or outgoing lead, and an enclosing chamber 13, all of which parts are of known construction.

Surrounding the electrodes are two pipe-rings 14 and 15 respectively, the pipe-ring 14 being supplied with gas from a gas inlet 17 controlled by a valve to be described hereinafter, and the pipe-ring 15 being supplied with oil from an oil-container 18. The pipe-ring 15 is connected, in this construction, with four equidistantly-spaced branch pipes 19, each having a portion 16 at right-angles, and, as shown more clearly in Figure 2, over each of the branch pipes 19 and inserted in the portions 16 there is an injector-tube 20 that is fed from the pipe-ring 14. For each injector-tube 20 there is provided a spraying nozzle 21 perforated on its inner face where it opens into the interior of an insulating shield 22 which surrounds the electrodes.

The gas control-valve comprises a cylinder 23 and a light piston-valve 24 therein. The latter is slidingly mounted on a valve-rod 25 to which are fixed upper and lower stops 26 and 27 respectively. The ends of the cylinder are partially closed by rings through which the stops 26, 27 can pass, and between these end rings and the adjacent ends of the piston are compression springs 28 and 29 respectively which tend normally to keep the valve centered in its open position, that is to say, in a position in which an annular groove in the piston will uncover both the inlet port at the end of the supply pipe 17, and an outlet port constituted by the end of a branch pipe 30 which connects the interior of the cylinder 23 with the pipe-ring 14.

As shown diagrammatically in Figure 3, the valve-rod 25 and the electrode rod 12 are interconnected by a cross bar so that they move in company. When the switch is fully closed, that is to say, when the electrode 11 projects within the electrode 10, the collar 27 forces the valve 24 upwards sufficiently to close the outlet port 30, but not sufficiently to close the inlet port 17 which has a larger orifice.

As soon as the opening stroke commences, the collar 27 is moved downwardly to permit the piston to return to its central position where it is held by the springs 28 and 29, and in this position gas is supplied to the jets 20 and spray-nozzles 21. The valve remains in this position until the fully-open position is reached, that is to say, a position in which the two electrodes are separated to a greater extent than that shown in Figure 1. In the fully-open position, the collar 26 engages the upper end of the valve 24 and forces it downwards to close the inlet port 30, thereby shutting off the gas from the sprayers.

Oil is supplied to the sprayers from the auxiliary container 18. The present example contemplates the use of an oil-switch in which the normal oil level is kept approximately at that of the line indicated by the reference numeral 31, being prevented from rising higher by the opening of a draw-off valve 33. It is preferable to use a separate supply of oil for the sprayers, as oil from the casing 13 might, in course of time, become carbonized and contain solid particles of a size which would clog the spraying nozzles. The oil level in the containers 18 and 13 may be controlled by means of a float or floats not illustrated.

The shield 22 serves to prevent the arc from striking on to the sprayers and oil and gas supply pipes, and to protect these parts from heat.

It is found that only a very small quantity of oil is used in the sprayers, and in one experimental device of this nature the sprayers were so designed that, when operating with gas at a pressure of thirty pounds per square inch, the oil was injected at the rate of approximately one gram per second per sprayer. The sprayers, however, will normally be in operation at each opening of the circuit-breaker for a considerably less period of time than one second, so that the injected oil has little effect on the oil level 31 which only occasionally requires adjustment, and the container 18 only requires occasional refilling.

The upper electrode is furnished with a vent-pipe 32 (which may be provided with a safety-valve), by or through which it is connected to the incoming lead attached to the lug 34, and in one circuit-breaker, which at 4,400 R. M. S. volts, has been utilized to break a circuit carrying 1,500 amperes on a single gap of approximately 1.5 c. m., the internal diameter of the vent-pipe was approximately one inch, and its height from the point

of contact separation to the top opening was approximately fifteen inches. On experiment, this circuit-breaker was found to be capable of extinguishing the arc in less than one cycle in normal operation on the voltage above mentioned.

It is preferred that the contact should move to open a short gap which, in the above-mentioned experiments, was approximately 1.5 c. m., and be then caused to pause by a cam or dash-pot operation for, say, one cycle to allow the arc to be extinguished without undue extension, after which the separating movement may continue until the tip of the electrode 11 is immersed in the oil contained in the casing 13 for insulating purposes. Thus Figure 3 shows a cam 41 comprising a circumferential portion 42 intermediate between two sloping portions 43 and 44. A spring 45 keeps a roller 46 on the foot of the electrode rod in contact with the cam and thus on opening the breaker by a clockwise rotation of the cam the electrode is withdrawn as the roller engages the portion 44 of the cam; it pauses in a preferred position while the roller engages the portion 42 and while it engages the portion 43 the electrode continues its movement until its tip is submerged in the oil.

The gas-pressure available at the sprayers may be such that it is insufficient to project the spray into the arc path while a heavy current is flowing, and it will be appreciated that the apparatus is designed so that the sprayers will have commenced operation preferably slightly before, or at least at, the commencement of separation of the electrodes 10 and 11.

The invention, therefore, may be said to include a system which, for cooling an arc formed on opening a circuit-breaker or switch, comprises the projection of a spray of cooling medium into the arc, which projection commences approximately when the arc commences.

In whatever form the invention is applied, any desired cooling fluid or fluids may be employed, such as oil, or any finely-divided solid, or any easily vaporizable liquid in association with any gas, though, in general, we employ gas or gases which cannot form explosive or easily combustible mixtures with the associated liquid and/or solid particles.

Although in the specific example illustrated in the accompanying drawings, the sprays are shown as directed transversely to the length of the arc path, it is within the present invention to project sprays in any other direction towards or into the arc path. Moreover, any number of spraying devices may be employed.

We claim:—

1. A circuit-breaker or switch having means for introducing cooling medium into the arc or arc-path in the form of a fine spray.

2. A circuit-breaker or switch having means for introducing cooling medium into the arc or arc-path in the form of a plurality of fine sprays.

3. A circuit-breaker or switch having means for introducing cooling medium into the arc or arc-path in the form of a fine spray and approximately at the commencement of the arc in point of time.

4. A circuit-breaker or switch having means for introducing cooling medium into the arc or arc-path in the form of a fine spray and slightly before the commencement of the arc in point of time.

5. A circuit-breaker or switch having means for introducing cooling medium into the arc or arc-path in the form of a fine spray that is continued throughout the whole period of arcing.

6. A circuit-breaker or switch having means for introducing cooling medium into the arc in the form of a fine spray, and means to prevent the cooling medium from entering the arc-path while the current is heavy.

7. A circuit-breaker or switch having means for introducing cooling medium into the arc or arc-path in the form of a fine spray, and under a pressure such that it cannot enter the arc-path while the current remains heavy.

8. A circuit-breaker or switch having means for introducing cooling medium into the arc or arc-path in the form of a fine spray and under such pressure that the spray will not enter the arc-path until the current is nearing its minimum value.

9. A circuit-breaker or switch having means for introducing cooling medium into the arc or arc-path in the form of a fine spray, said means comprising in combination a spraying jet, means to supply both liquid and gas to the jet in such a manner that one ingredient serves as an injector for the other.

10. A circuit-breaker or switch having means for introducing cooling medium into the arc or arc-path, said means comprising a spraying jet through which are supplied two media of different characteristics of which one medium serves as an injector for the other medium to supply a fine spray of cooling medium to the arc or arc-path.

11. A circuit-breaker or switch having means for introducing cooling medium into the arc or arc-path in the form of a fine spray, said means comprising one or more injector jets, means to supply a liquid and a gas thereto in company with finely-divided solid material so that one of the three media serves as an injector for the others.

12. A circuit-breaker or switch comprising in combination an injector jet for introducing cooling medium into the arc or arc-path, means for supplying at least two ingredients of different characteristics to the jet so that one medium serves as an injector for the cool-

ing media as a whole, a valve for controlling the supply of at least one of the ingredients, and means serving automatically to open the valve approximately at the time that the electrodes commence to move and to close it again shortly after the position has been reached at which the arc is intended to be extinguished.

13. A circuit-breaker or switch containing oil and having means to introduce cooling medium into the arc or arc-path combined with means to regulate the height of the oil so that it will not obstruct the free passage of the cooling medium into the arc-path.

14. A circuit-breaker or switch having means for introducing cooling medium into the arc or arc-path in the form of a fine spray, combined with a casing for the switch or circuit-breaker, oil within said casing and means for regulating the height of the oil therein so that it will not obstruct the free passage of the spray into the arc-path.

15. A circuit-breaker or switch having means for introducing cooling medium into the arc or arc-path in the form of a fine spray, in combination with a casing for the switch or circuit-breaker, oil within said casing, and a draw-off passage situated at such a level in the casing that the height of oil therein will be prevented from rising sufficiently to obstruct the free passage of the spray into the arc-path.

16. A switch or circuit-breaker having means for introducing cooling medium into the arc or arc-path in combination with means for moving at least one of the electrodes for opening the arc-path, and means for mechanically arresting the opening movement for at least a cycle at a relatively short gap suitable for arc extinction and thereafter for automatically causing further opening of the electrodes to enable sufficient insulation to be obtained between them after the injection of cooling medium has ceased.

17. A switch or circuit-breaker comprising in combination means to introduce cooling medium into the arc or arc-path in the form of a fine spray, means to move at least one electrode to open the arc-path, and means for mechanically arresting said opening movement for at least a cycle at a relatively short gap suitable for arc extinction and thereafter for automatically causing further opening of the electrodes to enable sufficient insulation to be obtained between them after the spray has ceased.

18. A circuit-breaker or switch having means actuated by a moving part thereof for providing and introducing a fine spray into the arc or arc-path.

19. A circuit-breaker or switch having means actuated by a moving part thereof for introducing a fine spray into the arc or arc-path during both the opening and closing movements of the electrodes of the circuit-breaker or switch.

20. A circuit-breaker or switch having means actuated by a moving part thereof for introducing cooling medium into the arc or arc-path during both the opening and closing movements of the electrodes of the circuit-breaker or switch.

21. A circuit-breaker or switch having a plurality of spraying devices for introducing cooling medium into the arc or arc-path in the form of fine sprays, said spraying devices being symmetrically placed around the axis of the arc.

22. A circuit-breaker or switch having a plurality of injector nozzles, each of which serves to introduce cooling medium into the arc or arc-path in the form of a fine spray, said nozzles being symmetrically placed around the axis of the arc.

23. A circuit-breaker or switch comprising in combination a closed container, male and female electrodes therein, a plurality of injector nozzles spaced around said electrodes, oil within the casing, a draw-off passage for maintaining the oil at a constant level beneath the height at which the injector nozzles will force sprays of cooling fluid into the arm or arc-path but sufficiently high that the lowermost electrode can be drawn beneath the oil surface, means to supply liquid and gas to the nozzles so that one medium serves as an injector to the other, a control valve for the injector medium, and a coupling between said valve and a movable electrode, whereby the valve is automatically opened approximately at the time that the electrodes commence to separate and is closed again approximately at the time that the arc is intended to be extinguished.

In testimony whereof we have signed our names to this specification.

WILLIS BEVAN WHITNEY.
EDMUND BASIL WEDMORE.