June 5, 1934. A. CLERC 1,961,475

CIRCUIT BREAKER WITH LIQUID OR GAS BLOW-OUTS

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Fig. 1

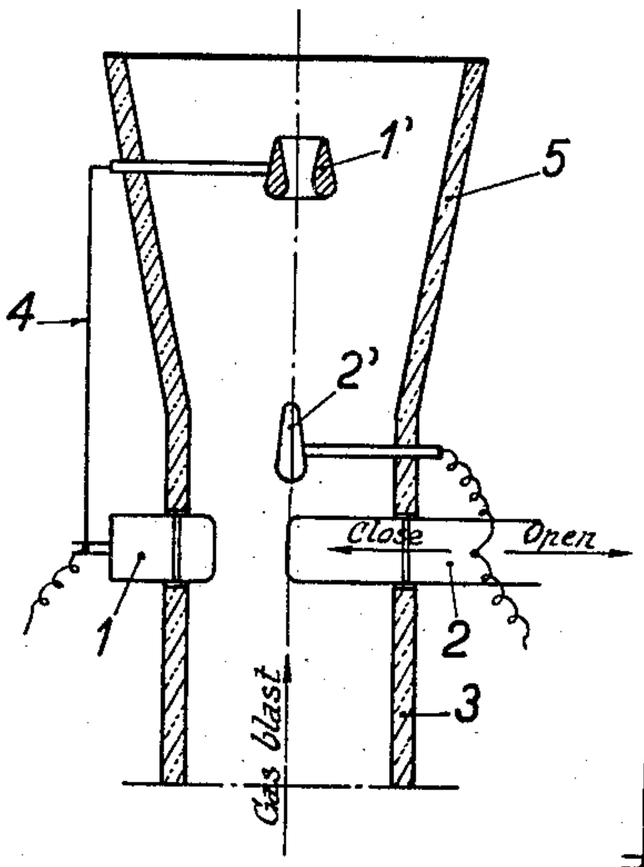
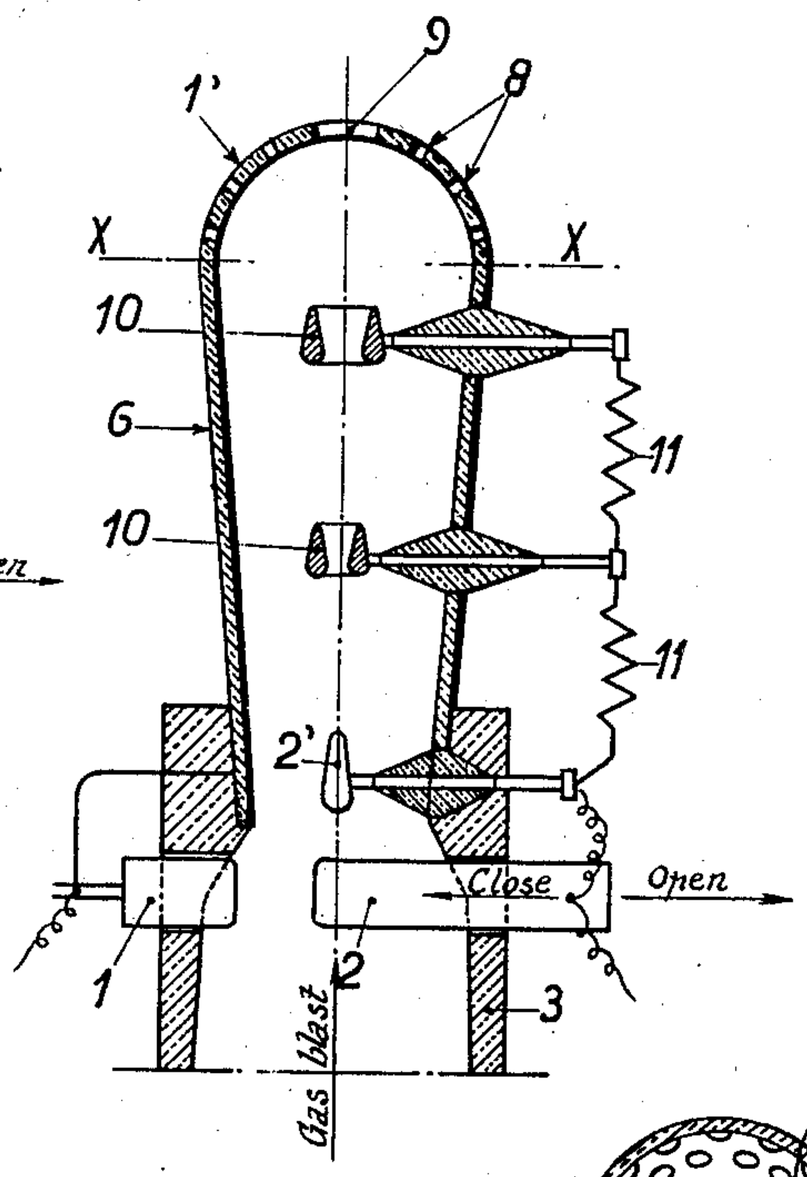


Fig. 2

Fig. 3



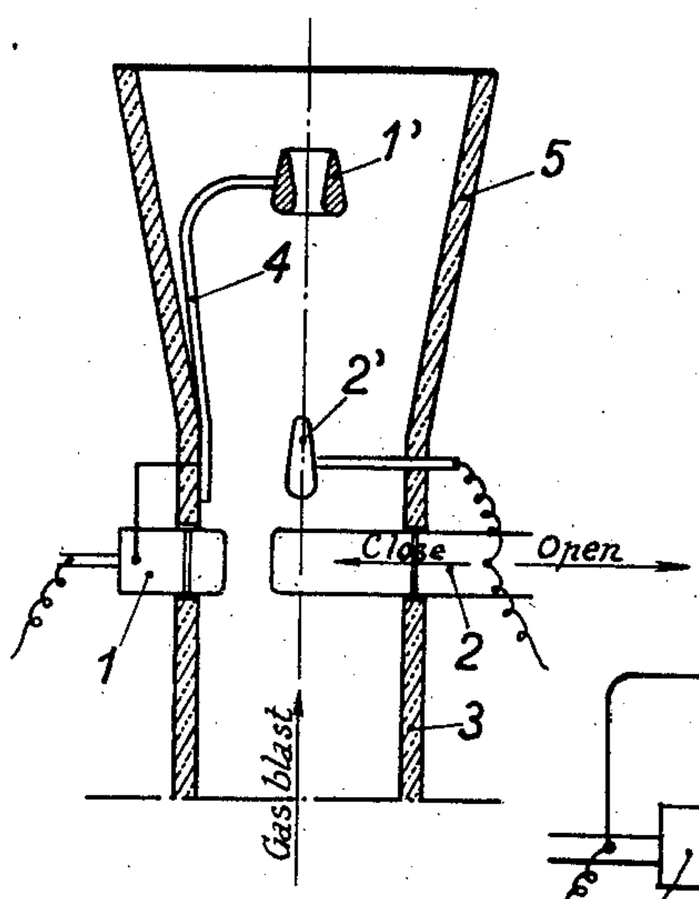


Fig. 4.

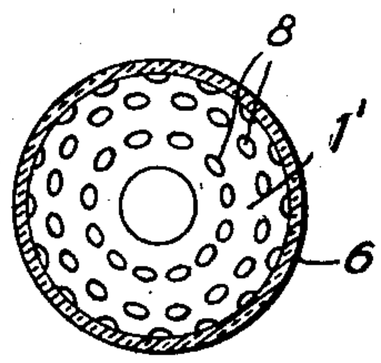


Fig. 17.

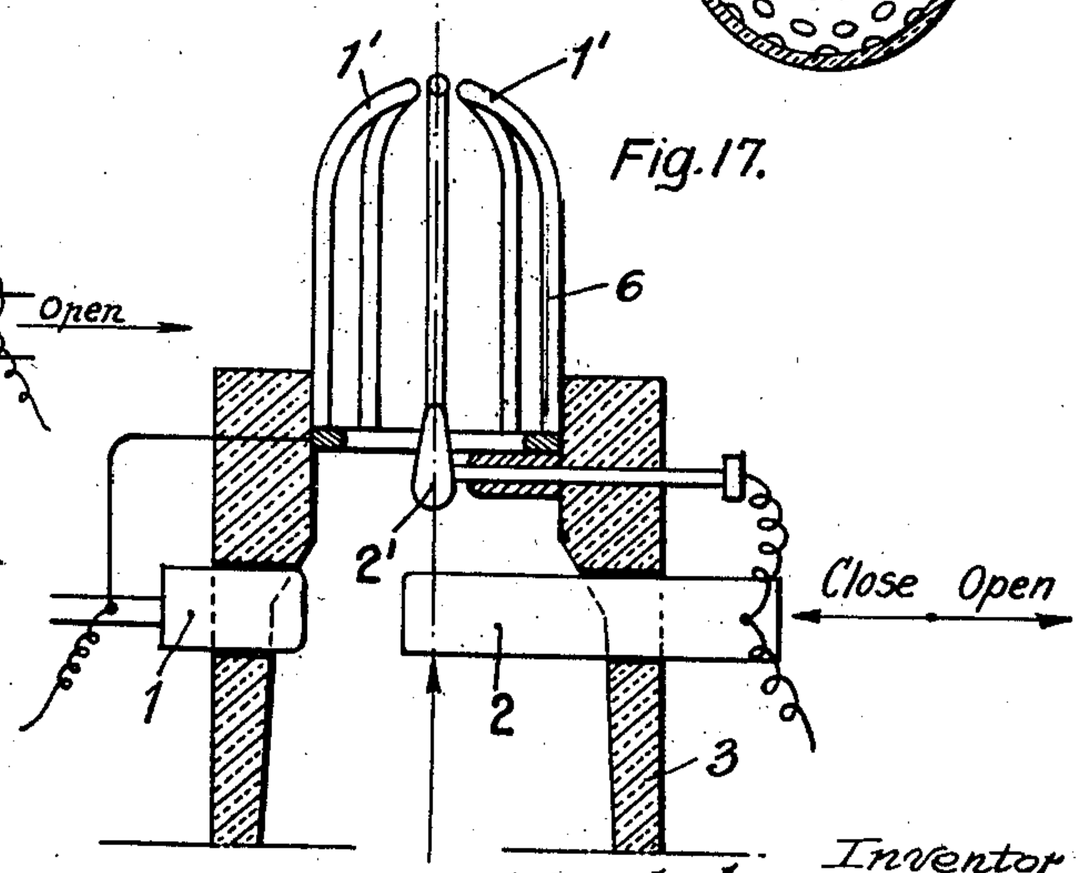


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Fig. 5

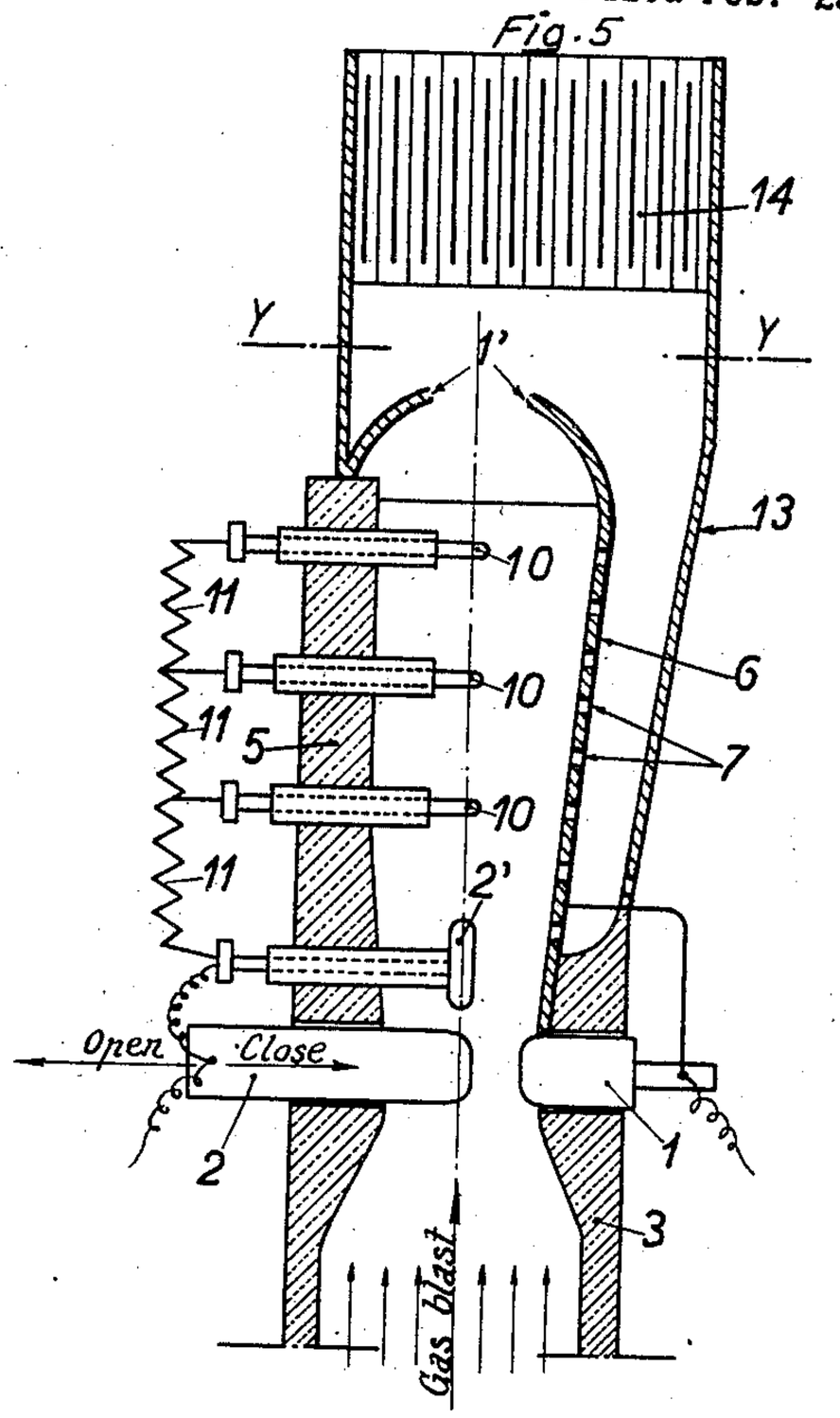

Fig. 6

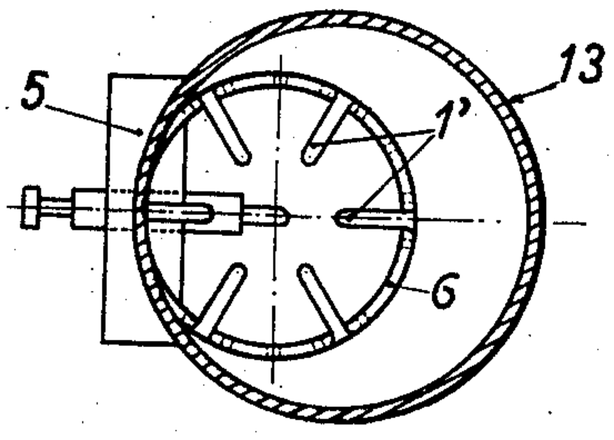

Fig. 7

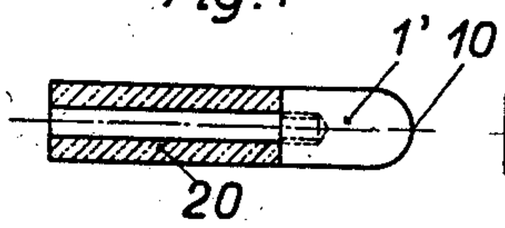

Fig. 8

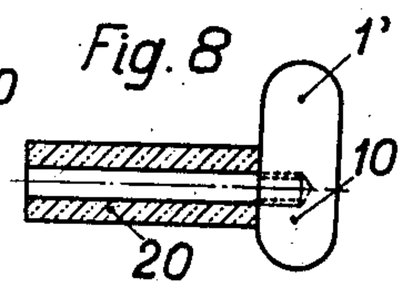

Fig. 9

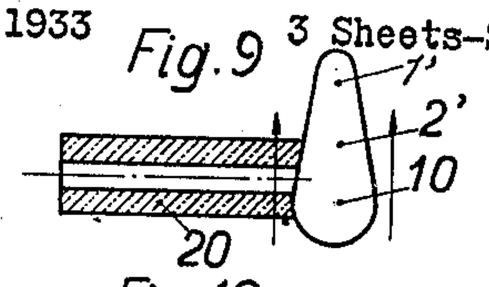

Fig. 10

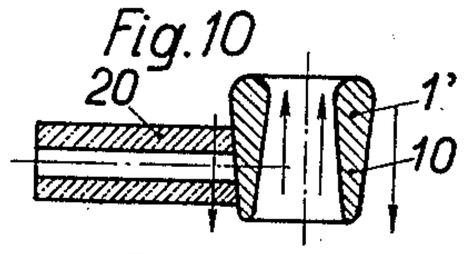

Fig. 11

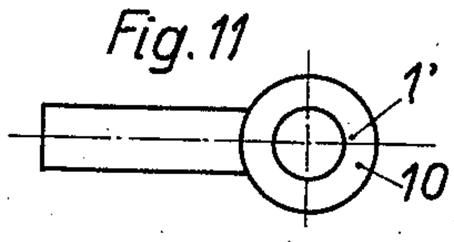

Fig. 12

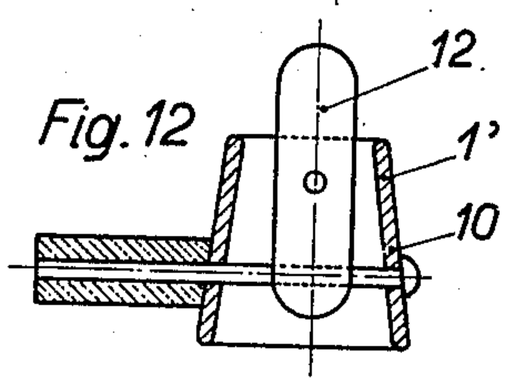

Fig. 13

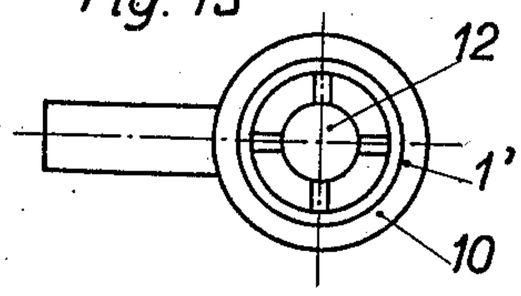

Fig. 14

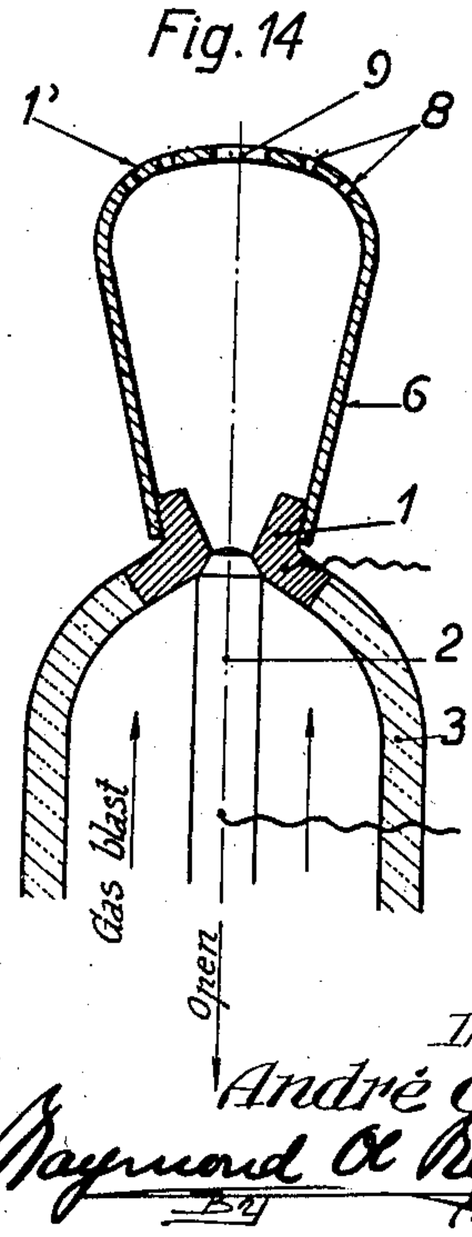

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Fig. 15

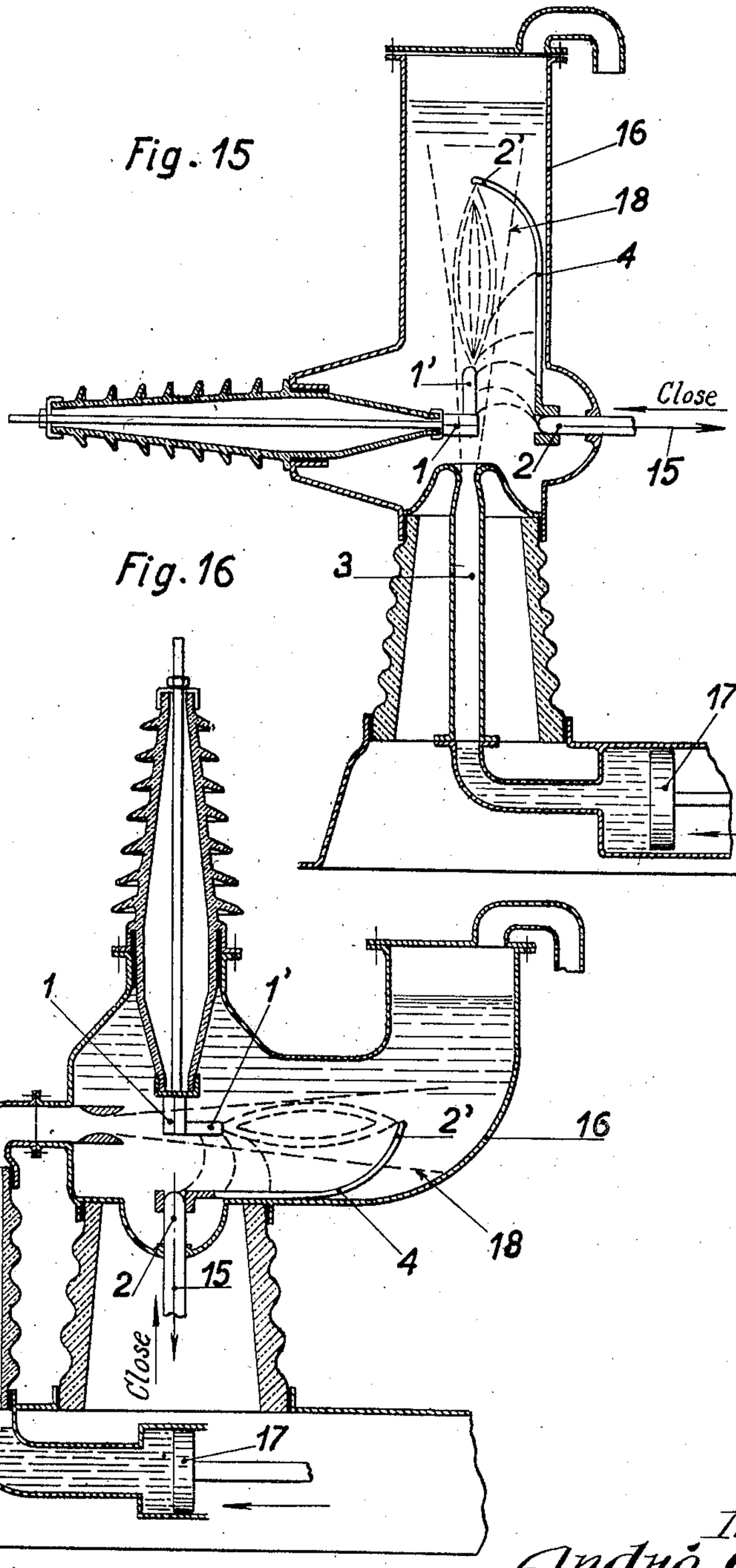

Fig. 16

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UNITED STATES PATENT OFFICE

1,961,475

CIRCUIT BREAKER WITH LIQUID OR GAS BLOW-OUTS

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Application February 23, 1933, Serial No. 658,085
In Germany February 22, 1932

19 Claims. (Cl. 200—148)

(Granted under the provisions of sec. 14, act of March 2, 1927; 357 O. G. 5)

It is known that when an arc flowing between two electrodes is blown by a compressed gas, such as air for example, it is lengthened out in the direction of the blast and tends at the same time to escape from same. In high tension currents this lengthening of the arc in no way facilitates its extinction; it provokes on the contrary an unnecessary increase in the energy dissipated in the apparatus, thus hindering the extinction and increasing the deteriorations of the extinction chamber.

The object of the present invention is to reduce the electric energy dissipated during the extinction to a minimum value consistent with the satisfactory operation of the circuit-breaker and further to eliminate the effects of the back pressure this energy is still capable of creating. These two points immediately lead to an important reduction in the energy to be imparted to the blowing out fluid without diminishing its efficiency.

The energy dissipated by an electric arc flowing in a gaseous medium maintained at constant pressure is proportional to the length of the arc and to the intensity of the current flowing through it as soon as this intensity exceeds some ten amperes. It follows that at constant pressure the energy in an arc carrying a given current depends only on its length. In order to reduce this energy to as low as a value as possible it is consequently necessary that this arc be very short. As on the other hand the specific energy of an arc (that is to say, at constant intensity, the voltage of the arc per unit length) increases with the pressure of the gas blast, it is necessary that this pressure be as low as possible. Thus in the case of a compressed air blow out in which the arc usually flows in atmospheric air, the pressure of the air blast should be equal or very slightly superior to that of the atmosphere.

The present invention permits the realization of these results. It relates to an electric circuit-breaker in which the arc is extinguished by the blast of a liquid or gaseous fluid characterized in that one of its contacts or an electrode connected to it and an extremity electrode connected to the other contact arc disposed in the stream of extinguishing fluid and preferably in the central zone of this latter in such manner that the line joining their opposed extremities is approximately parallel to the flow of the blast. It is advantageous to give to the extremity electrode as well as to the electrode to which it is opposed a form elongated in the direction of the blast. In reality, an arc emerging from the extremity of an electrode in the form of a metallic rod tends to assume the direction of this rod just as would a jet of water issuing from a nozzle. Consequently an arc whose points or origin are disposed on the opposite extremities of two elongated electrodes situated along a stream line of the blast should also assume a straight line direction. On the other hand it also seems opportune to dispose the common axis of the two opposed electrodes in the centre of the extinguishing blast where its action is most effective.

Finally it is well to note that the distance between the extremity electrode on the one hand and the contact not connected to this electrode or the electrode of opposite polarity connected to this contact on the other hand should preferably be greater than the maximum spacing between the two contacts.

The annexed drawings show several embodiments of the object of the invention.

Figs. 1, 2, 3, 5, 14 and 17 show in vertical section six applications of the invention to compressed gas circuit-breakers.

Figs. 4 and 6 are horizontal sections through the lines X—X and Y—Y in Figs. 3 and 5, and Fig. 18 is a plan view of the circuit-breaker shown in Fig. 17.

Figs. 7 to 13 show on a larger scale several alternatives of a detail of the object of the invention, Figs. 11 and 13 being plan views of the details shown in Figs. 10 and 12.

Finally Figs. 15 and 16 show in vertical section two applications of the invention to liquid blow out circuit-breakers.

In Figs. 1 to 5, 14 and 17, the fixed contact of the circuit-breaker is indicated by 1 and the movable contact by 2. These contacts are disposed in the interior of a blast pipe 3 through which the extinguishing gas is injected in the direction indicated by arrows.

In Figs. 1 and 2 the fixed contact 1 is electrically connected to an extremity electrode 1' disposed a certain distance away from the contacts in the centre of the extinguishing blast. In Fig. 1 the electrical connection 4 between the electrode 1' and the fixed contact 1 is disposed on the outside of an insulating chimney 5, whereas in Fig. 2 this connection is disposed chiefly in the interior of the chimney 5 and could even be entirely so disposed within the zone of influence of the air blast.

In Fig. 5 the insulating chimney 5 is partially suppressed and replaced by metallic walls 6 constituting in themselves both the blow out chimney and the electrical connection between the

fixed contact and the extremity electrode 1' fixed to the outlet orifice of the metallic chimney 6. This metallic chimney which may be cylindrical or have any widened out shape is preferably constituted by a conically shaped tube which may eventually be provided on its lateral sides with circular openings 7 or with elongated slits allowing the interior of the chimney to communicate with the atmosphere. The chimney could also be constituted by a cylindrical or widened out cage the bars of which are preferably disposed in parallel direction to the flow of the extinguishing blast. This latter disposition is realized in the device shown in Figs. 17 and 18.

In Figs. 1 and 2 the chimney is entirely open at its upper extremity, the extremity electrode being situated in the interior of the chimney. On the contrary in Figs. 3, 5, 14 and 17 the extremity electrode is disposed at and connected to the outlet of the metallic chimney. It forms a hood to the chimney in the embodiments shown in Figs. 3 and 14, whereas in the embodiments of Figs. 5 and 17 the extremity electrode 1' is constituted by a number of horns directed radially towards the axis of the chimney.

When the extremity electrode constitutes the hood of a metallic chimney, this hood is of course provided with openings 8 allowing the evacuation of the extinguishing gases. These openings can be uniformly distributed over the whole of the hood, however it seems preferable to have in the centre of the hood a large opening 9 allowing the arc to emerge to a greater or less extent outside the chimney. The point of origin of the arc located on the edge of the opening, situated itself in the centre of the extinguishing blast is in this manner efficiently swept by the blast of gas.

In certain embodiments a central opening 9 as well as small peripheral openings 8 will be used simultaneously.

In the embodiments illustrated in Figs. 1 to 5 and 17 in which the extinguishing blast is directed perpendicularly to the displacement of the movable contact, an arcing contact or electrode 2' connected to the movable contact 2 disposed in proximity to same in the central zone of the extinguishing blast may be used. This electrode can be pear shaped with section diminishing in the direction of the blast. The line joining the axes of the electrodes 1' and 2' coincides with the axis of the chimney and with the axis of the extinguishing blast.

On the other hand, one or several intermediate electrodes 10 can be disposed between the extremity electrode 1' and the arcing contact 2' along the central zone of the extinguishing blast and connected between themselves as well as with the arcing contact 2' by means of resistances 11 of low ohmic value. These intermediate electrodes, in the same manner as the extremity electrodes of Figs. 1 and 2, are constituted by hollow cylinders of revolution, the half sections of which are pear shaped. The shape of this electrode is clearly shown in Figs. 10 and 11 in which two directions of the displacement of the gases are indicated by full and dotted arrows. If needs be this electrode can surround a central member 12 as shown in Figs. 12 and 13. Other alternative electrodes are represented in Figs. 7 to 9, that shown in Fig. 9 being particularly applicable to the intermediate electrodes and to the arcing contacts 2'. It will be noticed that the stem holding these electrodes is enveloped in an arc resisting sleeve preferably of insulating material,

Finally in the embodiment of Fig. 5 the chimney 6 is further surrounded by a chamber 13 the outlet of which is constituted by a metallic plate or metallic cylinder cooling device 14 disposed in front of the extremity electrode. It is further well understood that the extremity electrode need not essentially be connected to the fixed contact but that it can equally well be connected to the movable contact. In this case, the fixed contact will preferably be connected to an electrode disposed in like manner to that shown by 2' on the drawings.

The operation of these devices is as follows. At the instant of separation of the contacts 1 and 2 an arc is struck between them. This arc is immediately blown by the gaseous blast and lengthens in the direction of the blast to such an extent that in the embodiments shown in Figs. 1 to 5 and 17 it almost immediately reaches the electrode 2'; at this instant the portion of the arc between 2 and 2' is extinguished and there only remains the arc 1, 2' disposed transversely to the extinguishing blast. The gases ionized by the arc are swept by the blast in such manner that a part of these gases is driven between the electrodes 1' and 2'. At this instant takes place a transfer of the arc 1, 2' upon the electrodes 1', 2'. There thus only remains a straight arc situated in the axis of the extinguishing blast, an arc whose length is limited by the distance 1', 2' and which is very rapidly extinguished under the influence of the gas blast.

The phenomenon of the transfer of the arc above referred to explains itself in the following manner: the arc 1, 2' being disposed transversely to the extinguishing blast (blast of air) in a zone in which this latter has a very powerful cooling and deionizing effect, the energy it absorbs is very great compared with that of a stable arc in a quiet gas or with that of an arc 1', 2' flowing between two electrodes situated one behind the other in an axial air blast. This increment of energy dissipated by the arc 1, 2' results in a considerable increase in the arc voltage per unit length, and this to such an extent that it is easy to conceive that the arc 1, 2' is far more unstable than that which one tends to strike between the central arcing contact 2' and the extremity electrode 1'; this in spite of the fact that the distance between these two latter electrodes is considerably greater than that between the contacts.

Oscillagraphic and high speed cinematographic investigations have shown the remarkable facility and rapidity with which it is possible to cause an arc to flow between 1' and 2' by the blowing of the gases of an arc originally struck between 1 and 2'. It is evident that the original transverse arc will only extinguish itself when its gases have reached the extremity electrode 1'. There is consequently no interval of time between the striking of the arc on the extremity electrode and the extinction of the original arc.

In certain embodiments in accordance with this invention in which the maximum separation between the contacts 1 and 2 or the distance between the contact 1 and the electrode 2' is an important fraction of the spacing between the electrodes 1' and 2', the arc extinguishing phenomenon can also take place as follows: at the instant of separation of the contacts 1 and 2 the arc is struck between their extremities and is immediately afterwards blown by the gaseous

blast on the one hand upon the arcing contact 2′ and on the other upon the extremity electrode 1′. In the device illustrated in Fig. 1 the arc assumes the form of a bow with points of origin fixed to the contact 1 and to the arcing contact 2′ whereas the apex of the bow reaches almost instantly the extremity electrode 1′. At this instant the left hand portion of the bow extinguishes itself and the remaining portion forms a straight arc situated in the axis of the extinguishing blast, this right hand arc being very rapidly suppressed.

In the other embodiments, on the contrary, one of the points of origin of the arc displaces itself along the connection 4 or along the interior of the metallic wall of the chimney 6, the second point of origin remaining fixed either on the contact 2 or on the arcing contact 2′. The arc apparently pivots about the arcing contact 2′ until it reaches the axial position in which it is rapidly extinguished. It is to be noted that this displacement of the arc is realized with extreme rapidity.

The length of the arc is thus strictly limited as it cannot extend to any great extent beyond the extremity electrode.

When the arc is extinguished by a liquid jet, water or oil for example, the construction and operation of the circuit-breakers are analogous.

The Figs. 15 and 16 of the annexed drawings show two such embodiments.

In these figures one recognizes the fixed contact 1 and the movable contact 2, the direction of displacement of which on opening is indicated by an arrow 15. These contacts are located in a vessel filled with a liquid, water or oil for example. Facing the contacts is disposed the nozzle of an injection tube 3 terminating in a piston 17 capable of projecting against the contacts 1 and 2 a jet of liquid whose theoretical zone of action is indicated by 18.

The fixed contact is connected to an arcing contact 1′, whereas the movable contact is connected to an extremity contact 2′, the elements 2′ and 1′ being disposed in the central zone of the extinguishing stream.

As shown in Figs. 15 and 16 the blow out may be vertical in upward direction or may be horizontal; it may equally be disposed in any other direction, for instance vertically in downward direction.

The operation of these devices is indicated by dotted lines showing the progressive displacement of the arc up to its final position in the centre of the extinguishing stream.

The word "electrode" used in this specification is intended to mean fixed members which are connected to a conductor under tension, but which members are never in mechanical engagement with a movable contact of the breaker.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. An electric circuit-breaker comprising two relatively movable contacts, means for projecting a jet of extinguishing fluid on these contacts transversely to their direction of motion, a fixed electrode connected to one of the contacts and a fixed extremity electrode connected to the other contact, the extremity electrode being situated behind the electrode considered in the direction of the said jet and the line joining the opposed extremities of the two electrodes being located in the central zone of the extinguishing jet and approximately parallel to its axis.

2. An electric circuit-breaker comprising two relatively movable contacts, means for projecting a jet of extinguishing fluid on the contacts transversely to their direction of motion, a fixed electrode connected to one of the contacts and a fixed extremity electrode connected to the other contact, the extremity electrode being situated behind the electrode, considered in the direction of the said jet, at a greater distance than the maximum separation of the two contacts, and the line joining the opposed extremities of the two electrodes being located in the central zone of the extinguishing jet and approximately parallel to its axis.

3. An electric circuit-breaker comprising two relatively movable contacts, means for projecting a jet of extinguishing fluid on these contacts transversely to their direction of motion, a fixed electrode connected to one of the contacts and a fixed extremity electrode connected to the other contact, these electrodes having an elongated form disposed along a common axis parallel to the extinguishing jet.

4. An electric circuit-breaker comprising two relatively movable contacts, means for projecting a jet of extinguishing fluid on these contacts transversely to their direction of motion, a fixed electrode connected to one of the contacts and a fixed extremity electrode connected to the other contact, the extremity electrode being situated behind the electrode considered in the direction of the extinguishing jet, and the line joining the opposed extremities of the two electrodes being situated approximately in the axis of the extinguishing jet.

5. An electric circuit-breaker comprising two relatively movable contacts, means for projecting a jet of extinguishing fluid on these contacts transversely to their direction of motion, a fixed electrode connected to one of the contacts and a fixed extremity electrode connected to the other contact by means of a conductor almost completely insulated from the arc, the extremity electrode being situated behind the electrode considered in the direction of the extinguishing jet, and the line joining the opposed extremities of the two electrodes being approximately parallel to the extinguishing jet.

6. An electric circuit-breaker comprising two relatively movable contacts, means for projecting a jet of extinguishing fluid on these contacts in view of lengthening the arc, a fixed electrode connected to one of the contacts and a fixed extremity electrode connected to the other contact, one end of the extremity electrode extending very near this latter contact in the path of the blown arc, the other end of this extremity electrode being situated behind the electrode considered in the direction of the extinguishing jet, and the line joining the opposed extremities of the two electrodes being approximately parallel to the extinguishing jet.

7. An electric circuit-breaker comprising two relatively movable contacts, a chimney with conducting interior surface, means for projecting a gas blast against these contacts and into this chimney, an electrode situated in the central zone of the extinguishing blast and being connected to one of the said contacts, and an extremity electrode situated at the outlet of the chimney and terminating in the central zone of the gas blast, this extremity electrode being connected to the conducting surface of the chimney and this sur-

face being connected to the other of said contacts.

8. An electric circuit-breaker comprising a fixed contact and a movable contact to open the circuit, a chimney with conducting interior surface, disposed around the common axis of these contacts, means for projecting a gas blast against these contacts and into this chimney in the direction of motion of the movable contact, an extremity electrode situated at the outlet of the said chimney, this extremity electrode being electrically connected to said chimney and to the fixed contact and terminating in the central zone of the extinguishing jet.

9. An electric circuit-breaker comprising two relatively movable contacts, a chimney with conducting interior surface, this chimney being terminated, at one end, by a metallic hood forming an extremity electrode and comprising a central opening forming outlet of the chimney, means for projecting a gas blast against these contacts and into this chimney, and an electrode situated in the central zone of the gas blast and being connected to one of the contacts, the other contact being connected to the conducting surface of the chimney and by this surface to the extremity electrode.

10. An electric circuit-breaker comprising two relatively movable contacts, a chimney with conducting interior surface, this chimney being terminated, at one end, by a metallic hood forming an extremity electrode and comprising a number of openings forming outlets of the chimney, means for projecting a gas blast against these contacts and into this chimney, and an electrode situated in the central zone of the gas blast and being connected to one of the contacts, the other contact being connected to the conducting surface of the chimney and by this surface to the extremity electrode.

11. An electric circuit-breaker comprising two relatively movable contacts, a chimney with conducting interior surface, this chimney being terminated, at one end, by a metallic hood forming an extremity electrode and comprising a number of perforations and a large central opening forming outlets of the chimney, means for projecting a gas blast against these contacts and into this chimney, and an electrode situated in the central zone of the gas blast and being connected to one of the contacts, the other contact being connected to the conducting surface of the chimney and by this surface to the extremity electrode.

12. An electric circuit-breaker comprising two relatively movable contacts, a chimney with conducting interior surface, this chimney being terminated, at one end, by a metallic horn directed towards the axis of the chimney and forming an extremity electrode means for projecting a gas blast against these contacts and into this chimney, and an electrode situated in the central zone of the gas blast and being connected to one of the contacts, the other contact being connected to the conducting surface of the chimney and by this surface to the extremity electrode.

13. An electric circuit-breaker comprising two relatively movable contacts, a chimney with conducting interior surface, this chimney being terminated, at one end, by several metallic horns directed radially towards the axis of the chimney and forming extremity electrodes, means for projecting a gas blast against these contacts and into this chimney, and an electrode situated in the central zone of the gas blast and being connected to one of the contacts, the other contact being connected to the conducting surface of the chimney and by this surface to the extremity electrode.

14. An electric circuit-breaker comprising two relatively movable contacts, a metallic chimney with inlet and outlet openings, openings at the lateral sides of this chimney, means for projecting a gas blast against these contacts and into this chimney, an electrode situated in the central zone of the gas blast and being connected to one of the said contacts, and an extremity electrode situated at the outlet opening of the said chimney and terminating in the central zone of the gas blast, this extremity electrode being connected to the metallic chimney and to the other of said contacts.

15. An electric circuit-breaker comprising two relatively movable contacts, a cage formed by metallic bars and connected to one of these contacts, means for projecting an extinguishing jet against these contacts and into this cage in parallel direction to the bars of the said cage, an electrode connected to the other of these contacts and situated in the central zone of the extinguishing jet, and extremity electrodes fixed at the outlet of the said cage and terminating in the central zone of the extinguishing jet.

16. An electric circuit-breaker comprising two relatively movable contacts, a chimney with conducting interior surface, a chamber surrounding that chimney, means for projecting a gas blast against these contacts and into this chimney, an electrode situated in the central zone of the gas blast and connected to the one of said contacts, an extremity electrode situated at the outlet of the chimney and terminating in the central zone of the gas blast, this extremity electrode being connected to the conducting chimney and this latter to the other of the said contacts and a cooling device for the escaping gases, this device being situated behind the extremity electrode seen in the direction of the gas blast and constituting the outlet of the said chamber.

17. An electric circuit-breaker comprising two relatively movable contacts, means for projecting a jet of extinguishing fluid on these contacts transversely to their direction of motion, an electrode connected to one of the said contacts, intermediate electrodes connected by means of resistances one to another and to this latter contact, an extremity electrode connected to the other of the said contacts, these various electrodes being fixed and the line joining their opposed extremities being located in the central zone of the extinguishing jet and approximately parallel to its axis.

18. An electric circuit-breaker comprising two contacts, fixed electrodes connected each to one of these contacts, means for projecting an extinguishing jet against these contacts and against these electrodes, these electrodes being constituted by hollow cylinders of revolution the half section of which is pear shaped, these electrodes being situated one behind the other in the axis of the extinguishing jet.

19. An electric circuit-breaker comprising two contacts, fixed electrodes connected each to one of these contacts, means for projecting an extinguishing jet against these contacts and against these electrodes, these electrodes being constituted by hollow cylinders of revolution, a metallic rod being fixed in the interior of each of these cylinders, these rods being disposed in the axis of the extinguishing jet.

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