Nov. 2, 1943. A. P. STROM 2,333,598

CIRCUIT INTERRUPTER

Filed Jan. 9, 1941 2 Sheets-Sheet 1

Fig. 1.

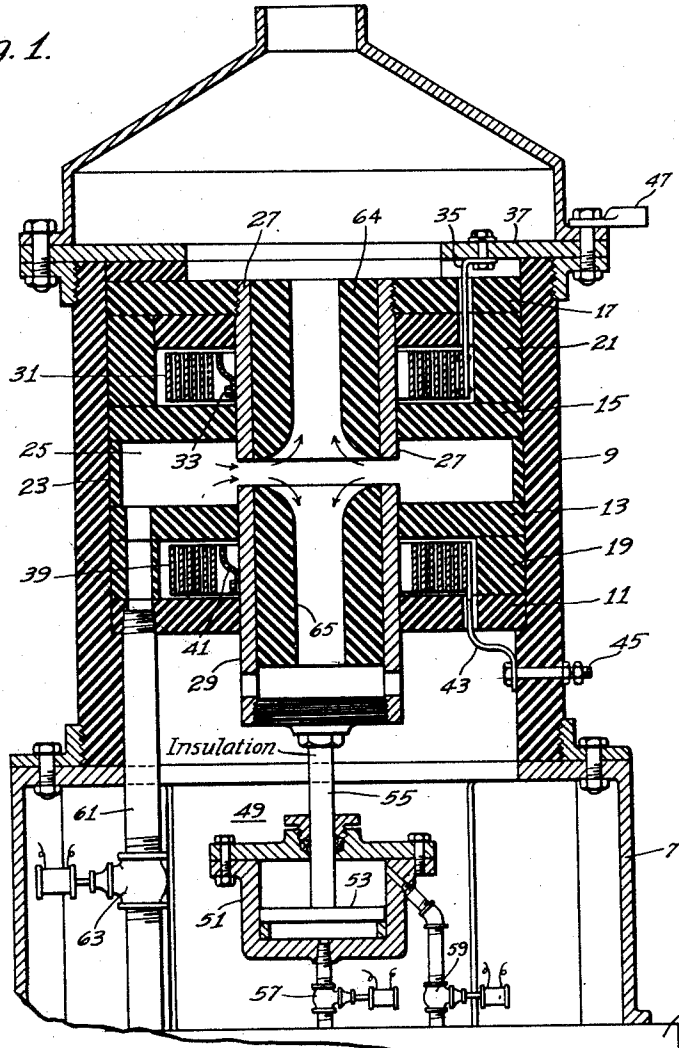
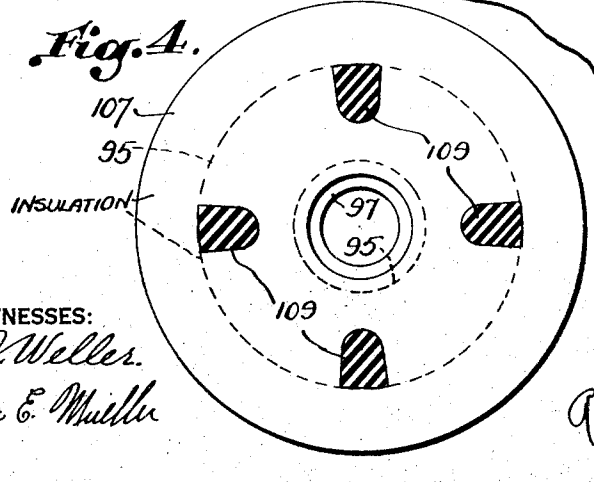


Fig. 4.



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Fig. 2.

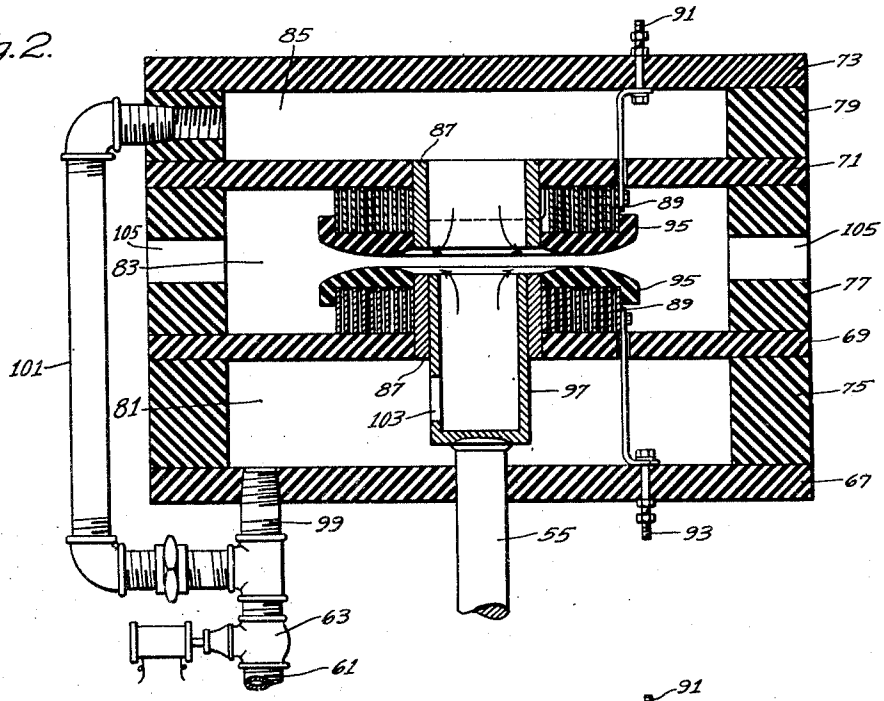
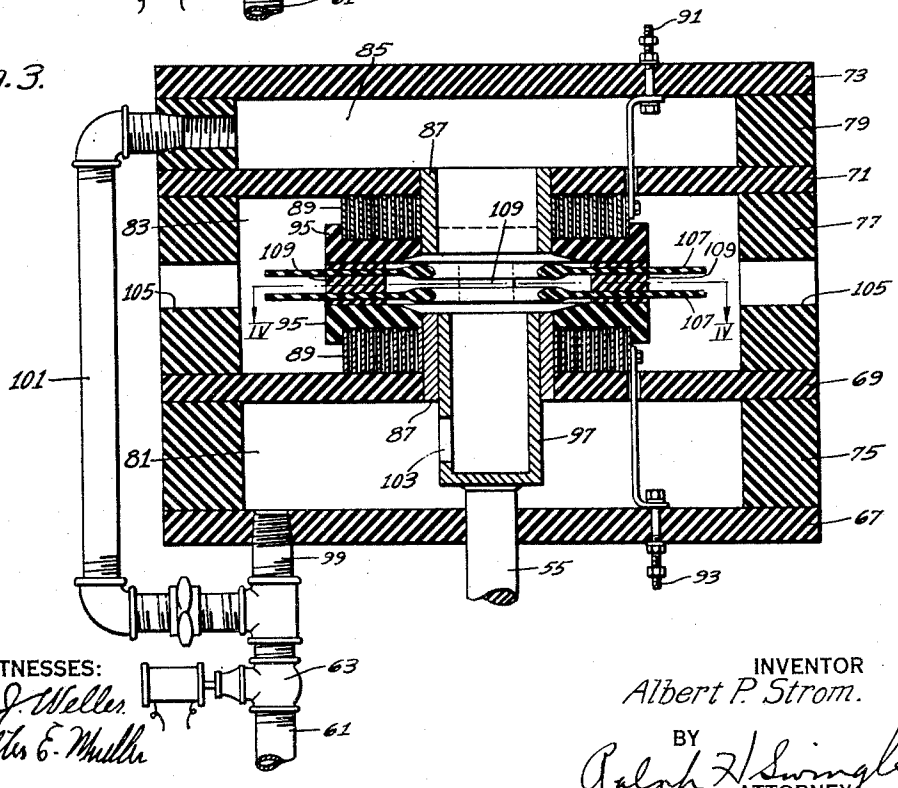


Fig. 3.



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CIRCUIT INTERRUPTER

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7 Claims. (Cl. 200—148)

This invention relates to improvements in circuit interrupters of the fluid-blast type and, particularly, to circuit interrupters utilizing compressed air as an arc-extinguishing medium.

Heretofore circuit interrupters have been developed which bring about arc-extinction by subjecting a substantially stationary arc to a blast of compressed gas. Although these interrupters have shown remarkable performance in extinguishing high power arcs, some difficulty has been encountered, particularly at the higher current ranges. At the higher current values rapid destruction by burning of the contacts and any adjacent insulating material takes place. In addition to the erosive effect caused by the stationary arc terminals a large volume of hot ionized gas, produced during the high current portion of a half cycle is permitted to remain in and about the arc path which interferes with the interrupting process at current zero.

It is an object of my invention to overcome the foregoing difficulties in circuit interrupters of the fluid-blast type so as to improve the current interrupting capacity thereof. My invention contemplates avoiding excessive burning at the contacts and of the adjacent insulating material by the provision of arc terminal paths for the terminal ends of the arc which will permit rapid movement of the arc over the arc terminal surfaces. An annular or recurrent arc path is preferred since this form of path lends itself admirably to achieving both high speed arc movement and efficient removal of the ionized arc gases from the arc path.

A further object of the invention resides in the provision of a circuit interrupter of high efficiency wherein arc length and arc energy are maintained at a low value.

It is also an object of my invention to obtain efficient circuit interruption in interrupters of the gas-blast type by the use of gas-blast pressures considerably lower than those generally used in prior art devices. This has been made possible in part by a more effective removal of the hot ionized gas particles from the arc stream and by subjecting the arc to mild blasts of gas formed by the action of the arc upon gas-forming material.

Other objects and advantages will become apparent in the following description when read in connection with the accompanying drawings, in which:

Figure 1 is an elevation view partially in section of a circuit interrupter embodying my invention;

Fig. 2 is a sectional view of a circuit interrupting unit which illustrates a further embodiment of the invention;

Fig. 3 is a sectional view of a circuit interrupting unit of still another form which illustrates the principles of my invention; and

Fig. 4 is a sectional view through the device of Fig. 3 taken on the line IV—IV.

Referring to the drawings and particularly to Figure 1, the reference numeral 5 designates a tank for storing gas, such as air, under pressure. Disposed upon the tank 5 is a supporting framework 7 which carries a tubular insulator 9. The insulator 9 has a plurality of partitions, in this instance, four, designated as 11, 13, 15 and 17, extending thereacross to divide the interior of the insulator 9 into a number of chambers. An annular spacing member 19 is disposed between the partition members 11 and 13, whereas a similar spacing member 21 separates the partitions 15 and 17. An annular spacing member 23 separates the partitions 13 and 15 to provide an arc chamber 25. Each of the partition members 11 to 17 has openings therethrough, as shown, for the reception of a pair of tubular contact members 27 and 29. Contact 27, in this instance, may be stationary, and may be screw threaded into the partition member 17 as shown. The contact member 29 is movable through the apertures in the partition members 11 and 13 so as to make contacting engagement with the stationary contact 27.

A field coil 31 is disposed in the annular space between partition members 15 and 17 in surrounding relation with respect to the tubular contact 27 and may, for example, be series connected with respect to the contact 27. More specifically one end of the coil may be connected to the tubular contact, as shown at 33, and the other end may be connected by a suitable connection 35 to a terminal plate 37 carried by the upper end of the insulator 9. A second field coil 39 is disposed in the annular space between the partition members 11 and 13 in surrounding relation with respect to the movable contact 29 and may also be series connected with respect to the movable contact 29. One end of the coil 39 is electrically connected by means of a flexible connection 41 to the movable contact 29 and has its other end joined with a conductor 43 which terminates at a line terminal 45. A second line terminal 47 is provided which makes electrical connection with the terminal plate 37. Thus, when the contacts 27 and 29 are in engagement, a circuit is completed through the interrupter from the line terminal 47 to the terminal plate 37, conductor 35,

field coil 31, contact 27, movable contact 29, field coil 39, conductor 43, to the line terminal 45. The purpose of field coils 31 and 39 and the manner in which they function will appear more fully hereinafter as the description proceeds.

Movement of the movable contact 29 to open and closed circuit positions may be accomplished by a fluid actuated driving means, generally indicated at 49. The driving means 49 comprises a cylinder 51 having a piston 53 operative therein which is coupled by an insulating operating rod 55 to the lower end of the movable contact 29. Compressed gas from the storage tank 5 controlled by an electromagnetically actuated valve 57 is admitted to the lower side of the piston 53 so as to move the piston and the movable contact 29 to the closed circuit position. Movement of the movable contact 29 to the open circuit position is accomplished by admitting compressed gas from the tank 5 to the upper side of the piston 53 through the electromagnetically controlled valve 59. The operating solenoids of the valves 57 and 59 may be connected to a suitable source of potential and controlled by manually operated switches as is well known in the art, and, in addition, the energization of the solenoid of the opening electromagnetic valve 59 may be controlled in accordance with the current conditions in the circuit in which the interrupter is connected, which control is also well known in the art and need not be further described.

Provision is also made by means of conduit 61 for conducting compressed gas from the storage tank 5 to the arc chamber 25. The flow of gas through the conduit 61 may be controlled by an electromagnetically actuated valve 63. The control of valve 63, for example, may be effected jointly with the control of valve 59 so that upon actuation of the movable contact 29 to the open circuit position, the valve 63 is opened to admit a blast of gas from the storage tank 5 through the conduit 61 into the arc chamber 25. In practice, it is desirable to provide a control for opening valve 63 slightly in advance of valve 59 so that fluid pressure will be available in the arc chamber 25 when the contacts 27 and 29 separate.

If the movable contact 29 is actuated to the open circuit position while the interrupter is carrying current, either as a result of a manual energization of the valve 59 or by automatic actuation thereof, an arc will be drawn between the annular contact surfaces formed on the faces of the tubular contacts 27 and 29. An arc formed at any point along the annular arc terminal path will then be subjected to a blast of compressed gas flowing from the chamber 25 through the annular space between the contacts. Inasmuch as the flow of gas is radially inward with respect to the tubular contacts 27 and 29, gas flow is established axially of the tubular contacts in the direction shown by the arrows. Thus, arc gases are driven from the region of the arc and caused to discharge through the passages provided by the tubular contacts. Due to the fact that field coils 31 and 39 are respectively serially connected to the contacts 27 and 29, these coils will be energized to establish a radial magnetic field across the arc gap between the contacts which is proportional to the intensity of the arc current. The field coils 31 and 39 are connected in opposition so as to produce a radial magnetic field with respect to the annular arc terminal path. The arc is thus caused to move rapidly over the annular terminal surfaces and at such a rate which prevents the formation of a hot cathode arc and, consequently, avoids burning of the arc terminal surfaces. In practice, I have found that arc velocities upwards of 1,000 feet per second may be obtained with an arrangement, as shown. If electrodes are employed having a mean diameter of approximately 2 inches it will thus be apparent that quite a large number of revolutions of the arc per half cycle may be obtained.

Under the conditions here present the gas pressure in the chamber 25 need only be high enough to carry away the hot ionized arc gases from the annular arcing space with sufficient rapidity so that the arc is rotated in a substantially unionized atmosphere of gas. As the current approaches zero, the arc decreases in cross section, and the rate of ionization of the gases also decreases so that at current zero the annular arcing space is substantially swept free of hot ionized gases produced during the high current portion of the half cycle. It, therefore, requires only a very low velocity flow of gas to finally bring about arc extinction at a current zero.

The contacts 27 and 29 are preferably lined with tubular members 64 and 65 of insulating material for the purpose of preventing the blast of gas traversing the arc from moving the arc inwardly from its annular arc terminal path. The insulating members 64 and 65 also prevent elongation of the arc along the inner surfaces of the tubular contacts 27 and 29 as a result of the blast action traversing the arc.

I have found that when employing tubular contacts having a mean diameter of approximately two inches and a contact separation of substantially 3/8 inch, interruption of 5000 amps. R. M. S. at 2300 volts R. M. S. on a circuit of 40,000 cycles natural frequency could be obtained with 50 pounds per square inch and less gas pressure, whereas in gas blast interrupters which maintain the arc substantially stationary, gas blast pressures upwards of 100 pounds per square inch are required.

Even though the field coils 31 and 39 are shown connected in series with their respective contacts 27 and 29 so that the coils are energized in accordance with the current flowing in the circuit, it should be understood that other methods of connecting these coils may be employed. For example, main current carrying contacts could be used in conjunction with arcing contacts as is well known in the art, and arranged so that when the main contacts are closed, the field coils are short circuited but upon separation of the contact structure and transfer of the current to the arcing contacts the field coils are connected in circuit and become energized.

In Fig. 2 a circuit interrupting unit of somewhat different form is shown. In this arrangement partition members 67, 69, 71 and 73 are separated, respectively, by annular spacing members 75, 77 and 79 so as to form in the order named a gas-receiving chamber 81, an arc chamber 83, and a second gas-receiving chamber 85. Each of the partition members 69 and 71 have openings therethrough for receiving stationary tubular arcing contacts 87. A field coil 89 may be serially connected to each tubular arcing contact and to a pair of line terminals 91 and 93, so as to provide a radial magnetic field between the arcing contacts 87 in a manner similar to that described in connection with Fig. 1. The field coils 89, in this instance, are protected and partially supported by a pair of annular insulating members 95 which are disposed adjacent to the contact terminal paths on the tubular arcing

contacts 87 and extend radially outwardly from these arcing contacts. The opposed surfaces of the annular members 95 are preferably convex with respect to each other so as to provide an annular nozzle for the control of gas flow with respect to the arc. The circuit is established between the stationary arcing contacts 87 by means of a tubular movable bridging member 97 slidably engaging the inner surfaces of the arcing contacts 87. The movable bridging member 97 may, in this instance, be actuated to the open and closed circuit positions by an insulating operating rod 55 forming part of the fluid-pressure driven mechanism 49 previously described.

As in the interrupter shown in Fig. 1, compressed gas may be supplied to the interrupter through the supply line 61 leading from the storage tank 5 and controlled by the electromagnetically actuated valve 63. In this instance, however, gas under pressure is conducted from the valve 63 through a conduit 99 to the chamber 81, and through a second conduit 101 to the chamber 85. The chamber 85 is in direct communication with the upper tubular arcing contact 87, whereas the chamber 81 communicates with the lower arcing contact 87 through an opening 103 provided in the tubular bridging member 97. Thus, upon movement of the bridging member 97 to the open circuit position as shown in Fig. 2, at a time when the interrupting unit is carrying current, an arc will be established in the annular arcing space between the arcing contacts 87. Field coils 89 will produce a radial magnetic field across the annular arcing space for rotating the arc at high speed thereabout. Compressed gas from the chambers 81 and 85 will flow through the tubular arcing contacts 87, as indicated by the arrows in the drawings, to traverse the rotating arc, and thereby carry the hot ionized arc gases from the annular arcing space through the annular nozzle formed by the opposed annular members 95 of insulating material. The hot ionized arc gases discharged into the arcing chamber 83 may be permitted to vent therefrom through openings 105 provided in the spacing member 77.

The annular nozzle produced by the members 95 of insulating material serves to maintain the proper pressure conditions within the annular arcing space so as to maintain efficient arc-extinguishing conditions.

Improved circuit interrupting performance has also been obtained by making the annular members 95 of a material which gives off gas when acted upon by an arc, as, for example, horn fiber. The improved performance is believed to be due to the fact that as the arc impinges upon the insulating surface, the surface emits a gas which reacts with the hot ionized gas particles in the arc stream and sets up a turbulence to a degree which permits the blast of extinguishing gas to penetrate the arc stream and thereby rapidly deionize the arc. In the absence of gas-producing material, there is a tendency to the formation of a layer of ionized gas adjacent the insulating surface which is substantially immovable and which cannot be penetrated by the arc-extinguishing blast of gas. Thus, higher arc-extinguishing blast pressures are needed to bring about arc-extinction where non-gas-forming materials are used adjacent the arc path than where gas-forming insulating materials are used. Gas evolving material is also believed to be better than refractory materials because the surface decomposition by the action of an arc on the former keeps the surface cool so that it continues to have a good surface breakdown characteristic. Keeping the surface cool also avoids possible thermionic emission from the surface which would render arc extinction more difficult.

In Fig. 3 a further form of circuit interrupter is shown which is substantially the same as that shown in Fig. 2 with the exception that the arcing contacts 87 are spaced further apart. This permits the use of a plurality of, in this instance, two, annularly-shaped arc splitting members 107 of insulating material to be inserted therebetween and in the space surrounding the annular arcing space. The arc splitting members 107 may be flat and of uniform thickness or have at least a narrow portion adjacent their inner edge of thickness somewhat greater than their remaining portions. If enlarged portions are provided, they are preferably of elliptical cross section, as shown, so as to provide a series of annular nozzles, respectively, between the insulating members 95 and the arc splitting members 107. These annular nozzles, as described in connection with Fig. 2, also serve to control the flow of gas from the annular arcing space between the arcing contacts 87, and thereby maintain the pressure in the arcing space at the desired value. The arc splitting plates 107 are preferably held in spaced relation with respect to each other and with respect to the annular members 95 by insulating spacer members 109 of segmental form, the latter having dimensions such as to further control the area of the gas discharge passages between the arc splitter members 107 and the annular members 95 as more clearly shown in Figure 4.

Movement of the conducting bridging member 97, as previously described, will establish an arc between the arcing contacts 87 which rotates about its annular arcing space between these contacts as a result of the radial magnetic field established by the coils 89. As previously described, compressed gas is admitted to the chambers 81 and 85 which flows through the tubular arcing contacts 87 transversely of the annular arcing space and also traverses the arc so as to move the same against the edges of the splitter plates 107 and, in effect, tends to split the arc into a plurality of serially related sections. Although the arc, in this instance, is drawn to a somewhat greater length than in the interrupter shown in Fig. 2, a higher deionizing effect is made possible due to the action of the splitter members 107 tending to sectionalize the arc, and thereby hastening its deionization. By making the insulating splitter plates 107 of material which gives off gas when acted upon by an arc, the deionizing action is materially enhanced and considerably higher currrents may be interrupted without increasing the blast pressure.

Although I have shown specific forms of circuit interrupting devices, it is to be understood that the same are for the purpose of illustration and that changes and modifications may be made by those skilled in the art without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. In a gas blast circuit interrupter, an arc chamber with insulating walls and having a pair of openings disposed in opposite sides thereof, a pair of tubular arcing contacts extending through said openings and arranged to provide an annular arc gap of predetermined length therebetween at least when the interrupter is in the open circuit position, means for establishing an arc

between said arcing contacts, a field coil surrounding at least one of said tubular arcing contacts, said coil being arranged to be energized to produce a radial magnetic field across said annular arc gap between said arcing contacts for rotating said arc therearound, means for projecting a blast of gas under pressure into one of said tubular contacts, out through said annular arc gap, and into said arc chamber, and means for venting the ionized arc gases from said arc chamber.

2. In a fluid blast circuit interrupter, a pair of ring-shaped arcing contacts arranged to provide an annular arc gap therebetween at least one of said arcing contacts being tubular, means for establishing an arc between said arcing contacts, means for rotating said arc around said annular arc gap, means of insulating material disposed about said arcing contacts and arranged to provide an annular discharge nozzle adjacent said annular arc gap, and means for projecting a blast of fluid into said tubular contact to cause a flow of fluid radially outwardly through said arc gap and said annular discharge nozzle, said annular nozzle controlling the rate of fluid discharge and confining said arc to substantially the annular arc gap between said arcing contacts.

3. In a circuit interrupter of the fluid blast type, a pair of contacts arranged to provide an annular arcing gap therebetween, at least one of said contacts being hollow, means for establishing an arc between said contacts, means for rotating said arc around said annular arcing gap, means for introducing a fluid under pressure into said hollow contact to establish a radial outward blast of fluid across said arcing gap and transversely of said arc as the latter is rotated, and at least one barrier member of insulating material disposed in surrounding relation about said annular arcing gap, said radial outward blast of fluid moving the arc laterally against said barrier member to split the arc gases into a plurality of sections.

4. In a circuit interrupter of the fluid blast type, a pair of contacts arranged to provide an annular arcing gap therebetween, at least one of said contacts being hollow, means for establishing an arc between said contacts, means for rotating said arc around said annular arcing gap, means for introducing a fluid under pressure into said hollow contact to establish a radial outward blast of fluid across said arcing gap and transversely of said arc as the latter is rotated, and a plurality of insulating annular arc gas splitters disposed about said annular arcing gap and against which said arc is blown, the inner edges of said insulating annular splitters being shaped to provide a plurality of annular fluid discharge nozzles for controlling the drop in pressure of said fluid blast in the region of said arcing gap.

5. In a gas blast circuit interrupter, a pair of arc terminal members between which an arc may be established, means for rotating said arc between said arc terminal members, at least one of said arc terminal members being tubular, means for causing a blast of gas to flow through the tubular arc terminal member and radially outwardly between the pair of arc terminal members to extinguish the rotating arc, and an annular member of insulating material covering part of said tubular arc terminal member adjacent the end thereof to limit the area on which the arc may play and direct the flow of said gas adjacent the end of the tubular arc terminal member.

6. In a circuit interrupter, a pair of arcing contacts, at least one of the contacts being tubular, means for establishing an arc between said contacts, means for rotating said arc around said contacts, and means for projecting a blast of gas under pressure into the tubular contact and radially outwardly across the region between said contacts to extinguish the arc.

7. In a circuit interrupter, a pair of relatively thin ring-shaped arcing contacts, one of said contacts being tubular, means for establishing an arc between said arcing contacts, means for rotating the arc around said relatively thin ring-shaped contacts, annular means of insulating material disposed around both arcing contacts to provide an annular discharge nozzle adjacent the opposed inner ends of said contacts, and means for projecting a blast of fluid into the tubular contact to cause a radial outward blast of fluid between the contacts, the nozzle confining the terminal ends of the arc to the contacts and also raising the pressure and hence the dielectric strength adjacent the arc.

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