Dec. 21, 1937. J. SLEPIAN 2,103,121

CIRCUIT INTERRUPTER

Original Filed Jan. 27, 1930

FIG. 1.

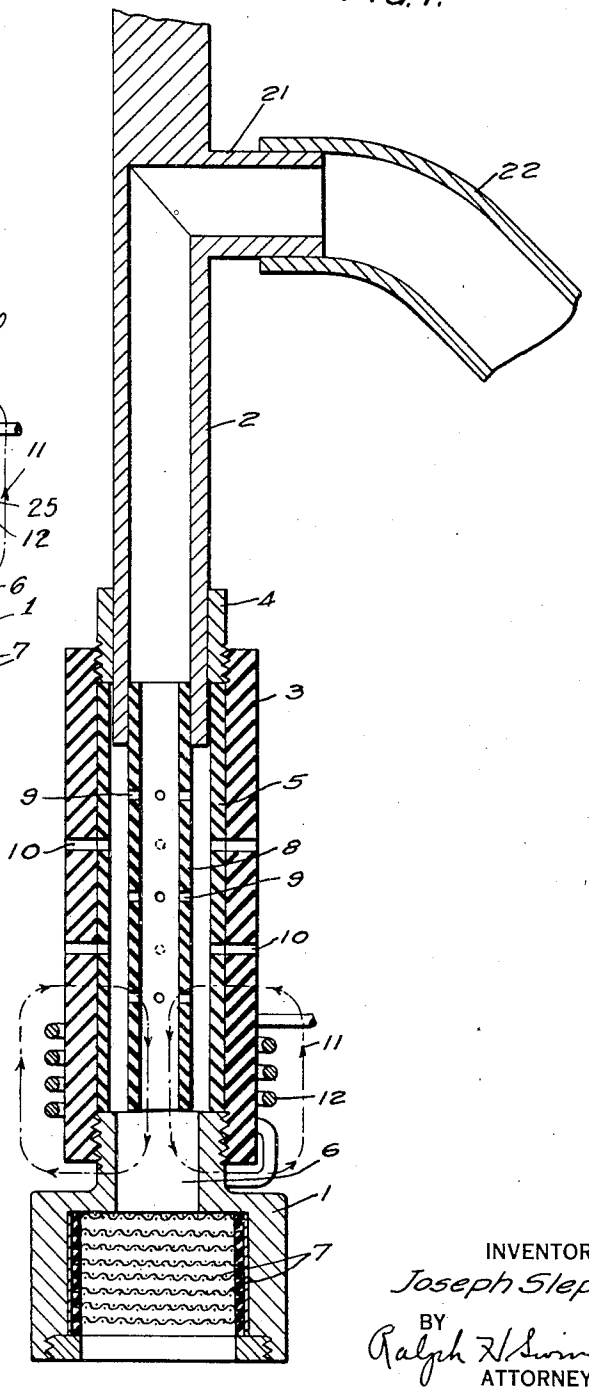
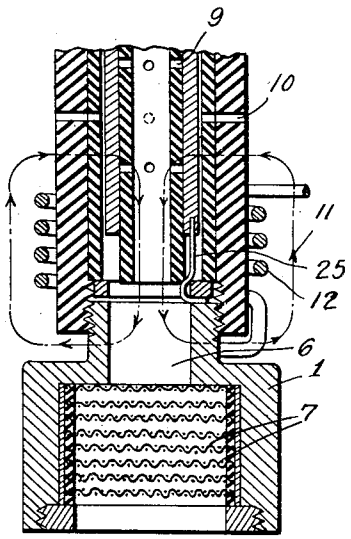


FIG. 2.



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2,103,121

CIRCUIT INTERRUPTER

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Original application January 27, 1930, Serial No. 423,660, now Patent No. 2,084,979, dated June 22, 1937. Divided and this application May 13, 1937, Serial No. 142,360

9 Claims. (Cl. 200—147)

My invention relates to circuit interrupters and particularly to interrupting devices that establish an arc in a gaseous medium. This application is a division of my application Serial No. 423,660, filed January 27, 1930, now Patent 2,084,979 issued June 22, 1937.

In my Patent No. 1,899,643 issued February 28, 1933, I disclose a device for deionizing the conducting gas path. This device utilized the gases that were generated from the arc quenching liquid which were retained in the vicinity of the arc core. The gas passed turbulently through the arc stream and formed relatively cool centers into which ions, from the current carrying portions of the arc space, diffused and recombined.

While the aforementioned application discloses the benefits derived from the deionizing gas generated from an arc quenching liquid, the present invention relates to apparatus for producing a similar gas that effects recombination of the ions in an arc path that is established in air.

One object of my invention is to provide an arc path, that is established in air or other gaseous medium, with means that shall evolve a deionizing gas in the presence of an arc, throughout the entire length of the arc.

Another object of my invention is to construct the side walls of an arc extinguishing device of such material that a deionizing gas is freely liberated therefrom in the presence of an arc.

A further object of my invention is to provide an arc extinguishing device of the above described type having deionizing material on the side walls thereof, with additional structure that shall be capable of deionizing arcs of small current values.

A still further object of my invention is to provide a circuit interrupting device of the above described type with a venting device comprising cool metal plates or screens upon which the gas escaping therethrough may be further deionized.

A still further object of my invention is to provide a circuit interrupter in which the arc is established in an annular passage defined by walls of insulating material with a radial magnetic field for causing rotation of the arc in the passage.

For a more complete understanding of the nature and objects of my invention reference should be had to the following description taken in conjunction with the accompanying drawing wherein:

Figure 1 is a sectional view, in elevation, of a circuit interrupter embodying my invention, and;

Figure 2 is a fragmentary sectional view, in elevation, of a modified form of circuit interrupter.

My invention comprises in general a stationary contact member 1, a cooperating movable contact member 2 and a tubular insulating casing 3 that encloses the path between the members 1 and 2 when separated. The casing 3 is threaded internally at each of its ends, the upper end having associated with the threads thereof a bushing 4 that is employed as a guide for the movable contact 2. The lower threaded section cooperates with the threaded end of the stationary contact member 1 and supports a removable insulating tube 5 within the insulating casing 3 directly adjacent to the movable contact member 2.

The removable insulating tube 5 is constructed of a material which will readily decompose when an arc is drawn between the contact members 1 and 2 giving off large volumes of deionizing gas that passes turbulently through the arc stream. Any fibrous material that is affected by an arc to freely liberate gases of low molecular weight may be successfully employed on my structure. Paper was successfully used as well as materials known in the art as "hard fibre". These materials contain a certain percentage of water, the vapors of which are effective in aiding ion recombination. They have the further advantage of being slowly burned away by the arc, leaving clean surfaces which have a high voltage breakdown.

The inner cross-sectional area of the tube 5 of gas forming material is approximately the same as the cross-sectional area of the moving contact member 2. This means that the opening of the tube is as small as it can be for the size of contact member which must be used to conduct the current which the contact must normally carry. This small size of the passage through the gas evolving material gives a desirable improvement since the gas evolving material is in close contact with the arc and causes a large volume of gas to be formed to extinguish the arc.

When employed on alternating current circuits the heat stored in the materials causes them to continue to give off the deionizing gases down to and including the time when the current is passing through the zero value of its alternating cycle. At current zero the arc extinguishes while the gases continue to be tur-

bulently thrown into the space it formerly occupied. The small volumes of cool unionized gas scattered through the ionized path as a result of the turbulent motion, causes the ions to very rapidly recombine thereon so that the space between the contacts loses its ions very rapidly. Because the density of ions decreases rapidly, the voltage gradient necessary to restrike the arc increases very rapidly so that the rise of recovery voltage impressed by the external circuit after current zero, will not be rapid enough to cause the reinitiation of the arc between the separated contact members.

While this construction is intended primarily for alternating current circuits for rapidly deionizing the arc path after arc extinguishment, it was also found to successfully extinguish an arc established in a direct current circuit. As the fresh gas is continually being fed into the arc stream, the small volumes thereof which are scattered through the arc space as a result of the turbulent motion, rapidly abstract ions, which must be reformed by the ionizing processes going on in the arc. Inasmuch as the formation of ions from neutral molecules requires a large amount of energy, far greater than that needed for the usual chemical reactions, it is clear that in order to maintain the arc, a greatly increased energy input from the electric circuit will be necessary, or in other words, to maintain an arc of a given current strength a great increase in the applied voltage is necessary. This aids in the extinction of the arc in a direct current circuit, because in such a circuit, it is necessary to make the arc voltage larger than the generated voltage if the current is to be reduced. Because the arc voltage is so greatly increased by the gas blast, this condition can be realized with a much shorter length of arc than would be necessary without the gas blast.

The large amount of gas that is evolved in the small space occupied by the arc is vented from within the tube **5** as it passes through the arc stream and is expelled into the atmosphere. These gases which are at high temperature, and contain large numbers of ions abstracted from the arc, appear as a flame of considerable extent outside the interrupting structure. This flame is objectionable when other conductors or apparatus are situated nearby as the hot ionized gas forms paths of low dielectric strength which increase the hazard of breakdown.

The contact **1** is provided with an opening **6** that constitutes a vent for the escaping gases which pass through the cooling and deionizing surfaces **7** located adjacent to the opening **6**. These cooling and deionizing surfaces may be insulating but are preferably made of metal in the form of plates or screens upon which the hot gases are cooled and the ions thereof recombined. This gas when coming in contact with the outer atmosphere will be completely cooled and deionized. As explained in the paper, "Flames from electric arcs", published in the September, 1929 issue of the A. I. E. E. Journal, the combination of ions upon surfaces takes place with extreme rapidity.

While the foregoing description has dealt with a circuit interrupting device wherein separable contact members are employed to establish an arc, it is to be understood that other means such as a fusible element **25** may be employed in lieu of the separable contact members as shown in Fig. 2 in which identical parts are designated by the same numerals of reference as in Fig. 1. The operation of the device shown in Fig. 2, following the fusion of the element **25**, is the same as that of the structure shown in Fig. 1.

In order that the structure may be utilized for deionizing the arc path of arcs that may have large or small currents flowing therethrough, the movable contact member **2** that cooperates with the stationary contact member **1**, is hollow and is provided with stem **21** that is connected, by means of a flexible tube **22**, to a source of compressed air or other gas or deionizing medium that may be passed through the tube **2** into the arc stream and the space occupied by the arc after it is extinguished.

In this construction arcs carrying large currents will be extinguished in the same manner as that hereinabove described. When, however, an arc having a small current flowing therethrough is present in the device, the difficulty in obtaining its extinguishment, is overcome by the additional deionizing gas that is supplied to the arc and the arc space through the tube **22** and the opening in the contact member **2**. The introduction of these gases have no detrimental effect upon the extinguishment of arcs of large currents, so that the gas may be injected into the chamber upon each operation of the circuit interrupter. Arrangement may be made however, under certain circumstances to have the additional gas injected into the chamber only when small current arcs are established.

It will thus be seen that I have provided a circuit interrupter that establishes an arc in air, with a material adjacent to the arc path that is affected by the arc to liberate deionizing gases for causing the ions of the space occupied by the arc to rapidly recombine after the arc is extinguished. In order to assure that a sufficient amount of gas will be provided when arcs of low current value are established, I provide additional means whereby the structure is as effective for preventing arcs of small current values from being reinitiated as those of large current values.

It may be worth while in some instances to provide inlets for high pressure gas at intervals along the path of the arc; and that under some conditions the provision of passages through which the gas may find vent between each pair of such gas inlets may be warranted. Either the inlet or outlet ducts may be of annular or other form adapted to permit radial movement of the gas with substantially equal facility in any meridian direction about the axis of the arc. Thus for example a hollow stationary duct or tube **8** of insulating material with a plurality of annular orifices **9** may be positioned in the interior of the hollow electrode **2**, the latter sliding over such duct. The hollow stationary tube **8** of insulating material also serves to cause arcs of small current magnitude to intimately contact the opposed walls of the arc passage formed by the tubes **5** and **8**. Annular vent-ducts **10** may be provided in the wall **5**, and these may if desired be positioned mid-way between the annular inlet ducts just described. Rotation of the arc about the insulated inlet duct, for instance by a radial magnetic field indicated by arrows **11**, and set up by coil **12**, is within the contemplation of my invention under such circumstances. Broadly any arrangement adapted to produce a gas and project it into an arc at a plurality of points

along its path, and/or to provide a plurality of outlet paths for such gas is within the purview of my invention. It will also be recognized that the inlet and outlet ducts above described may be interchanged without departing from my invention.

It will also be recognized that the distribution of gas sources along the arc is applicable where the arc is surrounded by oils or other insulating liquids as well as by the gaseous atmosphere specifically described herein.

While I have described a specific embodiment of my invention it is to be understood by those skilled in the art that many changes, additions, omissions and substitutions may be made therein without departing from the spirit and scope of my invention as set forth in the claims.

I claim as my invention:

1. In a circuit interrupter, means of insulating material including inner and outer members having an endless annularly-shaped narrow slot therebetween, a terminal member, a hollow tubular electrode extending into said endless annularly-shaped narrow slot, and said tubular electrode being slidable over said inner member away from said terminal member for drawing an arc in the endless slot.

2. In a circuit interrupter, means of insulating material including inner and outer members having an endless annularly-shaped narrow slot therebetween, a terminal member, a hollow tubular electrode extending into said endless annularly-shaped narrow slot, and said tubular electrode being slidable over said inner member away from said terminal member for drawing an arc in the endless slot, means included along said endless slot which when acted upon by the arc gives off gas to aid in extinguishing the arc, and one or more vents from the endless slot for the gas.

3. In a circuit interrupter, means of insulating material including inner and outer members having an endless annularly-shaped narrow slot therebetween, a terminal member, a hollow tubular electrode extending into said endless annularly-shaped narrow slot, and said tubular electrode being slidable over said inner member away from said terminal member for drawing an arc in the endless slot, and means for causing a radial magnetic field across the endless slot for whirling the arc around and around in the endless slot.

4. In a circuit interrupter, means for establishing an arc, an arc extinguisher including means of insulating material having an endless annularly-shaped slot for the arc after it is established and in which the arc is free to move completely around the slot, said slot for the arc being so narrow as to closely confine the arc and cause it to be in intimate contact with the walls of the slot, means along the slot which when acted upon by the arc gives off gas to aid in extinguishing the arc, and venting means from the slot through which said gas may flow with an expulsion action.

5. In a circuit interrupter, means for establishing an arc, an arc extinguisher including means of insulating material having an endless annularly-shaped slot for the arc after it is established and in which the arc is free to move completely around the slot, said slot for the arc being so narrow as to closely confine the arc and cause it to be in intimate contact with the walls of the slot, means along the slot which when acted upon by the arc gives off gas to aid in extinguishing the arc, and venting means from the slot through which said gas may flow with an expulsion action, and means for causing a radial magnetic field across the endless slot for rotating the arc over a recurrent path in the endless slot.

6. In a circuit interrupter, an arc extinguisher including means of insulating material having an endless annularly-shaped slot for the arc in which the arc is free to move completely around the slot, a pair of arc terminal members, one of which is tubular and has a cross-sectional area approximately that of the opening of said slot, said tubular arc terminal member being movable in the slot for drawing the arc therein, means along the slot which when acted upon by the arc gives off gas to aid in extinguishing the arc, and venting means for the gas.

7. In a circuit interrupter, an arc extinguisher including means of insulating material having an endless annularly-shaped slot for the arc in which the arc is free to move completely around the slot, a pair of arc terminal members, one of which is tubular and has a cross-sectional area approximately that of the opening of said slot, said tubular arc terminal member being movable in the slot for drawing the arc therein, means along the slot which when acted upon by the arc gives off gas to aid in extinguishing the arc, and venting means for the gas, and means for causing the arc to rotate in the slot with one end moving over a recurrent path on one of said arc terminal members.

8. In a circuit interrupter, means for establishing an arc, an arc extinguisher including means of insulating material having an endless annularly shaped slot for the arc after it is established, a pair of arc terminal means within said slot between which the arc is free to move completely around this slot, said slot for the arc being so narrow as to closely confine the arc and cause it to be in intimate contact with the walls of the slot, means along the slot which when acted upon by the arc gives off gas to aid in extinguishing the arc, and vent means for said slot comprising at least one opening through at least one of said arc terminal means for discharging gas from said slot.

9. In a circuit interrupter, means of insulating material for defining a recurrent arc passage of tubular form, said passage being closed at one end, means including a fusible element for establishing an arc within said tubular passage and means for producing a magnetic field radially across said passage for moving said arc laterally along the passage.

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