Sept. 1, 1942. H. L. RAWLINS 2,294,801

CIRCUIT INTERRUPTER

Filed May 25, 1938 2 Sheets-Sheet 1

Fig. 1.

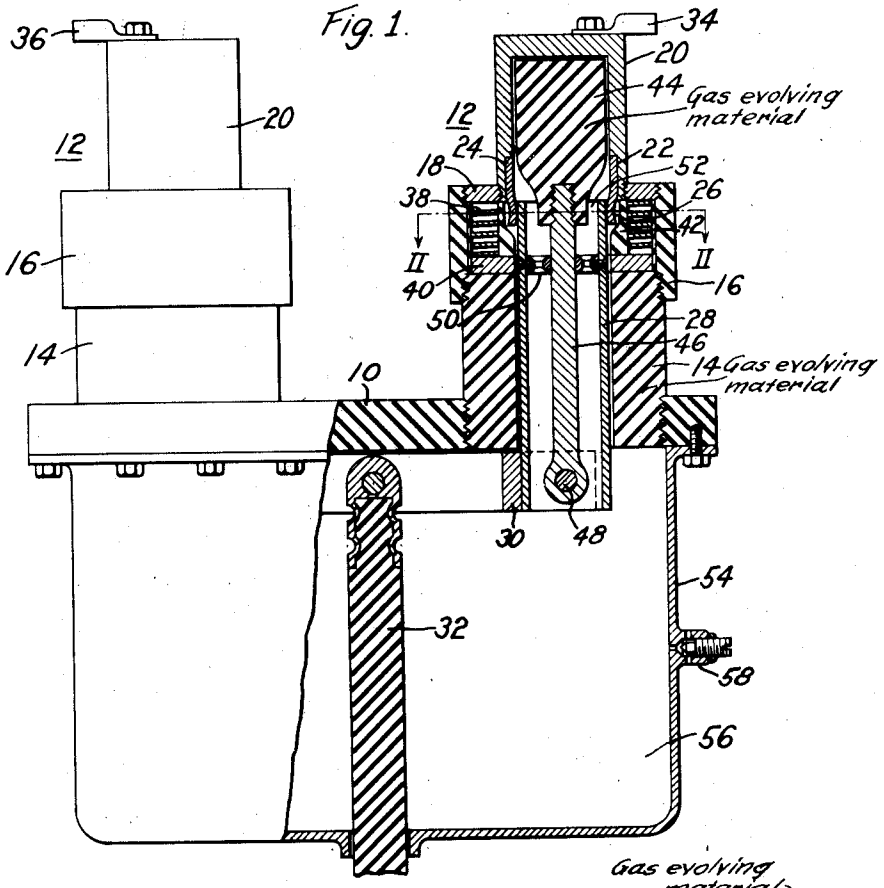


Fig. 2.

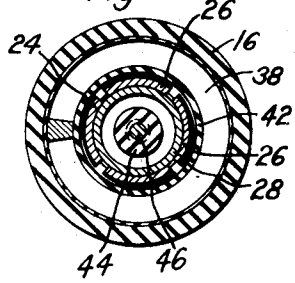


Fig. 3.

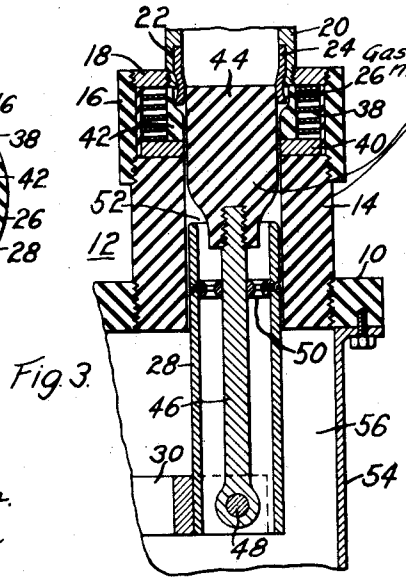
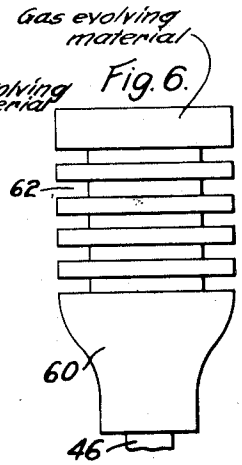


Fig. 6.



WITNESSES:

Wm. B. Sellers.

Walter E. Mueller

INVENTOR

Herbert L. Rawlins.

BY

Ralph W. Swingle

ATTORNEY

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CIRCUIT INTERRUPTER

Filed May 25, 1938 2 Sheets-Sheet 2

Fig. 4.

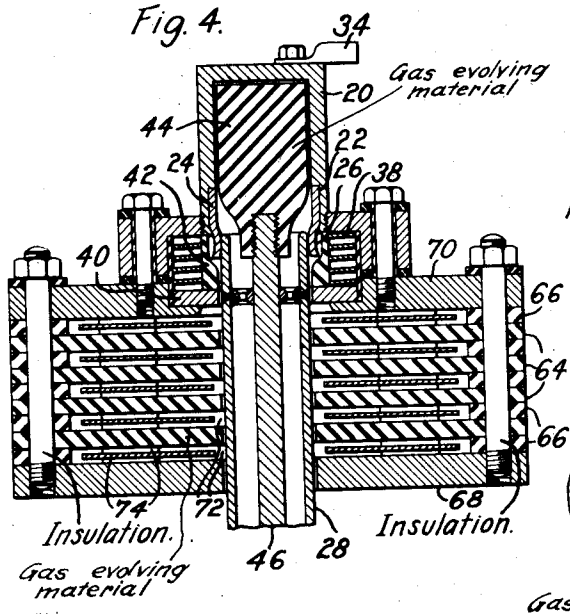
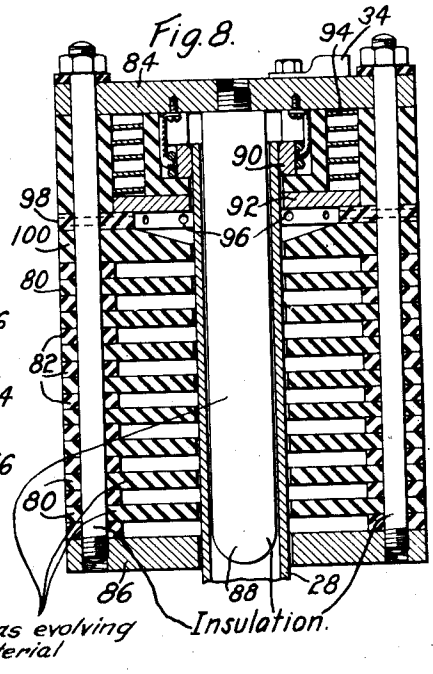


Fig. 8.



Gas evolving material

Fig. 5.

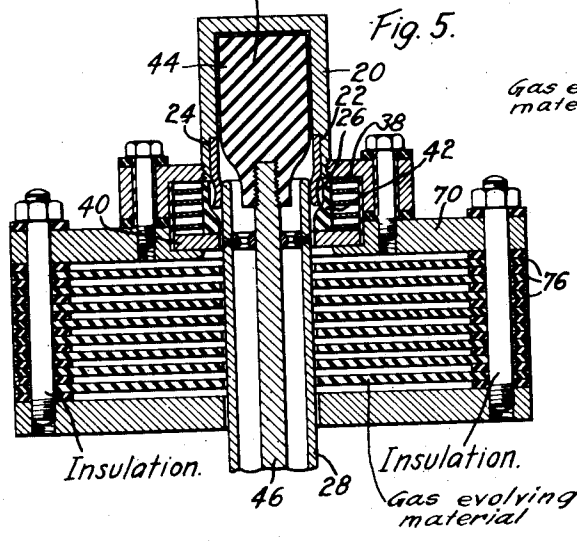
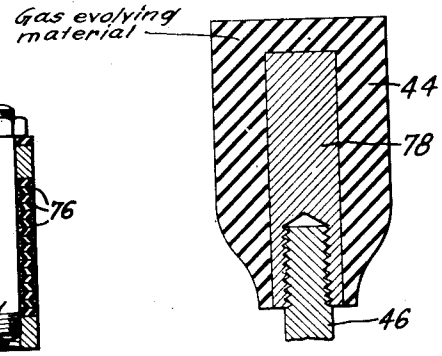


Fig. 7.



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INVENTOR

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BY

Ralph W. Swingle

ATTORNEY

Patented Sept. 1, 1942 2,294,801

UNITED STATES PATENT OFFICE

2,294,801

CIRCUIT INTERRUPTER

Herbert L. Rawlins, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application May 25, 1938, Serial No. 209,969

27 Claims. (Cl. 200—149)

This invention relates to circuit interrupters and more particularly to circuit interrupters of the air break type.

It is an object of my invention to provide a circuit interrupter capable of interrupting high voltage, high current arcs in air or gas without recourse to oil or other liquid arc extinguishing media.

A more specific object of my invention is to provide a circuit interrupter in which arc extinction is accomplished by compelling the established arc to operate in a narrow channel or slot between walls of insulating material.

Another object of the invention is the provision of an improved arc extinguishing structure for circuit interrupters of the expulsion type.

A further object of my invention is to improve the arc extinguishing ability of narrow slot type interrupters by the provision of gas generating materials adjacent the arc path so as to provide a flow of arc extinguishing gas through the arc stream.

Other objects and advantages relate to improvements in the structural arrangement of my circuit interrupter whereby a more efficient utilization of the products of decomposition of the arc is obtained during the circuit interrupting operation, and will appear more fully in the following description when read in connection with the accompanying drawings, in which:

Figure 1 is a side elevation view, partially in section, showing an embodiment of my invention;

Fig. 2 is a cross-sectional view taken along the line II—II of Fig. 1;

Fig. 3 is a sectional view of one of the interrupting units of my circuit interrupter showing the contacts in the open position;

Fig. 4 is a sectional view of a modified form of circuit interrupter;

Fig. 5 is a sectional view of another form of circuit interrupter;

Fig. 6 is an elevation view of a modified filling member or plunger which may be utilized in any of the foregoing circuit interrupters;

Fig. 7 is a sectional view of still another form of filling member which may be used in conjunction with the above-identified interrupters, and

Fig. 8 is a sectional view of still another form of circuit interrupter embodying the principles of my invention.

Referring to the drawings, and particularly to Figure 1, the reference character 10 designates a base, preferably of insulating material, which supports two arc extinguishing units generally designated at 12, the right hand unit being shown in vertical section. Each unit 12 comprises a tubular member 14 of insulating material which is open at both ends and has its lower end screw-threaded into the base 10 and its upper end screw-threaded for the reception of a collar or cylinderical member 16. The upper end of the collar 16 is partially closed by an annular plate 18, preferably of conducting material. The inner surface of the annular plate 18 is threaded for the reception of a cylindrical closure cap member 20 also of conducting material which is open at its lower end end closed at its upper end and has an internal diameter substantially the same as the diameter of the tubular member 14. The lower end of the cap member 20 is provided with an annular recess 22 in which a tubular fixed contact member 24 is positioned. The contact member 24 may be provided with a plurality of segmental contact sections 26 adapted to engage and cooperate with a movable tubular contact 28 extending through the bore of tubular member 14 and substantially filling the same. The tubular contacts 28 of the two circuit interrupting units 12 are supported from opposite ends of a metallic bridging bar 30. The bridging bar 30 may be actuated by an operating rod 32 coupled thereto as shown by any suitable operating mechanism not illustrated.

When the circuit interrupter is in the closed position as shown in Fig. 1, the circuit therethrough proceeds from a terminal 34 secured to the cap member 20, through the cap member 20 to the contact member 22, contacts 26, movable contact 28 to the bridging bar 30 from whence this circuit continues through the left hand interrupting unit 12 in a similar manner as previously described and emerges at the other line terminal 36. From the foregoing description it is apparent that as the bridging bar 30 is moved downwardly during conditions of load, an arc will be drawn between the fixed contacts 26 and the movable tubular contacts 28. As the two tubular contacts move through their respective tubular members 14, an arc will be drawn therein. In order to provide for uniform erosion of the inner walls of the tubular member 14, and also the exposed contact surfaces of both the fixed and movable contacts, I have provided an annular coil 38 disposed within the collar 16, the upper end of which is connected to the annular plate member 18 and the lower end of which is connected to an annular arcing plate 40.

The inner surface of the coil 18 is protected from the action of the arc by an annular member 42 of insulating material. Thus as the upper end of the moving tubular contact 28 moves below the arcing plate 40, the upper end of the arc established by this movement will transfer from the fixed contact 26 to the arcing ring 40. Transfer of the arc in this manner causes the coil 38 to be placed serially in the arc circuit which,

when thus energized, produces a radial magnetic field across the arc space for rotating the arc therearound. Arc extinction in this instance is rendered more effective by compelling the arc to operate in a narrow slot or passage. The narrow arc passage is provided between the tubular member 14 and a movable plunger member 44 of insulating material, preferably supported by and movable with the tubular contact 28 and bridging bar 30. For example, the plunger 44 may be secured at its lower end to a rod 46 which in turn is supported at its lower end by a transverse bolt 48 in fixed relation with respect to the bridging member 30.

The support rod 46 is preferably held centrally of the tubular contact 28 by means of a spider 50 which may be secured to the movable contact 28 by screws as shown. The plunger 44 has its lower end tapered and extends partially into the tubular contact 28, thereby providing an annular passage as shown at 52 between the upper edge of the contact 28 and the plunger. The plunger 44 also has such a diameter that when it is moved into the tubular member 14 an annular arc passage is provided of restricted cross section.

I have found that effective arc extinction may be obtained with an arc passage width of from 1/32" to 1/8". The requirement for a particular arc passage width, however, depends to some extent upon the materials used for the plunger 44 and the tubular member 14. In the event of the use of refractory or non-gas evolving materials, a much smaller arc passage width is recommended than if either the plunger 44 or the tubular member 14 is composed of gas-evolving insulating material. If non-gas evolving or refractory materials are used in forming the tubular member 14 and the plunger 44, arc extinction is accomplished in accordance with the deionization theory set forth in J. Slepian Patent No. 1,836,994, issued Dec. 15, 1931, in which deionization of the arc stream is accomplished by compelling the arc to operate in the narrow channel or passage. In this instance a narrow passage is provided between the tubular member 14 and the plunger 44. Under such conditions rapid deionization takes place so that when the arc passes through current zero, the space between the separating contacts in the constricted passage has been so completely deionized that the arc will not restrike when the voltage again builds up in the opposite direction.

Any products of decomposition resulting from the action of the arc upon the wall members of the annular passage will have free flow from the passage through the annular opening 52 and through the passage of the tubular contact 28.

I have found that arc extinction may be facilitated by making either the tubular members 14 or the plunger members 44, or both the tubular members and plunger members of insulating material which evolves considerable quantities of gas when acted upon by an arc. When such gas evolving materials are used to define the walls of the annular arc passage, it is apparent that due to the constricted nature of such passage an arc drawn between the fixed contacts 26 and the moving contact 28 will intimately contact the passage walls so as to produce considerable quantities of arc extinguishing gas. Inasmuch as the upper end of the arc extinguishing structure is completely closed by the cylindrical cap member 20, the only escape for the gas from the arc passage is through the annular opening 52. It will be observed that in passing through this opening the gas must flow over the upper surface of the tubular moving contact 28, and in so doing must pass through the arc stream. The flow of gas directed in this manner greatly facilitates arc extinction. The improved performance of the interrupter occasioned by the use of gas evolving material in the construction of the tubular member 14 and the plunger member 44 may be further explained as follows. The blast of gas generated by the heat of the arc upon the members of insulating material is projected more violently upon a section of the arc extending across the annular exhaust opening 52 and thus tends to destroy the continuity of the arc at that point. As long as a high degree of ionization persists in the arc stream, there is a strong tendency for the arc to maintain its continuity and the blast of gas will substantially completely flow around the arc and through the exhaust opening without appreciably deionizing the arc stream which is necessary to bring about arc extinction. It is only as the ionization decreases with decay of current as the arc current approaches zero that a gas blast can penetrate the arc stream and remove the ionized gas particles with sufficient rapidity to bring about arc extinction. The period during which arc extinction is normally made possible is necessarily short and corresponds to a very short time interval in the region of a current zero.

If the arc stream is caused to play against a refractory or non-gas forming surface and the blast of gas is caused to stream over the surface, greater difficulty is experienced in bringing about arc extinction than if the surface is composed of gas forming material.

The reason for this difference in performance may be explained as follows. In case of the non-gas forming surface a finite layer of gas of zero velocity is caused to form between the surface of the non-gas forming material and the moving stream of gas. This layer of immovable gas in the presence of an arc is highly ionized and tends to maintain the continuity of the arc until substantially a current zero. The time during which low ionization exists and during which the blast may penetrate the arc stream may, however, be so short that the arc stream is not sufficiently deionized to bring about arc extinction. If, on the other hand, the surface against which the arc plays is formed of gas producing material, the heat of the arc generates gas which sets up turbulence in the presence of a blast of gas streaming past the surface and thereby prevents the formation of an immovable layer of highly ionized gas adjacent to the surface. Thus the gas blast is permitted to penetrate the arc stream much earlier in the current cycle preceding a current zero and consequently permits a more rapid removal of the ionized particles from the arc stream.

I have also discovered that it is desirable to provide a housing 54 on the lower side of the base plate 10 for the purpose of providing a gas receiving chamber 56. The housing 54 also serves the purpose of protecting the moving contacts 28 on the bridging member 30 as well as any other parts of the operating mechanism which may be housed therein. The gas which is discharged through the tubular contacts 28 is thus collected within the chamber 56 where it is cooled and deionized prior to its escape to the atmosphere through a suitable escape valve 58. Thus the hot or partially ionized gases are

prevented from being discharged adjacent the line terminals which may otherwise produce flashover and breakdown of the insulating surfaces of the interrupter.

I have also discovered that somewhat improved results can be obtained by using a plunger 60 as shown in Fig. 6, having circumferential grooves or channels 62 therein instead of the smooth faced plunger 44 previously described. The improved operation is believed to be achieved in that the groves or channels 62 provide a storage space for gas during the high values of instantaneous current under which condition the pressures in the arc passage are at a maximum. As the instantaneous value of arc current approaches zero, the pressure in the arc passage decreases, thereby allowing the gas stored within the channels 62 to flow into the arc passage through the arc stream and to be expelled through the tubular contact 28. In other words, the channels 62 act as a storage reservoir for the storage of gas at time intervals when large quantities of gas are generated and provides means for delivery of gas through the arc stream as the arc current approaches zero, at which time a larger flow of gas is needed to completely deionize the arc stream.

I have also discovered that somewhat improved results may be obtained by providing pockets or grooves along the outside walls of the arc passage by means of a structure as shown in Fig. 4. In the arrangement shown in Fig. 4, the tubular member 14 has been replaced by a structure comprising a plurality of plates 64 having alined openings therethrough of slightly larger diameter than the outside diameter of the tubular contact 28. The plates 64 are preferably held in spaced relation with respect to each other by annular spacing members 66, and are clamped between two end plate members 68 and 70. The upper plate member 70 supports the cylindrical cap member 20, fixed contacts 26 and annular arcing plate 40, and a radial field coil 38 of construction similar to that described in connection with Fig. 1.

From the illustration in Fig. 4, it is apparent that the spacing members 66 between the plates 64 provide annular pockets or storage chambers 72 adjacent the arc passage. The improved results obtained with the arrangement shown in Fig. 4 is attributed to the greater gas storage capacity of the chamber 72, and also due to the fact that the plates 64 present considerable surface area to the gas stored therebetween, thereby cooling the gas to a considerable extent. This cooling effect is beneficial in producing a more rapid deionization of the arc stream.

I have also discovered that the gases may be cooled by use of annular metallic plates preferably of copper disposed in the chambers 72 between spacing members 74 as shown. More effective arc extinction may, however, be obtained by the use of a larger number of plates of gas evolving insulating material adjacent the arc passage as shown in Fig. 5. In this instance, the structure is essentially the same as shown in Fig. 4, except that the plates 64 of the former figure have been replaced by plates 76 having considerable less thickness than the plates 64 and somewhat less separation. The improved performance is attributed to the fact that the gases generated by the arc playing on the adjacent portions of insulating material are at a relatively high temperature. When these hot gases enter the spaces between the relatively cool plates 76, more gas is generated by the action of the hot gases on these plates. The net result is the formation of a larger quantity of relatively cooler gas since the process of decomposition removes heat from the gases first generated by the direct action of the arc. It will, of course, be understood that either of the structures shown in Fig. 4 or Fig. 5 may utilize a filling in member or plunger 60 having circumferentially disposed grooves 62 as shown in Fig. 6, with all the attending advantages of such a plunger.

It will also be understood that either the plunger 44 or the plunger 60 may be provided with an iron core 78 as specifically illustrated in Fig. 7. The use of an iron core 78 in the plunger strengthens the radial magnetic field set up by the coil 38 so as to obtain more positive rotation of the arc about the annular arc passage.

The principles of my invention may also be applied to a structure of the type illustrated in Fig. 8. As shown in this figure, the arc passage of the interrupting unit is formed by a plurality of plates 80 of insulating material having alined openings therethrough of diameter slightly greater than the outside diameter of the tubular movable contact 28. The plates 80 are held in spaced relation with respect to each other by means of annular spacing members 82. The entire assembly is clamped between upper and lower end plates 84 and 86, respectively. Instead of employing a movable plunger or filling member, a fixed filling member 88 of insulating material is suspended from the upper plate 84. The filling member 88 has an outside diameter which is substantially equal to the inside diameter of the tubular contact 28. The tubular contact 28 in this instance engages a fixed contact 90 disposed between the upper plate 84 and an annular arcing plate 92. A radial field coil 94 is also employed having its respective ends connected between the upper plate 84 and the arcing plate 92. In this instance, escape of the gas from the arc passage resulting from drawing an arc within the space between the plates 80 and the filling member 88 is provided by a plurality of vent openings 96 extending radially through an annular plate 98 adjacent the arcing plate 92. The plate immediately below the venting plate 98 shown at 100, is of considerably greater thickness than the plates 80 for the purpose of increasing the mechanical strength of the structure in order to enable the structure to withstand the pressure created within the arc passage. The upper portion of the plate 100 is so beveled as to provide an unimpeded flow of gas to the vent openings 96.

It will be observed that as the arc is drawn into the narrow arc passage formed between the side walls of the apertures in plates 80 and the filling member 88, a considerable quantity of gas is generated which is stored in the spaces between the plates 80 during the high values of instantaneous arc current. At or near current zero, when pressure in the arc passage has been materially lowered, the flow of gas is reversed and passes into the arc passage through the arc stream and finally through the vent openings 96.

Although I have shown the filling member 88 as comprising insulating material throughout, it will be understood that an iron core may also be used therein similar to the core 78 as shown in Fig. 7 for the purpose of strengthening the radial magnetic field across the annular arc passage. It will also be understood that the specific description and illustrations of the various em-

bodiments of my invention are merely 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 circuit interrupter, means of insulating material defining an arc chamber, a pair of contacts at least one of which is movable and has a passage therethrough, means for actuating said contacts to the open position for establishing an arc within said chamber, and means at least partially of insulating material normally outside of said arc chamber and movable into said chamber during the circuit opening operation for restricting the cross section thereof, the walls of said chamber producing a gas when acted upon by an arc, said means movable into said chamber substantially closing one end of said chamber for causing said gas to be expelled from said chamber through the arc path and through the passage in said one contact.

2. In a circuit interrupter, means of insulating material defining an arc chamber, a pair of contacts at least one of which is movable and has a passage therethrough, means for actuating said contacts to the open position for establishing an arc within said chamber, and a plunger at least partially of insulating material movable with said one contact into said arc chamber to restrict the cross section of the same during the circuit opening operation, said plunger substantially closing one end of said arc chamber but providing a free passage for the expulsion of the products of decomposition of said arc from said arc chamber through the arc path and said passage in said one contact.

3. In a circuit interrupter, means of insulating material defining an arc chamber open at both ends, a gas receiving chamber communicating with one end of said arc chamber, a fixed contact at the other end of said arc chamber, a cooperating tubular contact normally substantially filling said arc chamber, means for moving said tubular contact to establish an arc within said arc chamber, and a plunger movable with said tubular contact into said arc chamber, said plunger substantially closing said other end of said arc chamber to cause gas produced by said arc to be expelled from the arc chamber through said tubular contact into the gas receiving chamber.

4. In a circuit interrupter, means of insulating material defining an arc chamber open at both ends, a gas receiving chamber communicating with one end of said arc chamber, a fixed contact at the other end of said arc chamber, a cooperating tubular contact normally substantially filling said arc chamber, operating means within said gas receiving chamber for actuating said tubular contact to establish an arc within said arc chamber, and a plunger adapted to be moved into said arc chamber in response to movement of said tubular contact, said plunger substantially closing said other end of said arc chamber to cause gas produced by said arc to be expelled from the arc chamber through said tubular contact into the gas receiving chamber.

5. In a circuit interrupter, means of insulating material defining an arc passage, means for establishing an arc within said passage, filling means at least partially of insulating material normally outside of said passage and movable into said passage upon the establishment of said arc, and means for rotating said arc in the space between the walls of said passage and said movable filling means.

6. In a circuit interrupter, means of insulating material defining a cylindrical arc passage, means for establishing an arc within said passage, a cylindrical plunger at least partially of insulating material movable into said arc passage upon the establishment of said arc to provide an annular arc path, and means for setting up a radial magnetic field across said annular arc path for rotating the arc therearound.

7. In a circuit interrupter, means of insulating material defining a cylindrical arc chamber open at least at one end, a fixed contact adjacent one end of said chamber, a cooperating tubular contact normally substantially filling said chamber and movable through the open end thereof, means for operating said tubular contact to the open position to establish an arc within said chamber, a plunger at least partially of insulating material movable with said tubular contact into said arc chamber to provide a generally annular arc path, and means for rotating the arc around said arc path, said plunger causing the gas produced by the action of the arc to be expelled from said arc chamber through said tubular contact.

8. In a circuit interrupter, means of insulating material defining a cylindrical arc chamber open at least at one end, a fixed contact adjacent one end of said chamber, a cooperating tubular contact normally substantially filling said chamber and movable through the open end thereof, means for operating said tubular contact to the open position to establish an arc within said chamber, a plunger at least partially of insulating material movable with said tubular contact into said arc chamber to provide a generally annular arc path, and means for rotating the arc around said arc path, and a gas receiving chamber adjacent the open end of said arc chamber and into which said tubular contact is movable, said plunger causing the gas produced by the action of the arc to be expelled from said arc chamber through said tubular contact into said gas receiving chamber.

9. In a circuit interrupter for alternating current, means of insulating material defining an arc passage, means for establishing an arc within said passage, at least a portion of the walls of said passage producing a gas when acted upon by an arc to aid in extinguishing the arc, and a plunger at least partially of insulating material movable into said passage upon the establishment of said arc, said plunger having a plurality of recesses for the storage of gas during high values of instantaneous current in the cycle, said gas stored in said recesses being discharged into the arc stream as the current passes through zero.

10. In a circuit interrupter for alternating current, means of insulating material defining an arc passage, a fixed contact adjacent one end of said arc passage, a cooperating tubular contact normally substantially filling said arc passage, means for moving said tubular contact through said passage to establish an arc therein, and a grooved plunger at least partially of insulating material movable with said tubular contact into said arc passage, the walls of said arc passage and said plunger producing a gas when acted upon by said arc, said plunger being spaced from one end of said tubular contact to cause said gas to be expelled from said arc passage through the arc stream and through said tubular contact.

11. In a circuit interrupter, means of insulat-

ing material defining a cylindrical arc passage, means for establishing an arc within said passage, a cylindrical plunger at least partially of insulating material movable into said arc passage upon the establishment of said arc to provide an annular arc path, and means for setting up a radial magnetic field across said annular arc path for rotating the arc therearound, said plunger having a core of magnetic material for producing a more uniform distribution of magnetic flux across said annular arc path.

12. In a circuit interrupter, means of insulating material defining a cylindrical arc chamber, a fixed contact adjacent one end of said chamber, a movable contact cooperating with said fixed contact and movable through said arc chamber to establish an arc therein, a grooved cylindrical plunger at least partially of insulating material movable into said arc chamber upon the formation of an arc therein to provide a generally annular arc path, and means for setting up a radial magnetic field across said arc path for rotating the arc therearound, said plunger having a core of magnetic material for producing a more uniform distribution of magnetic flux across said annular arc path.

13. In a circuit interrupter, an arc extinguishing device including means of insulating material having an opening therethrough, means for establishing an arc within said opening, a filling member of insulating material movable into said opening to restrict the cross section thereof, and a plurality of pockets positioned along said opening for receiving gas produced by the action of said arc upon said insulating material, said pockets being of sufficient depth so that at least a relatively large portion of said gas is stored in said pockets during the high values of instantaneous current and expelled through the arc stream as the arc current passes through zero.

14. In a circuit interrupter, an arc extinguishing device including a plurality of plates of insulating material having aligned openings therethrough to define an arc passage, said plates being spaced from each other to provide pockets along said passage, said pockets being closed on all sides except the side leading to said passage, means for establishing an arc within said passage, and a plunger at least partially of insulating material normally outside said passage movable into said passage upon the formation of said arc, said plates and said plunger producing a gas when acted upon by an arc, and said pockets being relatively deep so that a relatively large quantity of gas is stored in said pockets during the high values of instantaneous arc current and discharged through the arc stream as the arc current passes through zero.

15. In a circuit interrupter, an arc extinguishing device including a plurality of plates of insulating material having aligned openings therethrough to define an arc passage, said plates being spaced from each other to provide pockets along said passage, said pockets being closed on all sides except the side leading to said passage, a fixed contact adjacent one end of said passage, a cooperating tubular contact normally substantially filling said arc passage, means for moving said tubular contact through said passage to establish an arc therein, and a filling member at least partially of insulating material movable with said tubular contact into said arc passage, said plates producing a gas when acted upon by an arc, which gas is retained in said pockets during predetermined pressure conditions in said arc passage and expelled into the arc passage in accordance with the pressure conditions therein, said filling member causing the gas to flow from said passage through the arc stream and through said tubular contact.

16. In a circuit interrupter, an arc extinguishing device including a plurality of plates of insulating material having openings therethrough to provide an arc passage, means spacing said plates from each other to provide gas receiving chambers along said arc passage, means for establishing an arc within said passage, said plates of insulating material producing a gas when acted upon by an arc, at least a portion of said gas being stored in said gas receiving chambers during high values of instantaneous arc current, said gas being returned to said arc passage when the arc current passes through zero, means disposed within said gas receiving chambers for cooling the gas therein, and means movable into said arc passage for directing said gas through the arc stream when it is expelled from said passage.

17. In a circuit interrupter, an arc extinguishing device including a plurality of plates of insulating material having openings therethrough to provide an arc passage, means spacing said plates from each other to provide gas receiving chambers along said arc passage, a fixed contact adjacent one end of said arc passage, a cooperating tubular contact normally within said arc passage and movable therethrough to establish an arc therein, said plates of insulating material producing a gas when acted upon by an arc, at least a portion of said gas being stored in said gas receiving chambers during predetermined pressure conditions within said arc passage and returnable to said arc passage during other predetermined pressure conditions in said passage, plates of metallic material disposed in said gas receiving chambers for cooling the gas therein, and a plunger movable with said tubuluar contact into said arc passage for causing gas to be expelled from said passage through the arc stream and said tubular contact.

18. In a circuit interrupter, an arc extinguishing device including means of insulating material having an opening therethrough, means for establishing an arc within said opening, a filling member of insulating material movable into said opening to restrict the cross section thereof and to provide a generally annular arc path, means for moving the arc around said annular path, and a plurality of recesses positioned along said opening for receiving gas produced by the action of said arc upon said insulating material, at least a portion of said gas being collected in said recesses and expelled through the arc stream in accordance with predetermined pressure conditions in said opening.

19. In a circuit interrupter, an arc extinguishing device including a plurality of plates of insulating material having openings therethrough to provide an arc passage, a fixed contact adjacent one end of said arc passage, a cooperating tubular contact normally substantially filling said arc passage and movable therethrough to establish an arc therein, a plunger movable into said arc passage upon the formation of an arc therein to provide a narrow generally annular arc path, and means for setting up a radial magnetic field across said annular arc path for rotating the arc therearound.

20. In a circuit interrupter, an arc extinguishing device including means of insulating mate-

rial having an opening therethrough, a filling member at least partially of insulating material extending into said opening to provide a narrow generally annular arc passage, a fixed contact adjacent one end of said arc passage, a cooperating tubular contact normally surrounding said filling member and substantially filling said annular arc passage, means for moving said tubular contact to establish an arc within said arc passage, said means of insulating material having a plurality of recesses positioned along said opening for receiving gas produced by the action of said arc upon said insulating material and venting means disposed to cause gas produced by the action of the arc upon said means of insulating material and said filling member to be expelled from said recesses and said arc passage through the arc stream in a direction opposite to the opening movement of said tubular contact.

21. In a circuit interrupter, an arc extinguishing device including a plurality of plates of insulating material having openings therethrough, a filling member at least partially of insulating material extending into said openings to provide a narrow generally annular arc passage, a fixed contact adjacent one end of said arc passage, a cooperating tubular contact normally surrounding said filling member and substantially filling said annular arc passage, means for moving said tubular contact to establish an arc within said arc passage, means for rotating the arc around said annular arc passage, and means spacing said plates from each other to provide a plurality of chambers along said arc passage for receiving gas produced by the action of said arc upon said plates and said filling member, at least a portion of said gas being collected in said chambers and expelled through the arc stream in accordance with predetermined pressure conditions in said arc passage.

22. In a circuit interrupter, an arc extinguishing device including a plurality of plates of gas-evolving material having aligned openings therethrough to define an arc passage, said plates being spaced from each other to provide deep pockets along said passage, said pockets being closed on all sides except the side leading to said passage, means for establishing an arc within said passage, and a plunger at least partially of insulating material normally outside said passage movable into said passage upon the formation of said arc, said plates and said plunger producing an arc extinguishing gas when acted upon by the arc, at least a considerable portion of said gas produced during the high values of instantaneous arc current filling said pockets and reacting upon said plates to produce an additional quantity of arc extinguishing gas, a substantial portion of said gas thus produced being discharged through the arc stream as the arc current passes through zero.

23. In an alternating-current circuit interrupter of the gas blast type, means at least partially of insulating material for defining the arc passage in which an arc is adapted to play, said passage having a plurality of deep recesses therealong, the walls of said passage including said recesses having gas evolving surfaces, the portions of said arc passage between adjacent recesses evolving an arc extinguishing gas when acted upon by an arc, the walls of said recesses providing storage and cooling spaces for said gas and an additional gas generating source during the peak of the current wave, said recesses being so disposed with respect to said arc passage that at the time of low pressure near current zero in said passage at least a portion of the gas stored, generated and cooled in said recesses will flow through the said arc passage.

24. In a circuit interrupter, means at least partially of insulating material defining an arc chamber having an exhaust opening, arcing means in said chamber for establishing a section of arc which is adapted to play opposite said opening and another section of arc being more confined for generating arc pressure in said chamber for causing a blast of gas through said exhaust opening and said first section of arc, and chamber means within said arc chamber and extended beyond the arc path for the flow of arc gases therein out of the arc path, and cooling means in said chamber means including material adapted to emit an arc extinguishing gas when subjected to the arc heat and the hot gases from said more confined section of arc.

25. In a circuit interrupter, means at least partially of insulating material defining an arc chamber having an exhaust opening, contact means for establishing an arc within said chamber, one section of said arc being located substantially opposite said exhaust opening so that gas in exhausting from said chamber is confined to a high velocity path directly traversing said arc, another section of arc being more remotely located in said chamber for generating pressure, and cooling structure within said chamber including a plurality of spaced plate members between which the hot arc gases from said remotely positioned arc section are adapted to flow to a position between said plates out of the path of said arc, said plate members presenting a large cooling surface to said gas and being in part composed of a material which emits an arc-extinguishing gas when subjected to the heat of the arc and the arc gases.

26. In a circuit interrupter, means at least partially of insulating material defining an arc chamber having an exhaust opening, means for establishing an arc in said chamber, cooling structure along the path of said arc within said chamber into which the arc gases are adapted to flow, said cooling structure extending beyond the path of said arc and including material which emits arc-extinguishing gas when acted upon by the heat of the arc and arc gases, and means movable along the arc path for directing the arc-extinguishing gas through the arc stream and said exhaust opening.

27. In a circuit interrupter, means at least partially of insulating material defining an arc chamber having an exhaust opening, arcing means in said chamber for establishing a section of arc which is adapted to play opposite said opening and another section of arc being more confined for generating arc pressure in said chamber for causing a blast of gas through said exhaust opening and said first section of arc, and chamber means within said arc chamber and extended beyond the arc path for the flow of arc gases therein out of the arc path, and cooling means in said chamber means including material adapted to emit an arc extinguishing gas when subjected to the arc heat and the hot gases from said more confined section of arc, and metallic cooling means.

HERBERT L. RAWLINS.