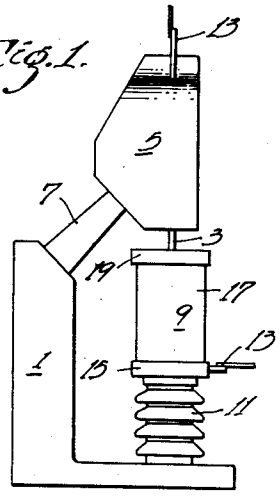
Oct. 12, 1937. H. BEIERSDORF 2,095,729

CIRCUIT INTERRUPTER

Filed March 8, 1935 2 Sheets-Sheet 1

Fig. 1.



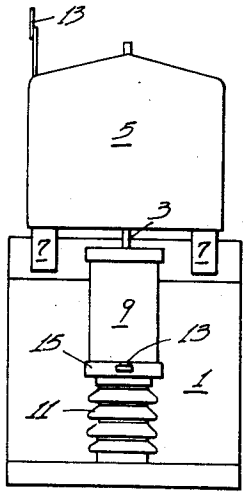


Fig. 2.

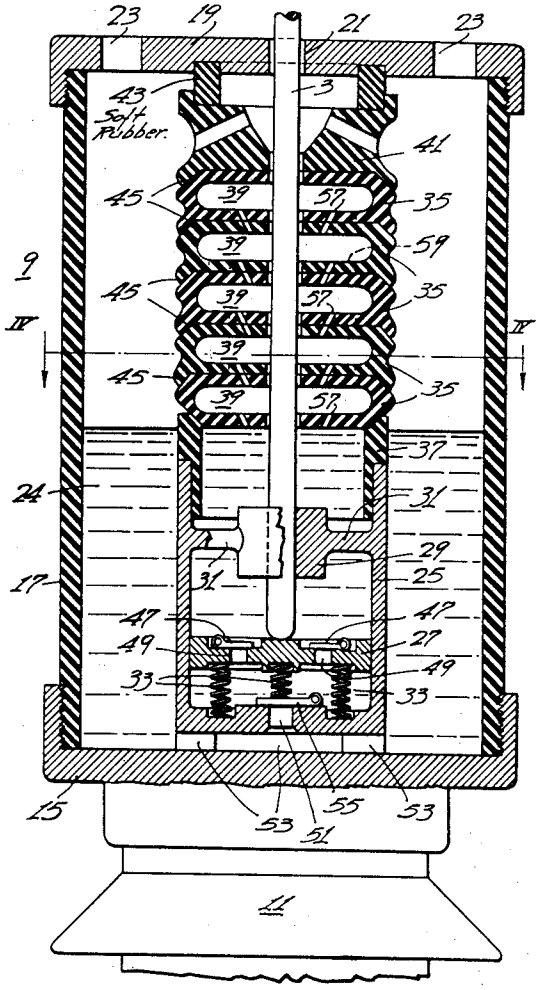


Fig. 3.

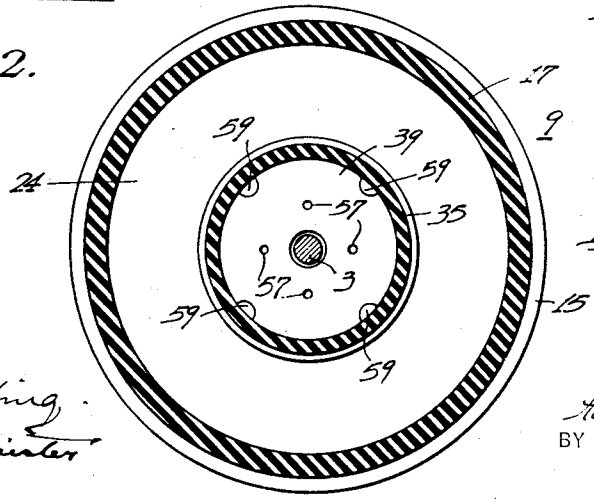


Fig. 4.

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CIRCUIT INTERRUPTER

Filed March 8, 1935 2 Sheets-Sheet 2

Fig. 5.

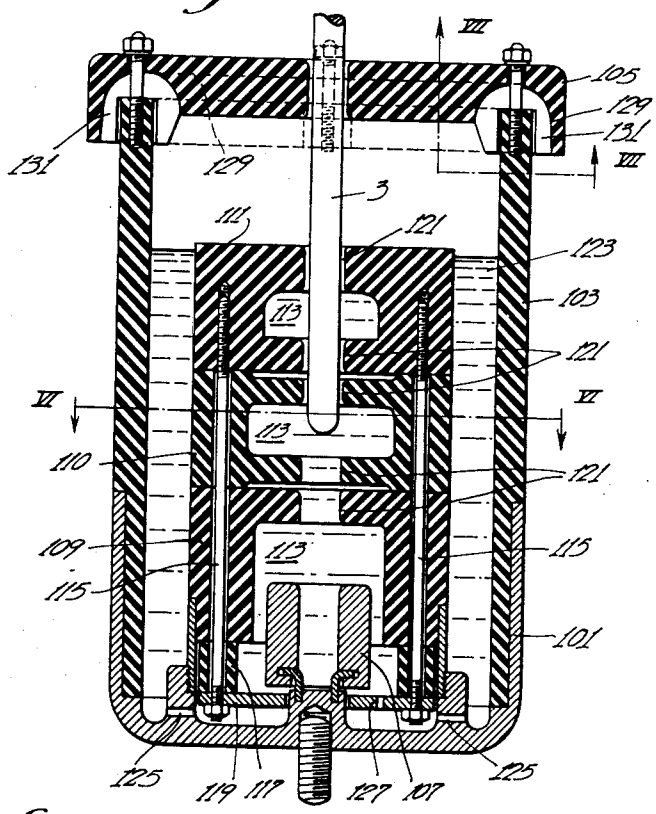


Fig. 6.

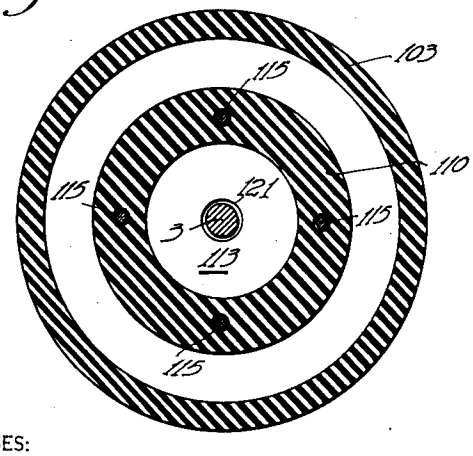
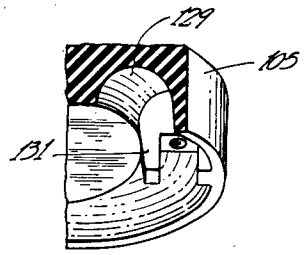


Fig. 7.



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2,095,729

CIRCUIT INTERRUPTER

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Application March 8, 1935, Serial No. 9,980
In Germany March 22, 1934

7 Claims. (Cl. 200—150)

My invention relates to circuit interrupters and particularly to high capacity circuit breakers which utilize arc extinguishing structures of the expansion type.

It is well known in the art that the extinction of alternating current arcs may best be effected during the occurrence of a zero point in the current wave. In fact, the interruption of a power circuit at a time other than the zero point in the current wave is apt to produce very undesirable transient surges, which may cause serious damage to other equipment connected into the circuit being interrupted.

The expansion type arc extinguisher is particularly designed to effect the extinction of arcs at the zero point in the current wave. Devices of this type depend for their operation upon the fact that an unionized molecule or atom is capable of attracting electrons or charged particles of matter thereto, and that it is much more difficult to reionize an arc stream which contains comparatively few electrons per unit volume than it is to reionize one which contains a large number of electrons per unit volume, the theoretical explanation of these experimentally proven facts being that reionization is usually brought about by the collision of electrons and molecules, and that the voltage necessary to impart sufficient velocity to an ion in order to bring about ionization by collision is much higher than for electrons. The expansion principle of arc extinction consists, therefore, in the provision of means whereby the arc stream may be surrounded, and turbulently intermixed with a large quantity of unionized gas or fluid during the period of circuit interruption, this large amount of unionized fluid causing the free electrons in the arc stream, at the time of a zero point in the current wave, to attach themselves to a molecule or atom and thereby become sufficiently immobile to prevent reionization by collision as the voltage restores itself on the circuit.

It has been found that the most effective means for producing this combination of free electrons with molecules or atoms consists in the turbulent intermingling of the arc stream with a quantity of arc extinguishing fluid in the vapor state, this state yielding the largest possible number of unionized molecules or atoms per unit volume with maximum mobility of those molecules. In one form of expansion arc extinguisher, the arc is drawn within a closed pressure chamber, the walls of which are formed by a stack of superposed contiguous laminations. A quantity of an arc extinguishing liquid which is capable of being vaporized, without breaking down into its constituent elements or compounds, is disposed within this pressure chamber, and the device is so arranged that the gas evolved by the arc from the liquid is allowed to expand adiabatically during the progress of the circuit opening operation. Since all of the heat imparted to the gas came from the arc and exists in the gas in the form of pressure energy, the free expansion of that gas during the arc extinguishing operation will cause it to condense and thus surround the arc stream with a quantity of arc extinguishing gas in the vapor state.

In the operation of these devices in the past, it has been found difficult to cause the expansion to persist over a sufficiently long period of time to assure that the arc stream shall be surrounded by arc extinguishing fluid in vapor state during at least one zero point in the current wave, and the primary object of the present invention is to provide means for overcoming this difficulty and thereby assuring satisfactory operation of the device under substantially all conditions.

A further object of the invention is to so design the laminations which are used in building up an arc extinguishing structure of the type discussed above that storage reservoirs shall be provided for the gas which is evolved from the arc extinguishing liquid or other source of arc extinguishing gas during the operation of the device.

Another object of the invention is to provide means for simplifying the structure of an expansion chamber, the walls of which are defined by a stack of separable, contiguous laminations, by providing means integral with the separable laminations for causing those laminations to automatically realign themselves following each operation of the breaker, and a still further object of the invention is to generally simplify and improve the structure of expansion type arc extinguishers in order to decrease the cost of manufacturing those devices and to improve their operation.

In carrying out these objects of my invention, I provide an expansion type of arc extinguishing structure which comprises a plurality of superposed, contiguous laminations for defining the walls of an arc passage, means for establishing the arc incident to the opening of the associated interrupter within that passage, and means for so supporting the laminations that they are separable upon the development of sufficient pressure within the arc passage to permit a free expansion of the arc extinguishing gas evolved

therein. The laminations differ from those used in the prior art structures in that they take the form of casings having secondary pressure chambers formed therein, these secondary pressure chambers serving as storage spaces for the gas evolved during the operation of the device, and the various elements of the interrupter are so correlated, with regard to these pressure chambers, that an adequate supply of arc extinguishing fluid in the vapor state is made available during at least one current zero point. In one form of the invention, the laminations engage each other with cooperating conical seats in order that they shall automatically realign themselves following each venting operation. Two specific embodiments of my invention are illustrated in the accompanying drawings, wherein

Figure 1 is a side elevational view of a circuit breaker utilizing an arc extinguishing structure constructed according to the invention;

Fig. 2 is a front elevation view of the circuit breaker shown in Fig. 1.

Fig. 3 is an enlarged sectional view through the expansion type arc extinguisher forming a part of the breaker illustrated in Figs. 1 and 2.

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

Fig. 5 is a sectional view, similar to Fig. 3, of a modified form of my invention suitable for use with the breaker shown in Figs. 1 and 2.

Fig. 6 is a sectional view on the line VI—VI of Fig. 5, and

Fig. 7 is a fragmentary, perspective view showing the details of the mounting means for the cover of the arc extinguisher shown in Fig. 5.

Referring particularly to Figs. 1 and 2, the circuit interrupter therein illustrated comprises an L-shaped base 1, a movable contact 3, an operating mechanism 5 therefor, which is mounted on the base 1 by means of a pair of insulators 7, an arc extinguishing structure 9 for cooperating with the movable contact 3, and a third insulator column 11 for supporting the arc extinguishing structure 9 on the base 1. The interrupter is provided with a pair of suitable terminals 13 for connecting it into an electrical circuit.

The movable contact 3 in this embodiment of my invention comprises a cylindrical rod member which is adapted to move through the arc extinguishing device 9 when opening and closing the circuit. The operating mechanism 5 for this contact rod is not an important part of the present invention, and any of the mechanisms which are already known in the art may be employed.

The arc extinguishing device 9 includes a base member 15 of metallic material which is engaged by a hollow cylindrical casing 17 forming the outer wall of the arc extinguishing device. The upper end of this casing 17 is closed by a cap member 19 which is provided with a suitable opening 21 for permitting the passage of the contact rod 3 therethrough and with vent openings 23 for preventing the development of unduly large pressures within the casing itself during the operation of the arc extinguisher. A quantity of arc extinguishing liquid 24 is normally contained within the casing 17.

The stationary contact means for cooperating with the movable contact rod 3 includes a hollow cylindrical member 25 which is rigidly supported upon the base 15 of the arc extinguisher, a piston member 27 movable within this cylindrical means, and a tubular guide 29 for the movable contact rod, this guide being supported adjacent the upper end of the hollow cylindrical member 25 by suitable arms 31. The piston member 27 comprises the main current carrying contact, and it is biased in the direction of the contact rod 3 by four equally spaced springs 33. This member 27 also serves as a means for causing the introduction of a quantity of the arc extinguishing liquid 24 into the upper portions of the arc passage during each operation of the device, as will be explained in detail later.

As mentioned previously, the arc extinguishing structure proper comprises a pressure chamber having an arc passage, through which the contact rod 3 moves, extending therethrough. The walls of the upper portion of the arc chamber are defined by a plurality of superposed contiguous laminations 35, which are positioned immediately above the hollow cylindrical member 25, an insulating support member 37 being interposed between the lowest lamination 35 and the upper end of the hollow cylindrical member. Each of the laminations 35 is formed from molded insulated material, or some other suitable substance, and comprises generally an annular casing which is hollowed out so as to define a secondary pressure chamber 39 therein, this chamber opening only into the main arc passage. The upper lamination is held in place by a suitable molded member 41 which engages the cap member 19 through an annular member 43 formed of rubber or other resilient material. This resilient member 43 serves to permanently bias the laminations 35 toward each other, while, at the same time, permitting those laminations to separate a definite amount upon the production of sufficient pressure within the arc chamber in order to form vent openings in the walls thereof.

The superposed laminations 35 engage each other with cooperating conical seats 45 formed integral therein. This arrangement allows the free separation of the laminations 35 during each venting operation, while, at the same time, it makes the stack self-centering assuring a proper realignment of the laminations when the pressure within the arc passage has been reduced to its normal value.

The portion of the arc passage which is defined by the superposed laminations 35 is located entirely above the normal level of the body of arc extinguishing liquid 24 which is contained within the main casing 17. In order to assure a rapid evolution of gas during each arc extinguishing operation, it is desirable to introduce a predetermined quantity of this liquid into the upper portion of the arc chamber, and, as mentioned above, the movable contact 27 is employed for this purpose. This contact 27 moves as a piston within the hollow cylindrical member 25, and is provided with a pair of flap valves 47 normally biased to the position shown in Fig. 3, these valves serving to cover openings 49 extending through the piston contact member 25.

The lower end of the hollow cylindrical member 27 is provided with a centrally disposed opening 51 and four passages 53 connecting therewith, in order to permit the entry of the arc extinguishing liquid into the arc chamber. The central opening 51 is normally closed by a flap valve 55 as is shown in Fig. 3. It is apparent from an inspection of the valve and piston arrangement that the upward movement of the contact rod 3 will allow the piston contact 27 to move upwardly, under the biasing action of the springs 33, and will thereby cause a predetermined quantity of the arc extinguishing liquid to be moved up into

the arc chamber, the amount of this liquid being readily controllable by varying the stroke of the piston contact member 27. During each circuit closing operation, the valves 47 will lift and thus assure the refilling of the space above the piston 27.

In order to facilitate the movement of the arc extinguishing liquid into the upper portions of the pressure chamber wherein the arc is drawn, and to attain a better distribution of that liquid between the several secondary pressure chambers 39 formed within the laminations 35, small vent openings 57 are provided for interconnecting the secondary pressure chambers 39. These openings 57 are of such small diameter, however, that they do not effect any substantial venting of the pressure chambers 39.

The circuit breaker is shown in the closed circuit position in Figs. 1, 2, and 3. Upon the occurrence of an overload or other abnormal condition, the actuating mechanism 5 is operated to move the contact rod 3 upwardly toward the normal open circuit position. This movement takes place at a relatively high speed, and, due to the retardation effect on this piston member 27 which results from the quantity of liquid entrapped above that member, an arc is drawn almost immediately between the lower end of the contact rod 3 and the central portion of the movable piston 27 which comprises the cooperating fixed contact, (or if the piston 27 should follow the upward moving contact, between that member and the guide 29).

Very shortly thereafter, this arc is drawn into that portion of the pressure chamber which is defined by the laminations 35, and simultaneously with the drawing of the arc into the upper portions of the pressure chamber, a predetermined, measured quantity of the arc extinguishing liquid 24 is moved therein by the upwardly moving piston. The heat of the arc volatilizes a considerable portion of this arc extinguishing liquid, and the secondary pressure chambers 39 provide storage spaces for containing this gas as it is evolved.

By the time the first zero point of the current wave has been reached, or if the arc current should be low by the time the second zero point in the current wave is reached, the pressure of this gas which is entrapped within the arc passage will ordinarily reach a sufficently large value to cause the laminations 35 to separate and form vent openings in the side walls of the pressure chamber through which the arc passage extends. The gas stored in the secondary pressure chambers, when venting, will flow longitudinally through the arc at high speed, and since the expansion is substantially adiabatic, this gas will return to the vapor state as it expands. The immediate result will be to effect either a removal of the electrons and ions from the arc stream, or the combination of the free electrons with previously uncharged molecules at such a rapid rate that reignition of the arc following the occurrence of the zero point becomes impossible. The secondary pressure chambers 39 provide a sufficient volume of gas so as to continue the expansion operation over a sufficiently long period of time to assure the inclusion of one zero point in the current wave. The greatly increased volume of the chamber or passage wherein the arc is drawn which results from these secondary pressure chambers also serves to aid in preventing the building up of excessive pressures within the arc extinguisher during the extinguishment of the very large current magnitude arcs, and thus adds considerable to the safety and reliability of operation of the breaker.

The provision of the cooperating conical seats 45 for the laminations 35 is of great value in simplifying the structure of the arc chamber, particularly through the elimination of any need for the provision of guide rods or the like for maintaining proper alignment of the laminations during the operation of the extinguisher. The amount of separation of the laminations 35 is definitely limited by the resilient member 43 to a value which is not in excess of the cooperating engagement of the seats 45. Thus, immediately upon the removal of the pressure from within the arc chamber, the resilient member 43 causes the wall defining laminations thereof to reengage each other, as shown in Fig. 3, the conical seats 45 assuring a proper realignment of these members. If the connecting vent openings 57 are used, it may be found desirable to utilize means such as the interengaging guide ribs 59 shown in Fig. 4 for preventing any displacement of the laminations in an angular direction.

For most efficient operation of the device, it is desirable to utilize an arc extinguishing liquid which is not broken down into any of its chemical constituents when exposed to an electric arc. It is possible, however, to utilize an arc extinguishing structure such as that previously described with decomposable fluids such as oil. If a fluid of this latter type is used, the extinguishing action resulting from the expansion of the gas from a heated to a vapor condition is lost. However, the extremely turbulent intermixing of the arc stream with the gases evolved from even decomposable arc extinguishing fluids which is brought about by the structure of my invention will effect the extinguishment of large current magnitude arcs with a greater degree of efficiency than the previously known devices.

The structure shown in Figs. 5, 6, and 7 is substantially similar in form and operation to the previously described arc extinguisher. It includes a base member 101, which may be bolted to an insulator column similar to the base member 15 in the previously described embodiment, a cylindrical casing 103 which defines the side walls of the main closure for the arc extinguishing structure, a cover 105 for the main closure, a stationary contact 107 affixed to the base 101, and three superposed laminations 109, 110, and 111 which define the arc chamber proper. Each of these laminations, as in the previously described structure, is provided with a secondary pressure chamber 113 formed integral therewith. The three laminations are maintained in proper alignment by means of four tie-rods 115 and are biased toward each other by means of an annular, resilient member 117 interposed between the lower lamination 109 and a thrust plate 119 which serve both to close the lower end of the chamber wherein the arc is drawn and to transmit the pull exerted by the tie-rods 115 to the resilient member 117.

Each of the laminations, as in the previously described embodiment, is preferably formed of molded insulated material and is substantially annular in outline. The secondary pressure chambers 113, one of which is formed in each of the laminations, are also substantially annular in outline and connect only with the central opening 121 which exists in each of the laminations for permitting the passage of the movable contact rod 3 therethrough. A quantity of arc extinguishing liquid 123 is contained within the

outer casing 103 and the level of this is maintained at a sufficiently high value to assure the complete filling of the chamber wherein the arc is drawn, at all times, suitable passageways 125 and 127 extending from the main body of arc extinguishing fluid into the arc chamber itself.

The movable contact rod 3 is exactly similar to the contact rod 3 previously described, and its operation may be effected by any suitable actuating mechanism.

The cover member 105 is so arranged that it provides vent passages leading from the inside of the outer casing to the atmosphere. These vent passages are formed through the provision of a groove 129 in the lower side of the cover member and suitable projections 131 extending downwardly into this groove for engaging the upper end of the cylindrical outer casing 103 so as to space the bottom of the groove above the top of the casing 103. A detail of the groove 129 and one of these downwardly projecting members 131 is shown in Fig. 7. This arrangement provides venting passages of large size while, at the same time, substantially preventing rain, snow, dirt or other foreign material from working into the interior of the arc extinguishing structure.

The operation of this modified form of my invention is very similar to the operation of the previously described embodiment. Upon the occurrence of an overload or other abnormal condition, the contact rod 3 is moved upwardly by the actuating mechanism and an arc is established within the arc passage extending through the pressure chamber. At least a portion of the arc extinguishing liquid 123 entrapped within this chamber is volatilized, and a certain amount of this vapor is stored within the secondary pressure chambers 113. When the internal pressure existing within the pressure chamber reaches a sufficiently high value, the wall defining laminations 109, 110, and 111 are separated against the biasing action of the resilient member 117 and the gases then existing within the arc chamber are allowed to vent through the annular openings thus created. The gases, in flowing outwardly from the secondary pressure chambers 113, intermix turbulently with the arc stream and effect a rapid extinction of the arc. If a non-decomposable arc extinguishing liquid is used, the arc extinguishing action is further aided by the presence of the arc extinguishing fluid in the vapor state.

In the foregoing, I have pointed out the structural details of a new and improved arc extinguishing device which is capable of much more efficient operation than the structures known to the prior art. While the invention is intended primarily as an improvement upon circuit interrupting devices which operate on the expansion principle, certain of the particular structural arrangements disclosed are suitable for use in arc extinguishing devices which do not employ that principle.

The improved arc extinguisher which I have disclosed utilizes an arc chamber of the pressure type, the walls of which are defined by a plurality of superposed, contiguous laminations. To overcome the difficulties experienced with prior art devices, each of these laminations is provided with a secondary pressure chamber formed therein, these secondary chambers opening only into the main arc chamber, and this arrangement is, perhaps, the most important single feature of the invention.

As a further means for improving structures of the type under consideration, I have shown how the separable plates of an arc extinguishing device may be so designed that they automatically reseat themselves following each operation. In addition, I have shown certain preferred structural arrangements of the various elements utilized in my improved arc extinguisher which have been found particularly desirable in carrying out the objects of my invention.

While, in accordance with the patent statutes, I have given the foregoing details of two preferred embodiments of my invention, it is to be understood that many of these details are merely illustrative and that variations in their precise form will be both desirable and necessary in some applications. I desire, therefore, that the language of the accompanying claims shall be accorded the broadest reasonable construction and that my invention shall be limited only by what is expressly stated therein and by the prior art.

I claim as my invention:

1. In a circuit interrupter, an arc extinguishing structure, including a plurality of superposed laminations which define the walls of an arc passage, means for so supporting said laminations that they are separable upon the occurrence of predetermined conditions to create vent openings in the walls of said arc passage, and means for establishing the arc incident to the opening of said interrupter within said arc passage, adjacent laminations having cooperating seat portions so shaped that said laminations automatically realign themselves with respect to the longitudinal axis of said arc passage following each separation thereof.

2. In a circuit interrupter, an arc extinguishing structure including a plurality of superposed, contiguous laminations, each of which has a centrally disposed opening therein, for defining the walls of an arc passage, resilient means normally biasing said laminations toward each other, means for so supporting said laminations that they are separable upon the occurrence of predetermined conditions to form vent openings in the walls of said arc passage, and means for establishing the arc incident to the opening of said interrupter within said arc passage, at least some of said laminations engaging each other with conical seats in order that said laminations shall automatically realign themselves following each venting operation.

3. In a circuit interrupter, an arc extinguishing structure including a plurality of superposed, contiguous annular members which define the walls of an arc passage, at least some of said annular members being of insulating material, means normally biasing said annular members toward each other, means for supporting said annular members about a common axis, said supporting means permitting said annular members to separate upon the occurrence of predetermined conditions to create vent openings in the walls of said arc passage, and means for establishing the arc incident to the opening of said interrupter within said arc passage, the engaging portions of adjacent members being so shaped that said laminations automatically realign themselves about said common axis following said each venting operation.

4. In a circuit interrupter, an arc extinguishing means including a plurality of superposed, contiguous laminations which define the walls of a substantially closed pressure chamber, resilient means for biasing said wall defining laminations toward each other, means for so supporting said

laminations that they are separable upon the occurrence of predetermined pressure conditions within said chamber to create vent openings in the walls of said chamber, means disposed within said chamber, at least during each circuit opening operation, which is capable of evolving an arc extinguishing gas when placed in proximity to an electric arc, and means for establishing the arc incident to the opening of said interrupter within said chamber, adjacent laminations having cooperating seat portions so shaped that said laminations automatically realign themselves under the biasing action of said biasing means following each venting operation.

5. In a circuit interrupter, an arc extinguishing means including a plurality of superposed, contiguous laminations which define the walls of a substantially closed pressure chamber, resilient means for biasing said wall defining laminations toward each other, means for so supporting said laminations that they are separable upon the occurrence of predetermined pressure conditions within said chamber to create vent openings in the walls of said chamber, means disposed within said chamber, at least during each circuit opening operation, which is capable of evolving an arc extinguishing gas when placed in proximity to an electric arc, and means for establishing the arc incident to the opening of said interrupter within said chamber, said laminations engaging each other with cooperating conical seats in order that said laminations may be automatically realigned by the biasing action of said biasing means following each venting operation.

6. In a circuit interrupter, an arc extinguishing structure including a plurality of superposed contiguous laminations which define the walls of a pressure chamber, resilient means normally biasing said laminations toward each other, means for so supporting said laminations that they are separable upon the occurrence of predetermined conditions to form vent openings in the walls of said pressure chamber, a body of arc extinguishing liquid, means for causing a predetermined quantity of said liquid to be entrapped within said pressure chamber during each circuit opening operation, and means for establishing the arc incident to the opening of said interrupter within said pressure chamber, at least some of said laminations engaging each other with cooperating conical seats in order that said laminations shall automatically realign themselves following each venting operation.

7. A circuit breaker comprising a casing, a body of arc extinguishing liquid contained therein, a plurality of separable plates of insulating material positioned above said liquid, yielding means for normally maintaining said plates in contiguous relation with respect to each other, each of said plates having an opening therethrough, said opening being aligned to define an arc passage, means for establishing an arc within said passage, and means incident to the establishing of said arc for moving some of said liquid into said passage, at least some of said plates having an annular pressure chamber surrounding the opening forming said arc passage, said yielding means being responsive to the pressure within said arc passage to enable said plates to separate to thereby provide a passage for the escape of gas from said pressure chamber through said arc passage, adjacent plates having cooperating seat portions so shaped to automatically realign said plates after each separation thereof.

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