Feb. 26, 1957 A. LATOUR 2,783,336

ARC EXTINGUISHING CHAMBER

Filed June 7, 1954 2 Sheets-Sheet 1

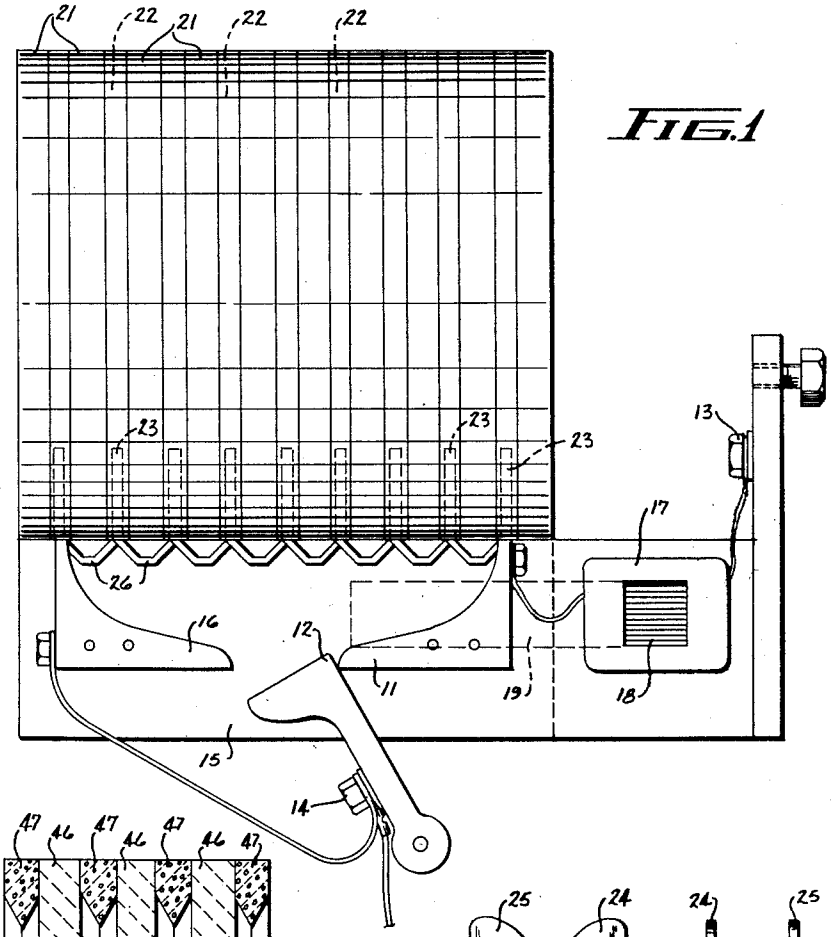


FIG. 1

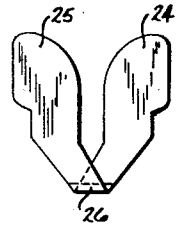


FIG. 2

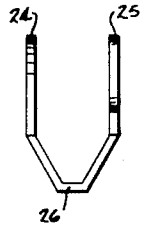


FIG. 3

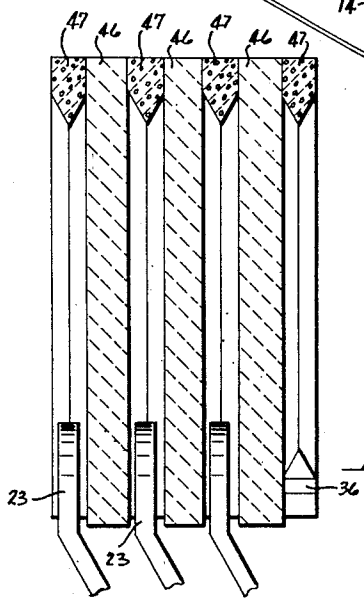


FIG. 7

INVENTOR.
ANDRÉ LATOUR
BY Heinrich Hochschild
ATTORNEY

Feb. 26, 1957 A. LATOUR 2,783,336

ARC EXTINGUISHING CHAMBER

Filed June 7, 1954 2 Sheets-Sheet 2

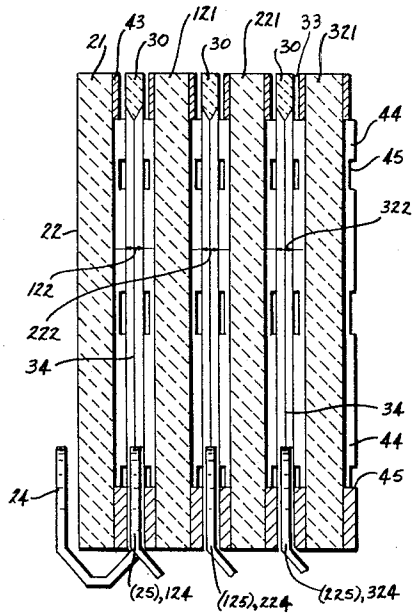


FIG. 4

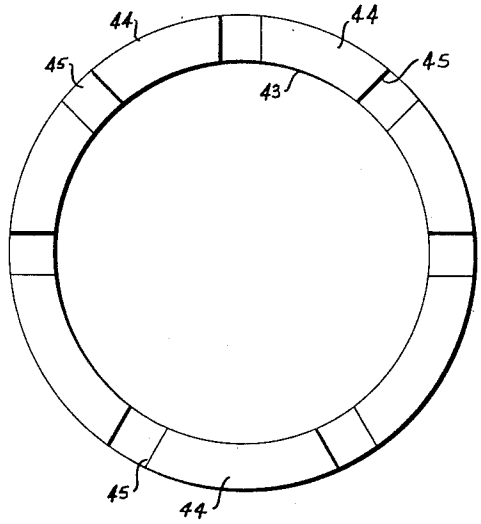


FIG. 6

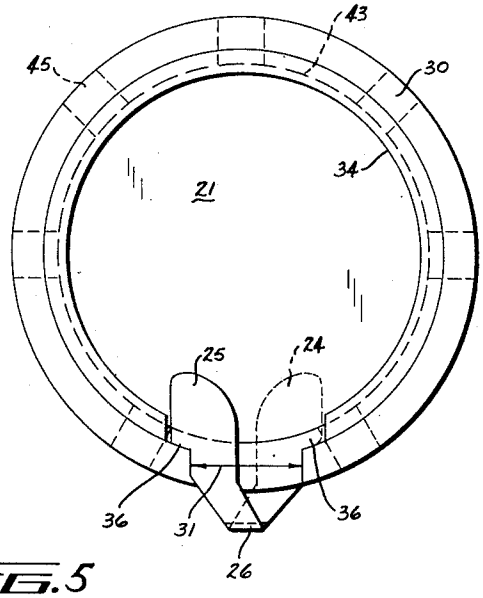


FIG. 5

INVENTOR.
ANDRÉ LATOUR
BY Heinrich Rothschild
ATTORNEY

United States Patent Office 2,783,336 Patented Feb. 26, 1957

2,783,336

ARC EXTINGUISHING CHAMBER

André Latour, Grenoble, France, assignor to Etablissements Merlin & Gerin, Grenoble, France

Application June 7, 1954, Serial No. 434,801

Claims priority, application France June 17, 1953

7 Claims. (Cl. 200—147)

The invention is concerned with a device for extinguishing an electrical arc to be drawn between separable contact members. More particularly the invention relates to a development of an arc extinguishing chamber of the type which comprises a set of at least two plates of refractory material partitioning the chamber into divisional chambers. The divisional chambers are provided with arc subdividing elements, each one shaped with a pair of legs, the legs diverging in V-form relatively to each other. The legs are comparatively short relatively to the height of the chamber. The conductive elements straddle with their legs the lower edges of the partitioning plates, the legs of opposite elements in each divisional chamber being disposed so as likewise to diverge in V-form relatively to each other. The arc thus is drawn as a whole or in sections into the space or spaces between the plates, is turned round into a position parallel to the plates and caused to form a peripherally expanding path within the space or spaces between the plates.

Arc extinguishing chambers of this type I have disclosed in my earlier U. S. Patent No. 2,668,890 and in my co-pending U. S. patent application Serial No. 360,299, now Patent No. 2,750,476 dated June 12, 1956, and patent application 360,300, now Patent No. 2,707,739, dated May 3, 1955, both filed on June 8, 1953.

It is a primary object of the invention to develop such an arc extinguishing chamber which is substantially closed around its perimeter except that there are provided an entrance opening for the conductive elements and, distributed around the circumference, restricted, gas permeable and arc attenuating passages out of the divisional chambers.

It is a further object of the invention to make use of the electrodynamic forces inherent to an electric arc for expanding within the chamber the arc, or within each one of the divisional chambers the arc sections to a nearly closed loop of a great arcus which, on further expansion will bear against the peripheral border member which encloses the divisional chamber.

In accordance with the invention, the peripheral border members, which like a frame enclose or border the divisional chambers or the interspaces between adjacent plates of refractory material, substantially close these interspaces with the following exceptions. Each border member is shaped with an entrance opening for extending therethrough the legs of the conductive elements into the divisional chambers. The border members are further formed with gas permeable, arc attenuating, restricted passages out of the divisional chambers and distributed around the perimeter of the divisional chambers. These passages are extremely narrow compared with the width of the chamber sections or interspaces.

The border member of the invention will thus have the effect of a flame arrester. For enhancing the flame arresting effect, the border member may be provided with an edge projecting into the chamber space. This flame arrester thus, besides presenting to the arc a considerably increased surface upon which the hot gases are in contact with a cold wall surface, will reduce the thickness of the flame sheet, both effects coming into play, ever according to the arrangement chosen, simultaneously or separately.

This effect may be achieved by approaching the transversal partitions of the arc extinguishing chamber closely to one another. It may also be achieved by means of one or more ring or frame-like thin laminae inserted between the transversal refractory plates or partitions and spaced apart from one another and also from the partitions by a narrow distance.

The inventor has discovered, and this forms part of the invention, that this arc expanding and extinguishing effect may be utilized for extinguishing the arc by means of a porous body. This will be the more readily achieved the closer together and the more numerous the arc loops are assembled within a relatively narrow space. Since the conductive elements in alternation with arc loops constitute a composite solenoidal path, whose convolutions are individually extended into the divisional chambers and are close together, a great expanding electrodynamic force will be imparted to the loops. The arc sections will thus not only bear and be pressed against the lateral border members of the divisional chambers but will also penetrate deeply into the narrow passages so that the attenuation caused by the flame arresting effect of the lateral border members of the invention will play an important part in the process of extinguishing the arc.

The inventor thus has discovered that the intensity of this expansive force may be utilized for causing the arc to enter to some extent into the lateral border wall if this wall, bordering the chamber sections, is made of porous material.

When the porosity is sufficiently high, such as pore spaces of a size between $\frac{1}{100}$ to 1 mm. and grain sizes of the porous material varying between similar limits, the ionized gases may easily traverse these border walls without causing an overpressure which might endanger the plates or might affect their durability. The flame arrester may thus be in the form of a porous enclosure or, with the exception of the entrance opening for the conductive elements, a fully closed but porous wall. The chamber sections of rectangular arc extinguishing chambers will thus be closed on three sides by three porous border walls which ensure the evacuation of the gases. If the arc extinguishing chamber is circular, it will be closed around its periphery, leaving only the opening for the insertion of the legs of the arc conducting elements.

To this purpose, any porous refractory material, natural or synthetic, may be employed which is insulating or semi-conductive, or material composed of grains of such insulating or semi-conductive, refractory material. Such material may be quartz, smelted silica, corundum, zirconia, glucina, magnesia, or the like. The material will preferably be used in pure condition, such as in the form of electrocast magnesia. The material may be recovered or brought into proper grain or particle size by grinding, crushing, or otherwise. The grains may be bound together by any conventional or convenient process, such as by fritting, that is a vitrifying process under such conditions of temperature and pressure that the grains are only imperfectly vitrified. Under the conditions of this process the grains will be fused together only superficially and, particularly, only to such an extent that contiguous or neighboring grains fuse together at their small contacting edges or areas. The grains or the individual grains thus will not be fused down as a whole, and the pores and thus the passages for the gases between the grains will be kept open.

The size of the grains may vary between wide limits,

thus the grains may be of a size that they pass 0.59 to 0.074 mm. sieve openings, corresponding to sieves Nos. 30 to 200, U. S. standard. The porosity of the material may vary for instance between pore sizes between similar limits, for instance between $\frac{1}{100}$ and 1 mm.

A fritting process will require higher baking temperatures, the temperatures depending upon the specific material employed. Lower moderate temperatures will suffice, for instance of the order of 1000° C. if the grains at their contacting areas are cemented together with the aid of very small quantities, e. g. up to 5%, of a fluxing agent whose adhesiveness may be activated or realized already at such moderate temperatures.

Any convenient or conventional fluxing agent may be employed, such as the aluminous, magnesic, calcic, or alkaline silicates or analogous borates or any other more or less vitrifiable agent. Fluxing agents such as the alkaline salts may also be employed, as known in the art, which are capable of combining with the siliceous material of the grains by superficial attack or reaction yielding a vitrified surface layer—glass, enamel—which thus binds the grains together.

For holding the grains together in the preliminary stage of the fusing or vitrifying process, water or any one of the conventional organic binders like sugars, glue, gelatine, dextrines, gums, starch, flour, molasses, sulfite waste liquors, and others, may be employed. The material, thus loosely bound together, may then be subjected to a pressure of several hundreds of kilograms per square centimeter at a temperature of about 1000° C. and the grains thus be bound together permanently at the contacting edges or surface areas.

In accordance with a further development of the invention, the porous border walls may consist of the refractory products known as "cermets," that is products obtained through the processing of a mixture of ceramic pastes, with more or less refractory metals such as titanium, zirconium, thorium, tantalum, tungsten, molybdenum, and others; products which as semiconductors present the advantage that through their semi-conductivity the penetration of the arc loops into the porous wall material will be enhanced. The oxides and carbides of such metals may also be employed in view of their high refractoriness. The arc loops will thus, so to say, be absorbed by the lateral walls of the chamber sections.

These and other features and objects of the invention will become apparent as the specific description of the invention proceeds in which the invention will be described with reference to the accompanying drawings which form part of this specification and which by way of example illustrate various embodiments of my invention. These drawings are to be understood explicative of the invention but not limitative of its scope. Other embodiments incorporating the principle underlying my invention are feasible without departing from the spirit and ambit of my appended claims.

In the drawings:

Fig. 1 is a diagrammatic side view of an embodiment of a circuit breaker with an arcing chamber partitioned by transversal refractory plates into divisional chambers, spaced apart and enclosed by peripheral border members;

Fig. 2 is a front view and

Fig. 3; a side view of an arc subdividing conductive element;

Fig. 4 is an elevational section of a part of a series of partitioning plates, with their arc conducting elements and circular border members enclosing the arc extinguishing divisional chambers;

Fig. 5 is a front view of a border wall and an adjacent partitioning plate with a conductive element straddling the partitioning plate;

Fig. 6 is a front view of an intermediate ring lamina providing narrow passages around, and out of, the divisional chambers; and

Fig. 7 a median elevational section similar to Fig. 4 of a modified arrangement of the peripheral wall member of the invention.

In Fig. 1 the fixed and movable contacts of the circuit breaker are designated by **11** and **12**. They are respectively connected to the terminals **13**, **14** of the network line. The two contacts are located inside an arc formation chamber **15**, not shown here in detail.

In order to develop the ignited arc more rapidly than the movement of the movable contact would allow, an arcing contact **16** may be placed within the arc formation chamber of insulating material. The arcing contact **16** may be connected to the movable contact **12**. A blow-out coil **17**, connected to one of the terminals, **13**, of the circuit breaker, may also be employed. The coil **17** acts upon the magnetic core **18**, the legs **19** which enclose the arc formation chamber.

The upper part of the circuit breaker, above the arc formation chamber **15**, constitutes the arc extinguishing chamber. Through a set of refractory plates **21**, in the instance illustrated, transversely of the contacts **11**, **12**, **16**, the arc extinguishing chamber is partitioned into divisional chambers **22**. Arc subdividing conductive elements **23** are interposed between the separable contact members or the main arcing contacts **11**, **16**. The conductive elements **23** are shaped, as Figs. 2, 3 and 5 illustrate with a pair of legs or wings **24**, **25**, diverging in V-form relatively to each other and connected through a bridge piece **26**. The conductive elements straddle with their legs and bridge pieces the lower edges of the partitioning plates **21** and reach with their legs, such as **24**, **25**; **124**, **125**; **224**, **225**; **324**, . . ., (Fig. 4), each into two consecutive divisional chambers **22**, **122**; **122**, **222**; **222**, **322**; **322** . . ., respectively, terminating at an intermediate point of the divisional chambers, preferably in the lower part thereof, as Figs. 4, 5 and 7 illustrate. Opposite elements, such as **25**, **124**; **125**, **224**; . . . in each sectional chamber, **122**, **222**, respectively, likewise diverge in V-form relatively to each other.

The chamber sections **22** are circumferentially framed or enclosed by border members by means of which, as Fig. 4 illustrates, the plates **21**, **121**, **221** . . . may be spaced apart from each other. These border members are shaped with an entrance opening **31**, Fig. 5, for the legs or wings **24**, **25** of the conductive elements and, moreover, between adjacent partitions and distributed around the divisional chambers, with gas permeable and arc attenuating restricted passages out of the divisional chambers.

In the embodiment of Figs. 4 to 6, the border members framing or enclosing the circular divisional chambers comprise a ring **30** as border wall which provides the spacing for the divisional chamber. This ring is open at the lower part, **31**, for the introduction into each divisional chamber of the legs of two successive or opposite conductive elements. Between the ring-like walls **30** and the partitioning plate **21**, there is inserted at both sides a ring-shaped lamina **43** provided with slightly raised spacing ribs **44** between which thus, distributed around the perimeter of the arc extinguishing chamber, fine, axially extremely narrow, radially directed, passages **45**, are shaped. These fine passages, while attenuating the arc, allow the escape of the hot gases. To enhance the attenuation of the arc, the ring-like wall **30** is further provided with an inwardly projecting edge.

The border members, besides spacing the refractory plates **21** apart from one another, thus serve as flame arresters. Through the obstacle presented by the ring-like wall, the arc loops, which are formed between legs **25**, **124**; **125**, **224**; . . ., are prevented from developing to the outside of the arc extinguishing chamber. The arc sections are thus compelled, while being expanded under the electrodynamic forces inherent to the arc loops, to reach and bear against the border wall, substantially around the whole periphery thereof, and thereon to enter the narrow gaps between plates and border wall. The

arc sections thus are attenuated and cooled at the surfaces of the partitioning plates and the inwardly projecting edge of the bordering wall of the gap. The arc sections will extinguish while, simultaneously, the hot ionized gases developed by the arc loops may escape through the gaps.

The stacked partitioning plates and interposed border members may be held together by any convenient means or framework, here, since not forming part of the invention, not shown.

The conductive elements **23** may be held in position by being seated with their lower edges on projections **36** of the ring-like walls **30**, Fig. 5. These conductive elements, instead of being seated on projections **36** of the ring-like walls **30**, might however be supported and secured at the stack of refractory plates by any other convenient means.

Instead of separate, passage providing ring-laminae, the passages may also be shaped within the surfaces of the partitioning plates or may be spared out of the surfaces of the ring-like walls **30** or may be provided both in the partitioning plates and the ring-like walls.

In the embodiments illustrated, the partitioning plates are circular discs, and the border members correspondingly of ring form. Partitioning plates and border members may also be rectangular, oblong, elliptic, or of any other shape, as conditions may ever require.

Through the serial arrangement of the subdividing conductive elements in alternation with the arc loops, a composite solenoidal path is constituted, with its convolutions close together and substantially parallel to one another. The arc loops are thus subjected to intensive electrodynamic forces which expand the loops until they reach substantially the whole circumference of the bordering wall member, bear thereagainst and finally are forced to penetrate into and pass through even very fine and narrow passages, such as the pores of a porous refractory wall member.

It is thus even possible to provide in addition to the narrow gaps **33**, or even exclusive thereof, wall members of refractory, highly porous material, instead of non-porous refractory material such as asbestos.

Fig. 7 illustrates an embodiment of this type. The ring-like walls **47** join directly the partitioning plates **46** without any openings or passages being provided other than those for the legs of the conductive elements.

The border walls **47** are of highly porous, refractory material, electrically insulating or semi-conductive as described hereinabove. When the arc has been drawn, the arc loops will expand and will finally extinguish through being absorbed by the porous material and cooled on the pore surfaces of very large size relatively to the mass of material, while the gases escape to the outside through the pores of the material.

I claim:

1. An arc extinguishing chamber of the type which comprises a set of at least two plates of refractory material partitioning the chamber into divisional chambers, arc subdividing conductive elements being provided at said chambers, each one of said elements shaped with a pair of legs of a length short relatively to the height of the chambers, said legs diverging in V-form relatively to each other and straddling the lower edges of said partitioning plates, the legs of opposite elements in each divisional chamber being disposed so as to diverge likewise in V-form relatively to each other; said chambers being provided with peripheral border members of a contour generally corresponding to the contour of said partitioning plates; said border members being shaped each with an entrance opening for extending said legs therethrough and into said divisional chambers; said border members being further formed with gas permeable and arc attenuating, restricted passages out of said divisional chambers, said passages being distributed around the perimeter of said divisional chambers; said border members being otherwise shaped so as to close said divisional chambers around said perimeter.

2. A divisional arc extinguishing chamber as set forth in claim 1 wherein said border members include a wall in the form of a frame-like element disposed between successive partitioning plates for spacing them apart a short distance, said frame-like elements being of a contour generally corresponding to the contour of said partitioning plates; said frame-like elements being shaped with an entrance opening for said legs, said border members further being formed with gas permeable and flame attenuating, narrow passages out of said divisional chambers and distributed around the perimeter thereof.

3. A device as set forth in claim 2 wherein said border members further include ring-shaped laminae disposed on each side of said frame-like element and between the same and the adjacent plate, said laminae being shaped with slightly raised spacer ribs, distributed around the perimeter of said ring-shaped laminae, so as to provide radially directed, extremely fine and narrow passages out of said divisional chambers.

4. Divisional chamber as set forth in claim 1 wherein said partitioning plates and said border members are of circular contour.

5. Divisional chamber as set forth in claim 1 wherein said border members are of highly porous refractory material.

6. Device as set forth in claim 5 wherein said refractory material is composed of a mixture of refractory metal and ceramic material.

7. In an arc extinguishing chamber, a set of parallel plates of refractory material, spaced apart from one another with a short distance therebetween, thereby to partition said arc extinguishing chamber into narrow divisional chambers, said divisional chambers each being provided with conductive elements, each element being shaped with a pair of diverging wings and a bridge piece connecting said wings, said conductive elements straddling with their bridge pieces the lower edges of said partitioning plates and reaching with their wings each into two consecutive chambers, terminating in the lower part thereof, the wings of opposite elements in each chamber likewise diverging in V-form from each other; peripheral border members being disposed circumferentially around said divisional chambers, the contour of said border members generally corresponding to the contour of said partitioning plates; said border members being shaped each with an entrance opening for said wings and with gas permeable and flame attenuating, restricted passages out of said divisional chambers, said passages being distributed around the perimeter of the divisional chambers; thereby, by means of said conductive elements, to develop the arc in sections expanding as loops within said divisional chambers, said conductive elements in alternation with arc loops constituting a composite solenoidal path; the convolutions of said solenoidal path, individually extended into said divisional chambers, being substantially close together and parallel each other; for thus expanding, under the action of the electrodynamic forces, the arc sections into nearly closed loops towards the border wall, so as to reach the same and bear there against and finally forcing the arc loops through said restricted passages, attenuating the same thereby, extinguishing them, and releasing the gases.

References Cited in the file of this patent

UNITED STATES PATENTS

2,564,178 Strobel ---------- Aug. 14, 1951