Sept. 17, 1968 R. S. DAVIS 3,402,273

ARC CHAMBER FOR CIRCUIT BREAKERS

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FIG. 1.

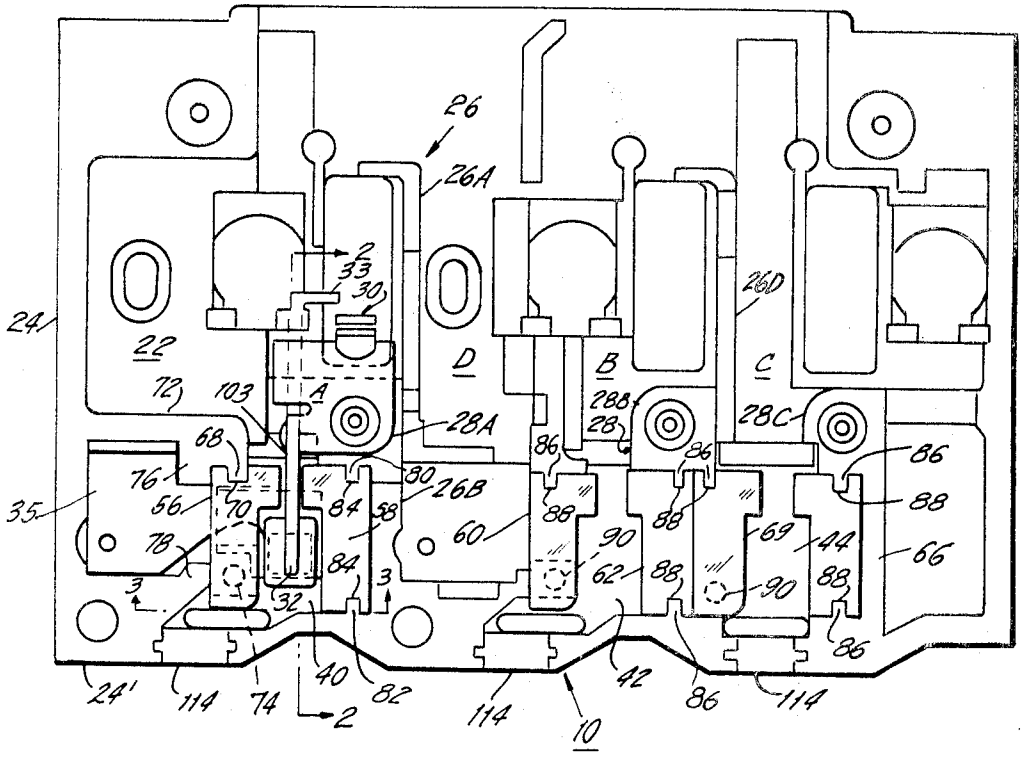


FIG. 2.

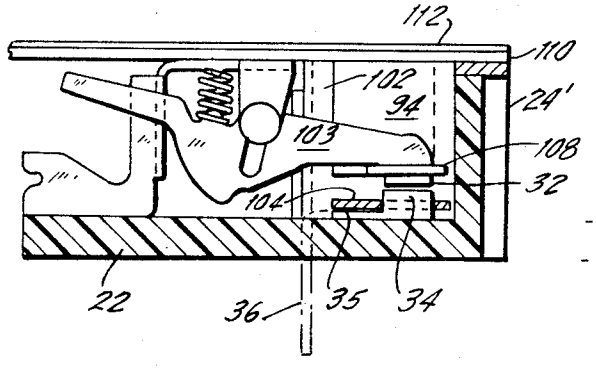
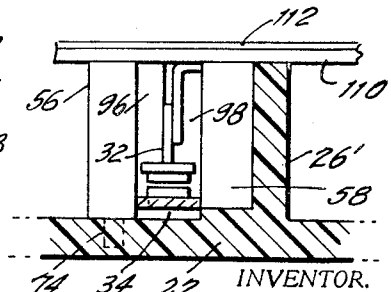


FIG. 3.



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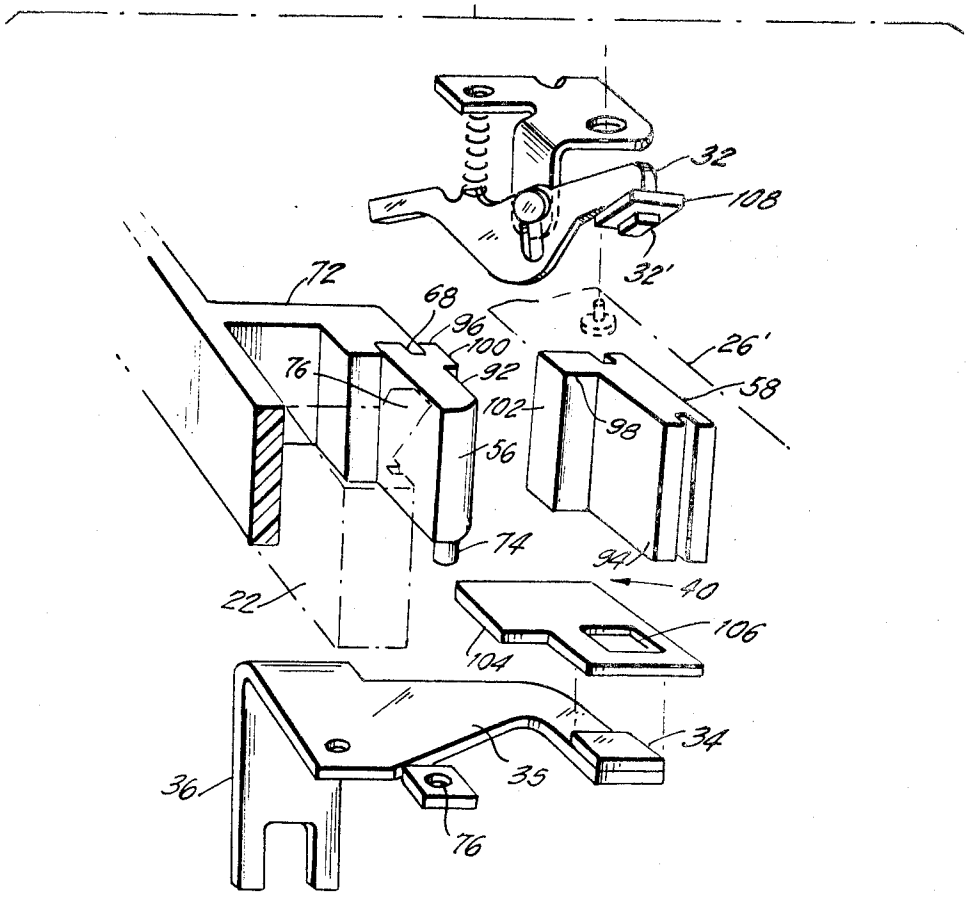
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FIG. 4.



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ARC CHAMBER FOR CIRCUIT BREAKERS

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9 Claims. (Cl. 200—144)

This invention relates to circuit breakers and more particularly relates to arc chambers which closely surround the cooperating contacts of a circuit breaker in such a manner as to materially hasten arc extinguishment.

Typical circuit breakers include a stationary contact and a movable contact automatically separable therefrom in response to prolonged overload and/or short circuit fault conditions. During interruption and until the contacts are separated by a predetermined distance dependent upon the current which is being interrupted, an electrical arc is drawn therebetween. Such arc is obviously undesirable for many reasons, only three of which are excessive heat, contact erosion due to prolonged arc concentration and possible re-strike between the supposedly isolated contacts due to the ionization of air immediately surrounding the contacts.

The instant invention is directed to an arrangement whereby a small well-defined arc chamber closely surrounds the cooperating contacts of a circuit breaker to materially hasten arc extinguishment and thereby effectively minimize the difficulties noted above. Further, the novel arc chambers permit increased voltage rating of the breaker in which they are used or in the alternative reduce the distance required to extinguish an arc drawn between the separating contacts. The arc chambers are formed by pairs of appropriately shaped inserts removably secured within the circuit breaker by various wall projections and ribs thereof. The inserts are made of material that will not support combustion, erode very little from contact with an electrical arc, and absorb heat during interruption by a very small amount of the material changing from a solid to an arc quenching gas. The inserts are shaped and mounted to surround the contacts as closely as possible thereby reducing the volume of air which can support combustion and possible re-strike.

The interchangeability of the inserts represents an important aspect of the instant invention in that inexpensive materials or materials more adaptable to case molding techniques may be used for the major portion of a circuit breaker while only the subsequently added inserts which form the surrounding arc chambers need be constructed of the preferred heat-absorbing, gas-evolving material. Similarly, the removability and interchangeability inherent in the instant invention permits the use of different arc chamber materials in the same circuit breaker, thereby increasing the versatility and capabilities of the one basic circuit breaker.

In a preferred embodiment of the instant invention the arc chamber defined by the pair of oppositely disposed inserts is complemented by a first insulating sheet disposed between the inserts and the base of the circuit breaker and by a second insulating sheet carried by and movable with the movable contacts. Thus the first and second insulating sheets form a top and bottom for the arc chamber defined by the inserts and thereby establish an even more closely defined arc chamber which cools the separating contacts by absorbing heat in exchange for an arc extinguishing gas while at the same time reducing the volume of air which might support combustion and re-strike.

As a particularly advantageous feature of the instant invention the inserts and insulating sheets are so constructed as to be securely maintained within the cooperating circuit breaker without the need for any special fastening means. Specifically, the bottom insulating sheet which surrounds the stationary contact, is held in place by the inserts, and the inserts are in turn held in place by the circuit breaker cover.

As a further feature of the instant invention, the inserts together with the top and bottom insulating sheets cooperate to define an open-ended channel for directing gaseous by-products of current interruption from the interior of the arc chamber to the exterior of the circuit breaker through appropriately located openings in the base of the circuit breaker.

It is therefore seen that it is an object of the instant invention to provide an arc chamber closely surrounding the stationary and movable contacts of a circuit breaker with such arc chamber including a pair of insulating members disposed close to such contacts on opposite sides thereof.

It is another object of the instant invention to provide such an arc chamber wherein the pair of oppositely disposed insulating members are constructed of a gas-evolving material which absorbs heat during circuit interruption by giving off arc-quenching gas.

Another object of the instant invention is to provide such an arc chamber wherein the inserts absorb heat during circuit interruption thereby cooling the separating contacts and minimizing erosion thereof.

Yet another object of the instant invention is to provide a small well-defined arc chamber of minimum dimensions thereby reducing the volume of air which will support combustion.

Still another object of the instant invention is to provide a small well-defined arc chamber surrounding the separating contacts of a circuit breaker, with such arc chamber being defined by a pair of oppositely disposed, removably secured inserts and a pair of insulating sheets which form top and bottom walls therefor.

Yet another object of the present invention is to provide such an arc chamber wherein the oppositely disposed inserts and the top and bottom insulating sheets are rigidly secured in place without the need for complex fastening arrangements.

Still another object of the instant invention is to provide such an arc chamber wherein the oppositely disposed inserts and top and bottom insulating sheets cooperate to define a channel for directing gases from the interior of the arc chamber to the exterior of the circuit breaker.

Still another object of the instant invention is to provide such an arc chamber wherein the removable inserts may be constructed of various materials dependent upon the current rating desired, and whereby the variety of insulating materials possible, inherently increases the versatility and capabilities of the basic circuit breaker.

Yet another object of the invention is to provide a well-defined arc chamber for the cooperating contacts of a circuit breaker wherein the arc chamber may be formed of a material preselected to give desired operating characteristics while the major portion of the circuit breaker may be constructed of inexpensive material or materials which are more adaptable to case molding techniques.

Other objects and a fuller understanding of the instant invention may be had by referring to the following description and drawings, in which:

FIGURE 1 is a plan view of a circuit breaker with its cover removed, showing a plurality of arc chambers formed in accordance with the teachings of the instant invention;

FIGURE 2 is a side view taken along the arrows 2—2 of FIGURE 1 and showing the cooperating contacts of

a single phase of the circuit breaker in their closed position within its associated arc chamber;

FIGURE 3 is a view of the contact pair and associated arc chamber shown in FIGURE 2, but taken along the arrows 3—3 of FIGURE 1; and

FIGURE 4 is an exploded perspective view of a cooperating contact pair and an arc chamber formed in accordance with the instant invention.

Referring to FIGURE 1, there is shown a partial plan view of a circuit breaker **10** of the type shown and described in detail in co-pending application Ser. No. 285,681 entitled "Multi-Pole Circuit Breaker," filed June 5, 1963 in the name of Elwood T. Platz and assigned to the assignee of the instant invention. Although the instant invention will be described with respect to a three-phase circuit breaker of the type shown in the aforementioned patent application, it is to be understood that the instant invenion is applicable in any single-phase or multi-phase circuit breaker or circuit interrupting device wherein it is desirable or necessary to hasten arc extinguishment.

Circuit breaker **10** includes a base **22** having upstanding side walls **24**, various partitions generally indicated at **26**, and various posts generally indicated at **28** to form four generally side-by-side elongated compartments A, B, C, and D. The base **22**, side walls **24**, and the various partitions and posts may be constructed of urea or any other material suitable for well known case molding techniques. Partitions **26A**, **26B** and post **28A** separate compartments A and D, partition **26C** and an insert **60**, to be described in greater detail, separate chambers B and D, while partition **26D**, post **28B** and inserts **62**, **64** separate compartments B and C. As explained in greater detail in the aforementioned patent application, chambers A, B and C each contain the individual current carrying and automatic tripping elements, indicated generally at **30** in FIGURE 1, for a single circuit breaker phase, while chamber D houses the common operating elements for all three phases.

Within the forward portion of each chamber A, B, and C is housed a cooperating contact pair which includes a stationary contact **34** (see FIGURES 2 and 4) integrally connected to a relatively large flat conductive line terminal **35** which passes through the base **22** as shown at **36** in FIGURE 2, whereby it may be connected to the appropriate conductor of a multi-phase panel board. The movable contact **32** is an elongated member which terminates in a latching tip **33** which cooperates with the automatic tripping means **30** in a manner described in the aforementioned patent application Ser. No. 285,861.

Although the details of circuit breaker operation form no part of the instant invention, it will be understood that upon the detection of a time-delayed overload or short circuit fault condition by the automatic tripping element **30** in any of the compartments A, B, and C, the movable contact **32** of the associated phase will be tripped and separated from its cooperating stationary contact **34** whereby current interruption will take place. Suitable operating means (not shown) connected between each of the phases assures that the opening of one set of contacts will simultaneously trip the contact pairs of the other phases.

As noted previously, separation of the cooperating contacts results in the drawing of an electrical arc until the movable contact has separated far enough from its cooperating stationary contact to bring about extinguishment.

To hasten arc extinguishment and thereby minimize the numerous problems inherent therewith, the instant invention provides arc chambers **40**, **42** and **44** for each of the contact pairs **32** and **34**, respectively, of the multiphase circuit breaker.

Arc chambers **40**, **42** and **44** are defined by oppositely disposed, removably secured, inserts **56**, **58**; **60**, **62**; and **64**, **66**. Insert **56** is removably held in place by a rib **68** which fits within a notch **70** provided on one end of the insert **56**. The rib **68** is preferably formed as the tip of a partition **72** which extends inwardly from side wall **24**. The opposite end of insert **56** is provided with a depending pin **74** which fits within a hole **76** provided in the base **22** of the breaker (see FIGURE 4). Rib **76** of internal partition **72** and projection **78** from front side wall **24'** reinforce the insert against combustion forces which are developed in the arc chamber **40** during circuit interruption.

Insert **58** is removably secured in place on the opposite side of contact pairs **32**, **34** by cooperating ribs **80** and **82** extending from post **28A** and the front wall **24'**, respectively, which fit within grooves **84** provided in the insert **58**. Insert **58** is backed up by partition **26B** against possible combustion forces in the arc chamber **40** produced during circuit interruption.

Inserts **60** and **64** of arc chambers **42** and **44**, respectively, are removably secured within the circuit breaker **10** in a similar manner as insert **56** by means of cooperating projections and grooves **86**, **88**; and pins **90** while inserts **62** and **66** are removably secured by means of oppositely disposed projection and groove arrangements **86** and **88**, respectively, in a manner similar to that for insert **58**.

Each of the inserts **56**, **58**, **60**, **62**, **64** and **66** is constructed of a material which will not support combustion, will erode very little from contact with an electrical arc, and will absorb heat during arc interruption by a very small amount of the material changing from a solid to an arc-quenching gas. Such characteristics reduce heat, hasten arc extinguishment, and reduce contact erosion by preventing prolonged arc concentration on the cooperating contacts. Although in no way intended to limit the instant invention to such material, a suitable material for the inserts might be the insulating material commonly known in the art as Glastic or Rostone 2150.

Although further discussion of the arc chambers of the instant invention will be directed solely to the arc chamber **40** defined by inserts **56** and **58**, it is to be understood that arc chambers **42** and **44** defined by insert pairs **60**, **62** and **64**, **66**, respectively, are similar in all respects thereto.

As most clearly seen in FIGURE 4 each of the inserts **56** and **58** has an interior surface **92** and **94**, respectively, which extends parallel to the plane of motion of the movable contact **32**, and which are spaced apart by a distance which is just slightly larger than the width of the movable contact (see plan view in FIGURE 1). Each of the inserts **56** and **58** include a leg portion **96** and **98**, respectively, disposed in a plane which is transverse to the plane of the interior surfaces **92** and **94**. The leg portions **96** and **98** are directed toward one another and define a rear wall which cooperates with the interior surfaces of the inserts to form the basic arc chamber **40**. Confronting faces **100** and **102** of leg portions **96** and **98**, respectively, are spaced from one another by a distance which is just slightly larger than the width of elongated portion **103** of movable contact **32** (see plan view in FIGURE 1).

To complete arc chamber **40** a fiber insulator sheet **104** is provided between the bottom of inserts **56** and **58**, and line terminal **35**. Insulator sheet **104** has an aperture **106** through which the movable-contact-engaging portion **34** of line terminal **35** may pass into arc chamber **40**. To provide a top surface for the arc chamber **40** a second fiber insulator sheet **108** is secured to and movable with movable contact **32**. Insulator sheet **108** is provided with an aperture through which the stationary-contact-engaging portion **32'** of movable contact **32** passes to enter arc chamber **40**.

In assembling the arc chambers of the instant invention the line terminal **35** is first placed on the base **22** of the circuit breaker with the depending stab **36** passing through base **22**. Fiber insulator sheet **104** is placed

over line terminal portion **35** with movable-contact-engaging portion **34** passing through aperture **106**. Inserts **56** and **58** are then positioned within the circuit breaker, by means of the projections, ribs and pins noted above, such that the insulator sheet **104** and line terminal portion **35** are rigidly held between the inserts **56**, **58** and the base **22**. Finally, a fiber liner **110** and cover **112** (see FIGURES 2 and 3) are placed over the open slide of the circuit breaker in firm engagement with the inserts **56** and **58** to hold the inserts, the insulator sheet **104**, and line terminal **35** firmly in their proper position.

As can be seen in FIGURE 1 the front wall **24'** of circuit breaker **10** is provided with a plurality of openings **114** extending therethrough. One of the openings **114** is located adjacent an associated arc chamber **40**, **42** or **44** and cooperates with portions of the front wall **24'** and the L-shaped inserts surrounding the arc chamber to define a channel for directing gaseous by-products developed during circuit interruption from the interior of the arc chamber to the exterior of the circuit breaker.

The above described arc chambers provide many advantages which improve the operating characteristics and reduce costs of the circuit breakers in which they are used. Specifically, it becomes apparent that a relatively inexpensive material, or materials which are more adaptable to case molding techniques, can be used for a major portion of the circuit breaker while only a limited amount of the gas-evolving insulating material need be used to form the arc chambers which surround the cooperating contact pairs. In the same vein, it should become readily apparent that different insulating materials may be used to produce arc chambers of varying characteristics whereby a single basic circuit breaker unit can be easily adapted to higher electrical requirements by simply interchanging insert pairs.

As noted previously, the closely defined arc chambers formed in accordance with the instant invention reduce the volume of air available for combustion and possible restrike, while at the same time absorbing heat in exchange for the giving off of an arc extinguishing gas which hastens arc extinguishment and thereby prevents excessive contact erosion caused by prolonged arc concentration.

The arc chambers of the instant invention cooperate to define a channel for directing gaseous by-products to the exterior of the circuit breaker, and furthermore the method of assembly contemplated in the instant invention rigidly secures a number of parts in place without the necessity of complex securing means.

In compartive tests conducted with circuit breakers of the type illustrated it has been found that a circuit breaker without the arc chambers of the instant invention have a continuous current carrying rating of 100 amperes while the identical circuit breaker embodying the instant invention has been tested and is rated to carry a continuous current of 125 amperes. Similarly, it has been found that by using the novel arc chambers of the instant invention, the short circuit interrupting capabilities of a circuit breaker similar to the type described has been unexpectedly raised from 5000 amperes to 10,000 amperes.

Although there has been described a preferred embodiment of this novel invention, many variations and modifications will now be apparent to those skilled in the art. Therefore, this invention is to be limited, not by the specific disclosure herein, but only by the appending claims.

What is claimed is:

1. In a circuit breaker having a base, a stationary contact mounted on said base, a movable contact movable in a predetermined plane of motion in and out of engagement with said stationary contact to interrupt the flow of current. therethrough and a cover removably secured to said base, the improvement comprising an arc chamber closely surrounding said stationary and movable contacts, said arc chamber including:

a pair of insulating members each provided with a groove which cooperates with an integral rib on said base to removably align said members on said base on opposite sides of said contacts, each of said insulating members having interior surfaces extending parallel to the plane motion of said movable contact, said interior surfaces being spaced from one another by a distance which is just slightly larger than the width of said movable contact;

a first insulating sheet disposed between said insulating members and said base, said first insulating sheet having an aperture through which a movable-contact-engaging portion of said stationary contact may pass into said arc chamber; said first insulating sheet being securely held in place by said insulating members when said cover is placed on said base; and

a second insulating sheet secured to said movable contact and movable therewith, said second insulating sheet having an aperture through which a stationary-contact-engaging portion of said movable contact may pass into said arc chamber;

said interior surface of said insulating members and said first and second insulating sheets cooperating to define a small arc chamber which closely surrounds said stationary and movable contacts to aid arc extinguishment when said stationary-contact-engaging portion of said movable contact is disengaged from said movable-contact-engaging portion of said stationary contact.

2. The arrangement of claim **1**, wherein said insulating members are constructed of a gas-evolving material which absorbs heat during circuit interruption by giving off arc quenching gas.

3. The arrangement of claim **2**, wherein said gas-evolving material is different from the material from which said base is constructed.

4. The arrangement of claim **1**, wherein one end of each of said insulating members includes a leg portion disposed in a plane transverse to said predetermined plane, said leg portions being directed toward one another to define a rear wall for said arc chamber, said leg portions including confronting faces which extend parallel to the interior surfaces of said insulating members, said confronting faces being spaced apart to define an opening in said wall through which an elongated portion of said movable contact may pass, said confronting faces being spaced from one another by a distance which is just slightly larger than the width of the elongated portion of said movable contact.

5. The arrangement of claim **4**, wherein said base is provided with an opening therethrough, said opening cooperating with portions of said base and a second end of each of said insulating members to define a channel for directing gases from the interiior of said arc chamber to the exterior of said circuit breaker.

6. In a circuit breaker having a base, a plurality of stationary contacts mounted on said base, and a plurality of movable contacts, each movable in a predetermined plane of motion in and out of engagement with an associated one of said stationary contacts to interrupt the flow of current therethrough, the improvement comprising a plurality of arc chambers, each of which closely surrounds a contact pair comprising one of said movable contacts and its associated stationary contact, each of said arc chambers including:

a pair of insulating members removably secured to said base on opposite sides of its respective contact pair, each of said insulating members having an interior surface extending parallel to the plane of motion of the movable contact of its respective contact pair, said interior surfaces being spaced from one another by a distance which is just slightly larger than the width of its respective contact pair, each of said insulating members including at one end thereof a leg portion disposed in a plane transverse to said

predetermined plane, said leg portions being directed toward one another to define a wall which cooperates with said interior surfaces to form said arc chamber said leg portions including confronting faces which extend parallel to said interior surfaces, said confronting faces being spaced apart to define an opening in said wall through which an elongated portion of the movable contact of said respective contact pair may pass, said confronting faces being spaced from one another by a distance which is just slightly larger than the width of the elongated portion of said movable contact.

7. The arrangement of claim **6**, and further including:

a cover removably secured to said base;

a plurality of first insulating sheets, each disposed between the pair of insulating members of each arc chamber and said base, each first insulating sheet having an aperture through which a movable-contact-engaging portion of the stationary contact of each respective contact pair may pass into said arc chamber, each of said first insulating sheets being securely held in place by the pair of insulating members of each arc chamber when said cover is placed on said base; and

a plurality of second insulating sheets each secured to the movable contact of a respective contact pair and movable therewith, each of said second insulating sheets having an aperture through which a stationary-contact-engaging portion of the movable contact of each respective contact pair may pass into its respective arc chamber;

said interior surfaces of each pair of insulating members, the wall defined by the leg portions of each pair of insulating members, one of said first insulating sheets, and one of said second insulating sheets cooperating to define a small arc chamber which closely surrounds its respective contact pair to aid arc extinguishment during current interruption.

8. The arrangement of claim **7**, wherein the insulating members of each arc chamber are constructed of a gas-evolving material which absorbs heat during circuit interruption by giving off arc quenching gas, said gas-evolving material being different from the material from which said base is constructed.

9. The arrangement of claim **8**, wherein said base is provided with a plurality of openings therethrough, each of said openings cooperating with portions of said base and a second end of the insulating members of one of said arc chambers to define a channel for directing gases from the interior of said arc chamber to the exterior of said circuit breaker.

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