Jan. 23, 1951 C. J. BALENTINE 2,539,175

LIQUID BLAST INTERRUPTER FOR ELECTRIC BREAKERS

Filed July 30, 1948 2 Sheets-Sheet 1

Fig. 1.

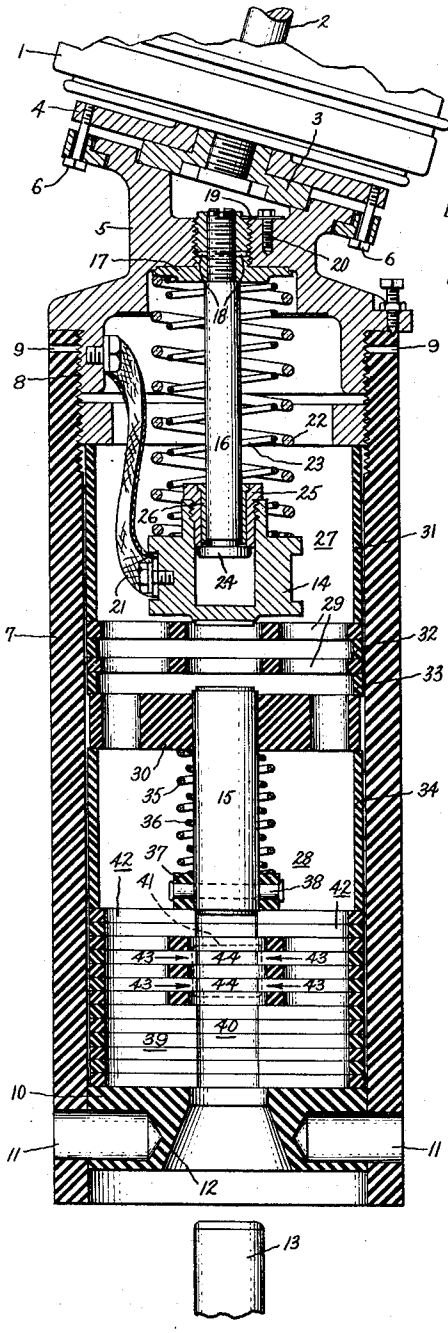


Fig. 2.

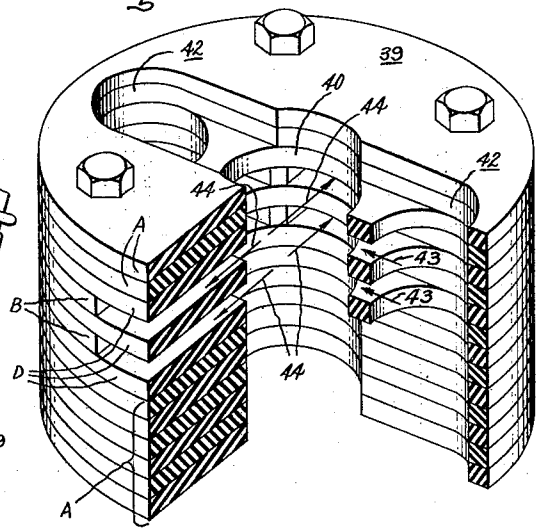
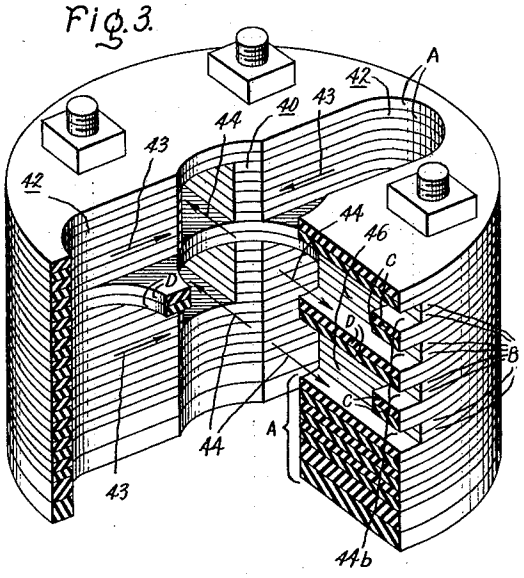


Fig. 3.



Inventor:
Conrad J. Balentine,
by Ernest C. Britton
His Attorney.

Jan. 23, 1951 C. J. BALENTINE 2,539,175

LIQUID BLAST INTERRUPTER FOR ELECTRIC BREAKERS

Filed July 30, 1948 2 Sheets-Sheet 2

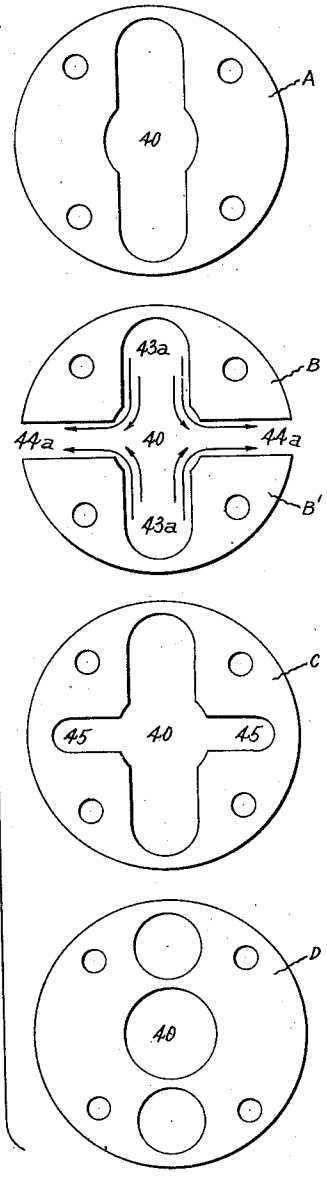


Fig. 4.

Inventor:
Conrad J. Balentine,
by Ernest C. Britton
His Attorney.

Patented Jan. 23, 1951 2,539,175

UNITED STATES PATENT OFFICE

2,539,175

LIQUID BLAST INTERRUPTER FOR ELECTRIC BREAKERS

Conrad J. Balentine, Philadelphia, Pa., assignor to General Electric Company, a corporation of New York

Application July 30, 1948, Serial No. 41,612

2 Claims. (Cl. 200—150)

1

My invention relates to electric circuit interrupters for high voltage circuits, and particularly to high speed circuit breakers of the liquid blast type for opening high voltage alternating current power circuits within a few half cycles.

More specifically, my invention is a further development and an improvement upon the series-break type of interrupter disclosed in U. S. Patent 1,548,799 granted on an application filed by J. D. Hilliard, which is assigned to the same assignee as the present application.

Nowadays the principle upon which this type of interrupter operates is known as "oil blast action," this being the process whereby an arc that is drawn close to an expulsion port within an oil confining structure is extinguished by displacement of the oil caused by a pressure established therein in the region adjacent the arc.

In the above-mentioned Hilliard patent, the pressure for displacing the arc to be interrupted is generated by means of a series so-called pressure-generating arc, although it is well understood that other means may be employed for establishing blast action such, for example, as an impulse piston. An example of a fluid blast breaker wherein the oil blast action is produced by means of an impulse piston is disclosed in U. S. Patent 2,147,497 to Prince et al., which is assigned to the same assignee as the present application.

Conventional forms that fluid blast action may assume are well known and may be defined as radial blast, axial blast, and cross blast. These three different forms are shown clearly in Figs. 1, 2 and 3 respectively of the above-mentioned Hilliard patent. Frequently, these several blast actions are combined. For example, it will be apparent that the oil blast produced in the case of Fig. 1 of the above Hilliard patent is an inward radial blast between the spaced superposed baffles, which blast continues as an axial blast down the bore of the throat insulator as the contact rod pulls downward from the interrupter into the tank. In other cases an axial blast is directed through, say, a hollow contact and then is caused to diverge radially outward as, for example, in U. S. Patent 2,434,506 to Buchwald et al., which is assigned to the same assignee as the present application.

A transverse or cross blast may be regarded as a concentrated inward radial blast stream which cuts directly across the axis of the arc passage and then exhausts diametrically therethrough. In contradistinction thereto, in accordance with my invention, I cause an inwardly directed blast stream to be deflected and vented laterally from the immediate locality of the arc passage into which it is directed. More specifically, I employ oil blast action for causing substantially balanced opposite streams of oil to impinge one another at different points along the arc drawn between a pair of relatively movable interrupting contacts, and, immediately adjacent these points of impingement, I provide lateral venting means for exhausting these impinging blast streams as soon as they have encountered the arc. In this manner, I provide for very effectively and expeditiously cooling the arc, scavenging the ionized products thereof and establishing a wall of high dielectric fluid between the separated contacts whereby to prevent the re-ignition and the re-establishment of the arc in the interrupting circuit.

2

By permitting the fluid which flows inwardly in a radial direction to exhaust laterally in opposite radial directions with substantially no axial flow along the arc length as in my invention, I have improved the interrupting performance of a high voltage interrupter while yet maintaining a simple structure of low manufacturing cost. The improved performance has been substantiated by comparative tests conducted in connection with the interrupter of my invention and other interrupters of the same general type and presumably is due primarily to my method of controlling the flow of the oil with respect to the arc. Otherwise stated, I achieve improved interrupting performance by immediately venting each blast stream upon its injection into the arc. By this method, the extinguishing blast streams are more effective for they are not so subject to stalling or reversal from back arc pressure and therefore flow more readily into the contact gap.

Thus, a principal object of my invention is to provide a circuit interrupter which is capable of performing a circuit interrupting operation in a more efficient manner than in prior arrangements and which, in addition, is simple and compact in construction.

Another object of my invention is the provision of an improved interrupting unit for an electric circuit breaker of the oil blast type wherein opposed inlet and outlet streams of oil are caused to flow into and out of the arc passage in substantially the same plane so that axial flow of the oil is minimized and an incisive arc interrupting action is accomplished wherein the arc is squeezed, cooled and extinguished by the intervention of forced oil under pressure which flows

radially into the arc from the oppositely disposed blast passageways.

Still another object of my invention is to provide an interrupting unit for electric circuit breakers of the oil blast type wherein the products of an interrupting operation are simultaneously expelled from the unit through oppositely arranged vent passageways so that objectionable sidewise stresses imposed on the interrupter unit due to back pressure from the surrounding fluid is substantially eliminated due to the fact that the thrusts from the oppositely disposed passageways tend to offset or counterbalance each other.

Still another object of my invention is the provision of an interrupting unit for high voltage circuit breakers which, due to the particular disposition of the inlet and outlet passages communicating with the arc passage of the unit, permits the arc to assume random positions within prescribed limits so that erosion of the insulating structure of the arcing chamber from burning is not concentrated appreciably at one side more than at another.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In the drawings, Fig. 1 represents a sectional view of a circuit interrupting unit embodying my invention; Fig. 2 is a perspective view partly in section of a baffle structure embodying my invention, which structure is disposed within the lower portion of the unit shown in Fig. 1; Fig. 3 is an alternative arrangement for the baffle structure shown in Fig. 2; and Fig. 4 is a view of the various baffle plates utilized in the assembly of the structures shown in Figs. 2 and 3.

The interrupting unit shown in Fig. 1 of the drawings is adapted to be mounted along with another similar unit inside a relatively large oil-filled enclosing metallic tank. These two interrupting units would cooperate with a reciprocating blade contact, such as is shown in Fig. 1 of the above-mentioned Hilliard Patent 1,548,799.

With reference to Fig. 1, the interrupting unit is shown secured to the electric bushing 1 constructed of insulating material through the bore of which is disposed a conductor stud 2. As is well known in the art, the bushing 1, a part of which is shown would contain a mounting flange which would cooperate with an opening in the cover of the large tank enclosing both the interrupting units. Threadedly engaging the lower portion of the conductor stud 2 is a flanged metallic nut 3 which secures the metallic flange 4 compressively with respect to the bushing. Adapter unit 5 in turn is secured to the flange 4 by means of bolts 6. The enclosing pressure confining casing 7 for the interrupter unit is threaded onto the lower portion of the adapter unit at 8. For the purpose of tightening up the casing 7, wrench holes 9 may be provided and a conventional set screw may be utilized for locking the tightened casing 7 with respect to the adapter unit 5, as shown. The lower portion of the enclosing casing 7 is partially enclosed by a throat member 10 constructed of insulating material, which throat is secured into the casing by means of dowel pins or screws 11. Throat member 10 is provided with a conical opening 12 through which the movable contact 13 vertically travels into or out of the interrupter during the opening or closing operation respectively of the circuit breaker.

The contact structure disposed within the enclosing casing 7 comprises a relatively fixed butt contact 14 and an intermediate "floating" contact 15. The relatively fixed contact 14 is mounted for limited resilient movement about a fixed guide rod 16 which is screwed into the flanged cylindrical spring retainer member 17, the two latter being united together by means of the pin 18.

It will be observed that the butt contact 14 and its associated parts which are mounted about the guide rod 16, together with the guide rod 16 and its spring retainer 17, constitute a complete sub-assembly which is screwed into the adapter 5. This easily renewable contact unit is prevented from slacking back by any conventional means, such as the locking plate 19, which may engage a suitable flat surface on the side of the spring retainer 17 and which is held fixedly by the screw 20.

Electrical contact is maintained between the butt contact 14 and the adapter 5 by means of conventional flexible connecting braids, such as is indicated at 21.

The limited resilient vertical movement or "wipe" of the fixed contact 14 provides for slight variations in the closed position of the movable contact 13 and also for subsequent erosion of the arcing contact faces. Nested springs 22 and 23, of suitable strength for adequate contact pressure, bias the fixed contact 14 toward its lower extreme position as determined by the head 24 of the guide rod 16 which abuts the lower rim of the threaded sleeve member 25. The sleeve 25 is screwed fixedly into contact 14 and may be equipped with an anti-friction bushing 26.

As pointed out above, pressure could be established for causing the oil to blast and extinguish the interrupting arc in any suitable manner. I have chosen to illustrate my invention in conjunction with an interrupter wherein pressure is established by a set of series contacts, such as 14 and 15, which draw a pressure generating arc just before the interrupting arc between the contacts 13 and 15 is drawn. Thus, the enclosing casing 7 is shown as including a pressure-generating chamber generally indicated by the numeral 27 and an interrupting chamber generally indicated by the numeral 28. These two chambers are separated by a common wall 30 having communicating apertures therein as shown. The arc confining baffles 29 in the pressure generating chamber and the wall 30 are secured within the casing 7 by means of suitable insulating spacer sleeves or rings 31, 32, 33 and 34, which are all maintained compressively in place by means of the threaded ring nut shown at the upper end of the casing.

The intermediate contact 15 is biased in the downward direction by means of springs, such as 35 and 36, which engage a ring 37 of insulating material which is secured to the lower portion of the contact 15 by means of a pin 38.

When the interrupter contacts are in the open position, as shown in Fig. 1, the intermediate contact 15 assumes its fully open position by engaging the lower baffle structure generally designated by the numeral 39 which is held compressively in position between the lower throat member 10 and the insulating spacer sleeve 34. To close the interrupter contacts from the open position shown, the contact 13 first is elevated through the arcing chamber passage generally designated by the numeral 40 which passage is constituted by the generally hollow baffle struc-

ture 39. After the contact 13 closes the interrupting arc gap by engaging the lower end of the intermediate contact 15, both of these contacts rise in unison. Contact 15 now is elevated slidingly in the wall 30 against the bias of its springs 35 and 36 so that it eventually closes the pressure generating arc gap by engaging the lower surface of the relatively fixed contact member 14. Moving contact 13 is finally arrested by its operating mechanism (not shown) when the fixed contact 14 has been moved upward a short suitable "wipe" distance by the intermediate contact 15.

When the circuit breaker is tripped open, the movable contact 13 moves downwardly at high speed with the intermediate contact 15 in follow-up engagement due to its springs 35 and 36, as will be understood from Fig. 1, until the contact 15 is arrested by engagement of its ring 37 with the baffle structure. During this initial downward movement, the gap produced between contacts 14 and 15 establishes an initial arc which generates pressure within the upper chamber 27. This pressure will urge oil to move downwardly through the openings in both the baffle plates 29 and the wall 30 into the interrupting chamber 28. As soon as the moving contact 13 leaves the intermediate contact 15, a second or series arc is established within the arcing passage 40. Since the baffle structure is vented to the low pressure region in the enclosing tank (not shown) through suitable expulsion ports such as 41 provided in opposite walls of casing 7, and because of the high pressure generated in the upper chamber 27, the oil in the lower chamber 28 consequently is caused to stream through the baffle structure 39 whereby the series interrupting arc drawn in the passage 40 is extinguished by this oil blast action produced by the pressure generating arc in the upper chamber 27.

In accordance with my invention, the baffle structure 39 is so constructed, as will be more clearly pointed out hereinafter, that arc extinguishing fluid under pressure is radially directed into the arcing passage 40 while this fluid and the associated arc products exhaust from the passage 40 through passages within the baffle structure 39 which radiate directly outwardly therefrom. As will be more fully explained hereinafter, the exhaust passageways are arranged so that the extinguishing fluid escapes from the arcing passage 40 after its entry thereinto without substantial movement axially along the arc itself.

The baffle members shown in Fig. 4 and designated by the letters A, B, B^1, C and D are assembled to form the bolted, stacked, baffle structures shown in Figs. 2 or 3, the baffle C being used only in the Fig. 3 arrangement. Although the exact assembly of the former will be readily discernable by comparing Figs. 2 and 4, a brief explanation of the composite extinguishing structure as shown in Fig. 2 will nevertheless be included here.

The interrupting arcing passage 40 is defined centrally within the baffle structure 39 by reason of the appropriate vertical alignment of the differently configured apertures in the several kinds of baffles which constitute the complete stack. Defined on opposite sides of this central passage 40 are two similar vertical ducts 42 down through which extinguishing fluid must flow in passing from the interrupting chamber 28 toward the arcing passage 40. From these vertical ducts 42 the fluid is diverted or directed radially into the interrupting arc within the central passage 40 along the several blast passages 43 which lie between the D baffles as indicated by arrows in Fig. 2. From Fig. 4 it will be observed that the side walls of the inward radial blast passages 43 are constituted by the bight portions 43a of the half baffles B and B^1 respectively. It will further be understood that the laterally arranged exhaust vents 44 are provided immediately adjacent the inward blast passages 43. This is best appreciated by reference to Fig. 4, from which it will be clear that these venting exhaust passages are constituted by the spacing 44a provided between the half baffles B and B^1. The flow arrows shown in Fig. 4 depict the oil blast action of my novel interrupter and illustrate clearly how the extinguishing fluid is urged inwardly in a pair of opposing streams which impinge one another in the arcing passage 40 and then readily vent laterally, with no intervening axial flow, through the substantially balanced and equal vent passages 44. These flow arrows reveal how an arc in passage 40 is subjected to a squeezing effect between the dynamically opposed blast streams which probably quickly resolves into a lateral blast effect (comparable to a cross blast) as the arc becomes displaced to the right or left against one or the other set of exhaust vents 44 adjacent either side of the blast passages 43. Irrespective of whether the arc is driven to one side or the other in the central passage 40, the arc is efficiently extinguished and prevented from re-establishing itself because of the effectiveness of this blast action.

It will be apparent that exhaust products expelled through the oppositely disposed radially extending vents 44 will not produce an appreciable sidewise stress on the interrupter unit because the back thrust produced by the expulsion on one side of the interrupter will offset that produced on the opposite side of the interrupter. Furthermore, long life of the baffle structure 39 is achieved because tests show that uniform arc burning occurs around the arcing passage 40, thus indicating that the burden of arcing is shared by both sides of the passage throughout a number of interrupting operations. Accordingly, erosion of the walls of the arcing passage 40 by burning from the arc is not concentrated along a particular surface but rather is likely to occur more or less uniformly along opposite sides of the arc passage. Also, by eliminating axial flow along the arc passage 40, excessive burning temperatures within the passage are avoided.

In view of the above description, it is clear that each pair of inward radially extending blast passages, such as 43, has a corresponding pair of outward venting passages 44 through which the fluid streams are free to escape after blasting the arc in the central passage 40. It is not vital, however, to the effective performance of an interrupting unit constructed in accordance with my invention that the blast passages must be arranged in such a precise fashion as is shown specifically in Fig. 2.

For example, the modified baffle structure shown in Fig. 3 is a practical equivalent of, and is equally proficient as, the structure of Fig. 2. In Fig. 3 the two vertically disposed oil ducts 42 of Fig. 2 are provided, as are also the inward blast passages 43 and the outward exhaust vents 44. The blast passages 43, however, are not so wide and are of a greater dimension in the vertical direction than those in Fig. 2; also the only

means provided for separating these two tiers of blast and exhaust passageways is the provision of a single "D" type barrier. It should be noted here that in Fig. 3 each lamination is half the thickness of those depicted in Fig. 2, thinner laminations being more easily punched out from stock than the thicker. Accordingly, the single baffle D in Fig. 3 is constituted by a pair of identical thin baffles abutting one another. Thus, only one, rather than three, D type baffles is found effective for diverting the downwardly flowing oil in the ducts **42** into inwardly flowing opposed oil blasts **43** on two different levels, one above and the other below the D baffle, as indicated by the arrows. Furthermore the D baffles prevent the arc from wandering into the fluid ducts **42**. I may further modify the laminated interrupter structure of my invention by providing baffles C having notches **45** intermediate the several B baffles as depicted in Fig. 3. It will be observed that the notches **45** of the C baffles are arranged in registry with the spaces *44a* between the B and B^1 baffles. The effect of these C baffles is to subdivide the deep exhaust vents **44** into a greater number of small horizontal gas vents *44b* with the result that the deep exhaust passages **44** now constitute a pair of arc pockets **46** rather than freely venting passages. Accordingly, the arc is entrapped loopingly into these pockets during the extinguishing process in the same manner as set forth and claimed in, and as shown in Fig. 2 of, U. S. Patent 2,156,450 to F. H. Cole, which is assigned to the same assignee as the present application.

From the above, it will be apparent that the structure of Fig. 3 is substantially like that of Fig. 2 in that axial flow of the oil along the path of the arc is substantially eliminated during its transition from inward blast to outward exhaust.

In such a modified arrangement, it will be readily understandable that appropriately long vertical expulsion ports would be provided in the wall of the casing **7** in lieu of the pair of rectangular ports **41**, one of which is shown in Fig. 1. These deeper, narrower ports would, of course, lie in registry over the group of small vents *44b* shown in Fig. 3.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects and I, therefore, intend in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An interrupting unit for a fluid blast circuit breaker including an arc extinguishing structure, said structure comprising a composite assembly including a stacked series of flat insulating members each having an opening therein, said openings being arranged in registry to define an arc passage through said structure and a fluid flow duct adjacent thereto, other insulating members forming a part of said assembly and comprising separated plate-like portions lying in the same plane some of which have a generally U-shaped notch therein, each said U-shaped notch defining a portion of said fluid flow duct and a blast guiding means into said arc passage from said fluid flow duct and the spacing between the said separated portions defining lateral exhaust guiding means from said passage for the fluid blast.

2. An interrupting unit for a fluid blast circuit breaker including an arc extinguishing structure, said structure comprising a composite assembly including a stacked series of flat insulating members each having an opening therein, said openings being arranged in registry to define an arc passage through said structure and a fluid flow duct adjacent thereto, at least one of said plates having an opening defining a portion of said arc passage and another separate opening defining a portion of said fluid duct, the portion of said one of said plates which is disposed between the separate openings therein being effective to subdivide said fluid flow duct and to prevent the arc in said arc passage from wandering into said flow duct, other insulating members forming a part of said assembly and comprising separated plate-like portions lying in the same plane some of which have a generally U-shaped notch therein, each said U-shaped notch defining a portion of said fluid flow duct and a blast guiding means into said arc passage from said fluid flow duct and the spacing between the said separated portions defining lateral exhaust guiding means from said passage for the fluid blast.

CONRAD J. BALENTINE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,156,450	Cole	May 2, 1939
2,385,008	Leeds	Sept. 18, 1945
2,406,469	Ludwig	Aug. 27, 1946
2,422,569	Leeds	June 17, 1947