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D. M. UMPHREY

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CIRCUIT INTERRUPTER

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Fig. 1.

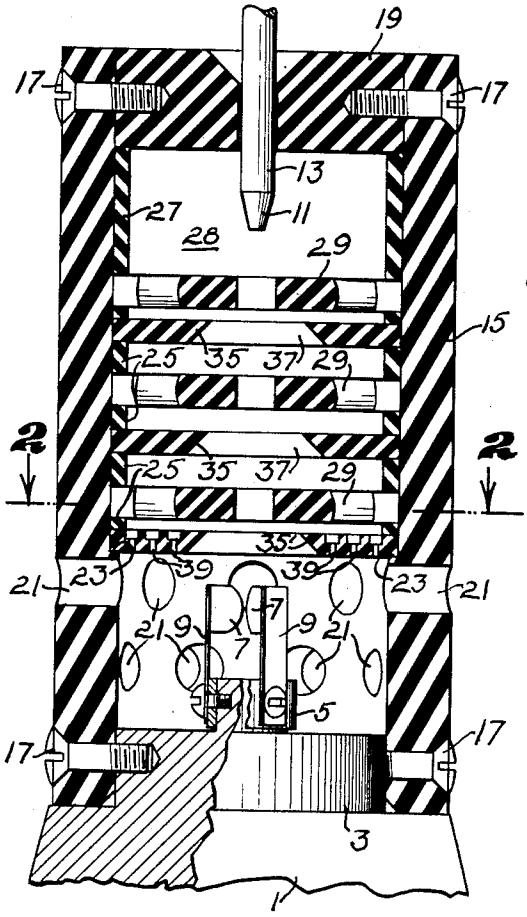
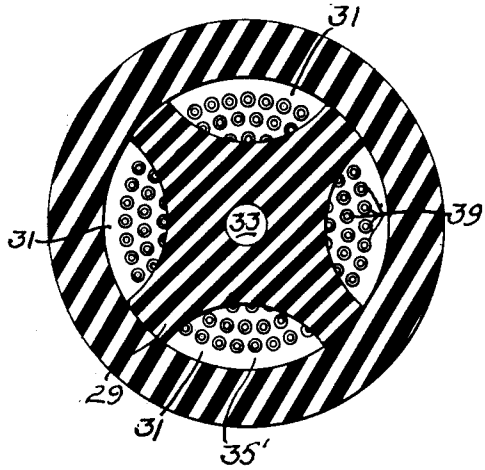


Fig. 2.



INVENTOR,
DONALD M. UMPHREY.
BY
Lippincott + Smith

ATTORNEYS.

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CIRCUIT INTERRUPTER

Donald M. Umphrey, Palo Alto, Calif., assignor to Pacific Electric Manufacturing Corp., a corporation of California

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5 Claims. (Cl. 200—150)

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This invention relates to circuit breakers of the oil-break type, and, specifically, to interrupter structures for extinguishing the arc formed when the break occurs and preventing its reestablishment. In certain aspects it is a specific form of the type of interrupter which is described generically in my co-pending application, Serial No. 105,388, filed July 18, 1949; in certain other features, however, it differs from the devices described in the aforementioned application.

High voltage circuit breakers in general interrupt the circuit by means of a separation of a moving contact, ordinarily consisting of a conducting rod, and a fixed contact. In the oil-break type, so-called, the contacts are submerged in a dielectric liquid which is usually a mineral oil but which may be of some other character, the purpose of which is to assist in cooling and extinguishing the arc formed when the contacts are separated and to increase the dielectric strength of the gap formed between them when once the circuit is broken.

It is usual in the art to have the break take place within an interrupter structure. This structure frequently consists of a housing or closure of insulating material, such as horn fiber, provided with a plurality of transverse baffles which are apertured to permit the passage of the movable contact and to form an arc path when the contacts are separated. The spaces between the baffles form pockets in which the oil or other dielectric liquid is retained, and means are frequently provided for driving the liquid from these pockets through the arc by means of pressure developed by vaporization of liquid, in order to raise its resistance and cause it to break earlier. Where this latter feature is not provided it is sometimes stated that the gaseous material developed in the arc will, in its escape from the housing, entrain the oil and accomplish much the same results.

In my prior application Serial No. 105,388, filed July 18, 1949, I have shown that the injection of oil streams into and through the arc is largely self-defeating, in that by increasing the arc resistance during periods of maximum current the energy liberated within the interrupter structure is greatly increased and that the explosive effects developed by such large liberation of energy are due in large degree to this

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fact. I have also shown that such explosive effects can be minimized, if not entirely prevented, by injecting oil into the arc vapors and gases outside of the arc path itself and thus condensing the vapor component, and that such condensation, by small oil jets, reduces the period during which the gases remain at high temperature, thereby minimizing cracking and the consequent formation of both fixed gases and of carbon. Furthermore, I have shown that while cooling of the arc itself during periods of high current density it is highly undesirable, if the resistance of the arc path can be increased as the current passes through zero and the gases be promptly deionized during this period, the reestablishment of the arc can be prevented and the break take place with the minimum explosive effects.

The present invention is designed to take advantage of these factors. Broadly, the structure comprises a housing of insulating material with cross baffles of like material much as has been described above. One end of the housing is substantially closed, while the other end is apertured, the apertures opening laterally so that the flow of material through them, when the circuit is broken, is transversely outward away from the arc path. The baffles are grouped, centrally of the housing, to form a chamber at each end of the housing so that at the completion of the breaking operation one of the two contacts is positioned in each chamber. The arc path then extends through the central openings in the baffles through which the movable contact extends when the breaker is closed. It will be seen that the description as thus far given is very much the same as that of the conventional interrupter structures that have already been described. The novel features lie in the formation of the baffles and their disposition relative to the arc path and the apertures in the housing. Two sets of baffles are used, which are disposed alternately. The baffles of the first set, including that nearest the closed end of the housing, have formed in them relatively large openings adjacent their peripheries. This is in addition to the central apertures which are only large enough to permit easy passage of the movable contact.

The baffles of the second set have no peripheral openings, but their central apertures are mate-

rially larger than is necessary to pass the movable contact. Preferably, too, these openings flare outwardly in the direction toward the open end of the housing. The last baffle of this second series, next the chamber at the open end, is provided with a multiplicity of small perforations, the purpose of which is to inject oil jets into the gases flowing outwardly through the openings in the housing.

All of this will be better appreciated by reference to the ensuing detailed description of one preferred form of my invention, taken in connection with the accompanying drawings wherein:

Fig. 1 is an axial sectional view of a preferred form of the interrupter structure; and

Fig. 2 is a transverse sectional view, the plane of section being indicated by the lines 2—2 of the first figure.

In the figures only the interrupter structure and the breaker contacts themselves are shown; the breaker may be of any of the types generally known in the art, the particular mechanism which causes the opening of the contact when a fault occurs, or when the device is used for switching, being no part of this invention. Suitable forms of breaker mechanism are indicated in my prior application already cited and in my co-pending applications Serial Nos. 235,586 and 235,587, but other conventional types of breaker mechanism may equally well be used.

Considering first Fig. 1, the drawing shows a fixed contact base 1, formed of metal of high conductivity such as brass or bronze and including a cylindrical boss 3 on which there is formed a central projecting tip 5. This tip carries fixed contacts 7, which are, as is customary, mounted upon conducting springs 9 of phosphor bronze or the like resilient material. When the breaker is closed these springs give to admit the conical or rounded tip 11 of a movable rod contact 13; the contacts 7 making a wiping connection with the movable contact under the pressure of the springs. This is in conformity with usual practice, and this structure may be modified to meet the requirements of any particular service if desired.

A housing 15, preferably of horn fiber, is fitted over the boss 3 and secured firmly thereto, as, for example, by the screws 17. The upper end of the housing is closed by a cap 19, similarly secured, the only opening in this cap being that to admit the passage of the rod contact 13. Since this contact is not withdrawn from the aperture, during the breaking operation (as shown in the drawing) the cap end of the housing is effectively closed.

A plurality of apertures 21 are formed laterally through the walls of the housing at its lower end. These apertures are preferably as large in number and in size as is consistent with maintaining the strength of the structure, since what is desired is a free lateral outward flow of fluid from this portion of the housing. In the present instance the apertures are shown in the end of the housing adjacent the fixed contacts, this being preferred since it permits ready outward flow with minimum inertia opposing such flow from the instant the arc starts to form upon the separation of the fixed moving contacts.

In the device shown an internal shoulder 23 is formed within the housing immediately above the apertures 21. This shoulder serves to support a stack of baffles, the baffles in the stack being separated by insulating spacer rings 25 to form

narrow chambers therebetween. Above the top baffle of the stack is a wide spacer ring 27 which bears against the closure 19 and holds the entire stack in place, and forms a relatively wide chamber 28 into which the end 11 of the movable contact projects when the breaker is fully open.

The baffles in the stacks alternate between two distinct types. The baffle 29, nearest the closed end of the housing, and the alternate baffles thereafter which are designated by the same reference character, are of the first type. As shown in the sectional view of Fig. 2 these baffles have openings 31 in their peripheries giving them something of a star or cruciform shape; the shape of the openings and therefore the baffles themselves is unimportant as long as the lumen of the openings is relatively large. The central hole 33, which permits the passage of the movable contact and also forms the arc path, is made only large enough to permit the free passage of the contact.

Intermediate the successive baffles 29 are the baffles 35 of the second type. These have no peripheral openings formed therein but the central aperture is considerably larger than those formed of the baffles 29. Preferably these apertures 37 flare outwardly toward the open end of the housing, as shown. The final baffle of the stack, designated as 35', is similar in shape to the baffles 35 but differs in that it is provided with a multiplicity of small perforations 39 distributed over its area.

In operation, when the breaker is tripped, either in switching or under a fault, an arc is formed between contacts 7 and the tip 11 of the movable contact as soon as they start to separate, the arc lengthening until the electrodes or contacts are in the position shown in the diagram. The formation of the arc immediately causes a large pressure rise within the housing due to the vaporization of oil within the interrupter. Since the upper end of the housing is substantially closed, whereas there are openings of large area out of the lower chamber, a pressure gradient is at once set up along the length of the housing which tends to scavenge both oil and vapor from the housing and out through the apertures 21. The pressure within the arc path itself is relatively high when considered at any level along the path, since it is within the arc that the vapor pressure is being generated.

Considering first the peak periods of the current cycle, the pressure in the chamber 28 tends to force the oil from it through the openings 31 into the space between the upper baffle 29 and the next succeeding baffle 35. As there are no peripheral openings in this latter baffle the oil is redirected inwardly toward the arc from all sides, and thence down and along the surface of the arc path through the aperture 37, following the flare in this aperture toward the openings 31 in the next succeeding baffle. This process is repeated between each successive set of baffles until the final baffle 35' is reached. At this point, both because of its momentum and because of the increasing volume of vapor surrounding the arc at this point, the oil is forced through the perforations 39 and emerges into the lower chamber of the housing in the form of jets.

There are several points to be noted about the flow as thus described. First, within the gaseous path that constitutes the arc itself, the pressure gradient transverse of the path is either non-existent or falls outwardly; there is no escape laterally for the gases developed and since these constantly tend to expand the flow of fluid with-

in the interrupter housing can only be longitudinal thereof. The flow therefore must necessarily comprise an inner core of gas which is surrounded by the liquid. Second, even when the liquid flow is directed radially inward between baffles **29** and **35**, very little of this liquid can enter the arc stream because of the high pressure just mentioned. Accordingly the liquid flow is deflected, almost as by striking a wall, and, following the longitudinal pressure gradient through the interrupter, eventually reaches the apertured chamber. In the meantime the gas surrounding or constituting the arc itself forms a core of increasing diameter as the open end of the housing is reached, both because of expansion due to reduced pressure and to the generation of more gas along the length of the arc. The diameter of the gaseous core will, of course, vary with the amount of current and heat generated in the arc flow and under a heavy fault it may quite possibly fill substantially the entire central aperture in the lowest baffle **35'**. Experience has shown, however, that because of the effects mentioned there will be still enough oil forced through the perforations **39** to form condensing jets which are projected transversely into the stream of vapor flowing toward the lateral apertures **21**. These jets condense the vapor so that there is almost no gas bubble escaping into the liquid in which the interrupter is immersed. This is the case even though the arc may persist for periods which are quite long in comparison with one cycle of the current to be interrupted; in experimental work the movable contact has been withdrawn manually at a rate of only a few feet per second at most, so that the arc length increased very slowly indeed in comparison with ordinary circuit breaker operation. Even under these circumstances, which would normally be conducive to extremely violent explosive effects, the breaking of the circuit is accomplished without commotion of any kind.

When, in the course of the alternating current cycle, the current through the arc approaches zero, a quite different set of conditions obtains. At this instant the rate at which energy is liberated in the arc is falling very rapidly and the generation of pressure within the arc stream accordingly decreases with like rapidity. There still exists gas pressure within chamber **28** which continues to force the oil along its sinuous path through the interrupter. The pressure within the arc stream itself now decreasing rapidly, however, the radially inflowing oil from above each of the baffles **35** can penetrate the arc more deeply, cool and deionize it more rapidly and thus raise its resistance, tending to cause it to break and effect final interruption in the circuit.

The current density in the arc remains substantially constant. As the current falls toward zero, preparatory to reversing, the cross section of the arc decreases proportionally and the radius and circumference as the square root of the current. The radiation from the circumference remains high, so that in the last few microseconds the arc cools rapidly. In these last microseconds the rate of change of the radius is so rapid that it is impossible for a mechanically propelled fluid to keep up with it, but in these last instants the liquid does tend to follow the collapsing arc, rendering it more difficult for it to re-establish itself.

The jet condenser principle which is used in this invention to liquify and thus dispose of the condensible portion of the vaporized oil is covered

broadly by claims entered in my co-pending application first above referred to. What it is desired to protect as broadly as possible in the present application is the means of so controlling the oil flow within the interrupter structure as to take advantage of the changing pressure and current conditions within the arc itself; raising the resistance, energy liberation and temperature within the arc very slightly during current maxima, and, in the following instant, when the energy liberation is at a minimum in any event, to cause the liquid to enter the stream of ionized gas and have maximum interrupting effect. The details of construction as shown in the drawings are to be taken as illustrative merely; the stack of baffles used may be as long as desired and the actual shapes of the baffles may vary widely. What is desired therefore, is protection on the invention as broadly as defined by the following claims.

I claim:

1. An interrupter structure for high voltage oil type circuit breakers comprising a tubular housing of insulating material, closures fixed to each end of said housing, a fixed contact mounted on one of said closures, the other being apertured to permit the passage of a movable rod contact, and a plurality of transverse baffles positioned intermediate the ends of said housing, said baffles being grouped to form relatively narrow chambers therebetween and spaced from both closures to form relatively wide chambers at the ends of the housing, said housing having relatively large apertures therein opening into one of said wider chambers; all of said baffles being centrally apertured to permit the passage of said movable contact, alternate baffles having openings therein adjacent the peripheries thereof and the remaining baffles having relatively larger central apertures, the baffle nearest the apertured end of the housing having a multiplicity of perforations distributed over the surface thereof to direct jets transversely across fluid flowing radially outward through the housing apertures.

2. An interrupter structure in accordance with claim 1 wherein said fixed contact is positioned in the apertured end of said housing.

3. An interrupter structure in accordance with claim 1 wherein the larger central apertures in said second described baffles are flared outwardly toward the apertured end of said housing.

4. An interrupter structure for circuit breakers of the oil-break type comprising a housing substantially closed at one end and having openings at the other to permit ingress and egress of a dielectric liquid, a fixed contact in one end of said housing, the other end having an aperture therein to permit the passage of a movable contact, and a plurality of baffles grouped centrally of said housing to form larger chambers adjacent the ends of said housing than between said baffles, all of said baffles being apertured to permit the passage of said movable contact and to provide an arc path between said contacts, alternate baffles, starting with that nearest the substantially closed end of said housing, having openings therein adjacent their peripheries and enlarged apertures surrounding said arc path respectively, whereby said dielectric liquid when forced out of said housing by pressure generated by an arc, is constrained to follow a sinuous path past said baffles, alternately outwardly toward and through the peripheral openings of one set of baffles and inwardly toward and through the enlarged central openings of the alternate baffles.

5. An interrupter structure in accordance with claim 4 wherein the baffle adjacent the open end of said housing is provided with perforations shaped to direct jets of said dielectric liquid into and through the fluid in the chamber adjacent the open end of said housing.

DONALD M. UMPHREY.

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