Aug. 17, 1965 E. BALDINI 3,201,552

ARC-EXTINGUISHING GRID STRUCTURE FOR LIQUID-TYPE INTERRUPTER

Filed April 10, 1962

2 Sheets-Sheet 1

Fig. 1

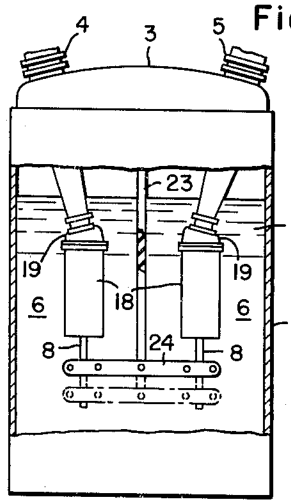
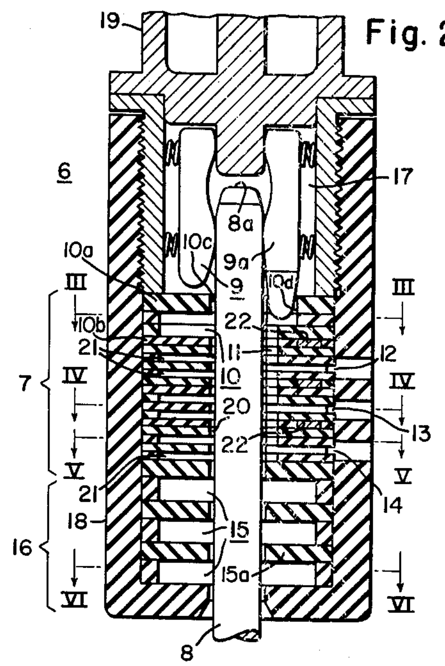



Fig. 2



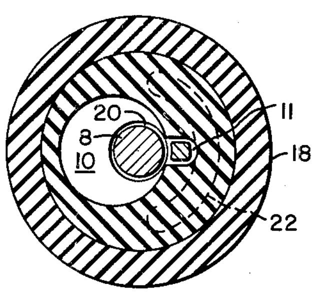




Fig. 3

Fig. 4

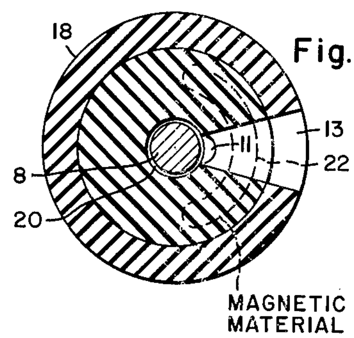
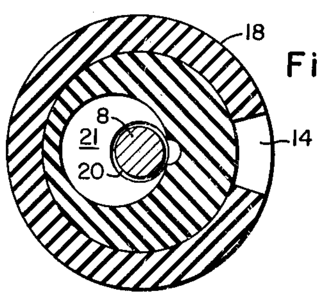



Fig. 5



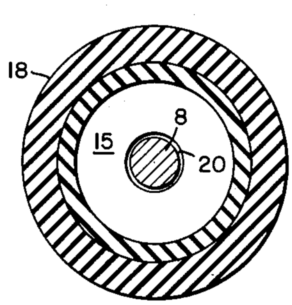




Fig. 6

WITNESSES

John E. Healy, Jr.

James F. Young

INVENTOR

Enrico Baldini

BY

Willard R. Crout

ATTORNEY

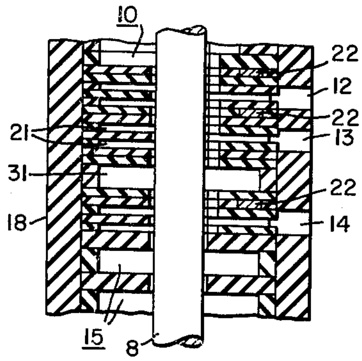
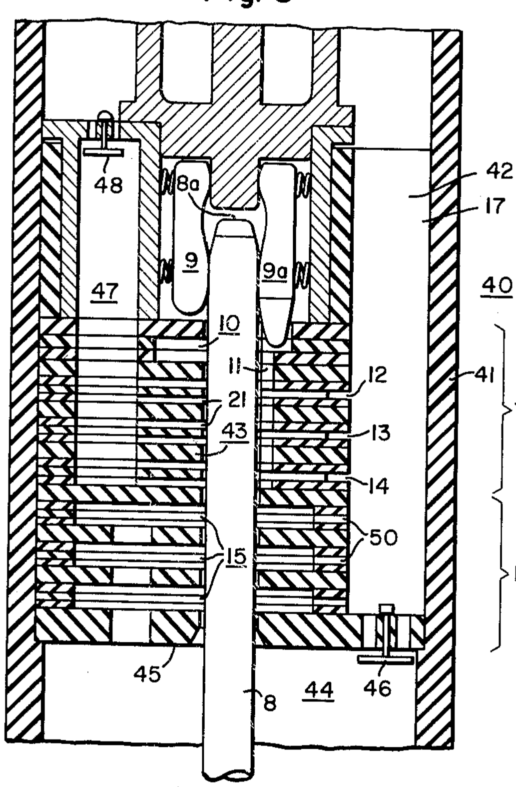



Fig. 7

Fig. 8



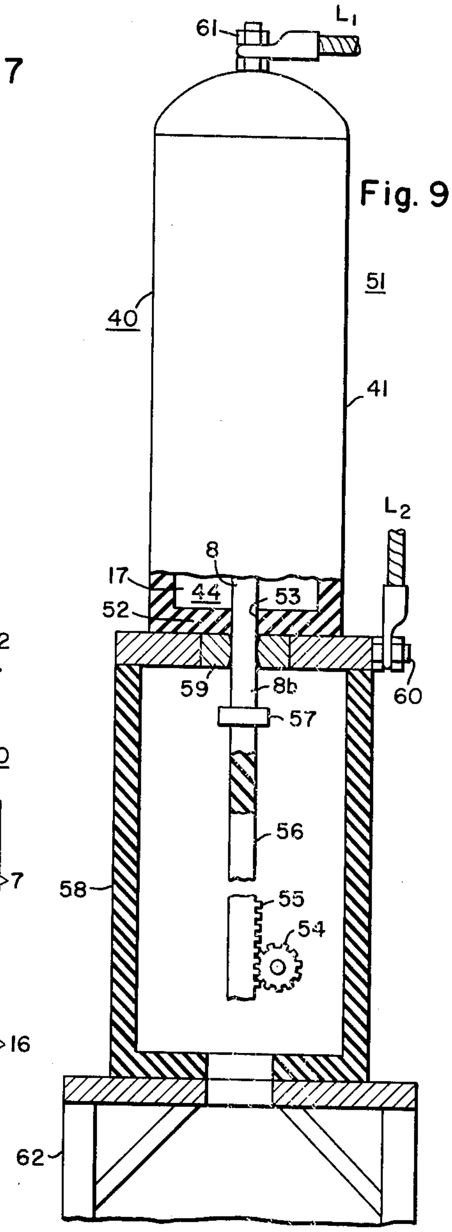




Fig. 9

United States Patent Office

3,201,552
Patented Aug. 17, 1965



3,201,552

# ARC-EXTINGUISHING GRID STRUCTURE FOR LIQUID-TYPE INTERRUPTER

Enrico Baldini, Bergamo, Italy, assignor to Magrini Societa per Azioni, Bergamo, Italy, a corporation of Italy

Filed Apr. 10, 1962, Ser. No. 186,442
Claims priority, application Italy, Apr. 11, 1961, 12,174/61
6 Claims. (Cl. 200—150)

This invention relates to arc-extinguishing grid structures for liquid-break circuit interrupters in general, and, more particularly, to grid structures for liquid-break circuit interrupters utilizing a blast of arc-extinguishing liquid injected into the established arc stream to effect the extinction thereof.

A general object of the present invention is to provide an improved liquid-break type of circuit interrupter which will effectively bring about circuit interruption over a wide range of current values.

A more specific object of the present invention is to provide an improved arc-chamber construction, in which, by a suitable disposition of venting passages and pocket construction, a more efficient interruption of the circuit is brought about.

Another object of the present invention is the provision of an improved arc-extinguishing unit for a liquid-break circuit interrupter, in which two portions of the arc-extinguishing unit are provided, and in which one portion is particularly suitable for high-current interruption such as that associated with fault currents, whereas the other portion of the arc-extinguishing unit is particularly adapted for low and medium-current interruption.

Yet a further object of the present invention is the provision of an improved liquid-break circuit interrupter involving a rod-shaped movable contact, in which suitable laminated plate structure is provided to locate, and to maintain the arc adjacent a plurality of vents, and in which the liquid flow, such as oil flow, is more efficiently directed along the arc stream to rapidly bring about circuit interruption with a minimum expenditure of arc energy.

Still a further object of the present invention is the provision of an improved arc-extinguishing unit which may be utilized either in a tank-type circuit interrupter, or in an oil-poor type of circuit interrupter construction.

A further object of the present invention is the provision of an improved laminated-plate arc-extinguishing unit construction, in which suitable vent passages are provided for positively locating the established arc, and in which magnetic means, such as suitably-configured substantially U-shaped plates of magnetic material, are interposed within the plate structure to assist in maintaining the arc adjacent such venting means.

The present invention is particularly adapted to fluid-type circuit-interrupting units, particularly those of the oil-break type, and may be extended over a wide-voltage and wide-power application. It has been discovered that particular effectiveness is achieved by an interrupting chamber construction in which the vents are suitably arranged for the escape of gases generated by the arc during circuit interruption. As well known by those skilled in the art, generally there are two types of interrupting chambers. One type involves the interruption of the arc by drawing the same along an axis, and then providing axial venting for the gas products. The other type of generally recognized arcing chamber involves the utilization of transverse, or cross vents, which provide a transverse flow and venting of the arc-extinguishing medium with the consequent escape of the generated gas.



It has been noted that interrupting chambers having an axial flow of arc-extinguishing fluid demonstrate particular effectiveness during the interruption of small and medium current values. For higher currents, on the other hand, such an interrupting chamber results in considerably longer arcing time, and hence the internal pressure may rise above a desirable value. On the other hand, it has been discovered that arcing chambers having transverse, or cross vents, instead of axial vents, provide particular effectiveness for high-value currents, but have the disadvantage of relatively long arcing time in attempting to interrupt small and medium-value currents.

In the interruption of short-circuit currents with transversal flow it is not generally possible to generate excessive pressures since the gases may readily escape near the vicinity at which they are produced. On the other hand, with transversal flow in the interruption of small and medium-value currents the developed pressures may be inadequate for rapid interruption and, consequently such adequate pressures as are necessary are not obtainable with a cross-blast construction to result in reasonably short arcing times.

It is an important feature of the present invention to provide an improved arcing chamber, which combines the characteristics of an arcing chamber having transversal flow with an arcing chamber having axial flow, to result in the elimination of the foregoing disadvantages, and yet to preserve the advantages of the two types of flow mentioned above. The part of the arcing chamber functioning with axial flow is reserved for the interruption of small and medium-value currents, whereas the part of the arcing chamber, which functions with transversal flow, comes into particular effectiveness during the interruption of high-value short-circuit currents, and it is relatively ineffective when interrupting small and medium-value currents. In fact, considering cases of high short-circuit currents, the energy brought into existence is relatively high, and adequate venting area of considerable size must consequently be allowed. On the other hand, when one considers the interruption of small and medium-value currents, during which the arc energy is somewhat limited, it is, therefore, possible for the gases to escape substantially immediately adjacent the point at which they are produced, and at a consequent current zero there is not sufficient pressure to bring about effective circuit interruption.

In the absence of external sources which assist in deionization, the interruption of small and medium-value currents should be effectively contained in the part of the arcing chamber having an axial flow. It is obvious that it is, therefore, exceedingly difficult to design an arcing chamber, which is effective over the entire current range, that is having the ability to interrupt low, medium and high value currents. Such a construction is apt to be quite expensive. In addition, one has the disadvantage that for the lower-value currents and for the maximum short-circuit currents the dimensions for adequate flow conditions may vary, and one may obtain higher arcing times than if the arcing chamber contains only axial flow. It results that, for example, in the interruption of currents of 10% or below of interrupter rating, the arcing times may be considerably longer than those which are obtained when one approaches 100% rating of the interrupter.

In the present invention, it is desired to bring about an axial flow for the interruption of small and medium-value currents, and also to provide for a certain portion of the arcing chamber a cross-blast or transversal flow. Such an arrangement must, however, avoid the disadvantage of internal vertical movements of the arc-extinguishing fluids within the chamber causing the arc to assume an unfavorable position relative to the vents for rapid circuit interruption, particularly when interrupting high-value short-circuit currents, and in which type of interruption the higher pressures result.

It will, of course, be obvious that for different values of voltage and for short-circuit currents, the number of venting passages, and the number of arcing chambers in which the arc is drawn may be varied to bring about maximum effectiveness. In addition, it is desirable to cause the arc to assume the most advantageous position with respect to the vents. In such connection it is also to be noted that there is a possibility of movement of the fluid inside of the arcing chamber near the vents in their immediate vicinity, and that such fluid movement plays an important role during the interruption phenomena.

As mentioned hereinbefore, it is a distinct purpose of the present invention to provide an improved arc-extinction chamber having transversal and, in addition, axial flow to result thereby in an arrangement in which it is possible to interrupt high currents at high voltages with short arcing times, and with the arc energy considerably reduced. In addition, it is desirable to utilize a relatively small quantity of arc-extinguishing fluid, and therefore the vent areas are preferably reduced as much as possible.

The portion of the arcing chamber having transversal flow is arranged to be particularly effective in the interruption of high-value short-circuit currents, but in addition, has substantially constant arcing time over a wide range of currents say between 10% and 100% of interrupter rating. In this range, the arc is maintained in an advantageous position with respect to the transverse vents. A particularly effective means for bringing about such an advantageous position of the arc is to provide a fixed arcing contact of such form as to assure that at the instant of opening the circuit it will cause the arc to originate at the most advantageous point. Preferably, this fixed arcing contact is itself disposed in the symmetrical plane of the transverse vents. In addition, pockets, containing arc-extinguishing fluid, are of limited height to avoid axial movement of the fluid therein, which could possible displace the arc laterally into an undesired position. Particularly effective location and maintenance of the arc position is obtained by the use of substantially U-shaped members of magnetic material, which are preferably inserted within the insulating plates in desired locations with respect to the transverse vents, and hence result in the formation of a magnetic field to maintain the arc in the desired position relative to such transverse vents.

It has been discovered that by the provision of a longitudinal groove disposed inside of the arcing chamber arranged axially of the bore thereof, and disposed in the immediate vicinity of the transverse vents, that the gas produced by the arc may, in conjunction with a suitable pocket of fluid, escape at the rear putting into motion fluid, which is trapped in the vent channels ever before the moving contact clears the vent openings, thereby creating in the longitudinal groove and in the vent channels the lower pressure which is conducive for the desirable positioning of the arc. The presence of the aforesaid longitudinal groove adjacent the stationary-contact end of the arcing unit provides additionally highly-effective conditions for extinguishing the arc. Among these advantages are a pre-acceleration of the fluid in the transverse vents near the zone of the arcing contact, even before the tip of the moving contact clears such vents. Such an arrangement favors the establishment of a transversal flow at the instant of formation of the gas in the lower pockets of fluid. One obtains in such manner relatively short arcing times with a reduction of pressure in the vents.

The utilization of a longitudinal groove also provides the advantage in that the fluid near the fixed contact zone, after the movement of the moving contact during a closing operation, may escape at the rear of the chamber through the transverse vents without having to reflow through auxiliary vents provided in the region of the fixed contacts. As a result, such auxiliary vents, if provided, would permit the escape of gas at many points and could alter the position of the arc during an interrupting operation. In addition, the presence of the longitudinal groove results in a remarkable reduction of pressure created by the re-ignition, or prearcing during the closing operation of the interrupter in the vicinity of the fixed contacts.

The reduction of arc energy obtained by a utilization of the improved interrupting unit of the present invention results in obtaining rapid reclosures with a minimum expenditure of arc energy. Such rapid reclosures may occur within 0.2 or 0.3 seconds, even with relatively high-value short-circuit currents.

It is to be noted that the fluid, which is contained within the fluid pockets, is not all involved in the movement of the arc, and that a relatively small quantity thereof is actually involved in the circuit-interruption phenomena. For relatively high-value short-circuit power it is possible to augment the quantity of fluid available for the interruption without varying the form and dimensions of the pockets by communicating the pockets with an auxiliary reservoir, which may be located at a point opposite the position of the transverse vents with respect to the axis of the moving contact. Preferably, such an auxiliary reservoir is provided at the upper part thereof with one or more valves, which close when a pressure is generated inside of such auxiliary reservoir to result in the application of fresh fluid toward the active fluid pockets, without altering the position of the arc during circuit interruption. In addition, at a natural current zero, and hence at a time of relatively low arc energy, the fluid under pressure contained in such auxiliary reservoir provides laminar jets through the transverse vents and thereby results in rapid arc interruption.

With such an arrangement, it is to be noted that there results a considerable reduction in the magnitude of the arc voltage. Moreover, the pressure of the fluid is particularly effective in the vicinity of current zero. Moreover, such an arrangement permits an immediate replenishment of the arc-extinguishing fluid after each circuit-opening operation, rendering thereby possible rapid cycles of reclosure with relatively high-value short-circuit currents.

The improved circuit-interrupting unit of the present invention avoids transverse fluid flow in the lower portion of the interrupting unit, so that the generated arc gases may escape only in an axial direction. To facilitate the interruption of relatively small-value currents at relatively high voltage it may be advantageous to instigate during the opening operation an initiation of fluid only in the lower part of the arcing chamber. Such initiation may be obtained by utilizing the quantity of fluid naturally moved by the moving contact during its descent toward the opening direction, and is brought about by a displacement pumping action.

Further objects and advantages will readily become apparent upon reading the following specification, taken in conjunction with the drawings, in which:

FIG. 1 is a side elevational view of a tank-type circuit interrupter, partially in vertical section, embodying the present invention, and the contact structure being illustrated in the closed-circuit position;

FIG. 2 is a considerably-enlarged vertical sectional view taken through one of the two arc-extinguishing units of the tank-type circuit interrupter of FIG. 1, again the contact structure being illustrated in the closed-circuit position;

FIGS. 3–6 are cross-sectional views taken respectively along the lines III—III, IV—IV, V—V and VI—VI of the arc-extinguishing unit of FIG. 2;

FIG. 7 is a fragmentary vertical sectional view taken through a modified-type of arc-extinguishing unit having a slightly different pocket construction than that illustrated in FIG. 2;

FIG. 8 is a vertical sectional view taken through another modified-type arc-extinguishing unit, which may be substituted for the arc-extinguishing unit of FIG. 2 in the tank structure of FIG. 1, again the contact structure being illustrated in the closed-circuit position; and,

FIG. 9 is a side elevational view, partially in vertical section, of an oil-poor type of circuit interrupter utilizing the arc-extinguishing unit construction of FIG. 8, with the contact structure being illustrated in the closed-circuit position.

Referring to the drawings, and more particularly to FIG. 1 thereof, the reference numeral **1** generally designates a liquid-break circuit interrupter including a tank structure **2** having a cover **3**, through which a pair of terminal bushings **4, 5** project. Each of the terminal bushings **4, 5** has attached thereto, adjacent the lower end thereof, an arc-extinguishing unit or chamber **6**.

FIGS. 2–6 more clearly illustrate the arc-extinguishing structure. With reference to FIG. 2, it will be noted that the movable contact **8** cooperates with a plurality of relatively fixed main contacts **9**, and also with a relatively longer arcing finger contact **9***a*. Since the arcing finger contact **9***a* extends axially to a greater extent than the other main contacts **9**, it will be apparent that the arc, which is established during the opening operation, is drawn at the lower extremity of the arcing contact **9***a*.

Preferably the arc-extinguishing unit or chamber **6** comprises a plurality of stacked laminated insulating plates or plate portions of suitable configuration to provide an enlarged unvented pressure pocket opening **10**, a longitudinal groove **11**, a plurality of transverse vents **12–14**, and a plurality of relatively large lower pocket chambers **15** containing a suitable arc-extinguishing fluid, such as oil **17**.

Enveloping the laminated plate structure is preferably provided an insulating casing **18**, which may be attached, by means not disclosed, to an upper contact-foot casting **19**. The contact-foot casting **19** is preferably threadedly secured, and clamped to the lower ends of the terminal bushings **4, 5** in a manner more clearly illustrated in FIG. 1.

It is to be noted that the lateral venting means comprising the transverse vents **12–14** are provided only adjacent the upper portion **7** of the interrupting unit **6**, and that they are particularly designed for the interruption of relatively high-value short-circuit currents.

FIG. 3 more clearly shows the longitudinal groove **11**, which extends axially of the bore **20** of the interrupting unit **6**, and through which gas produced by the arc may escape externally of the chamber **6** prior to the actual clearance of the moving contact **8** across the transverse vents **12–14**.

It will be noted that the upper unvented pressure pocket **10** contains considerable pressure during the opening operation, whereas the pockets **15**, disposed at the lower end **16** of the interrupting unit **6** are particularly designed for the interruption of small or medium-value currents. In addition, it is to be noted that the intermediate laminated pockets or pocket chambers **21** have a smaller height than those of the pockets **10** and **15**. As illustrated in FIGS. 3–6, the pockets **10, 15** and **20** are provided by the suitable stacking of suitably configured insulating plates, and a plurality of substantially U-shaped magnetic plates **22** are interposed between adjacent insulating plates. The entire stack may be keyed, in a manner not shown, so as to prevent the several plates from being disarranged and finally cemented, if desired, into the proper position.

FIGURE 1 illustrates the disposition of the interrupting unit **6** in a tank **2** containing a suitable arc-extinguishing fluid **17**, such as circuit-breaker oil. During the opening operation, a lift rod **23** carrying a cross-bar **24** forcibly causes the movable contacts **8** to move downwardly in a circuit opening direction. When the moving contacts **8** move downwardly in the opening direction, the arc, not shown, is drawn between the arcing contact finger **9***a* and the upper extremity **8***a* of the moving contact **8**. As mentioned hereinbefore, the pressure generated within the upper enlarged pressure pocket **10** causes an initial downward displacement of fluid within the longitudinal groove **11** and out through the transverse vents **12–14**. The arc is drawn across the inlets of the cross vents **12–14** and subjected to a lateral blast of oil under pressure, as generated by the arc itself.



The unvented pressure pocket **10** is, in part, defined by an end insulating closure plate portion **10***a* and by another plate portion **10***b* spaced therefrom axially along the arc-extinguishing chamber **6**. The end closure plate **10***a* has an aperture **10***c* provided therein to accommodate the movable rod-shaped contact **8**. In addition, the end closure plate **10***a* has a lateral communicating groove opening **10***d* on one side thereof through which the tip portion of the elongated contact **9***a* extends with slight clearance.

When not dealing with relatively small inductive currents, the first portion of the arc is established within the pressure pocket **10**, which is unvented. As a result, the pressure rises in the pressure pocket **10**, and the pressure escapes longitudinally of the groove **11** and out the transverse vents **12–14** causing an initial flow of fluid therethrough. As a result the fluid in such vents **12–14** is caused to assume an initial displacement by the time the upper extremity **8***a* of the moving contact **8** uncovers, or clears the vents **12–14**. As a result, there are not encountered prohibitive pressures since there has previously been established an initial acceleration of fluid through the vents **12–14**.

The magnetic field created by the use of the substantially U-shaped magnetic members **22**, in addition to the flow of gas generated within the pressure pocket **10**, causes the arc to be drawn and to remain in the most advantageous exposed position susceptible to interruption, that is in front of the transverse vents **12–14**.

The non-ionized relatively cold gas products within the pockets **21** are compelled to mix with the ionized gas of the arc column for a period of time close to current zero to result in a rapid dielectric recovery, and thus a quick interruption of the arc results before the moving contact **8** has reached the lower portion or low-current interrupting section **16** of the interrupting unit **8** in which the axial flow occurs.

The position of the arc, and the form and dimensions of the pockets **21** and transverse vents **12–14** are such that the deionizing action achieves its maximum effectiveness when the instantaneous value of the short-circuit current diminishes toward a current zero. As a result, there is no unnecessary increase in arc voltage, and hence there is a minimum of decomposition of fluid **17**. The fact that relatively low arc voltage results even with relatively high-value currents enables one to utilize an interrupting chamber **6** of reduced dimensions, and obtain many interrupting operations with rapid reclosures, if desired.

The minimum energy developed by the arc during high-current interruption, and the minimum quantity of arc products resulting permits a rapid diffusion of the gases themselves across the transverse vents **12–14**, which may be, correspondingly, of reduced cross-sectional dimensions. Such reduced dimensions have the additional advantage that in the case of short-circuit currents it is possible to obtain sufficient pressures even in the case of rapid arc interruption.

In the case of relatively small or medium-value currents, say of an inductive nature, the arc may become elongated into the lower portion or low-current interrupting region **16** of the unit **6** and into the arcing pockets **15**. In these pockets, or arcing chambers **15** the gases generally flow along the bore 20 of the moving contact 8 and effect an axial quenching of the established arc by the fluid flowing in opposite directions upwardly and downwardly. In more detail, the low-current interrupting section 16 comprises a plurality of spaced closed pocket chambers 15 having spaced orifice plates 15*a*.

The relation in size between the upper chamber 7 and the lower chamber 16 will naturally vary with the voltage and current rating of the particular circuit interrupter 1. Preferably, the transverse vents 12–14 are arranged angularly with respect to one another to avoid the possibility of external re-ignition of the arc gases outside of the insulating casing 18.

FIG. 7 illustrates a slightly modified-type of arc-extinguishing unit 30 in which a plurality of unvented relatively large arcing chambers 31 are provided between adjacent vent openings 12–14. These pressure pockets 31 assist in circuit interruption for particular applications.

FIGS. 8 and 9 illustrate a modification of the invention in which a modified-type of arc-extinguishing unit 40 may be employed. The arc-extinguishing unit 40 may be utilized in place of the arc-extinguishing unit 6, or 30 in the tank structure 2 of FIG. 1, or the modified-type of arc-extinguishing unit 40 may be utilized in an oil-poor circuit-interrupter construction, as pictured in FIG. 9 of the drawings.

With reference to FIG. 8, it will be noted that the modified-type arcing chamber 40 includes an insulating casing 41 filled with a suitable arc-extinguishing fluid 17, such as oil. The upper chamber 42 provides for the expansion of the arc products. A lower chamber 44 is filled with the fluid 17, and is separated from the upper chamber 42 by a diaphragm 45 having a valve 46 controlling the flow therebetween. The extinction chamber 43 located directly above the diaphragm 45 is provided with an auxiliary reservoir chamber 47, which is filled with fluid 17 and preferably has a valve 48 at its upper end. This valve 48 closes when the pressure rises within the auxiliary reservoir 47. The reservoir 47 communicates with the lower portion of the chamber having the transverse vents 12–14. Such a reservoir 47 may be cylindrical, or annular in configuration.

During the interruption of short-circuit currents, the fluid 17, contained within the auxiliary reservoir 47, rises in pressure, and causes the closing of the valve 48. When at the time of a natural current zero the arc energy, associted with the arc is zero, the fluid under pressure maintained, within the auxiliary reservoir 47, causes a plurality of lateral jets of fluid into the pockets 21. This fluid traverses the established arc, and vents out of the chamber 43 through the lateral vent openings 12–14. In such action, the position of the arc itself in front of the vent openings 12–14 is not affected. The deionizing action is hence particularly effective in the proximity of current zero, and hence the arc voltage and its duration is limited. After each interruption, the fluid 17 within the auxiliary arcing chamber 47 is replenished by opening of the valve 48. The positioning of the arc, and the affect of the magnetic members 22 and the pre-acceleration of the fluid contained in the transverse vents 12–14 through the longitudinal groove 11 is identical to the manner described above in connection with FIG. 2 of the drawings.

It is to be noted that the interruption of small inductive currents is considerably facilitated by a jet of fluid which follows the downward displacement of the moving contact 8 into the chamber 44 filled with fluid 17 and separated by means of the diaphragm 45 and the valve 46 from the expansion chamber 42. Such fluid causes jets of oil to traverse the arc, and moreover causes an axial flow toward the top and the bottom of the lower portion 16 of the interrupting unit 40.

During the initial travel of the moving contact 8, that is until the upper extremity 8*a* of the contact 8 has not left the upper chamber 7 having transversal flow, the fluid may be injected from the lower part of the chamber 43, that is from region 44, and may flow externally of the extinction chamber 43 across the vents 50, which may be adequately dimensioned. Following a circuit-opening operation, the fluid within the lower chamber 44 may be replenished by opening of the control valve 46.



The injection of fluid in the lower part of the arcing chamber 43 may be obtained by the displacement of fluid 17 occurring during the opening of the moving contact 8 into the chamber 44. In effect, such displacement is brought about by the action of the moving contact 8 itself.

As well known by those skilled in the art, certain variations in dimensions and constructional details may be provided dependent upon the voltage and current rating desired to be effected.

FIG. 9 illustrates an application of the modified-type arc-extinguishing unit 40 of FIG. 8 to an oil-poor type of circuit interrupter 51. As shown, the unit 40 has a lower closure plate portion 52, through an aperture 53 of which the rod-shaped movable contact may be actuated by a pinion gear 54. The pinion gear 54 meshes with a rack portion 55 on the side of an insulating operating rod 56. The upper end of the insulating operating rod 56 is attached, through a coupling connection 57, with the lower extremity 8*b* of the moving contact rod 8.

An insulating pedestal 58 supports the unit 40, and slider contacts 59 transmit the line current to a lower terminal 60 of the interrupter 51. An upper terminal 61 is connected to the relatively stationary contact 9 of the unit. A lower grounded framework 62, which may be formed from angle-irons may be used to support the entire structure up in the air an adequate distance above ground potential.

Although there has been illustrated and described specific structures, it is to be clearly understood that the same were merely for the purpose of illustration, and that changes and modifications may readily be made therein by those skilled in the art, without departing from the spirit and scope of the invention.

I claim as my invention:

1. A circuit interrupter of the liquid-break type including an arc-extinguishing chamber, relatively stationary contact structure including a plurality of finger contacts disposed adjacent one end of said arc-extinguishing chamber including an elongated contact finger extending a greater distance toward the other end of said chamber than the other stationary finger contacts, a movable cooperable rod-shaped contact separable from said relatively stationary contact structure to establish an arc interiorly of the arc-extinguishing chamber, extinguishing means including a stack of apertured contiguously-disposed plate portions having an end insulating closure plate with an aperture therein, through which said movable rod-shaped contact moves with slight clearance, said aperture in said end closure plate having a lateral communicating groove opening on one side thereof through which the tip portion of said elongated contact extends with slight clearance, said extinguishing means defining an unvented pressure pocket (10) on the other side of said movable contact, said unvented pressure pocket in part defined by said closure plate and by another plate portion spaced therefrom axially along said chamber, said extinguishing means defining an axial groove (11) in the plane of said lateral opening in the end closure plate and adjoining plate portions communicating with the apertures through the several plate portions, lateral venting means extending out of said chamber and disposed at a location spaced axially toward the other end of said chamber from said unvented pressure pocket (10), whereby a pre-acceleration of the liquid occurs along said groove and out of said lateral venting means prior to clearance of the tip of the movable contact past such venting means.

2. The combination according to claim 1, wherein a low-current interrupting section is provided adjacent the

other end of the arc-extinguishing chamber comprising a plurality of spaced closed pocket chambers having spaced orifice plates, through which the movable rod-shaped contact consecutively passes, whereby axial flow occurs through the orifice plates.

**3.** The combination according to claim **1**, wherein the lateral venting means comprises a plurality of axially-spaced lateral vent openings extending out of the chamber, and there is additionally provided one or more intervening substantially-closed pocket chambers of less axial length than said unvented pressure pocket (**10**).

**4.** The combination according to claim **3**, wherein means defining an auxiliary reservoir chamber communicates with said one or more intervening pocket chambers of less axial length than said unvented pressure pocket (**10**).

**5.** The combination according to claim **1**, wherein magnetic means is utilized to bias the established arc toward the lateral venting means.

**6.** The combination according to claim **5**, wherein the auxiliary reservoir chamber is valve-controlled to close at high pressure.

**References Cited by the Examiner**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 1,981,404 | 11/34 | Whitney et al. | 200—150 |
| 2,562,160 | 7/51 | Yabuno et al. | 200—150 |
| 2,647,973 | 8/53 | Umphrey | 200—150 |
| 2,717,294 | 9/55 | Balentine | 200—150 |
| 3,080,467 | 3/63 | Date | 200—150 |
| 3,128,360 | 4/64 | Rietz | 200—150 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 1,140,558 | 3/57 | France. |
| 870,997 | 6/61 | Great Britain. |
| 341,877 | 12/59 | Switzerland. |

ROBERT K. SCHAEFER, *Acting Primary Examiner.*

BERNARD A. GILHEANY, *Examiner.*