

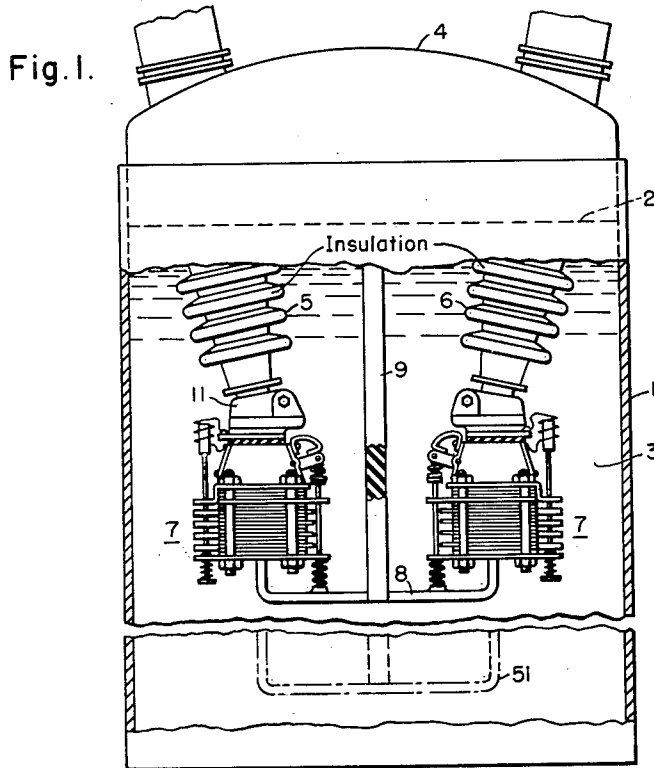
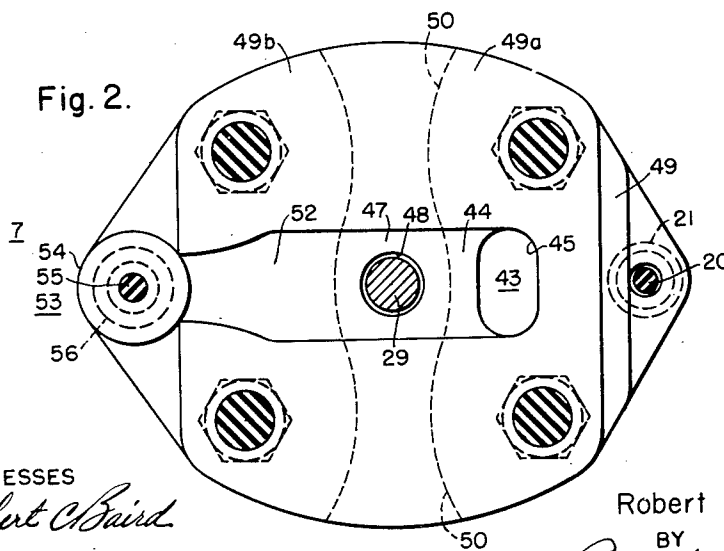
Dec. 4, 1956

R. E. FRIEDRICH
CIRCUIT INTERRUPTER

2,773,155

Filed Nov. 27, 1953

3 Sheets-Sheet 1



WITNESSES

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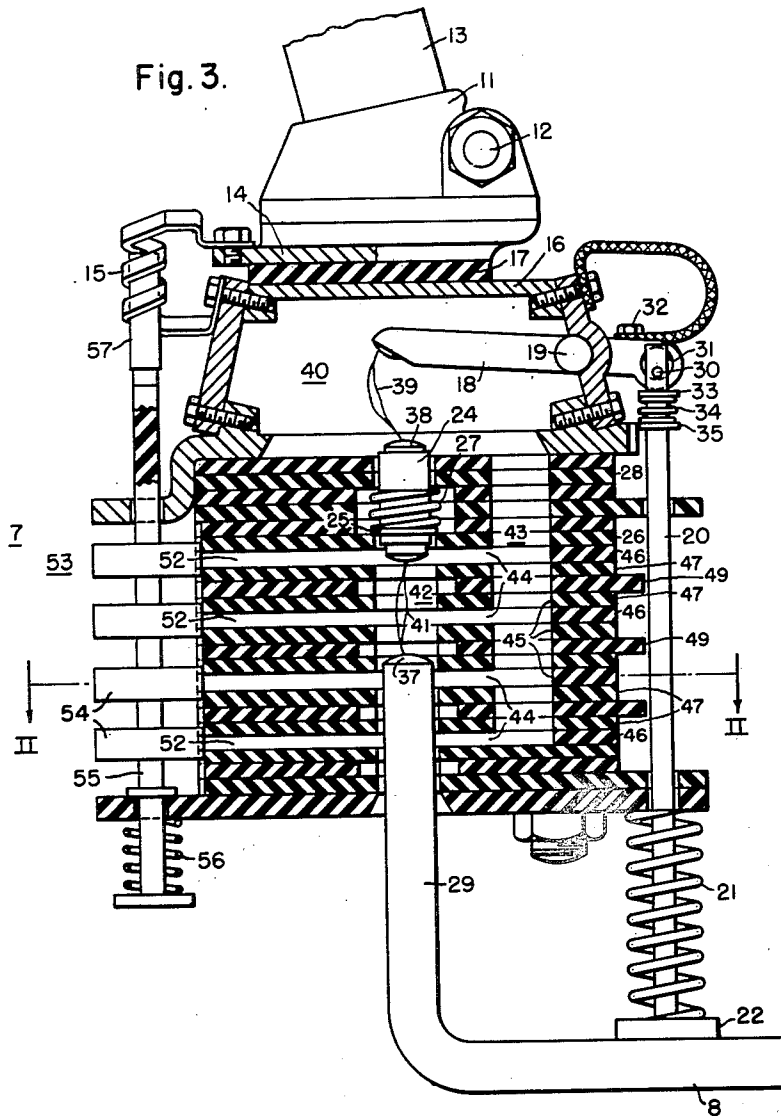
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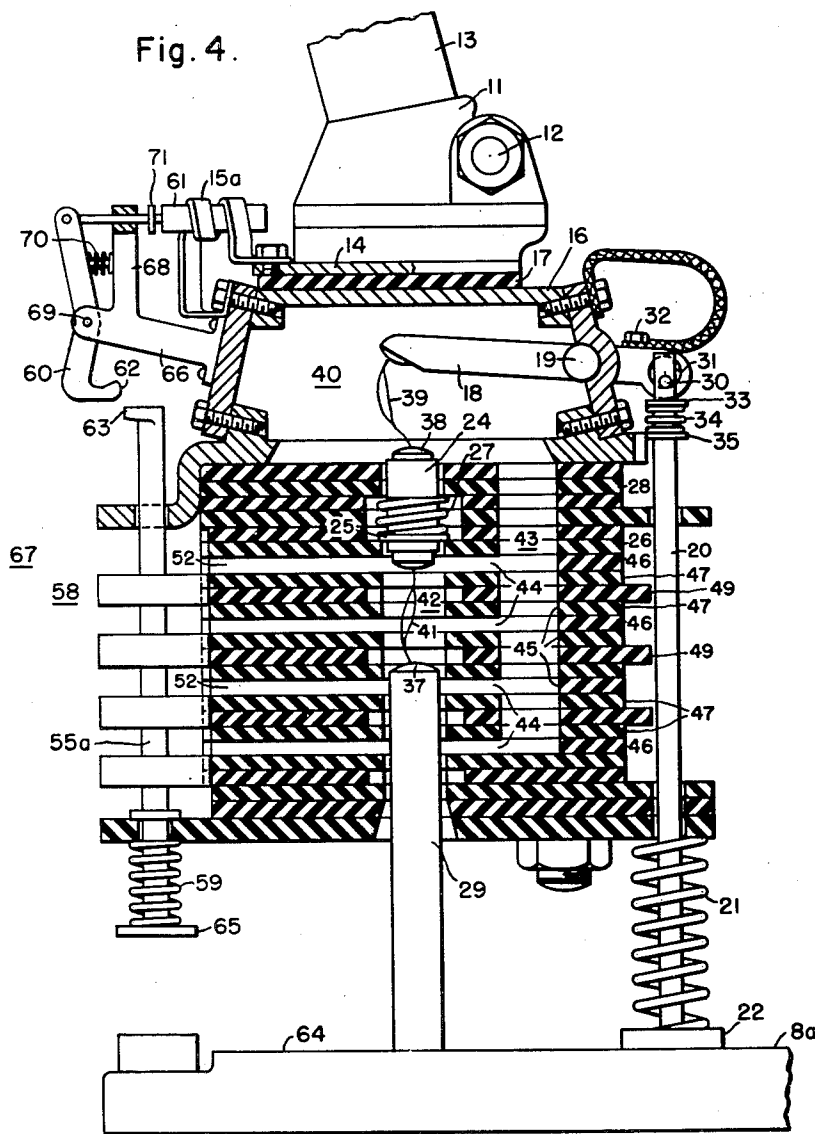
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CIRCUIT INTERRUPTER

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Application November 27, 1953, Serial No. 394,578

15 Claims. (Cl. 200—150)

This invention relates to circuit interrupters in general, and more particularly to arc-extinguishing structures for circuit interrupters of the fluid-blast type.

A general object of my invention is to provide an improved circuit interrupter which will effect a more rapid and effective opening of the circuit therethrough than has been obtained heretofore.

A more specific object of my invention is to provide an improved circuit interrupter in which a valve structure is utilized to control auxiliary venting passages, and operation of the valve structure is effected early in the operation, preferably prior to contact parting.

Still another object is to provide an improved circuit interrupter utilizing a series solenoid coil serially connected in the circuit, with means for employing the coil to effect operation of the valve structure controlling one or more auxiliary venting passages.

In U. S. Patent 2,752,460, issued June 26, 1956, to Winthrop M. Leeds, and assigned to the assignee of the instant application, there is disclosed a circuit interrupter of the fluid-blast type involving a valve structure which controls auxiliary venting during the interruption of high-amperage currents. The operation of the valve structure is responsive to the pressure within the interrupter.

It is a further object of my invention to improve the interrupting structure set out in the aforesaid patent by eliminating any time delay for the building up of pressure for operation of the valve structure, and preferably actuating such a valve structure prior to the separation of the contacts to establish arcing.

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

Figure 1 is a side elevational view, partially in substantially vertical section, of a circuit interrupter embodying my invention, the contact structure being shown in the closed-circuit position;

Fig. 2 is a sectional view taken along the line II—II of the interrupter illustrated in Fig. 3;

Fig. 3 is an enlarged vertical sectional view through one of the arc-extinguishing units depicted in Fig. 1, the contact structure being illustrated in the partially open-circuit position, and in this particular instance the adjacent valve structure is not being operated because of the relatively low-value current being interrupted; and,

Fig. 4 is a vertical sectional view through a modified type of arc-extinguishing unit embodying the principles of my invention, the contact structure being shown in the partially open-circuit position and the valve structure having been actuated to provide auxiliary venting of the interrupter.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral 1 designates a tank filled to the level 2 with a suitable arc-extinguishing fluid 3, in this instance circuit-breaker oil.

Depending from the cover 4 of the tank 1 is a pair of terminal bushings 5, 6 to the lower ends of which

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are threadedly secured and clamped identical arc-extinguishing units, generally designated by the reference numeral 7. Electrically interconnecting the arc-extinguishing units 7 is a conducting cross-bar 8, vertically actuated in a reciprocal manner by an insulating operating rod 9, the latter being actuated by any suitable operating mechanism (not shown).

Referring to Figs. 2 and 3, which more clearly illustrate the internal construction of the extinguishing unit 7, it will be observed that there is provided a conducting adapter 11, which is threadedly secured and clamped, by a clamping bolt 12, to the lower end of the terminal stud 13 extending internally through the terminal bushing 5. Integrally formed with the adapter 11 is a support plate 14, composed of a conducting material and preferably formed with the adapter 11. An actuating solenoid 15 is electrically connected between the support plate portion 14 and the top dome casting 16 of the extinguishing unit 7. The top dome casting 16 is insulated from the plate portion 14 by an insulating plate 17 and secured thereto in any suitable manner, such as by insulated bolts (not shown).

Pivotally mounted within the top dome casting 16 is a rotatably pressure-generating contact 18 pivotally mounted, as at 19, and externally actuated by a side insulating operating rod 20. The operating rod 20 is biased downwardly in a circuit opening direction by a compression spring 21 having its lower end seated upon a cap 22 secured to the lower end of the operating rod 20.

During the closing operation the cross-bar 8 moves upwardly into abutting engagement with the cap 22, compressing the spring 21, and forcing the operating rod 20 upwardly to cause pivotal closing motion of the pressure-generating contact 18 into engagement with an intermediate contact, designated by the reference numeral 24. The intermediate contact 24 has a flange portion 25 which makes engagement with a plate 26 to limit the downward opening movement of the intermediate contact 24. A spring 27, having its lower end seated upon the flange portion 25, and having its upper end bearing against a plate 28, tends to bias the intermediate contact 24 downwardly. Cooperating with the intermediate contact 24 is a lower movable interrupting contact 29, in this particular instance constituting an extremity of the cross-bar 8, which is turned upwardly, as shown in Fig. 3 of the drawings.

A pin 30 extends through the upper end of the operating rod 20 and also passes through a pair of apertures 31 provided in a pair of actuating arms 32 forming integral extensions of the pressure-generating contact 18. A washer 33 slides upon the operating rod 20 and abuts against the lower sides of the actuating arms 32, as shown in Fig. 3. A contact compression spring 34 is interposed between the washer 33 and a second washer 35, which is rigidly affixed to, and movable with, the side operating rod 20.

Thus, during the closing operation the operating rod 9 moves upwardly, carrying with it the cross-bar 8 and the lower movable interrupting contacts 29. The cross-bar 8 picks up the two operating rods 20, compressing the springs 21, and effecting closing rotative motion of the pressure-generating contacts 18. The tip portion 37 of the interrupting contact 29 strikes the intermediate contact 24 prior to the pressure-generating contact 18 striking the upper end 38 of the intermediate contact 24, thereby slightly compressing the spring 27. In the meantime the pin 30 has raised slightly within the apertures 31 compressing the spring 34, which provides the requisite contact pressure between the several contacts.

During the opening operation, as will be obvious, the

lift-rod 9 and the cross-bar 8 move downwardly in response to the operation of the circuit-breaker mechanism (not shown). Because of the compression spring 21 the side operating rod 20 moves downwardly so that the cap 22 remains in abutting engagement with the cross-bar 8, causing upward separating motion of the pressure-generating contact 18 away from the intermediate contact 24 at substantially the same time that the lower movable interrupting contact 29 separates therefrom.

This results in the establishment of two serially related arcs, as shown in Fig. 3, the upper one being a pressure-generating arc 39, established within the pressure-generating chamber 40, and the lower one being an interrupting arc 41, established along an arc passage 42 defined by a plurality of contiguously disposed plates.

The pressure-generating arc 39 sets up pressure within the oil, which completely fills the unit 7, and causes a downward flow of oil within the conduit 43, the disposition of which is more clearly apparent from an inspection of Fig. 2 of the drawings. Leading from the conduit 43 are inlet passages 44 directing fluid, in this instance oil, toward the arc passage 42. The conduit 43 is formed by apertures 45 provided in the several plates making up the extinguishing unit 7. The inlet passages 44 are provided by removing portions of plates 46, herein called inlet plates. On the upper and lower side of each inlet plate 46 is an orifice plate, designated by the reference numeral 47, and having an aperture 48 therein only slightly larger than the movable interrupting contact 29. On the other side of the orifice plate 47 is a vent plate, generally designated by the reference numeral 49, and comprising two plate-halves 49a and 49b, spaced laterally apart to provide thereby opposed venting passages 50.

During the interruption of load currents and relatively low value fault currents the normal functioning of the interrupter 7 is such that the liquid flow travels downwardly through the vertically disposed conduit 43, inwardly through the inlet passages 44, and into engagement with the interrupting arc 41. The fluid, in this instance oil, then passes through the apertures 48 in the orifice plates 47 to pass outwardly through the venting passages 50 to the region externally of the extinguishing unit 7. Circuit interruption soon follows, and the cross-bar 8 separates downwardly away from the cap portions 25 to an isolating position, indicated by the dotted lines 51 in Fig. 1.

During the interruption of fault currents, or currents of high amperage, it is desirable to provide additional venting for assisting in interruption of the interrupting arc 41 and to relieve the internal pressure within the extinguishing unit 7. For this reason, I provide auxiliary venting passages 52, which normally are closed by a valve structure 53, as indicated in Figs. 2 and 3. The valve structure 53 comprises a plurality of superimposed valve elements 54 secured to and movable with a valve rod 55, and biased downwardly by a compression spring 56 to a closed position. The valve rod 55 is preferably formed of insulating material and has affixed thereto at its upper end an armature 57 threading the solenoid 15 and actuated thereby.

During the interruption of high-fault currents, even before the contacts 18, 24 and 29 separate, the coil 15 will be responsive to the fault current and will effect upward movement of the valve rod 55 and thus opening of the several venting passages 52. As a result, there will occur a cross-blast action across the arc 41 in addition to the normal fluid flow as heretofore described.

Actuation of the valve structure 53 will, therefore, not only serve to relieve the pressure within the interrupter 7, but will also provide additional interrupting fluid-blast action across the arc 41. The valve structure 53 has the advantage over the valve structure of the aforesaid patent in that it is immediately actuated, without any delay, and even prior to the separation of the contact structure. The result, therefore, is an extremely fast acting inter-

rupter 7, bringing about very high-speed interruption of the circuit.

Fig. 4 shows a modification of my invention in which the valve structure 58 is spring-biased downwardly to an open position by a compression spring 59, and is latched in its upper position by a latch 60, which is electromagnetically actuated. In other words, a solenoid 15a responsive to the series current passing through the interrupter actuates the armature 61 to effect pivotal releasing action of the latch 60, causing the nose 62 thereof to clear the hook-portion 63 disposed at the upper end of the valve rod 55a. During the closing operation, an extension 64 of the cross-bar 8a picks up the cap 65 and relatches the valve structure 58. The latch 60 is biased by a spring 70 in a counter-clockwise direction about its pivot 67 to a limiting position, as determined by the stop 71. During closing, the nose 63 of rod 55a moves the latch 60 to one side so that the valve structure 58 is related.

The arrangement illustrated in Fig. 4 has the advantage over that of Figs. 2 and 3 since the solenoid 15a need not be designed to perform the energy requirements required of the solenoid 15 in Fig. 3. Only a release of the latch 60 is required of the solenoid 15a in Fig. 4. As shown, a bracket 66 pivotally supports the latch, as at 67 and has an upper guide portion 68 to guide the armature 61. The internal construction of the modified unit 67 is otherwise the same as in the construction set out in Figs. 2 and 3; consequently, the operation will not be repeated.

From the foregoing description of my invention, it will be apparent that I have provided an extremely high-speed and effective circuit interrupter in which auxiliary venting passages are opened up during the interruption of high-amperage currents to relieve the pressure and to assist in arc interruption by providing a desired transverse cross-blast action. I have illustrated two arrangements for electromagnetically causing the actuation of the valve structures 53, 58.

Although I have shown 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 fluid-blast type including separable contact means for establishing an arc, a first venting means, means for sending a flow of fluid against the arc and out the first venting means, auxiliary second venting means, valve structure normally closing the second venting means, and electromagnetic means responsive to the average value of the current passing through the interrupter during the period the contact means is separating to effect opening of the valve structure at a predetermined average current magnitude during the time the arc is established.
2. A circuit interrupter of the fluid-blast type including an arc-extinguishing unit, means for establishing an arc within the unit, a first venting means, means for sending a flow of fluid against the arc and out the first venting means, auxiliary second venting means, valve structure normally closing the second venting means, a solenoid mounted on the arc-extinguishing unit and responsive to the average series current passing through the interrupter, an armature, means interconnecting attractive motion of the armature with opening of the valve structure, and the valve structure opening during the time the arc is established.
3. A circuit interrupter of the fluid-blast type including means for establishing an arc, operating means for effecting the actuation of said means, a first venting means, means for sending a flow of fluid against the arc and out the first venting means, auxiliary second venting means, valve structure normally closing the second vent-

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ing means, latching means for the valve structure latching it in the closed position, and electromagnetic means independent of the operating means and responsive to the average value of the current passing through the interrupter to effect release of the latching means at a predetermined average current magnitude.

4. The combination in a circuit interrupter of separable contact means for establishing a pressure-generating arc and a serially related interrupting arc, means utilizing the pressure established at the pressure-generating arc to force fluid toward the interrupting arc, a first venting means for the interrupting arc which is normally open, a second venting means for the interrupting arc, valve means for normally closing the second venting means, and electroresponsive means responsive to the average current passing through the interrupter during the period the contact means are separating to cause opening of the second venting means.

5. A circuit interrupter of the fluid-blast type including an arc-extinguishing unit, means for establishing a pressure-generating arc and an interrupting arc within the unit, an interrupting structure disposed adjacent the interrupting arc and having a first venting means associated therewith, a first fluid-transmitting passage interconnecting the pressure-generating arc with the interrupting structure, a second venting means, a second fluid-transmitting passage leading from the interrupting structure to said second venting means, valve means normally closing the second venting means, and electroresponsive means mounted on the arc-extinguishing unit and responsive to the average series current passing through the interrupter for actuating the valve means at a predetermined average current.

6. A circuit interrupter of the fluid-blast type including an arc-extinguishing unit, separable contact means for establishing a pressure-generating arc and an interrupting arc within the unit, an interrupting structure disposed adjacent the interrupting arc and having a first normally-open venting means associated therewith, a first fluid-transmitting passage interconnecting the pressure-generating arc with the interrupting structure, a second normally-closed venting means, a second fluid-transmitting passage leading from the interrupting structure to said second venting means, valve means for controlling the opening of the normally closed venting means, and electro-responsive means responsive to the average series current passing through the interrupter during the period the contact means are separating for opening said valve means at a predetermined current.

7. A circuit interrupter of the liquid-blast type including an arc-extinguishing unit, means for establishing a pressure-generating arc and an interrupting arc within the unit, an interrupting structure disposed adjacent the interrupting arc and having a first venting means associated therewith, a first liquid-transmitting passage interconnecting the pressure-generating arc with the interrupting structure, a second venting means, a second liquid-transmitting passage leading from the interrupting structure to said second venting means, valve means for controlling the second venting means, a solenoid responsive to the series current passing through the interrupter, an armature, and means interconnecting the armature with the valve means so that at a predetermined current the solenoid will effect movement of the armature and open said valve means.

8. A circuit interrupter of the fluid-blast type including an arc-extinguishing unit, means for establishing a pressure-generating arc and an interrupting arc within the unit, operating means for effecting the actuation of said means, a multi-orifice interrupting structure disposed adjacent the interrupting arc and having a first venting means associated therewith, a first fluid-transmitting passage interconnecting the pressure-generating arc with the multi-orifice interrupting structure, a second venting means, a second fluid-transmitting passage lead-

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ing from the multi-orifice interrupting structure to said second venting means, valve means normally closing the second venting means, and electroresponsive means independent of the operating means and responsive to the series current passing through the interrupter to effect opening of the valve means at a predetermined current.

9. A circuit interrupter including an arc-extinguishing unit immersed in an arc-extinguishing liquid, a movable pressure-generating contact separable from a relatively stationary intermediate contact to establish a pressure-generating arc, an arcing passage, a rod-shaped movable interrupting contact separable from said intermediate contact along said arcing passage to establish an interrupting arc progressively along said arcing passage, operating means for actuating said contacts, a plurality of inlet passages leading into said arcing passage, means interconnecting the inlet passages with the pressure-generating arc, a normally open first venting means communicating with the arcing passage, a plurality of spaced exhaust passages leading away from the arcing passage, a second venting means connecting the exhaust passages with the region exteriorly of the unit, valve means controlling the second venting means, and electroresponsive means independent of the operating means and responsive to the series current passing through the interrupter for opening said valve means at a predetermined current.

10. A circuit interrupter including an arc-extinguishing unit immersed in an arc-extinguishing liquid, a movable pressure-generating contact separable from a relatively stationary intermediate contact to establish a pressure-generating arc, an arcing passage, a rod-shaped movable interrupting contact separable from said intermediate contact along said arcing passage to establish an interrupting arc progressively along said arcing passage, operating means for actuating said contacts, a plurality of inlet passages leading into said arcing passage, means interconnecting the inlet passages with the pressure-generating arc, a normally open first venting means communicating with the arcing passage, a plurality of spaced exhaust passages leading away from the arcing passage, a slide valve normally closing the exhausting of liquid out through the exhaust passages, and electro-responsive means independent of the operating means and responsive to the series current passing through the interrupter for actuating the slide valve and so opening the exhaust passages at a predetermined current.

11. A circuit interrupter of the fluid-blast type including a casing, means for establishing an arc within the casing, operating means for effecting the actuation of said means, a first venting means leading out of the casing, means for establishing pressure within the casing for sending a flow of fluid against the arc and out of the casing through the first venting means, auxiliary second venting means leading out of the casing, valve structure normally closing the second venting means, and electromagnetic means independent of the operating means and responsive to the average value of the current passing through the interrupter to effect opening of the valve structure at a predetermined average current magnitude.

12. A circuit interrupter of the fluid-blast type including a casing, means for establishing an arc within the casing, a first venting means leading out of the casing, means for establishing pressure within the casing for sending a flow of fluid against the arc and out of the casing through the first venting means, auxiliary second venting means leading out of the casing, valve structure normally closing the second venting means, a solenoid mounted on the casing and responsive to the average series current passing through the interrupter, an armature, and means interconnecting attractive motion of the armature with opening of the valve structure.

13. A circuit interrupter of the fluid-blast type including means for establishing an arc, a first venting means, means for sending a flow of fluid against the arc and out of the first venting means, auxiliary second venting

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means, valve structure normally closing the second venting means, electromagnetic means responsive to the average value of the current passing through the interrupter and actuable only above a predetermined average current magnitude, and a direct, positive connection between the valve structure and the electromagnetic means to effect opening of the valve structure every time the electromagnetic means actuates.

14. A circuit interrupter of the fluid-blast type including an arc-extinguishing unit, means for establishing a pressure-generating arc and an interrupting arc within the unit, an interrupting structure disposed adjacent the interrupting arc and having a first venting means associated therewith, a first fluid transmitting passage interconnecting the pressure-generating arc with the interrupting structure, a second venting means, a second fluid transmitting passage leading from the interrupting structure to said second venting means, valve means normally closing the second venting means, electromagnetic means responsive to the average value of the current passing through the interrupter and actuable only above a predetermined average current magnitude, and a direct, positive connection between the valve means and the electromagnetic means to effect opening of the valve means every time the electromagnetic means actuates.

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15. A circuit interrupter of the fluid-blast type including an arc-extinguishing unit, means for establishing a pressure-generating arc and an interrupting arc within the unit, means defining a substantially enclosed elongated arc passage within which the interrupting arc is drawn and having one or more laterally disposed venting passages disposed therealong, a first fluid transmitting passage interconnecting the pressure-generating arc with the substantially enclosed arc passage, one or more second laterally disposed venting passages leading out of the arc passage, valve means normally closing said one or more second laterally disposed venting passages, electromagnetic means responsive to the average value of the current passing through the interrupter and actuable only above a predetermined average current magnitude, and a direct, positive connection between the valve means and the electromagnetic means to effect opening of the valve means every time the electromagnetic means actuates.

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