ABSTRACT OF THE DISCLOSURE

Condenser for gas from a fuse has an arc products director interposed between sections of heavy wire screen in a housing.

This invention is an improvement over the constructions disclosed in Lindell U.S. Patent 3,230,334, issued Jan. 18, 1966.

Among the objects of this invention are: To increase substantially the effectiveness of the construction of the aforesaid patent without substantially increasing the over all physical size thereof for a given rated fuse duty; to permit a substantial increase in the fault interrupting capacity of a solid material type fuse by equipping it with a gas and arc products condenser capable of handling the increased discharge due to the interruption of higher fault current; to increase substantially the number of maximum severity operations that can be withstood by a gas and arc products condenser used for receiving the same to reduce noise and emission of gas and metallic particles to the atmosphere at a given duty; to interpose between the heavy wire screen sections in a housing or a shell arranged to receive the gas and arc products from a solid material type fuse, an arc products director or arc transfer terminal having longitudinal openings for directing and distributing the exhaust flow of the gas and arc products into the wire screen therebelow, capable of absorbing a substantial portion of the energy therein, and thereby reducing erosion and vaporization of the wire screen sections; to transfer and hold the arc root substantially centrally of the director or arc transfer terminal by providing a pocket therein opening centrally thereof toward the source of the exhaust flow along the rim of which the arc root tends to remain; to restrict and position the individual openings in the arc products director to avoid high back pressure in the fuse unit on high current interruption by permitting and distributing free total flow of the gas and arc products through the several openings into the wire screen section therebelow while preventing direct impingement from the fuse bore of these products and transfer of the arc root onto this wire section.

According to this invention a high thermal capacity good heat conductivity gas or arc products director is interposed between heavy wire screen sections in a housing or shell of a condenser or muffler secured to the discharge end of a solid material type fuse that may be called upon to interrupt alternating fault current flow of the order of several thousands of amperes. Because of the shape and construction of the director it acts both as an arc transfer terminal and as a shield for the wire screen section on which it is mounted. The director has openings through it which are so shaped as to permit free flow of gas and arc products therethrough to distribute them relatively uniformly and with a smooth flow pattern into this wire screen section with the result that high back pressure in the fuse bore is not developed. A pocket or cavity is provided in the central portion of the director and it opens toward the source of the arc establishing means to hold the arc root transferred thereto in the vicinity thereof thereby preventing its impingement on and accompanying erosion of the sections of wire screen.

In the drawings: FIG. 1 is a perspective view of a circuit interrupter in which the present invention is embodied. FIGS. 2A and 2B, taken together with the former placed above the latter, show a vertical longitudinal sectional view through the circuit interrupter illustrated in FIG. 1 and through a portion of the condenser therefor, the remaining portion of the condenser being shown in elevation. FIG. 3 is a vertical sectional view, at an enlarged scale, showing the details of construction of the condenser or muffler shown in FIG. 2B. FIG. 4 is a bottom plan view of the condenser shown in FIG. 3. FIG. 5 is a top plan view of the gas or arc products director. FIG. 6 is a bottom plan view of the director. FIG. 7 is a view, similar to FIG. 3, and shows another embodiment of the condenser or muffler. FIG. 8 is a top plan view of the gas or arc products director in FIG. 7. FIG. 9 is a horizontal sectional view taken generally along the line 9--9 of FIG. 7.

Referring now particularly to FIG. 1 of the drawings, it will be observed that the reference character 10 designates a base which may be a metal base carrying upper and lower insulators 11 and 12. It will be understood that the length of the insulators 11 and 12 and their spacing apart depend upon the voltage of the system with which the present invention is employed. Upper and lower contact clips 13 and 14 are carried by the insulators 11 and 12 at their outer ends for detectably receiving upper and lower terminals 15 and 16 that are mounted on the upper and lower ends of a tubular insulating housing or fuse holder 17 of a circuit interrupter that is indicated, generally, at 18. Associated with the lower terminal 16 is a condenser or muffler 19 in which the present invention is embodied.

As shown in FIGS. 2A--2B a coil tension spring 21 and a flexible cable or conductor 22 interconnect the upper terminal 14 and a spring and cable fastener 23 which forms a part of a replaceable cartridge, shown generally at 24. The replaceable cartridge 24 includes a rod-like terminal 25 which is connected at its upper end to the spring and cable fastener 23 and moves therewith upwardly under the influence of the coil tension spring 21 when it is released. At the lower end of the rod-like terminal 25 there is a fusible element 26 which is connected to a terminal fitting 27 that extends radially inwardly from the stationary terminal 28 at the lower end of the cartridge 24. The rod-like terminal 25 moves upwardly through a bore 29 that is formed in a body 30 of arc extinguishing material which may be boric acid or other water containing dielectric material. In parallel with the rod-like terminal 25 and fusible element 26 is a strain element assembly 31. It is connected at its upper end to the spring and cable fastener 23 and extends through an auxiliary bore 32 in the body 30 of arc extinguishing material and is connected at its lower end to a strain element pin 33 that extends radially inwardly from the stationary terminal 28. The lower end of the cartridge 24 is closed by a frangible disc 34 that is held in place by a snap lock spring 35. Connection between the terminal 28 and the lower terminal 16 is provided by contact fingers 36 depending from the latter and engaging the periphery of the former. The lower ends of the contact fingers 36 abut a locking ring 37 threaded on the terminal 28.

When a circuit interrupter of the type illustrated at 18 and described hereinbefore operates to interrupt the flow of alternating fault current, particularly a relatively heavy fault current, a large amount of water vapor or gas is evolved from the bore 29 in the body 30 of arc extinguishing material. This vapor or gas together with arc plasma at extremely high temperature and pressure flows through the bore 29 and out of the lower end of the cartridge 24. The frangible disc 34 initially is promptly expelled along with the metal vapors and arc plasma incident to the blow.
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ing of the fusible element 25 and release of the strain element assembly 31 which permit the spring 21 to retract the rod-like terminal 25 into the bore 29. When these arc producing terminals are permitted to flow directly to the atmosphere, no particular interruption problem is involved although care must be taken that the part of the highly ionized arc core that usually extends below the discharge end of the fuse cartridge 24 does not cause an external fault to another circuit or to ground or that the incident shock wave is not too severe in enclosed installation. When the circuit interrupter 18 is mounted within a relatively small enclosure, provision is made, according to this invention, by mounting the condenser 19 on the lower terminal 16 for confining the arc to the inner end of the condenser 19 and for limiting the discharge of arc products during the relatively short critical period when the high temperatures and pressures tend to be created with the result that the shock waves incident thereto are reduced to such an extent at a given current level that an ordinary enclosure can withstand them and the conductivity of the exhaust products is lowered so that no reactions or insulating shields are not necessary within such enclosure except at the very highest levels considerably in excess of the capabilities of the constructions disclosed in the above identified patent.

The condenser or muller 19 includes an adapter 38, which may be formed of brass, having an internal thread 39 for cooperation with an external thread on the lower terminal 16. The adapter 38 has an external thread 40 to receive the upper end of an elongated cylindrical shell 41. The adapter 38 also has a conical surface 42 for engaging the contact fingers 36 and clamping them against the terminal 16.

FIGS. 3, 4, 5 and 6 show more clearly the details of construction of the elongated condenser or muller 19 which is especially designed and proportioned for use with a fuse type circuit interrupter 18 having a continuous current rating of 200 amperes, a voltage rating of 15,000 volts and an interrupting rating of this voltage of 25,000 amperes. Here it will be observed that the adapter 38 is threaded into the upper end of the elongated cylindrical shell 41 which is formed of suitable high strength metal. Retaining pins 43 extend along the threads 40 to hold the shell 41 against rotation relative to the adapter 38. The adapter 38 has a central depending flange 44 on the conical surface 45 of which is conical for a purpose that will be apparent presently. The lower end of the shell 41 is slotted transversely as indicated at 46 for receiving a bar to facilitate the application or removal of the condenser 19 to or from terminal 16 at the lower end of the circuit interrupter 18. The extreme lower end 47 of the shell 41 is deformed inwardly to hold in place a cover disc or closure 48 that may be formed of hot rolled steel plate. The upper peripheral surface of the cover disc or closure 48 bears against an annular shoulder 49 which is formed along the inner wall of the shell 41 and against which the cover disc or closure 48 is held when the lower end 47 is inturmed. Exhaust ports 50, of which there may be eight in number as shown in FIG. 4, are formed in the cover disc or closure 48 to provide a communication to the atmosphere.

At the upper end of the shell 41 there is positioned a first annular section 54 of wire screen. The section 54 of wire screen is relatively short and is formed of high heat conductivity relatively rigid convolutely wound mesh wire screen that is formed by intertwining lengthwise extending wires and circularly extending wires of copper. The arrangement is such that a large diameter passageway 57 is provided centrally of the shell 41 and in alignment with and of larger diameter than the discharge opening 58 through the terminal 28. The conical surface 45 of the central depending flange 44 fits snugly into the upper end of the passageway 57. The large diameter passageway 57 provides a large area for receiving the initial blast from the circuit interrupter 18 on blowing of the fusible element 25 and the strain element assembly 31. As shown, in FIG. 3 the outer periphery of the first wire screen section 54 is juxtaposed to the inner surface of the shell 41 and thus substantially fills the cross section thereof except for the large diametrical opening 57 through which gas products are permitted to flow directly to the atmosphere.

Below and spaced slightly from the first wire screen section 54 is a second annular section 60 of wire screen which is substantially longer than the first section 54 and is formed in the same manner by convolutely winding relatively heavy wire screen of the same size as referred to above. Another end wire screen section 60 is formed with a small diameter opening 63 there-through which is substantially filled by a metallic stud 64 that preferably is formed of good heat conducting metal such as silicon bronze rod. The outer periphery of the second wire screen section 60 is such as to fit snugly against the inner surface of the shell 41 while the diameter of the opening 63 is such that the inner periphery fits snugly against the outer surface of the metallic stud 64. Except for the metallic stud 64 the second wire screen section 60 substantially fills the cross section of the lower end of the shell 41.

At its lower end the metallic stud 64 has a reduced diameter section 65 that extends through a central opening 66 in the cover disc or closure 48. The outer end is peened over as indicated at 67 to secure the metallic stud 64 to the cover disc or closure 48.

With a view to absorbing a substantial amount of heat energy from the arc products that flow through the large diameter passageway 57 from the circuit interrupter 18 on blowing of the arc products, there is provided in the central core of the condenser 19 a large capacity receptacle 68 for containing arc products and transferring the same to the inner surfaces of the condenser 19. This receptacle 68 may comprise a large capacity vessel 71 having a central core section 70. The receptacle 68 is constructed with the outer periphery of the first wire screen section 54 being juxtaposed to the inner surface of the receptacle 68. However, the area of the openings 74 is such as to permit sufficient flow therethrough...
of the gas and arc products that the back pressure in the bore 29 of the circuit interrupter 18 does not become excessive.

It is important that the arc root or the terminal of the arc drawn on blowing of the fusible element 26 and strain element assembly 31 that is blown into the condenser or muffler 19 remain on the gas or arc products director 68 and particularly on the central section 69 thereof to minimize erosion of the annular sections 54 and 60 of the wire screen. It is for this purpose that the upper end 80 of the stud 64 is spaced from the upper end of the threaded opening 78, thereby providing a cavity or pocket 81 along the periphery of which there is a great tendency for the arc root or terminal to locate in contra-distinction to the outer surface of the central section 69 or any other part of the gas or arc products director 68 or of the annular sections 54 and 60 of wire screen.

In FIG. 6 the broken line circle 82 encloses the area of the central section 69 adjacent the second section 60 of wire screen. This area is about the same as the area of the discharge opening 58 in the terminal 28 through the large diameter passageway 57 in FIG. 2B. This relationship minimizes the impingement of the arc products onto the upper end of this wire screen section.

In assembling the elongated condenser or muffler 19, the adapter 85 is threaded into the upper end of the shell 41 which may be secured in place by the pins 43. Next the first wire screen section 54 is inserted into the shell 41 which, for assembly purposes, is turned upside down. The upper end of the large diameter passageway 57 overlays the central depending flange 44. The second wire screen section 60, mounted on the cover disc or closure 48 in the metallic stud 64 and held in place by the director 68, next is inserted with the central conical section 69 projecting into the large diameter passageway 57. Finally the lower intumis end 47 is formed to the shape indicated at the lower end of FIG. 3 to securely hold the assembly in place.

The arrangement just described provides for a relatively streamline flow of the gas and arc products from the discharge opening 58 in the terminal 28 through the large diameter passageway 57 and through the openings 74 in the director 68 for equal distribution through the interstices of the second wire screen 60. In addition as the arc products and gas flow through the openings 74 into the wire screen section 60, a substantial amount of heat energy is absorbed therefrom. Also the central upper end of the section 69 acts as a stationary arc transfer terminal. Due to the cavity or pocket 81, the arc root centers in or around it and erosion due to direct impingement of the arc products or the arc takes place here rather than on the first wire screen section 54 or the underlying screen section 60. Because the gas and arc products are so well distributed with a relatively smooth flow pattern, the wire screen sections 54 and 60, and particularly the latter, are more efficiently used. A substantial portion of the heat is absorbed before the gas and arc products are discharged through the exhaust ports 50 in the closure 48. The net result is a limited volume of relatively cool gases that is finally discharged at lower pressures with reduced flame and sound and shock waves as an incident to maximum value of the current flow that is interrupted by the arc root. This makes the overall assembly much more suitable for relatively smaller and lighter enclosures, especially when higher interrupting capacities are required.

In FIGS. 7, 8 and 9 there are shown details of construction of a modified form of elongated condenser or muffler that is an annular section 93 of wire screen that is utilized in conjunction with a circuit interrupter 18 of the fuse type described hereinafore having a continuous current rating of 400 amperes, a voltage rating of 15,000 volts, and an interrupting rating at this voltage of 40,000 amperes. An adapter 85 is employed having an internal thread 86 for mounting the condenser or muffler 84 on the lower terminal 16 of the circuit interrupter 18. The adapter 85 has a conical opening 87 and is threaded into an adapter extension ring 88 which, in turn, is threaded into the upper end of an elongated cylindrical shell 89 that may be formed of high strength metal such as steel. At its lower end the shell 89 has a cover disc or closure 90 that may be formed of steel or brass. For example the closure 90 may be a copper alloy casing and it is provided with sector shaped openings 91. The lower end of the shell 89 is threaded at 92 for receiving the cover disc or closure 90.

At the upper end of the shell 89 and below the adapter extension ring 88 there is provided a first annular section 95 of wire screen. It is formed of the same material as the first annular section 54 of wire screen referred to herebefore. The shell 95 of wire screen is a sector section 97 of wire screen which is relatively long. Both sections 95 and 97 of wire screen are juxtaposed to the inner surface of the shell 89 and substantially fill the same except for the large diameter passageway 96 in the former and a small diameter opening 98 in the latter. A metallic stud 99 of copper alloy substantially fills the small diameter opening 98 through the section 97 of wire screen. At its lower end the stud 99 is threaded as indicated at 100 in the cover disc or closure 90 centrally thereof. At its upper end the stud 99 is threaded, as indicated at 101, into the central section 102 of a gas or arc products director 103. Thus arc products director 103 is formed preferably of high heat conductivity material such as cast copper alloy. For the purpose of placing the large diameter passageway 96 in communication with the space below the gas or arc products director 103 which is filled by the second annular section 97 of wire screen and the metallic stud 99, sector shaped openings 104 are provided between a rim 105 of the gas or arc products director 103 and the central section 102 thereof. The sector shaped openings 104 are tapered from the side that faces the second annular section 97 of wire screen to a larger area opening at the upper end. The rim 105 is generally trapezoidal in cross section and it has a generally cylindrical surface 106 which has a snug fit with the juxtaposed inner surface of the shell 89. The sector shaped openings 104 in the cover disc or closure 90 are tapered similar to the taper for the openings 104 from a minimum at the outer side to a maximum at the top side.

The lateral dimension of each of the sector shaped openings 104 in the gas or arc products director 103 along their pitch circle 107 is substantially larger than the longitudinal dimension of each opening 104 at the pitch circle 107. The reason for this, as previously pointed out for the gas or arc products director 68, is to prevent the arc from looping downward past rims 108 which interconnect the central section 102 and the rim 105 and impinging on the upper end of the screen section 97 therebelow. However, the area of the sector shaped openings 104 is such as to permit sufficient flow therethrough of the gas and arc products that the back pressure in the bore 29 of the circuit interrupter 18 does not become excessive which would impede the exhaust from the bore 29 and would tend to prolong arcing.

It is important that the root of the arc that is blown into the large diameter passageway 96 be held on the central section 102 of the gas or arc products director 103 and not be permitted to wander to the first annular sector section 97 of wire screen through the sector shaped openings 104 to impinge on the annular section 97 of wire screen therebelow. Accordingly, the passageway 96 in the first annular section 95 is larger than the exhaust opening 58 in the terminal 28 and is greater than the area of the central section 102 of the director 103. Further, the upper end 109 of the metallic stud 99 is threaded only part
7. The circuit interrupter according to claim 1 wherein said arc products director means has a central generally truncated conical section with the smaller end projecting into said relatively large diameter passageway.

8. The circuit interrupter according to claim 1 wherein said arc products director means includes a central generally truncated conical section with the smaller end projecting into said relatively large diameter passageway.

6. The circuit interrupter according to claim 1 wherein said arc products director means is a curved metallic plate having ribs extending radially from said central portion thereof to a rim juxtaposed to the inner surface of said shell, and said openings are located between said ribs and are sector shaped.

9. The circuit interrupter according to claim 8 wherein said ribs decrease in thickness from a maximum adjacent said second section of wire screen.

10. In a circuit interrupter means for establishing an arc and causing an exhaust flow of condensible gas and arc products at high temperature and pressure, an elongated cylindrical shell joined to said arc establishing means and providing a cylindrical chamber for receiving said exhaust flow at one end and centrally thereof, a closure at the other end of said chamber secured to said shell and having exhaust ports venting said chamber to the atmosphere, a first annular section of wire screen at said one end of said chamber with its outer periphery juxtaposed to the inner surface thereof and its inner surface out of the direct path of said exhaust flow and defining a passageway having a relatively large diameter for receiving said exhaust flow, a second annular section of wire screen in said chamber in engagement at one end with said closure, spaced at its other end from said first annular section, having its outer periphery juxtaposed to said inner surface of said chamber, and having a relatively small diameter opening extending centrally thereof, and metallic arc products director means interposed between the juxtaposed ends of said sections of wire screen, extending into juxtaposition with said inner surface of said shell, having a solid central portion in the direct path of said exhaust flow, and having openings therethrough between said central portion and the periphery of said director means for directing said exhaust flow from said relatively large diameter passageway in said first section of wire screen into said second section of wire screen to be cooled and condensed and to flow through said exhaust ports in said closure.

2. The circuit interrupter according to claim 1 wherein a metallic stud extends through said relatively small diameter opening in said second annular section of wire screen and substantially fills it, and means secure one end of said stud to said closure and the other end of said stud to said arc products director means.

3. The circuit interrupter according to claim 1 wherein said arc products director means has a circumferential rim that is juxtaposed to the inner surface of said shell and overlies said second annular section of wire screen.

4. The circuit interrupter according to claim 1 wherein said openings in said arc products director means are located between ribs that extend radially from said central portion thereof to a rim juxtaposed to said inner surface of said shell, and the lateral dimension of each of said openings along their pitch circle is not substantially greater than the longitudinal dimension of each opening at said pitch circle.

5. The circuit interrupter according to claim 4 wherein said openings are sector shaped.
13. The circuit interrupter according to claim 11 wherein
said openings in said arc products director means are
located between ribs that extend radially from said
central portion thereof to a rim juxtaposed to said
inner surface of said shell, and
the lateral dimension of each of said openings along
their pitch circle is not substantially greater than the
longitudinal dimension of each opening at said pitch
circle.

14. The circuit interrupter according to claim 11 wherein
said arc products director means has a central gener-
ally truncated conical section with the smaller end pro-
jecting into said relatively large diameter passageway.

15. The circuit interrupter according to claim 11 wherein
said arc products director means includes
a central generally truncated conical section with the
smaller end projecting into said relatively large di-
ameter passageway,
a rim having a cylindrical outer periphery, and
ribs extending radially between said central section and
said rim, said ribs decreasing in thickness from a
maximum adjacent said second section of wire
screen.

16. The circuit interrupter according to claim 11 wherein
said arc products director means is a circular metallic
plate having ribs extending radially from said cen-
tral portion thereof to a rim juxtaposed to the inner
surface of said shell, and
said openings are located between ribs and are sector
shaped.

17. The circuit interrupter according to claim 11 wherein
said ribs decrease in thickness from a maximum ad-
jacent said second section of wire screen.

References Cited

UNITED STATES PATENTS
1,502,881 7/1924 Sandin -------------- 200—120
2,091,423 8/1937 Tripllett -------------- 200—117
2,319,277 5/1943 Tripllett -------------- 200—117 X
3,178,537 4/1965 Patterson -------------- 200—120
3,230,331 1/1966 Lindell -------------- 220—120

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