United States Patent [19]

Harner et al.

[11] **3,719,912**

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[54] **EXHAUST CONTROL DEVICE FOR CIRCUIT INTERRUPTING DEVICES**

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[73] Assignee: **S. C. Electric Company**, Chicago, Ill.

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[52] **U.S. Cl.** **337/280**, 337/203, 337/250, 337/273, 337/276, 337/282

[51] **Int. Cl.**.....**H01h 85/38**

[58] **Field of Search**.....337/203, 249, 250, 273, 276, 337/280, 282

[56] **References Cited**

UNITED STATES PATENTS

3,391,368	7/1968	Fahnoe	337/280 X
2,393,584	1/1946	Bennett	337/203 X

FOREIGN PATENTS OR APPLICATIONS

811,555	4/1937	France	337/250
741,676	2/1933	France	337/249
272,989	7/1964	Australia	337/280

Primary Examiner—Bernard A. Gilheany
Assistant Examiner—F. E. Bell
Attorney—Robert R. Lockwood

[57] **ABSTRACT**

A mass of small diameter ceramic pellets, for example of activated alumina, is located in a cylindrical metallic housing between its closed end and metallic heat absorbent material in the housing through the open end of which flow arc products incident to blowing of a fuse or similar circuit interrupting device. An apertured deflector disc overlies the pellets and prevents bypassing thereof along the inner surface of the housing. One or more metallic filter elements in the closed end of the housing place the interior thereof in limited communication with the atmosphere.

3 Claims, 10 Drawing Figures

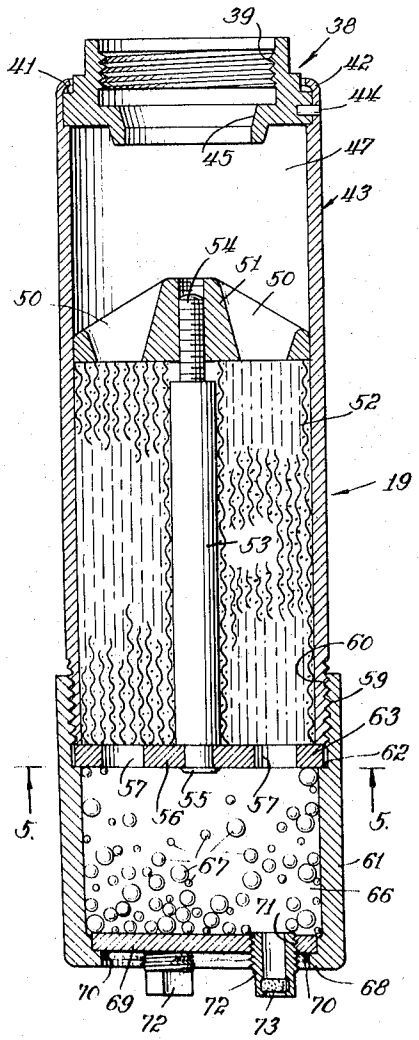


FIG. 1

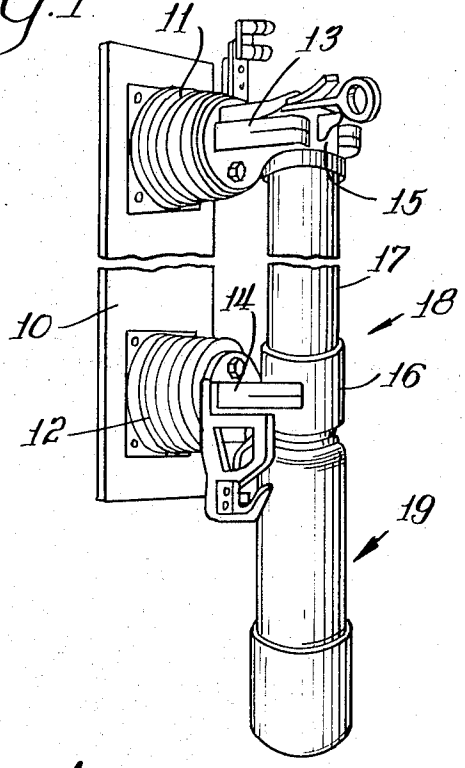


FIG. 2A.

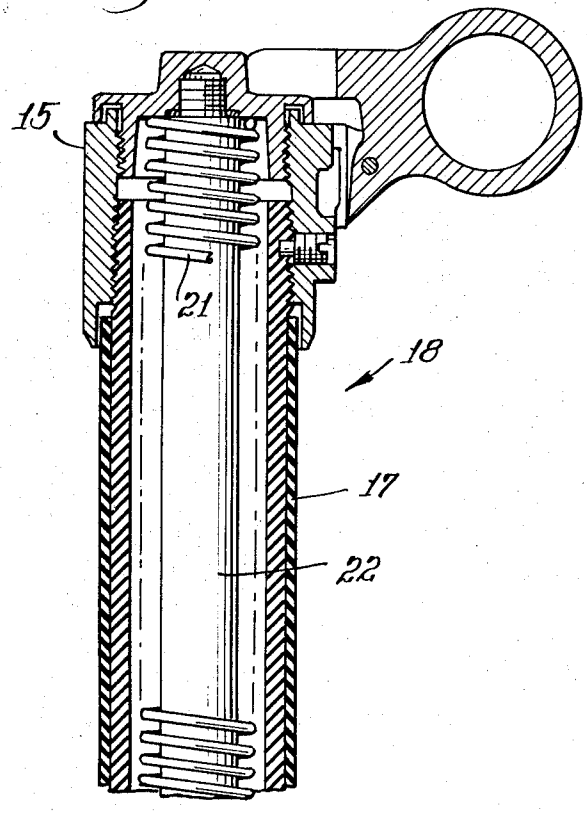


FIG. 2B.

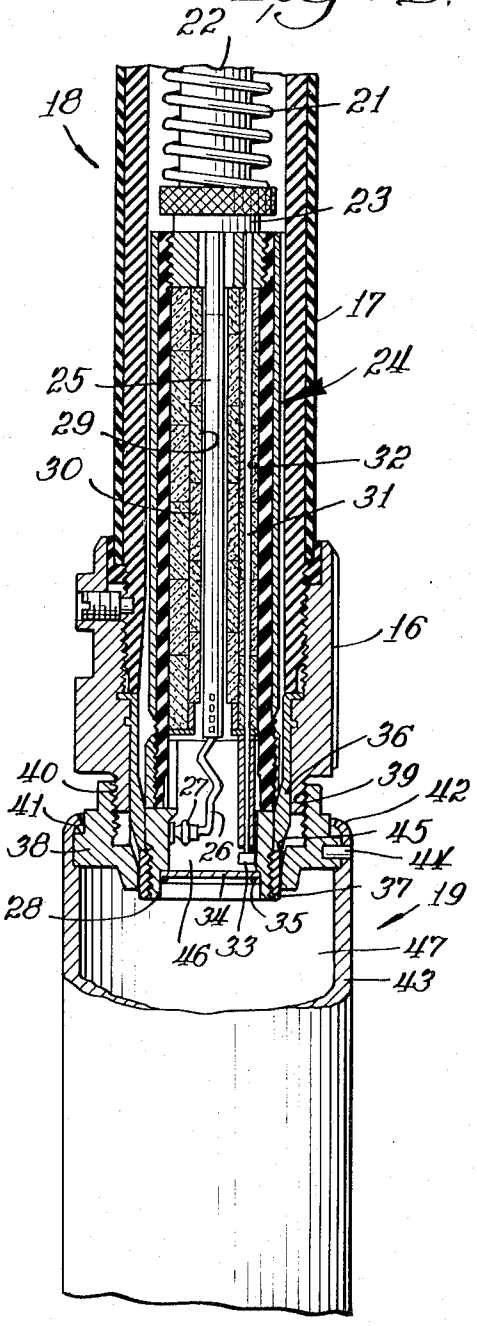


Fig. 3

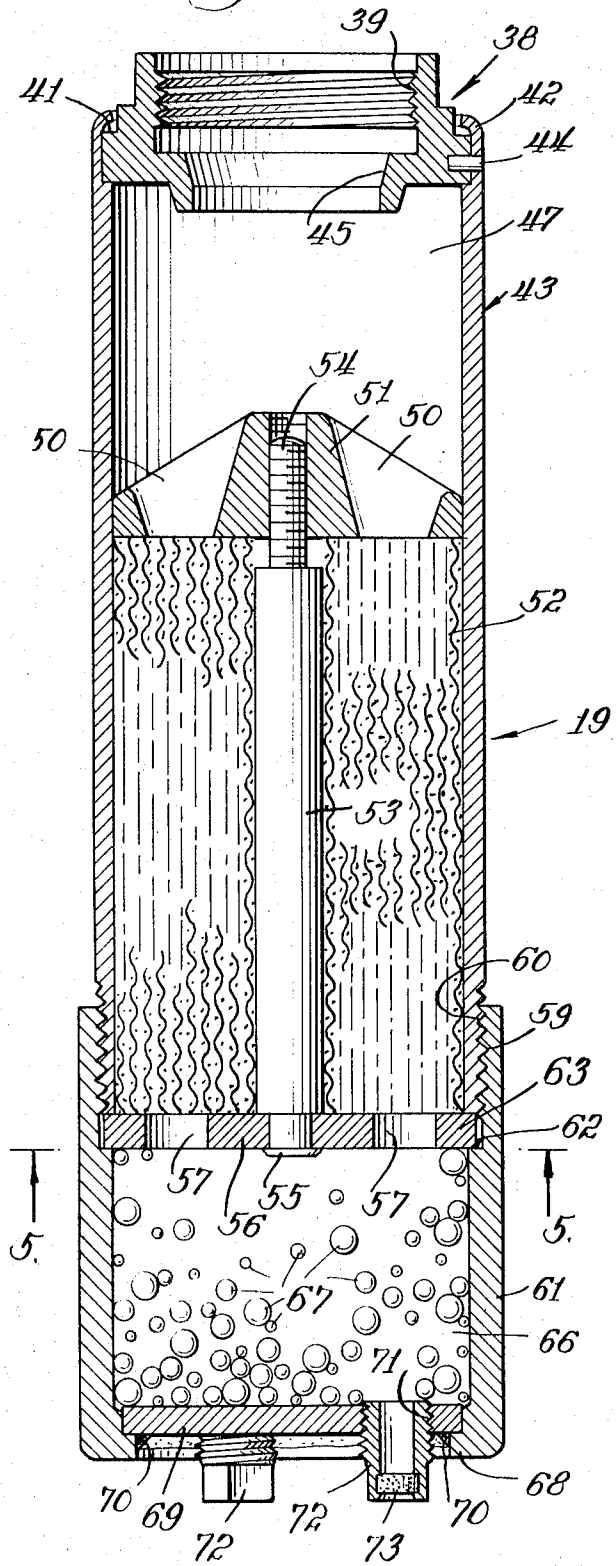


Fig. 4

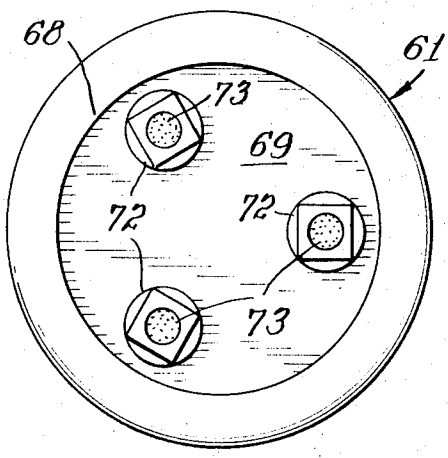
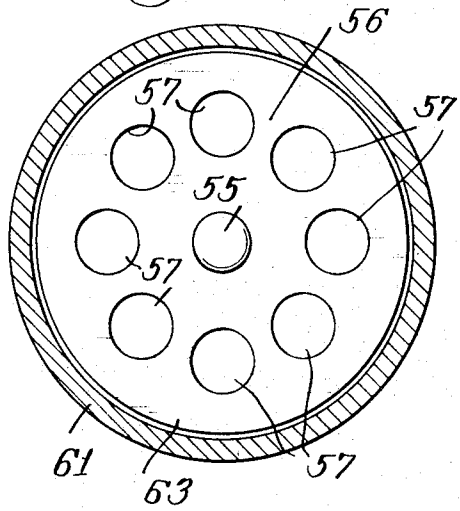
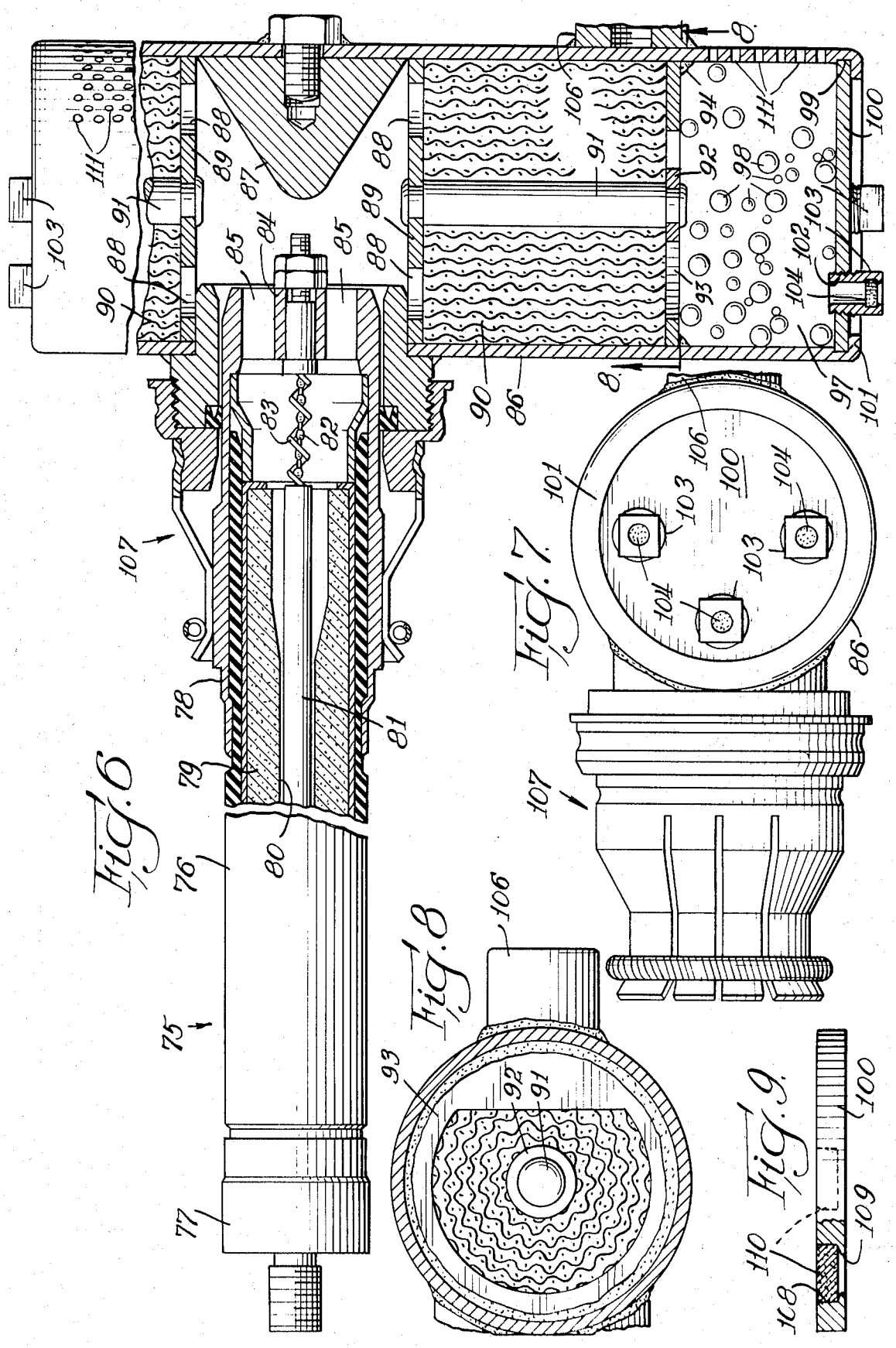


Fig. 5




Fig. 6
Fig. 7
Fig. 8
Fig. 9

EXHAUST CONTROL DEVICE FOR CIRCUIT INTERRUPTING DEVICES

This invention relates, generally, to circuit interrupting devices and it has particular relation to exhaust control devices for high voltage electric power fuses. It constitutes an improvement over the construction disclosed in Fahnoe U.S. Pat. Nos. 3,391,368, issued July 2, 1968 and 3,575,682, issued Apr. 20, 1971 and the patents referred to herein. It also constitutes an improvement over the following U.S. Patents:

Inventor	Patent No.	Issue Date
Van Aller	720,087	Feb. 10, 1903
Slepian	1,959,770	May 22, 1934
Glowacki	2,011,491	Oct. 15, 1935
Glowacki	2,017,492	Oct. 15, 1935
Saudicoeur	2,071,435	Feb. 23, 1937
Triplett	2,379,200	June 26, 1945
Bennett	2,393,584	Jan. 29, 1946

Among the objects of this invention are: To prevent discharge into the atmosphere of the arc products incident to the operation of a circuit interrupting device; to construct an exhaust control device for expulsion fuses of the solid material type that does not require rapid venting to the atmosphere while eliminating back flow of arc products into the arcing chamber, thereby reducing the likelihood of restriking of an arc therein after the arc initially drawn on circuit interruption has been extinguished; to reduce the noise incident to blowing of an expulsion fuse; to reduce the electrical clearances that are required between expulsion fuses and between them and ground; to provide for absorbing substantially all of the energy in the arc products of an expulsion fuse when it blows; to cool and condense metallic vapors and high temperature gas incident to blowing of a high voltage fuse of the solid material type on a mass of ceramic pellets in a housing into which the arc products of the fuse are discharged; to form the ceramic pellets of activated alumina; to vent gradually to the atmosphere the residue of arc products of an expulsion fuse of the solid material type that are discharged into the housing of an exhaust control device when the fuse blows; and to provide a three stage exhaust control device for an expulsion fuse of the solid material type, the first stage comprising metallic heat energy absorbing material, the second stage comprising pelletized ceramic metallic vapor and gas absorbing material and the third stage comprising one or more filter elements capable of preventing flow of metallic particles to the atmosphere while permitting gas flow therethrough at low temperature and pressure.

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 longtitudinal sectional view through the circuit interrupter illustrated in FIG. 1 and through a portion of the exhaust control device therefor, the remaining portion of the latter being shown in elevation.

FIG. 3 is a vertical sectional view, at an enlarged scale, showing the details of construction of the exhaust control device illustrated in FIG. 2B.

FIG. 4 is a bottom plan view of the exhaust control device shown in FIG. 3.

FIG. 5 is a sectional view taken generally along line 5—5 of FIG. 3.

FIG. 6 is a view, partly in side elevation and partly in section, showing a modified form of circuit interrupter provided with a generally T-shaped exhaust control device.

FIG. 7 is a view, in end elevation, of the exhaust control device shown in FIG. 6.

FIG. 8 is a vertical sectional view taken generally along line 8—8 of FIG. 6.

FIG. 9 is a view, partly in side elevation and partly in section showing a modification of the mounting of the metallic filter element.

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 line contact clips 13 and 14 are carried by the insulators 11 and 12 at their outer ends for detachably 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 an elongated exhaust control device 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 a 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 types of arc extinguishing material. In parallel with the rod-like terminal 25 and the 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 blowing 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 products 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 installations. When the circuit interrupter 18 is mounted within a relatively small enclosure, provision is made, according to this invention by mounting the elongated exhaust control device 19 on the lower terminal 16 for confining the arc to the inner end of the elongated exhaust control device 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 a result that the shock waves incident thereto are reduced substantially to zero. Accordingly an ordinary enclosure can withstand them. The conductivity of the exhaust products is lowered to substantially zero so that large clearances or insulating shields are rendered unnecessary within the metallic enclosure.

The elongated exhaust control device 19 includes a metallic adapter 38 and has an internal thread 39 for cooperation with an external thread 40 on the lower terminal 16. The adapter 38 has a shoulder 41 to receive the upper turned over end 42 of an elongated cylindrical shell 43 which forms a part of a housing for the exhaust control device 19. The shell 43 can be formed of suitable metal such as brass or steel. Pins, one shown at 44, secure the shell 43 to the adapter 38. A conical surface 45 is provided on the adapter 38 for engaging the contact fingers 36 and clamping them against the terminal 28.

As shown in FIG. 2B the frangible disc 34 closes a discharge opening 46 from the lower end of the cartridge 24. Under fault conditions when the circuit interrupter 18 blows, the disc 34 is blown out and the arc products are discharged through the opening 46 into a chamber 47 at the upper end of the shell 43.

Referring to FIGS. 3, 4 and 5, it will be observed that the arc products discharged into the chamber 47 flow through openings 50 in a gas or arc product deflector 51 of metal and into a metallic heat absorbent material 52 which may be in the form of an annular section of wire screen or it may be a stack of copper discs suitably spaced apart and provided with openings through which the arc products can flow. The metallic heat absorbent material 52 is located around a metallic stud 53 the upper end 54 of which is threaded into the central portion of the deflector 51. The lower end 55 of the stud 53 is peened to a metallic deflector disc 56 which is located at the lower end of the shell 43 and has the metallic heat absorbent material 52 resting thereon. As shown in FIG. 5 the deflector disc 56 is provided with vents or apertures 57 through which the arc products, not disposed of within the shell 43, can flow downwardly.

It has been found that it is desirable to provide additional cooling and condensing means in order to more completely dissipate the arc products which may remain after passing through the shell 43 and through the metallic heat absorbent material 52. Accordingly, the lower end of the shell 43 is provided with an external thread 59 for receiving an internal thread 60 of a metallic cylindrical extension 61 which contains additional arc product absorbing means. It will be noted that the upper end of the extension 61 has a radial shoulder 62 for receiving the periphery 63 of the deflector disc 56. It also will be observed that the periphery 63 extends underneath the lower end of the shell 43. The reason for this is to direct all of the arc products remaining after passage through the metallic heat absorbent material 52 to flow solely through the apertures 57 and not downwardly along the inner surface of the extension 61.

The remaining arc products discharged through the apertures 57 flow into a chamber 66 formed in the extension 61. The chamber 66 is filled with pellets 67 of activated alumina. Preferably the pellets 67 range in diameter from one-sixteenth inch to three-sixteenths inch. In addition to activated alumina, tabular and hydrated alumina can be employed.

It has been found that activated alumina for the formation of the pellets 67 provides a unique absorbent material for the gas and metallic particles flowing into the chamber 66. Activated alumina is a porous form of aluminum oxide of high surface area. It absorbs liquids, vapors, and gases without change of form or properties. Activated alumina is inert chemically to the gases and vapors in the arc products, is non-toxic and does not soften, swell or disintegrate when subjected to high humidity conditions. High resistance to shock and abrasion are two of its important physical characteristics. One form of this material that is highly satisfactory is a granular dessiccant formed into the pellets 67 in the range of diameters above indicated by the thermal treatment of rock-like granules of hydrated alumina.

The heat transfer properties of the pellets 67 and the manner in which they are packed into the chamber 66 are such that the metallic vapors are condensed within this material and not discharged into the atmosphere. High temperature gas flowing through the bed of ceramic pellets 67 incurs an energy loss by successive expansion and contraction of the gas as it flows thru the voids and restrictions within the bed material. Since this expansion and compression process is not reversible thermodynamically, a relatively large amount of thermal energy is extracted from the gas. The pellets 67 have the characteristic of absorbing gaseous material within their porous structure, thereby tending to effect an additional drop in pressure and temperature.

It will be noted that the lower end of the cylindrical extension 61 has a radial inwardly extending flange 68 for receiving and holding in place a closure disc 69 of suitable metal. The closure disc 69 can be welded in place as indicated at 70.

It is desirable that there be some communication between the chamber 66 and the atmosphere but that such communication be so limited that the discharge gases from the pellets 67 are at very low temperature, low pressure and low volume. For this purpose the closure disc 69 is provided with threaded openings 71, for example three in number, for receiving hollow threaded plugs 72 of brass or bronze. At the outer end

of each hollow plug 72 there is provided an insert or metallic filter 73, having a filtration rating in the range of 50 to 300 microns, i.e., will permit flow therethrough only of particles in this size range. For this purpose sintered bronze has been found to be particularly well adapted.

After ceramic dust is discharged through the inserts 73 in the hollow plugs 72 during the first operation of the circuit interrupting device, the exhaust control device 19 is essentially non-venting i.e., there is some reduction in the flow through characteristic of the inserts 73. The inserts 73 in the hollow filter vent plugs 72 serve to relieve the internal pressure of the exhaust control device 19 at such a relatively low rate that there is substantially no noise. Also the operation is such that gas back-flow into the circuit interrupter 18 does not occur. This is highly desirable since high temperature gas flowing back into the bore 29 as a result of a sustained pressure generated within the exhaust control device 19 would tend to cause the body of arc extinguishing material 30 to decompose. If such action occurs, leakage current through the circuit interrupter between the terminals 15 and 16 is likely to increase as a result of circuit voltage sustained across the device after the fusible element 26 and the strain element 31 has been blown. Under these conditions there is a possibility that the arc will be reestablished within the bore 29 thus causing failure of the fuse to interrupt the circuit. Through the provision of the inserts 73 in the hollow filter plugs 72, the space 66 is placed in limited communication with the atmosphere and the high pressure likely to cause the arc in the bore 29 to be restruck is not sustained. On the other hand the external noise due to gas discharge can scarcely be detected. The discharge through the inserts 73 in the hollow filter plugs 72 is non-conducting thereby making it possible to reduce to a minimum electrical clearances between circuit interrupters and between them and ground and avoid the necessity for using insulating barriers. Accordingly, it is possible to employ a relatively small metallic enclosure. Since substantially no external pressure is developed, the metallic enclosure is not subjected to a shock wave incident to circuit interrupter operation.

The inserts 73 in the hollow filter plugs 72 should have the following characteristics: (1) High melting temperature (2) A degree of porosity such that the pressure within the chamber 66 can be relieved within seconds (3) Ceramic dust or metallic particles do not completely clog them on the initial operation of the circuit interrupter 18 and for several operations thereafter (4) They allow water to drain freely should it become entrapped in the chamber 66. Sintered bronze, in a certain form, meets these requirements. Other screening or filtering materials can be used.

In FIGS. 6, 7, 8 and 9 another embodiment of this invention is illustrated. Here it will be observed that an expulsion fuse, shown generally at 75, is employed that is similar to the circuit interrupter 18 previously described. The expulsion fuse 75 comprises a fuse tube 76 having metallic end terminals 77 and 78. Within the fuse tube 76 is a body 79 of solid arc extinguishing material, such as boric acid. A bore 80 extends through the body 79 in which a rod-like terminal 81 is movable under the influence of a spring (not shown). The rod-like terminal 81 is restrained against movement by a strain wire 82 having a fusible element 83 in parallel therewith. The strain wire 82 and the fusible element 83 connect the rod-like terminal 81 to an end portion 84 of the end terminal 78. When they blow, the arc products are discharged through openings 85 in the end portion 84 into an elongated tubular metallic housing 86 which extends transversely to the expulsion fuse 75.

The arc products are directed against a metallic deflector 87 which is suitably secured to the interior of the metallic housing 86. The arc products then are directed to flow through apertures 88 in metallic discs 89 which overlie metallic heat absorbent material 90 that may be formed of rolled copper wire screen or a stack of copper discs. The heat absorbent material 90 is positioned around metallic studs 91. The inner ends of the studs 91 are peened over the respective disc 89. The outer ends of the studs 91 are peened over washers one of which is indicated at 92. The metallic heat absorbent material 90 is held in place within the housing 86 by metallic rings, one being indicated at 93, and is welded at 94 to the inner surface of the metallic housing 86.

It will be understood that the metallic heat absorbent material 90 extracts a substantial portion of the heat from the arc products so that a reduced amount flows through the rings 93 and into chambers one of which is indicated at 97 at each end of the housing 86.

Each of the chambers 97, like the chamber 66, is filled with pellets 98 of ceramic material, preferably activated alumina. This material functions in the manner previously described to extract substantially all of the remaining heat and pressure and metallic particles from the arc products flowing into the chambers 97.

At each outer end of the metallic housing 86 an annular groove 99 is formed for receiving a closure disc 100. A turned over flange 101 secures the flange 100 in position and securely holds the pellets 98 of activated alumina in place.

Threaded openings 102 are formed in each closure disc 100 for receiving hollow filter plugs 103, for example, three in number, each having an insert 104 of sintered bronze. The functioning of the hollow filter plugs 103 with the inserts 104 of sintered bronze in conjunction with the pellets 98 of activated alumina and the metallic heat absorbent material 90 is essentially the same as described hereinbefore in connection with the exhaust control device 19.

Mounting lugs, one of which is shown at 106, are provided on the outer side of the metallic housing 86 for stationarily locating it. On the opposite side a contact assembly 107 is secured for receiving the end terminal 78 of the expulsion fuse 75.

In FIG. 9 the closure disc 100 is shown as being provided with countersunk openings, one of which is indicated at 108. Each opening 108 has a radial flange 109 at the outer end for receiving a disc 110 of sintered bronze of the kind and character above referred to.

As alternative to using filter plugs 72 or 103, a number of vents 111, FIG. 6, can be formed in the wall of the housing 86, preferably at both ends, for placing the chamber 97 directly in communication with the atmosphere. There may be 20 to 30 in number and of a diameter ranging from one thirty-second inch to one-sixteenth inch in diameter. When the vents 111 are employed, the closure disc 100 is imperforate.

While improved results are obtained using the inserts or discs **73**, **104** and **110** of sintered bronze, under certain conditions where substantially complete disposition of the arc products is not required, they may be omitted and the vents **111** used but with consequent loss of the final filtering function of the inserts or discs **73**, **104** and **110** as described hereinbefore.

Satisfactory results can be obtained with the exhaust control device **19** modified to omit the metallic heat absorbent material **52**. However, optimum circuit interruption is accomplished when this material is used with the pellets **67** in the extension **61**.

It will be understood that the exhaust control device **19** can be employed in conjunction with any circuit interrupting device in which gas and other arc products are discharged to the atmosphere where control of such discharge is desirable.

We claim:

1. An exhaust control device for a circuit interrupter comprising a housing for receiving at one end exhaust gas incident to opening of said circuit interrupter, a vented closure at the other end of said housing, a mass of spherical pellets of gas and metal vapor absorbent material selected from the class consisting of activated alumina, tabular alumina and hydrated alumina in said housing ranging in size from one-sixteenth inch to three-sixteenths inch in diameter to provide alternately large and small interstices therebetween for repetitive expansion and contraction of said exhaust gas to cool, condense and absorb metal vapor and decomposition gases of said exhaust gas; and metallic heat absorbent material in said housing between said one end and said mass of pellets for initially receiving and extracting heat from said exhaust gas.

2. An exhaust control device according to claim **1** wherein one or more metallic filters in said closure place the space occupied by said pellets in limited communication with the atmosphere.

3. An exhaust control device according to claim **2** wherein each metallic filter has a rating of 60 to 300 microns.

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