United States Patent [19]

Harner

[11] **3,893,056**

[45] **July 1, 1975**

[54] **FUSE DEVICE**

[75] Inventor: **Robert H. Harner**, Park Ridge, Ill.

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

[22] Filed: **Apr. 1, 1974**

[21] Appl. No.: **456,866**

[52] **U.S. Cl.** **337/283;** 337/162; 337/275

[51] **Int. Cl.** **H01h 85/02**

[58] **Field of Search** 337/283, 274, 275, 162, 337/161, 144, 249, 281, 247, 201, 284, 164, 288, 292, 293

[56] **References Cited**

UNITED STATES PATENTS

2,294,767	9/1942	Williams, Jr.	337/275
3,304,390	2/1967	Lindell	337/162

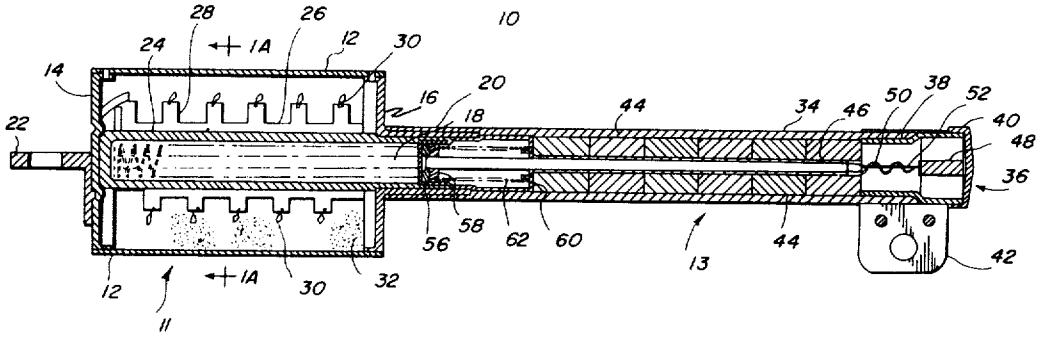
Primary Examiner—Harold Broome

Attorney, Agent, or Firm—Kirkland & Ellis

[57] **ABSTRACT**

A current-limiting device is joined in series with an expulsion fuse to provide current interruption for a full range of fault currents. The expulsion fuse portion is joined to the current-limiting device in such a way as to reduce the overall length of the combination by allowing the operative elements of the expulsion fuse portion to move into the current-limiting fuse portion upon operation of the expulsion fuse portion. Also, in those instances where it is desirable to use an exhaust control device in conjunction with the expulsion fuse portion, the exhaust control device can be positioned within the current-limiting device to reduce the overall length of the device.

19 Claims, 6 Drawing Figures



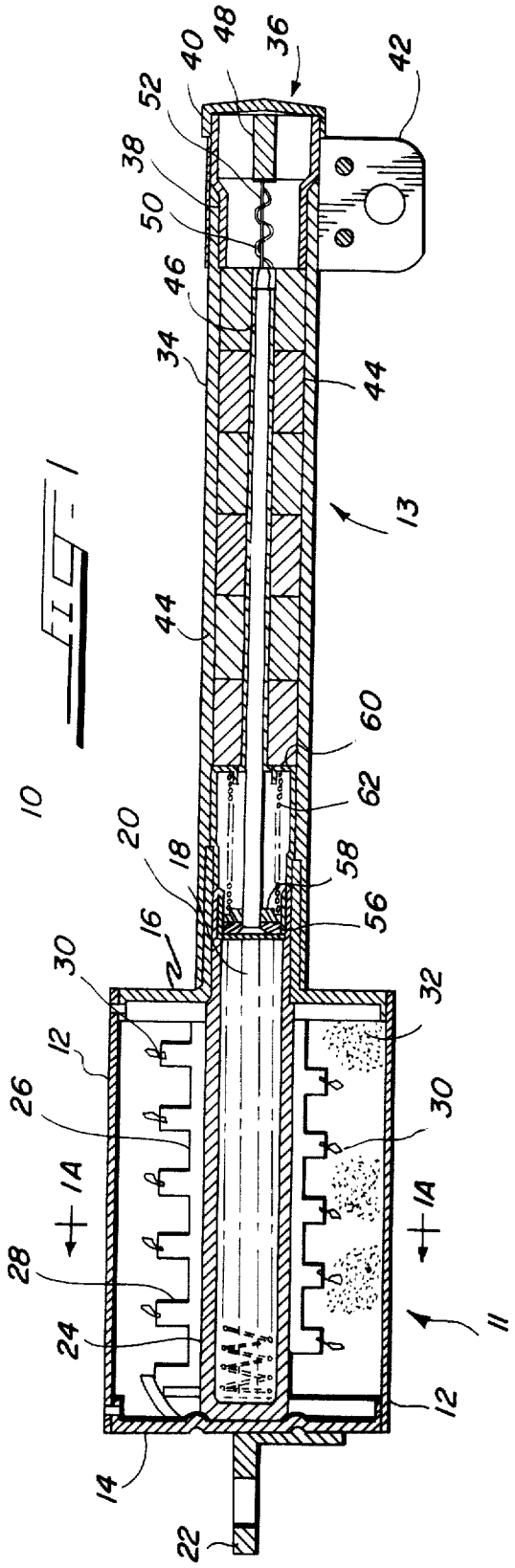

10
11
12
13
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
56
58
60
62
14
14

FIG. 1

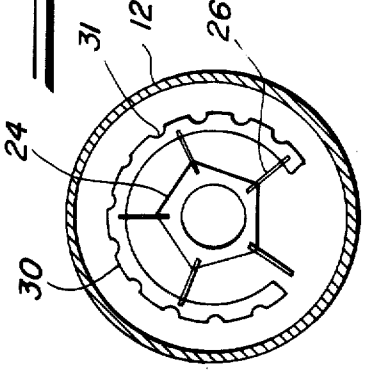

12
24
26
30
31

FIG. 1A

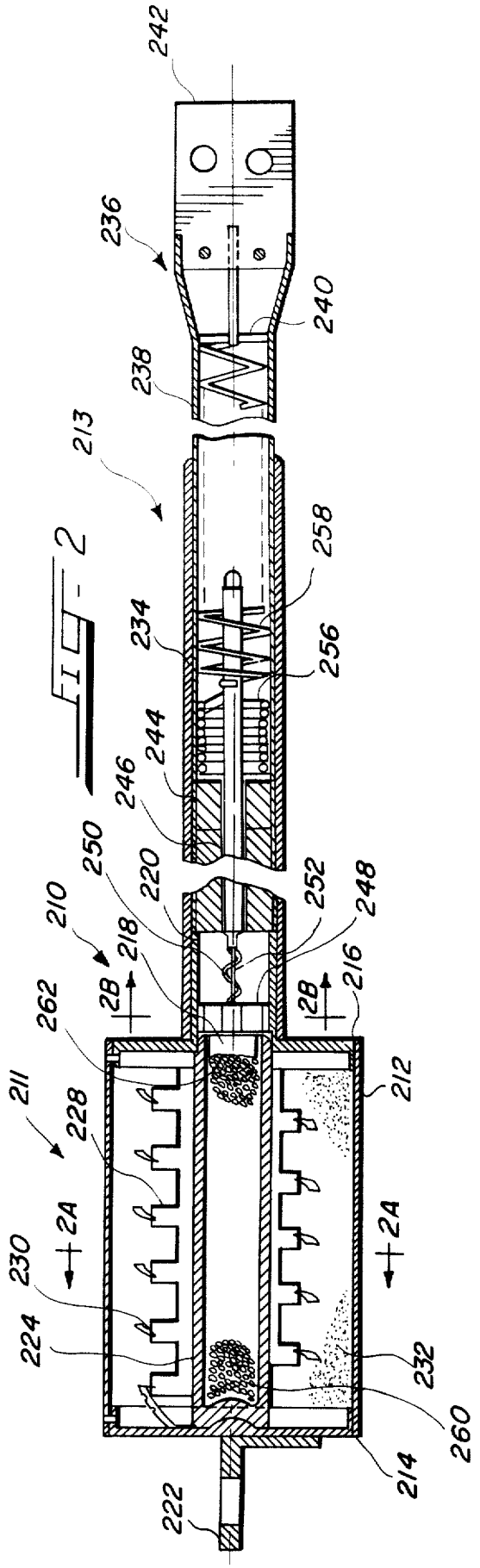


FIG - 2

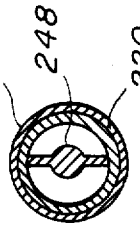


FIG - 2B

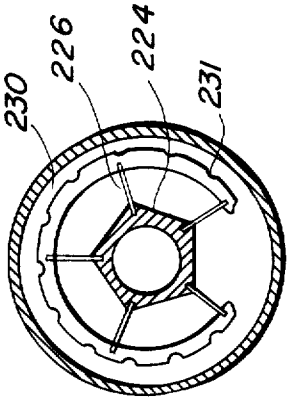


FIG - 2A

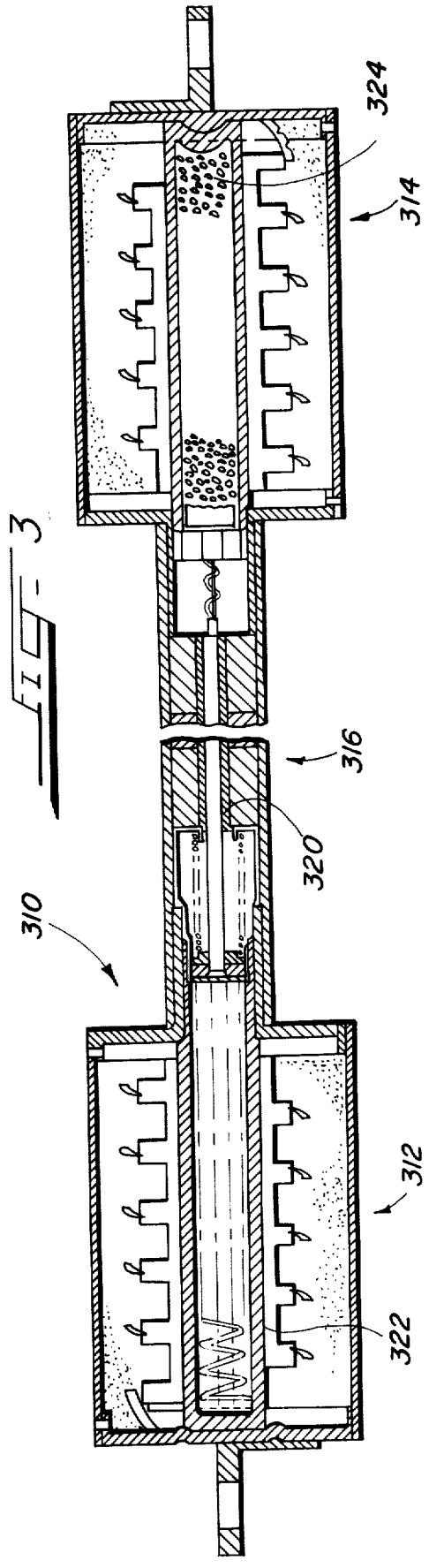


FIG - 3

FUSE DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to high voltage power fuses and more particularly to the combination of current-limiting devices with expulsion fuses to obtain a desirable full range of operating characteristics.

2. Description of the Prior Art

Expulsion fuses are well known in the art and are designed to interrupt relatively low levels of current. However, expulsion fuses are not as suitable for high current interruption as current-limiting fuses for several reasons. For example, the forces resulting from gas pressure caused by fuse operation for high current levels are extremely large, necessitating expensive housing designs to withstand the forces created by expulsion fuse operation at high current levels. In addition, expulsion fuses designed to operate at high current levels can produce objectionable noise, hazardous gases and shrapnel during operation. Further, for cost and size of package, current-limiting devices are more suited for high current interruption.

High currents can be limited by a current-limiting fuse arrangement which operates to limit prospective extremely high fault currents to a much lower level. However, current-limiting devices are inherently unsuited for interrupting current flow at low current levels.

It has been previously recognized that current-limiting fuses and expulsion type fuses can be connected serially to provide a greater range of current interruption capabilities. For example, U.S. Pat. No. 2,917,605 — Fahnoe recognizes that current-limiting fuse elements can be associated with expulsion type fuse elements to provide a broad spectrum of current interruption capabilities. However, such prior art combinations have resulted in an undesirable long fuse device since the current-limiting fuse and the expulsion fuse have been serially joined. This increased length requires more expensive and bulky fuse mounting equipment and tends to preclude utilization of the conventional fuse mounting structure.

Therefore, it would be a highly desirable advance in the art to provide a fuse device that combines the high current-limiting properties of a current-limiting fuse and the low current interrupting properties of an expulsion fuse in a relatively short housing so that the most efficient operating range of both devices can be optimized to provide for efficient interruption across a greater range of currents.

BRIEF DESCRIPTION OF THE INVENTION

A fuse device in accordance with the present invention comprises the utilization of an expulsion fuse means and a current-limiting means that are joined together so that the internal portions of the current-limiting means can receive the operative portions of the expulsion fuse means thereby reducing the overall length of the fuse device.

More specifically, a fuse device for interrupting current flow between two points of an electrical circuit in accordance with the present invention comprises a hollow first housing formed of an electrically insulating material having a first end plate connected to one point of the circuit sealing one end of the first housing and a second end plate sealing the other end of the first housing. The second end plate has an aperture opening at the center thereof through which a hollow thimble is mounted so that the thimble is positioned within the first hollow housing. A fuse element connects the first and second end plates. The fuse element will fuse when a predetermined current level is exceeded. A hollow second housing formed of an electrical insulating material is mounted at one end to the second end plate around the aperture. A second electrical terminal connected to another point of the electrical circuit is mounted on the other end of the second housing. A movable arcing rod is movably mounted within the second housing and a fusible wire connects the arcing rod and the third end plate. The fusible wire will fuse when a second predetermined current level is exceeded. Contact means are provided connecting the second end plate and the arcing rod so that a circuit is completed between the first end plate and second terminal. Spring means are provided within the second housing for urging the arcing rod towards the hollow thimble so that the arcing rod will be rapidly moved into the hollow thimble within the first housing when the fusible wire fuses.

An insulating material such as quartz sand as is well known in the art is placed in the first housing to assist in the current-limiting function of the current-limiting portion of the fuse device. A hollow annular liner, formed of a material capable of producing an arc-quenching gas when exposed to an electrical arc, is positioned in the second housing around the arcing rod. Thus, the liner facilitates the extinguishment of the art after the fusible wire fuses.

The fuse element in the first housing may be an essentially flat ribbon having two opposite flat sides. Thus fuse element may be helically wound in an edge-wound configuration so that the flat sides of the fuse element are essentially perpendicular to the center line between the first and second end plates. Suitable mounting brackets may be affixed to the first and third end plates for mounting the fuse device to electrical circuit elements.

Thus, it is a primary object of the present invention to provide a fuse device combining the relative advantages of a current-limiting device and an expulsion fuse so that a wide range of current interruption performance can be provided in a relatively short housing.

These and other objects, advantages and features shall hereinafter appear in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional side view of a preferred embodiment of the present invention.

FIG. 1A is a cross-sectional view of the embodiment shown in FIG. 1 taken substantially along line 1A—1A in FIG. 1.

FIG. 2 is a cross-sectional side view of an alternative embodiment of the present invention.

FIG. 2A is a cross-sectional view of the alternative embodiment shown in FIG. 2 taken substantially along line 2A—2A in FIG. 2.

FIG. 2B is a cross-sectional view taken substantially along 2B—2B in FIG. 2.

FIG. 3 is a cross-sectional side view of another alternative embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIG. 1, fuse device 10 comprises current-limiting portion 11 and expulsion portion 13. Current-limiting portion 11 comprises a first cylindrical housing 12 formed of an electrically insulating material having the ends thereof sealed by first end plate 14 and second end plate 16. Formed in the center of second end plate 16 is aperture 18 surrounded by flange 20 that is formed perpendicular to the surface of second end plate 16. Mounted to first end plate 14 is mounting terminal 22 having an opening therein for mounting fuse device 10 to an appropriate portion of an electrical circuit.

Mounted to second end plate 16 and extending through aperture 18 is hollow thimble 24 comprised of insulating material, which extends through first cylindrical housing 12. Hollow thimble 24 is pentagonal in cross section and has a hollow circular interior portion. Mounted in grooves at the corner apexes of the hollow thimble 24 (see FIG. 1A) are support strips 26. Formed on support strips 26 are tongues 28 (see FIG. 1) which support a fusible element 30 that is helically wound around support strips 26. Fusible element 30 is connected at one end to first end plate 14 and at the other end to second end plate 16. Fusible element 30 has formed therein indentations 31 along the edge thereof to provide initial fusion points and also to facilitate winding of the element.

First housing 12 is filled with a suitable insulating material such as quartz sand 32 that assists in the current-limiting function of the current-limiting portion 11 when fusible element 30 fuses.

Mounted to the flange 20 on second end plate 16 is second hollow housing 34 formed of an electrical insulating material. Mounted over the opposite end of second hollow housing 34 is third end assembly 36 which seals second hollow housing 34. Third end assembly 36 comprises ferrule 38 partially inserted into second hollow housing 34 over which is mounted cap 40. Mounted within ferrule 38 is contact member 48. Also mounted externally to ferrule 38 is mounting terminal 42.

Positioned within second hollow housing 34 is annular liner 44 formed of a material that will produce an arc quenching gas when exposed to an electrical arc. Annular liner 44 has a hollow interior in which is positioned arcing rod 46. Arcing rod 46 is connected at one end to contact member 48 by fusible wires 50 and 52. Fusible wire 52 is made of a nichrome and fusible wire 50 is made of silver. Silver wire 50 is the main current carrying element and fuses in response to heating when a predetermined current level is exceeded. Nichrome wire 52 is provided to withstand forces exerted upon the arcing rod so that the silver wire 50 does not have any tensile force exerted upon it. Nichrome wire 52 fuses immediately upon the fusion of silver wire 50.

Connected to the opposite end of arcing rod 46 is contact button 56 and positioned immediately adjacent to contact button 56 is spring insulator 58. Spring cup 60 is mounted within second housing 34 and electrically engages flange 20 of second end plate 16 and also electrically engages contact button 56 connected to arcing rod 46. A spring 62 is mounted within spring cup 60 and engages spring insulator 58. Spring 62 is compressed in the position shown in FIG. 1 so that arcing rod 46, contact button 56, and spring insulator 58 are all urged toward the left as shown in FIG. 1 thereby causing tensile stress to be exerted upon nichrome wire 52.

Fusible element 30 is designed so that when a predetermined current flowing through fusible element 30 is exceeded, fusible element 30 will fuse initially at indentations 31 on the edge of fusible element 30. If a severe and high magnitude fault occurs in the circuit being protected by the fuse device 10, fusible element 30 will almost instantaneously fuse and vaporize the silver material from which fuse element 30 is fabricated. Fusible element 30 thus acts in such a way as to effectively insert a high resistance between the two end plates thereby limiting the current to a fraction of the potential fault current that would otherwise flow.

Silver wire 50 and nichrome wire 52 and designed to effectively operate to interrupt current flow at much lower current levels than the current-limiting portion 11 of fuse device 10.

The current-limiting portion 11 of fuse device 10 operates most effectively to interrupt high current levels, whereas expulsion fuse portion 13 of fuse device 10 operates most effectively to interrupt lower current levels.

After silver wire 50 and nichrome wire 52 fuse, spring 62 moves arcing rod 46 through the opening in liner 44 until the end of arcing rod 46 has moved all the way into thimble 24. When silver wire 50 and nichrome wire 52 fuse, an arc forms between arcing rod 46 and contact member 48. However, as arcing rod 46 moves rapidly through liner 44 and the arc is "stretched," the arc comes in contact with annular liner 44 which is formed of a material which emits an arc-quenching gas when exposed to an electrical arc. Thus, the rapid combination of the movement of arcing rod 46 and the emission of arc-quenching gas from liner 44 tends to extinguish the arc thereby interrupting current flow.

One unique feature of the present invention is the combination of a current-limiting fuse portion and an expulsion type fuse portion so that the moving parts of the expulsion type fuse, namely arcing rod 46, contact button 56 and spring insulator 58 move into a space within the current-limiting portion of the fuse, i.e., thimble 24. It would ordinarily be expected that it would be impractical to permit metallic components to enter into or along the length of the current-limiting portion of a fuse device because this might limit the voltage withstand capabilities of the current-limiting portion of the fuse device.

However, it has been discovered that this unique combination does not affect the voltage withstand capabilities of the current-limiting portion of the fuse device. For example, at overload or low fault current levels, only the expulsion fuse portion, i.e., only silver wire 50 and nichrome wire 52 fuses and fusible element 30 remains intact. In this instance, no voltage appears across first and second end plates 14 and 15 and the presence of the arcing rod 46, contact button 56, and spring insulator 58 within thimble 24 has a limited, inconsequential effect upon the voltage withstand capabilities of the current-limiting portion of the fuse device 10.

At intermediate current levels, where the current is high enough to melt the fusible element 30 as well as silver wire 50 and nichrome wire 52, the movement of the fuse components into thimble 24 still produces no detrimental effect because either the expulsion fuse

portion of the fuse device **10** is sufficient to interrupt current flow without assistance from the current-limiting portion, or at currents of this level, the maximum arc voltage produced by the current-limiting section is relatively low, tending to be inversely proportional to the excursion of the fuse arcing rod at the time crest voltage occurs. Thus, the withstand capabilities of the current-limiting portion enclosed in housing **12** are not affected, and the thimble is thus not subjected to severe dielectric stress.

At high fault currents, interruption is substantially brought about by the current-limiting section. The current is rapidly forced to a low level when fusible element **30** fuses, and is thus interrupted before a significant motion of fuse arcing rod **46** occurs. Thus, during the portion of time that maximum voltage exists between first and second end plates **14** and **16**, the metallic fuse components, i.e., arcing rod **46** and contact button **56**, do not extend far enough into thimble **24** so as to reduce the voltage withstand capability and cause dielectric failure of the thimble wall between the element **30** and the metallic fuse parts.

With reference to FIG. **2**, an alternative embodiment of the present invention is illustrated. Fuse device **210** comprises current-limiting portion **211** and expulsion portion **213**. Current-limiting portion **211** comprises first cylindrical housing **212** sealed at one end by first end plate **214** and sealed at the other end of second end plate **216**. Second end plate **216** has formed therein aperture **218** around which is formed flange **220**. A mounting terminal **222** is mounted to first end plate **214** for mounting the fuse device to appropriate portions of an electrical circuit.

Positioned within first cylindrical housing **212** is hollow thimble **224**. Hollow thimble **224** has a pentagonal cross section and supported at grooves at each corner of the pentagonal hollow thimble **224** are support strips **226** (see FIG. 2A). Tongues **228** are formed on support strips **226** (see FIG. 2) and support a fusible element **230**. Fusible element **230** has indentations **231** formed around the edge thereof to facilitate hexagonal winding of the fusible element **230**, and also to provide a reduced area for initial fusion of fusible element **230**. First cylindrical housing **212** is filled with a suitable insulating material such as quartz sand **232** that assists in the current-limiting function of the current-limiting portion **211**. Mounted to flange **220** around aperture **218** is second hollow housing **234**. Partially inserted into the other end of second hollow housing **234** is third end assembly **236** comprising cylindrical portion **238**, sealing plate **240** and mounting terminal **242**.

Positioned within second hollow housing **234** is hollow annular liner **244** which is formed of a material that produces an arc-quenching gas when exposed to an electrical arc. Positioned within the hollow portion of annular portion **244** is arcing rod **246**.

A contact member **248** (see FIGS. 2 and 2B) is electrically connected to flange **220** of second end plate **216**. Arcing rod **246** is connected to contact member **248** by silver wire **250** and nichrome wire **252**. Silver wire **250** and nichrome wire **252** are designed to fuse in response to heating when a predetermined current level is exceeded.

A cable **256** is connected between arcing rod **246** and cylindrical portion **238** of third end assembly **236** so that a positive electrical connection is maintained between the arcing rod **246** and the third end assembly **236**. A spring **258** is connected to arcing rod **246** and to sealing plate **240**. Spring **258** is stretched so that it tends to urge arcing rod **246** towards the right as viewed in FIG. **2**. However, as long as nichrome wire **252** remains intact, arcing rod **246** is retained in the position illustrated in FIG. **2**.

Thimble **224** forms an exhaust control chamber that may be filled with any suitable condensing media such as alumina particles **260** which act as a muffler to condense hot arc gases when silver wire **250** and nichrome wire **252** are fused during the operation of expulsion portion **213**. A perforated cap **262** retains alumina particles **260** within hollow thimble **224**, but allows the entry of arc gases during the operation of expulsion portion **213**.

FIG. **2** embodiment operates in substantially the same manner as the FIG. **1** embodiment except that the arcing rod moves away from the current-limiting portion **211** during operation of the expulsion portion **213**. Thus, there is no movement of metallic members into the current-limiting portion **211** during operation of the fuse device **210**. The muffler portion comprising alumina particles **260** is positioned within the current-limiting portion **211** to facilitate the condensation of hot arc gases thereby permitting operation of the expulsion portion **213** within discharge of hot gases to the ambient atmosphere.

FIG. **3** illustrates a third embodiment of the present invention. In this embodiment fuse device **310** comprises two current-limiting portions **312** and **314** connected to opposite ends of an expulsion portion **316**. It can be readily observed without detailed explanation that the FIG. **3** embodiment comprises a combination of the FIG. **1** and FIG. **2** embodiments so that the arcing rod **320** moves into thimble **322** in current-limiting portion **312** and the arc gases are condensed in muffler **324** in current-limiting portion **314** upon operation of expulsion portion **316**. The FIG. **3** embodiment provides increased current interrupting capabilities at high current levels since the separate current-limiting portions **312** and **314** need to only be capable of providing one-half the total interrupting capability of the fuse device **310** at high current levels.

I claim:

1. A current-limiting fuse device for interrupting current flow comprising:

an expulsion fuse means comprising at least one fusible element for optimumly interrupting current flow in a first current range, said expulsion fuse means having operative portions; and

a current-limiting means for optimumly interrupting current flow in a second current range, said current-limiting portion having a hollow interior portion;

said expulsion fuse means and said current-limiting means being joined together so that the internal portion of the current-limiting means can receive at least one of the operative portions of the expulsion fuse means without adversely affecting the voltage withstand capabilities of the current-limiting means thereby reducing the overall length of the fuse device.

2. A current-limiting fuse device, as claimed in claim **1**, wherein said current-limiting means comprises:

a hollow first housing formed of an electrically insulating material;

a first conductive end plate sealing one end of said first housing connected to the first point of an electrical circuit;

a second end plate sealing the other end of said first housing, said second end plate having an aperture formed through the center thereof;

a fuse element connecting said first and second end plates, said fuse element formed of a material that will fuse when a first predetermined current level is exceeded;

a hollow thimble mounted to said second end plate through the aperture so that said thimble is positioned within said first hollow housing.

3. A current-limiting fuse device, as claimed in claim **2**, wherein said expulsion fuse portion comprises:

a hollow second housing formed of an electrically insulating material mounted at one end to the second end plate around said aperture;

an electrical terminal connected to the other end of said second housing, said electrical terminal connected to the second point of the electrical circuit;

a movable arcing rod positioned within said second housing; a fusible wire means connected between said arcing rod and said terminal, said fusible wire means formed of a material that will fuse when a second predetermined current level is exceeded;

contact means connecting said second end plate and said arcing rod so that a circuit is completed between said first end plate and said terminal;

spring means within said second housing for urging said arcing rod towards said hollow thimble so that said arcing rod will be rapidly moved into said hollow thimble within said first housing when said fusible wire means fuse.

4. A current-limiting fuse device for interrupting current flow between a first and second point of an electrical current comprising:

a hollow first housing formed of an electrically insulating material;

a first conductive end plate sealing one end of said first housing connected to the first point of the electrical circuit;

a second end plate sealing the other end of said first housing, said second end plate having an aperture formed through the center thereof;

a fuse element connecting said first and second end plates, said fuse element formed of a material that will fuse when a first predetermined current level is exceeded;

a hollow thimble mounted to said second end plate through the aperture so that said thimble is positioned within said first hollow housing;

a hollow second housing formed of an electrically insulating material mounted at one end to the second end plate around said aperture;

an electrical terminal connected to the other end of said second housing, said electrical terminal connected to the second point of the electrical circuit;

a movable arcing rod positioned within said second housing;

a fusible wire means connected between said arcing rod and said terminal, said fusible wire means formed of a material that will fuse when a second predetermined current level is exceeded;

contact means connecting said second end plate and said arcing rod so that a circuit is completed between said first end plate and said terminal;

spring means within said second housing for urging said arcing rod towards said hollow thimble so that said arcing rod will be rapidly moved into said hollow thimble within said first housing when said fusible wire means fuses.

5. A fuse device, as claimed in claim **4**, wherein the first hollow housing is filled with an insulating material.

6. A fuse device, as claimed in claim **5**, wherein said insulating material is quartz sand.

7. A fuse device, as claimed in claim **4**, further comprising an annular liner having a hollow center positioned around said arcing rod in said second housing; said liner formed of a material capable of producing an arc-quenching gas when exposed to an electrical arc

8. A fuse device, as claimed in claim **4**, wherein said fuse element is an essentially flat ribbon having two opposite flat sides and said fuse element is helically wound so that said flat sides of said fuse element are essentially perpendicular to a center line between said first and second end plates.

9. A fuse device, as claimed in claim **4**, further comprising mounting terminal means attached to said first end plate for mounting said fuse device.

10. A fuse device, as claimed in claim **4**, wherein said fusible wire means comprises a silver wire and a nichrome wire.

11. A current-limiting fuse device for interrupting current flow between a first and a second point of an electrical circuit comprising:

a hollow first housing formed of an electrically insulating material;

a first conductive end plate sealing one end of said first housing connected to the first point of the electrical circuit;

a second end plate sealing the other end of said first housing, said second end plate having an aperture formed at the center thereof;

a fuse element connecting said first and second end plates, said fuse element formed of a material that will fuse when a first predetermined current level is exceeded;

a hollow thimble mounted to said second end plate through the aperture so that said thimble is positioned within said first hollow housing;

a hollow second housing formed of an electrically insulating material mounted at one end to said second end plate around said aperture;

an electrical terminal connected to the other end of said second housing;

a movable arcing rod positioned within said second housing;

contact means electrically connected to said second end plate and positioned over said aperture, said contact means having openings therethrough communicating with the hollow portion of said thimble;

fusible wire means connecting said contact means and said arcing rod, said fusible wire means formed of a material that will fuse when a second predetermined current level is exceeded;

muffler means within said hollow thimble for condensing arc gases resulting when said fusible wire means fuses;

spring means within said second housing for urging said arcing rod away from said contact means so that said rod will move rapidly away from said contact means when said fusible wire means fuses.

12. A fuse device, as claimed in claim 11, wherein said muffler means comprises activated alumina particles.

13. A fuse device, as claimed in claim 11, wherein said first hollow housing is filled with an insulating material.

14. A fuse device, as claimed in claim 13, wherein said insulating material is quartz sand.

15. A fuse device, as claimed in claim 11, wherein said fuse element is an essentially flat ribbon having two opposite flat sides and said fuse element is helically wound so that said flat sides of said fuse element are essentially perpendicular to a center line between said first and second end plates.

16. A fuse device, as claimed in claim 11, further comprising mounting bracket means attached to said first end plate for mounting said fuse device.

17. A fuse device, as claimed in claim 11, further comprising an annular liner having a hollow center positioned around said arcing rod in said second housing; said liner formed of a material capable of producing an arc-quenching gas when exposed to an electrical arc.

18. A fuse device, as claimed in claim 11, wherein said fusible wire means comprises a silver wire and a nichrome wire.

19. A current-limiting fuse device for interrupting current flow between a first and second point of an electrical current comprising:

a hollow first housing formed of an electrically insulating material;

a first conductive end plate sealing one end of said first housing connected to the first point of the electrical circuit;

a second end plate sealing the other end of said first housing, said second end plate having a first aperture formed through the center thereof;

a first fuse element connecting said first and second end plates, said first fuse element formed of a material that will fuse when a first predetermined current level is exceeded;

a hollow first thimble mounted to said second end plate through said first aperture so that said thimble is positioned within said first hollow housing;

a hollow second housing formed of an electrically insulating material mounted at a first end to the second end plate around said aperture;

first contact means mounted at the other end of said second housing, said first contact means having openings therethrough;

a movable arcing rod positioned within said second housing;

a fusible wire means connected between said arcing rod and said first contact means, said fusible wire means formed of a material that will fuse when a second predetermined current level is exceeded;

second contact means electrically connecting said second end plate and said arcing rod;

spring means within said second housing for urging said arcing rod towards said first hollow thimble so that said arcing rod will be rapidly moved into said first hollow thimble within said first housing when said fusible wire means fuses;

a hollow third housing formed of an electrically insulating material;

a third conductive end plate sealing one end of said third housing connected to the second point of the electrical circuit;

a fourth end plate sealing the other end of said third housing said fourth end plate having a second aperture formed at the center thereof;

a second fuse element connecting said third and fourth end plates, said second fuse element formed of a material that will fuse when a third predetermined current level is exceeded;

a hollow second thimble mounted to said second end plate through said second aperture so that said thimble is positioned within said third hollow housing;

said hollow second housing being mounted at a second end to said fourth end plate around said second aperture;

muffler means within said second hollow thimble for condensing arc gases resulting when said fusible wire means fuses.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,893,056
DATED : July 1, 1975
INVENTOR(S) : Robert H. Harner

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 54, "portion" (first occurrence) should read --means--.

Column 7, line 15, "portion" should read --means--.

Signed and Sealed this

Twenty-eighth Day of *February 1978*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

LUTRELLE F. PARKER
Acting Commissioner of Patents and Trademarks