United States Patent [19]

Blewitt

[11] **3,925,745**

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[54] **HIGH VOLTAGE FUSE WITH LOCALIZED GAS EVOLVING SUPPRESSORS**

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[73] Assignee: **Westinghouse Electric Corporation,** Pittsburgh, Pa.

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[52] **U.S. Cl.** **337/279;** 337/273

[51] **Int. Cl.²** **H01H 85/44**

[58] **Field of Search** 337/158, 159, 160, 161, 337/162, 168, 273, 276, 279

[56] **References Cited**

UNITED STATES PATENTS

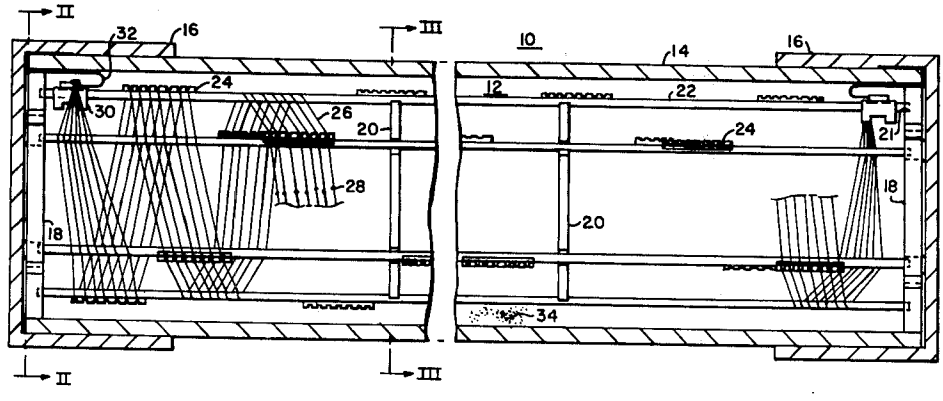
2,667,549	1/1954	Fahnoe et al.	337/161
3,287,525	11/1966	Mikulecky	337/161
3,437,971	4/1969	Mikulecky	337/158

Primary Examiner—J. D. Miller
Assistant Examiner—Fred E. Bell
Attorney, Agent, or Firm—M. J. Moran

[57] **ABSTRACT**

Dielectric core assembly with alternating gas evolving suppressors disposed thereon for supporting and for positioning helically wound fuse elements and evolving arc cooling gas in localized areas.

19 Claims, 7 Drawing Figures



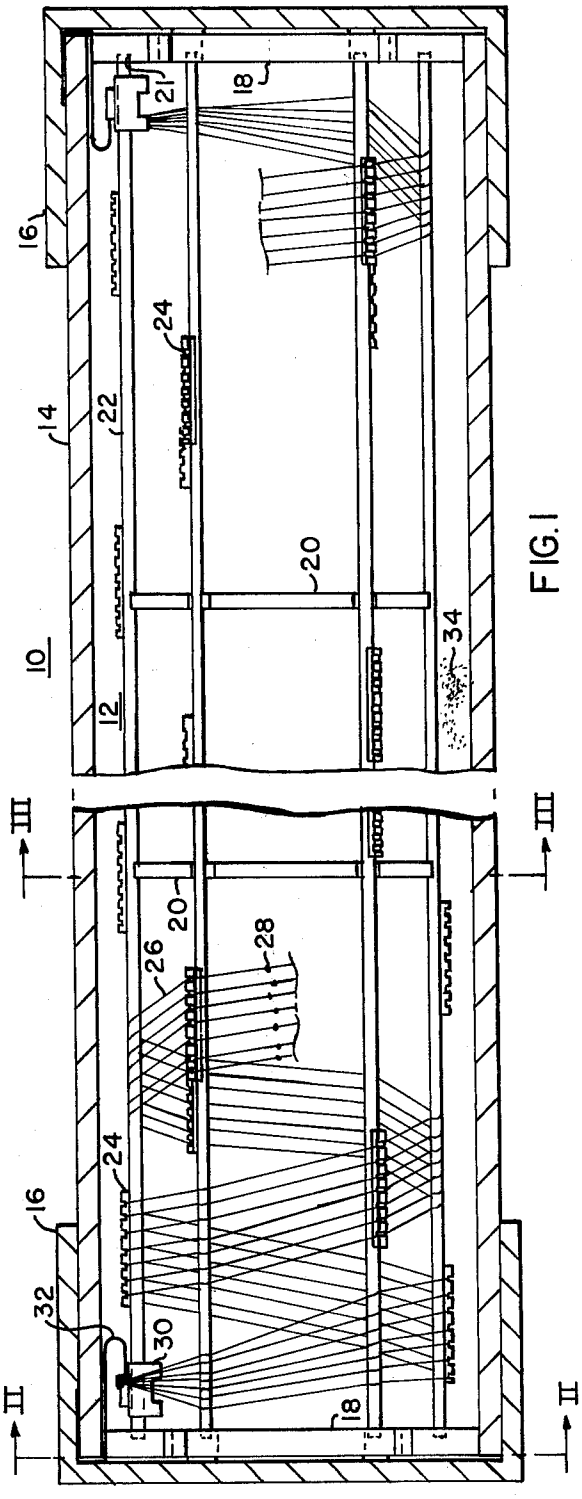


FIG. 1

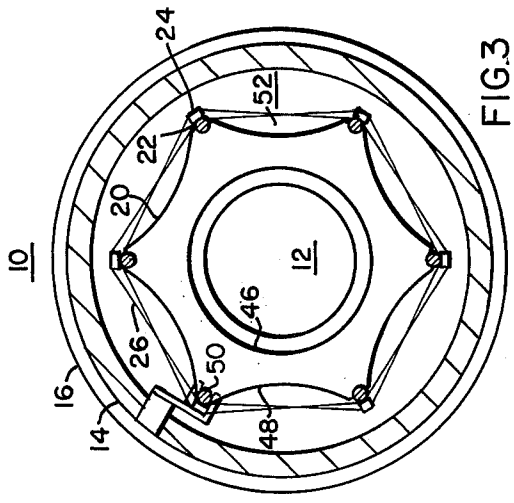


FIG. 3

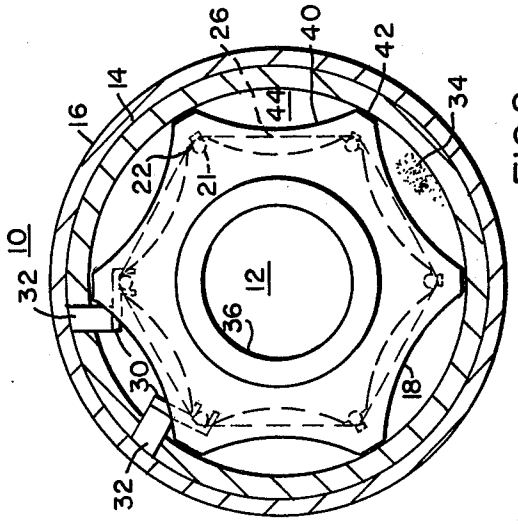


FIG. 2

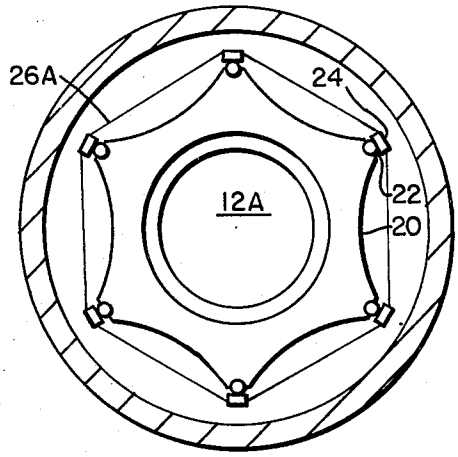


FIG. 3A

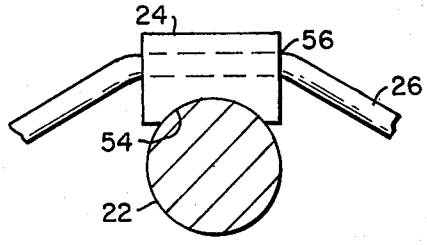


FIG. 4

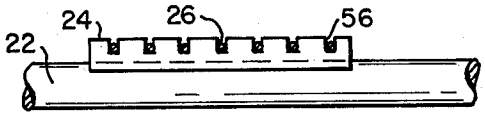


FIG. 5

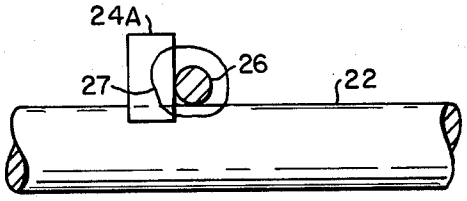


FIG. 6

HIGH VOLTAGE FUSE WITH LOCALIZED GAS EVOLVING SUPPRESSORS

BACKGROUND OF THE INVENTION

This invention is related generally to wide range electrical fuses having gas evolving material therein and is related more specifically to high voltage helically wound fuses having the gas evolving material disposed in localized areas.

It is known to utilize helically wound fuse elements in a high voltage electrical fuse. In the simplest case the helically wound fuse element is disposed upon a solid mandrel or core. Such fuse elements are described in U.S. Pat. No. 3,742,415 issued to Cameron et al. on June 26, 1973 and assigned to the assignee of the present invention, U.S. Pat. No. 3,012,121 issued to B. C. Hicks on Dec. 5,1961 and German Pat. No. 703,631 issued to Vitaly Grosse on Mar. 13, 1941. In the latter mentioned patents the purpose of the mandrel is generally for providing support for the helically wound fuse elements and in some instances gas evolving material is utilized to cool and quench the electric arc produced when the fuse element melts. Mandrels for helically wound fuse elements have been described in the prior art which utilize grooves or screw-like threads to accommodate the helically wound fuse element. Such mandrels are described in U.S. Pat. No. 2,523,139 issued to J. B. Owens on Sept. 19, 1950; U.S. Pat. No. 2,667,549 issued to H. H. Fahnoe et al. on Jan. 26, 1954; U.S. Pat. No. 2,917,605 issued to H. H. Fahnoe on Dec. 15, 1969; U.S. Pat. No. 3,259,719 issued to R. T. Innis et al. on July 5, 1966; Norwegian Pat. No. 28,311 issued to Nielsen on Apr. 12, 1917 and U.S. Pat. No. 3,251,968 ussued to F. L. Cameron on May 17, 1966 the latter patent being assigned to the assignee of the present invention. Still another mandrel arrangement includes a hollow mandrel having holes drilled therein for allowing the fuse element to be wound partially outside of the mandrel and partially inside of the mandrel. Such a construction is described in Canadian Pat. No. 644,378 issued July 10, 1962 to Henry Simmonds. Still another mandrel construction employs segmented or built up mandrel portions as described in the U.S. Pat. No. 2,605,371 issued on July 29, 1952 to H. H. Fahnoe. All of the above-mentioned mandrel type fuse constructions have a number of disadvantages. One of the disadvantages lies in the fact that the mandrel tends to occupy the entire center space of the fuse, another disadvantage lies in the fact that the mandrel tends to be heavy because of its size, shape and still another disadvantage lies in the fact that the mandrel, if made of gas evolving material, may produce excessive gas under certain high voltage fusing conditions which excessive gas may burst the fuse housing if not vented. Another kind of fuse construction is the separated spacer fuse construction where periodically disposed spacers are supported primarily by the inside of the fuse housing. There are holes or openings through the body of the spacer to accommodate fuse elements along the length of the fuse. This kind of fuse has a disadvantage in regard to high voltage fuses in that it is not easily adapted to accommodated helically wound fuse elements. Still another fuse construction employs the spider or star. The spider or star is typified by a support member having a relatively smaller central portion than the mandrel type previously described but having radially extending arms. One of the simplest

kinds of fuse supports of this kind may be classified as the one piece star. Examples of this kind of fuse support may be found in U.S. Pat. No. 3,138,682 issued to Dannenberg et al on June 23, 1964; U.S. Pat. No. 3,269,350 issued to Cox on May 19, 1953; German Pat. No. 730,954 issued to Lohausen and Mayr on Jan. 29, 1943 and U.S. Pat. No. 2,417,268 issued to Powell on Mar. 11, 1947. An improvement of this type of construction is the one piece star with offset grooves in which the helically wound fuse wire is disposed. Support members of this type are described in U.S. Pat. No. 2,230,207 issued to Thommen et al. on Jan. 28, 1941; U.S. Pat. No. 3,437,971 issued to Mikulecky on Apr. 8, 1961; German Pat. No. 112,437 issued to Lohausen on Feb. 22, 1962 (inspection date); four U.S. Pat. Nos. 3,304,387 through 3,304,390 issued to Lindell on Feb. 14, 1967 and U.S. Pat. No. 3,569,891 issued to Cameron on Mar. 9, 1971 the latter patent being assigned to the same assignee as the assignee of the present invention. One variation of the latter two mentioned types of star arrangements is found in German Pat. No. 1,014,206 issued to Feindt and Frentzen on Aug. 22, 1957 (inspection date) and another variation is found in copending U.S. application Ser. No. 391,919, filed Aug. 27, 1973 by Miller and assigned to the same assignee as the assignee of the present invention. All of the previously described star shaped or spider shaped elements have a number of disadvantages, one of which lies in the fact that the central portion of the core of the fuse in which these elements are disposed is occupied by part of the support means. Another disadvantage lies in the fact that the star shaped elements, like the mandrel type elements in the prior art, tend to be either exclusively gas evolving or non gas evolving or evolve excessive gas under high interruption conditions. It would be advantageous if there were a fuse in which there was support means which could support helically wound fuse elements but which let the central portion of the fuse open so that pulverulent arc quenching material or blown fuse indicating means could be disposed therein for useful purposes.

SUMMARY OF THE INVENTION

In accordance with the invention a fuse is provided which is adapted for a wide range of voltage and current apparatus including high voltage fusing which utilizes a helically wound fuse element wound on a central core which is skeletal in nature. The central core is formed by providing spacers having central holes therein. The spacers have disposed on the arms thereof rods which traverse the length of the fuse. In a preferred embodiment of the invention neither the rods nor the spacers comprise gas evolving material. In another embodiment of the invention the rods and the spacers are dielectric but non gas evolving. In either of the previously described embodiment of the invention suppressor blocks are disposed in convenient locations along the rods. The helically wound fuse elements pass through or over the suppressor elements or blocks which perform two functions. The first function is to space the fuse element and the second function is to provide a gas for cooling the arc under fusing or melting conditions. The suppressor elements comprise a gas evolving material even though the rods upon which they are disposed and the spacers upon which the rods are disposed are not gas evolving. The suppressor elements are generally electrically insulating. In one embodiment of the invention the helically wound fuse ele-

ment makes alternating physical contact with a suppressor element and with the previously described rods. In another embodiment of the invention the helically wound fuse element makes physical contact only with the suppressor segments. The fuse as constructed has the characteristic of being relatively lightweight, with a central opening in the fuse core assembly for the disposition of pulverulent arc quenching material therein or for the disposition of a blown fuse indicator therein. As constructed the core assembly provides localized arc quenching for effectively cooling the arc without evolving excessive quantities of arc quenching gas which may rupture or otherwise damage the fuse.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, reference may be had to the preferred embodiment exemplary of the invention shown in the accompanying drawings in which:

FIG. **1** shows a side elevation partially cut away and partially in section of a fuse utilizing the principles of the present invention;

FIG. **2** shows a cross-sectional view through the fuse of FIG. **1** at Section II—II;

FIG. **3** shows a cross-sectional view through the fuse of FIG. **1** at Section III—III;

FIG. **3A** shows an alternative for the embodiment shown in FIG. **3**;

FIG. **4** shows a side elevation of a suppressor block;

FIG. **5** shows a front elevation of the suppressor block of FIG. **4**; and

FIG. **6** shows a front elevation of a suppressor block for another embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and FIG. **1** in particular a fuse **10** is shown. The fuse **10** may be of the type utilized over a wide range of current and voltage and may be a current limiting fuse although it is not necessarily limited to that construction. Generally fuse **10** is of the helically wound fuse element construction where an elongated fuse element is accommodated within a shorter fuse housing by winding the fuse element therein to accommodate for the length of the fuse element. The fuse **10** may comprise a core assembly **12** disposed within a fuse housing **14** which housing may be of the hollow, tubular, cylindrical, elongated type having open ends and having electrically conducting ferrule members **16** disposed at the open ends thereof to close the open ends. There are provided end spacers or end plates **18** at either end of the core assembly **12.** Longitudinally disposed and spaced from the end spacer **18** and from each other are spacers **20.** The end plates **18** and the spacers **20** are interconnected with elongated rods **22** which are radially disposed in circumferential arrangement around the outer periphery of the spacers **20** and in convenient recesses **21** in the end plates **18.** The core assembly as constructed has the characteristic shape of a cylindrical skeletal structure. It is around this previously described cylindrical skeletal structure that at least one fuse element **26** is helically wound. The fuse element **26** may have the well known tinned portion **28** where fusing may be initiated at low overload currents. The fuse element **26** is terminated at either end thereof by a clamp **30** which is disposed on one of the previously described elongated rods **22.** The clamp **30** has a tubular portion **32** which is conveniently arranged to be placed in electrical contact with the previously described ferrule **16** as shown. There are disposed upon the rods **22** suppressor means **24.** In the preferred embodiment of the invention the end plates **18,** the spacers **20,** and the rods **22** comprise dielectric material but do not comprise of gas evolving material. However, the suppressors **24** although being dielectric or electrically insulating comprise gas evolving material. In the preferred embodiment of the invention the suppressors **24** comprise organic material which is especially suited for evolving gas for cooling an electric arc. The end plate **18,** the spacers **20** and the rods **22** in a preferred embodiment comprise inorganic material. If all of the elements of the core assembly **12** were of a non gas evolving material low current interruption would be degraded. There may be provided pulverulent arcing material **34** which occupies substantially all of the remaining space within the tubular housing **14.** As the arc of interruption expands or elongates during a fusing operation it eventually crosses or comes into contact with a suppressor **24** where localized gas is evolved which cools the arc thus generally increasing its resistance. If the central core **12** were comprised of all gas evolving material the electric arc might damage or degenerate the insulating qualities of the core and the carbon products formed thereby would likely lead to many current leakage paths along the rods **22** or through the fulgurite which would be contaminated by the decomposition of the arc quenching material **34.** Consequently the disposition of gas evolving suppressors **24** on a generally non gas evolving skeletal frames provides a compromise construction. In addition by providing localized suppressors **24,** as the gas therefrom is evolved it is less likely that excessive high pressure is built up within the fuse housing **14** thus leading to a rupture thereof.

Referring now to FIG. **2** there is shown a cross-sectional view of the fuse shown in FIG. **1** through the Section II—II. The outer electrically conducting ferrule **16** or terminal means **16** is shown as well as the cylindrically shaped hollow tubular housing **14.** An end plate **18** is also shown. It will be noted that the end plate **18** comprises a central opening **36.** The end plate **18** comprises arm-like protrusions **42** which may be supported by and make contact with the inner portion of the housing **14** at the points **42.** This provides regions **44** which are open and which can accommodate pulverulent arc quenching material for the absorption of heat from the fuse element during a fusing operation. The previously described terminating means **30** and interconnecting electrically conducting flexible tab **32** are also shown. It will be noted that the core assembly **12** has in this embodiment of the invention six radially spaced generally circular rods **22** which terminate in convenience recesses **21** in the end plate **18.** A fuse element **26** which is helically wound around the skeletal mandrel of the combination rods **22** as viewed in FIG. **2** is shielded by the end plate **18.** Consequently, if sand or pulverulent arc quenching material is provided to the fuse through the central opening **36** or through any of the open spaces **44** it can fill all regions along the entire length of the fuse **10** and around the fuse elements **26** without making forceful contact with the fuse element **26** as the pulverulent arc quenching material is filled or provided to the fuse.

FIG. **3** shows another section of the fuse **10** as shown in FIG. **1** through Section III—III. The tubular fuse housing **14** is shown and there is also shown a spacer

member or spider member **20** having a central opening **46** and radially extending arm portions **48.** At the end of each arm portion there may be disposed a groove **50** of semi-circular cross section into which one portion of a rod **22** is disposed and conveniently attached such as by gluing. On another portion of the rod **22** may be disposed the previously described suppressor means or block **24.** The fuse element **26** is shown wound over suppressor means **24** and rods **22** in alternating arrangement. The alternating arrangement may be along a rod or along the helix from rod to rod or both.

Referring now to FIG. **3A** another embodiment of the invention is shown in which fuse wire or element **26** is wound on the core assembly **12A** over the previously described suppressor means **24** as disposed on the rod or rods **22** by helically winding the wire **26A** so that it only makes contact with the suppressor elements **24** and not with the rods **22.** Consequently, depending upon the embodiment of the invention utilized the wire **26** or **26A** as the case may be, may make contact with gas evolving suppressor material and non gas evolving material or may make contact only with gas evolving suppressor material. It being realized that the previously described arrangements are different.

By referring now to FIG. **4** a side elevation of a suppressor **24** is shown in which a groove **54** is provided in the bottom thereof for conveniently disposing the suppressor element **24** on the rod **22.** There are provided transverse grooves **56** better shown in FIG. **5** for accommodating wire or fuse material **26.**

Referring now to FIG. **5** there is shown a front view of the suppressor element **24** of FIG. **4.** The suppressor element **24** may comprise a plurality of parallel transverse grooves **56** which are rounded at the bottom to be of the same shape as the wire **26** which may be disposed therein consequently providing a large surface to surface contact between the suppressor material and the wire **26** for an efficient evolution of gas during a fusing operation.

Referring now to FIG. **6** there is shown another embodiment of the invention in which the fuse wire **26** is disposed upon the rod **22** in proximity to a suppressor **24A** such that the plasma volume **27** of an arc may interact with the gas evolving material in the suppressor **24A** and cause the evolution of gas for the purposes previously described.

With respect to all the embodiments of the invention it is noted that the central opening **36** of element **18** and central opening **46** of element **20** provide a path or central opening in the fuse **10** where a blown fuse indicator may be disposed or where pulverulent arc quenching material may be disposed for enhanced cooling of the fuse element during a fusing operation. This generally unobstructed central portion of the core assembly **12** is advantageously provided for this purpose.

It is to be understood with respect to the embodiments of the invention that the description of the ferrules **16** and the housing **14** are not limiting nor is the provision of the pulverulent arc quenching material **34** limiting. It is also to be understood that the suppressor element **24** may be molded and may comprise Glass Malamine material as the gas evolving material. It is also to be understood that the rod or rods **22** may be of a ceramic construction. It is also to be understood that the spacers **20** or end plates **18** may comprise gas evolving material or not. It is also to be understood that the helically wound fuse element may be of any pitch that is convenient. It is also to be understood that parallel wires may be wound helically around the skeletal structure **12** to carry higher amounts of rated currents for the fuse **10.** It is also to be understood that the word "helical" is not limiting but is nearly indicative of a wound construction.

The apparatus taught in this invention have many advantages. One advantage lies in the fact that the core assembly although relatively strong is nevertheless light in weight and does not occupy a large volume within the fuse housing **14.** Another advantage lies in the fact that the evolution of excessive gas under certain operating conditions is minimized because gas is evolved locally on a limited scale. Another advantage lies in the fact that the described fuse construction allows for the helical winding of the fuse element for a high voltage fuse. Another advantage lies in the fact that the central portion of the fuse element is left unobstructed and open so that a blown fuse indicator may be provided therein or pulverulent arc quenching material may be provided therein.

What we claim is:

1. An electrical fuse, comprising:
a. fuse housing means;
b. fuse terminal means disposed on said fuse housing means;
c. fuse element means electrically interconnected with said fuse terminal means; and
d. support means disposed within said fuse housing means for supporting said fuse element means thereon, said support means comprising gas evolving-electrically insulating material only in a region near and including a place where said fuse element means is in physical contact with said support means for evolving gas when exposed to an electric arc.

2. The combination as claimed in claim **1** wherein said support means is gas evolving generally within the plasma volume of an electric arc.

3. An electrical fuse, comprising:
a. fuse housing means;
b. fuse terminal means disposed on said fuse housing means;
c. fuse element means electrically interconnected with said fuse terminal means;
d. non gas evolving electrically insulating support means disposed within said fuse housing means; and
e. gas evolving electrically insulating suppressor means disposed upon said support means and disposed in physical contact with said fuse element means to evolve arc quenching gas when said fuse element means fuses and forms an electric arc.

4. The combination as claimed in claim **3** wherein said arc quenching gas is evolved when said fuse element means fuses at a place on said fuse element means where said fuse element means is in said physical contact with said suppressor means.

5. The combination as claimed in claim **3** wherein said non gas evolving electrically insulating support means comprises a rod, wherein said suppressor means is disposed upon said rod.

6. The combination as claimed in claim **3** wherein said non gas evolving electrically insulating support means comprises a plurality of spaced rods, wherein said suppressor means are disposed upon said spaced rods.

7. The combination as claimed in claim 6 wherein said spaced rods are elongated and are additionally spaced from a central longitudinal axis, the resultant structure having the shape of a cylindrical skeletal structure, said fuse element means being helically wound upon said cylindrical skeletal structure.

8. The combination as claimed in claim 7 wherein said suppressor means are spaced on said rods in such a manner that said fuse element touches a non suppressor region on said rod alternately with the touching a suppressor region on said rod.

9. The combination as claimed in claim 8 wherein said alternate touching is along a rod.

10. The combination as claimed in claim 8 wherein said alternate touching is along the helixial fuse element from rod to rod.

11. The combination as claimed in claim 7 comprising pulverulent arc quenching material disposed in said fuse housing for quenching said arc.

12. The combination as claimed in claim 11 wherein said support means comprises inorganic material, wherein said suppressor means comprises organic material.

13. The combination as claimed in claim 3 wherein said suppressor means has a groove therein in which said fuse element means is disposed.

14. The combination as claimed in claim 5 wherein said suppressor means has a groove therein whereat said suppressor means is disposed upon said rod.

15. The combination as claimed in claim 11 wherein said region proximate said central longitudinal axis is generally unobstructed by portions of said support means.

16. The combination as claimed in claim 11 wherein said region proximate said central longitudinal axis is generally unobstructed by portions of said support means and contains said pulverulent arc quenching material for enhanced quenching of said arc.

17. An electrical fuse, comprising:

a. an elongated tubular fuse housing having a longitudinal axis and being opened at either end thereof;

b. spaced ferrules disposed on said fuse housing to close the opened ends thereof;

c. a helically wound fuse element disposed within said fuse housing and electrically interconnected to each of said ferrules; and

d. a core assembly within said housing comprising:

1. a spider; having a central opening and a plurality of arms extending radially of said longitudinal axis;

2. electrically insulating non gas evolving rods disposed parallel of said longitudinal axis at said arms, said spider and said rods having the characteristic shape of a generally cylindrical skeletal structure;

3. at least one electrically insulating gas evolving suppressor member disposed on at least one of said rods, said helically wound fuse element passing over said suppressor member and around said skeletal structure, said suppressor member evolving a limited quantity of gas when said fuse element arcs to thus cool and quench said arc; and

4. pulverulent arc quenching material disposed within said fuse housing including the region within said central opening of said spider and the region where said fuse element passes over said suppressor member to provide enhanced quenching and cooling of said arc.

18. The combination as claimed in claim 17 comprising a plurality of said suppressor members disposed on said rods.

19. The combination as claimed in claim 17 comprising a plurality of said suppressor members disposed on a plurality of said rods.

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