United States Patent [19]

Link

[11] **3,840,836**

[45] **Oct. 8, 1974**

[54] **CURRENT LIMITING SAND FUSE**

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[73] Assignee: **RTE Corporation,** Waukesha, Wis.

[22] Filed: **July 26, 1972**

[21] Appl. No.: **275,180**

[52] **U.S. Cl.** **337/292,** 337/161, 337/276

[51] **Int. Cl.** **H01h 85/04**

[58] **Field of Search** ..... 337/162, 292, 161, 276, 337/297, 291; 200/144 C

[56] **References Cited**

UNITED STATES PATENTS

1,965,239	7/1934	Hill	337/291 X
2,768,264	10/1956	Jones et al.	200/144 C
2,809,254	10/1957	Edsall	337/162
3,179,773	4/1965	Keeley	337/276
3,287,524	11/1966	Huber et al.	337/276 X
3,294,936	12/1966	Mikulecky	337/297 X

FOREIGN PATENTS OR APPLICATIONS

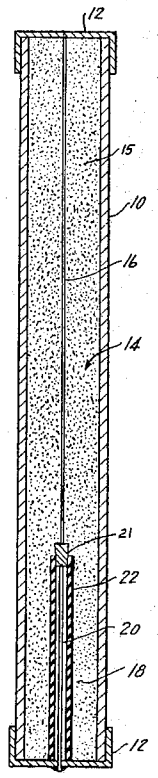
1,513,338	2/1970	Germany	337/292
614,615	12/1948	Great Britain	337/292

Primary Examiner—J. D. Miller
Assistant Examiner—Fred E. Bell

[57] **ABSTRACT**

A current limiting fuse having electrical terminals at each end of a tubular housing, a fusible assembly provided within said housing to interconnect the terminals. The fusible assembly including a first fusible element of high current clearing characteristic and a second fusible element of low current clearing characteristic, the first fusible element substantially surrounded by a granular dielectric material, the second fusible element being positioned within an arc extinguishing sleeve formed of a material which is deionizing under the influence of an electrical arc.

13 Claims, 2 Drawing Figures



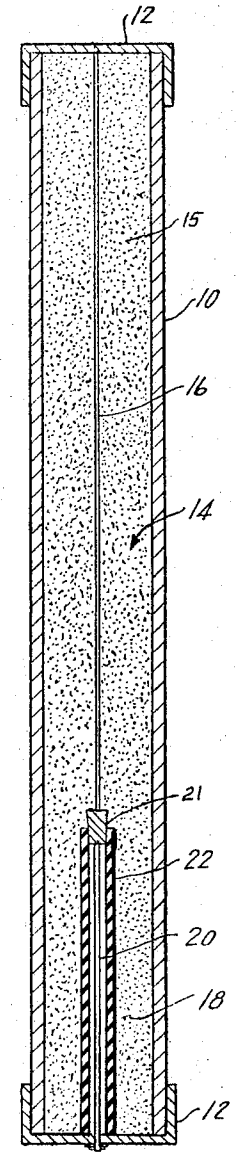

12
15
10
16
14
21
22
20
18
12

Fig. 1

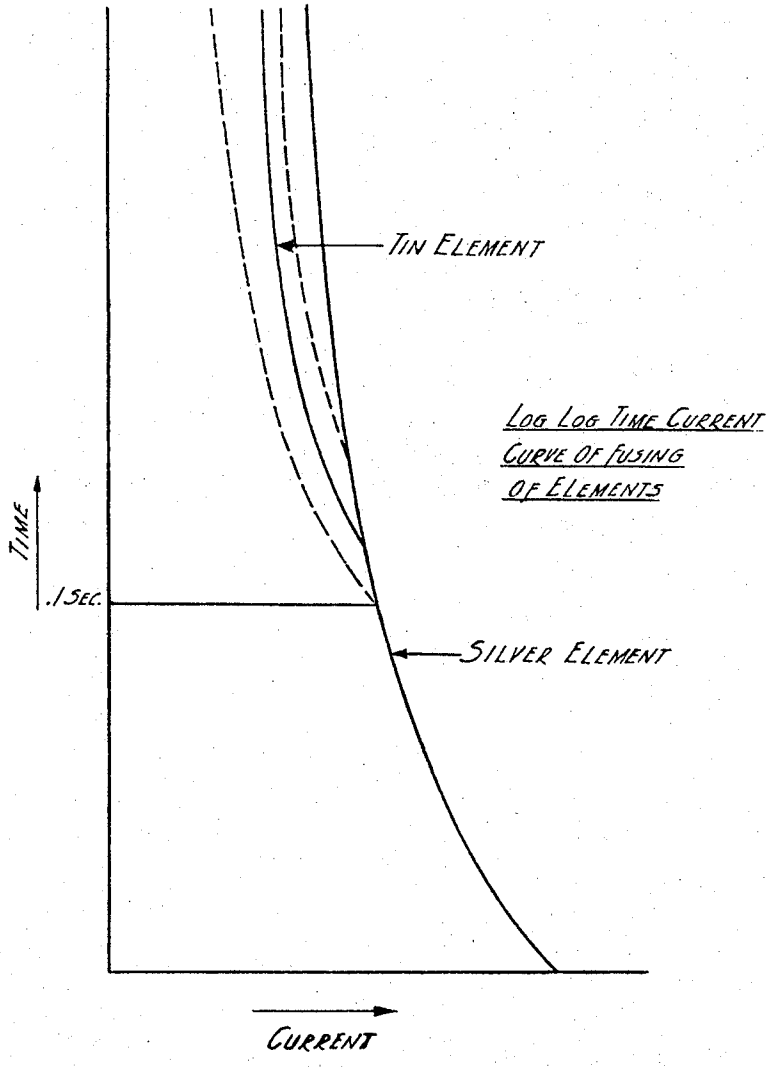

TIN ELEMENT
LOG LOG TIME CURRENT
CURVE OF FUSING
OF ELEMENTS
TIME
.1 SEC.
SILVER ELEMENT
CURRENT

Fig. 2

CURRENT LIMITING SAND FUSE

BACKGROUND OF THE INVENTION

Current limiting fuses of the type shown in the Mikulecky U.S. Pat. No. 3,294,936 are designed to interrupt currents of overload proportions as well as currents of short circuit proportions. The difficulty encountered in fuses of this type is the interruption of currents of relatively small magnitude of long duration, i.e., a second or more. The arc gap which forms in the small cross sectional area portions of the fusible element of this type is progressively enlarged by vaporization and the fulgurite is generally continuous. If the arcing is prolonged in interrupting fault currents of relatively small magnitude, excessive high arc energy is released and intense heating of the filler adjacent to the arc region occurs before completion of the interrupting process. This intense heating and the excessive arc energy tend to delay cooling of the fulgurite and to allow flow of full or leakage current through the fulgurite often resulting in a restrike and rekindling of the arc after initial interruption of the fuse.

In the Mikulecky type current limiting fuse as described in U.S. Pat. No. 3,294,936, lead-tin allow beads are provided in intimate contact with each silver wire. The lead-tin alloy beads reduce the melting temperature of the silver wire due to the formation of an alloy on melting of the lead-tin bead on the silver. However, it has been found that even though the fusible element fails, the fuse does not necessarily interrupt current because of the presence of an arc gap which is not long enough to obtain arc interruption. If this condition occurs for any period of time, the temperature of the fuse can rise to temperatures higher than the destruction temperatures of the surrounding environment.

SUMMARY OF THE INVENTION

The current limiting fuse of the present invention provides for positive interruption of overload currents either under overload or fault current conditions. The fuse includes a fusible assembly including a silver wire member and a tin wire member connected in series. The fuse combines the current limiting characteristics of the serially connected members in order to assure that the fuse clears under prolonged overload conditions at temperatures below the destruction temperature of the surrounding environment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevational view in section showing the current limiting fuse of the invention; and

FIG. **2** is a log log time current curve of fusing elements.

DESCRIPTION OF THE INVENTION

The fuse of the present invention as seen in FIG. **1** includes a hollow insulating casing or housing **10** of a predetermined length having a conductive ferrule or cap **12** mounted on each end. A fuse assembly **14** is positioned within said casing **10** and interconnects said caps.

In accordance with the invention, the fuse assembly **14** includes a first means **16** of high current clearing characteristic and a second means **18** having a low current clearing characteristic. In regard to the former, the first means includes an element having a high melting point temperature, such as a silver wire which melts at

980° C or copper wire which melts at 1,082°C. (Silver oxidizes in air and when temperature rises to a predetermined temperature the silver oxide converts to silver.) The element **20** depending on the desired current clearing characteristic, can be in the form of a perforated or notched strip or a plain wire. The element **20** is electrically connected to the cap **12** and to the plug **21.** The element **20** is embedded in a granular refractory material **15** such as sand.

The second means **18** includes a fusible element **20** and an arc extinguishing sleeve **22.** The fusible element **20** is formed from a material having a low melting point temperature such as tin wire which melts at 232°C. The element **20** is electrically connected to the cap **12** and to a conductive plug **21** at the other end of the sleeve **22.**

The fusible element **20** is thermally insulated by means of the arc extinguishing tube or sleeve **22** which is made of a material such as silicone rubber. The inside diameter and length of the tube can be selected to provide a clearing ability for the fuse at voltages and currents compatible with the destruction temperatures of the components of the surrounding electrical apparatus. The second means **18** can be embedded in the granular refractory material in the sleeve **10.** In either case the caps **12** should be sealed to the sleeve **10** to enclose said first means **16.**

Referring to FIG. **2,** the time current characteristic for silver and tin is shown plotted on a logarithmic scale. It will be noted that the characteristic for tin has a greater slope than the characteristic for silver and intersects the silver characteristic. It should be apparent from the diagram that the low overload current time characteristic of the tin is being used to limit or interrupt the current in the fuse and thereby prevent the temperature of the fuse from rising to destruction temperatures. We are also using the high overload or fault current short time characteristic of the silver to clear the fuse under fault current conditions.

It is generally understood that the length of the wire in sand determines the voltage restoration capability of the fuse. In this regard, it is generally well known that if the wire is too short, the recovery voltage will maintain the element conductive and not allow complete interruption of the circuit. The phenomenon which enables the fuse to clear is the ability of the molten silver to form a fulgurite in the sand when the silver reaches the molten stage. During the formation of this fulgurite heat is absorbed at a very fast rate thus causing a resistance to current flow to build to a point where the voltage across the fuse is not sufficient to maintain a conductive circuit.

I claim:

1. A current limiting fuse comprising, a housing, an electrical terminal at each end of said housing, a fusible assembly having one end connected to one of said terminals and the other end connected to the other of said terminals and within said housing, said fusible assembly including a first fusible element of high current clearing characteristic, a second fusible element of metallic material of low current clearing characteristic, said first and second elements being connected together to form a series circuit, and an arc extinguishing member being formed of material which is deionizing under the influence of an electrical arc and a granular dielectric material completely filling said housing and surrounding said assembly.

2. The fuse according to claim 1 wherein said arc extinguishing member is in the form of a sleeve having a length substantially equal to the length of said second element whereby said second fusible element is insulated from said granular material so that its long time minimum melting current characteristic is less than said first element.

3. The fuse according to claim 2 wherein said sleeve is formed of silicone rubber.

4. A fuse according to claim 1 wherein said second fusible element comprises a metallic conductor having a long time minimum melting current characteristic less than said first fusible element.

5. The fuse according to claim 1 wherein said first fusible element is formed from one of silver and copper wire and said second fusible element is formed from tin.

6. The fuse according to claim 1 wherein said arc extinguishing sleeve comprises a silicone rubber tube.

7. A current limiting sand fuse comprising: a hollow casing, a conductive cap at each end of said casing, a fuse assembly positioned in said casing and having one end connected to one of said caps and the other end connected to the other of said caps, said assembly including first means for providing a high current clearing charcteristic, second means for providing a low current clearing characteristic, said first and second means being conducted in series, a granular dielectric material completely filling said casing, and an arc extinguishing sleeve enclosing the full length of said second means for thermally insulating said second means from said granular dielectric material.

8. The fuse according to claim 7 wherein said first means includes a fusible element formed from one of silver and copper wire and said second means includes a tin element.

9. A high voltage fuse of the current limiting type,
a hollow insulating casing,
a conductive cap on each end of said casing,
a fusible assembly within said casing and connected at each end to one of said caps, said assembly including,
a main fusible element for providing high current clearing characteristics,
and a secondary fusible element connected in series with said first element for providing low current clearing characteristics, said secondary element including
a low melting point metal wire and a thermally insulating sleeve enclosing the full length of said secondary element,
and granular inert refractory arc quenching material within said casing embedding said main fusible element and said sleeve.

10. The fuse according to claim 9 wherein said secondary fusible element limits the long time temperature rise to a level of not more than 300° C.

11. The fuse according to claim 10 wherein said metal wire is tin and said insulating sleeve is a silicone rubber tube.

12. The fuse according to claim 9 wherein said main fusible element includes a silver wire, said secondary fusible element includes a tin wire connected in series with said silver wire and said thermally insulating member comprises a silicone rubber tube.

13. The fuse according to claim 9 wherein said main fusible element is sealed within said casing.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,840,836 Dated October 8, 1974

Inventor(s) Edwin A. Link

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

Col. 2, line 4, delete "20" and substitute ---16---;

Col. 2, line 6, delete "20" and substitute ---16---;

Col. 2, line 8, delete "20" and substitute ---16---;

Col. 2, line 63, after "member" insert ---enclosing the full length of said second fusible element, said arc extinguishing member---.

Signed and sealed this 4th day of February 1975.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

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(5/69)

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