United States Patent [19]

Pitha

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[54] **CORDIERITE BINDER COMPOSITION**

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[73] Assignee: **General Electric Company**

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Related U.S. Application Data

[62] Division of Ser. No. 781,473, Dec. 5, 1968, Pat. No. 3,607,790.

[52] **U.S. Cl.** **106/39.6,** 106/44, 106/46, 106/52, 106/71, 106/73.4, 106/73.5, 252/516

[51] **Int. Cl.** **Co3c 3/22,** C04b 33/26

[58] **Field of Search** .... 106/39 R, 46, 44, 39 DV, 106/39.6, 46, 45, 71, 73.4, 52; 252/63.5, 516; 174/3

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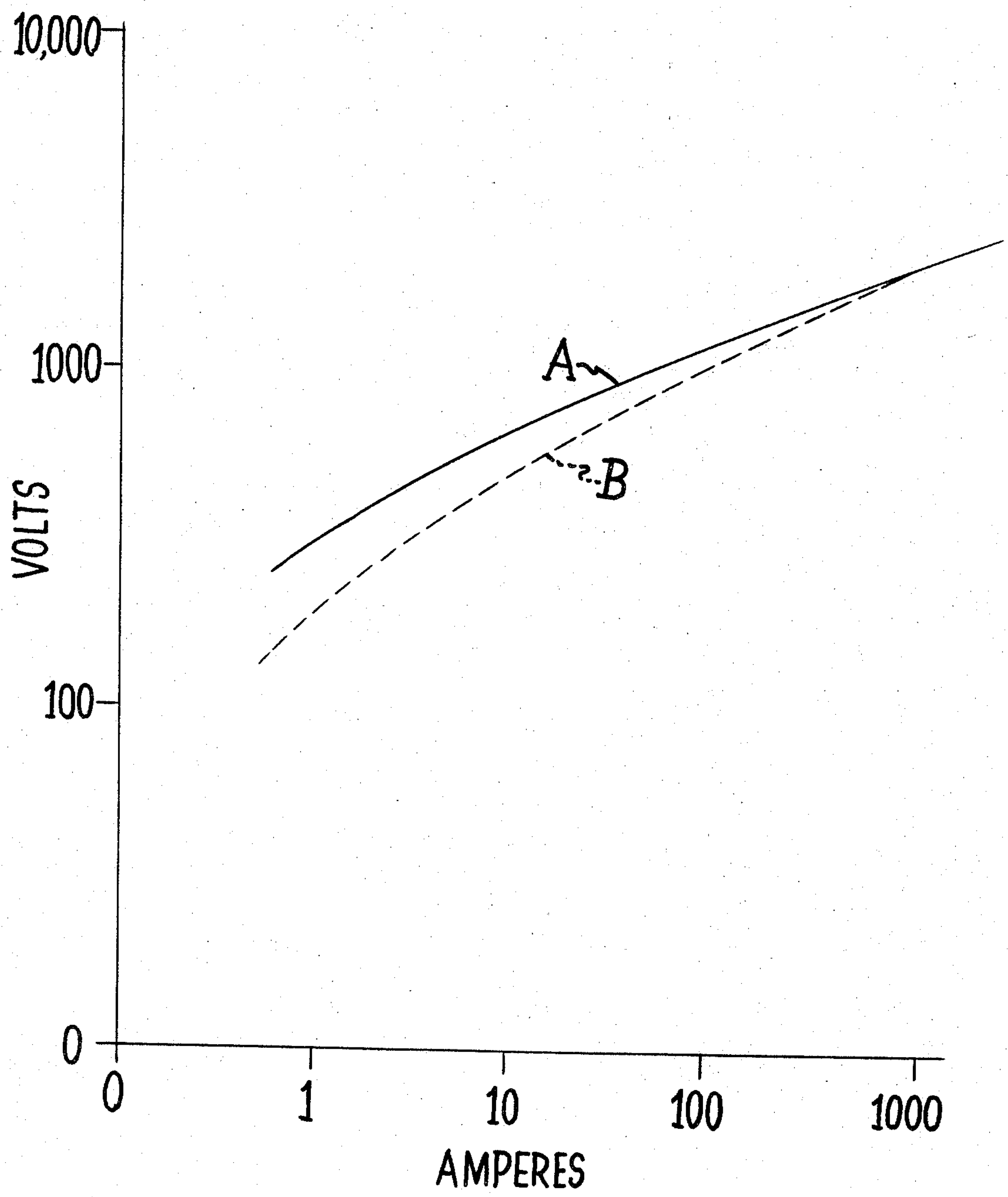
[57] **ABSTRACT**

Lightning arrester resistance material is composed of silicon carbide particles and a binder therefor composed of cordierite formed of a fired mixture of cordierite-forming glass material and cordierite-forming crystalline material.

3 Claims, 1 Drawing Figure


10,000
1000
100
0
VOLTS
A
B
0
1
10
100
1000
AMPERES

CORDIERITE BINDER COMPOSITION

This application is a division of application Ser. No. 781,473, filed Dec. 5, 1968, which issued as U.S. Pat. No. 3,607,790 on Sept. 21, 1971, and which is assigned to the same assignee as the present invention.

The present invention relates to resistance material, and more particularly to resistance material for use with electric discharge devices, such as lightning arresters, and the method of making the resistance material. Such material, also known as non-linear resistance or valve element material, is of the type having variable resistance characteristics, so that when placed in electrical circuit with a source of electrical potential applied thereto, its resistance decreases with an increase in the electrical potential. In known types of overvoltage protective devices such as lightning arresters, a gap structure is usually arranged in series with the resistance material, and when the device is subjected to overvoltage, such as caused by lightning or a switching surge, the gap arcs over and with the non-linear resistance material forms a low resistance path to ground. The resistance material provides a low resistance path to high voltages and a high resistance path to low voltages. When the overvoltage surge has been discharged, the resistance material provides a high resistance path to the power follow current, limiting such current to enable the gap structure to interrupt the current and return the arrester to its open circuit condition.

Resistance material of the above-described type comprising a mixture of silicon carbide particles and a binder material therefor comprising cordierite is disclosed in U.S. Pat. No. 3,291,759 - Pitha, granted Dec. 13, 1966. The present invention is an improvement on the material and method of the latter patent.

It is an object of the invention to provide improved non-linear resistance material of the above-described type and a method of making the same.

Another object of the invention is to provide non-linear resistance material of the above type having improved resistivity characteristics for passing current during over-voltage conditions while providing reduced power follow currents.

A particular object of the invention is the provision of an improved non-linear resistance material comprising silicon carbide particles and a cordierite binder therefor.

Still another object of the invention is to provide an improved composition and method for forming cordierite, and for making non-linear resistance material incorporating such cordierite-forming composition.

Other objects and advantages will become apparent from the following description and the appended claims.

With the above objects in view, the present invention in one of its aspects relates to a method of making non-linear resistance material comprising the steps of mixing silicon carbide particles with a cordierite-forming glass material and cordierite-forming crystalline material, compacting the mixture, and firing the thus treated mixture at elevated temperature for reacting the crystalline material and for forming a cordierite binder for the silicon carbide particles from the mixture of glass material and crystalline material.

The invention will be better understood from the following description taken in conjunction with the accompanying drawing, in which:

The single FIGURE is a graph showing a comparison of the volt-ampere characteristics of the resistance material of the present invention and those of prior art resistance material.

In the aforementioned Pitha patent, there is disclosed a non-linear resistance material formed of a mixture of silicon carbide particles and a cordierite binder therefor, wherein the binder material is obtained by firing a mixture of appropriate proportions of talc and a porcelain mixture including flint, clay and soda or potash spar.

In accordance with the present invention an improved resistance material is made by including in the initial binder mixture a suitable proportion of cordierite-forming glass. By "cordierite-forming glass" as used herein is meant a non-crystalline solid material having the composition $2MgO. 2Al_2O_3. 5SiO_2$ and which when heated to elevated temperature below the melting point of the glass and gradually cooled will form a ceramic composed of cordierite. The cordierite-forming glass used in the present invention (also referred to herein simply as cordierite glass) is thus distinguished from the aforementioned mixture of crystalline compounds used in the prior process to form the cordierite binder in the fired product. As indicated, however, both types of cordierite-forming materials are used in the present invention to obtain non-linear resistance material of optimum properties.

By virtue of the addition of cordierite glass to the binder forming material in accordance with the invention, the resultant resistance material retains all the advantages of the prior material made with only crystalline cordierite-forming compounds, such as low resistivity to overvoltages and high capacity to withstand repeated surges of current, and in addition it is characterized by a substantially higher resistance in the low voltage range than the prior resistance material. As a result, the improved material when used, for example, in lightning arresters, more effectively cuts out power follow currents and thus enables more rapid extinguishing of the arc formed by overvoltages in the arrester, so that the electrical apparatus protected by the arrester resumes normal operation in a shorter time. An additional advantage obtained by such properties of the non-linear resistance material is that the life of the lightning arrester is thereby substantially prolonged.

The FIGURE graphically illustrates the comparative volt-ampere characteristics of the prior and present non-linear resistance materials. In the graph, in which the volts and amperes are plotted in logarithmic scale, Curve B represents the prior material as made by the process described in the aforementioned Pitha patent, while Curve A represents resistance material of the present invention. As is evident, at the lower voltage levels, e.g., below 1,000 volts, the material represented by Curve A exhibits substantially higher resistivity than the Curve B material, while at voltages from 2,000 volts and higher, the resistivities of the respective materials are equivalent, and thus they provide equivalent protection under high overvoltage conditions. The increased resistivity of the improved resistance material at the lower voltage levels as shown is as much as 58 percent in terms of voltage required for passage of 1 ampere of current.

In a typical process of making the improved resistance material the following preferred composition in percent by weight has been found to produce satisfactory results for use in DC lightning arresters:

Silicon carbide	75%
Cordierite glass	10
Talc	6
Porcelain mixture	9

As well understood by those versed in the art, the porcelain mixture may comprise flint, clay and soda or potash spar, but any particular type or composition of porcelain mixture may be utilized in practicing the present invention.

The cordierite glass used in the above mixture is made by mixing the following ingredients in the typical composition shown in percent by weight:

SiO_2	51.3%
Al_2O_3	34.9
MgO	13.8

This mixture is heated to fusion in an electric arc furnace at a temperature no lower than about 1,800°C, causing the reaction of the ingredients and forming a molten glass material which is then quenched to prevent devitrification, as a result of which the material solidifies as a glass. The solid glass is thereafter ground into finely divided form for use in the binder mixture described above. When such glass is fired at elevated temperature below the melting point of the glass and thereafter cooled, it devitrifies (crystallizes) into a hard, dense ceramic material consisting of cordierite, which has the formula $2MgO \cdot 2Al_2O_3 \cdot 5SiO_2$.

The remaining binder ingredients, viz., talc and porcelain mixture, are also capable of forming cordierite when heated to elevated temperature, but in contrast to the pre-reacted cordierite-forming glass component, are crystalline in nature and are employed in this form in the prefired mixture.

After all of the described components in finely divided form are mixed together and a suitable temporary binder such as water is added, the mixture is pressed into discs or otherwise formed into desired shapes, and in such form the material is fired at a temperature of from about 1,200°C to about 1,300°C in a hydrogen atmosphere, removed from the furnace and cooled. As a result of such firing and cooling, both the pre-reacted glass material and the crystalline binder ingredients form a ceramic binder composed of cordierite in crystalline form, with the silicon carbide particles held therein. As will be understood, the cooling of the fired material is relatively gradual, in distinction to the quenching step herein above referred to in connection with making the cordierite glass.

While the above specific composition is a typically preferred mixture, the resistance material of the invention may be formed from a composition within the following ranges, in percent by weight:

Silicon carbide	55.0 to 80.0%
Cordierite glass	6.0 to 22.5
Talc	4.0 to 27.0
Porcelain mixture	4.0 to 19.0

An example of a suitable porcelain mixture which may be employed in the foregoing compositions is as follows, in percent by weight:

Flint	14.3%
Clay	47.6
Soda or potash spar	38.1

Preferably, the talc and porcelain mixture components of the crystalline binder material vary in the range of 40 to 60 percent by weight of talc and 60 to 40 percent of porcelain mixture.

The porcelain mixture may be replaced by a china clay such as Florida kaolin, and in the binder mixture equal parts by weight of such kaolin and talc may typically be used as the cordierite-forming crystalline ingredients.

While the present invention has been described with reference to particular embodiments thereof, it will be understood that numerous modifications may be made by those skilled in the art without actually departing from the scope of the invention. Therefore, the appended claims are intended to cover all such equivalent variations as come within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A composition of matter, suitable for use as a binder, consisting essentially of a mixture of about 6 to 22.5 parts by weight of cordierite-forming glass material and about 8 to 46 parts by weight of cordierite-forming crystalline material, in which the glass material is a fired and vitrified mixture of SiO_2, Al_2O_3 and MgO, the crystalline material being talc plus a member of the group consisting of a porcelain mixture and kaolin.

2. A composition as defined in claim **1**, said crystalline material comprising, in percent by weight, about 40 to about 60 percent talc and about 60 to about 40 percent porcelain mixture.

3. A composition as defined in claim **1**, said crystalline material comprising talc and kaolin in about equal parts by weight.

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