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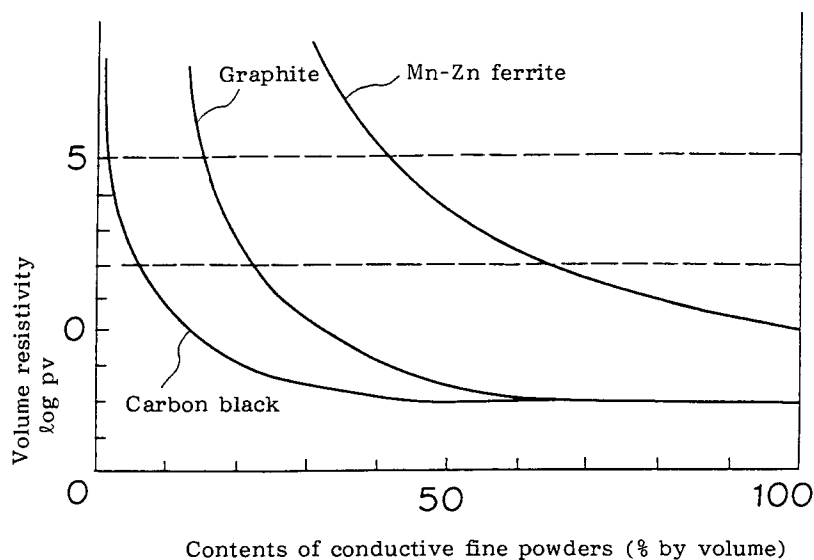
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Tal 29
W-8000 München 2(DE)(54) **Electric heater.**

(57) An electric heater comprising a resisting element composed essentially of a composition comprising an organic polymer material and a conductive fine powder dispersed in the polymer material and adapted to be heated by application of a voltage to the resisting element, wherein the conductive fine powder is Mn-Zn ferrite.

FIGURE I**EP 0 522 228 A1**

The present invention relates to an electric heater useful for various heating equipments or devices.

Heaters are known which comprise an organic polymer material and a fine powder of e.g. carbon black or graphite having a volume resistivity of at most about $10^{-2} \Omega \cdot \text{cm}$, kneaded and dispersed in the polymer material.

However, heaters containing such fine powders had the following problems.

1) Carbon black and graphite have a low volume resistivity at a level of $10^{-2} \Omega \cdot \text{cm}$. Accordingly, to obtain a volume resistivity of from 10^2 to $10^5 \Omega \cdot \text{cm}$ required for an electric heater, it is sufficient to incorporate carbon black or graphite in such a low amount as not more than 20% by volume to an organic polymer material. Therefore, a high level of kneading and dispersing technique is required in order to obtain a heater having a minimum variation in the resistivity, or it is unavoidable to have a variation in the resistivity to some extent.

2) Carbon black and graphite are inflammable by themselves and will burn when they undergo burning. A possibility of danger of burning tends to be high when a voltage is applied in the thickness direction particularly in the case of a thin heater element.

According to the present invention, the above problems have been solved by employing Mn-Zn ferrite as conductive fine powder for a resisting element of an electric heater.

Thus, the present invention provides an electric heater comprising a resisting element composed essentially of a composition comprising an organic polymer material and a conductive fine powder dispersed in the polymer material and adapted to be heated by application of a voltage to the resisting element, wherein the conductive fine powder is Mn-Zn ferrite.

The Mn-Zn ferrite has a higher volume resistivity than carbon black or graphite, and its content will accordingly be large, whereby a variation in the resistivity due to a fluctuation in the content can be minimized, and the ferrite itself is not inflammable and thus it is free from a danger of burning.

Now, the present invention will be described in detail with reference to the accompanying drawings.

Figure 1 is a graph showing the relation between the contents of various conductive fine powders and the volume resistivities (logarithmic values).

Figure 2 is a view illustrating a state in which a voltage is applied in the thickness direction to a thin heater.

Figure 1 will be described. Using polyethylene as the organic polymer material, carbon black, graphite or Mn-Zn ferrite is incorporated thereto. In the case of carbon black or graphite, only a small amount at a level of not more than 20% by volume is required to obtain a volume resistivity of from 10^2 to $10^5 \Omega \cdot \text{cm}$ required for an electric heater. Accordingly, it is difficult to disperse it uniformly in the organic polymer. If the dispersion is non-uniform, the volume resistivity varies substantially.

Accordingly, if a voltage is applied in the thickness direction by an electrode 2 to a thin heater (sheet-shaped heater) 1 as shown in Figure 2, there will be a locally excessively heated portion, and there is a possible of danger of burning.

Whereas, Mn-Zn (manganese-zinc) ferrite has a volume resistivity of its own at a level of e.g. about $10^0 \Omega \cdot \text{cm}$. Accordingly, its content in an electric heater will be at least 30% by volume, whereby uniform dispersion is easy. Further, as is evident from the small inclination of the curve in Figure 1, even when there is a some fluctuation in the dispersion, the variation in the volume resistivity attributable to the fluctuation in the dispersion, is small. The Mn-Zn ferrite preferably has a volume resistivity of from 10^0 to $10^3 \Omega \cdot \text{cm}$. Further, its particle size is preferably from 0.1 to $10 \mu\text{m}$, more preferably from 1 to $5 \mu\text{m}$.

There is no particular restriction as to the organic polymer material for the electric heater. For example, polyethylene, polypropylene, polyvinyl chloride, polyamide, polyester, polyphenylene sulfide, polyetherimide, polyether ether ketone, polyether sulfone, or a mixture thereof may be mentioned. Preferred is a crystalline heat resistant resin having a melting point of at least 200°C , particularly at least 250°C , such as polyphenylene sulfide, polyether ether ketone, polyether ketone ketone, polyether ketone, or a mixture thereof. The crystalline resin has a low melt viscosity, whereby incorporation of the Mn-Zn ferrite is easy.

As is apparent from Figure 1, the Mn-Zn ferrite is added usually in an amount of from 30 to 70% by volume, preferably from 40 to 60% by volume, based on the total amount by volume of the organic polymer material and the Mn-Zn ferrite.

Mixing of the organic polymer material and the Mn-Zn ferrite can be conducted, for example, by an extruder.

When the volume resistivity is adjusted substantially to a level of $10^4 \Omega \cdot \text{cm}$ using the materials shown in Figure 1, the required contents (% by volume) of the respective materials and variations in the volume resistivity ρ_v ($\Omega \cdot \text{cm}$) were as shown in Table 1. The variations in ρ_v were represented by $3\sigma/x$ (σ is a standard deviation, and x is an average value).

Table 1

	Content (% by volume)	$4 \rho_v (\times 10^4)$	variations in ρ_v
Carbon black	3	8.2	0.18
Graphite	15	7.5	0.12
Mn-Zn ferrite	45	4.0	0.05

Thus, according to the present invention, the variation in the volume resistivity is small.

Further, the variation in the volume resistivity was evaluated in the same manner as above except that polyether ether ketone (PEEK, melting point: 330 °C) was used as the organic polymer material, whereby similar effects were obtained. Further, the plate adhesion and the heat resistance were evaluated. The plate adhesion was evaluated in such a manner that the surface was subjected to etching with a solution of a mixture of chromic acid and sulfuric acid for 3 minutes and then copper was chemically plated, and a cooling and heating cycle between 23 °C and 200 °C was repeated ten times. With the product having carbon black incorporated to PEEK, peeling of the plated layer was observed. Whereas, with the product of the present invention having the Mn-Zn ferrite incorporated to PEEK, no peeling of the plated layer was observed, thus indicating excellent plating properties for the formation of an electrode. Further, the product of the present invention having the Mn-Zn ferrite incorporated to PEEK was useful at a heating temperature of 220 °C without any deformation, and thus was superior to the one wherein polyethylene was used.

According to the present invention, it is possible to obtain an electric heater having a minimum variation in the resistivity and being free from burning. The electric heater of the present invention is useful particularly for an application where a voltage is applied in the thickness direction of a thin heater.

Claims

1. An electric heater comprising a resisting element composed essentially of a composition comprising an organic polymer material and a conductive fine powder dispersed in the polymer material and adapted to be heated by application of a voltage to the resisting element, wherein the conductive fine powder is Mn-Zn ferrite.
2. The electric heater according to Claim 1, wherein the resisting element has a volume resistivity of from 10^2 to $10^5 \Omega \cdot \text{cm}$.
3. The electric heater according to Claim 1, wherein the Mn-Zn ferrite has a volume resistivity of from 10^0 to $10^3 \Omega \cdot \text{cm}$.
4. The electric heater according to Claim 1, wherein the Mn-Zn ferrite has a particle size of from 0.1 to 10 μm .
5. The electric heater according to Claim 1, wherein the Mn-Zn ferrite has a particle size of from 1 to 5 μm .
6. The electric heater according to Claim 1, wherein the polymer material is polyethylene, polypropylene, polyvinyl chloride, polyamide, polyester, polyphenylene sulfide, polyetherimide, polyether ether ketone, polyether sulfone, or a mixture thereof.
7. The electric heater according to Claim 1, wherein the polymer material is a crystalline heat resistant resin having a melting point of at least 200 °C.
8. The electric heater according to Claim 7, wherein the crystalline heat resistant resin is polyphenylene sulfide, polyether ether ketone, polyether ketone ketone, polyether ketone, or a mixture thereof.
9. The electric heater according to Claim 1, wherein the Mn-Zn ferrite is from 30 to 70% by volume based on the total amount by volume of the organic polymer material and the Mn-Zn ferrite.

- 10.** The electric heater according to Claim 1, wherein the Mn-Zn ferrite is from 40 to 60% by volume based on the total amount by volume of the organic polymer material and the Mn-Zn ferrite.

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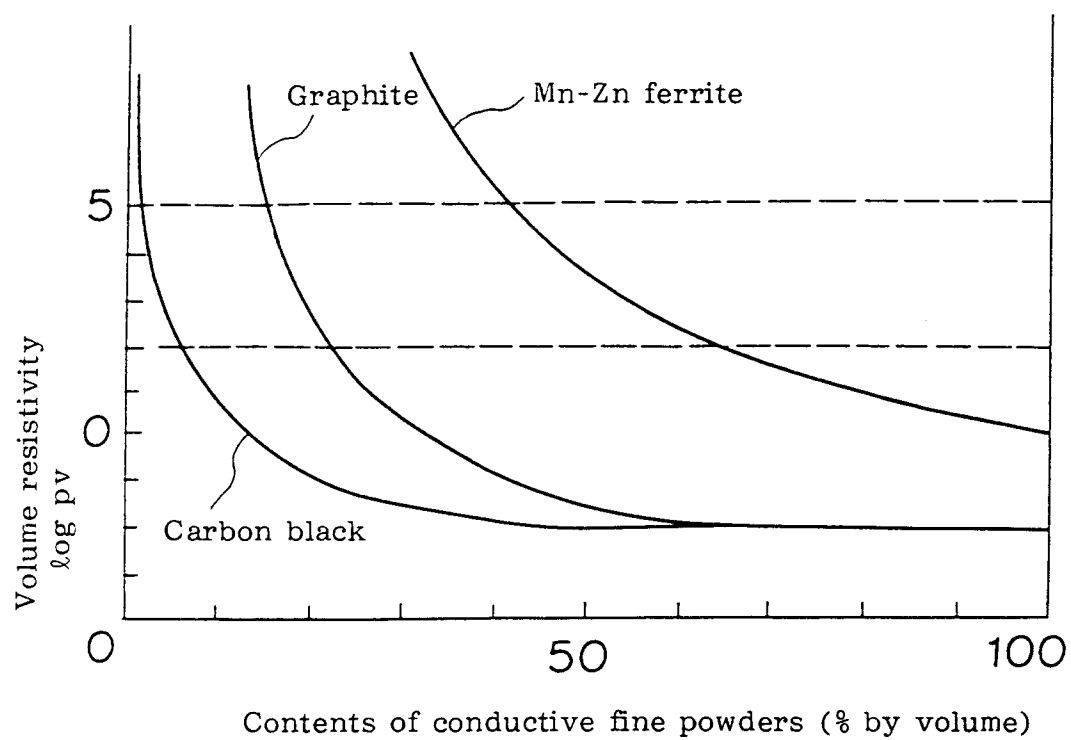
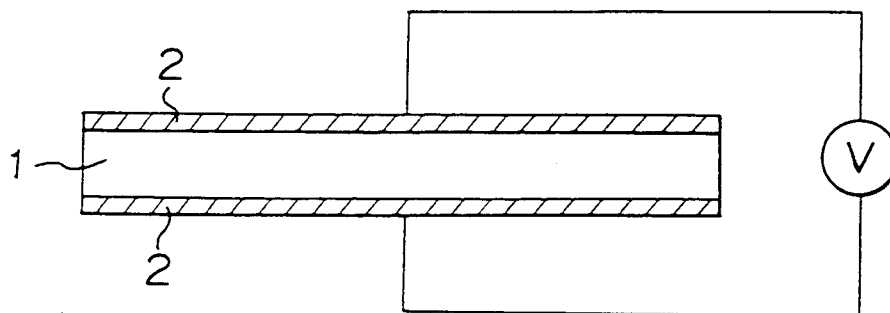
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FIGURE 1**FIGURE 2**



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EUROPEAN SEARCH REPORT

Application Number

EP 92 10 0534

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-3 852 566 (QUIRK) * column 2, paragraph 3 * * column 4, line 17 - line 59 * ---	1-3,9,10	H05B3/14
A	EP-A-0 172 302 (TOKYO COSMOS ELECTRIC CO., LTD.) * page 3, line 32 - page 4, line 10 * ---	1,2,6,7,9,10	
A	EP-A-0 250 905 (AWAJI SANGYO K.K. ET AL.) * page 4, line 5 - line 53 * ---	1,2,6-9	
A	FR-A-2 186 801 (PILATO MAURICE) ---		
A	US-A-4 107 387 (BOONSTRA ET AL.) ---		
A	US-A-4 818 439 (BLACKLEDGE ET AL.) -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H05B H01C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 29 OCTOBER 1992	Examiner RAUSCH R.G.
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