

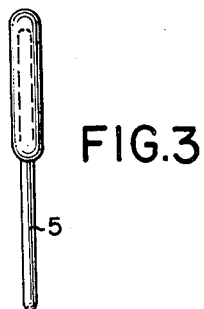
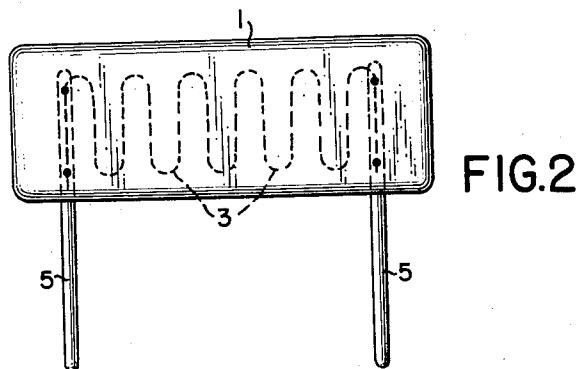
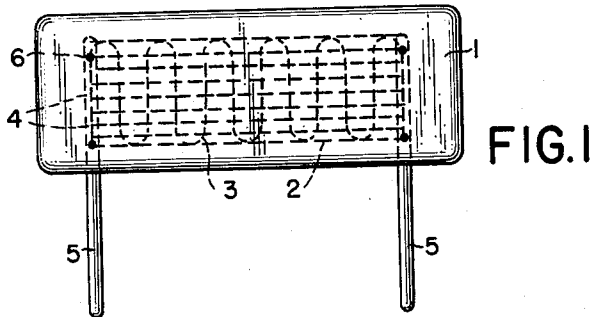
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F. MATH

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ELECTRICAL WIRE RESISTORS AND METHOD OF MANUFACTURING THE SAME

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INVENTOR

FRITZ MATH

BY

*Michael S. Stinker*

ATTORNEY

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## ELECTRICAL WIRE RESISTORS AND METHOD OF MANUFACTURING THE SAME

Fritz Math, Wiesbaden, Germany

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1 Claim. (Cl. 29—155.63)

There have been known wire-wound electrical resistances in which a resistance wire is wound onto an insulating body and fitted with suitable terminals. There have also been known wire-wound resistances or resistors in which the wire, which is wound in the manner just indicated, is provided with a coating, particularly a coating consisting of a glazing material. The manufacture of such known wire-wound resistors requires the step of winding the wires around and onto a resistor body or core, this step being time-consuming and requiring specialized machinery, and upon completion of the winding operation it is still necessary to measure the actual resistance and to adjust it in the desired manner.

In contrast to the foregoing, the present invention relates to a method which provides for a considerable simplification of wire resistances and their manufacture, especially on a mass-production basis. According to the method of the invention, a woven wire mesh or fabric comprising warp wires consisting of a material having a relatively lower melting point and weft wires consisting of a material having a relatively higher melting point is surrounded with or embedded in a suitable heat-resistant substance such as a ceramic substance, glass material, glazing compound or plastic compound or with layers formed of such materials or with a mixture of any of the materials mentioned, this step being performed, for example, by pressing and/or injection molding and/or dipping, whereupon the work piece thus obtained is heated to a temperature below the crystallization range of the weft wires, at which temperature the warp wires are burned away, and to a higher temperature within the recrystallization range of the weft wires, the heating to this higher temperature being continued until the weft wires have a resistance while hot which corresponds to the resistance which the resistor is intended to have when cold. When practicing this method it is no longer necessary to wind the wire, but the path of the resistance wire is determined by the fact that it forms the weft material of the said mesh or fabric. It has been found that after the burning-away of the warp wires no residual conductivity of the warp wire remains which might adversely affect the resistance of the resistor, i.e. the weft wire, upon passage of an electric current therethrough. The aforementioned step of coating the resistor by a pressing, injection molding or dipping step positively locates the weft wire in such a manner that it can no longer change its position after the warp wires have been burned away.

The two types of wire forming the warp wires and the weft wire, respectively, should be so selected that the recrystallization range of the weft wire lies above that temperature range within which the warp wires will be burned away. In this case it is possible, by suitable temperature control, separately to control the burning-away of the warp wires and the recrystallization of the weft wire.

It has been found convenient, when practicing the method of the invention, before coating the wire mesh

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by the said pressing, injection molding or dipping step, to cut the wire mesh to a predetermined length which approximately corresponds to the desired resistance value of the weft wire, taking into account the subsequent treatment of the same. It will be understood that it is necessary to use a piece of wire mesh of which the weft wire is not interrupted within the said predetermined length, but in which the weft wire forms 180° bends at the edges of said length. The cut-off ends of the wire mesh will then be fitted with terminals such as clips or clamps which may be clamped or welded in position.

The cut-to-length pieces of wire mesh fitted with said terminals are gripped by said terminals by suitable means provided on a conveyor which inserts each piece into a die which serves to embed the piece in a ceramic mass, a glass mass, a plastic material or the like, this being done by means of a pressing operation; this method of handling the pieces provides for mass production. If desired, the embedded work pieces may be coated with a glazing which may be applied, for example, by stationary spray pistols.

Following this, the conveyor carries the work pieces into a furnace in which the embedding mass and the glazing, if any, is dried and baked if necessary. By suitably selecting the embedding and/or glazing materials as well as the material of the warp wire it is possible to provide for the warp wires to be burned away at the same temperature at which the embedding material and the glaze is fired or baked. Otherwise it will be necessary to perform the baking of the embedding material and the glaze on the one hand and the burning-away of the warp wires on the other at different temperatures.

Whereas it has been found convenient to heat the embedding material and the glazing material from the outside for the purpose of baking and of burning-away the warp wires, it has proved to be of advantage to heat by means of an electric current the remaining weft wire so as to bring said wire to a temperature within the recrystallization range. After the necessary strength of the current and the duration of the heating process have been initially determined by tests, it is possible, during mass production runs, to treat each consecutive work piece in an identical manner. In order to provide for the introduction of an electric current into the work piece for the purpose of heating it to within the recrystallization range, the gripping members of the said conveyor serving to locate the terminals of the work pieces are also constructed to serve as current lead-ins. Upon the respective section of the conveyor arriving at a predetermined point in its path, the current is turned on automatically, the work piece being subjected to current passage therethrough for a predetermined period of time. Provided that this period is sufficiently short, the amperage of said current may amount to a multiple of its normal value.

Heating the weft wire to a temperature within its recrystallization range will cause its electric resistance to be reduced, this reduction in resistance continuing gradually until a predetermined final value is reached. It will be appreciated that it is possible to interrupt the heating process at that moment when the weft wire reaches that resistance while hot which corresponds to the desired resistance of the resistor in its cold condition. The correct length of the heating period may be determined in two different ways. Suitable for mass production is the aforementioned method whereby the length of time necessary for the attainment of the desired resistance while hot is initially established, all work pieces then being heated for the same period of time while a constant voltage is applied.

Another method comprises the steps of connecting in circuit with a given work piece a measuring instrument

and of interrupting the electric current at that moment in which the intensity of the current has risen to a predetermined value because of the reduction in resistance caused by the heating of the resistor.

In either case it is possible to time the turning-on and the turning-off of the current in such a manner as to occur automatically in unison with the movement of the conveyor.

Where ceramic materials are used to embed the resistor, which ceramic materials have a very high melting point, it has been found convenient to admix to the ceramic material a material such as glass, for example in the form of pulverized glass, in order to reduce the melting or sintering temperature of the composite material in relation to the recrystallization temperature of the weft wire. In this case it is necessary to use proper care in slowly cooling the work piece after the recrystallization process in order to prevent the glass mass from being cracked due to internal stresses.

Other objects, features and advantages of the present invention will be readily apparent from the following detailed description of a preferred embodiment thereof taken in conjunction with the accompanying drawings, in which:

Fig. 1 shows an embedded wire mesh, the material in which the wire mesh is embedded being partly broken away, the wire mesh being shown in its condition prior to the burning-away of the warp wires;

Fig. 2 shows the same resistor work piece after the warp wires have been burned away; and

Fig. 3 shows the same resistor viewed from the opposite side.

With the work piece in the condition illustrated in Fig. 1, the embedding material 1 surrounds the wire mesh which comprises a plurality of warp wires 2 and a weft wire 3, these wires being interlaced in the usual manner. The weft wire extends along a zig-zag path along the entire body and this wire is uninterrupted. At the ends 4, both the weft wire and the warp wires have been simply cut off, and before the embedding process these ends are fitted with terminals 5 which are either clamped to the wire mesh or which are tack welded as indicated at 6, care being taken to have said tack welds include also the weft wire 3.

After the burning-away of the warp wires there will only remain the weft wire 3 as shown in Fig. 2.

The warp wires may be formed, for example, of brass, zinc, lead or of alloys of these metals, whereas the weft

wire may consist of any of the well-known resistance alloys such as are available under the trade names Nichrome, Kanthal, Megapyr, etc., which alloys have melting points which are considerably higher than those of the aforementioned materials used in the warp wires. However, it is not essential to use any metal in the warp wires, as it is equally convenient to use ribbons or threads made of plastic, glass fibers, textile fibers and the like.

It has been found in practice that the method of the invention provides for the simple and low-cost manufacture of resistors on a mass-production basis, the resistors thus made showing a high accuracy of their electrical data and a high mechanical strength.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention, but it is understood that the application is to be limited only by the scope of the appended claims.

Every passage according to the preceding specification containing the words "glass composition" and "glass compounds" or "glass mass" or "glass particles" may be substituted by "frit (ferretto)" as it is used in the glass manufacture.

What is claimed is:

A method of producing electrical wire resistors, comprising the steps of preparing a strip of mesh composed of a continuous weft wire made of metal having electric resistance characteristics and a relatively high melting point, and of warp strands made of metal and adapted to be oxidized at a temperature substantially below said melting point; embedding said strip of mesh in a heat-resistant dielectric substance; and heating said strip of mesh embedded in said substance to a temperature sufficient to burn said warp strands, so that after burning said strands an electric wire resistor remains consisting of said continuous weft wire embedded in a dielectric substance.

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