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METHOD OF MAKING NON-METALLIC ELECTRIC RESISTANCE ELEMENTS

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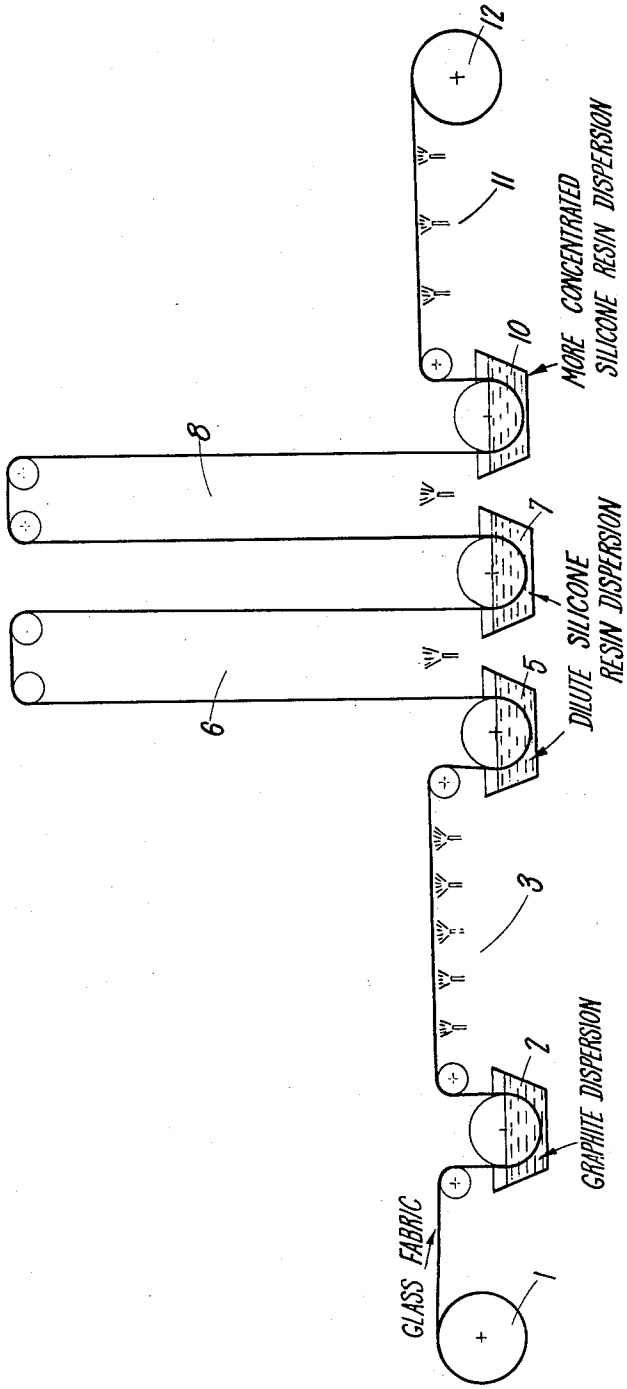

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METHOD OF MAKING NON-METALLIC ELECTRIC RESISTANCE ELEMENTS

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The invention relates to the manufacture of non-metallic electric resistance elements (e.g. for heating purposes) and is concerned with such elements which are composed of an inorganic thread or fabric (e.g. of glass fibres) coated with a thin graphite layer and then coated with a resin varnish or the like to protect the graphite. Such fabric elements and their manufacture are described in British patent specification No. 747,257.

Said British patent specification describes a method of manufacturing such fabric elements which consists in coating a non-combustible previously cleaned inorganic fabric with liquid dispersion of colloidal graphite, heating or allowing to dry to remove liquid and subsequently heating to a temperature in the region of 500° C., cooling and finally coating with a protective varnish. The present invention is particularly concerned with the step in the above or analogous methods, of finally coating with the protective varnish.

It is important, if the most satisfactory product is to be obtained, that the mono-filaments of the inorganic fabrics or threads, which are usually of glass, and their coatings of graphite should be individually coated with the varnish. While this presents little or no difficulty with certain resins such as the "Araldite" adhesive specifically mentioned in the said British specification No. 747,257, it has now been found that certain other resins tend to coat only the outsides of the threads, whether they be single threads or woven into a fabric, and not to penetrate to the individual mono-filaments as is desirable. The silicone resins, which are particularly suitable in other respects, exhibit this difficulty. The present invention, which seeks to reduce the difficulty in respect of silicone resins is based on two discoveries. The first is that effective penetration of the resin to the mono-filaments can be achieved if the resin is applied or first applied in the form of a very dilute solution or dispersion, although several applications with intermediate drying will usually be required to obtain an effective coating. The other discovery is that the electrical resistance of the graphite coated threads or fabric increases with application of the resin but reaches a constant value when an effective resin coating has been applied. Hence there is available a convenient means of determining when sufficient resin has been applied.

The invention accordingly provides the method of manufacturing non-metallic electric resistance elements which comprises coating a clean inorganic fabric or a clean inorganic thread with liquid dispersion of colloidal graphite, drying and heating to remove impurities, applying to the graphite coated fabric or thread a dilute solution or suspension of a silicone resin to impregnate the fabric or thread to the extent that there is substantially no increase in electrical resistance of the fabric or thread on further application of the dilute solution or suspension and then applying a coating of a more concentrated silicone resin, drying and if necessary curing the resin.

If necessary or desirable in order to effect impregnation to the above extent, there may be made repeated applications, with intermediate drying, of the dilute solution or suspension.

The dilute solution or suspension may contain about 0.1% solids. For example, a normal silicone resin composition of approximately 60% solids may be diluted with a suitable solvent such as xylene to a solid content of about 0.1% or even less, depending on the viscosity of the resin, and applied by dipping the element, followed by evaporation of the solvent and, if necessary or desirable, partial or complete normal curing treatment for the resin. One or more futher coatings of the resin of a suitable dilution, e.g. progressively less dilute than the first coating, may be given until no further increase in electrical resistance occurs and an effective protective layer is obtained on the filaments of the layer. The solvent may be removed by heating.

It is stressed that it is impracticable to apply in one operation silicone resins in a dilution which is concentrated enough to provide an efficient protective layer. The use of a very dilute pre-coat or primer is most important if a satisfactory result is to be obtained.

A specific example of the method according to the invention will now be given.

A glass fibre woven fabric is first thoroughly cleaned and then coated with a liquid dispersion of colloidal graphite and heated to remove liquid and then heated to about 500° C. This coating process is repeated, if necessary, to provide a fabric having an electrical resistance of about 40 ohms per unit square. Folding or creasing of the fabric at this stage should be avoided. The fabric is then dipped into a dilute silicone resin solution and dried using a commercial dipping and drying tower and its resistance again tested. It will be found that the resistance has increased, possibly up to about 60 ohms per unit square. The fabric is again dipped and dried and the process repeated, if necessary, until a resistance is reached which does not further increase with additional resin application. The resin used in this example is a normal silicone resin such as is thoroughly well known in the art for coating and impregnating purposes. Such resins are available in various grades according to the rate at which they dry and become non-tacky. The particular grade used by applicants and known as "Silicone 230" has the property that when the fibre impregnated with the dilute solution is heated around 100° C. for about five minutes the surface ceases to be tacky and a further coating can be applied or the material handled. This resin is diluted with xylene to a solids content of about 0.1%.

The fabric is given a final coat of the undiluted normal silicone resin and heated.

At least the final coat and probably one or more intermediate coats may consist of a silicone rubber which may be applied as a paste, a dilution into which the element may be immersed, or as a rubber stock.

The accompanying drawing illustrates the coating process just described. The clean fabric is drawn from a supply reel and through a trough 2 containing graphite dispersion, over heaters 3 to dry the fabric and then heat it to 500° C. The fabric is then drawn through a trough 5 containing dilute silicone resin dispersion, up and over a drying tower 6, through a second trough 7 containing dilute silicon resin dispersion, up and over a second drying tower, through a trough 10 containing the more concentrated silicon resin dispersion, over curing heaters 11 and finally to a re-wind reel 12.

I claim:

1. The method of manufacturing non-metallic electric resistance heating elements which comprises coating clean inorganic fibrous material with liquid dispersion of colloidal graphite, drying, and heating to remove impurities, impregnating the coated fibrous material with a dilute liquid dispersion of silicone resin containing about 0.1% solids and to the extent that there is substantially no increase in electrical resistance of the coated fibrous material on further application of the dilute resin dispersion,

applying a coating of a more concentrated silicone resin dispersion containing about 60% solids and drying.

2. The method according to claim 1 in which repeated applications, with intermediate drying, of the dilute liquid dispersion of silicone resin are made.

3. The method according to claim 1 which the more-concentrated silicone resin is applied in the form of a silicone rubber.

4. The method according to claim 1 in which the fibrous material is in the form of a woven fabric of glass fibres.

References Cited in the file of this patent

UNITED STATES PATENTS

602,797	Annison	Apr. 19, 1898
1,439,743	Mathes	Dec. 26, 1922
1,857,690	Mellanoff	May 10, 1932
1,963,554	McDill	June 19, 1934
2,683,673	Silversher	July 13, 1954
3,002,862	Smith-Johannsen	Oct. 3, 1961

FOREIGN PATENTS

211,324	Great Britain	Feb. 21, 1924

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,081,202 March 12, 1963

Allan John Kemp

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the heading to the printed specification, between lines 7 and 8, insert -- Claims priority, application Great Britain May 1, 1959 --.

Signed and sealed this 5th day of November 1963.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWIN L. REYNOLDS
Acting Commissioner of Patents