(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 041 824**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 81302457.7

(22) Date of filing: 03.06.81

(51) Int. Cl.³: B 05 D 1/06
B 05 D 5/12, H 01 B 13/00

(30) Priority: 11.06.80 GB 8019114

(43) Date of publication of application:
16.12.81 Bulletin 81/50

(84) Designated Contracting States:
AT BE CH DE FR IT LI

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(54) **A method of manufacturing electrical insulation.**

(57) A method of forming electrical insulation comprises spraying on to a surface both a bonding material and flakes of an insulating material, more especially mica flakes having a maximum dimension significantly smaller than 1 mm, so as to form a mixture of the materials, and treating the mixture to form a compact coherent layer on the surface.

EP 0 041 824 A1

COMPLETE DOCUMENT

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This invention relates to a method of manufacturing electrical insulation and also to electrical insulation manufactured according to the method.

Mica is well known as an excellent electrical insulating material, having a very high dielectric strength, a great resistance to electric stress and discharge, excellent longevity, resistance to vibrations and is flexible. One common way of using mica for electrical insulation is to lay cleaved flakes onto a backing in an overlapping pattern interspersed or subsequently infiltrated with a bonding agent. The sizes of the flakes commonly used range from a few microns to 100 mm. However both the price and quality of the product increases sharply with the size of the flakes. The backing is often in the form of a sheet and such backing sheets carrying bonded mica flakes are generally cut into tapes which are wound around the components to be insulated. Both the labour and capital costs involved in such processes are high.

According to this invention a method of forming electrical insulation comprises spraying both a bonding material and flakes of an insulating material onto a surface to form a mixture thereupon of the said materials, and treating the said materials to form a compact coherent layer on said surface.

This invention facilitates the use of very small flakes of insulating material. This is an advantage, because in the manufacture of electrically insulating coatings using flakes there is a tendency for air to be trapped in the coating to an extent dependent on the size of the flakes. This is undesirable because the presence of air in a coating tends to promote electrical discharges at lower applied voltages than would otherwise be the case, and the trapping of air can be significant with

solid bonding materials when the flake dimension approaches or exceeds 1 mm. Coatings incorporating flakes less than 200 microns in size and applied in accordance with the invention have been found to contain very little air and flakes 50 microns in size yield coatings containing virtually no air. Much larger flakes can be sprayed with liquid bonding materials.

A method according to the invention preferably includes electrostatic spraying, the voltage being such that the flakes of insulating material are caused to lie parallel to the said surface.

It has been found that flakes of insulating material 50 to 100 microns in size may be sprayed at a voltage of about 35 kV and that for flakes of 200 to 400 microns in size the optimum voltage is about 15 kV.

A combination of electrostatic and non-electrostatic spraying may be used to great effect. Electrostatic spraying tends to deposit an excessive coating on convex edges and corners whereas a non-electrostatically sprayed coating tends to deposit less at such positions relative to other surfaces. Judicious use of a combination of electrostatic and non-electrostatic spraying gives a more uniform coating than may be obtained by the use of either technique alone. Moreover electrostatic spraying enables coatings to be applied around and behind bodies of complex and re-entrant shape.

Because coatings in accordance with the invention are insulating there is a limit to the thickness that can be applied electrostatically. With a cold surface this is around 125 microns in one application or 200 microns with two applications. Greater thicknesses can be applied to heated surfaces. This self limiting effect provides a useful means of controlling the thickness of a coating.

A bonding material in accordance with the invention is conveniently a thermally curable or thermoplastic polymeric material or varnish. Such materials include epoxy, acrylic and polyimide resins. A mixture of a thermally curable polymer and flakes of insulating material may be treated in accordance with the invention to form a compact and flexible layer by baking it in an oven. The process may be repeated to form thick layers.

The insulating flakes and a suitable varnish may be simultaneously or alternately sprayed from separate spray guns to give a coating which may subsequently be hardened or cured in an oven.

Alternatively an intimate mixture of insulating flakes and an appropriate polymeric material in powdered form may be sprayed as previously stated onto a pre-heated surface so that the coating flows out while being sprayed and may thereby be partially or wholly cured. When necessary complete curing may be achieved by subsequent heating in an oven. Spraying onto a heated surface may provide coatings up to 1 mm thick or thicker with repeat coatings.

An insulating material which is available as thin flakes and is particularly suitable for use in accordance with this invention is mica.

The optimum proportion by weight of polymer to mica has been found to lie in the range of 1 to 4 parts of polymer to each part of mica.

Electrical insulation in accordance with the invention may be formed as a coating directly onto a substrate which is desired to be insulated, or may be applied to a flexible backing such as woven glass cloth or plastics sheet which can be subsequently applied to a surface requiring insulation. The backing can be cut into strips or other shapes before application to said surface as may be appropriate.

The initial coating will, in general be

relatively flexible, and in the case where the binder is thermally curable, it is conveniently left in an uncured or semi-cured state for applying to a component requiring insulation, curing or completion of curing, as the case may be, being effected after its application.

Moreover additives to the coating mixture may also be used to modify the mechanical or other properties of the formed coating.

For example glass fibre may be added to increase the mechanical strength of the coating.

Alternatively finely divided silica may be used as an additive to increase the hardness and abrasion resistance of the coating.

An insulating coating may alternatively be formed on a non-stick mould from which it is removed after being hardened so that the finished coating may subsequently be relocated as desired.

Alumina or other mineral fillers in the form of thin flakes may be used in place of or additionally to mica for forming electrical insulation in accordance with the invention.

The invention may be better understood from the following examples of methods in accordance with the invention.

A powder composite was prepared by ball milling for 16 hours a mixture of epoxy resin powder containing curing, heat stablising and flow agents appropriate to the resin and mica, the latter having a flake size of 100 microns across and 4 microns thick. The particle size of the epoxy resin powder was in the range 50 to 150μm and the mass ratio of mica flake to epoxy powder was 1 to 2.

The composite mixture as prepared above was sprayed onto an earthed, cold 3.5 x 15 mm copper armature conductor, using an air assisted electrostatic powder spray unit, to form a coating of insulation on the conductor. A charging voltage of 35 kV was employed with 17 kPa pressure air assistance. The thickness of the coating was self limiting. The armature conductor was, within 5 minutes of spraying, passed through a convection oven at 200°C for 15 minutes to fuse and cure the coating. The fully cured coating had a thickness of 100 microns and retained sufficient flexibility to withstand a 180° bend around a radius of 25 mm.

It was able to withstand voltages of up to 2.8 kV (28 MV/m) applied from a foil electrode without failure.

In a second example, four 5 mm x 7 mm glass cloth and varnish insulated aluminium conductors were used together, as one component, to wind a stator coil for an electrical machine. The breakdown strength of the glass insulation was 900 volts. To give an increased breakdown strength between turns, of the coil, the turns, each comprising the four aluminium conductors, were prised apart to give gaps of 20-30 mm between the turns.

The composite mixture, as prepared in the

example above, was sprayed onto the earthed cold coil using an air assisted electrostatic spray unit to form a self-limiting insulating coating around each component of four conductors. A charging voltage of 35 kV was employed together with 17 kPa pressure air assistance. The coil was, within 5 minutes of spraying, passed through a convection oven for 15 minutes at 80°C to fuse the coating. The components were then clamped together to form the final winding and cured for 15 minutes at 200°C. The final layer between turns had a thickness of 312 microns and was able to withstand applied voltages up to 7 kV without failure (22½ MV/m).

CLAIMS

1. A method of forming electrical insulation comprising spraying both a bonding material and flakes of an insulating material onto a surface to form a mixture thereupon of the said materials, and treating the said materials to form a compact coherent layer on said surface.

2. A method according to Claim 1 wherein the flakes have a maximum dimension which is less than 1 mm.

3. A method according to Claim 2 wherein the flakes have a maximum dimension which is less than 200 microns.

4. A method according to Claim 2 wherein the flakes have a maximum dimension which is less than 50 microns.

5. A method according to any preceding Claim wherein the bonding material and flakes are sprayed onto said surface utilising an electrostatic spraying technique.

6. A method according to Claim 5 wherein the surface is heated during spraying.

7. A method according to any preceding Claim in which the insulating flakes are formed of mica.

8. A method according to any preceding Claim wherein the bonding material is a thermally curable or thermoplastic polymeric material or a varnish.

9. A method according to Claim 8 wherein the bonding material comprises a polymeric material which is sprayed on to the pre-heated surface in powdered form.

10. A method according to Claim 9 wherein the flakes are of mica and the proportion by weight of polymeric material to mica lies in the range of 1 to 4 parts of polymer to each part of mica.

11. A method according to any preceding Claim

wherein a quantity of glass fibre or finely divided silica is added to the coating material.

12. A method according to any preceding Claim wherein the surface to be coated is of metal.

13. A method according to any one of Claims 1 to 11 wherein the surface to be coated consists of a non-stick surface of a mould from which the coating is removed after hardening.

14. A method according to any one of Claims 1 to 11 wherein the surface to be coated is a flexible strip or sheet of insulating material.

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EUROPEAN SEARCH REPORT

0041824

Application number

EP 81 30 2457

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	US - A - 3 546 017 (PENDLETON et al.) * Complete document *	1-6,8, 9,12
X	US - A - 3 617 379 (ULMER et al.) * Complete document *	1-5,8, 9,12
	GB - A - 1 558 163 (NORSK HYDRO A.S.) * Claims; page 2, lines 4-15; lines 32-35 *	1,5,8, 9
A	US - A - 4 095 557 (CROOP et al.)	

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

B 05 D 1/06
5/12
H 01 B 13/00

TECHNICAL FIELDS SEARCHED (Int. Cl.³)

B 05 D 1/06
5/12
7/14
H 01 B 13/00

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27-07-1981	CECCHINI

EPO Form 1503.1 06.78