FLEXIBLE MICA COMPOSITIONS

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Fig. 1.

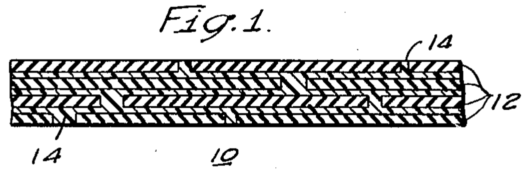


Fig. 2.

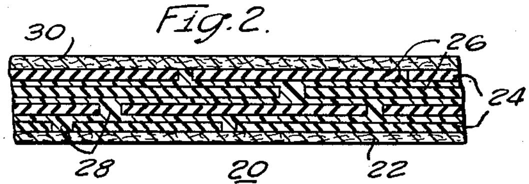


Fig. 3.

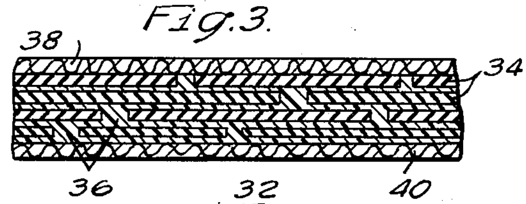
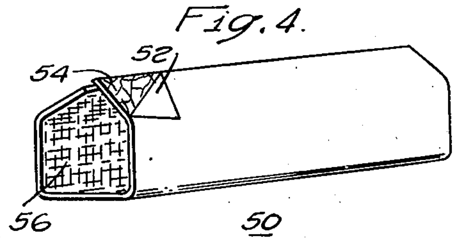


Fig. 4.



WITNESSES:
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UNITED STATES PATENT OFFICE

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FLEXIBLE MICA COMPOSITIONS

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8 Claims. (Cl. 154—2.6)

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This invention relates to insulating compositions, and in particular, to mica bonded with a relatively permanently flexible binder for use in laminated insulation.

There is a demand in the electrical industry for insulating material composed of mica flakes and a flexible, non-hardening binder, so that the insulating material will remain substantially permanently flexible and hardening with age will not occur during storage of the material and in subsequent use. Flexible mica insulation is particularly desirable for wrapping and tapes. Furthermore, mica bonded with a permanently flexible binder when applied to members is capable of distributing stresses more effectively than a rigid insulating member would, and, therefore, will withstand physical stresses better. In addition, cracking, curling, shrinkage and similar undesirable phenomena associated with certain rigid mica insulation are avoided with flexible mica insulation.

The object of this invention is to provide for a relatively flexible mica insulation embodying heat treated pine tar binder.

A further object of the invention is to provide for bonding mica with heat-treated pine tar to produce a substantially permanently flexible composite insulation.

A still further object is to provide for heat-treating pine tar to render it usable for bonding mica.

Other objects of the invention will, in part, be obvious and, will, in part appear hereinafter. For a fuller understanding of the nature and objects of this invention reference should be had to the following detailed description and drawing in which:

Fig. 1 is an enlarged view in vertical cross-section of mica insulation;

Fig. 2 is an enlarged view in vertical cross-section of a modification;

Fig. 3 is an enlarged view in vertical cross-section of another modification; and

Fig. 4 is a view in perspective of a slot cell.

According to the present invention, a substantially permanently flexible mica insulation is prepared by bonding mica flakes with heat-treated pine tar. Pine tar is produced by the destructive distillation of pine wood wherein a mixture of various volatile materials distill from the wood, and in subsequent refining of the mixture the pine tar is the last volatile material given off. The pine tar distills within a range of temperatures of from 200° C. to 400° C., depending upon the particular process employed. The specific

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gravity of pine tar varies from about 1.03 to 1.07. The product may be designated as crude pine tar since it consists of a variable mixture having a characteristic odor composed of tarry constituents, light oils and other volatile ingredients. Crude pine tar sold to the trade is entirely unsuitable for use as a mica bond. It will not bond mica flakes together. Mica flakes treated with crude pine tar fall apart. Other properties of the crude pine tar, such as variable composition and electrical characteristics further would render it unsuited for this application.

It has been discovered that heat treatment of crude pine tar at a temperature of the order of 225° C., preferably in the range of from 200° C. to 250° C., for from 3 to 8 hours drives off about a third of its weight in oils and other volatile material leaving a more uniform and homogeneous body which possess the new and unexpected characteristic of excellent adhesion to mica flakes. Heat-treatment at much higher temperatures, as at 300° C., however renders the pine tar unsuitable for this use due to pyrolytic decomposition. A complete reversal of the properties of the pine tar are produced by the heat-treatment insofar as mica bonding and electrical insulation is concerned. Furthermore, by heat treatment the pine tar is rendered much more stable so that it will not deteriorate or harden with age and it remains substantially permanently flexible. It is also no longer soluble in oils, such as transformer oil. Hereinafter, the term "heat-treated pine tar" will refer to crude pine tar heat treated at the temperature above indicated for a sufficient time to drive off all the oils and other volatile matter. The heat treatment is carried out in the open atmosphere. If enclosed vessels connected to a vacuum pump are employed, lower temperatures or a shorter time period will produce the same product.

As an example, medium retort pine tar was heat-treated at 225° C. for 6 hours. Approximately 35% of its weight in oils and other volatile matter was driven off in this time. The viscosity of the heat treated pine tar was in the range of 40 to 70 poises. A heat-treated product having a viscosity of from about 10 to 100 poises may be employed in the practice of the invention.

Heavy retort pine tar requires about 4 hours at 225° C. to render it satisfactory for mica bonding and less than 30% volatile is driven off. Light retort pine tar has more volatile present and may require the longest heat-treatment time.

The heat-treated pine tar is dissolved in a volatile solvent to produce a solution of from 15% to 50% concentration depending upon the requirements. A 35% solution of heat treated pine tar in ethyl alcohol has been employed with highly satisfactory results in treating mica flakes. Other suitable solvents are acetone, toluene and xylene. Mixtures of solvents obviously may be employed. For treating mica flakes applied to a paper or a cloth base, solutions containing 40% to 50% of heat-treated pine tar have been found advantageous since these solutions will impregnate the cloth or paper and the interstices thereof will be filled with the heat-treated pine tar better than from more dilute solutions.

In preparing a sheet composed of only mica flakes and heat-treated pine tar adhesive, the following procedure has been found satisfactory. Mica flakes applied to a moving screen from an elevated position whereby the mica flakes are uniformly scattered upon the moving screen to form a layer about 10 mils in thickness, this apparatus being well known and conventionally used in the art, were sprinkled from a trough with a 35% solution of the heat-treated pine tar in ethyl alcohol. Approximately 15 parts by weight of the heat-treated pine tar to 85 parts by weight of the mica flakes was so applied. The insulation was then passed into an oven and heated for a few minutes at a temperature of about 100° C. to evaporate the ethyl alcohol solvent. Two layers of the dried pine tar treated mica insulation were superimposed and a single layer of dry, untreated mica flakes was applied on either side of the resulting stack to prevent sticking. The stack was then compressed at a pressure of about 5 pounds per square inch in a press heated to a temperature of 140° C. for ten minutes. A twenty mil sheet of mica insulation was produced. The sheet was extremely flexible but adherently held together by the heat-treated pine tar. It required a substantial amount of pressure between the fingers to cause the mica flakes in the sheet to shift with respect to one another. Referring to Fig. 1 of the drawing there is shown an enlarged vertical cross-section through a sheet of mica insulation **10** so prepared comprising the mica flakes **12** bonded with the heat-treated pine tar **14**.

The following electrical properties were found by subjecting the sheet to standard tests:

Short time dielectric strength	736 volts/mil
Insulation resistance	Infinity megohms
Arc resistance	184 seconds

Power Factor	Temperatre		
	25° C.	50° C.	100° C.
1,000 Volts	2.53	3.20	12.53
1,500 Volts	2.20	3.10	12.53
2,000 Volts	1.93	3.23	13.10

In order to prepare somewhat stiffer mica insulation than can be secured by employing heat-treated pine tar alone without, however, producing a rigid insulation, there may be added up to 10% of the weight of the pine tar of a hardening agent selected from the group of mica bonding agents consisting of shellac, alkyd resins and the residue from solvent extracted pine wood pitch. The latter residue is available to the trade under the trade name "Vinsol." Examples of suitable alkyd resins are glycerol phthalate, glycol maleate and pentaerythritol-maleate-phthalate. When approximately 5% of one of the above hardening agents are added to heat-treated pine tar and the mica insulation produced therewith is definitely stiffer but still quite flexible. Approximately twice as much pressure must be applied between the fingers to cause the mica flakes to slip over each other as compared to the pressure required to slip mica bonded with the heat-treated pine tar alone.

A twenty mil sheet thick of mica flakes bonded with 15% of its weight of a composition composed of 95% by weight of treated pine tar and 5% "Vinsol" resin had the following properties on being tested:

Short time dielectric strength	730 volts/mil
Insulation resistance	Infinity megohms
Arc resistance	210 seconds

Power Factor	Temperature		
	25° C.	50° C.	100° C.
1,000 Volts	2.30	2.60	8.07
1,500 Volts	1.93	2.60	8.13
2,000 Volts	1.83	2.60	8.33

In preparing thin tapes and wrapping material from mica insulation bonded with heat-treated pine tar, it is desirable to employ a fibrous base material, particularly where producing extremely thin material of the order of 4 mils in thickness to secure abrasion and scuff resistance. Suitable fibrous reinforcing base materials are rope paper, cement paper, cambric, glass fiber cloth, asbestos paper and asbestos cloth. The preparation of a flexible mica tape is as follows. Referring to Fig. 2 of the drawing, the insulation **20** is prepared from 1 mil thick rope paper **22** covered with a 2 mil thick layer **24** of mica flakes **26**, then the mica flakes are sprinkled with a 40% solution of the heat-treated pine tar alone or with a small proportion of a hardening agent as above described. On drying the binder **28** is present in the insulation. After the solvent has been evaporated, a top sheet **30** of 1 mil thick rope paper similar to the bottom sheet is applied over the mica flakes. By pressing at a pressure of the order of 5 pounds per square inch, and heat treating during the pressing at a temperature of the order of 125° C. for a few minutes, an extremely flexible material **20** is produced. The sheet insulation so produced may be slit into tapes of any convenient width. These tapes have been stored for periods of a year without any appreciable change in flexibility.

Illustrated in Fig. 3 is another form of composite insulation **32** comprising a layer of mica flakes **34** bonded with the heat treated pine tar **36** and an upper and lower layer of glass cloth **38** and **40** applied thereto.

As illustrated in Fig. 4 slot cell liner **50** may be produced by combining an outer backing **52** of fish paper and mica flakes in a layer **54** of suitable thickness and impregnating the applied mica flakes with the heat-treated pine tar, preferably with about 5% to 10% of one of the hardening agents listed herein. After drying the composite material at a temperature of about 100° C., the mica flakes may be covered with a thin glass fiber cloth **56** to provide for abrasion resistance. The composite material may be compressed in a heated press at 10 pounds per square inch at a temperature of about 150° C. for a few minutes. The compressed material may be cut and shaped into slot cell liners **50**. The fish paper **52** will provide a relatively rigid backing which will permit the slot cell liners to be easily inserted into the slots in motor and generator armatures. The glass cloth **56** will permit the ready introduction of the windings into the slot cell without damage or undue shifting of the mica flakes. The flexible heat-treated pine tar binder will accommodate elongation and contraction of the conductors during use of the dynamoelectric machine. The slot cell liners will not become rigid due to the permanently flexible nature of the heat-treated pine tar.

The pressing of mica insulation carrying the heat-treated pine tar bonding agent is primarily to secure good consolidation. The press is heated in order to reduce the viscosity of the pine tar bonding agent so that it will distribute uniformly under moderate pressures of the order of a few pounds per square inch. Obviously higher pressures may be employed, but are not critical.

Numerous forms of insulation embodying mica flakes and the heat-treated pine tar bonding agent disclosed herein may be prepared. Insulation composed of mica flakes with various reinforcing and backing materials may be produced using the heat-treated pine tar bonding agent of this invention.

Since certain changes in carrying out the above processes and certain modifications in the articles which embody the invention may be made without departing from the scope thereof, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

We claim as our invention:

1. Insulating material comprising in combination mica flakes and a bonding agent applied to the mica flakes, the bonding agent comprising heat-treated pine tar of a viscosity of from 10 to 100 poises free from oil and other volatile material corresponding to the product derived by heating pine tar for from about 3 to 8 hours at a temperature of from about 200° to 250° C. under atmospheric pressure, the heat treatment driving off the oil and other volatiles in the pine tar.

2. Insulating material comprising in combination mica flakes and a bonding agent applied to the mica flakes, the bonding agent comprising heat-treated pine tar of a viscosity of from 10 to 100 poises free from oil and other volatile material derived by heating pine tar for from about 3 to 8 hours at a temperature of from about 200° C. to 250° C., the heat treatment driving off the oil and other volatiles in the pine tar and up to 10% of the weight of the pine tar of a mica bonding agent selected from the group consisting of shellac, alkyd resins and the residue from solvent extracted pine wood pitch resin.

3. A laminated electrically insulating material comprising a fibrous sheet, mica flakes applied to the fibrous sheet and a bonding agent for binding the fibrous sheet and the mica flakes into a whole, the bonding agent comprising heat-treated pine tar of a viscosity of from 10 to 100 poises free from oil and other volatile material derived by heating pine tar for from about 3 to 8 hours at a temperature of from about 200° C. to 250° C., the heat treatment driving off the oil and other volatiles in the pine tar.

4. A laminated electrically insulating material comprising a fibrous sheet, mica flakes applied to the fibrous sheet and a bonding agent for binding the fibrous sheet and the mica flakes into a whole, the bonding agent comprising heat-treated pine tar of a viscosity of from 10 to 100 poises free from oil and other volatile material derived by heating pine tar for from about 3 to 8 hours at a temperature of from about 200° C. to 250° C., the heat treatment driving off the oil and other volatiles in the pine tar, and up to 10% of the weight of the pine tar of a mica bonding agent selected from the group consisting of shellac, alkyd resins and the residue from solvent extracted pine wood pitch resin.

5. A laminated electrically insulating material comprising, in combination, a base sheet of paper, mica flakes applied to the base, a top sheet of paper coextensive with the base sheet and a bonding agent applied to the mica flakes to unite the base and top sheets of paper therewith, the bonding agent comprising heat-treated pine tar of a viscosity of from 10 to 100 poises free from oil and other volatile material derived by heating pine tar for from about 3 to 8 hours at a temperature of from about 200° C. to 250° C., the heat treatment driving off the oil and other volatiles in the pine tar.

6. A laminated electrically insulating material comprising, in combination, a base comprising a fabric of glass fibers, mica flakes applied to the base and a bonding agent applied to the mica flakes and glass fabric to unite them into a whole, the bonding agent comprising heat-treated pine tar of a viscosity of from 10 to 100 poises free from oil and other volatile material derived by heating pine tar for from 3 to 8 hours at a temperature of from about 200° C. to 250° C., the heat treatment driving off the oil and other volatiles in the pine tar.

7. A laminated electrically insulating material comprising, in combination, a base comprising a fabric of asbestos fibers, mica flakes applied to the base and a bonding agent applied to the mica flakes and asbestos fabric to unite them into a whole, the bonding agent comprising heat-treated pine tar of a viscosity of from 10 to 100 poiess free from oil and other volatile material derived by heating pine tar for from about 3 to 8 hours at a temperature of from about 200° C. to 250° C., the heat treatment driving off the oil and other volatiles in the pine tar.

8. An adhesive composition comprising heat-treated pine tar of a viscosity of from 10 to 100 poises substantially free of oils and other volatile matter, corresponding to the product derived by heating pine tar for from about 3 to 8 hours at a temperature of from about 200° C. to 250° C., exposed to atmospheric pressure to free the pine tar from the coils and other volatile material.

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