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INSULATING MATERIAL

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My invention relates to electrical insulating material and the method of producing same and more particularly to an improved electrical insulation that is stable at comparatively high temperatures.

An object of my invention is to provide an insulation having a comparatively high electrical resistance that is non-hygroscopic and substantially free from volatile matter.

Another object of my invention is to provide an improved insulation containing both organic and inorganic materials, in which the volatile matter in the organic material is practically eliminated and the tendency for the inorganic material to absorb moisture from the air is substantially reduced.

A further and more specific object of my invention is to provide an improved electrical insulation composed of partially carbonized asbestos paper impregnated with a polymerized vegetable drying oil or a vegetable drying oil that has been heated beyond the polymerization stage.

A still further object of my invention is to provide a method of producing insulating material which comprises passing asbestos paper between steel rollers to break up any conducting particles that may be present, impregnating the paper with a vegetable drying oil and then heating the impregnated paper to a sufficient temperature to polymerize the vegetable oil and to decompose and partially carbonize the starch or cellulose that may be present in the asbestos paper.

Asbestos paper has heretofore been utilized as insulation between the turns of the field coils of generators or other electrical apparatus. It has previously been the practice to coat the helical coils with shellac and to insert a plurality of layers of asbestos paper between adjacent turns of the coil, the contacting sides of each layer of paper being also impregnated with shellac. A current is then passed through the coil to fuse the shellac and pressure is simultaneously applied which cements and solidifies the mass into a form which may be readily mounted upon the pole pieces of the apparatus.

Electrical conductors that are insulated from each other in this manner, however, have not been altogether satisfactory. Asbestos is a finely divided porous material and in common with such materials has the property of absorbing moisture from the air which impairs its efficiency as an insulation. Asbestos insulation, such as asbestos paper, cloth or tape, also usually contains an organic binding material, such as cellulose or starch, or a combination of these materials, which is incorporated in the interstices between the fibres and in the pores of the fibres themselves to improve the structure of the asbestos sheet. The organic material that is utilized for this purpose, however, is not stable at elevated temperatures. At about 125° C. it has the tendency to evolve water and other vapors which increase the conductivity and cause a swelling and decomposition of the insulation, and this is especially true when the insulated coils are utilized in oil-filled apparatus, or when the surface of the insulation is impregnated with organic material that prevents the escape of the vapors, such as resins, gums or varnishes.

Asbestos also contains magnetic conducting particles, such as magnetite, and when asbestos paper is utilized as an insulation for the purpose specified, the conducting particles have the tendency to cause short circuits in the coils which decrease the efficiency of the machine. Magnetite is usually present in the original rock from which the asbestos is obtained, and since it is not a highly active chemical compound, it is difficult to remove without impairing the properties of the asbestos fibres.

I have made the discovery that insulation containing asbestos, such as asbestos paper, can be considerably improved by a series of operations, each of which eliminates one of the defects which has heretofore existed and a final product is obtained that has improved physical and insulating properties.

In practicing my invention, the asbestos paper is first passed between metal rollers to crush the conducting particles. In accordance with previous practice, when two layers of asbestos paper were placed between the turns of a helical coil, the pressure that was applied to cement the insulation and coils together forced the conducting particles in one layer of the paper through the adjacent layer, thus forming the short circuits to which reference has previously been made.

By passing the asbestos paper between steel rollers, however, the conducting particles are crushed and broken into small pieces. If only a single sheet of asbestos paper were interposed between the coils, no advantage would be gained by this process, but when a double layer is utilized as in ordinary practice, it is improbable that the conducting particles in one sheet will come in contact with those in the adjacent sheet.

The crushing of the paper is effected by passing a single ply between a set of rollers during which

process paper having a thickness of 10 mills is reduced to a thickness of approximately 7 mills and paper having a thickness of 7 mills is reduced to a thickness of between 4 and 5 mills. It is found advantageous during this operation to add a small amount of oil to the rollers to prevent sticking of the paper.

The following experiments clearly demonstrate that when asbestos is treated in the manner specified it is much more effective as an insulation. In making the experiments, a test piece consisting of two layers of ordinary asbestos paper and another test piece consisting of two layers of asbestos paper, each sheet of which had been passed between a set of rollers to crush the conductive particles were utilized. The comparative insulation value of the test pieces was determined by placing them between copper plates under a pressure of 5000# per square inch and maintaining a potential difference of 220 volts between the copper plates. In 12 consecutive experiments on each test piece, it was found that the insulation containing two layers of ordinary asbestos failed in 8 out of 12 tests, while in all 12 tests the insulation containing the layers which had previously been rolled were capable of resisting the impressed voltage.

According to the preferred embodiment of my invention, China wood oil is next applied to the asbestos paper and the coated paper baked at a sufficient temperature to decompose and partially carbonize the cellulose and starch and to polymerize the China wood oil or to heat it beyond the polymerization stage. While these operations may be performed in any desired manner, I prefer to pass the asbestos sheet in a continuous manner between rollers impregnated with the oil and to perform the baking operation by passing the coated sheets over an electrically heated plate which is maintained at a temperature between 350 and 450° C. At the temperature specified, the baking operation usually requires about 30 seconds, although it will be understood that a longer period will be required at lower temperatures. A temperature of at least 250° C., however, should be maintained.

When a vegetable drying oil, such as China wood oil, linseed oil or perilla oil, is utilized as the impregnating agent, the particular sequence in which the operations are performed is not a controlling factor in my invention, as good results have been obtained by first subjecting the asbestos paper to a baking operation and then applying a vegetable drying oil that has been heated beyond the polymerization stage. This may be accomplished by heating the oil to a temperature of approximately 350° C. in a closed retort.

Other organic materials may be utilized as the impregnating agent. In such cases, however, it is desirable that they be applied to the asbestos paper before the baking operation. The following table shows the resistivity of asbestos plates which have been impregnated with various materials and baked at such temperatures that partial carbonization of the organic material is effected:

Impregnating substances	Baking temperature	Resistance in megohms
Mixture of China-wood oil and shellac	400° C.	40,000
Phenolic condensation product	410° C.	2,300
Glycerol phthalate resin	365° C.	5,800
Gilsonite	365° C.	1,000

My invention, however, is not limited to asbestos paper which has been impregnated with oils, resins or varnishes, as I have found that asbestos fibres or other inorganic material, such as mica, glass wool or talc, that is bound together with an organic material, such as cellulose, starch or shellac, may be improved by a heat treatment which is sufficient to expel the water and partially carbonize the organic material.

It has been found that insulation which has been subjected to such a heat treatment has an improved insulation value and that swelling and decomposition in service is practically eliminated.

The heat treatment may be varied as to intensity and duration, but, of course, these factors, and especially the heating temperature, should be considerably greater than that which occurs in service. Ordinarily, the temperature should not exceed 500° C. because many organic materials are entirely decomposed at that temperature. I prefer to utilize a temperature between 300° C. and 450° C. although it will be understood that lower temperatures, say from 250° to 300° C., may be employed. The duration of heat treatment will, of course, depend upon the temperature employed and whether single sheets or rolls of the material are to be baked.

The heat treatment may be conducted in a retort or suitable container that is designed to exclude an excess of air, but which permits the escape of vapors. It has been found that although this heat treatment has the tendency to partially decompose and carbonize the organic material that may be present, the tarry residue of these organic substances has a high insulation value. For example, a roll of asbestos paper was heated in a closed container provided with an outlet for the escape of vapors. The paper was baked at a temperature of 300° C. for more than three hours. When the evolution of vapors had practically ceased, the carbon and starch in the paper had been partially carbonized and changed into non-hygroscopic, high insulating substances which covered the asbestos fibers. The baked paper was stiffer and stronger than the original and had a much higher electrical resistivity. It was not softened as much when moistened as the original paper, and was, therefore, more capable of resisting a subsequent shellac varnish treatment.

When vegetable oils are utilized to impregnate the insulation they may be applied to the asbestos paper or other insulation either before or after the baking treatment. I prefer to utilize China wood oil and to apply it to the asbestos fabric prior to the baking operation so that the starch and cellulose in the asbestos paper may be decomposed and partiallly carbonized, the oil polymerized, or heated beyond the polymerization stage, and the volatile vapors in both ingredients eliminated at one operation. This can be readily accomplished by the process referred to which consists in passing a single sheet of asbestos paper first between rollers impregnated with the oil and then over an electrically heated hot plate. By utilizing this method, the strength and flexibility of the paper may be controlled and an excellent product obtained. This method also eliminates the undesirable features of sticking and tearing which are encountered when attempts have been made to uniformly heat thick rolls of paper.

If it is desired to add the China wood oil after the baking operation, better results are obtained when it is given a sufficient preliminary heat

treatment to carry it beyond the gel stage. China wood oil oxidizes rapidly and at a temperature of 250° C., it sets in a short time to a stiff, brittle jell. When heated to a temperature of 350° C., in a suitable still or retort in the absence of air, it undergoes a chemical change. The volatile substances are expelled and a residue remains which has a higher viscosity than the original oil and its drying properties are radically changed. After 75 days at a temperature of 250° C., a film of oil was still in a "tacky" state. Another sample, when maintained at a temperature of 100° C. for four days was still "tacky" and was tough and flexible even after 75 days at this temperature. The treated oil may be applied to the baked asbestos fabric either with or without a solvent such as benzol, or other hydrocarbons.

It should be understood that each step in my process is capable in and by itself of producing an improved insulation. When they are combined, however, and all utilized, an improved product is obtained that has distinctly superior insulating properties.

While I have described my invention in considerable detail, it will be understood that various modifications may be made therein without departing from the spirit of my invention. For example, the insulation may be utilized for other purposes than those specified or in any desired form, such as in plates, tubes or channels. Insulation containing mica or other inorganic material, such as glass wool or talc, which are bound together or impregnated with organic materials, such as starch, cellulose, gums, oils or resins, may be improved by a similar heat treatment.

In some cases, and especially where strong mechanical properties are not required, a partially carbonized organic material of the carbohydrate type may be utilized by itself as an insulation without the presence of an inorganic substance. Cellulosic material, such as paper or cotton cloth, after being heated to a sufficient temperature to render it black and brittle, say from 200 to 400° C., is especially suitable and has a high insulation value although somewhat deficient in mechanical properties.

Other modifications of my invention will be apparent to those skilled in the art. I desire, therefore, that only such limitations shall be imposed upon my invention as is required by the prior art and the appended claims.

I claim as my invention:

1. An insulating material comprising a plurality of layers of asbestos paper which have been rolled to crush conducting particles, each layer of paper comprising asbestos bound together with a partially carbonized organic material.

2. The process of producing an insulating material which comprises passing asbestos paper between rollers to crush any conductive particles, impregnating the sheet with China wood oil and then heating the impregnated paper at a temperature of 200 to 400° C. to partially carbonize the organic material in the asbestos paper and to at least polymerize the China wood oil.

3. An insulating material comprising a plurality of layers of asbestos paper which have been rolled to crush any conducting particles, each layer of paper comprising asbestos bound together with a partially carbonized organic material and impregnated with an oxidizing oil that has been heated beyond the polymerization stage.

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