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INSULATION FOR MAGNETIC STEEL
AND THE LIKE

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No Drawing. Original application July 7, 1943, Serial No. 493,760. Divided and this application September 29, 1944, Serial No. 556,492

4 Claims. (Cl. 117-127)

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The present application is a division of our co-pending application Serial No. 493,760, filed July 7, 1943, now Patent No. 2,364,436, and relates to insulating coatings for magnetic material and more particularly to very thin inorganic insulating coatings adapted for use on laminations employed in electrical apparatus such as transformers, motors, etc. Heretofore a water vermiculite solution has been applied successfully to magnetic material and baked thereon to provide an insulating medium. We have found, however, that such a coating may be improved by the addition thereto of about 2 to 20% of magnesium oxide or any other magnesium compound which, upon reduction, will provide magnesium oxide, for example magnesium hydroxide.

It is one of the objects of the present invention to provide an improved coating on thin magnetic material which will not only provide suitable electrical insulation between adjacent sheets or convolutions but which will act as an effective separator between such adjacent sheets or convolutions when they are annealed at a relatively high temperature. Other objects will appear hereinafter.

In carrying out the present invention the magnetic material which, for purposes of illustration only, may be considered as consisting of silicon steel strip, is generally given a preliminary treatment which consists of pickling and washing or bright annealing the steel. Thereafter the insulating coating is sprayed onto the steel and dried. The steel is then formed into a stack or tightly wound core and annealed in an oxidizing, reducing or neutral atmosphere at a temperature which may vary from about 850 to 1200° C. During the anneal our improved coating prevents adjacent steel layers or convolutions from welding or sticking together. After anneal the coating on the steel will be found to be uniform and, although very thin, sufficient to substantially eliminate eddy current losses.

Our improved insulating coating may consist of vermiculite and magnesium oxide with or without the addition of bentonite or bentonite and feldspar, or bentonite and other suitable fluxing agents. A suitable coating contains about 98% vermiculite and about 2% magnesium oxide. In general the mixture contains at least 1% of magnesium oxide. About one and one-half pounds of the mixed ingredients are added to about 1 gallon of water to provide a mixture suitable for spraying. If desired, the mixture may contain a small percentage for example 5% of feldspar or other suitable fluxing agent. Generally about 45

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pounds of the mixture is added to enough water to make about 80 gallons of spraying solution.

While we prefer to apply the mixed powders in the form of a liquid spray, they may if desired be brushed, rolled, flowed or dusted onto the wet or dried metal surfaces. If a spray is employed, the steel strip is fed from the roll between two spray guns which face one another and the coating is sprayed on both sides of the steel at the rate of about 210 to 240 feet per minute. The coated material then passes through a dryer and the water in the coating is driven off leaving an even coating about one mil thick on the steel. When the steel strip leaves the drying oven it is wound into tight rolls which are boxed, annealed in dry hydrogen, and thereafter wound into cores. After this anneal the very thin inorganic insulating coating will be found to be firmly bonded to the steel.

The coating is not affected by Pyranol or oils generally employed as liquid dielectric mediums in transformers. On the other hand, such dielectrics are not adversely affected by the coating on the steel. If vermiculite is employed alone as the insulating or separating medium it will be found that the coating will bond to the steel. However, there is a tendency for the particles of vermiculite to bond tightly to one another thereby causing some difficulty in unwinding a coil of annealed steel and forming it into cores. The addition of about 2% or more of magnesium oxide to the vermiculite eliminates the tendency for the vermiculite particles to bond to one another without interfering with the bonding of the vermiculite to the steel. At the same time the magnesium oxide increases the electrical insulating character of the vermiculite coating. Magnesium oxide employed alone may serve as an excellent medium for separating the steel during a high temperature anneal but the oxide does not remain in place when the coated metal is wound into a core.

The magnesium oxide employed preferably is U. S. P. heavy grade. It has a density of 3.58 as against a density of 3.43 for the light grade. When 1 to 5% of magnesium oxide is employed with vermiculite the magnesium oxide is more effective than the vermiculite in keeping the adjacent steel sheets from sticking together during anneal since it does not fuse at temperatures around 1200° C. but remains on the steel as a powder. When employed with vermiculite the magnesium oxide is bonded to the steel by the vermiculite but reduces the adhesion of the particles of vermiculite to themselves. Due to this characteristic a small quantity of magnesium

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oxide mixed with vermiculite provides easy separation of coated magnetic material after anneal. However, an excess quantity of magnesium oxide may result in insufficient bonding of the insulating mixture to the steel.

We prefer to employ a grade of expanded vermiculite which is reduced to the desired mesh of 200 or less by an air or steam impingement of the particles against each other. Such material is manufactured under the trade name of "Pulvazon" and when added to water the viscosity of the solution is increased to a greater extent than with other grades of vermiculite. However, other types of expanded vermiculite and other mesh sizes may be employed where coating methods, other than spraying, for example brushing, dusting, etc. are used to apply the coating to the steel. The Pulvazon has other advantages; for example, it is distributed more uniformly in water suspension and has a better adhesion to the steel after drying and prior to anneal than other grades of vermiculite.

While the present invention has been illustrated in connection with certain percentages of mixed ingredients, the invention, as hereinbefore indicated, is not limited to these exact quantities. Furthermore, while we prefer to employ water as the suspension medium other liquid suspension vehicles may be employed. Such vehicles, in general, should not contain carbon since carbon has a detrimental effect on the steel during anneal. However, if they do contain carbon they should completely volatilize at a low temperature leaving no carbon deposit.

What we claim as new and desire to secure by Letters Patent of the United States, is:

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1. Magnetic sheetlike material having a coating thereon consisting of about 98% vermiculite and about 2% of magnesium oxide.

2. Magnetic sheetlike material having an insulating coating bonded thereto, said coating consisting of about 2 to 20% magnesium oxide with the remainder substantially all vermiculite.

3. Magnetic sheetlike material having a thin, adhesive, insulating coating thereon about .001" thick and consisting of at least 1% but not more than 20% of magnesium oxide with the remainder substantially all vermiculite.

4. Magnetic sheetlike material having a thin, adhesive, insulating coating thereon about .001" thick consisting of vermiculite and at least 1% but not more than 20% of magnesium oxide, said oxide having a specific gravity of about 3.58.

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