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METHOD OF MAKING INSULATED CORES

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Fig.1.

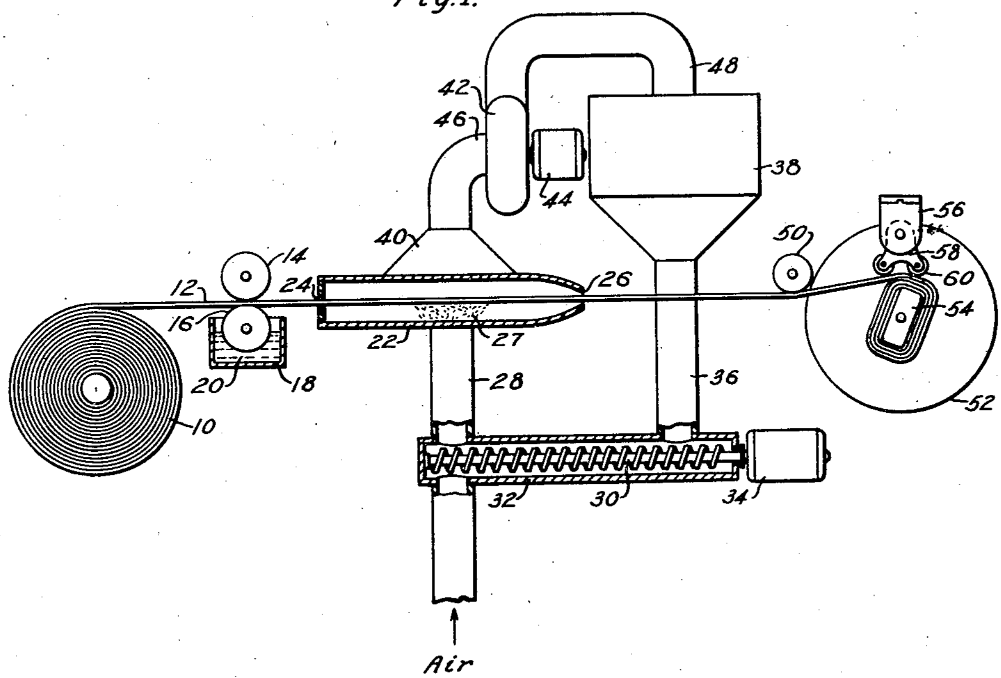
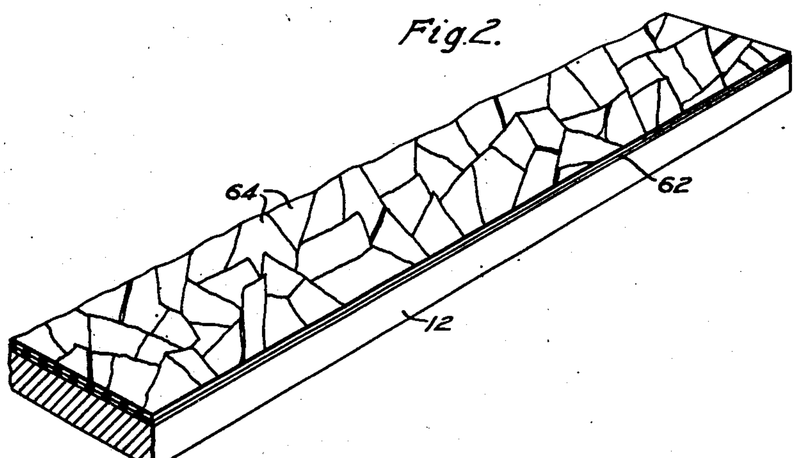


Fig.2.



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METHOD OF MAKING INSULATED CORES

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5 Claims. (Cl. 154—2.6)

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This invention relates to a process for applying flake insulation to electrical members.

In the process of building electrical members, particularly magnetic cores composed of laminations of sheet magnetic material, it is necessary that the layers forming the laminations of the core be insulated from one another in order to reduce the electrical losses during operation. The magnetic material is frequently bent or mechanically deformed when being formed into the core and becomes strained due to such deformation. Strains introduced into magnetic material increases electrical losses and accordingly the assembled core is annealed at an elevated temperature in order to eliminate the mechanical strains. Wound cores consisting of a plurality of turns of a magnetic material in particular must be strain annealed in order to secure a suitable low loss core.

One of the critical problems involving the manufacture of cores has been the introduction as interlamination insulation a material which will permit winding or otherwise building up magnetic cores capable of withstanding the strain anneal temperatures applied to the completed cores. The space factor should be low in order to permit satisfactory commercial manufacture.

Organic materials are not desirable as interlamination insulation for several reasons. No organic material available to the art will withstand the elevated annealing temperatures without evaporating, decomposing, or otherwise deteriorating to produce a carbonaceous conducting mass. Further, at elevated temperatures, organic materials will introduce carbon into the magnetic material and carbon has been found to be detrimental to the ageing and loss characteristics of the high efficiency magnetic materials employed at the present time in building magnetic cores. It has been found impractical to build a satisfactorily insulated core by attempting to introduce interlamination insulation after the core is built.

The object of this invention is to provide for applying inorganic insulation, capable of withstanding elevated temperatures, to sheet material.

A further object of the invention is to provide for applying a substantially single thickness of mica flakes to sheet magnetic material.

A still further object of the invention is to provide for building a wound core from sheet magnetic material with substantially only a single thickness of mica flakes between laminations so as to achieve a high space factor.

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Other objects of the invention will in part be obvious and will in part appear hereinafter.

For a better understanding of the nature and objects of the invention, reference should be had to the following detailed description and drawing, in which:

Figure 1 is a schematic view of an apparatus for carrying out the invention; and

Fig. 2 is a greatly enlarged fragmentary cross section of a sheet of magnetic material embodying the invention.

Due to the availability of a silicon iron sheet material having the grains oriented in a given direction, wound cores have been extensively manufactured to secure the utmost benefit from such material. Highly efficient wound magnetic cores have been produced from preferentially oriented silicon iron. The attainment of the maximum possible efficiency and lowest losses has been limited by the interlamination insulation obtained. A resistance of at least one ohm per square centimeter between each lamination is required as a minimum resistance for satisfactory low loss cores.

According to the present invention, sheet ferrous magnetic material of any kind is produced with an extremely thin layer of inorganic mica insulation on one surface and wound into a core having a high space factor. The wound core with applied inorganic mica insulation is heat treated to remove all strains and to secure the best magnetic properties.

It has been discovered that if the surfaces of the strips of magnetic material are lightly coated wth an easily volatilizable adhesive capable of adhering to the magnetic material and to mica flakes, a substantially single thickness of mica flakes may be applied thereto and held in place for a length of time to enable the making of a wound core therefrom. Readily volatile adhesives suitable for the practice of the invention are glycerol, ethylene glycol, propylene glycol, castor oil, short chain liquid aliphatic hydrocarbon compounds, and gum elemi. The adhesive should substantially completely evaporate at moderate temperatures, preferably below 300° C.

The adhesive may be applied by a roll coating process or by spraying or equivalent method. Thin layers of adhesive just sufficient to retain the mica on the surface of the magnetic sheet material are preferred. An excess of the adhesive not only is uneconomical but may permit the mica flakes to accumulate several thicknesses deep. Further, excess adhesive may cause the mica flakes to slip and to squeeze out when a core is wound from the strip material.

Mica flakes for practicing the invention have been found to give the best coatings when divided to a size passing through a ¼ inch mesh screen but held on a 100 mesh screen. Mica dust finer than 100 mesh is not particularly beneficial. Mica flakes of this size have necessarily been subjected to forces sufficient to break up the flakes into the thinnest possible laminae, usually of a thickness of less than one mil. Furthermore, almost complete coverage of the surfaces of sheet material has been secured when the mica flakes are of the size indicated. Good results have been obtained where the mica flakes have been as large as ½ inch mesh. Likewise, mica flakes passing through a ⅛ inch mesh screen and held on a 100 mesh screen have given good results. It will be obvious that where ordinary magnetic iron sheet material is made into cores, low losses may not be critical and the mica employed may vary from these sizes, whereas for maximum efficiency ordinarily called for when preferentially oriented material is employed, the selection of the size of mica flakes is critical.

Flaky materials suitable for the practice of the invention are various types of mica such as muscovite, phlogopite and vermiculite. Sheets or flakes prepared from bentonite, with or without inorganic additions, may be cut into flakes of a size usable for the invention. Also thin flakes of glass of suitably high melting temperature may be employed. Other flake-like substances may be obviously applied as described herein.

Referring to Fig. 1 of the drawing, there is illustrated an apparatus for practicing the invention. The roll 10 of strip magnetic material mounted for free unwinding is composed of the continuous strip 12 of silicon iron or the like. The strip 12 is passed between the upper roll 14 and the coating roll 16 mounted within a receptacle 18 carrying an adhesive 20, such, for example, as glycerine. One side only of the strip need be coated, though for some purposes both sides may be coated if it is desired to apply mica insulation to both sides.

The adhesive coated strip 12 is conveyed through the enclosed casing 22 provided with a narrow aperture 24 accommodating the strip 12 and having sufficient clearance to prevent any adhesive being scraped off. Likewise, an exit aperture 26 closely accommodating the strip 12 is provided at the opposite end of the housing 22. The lowermost lower coated side of the strip 12 is subjected to a stream 27 of air-borne mica particles of the size described herein. The air-borne mica impinges against the adhesive and is retained if any portion of the surface of the adhesive coated surface of the strip is exposed. In this way, all exposed parts of the surface are completely coated with the mica flakes while mica coated surfaces will not retain mica flakes blown thereagainst. Thereby substantially only a single layer of mica flakes is held by the adhesive. There may be a slight overlapping between the mica flakes; however, this has been found to be negligible in increasing space factor. The stream of mica flakes is blown through the tube 28 by a stream of air delivered from a source such as a blower (not shown) to which mica flakes are fed continually at a predetermined rate by the screw 30 disposed in the housing 32 connected to the tube 28. A controllable speed motor 34 drives the screw 30. A mica feed pipe 36 continually replenishes the screw 30 from the storage bin and collector unit 38.

The housing 22 is provided with a hood 40 for exhausting the excess mica flakes and the air introduced through tube 28. It will be apparent that a great excess of mica flakes is introduced above that required to coat the bottom side of strip 12. An exhaust fan 42 driven by motor 44 is connected by the tube 46 to the hood 40 for withdrawing the mica flakes and exhausting the mica flakes through the outlet 48 into the separator and collector 38. The separator 38 may be a conventional type of centrifugal separator capable of separating the mica flakes from the air and making them available for reuse.

The mica flake coated strip 12 now passes to a core winding machine under a guide roll 50. The core winding machine may be composed of a rotating plate 52 carrying a mandrel 54 corresponding to the desired shape of window for the core. Obviously, the core may be of circular cross section or any other predetermined shape or size. The laminations are subjected to pressure from an oscillating head 56 provided with a pivotable arm 58 carrying two follow-up rollers 60 for applying pressure to the sheet material in order to secure predetermined space factor. After a core of predetermined size has been wound, the sheet material may be cut and the loose end fastened to the body of the core by appropriate means, as by welding. The wound core may be subjected to a heat treatment which should be so conducted initially at a low temperature that the adhesive is caused to evaporate without forming any carbonaceous residue and leaving only the mica flakes between the laminations. Thereafter, the core may be subjected to higher temperatures of the order of 600° to 1000° C. to strain anneal the wound core and to accomplish any other purpose, including the completion of the process of orienting the crystals in the magnetic material.

The strip 12 is illustrated with greatly enlarged detail in Fig. 2 where the adhesive 62 and the substantially single thickness of mica flakes 64 is evident. It will be appreciated that the total thickness of the layers 62 and 64 is usually less than one mil. Cores wound from 15 mil sheet material have been regularly made with space factors of 95% and higher.

The invention has given excellent results in practice. In many cases, the losses in the core have been approximately those of the Epstein tests of the magnetic material.

The invention is not necessarily limited to the manufacture of wound magnetic cores but may be employed with success in making coils from copper sheet or strap. Since copper sheet or strap need not be strain annealed, a high temperature adhesive that need not be removed by evaporation may be fully adequate. For instance a thin layer of a liquid silicone resin may be employed as the adhesive for the mica flakes.

Although this invention has been described with reference to a particular embodiment thereof, it is of course, not to be limited thereto except insofar as is necessitated by the scope of the appended claims.

We claim as our invention:

1. In the method of preparing annealed insulated cores of high space factor from sheet magnetic material the steps comprising, applying to the underside of strips of the magnetic material a thin coating of a readily volatilized adhesive composition composed of an organic liquid having a boiling point below 300° C. capable of adhering to the magnetic material and to thin flake-like insulation, thereafter applying an air-borne suspension of flake insulation of a size held on a 100 mesh screen and passing through a ½ inch mesh screen to the coating of the adhesive composition whereby substantially a single thickness of flake insulation is adherently held by the adhesive composition and any excess falls off, winding a core from the strip magnetic material carrying the flake insulation and heat-treating the wound core to drive off the adhesive composition and to anneal the sheet magnetic material to relieve strains developed during winding.

2. In the method of preparing annealed insulated cores of high space factor from sheet magnetic material the steps comprising, applying to strips of the magnetic material a thin coating of a readily volatilized adhesive composition composed of an organic liquid having a boiling point below 300° C. capable of adhering to the magnetic material and to mica flakes, blowing mica flakes of a size passing through ¼ inch mesh but retained on a 100 mesh screen upwardly against the coating of the adhesive composition whereby substantially a single thickness of mica flakes is adherently held by the adhesive composition, any excess mica flakes dropping off, winding a core from the strip magnetic material carrying the mica flakes and heat-treating the wound core to drive off the adhesive composition and to anneal the sheet magnetic material to relieve strains developed during winding.

3. The method of preparing annealed insulated wound cores of high space factor from sheet magnetic material comprising, applying to the underside of strips of the magnetic material a thin coating of a readily volatilized adhesive composition composed of an organic liquid having a boiling point below 300° C., applying an air-borne suspension of mica flakes of a size held on a 100 mesh screen and passing through a ¼ inch mesh screen to the coating of the adhesive composition whereby substantially a single thickness of mica flakes is adherently held by the adhesive composition and any excess falls off, winding a core from the strip of magnetic material carrying the mica flakes and heat-treating the wound core to drive off the adhesive composition and to anneal the magnetic material to relieve strains developed during winding.

4. In the method of preparing annealed insulated wound cores of high space factor from sheet magnetic material the steps comprising, applying to one side of strips of the magnetic material a thin coating of a readily volatilized adhesive composition composed of an organic liquid having a boiling point below 300° C., blowing mica flakes of a size passing through ¼ inch mesh but retained on a 100 mesh screen upwardly against the coating of the adhesive composition whereby substantially a single thickness of mica flakes is adherently held by the adhesive composition, any excess mica flakes dropping off, winding a core from the strip of magnetic material carrying the mica flakes and heat treating the wound core to drive off the adhesive composition and to anneal the magnetic material to relieve strains developed during winding.

5. In the method of preparing an insulated wound member from metallic strip material, the steps comprising applying to one side of a metallic strip a thin coating of an adhesive composition, blowing small mica flakes passing through a ½ inch mesh screen but held on a 100 mesh screen upwardly against the coating of adhesive composition whereby substantially a single thickness of mica flakes is adherently held on the surface of the strip material by the adhesive composition and winding the metallic strip material carrying the mica flakes into a wound member with mica flakes between adjacent turns to provide a high space factor.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
386,925	Lee	July 31, 1883
703,197	Heany	June 24, 1902
1,187,259	Casler	June 13, 1916
1,228,371	Haefely	May 29, 1917
1,239,894	Edgecomb	Sept. 11, 1917
1,337,619	Pipe	Apr. 20, 1920
1,867,362	Lathrop	July 12, 1932
1,895,711	Foley	Jan. 31, 1933
1,952,502	Kinkead	Mar. 27, 1934
2,173,032	Wintermute	Sept. 12, 1939