106. COMPOSITIONS, COATING OR PLASTIC

CROSS REFERENCE

Examiner

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Patented May 10, 1932

1,857,201

UNITED STATES PATENT OFFICE

HUBBEL LATHROP, OF GREENWICH, CONNECTICUT, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

PROCESS FOR INSULATING MAGNETIC BODIES

No Drawing. Application filed July 2, 1931. Serial No. 548,484.

This invention relates to magnetic bodies and particularly to methods of producing magnetic bodies of the type employing finely divided magnetic material.

An object of the invention is to improve the magnetic characteristics of magnetic bodies of the type employing magnetic material in finely divided form, for example, magnetic dust cores for loading coils.

Magnetic cores made from finely divided magnetic material, so-called magnetic dust cores, are being extensively used for the loading coils which are inserted in telephone lines to improve their transmission characteristics. Such cores are usually constructed by subjecting the finely divided particles of the magnetic material and a non-magnetic material between the magnetic particles, to extremely high pressures in the neighborhood of 200,000 pounds per square inch. The high pressures are utilized to form the component materials into a substantially homogeneous mass in the desired core form, and to give sufficient mechanical strength to the completed core. The non-magnetic material is of such a nature as to serve as a binder, and also as an insulation between the magnetic particles to reduce eddy current losses in the completed core. In the case especially where the magnetic material in the core made in the above described manner is a magnetic alloy including nickel and iron, it is desirable also to subject the core to subsequent heat treatment at a high temperature to remove the strains introduced in the magnetic material by the pressing operation tending to impair the magnetic properties of the magnetic alloy in the core, and to fully develop the magnetic characteristics of the alloy. It is desirable, therefore, that the insulating material have such characteristics and be applied in such manner to the dust particles that it will withstand without deterioration from an insulating standpoint the heat treatment and mechanical operations utilized in producing the core.

A method commonly used for insulating the magnetic dust in the process of making loading coil cores is to mix the magnetic dust with the insulating material in finely divided form, and a volatile liquid, such as water, and then to evaporate the whole to dryness with constant stirring in order to coat the magnetic particles with the insulating material. The total amount of insulating material is thus applied to the magnetic dust particles in one layer. The insulated magnetic particles are then compressed under high pressure into the desired core form, and the resulting cores are given a subsequent annealing heat treatment to improve their magnetic characteristics.

In accordance with the present invention the process of insulation above described is modified in that the insulating material is applied to the magnetic dust particles a portion at a time so as to obtain several layers of the same insulating material between the magnetic particles. This change in the method of insulating has been found to materially improve the magnetic properties, and particularly to reduce the eddy current loss in the completed core.

The exact nature of the invention and the advantages thereof will be better understood from the following detailed description of the process for producing a magnetic dust core or a loading coil embodying the invention.

In practicing the present invention, the magnetic material is preferably prepared from a brittle alloy containing nickel and iron, with or without the addition of other constituents, and commonly known as "permalloy". The alloy may be prepared in the manner described in the U. S. Patent No. 1,669,649 issued May 15, 1928 to C. P. Beath and H. M. E. Heinicke, wherein the magnetic metals, for example, nickel and iron in proportions depending upon the desired percentage of the alloy, are melted together in an oxidizing atmosphere, the resulting alloy being poured into a mold to form an ingot. The ingot while still hot is successively passed through progressively reducing rolls to decrease its cross-section, the final roll being preferably effected at approximately the temperature at which the alloy ceases to be malleable, after which the ingot is quenched in water at a temperature below that in which it loses its malleability. This treatment is for the purpose of producing a fine crystalline structure in the alloy material since when the material is reduced to finely divided form its disintegration takes place at the crystal boundaries, and consequently the smaller the size of the crystals the finer the dust which can be produced therefrom. The slabs of alloy material so produced are then broken into short pieces and the pieces reduced to the form of dust in any suitable manner for example by crushing in a rock crusher, hammer mill, or other suitable apparatus, after which the crushed material is pulverized by rolling in a ball mill for several hours. After several hours of rolling the resulting dust is sieved through a 120 mesh sieve and that portion which will not pass through the sieve is returned to the ball mill for further rolling, this process being repeated until a sufficient quantity of the very fine dust is obtained. Prior to the addition of the insulating material the finely divided particles of the alloy are annealed in a closed container at a temperature of approximately 885° C. It is then necessary to again reduce the annealed alloy which is now in the form of a cake to a finely divided form ready for insulation.

The general method of insulating the magnetic particles in accordance with this invention was tried with several insulating compositions. In each case a material improvement in the magnetic properties of the completed core was observed over that obtained when the usual method of insulation was employed.

In one case the method of the invention was applied to the insulation of the annealed magnetic particles with an insulating composition comprising kaolin, talc, sodium silicate, chromic acetate and water, such as disclosed and specifically claimed in my copending application, Serial No. 556,951, filed August 14, 1931. It was desired to insulate 1000 grams of the annealed permalloy dust with a total of 6.5 grams finely divided kaolin, 6.5 grams finely divided talc and 11.0 grams of sodium silicate in solution with 1.1 grams of chromic acetate.

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This was done as follows:

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The 11.0 grams of sodium silicate and 1.1 grams of chromic acetate were first dissolved in water to a total solution volume of 333 cc. Each 1000 grams of permalloy dust were then mixed with 2.5 grams finely divided talc and 2.5 grams finely divided kaolin, 111 cc. of the solution of sodium silicate and chromic acetate was added thereto and then the mixture was evaporated to dryness with constant stirring, to form the first layer of the insulation on the permalloy dust particles. Then, an additional 2.0 grams talc and 2.0 grams kaolin were mixed with the coated magnetic particles, an additional 111 cc. of the solution added thereto, and the whole evaporated again to dryness with constant stirring, to form a second layer of insulation on the permalloy dust particles. Then the resulting coated magnetic particles were mixed with the remaining 2.0 grams talc and 2.0 grams kaolin, the remaining 111 cc. of the solution added thereto, and the whole evaporated to dryness to form a third layer of insulation on the magnetic particles.

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In another case it was desired to insulate the annealed permalloy dust with an insulating composition such as disclosed in my copending application, Serial No. 459,564 filed June 6, 1930. The insulating material used comprises 1.6 grams sodium silicate and 1.0 grams talc for each 100 grams of the magnetic dust. A solution of the sodium silicate in water was first made up, 40 cc. of water being used for each 1.6 grams of the sodium silicate. One third of the talc in dry powder form was then mixed with the total amount of the permalloy dust, one third of the sodium silicate solution was added thereto, and then the whole evaporated to dryness to form the first insulating layer on the magnetic particles. The insulated magnetic particles were then mixed with another one third of the talc, another one third of the sodium silicate solution was added thereto and the resulting mixture was again evaporated to dryness to form the second coating of the insulating material on the magnetic dust particles. The remaining one third portion of talc was then mixed with the insulated magnetic dust particles, the remaining one third of the sodium silicate solution was added thereto and then the resulting mixture was evaporated to dryness to form the third coating of insulating material upon the magnetic particles.

The magnetic dust particles insulated with the different insulating compositions in the above described manner were respectively sifted through a 16 mesh sieve, placed in a mold and compressed into core parts under a pressure of approximately 200,000 pounds per square inch. The core parts were then transferred to an annealing furnace where they were annealed at a high temperature either in air or in hydrogen to relieve the internal stresses set up by the pressing operation, thereby producing a core having low hysteresis loss.

Where the annealing heat treatment is carried out in air, the core parts are preferably subjected to a temperature of approximately 500° C. for about 45 minutes. Where the annealing heat treatment is carried out in hydrogen, the core parts are preferably subjected to a temperature of approximately 650° C. for about 30 minutes.

One or more core parts thus formed are then stacked to form a core to which the usual toroidal winding is applied to form a loading coil, the number of core parts used in each core depending upon the electrical characteristics of the circuit with which the loading coil is to be associated.

Tests of magnetic cores insulated by the method of the invention in which the insulating material was applied in three or more stages as described above and other cores made at the same time using the same amount and kind of insulating material applied in a single layer by the usual method, showed that the former method resulted in much lower eddy current losses in all cases and in most cases in improved hysteresis characteristics as well. In the case of the particular insulating materials mentioned above, the reduction in eddy current losses obtained by the method of the invention was found to be approximately 20 to 60 per cent lower than that obtainable employing the methods of the prior art.

It is to be understood that the invention is not limited to the particular constituents and proportions of the magnetic and insulating materials above mentioned which were given by way of example only, but that it is of a generic nature applicable to all magnetic and insulating materials which are commonly used in the production of magnetic bodies of the type employing magnetic material in finely divided form. It is to be understood also that the method of applying the insulating material may be varied somewhat from that described above without departing from the spirit of the invention which is limited only within the scope of the appended claims.

What is claimed is:

1. In the process of making a magnetc body comprising finely divided magnetic particles insulated from each other by a given amount of insulating material, the method of insulating the magnetic particles which consists in mixing said particles with a portion of the insulating material in a volatile liquid and evaporating the mixture to dryness, and mixing the resulting product with another portion of the insulating material in a volatile liquid and evaporating to dryness.

2. In the process of making a magnetic body comprising finely divided magnetic particles insulated from each other by a given amount of insulating material, the method of insulating the magnetic particles which consists in mixing said magnetic particles with a portion of the total amount of insulating material in a volatile liquid and evaporating the mixture to dryness to form an insulating coating on the particles, mixing the coated particles with another portion of the insulating material in a volatile liquid and evaporating the mixture to dryness to form a second layer of insulating material on the particles, and repeating the process until the entire amount of insulating material has been applied to the magnetic particles in layers.

3. The method of producing a magnetic body having a low eddy current loss from a given amount of finely divided magnetic material and a given amount of a finely divided insulating and binding material including both soluble and insoluble ingredients, which method consists in mixing the total amount of the magnetic material with a portion of the insoluble ingredients of the insulating and binding material in dry form, adding to the mixture a liquid solution of a portion of the soluble ingredients of the insulating and binding material and evaporating the whole to dryness with constant stirring, mixing the resulting coated magnetic particles with another portion of said insoluble ingredients in dry form, adding to the resulting mixture a liquid solution of another portion of said soluble ingredients and evaporating the whole to dryness with constant stirring, repeating the process until all of the insulating and binding material has been applied as coatings to the magnetic particles, compressing the resultant product into a substantially homogeneous mass in the desired form, and then heat treating the formed product to remove strains in the magnetic material.

4. In the process of making a magnetic body comprising finely divided particles of magnetic material insulated from each other by a given amount of insulation comprising several constituent materials, the method of insulating the magnetic particles which consists in mixing in a volatile liquid said magnetic particles with a portion of the insulation comprising a portion of each of the constituent materials and evaporating the mixture to dryness, mixing the resulting product in a volatile liquid with another portion of the insulation comprising a portion of each constituent material and evaporating the mixture to dryness, and repeating this process until the entire amount of the insulation has been applied to the magnetic particles in successive layers.

In witness whereof, I hereunto subscribe my name this 1st day of July, 1931.

HUBBEL LATHROP.