Oct. 13, 1931. J. W. ANDREWS 1,826,711

METHOD OF MAKING MAGNETIC STRUCTURES

Filed Aug. 24, 1929

Fig. 1.

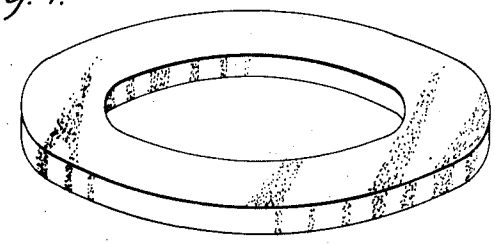
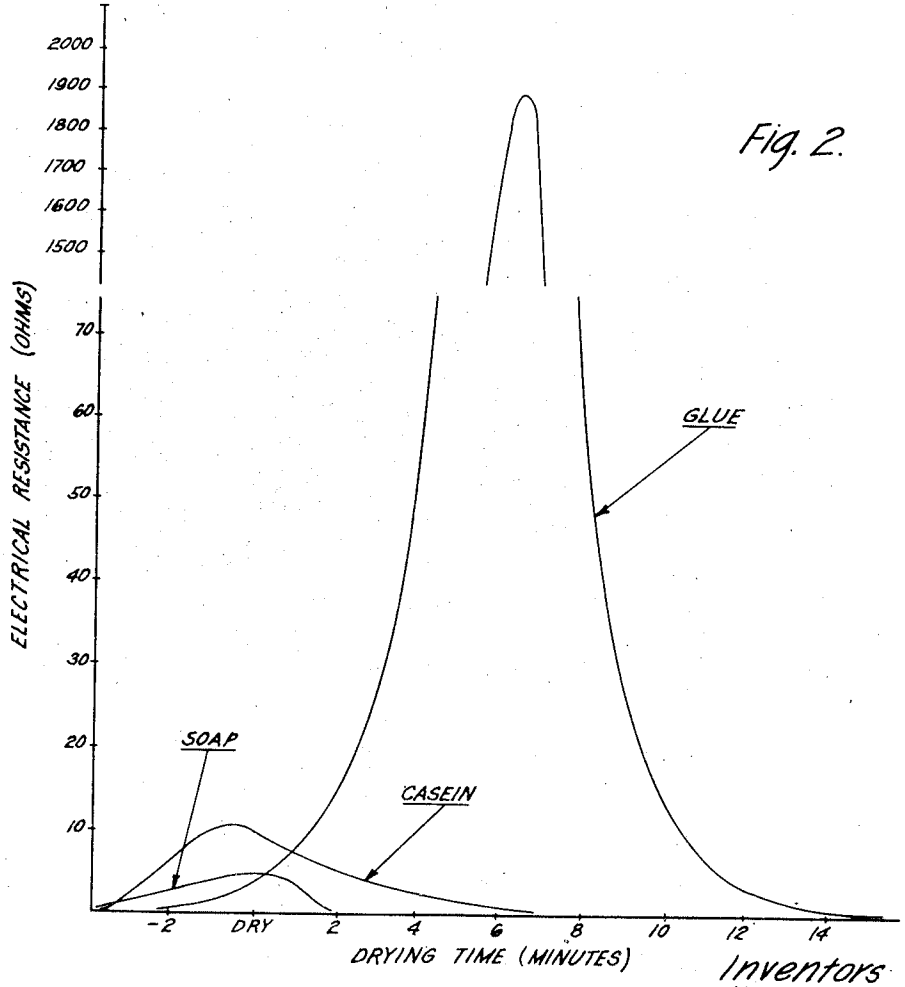


Fig. 2.



Inventors
John W. Andrews
By H. A. Pattison Att'y.

Patented Oct. 13, 1931

1,826,711

UNITED STATES PATENT OFFICE

JOHN W. ANDREWS, OF CHICAGO, ILLINOIS, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

METHOD OF MAKING MAGNETIC STRUCTURES

Application filed August 24, 1929. Serial No. 388,082.

This invention relates to a method of making magnetic structures, and more particularly to a method of producing magnetic cores of a compressed dust type for use in telephonic communicating systems.

The principal object of the invention is to provide a method of producing magnetic structures having low core losses and a relatively high permeability to enable a given inductance to be obtained from a minimum amount of material and possessing to a high degree those electrical and magnetic characteristics which make it highly desirable for use in electrical signaling apparatus, particularly in loading coils for telephone circuits.

One embodiment of the invention contemplates the construction of magnetic cores for loading coils of nickel-iron alloys in finely divided form having higher inherent magnetic permeability and lower inherent hysteresis loss than iron. These properties are obtained by treating metal or alloy particles with certain organic materials which upon heating disintegrate, passing through a gradual and continuous transition from a gummy substance to a solid to form an insulating coating thereon after which the insulated particles are compressed into cores of any desired shape and size. The cores are then heat treated at the optimum temperature for the particular alloy of which the cores are constructed to stabilize the insulator and to give a high permeability and low hysteresis loss.

Other features and advantages of the invention will become apparent from the following detailed description of one embodiment thereof, reference being had to the accompanying drawings, wherein

Fig. 1 is a perspective view of a section of an inductance loading core made in accordance with the present invention, and

Fig. 2 shows a curve illustrating the insulative resistances obtainable with various organic insulating materials.

It will be understood, however, that Fig. 1 is merely illustrative and the invention is not limited to the production of this form of core, but is adapted to the production of magnetic parts of various forms.

In practicing the present invention, the magnetic material is preferably prepared from brittle alloys containing various percentages of nickel and iron. These alloys are prepared as fully described in the patent to C. P. Beath and H. M. E. Heinicke, No. 1,669,649 issued May 15, 1928. The preferred form of the alloy, commonly referred to as "permalloy", is prepared by melting approximately 81 parts of nickel and 19 parts of iron in an oxidizing atmosphere and pouring the resulting alloy into a mold.

An alloy thus prepared is rolled while hot into relatively thin slabs and quenched to produce a fine crystalline structure which is very desirable since the disintegration of the material takes place at the crystal boundaries, and consequently the smaller size of the crystals, the finer the dust which can be produced from the finished product. The magnetic alloy thus received in slab form is reduced to a finely divided form or dust, in any well known manner; as for example, in a hammer mill or other suitable reducing apparatus, and subsequently pulverized in an attrition or ball mill.

The dust from the attrition mill is sieved and the portion passing through a 120 mesh sieve is placed in a closed container and annealed at a temperature of approximately 885° C. The annealed dust is removed from the container in the form of a cake which is again reduced to a powder by crushing in a rotary crusher and subsequently grinding in an attrition mill. The ground dust is again sieved through a standard 120 mesh screen and the dust passing through such a screen is insulated with an organic insulator.

According to one form of the invention, the insulator for the dust particles is prepared by mixing the ingredients in approximately the following proportions:

1 part of glue or soap
30 parts of water.

The metallic dust is thoroughly mixed with the solution, the amount of the metallic dust added being determined by the permeability desired and the particular use to which the finished cores are to be put. The entire mass

is then boiled to a predetermined degree of dryness as determined by the point at which maximum resistance is obtainable for the particular organic substance being used, accompanied by constant stirring to prevent caking and to insure a thorough coating of the individual dust particles.

The insulated dust is sieved through a 16 mesh screen and placed in a mold and compressed into core parts under a pressure of approximately 200,000 pounds per square inch. The core parts are then transferred to an annealing furnace where they are annealed at the optimum annealing temperature of approximately 500° C. and cooled. The core parts are then dipped in shellac to give them a moisture proof coating.

A plurality of core parts thus formed are then stacked co-axially to form a core on which the usual toroidal winding is applied, the number of such parts used depending upon the existing electrical characteristics of the telephone circuit with which the loading coils are to be associated.

As indicated by the graphical representation of Fig. 2 the time of drying of the dust being insulated is controlled by the particular organic insulating material used and the maximum resistance obtainable. By the term "dry" as used with reference to that point on the curve is meant that degree of dryness when the insulated dust rolls freely from a polished metallic surface. As illustrated by the curves of Fig. 2, the maximum resistance obtainable with soap or casein occurs substantially at the dry point just described. Whereas with the use of glue as the insulator, the maximum resistance occurs when the time of heating is carried approximately 6½ minutes beyond the dry point, terminating at a temperature of approximately 200° C. The underlying principle of the success of an organic material as an insulator is that the material upon heating disintegrates, passing through a gradual and continuous transition from a gummy substance to a brittle solid to provide insulation between the metallic particles.

Casein as an insulator for the dust particles is prepared by thoroughly mixing one part of casein with ten parts of water. For example, skim milk has been found to give satisfactory results.

Although the metallic dust has been described as being insulated with a solution of glue, casein, soap or milk in definite proportions, it is of course to be understood that the proportions of the different ingredients may be varied without departing from the spirit and scope of the invention. Also, other organic materials such as colloidal nitrogenous substances, sugars, refinery syrups, starches, and dextrin may be successfully used. It will also be understood that the organic insulators are not confined to aqueous solutions since benzine solutions of asphalt, rubber dissolved in carbon bisulphide, or varnishes may be used with satisfactory results.

What is claimed is:

1. The method of making magnetic structures, which consists in coating particles of a magnetic material with an organic material which disintegrates upon heating to form an insulating solid, and forming a mass of the insulated particles into a homogeneous structure.

2. The method of making magnetic structures, which consists in coating particles of a magnetic material with a solution of organic material which disintegrates upon heating to form an insulating solid, heating the coated particles to cause the organic material to disintegrate to form an insulating solid, and forming a mass of the insulated particles into a homogeneous structure.

3. The method of making magnetic structures composed of an alloy, which consists in reducing the alloy to finely divided particles, coating the particles with an organic insulating material which disintegrates upon heating to form a solid, and forming a mass of the insulated particles into a homogeneous structure.

4. The method of making magnetic structures, which consists in reducing an alloy to fine particles, heat treating the particles, reducing the product so obtained to dust, coating the dust uniformly throughout with an organic material which disintegrates upon heating to form an insulating solid, and forming a mass of the insulated dust into a homogeneous structure.

5. The method of making magnetic structures, which consists of mixing particles of magnetic material with a solution of organic material adapted to disintegrate and form an insulating solid, heating the mixture to cause the organic material to disintegrate and form an insulating solid over each particle, and forming a mass of the insulated particles into a homogeneous structure.

6. The method of making magnetic structures, which consists in mixing particles of a magnetic material with a solution of organic material adapted to disintegrate and form an insulating solid, heating the mixture to cause the organic material to disintegrate and form an insulating solid over each particle, forming a mass of the insulated particles into a homogeneous structure, and heat treating the structure.

7. The method of making magnetic structures, which consists in reducing an alloy to finely divided particles, coating the particles with an organic insulating material which disintegrates upon heating to form a solid, forming a mass of insulated particles into a homogeneous structure, and heat treating the structure to a temperature of approximately 500° C.

8. The method of making magnetic structures, which consists in mixing particles of a magnetic material with a solution of organic material which disintegrates upon heating to form an insulating solid, forming a mass of the insulated particles into a homogeneous structure, and heat treating the structure at an optimum temperature determined by the point of minimum loss.

9. The method of making magnetic structures, which consists of mixing nickel-iron particles with a solution of organic material which disintegrates upon heating to form an insulating solid, compressing a mass of the insulated particles into a homogeneous structure, and heat treating the structure at an optimum temperature determined by the point of minimum loss.

10. The method of making magnetic structures composed of an alloy of not more than 25% nickel and the remainder principally iron, which consists in reducing the alloy to finely divided particles, mixing the particles with organic material adapted to disintegrate and form an insulating solid, simultaneously heating and stirring the mixture to cause the organic material to disintegrate and form an insulating solid over each particle, and forming a mass of the insulated dust into a homogeneous structure.

11. The method of making magnetic structures composed of a ferrous magnetic alloy containing 81% nickel, which consists of coating particles of the alloy with an organic material which disintegrates upon heating to form an insulating solid, and forming a mass of the insulated particles into a homogeneous structure.

12. The method of making magnetic structures, which consists in mixing particles of a magnetic material with a solution of a colloidal organic substance which disintegrates upon heating to form an insulating solid, simultaneously heating and stirring the mixture to form an insulating solid over each of the particles, and forming a mass of the insulated particles into a homogeneous structure.

13. The method of making magnetic structures, which consists in mixing particles of a magnetic material with a solution of glue, simultaneously heating and stirring the mixture to cause the glue to disintegrate and pass through a gradual and continuous transition from a gummy substance to a solid to form an insulating coating over each of the particles, and forming a mass of the insulated particles into a homogeneous structure.

14. The method of making magnetic structures, which consists in mixing particles of a magnetic material with an organic material, heating the material to effect its disintegration and gradual and continuous transition from a gummy substance to a solid to form an insulating coating on the magnetic particles, and forming a mass of the insulated particles into a homogeneous structure.

15. The method of making magnetic structures, which consists in coating particles of a magnetic material with casein which disintegrates upon heating to form an insulating solid, and forming a mass of the thus insulated particles into a homogeneous structure.

In witness whereof, I hereunto subscribe my name this 15th day of August, A. D. 1929.

JOHN W. ANDREWS.