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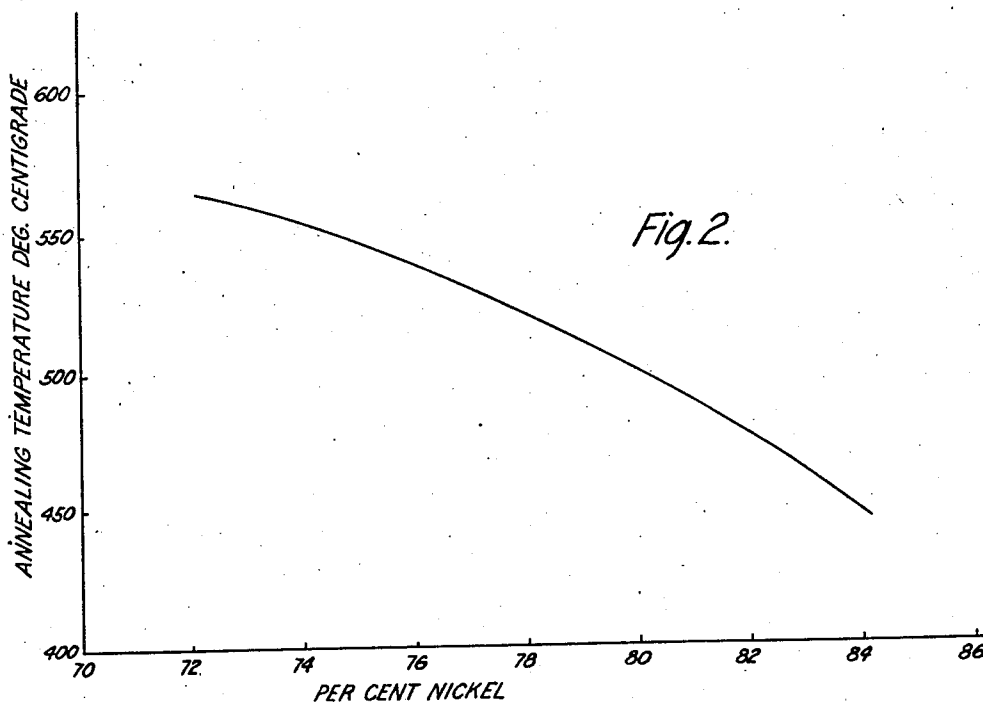
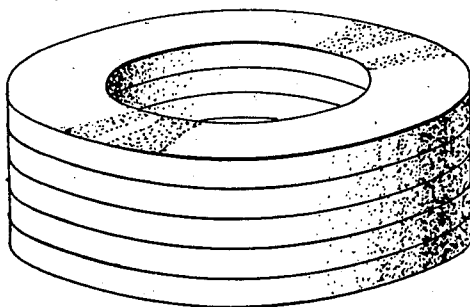
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1,845,144

METHOD OF MAKING MAGNETIC STRUCTURES

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Fig. 1.



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METHOD OF MAKING MAGNETIC STRUCTURES

Application filed November 8, 1928. Serial No. 317,830.

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 object of the invention is to provide a method of producing magnetic structures having stable magnetic properties under varying magnetic conditions.

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 a refractory insulating material to form an insulating coating thereon after which they are compressed into cores of the desired shape and size. The cores are then heat treated to give substantially zero stability of permeability and hysteresis loss to magnetization as determined by the composition of the alloy.

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 illustrates a plurality of magnetic rings or core parts made in accordance with the present invention and combined to form a complete loading coil core, and

Fig. 2 shows a curve illustrating the optimum annealing temperatures for various compositions of nickel-iron alloys to procure substantially zero stability of permeability and hysteresis loss to instantaneous magnetization.

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.

By the term zero stability of permeability and hysteresis loss to instantaneous magnetization, as employed in the specification and in the annexed claims, is meant that the permeability and hysteresis loss of the material, and consequently the inductance and

effective resistance of an inductance coil having a core of such material is substantially unaffected by instantaneous direct or alternating current magnetizations. That is, for a core to have zero stability to magnetization, the value of the inductance and the effective resistance of the inductance coil would remain the same after being subjected to an instantaneous current.

In carrying out 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.

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 distintegration of the material takes place at the crystal boundaries, and consequently the smaller the 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 mill.

The dust from the attrition mill is sifted, 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 sifted through a standard 120 mesh screen and the dust passing through such a screen is insulated with a solution of chromic acid, sodium silicate, powdered talcum, and water. This mixture is heated and stirred until dry, as fully described in Patent No. 1,669,643 issued May 15, 1928, to J. W. Andrews and R. Gillis. As clearly described therein, the desired permeability can be obtained by varying the amount of the insulating material. Obviously, other methods of insulating the

dust, well known to the art, could also be employed.

The insulated dust is sifted 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 in air tight containers to an annealing furnace where they are annealed at an optimum temperature determined by the composition of the alloy comprising the dust. As indicated by the graphical representation of Fig. 2, ferrous alloys having various percentages of nickel may be heat treated at these optimum temperatures so that the magnetic structures produced therefrom will have substantially zero stability of permeability and hysteresis loss to magnetization.

The law deducible from the curve of Fig. 2 is that the annealing temperature necessary to produce a satisfactory stability of permeability and hysteresis loss must be increased as the percentage of nickel in the alloy is decreased. In other words, the annealing temperature should be selected in accordance with the formula represented graphically by the curve, which is:

$$T = -.382 N^2 + 50N - 1056$$

where T is the annealing temperature in degrees centigrade and N is the percent of nickel in the alloy. Stability of permeability and hysteresis loss are very desirable in the construction of inductance coils for the inductive loading of telephone circuits. Improved transmission characteristics are obtained when inductance coils are used having substantially constant inductance and a low and constant effective resistance. The constancy of such coils cannot be economically obtained except by the use of stable core material. The core material can only be made stable by the optimum choice of composition and heat treatment. A heat treatment of the cores at approximately 500° C. has been found to have a very desirable effect upon the hysteresis loss. In order to take advantage of such a heat treatment it is necessary to choose an alloy having the proper nickel content so that satisfactory stability as well as low hysteresis loss are obtained simultaneously. The very high quality of the magnetic material is therefore obtained by the optimum choice of composition and heat treatment as illustrated by the curve of Fig. 2.

In order to make the core chemically stable and to remove all soluble substances such as chromates, the core parts are boiled in water until a solution obtained, by boiling a crushed test ring in water, will show only a small trace of soluble chromates when tested with silver nitrate. Following the washing, the core parts are placed in a drying tank where they are heated and the tank evacuated to thoroughly dry them. 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 coaxially 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.

Such cores, due to their magnetic stability, are also very desirable for use as inductance standards, as well as for use in telephone systems.

What is claimed is:

1. The method of making a magnetic article, which consists in compressing finely divided particles of a ferrous magnetic alloy containing 74% nickel into a predetermined shape, and heat treating the resulting article at a temperature of approximately 550° centigrade to give stable magnetic properties under varying magnetic conditions.

2. The method of making a magnetic article, which comprises forming finely divided insulated particles of a nickel-iron alloy into a predetermined shape by pressure, and annealing the formed article at a temperature selected in accordance with the formula

$$T = -.382 N^2 + 50N - 1056$$

where T is the annealing temperature in degrees centigrade and N is the percent of nickel in the alloy.

3. The method of making a magnetic core which comprises forming finely divided particles of a nickel-iron alloy into a predetermined shape under a pressure of approximately 200,000 pounds per square inch, and heat treating the formed core at a temperature selected in accordance with the formula

$$T = -.382 N^2 + 50N - 1056$$

where T is the annealing temperature in degrees centigrade and N is the percent of nickel in the alloy.

4. The method of making a magnetic core, which comprises applying a high pressure to finely divided particles of a nickel-iron alloy to form them into an annular shape, and annealing the formed article at a temperature selected in accordance with the formula

$$T = -.382 N^2 + 50N - 1056$$

where T is the annealing temperature in degrees centigrade and N is the percent of nickel in the alloy.

In witness whereof, I hereunto subscribe my name this 27th day of October A. D. 1928.

RANDALL GILLIS.