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MAGNETIC STRUCTURE

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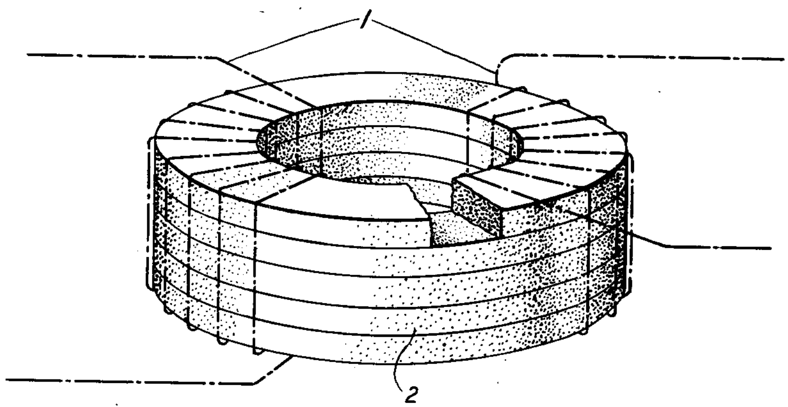

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MAGNETIC STRUCTURE

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This invention relates to magnetic materials and magnet cores, and more particularly to magnet cores for loading coils for telephone circuits and to their method of production.

The principal object of the invention is to produce a magnetic element which has low core losses and a relatively high permeability and which possesses to a high degree the electrical and magnetic characteristics that are desirable in electrical signaling apparatus generally and in loading coils for telephone circuits particularly.

The present invention, in one of its embodiments, is applied to the construction of magnet cores comprising fine particles of a nickel-iron alloy bound together with a suitable insulating material and heat treated to have a higher inherent magnetic permeability and lower inherent hysteresis loss than iron. More specifically, the invention is directed to the formation of magnet cores of a nickel-iron alloy in finely divided form in which 25% of the alloy comprises nickel and the remainder principally iron, the nickel content in one form which has proven satisfactory being approximately 78½% of the whole. The metal particles are mixed with a binding material, such as kaolin, and treated with a colloidal solution formed by adding a solution of an organic salt, such as chromic acetate, to a solution of sodium silicate. The whole is evaporated to dryness with constant stirring, leaving a coating on the metal particles. The coated particles are then pressed into cores of the desired size and shape. The cores so formed are finally heat treated at the optimum temperature for the particular alloy of which the cores are constructed, whereby the organic material left by evaporation is driven off and a supplementary insulation is formed, which comprises chiefly the oxide of the metallic element of the organic salt which remains. The heat treatment gives the allow a high permeability, low hysteresis losses and high specific resistance, and hence results in low eddy current losses in the cores.

The nature of the present invention will more fully appear in the following detailed description of a specific embodiment thereof.

The single figure of the drawing is a perspective view of a loading coil core made in accordance with the present invention. It will be understood, however, that this is merely illustrative and that the invention is not limited to the production of this form of core but is adapted to the production of cores of magnetic particles in many forms.

In carrying out the present invention, the magnetic material employed is preferably prepared from a nickel-iron alloy commonly referred to as "permalloy", which is treated in a manner more fully described in U. S. Patent 1,669,649, issued May 15, 1928 to C. P. Beath and H. M. E. Heinicke, to reduce the alloy to a finely divided form. Experience has proved that where low eddy current losses are desired, it is essential that the particles be of small size and preferably of such size that all of them readily pass through what is generally known as a 120 mesh screen and that a large percentage pass through a 200 mesh screen. According to one embodiment of the invention, the alloy is prepared by melting approximately 78½ parts of nickel and 21½ parts of iron in an oxidizing atmosphere and pouring the resulting alloy into a mold. When prepared according to the foregoing process, the resulting alloy is exceedingly brittle, and it is therefore particularly adapted to be reduced to a finely divided or dust form from which the finished cores are molded.

After the brittle ingots are obtained, they are successively passed while hot through progressively reducing rolls which form the alloy into flat slabs approximately one-quarter of an inch thick. By the hot-rolling process the size of the crystalline structure is materially reduced, which, since the disintegration of the material takes place mainly at the crystal boundaries, is essential in order to have a satsfactory yield of dust. The rolled slabs are broken into short pieces and are then further reduced by crushing in a jaw crusher, hammer mill, or any other suitable type of apparatus. The material after being passed through the jaw crusher is subsequently rolled in a ball mill until it is reduced to a fine dust. The dust is then passed through a 120 mesh sieve. Any residue is remelted and the foregoing operation is repeated to again reduce the material to a finely divided form. Prior to the addition of the insulating material, the finely divided particles of the nickel-iron alloy are annealed in a closed container at a temperature of from approximately 750° C. to 980° C., a temperature of about 925° C. producing very satisfactory results. It is then necessary to again reduce the annealed alloy, which is now in the form of a cake, to a finely divided form, after which it is mixed with the insulating material.

According to one form of the invention, the materials are prepared as follows. With every 100 parts by weight of the magnetic particles, 1.1 parts of kaolin and 0.4 parts of talc are mixed dry. To 1.15 parts of sodium silicate dissolved in water are added 0.115 parts of chromic acetate in the form of a 5% aqueous solution. This latter combination results in a colloidal silica sol, which is then added to the mixture of magnetic particles and binding material and thoroughly stirred therewith. The entire mass is then evaporated to dryness, accompanied by constant stirring to prevent caking and to insure a complete coating of the particles. After this process is completed, the coated dust particles are in a form suitable for pressing into cores or rings. These latter are preferably formed under a pressure of approximately 200,000 pounds per square inch. A high pressure is used in forming the ring in order to increase their density, since it has been found that the permeability of the cores increases with increase in density. Finally the cores are transferred to an annealing furnace where they are annealed, preferably at a temperature of from approximately 470° C. to 850° C. The temperature and duration of this process is sufficient to break down and drive off the organic component of the residue left by evaporation. At the same time the metallic component of the organic salt originally present is converted to the oxide, which remains as an insulating layer supplementing that due to the silica gel left by the evaporation of the colloidal silica solution. Except for the requirements of the annealing process, a temperature of 400° C. or less could be used to effect these chemical changes.

In a pending application of C. C. Neighbors bearing Serial No. 505,956, filed December 31, 1930, there is described an insulating material for finely divided magnetic particles that includes the end-products obtained by heating a mixture of sodium silicate and an organic acid. In this case the peptizing agent, i. e., the organic acid, is entirely removed by the heating process. A metal salt of an organic acid has the same peptizing effect as the acid, it is found, and at the same time it affords a substantial supplementary insulation due to the oxidation of the metallic component.

A plurality of the rings thus formed are stacked, as shown in Fig. 1, to form a core 2, to which the usual toroidal windings 1 are applied. The number of such rings used depends, of course, upon the existing electrical characteristics of the telephone circuit with which the loading coils are to be associated.

Although the permalloy particles have been described as insulated with a mixture of chromic acetate, sodium silicate, kaolin and talc in definite proportions, it is to be understood, of course, that the nature and proportions of the several ingredients may be varied without departing from the spirit and scope of the present invention. The sodium silicate, for example, may be replaced with other equivalent salts, such as sodium aluminate; either the kaolin or the talc may be used alone as the binding agent or they may be replaced with such fillers as zinc oxide, aluminum oxide, and barium oxide. Other organic salts than zinc acetate will serve satisfactorily as a peptizing agent, among which are included aluminum acetate, calcium acetate, nickel acetate, chromic acetate, cupric acetate, magnesium citrate, magnesium acetate, cobaltic acetate and other suitable salts which are decomposed by heat to leave an oxide. The proportions will vary according to the mechanical and electrical requirements of the finished cores. Other magnetic alloys than the one specified may also be employed and the insulating material selected may be adapted to the heat treatment required by the alloy.

Magnetic cores made in accordance with the method described herein are characterized by high permeability and low hysteresis and eddy current losses, which are especially desirable electrical characteristics.

What is claimed is:

1. As a new article of manufacture, a substance composed of particles of a magnetic material and an insulating material therebetween, said insulating material being made up of sodium silicate and a peptizing agent having a metallic and an organic component.

2. As a new article of manufacture, a magnetic substance composed of particles of a magnetic material, and an insulating material separating said particles made up of sodium silicate, a metal salt of an organic acid and a binding material.

3. As a new article of manufacture, a magnetic substance composed of particles of a magnetic material, and an insulating material comprising sodium aluminate, a metal salt of an organic acid and a binding material.

4. As a new article of manufacture, a magnetic substance composed of particles of a magnetic alloy of nickel and iron, and an insulating material separating the particles

comprising material such as sodium silicate or aluminate, a metal salt of an organic acid and kaolin.

5. As a new article of manufacture, a magnetic substance composed of finely divided particles of a magnetic alloy of nickel and iron, and an insulating material comprising sodium silicate, chromic acetate and a filler separating the particles.

6. As a new article of manufacture, a magnetic substances composed of finely divided particles of a magnetic alloy of nickel and iron, and an insulating material comprising sodium silicate, chromic acetate and a filler separating the particles.

7. As a new article of manufacture, a magnetic substance composed of finely divided particles of a magnetic alloy of nickel and iron, and an insulating material comprising sodium silicate, chromic acetate and kaolin separating the particles.

8. As a new article of manufacture, a magnetic substance composed of finely divided particles of a magnetic alloy of nickel and iron, and an insulating material made up of ten parts of sodium silicate and one part of chromic acetate, and a binding material, separating the particles.

9. As a new article of manufacture, a magnetic substance composed of finely divided particles of a magnetic alloy of nickel and iron, and an insulating material made up of ten parts of sodium silicate, one part of chromic acetate, and thirteen parts of filler separating the particles.

10. As a new article of manufacture, a magnetic substance composed of finely divided particles of a magnetic alloy, said alloy being composed of more than 25% nickel and the remainder principally iron, and an insulating material consisting of ten parts of sodium silicate, one part of chromic acetate, ten parts of kaolin and three parts of talc separating the particles.

11. A magnetic material comprising finely divided particles of a magnetic metal insulated with the end-products obtained by mixing and heating therewith sodium silicate, water and a decomposable peptizing agent having a metallic component whose oxide is highly non-conductive.

12. A magnetic structure comprising particles of a magnetic material and an insulating composition coating said particles, said composition including the end-products obtained by heating a mixture of sodium silicate and a metallic salt or an organic acid to a temperature above 400° C.

13. The method of making magnetic structures, which comprises coating particles of a magnetic material with a mixture comprising sodium silicate and a metal salt of an organic acid, forming a mass of such coated particles into a homogeneous solid, and subjecting said solid to heat treatment, whereby said mixture is caused to change chemically to form an insulating binder between said particles.

14. The method of making magnetic structures, which comprises reducing a magnetic alloy to a finely divided form, heat treating the finely divided particles, reducing the product so obtained to a finely divided form, coating the resulting product with a mixture including sodium silicate and a metallic salt peptizing agent, forming a mass of such coated particles into a homogeneous structure, and heat treating said structure to form an insulating binder between said particles.

15. The method of making magnetic structures which comprises mixing particles of magnetic material with a colloidal solution of a metallic salt of an organic acid and a water-insoluble insulating material such as silica, dehydrating the mixture, and heat treating it to decompose its organic constituents and to form a highly insulating coating on said particles.

16. The method of making magnetic structures which comprises mixing particles of a magnetic material with a colloidal sol comprised of a material such as sodium silicate and a metallic salt, dehydrating the mixture, and heat treating it to form an insulating material from said metallic salt.

17. The method of making magnetic structures which comprises mixing particles of a magnetic material with a material such as water glass and a metallic salt of an organic acid, evaporating the mixture to dryness, and heat treating it to remove the organic component of said salt and to form an insulating oxide from the metallic component of said salt.

18. The method of making magnetic structures which comprises combining solutions of sodium silicate and chromic acetate, mixing the resulting combination with finely divided particles of an iron-nickel alloy, desolvating the mixture, forming said mixture in a homogeneous solid, and heat treating it to drive off substantially all of the volatile constituents thereof, whereby a high degree of insulation between said particles is obtained and the magnetic characteristics of said alloy are improved.

19. The method of making magnetic structures composed of finely divided particles of an alloy consisting of more than 25% nickel and the remainder principally iron, which comprises mixing ten parts of sodium silicate, one part of chromic acetate in aqueous solution, and a binding material with said particles, drying said mixture, forming it, and heat treating it to improve the magnetic and electrical properties of the resultant structure.

In witness whereof, I hereunto subscribe my name, this 7th day of August, 1931.

HUBBEL LATHROP.