

UNITED STATES PATENT OFFICE.

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MAGNETIC MATERIAL.

No Drawing.

Application filed April 10, 1926. Serial No. 101,179.

This invention relates to methods of producing magnetic materials, and more particularly to methods of producing brittle magnetic alloys for use in electrical signaling apparatus, such as cores for loading coils employed in telephone circuits.

The principal object of the invention is the production of a brittle magnetic material, having a fine crystalline structure, to facilitate its reduction to a very finely divided form, and possessing to a high degree those physical, electrical and magnetic properties which make it highly desirable in electrical signaling apparatus, especially in cores for loading coils for telephone circuits.

The magnetic material produced in accordance with the invention is of particular advantage in the production of magnet cores of the so-called "dust" type in which a magnetic material is reduced to very finely divided particles, the particles covered with a suitable insulating material and pressed into rings or cores. It is especially adapted to be used in connection with the insulating material and in the manner more fully described in the copending application, Serial No. 102,729, filed April 17, 1926, by J. W. Andrews and R. Gillis. However, the magnetic material is not limited in its use to the particular insulator disclosed in the foregoing application nor to any particular form of core, but may be put to any use within the scope of the appended claims.

In accordance with one embodiment, the present invention contemplates the production of brittle alloys of nickel and iron by a partial oxidation of the metals constituting the melt. More specifically, the invention contemplates the production of brittle nickel iron alloys, generally known as permalloy, in which the proportions of its constituents are more than 25% nickel and the remainder principally iron, and in one form which has proven satisfactory the nickel content being approximately 78½% of the whole, by melting the constituents in an uncovered furnace in the presence of oxygen and an oxidizing substance, boiling the molten material until it is oxidized, pouring it into a mold, and rolling the material while hot into a thin slab to produce a fine crystalline structure.

The preferred method of producing the

brittle, fine grained material in accordance with the invention is to place the required quantities of nickel and iron in an uncovered furnace, preferably electrically heated, adding a calculated quantity of oxidized material of the same purity, and heating until the material is molten, the melting being done in an uncovered furnace in order that the material may be oxidized by atmospheric oxygen. Since, if virgin metal is used, it requires considerable time to obtain a melt which is oxidized to the right degree, oxidized material is added to furnish additional oxygen. Iron oxide in the form of iron ore may also be added to furnish oxygen within the bath. When the material has become molten it is oxidized by boiling for a length of time determined by the amount of oxidation desired and the type of furnace used. The degree of oxidation of the material depends upon the length of the melting period, the length of the boiling period, the amount of the surface of the melt exposed to the air, and the amount of oxygen present in the charged material, and the heating and boiling periods are governed by the various charges and the type of furnace used. Experiments have shown that the metal of a melt which is not sufficiently oxidized is not brittle. Consequently to insure the exact amount of oxidation, the melt is heavily oxidized and a small quantity of a suitable deoxidizer, such as magnesium-nickel alloy, aluminum or chromium, may be added just before the melt is poured. After the molten material has been boiled the required length of time, it is then poured into an ingot mold, and as soon as the material is solidified, the mold is removed and the ingot is allowed to cool. Samples of the material are taken from various parts of the ingot which are analyzed and if the material is of the required composition it is placed in a furnace where it is heated to approximately 1325° C. at which temperature it may be easily rolled.

In order to obtain a fine dust, the material should have a very fine crystalline structure which is obtained by successively passing the hot billets from the heating furnace through progressively reducing rolls which form the material into a flat strip of about one-fourth of an inch in thickness and five

inches in width. The rolling should be completed without reheating the material and the final rolling should be done with the material at as low a temperature as possible in order to prevent the crystals growing in size after final rolling. The working of the metal breaks down the crystalline structure of the ingot and large grains of the billet and produces a very fine grained crystalline product which is extremely brittle, and since in this material the fracture takes place principally along the crystalline boundaries, the greater the reduction of area of the billet after the last heating the finer the grain structure and the finer the dust which can be produced from the finished product. The rolled slabs are broken into short pieces and are then crushed in a jaw crusher, hammer mill, or any other suitable type of apparatus in which a further reduction occurs. 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 sieved through a 120 mesh sieve and any residue is remelted and the foregoing operation is repeated to again reduce the material to a finely divided form.

By using an alloy of the proportions stated in the preceding paragraph and by following the foregoing method of procedure, a very fine grained crystalline product is obtained which is extremely brittle and which when reduced to a fine dust yields a large percentage of particles which are small enough to pass through what is commonly known as a 200 mesh sieve. When reduced to a finely divided form, the material is then in a form to be used for either continuous or lump loading of telephone circuits.

The material is particularly adapted to be formed into rings or cores for loading coils in the manner more fully described in the aforementioned application in which the finely divided particles are heated to a high temperature, are individually insulated by coating the particles with an insulator consisting of chromic acid, water glass and talc, the insulated material formed into rings or cores by the application of a high pressure, the rings boiled to render them chemically stable, and finally annealed to stabilize the insulator and to give the rings the desired magnetic properties. A plurality of rings thus formed are then stacked coaxially to form a core on which the usual toroidal winding is applied, the number of such rings used depending upon the existing electrical characteristics of the telephone circuit with which the loading coils are to be associated. Since, in order to have low core losses in loading coil cores made of permalloy dust in the above described manner, it is desirable that all of the material pass through a 120 mesh sieve and a large per-

centage pass through a 200 mesh sieve, it is readily seen that the material produced according to this invention is especially adapted to be used in the production of such cores.

What is claimed is:

1. A method of embrittling iron-nickel alloys, which consists in heating iron and nickel in the presence of an oxidizer at a temperature sufficient to cause complete fusion between the elements.

2. A method of embrittling iron-nickel alloys, which consists in melting the ingredients of the alloys in the presence of an oxide.

3. A method of embrittling iron-nickel alloys, which consists in oxidizing the constituents while in a molten state.

4. A method of embrittling iron-nickel alloys, which consists in oxidizing the ingredients by means of oxidized metal which is heated at its melting temperature.

5. A method of embrittling iron-nickel alloys, which consists in melting iron and nickel in the presence of oxidized iron-nickel alloy and oxygen.

6. A method of embrittling iron-nickel alloys, which consists in melting the ingredients in the presence of oxygen.

7. The method of making brittle magnetic alloys, which consists in melting nickel and iron in the presence of oxygen and boiling the molten material.

8. The method of making brittle magnetic alloys, which consists in melting nickel and iron in the presence of oxygen, boiling the molten material, allowing the material to solidify, and rolling the material while hot into a strip.

9. The method of making brittle magnetic alloys composed of more than 25% nickel and the remainder principally iron, which consists in melting the ingredients in the presence of oxygen and boiling the ingredients until oxidized.

10. The method of preparing magnetic materials composed of more than 25% nickel and the remainder principally iron in a finely divided form, which consists in melting the ingredients in the presence of oxygen, boiling the ingredients until oxidized, allowing the material to solidify, and working the material to produce finely divided particles.

11. The method of preparing magnetic materials in a finely divided form, which consists in melting approximately 78 1/2 parts of nickel and 21 1/2 parts of iron in the presence of oxygen, boiling the molten material until oxidized, allowing the material to solidify, working the material to produce a change in the crystalline structure and subsequently reducing the material to finely divided particles.

12. The method of preparing magnetic

materials in a finely divided form, which consists in melting approximately 78½ parts of nickel and 21½ parts of iron with oxidized magnetic material of the same purity, boiling the molten material, and working the material to produce finely divided particles.

13. The method of preparing magnetic materials in a finely divided form, which consists in melting approximately 78½ parts of nickel and 21½ parts of iron with oxidized magnetic material of the same purity, boiling the molten material, allowing the material to solidify, working the material to produce a change in the crystalline structure, and subsequently reducing the material to finely divided particles.

14. A method of embrittling magnetic alloys of iron and nickel, which consists in

heating the ingredients in the open air for a period sufficient to cause their liquidation and oxidation.

15. A method of embrittling ferrous alloys, which consists in partially oxidizing the alloy by heating the ingredients thereof at their melting temperature in the presence of an oxidizing agent.

16. A method of embrittling iron and nickel alloys in which the nickel content exceeds 25%, which consists in heating the ingredients in the presence of free oxygen, allowing the alloy to solidify, and reducing the alloy to a finely divided form.

In witness whereof, we hereunto subscribe our names this 3rd day of April, A. D., 1926.

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