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MAGNETIC MATERIAL AND PROCESS OF MAKING THE SAME

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1 Claim. (Cl. 148—12)

My invention relates to magnetic material of high stability and of low hysteresis losses and to a process of making the same.

The U. S. Patent #2,147,791 to Holst et al. describes a process of making magnetic material from a homogeneous alloy of metals of the iron group in which the alloy is subjected to a cold deformation, is annealed and is then subjected to a second cold deformation. The first deformation is carried out to such an extent that the recrystallization during the subsequent annealing will cause the crystals of the material to be orientated in the same direction and the material to have preferred directions of magnetization. As a result of the second cold deformation internal stresses are set up in the material and at least one of the preferred directions of magnetization is suppressed. This method is preferably carried out with an iron-nickel alloy containing substantially equal parts of nickel and iron, i. e. about 50% iron and 50% nickel. For example, a band of this alloy having a thickness of about 5 mms. is subjected to a cold rolling to reduce its thickness more than 90%, for instance to about 110 microns, is recrystallized by an annealing treatment at about 1,100° C., and is then cold rolled to a thickness of about 60 microns. In some cases it may be desirable to subject the material to a final annealing operation at a temperature below the temperature of recrystallization.

Commercial iron-nickel alloys usually contain about 0.015 to 0.025% of phosphorus, and when using the same as the starting material in the above-described process the resulting magnetic material has a hysteresis factor (h_0) of about 4. The hysteresis factor h_0 is given by the expression

$$h_0=\frac{h}{V\mu_0}$$

wherein μ_0 is the initial permeability and h is defined by H. Jordan in Elektrische Nachrichtentechnik, volume 1, page 7, 1924.

In accordance with the present invention, I obtain a reduction in the hysteresis factors of material made in accordance with the above patent by starting with a nickel-iron alloy which contains less than about 0.01% of phosphorus. To further reduce the hysteresis factor, I may add to the alloy during the melting, small quantities of calcium, a mixture of calcium and silicium or a mixture of calcium and aluminium.

If the phosphorus content is reduced to 0.01% or less according to the present invention, it is possible to obtain hysteresis factors between 3 and 4.

With regard to the addition of calicum, calcium-silicium or calcium-aluminium, I have found that if one of these substances is added to a usual commercial nickel-iron alloy containing about 0.015% to 0.025% of phosphorus and the resulting alloy is subjected to the above-described process, the resulting magnetic material will have a hysteresis factor which is greater than if the substance had not been added. More particularly, if about 0.25% of calcium is added to an alloy containing substantially equal parts of iron and nickel and about 0.020% of phosphorus, the hysteresis factor of the magnetic material produced by treating the alloy by the above-described process will be about 5.7, whereas it would be about 4 if the calcium had not been added.

Contrary to the above, the addition of calcium to an iron-nickel alloy which, in accordance with the present invention, contains less than 0.01% of phosphorus will result in a substantial reduction of the hysteresis factor. More particularly, if about 0.2% of calcium is added to a nickel-iron alloy containing less than 0.003% of phosphorus and the alloy is treated by the above-described process, the resulting magnetic material has a hysteresis factor of about 1.85. Similarly if about 0.6% of calcium-silicium is added to a nickel-iron alloy containing less than 0.004% of phosphorus, the magnetic material produced therefrom by the above method will have a hysteresis factor of about 1.8. Similar results are obtained when adding calcium aluminium, instead of calcium or calcium silicium.

When using calcium, calcium and silicium or calcium and aluminium, I prefer to add between about 0.2% and 0.5% of calcium, between about 0.1% and 0.4% of calcium and silicium containing about 35% Ca and 65% Si or 0.1% to 0.4% of calcium and aluminium containing about 20% Ca and 80% Al.

Although I have described my invention with reference to specific examples, I do not desire to be limited thereto because obvious modifications will appear to one skilled in this art.

What I claim is:

The process of producing a homogeneous magnetic material of substantially constant permeability and low hysteresis losses, comprising the steps of melting a nickel-iron alloy in the middle percentage and containing less than 0.01% phosphorus, adding about 0.2% to 0.5% of calcium to the alloy, cooling the alloy and forming a band of the alloy, cold-working the band without intermediate annealing to reduce its thickness at least of the order of 90%, heat-treating the band above the recrystallizing temperature, said cold-working and heat-treating bringing most of the crystals into substantially the same orientation and producing preferred directions of magnetization, and subsequently cold-working the band to internally stress the same and to suppress one of the preferred directions of magnetization.

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