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METHOD OF MAKING MAGNETIC MATERIALS.

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To all whom it may concern:

Be it known that I, ROBERT ABBOTT HADFIELD, a subject of the King of Great Britain, and a resident of Sheffield, in the county of York, England, have invented certain new and useful Improvements in Methods of Making Magnetic Materials, of which the following is a specification.

My invention relates to the making of material having magnetic and electrical properties which render it suitable for use in various electrical apparatus, such as ballast-coils, transformer-plates, and the like.

I have heretofore discovered that a material suitable for the above purposes can be produced by alloying iron with other elements, more particularly silicon, aluminium, and phosphorus. Material thus produced has a high permeability and electrical resistance and a low hysteresis quality, which advantageous qualities may be further increased by a treatment involving successive heating and cooling. In the further practice of the above invention I have discovered that when the material treated is in the nature of thin sheets the process requires considerable modification in order to secure the best results.

My present invention therefore has for its object the treatment of magnetic materials when in the form of thin sheets or the like for the purpose of increasing the permeability and electrical resistance and decreasing the hysteresis.

As an example of my invention I will describe the following procedure: In a common crucible or in an electrical crucible I melt pure iron with silicon or aluminium or phosphorus, employing a percentage of these additions varying from one-quarter of one per cent. to eight per cent. I may employ only one of the three elements mentioned or two of them or all three. Instead of the crucible process I may employ the decarbonized or desiliconized iron produced by any steel-making process, such as the open-hearth, the pneumatic, or the electrical process, adding the desired percentage of silicon, aluminium, or phosphorus to the iron during such process. The molten alloy is poured into suitable ingots, which are then rolled into sheets in the usual manner. The exact composition of the alloy varies, but a typical example contained the following percentages: 2.75 per cent. of silicon, .07 per cent. of carbon, .08 per cent. of manganese, .03 per cent. of sulfur, .03 per cent. of phosphorus.

The material produced by melting and rolling, as above described, has a high magnetic permeability, a high electrical resistance, and a low hysteresis; but the process up to the point to which I have described it is not the subject of the present application. My present invention relates to the treatment, which I will now describe, to which I subject the magnetic material produced in accordance with the indications above given or any other analogous magnetic material of small thickness.

My improved treatment is as follows: I first heat the sheet or other thin material to a temperature considerably below its melting-point—say about 800° centigrade—and then allow it to cool, preferably quickly, as by exposing the material to atmospheric air of ordinary temperature. Thereupon I reheat the material to a temperature higher than that employed during the first heating, but still below the melting-point. A temperature of 950° centigrade, as indicated by the Chatelier thermo-electric couple in current practice, is well adapted for this purpose with a material of the composition indicated above. Then the metal is allowed to cool very slowly, as by leaving it in a furnace, the cooling being often extended to last several days. Another treatment consists in first heating this material to 950° centigrade and, if necessary, cooling in air, then reheating it to 750° centigrade, and cooling slowly in furnace. Either one or both of these treatments may be repeated, or after the first treatment has been carried out the second type of heating may be repeated frequently. By these treatments I secure a very marked increase of magnetic permeability and also a material decrease in hysteresis.

In sundry of the appended claims I have referred to a magnetic material containing silicon; but I desire it to be understood that the term "silicon" is to cover equivalents,

such as aluminium, phosphorus, and their combinations with each other or with silicon.

What I claim as new, and desire to secure by Letters Patent, is—

1. The herein-described methods of producing a magnetic material of high permeability and low hysteresis action, which consists in alloying a magnetic substance with silicon, reducing the alloy to a thin body, heating such thin body to a temperature below its melting-point, allowing it to cool, reheating it to a temperature above that first employed, and again allowing it to cool.

2. The herein-described methods of increasing the permeability and decreasing the hysteresis of magnetic materials when in the form of thin bodies, which consists in heating said bodies to a temperature below the melting-point, then allowing them to cool, then reheating to a temperature above that first employed, and again allowing them to cool.

3. The herein-described methods of increasing the permeability and decreasing the hysteresis of magnetic materials when in the form of thin bodies, which consists in heating said bodies to a temperature below the melting-point, then cooling them quickly, then reheating to a temperature above that first employed, and then allowing them to cool slowly.

4. The herein-described methods of producing a magnetic material of high permeability and low hysteresis, which consists in alloying a magnetic substance with silicon and reducing the alloy to a thin body, heating such body to a temperature below its melting-point, allowing it to cool quickly, reheating to a temperature above that first employed and allowing it to cool slowly.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

R. A. HADFIELD.

Witnesses:

EDWIN MORTIMER,

H. MARTIN.