

UNITED STATES PATENT OFFICE

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MANUFACTURE OF MAGNETIC MATERIAL

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This invention relates to magnetic materials and has two objects. The first is to improve the magnetic characteristics of such a material and the second is to improve it for use as a loading material particularly for the continuous loading of conductors.

duce the thickness of the metallic tape, which is normally determined by the requisite mechanical strength to permit its winding on the conductor, thereby reducing hysteresis and eddy current losses.

The cementation resulting from subjection to a gas may be carried out before or after the wire is drawn to its final size, since such a process gives a product in which there is no distinct line of demarkation between the high resistivity layer and the main body of the loading wire or tape, so that the product may be subjected to mechanical working after the cementation process has taken place.

An alternative to the use of ammonia as above may consist in the use of a hydrocarbon such as a paraffin (e. g. methane and its homologues), olefines or an aromatic benzene or other hydrocarbon of the same or related series. In this method gaseous hydrocarbon or the vapor of a liquid hydrocarbon is caused to circulate round the heated metal. The gas or vapor may be circulated by itself or mixed with a reactive or non-reactive carrier gas such as hydrogen or nitrogen respectively. By whatever method the hydrocarbon is passed into the reaction zone, the high temperature of the latter causes dissociation of the hydrocarbon and results in the liberation of hydrogen which acts as before in the case of ammonia, whereas the liberated carbon carburizes the outer layers of the magnetic material probably forming iron carbide.

A somewhat similar product in the form of a magnetic material having a layer of high resistivity material diffused into the underlying magnetic material may be obtained by a process of solid cementation.

As an example chromium may be caused to diffuse into the outer layer of the tape giving thereto the increased resistivity desired. To effect this cementation the wire or tape may be passed through a chamber containing ferro-chrome, the chamber being maintained at a sufficiently high temperature. A suitable gas, such as hydrogen, nitrogen, etc. may be caused to circulate in the reaction chamber in order to assist in the promotion of the cementation. By this treatment the chromium diffuses into the outer layer of the

According to one feature of the invention, a magnetic material is subjected to a heat treatment in ammonia. In a broader aspect the invention may be regarded as a method of improving magnetic material by subjecting it to cementation or diffusion by subjection to a gas or vapor, whereby on the surface of the material there may be formed a layer having a higher resistivity than the underlying magnetic material whose permeability is at least as great as that of soft iron at low flux densities. This can only be satisfactorily obtained in accordance with the principles of the present invention by ensuring that there is no pronounced demarkation between the layer or layers of comparatively high resistivity and the underlying magnetic material. These and other features of the invention will be more apparent from the following more detailed description.

A structure according to the invention may be obtained if a tape or wire of high initial permeability at low flux densities is heat treated in ammonia, which may be effected by using ammonia of ordinary purity under pressures ranging from between two atmospheres and 30 mms. of mercury. Dry ammonia gas is caused to circulate round the metal which is heated at temperatures approaching but below, the melting point of the magnetic material (1000-1200° C.) this being followed by cooling at a suitable rate. Preferably the complete process, for a thin tape of magnetic material, comprises heating the material in said atmosphere for about 40 minutes, cooling the material to room temperature, re-heating the material in ammonia to a temperature below the magnetic transformation point (say 580° C.) for about 30 minutes and then cooling again to room temperature. The iron nitrides or other nitrides formed on the surface of the tape constitute an improvement because they make a layer of material having a high resistivity and re-

loading tape, the amount of chromium introduced being dependent upon the temperature at which cementation is allowed to take place, and the duration of the process.

- 5 The effect of cementation may also be obtained by electrolytically depositing on the magnetic metals and then heat treating under such conditions that the latter diffuses into the body of the magnetic material. As
10 an example, a magnetic material composed of an alloy of iron and nickel may be coated electrolytically with a layer of nickel followed by a layer of chromium. By annealing at a temperature between 1,000 and 1,200°
15 C. for a time depending upon the temperature chosen, the nickel and chromium may be caused to diffuse together forming a new chromium alloy of high resistance on the surface of the magnetic material.

20 What is claimed is:

1. A method of treating magnetic material by subjecting same to the action of ferrochrome.
2. A method of improving the characteristics of magnetic material which comprises
25 first depositing a layer of nickel on said magnetic material and secondly a layer of chromium.
3. A magnetic material in whose outer layer
30 chromium is diffused.
4. A magnetic material comprising a tape on the surface of which is an exceedingly thin layer of chromium, said layer being diffused into an underlying magnetic material whose
35 permeability is at least as great as that of soft iron at low flux densities.

In witness whereof, we hereunto subscribe our names this fifth day of May, 1930.

GEORGE LAWTON.

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