

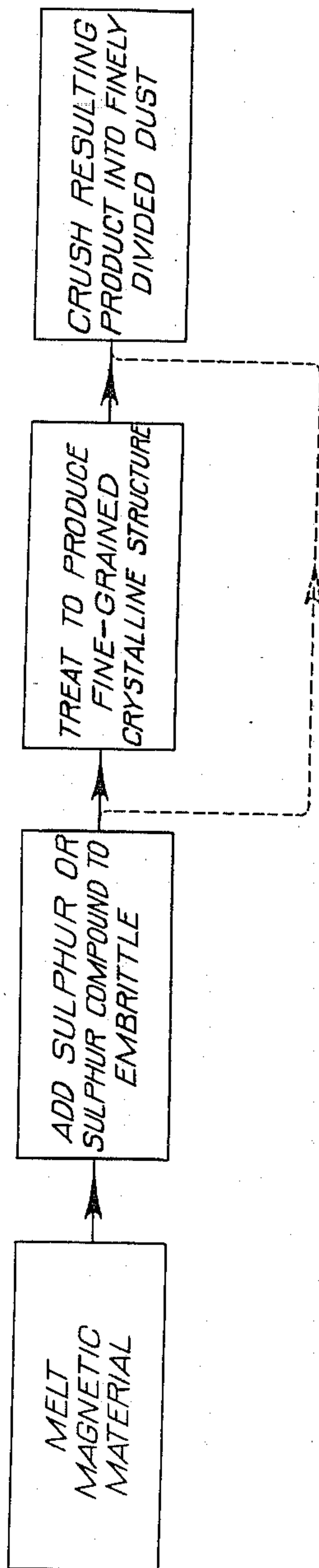
Dec. 10, 1929.

J. H. WHITE

1,739,052

PRODUCTION OF FINELY DIVIDED METALLIC MATERIALS

Filed Jan. 31, 1929



INVENTOR
J. H. WHITE
BY
H. A. Burgess
ATTORNEY

UNITED STATES PATENT OFFICE

JOHN H. WHITE, OF CRANFORD, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

PRODUCTION OF FINELY-DIVIDED METALLIC MATERIALS

Application filed January 31, 1929. Serial No. 336,431.

This invention relates to finely divided metallic materials and particularly to methods of producing such materials.

An object of the invention is to facilitate the production of finely divided metallic material, such as finely divided magnetic material for use in loading coil cores and the like.

Another and more specific object is to embrittle a magnetic material, such as an alloy containing nickel and iron, so that without deleteriously affecting its electrical and magnetic characteristics, the material may be readily reduced to finely divided form suitable for use in magnetic cores for loading coils and the like.

The invention is of advantage in the production of magnet cores, particularly loading coil cores of the so-called "dust" type comprising finely divided magnetic material and insulation, such as are described in the U. S. patent to Elmen 1,297,126, issued March 11, 1919. In the manufacture of such magnetic cores, it is the usual practice to subject the magnetic material in solid form to mechanical processes, such as hot rolling, grinding, crushing and sieving, in order to reduce the material to a suitably finely divided state. Where especially good magnetic characteristics are required in such cores, alloys comprising nickel and iron alone or in combination with other metals are often used as the magnetic materials. Such alloys are sometimes very tough and therefore are not easily converted into finely divided form by the usual mechanical processes. It is usual therefore before subjecting these magnetic alloys to such mechanical processes to add some additional material thereto which will not impair the magnetic characteristics of the alloy, but will serve to embrittle it, so that it may be readily reduced to finely divided form by mechanical processes.

In accordance with the invention, a tough metallic material is embrittled to a desired degree by incorporating therein a small amount of sulphur in such manner that the sulphur is distributed more or less uniformly throughout the material. It has been found that a very small amount of sulphur incor-

porated in a magnetic alloy, for example, a nickel-iron alloy, will, without impairing appreciably the electrical or magnetic properties thereof, sufficiently embrittle the alloy so that it may be easily reduced to finely divided form. The incorporated sulphur may be in any desired form but is preferably in the form of a sulphide of one of the magnetic materials forming the alloy, for instance, iron sulphide or nickel sulphide.

The exact nature of the invention will be understood from the following detailed description thereof when read in connection with the accompanying drawing, the single figure of which shows schematically an application of the invention to the production of finely divided magnetic material.

The invention will be described as applied to the production of finely divided magnetic material. As indicated in the drawing, the magnetic material is first melted. This may be conveniently done by placing the solid material in a suitable container and subjecting it to heat in a suitable furnace until the material is reduced to molten form. A small quantity of sulphur or a sulphur compound, preferably a sulphide of one of the constituents of the magnetic material, is then added to the molten magnetic material and mixed thoroughly therewith. After the sulphur or sulphur compound has been thoroughly distributed throughout the molten material, the resulting product is poured into an ingot mold, and as soon as the material is solidified the mold is removed and the ingot allowed to cool. The ingot obtained in this way is of extremely brittle crystalline structure, and therefore may be easily reduced to finely divided form by subsequent mechanical operations such as crushing, rolling and sieving.

The fineness of the dust particles obtained by the above described process will depend upon the size of the crystals in the ingot. If it is desired to obtain very fine dust, it is usually necessary to subject the ingot to certain treatment prior to breaking it up, to produce a fine grained structure therein. One method for accomplishing this, which is described in the U. S. patent to Beath et al., 1,669,649 issued May 15, 1928, consists in successively

passing the hot ingots or billets of magnetic material received from the heating furnace through progressively reducing rolls until they have been greatly reduced in cross-section. This mechanical working of the metal breaks down the crystalline structure of the billet and produces a very fine grained crystalline structure therein. If a small amount of sulphur has been previously incorporated in the magnetic material of the ingot in the manner described above, fracture of the material in the subsequent crushing will take place principally along the crystal boundaries, probably due to the incorporated sulphur being collected between the crystals of the material. This will result in the yield of a large percentage of dust particles which are small enough to pass through a 120 mesh sieve, and which are particularly suitable for continuous or lump loading of signaling circuits.

The method of the invention as described above is applicable to metallic materials in general, but it is of particular advantage in connection with the reduction to finely divided form of tough metallic materials, such as magnetic alloys including nickel and iron.

The amount of sulphur or sulphur compounds necessary to be added to embrittle the particular material will depend upon the nature of the elements constituting the material and their degree of purity. In a particular case in which the material to be reduced to finely divided form comprised a magnetic alloy of high grade commercial nickel and iron in the ratio of about $78\frac{1}{2}$ per cent nickel to $21\frac{1}{2}$ per cent iron, which alloy contained some sulphur as an impurity, it was found that the addition of iron sulphide in the proportions of 0.02 per cent by weight of the alloy did not impair the magnetic characteristics of the material and made the alloy sufficiently brittle. When the materials to be embrittled do not contain sulphur or other embrittling material as impurities, it will be necessary to add a larger amount of the sulphur or sulphur compound for embrittling the material.

Magnetic dust made in accordance with the method of the invention is particularly adapted for use in magnetic rings or cores for loading coils which may be constructed in a manner similar to that described in the U. S. patent to Andrews et al., 1,669,645, issued May 15, 1928. The essential steps in the method of producing such cores or rings described in that patent consisted in first annealing the magnetic particles, coating the finely divided magnetic particles with a suitable insulating material, and then forming the coated particles into rings or cores by the application of high pressure thereto, the resulting rings or cores being given a subsequent annealing heat treatment to improve their magnetic characteristics. A plurality of rings thus formed are then stacked coax-

ially to form a core, on which is mounted the usual toroidal winding, the number of rings used depending upon the existing electrical characteristics of the circuit with which the loading coils are to be associated.

To enable a clearer understanding of the invention, a specific embodiment of the invention has been described above, but it is to be understood that the particular materials and proportions thereof set forth therein and the specific details of the method described are given by way of example only and that the invention is not limited thereby, but only by the scope of the appended claims.

What is claimed is:

1. The method of reducing a tough metallic material to finely divided form, which consists in incorporating in said material a small quantity of sulphur to embrittle it, and then mechanically breaking up the resulting product to the desired degree of fineness.

2. The method of reducing a tough metallic material to finely divided form, which consists in alloying said material with a small quantity of sulphur to embrittle it, treating the embrittled alloy to produce a fine-grained crystalline structure therein, and then breaking up the resulting product.

3. The method of reducing an alloy of metals which is ordinarily quite tough to a finely divided form which consists in incorporating in said alloy of metals a small quantity of sulphur to embrittle it, treating the embrittled alloy to produce a fine-grained crystalline structure therein, and then breaking up the resulting product to the desired degree of fineness.

4. The method of reducing a magnetic material containing nickel and iron to a finely divided form which consists in alloying the magnetic material with a small quantity of sulphur to embrittle it, treating the embrittled alloy to produce a fine-grained crystalline structure therein, and breaking up the resulting product to the desired degree of fineness.

5. The method of producing finely divided core material for induction coils from magnetic material containing nickel and iron, which consists in reducing said magnetic material to the molten state, distributing throughout the molten material a small quantity of a sulphide of one of the constituents of said magnetic material to embrittle said material, treating the resulting compound to produce a fine-grained crystalline structure therein, and breaking up the resulting product to the desired degree of fineness.

In witness whereof, I hereunto subscribe my name this 30th day of January, 1929.

JOHN H. WHITE.