Sept. 16, 1941. A. F. BANDUR 2,255,873

MAGNETIC BODY

Filed Feb. 25, 1938

FIG. 1

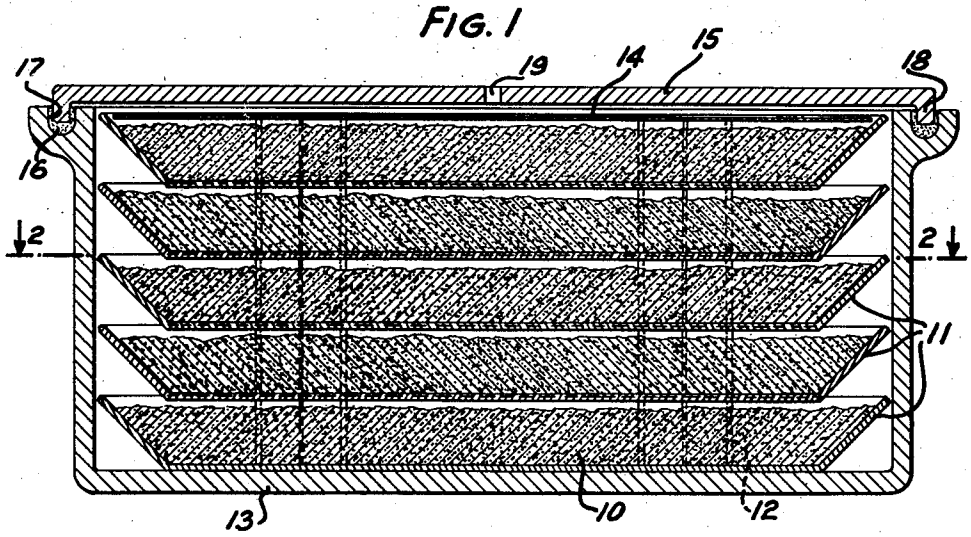
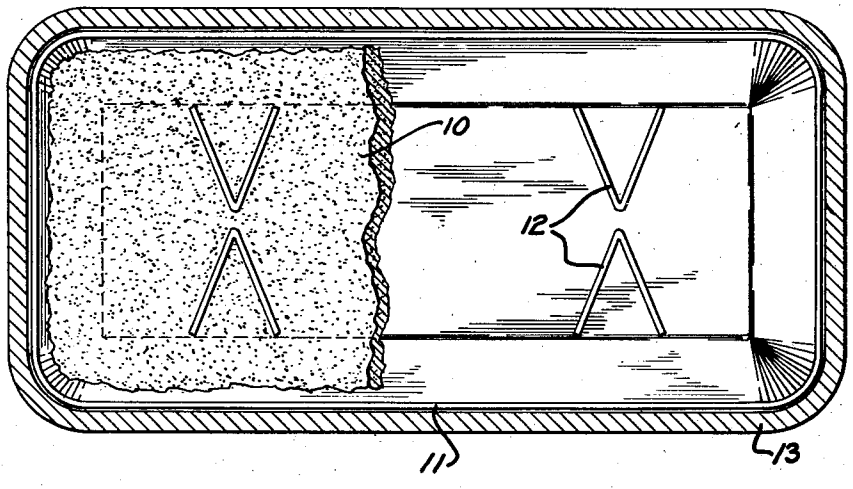


FIG. 2



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MAGNETIC BODY

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5 Claims. (Cl. 148—16)

This invention relates to the manufacture of magnetic bodies and more particularly to methods for making magnetic cores of the insulated dust type in which finely divided particles of magnetic material are coated with insulation and compressed into form.

In the manufacture of insulated dust magnetic cores the magnetic metal or alloy is usually cast in an ingot and pulverized to the required fineness on suitable apparatus, after which the particles are coated with insulation and compressed into required shape. Because the pulverizing action produces internal stresses in the particles which detract from their magnetic properties, the particles are annealed before they are incorporated in a core. It has been customary to anneal the dust in a conventional sealed pot and, as the dust tends to sinter during this operation, it has generally been necessary to regrind the annealed material before use which results in the restoration of objectionable stresses therein.

An object of this invention is the provision of improved methods for the heat treatment of finely divided magnetic material for use in insulated dust cores.

In one embodiment of the invention comminuted magnetic material in a plurality of shallow trays supported at spaced intervals in a ventilated container is subjected to a heat treating cycle in a furnace. A cover on the container has a vent in its central portion through which gases generated by the magnetic material during one portion of the cycle escape from the container and through which outside air is admitted to the container during another portion of the cycle. The incoming air passes over a sheet of hot iron which removes oxygen from the air. With this procedure and apparatus the dust is effectively annealed without sintering, which precludes regrinding, and the treated dust is more adaptable to subsequently applied insulation than previous materials, which enables the production of cores having higher permeability values.

This process and apparatus are especially suitable for treating nickel-iron magnetic alloys of the Permalloy type and have been adapted to a molybdenum Permalloy magnetic alloy, comprising essentially 82% nickel, 16% iron, and 2% molybdenum. For convenience the invention will be described in detail as applied to that material, in conjunction with the appended drawing, in which

Fig. 1 is an elevation in section of an apparatus for the heat treatment of magnetic dust embodying certain features of the invention, and

Fig. 2 is a sectional view of Fig. 1 taken on the line 2—2.

In the preparation of the alloy, molybdenum, nickel and iron in suitable proportions, and preferably a small amount of iron sulphide or other embrittling agent, are melted together in a furnace and the resulting alloy is poured into a mold to form an ingot. To develop a fine grain structure in the alloy the hot ingot is passed successively through progressively reducing rolls, the final reduction being effected at the approximate temperature at which the alloy ceases to be malleable, after which the rolled material is quenched in water at a temperature below its malleability range. The resultant ingots are broken into fragments and the fragments are crushed in a hammer mill, or other suitable apparatus, after which the crushed material is pulverized in an attrition mill or similar apparatus. The resulting dust is sieved and any portion that will not pass through the sieve is returned to the mill for further pulverizing, this process being repeated until a sufficient quantity of fine dust is obtained.

The dust is then heat treated in the apparatus shown in the drawing, and disclosed in my United States Patent 2,211,311, to relieve the stresses produced by the pulverizing action and otherwise improve the magnetic qualities of the dust.

A measured quantity of dust 10 is placed in a shallow flat-bottomed tray 11 or pan having sides extending at an angle of about 45° to the plane of the bottom. Inside the tray and welded or otherwise secured to the bottom thereof are four V-shaped supports 12, conveniently formed from strip steel, which have flat top portions positioned about ⅛" below the top rim of the tray. The tray can be made of sheet metal and a low carbon steel gives good results.

The dust is spread evenly in the tray to a depth governed by the sintering tendency of the particular material under treatment. Sintering is a function of temperature and pressure, which vary with the composition and particle size of the dust, and in each case the depth of the dust in the tray is restricted to avoid a fusing pressure on the bottom strata of dust in the tray at the applied temperature. For molybdenum Permalloy dust of 120 mesh size a depth of about one inch is satisfactory and the optimum value for other materials is readily determined experimentally.

A number of the loaded trays are placed in a thick walled container 13 or box of rectangular shape. The number of trays in each container is

based on handling convenience, but it is advantageous to treat a substantial quantity of dust in a single container to provide material of uniform quality. The lower tray rests on the flat container floor and the upper trays are successively positioned on the four supports in the adjacently lower tray. On the supports in the top tray is is placed a rectangular sheet of iron 14 which extends over the entire surface of the dust in the tray and extends closely to the tray edges on all sides.

After the trays and sheet iron are positioned in the container, a flat cover 15 is placed on the container and its edges are sealed thereto with loam 16 or other suitable medium in a continuous channel 17 at the top of the container into which a peripheral flange 18 on the cover extends to provide an effective seal. At the approximate center of and extending through the cover is a vent 19 about one-eighth inch in diameter providing an opening into the container.

The assembled container is placed in a suitable furnace (not shown) and subjected to a prescribed heat treating routine. For the treatment of the molybdenum Permalloy dust the container is heated to a temperature around 850° C. and maintained at that temperature for about one hour. During this period of heat application an internal pressure is built up in the container due to the development of certain gases generated by heating of the dust. These gases escape from the container through the cover vent and burn in a tapering flame at the outside of the cover. It is desirable to completely exhaust the gas generating capacity of the dust during the heating period and therefore the period may be extended beyond the prescribed one hour. This is readily controlled by observation of the flame at the vent and if necessary the heating is prolonged until the flame discontinues.

After the completion of the heating cycle the container and contents are cooled at a rate not exceeding 10° C. per minute. During this cooling period the gases in the container contract in volume, and the current flow is consequently reversed, causing air to enter the vent into the container from the furnace chamber. It is desirable to prevent oxidation of the hot dust during this interval and this is accomplished by removing oxygen from the incoming air by means of the heated iron sheet over the top tray, and the heated trays. Before reaching the dust particles in the pans the air passes through a labyrinth of hot iron formed by the sheet and trays. The hot iron has a high affinity for oxygen which causes deoxidation of the air and prevents oxidation of the dust. To maintain the full deoxidizing effectiveness of the labyrinth the trays are cleaned at suitable intervals to remove any surface oxide and the iron sheet is cleaned or replaced periodically.

At the termination of the cooling cycle the dust is removed from the trays and the particles are coated with suitable insulation such as the mixture of magnesium silicate, sodium silicate and magnesium hydroxide disclosed in applicant's Patent 2,105,070 after which the insulated particles are compressed at high pressure into the form of a core.

Magnetic particles treated as described exhibit new and improved properties that are valuable in insulated dust cores. Formerly, when the dust was heat treated in a sealed pot any gases generated by heating were largely reabsorbed during the cooling period. By eliminating these gases and cooling the dust in deoxidized air as provided in the present disclosure a dust is produced that requires less insulation when incorporated in a core. Apparently the described treatment imparts to the particles a new capacity to receive and retain a thin coating of insulation. Cores made with molybdenum Permalloy particles treated by applicant's process required 10% less insulation than dust treated by old methods for equivalent core service. Because of the smaller percentage of insulation present, the new cores have higher permeability values than the old structures which enhances the utility of the cores when they are used in loading coils and similar apparatus.

The described methods and apparatus are applicable to various types of magnetic material and modifications of the methods and apparatus specifically disclosed herein can be readily adapted to a variety of materials to supply new and useful properties thereto. It is, therefore, to be understood that the invention is restricted only by the scope of the appended claims.

What is claimed is:

1. A method of treating finely divided magnetic particles to improve the magnetic properties and insulatability thereof which comprises heating a mass of the finely divided particles in a vented container at such a temperature as to generate and drive off deleterious gases, removing the gas from the particle mass as the gas is formed, subsequently cooling the particles in the container, and removing oxygen from air entering the vented container during the cooling period.

2. A method of heat treating finely divided magnetic material to improve the magnetic properties and insulatability thereof which comprises placing the material in a vented container in a layer sufficiently thin to substantially eliminate sintering thereof, heating the container for a period sufficient to generate and expel gases from said material, exhausting the container during said heating period, cooling the container and material, and removing oxygen from air entering the vented container during the cooling period.

3. A method of treating finely divided magnetic material to improve the magnetic properties thereof by heating the material to a prescribed temperature and subsequently cooling the material at a fixed rate, which comprises placing the material in shallow trays, the depth of the material in each tray being maintained within the value at which a sintering pressure is produced on a portion of the material at the prescribed temperature, assembling a number of the material containing trays in fixed relative positions in a ventilated container, heating the container at the prescribed temperature, subsequently cooling the container at the fixed rate, and removing oxygen from air entering the ventilated container during the cooling period.

4. A method of treating a magnetic nickel iron alloy in the form of small particles to improve the magnetic properties and insulatability thereof, which comprises placing the particles in a vented container, heating the container at such a temperature and period as to generate and expel gases from the particles and the vented container, cooling the particles in the container, and removing oxygen from air entering the container during the cooling period.

5. A method of treating finely divided particles

of a magnetic alloy comprising substantially 82% nickel, 2% molybdenum, and the balance iron for the purpose of improving the magnetic properties of the particles and the insulatability thereof, which comprises placing the particles in a vented container, heating the container at a temperature around 850° C. for two hours, removing generated gases from the container during said heating, subsequently cooling the particles in the container at a rate not exceeding 10° C. per minute, and removing oxygen from air entering the container during said cooling period.

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