May 15, 1928.

1,669,658

G. W. ELMEN

MAGNETIC CORE

Filed Sept. 11. 1926

Fig.1

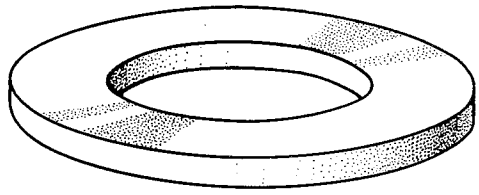
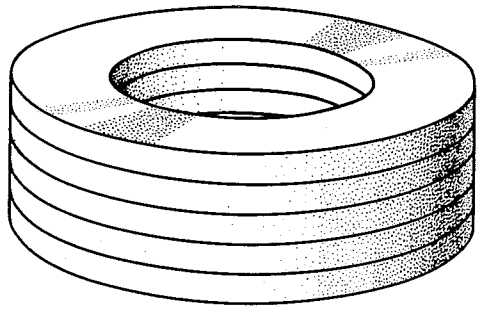


Fig.2



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UNITED STATES PATENT OFFICE.

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MAGNETIC CORE.

Application filed September 11, 1926. Serial No. 134,919.

This invention relates to magnetic material and more particularly to magnetic cores of the so-called compressed "dust" type.

The general object of this invention is to improve the magnetic or electric properties or both of compressed "dust" cores by a heat treatment carried out simultaneously with or subsequently to the performance of all the mechanical operations of manufacture which would deleteriously affect these properties.

Heretofore, in the manufacture of magnetic cores from finely divided magnetic material, such as iron, it has been customary to give the compressed cores a heat treatment to render the permeability stable and constant. Such a method is disclosed in Milton Patent No. 1,378,969, issued May 24, 1921. This heat treatment is at the relatively low temperatures of from 200° F. to 230° F. and extends over a relatively long period of time of about 12 hours. When a high permeability magnetic material such as an alloy of nickel and iron having high initial permeability is employed for the cores in the manner disclosed in Elmen Patent No. 1,523,109, issued January 13, 1925, there results a core which has materially less satisfactory electrical and magnetic properties than the value of the original material would indicate. This deleterious effect is apparently attributable to the pressing operation. In certain cores this effect is exhibited in a low permeability and high hysteresis loss.

According to the present invention, this deleterious effect is neutralized by a heat treatment of the compressed core at appreciably higher temperatures than have previously been employed. The original quality of the magnetic material is thereby restored and an appreciably more satisfactory core is obtained.

While an alloy of nickel and iron has been specifically mentioned as representative of a high permeability material which is advantageously heat-treated after compression according to this invention, other high permeability magnetic materials exhibit the same characteristics and therefore come within the field of this invention.

The method of controlling and increasing permeability and of reducing the hysteresis loss of the compressed cores in accordance with this invention consists of a heat treating process subsequent to the insulation of the finely divided material and subsequent to or simultaneously with the compression of the insulated finely divided material into finished form. The heat treatment may be carried out either by heating the formed material to the desired temperature just before compression and hot compressing it and then placing the hot cores in suitable ovens or cooling chambers in which they are caused to reach room temperature within the proper time, or by subjecting the finished cores to the proper heat treatment at any time after the mechanical operations have been completed. The degree of improvement in the magnetic and electrical properties of the cores thus treated depend upon the temperature and the duration of the heat treating process, while the limiting temperature which may be employed is determined by the temperature which the insulating material will withstand without breaking down.

Cores using an oxide coating as insulation for the dust particles and heated to between 500 and 600° C. for 15 minutes and cooled to room temperature showed a substantial increase in permeability and a material reduction in hysteresis loss. For example, a dust core composed of nickel-iron alloy particles containing approximately 78½ per cent nickel and 21½ per cent iron and insulated by oxidizing the surface of the particles and compressed into a core under a pressure of 200,000 pounds per square inch had an initial permeability of approximately 35. This core was then placed in a furnace and held at 500° C. for 30 minutes and then slowly cooled to room temperature. The initial permeability was thereby increased to 85 and the hysteresis loss was correspondingly decreased. Cores using shellac as insulating material for the dust particles have been heat treated after compression to a temperature as high as 800° C. Cores heated to this temperature for 10 minutes and allowed to cool in air also showed a decided improvement in their mechanical properties.

By employing various heat treatments after compression, improved magnetic and electric properties may be secured and this process affords means of improving and controlling both the permeability and the hysteresis loss.

The magnetic particles are insulated before being compressed to greatly increase the electrical resistance of the cores and

thereby lower the eddy current loss when the core is subjected to an alternating magnetic field. The pressure employed to compact the material is sufficient to cause its density to approach that of the metal forming the dust particles and to substantially eliminate the voids between the insulated particles so that the compressed core is substantially a solid homogeneous mass. The compression operation appears to cut through or rub off some of the insulation on the particles and thereby reduces the electrical resistance of the formed mass. This may be remedied by adding a small amount of lubricant such as paraffine oil, to coat the insulated magnetic particles before undergoing compression and by properly controlling the character and application of the lubricant, the core strength is maintained and a higher electrical resistance obtained.

In the drawing Fig. 1 is a perspective view of a section of a loading coil core made in accordance with this invention. Fig. 2 shows a plurality of these sections assembled to form a complete core. It has been found desirable in practice in making loading coil cores to use sections having a thickness of about 1/8 of an inch and to use five or more sections with suitable insulating material such as paper or shellac interposed between sections. However, these dimensions and the type of core shown in the drawing are merely illustrative.

The invention disclosed herein is obviously applicable to various elements and alloys and susceptible to various modifications and adaptations without departing from the scope and spirit of the invention and it is not intended to limit the invention to the specific construction herein shown and described except as defined by the appended claims.

What is claimed is:

1. The process of making magnetic cores which comprises compressing finely divided insulated particles of magnetic material having an initial permeability substantially higher than iron, and heat treating the compressed mass at a temperature sufficient to improve the magnetic properties of said core.

2. The process of making a magnetic core of high permeability from magnetic material in finely divided form having an initial permeability substantially higher than iron, and insulating material, which comprises forming the material under high pressure into a substantially homogeneous mass to produce a core of the required density and mechanical strength, and thereafter heat treating the compressed core at a temperature sufficient to fully develop the magnetic and the electric properties of the magnetic material in the core.

3. The process of making a magnetic core of high permeability from magnetic material in finely divided form having an initial permeability substantially higher than iron, and insulating material, which comprises forming the material under high pressure into a substantially homogeneous mass to produce a core, and hereafter heat treating the compressed core at such a temperature as to develop the magnetic and electric properties of the magnetic material in the cores in varying amounts depending upon the heat treatment employed.

4. The process of making magnetic cores which comprises hot compressing finely divided particles of magnetic material having an initial permeability substantially higher than iron and coated with an insulating material, pre-heated immediately prior to compression at a temperature sufficient to prevent loss of permeability by compression and to fully develop the magnetic and electric properties of the material in the said cores.

5. The process of making a magnetic core having high permeability and low hysteresis losses from an alloy including nickel and iron, in finely divided form, and insulating material having a high breakdown temperature, which comprises coating the individual alloy particles with said insulating material, forming the insulated particles under high pressure into a substantially homogeneous mass to produce a core, and heat treating the compressed core at such a temperature and for sufficient time to restore the magnetic and electrical properties inherent in the alloy material but lost during the pressing operation.

6. A process in accordance with claim 5, and in which the maximum temperature of the heat treatment is below the breakdown temperature of said insulating material.

7. A process in accordance with that of claim 5, and in which the maximum temperature of said heat treatment is below the breakdown temperature of said insulating material and below the fusing temperature of the alloy.

8. The process of making a magnetic core which comprises applying a coating, including insulating material and a small amount of lubricant, to the individual particles of a mass of magnetic material in finely divided state, and compressing the insulated particles to form a substantially homogeneous core, said lubricant serving to prevent any injury to the insulating coating on said particles during the pressing operation which would tend to reduce the electrical resistance and mechanical strength of the completed core.

9. The process of making a magnetic core having high permeability, high mechanical strength, and low hysteresis losses from finely divided magnetic material which requires heat treatment at a high tempera-

ture to restore its inherent magnetic properties after the application of high pressure thereto, which process comprises insulating said finely divided particles, heating the insulated particles to said high temperature, compressing said insulated particles under high pressure to form them into a homogeneous mass of the desired form while maintaining said particles at substantially said high temperature, and subsequently cooling the compressed mass at a suitable rate.

In witness whereof, I hereunto subscribe my name this 8th day of September A. D., 1926.

GUSTAF W. ELMEN.