

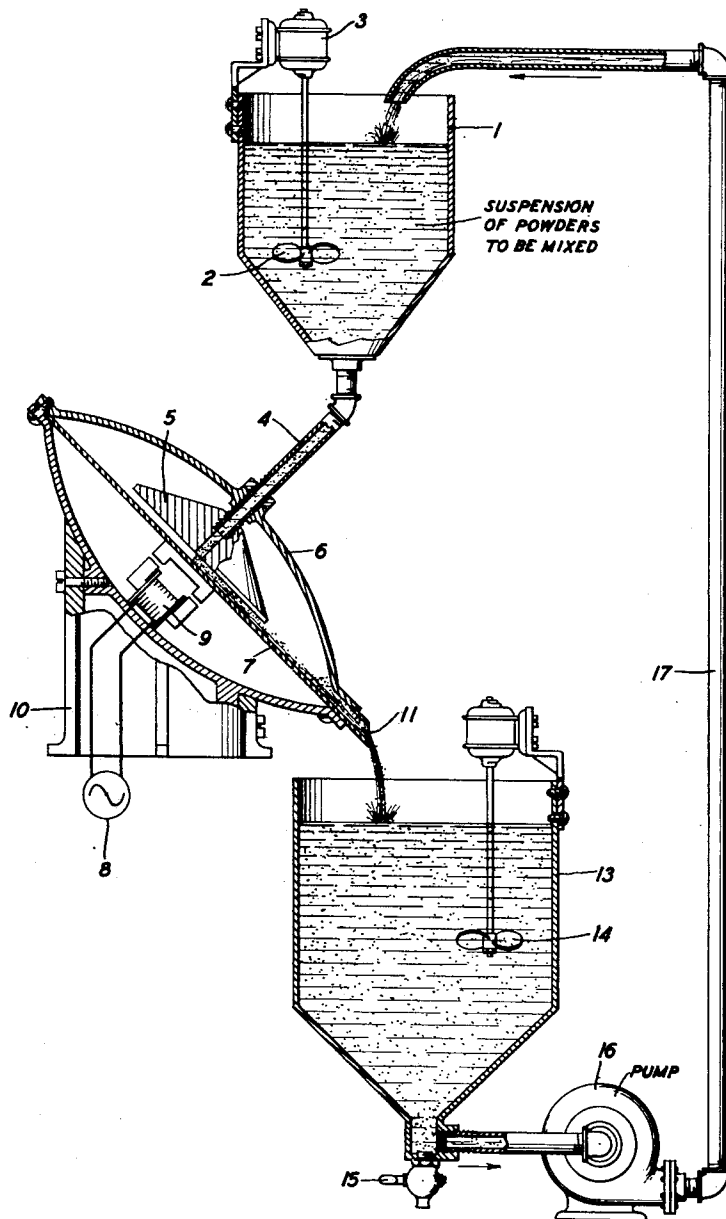
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V. E. LEGG

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METHOD OF MAKING MAGNETIC BODIES

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INVENTOR
V. E. LEGG

BY
T. H. Jackson

ATTORNEY

UNITED STATES PATENT OFFICE

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METHOD OF MAKING MAGNETIC BODIES

Victor E. Legg, Maplewood, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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This invention relates to the intimate mixing of finely divided materials and particularly to the electrical insulation of finely divided magnetic material employed in magnetic bodies such as loading coils and the like.

An object of the invention is to improve the magnetic, electrical and mechanical characteristics of magnetic bodies of the type employing magnetic material in finely divided form. A particular object is to obtain an improved insulating coating on magnetic particles.

In the manufacture of magnetic dust cores for loading coils and the like, it is frequently the custom, as disclosed, for example, in the Ellis U. S. Patent No. 1,943,115 of January 9, 1934, to add the magnetic particles to a water suspension of the pulverized insulating material, such as colloidal clay, and possibly other insulating ingredients. The mixture is thoroughly stirred for a substantial length of time after which the mixture is evaporated to dryness and the product formed under high pressure into a core of the desired shape, which core is subsequently annealed in a suitable manner to improve the magnetic properties.

However, it has been found that in such a mixing process agglomerations of the magnetic particles and also of the insulating dust tend to form which cannot be eliminated even with a long stirring process and these agglomerations, to the extent that they are present, prevent each magnetic particle from preceiving the desired uniform coating of insulation. It will be apparent that the lack of a uniform coating on the magnetic particles will cause the magnetic core made therefrom to have a relatively high eddy-current loss. While the eddy-current losses may be reduced by repeating the above process to produce multiple coatings on the particles, the multiple coating process with prolonged stirring for each coating obviously increases the time and cost of manufacture. It is also true that the greater the amount of non-magnetic material employed, the lower will be the core permeability.

In accordance with this invention it is proposed to obtain a more intimate mixture of the magnetic particles and the insulating material and hence obtain a more uniform insulating coating on the magnetic particles by subjecting the mixture to sustained trains of compressional elastic waves of a definite high frequency. The powerful, rhythmical forces produced by the high frequency waves attack the agglomerates in the mixture and cause continued change in position of the individual particles. Continued change of

direction of the particle movement has the effect that any existing agglomerations of individual particles are loosened in their structure and finally destroyed, thereby obtaining the desired intimate mixture of the magnetic material and the insulating material.

Referring to the drawing, the single figure illustrates apparatus that may be employed in subjecting a mixture of magnetic particles and insulating material to high frequency vibrations.

While this invention is not concerned with the type of insulating material or magnetic material employed, it may be assumed that the magnetic material comprises permalloy dust of the desired fineness, capable, for example, of passing through a 120-mesh or 400-mesh sieve. The insulation may comprise colloidal clay, sodium silicate and milk of magnesia, in the proportions disclosed in the above-mentioned Ellis patent. For example, for each kilogram of magnetic dust there may be added 7.6 grams of colloidal clay, 12.8 grams of sodium silicate and 42.0 grams of milk of magnesia. Water is added in a ratio of 20 cc. or more of water to 100 grams of dust.

After the magnetic dust and the insulating materials have been added to the proper amount of water, the resulting mixture is poured into a suitable container 1 where the insoluble dust particles are kept in thorough suspension by mechanical stirring, as by an agitator blade 2 operated by a motor 3. A pipe 4 leads from the bottom of reservoir 1 to a centrally located aperture in an anvil 5 enclosed within the housing of an electro-magnetic vibrator 6. Closely adjacent the flat surface of anvil 5 is a large diaphragm 7 which is vibrated in an obvious manner by current from the alternating current source 8 connected to driving coil 9. The gap between the adjacent surface of anvil 5 and diaphragm 7 is preferably only a few miles wide, a gap of about 10 mils having been found satisfactory in one instance. In the drawing this gap is shown greatly exaggerated. The desired gap between the anvil and the diaphragm is preferably secured by having the anvil adjustable, moving the anvil towards the diaphragm until the vibrating diaphragm strikes the anvil and then withdrawing the anvil slightly until the diaphragm fails to contact with the anvil. The mounting 10 for the vibrator 6 is preferably such that the plane of diaphragm 7 forms an angle with the horizontal great enough to provide a sufficiently rapid flow of the mixture through the vibrator without danger of any substantial settling-out of the suspended par-

ticles. An angle of 30 degrees to 45 degrees has been found satisfactory.

As shown in the drawing, the liquid mixture passes through the central aperture in anvil 5 to the gap between the diaphragm 7 and the anvil 5 where it is subjected to sustained trains of compressional elastic waves by the rapid vibration of diaphragm 7 as the mixture flows under gravity towards an exit opening 11 between diaphragm 7 and the upper part of the vibrator housing 6.

The liquid mixture in passing out of opening 11 falls into an auxiliary container 13 where it is again agitated by a motor driven stirrer 14 to keep the powdered material in uniform suspension in the liquid. An outlet at the bottom of container 13 leads to a centrifugal pump 16 to return the liquid mixture through pipe 17 to the upper container 1 where it is again agitated before being subjected to another passage through the vibrator 6.

It will generally be found advisable to pass the entire mixture ten to twenty times through the vibrator 6 before stopping the vibration of diaphragm 7 and opening the drain 15 to remove the liquid mixture from the apparatus.

After the above-described treatment, the mixture is evaporated to complete dryness with continued stirring and then placed in a mould and compressed into core parts under a pressure of approximately 200,000 pounds per square inch. The core parts are then transferred to an annealing furnace where they are annealed at a high temperature, preferably in hydrogen or in an inert atmosphere, to relieve the internal stresses set up in the material by the pressing operation. Where the annealing heat treatment is carried out in air the core parts are preferably subjected to a temperature of approximately 500° C. for about 45 minutes. When the annealing heat treatment is carried out in hydrogen, which enables higher annealing temperatures to be used, the core parts are preferably subjected to a temperature of approximately 650° C. for about 60 minutes. The usual loading coil toroidal windings are wound on the single core parts thus produced or on a plurality of said core parts stacked coaxially.

In performing the above process, it is important to keep the powdered insoluble material in uniform suspension in the liquid not only by thorough agitation immediately before and after passing through the vibrator but also by having diaphragm 7 steeply inclined to produce a rapid flow of the mixture through the vibrator.

It has been found by experiment that the eddy-

current losses in a core made from the material produced in accordance with this invention are much lower than are obtainable by a single-stage insulation of the magnetic particles produced solely by prolonged stirring of the liquid containing the magnetic material and the insulating material. For example, where the insulating coating was secured by high speed mixing alone the resulting core had an eddy-current constant of 140 but with the process of this invention the eddy-current constant was 16; this comparison being made, of course, with magnetic material of the same composition and treatment and with the same insulating material. This comparison is for magnetic material comprising approximately 81% nickel, 17% iron, and 2% molybdenum.

Diaphragm 7 is preferably a circular, stretched diaphragm suitably held by the two cup-shaped portions of housing 6. The diameter of the diaphragm and the associated anvil will depend upon several factors but in a particular example the diaphragm 7 had a diameter of 9 inches and the diameter of anvil 5 was about 3 inches. With a diaphragm 7 of the above size it was found satisfactory to have the diameter of pipe 4 and the diameter of the opening in anvil 5 about 1/4 inch.

The frequency of vibration of diaphragm 7 does not appear to have a definite optimum value as long as the frequency is fairly high, for example, in the neighborhood of 1000 to 1100 cycles per second.

What is claimed is:

1. The method of insulating magnetic dust particles carried in suspension in a liquid medium including an insulating material for said particles, which method comprises agitating said medium to place said particles in suspension in said medium, directing said medium through a zone of restricted cross-sectional area, subjecting said medium while passing through said zone to trains of compressional elastic waves of high frequency, and subsequently drying said particles.

2. The method of insulating magnetic dust particles carried in a liquid medium including an insulating material for said particles, which method comprises directing said medium into a restricted passageway defined by closely adjacent upper and lower walls through which passageway the medium is compelled to flow in a shallow stream, and vibrating a wall of said passageway at a sustained high frequency rate.

VICTOR E. LEGG.