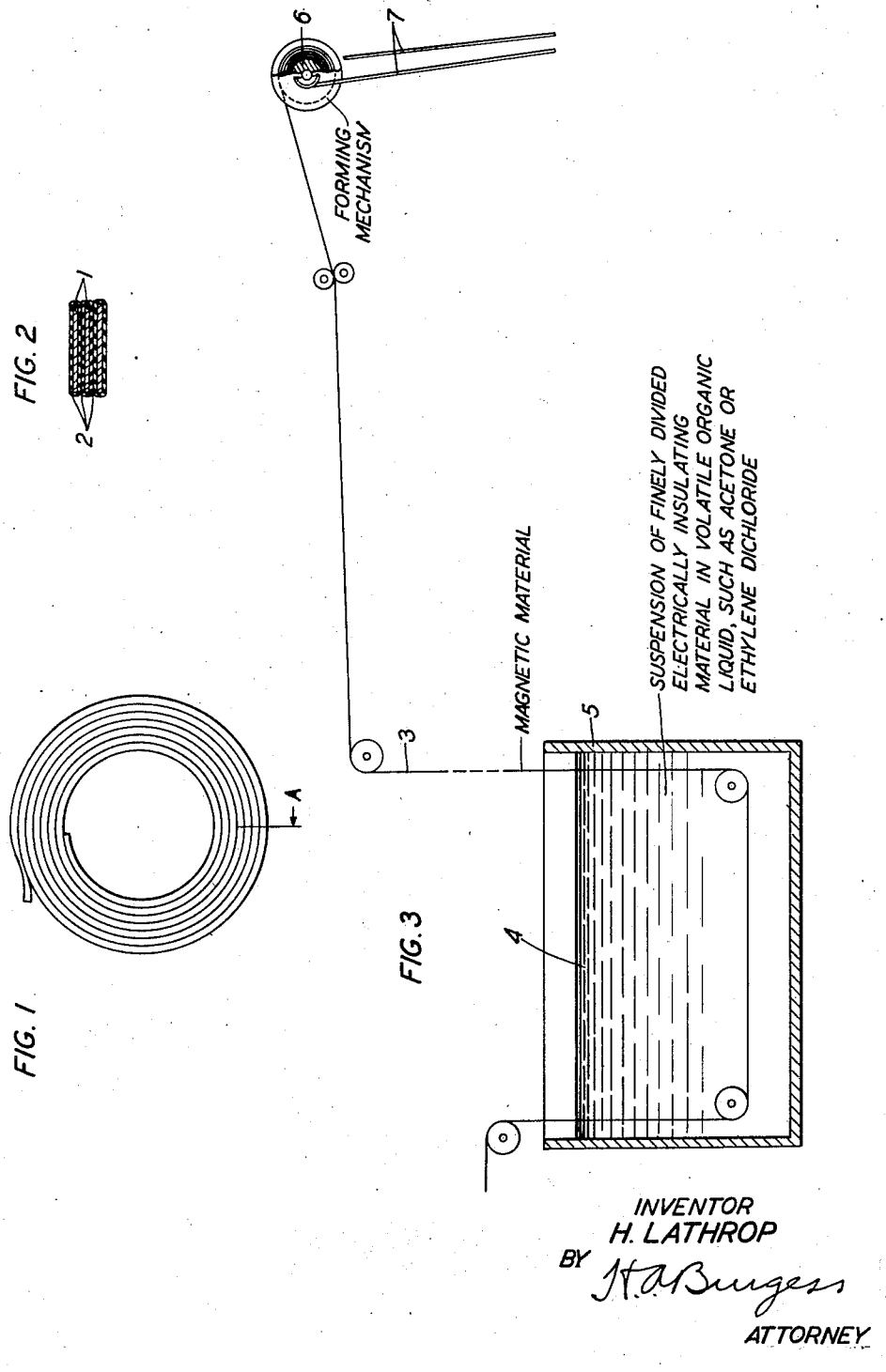
July 12, 1932. H. LATHROP 1,867,362

INSULATION OF METAL BODIES

Filed Nov. 21, 1930



INVENTOR
H. LATHROP
BY H. A. Burgess
ATTORNEY

Patented July 12, 1932 1,867,362

UNITED STATES PATENT OFFICE

HUBBEL LATHROP, OF GREENWICH, CONNECTICUT, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

INSULATION OF METAL BODIES

Application filed November 21, 1930. Serial No. 497,261.

This invention relates to electrical insulation, and particularly to the insulation of metals in finely divided form, such as the magnetic ribbons or sheets used in the manufacture of magnetic elements for inductance devices.

An object of the invention is to apply a permanent electrical insulation on metal material of the above-mentioned kind, which will not deteriorate when subjected subsequently to mechanical forming processes and to heat treatments at high temperatures.

The invention has specific application to inductance devices of the type employing magnetic elements composed of very thin ribbons or sheets of magnetic material insulated from each other by electrically insulating material to reduce eddy current losses, such as transformers, and so-called magnetic cross-talk adjusting coils or beads. In the case especially, where the magnetic elements of such devices are made from magnetic alloys containing nickel and iron, it is often desirable to subject them to a subsequent annealing heat treatment at a very high temperature to improve their magnetic properties and to remove the strains produced therein by preceding mechanical forming processes, tending to impair the desirable electrical and magnetic properties of the magnetic alloy, which are otherwise obtainable.

In general, an insulating material to be suitable for insulating finely divided metallic material, for example, the magnetic elements used in magnetic bodies, requiring subsequent mechanical and thermal treatments, must be one which will have sufficient strength to withstand the mechanical treatment, a high resistance to decomposition by heat, and one which will satisfactorily adhere to the metallic material so as to give a uniform, permanent insulation thereon.

In accordance with the invention it has been found that an insulation having the above-mentioned advantageous properties may be obtained on metallic elements, for example, on the thin sheets or ribbons of magnetic material used in inductance devices, by applying thereto a suspension of finely divided insulating material such as colloidal clay (kaolin), talc, or other finely divided material of similar characteristics, in a suitable organic liquid suspending medium which will evaporate at ordinary room temperatures, such as acetone or ethylene dichloride. When the metallic material is in the form of a thin ribbon, sheet or tape, the insulating material may be applied thereto by momentarily immersing in, or drawing the ribbon, sheet or tape, quickly through the suspension of insulating material while rapidly stirring the latter. If the thin metallic material is wound or formed into its final form before the organic medium has completely evaporated, a permanent adherent electrical insulation will be produced on the surfaces of the formed metallic material, which will not deteriorate when subjected to a subsequent heat treatment at extremely high temperatures.

The details of the invention and the advantages thereof will be clear from the following detailed description thereof when read in connection with the accompanying drawing:

Figs. 1 and 2 of which show magnified views of portions of a magnetic cross-talk adjusting coil or bead to which the process of the invention is particularly applicable; and

Fig. 3 shows diagrammatically one way of making the product illustrated in Figs. 1 and 2 utilizing the insulating process of the invention.

The invention will be described as applied to the insulation of small magnetic coils utilized for correcting for the inductance unbalances in the line windings of loading units in telephone circuits so as to minimize cross-talk therein, so-called magnetic cross-talk adjusting beads, one of which is illustrated in

Fig. 1, but it is applicable as well to the insulation of magnetic materials for use in other types of magnetic bodies and to the insulation of metallic materials in general which must be subjected subsequently to mechanical forming processes and to heat treatments at very high temperatures.

Fig. 1 shows in magnified form a plan view of a magnetic cross-talk adjusting bead or coil of the type to which the process of the invention is particularly applicable, and Fig. 2 shows an enlarged cross section of a few turns thereof taken along the line A. As indicated in Figs. 1 and 2, the bead comprises a closely wound spiral of thin, flat ribbon of a magnetic metal, such as a magnetic alloy including nickel and iron, and adherent insulating material between the adjacent turns of the spiral. In a commercial product utilized for adjusting the inductance of telephone loading coils, the bead comprises approximately 40 turns of a magnetic ribbon coated with insulating material, about $\frac{1}{8}$ inch wide by 0.003 inch thick, the outside diameter of this spiral being approximately $\frac{1}{2}$ inch, and the inside diameter approximately 0.06 inch to 0.08 inch. The material of the magnetic ribbon in said commercial product comprises a magnetic alloy including nickel, iron and molybdenum. The outer end of spiral is secured by spot welding to the preceding turn.

To properly develop the magnetic properties of the magnetic material in such a bead, it is desirable to subject it after the insulating and forming process to an annealing heat treatment at a very high temperature of the order of 500° C. or more, the particular heat treatment used depending upon the constituents of the magnetic material and the breakdown temperature of the insulating material to remove the strains therein which tend to impair the magnetic properties of the magnetic material which otherwise would be obtained. This is usually accomplished by heating the bead or beads placed in a sealed pot in a suitable furnace at the desired temperature for about an hour, and then allowing it to cool in the furnace. The insulation between the adjacent turns of the magnetic ribbon in the spiral, therefore, should be such as will withstand without deterioration from a mechanical and electrical standpoint, the forming process and the high temperature of the annealing heat treatment.

A preferable insulation in accordance with the invention is colloidal clay (kaolin) applied as a coating to the magnetic ribbon in a manner similar to that illustrated in Fig. 3 of the drawing.

The very fine magnetic ribbon 3 is drawn by suitable mechanical means quickly through a suspension 4 of colloidal clay in an organic suspending liquid which will volatilize quickly at room temperatures, such as acetone or ethylene dichloride, in a suitable container 5, while the suspension is continuously stirred. When the magnetic ribbon so treated is exposed to the atmosphere, which may be air or other gas at ordinary room temperatures, the acetone or ethylene dichloride evaporates leaving an adherent insulating coating of the colloidal clay (kaolin) on the surfaces of the ribbon. The magnetic ribbon so treated is preferably formed by suitable mechanical means into its final form, in this case a closely wound spiral of the magnetic ribbon with the insulation between adjacent turns, for example, as illustrated in Fig. 3, by winding it on the drum 6 rotated at the proper speed by means of the belt 7, during the period while acetone or ethylene dichloride is evaporating. The coating of colloidal clay on the surfaces of the magnetic ribbon forms a permanent insulation between the turns of the spiral in the cross-talk adjusting bead. It has been found that when the suspension 4 used comprises approximately one part of colloidal clay to six parts of acetone, by weight, the insulating coating is sufficiently adherent to the magnetic material to withstand without deterioration from a mechanical standpoint the forming operation and the usual mechanical handling to which cross-talk adjusting beads are subjected in service, and to withstand without deterioration from an electrical insulating standpoint a subsequent annealing heat treatment at a temperature in the order of 1,000° C. or more to remove strains and to improve the magnetic characteristics of the magnetic material in the bead.

Other insulating materials besides colloidal clays may be used if they are such as will withstand the high temperatures of the annealing heat treatment to which the magnetic material is to be subjected. For example, approximately the same proportions of colloidal talc has been found to be a suitable substitute for the colloidal clay.

One of the important applications of the invention is in connection with magnetic cores for transformers and the like where the core comprises thin sheets or layers of a magnetic material separated by insulating material, especially where the magnetic material in the core is such as to require a subsequent annealing heat treatment at a very high temperature to properly develop the magnetic characteristics of the magnetic material.

It is to be understood that the invention is not limited to the particular magnetic materials, the particular insulating materials, and the particular proportions thereof, and the volatile organic liquid in the suspension, specified, nor to the particular mechanism illustrated and described for carrying out the process of the invention, which have been given by way of example only, and that any

other suitable magnetic and insulating materials, proportions of the materials in the suspension, and mechanisms may be used within the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. The process of applying a permanent, adherent coating of an insulating material to a metal body requiring subsequent heat treatment at high temperatures, which consists in mixing the insulating material in colloidal form with an organic liquid comprising acetone to form a suspension of said insulating material, immersing said body in said suspension while rapidly stirring the latter to coat said body, and then exposing the coated body to the atmosphere to evaporate the acetone.

2. The process of making a magnetic body from sheet magnetic material and insulating material, which consists in making a suspension of the insulating material in finely divided form, in an organic liquid suspending medium having the property of evaporating quickly in air at ordinary room temperatures, drawing the magnetic sheets through the suspension while rapidly stirring the latter to coat the sheets with the organic liquid and insulation mixture, and then exposing the coated sheets to the atmosphere while forming the magnetic body therefrom, to vaporize the organic liquid and produce adherent, solid coatings of the insulating material on the magnetic sheets.

3. The process of making a magnetic body comprising adherent, alternate layers of sheet magnetic material and clay insulating material, which consists in making a colloidal suspension of the clay in a suspending medium comprising acetone in the approximate proportions by weight of one part clay to six parts acetone, immersing the magnetic sheets in said suspenion while rapidly stirring the latter to form liquid coatings thereof on said sheet, and then exposing the coated sheets to the atmosphere while forming them into a compact mass in the desired form, to vaporize the acetone and produce adherent, solid coatings of clay on the magnetic sheets.

4. The process of making a magnetic body comprising adherent, alternate layers of sheet magnetic material and talc insulating material, which consists in making a colloidal suspension of the talc in a suspending medium comprising ethylene dichloride in the approximate proportions by weight of one part talc to six parts ethylene dichloride, immercing the magnetic sheets in said suspension while rapidly stirring the latter to form liquid coatings thereof on said sheets, and then exposing the coated sheets to air while simultaneously forming them into a compact mass in the desired form, to vaporize the ethylene dichloride and produce solid, adherent coatings of talc on said sheets.

5. An insulating composition comprising a suspension of finely divided insulating material in acetone.

6. The composition of claim 5 and in which said insulating material comprises colloidal clay.

7. The composition of claim 5 and in which said insulating material comprises colloidal talc.

In witness whereof, I hereunto subscrib my name this 11th day of November, 1930.

HUBBEL LATHROP.