METHOD OF MANUFACTURING BUNDLES
OF VERY THIN MAGNETIC WIRES
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METHOD OF MANUFACTURING BUNDLES OF VERY THIN MAGNETIC WIRES

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This invention relates to processes for manufacturing bundles of very thin wires formed of a magnetic metal particularly for use in high frequency alternating current equipment.

Very thin metallic wires have hitherto been manufactured by reducing the diameter of a given wire (herein referred to as a primary wire) by successive passes through dies of diminishing diameter. With very thin wires this reduction of diameter presents many practical difficulties and the output per hour of a wire drawing machine (which output is approximately proportional to the cross section of the wire being drawn) falls off rapidly when small diameter wires are being drawn thereby resulting in a high cost price of such wires. Consequently, wires having a diameter below 50 thousandths of a millimetre are now used only when their use is unavoidable and when the required quantity of wire is small, such as, for example, in the manufacturing of the moving coils of electrical measuring instruments.

One of the domains in which it would be most desirable to take advantage of processes for manufacturing very thin metallic wires at low cost is that of magnetic materials for use in components of high frequency alternating current equipment. These materials must be divided to cut down the prejudicial action of eddy currents which give rise, on the one hand, to a loss of energy which diminishes the quality factor of the windings and, on the other hand, to an antagonistic magnetic field which is opposed to the principal field and reduces the inductive effect of the material. It can be shown that this prejudicial action is proportional to the second power of the frequency of operation of the equipment and to the second power of the thickness of the strips, or of the diameter of the wires of which a component may be made. It follows therefore that the finer are the constituent wires of the component, the higher is the frequency at which the component can be used. Thus, in the manufacture of high quality inductance cores for use at 100 kilocycles per second it is necessary to use wires having a diameter of about 15 thousandths of a millimetre, and in the manufacture of such cores for use at 250 kilocycles per second, it is necessary to use wires of about 6 thousandths of a millimetre diameter.

According to the present invention there is provided a process for manufacturing bundles of very thin magnetic metal wires which consists in drawing primary metallic wires enclosed within a metallic sheath, the said metallic wires being kept separated, (a) from one another and (b) from the sheath by a friable material or a powder composed of very small particles.

The powder particles, which may be those of a layer of oxide or of another compound deposited upon the surface of the wires to be drawn serves, as stated, to separate the wires, and at the same time to prevent the wires from adhering to one another or to the sheath and, further, to insulate the wires electrically.

It is evident that as the sheath has an external diameter considerably greater than that of the wire or wires being drawn, the usual practical difficulties met with in the drawing of very thin wires are avoided. Furthermore, a great number of wires enclosed within the same sheath may of course be drawn simultaneously, thereby greatly reducing the cost price of the wires.

The invention will now be described with reference to certain specific embodiments given solely by way of illustrative examples. In the drawings:

Fig. 1 is a diagrammatic sectional view of a first embodiment;

Figs. 2 and 3 are similar views of variations from the form of Fig. 1; and

Fig. 4 is a view to a larger scale of a composite form suitable for repeated treatment.

The following description of one manner in which the process according to the invention may be carried out, is more particularly directed to the manufacture of a material suitable for magnetic cores and windings.

The invention is based on the experimental fact that when a bundle of metallic wires which are either bare or separated from one another by a friable or pulverulent material are subjected to a drawing process when enclosed within a common cylindrical sheath, the sheath and its enclosures are drawn as a whole, as if it were a homogeneous material.

It is advisable to insert a separating material between the wires with a view to avoiding the sticking together of the wires. It must be noted, moreover, that if several wires have to be drawn together and if they are intended to preserve a circular cross section they must be surrounded by a sufficient quantity of separating material to prevent them from being flattened one against the other.

In magnetic cores used for alternating currents, it is necessary, for the purposes of limiting the losses due to eddy currents to ensure that, in the final product, the individual wires should be electrically insulated from each other. In order to make it possible to obtain, by the above-described process, a bundle of wires electrically insulated individually from each other, it is sufficient to use an electrically insulating material as separating material.

The separating material used in the process must be capable of withstanding, without losing its separating or insulating properties, the effects of the annealing temperature of the metals of the wires and the sheath. For example, use may be made, as separating material, of metallic oxides such as magnesia, alumina, copper-oxide, zinc-oxide, and iron-oxide; or else mixtures of oxides and metallic salts which are stable at high temperatures, such as, silicates, may be used.

The separating material used may be put in position for the process in any known manner. It may for instance be used in the form of an emulsion of adequate consistency, prepared by dissolving or suspending the separating material in a liquid, the wires being then immersed in the emulsion and dried.

In Fig. 1, the wires 1, coated with the separating material 2, are assembled into a bundle and then inserted into the sheath 3, which can for instance be constituted by a metallic tube. During the assembling of the bundle and its insertion into the sheath, a certain amount of powdered separating material can be added in order to insure adequate filling of the sheath.

As shown in Fig. 2, the insertion of the bundle into the sheath will be much easier if a longitudinally slit tube 4 is used as the sheath, such a tube being easily formed by the longitudinal folding of a metallic strip to surround the bundle of primary wires 1. A tube with two longitudinal slits can also be formed by folding two strips round the bundle, each of which covers half of the bundle periphery. It has been experimentally as-
certained that the longitudinal slits do not hinder the drawing process.

In order to prevent the wires or the separating material from coming out of the sheath by way of the slit or slits therein, as shown in Fig. 3 the slit sheath 4 may be surrounded by a second slit sheath 5, the slit or slits of the sheath being disposed in such a manner that they do not coincide with those of the first sheath.

The sheath enclosing the wires is then drawn, with reheating between successive passes according to the known process. If it is required to produce very thin wires it may be advantageous to avoid the use of very small drawing diameters and to stop the drawing process at a given stage thereof, to remove the sheath by one of the processes hereinafter to be described and to make up a fresh sheath of greater diameter in accordance with Fig. 4 to enclose several bundles of the drawn wires, whereupon the drawing process is repeated using as primary wire, wire which has been already drawn. This use of the drawn wire bundles may be repeated as often as necessary.

To remove the metallic sheath or sheaths, recourse may be had to chemical, mechanical or thermal processes.

If a chemical process is chosen, the sheath is dissolved away by an appropriate reagent, but this method has the drawback of exposing the separating material and the wires to the action of the reagent used, unless the reaction is stopped when the action of the reagent upon the sheath is just at its end. If this is not possible, it is advisable to use different metals for the sheath and the wires and to choose a reagent which does not attack the wires. The wires may, for example, be made of a magnetic nickel-iron alloy and be drawn in iron sheaths, the iron being afterwards dissolved in sulphuric acid which does not attack the nickel-iron alloy. However, if the wires are intended for use in a magnetic core or winding, it is generally necessary to reimulate them, for example, by varnishing or enamelling.

If a mechanical process is chosen, the removal of the sheath may be effected by a device similar to that used for stripping the cover from lead-sheathed electric cables, i.e., by cutting the sheath at both ends of a diameter and then taking off the two strips so obtained by pushing them aside. This process will of course be easier to apply if slit sheaths, as described above, are used.

If a thermal process is chosen, a metal with a melting-point inferior to that of the wires and the separating material is used to compose the sheath or sheaths which are then removed by melting, the coated bundle being led through an oven at a temperature intermediate the melting point of the sheath or sheaths and that of the wires and of the separating material.

The sheath may also be transformed into an oxide or a salt of the metal it is made of, the reagent used for the said transformation being such as to have no prejudicial action which might impair the subsequent working up and/or use of the final product.

As has been stated, the bundles of wires obtained by drawing can be used directly for certain applications and, in particular, for making magnetic cores or windings.

The mechanical resistance of the bundle of wires may, if necessary, be increased by slight twisting. If the bundle is intended to have a shape other than circular, for example, a strip-like shape, then the drawing process is finished by one or several rollings. Resistance to friction and superficial insulation of the bundle may also be increased by any of the known processes such as, for example, varnishing or enamelling.

If the bundles are used to compose induction coils or transformer cores, the mechanical resistance of the cores may be increased by compressing them in moulds and/or by impregnating them with an insulating varnish as are the loading coils of telephone cables.

What is claimed is:

1. A process for manufacturing bundles of very thin magnetic wires to provide a flexible magnetic material for use in high frequency electrical equipment; said process comprising the steps of immersing primary ferromagnetic material in an emulsion of a metallic compound having electrical insulating properties, said metallic compound being selected from the group consisting of metallic oxides, metallic silicates and mixtures of the same, and being in suspension within said emulsion, drying the primary wires after immersion to leave a covering layer thereon of the electrical insulating metallic compound, assembling together a bundle of the covered wires and enclosing the bundle within a metal casing so that the wires are insulated from each other and from said casing by the electrical insulating metallic compound, drawing the casing with the bundle of covered wires therein until the wires are each reduced to a diameter of less than 0.03 mm., annealing the drawn casing and wires, and removing the casing from the bundle of wires without disturbing the covering of electrical insulating metallic compound on each of the wires so that the bundle of very fine wires electrically insulated from each other provides a flexible magnetic material.

2. A process for manufacturing bundles of very thin magnetic wires to provide a flexible magnetic material for use in high frequency electrical equipment; said process comprising the steps of immersing primary ferromagnetic material in an emulsion of a metallic oxide in suspension having electrical insulating properties, drying the primary wires after immersion to leave a covering layer thereon of the electrical insulating metallic oxide, assembling together a bundle of the covered wires and enclosing the bundle within a metal casing so that the wires are insulated from each other and from said casing by the electrical insulating metallic oxide, drawing the casing with the bundle of covered wires therein until the wires are each reduced to a diameter of less than 0.03 mm., annealing the drawn casing and wires, and removing the casing from the bundle of wires without disturbing the covering of electrical insulating metallic oxide on each of the wires so that the bundle of very fine wires electrically insulated from each other provides a flexible magnetic material.

3. A process according to claim 2; wherein said metallic oxide is magnesium oxide.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 20,507 Andrews et al. September 14, 1937
874,908 Fritts December 1, 1907
1,274,952 Speed August 6, 1918
1,292,659 Speed January 28, 1919
1,525,840 Weed February 10, 1925
1,650,972 Backer November 29, 1927
1,850,181 Roseby March 22, 1932
1,981,468 Roseby November 20, 1934
1,991,143 Ehlers November 20, 1934
2,050,298 Everett August 11, 1936
2,064,184 Stevens December 15, 1936
2,077,682 Everett April 20, 1937
2,088,446 Specht July 27, 1937
2,215,477 Pipkin September 24, 1940
2,318,045 Leonard December 28, 1943
2,341,235 Palmer February 8, 1944
2,383,118 Ferreri August 21, 1944
2,493,609 Young January 3, 1950
2,513,161 Friend June 27, 1950