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METHOD OF MANUFACTURE AND COMPOSITION FOR MAGNETIC CORES

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ABSTRACT OF THE DISCLOSURE

A method of and a new composition of matter for use in manufacturing magnetic powder cores, particularly of the "Permalloy" type. Finally divided metal particles of magnetic material are insulated in a slurry consisting essentially of sodium silicate, magnesium hydroxide, aluminum silicate, magnesium silicate and a viscosity modifying agent selected from the group consisting of polyvinyl alcohol and carboxymethyl-cellulose. A peculiar percentage relationship, by weight, between the aluminum silicate and magnesium silicate is primarily responsible for magnetic cores made from the composition exhibiting consistently high, linear positive temperature coefficients and relatively high permeabilities. The particular types of viscosity modifying agents selectively employed make possible a "one-coat" application of the insulating materials on the magnetic particles, and effect a substantial reduction in the total losses normally experienced in cores having aluminum silicate as an insulating material.

This invention relates to a method of and a new composition of matter for use in manufacturing magnetic cores and, more particularly, to a method of and a composition for use in manufacturing "Permalloy" type magnetic powder cores which exhibit certain improved physical and magnetic properties. It is an object of this invention to provide a new and improved magnetic powder core of such character.

Certain tuned or balanced inductance-capacitance (LC) networks utilize as the inductance element thereof a coil wound on a magnetic core of the Permalloy type, and as the capacitance element thereof a capacitor having polystyrene plastic as the dielectric medium. In order to insure that the resonant frequency of such networks remain within prescribed limits with respect to changes in temperature, it has been found necessary to "balance" or offset the negative and substantially linear rate of change of capacitance with temperature characteristic exhibited by the polystyrene capacitors with the positive permeability versus temperature counterpart exhibited by the Permalloy type inductors. Hereinafter, a change of permeability with temperature of an element will be referred to simply as the temperature coefficient of that element.

Prior art magnetic core compositions utilizing finely divided dust particles of a nickel-iron alloy, referred to as Permalloy, have generally proven unsatisfactory with respect to yielding cores which have a positive, linear temperature coefficient closely approximating, in absolute value, the negative, substantially linear temperature coefficient of polystyrene capacitors.

Failure to achieve the desired characteristics heretofore is believed to reside, in large part, on the differential thermal expansions of the magnetic particles and the insulating coatings thereon. More particularly, the insulating coatings or films on and separating adjacent particles in a powder core effectively establish and act as air gaps in a magnetic circuit and, as such, have a direct bearing on core inductance or permeability. In addition, variations in the spacing of these air gaps, resulting from the

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differential thermal expansions of the particles and coatings, are believed to be the primary cause of changes in core permeability (or inductance) with temperature, which defines the temperature coefficient.

It has been found that the temperature coefficient of magnetic powder cores made from a given lot of Permalloy powder can be increased by reducing the thermal coefficient of expansion of the insulating coating and vice versa. For example, in two well known insulation forming compositions utilized extensively heretofore, a refractory metal silicate in the form of either talc (magnesium silicate) or colloidal clay (aluminum silicate), has been utilized together with magnesium hydroxide and an alkali metal silicate, such as sodium silicate. As between colloidal clay and talc, the former has a lower coefficient of thermal expansion than talc, and therefore, the substitution of colloidal clay for talc has been found to result in a reduction of the coefficient of thermal expansion of the insulating coating on the magnetic particles, and an increase in the temperature coefficient of the finalized cores.

Unfortunately, however, the mere interchange of colloidal clay for talc in an attempt to obtain a high particular average value for the temperature coefficient of the resultant cores does not insure the attainment of consistently high and linear temperature coefficients. Moreover, the selective use of either talc or colloidal clay with sodium silicate and magnesium hydroxide, for example, gives rise to other selective disadvantages which are not necessarily directly related to the temperature coefficient characteristics desired.

In order to amplify further on the above problems, reference is made first to one well known Permalloy core-forming composition utilizing talc, generally referred to as the Bandur composition, disclosed in U.S. Patent 2,105,070 of A. F. Bandur, issued Jan. 11, 1938. Magnetic cores manufactured in accordance with that teaching exhibit satisfactory overall magnetic and physical characteristics for many general applications. However, with respect to certain specific circuit application, such as where it is important that an inductance element exhibit a high, linear temperature coefficient, Bandur type powder cores have not proven satisfactory as they normally exhibit an average temperature coefficient, expressed in change of permeability in parts per million per degree Fahrenheit, of ± 40 p.p.m./° F., ± 20 p.p.m./° F., from room temperature (70–80° F.) to about 140° F. This range for the positive temperature coefficient is, on the average, far below the nominal negative temperature coefficient of -75 p.p.m./° F., which typically characterizes polystyrene capacitors. In addition, the temperature coefficient often does not vary linearly so as to match the negative counterpart exhibited by such capacitors.

Aside from the resulting temperature coefficient characteristics, the Bandur composition also normally requires a four-coat operation to provide an adequate insulation build-up on the magnetic particles, the denseness and uniformity of this coating having a significant effect on core losses.

With respect to permalloy core forming compositions utilizing colloidal clay rather than talc as one of the insulating materials, the magnetic cores resulting therefrom may possibly attain a temperature coefficient of ± 75 p.p.m./° F., however, such results have proven to be very unpredictable, as the temperature coefficient has been found to vary considerably from one lot to the next, and to vary non-linearly, as is often the case when talc is used as an insulating constituent.

Moreover, cores manufactured with colloidal clay generally exhibit relatively high core losses, often in excess of 0.240 (ohms/henry/unit of permeability). In ad-

dition, the utilization of colloidal clay, as with talc, normally requires several applications of insulating materials to the magnetic particles in order to provide a satisfactory coating thereon.

Because of the aforementioned problems encountered heretofore in manufacturing Permalloy type magnetic powder cores with consistently high and linear temperature coefficients, it has generally been necessary in certain demanding applications to test and categorize individual cores made from prior art compositions so that only those cores which had a temperature coefficient falling within an acceptable range, such as from $+55$ p.p.m./° F. to $+95$ p.p.m./° F., would be adequately matched with polystyrene capacitors having an average temperature coefficient of -75 p.p.m./° F. Of course, the necessity of having to select individual cores from a large number of cores is not only a time consuming and costly operation, but results in usable core yields of considerably less than 100 percent.

Therefore, it is another object of this invention to provide an improved method and a new composition of matter conducive to the manufacture of magnetic powder cores which exhibit an average, linear temperature coefficient of $+75$ p.p.m./° F., ± 20 p.p.m./° F.

It is a further object of this invention to provide an improved method and a new composition conducive to the manufacture of magnetic powder cores wherein only one coating application of insulating materials is normally required to achieve a dense, uniform and durable insulating coating on the magnetic particles, and which results in physically strong cores exhibiting relatively low core losses.

It is an additional object of this invention to provide improved method and a new composition conducive to the manufacture of Permalloy-type magnetic powder cores which are particularly suitable for utilization with polystyrene capacitors as matched circuit elements of a tuned LC network.

It is still another object of this invention to provide a new and improved Permalloy-type magnetic powder core which not only exhibits a consistently high, linear temperature, coefficient, but also exhibits overall magnetic and physical characteristics comparable with those realized with prior art cores of similar type.

In accordance with the principles of this invention, a new magnetic core forming composition is formed initially as a slurry comprised of finely divided metal particles of the permalloy type, and insulation-forming materials comprising an alkali metal silicate, magnesium hydroxide, two different refractory metal silicates, water and a viscosity modifying agent. The basic form of the composition comprises the dry magnetic powder resulting from the heating of the slurry to evaporate the volatile constituents therein, and the magnetic cores of the present invention comprise the pressed and fired reaction product of the dry magnetic powder.

Considering the various core-forming constituents more specifically, the metal particles consist of a nickel-iron-molybdenum alloy, and the insulation forming materials comprise predetermined quantities of sodium silicate, magnesium hydroxide, colloidal clay (aluminum silicate), talc (magnesium silicate), water, and a viscosity modifying agent selected from the group consisting of polyvinyl alcohol and carboxymethyl-cellulose.

The viscosity modifying agent, added to the core forming composition in accordance with the principles of this invention, is particularly significant in that it has been found to improve the degree of suspension of the finely divided metal particles and the insulating materials therefor within an agitated water slurry. As a result, when the slurry is subjected to heat during a drying operation carried out thereon, the insulating materials have been found to be more thoroughly and uniformly coated on the metal particles than was possible with prior core forming compositions. One possible explanation for this from a more technical standpoint is that the addition of the

viscosity modifying agent is believed to deflocculate (separate) the clay particles, and thereby improve the ultimate bonds between the particles and their respective insulating coatings.

Because of the degree of uniformity with which the insulating materials adhere to the metal particles, it has been found that the resultant dry composition may be molded into cores without the need of repeated applications of the insulating materials to the initially coated particles, as is generally necessary when prior permalloy core forming compositions are employed. The utilization of a "one coat" insulating process, of course, greatly reduces the time and costs involved in the manufacture of magnetic powder cores.

An additional advantage realized through the use of the viscosity modifying agent is that it reduces substantially the total losses normally experienced in cores having colloidal clay rather than talc as one of the insulating materials.

The two refractory metal silicates, namely, the colloidal clay and talc, when utilized within the percentage ranges set forth hereinafter, have been found to result in permalloy type magnetic powder cores which consistently exhibit higher average, linear temperature coefficients than have been realized heretofore. In addition, the temperature coefficients of the present cores are also more predictably controlled and fall within a more restrictive range, in terms of the percent deviation from the average value.

More specifically, it has been found that the present cores typically exhibit an average, linear temperature coefficient of $+75$ p.p.m./° F., ± 20 p.p.m./° F., as compared to an average TC of $+40$ p.p.m./° F., ± 20 p.p.m./° F., realized in accordance with other prior art cores, such as those manufactured in accordance with the aforementioned Bandur composition. The interrelationship between the thermal coefficients of expansion between the talc, clay and Permalloy particles, for the percentage ranges, by weight, of each in the core forming compositions set forth hereinafter, is believed to contribute significantly to the beneficial core characteristics ultimately obtained.

Cores exhibiting the higher average temperature coefficient of $+75$ p.p.m./° F. are, of course, particularly important when intended for use in compensating for or balancing out a substantially equivalent, but negative temperature coefficient exhibited by polystyrene capacitors in LC electrical networks.

Additional advantageous characteristics realized in accordance with the principles of this invention are that the core forming composition, while still in a slurry state, is more conducive to spray drying as well as rotating drum drying, by reason of the presence of the viscosity modifying agent, and the cores are generally stronger in both the green and fired states, and normally exhibit lower losses than prior cores of similar type, by reason of the new and improved overall composition.

Permalloy type powder cores made according to this invention, of course, are not limited to demanding temperature coefficient applications, as they also exhibit overall physical and magnetic properties which are comparable to those of cores made by the Bandur process, as well as by others.

This invention, together with further objects and advantages thereof, will best be understood by reference to the following description which sets forth in detail both preferred ranges for the core forming constituents, and a brief description of the method by which the composition is transformed into a new and improved magnetic powder core of the permalloy type.

The present composition is formed by mixing with each 1000 grams of finely divided Permalloy-forming metal particles, which consist of 80.0 to 83.0% by weight nickel, 15.0 to 17.0% by weight iron, and 1.75 and 2.45% by weight molybdenum, the following constituents for

and ranges of the insulation-forming materials: 4.93 to 11.41 grams of sodium silicate wherein the sodium oxide (Na_2O) to silicon dioxide (SiO_2) ratio is 2.84 to 1; 6.72 to 15.48 grams of magnesium hydroxide liquid containing 32 to 40 grains of $\text{Mg}(\text{OH})_2$ per fluid ounce; 5.24 to 12.05 grams of colloidal clay (aluminum silicate); and 0.62 to 1.41 grams of talc (magnesium silicate). To this mixture is added 66.0 to 110.2 cc. of water, preferably distilled, and 14.89 to 24.81 cc. of a viscosity modifying agent selected from the group consisting of a 10% by weight solution of polyvinyl alcohol and a 0.5% by weight solution of carboxymethylcellulose.

After all of these constituents are mixed sufficiently to form a homogenous slurry, heat is applied to the slurry to evaporate the volatile constituents or components therein, whereby a dry, insulated Permalloy powder is obtained. This powder is then pressed into cores, with the cores thereafter being fired to establish a stabilized magnetic state. The resultant insulating coating on the permalloy particles of the cores is thus seen to comprise the fired reaction product of the heat treated slurry, i.e., the fired reaction product of the dry magnetic powder. For the percentage ranges of the core-forming constituents set forth above, the resultant insulating coating will typically fall within a range of 0.975 to 2.25%, by weight, of the total dry weight of the insulated particles, with a range of 1.3 to 1.8% generally being preferred.

After being fired, the cores exhibit a permeability in the range of 115-145, a total core loss less than 0.240 (ohm/henry/unit of permeability), typically about 0.160 unit, and a relatively high average temperature coefficient of approximately ± 75 p.p.m./° F., ± 20 p.p.m./° F., which is linear. The values for permeability and core loss are both referenced to a core subjected to a frequency of 1800 cycles per second, and a flux density of 20 gauss.

By way of further illustration, one preferred method and specific composition for manufacturing Permalloy type powder cores of the present invention in commercially significant quantities will now be described. First 250 lbs. (113,400 grams) of finely divided permalloy metal particles, prepared in accordance with the general teaching of the aforementioned Bandur patent, are carefully weighed out and charged into a mixing barrel. The finely divided particles, which pass through a 120 mesh sieve, preferably consist, by weight, of 80-83% nickel, 15-17% iron and 1.75-2.45% molybdenum.

The mixing barrel into which the particles are charged is mounted for rotation about an axis preferably inclined approximately 35° with respect to the horizontal. A stationary scraper positioned near the top of the barrel is also advantageous in insuring thorough mixing of the contents in the barrel when it is rotated.

Once the mixing barrel is charged with the permalloy particles, 874 grams of colloidal clay (aluminum silicate, $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$) and 114 grams of talc (magnesium silicate, $4\text{MgO} \cdot 5\text{SiO}_2 \cdot \text{H}_2\text{O}$) are carefully weighed out and added to the barrel. The barrel is then rotated for a period of approximately 3 minutes to facilitate the dry mixing of the colloidal clay, the talc and the permalloy particles. The order in which the above constituents are

barrel, 10,000 cc. of distilled water is measured out and poured into a mixing kettle. Then 920 grams of sodium silicate having an Na_2O to SiO_2 ratio of 2.84 to 1.0 is weighed out and added to the water in the mixing kettle. A mixer associated with the kettle is started and while the contents of the kettle are being agitated, 1250 grams of magnesium hydroxide liquid containing 32-40 grains of $\text{Mg}(\text{OH})_2$ per fluid ounce is added to the contents of the kettle.

After five additional minutes of agitation of the contents in the mixing kettle, the contents therein are transferred to the mixing barrel. At this time, 2250 cc. of either a 10% by weight solution of polyvinyl alcohol or a 0.5% by weight solution of carboxymethyl-cellulose, comprising the viscosity modifying agent utilized in accordance with the principles of the present invention, is also added to the mixing barrel. All of the individual constituents which ultimately form one preferred new core forming composition are now in the barrel, and it is rotated until the contents thereof form a homogenous mixture.

As a final step in preparing the composition for magnetic cores, heat is applied to the mixing barrel, for example, by a gas flame directed against the side thereof. This heat evaporates the volatile constituents in the barrel whereby a dry, insulated Permalloy powder is obtained which is suitable for pressing into core rings for subsequent firing to make finished magnetic cores. More specifically, the constituents are heated in the mixing barrel until such time as the non-volatilized constituents reach a temperature of approximately 260° F. When the prescribed temperature is reached, the resultant dry, insulated powder is sifted through an 80 mesh screen and collected in individual lots.

In order to produce finished permalloy cores from the dry magnetic powder, the following process steps are performed. The magnetic powder is formed or pressed into toroidal shaped cores by charging measured portions of the powder in a mold cavity of a molding press, for example, and then subjecting the powder to a pressure in the neighborhood of 200,000 lbs. per square inch. During the application of this pressure, as is well known, the metal particles are subjected to strains which may impair the magnetic properties of the core. Therefore, the cores are annealed by a heat treatment, preferably in a hydrogen atmosphere, at a temperature from 1000 to 1200° F., for a period of approximately 20 minutes. During this heat treatment, the insulating materials are fully cured.

A preferred method and one specific example of the composition has thus been set forth which results in a new and improved Permalloy powder core wherein the metal particles thereof acquire insulating coatings of about 1.6%, by weight, of the total dry weight of the insulated particles. Other preferred examples of the core forming composition for different percentages, by weight, of the insulating materials coated on the particles are set forth in the following table, wherein the constituent quantities associated with each example are referenced to 250 lbs. of permalloy particles as a starting base.

Percent insulation	Sodium silicate, grams	Magnesium hydroxide, grams	Colloidal clay, grams	Talc, grams	Polyvinyl alcohol or carboxymethyl-cellulose, cc.	Distilled water, cc.
1.3-----	747	916	792	93	2,250	10,000
1.4-----	805	1,094	853	100	2,250	10,000
1.5-----	863	1,172	914	107	2,250	10,000
1.6-----	920	1,250	974	114	2,250	10,000
1.7-----	978	1,328	1,035	121	2,250	10,000
1.8-----	1,035	1,406	1,096	128	2,250	10,000

added to form the composition of matter of this invention is not critical, and the one specified is deemed to be the most desirable in accordance with the standards of good mixing practice.

As the above constituents are being dry mixed in the

It should be noted that the sodium silicate and magnesium hydroxide, as listed in the above table, are in liquid form, and that the percentages of insulation listed are calculated on the basis of the weight of solid materials in a dry state. It should also be noted that a 0.5%

by weight solution of carboxymethyl-cellulose may be substituted for the polyvinyl alcohol utilized in the specific example described above.

While specific quantities have been set forth in the above table for the various core forming constituents of each example, these constituents may be varied within plus or minus 25 percent of the specified amounts without significantly changing the magnetic properties of the particular core produced therefrom. For the sake of clarity, certain of the appended claims have been drafted such that the compositions claimed therein have, as a starting base, 1000 grams of magnetic particles. Accordingly, the numbers utilized in the above table are equated to this 1000 grams base by simply using 113.4 as a common divisor.

There has thus been disclosed herein an improved method and new and improved compositions for producing Permalloy type magnetic powder cores which are physically strong, and exhibit both predictably high, linear temperature coefficients of $+75 \text{ p.p.m./}^\circ \text{F.}$, $\pm 20 \text{ p.p.m./}^\circ \text{F.}$, and low core losses, with all of these attributes being realized with a "one coat" layer of insulation on the metal particles.

What is claimed is:

1. In a method of making a composition of matter wherein finely divided magnetic metal particles are given an insulating coating, including as materials thereof, initially mixed in a slurry, an alkali metal silicate, magnesium hydroxide, magnesium silicate and water; and wherein the slurry is subjected to a heat treatment to evaporate the volatile constituents of the slurry to form a dry, magnetic powder, the improvement comprising:

adding aluminum silicate in the range of approximately 3.7 to 19.2 times the amount of magnesium silicate, by weight, and based on 1,000 grams of said metal particles as a unit of reference, 14.89 to 24.81 cc. of a viscosity modifying agent selected from the group consisting of a 10%, by weight, solution of polyvinyl alcohol and a 0.5%, by weight, solution of carboxymethyl-cellulose to the slurry prior to the heating step.

2. In a method of making a composition of matter in accordance with claim 1, the alkali metal silicate comprises sodium silicate.

3. In a method of making a composition of matter in accordance with claim 2, said finely divided magnetic metal particles are given an insulating coating of between 0.975 and 2.25%, by weight, of the total dry weight of the resultant insulated particles, and based on 1000 grams of the metal particles as a unit of reference, the insulating coating consisting essentially of the heat-treated product of:

4.93 to 11.41 grams of the sodium silicate having a Na_2O to SiO_2 ratio of 2.84 to 1;

6.72 to 15.48 grams of the magnesium hydroxide in liquid form containing 32 to 40 grains of $\text{Mg}(\text{OH})_2$ per fluid ounce;

5.24 to 12.05 grams of the aluminum silicate;

0.62 to 1.41 grams of the magnesium silicate;

14.89 to 24.81 cc. of the viscosity modifying agent selected from the group consisting of a 10% by weight solution of polyvinyl alcohol and a 0.5% by weight solution of carboxymethyl-cellulose; and

66.00 to 110.2 cc. of water.

4. A method of manufacturing Permalloy-type magnetic powder cores exhibiting consistently high, linear temperature coefficients and low core losses comprising the steps of:

mixing finely divided Permalloy metal particles together with an insulation-forming wet mixture of sodium silicate, magnesium hydroxide, aluminum silicate, magnesium silicate and water in selected proportions sufficient both to establish the consistency of a slurry when agitated and to produce an ultimate insulating coating on said metal particles of 0.975 to 2.25%, by

weight, of the resultant total dry weight of the insulated particles;

adding to and mixing with said Permalloy particles and said insulation forming wet mixture, and based on 1,000 grams of said metal particles as a unit of reference 14.89 to 24.81 cc. of a viscosity modifying agent selected from the group consisting of a 10%, by weight, solution of polyvinyl alcohol and a 0.5%, by weight, solution of carboxymethyl-cellulose, said viscosity modifying agent improving the degree of suspension of the Permalloy particles and the insulation-forming materials in the slurry, and ultimately minimizing the core losses, and

heating said mixed slurry with the viscosity modifying agent sufficiently to evaporate the volatile components in said slurry and to form a Permalloy core-forming powder composition;

charging the resultant dry composition into a mold and applying sufficient pressure thereto to form a Permalloy core; and

applying heat to said formed Permalloy core both to cure and to reduce any physical strains therein which could otherwise adversely affect the magnetic properties thereof.

5. A method in accordance with claim 4 wherein said Permalloy particles consist, by weight, of 80.0 to 83.0% nickel, 17.0 to 15.0% iron and 2.45 to 1.75% molybdenum, and wherein for each one thousand grams of said Permalloy-forming particles, said insulation forming wet mixture added and mixed therewith consisting essentially of 4.93 to 11.41 grams of sodium silicate having a Na_2O to SiO_2 ratio of 2.84 to 1, 6.72 to 15.48 grams of magnesium hydroxide liquid containing 32 to 40 grains of $\text{Mg}(\text{OH})_2$ per fluid ounce, 5.24 to 12.05 grams of aluminum silicate, 0.62 to 1.41 grams of magnesium silicate, 66.00 to 110.2 cc. of water, and wherein said viscosity modifying agent consists of 14.89 to 24.81 cc. of a 10% by weight solution of polyvinyl alcohol and a 0.5% by weight solution of carboxymethyl-cellulose.

6. A method in accordance with claim 5 wherein the nonvolatilized constituents of the mixed slurry are heated to a temperature of approximately 260°F. to evaporate the volatile constituents, wherein the dry powder composition is subjected to a pressure of approximately 200,000 lbs./square inch in the mold to form said cores and wherein the formed cores are finally subjected to a temperature between 1000 to 1200°F. for a period of approximately 20 minutes to cure said molded cores.

7. A method of manufacturing Permalloy-type magnetic powder cores comprising the steps of:

dry mixing for a period of 1 to 5 minutes in a suitable container one thousand grams of finely divided Permalloy metal particles consisting, by weight, of 80.0 to 83.0% nickel, 17.0 to 15.0% iron and 2.45 to 1.75% molybdenum, with 6.99 to 9.64 grams of aluminum silicate, and 0.82 to 1.13 grams of magnesium silicate;

wet mixing in a second suitable container 6.58 to 9.13 grams of sodium silicate having a Na_2O to SiO_2 ratio of 2.84 to 1, 8.96 to 12.39 grams of magnesium hydroxide liquid containing 32 to 40 grains of $\text{Mg}(\text{OH})_2$ per fluid ounce, 66.00 to 110.2 cc. of water and 14.89 to 24.81 cc. of a viscosity modifying agent selected from the group consisting of a 10% by weight solution of polyvinyl alcohol and a 0.5% by weight solution of carboxymethyl-cellulose, said mixing being for a period of time sufficient to obtain a homogenous mixture thereof;

adding the homogenous wet mix constituents in the second container to the dry mix constituents in said first mixing container;

mixing said dry mix constituents with said wet mix constituents until a homogenous wet composition thereof is formed;

applying heat to said homogenous wet composition until the volatile constituents therein are evaporated; charging the resultant dry powder composition of insulated Permalloy particles into a core-forming mold and then subjecting the composition to a pressure sufficient to form a durable magnetic powder core; and

curing and releasing any adverse physical strains in said pressed core by heating the core to a temperature within a range of 1000 to 1200° F.

8. A method in accordance with claim 7 wherein said dry mix is agitated for a period of 2-4 minutes in a suitable mixing barrel, wherein said wet mix is agitated for a period of 3-7 minutes, wherein the heat applied to said homogenous wet composition to evaporate the volatile constituents therein raises the temperature of the non-volatilized constituents to a temperature of 260° F., wherein said dry powder composition is subjected to a pressure of approximately 200,000 lbs. per square inch in the mold to form a magnetic core, and wherein said Permalloy cores are cured at a temperature of 1000-1200° F. for a period of approximately 20 minutes.

9. A new composition of matter composed of:

finely divided metal particles consisting by weight of 80.0 to 83.0% nickel, 17.0 to 15.0% iron and 2.45 to 1.75% molybdenum and, based on 1000 grams of said powder as a unit of reference,

an insulating coating on and separating adjacent metal particles consisting essentially of the heat-treated, dry powder product of:

4.93 to 11.41 grams of sodium silicate having a Na_2O to SiO_2 ratio of 2.84 to 1;

6.72 to 15.48 grams of magnesium hydroxide liquid containing 32 to 40 grains of $\text{Mg}(\text{OH})_2$ per fluid ounce;

5.24 to 12.05 grams of aluminum silicate;

0.62 to 1.41 grams of magnesium silicate;

14.89 to 24.81 cc. of a viscosity modifying agent selected from the group consisting of a 10% by weight solution of polyvinyl alcohol and a 0.5% by weight solution of carboxymethyl-cellulose; and

66.00 to 110.2 cc. of water.

10. As a new article of manufacture, a magnetic powder core composed of:

finely divided metal particles separated from each other by

an insulating coating of between 0.975 and 2.25%, by weight, of the total dry weight of the resultant insulated particles and, based on 1000 grams of said metal particles as a unit of reference, said insulating coating consisting essentially of the heat-treated and fired reaction product of:

4.93 to 11.41 grams of sodium silicate having a Na_2O to SiO_2 ratio of 2.84 to 1;

6.72 to 15.48 grams of magnesium hydroxide liquid containing 32 to 40 grains of $\text{Mg}(\text{OH})_2$ per fluid ounce;

5.24 to 12.05 grams of aluminum silicate;

0.62 to 1.41 grams of magnesium silicate;

14.89 to 24.81 cc. of a viscosity modifying agent selected from the group consisting of a 10% by weight solution of polyvinyl alcohol and a 0.5% by weight solution of carboxymethyl-cellulose, and

66.00 to 110.2 cc. of water.

11. A magnetic powder core in accordance with claim 10 wherein said finely divided metal particles are an alloy which consist, by weight, of 80.0 to 83.0% nickel, 17.0 to 15.0% iron and 2.45 to 1.75% molybdenum.

12. As a new article of manufacture, a magnetic powder core composed of:

finely divided metal alloy particles consisting by weight of 80.0 to 83.0% nickel, 17.0 to 15.0% iron and 2.45 to 1.75% molybdenum, said particles being separated from each other by

an insulating coating of between 1.3 and 1.8%, by weight, of the total dry weight of the resultant insulated particles and, based on 1000 grams of said particles as a unit of reference, said insulating coating consisting essentially of the heat treated and fired reaction product of:

6.58 to 9.13 grams of sodium silicate having a Na_2O to SiO_2 ratio of 2.84 to 1;

8.96 to 12.39 grams of magnesium hydroxide liquid containing 32 to 40 grains of $\text{Mg}(\text{OH})_2$ per fluid ounce;

6.99 to 9.64 grams of aluminum silicate;

0.82 to 1.13 grams of magnesium silicate;

14.89 to 24.81 cc. of a viscosity modifying agent selected from the group consisting of a 10% by weight solution of polyvinyl alcohol and a 0.5% by weight solution of carboxymethyl cellulose; and

66.00 to 110.2 cc. of water.

References Cited

UNITED STATES PATENTS

2,105,070	1/1938	Bandur	-----	148—104
2,977,263	3/1961	Harendza-Harinxma	--	148—104

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148—104