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RUSTPROOFED FERROMAGNETIC POWDER CORE

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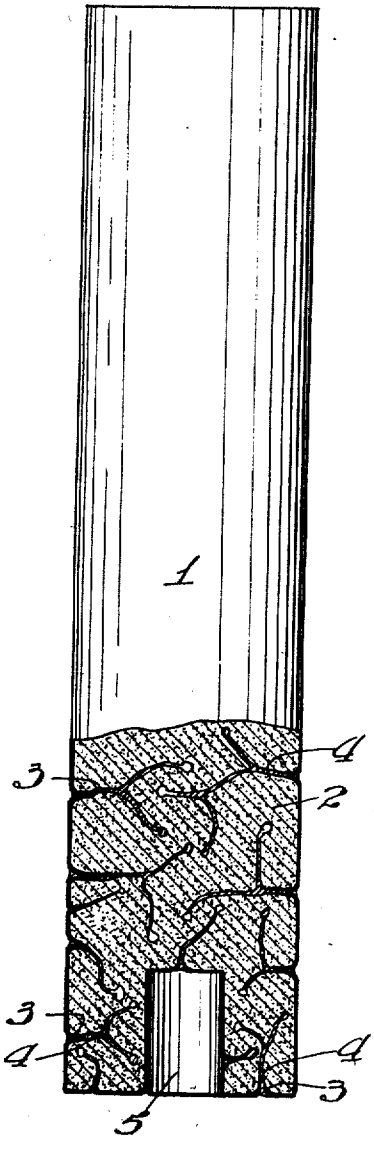
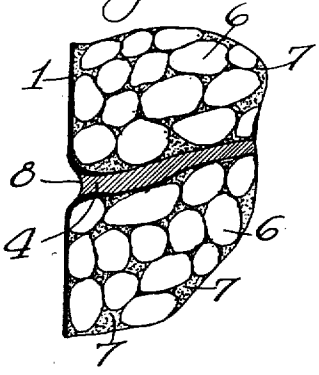


Fig. 1.

Fig. 2.



ILLUSTRATIVE ELEMENTS 4 ARE IRON NAPHTHENATE IN MINERAL OIL

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RUSTPROOFED FERROMAGNETIC POWDER CORE

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5 Claims. (Cl. 175—21)

The present invention relates to cores of magnetic material such as are used in the inductance coils of the low and high frequency arts. The invention relates especially to cores of the type constructed from minute particles of magnetic material, such as iron or iron alloys which have been molded, in the presence of insulating binders, into solid bodies of desired shapes.

By the use of suitable binders and by the proper degrees of compression, cores of this type may be made of considerable mechanical strength so that they may withstand the strains to which they are subjected during transportation and during practical use. It was found, however, that in spite of high degrees of mechanical strength initially possessed by such cores they showed a tendency to become brittle and to break readily after certain periods of time. This was particularly noticeable in places where salt spray or corrosive fumes were plentiful in the air, such as coastal regions or industrial areas. An investigation of cores thus deteriorated revealed that a considerable amount of rusting had occurred on the outside and in the interior thereof. When the metallic constituents of such cores rust, that is to say, when they oxidize under the influence of humidity or industrial fumes, this loosens the coherency of the core body, and since metal oxides are larger in volume than their metallic constituents expansive strains are set up in the interior of the cores which eventually disrupt their structure.

In cores of the movable type, i. e., in cores used for permeability tuning, rusting is harmful also for the reason that it interferes with the mobility of the cores in the forms of the coils with which they cooperate because rusted surfaces are rough and do not glide easily, also rusting increases the volume of the cores so that they ultimately jam in the coil forms.

To remedy these defects cores of the type under discussion were provided with coats of artificial resin varnishes, preferably of the urea formaldehyde type, to exclude moisture and corrosive fumes from the surface and the interior thereof. Unfortunately, however, this way of rust-proofing cores created a series of new difficulties. The coats formed by such varnishes were of appreciable thickness which was frequently uneven for different cores or for different places of one and the same core, and as a result thereof the finished cores showed different magnetic properties when put to practical use, because the unevenness of the thickness of their protective layers slightly varied their positions relatively to the coils with which they cooperated. This meant a considerable increase in the number of cores that had to be rejected. Additionally cores of the type under discussion were frequently provided with indentations or holes for mounting purposes or for the reception of adjustment devices, and these were invariably filled up with the artificial resin varnish and had to be burned out or otherwise cleared in separate operations before the cores were ready for practical use. Also, cores provided with such coatings were found to cause unpleasant microphonic noises during practical use in radio receivers, believed to be due to the fact that the resin coatings were charged with static electricity by friction against the coil form during movement of the core. Thus, whatever protection was secured against the harmful effects of rusting was bought at rather a heavy increase of the manufacturing costs and in exchange for other disadvantages.

It is an object of the present invention to provide magnetic cores that are highly resistant to the effects of humidity and corrosive fumes and which retain their original mechanical strength for long periods of time.

It is another object of the present invention to provide rust-proof cores which are free from tackiness.

It is still another object of the present invention to provide rust-proof cores of the type under discussion which do not cause microphonic disturbances during practical use.

Additionally, it is an object of the present invention to rust-proof cores of the type under discussion in such a manner that the physical dimensions of the cores are not noticeably affected and that indentations and bores that may be provided in the surfaces of the cores for mounting purposes are not interfered with.

It is still another object of the present invention to provide a process for rust-proofing magnetic cores of the type under discussion which does not affect the electrical and magnetic properties of the cores treated.

According to the invention magnetic cores of the type described are impregnated with a solution of a water-insoluble metallic soap in a non-drying oil. Metallic soaps are the salts of metals with one of the higher fatty acids such as oleic acid, stearic acid or palmitic acid. Some of these soaps are soluble in water, such as the sodium and potassium salts of the fatty acids, but others are insoluble in water and these are the ones which are to be employed in accordance with the present invention. Copper naphthenate, for

instance, was found to be very suitable. It is the copper salt of naphthenic acid ($C_6H_{11}COOH$). Lead oleate ($Pb(C_{18}H_{33}O_2)_2$) may be mentioned as another example. For best results, however, I prefer to use water-insoluble soaps of the same metal or metals from which the core to be treated is constructed lest an electrolytic interaction be set up on or within the core between the metal forming the magnetic material of the core and the metal contained in the impregnating substance. Thus, if the core is made from iron, I prefer to use a water-insoluble iron soap, such as iron oleate or iron naphthenate and in cases where the core is constructed of an alloy of iron and tin a mixture of water-insoluble soaps of iron and tin has been found to be very satisfactory.

The non-drying oil in which I solve the water-insoluble metallic soap selected for the treatment of a particular core may be an animal, vegetable or mineral oil, the important point being that it is of the type that does not become gummy on exposure to air. Also care should be taken that the oil employed is free from sulphur and acids. For best results I prefer to use a mineral oil either of the paraffin-base type or of the naphthalene (asphalt) base type having a viscosity characteristic between C and I as determined with the Gardner-Holdt bubble viscometer, or expressed in the C. G. S. system, having a viscosity between about 1.85 to 2.25 poises.

In an exemplary and preferred embodiment of the process of the present invention intended to rust-proof cores made from finely divided iron, I dissolve iron naphthenate in a mineral oil of the paraffin-base type known under the trade name of Quaker State 10. Iron naphthenate is the iron salt of naphthenic acid ($C_6H_{11}COOH$), and the solution should contain from 2–15% of iron naphthenate and from 98–85% of mineral oil. The solution is heated to approximately 220° F. in a suitable container, whereupon the cores are immersed into the liquid for a sufficient time to allow the heat to expel as much as possible the air and moisture held within the pores of the core, which will rise to the surface of the bath in numerous bubbles. I prefer to use a vacuum container for this treatment since it promotes the expulsion of the air and moisture held within the pores of the core. By vacuum container I mean a closed container from which the air has been completely or partly removed. As soon as the bubbling has ceased, which in the example described may require from 5 to 7 minutes, normal atmospheric conditions are restored within the container and the pressure of air upon the surface of the impregnation substance then forces part of this substance into the vacua that have been produced within the pores and cavities of the cores during the preceding treatment, until they are filled to such an extent that no space is left in the interior of the cores from which rusting due to the action of moisture or acid content of the air may commence. Thereupon the cores are removed into a space of materially lower temperature than existed within the container, and for this purpose the temperature of an ordinary workshop will usually be sufficient. The excess oil on the surface of the cores should then be wiped off; to this end the cores may be tumbled in sawdust. Thereupon I place the cores into an oven and subject them to a temperature higher than any temperature to which the cores may be exposed during practical use. In the particular example I am describing I find a temperature of the order of 160° F. very satisfactory. As the cores are heated to this temperature the impregnation substance held within their pores expands and part of it may appear on the surface of the cores. This should be wiped off while the cores are still hot, for which purpose the cores may again be tumbled in sawdust. On cooling, the bodies of oil retained in the pores will somewhat recede from the surface of the cores and will form concave menisci towards the outside which will effectively inhibit exudation of the liquid from the cores during practical use.

The cores are now ready for practical use. Their pores are filled with the impregnation substance which prevents the intrusion of moisture and corrosive fumes and which is securely held within the structure of the cores by the forces of capillarity. They have dry and smooth surfaces, are free from tackiness and will at no time during practical use exude any of the impregnation substance held within their pores.

Also the surfaces of the cores treated in accordance with the present invention are highly resistant to corrosion. Since I am unable to measure any change in the dimensions of cores treated in accordance with the invention which might indicate that a protective coating has formed around these cores, and although I do not wish to exclude the possibility of a film of molecular fineness having been produced on the cores, I believe that their surfaces have been placed into a condition known as passivity in the chemical art, the exact nature of which I am not able to explain.

In the accompanying drawing Fig. 1 is an enlarged view of a core treated in accordance with the present invention with the lower part being shown in central vertical section to disclose the inner core structure.

Fig. 2 illustrates a detail of the core shown in Fig. 1 on a still further enlarged scale.

Sectioned part 2 of core 1 shows a number of pores or passage networks 3 of greatly exaggerated thickness and represented as if they extended substantially in the plane of the drawing. It will be understood that in reality these pores are extremely fine and are not confined to any one plane but frequently turn and extend irregularly in a plurality of different directions. Through these pores, which are scarcely visible in the actual core, moisture and corrosive fumes may reach the interior of the core with the destructive consequences described above. The drawing shows that these cores are now filled up or closed off by bodies 4 of impregnation substance so that the core is no longer subject to intrusion of moisture or corrosive fumes and consequent destruction by rust.

Fig. 2 shows an enlarged view of part of a pore 3 formed by metallic particles 6 and inert matter 7 and extending from the surface of core 1 into its interior. Pore 3 contains a body 4 of impregnation substance held within the pore by the forces of capillarity and forming a concave meniscus 8 as produced by the final heat treatment described above.

Reverting to Fig. 1 this figure also shows a hole or cavity 5 such as may be provided in cores of the type under discussion for the reception of a mounting rod. Cavities of this type may be molded during the manufacture of the cores and in rust-proofing cores these cavities must not be filled up nor must their dimensions be ap-

preciably affected as otherwise separate and costly manufacturing operations become necessary to recondition them for practical use. As shown in the drawing neither the dimensions of the cavity nor the dimensions of the core as a whole have been changed by the process of the present invention so that after the rust-proofing treatment the core is ready for practical use without any reconditioning being necessary. While I am unable to measure any change in the dimensions of the core or the cavity that would indicate the presence of a protective coating, I nevertheless show the contours of the sectionalized part of the core in a line of somewhat exaggerated thickness to indicate that as a result of the process of the present invention some change has taken place on its surface which renders it resistant to corrosion.

Cores treated in accordance with the present invention have been subjected to standard salt spray tests for 24 hours without any signs of rust on the surface or in the interior thereof. They have also been exposed to atmospheres of a relative humidity of 90% at elevated temperatures such as 140° F. for more than 100 hours without their appearance or mechanical strength being affected in any way.

The process of the present invention lends itself readily to mass production so that the added cost of manufacture is very low. The treatment used in accordance with the present invention does not produce any measurable change in the proportions or dimensions of the cores. Thus no source of non-uniformity in the magnetic and electrical qualities of the core is introduced. Furthermore, the cores treated in accordance with the present invention do not introduce microphonic noises of any kind in the receivers in which they are used.

While I have explained my invention above as applied to a core of a particular magnetic material and with the aid of a particular water-insoluble soap and a particular mineral oil, I do not limit myself to the type of core nor to the substances of treatment mentioned. The process of the invention may be applied to magnetic cores constructed from magnetic materials other than iron, and other water-insoluble metallic soaps and non-drying oils than those mentioned may be employed within the scope of the present invention. Also I do not limit myself to the particular temperatures or durations of treatment given in the specification. They may be varied to suit particular requirements, without departing from the scope of the invention. Likewise, although I have illustrated my invention with the aid of a cylindrical core, it will be understood that the invention may be applied to cores of any shape now in use, or which may be conceived in the future.

Having thus described my invention what I claim is:

1. A compressed ferromagnetic powder core having a porous structure and containing in said porous structure a solution of a water-insoluble metal soap in a non-drying oil.

2. A compressed ferromagnetic powder core including metallic particles and having a porous structure, said core containing in said porous structure a solution of a water-insoluble soap of the same metal from which said core is constructed, in a non-drying oil.

3. A compressed ferromagnetic powder core having a porous structure and containing in said porous structure a solution of a water-insoluble metal naphthenate in a mineral oil.

4. A compressed ferromagnetic powder core having a porous structure and containing in said porous structure a solution of an iron naphthenate in a mineral oil.

5. A compressed ferromagnetic powder core having a porous structure impregnated with a solution of a water-insoluble metal soap in a non-drying oil.

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