

UNITED STATES PATENT OFFICE.

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CORE FOR ELECTROMAGNETIC APPARATUS.

No Drawing.

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To all whom it may concern:

Be it known that I, HARRY ROBERT MAC-KNIGHT, a citizen of the United States, residing at Bedford, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvements in Cores for Electromagnetic Apparatus, of which the following is a full, clear, and exact description.

This invention relates to electro-magnetic apparatus generally, and more particularly to the cores of such apparatus; and has for its object to provide a core which will reduce to a minimum losses of electrical energy due to eddy currents and hysteresis, while enabling the desired density of magnetic flux to be obtained.

My invention contemplates broadly constructing the cores for all descriptions of electro-magnetic apparatus from finely divided, insulated particles of iron, the iron being of the quality usually employed for the cores of magnetic apparatus; the higher the frequency of the current passing through the core, the finer will be the particles. For instance, with a frequency of about 100,000 the greatest diameter of each particle will be approximately $1/2000''$, and the insulation employed with and between such particles will be liquid, semi-plastic, plastic, or solid, according to the uses to which the core is to be put and the particular losses to be overcome. A fluid or mobile insulation, such as oil, enables the particles to be separated from each other by a very minute film of oil which not only insulates these particles and prevents the formation of eddy currents, but at the same time enables the desired electro-magnetic flux to flow in a circuit including the core, with a greatly reduced, or entirely eliminated, loss due to hysteresis. The most efficient results in eliminating hysteresis losses are secured by using iron, powdered or otherwise reduced to very minute dimensions, and suspending the powder in a deflocculent state in a fluid or mobile insulation, such as oil. When the iron is thus finely divided, in such deflocculent condition, it will remain suspended in the insulating oil, each particle being free to turn through an arc of 180° on its own axis. Thus a change of polarity, due to a reversal of the electric current, will not create a hysteresis loss inasmuch as each particle will

rotate or oscillate back and forth through an arc of 180° in synchronism with the frequency of the electric current. The loss of mechanical energy due to the friction of the iron particle in oscillating on its own axis while in suspension is strictly in accordance with the diameter of said iron particle, and in the case of fine iron powder is almost nil. In fact, the iron powder is virtually a part of the liquid, giving the liquid the magnetic permeability of iron, without the eddy current and hysteresis losses.

A core consisting essentially of such finely divided iron suspended in a mobile insulating fluid, such as oil, will obviously reduce to a minimum, or practically eliminate, the formation of eddy currents. However, such eddy currents may be prevented or eliminated by using for the insulation, and surrounding the iron particles with, plastic or semi-plastic, or even solid insulation, such as wax, Bakelite, shellac, insulating varnish and powdered mica, bearing in mind that, the higher the frequency of the current or circuit, the finer should be the size of the iron particles. By employing for the cores iron particles the largest dimensions of which are not materially greater than $1/1000$ inch, I am able to effect a marked saving in eddy-current losses in apparatus employing high-frequency current; in fact, the higher the frequency, the greater will be the saving; and this saving will be effected whether the insulation be mobile or otherwise. This enables the use of iron in cores of apparatus wherein the use of iron heretofore has been impracticable because of the great eddy-current losses.

As pointed out hereinbefore, my core may be used for all sorts of electro-magnetic apparatus, such as generators, motors, transformers, induction coils, electro-magnets of all descriptions, armatures, rotors, stators, and electro-magnetic fields. To construct a core for such apparatus, it is, of course, necessary to provide a shell or container for the iron powder and its insulation where the insulation is fluid or mobile, plastic or semi-plastic.

When the powdered iron is fixed or held rigid, it may be first immersed in insulating compounds such as varnish, shellac, Bakelite, etc. in such proportions as to obtain the desired mechanical strength, dielectric strength and magnetic permeability, af-

ter which it may be molded to the desired form and heat treated to obtain the proper bonding and mechanical strength.

My invention is likewise particularly useful in radio apparatus, such as inductance coils of all kinds, employing primaries and secondaries, where the frequency is so high that ordinary iron or sheet steel construction would result in such tremendous losses due to hysteresis and eddy currents, that such iron or steel is not at present in use for increasing or multiplying the magnetic flux in such circuits.

Having thus described my invention, what I claim is:

1. A core for electro-magnetic apparatus composed of minute particles of permeable material, such as iron, suspended in a fluid or mobile insulating compound.

2. A core for electro-magnetic apparatus composed of minute particles of permeable material, such as iron, suspended in insulating oil.

In testimony whereof, I hereunto affix my signature.

HARRY ROBERT MACKNIGHT.