The present invention relates to a method for improving the magnetic and electric qualities of ferro-magnetic metal sheets, bands and the like.

The said method is based on the fact that the magnetic and electric qualities of usual metals and, more particularly, the permeability and aptitude to losses of energy in the mass of ferromagnetic metals are not regularly distributed throughout the mass, the outer layer of said mass showing a higher conductivity than the inner layers which, on another hand, have a higher permeability than the outer layer.

One object of the invention is to provide ferromagnetic sheets, bands and the like, e.g., for the purpose of forming magnetic cores for relays and the like, or transformer yokes, with high magnetic and electric qualities.

Another object of the invention is to provide means to obtain such sheets, bands or the like at will with the required qualities of low aptitude to energy losses or high permeability in the most economical conditions.

According to the invention and in order to increase the above mentioned electric and magnetic qualities, the ferro-magnetic sheets, bands and the like are submitted to an electrolytic polishing treatment removing their superficial layer.

The electrolytic polishing treatment may be any known treatment, provided it is carried out with care. It may advantageously be the method described in the co-pending application Serial Number 46,744, filed August 30, 1948, for Electrolytic Polishing of Metals.

The thickness of the layer removed from the sheets, bands and the like treated according to the invention depends on the result which it is desired to obtain. The thicker the layer removed, the more the magnetic and electric qualities, generally speaking, are increased, but, on the other hand, the higher the cost of the operation. A balance should be established taking into account the qualities required for the treated parts.

In fact, the optimum thickness of the layer to be removed is not the same when the aptitude to energy losses should be decreased, or when the permeability should at the same time be increased.

In order to obtain a substantial decrease of energy losses in the ferro-magnetic substances, even under very low frequencies, it is sufficient to remove through electrolytic polishing a superficial layer the thickness of which is lower than 10% of the total thickness of the treated sheet, band or the like. The loss of material is thus lower than a few units percent of the total weight.

The removal of this superficial layer of a ferromagnetic substance decreases considerably the losses through eddy currents; theoretical studies, confirmed by experiments, have shown that the superficial layer has a higher conductivity for such currents than the inner layers.

Such a treatment is particularly advantageous for substances already having a high permeability, the inner layers of which often have a higher permeability than the outer layer, which develops particularly important eddy currents induced by the inner layers and running in the outer layer the conductivity of which is higher. It is also advantageous for thin sheets in which, as is already well known, the coefficient of losses through eddy currents is particularly high.

In order to obtain a substantial increase of permeability in similar material, the thickness of the removed layer should be around 10% or more of the total thickness of metal.

The following are examples of embodiments of the invention.

The treated metal was a common iron-nickel alloy and the polishing was carried out in a bath formed of perchloric acid and acetic anhydride.

Example I.—Band 0.11 mm. thick.

Measurements were carried out under an alternating current of 400 cycles per sec. The initial permeability, before electrolytic polishing, was 3,700.

After removing eight percent of the cross section of the band through electrolytic polishing, the permeability was 4,300 and the losses were decreased by 34%.

By removing further 38% of the cross section, the permeability reached 5,700.

In both cases, the increase in permeability is still greater under higher frequencies. For instance, under a current of 10 kilocycles per sec. the initial permeability is multiplied by 1.6 after the first above mentioned polishing and by 2.5 after the second.

Example II.—Imbricated piled up sheets (telecommunication transformer yoke).

The measurements were carried out on a unit of 40 sheets each 0.1 mm. thick.

At low frequencies (50 to 1,500 cycles per sec.), the losses in low fields decreased by 7% when 4.7% of the weight of each sheet had been removed.

The increase of the apparent permeability was only 4% at 1 kc./s. When 11% of the weight of the sheets had been removed, the losses, at low frequency, decreased by 25%. At 1 kc./s., the
apparent permeability had increased by 6% and, at 100 kc./s., by 34%.

The above mentioned results relate to un-insulated sheets and still better performances may be obtained, in Example II, by insulating the surface of the sheets, after polishing, through usual means, e. g. through varnishing.

Furthermore, the treatment according to the invention increases the resistance of the treated parts to corrosion and, by reason of the protection given to the surface of the metal, stabilizes the electric and magnetic qualities of the ferromagnetic substance.

The said treatment may be applied before or after the heat or mechanical treatments to which the sheets, bands or the like may have to be submitted.

What I claim is:

1. A process for the manufacture of electromagnetic laminated cores which consists in electro-polishing the superficial layers of ferromagnetic lamina for decreasing the thickness thereof, thereby increasing the magnetic permeability and decreasing losses due to eddy currents, varnishing the polished surfaces of said lamina, and then piling up the polished varnished lamina in stacked relationship.

2. A process for the manufacture of laminated electromagnetic cores made of ferro-magnetic lamina which consists in electrolytically polishing said ferro-magnetic lamina for a time period sufficient to decrease the thickness of the ferro-magnetic lamina from an initial thickness to a final thickness which is approximately less than 10% the initial thickness of said lamina thereby increasing the magnetic permeability and decreasing losses due to eddy currents of said lamina, and thereafter piling up said lamina in superimposed relationship with the polished surfaces thereof in intimate relation.

3. A process for the manufacture of laminated electromagnetic cores made of ferro-magnetic lamina having a relatively minute thickness dimension as compared to width and length dimensions which consists in electrolytically polishing the surfaces of the ferro-magnetic lamina for reducing the thickness dimension thereof by an amount which is approximately 10% of the initial thickness of said lamina, thereby decreasing losses in said lamina due to eddy currents while increasing the magnetic permeability thereof and polishing the surfaces thereof and piling up the polished lamina of reduced thickness in a stack with the polished surfaces thereof in intimate contact to form said core.

ISRAEL EPELBOIN.

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