

## UNITED STATES PATENT OFFICE

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## COATING FOR FERROUS ALLOYS

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This invention relates generally to coatings for ferrous alloys and particularly to a coating for magnetic material.

An object of this invention is the provision of a lubricating and refractory coating for magnetic material.

Another object of this invention is the provision of a coating for ferrous alloys which will function as a die lubricant, a refractory, and an insulating material.

Another object of this invention is the provision of a coating for magnetic material which will not cause deterioration of insulating liquids.

Other objects will become apparent from the following description.

In electrical apparatus, such as transformers, the magnetic material employed as the core members is fabricated from ferrous alloys by rolling an ingot of the ferrous alloy to a predetermined thickness, shearing or punching the rolled material into sheets of a desired size and then annealing the sheets of ferrous alloy to develop its magnetic properties. In fabricating the magnetic material, it is desired to provide a coating on the surface of the alloy that will function as a lubricant during the shearing or punching steps, and as a refractory material between the sheets to prevent the sheets from fusing together during the anneal.

Since the sheets of magnetic material are often employed in conjunction with an insulating liquid, the lubricating and refractory coating on the sheets must not react with the insulating liquid to cause sludging or otherwise impair the insulating properties of the liquid. In addition to these properties, it is desired that the coating provide insulation for the sheets of magnetic material to prevent eddy currents in the assembled apparatus.

In practicing this invention, a coating is provided that will satisfy the requirements hereinbefore enumerated. The coating of this invention comprises a mixture of a colloidal aluminum silicate of a clay-like nature, such as bentonite or kaolin, in a solution of boric acid and magnesium oxide. The colloidal aluminum silicate is a refractory material and when applied as a coating on sheets of ferrous alloy will prevent the sheets from sticking when subjected to an annealing temperature. In order to prevent the refractory material from flaking and blowing off of the sheets of ferrous material during the annealing, the refractory material is carried in a binder comprising a solution of boric acid, magnesium oxide and water.

The boric acid employed in the solution has of itself no binding or adhesive value, but when chemically reacted with magnesium oxide, the boric acid and magnesium oxide form a strong adhesive film-forming substance somewhat similar to "water glass", which is quite effective in maintaining the colloidal aluminum silicate on the surface of the sheets of magnetic material. Since the coating is often employed in conjunction with insulating liquids, the boric acid in the binder is of special value to the coating, since it has been proven through experiments that boric acid retards the deterioration of insulating fluids, such as oil.

In practice, the coating employed comprises 100 parts by weight of water, 1 to 100 parts by weight of the colloidal aluminum silicate, 1 to 10 parts by weight of boric acid, and magnesia in an amount ranging from 1 to 100% of the weight of the boric acid employed. The choice of the amount of the colloidal aluminum silicate depends upon the material employed and the annealing temperature to which the coating will be subjected.

Where low annealing temperatures of the order of 725° C. are employed, the refractory material, bentonite, will substantially prevent the sticking of the sheets of ferrous alloy. In the bentonite coatings, 1 to 50 parts by weight of bentonite gives a stiff mixture when employed in the solution within the ranges given hereinbefore and produces satisfactory results.

Where the coating is to be subjected to a high annealing temperature, it is sometimes desirable to employ kaolin as the refractory material instead of bentonite. This is because kaolin, being a purer grade of colloidal aluminum silicate, is more refractory than bentonite. In order to produce a coating of the same constituency as when bentonite is employed, it is necessary to employ more of the kaolin than the bentonite with a given solution. As much as 100 parts by weight of kaolin may be employed with the boric acid-magnesium oxide solution given hereinbefore.

Sufficient magnesium oxide is employed in solution with boric acid to render the solution substantially neutral. This solution is a good binding agent for the refractory materials. When applied to the sheets of ferrous alloy, the boric acid solution containing the refractory material may be easily dried leaving a glassy film on the surface of the sheets. This film functions as a lubricant for the shears or dies employed in shearing or punching the sheets to the desired size. The magnesium oxide in the coating, in

addition to reacting with the boric acid to make the solution neutral, further functions as a refractory material.

Some of the preferred bentonite coatings are given in the following table:

|                        | Parts by weight |        |        |
|------------------------|-----------------|--------|--------|
|                        | #74             | #86    | #100   |
| Bentonite.....         | 17.15           | 9.5    | 8.     |
| Boric acid.....        | 5.75            | .5     | 8.     |
| Magnesium oxide.....   | .43             | .036   | .29    |
| Water.....             | 100.00          | 100.00 | 100.00 |
| Red oxide of iron..... |                 |        | 1.7    |

In the above table, it is noted that coating #100 contains 1.7 parts by weight of red oxide of iron. The red oxide of iron is added to the solution in order to give a distinctive color to the coating. In addition to giving a particular color to the coating, the iron oxide also functions, when the coating is applied to the sheets of ferrous alloy, as a refractory and aids in preventing the sheets from sticking during the annealing process. Red oxide of iron may or may not be added to the coating as desired.

Where the sheets of ferrous alloy are subjected to annealing temperatures of 1100° C. or higher, a more refractory coating than the bentonite coatings listed above may be desired. A kaolin coating comprising 80 parts by weight of Georgia kaolin, 2 parts by weight of boric acid, .15 part by weight of magnesium oxide, and 100 parts by weight of water is particularly satisfactory at the higher temperatures since it does not fuse, but instead prevents the sheets from sticking together.

Other alkaline earth bases such as calcium, strontium or barium may be employed in the coating with satisfactory results instead of magnesium oxide referred to in the specific examples given although magnesium oxide is preferred. Alkalis, such as lithium, sodium and potassium may also be employed with satisfactory results.

The coatings comprising the ingredients in the proportions hereinbefore described are satisfactory since each of them functions as a lubricant

for lubricating the shears during the shearing step in addition to acting as a refractory to prevent the sticking of the sheets. Under test, it is found that the film deposited on the sheet when the solution is evaporated provides sufficient insulation for preventing eddy currents. The coatings further do not cause deterioration of the insulating liquids with which they are employed.

Although this invention has been described with reference to a particular embodiment thereof, it is, of course, not to be limited thereto except insofar as is necessitated by the prior art and the scope of the appended claims.

I claim as my invention:

1. A coating for ferrous alloys comprising from 1 to 100 parts by weight of a colloidal aluminum silicate selected from the group consisting of bentonite and kaolin in a solution consisting of about 100 parts by weight of water, from 1 to 10 parts by weight of boric acid and magnesium oxide in an amount ranging from 1% to 100% of the weight of the boric acid.

2. A coating for ferrous alloys comprising from 1 to 100 parts by weight of kaolin in a solution consisting of about 100 parts by weight of water, from 1 to 10 parts by weight of boric acid and magnesium oxide in an amount ranging from 1% to 100% of the weight of the boric acid.

3. A coating for ferrous alloys comprising from 1 to 50 parts by weight of bentonite in a solution consisting of about 100 parts by weight of water, from 1 to 10 parts by weight of boric acid and magnesium oxide in an amount ranging from 1% to 100% of the weight of the boric acid.

4. A coating for ferrous alloys comprising about 17 parts by weight of bentonite, about 5.75 parts by weight of boric acid, about 0.45 part by weight of magnesium oxide and about 100 parts by weight of water.

5. A coating for ferrous alloys comprising about 80 parts by weight of kaolin, about 2 parts by weight of boric acid, about 0.15 part by weight of magnesia, and about 100 parts by weight of water.

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