Patented Jan. 7, 1947

2,413,949

UNITED STATES PATENT OFFICE

2,413,949

TREATING SILICON STEEL STRIP

Michael Broverman, Pittsfield, Mass., assignor to General Electric Company, a corporation of New York

No Drawing. Application December 23, 1942, Serial No. 469,938

4 Claims. (Cl. 148—7)

1

The present invention relates to treating silicon steel and to a process for annealing and insulating such steel particularly when in the form of cold rolled strip. In the manufacture of cold rolled silicon steel strip for use in dynamo electric machines, transformers and the like, it is desirable to anneal the steel strip at a temperature of about 980° C. to 1180° C. in a reducing atmosphere such as hydrogen and thereafter to anneal the strip at a temperature in the neighborhood of 875° C. and generally in a slightly oxidizing atmosphere. Such a process is effective for obtaining minimum watt losses when the steel is employed in electrical apparatus.

It is one of the objects of the present invention to provide an easily removable coating on the steel prior to the high temperature hydrogen anneal to prevent adjacent layers of the coiled steel from sticking or fusing during the anneal. It is a further object of the invention to provide the steel, prior to the final anneal, with an insulating coating which, after the anneal, provides an effective insulation without adversely affecting the space factor between adjacent steel layers.

In carrying out my invention cold rolled silicon steel strip in the order of 10 to 14 mils in thickness is employed. If the annealing temperature to be employed is in the neighborhood of 1180° C. the steel strip, which preferably has been brushed to provide a clean surface, is supplied with a coating of magnesium oxide. For this purpose the oxide is mixed with water and sprayed onto both sides of the strip. The steel is then baked in a low temperature oven to remove some of the water and to cause the coating to adhere to the surface of the strip. The strip as it leaves the oven is wound tightly into reels. Thereafter the coiled steel is annealed preferably at a temperature in the neighborhood of 1180° C. After the anneal the magnesium oxide is relatively loose on the steel and as the coil is unwound the magnesium oxide is removed by motor driven brushes and carried away by suction fans for later reuse.

The cleaned strip is now coated by passing it through a dilute phosphoric acid solution containing a small percentage of nitrates. The steel is immersed in the acid solution only for one or two minutes after which it is rinsed in water. The coated steel is then wound into cores of the desired weight and shape and annealed at a temperature of 875° C. The anneal preferably is carried out in a water sealed furnace having a wet gas atmosphere which is mildly oxidizing and may consist of about 85% nitrogen and 15% hydrogen. The acid phosphate coating provides the

2

surface of the steel with an inert phosphate coating. Prior to the final anneal the acid phosphate coating is about .2 to .3 mils thick but after the anneal the thickness of the coating is substantially negligible although the insulation provided by it is entirely effective. The very thin insulation coating provided by my improved process is a particularly desirable feature since the space factor of the resulting electrical structure is improved to that extent.

If the cold rolled silicon steel is to be subjected to a relatively low annealing temperature for example a temperature of about 980° C. rather than 1180° C. the magnesium oxide coating is omitted since there is no tendency for the adjacent turns of the coiled steel to stick together at this temperature. In that case, the silicon strip is wound into a tight reel, annealed at about 980° C., unwound, brushed to provide a clean surface, and then provided with an acid phosphate coating as hereinbefore set forth.

The desirable results attained by the present process appear to be due to a combination of several factors; first, the period of time that the steel is immersed in the acid solution is relatively short, for example one or two minutes; second, the final anneal is carried out in an atmosphere which is only mildly oxidizing, for example in wet gas consisting of about 85% nitrogen and 15% hydrogen; and third, while the final anneal of the steel materially reduces the thickness of the applied insulation, the coating is sufficiently thick to provide the desired insulation and space factor. If the final anneal is carried out either in a reducing atmosphere such as hydrogen or in a strongly oxidizing atmosphere the coating disintegrates and leaves no insulation and provides no corrosion protection.

The ingredients of the present coating bath are mixed in the proportion of about 70 pounds to 100 gallons of water. The pH of the solution is about 2 to 2.5 and the total acidity varies from about .25 to .50% phosphoric acid.

While I have described my invention particularly in connection with cold rolled silicon steel strip, it will be clear that my improved process also may be applied if desired to silicon steel sheets or laminations.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of insulating silicon steel which comprises applying an acid phosphate coating to the steel and thereafter annealing the steel in a slightly oxidizing atmosphere of wet gas consisting of about 85% nitrogen and 15% hydrogen

and at a temperature in the neighborhood of 875° C.

2. The method of treating silicon steel strip which comprises applying an acid phosphate coating to the strip, tightly winding the strip into the form of a core and thereafter annealing the wound core at a temperature in the neighborhood of 875° C. and in an atmosphere of wet gas consisting of about 85% nitrogen and 15% hydrogen and which is only slightly oxidizing.

3. The method of treating cold rolled silicon steel strip which comprises immersing the strip in an acid phosphate solution for about one or two minutes, annealing the strip at about 875° C. in a water sealed furnace and in an atmosphere consisting of about 85% nitrogen and 15% hydrogen.

4. The method of treating cold rolled silicon steel strip which comprises immersing the strip in an acid phosphate solution for about one or two minutes and annealing the strip in wet gas consisting of about 85% nitrogen and 15% hydrogen at a temperature of about 875° C.

MICHAEL BROVERMAN.