

UNITED STATES PATENT OFFICE

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TREATING SILICON STEEL

No Drawing.

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My invention relates to the production of silicon steel for electrical purposes, and is particularly directed to the obtaining of improved surface conditions in the product after it has been annealed to impart proper electrical properties.

The treatment of silicon steel sheets in order to clean and flatten them, and anneal them without injuring the surface, is quite difficult, due to a number of factors among which are the adhesiveness of the mill scale on the hot rolled sheet, which calls for particular care in the pickling operation, and the troublesome tendency of the sheets to stick to each other during the annealing cycle. It has been the practice to underpickle silicon steel sheets so as to avoid pickle brittleness and to leave some of the scale in place, due to the tendency of perfectly clean sheets to stick to each other. It has also been the practice to use a mechanical separator such as lime in order to prevent the adhesion of sheets during annealing. Both of these methods are not, however, entirely satisfactory.

It is the object of my invention to provide a separator for silicon steel sheets during annealing, which undergoes a chemical reaction in conjunction with the silicon in the steel, and results in the formation of a separator or spacer.

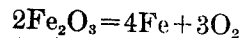
I accomplish my object by providing the sheets with a coating of oxide, either prepared on the sheet itself, or imposed upon the sheet, and I will describe a number of different ways of obtaining this oxide coating which must be of substantial thickness, as compared, for example with the oxide which will form naturally on the product upon exposure to the air within the mill buildings.

The idea of using a thin film of oxide as a separator during annealing has been suggested for ordinary steel sheets, but it is very questionable whether such films would serve any good purpose. The reducing conditions of annealing would reduce the oxide content of the film and the ferrous iron thus produced would be likely to bind or weld the sheets together, instead of spacing them.

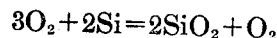
With a fairly thick oxide coating on silicon steel, however, the result of the reducing conditions of annealing is to form ferrous iron, as above indicated, but a portion of the oxygen combines with the silicon in the steel producing silica, which forms a fine whitish powder, nonadherent, and readily removed by mechanical means. This silica is the product which functions as the spacer.

The probable chemical reaction which takes place during the annealing is as follows:

Reduction



Oxidation



According to one process which I have followed with success, hot rolled silicon steel sheets are pickled in sulphuric acid solution, to an extent which entirely removes all scale thereon, leaving them perfectly clean.

The sheets are then washed so as to be free from acid, and passed slowly through a furnace under oxidizing conditions. In the furnace a temperature of around 1200 degrees Fahrenheit may be maintained, and the time of exposure within the furnace should be such as to build up a thick coating of oxide.

Such pickle brittleness as develops because of fully pickling the sheets, is dissipated by the heating thereof when oxidizing them. A temperature of around 1200 degrees is not such as will effect the electrical properties under the conditions noted.

The sheets with the oxide coating hereon, and formed into piles, are placed into annealing boxes and given the annealing treatment in the usual manner for imparting desired electrical properties. If desired, additional spacer material such as lime may be employed, although in my present practice, I do not find any advantage in doing so.

If required to impart flatness, there may be a cold rolling between the several heatings of the annealing cycle.

If the oxide coating is thick enough, the result of the annealing is to bring about the chemical reactions above indicated, and the

product after annealing is covered with a fine whitish powder which is mainly formed of silica. This silica is readily brushed, blasted or wiped away, leaving the sheets with a fine silvery surface of great smoothness and uniformity.

There will be practically no sticking of sheets to each other due to the silica spacer, the effectiveness of the spacer being apparently directly proportional to the thickness of the primary oxide coating.

It will be found that silicon steel sheets will develop the maximum oxide coating, due to heating under oxidizing conditions, quite rapidly, and it will be sufficient direction to state that the maximum oxide coating should be obtained.

It is also practical to impose upon the hot rolled and pickled sheets an artificial oxide coating. This is best done either by forming a water suspension of iron oxide, and spraying it upon the sheets, or passing the sheets between rolls which are supplied with a coating of water suspended oxide. A fairly thick coating should be applied, which covers the surfaces of the sheets fully.

I do not wish to limit myself to the three methods noted of coating silicon steel sheets with oxide, as any method of surfacing the sheets with the oxide will serve my purpose.

In the artificial coatings I have found that a grade of ferric oxide containing up to 90 per cent of the oxide, together with other metallic oxides, such as those of silicon, aluminum and calcium, will serve effectively, although many other grades have been employed with satisfactory results, some of which have as low as 60% ferric oxide. Thus, by reference to iron oxide in the claims that follow, I wish to include substances which contain sufficient proportion of ferric oxide to take their character generally therefrom.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A process for treating silicon steel sheets which comprises forming upon the said sheets a coating of iron oxide assembling said sheets into packs, and afterward annealing said sheets under reducing conditions.

2. A process for treating silicon steel sheets which comprises heating said sheets under oxidizing conditions to around 1200° F. so as to form a coating of oxide thereon, cooling said sheets, assembling them in piles, and afterwards annealing them under reducing conditions.

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