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PORTER H. BRACE, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

PRODUCTION OF THIN STEEL.

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This invention relates to thin steel sheets, more particularly to extremely thin sheets which are adapted for use in cores and pole pieces of high-frequency electrical apparatus.

In cases where machinery for the production of high-frequency currents is utilized, as in radio apparatus, it has been found that the ordinary laminations or steel sheets of three to five mils thickness cannot be used successfully on account of the extremely high losses, due to hysteresis and eddy currents, which cause rapid heating of the core or pole pieces, with a great waste of energy and heating of the apparatus, thus greatly decreasing its efficiency.

All previous attempts to produce very thin steel sheets for this purpose have failed of success. When a pack of steel sheets to be reduced in size is passed through reducing rolls there is a tendency for the formation of a roughened surface thereon. This effect is, apparently, due to the directional properties of the crystals comprising the sheet. The crystals in one sheet, which are oriented in the direction of maximum resistance to the rolling stresses, form indentations on the adjacent surface of the contiguous sheet, resulting in the roughening of all the surfaces, which persists and is intensified as the sheets are reduced in thickness.

In attempting to roll such sheets to very thin sizes, in the neighborhood of two mils or less in thickness, there is a tendency for the sheets to adhere to each other, and perforations appeared in the sheets when their thickness was reduced to about two mils or less.

It is among the objects of the present invention to produce thin steel sheets and to provide a method of producing the same which is efficient and will result in steel sheets of extreme thinness, the surfaces of which are smooth, in which there are no perforations and the cross section of which is uniform throughout.

My invention is based on the fact that the metal, when first subjected to cold plastic deformation, such as rolling, will recrystallize on annealing. By choosing a suitable annealing temperature the grain sizes of the recrystallized material may be made much smaller than those of the original metal.

In practising my invention, I combine hot rolling of the steel sheet material with cold rolling and annealing in such manner that the grain size of the sheets is kept small relative to the thickness thereof at all stages of the process.

More specifically, my invention contemplates the reduction of a pack of steel sheets by hot rolling the pack, then cold rolling the separated individual sheets, subsequently annealing the same in packs to reduce the grain sizes and then rerolling. These steps may be repeated in cycles and the hot rolling may be omitted, if desired, in some of the repeated operations.

A method of producing very thin steel sheets of a thickness of about .4 mils is as follows:

A number of sheets of steel are assembled to form a pack which is rolled at a temperature of about 750° to 800° C. to form individual sheets of about five mils in thickness. The edges of the pack are then trimmed, the sheets separated and cold rolled individually with the rolls tight together. The sheets are then packed together and hot rolled at a temperature of 700° to 750° C. to produce sheets about three mils thick. The edges of the pack are then trimmed, the sheets separated and cold rolled individually, as before.

The sheets are again packed and then annealed at 700° to 800° C. and cold rolled in the pack to produce sheets about 1.5 mils in thickness. The edges of the pack are then trimmed, the sheets separated and cold rolled individually, as before. The packing, annealing at 700° to 800° C., the subsequent cold rolling to reduce the sheets and rolling the sheets individually cold may be repeated as many times as desired, reducing the thickness of the sheets a desired amount with each cold rolling of the pack. In order to reduce sheets of 1.5 mils to .4 mils in thickness two cold rollings are usually sufficient.

Although I have described specifically and in detail my invention as applied to the production of steel having a thickness of .4 mils and have stated temperatures and details of manipulation, it is obvious that my invention is not limited to the exact embodiment described. I may vary the details of manipulation, using various thicknesses and sizes of sheets and I may use temperatures other than those specified. I may perform the

various operations in a reducing atmosphere, if desired, especially when there is a tendency for the rolled sheets to adhere to each other, due, in large measure, to the presence of oxide on the surfaces thereof.

I claim as my invention:

1. A method of producing thin steel sheets of less than two mils thickness which comprises rolling the steel, annealing the same at a temperature of 700° to 800° C. to reduce the grain size and then rolling to further reduce the thickness.

2. A method of producing thin steel sheets which comprises rolling the steel, annealing the same to reduce the grain size and then cold rolling and repeating the process.

3. A method of producing thin steel sheets which comprises hot rolling a pack of sheets, cold rolling the individual sheets, annealing the same to reduce the grain size and then cold rolling.

4. A method of producing thin steel sheets which comprises hot rolling a pack of sheets, cold rolling the individual sheets, packing the same, annealing said pack, and then cold rolling.

5. A method of producing thin steel sheets which comprises hot rolling a pack of sheets, cold rolling the individual sheets, packing the same, annealing said pack to 700° to 800° C. to reduce the grain size, and then cold rolling.

6. A method of producing thin steel sheets which comprises hot rolling a pack of sheets, cold rolling the individual sheets, packing the same, annealing said pack at 700° to 800° C. to reduce the grain size, separating the sheets and cold rolling the same individually.

7. A method of producing thin steel sheets of less than two mils thickness which comprises hot rolling, cold rolling and annealing under such conditions that the grain size of the sheet is made small in relation to its thickness.

8. A method of producing thin steel sheets which comprises the steps of reducing the thickness of the sheets by cold rolling in a pack and then annealing at a temperature sufficient to recrystallize the steel and avoid the growth of grains which are large as compared to the thickness of the sheet.

9. A method of producing thin steel sheets which comprises the steps of successively reducing the thickness of the sheets by cold rolling and then annealing at a temperature sufficient to recrystallize the steel and avoid the growth of grains which are large as compared to the thickness of the sheet and intermittently cold rolling the individual sheets to prevent unevenness in the surfaces thereof.

10. The method of producing thin steel sheets which comprises the steps of successively cold rolling the sheets in a pack, heating to a temperature sufficient to recrystallize the steel but insufficient to produce grains which are large in comparison to the thickness of a sheet and smoothing the sheets at intervals by rolling the same individually.

In testimony whereof, I have hereunto subscribed my name this 10th day of February, 1921.

PORTER H. BRACE.