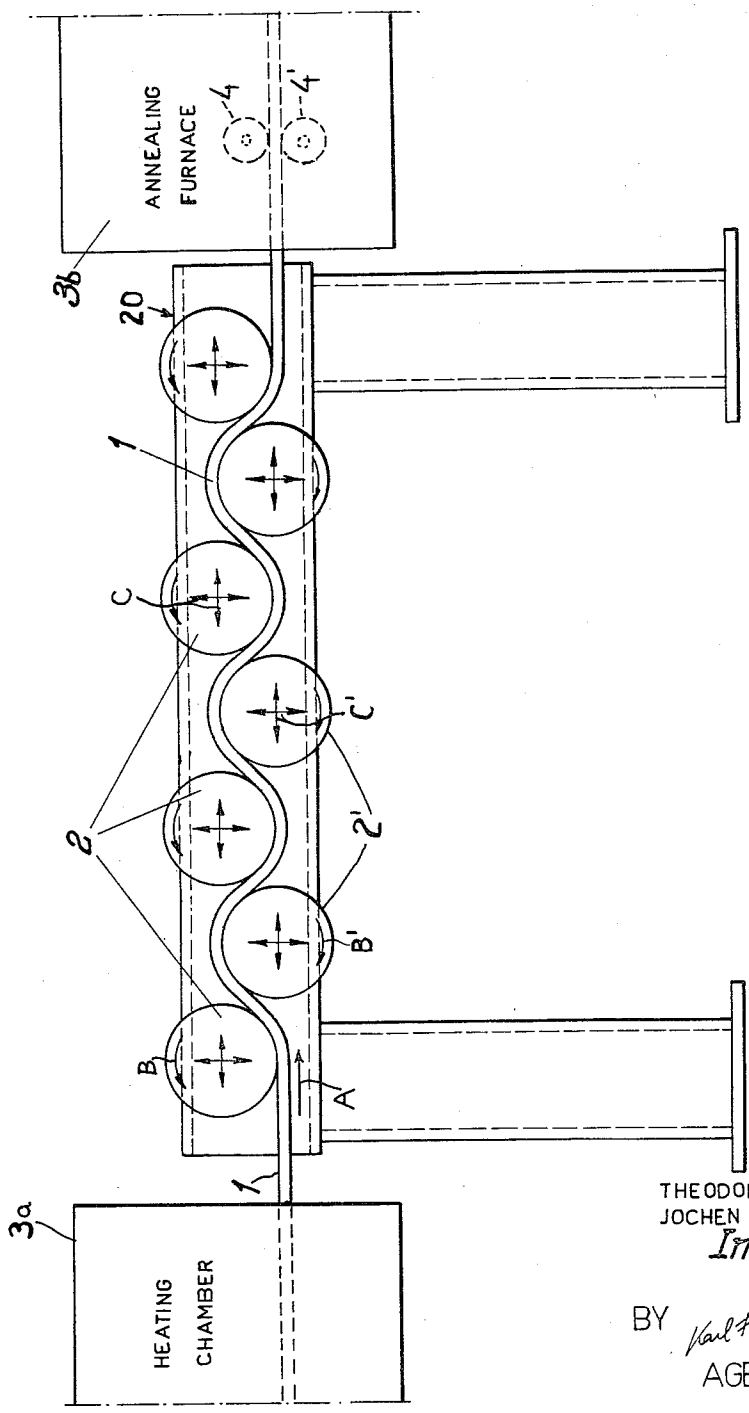
Dec. 29, 1964 T. SCHMIDT ETAL 3,163,201

PROCESS AND APPARATUS FOR PRODUCING CONDUCTIVE SHEET MATERIAL HAVING LOW POWER LOSSES

Filed Feb. 6, 1961



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United States Patent Office 3,163,201
Patented Dec. 29, 1964

3,163,201

PROCESS AND APPARATUS FOR PRODUCING CONDUCTIVE SHEET MATERIAL HAVING LOW POWER LOSSES

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Filed Feb. 6, 1961, Ser. No. 87,444
Claims priority, application Germany, Feb. 10, 1960, J 17,676
3 Claims. (Cl. 153—86)

Our present invention relates to the manufacture of conductive sheet material and, more particularly, to a process and an apparatus for producing sheet-metal bodies such as plates, bands and strips which have low power losses and which may therefore be used economically for electric transducers (e.g. transformers), electromechanical machines (e.g. motors and generators) and the like.

Conductive plates, bands and strips, adapted to be used in the above-mentioned electric devices and in others wherein low power losses due to eddy-current effects are required, have been manufactured hitherto by processes in which the raw high-loss sheets and strips are finished by annealing and subsequent cold working to improve their electrical performance. The cold working generally involved the passing of the sheet material between the rollers of a conventional cold-rolling mill, usually under tension and in a repeated operation to realize the desired effect. These cold-rolling processes necessitated considerable deformation, often reducing the bulk of the sheets by about 20% upon each pass between the rollers, in order to reduce the loss factor of the material to any satisfactory extent. The rollers utilized in these processes experienced substantial wear and required frequent adjustment and/or replacement while the finished sheet was always of diminished thickness. Other known sheet-treating processes for reducing power losses were equally unsatisfactory.

It is an object of our invention to provide an improved process for reducing the power losses of conductive sheet material without appreciable alteration of the thickness thereof.

It is a further object of the invention to provide a low-cost continuous process for producing sheet materials having low power losses.

Still another object of the present invention is to provide means for reducing the power losses of such sheets without permanently deforming them.

According to a feature of the invention, metallic plates and strips having relatively high power losses may be treated to reduce these losses by a process in which each part of a sheet-metal body having the desired final thickness is alternately bent in opposite directions and thereafter straightened substantially without compression. The sheet may thus be passed through a corrugating device having a plurality of spaced-apart rollers alternatingly engaging the sheet on opposite sides thereof and extending transversely to the direction of travel of the sheet. The sheet is thus temporarily given an undulating configuration and thereafter drawn from the device as a flattened body. The finished material will then be found to have substantially reduced power losses and a thickness generally equal to that of the starting material. The sheet is, moreover, heat-treated or annealed during corrugation or subsequently thereto to complete and perpetuate the rearrangement of its molecular structure.

We have found that the power loss of a metallic sheet may be reduced still further when tension is applied to the sheet as it passes between the deforming rollers. Each deformation is then accompanied by a certain degree of stretching which, however, should be limited (especially when the operation is carried out at elevated temperatures) so as not materially to alter the thickness of the sheet.

The corrugating device is, according to a more specific feature of the invention, disposed adjacent an annealing furnace through which the sheet passes during or after its mechanical deformation. Thus it is possible, and often desirable, to position the device within the furnace or between a pair of furnaces or heating chambers. The rollers of the device are then advantageously provided with cooling means adapted to regulate the temperature of the sheet.

We have found that particularly gratifying results may be obtained if the sheet is passed through the aforedescribed corrugating device at the recrystallization temperature of the metal. This mode of treatment evidently has a more profound effect upon the metallic structure than a deformation at lower temperatures.

Since there is substantially no permanent deformation of the sheet passing through the corrugating device, the process according to the invention does not require frequent adjustment and replacement of the deforming rollers. If the rollers are properly centered, all portions of a sheet pass through the same sequence of deformations. Sheets treated by our process, therefore, have reproducible power factors and other electrical and magnetic characteristics which are substantially uniform over their entire length and width. The effects of the rollers are cumulative up to a point, hence an increase in the number of rollers will often afford greater improvement.

The above and other objects, features and advantages of the invention will become more readily apparent from the following detailed description, reference being made to the accompanying drawing the sole figure of which is a somewhat diagrammatic illustration of an apparatus for carrying out the process of the invention.

In the drawing, a conventionally manufactured metal sheet or strip **1** with the usual high power losses emerges hot from a heating chamber *3a*, advancing in the direction of arrow A between two sets of opposing rollers **2**, **2'** of a corrugating device **20** and thence passing through an annealing furnace *3b*. Additional feed rollers **4** and **4'**, together with the rollers **2**, **2'** which may be positively driven as indicated by the arrows B and B', advantageously maintain the sheet under limited tension to assist in the reorientation of its crystalline structure. It will be noted that the minimum distance between any two rollers **2** and **2'**, which may be individually or jointly adjustable as indicated by the arrows C and C', is always greater than the thickness of the sheet-metal body **1** so that the latter will not undergo any compression on its passage through the device **20**. One observes that the rollers **2**, **2'** temporarily deform the sheet **1** into an undulating pattern which remains stationary as the sheet advances through the heating zone *3a*, *3b*. The exact sheet temperature during deformation may be further controlled by passing a cooling (or heating) fluid through the rollers as is well known per se.

It will be apparent that the apparatus shown in the drawing may constitute one of the stages of a plant for the continuous manufacture of sheet-metal plates, strips and the like. In such case the heating chamber *3a* may be constituted by the final hot-rolling stage from which the sheets emerge with substantially their design thickness.

The invention as described and illustrated is believed to admit of many variations and modifications intended to be included within its scope as claimed. For example, while we prefer to deform the sheet material at a temperature in the vicinity of its recrystallization temperature, some deviations therefrom in either sense can be tolerated.

We claim:

1. A process for reducing the electric power losses of a sheet-metal body, comprising the steps of heating said body to an elevated temperature, bending the heated body in an undulating pattern without substantial alteration of the dimensions thereof, straightening said body and annealing said body.

2. A process for reducing the electric power losses of a sheet-metal body, comprising the steps of heating said body to an elevated temperature close to the recrystallization temperature of the metal, bending the heated body in an undulating pattern without substantial alteration of the dimensions thereof, straightening said body and annealing said body.

3. A process for reducing the electric power losses of a sheet-metal body, comprising the steps of progressively advancing said body through a heating zone, successively bending each part of the heated body alternately about transverse axes on opposite sides thereof without substantial alteration of the dimensions thereof, thereafter straightening said body, and annealing said body.

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