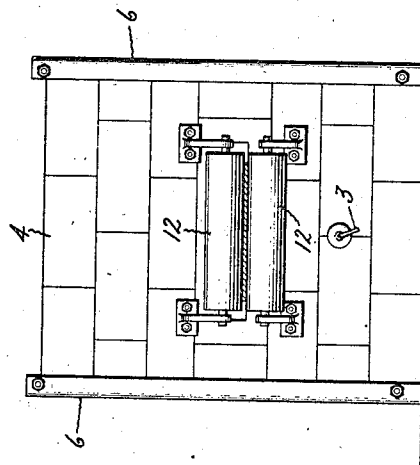
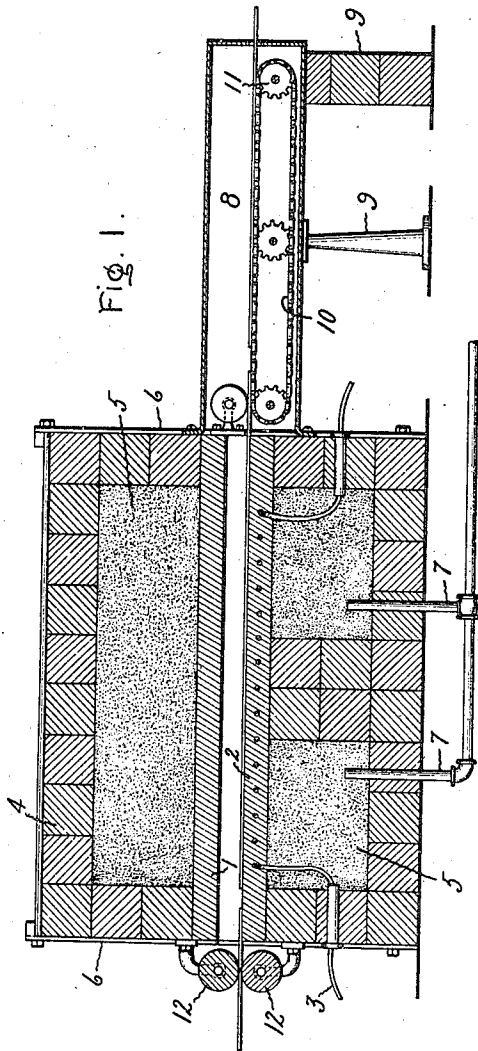


W. E. RUDER.
PROCESS FOR ANNEALING MAGNETIC MATERIAL.
APPLICATION FILED SEPT. 14, 1912.

1,156,496.

Patented Oct. 12, 1915.



Witnesses:

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Inventor:

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by *Alfred H. Davis*
His Attorney.

UNITED STATES PATENT OFFICE.

WILLIAM E. RUDER, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

PROCESS FOR ANNEALING MAGNETIC MATERIAL.

1,156,496.

Specification of Letters Patent.

Patented Oct. 12, 1915.

Application filed September 14, 1912. Serial No. 720,340.

To all whom it may concern:

Be it known that I, WILLIAM E. RUDER, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Processes for Annealing Magnetic Material, of which the following is a specification.

The present invention relates to the manufacture of magnetic steel, such as silicon steel, and comprises particularly a process of annealing the steel after it has been mechanically worked.

Silicon steel, after having been rolled in sheet form, has heretofore been stacked in iron pots and annealed for about thirty-six hours in a gas-fired furnace at a temperature of about 700–800° C. The magnetic properties of the steel are improved by this treatment.

I have discovered that magnetic properties may be imparted to the steel equal to those produced by the above described treatment in a very short time by passing the sheets continuously through a heating zone supplied with a non-oxidizing or a reducing gas, the temperature of the zone and the rate of progress of the sheets being so adjusted that the sheets are heated to a temperature above the ordinary annealing temperature, preferably to a temperature of at least 1000° C. as will appear from the following description taken in connection with the accompanying drawing in which—

Figure 1 is a longitudinal section of a furnace suitable for carrying out the annealing process, and Fig. 2 is a side elevation of the same.

Referring to Fig. 1, a heating zone is surrounded by alundum slabs, the upper and lower of which, numbered 1 and 2, are shown in section in Fig. 1. As indicated in the drawing the lower alundum slab is provided with a resistance heater 3, which passes back and forth in a zig-zag manner through the slab. The heater 3 may consist of a refractory metal such as molybdenum or tungsten and is threaded through holes provided in the slab. The lining of the heating zone is surrounded by chambers constituted of firebrick walls 4 and filled with a suitable refractory heat insulation 5, such as powdered alumina, silica or the like. The firebrick and the alundum linings are held in position by a suitable metal frame-

work 6. Hydrogen, nitrogen or other gas serving to protect the sheets from oxidation during the heat treatment is introduced into the chamber forming the heating zone by pipes 7, the gas diffusing readily through the heat insulation and the alundum lining into the heating zone proper.

At one end of the furnace is provided a cooling chamber 8 which may consist simply of a metal walled chamber suitably supported by posts 9 as indicated. This chamber being surrounded by the atmosphere and not being thermally insulated affords quick cooling for the steel in its progress through the chamber. The cooling chamber is provided with a chain conveyer 10 driven by a pinion 11. The silicon steel sheets in packs, or singly are fed into the furnace between guide rollers 12 which may be power driven if desired and are passed through the heating zone at a rate varying with the temperature of the furnace and the temperature at which it is desired to anneal the sheet steel.

I find that results comparable with the ordinary slow anneal formerly carried out may be obtained by imparting to the steel any temperature above 800° C., but preferably a temperature of about 1000° C. By operating the furnace at a temperature above this value, for example, at a temperature of 1300 to 1500° C. the requisite temperature may be imparted to the sheets in a very short time. By thus operating the furnace at a temperature higher than the temperature desired in the sheets I have found it possible to anneal the sheets by subjecting any given part of the same to the heating zone for about ten seconds. It may be desirable to operate the furnace at a lower temperature, and in that case of course, the annealing period must be increased and may be as long as five minutes. As the cooling zone roughly approximates in length the heating zone and the sheets pass through both zones at the same rate, the rate of cooling necessarily approximates the rate of heating.

While I do not rely upon the reducing effect of hydrogen, or whatever other reducing gas that may be used, yet as described in my copending application, Serial No. 705,251, filed June 22, 1912, a still further improvement in magnetic properties may be secured by the use of such or other

reducing gas and at the same time raising the temperature and increasing the annealing period.

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

1. The process of treating silicon steel which consists in passing it through a heating zone supplied with a non-oxidizing atmosphere, supplying sufficient heat thereto during its passage through said zone to heat the steel to a temperature above 800°C . and then transferring the said steel to a cooling zone in good thermal relation to the atmosphere in which the rate of cooling approximates the rate of heating.
2. The process of annealing silicon steel which consists in feeding it through a zone supplied with a reducing gas and maintained at a temperature of at least 1000°C . at such rate as will impart to the steel a temperature of about 1000°C . and then cooling said steel to the ordinary temperature at substantially the same rate.
3. The process of annealing silicon sheet steel which consists in passing the same through a heating zone supplied with a non-oxidizing gas, and maintained at a temperature of about 1300° – 1500°C ., at a rate which will impart to said sheets a temperature of at least 1000°C ., transferring said steel to

a cooling zone also supplied with a non-oxidizing gas and cooling at a rate approximating the rate of heating.

4. The process of annealing silicon sheet steel which consists in passing the same continuously through a zone charged with hydrogen and maintained at a temperature of about 1300° to 1500°C . at a rate which will impart to said sheets a temperature of about 1000°C . in an interval of time not substantially greater than a few minutes, and then withdrawing the steel from said zone to immediately cool the same to ordinary temperatures at approximately the same rate.

5. The process of annealing silicon steel to improve its magnetic properties, which consists in introducing isolated sheets of such steel into a heating zone charged with hydrogen and maintained at the minimum temperature of about 1000°C ., retaining the sheets in the heating zone until they have attained a temperature of about 1000°C . and then removing the sheets from said zone and cooling at a rate approximately the rate of heating.

In witness whereof, I have hereunto set my hand this 13th day of September, 1912.

WILLIAM E. RUDER.

Witnesses:

BENJAMIN B. HULL,
HELEN ORFORD.