United States Patent Office 2,826,520 Patented Mar. 11, 1958

2,826,520

METHOD OF PROCESSING GRAIN-ORIENTED SILICON STEEL

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No Drawing. Application January 19, 1956 Serial No. 560,082

2 Claims. (Cl. 148—111)

This invention relates to an improved method of processing grain-oriented silicon steel and more particularly to an improved method of heating so-called 3% silicon steel slabs prior to hot rolling, cold reducing and heat treating the same to produce a grain-oriented structure therein.

It has previously been proposed to heat slabs of steel containing about 3 to 3.50% silicon prior to processing them to develop magnetic properties, to a temperature in the neighborhood of 2500° F. This practice is disclosed in the Littmann and Heck Patent No. 2,599,340, issued June 3, 1952. This practice has certain practical disadvantages which limits its use in commercial production. Heating of silicon steel slabs to such high temperatures causes a condition known as "dripping." The oxides of iron and silicon when mixed in the proportions commonly found on the surface of silicon steel slabs containing about 3 to 3.5% silicon have a melting point that is within this temperature range. This mixture runs off the tops of the slabs and drips on the hearth of the slab reheating furnaces. In time, these drippings build up to such a height that they interfere with the passage of the slabs through the furnace. It is then necessary to shut the furnace down and remove the build-up. Furthermore, the use of high temperatures in these furnaces reduces their life considerably, necessitating frequent replacement of linings and other essential furnace equipment. Also, hot rolling this steel at these high temperatures results in increased edge cracking and a consequent reduction in yield.

It is accordingly an object of this invention to eliminate the foregoing difficulties and to provide a method of producing grain-oriented silicon steel having improved properties.

I have discovered that the foregoing objects can be accomplished by soaking slabs of silicon steel containing between 3 and 3.5% silicon at temperatures between about 2225 and 2275° F., preferably at about 2250° F. for a minimum of about 8 hours prior to hot rolling. For economical reasons, it is preferred not to soak the slabs for times longer than about 10 hours at 2250° F. These slabs result from conventional "slabbing" or rolling of ingots to an intermediate gauge workpiece which may range from 2 or 3" in thickness to 6 or 7" in thickness. The steel ordinarily contains a maximum of .025% carbon, .08% maximum manganese, .005% maximum phosphorus, .025% maximum sulphur and .15% maximum copper in addition to the foregoing silicon content.

I have discovered that the foregoing practice substantially completely homogenizes microsegregations of various elements in the steel. The reason for the erratic response of silicon steels to treatments designed to produce a grain-oriented structure therein have heretofore been unknown. I believe that such response is due to microsegregation of various elements, particularly phosphorus and manganese which develop during solidification of the ingots. Unless the steel is substantially completely homogenized such segregations persist throughout the processing to develop magnetic properties and

interfere with the attainment of complete grain orientation and therefore optimum magnetic properties, particularly permeability.

Following soaking the slabs for between 8 and 10 hours at temperatures between 2225 and 2275° F. they are hot rolled as quickly as possible to about .08" gauge strip and coiled. To obtain optimum qualities, such hot rolling must be completed at temperatures in excess of about 1750° F. Following this, the hot-rolled coils are treated in accordance with conventional practice to produce a grain-oriented structure therein. That is the hot-rolled strip is cold reduced to gauge in two stages with an intermediate anneal, at about 1700° F. Such anneal is ordinarily a continuous anneal. In the first cold reduction, the strip is reduced from .08" to .028". In the second cold reduction, the strip is reduced from about .028" to .014". After this second cold reduction, the strip is continuously annealed at about 1500° F. and is then given a high temperature box anneal at about 2000° F. to develop the grain orientation and magnetic properties.

The following Table A amply illustrates the improvement in properties obtained by practicing this invention:

Table A

Slab Heating Practice		Avg. Magnetic Properties at 15 kg.	
Time, Hrs.	Temp., ° F.	Core Loss, W./#	A. C. Permeability
1½ (normal)	2,250	.74	12,670
10	2,250 to 2,300	.69	18,121
1½ (normal)	2,400	.68	20,263

This application is a continuation-in-part of my copending application, Serial No. 436,223, filed June 11, 1954, now abandoned.

While I have shown and described several specific embodiments of my invention, it will be understood that these embodiments are merely for the purpose of illustration and description and that various other forms may be devised within the scope of my invention, as defined in the appended claims.

I claim:

1. A method of processing grain-oriented silicon steel characterized by heating slabs of steel containing between 3 and 3.5% silicon at a temperature between 2225 and 2275° F. for a minimum of 8 hours and hot rolling said slabs to the desired gauge, said hot rolling being completed at temperatures in excess of about 1750° F.

2. A method of processing grain-oriented silicon steel characterized by heating slabs of steel containing between 3 and 3.5% silicon at a temperature of about 2250° F. for between 8 and 10 hours and hot rolling said slabs to about .08" gauge, said hot rolling being completed at temperatures in excess of 1750° F.

References Cited in the file of this patent

UNITED STATES PATENTS

2,084,337	Goss	June 22, 1937
2,378,321	Pakkala	June 12, 1945
2,599,340	Littmann	June 3, 1952
2,618,843	Goodsell	Nov. 25, 1952

OTHER REFERENCES

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The Making, Shaping and Treating of Steel, Camp and Francis, sixth edition, pages 1302 and 1303, 1951.