Dec. 2, 1941. W. E. RUDER 2,264,859

ANNEALING SILICON STEEL STRIP

Filed Feb. 23, 1939

Fig. 1.

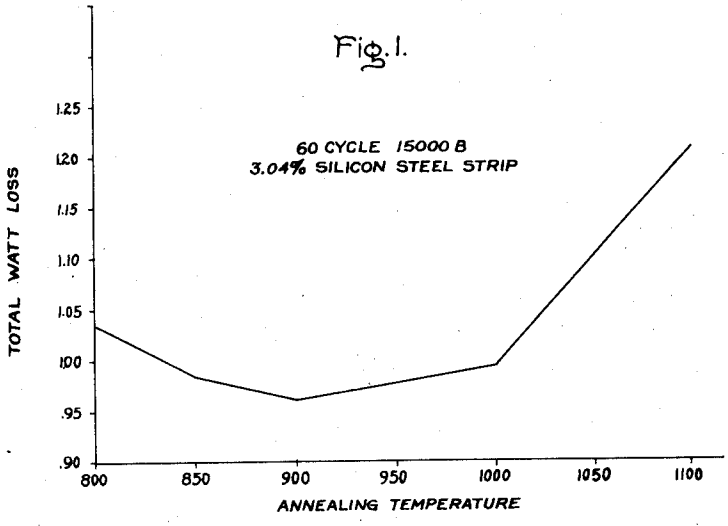
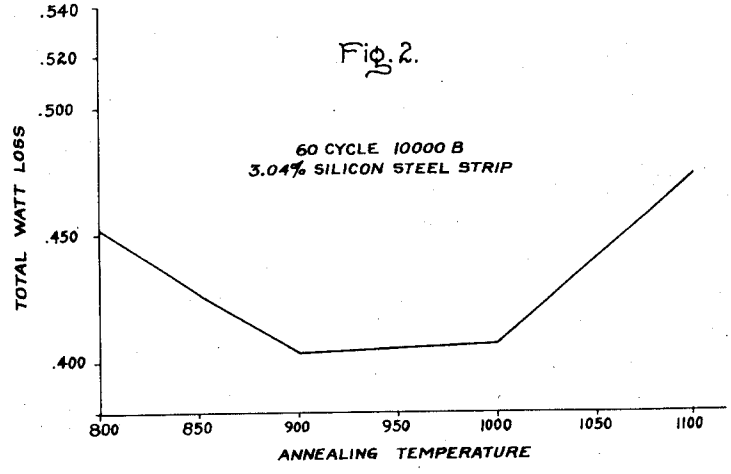


Fig. 2.



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2,264,859

ANNEALING SILICON STEEL STRIP

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4 Claims. (Cl. 148—12)

The present invention relates to silicon steel and more particularly to a heat treatment to be applied to cold rolled silicon steel strip. Silicon steel strip intended for use in core wound transformers usually is cold rolled to a thickness of .011 to .012 inch and the successive steps generally employed in producing it are as set forth in the patent to Smith No. 1,915,766, June 27, 1933, and in the patent to Goss No. 1,965,559, July 3, 1934. While the Smith process usually employs only one cold reduction of about 60 to 70%, the process generally employed in the production of cold rolled silicon steel strip is that disclosed in the Goss patent.

The Goss process comprises two cold reductions with an intermediate normalizing at about 925° C. for a few minutes. After the second or final cold reduction the strip is normalized at about 1100° C. in hydrogen for about four minutes. The total losses in 3% silicon steel prepared in accordance with the Goss process average about .475 watt per pound at 10,000 B. and 60 cycles, and about 1.21 watts per pound at 15,000 B. and 60 cycles. However, cold rolled silicon steel strip prepared by any of the cold rolling processes heretofore employed is unstable, i. e. the watt losses which may be obtained vary from time to time.

It is one of the objects of the present invention to provide stabilized silicon steel strip and also to improve the watt losses heretofore obtained with such material.

The novel features which are characteristic of my invention are set forth with particularity in the appended claims. My invention itself however will best be understood from reference to the following specification when considered in connection with the accompanying drawing in which Figs. 1 and 2 represent diagrammatically the total watt losses at 15,000 B. and 60 cycles and 10,000 B. and 60 cycles respectively in 3.04 per cent silicon steel which has been heat treated according to the present invention.

In carrying out the present invention silicon steel is employed which preferably has been cold rolled as indicated in the Goss patent, or in accordance with any of the well known processes employed for cold rolling silicon steel strip. The steel usually contains about 3% silicon and is cold rolled to a final thickness of about .011 to .012 inch. The final normalizing step in the prior process, as indicated above, is a heat treatment in a reducing atmosphere at about 1100° C. for about 2 to 4 minutes. In accordance with the present invention I may employ the usual reducing atmosphere in the normalizing step. However, for best results I prefer to employ in the final normalizing step an atmosphere which is only slightly oxidizing in character. If the normalizing atmosphere is without question reducing in character or if the condition of the atmosphere in the final normalizing step is unknown, the strip steel preferably should be normalized in a hydrogen or other reducing atmosphere which is slightly oxidizing, for example, oxidizing enough to remove some of the carbon from the steel.

A normalizing temperature of about 1100° C. and a heating period of about 2 to 4 minutes in general produce the best results. Normalizing temperatures below 1100° C. may be employed if desired but normalizing temperatures materially higher than 1150° C. are undesirable since there is a tendency to burn the steel at such temperatures. Satisfactory results may be obtained by employing normalizing temperatures between 1050 and 1150° C. for a period of time varying from about 3 to 5 minutes.

After the cold rolled strip has been normalized in a slightly oxidizing atmosphere as indicated above, and has been wound as in a core wound transformer, punched or formed to the shape in which it will be used, it is annealed in a reducing atmosphere, for example hydrogen, for about two hours, more or less, depending upon the size, shape and weight of the material and at a temperature varying from about 850° C. to about 1050° C.

As indicated in Fig. 1 of the accompanying drawing, the total watt losses in 3% silicon steel strip at 15,000 B. and 60 cycles are a minimum in steel which has been annealed at 900° C. The watt losses increase slightly up to 1000° C. The total watt losses in 3% silicon steel strip at 10,000 B. and 60 cycles are also a minimum at 900° C. and change very slightly when the temperature is increased to 1000° C. Beyond 1000° C. however the losses increase very rapidly both at 10,000 B. and 15,000 B. Three per cent silicon steel which has been normalized at about 1100° C. in a slightly oxidizing atmosphere and then annealed at 900° C. to 1000° C. and tested at 10,000 B. and 60 cycles shows core losses of about .400 watt per pound while the core losses of the same material at 15,000 B. and 60 cycles are well below 1.00.

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

1. A method for improving the watt losses in cold rolled silicon steel strip which comprises

normalizing the cold rolled strip in an atmosphere which is only slightly oxidizing and at a temperature not materially in excess of 1100° C. and thereafter annealing the steel in a reducing atmosphere at temperatures within the range of about 850° C. to 1050° C.

2. A method for improving the watt losses in cold rolled silicon steel strip which comprises as the final steps of the process a normalizing treatment followed by an anneal, said normalizing treatment being carried out in an atmosphere which is only slightly oxidizing, and said anneal being carried out in a reducing atmosphere and at a temperature within the range of 850° C. to 1050° C.

3. The method for improving the watt losses in cold rolled silicon steel strip which comprises normalizing the cold rolled strip in an atmosphere which is slightly oxidizing and at a temperature not materially in excess of 1100° C., forming the strip into the shape in which it will be used and thereafter annealing the strip in a reducing atmosphere at temperatures within the range of about 850° C. to 1050° C.

4. A method for improving the watt losses in cold rolled silicon steel strip which comprises normalizing the cold rolled strip for a few minutes in an atmosphere which is only slightly oxidizing and at a temperature not materially in excess of 1100° C. forming the strip into the shape of a wound transformer core and thereafter annealing said core in a reducing atmosphere at a temperature within the range of about 850° C. to 1050° C.

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