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PROCESS FOR IMPROVING THE MAGNETIC PROPERTIES OF IRON AND IRON ALLOYS

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High grade magnetic materials such as transformer or dynamo plates before being used for constructional purposes must be subjected to an annealing treatment in order to remove stresses and residual hardness which are due to the plastic deformation set up during rolling, stamping and forming. In other cases reactions may be set up in the metal by the annealing atmosphere or changes may be brought about in the metal itself by the suitable selection of the annealing process and these may be employed for the purification and magnetic improvement of the material. For example annealing is carried out in a moist hydrogen atmosphere in order to effect decarbonization or in a vacuum for the purpose of entirely removing gas contents.

The invention is based on a new combination of these various annealing processes and consists in the fact that the annealing is first carried out in a current of hydrogen and subsequently in a vacuum. The effect of such a treatment is shown in the following example in connection with electrolytic iron.

Electrolytic sheet iron is very hard and of magnetically poor quality after separation, so that an annealing treatment is just as necessary for it as for cold rolled material. The annealing temperature was in all cases 850°, the duration of the annealing and annealing atmosphere being varied. Cooling took place slowly in the furnace in order to prevent heat stresses, and in order to prevent the carbon from remaining dissolved, as the carbon which remains in solution because of rapid cooling increases the hysteresis loss and gives rise to aging phenomena. Slow cooling provides sufficient time for the carbon to be separated so that the above indicated phenomena are avoided. In order to show the actual improvements attained, the figures for the losses where determined (hysteresis loss for an induction of 10,000 lines

(*a*) 4 hours annealing in H_2 atmosphere V_{10}=1.2 to 1.3 Watt/kg.
8 hours annealing in H_2 atmosphere V_{10}=1.2 to 1.3 Watt/kg.

(*b*) 4 hours annealing in Vacuum of an Oilpump V_{10}=1.15 Watt/kg.
8 hours annealing in Vacuum of an Oilpump V_{10}=1.1 to 1.15 Watt/kg.

(*c*) 4 hours annealing in Vacuum with subsequent annealing for 4 hours in H_2 atmosphere V_{10}=1.1 to 1.15 Watt/kg.

(*d*) 4 hours annealing in H_2 atmosphere with subsequent annealing for 4 hours in vacuum V_{10}=0.7 to 0.75 Watt/kg.

The improvement achieved by the combined annealing process under *d* is appreciable. As may be seen from the figures given under *a–c*, it cannot be attributed to the duration or the effect of a separate annealing atmosphere. The necessary assumption is that it is apparently due to the sequence of the annealing treatment given under *d*.

The tests referred to above only represent an example of the new process, the advantages of which may be confirmed if desired by tests not only on electrolytic iron but also to a more or less marked degree on other magnetic alloys of iron. It appears obvious that the advantageous effect is due to changes in the carbon content which is always present as an undesired admixture.

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

1. In the art of magnetic material the process for improving the magnetic properties of iron and iron alloys which comprises annealing the metal in a current of hydrogen and subsequently annealing it in a vacuum.

2. In the art of magnetic material the process for improving the magnetic properties of iron and iron alloys which comprises annealing the metal in a current of hydrogen at a temperature of 850° C. and subsequently annealing it in a vacuum for about four hours.

3. In the art of magnetic material, the process for improving the magnetic properties of iron alloys which comprises annealing the metal in a current of hydrogen for about four hours, cooling the metal at a rate to prevent heat strains and to prevent the carbon in the metal from remaining dissolved, and subsequently annealing the metal in a vacuum for about four hours.

4. The process for improving the magnetic properties of electrolytic iron or iron alloys which comprises annealing the metal in a current of hydrogen at a temperature of about 850° C., slowly cooling the metal to room temperature and annealing it in a vacuum for about four hours.

5. The method for improving the watt losses in magnetic ferrous alloy plates suitable for use in the magnetic circuits of electrical apparatus which comprises annealing said plates in hydrogen at a temperature of about 850° C., slowly cooling said plates to room temperature and annealing them in a vacuum for about four hours.

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