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PERMANENT MAGNET STEEL

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This invention relates to permanent magnet steel and a method of making such steel, and more particularly to permanent magnets of such steel and a method of making the same.

Carbon manganese steel is well known as a permanent magnet material, although other steels such as chromium, cobalt, or tungsten have been more commonly used in recent years. However, now because of restrictions on the quantity which may be used of certain critical materials, many of the ordinary magnet steels are no longer generally available and therefore resort must be had to combinations involving the use of smaller quantities of the restricted materials or to materials not restricted. Thus, carbon manganese steel is again being proposed as a permanent magnet material.

Some difficulties have been experienced with carbon manganese steel due to the necessity of water quenching and the consequent rapid cooling of the steel, which sometimes causes serious cracking and warping. It is generally understood that by rapid cooling through water quenching the precipitation of carbides is held at an incipient stage and that this produces the desired magnetic properties. However, rapid cooling tends to cause cracking and warping.

It is an object of the present invention to provide an improved permanent magnet steel and an improved method of making the same.

In accordance with one embodiment of this invention, a small percentage of chromium is added to the carbon manganese steel melt and then the alloy is quenched in oil. An oil quench affords a substantially slower cooling rate than that afforded by a water quench, thus reducing warping or cracking of the steel.

The above described and other objects and advantages of this invention will be apparent from the following detailed description:

Carbon manganese steel as used for permanent magnets heretofore had in general the composition of .5% to 1% carbon, .5% to 1.25% manganese and the rest iron. While this composition produced a permanent magnet steel having satisfactory magnetic properties, the steel had to be water quenched to prevent rapid precipitation of carbides and consequent loss of magnetic properties. Because of the physical properties of this composition, rapid cooling had the undesirable effect of causing cracking and warping of the steel. By adding .2% to .75% chromium to a melt of carbon manganese steel of the composition just described, it appears that the former rate of precipitation of carbides is sufficiently reduced so that slower cooling in an oil quench is feasible. Slower cooling reduces greatly the warping and cracking of the steel heretofore encountered. It further appears that an alloy comprising .5% chromium, .6% carbon, .85% manganese and the rest iron, gives satisfactory magnetic and physical properties for many purposes.

The carbon, manganese, chromium and iron may be first melted together and the alloy thus produced cast into ingots and fabricated into the desired shapes. During casting and fabrication, the alloy cools slowly and carbides are precipitated in an excessive amount with a consequent loss of magnetic properties. The fabricated alloy is therefore reheated sufficiently to cause the carbon to reenter solution with the iron. With an alloy of the composition indicated above as satisfactory, a temperature of about 1450° F. appears to be slightly above the critical point and sufficient to cause the carbon to reenter solution with the iron. It will be understood that with other alloys having different proportions, the critical temperature may also be different. The temperature is maintained long enough to permit substantially all of the carbon to reenter solution with the iron. Then the alloy is quenched in an oil quench, thus providing a rate of cooling enough lower than that afforded by water to prevent warping and cracking, while at the time rapid enough to retain the desired magnetic properties in the alloy. The alloy is cooled to substantially room temperature in the oil.

While but one embodiment of this invention has been shown, it will be understood that many changes and modifications may be made therein without departing from the spirit and scope of the present invention.

What is claimed is:

1. A method of making a permanent magnet comprising the steps of melting .2% to .75% chromium, .5% to 1% carbon, .5% to 1.25% manganese and the rest iron together to form an alloy, heating the alloy to cause the carbon to enter solution with the iron and then cooling the alloy in an oil quench.

2. A method of making a permanent magnet comprising the steps of melting .5% chromium, .60% carbon, .85% manganese and the rest iron together to form an alloy, heating the alloy to cause the carbon to enter solution with the iron, and then cooling the alloy in an oil quench.

3. A method of making a permanent magnet comprising melting .2% to .75% chromium, .5% to 1% carbon, .5% to 1.25% manganese and the rest iron together to form an alloy, fabricating

a magnet, reheating the alloy to cause the carbon to enter solution with the iron, and then cooling the alloy in an oil quench.

4. A method of making a permanent magnet which comprises heating an alloy of .2% to .75% chromium, .5% to 1% carbon, .5% to 1.25% manganese and the balance iron, to cause the carbon to enter solution with the iron and then quenching the alloy in oil.

5. A method of making a permanent magnet which comprises heating an alloy of .5% chromium, .60% carbon, .85% manganese and the balance iron, to cause the carbon to enter solution with the iron and then quenching the alloy in oil.

6. A permanent magnet comprising .2% to .75% chromium, .5% to 1% carbon, .5% to 1.25% manganese and the rest iron, the alloy having been heated to cause the carbon to enter solution with the iron and then cooled in an oil quench.

7. A permanent magnet comprising .5% chromium, .60% carbon, .85% manganese and the rest iron, the alloy having been heated to cause the carbon to enter solution with the iron, and cooled in an oil quench.

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