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CASE HARDENING

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6 Claims. (Cl. 148—14)

The invention relates to the case hardening of various metals.

One object of the invention is to provide a case hardening method adapted to produce a particularly hard surface. Another object of the invention is to provide a case hardening method which shall produce a skin which is highly resistant to corrosion. Another object of the invention is to provide a case hardening method susceptible of practical application for all types of soft steels which shall product a very hard skin thereon at reasonably low cost. Another object of the invention is to provide a case hardening method which shall produce a thick case in a shorter time than heretofore. Another object of the invention is to provide a ferrous article having an extremely tough and hard case. Another object of the invention is to introduce into a piece of steel not only carbon but also boron. Another object of the invention is to make a steel article which shall be highly resistant to corrosives. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combination of elements, arrangements of parts, and in the several steps and relation and order of each of said steps to one or more of the others thereof, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

I provide a carburizing pot of any suitable type. Such carburizing pots are known to the art and consist of highly refractory materials formed into a suitable pot-like shape and having a cover to exclude air. As such a pot might be made of many different materials I do not confine myself to any particular one, and merely note that a refractory which will stand a heat of 1400° C. should be used in carrying out my invention in the preferred form.

I further provide a furnace for carburizing which may be a gas furnace or a furnace of any other suitable type, and according to the preferred form of my invention this furnace should be capable of heating the carburizing pot or pots and the contents thereof to a temperature of 1400° C., maintaining it at that temperature for a considerable period of time. I need not further describe such furnaces as they are well known.

The method of the invention is particularly applicable to the treatment of steels as distinguished from cast iron, although I am not limited to any particular ferrous metal, the scope of the invention being set forth in the following claims.

Assuming, therefore, that it is desired to form a hard case upon a piece of steel, which may or may not be formed into a particular manufactured shape, I select a carburizing pot large enough to hold one or a number of such pieces with ample room for the carburizing material which should embed the pieces to be case hardened. Placing in the carburizing pot a quantity of boron carbide (B_4C) I place the first article to be case hardened in the pot, and fill the pot with articles and boron carbide so that each one is completely surrounded by the boron carbide. One or more steel articles may be treated at a time.

I have specified boron carbide of the formula B_4C as this is the preferred way of carrying my invention into effect, but other boron carbon compounds may be used, and also a boron carbide having some other material alloyed therewith, if any such, and for carrying my invention into practice I note that boron carbide may be produced according to the United States Letters Patent No. 1,897,214.

I may use any grain size of boron carbide or a mixture of various grain sizes. In actual practice I have found No. 16 mesh grain boron carbide to be highly satisfactory, but I do not attribute the advantageous results of my process to the particular grain size employed and there appears to me to be no reason why a very fine mesh grain would not be equally advantageous, and furthermore larger grain sizes can be used. The selection of grain size will be largely determined by convenience of handling and cost, although I prefer to avoid very large lumps as it is desirable to maintain a good contact between the grain and the piece being treated. With that end in view a mixture of grain sizes yields good results in so much as a tighter packing may be made of grain in mixed sizes.

I fill the carburizing pot with articles and boron carbide nearly to the top thereof, and then cover the boron carbide with a carbonaceous substance, such as graphite, lamp black, coke, or the like. I then apply the cover and place the carburizing pot in the furnace. The purpose of the carbonaceous substance on the top of the pot is to absorb any oxygen that may creep by the cover and so prevent it from reaching the boron carbide, as boron carbide oxidizes under temperatures below those preferably employed by me in carrying out this invention.

In the preferred form of the invention I heat the

pot and contents to around 1400° C. For the production of a substantial case upon a small steel article, say a rod 6'' x 1½'' diameter, a treatment under the foregoing conditions for one hour may be employed. After the carburizing pot and contents have been maintained at the desired temperature for the desired length of time I quench the article or articles in water or oil or in any other manner according to prior practice. This may involve a reheating of the objects for convenience, and such reheating may carry the articles to around 900° C. more or less, as prior practice may be adhered to so far as the quenching is concerned with excellent results in my novel process. Under such conditions I have achieved a hard case upon a 1½'' diameter rod approximately ⅛'' in depth. With a longer treatment I can produce a thicker case. It is highly practical to harden small diameter rods completely according to my method, in which event the case is conterminous with the article. Furthermore, in order to produce a tough case upon a piece of steel, I may bring the pot and contents up to the desired temperature and may cool, in so much as the reaction is extremely fast.

Although I do not wish to be made responsible for theories of what happens, nevertheless I will now give my present understanding of the nature of the transformation. In so much as iron in all its forms has a high affinity for carbon, which affinity is greatly increased by high temperatures, the iron, especially if it be relatively carbon free, draws the carbon atoms from the boron carbide thus disassociating the chemical compound B_4C or other boron carbon compound. In drawing the carbon into itself, however, the iron also draws a large amount of boron, and possibly the proportionate amount indicated by the formula B_4C. I believe, however, that the case contains iron and boron and carbon rather than iron impregnated with boron carbide, and I believe that an actual dissociation of the boron carbide occurs. Iron is hardened by the inclusion in solid solution of carbon, which has been well known for a long time, but the addition of boron atoms in solid solution or otherwise greatly increases the hardness of the combination. Boron itself will harden iron but in the practice of my invention it is preferred to introduce boron by way of boron carbide as described, and iron containing both carbon and boron appears to be harder than iron containing boron alone. At all events the result is iron with an alloy of something which is extremely hard and which analytically contains boron and carbon.

I have stated that 1400° C. is the preferred temperature employed in carrying out my invention, and it will be understood that this is plus or minus a considerable amount. A white heat of the steel is preferably employed. The heat should not be so great as to melt the steel, and according the melting point of the particular steel may be considered. It is desirable to attain temperatures as high as possible without deforming the pieces of steel, as boron carbide is decidedly more reactive at the higher temperatures. Although lower temperatures than 1400° C. may be employed I prefer to use temperatures of 1250° C. and up.

The articles made according to the invention may be annealed for purposes of destroying the hardness, whereupon they can be bent and worked and thereafter hardened again by a new heating and quenching. The case or hardened portion is not only hard but also tough and extremely resistant to corrosive action of acids and alkalies, and to oxidation and may be used in any situation where a hard iron or steel article is desired.

In my copending application Serial No. 36,373, filed August 15, 1935, I have described a different method for the production of a steel article having a layer of ferrous alloy with boron and carbon, and claims to the article produced by the method of this present invention are included in such prior copending application.

It will thus be seen that there has been provided by this invention a method and an article of manufacture in which the various objects hereinabove set forth together with many thoroughly practical advantages are achieved. As various possible embodiments might be made of the various features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinbefore set forth is to be interpreted as illustrative and not in a limiting sense. In the claims, the word "case" is to be understood as including also the condition in which the case extends to the core of the material and is conterminous with it or with a section thereof.

I claim:

1. Method of case hardening steel which comprises placing a steel article in a carburizing pot with comminuted born carbide, heating the same to a high temperature and quenching the article.

2. Method of case hardening steel which comprises placing a steel article in a carburizing pot with boron carbide of the formula B_4C, heating to a high temperature and quenching.

3. Method of case hardening steel which comprises placing a steel article in a carburizing pot with comminuted boron carbide, heating to 1250° C. or above, and quenching.

4. Method of case hardening steel which comprises placing a steel article in a carburizing pot with comminuted boron carbide, heating to in the neighborhood of 1400° C. and quenching.

5. Method of case hardening ferrous metal which comprises heating the metal in the presence of boron carbide to a temperature at or above 1250° C. and quenching.

6. Method of case hardening ferrous metal which comprises placing a piece of the metal in a carburizing pot with comminuted boron carbide, covering the boron carbide with carbonaceous material, heating to a high temperature and quenching.

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