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STEEL

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11 Claims. (Cl. 75—45)

This invention relates to a new and improved method for making steel having an unusual degree of hardness and toughness.

The invention provides a steel having these properties with an extremely low carbon content.

The invention furthermore provides a new and improved process for making steel with an extremely low carbon content and nevertheless possessing hardness and ductility to an unusual extent.

The invention looked at from another aspect provides a process of hardening iron to produce what is termed steel without the assistance of the relatively large proportions of carbon heretofore employed for that purpose.

By proceeding as herein described, a hardened iron or steel is produced by a new and improved and very simple process which has an unusual degree of toughness, that is to say, a combination of hardness and ductility.

In my copending application I have described a steel of general character herein set forth in which the upper limit of carbon content was disclosed as 0.50 per cent. The present invention comprises an improvement of the invention disclosed in my copending application, Serial No. 334,856, filed January 24, 1929, and in the present invention I disclose a steel and process for making the same in which the upper limit of the carbon content is 0.30 per cent and may be much less, such as 0.05 per cent.

As in my former application I employ a plurality of metals which, acting in combination with each other, produce a steel of the desired characteristics and enable me to obtain a steel having the required hardness and ductility although extremely small carbon contents are utilized.

In the present invention, as in the invention covered by my copending application, I utilize the action of an oxidizing agent such as sodium bichromate on zirconium and titanium as one of the elements of my invention and in addition thereto I employ a combination of boron, tungsten, vanadium and cobalt, and in the preferred form of my invention I also employ in combination the following group of elements, this group being also employed in the invention covered by my copending application, viz:

Molybdenum
Nickel
Copper
Manganese
Silicon
Chromium

For many years, attempts have been made to produce highly hardened steel without the assistance of carbon, one of the objects being to eliminate or reduce brittleness and to attain the highest degree of hardness and toughness which are so desirable for many purposes, particularly those purposes where a highly shock resistant product is desired. The present invention provides a method for accomplishing this object and the product produced by that method.

To accomplish the process herein set forth, it has been found necessary to employ a relatively large number of elements which however are not merely additive in their individual effects but have been found to cooperate with each other to bring about the attainment, without the assistance of carbon, of the requisite degree of hardness and toughness or shock resistance. When it is said that the object is attained without the assistance of carbon; it is meant to state that the percentage of carbon is extremely small compared to that which has been formerly employed for producing highly hardened steels.

In a typical case I proceed as follows:

To a batch of iron at the usual requisite high temperatures, metals are added as follows and in the following proportions.

Zirconium	0.20 to 0.50	for example 0.30
Titanium	0.20 to 0.50	for example 0.30
Boron	a trace	
Tungsten	0.30 to 0.60	for example 0.50
Vanadium	0.10 to 0.20	for example 0.20
Cobalt	a trace	
Molybdenum	0.75 to 1.50	for example 1.00
Nickel	0.50 to 1.00	for example .75
Copper	0.30 to 7.00	for example 4.00
Manganese	0.80 to 1.20	for example 1.00
Silicon	0.80 to 1.20	for example 1.00
Chromium	0.50 to 1.00	for example .75

When thorough distribution of these metals has taken place, sodium bichromate is added. The object of the sodium bichromate is to oxidize the zirconium and titanium which is evidenced by the observation that the percent of zirconium and titanium in the final steel is less than that employed in the process of manufacture as set forth in the above formula.

It has been found that by proceeding as herein described, a steel is produced having exceptionally high hardness and shock resistance which may be employed for numerous purposes particularly where high hardness and shock resistance is required, as for example, in the production of die-blocks, rails, piston rods, tires, crank shafts, etc.

The advantages of the invention have been set forth in some detail and the preferred embodiments have been described. It is to be understood, however, that various changes may be made without departing from the invention or sacrificing any of the advantages enumerated, or any other advantageous results which may be

attained by an application of the principles and facts set forth.

What I claim is:—

1. The process of making a hard tough steel containing carbon in an amount not greater than 0.30 per cent which comprises treating iron at a high temperature with boron, tungsten, vanadium, cobalt, zirconium, and titanium and incorporating a chromate oxidizing agent to oxidize the zirconium and titanium.

2. The process of making a hard tough steel containing carbon in an amount not greater than 0.30 per cent which comprises treating iron at a high temperature with boron, tungsten, vanadium, cobalt, zirconium, and titanium and incorporating a bichromate to oxidize the zirconium and titanium.

3. The process of making a hard tough steel containing carbon in an amount not greater than 0.30 per cent which comprises treating iron at a high temperature with boron, tungsten, vanadium, cobalt, zirconium, and titanium and incorporating sodium bichromate to oxidize the zirconium and titanium.

4. The process of making a hard tough steel containing carbon in an amount not greater than 0.30 per cent which comprises treating iron at a high temperature with boron, tungsten 0.30 to 0.60 per cent, vanadium 0.10 to 0.20 per cent, cobalt, zirconium 0.20 to 0.50 per cent, and titanium 0.20 to 0.50 and incorporating a chromate oxidizing agent to oxidize the zirconium and titanium.

5. The process of making a hardened ductile steel containing carbon in an amount not greater than 0.30 per cent which comprises treating iron at a high temperature with 0.05 to 0.30 per cent of carbon, adding boron, tungsten, vanadium and cobalt, and in addition molybdenum, nickel, copper, manganese, silicon, chromium, and zirconium and titanium and incorporating a chromate oxidizing agent to oxidize the zirconium and titanium.

6. The process of making a hardened ductile steel containing carbon in an amount not greater than 0.30 per cent which comprises treating iron at a high temperature with 0.05 to 0.30 per cent of carbon, adding boron, tungsten, vanadium and cobalt, and in addition molybdenum, nickel, copper, manganese, silicon, chromium and zirconium and titanium and incorporating a bichromate oxidizing agent to oxidize the zirconium and titanium.

7. The process of making a hardened ductile steel containing carbon in an amount not greater than 0.30 per cent which comprises treating iron at a high temperature with 0.05 to 0.30 per cent of carbon, adding boron, tungsten, vanadium and cobalt, and in addition molybdenum, nickel, copper, manganese, silicon, chromium and zirconium and titanium and incorporating sodium bichromate to oxidize the zirconium and titanium.

8. The process of making a hardened ductile steel containing carbon in an amount not greater than 0.30 per cent which comprises treating iron at a high temperature with 0.05 to 0.30 per cent of carbon, adding boron, tungsten 0.30 to 0.60 per cent, vanadium 0.10 to 0.20 per cent and cobalt, and in addition molybdenum 0.75 to 1.50 per cent, nickel 0.50 to 1.00 per cent, copper 0.30 to 7.00 per cent, manganese 0.80 to 1.20 per cent, silicon 0.80 to 1.20 per cent, chromium 0.50 to 1.00 per cent and zirconium 0.20 to 0.50 per cent and titanium 0.20 to 0.50 per cent and incorporating a chromate oxidizing agent to oxidize the zirconium and titanium.

9. A hardened ductile steel comprising carbon in an amount from 0.05 to 0.30 per cent, and boron a trace, tungsten 0.3 to 0.6 per cent, vanadium 0.1 to 0.2 per cent, cobalt a trace, the balance substantially iron, said steel having been treated in the molten condition with zirconium, titanium and a bichromate.

10. A hardened ductile steel comprising carbon in an amount from 0.05 to 0.30 per cent, and boron a trace, tungsten 0.3 to 0.6 per cent, vanadium 0.1 to 0.2 per cent, cobalt a trace, the balance substantially iron, said steel having been treated in the molten condition with zirconium, titanium and sodium bichromate.

11. A hardened ductile steel comprising carbon in an amount from 0.05 to 0.30 per cent, boron a trace, tungsten 0.3 to 0.6 per cent, vanadium 0.1 to 0.2 per cent, cobalt a trace, and in addition, molybdenum 0.75 to 1.5 per cent, nickel 0.5 to 1.0 per cent, copper 0.3 to 7.0 per cent, manganese 0.8 to 1.2 per cent, silicon 0.8 to 1.2 per cent, chromium 0.50 to 1.00 per cent, the balance substantially iron, said steel characterized by having been treated in the molten condition with zirconium, titanium and a bichromate.

JOHN THOMAS WHITELEY.

CERTIFICATE OF CORRECTION.

Patent No. 1,959,398. May 22, 1934.

JOHN THOMAS WHITELEY.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, line 6, claim 1, for "0.30" read 0.20; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 24th day of July, A. D. 1934.

Bryan M. Battey

(Seal) Acting Commissioner of Patents.