J. CHURCHWARD.

STEEL PROCESS.

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1,069,387. Patented Aug. 5, 1913.

WITNESSES

[signatures]

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STEEL PROCESS.

1,069,387. Specification of Letters Patent. Patented Aug. 5, 1913.

Application filed March 18, 1911. Serial No. 615,305.

To all whom it may concern:

Be it known that I, JAMES CHURCHWARD, a subject of the King of England, residing at Mount Vernon, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Steel Processes, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to a process for treating metals, and, with respect to its specific features, to a means for producing a fibrous structure in steel and compositions of steel.

One of the objects of the invention is to provide a practical and efficient process of the kind described for removing from the substance treated that property which induces its granular form.

Another object is to provide a process of the kind described whereby the physical and chemical characteristics of the resulting product may be easily controlled.

Another object is to provide a rapid process of the kind described which will be simple and inexpensive.

Another object is to produce a steel product which shall be cheap and at the same time possess high physical constants and, in general, desirable chemical and physical properties.

Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the several steps and the relation and order of one or more of said steps with relation to each of the others thereof which will be exemplified in the hereinafter disclosed process and the scope of the application of which will be indicated in the claims that follow.

The drawing represents a specimen of the material made in accordance with the invention.

In order to render certain aspects of the invention clearer, it is to be noted that steel and compositions of steel ordinarily possess a granular crystalline structure. Further, in the process of steel formation the particles making up the body of the material seem to assume a globular form or to globulize, and in consequence thereof the effect of certain valuable characteristics in the completed product is diminished. Experiment indicates that the granular structure is due, at least in part, to a certain astringent capacity of the carbon, appearing in substantially all steels and compositions of iron and carbon. By virtue of this capacity, when carbon is brought into contact with molten iron fibers in a furnace or metal bath, it exercises a contracting action thereupon and draws the fibers into globules. When steel is formed in the usual way this astringent capacity of carbon acts as indicated and upon casting and cooling, a granular crystalline structure results.

It has been found, in accordance with the present invention, that this astringent capacity of carbon may be removed from steels of all types by heating them to a temperature of approximately 3100° F. and maintaining them at that temperature for a certain interval. The metal upon cooling will be found to have assumed a fibrous form.

According to the length of time during which the substances are subjected to the process and to the temperature employed in carrying it out, the characteristics of the product will be altered. At a temperature of approximately 3150° F. the action will begin to take place in from fifteen to twenty minutes. Its completeness may be judged by a practised eye by observing the manner in which the bath boils. The temperature must be maintained at this point for another ten to fifteen minutes to allow the globules to assume a fibrous form. If the lowest temperature at which the reaction takes place is used and too short a time is allowed for reforming, the finished product shows by its crystals only the commencement of fiber formation. On the other hand, with the use of an excessive temperature, say above 3250° F. for too long a time, practically all of the carbon will be removed or technically "boiled out" from the metal. This boiling out of the carbon will also take place if a comparatively low temperature, say, slightly above 3100° F. is employed for too long a time.

The length of time during which the combination of iron and carbon must be subjected to the process also varies somewhat according to the kind of carbonaceous material which is present in the combination.

For example, vegetable carbons, or carbons extracted and obtained from vegetable matter, provide the quickest and most violent reaction. Bone carbons are next in order of rapidity and then in succession in the scale of rapidity, mineral carbons and crustacean carbons. The difference in time in the case of the most rapid and least rapid carbons in the scale is however, short, being not more than five minutes between vegetable and crustacean carbon. It is to be noted that the character of the carbon also leaves its impression on the physical qualities of the steel; thus, one per cent. of vegetable carbon in a steel product gives a very much more ductile product than if one per cent. of crustacean carbon is used, and there is also a marked degree of difference in the hardness of the two metals.

The following tabulation is an example of the composition of a steel made according to the process:

Nickel	3.50%
Chromium	2.00
Manganese	0.40
Vanadium	0.25
Carbon	0.30
Iron	93.55
	100.00%

If a temperature of 3150° F. to 3200° F. is used and the proper time is allowed to remove the granular structure of the materials, the product obtained will have a wholly fibrous consistency and may be split like a piece of hard wood.

A product may be obtained by means of this process which is hard, tough, compact and durable, and possesses an integral fibrous structure resembling that of wood, such as oak, (as shown in the drawing). Further, a product may be obtained which is generally heavier than chemically similar compositions of steel having a granular structure. The relatively heavy character of the product as compared with ordinary steel is probably due to its greater compactness, two specimens which were tested showing a greater specific gravity than ordinary steel.

After the fibrous structure has been given to the steel or steel composition, in case it is desired to work the resulting product into various shapes and forms, it may be passed through the customary casting, welding and forging processes. The heating which is usually necessary in these processes is apt to alter the structural relations of the fibers, but these may be readily restored by reheating the material after it has been worked into any desired form to a predetermined temperature, maintaining it at this temperature until the fibers have resumed their original positions, and subsequently cooling it. The temperature employed in reheating will vary according to the kind of metal under treatment and also according to the intended use of the metal. For example, the steel mentioned above might be reheated to approximately 1605° to 1650° F., maintained there for a time, and then cooled. It may be found advisable in some instances to repeat, at successively lower temperatures, this reheating and cooling, and if this is done a more compact product is assured in view of the fact that thereby the molecules are expanded and enlarged to fill the pores of the structure. For example, the steel mentioned might be reheated again to approximately 1290° to 1335° F. and cooled, then once more reheated to approximately 1070° to 1110° F. and cooled. It is preferable, in conducting the heating processes, to maintain the metal at the desired temperature until it has acquired an even heat throughout.

The process is applicable to alloy or "special steels," if the precautions for restoring the alloys to the original chemical union of each, after heating to the high temperature necessary for this process, is observed, as set forth in my U. S. Letters Patent Numbers 855,756, 883,698, 884,009 and 899,713. For example, if the steel is alloyed with manganese the temperatures which will be used for restoring the chemical union of the alloy and preserving the fibrous structure will be as follows: First: From approximately 1600° F. to approximately 1650° F. Second: From approximately 1290° F. to approximately 1340° F. for the restoration and redistribution of the carbon. Third: From approximately 1025° F. to approximately 1110° F. in case the metal must be extraordinarily tough. After each of these restoring heating processes the metal may be quenched, preferably in oil, or it may be slowly cooled. Slow cooling will give the greatest toughness.

It will thus be seen that a simple, practical process is provided wherein the objects of the invention are achieved.

The product formed according to the present process shows high physical constants, for instance, great tensile strength, ductility, etc. It also possesses all of the desirable physical and chemical properties of ordinary steel. There is a tendency in some steels made by ordinary processes to rust, due to the presence of certain constituents added to improve the physical constants and other qualities of the steel, but the article made by the present process shows great resistance to rust and withal is a highly desirable and durable product.

As many changes could be made in carrying out the above process without departing from the scope of the invention, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the language used in the following claims is intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention, which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. A process of the nature disclosed, which consists in subjecting a combination of carbon and iron to an agent adapted to remove the astringent capacity of the carbon, whereby the resulting combination of iron and carbon assumes a fibrous structure.

2. A process of the nature disclosed, which consists in heating a combination of carbon and iron, having a granular structure, whereby the astringent capacity residing in the combination is removed and the structure of the resulting product is rendered fibrous.

3. A process of the nature disclosed, which consists in heating a combination of carbon and iron having a granular structure to approximately 3100° F. and maintaining said temperature whereby said combination assumes a fibrous structure upon solidifying.

4. A process of the nature disclosed, which consists in heating steel having a granular structure to approximately 3100° F. and maintaining said temperature for a predetermined interval whereby the granular structure of said steel is changed and upon solidifying it assumes a fibrous structure.

5. A process of the nature disclosed, which consists in subjecting a combination of carbon and iron having a granular structure to an agent adapted to destroy said granular structure whereby said combination assumes a fibrous structure, working said combination of carbon and iron into an object of any desired form and maintaining said object at a predetermined temperature to restore any derangement of fibrous structure resulting from the process of formation of said object.

6. A process of the nature disclosed, which consists in heating steel to approximately 3100° F., and maintaining said steel at this temperature for a predetermined interval whereby said steel assumes a fibrous structure upon solidifying, working said steel into an object of any desired shape and alternately maintaining said object at a predetermined temperature and cooling said object whereby any derangement of fibrous structure due to the working of said steel is rectified and the fibers are swelled to form a compact and continuous surface.

7. As an article of manufacture, a composition, containing iron and carbon having an integral fibrous structure resembling that of hard wood and possessing generally greater weight than chemically similar compositions of iron and carbon having other than a fibrous structure, substantially as described.

8. A process of the nature disclosed, which consists in heating a combination of iron and carbon having a granular structure to a temperature which will remove the astringent quality of the carbon, and then maintaining the temperature for a sufficient time and such as to change the molecular structure of the combination to fibrous upon solidifying.

In testimony whereof I affix my signature, in the presence of two witnesses.

JAMES CHURCHWARD.

Witnesses:

J. Thomson,

L. A. Watson.