UNITED STATES PATENT OFFICE.

SAMUEL S. WALES, OF MUNHALL, PENNSYLVANIA, ASSIGNOR TO CARNEGIE STEEL COMPANY, OF PITTSBURG, PENNSYLVANIA, A CORPORATION OF NEW JERSEY.

METHOD OF TREATING ARMOR OR DECK PLATES.

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To all whom it may concern:

Be it known that I, SAMUEL S. WALES, of Munhall, Allegheny county, Pennsylvania, have invented a new and useful Method of Treating Armor or Deck Plates, of which the following is a specification.

Of recent years it has been the practice in the manufacture of armor plate to make the plate of steel having substantially the following theoretical composition:—

Carb	.28 per cent.
Manganese	.35 per cent.
Nickel	3.75 per cent.
Chromium	1.70 per cent.

the sulfur and silicon being low,—below .04 per cent. The steel of this composition is then treated by the Harvey or Krupp processes by which its surface is highly supercarburized for the purpose of rendering it more resistant to the impact of projectiles.

I have discovered a new alloy or composition and a new mode of heat treatment by which I am enabled to increase the ballistic resistance over that obtained by the alloys and treatments heretofore in use.

The elements which I alloy with the iron in order to produce my new composition are as follows, and in stating them I desire to premise that in addition to these elements others may be added if desired or the proportions may be varied within certain limits, those which I give being such as I have found best suited to the purpose:—

Carbon	.20	to	.30	per cent.
Manganese	.25	to	4	per cent.
Chromium	1.25	to	1.75	per cent.
Vanadium	.10	to	.25	per cent.
Nickel	3.50	to	4	per cent.

The steel which I employ is preferably open hearth steel, and I prefer to add the nickel as a part of the charge of the furnace in a cold condition. I preferably preheat the chromium and add it to the open hearth charge just before tapping. The manganese is preferably added cold in the ladle and the vanadium is preferably added to the ladle in the form of preheated ferro-vanadium alloy. These alloys may however be added in a molten form in the ladle or otherwise as desired. The proper portion of carbon may be added by recarburizing by the usual methods. The silicon contents of the steel should be low, less than .15 per cent. The sulfur should be as low as possible, preferably less than .04 per cent. It is extremely important in this vanadium alloy that the phosphorus should be extremely low because the vanadium is found to intensify the action of this element. The phosphorus should not exceed .04 per cent.

Having cast the ingot, it may be forged or rolled to the desired thickness. It is then raised to a temperature of about 700 degrees C. and allowed to become cold slowly, preferably in air; or it may be annealed by bedding in lime or ashes. If the processes are to be continuous, the intermediate annealing may be omitted. The plate is then heated above 875 degrees C. and preferably about 900 degrees C. and quenched with water until it is either at the temperature of the atmosphere or at a temperature of not over 400 degrees. I then preferably anneal the plate by raising to a temperature above 350 degrees C. and below 700 degrees C., depending upon the purpose for which the plate is to be used; and cool the same slowly, preferably in air. The lower the temperature of the last or third heat treatment, the harder and less ductile the material will be. By taking the plate after the third treatment and again raising it to about 900 degrees C., water-quenching it, and re-annealing it, the plate may be further toughened. By simply repeating the third heat treatment, or annealing step, the plate may be rendered more ductile. The plate will be given a fibrous character by the preceding treatment, including the heat treatment of 700 degrees and following annealings. This fibrous character, however, may be imparted in any desirable or well known manner.

The advantages of my invention result from the increased ballistic value, since the plates thus obtained are capable of resisting shocks to a greater extent than ordinary steel plates. Another great advantage of the product thus obtained is that it may be machined by ordinary tools in finished condition or after its final metallurgical treatment. Another advantage is that the fibrous character which is imparted to the plate during certain stages of the treatment is retained through the subsequent steps of treatment.

Those skilled in the art will be able to modify the steps of the heat treatment with-

in certain limits, without departing from my invention.

I claim:—

1. The method of making armor or deck plates, consisting in preparing a steel plate containing vanadium, imparting a fibrous character to the plate by heat treatment, then hardening the plate by raising it to a higher temperature than that employed in fibering, and then annealing the plate; substantially as described.

2. The method of making armor or deck plates, consisting in preparing a steel plate containing vanadium, imparting a fibrous character to the plate by heat treatment, then raising the plate to a temperature above 875 degrees C., suddenly cooling it, and then annealing the plate; substantially as described.

3. The method of making armor or deck plates, consisting in preparing a steel plate containing vanadium, imparting a fibrous character to the plate by heat treatment, then raising the plate to a temperature above 875 degrees C., suddenly cooling it, and then annealing it by raising it to a temperature above 350 degrees and below 700 degrees C., and cooling it slowly; substantially as described.

4. The method of making armor or deck plates, consisting in preparing a steel plate containing below one per cent. of vanadium, imparting a fibrous character to the plate by heat treatment, then raising the plate to a temperature above 875 degrees C., suddenly cooling it, and then annealing it by raising it to a temperature above 350 degrees and below 700 degrees C., and cooling it slowly; substantially as described.

In testimony whereof, I have hereunto set my hand.

SAMUEL S. WALES.

Witnesses:
JOHN MILLER,
H. M. CORWIN.