UNITED STATES PATENT OFFICE.

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MANUFACTURE OF ARMOR-PLATES AND OTHER STEEL ARTICLES.

1,079,323. Specification of Letters Patent. Patented Nov. 25, 1913.

No Drawing. Application filed July 13, 1912. Serial No. 709,204.

To all whom it may concern:

Be it known that I, JOHN LAWRENCE BENTHALL, a subject of the King of Great Britain, residing at Highfield Hall, Chesterfield, in the county of Derby, England, have invented certain new and useful Improvements in or Relating to the Manufacture of Armor-Plates and other Steel Articles, of which the following is a specification.

This invention relates to the manufacture of armor plates and other steel articles of the kind that are composed of nickel steel alloyed with one or more of the metals, chromium, molybdenum, vanadium, tantalum, tungsten, and that are subjected during their manufacture to heat treatment adapted to impart hardness at certain parts and softness or toughness at other parts.

The steel preferably employed contains from .15 to .60% carbon, .20 to .40% manganese, 3.6 to 6.0% nickel, and .25 to 2.50% chromium, and may also contain a suitable percentage of one or more of the other metals referred to, which in the case of molybdenum may be as high as 2%.

According to the present invention the plate is subjected, after cementation and oil or water hardening but before machining, to two successive heating and cooling treatments, the temperature to which the plate is heated on each occasion being from 1150° to 1350° F., and, subsequent to the machining operation but prior to the final or "differential" hardening, to a further succession of heating and cooling treatments, the first of which consists in heating the plate to from 1300° to 1550° F. and oil or water hardening it, after which the plate is heated to from 1200° to 1350° F. and bent to counteract any distortion, and while still hot is again heated to from 1200° to 1350° F. and then sprinkled. The effect of the successive heating and cooling treatments subsequent to the machining is to harden the plate to such an extent that after the subsequent final or "differential" hardening process, to which the plate is subjected in accordance with the well known Krupp treatment, the back of the plate will possess the proper degree of strength and toughness.

In order that the invention may be clearly understood and readily carried into effect, the same will now be described more fully with reference to the manufacture of an armor plate of a composition varying between the proportions hereinbefore referred to.

An ingot of the steel is rolled to the desired thickness and is heated to a temperature of from 1050° to 1250° F. in order to remove any internal stresses due to rolling, and is then allowed to cool in air on supports until cold. It is then again heated to from 1050° to 1250° F. and allowed to cool on supports so as to soften the plate sufficiently to enable it to be machine-surfaced before being cemented. If the plate does not require to be machine-surfaced before cementation this second softening heat may be omitted. The side that is eventually to serve as the face of the plate is then cemented in the usual way at a temperature of from about 1700° to 1850° F. this temperature being maintained for a period of eight to fourteen days according to the thickness of the plate. The plate is then either removed from the cementation furnace and separately heated at a temperature of from 1400° to 1550° F. or retained in the cementation furnace while the temperature therein is allowed to drop to the lower temperature above stated, thus saving a separate heating. In either case the plate is then bent as may be required and while still hot is reheated to a temperature of from 1400° to 1600° F. and oil or water hardened. The plate is then subjected to two successive heating and cooling treatments which consist in first heating the plate to a temperature of from 1150° to 1350° F. and sprinkling it, and then reheating the said plate to a temperature of from 1150° to 1350° F. and then sprinkling it a second time. After the first of these two heatings the plate may be allowed to cool in air on supports instead of being sprinkled, if desired. The plate is then machined, drilled for small holes on the face, and test pieces are "nicked down" in the usual manner, to render the said plate ready for the final treatments.

The final treatments consist in first heating the plate to a temperature of from 1300° to 1550° F. and hardening in oil or water. The plate is then subjected to two successive heating and cooling treatments the first of which consists in heating the plate to a temperature of from 1200° to 1350° F. and rebending it to counteract any distortion thereof, and, while still hot, re-heating it to

a temperature between 1200° to 1350° F. and then sprinkling it. The plate is then embedded with its back in sand and its face exposed, and is subjected to a final hardening temperature varying from 1200° to 1750° F. for a length of time sufficient for the face of the plate to reach the desired temperature to give the correct depth of hardening, as in the well known Krupp method of final or "differential" hardening, and is then sprinkled with water.

What I claim and desire to secure by Letters Patent of the United States is:—

1. In the manufacture of armor plates, subjecting the plate to cementation, heating it to a temperature suitable for oil or water hardening, hardening it with oil or water, heating the plate to a temperature of from 1150° to 1350° F. and cooling it, again heating it to a temperature of from 1150° to 1350° F. and again cooling it, then machining the plate, then again heating it to a temperature suitable for oil or water hardening, hardening it with oil or water, heating the plate to a temperature of from 1200° to 1350° F., bending it, and, while still hot, reheating it to a temperature of from 1200° to 1350° F., sprinkling it with water, and then subjecting the plate to "differential" hardening.

2. In the manufacture of armor plates, subjecting the plate to cementation, heating it to a temperature suitable for oil or water hardening, hardening it with oil or water, heating the plate to a temperature of from 1150° to 1350° F. and cooling it, again heating it to a temperature of from 1150° to 1350° F. and again cooling it, then machining the plate, then again heating it to a temperature suitable for oil or water hardening, hardening it with oil or water, heating the plate to a temperature of from 1200° to 1350° F., bending it, and, while still hot, reheating it to a temperature of from 1200° to 1350° F., sprinkling it with water, then embedding the back of the plate in sand leaving its face exposed, subjecting it to a temperature of from 1200° to 1750° F. and then sprinkling with water.

3. The manufacture of armor plates, consisting in rolling the plate, heating it to a temperature of from 1050° to 1250° F. allowing it to cool in air, cementing the face of the plate at a temperature of from 1700° to 1850° F. bending the plate and while still hot heating it to a temperature of from 1400° to 1600° F. then hardening it with oil or water, then heating the plate to a temperature of from 1150° to 1350° F. and cooling it, again heating it to a temperature of from 1150° to 1350° F. and sprinkling it, then machining the plate, then heating it to a temperature of from 1300° to 1550° F. hardening it with oil or water, heating the plate to a temperature of from 1200° to 1350° F. bending it, and, while still hot, reheating it to a temperature of from 1200° to 1350° F. sprinkling it with water, then embedding the back of the plate in sand leaving its face exposed, subjecting it to a temperature of from 1200° to 1750° F. and then sprinkling with water.

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

JOHN LAWRENCE BENTHALL.

Witnesses:

JNO. R. CASWELL,

E. W. GIBSON.