A6333 XR 774,959 [redacted]

mn = .25 - .30%
Ni = 2.25 - 2.50 %
Tung = .25 - .32 %

No. 774,959. Patented November 15, 1904.

UNITED STATES PATENT OFFICE.

TOLMIE JOHN TRESIDDER, OF SHEFFIELD, ENGLAND.

MANUFACTURE OF STEEL ARMOR-PLATE, &c., WITH A HARDENED FACE.

SPECIFICATION forming part of Letters Patent No. 774,959, dated November 15, 1904.

Application filed July 17, 1903. Serial No. 166,013. (No model.)

To all whom it may concern:

Be it known that I, TOLMIE JOHN TRESIDDER, a subject of the King of Great Britain and Ireland, residing at Atlas Iron and Steel Works, Sheffield, in the county of York, England, have invented certain new and useful Improvements in the Manufacture of Steel Armor-Plates or other Plates of Steel with a Hardened Face, of which the following is a specification.

The object of this invention is to provide steel plates for armor or other purposes with hardened faces and with tough backs which will not crack and which can be manufactured in a simple and reliable manner.

It is presumed for the purpose of description that the plates to be produced are armor-plates; but it is to be understood that the invention is applicable to the production of face-hardened steel plates for any other purpose.

Armor-plates with a hardened face as hitherto made may be divided into two main kinds, the first kind being those which, although simple to manufacture, have a body part or back which is not sufficiently tough to enable the plates to bear heavy blows or artillery fire without cracking, and the second kind being those which, although they have a body part or back which is not liable to crack under heavy blows or artillery fire, yet are at certain stages of their manufacture extremely delicate and require great care and precaution in manipulation, and even then it is not unusual to have failures necessitating the remelting of the metal. Moreover, the roughness of the rolled surface of plates which, like those of the hereinbefore-referred-to second kind, contain a comparatively large proportion of nickel is such that in many cases they have to be surfaced in a planing-machine. The difficulties of manufacture of plates of the said second kind also increase as the thickness of the plates decreases.

According to this invention plates can be manufactured with all the facility of manufacture of the aforesaid first kind and without limitation as to thickness and at the same time with the high ballistic resistance and immunity from cracking hitherto obtainable only by a complicated and expensive process.

According to this invention a steel is produced having such a composition that when a plate made therefrom is treated as hereinafter described it can have imparted to it a fibrous structure which will remain undeteriorated, or even be improved, when the plate is heated throughout to a high temperature and suddenly cooled, the invention including operations, as hereinafter described, for restoring to the metal its fibrous character after it has necessarily been temporarily deprived of it in the cementation-furnace.

An ingot is first produced composed of steel having the following composition—namely, iron, carbon, manganese, nickel, and tungsten—in or about the following proportions in each ten thousand parts, by weight, of the steel mixture; carbon, from twenty-eight to thirty-two parts, by weight; manganese, from twenty-five to thirty parts, by weight; nickel, from two hundred and twenty-five to two hundred and fifty parts, by weight; tungsten, from twenty-eight to thirty-two parts, by weight, the remainder being iron with a little silicon and the usual impurities kept within the low limits usual in high-class steels.

The following is the preferred way of proceeding in manufacturing the steel having the above composition. The charge, consisting of about one-half good hematite or Swedish pig-iron and the other half good pure steel-scrap, is melted on the Siemens hearth until the impurities have been eliminated and the carbon, as judged by fracture of a spoon sample, is under one-fifth per cent., and then nickel, preferably in the form of rondelles of metallic nickel, is thrown into the bath and stirred therein. When this is thoroughly incorporated, which will usually be in about ten minutes, red-hot ferromanganese is added in such quantity as experience shows will after allowing for the inevitable loss leave the desired percentage of manganese. When the said ferromanganese has been well stirred in, the tungsten is added, preferably in the condition of red-hot ferrotungsten containing about one-third tungsten and two-thirds iron. No allowance need be made for loss of tungsten. As soon as the ferrotungsten has had time to become thoroughly mixed the steel is tapped into a ladle and cast into an ingot. The ingot thus produced is of such a character that before being reheated it can be laid down and allowed to cool without being liable to spontaneous disintegration; but, if desired, it can while still hot be at once taken to the forging-press or rolling-mills to be forged or rolled into plates without any special precautions being necessary, and if ordinary steps be taken for removing scale the surface will not require to be machined; but if it be desired to machine it machining can be done with facility. The plate having been pressed or rolled to the desired thickness is allowed to become cold, and rough-machining can, if desired, be done at this stage. It is next placed in a cementing-furnace, where one side is supercarburized, which may be done in any of the usual ways, and preferably to a fairly high degree—say so as to analyze about one and one-half per cent. of carbon at the face. The plate must not be allowed to cool in the cementation-furnace, but must be taken out hot and be immediately subjected to one of the following treatments, viz: (*a*) Rerolling or reforging while at a temperature of about 1,800° Fahrenheit. In this case the original rolling or forging should be stopped while the plate is still about one-third thicker than is ultimately required. (*b*) Quenching in oil from a temperature of 1,600° to 1,700° Fahrenheit. (*c*) Chilling with a water douche from a temperature of about 1,550° to 1,650° Fahrenheit. Of these treatments the last (*c*) is recommended for plates under four inches thick, and the second (*b*) for plates over that thickness, while the first, (*a*,) which involves risk of loss of carbon from the face, is best restricted to plates which are too thin to be conveniently carburized at their finished thickness. The next process is to uniformly heat the plate to about 1,100° Fahrenheit (or more if considerable curvature has to be given to it) and after bending to shape, if required, (allowing for the warping that may be expected from the final process,) permitting the plate to cool gradually. It should then be machined to finished dimensions and subjected to a repetition of either of the treatments hereinbefore mentioned under *b* and *c*, after which the final treatment may be applied, which consists in heating the plate uniformly throughout to from 1,450° to 1,550° Fahrenheit and chilling it with a water douche.

"Test-scrap" for fracture should be left attached to the plate as usual, and the fracture should be examined after the second of the hereinbefore-mentioned treatments *b* or *c*. At this stage the non-cemented portion should show a good fiber; but if not either the treatment *b* or *c*, preferably *c*, should be repeated before proceeding further, as the fibrous structure of the non-cemented portion must be obtained before the plate is finally chilled.

Owing to the peculiar properties of the steel manufactured as above described, the final chilling, while conferring glass hardness to the face, will not destroy, but will even improve the fibrous structure of the back.

In all heatings subsequent to cementation the usual precautions must be taken to avoid decarburization.

As in neither of the hereinbefore-described treatments is it required to have the face and back of the plate simultaneously at different temperatures, very thin plates with hard faces and tough backs—such as are suitable, for instance, in making safes and the like—can be produced.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is—

1. The manufacture of steel plates by first producing an ingot of steel composed of iron, carbon, manganese, nickel and tungsten, and forging, or rolling; then cementing, or supercarburizing, the face and cooling, and afterward restoring the fibrous character to the uncemented part; all substantially as hereinbefore described.

2. The manufacture of steel plates by first making an ingot of steel composed of iron, carbon, manganese, nickel and tungsten, reforging or rolling, supercarburizing the face and cooling, reheating and gradually cooling, and finally heating and face-hardening; all substantially as hereinbefore described.

3. The manufacture of steel plates by first making an ingot of steel composed of iron, carbon, manganese, nickel and tungsten, and then, while hot, forging, or rolling it, and allowing it to cool, then cementing, or supercarburizing, one side and, quickly cooling, then uniformly heating the plate, and cooling gradually, and after machining to the finished dimensions, reheating and quenching till a good fibrous condition of the uncemented part is obtained; and finally uniformly heating and chilling; all substantially as hereinbefore described.

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

TOLMIE JOHN TRESIDDER.

Witnesses:

EDWARD CHARLES HAMMOND,

WILLIAM GERALD REYNOLDS.