UNITED STATES PATENT OFFICE.

HECTOR DE NOLLY, OF ST. CHAMOND, FRANCE, ASSIGNOR TO COMPAGNIE DES FORGES & ACIERIES DE LA MARINE ET D'HONRECOURT, OF ST. CHAMOND, FRANCE.

PROCESS OF MAKING HARDENED STEEL.

957,706. Specification of Letters Patent. Patented May 10, 1910.

No Drawing. Application filed November 25, 1907. Serial No. 403,789.

To all whom it may concern:

Be it known that I, HECTOR DE NOLLY, a citizen of the Republic of France, and residing at St. Chamond, France, have invented an Improvement in and a Process of Making Hardened Steel, of which the following is a specification.

This invention has for object to produce a steel which is more especially suitable for the manufacture of armor plates, but is capable of other applications, for example the manufacture of projectiles, various parts of automobiles and otherwise.

The improved steel is characterized by its composition which is such as to permit the employment of a method of hardening that does away with cementation without causing fragility in the mass. In effect the composition is such as to impart to the metal the faculty of acquiring by suitable treatment: 1. A fine grained texture having great softness such as to greatly facilitate the various operations of working or tooling in a cold state. 2. A fibrous texture having a tenacity and a suppleness at least equal to those of the mattress of armor plates as at present produced, and energetically opposing the production of cracks at the time of impact. 3. A porcelain texture having a hardness equal to that of cemented steels, and, in consequence, capable of breaking the points of projectiles.

The possibility of suppressing cementation has great advantages, both on the score of economy by reason of the rapidity of manufacture and of the augmentation of production which results therefrom, as well as on the score of the certainty derived therefrom of obtaining a satisfactory texture owing to the absence of coarse grain, which is often difficult to eradicate and the formation of which is provoked by the prolonged keeping of the metal at a high temperature. The steel according to this invention and which fulfils these conditions is a nickel chromium steel, containing a high percentage of carbon and chromium, and in which these two elements are present in definite relative proportions. The composition of the alloy is as follows:—

Carbon, at least 0.65%--------at most 0.800
Chromium at least 3%--------at most 4%
Nickel about 2.5%.

The method of treating this metal more specially for the manufacture of armor plates is as follows:

1. After having been laminated the plate is subjected to two annealing operations, the first at a temperature between 850° C. and 900° C. and the second at a temperature of about 775° C. that is to say at a temperature slightly above that at which the alloy changes its molecular state. The duration of these annealing operations depends upon the thickness of the plates under treatment but in a general way the second annealing is not maintained as long as the first. In this state the steel can be easily cut and its texture presents great fineness.

2. After being worked, the plate is heated uniformly to about 775° C. and quenched in oil; this quenching is followed by annealing at the same temperature, then by a quenching with water after uniform reheating to between 650° C. and 675° C. This series of operations renders the texture fibrous throughout the whole mass and its resilient properties are greatly increased.

3. The treatment is terminated by a water quenching effected by sprinkling the plate which then presents a gradation of temperatures such that the mass preserves its fibrous texture while the impact face thereof is capable of acquiring an extra hard porcelain texture. For that purpose it is necessary that the body of the plate be maintained at a temperature below 675° C. and that the face to be hardened be brought to a temperature of between 800° C. and 850° C. that is to say to a temperature distinctly superior to that at which the alloy changes its molecular state, in order that the quenching may be effective.

In this way there is obtained a plate which is hardened on one side only, by quenching, without cementation and by finally quenching in the manner described the plate face, the temperature of which is constantly decreasing in front of the rear face and body of an uncemented armor plate there can be obtained all gradations that may be desired, either for hardness or for the thickness of the hardened portion.

What I claim is:—

1. Armor plates manufactured from chrome nickel steel containing at least 0.65% and at most 0.8% of carbon, at least 3% and at most 4% of chromium and about 2.5% of nickel, by annealing at a temperature above

that at which the steel alloy changes its molecular condition, working it and then subjecting it to two heatings the first to a temperature above that at which the alloy changes its molecular condition and the second to a temperature below that point, said heating operations being each followed by quenching, heating the face thereof to a temperature above that at which the alloy changes its molecular condition while maintaining the body thereof at a temperature below this point of change and quenching with water.

2. Armor plates manufactured from chrome nickel steel containing at least 0.65% and at most 0.8% of carbon, at least 3% and at most 4% of chromium and about 2.5% of nickel, by treatment consisting of subjecting the plates to two annealing operations, the first at a temperature between 850° C. and 900° C. and the second at a temperature of about 775° C., heating uniformly to about 775° C., quenching in oil, annealing at a temperature of about 775° C., quenching with water after uniform reheating to between 650° C. and 675° C., heating the face to be hardened to a temperature of between 800° C. and 850° C. while maintaining the body of the plate at a temperature below 675° C. and finally quenching by sprinkling with water.

3. An armor plate manufactured from chrome nickel steel containing from 0.65% to 0.8% of carbon, 3% to 4% of chromium, and about 2.5% of nickel, said plates having a body portion of fibrous texture and an impact face of extra hard porcelain texture.

4. The process of manufacturing hardened steel objects such as for example, armor plates, which consists in subjecting a charge of chrome nickel steel containing from 0.65 to 0.8 per cent. carbon, 3 to 4 per cent. chromium and about 2.5 per cent. nickel to a plurality of annealings at temperatures above that at which the alloy changes its molecular state, working the metal so treated into desired shape, subjecting the shaped metal to two heatings, the first to a temperature above that at which the alloy changes its molecular state and the second at a temperature below that point said heatings being followed by quenchings adapted to produce a fibrous texture throughout and then heating a portion thereof to a temperature above that at which the alloy changes its molecular state while maintaining the remainder at a temperature below this point and quenching the highly heated surface to produce a hard porcelain texture without affecting the fibrous character of the remainder, substantially as described.

5. The process of manufacturing hardened steel objects such as for example, armor plates, which consist in subjecting a charge of chrome nickel steel containing from 0.65 to 0.8 per cent. carbon, 3 to 4 per cent. chromium and about 2.5 per cent. nickel to a plurality of annealings at temperatures between 775° C. and 900° C. working the metal so treated into desired shape, heating the shaped metal to a temperature of approximately 775° C., quenching the same, reheating to between approximately 650° C. and 675° C. and again quenching whereby a fibrous texture throughout is produced and then heating a portion thereof to a temperature between 800° C. and 850° C. while maintaining the remainder at a temperature below 675° C. and quenching the highly heated surface to produce a hard porcelain texture without affecting the fibrous character of the remainder, substantially as described.

6. The process of manufacturing hardened steel objects such as for example, armor plates, which consists in subjecting a charge of chrome nickel steel containing from 0.65 to 0.8 per cent. carbon, 3 to 4 per cent. chromium and about 2.5 per cent. nickel to a plurality of annealings at temperatures between 775° C. and 900° C. working the metal so treated into desired shape, heating the shaped metal to successively lower temperatures between 775° C. and 650° C., each of said heatings being followed by quenching whereby a fibrous texture throughout is produced, and then heating a portion thereof to a temperature between 800° C. and 850° C. while maintaining the remainder at a temperature below 675° C. and quenching the highly heated surface to produce a hard porcelain texture without affecting the fibrous character of the remainder, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses.

HECTOR DE NOLLY.

Witnesses:
CLAUDIUS MOLEYREZ,
NURITZ BURROUGHS.