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ARMOR PLATE

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The present invention relates to armor plates hardened on one side and manufactured from a steel alloy the constituents of which are so determined that, on heating, the lower critical point (point A_{c1}) has a comparatively high position so that the interval of temperature existing between the lower and upper critical point (A_{c1} to A_{c3}) is small. An armor plate of this kind consists for instance of a steel alloy containing about 0.2 to 0.65% carbon, about 0.5 to 4% nickel, about 2.0 to 4.5% chromium and about 0.2 to 1.5% molybdenum, wherein the molybdenum may be replaced partly or wholly by a 1.5 to 3-fold quantity of tungsten.

Steel alloys hitherto used for the manufacture of armor plates contain about 0.25 to 0.35% carbon, about 3 to 5% nickel and about 1 to 1.8% chromium. In order to facilitate the heat treatment, sometimes molybdenum or tungsten or both these metals have been added to these steel alloys.

Now exhaustive tests have shown that the toughness of armor plates and their resistance to being injured by projectiles can be improved to an extraordinary extent by limiting the nickel content to 4% at the most and at the same time increasing the chromium content to about 2 to 4.5%. Advantageously the percentage of nickel is determined according to the thickness of the armor plate, but it is of particular advantage to limit the nickel content to not more than about 3% even with the thickest plates. With decreasing thickness of the plates the nickel content may be reduced correspondingly, so as to amount with thin plates only to about 0.5%.

The armor plate forming the subject-matter of the invention is remarkable for the feature that, after having been brought to a condition of highest toughness by hardening and re-heating, it is capable of being hardened on one side without cementation, but does not lose to an inadmissible extent its toughness on the non-hardened side. With the armor plates of the known composition this is impossible for the following reasons: With the steel alloys the known armor plates are made from, the point A_{c1} at which the transformation begins in heating the plate, lies between 650 and 700° C., whilst the practically required hardening temperature is about 850° C., that is nearly 200° higher. Now with thin plates it is practically impossible to heat the plate on one side to a temperature of 850° C. and to keep the non-heated side in a layer of sufficient depth at a temperature below the point A_{c1} , that is about 200° C. lower. With thicker

plates such a heating would be possible, but there would be a broad layer which has a temperature lying between the points A_{c1} and A_{c3} and therefore loses its toughness after the quenching and therefor acquires only insufficient hardness. Armor plates manufactured according to the invention behave otherwise. For, in the new plates the point A_{c1} is not only raised owing to the increased chromium percentage and reduced nickel percentage, but also the distance between the point A_{c1} and the hardening temperature, which lies above the point A_{c3} , is reduced. The increased carbon content acts in the same direction. This small distance existing between the point A_{c1} and the hardening temperature in conjunction with the property of the chromium steels of easily being hardened makes it possible to harden the armor plates according to the invention at a temperature which lies about 50 to 100° C. above their point A_{c1} , which lies at about 770 to 800° C. Such a difference of temperature, however, can be obtained also in comparatively thin plates so that it is possible to bring one side of the plate to hardening temperature and to maintain at the same time a sufficiently thick layer of the other side at a temperature which is below the point A_{c1} , and therewith in the condition of the highest toughness, the transition layer which possesses less favorable properties becoming considerably thinner than with the plates of known composition.

The heat treatment of the armor plates according to the invention consists in hardening the plates from a temperature above the point A_{c3} and re-heating them to a temperature close below the point A_{c1} , whereby the plates acquire highest toughness. As a consequence of this high re-heating temperature enabled by the high position of the point A_{c1} , a degree of toughness is obtained which could not be reached with the plates of the known composition. Thereupon the plates are brought to hardening temperature only on the outer layer by heating them on one side, and then hardened on this side by subsequent quick cooling.

It is possible in itself of course, to cement the plates previous to hardening, but this would involve certain technical and economical disadvantages.

The following examples for the composition of armor plates forming the subject-matter of the invention may be given:

1. Armor plate of about 100 mm. thickness, containing about: 0.38% carbon, 2.5% chromium, 1.3% nickel and 0.4% molybdenum.

2. Armor plate of about 150 mm. thickness, containing about: 0.45% carbon, 2.6% chromium, 1.8% nickel, and 0.45% molybdenum.

What I claim as my invention is:

5 1. Armor plates composed of a steel alloy having an A_{c1} point of about 770° C. or more and a hardening temperature not substantially over 100° C. above the A_{c1} point, said alloy containing about 0.2 to 0.65% of carbon, 0.5 to 3% of nickel,
10 2.0 to 4.5% of chromium, and 0.2 to 1.5% of molybdenum, the balance substantially iron, said plates being hardened on the outside and having a strong tough layer on the inside, the intermediate band of softer steel being relatively narrow.

15 2. Armor plates as described in claim 1, wherein the molybdenum content is replaced at least partly by a 1.5 to 3 fold quantity of tungsten.

20 3. Armor plates composed of a steel alloy having an A_{c1} point of about 770° C. or more and a hardening temperature not substantially over 100° C. above the A_{c1} point, said alloy containing about 0.2 to 0.65% of carbon, 0.5 to 3% of nickel, 2.5 to 4.5% of chromium, and 0.2 to 1.5% of
25 molybdenum, the balance substantially iron, said plates being hardened on the outside and having a strong tough layer on the inside, the intermediate band of softer steel being relatively narrow.

4. Armor plates as described in claim 3, where-

in the molybdenum content is replaced at least partly by a 1.5 to 3 fold quantity of tungsten.

5. Armor plates composed of a steel alloy having an A_{c1} point of about 770° C. or more and a hardening temperature not substantially over 100° C. above the A_{c1} point, said alloy containing about 0.2 to 0.45% of carbon, 0.5 to 3% of nickel, 2.0 to 4.5% of chromium, and 0.2 to 1.5% of molybdenum, the balance substantially iron, said plates being hardened on the outside and having a strong tough layer on the inside, the intermediate band of softer steel being relatively narrow.

6. Armor plates as described in claim 5, wherein the molybdenum content is replaced at least partly by a 1.5 to 3 fold quantity of tungsten.

7. Armor plates composed of a steel alloy having an A_{c1} point of about 770° C. or more and a hardening temperature not substantially over 100° C. above the A_{c1} point, said alloy containing about 0.2 to 0.45% of carbon, 0.5 to 3% of nickel, 2.5 to 4.5% of chromium, and 0.2 to 1.5% of molybdenum, the balance substantially iron, said plates being hardened on the outside and having a strong tough layer on the inside, the intermediate band of softer steel being relatively narrow.

8. Armor plates as described in claim 7, wherein the molybdenum content is replaced at least partly by a 1.5 to 3 fold quantity of tungsten.

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