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CHARLES McKNIGHT, JR., OF MONTCLAIR, AND THOMAS H. WICKENDEN, OF ROSELLE, NEW JERSEY, AND PAUL D. MERICA, OF NEW YORK, N. Y., ASSIGNORS TO THE INTERNATIONAL NICKEL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

NICKEL MANGANESE STEEL ALLOY AND METHOD OF TREATING THE SAME.

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Our invention relates to alloy steels and particularly to those containing nickel, manganese and carbon, in the proportions of carbon .10 to .60% (preferably .35 to .50%); manganese .70 to 2% (preferably .90 to 1.10%) and nickel .50 to 3.50% (preferably 1.50 to 2%). The other metalloids may be in ordinary proportions, and we prefer that the steel shall contain silicon from .10 to .50% (preferably .15 to .25%) with the sulphur and phosphorus each under .05%. Any other elements will be merely incidental.

We have discovered that if such a steel is subjected to a mild heat treatment, as for example, an annealing, a double annealing, or quenching in air and drawing, the material is particularly desirable for forgings, particularly heavy forgings. It is also desirable for structural shapes and plates, I-bars, oil field drilling tools and railroad rails.

In carrying out our invention, we may make the alloy steel in any desirable way, as for example, by the open hearth (acid or basic), electric furnace, crucible, or Bessemer method. Such a steel is particularly adapted to mild heat treatment, as distinguished from the drastic heat treatment of heating and quenching in liquids. We dispense with this drastic treatment, whereby the steel is heated to above the critical point and quenched in liquid, and impart to such a steel a desirable set of physical properties by a mild heat treatment, such for example, as follows:

a. Simply heat the steel to a temperature above the critical point (about 1400° F.) and permit it to cool slowly either in the furnace or in some insulating material, such as lime or ashes;

b. A double anneal which may be carried out in substantially the same way as the single anneal, except that the metal is twice cooled from above the critical point. In this case, both coolings may be carried out slowly as in the furnace, or rapidly as in the open air, or once rapidly and once slowly;

c. The air quench and draw. This method is particularly recommended, and consists in heating the steel to or over the critical point, holding it at such temperature sufficiently long to thoroughly soak the steel and accomplish the heat transformation, and then allowing it to cool in quiescent air. It is then again heated to a predetermined temperature, preferably about 1200° F., allowed to remain at this point for a suitable time to insure thorough soaking, and then again cooled, either in a quiescent air or in a furnace.

Such a treatment will, if properly carried out, give the steel the following desirable tensile properties:

Yield point or elastic limit about 55,000 to 80,000 psi.

Ultimate tensile strength, 85,000 to 110,000 psi.

Elongation, 20 to 30%.

Reduction of area, 40 to 55%.

These properties may, of course, be varied somewhat by varying the heat treatment which, however, should preferably always be of the mild type.

This steel, thus heat treated, is particularly desirable in the field of heavy forgings for railroad and similar work. Also for automobile parts, structural shapes and plates, oil field drilling tools, railroad rails, etc.

This treatment does not require quenching tanks and handling equipment, and hence, it is particularly adapted for shops not so equipped.

The material is preferably treated in its secondary or worked condition, as distinguished from the primary or cast condition.

Other alloying elements or metalloids may be added, the details of the gentle or mild heat treatment may be varied, and other variations may be made without departing from our invention.

While our alloy steel is particularly adapted for a mild heat treatment and has the herein described desirable characteristics imparted to it by such treatment, it is also a superior alloy adapted for other forms of heat treatment, including the more drastic type.

By the words "in alloying proportions", we mean manganese in such proportions in the final alloy that the manganese has a discernible and material effect on the properties of the material in coaction with the other elements of the alloy, as distinguished from a case where manganese is added for deoxidiz-

ing purposes and there remains in the metal merely a small negligible content of managanese, which content has no material coactive effect with the other parts of the alloy as regards the properties thereof.

We claim:

1. An alloy steel containing nickel 0.5% to 3.5%, carbon 0.1% to 0.6%, and manganese in alloying proportions from about 0.9% to 2.0%, said alloy being capable of developing in heavy sections high physical properties and ductility by mild heat treatment.

2. As a new article of manufacture, an air-cooled forging of heavy section containing nickel 0.5% to 3.5%, carbon 0.1% to 0.6% and manganese in alloying proportions from about 0.9% to 2.0%, said article having enhanced physical properties with good ductility obtained by mild heat treatment.

3. An air-cooled forging of heavy section containing 1.0% to 2.5% nickel, 0.1% to 0.5% carbon, and manganese in alloying proportions from about 0.9% to 2.0%, said alloy being capable of developing high physical properties and ductility by mild heat treatment.

4. As a new article of manufacture, an air-cooled forging of heavy section containing 1.0% to 2.5% nickel, 0.1% to 0.5% carbon, and manganese in alloying proportions from about 0.9% to 2.0%, said article having enhanced physical properties with good ductility obtained by mild heat treatment.

5. As a new article of manufacture, an article of over 1 inch in cross section containing 0.5% to 3.5% nickel, 0.1% to 0.6% carbon, and manganese in alloying proportions from about 0.9% to 2.0%, and which after mild heat treatment comprising air quenching and drawing will show properties of 55,000 to 80,000 psi yield point and 80,000 to 110,000 psi tensile strength.

6. As a new article of manufacture, an alloy steel containing nickel 0.5% to 3.5%, carbon 0.1% to 0.6%, manganese in alloying proportions from about 0.9% to 2.0%, and having throughout high physical properties imparted by mild and gentle heat treatment.

7. As a new article of manufacture, an article of over 1 inch in cross section containing 1.0% to 2.5% nickel, 0.1% to 0.5% carbon, and manganese in alloying proportions from about 0.9% to 2.0%, and which after mild heat treatment comprising air quenching and drawing will show properties of 55,000 to 80,000 psi yield point and 80,000 to 110,000 psi tensile strength.

In testimony whereof we have hereunto set our hands.

CHARLES McKNIGHT, JR.
THOMAS H. WICKENDEN.
PAUL D. MERICA.