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[54] **METHOD OF PRODUCING A STEEL WITH HIGH STRENGTH, HIGH DUCTILITY AND GOOD WELDABILITY**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **148/12 F;** 148/12.1; 148/12.4

[51] **Int. Cl.**[2] **C21D 7/02**

[58] **Field of Search** ..... 148/12, 12.4, 12.1; 75/123 J

[56] **References Cited**

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[57] **ABSTRACT**

A process for treating steel containing up to 0.25% C, up to 0.5% Si, about 0.5 to about 2% Mn, 0 to 0.1% Nb, 0 to 0.2% V, 0 to 0.2% Ti and 0 to 0.1% Al, balance iron and impurities comprising heating the steel to the austenitizing point, thereafter immediately cooling said steel to the transformation temperature in a lead bath having a temperature of about 350°C. and cold working said steel to achieve an area reduction of 0.5 to 10% whereby a steel having the properties of high strength, good formability and good weldability is produced.

4 Claims, No Drawings

METHOD OF PRODUCING A STEEL WITH HIGH STRENGTH, HIGH DUCTILITY AND GOOD WELDABILITY

DESCRIPTION OF THE INVENTION

This invention relates to a method of making steel having the qualities of high strength, good ductility and good weldability. The steel industry is continually seeking a solution to the problem of making a steel which simultaneously has high strength, good ductility and good weldability. Procedures known heretofore, however, have produced steels having only two of the above mentioned qualities simultaneously, which, of course, has limited the fitness of the steel. Through the practice of the present invention it is possible to produce steel which has all the qualities mentioned.

According to the present invention, steel having the following composition:

up to 0.25% C, up to 0.50% Si, about 0.5 to about 2.0% Mn, 0–0.1% Nb, 0–0.2% V, 0–0.2% Ti, 0–0.1% Al, balance iron, a steel, the qualities of which are already known, in the form of hot or cold-rolled strips is heated to the austenitizing point at a temperature of 950° – 960°C. and immediately thereafter cooled to the transformation point at a temperature of 300°C. to 650°C. to form a structure mainly consisting of bainite and ferrite with elements of martensite and fine lamellar perlite. Cooling and transformation is suitably carried out in a lead bath maintained at a temperature of 350°C. through which the austenitized strip is fed and where cooling to a temperature of about 300°C. occurs at a controlled rate of about 0.6°C./sec. to 60°C./sec. Subsequently the strip is cold-worked with an area-reduction of 0.5 – 10% by volume. In the cases where strips are used as basic material, the cold-working operation is carried out suitably as a cold-rolling. Despite the small reduction in surface area occasioned by the cold-working, the yield-point of the steel is considerably increased in the material in question with this procedure without any mentionable decrease of the ductility.

The invention will now be described according to the following example.

As a basic material a cold-rolled strip was used with the following dimensions: 340 × 1.53 mm. The composition of the basic material was:

0.17% C, 0.36% Si, 1.50% Mn, 0.0.27% Nb, 0%V, 0% Ti, 0.0.3% Al, balance iron.

This material was subject to a special heat treatment in a continuous vertical furnace. The heat treatment resulted in a mixed structure consisting mainly of bainite and ferrite with elements of martensite and fine-lamellar perlite.

Thereafter, the material was subject to a cold-rolling with a reduction of thickness from 1.53 to 1.50 mm.

The treatment resulted in the following tensile properties:

$$\sigma_{0.2} = 79 \text{ Kp./mm}^2$$

$$\delta_5 = 23.2\%$$

After test welding, the steel had a hardness in the areas influenced by the heat generated by the welding procedure in the range 80–90% of the initial hardness which must be regarded as a good weldability.

Compared with steel qualities known heretofore, a steel produced according to this invention has excellent formability, that is, a good elongation in proportion to the high strength. Moreover, it has a good weldability which means a broader range of applicability for the steel. The steel produced according to the invention combines in a way not known heretofore the three properties aimed at namely high strength, good formability and good weldability.

Modification of the invention other than using strips as a basic material and cold-rolling as cold-working can be made of course without departing from the invention. For instance, steel wire can be used as basic material which at cold-working is cold-drawn or cold-roller.

The scope of the invention therefore is limited by the appended claims wherein what is claimed is:

1. A method for treating steel containing a maximum of 0.25% C, a maximum of 0.5% Si, about 0.5 to about 2% Mn, 0 to 0.1% Nb, 0 to 0.2% V, 0 to 0.22 Ti, 0 to 0.1% Al, balance iron and residual impurities, comprising

1. heating said steel to a temperature sufficient for said steel to be substantially completely austenitized,
2. immediately cooling said steel to a transformation temperature in a range of about 300°C. to 650°C. at a cooling rate ranging from 0.6°C./sec. to 60°C./sec. whereby a steel is produced having a structure of mainly bainite and ferrite with elements of martensite and fine-lamellar pearlite and,
3. cold working said steel to achieve an area reduction of 0.5 to 10%, said steps producing a steel having the properties of high strength, good formability and good weldability.

2. The process according to claim **1** wherein said steel is heated to a temperature of about 950°–960°C. to achieve austenitization and cooled to said transformation temperature in a lead bath maintained at a temperature of about 350°C.

3. The process according to claim **1** wherein said treated steel has a yield strength of about 79 Kp/mn^2.

4. A steel having the properties of high strength, good formability and good weldability produced by treating a steel containing a maximum of 0.25%C, a maximum of 0.5% Si, about 0.5 to 2% Mn, 0 to 0.1% Nb, 0 to 0.2% V, 0 to 0.2% Ti, 0 to 0.1% Al, balance iron and residual impurities by

1. heating said steel to a temperature sufficient for said steel to be substantially completely austenitized,
2. immediately cooling said steel to a transformation temperature in a range of about 300°C. to 650°C. at a cooling rate ranging from 0.6°C./sec. to 60°C./sec. whereby a steel is produced having a structure of mainly bainite and ferrite with elements of martensite and fine-lamellar pearlite and,
3. cold working said steel to achieve an area reduction of 0.5 to 10% in said steel.

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