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HEAT-TREATMENT FOR HIGH CARBON HIGH CHROMIUM STEEL

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This invention relates to high carbon high chromium steels and more particularly to thermal treatments for such steels.

The use of high carbon high chromium steels of the class containing from .5 to 1.25 per cent carbon and 10 to 16 per cent chromium, manganese in effective amounts but not over 1.10 per cent, .25 per cent maximum nickel, normal amounts of phosphorus, sulphur and silicon and the balance substantially iron except for residual amounts of other elements, has heretofore been restricted because of their extreme brittleness at room temperature. A typical analysis of a steel within this class is about 1 per cent carbon, 14 per cent chromium, and .80 per cent manganese. Such a steel is generally considered martensitic.

By treating such steels as the foregoing in accordance with the teachings of our invention, as hereinafter described, it becomes possible to cold process them after being hot rolled or forged. Ordinarily such steels cannot be further processed to any great extent by cold rolling or other deforming at or near room temperature because of their extreme brittleness. In part, this brittleness, which results in fracturing of the steel upon very slight deformations at or near room temperature, is the result of excessively large, usually angular, carbides formed during the solidification and cooling of the steel. These carbides may increase in size during the hot working heating operations.

In accordance with the teachings of our invention, such steels can be annealed and rendered suitable for cold deformation in the following manner. Articles of steel of the specified composition are heated preferably to between 50° and 75° F. below the melting range of the steel, or to from 2100° to 2250° F. and held at such temperature between fifteen minutes and four hours. The steel is then cooled in a relatively rapid manner to below 1000° F., either in air or in liquid, but in any case at a rate of at least 50° per hour.

The steel is then reheated to within the temperature range of 1250° to 1500° F. for an interval of between four and twenty-four hours and preferably cooled in any convenient manner to substantially room temperature. Such cooling should exceed at least 25° per hour.

Either after such a cooling to substantially room temperature or directly from a temperature in the range of 1250° to 1500° F. the steel is heated to a temperature of 1650° to 1700° F. for from fifteen minutes to eight hours and then cooled in any suitable manner, which does not form

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coarse carbides, but which must be in excess of 25° F. per hour, preferably to within but not below the temperature range of 1250° to 1450° F.

The final step in our treatment is holding the steel within the temperature range of 1250° to 1450° F. for from four to twenty-four hours followed by cooling to room temperature in any manner desired.

These heating steps cause a series of phase or constituent changes or transformations of the steel, which must follow one another in the correct sequence to produce the final desired type of phase or constituent aggregate having the desired properties for cold working. Therefore, it is an essential feature of the foregoing heating operations that they be performed in the sequence described in order to obtain the desired ductility and quality of being cold-deformable.

While we have described certain specific embodiments of our invention, it will be understood that these embodiments are merely for the purpose of illustration and description and that various other forms may be devised within the scope of our invention, as defined in the appended claims.

We claim:

1. A method of producing cold-deformable high chromium alloy steel containing between .5 and 1.25 per cent carbon, 10 to 16 per cent chromium, manganese in effective amounts up to 1.10 per cent; not over .25 per cent nickel and balance substantially iron comprising heating said alloy steel to a temperature between 2100° and 2250° F., holding at said temperature for between fifteen minutes and four hours, rapidly cooling from such temperature to below 1000° F. at a rate of at least 50° per hour, heating to within the range of 1250° to 1500° F., holding in such range for a time between four and twenty-four hours, reheating to a temperature within the range of 1600° to 1750° F., holding at such temperature for from fifteen minutes to eight hours, cooling to within the range of from 1250° to 1450° F. at a rate in excess of 25° per hour and holding in such range for from four to twenty-four hours.

2. A method of producing cold-deformable high chromium alloy steel containing between .5 and 1.25 per cent carbon, 10 to 16 per cent chromium, manganese in effective amounts up to 1.10 per cent, not over .25 per cent nickel and balance substantially iron comprising heating said alloy steel to a temperature within 50° to 75° F. below the melting range of the steel, holding at said temperature for between fifteen minutes and four hours, rapidly cooling from such temperature to

below 1000° F. at a rate of at least 50° per hour, heating to within the range of 1250° to 1500° F., holding in such range for a time between four and twenty-four hours, reheating to a temperature within the range of 1600° to 1750° F., holding at such temperature for from fifteen minutes to eight hours, cooling to within the range of from 1250° to 1450° F. at a rate in excess of 25° per hour and holding in such range for from four to twenty-four hours.

3. A method of producing cold-deformable high chromium alloy steel containing between .5 and 1.25 per cent carbon, 10 to 16 per cent chromium, manganese in effective amounts up to 1.10 per cent, not over .25 per cent nickel and balance substantially iron comprising heating said alloy steel to a temperature between 2100° and 2250° F., holding at said temperature for between fifteen minutes and four hours, rapidly cooling from such temperature to below 1000° F. at a rate of at least 50° per hour, heating to within the range of 1250° to 1500° F., holding in such range for a time between four and twenty-four hours, cooling to substantially room temperature at a rate in excess of 25° per hour, reheating to a temperature within the range of 1600° to 1750° F., holding at such temperature for from fifteen minutes to eight hours, cooling to within the range of from 1250° to 1450° F. at a rate in excess of 25° per hour and holding in such range for from four to twenty-four hours.

4. A method of producing cold-deformable high chromium alloy steel containing between .5 and 1.25 per cent carbon, 10 to 16 per cent chromium, manganese in effective amounts up to 1.10 per cent, not over .25 per cent nickel and balance

substantially iron comprising heating said alloy steel to a temperature within 50° to 75° F. below the melting range of the steel, holding at said temperature for between fifteen minutes and four hours, rapidly cooling from such temperature to below 1000° F. at a rate of at least 50° per hour, heating to within the range of 1250° to 1500° F., holding in such range for a time between four and twenty-four hours, cooling to substantially room temperature at a rate in excess of 25° per hour, reheating to a temperature within the range of 1600° to 1750° F., holding at such temperature for from fifteen minutes to eight hours, cooling to within the range of from 1250° to 1450° F. at a rate in excess of 25° per hour and holding in such range for from four to twenty-four hours.

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