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METHOD OF TREATING METALS

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This invention relates to a method for treating metals, particularly ferrous metals such as steel of relatively low carbon content. The present invention is concerned with the treatment of metals, particularly low carbon content ferrous metals, to the end of securing certain desired characteristics in the metal, finally resulting from the treatment. This application is a continuation in part of my copending application, Serial No. 485,316, filed September 29, 1930. I have discovered that the cooling or quenching of a metal, heated to a tempering temperature at about 1650° F., by means of a suitable composition results in the metal having certain very desirable properties and characteristics. Present methods of quenching do not enable these desirable characteristics to be secured by simple heating and cooling operations; and when materials having these characteristics are desired they must be secured by processes and treatments other than the aforementioned simple operations.

It is in general the broad object of the present invention to devise a novel process for the treatment of metals, particularly ferrous metals, by means of which process the characteristics and properties of the metal are desirably affected.

Another object of the invention is the provision of a simple and inexpensive process for treating low carbon content ferrous metals, such as low carbon steel, whereby the strength, toughness and hardness of the metal thus treated are materially increased.

A further object of the invention is to provide a composition useful to the end of enabling the process to be successfully conducted.

The invention possesses other advantageous features and objects some of which, with the foregoing, will be set forth at length in the following wherein I have outlined the preferred form of a process of treating metals of my invention and the preferred composition of materials.

Briefly stated my invention consists in the discovery that metals, when quenched in a solution of a salt, from a tempering temperature, have certain desirable properties imparted, formed or retained in them. Apparently, although I do not wish to be bound by this, the effect is due to a more rapid cooling or quenching of the metal by keeping the surface of the metal wet and in contact with the quenching material. The compound which I have found particularly useful is potassium hydroxide which may be applied to the metal to be quenched in a form of a suitable solution or by applying the salt directly on the metal before, during or after heating and then

quenching in water. This treatment amounts to quenching the metal in a salt solution since one is formed locally about the piece. The potassium hydroxide and other salts, which I have found can be employed with this invention, apparently prevent steam formation and remove scale to some extent so that heat is conducted rapidly out of the metal.

The aqueous solution of the potassium hydroxide, or other salt solution, is preferably kept at approximately room temperature, since its effectiveness as a quenching agent apparently decreases for an increase in temperature, particularly above about 125° F. In some instances the use of a very cold solution is more effective than the same solution at a higher temperature. Thus an aqueous solution of calcium chloride at minus 24° C. gave a hardening effect equal to that of a 40% aqueous solution of potassium hydroxide at room temperature.

As a tempering temperature is meant one to which the metal is heated before being quenched so that the metal finally has certain desired properties. In general, this temperature will be between 900° F. and 1650° F. which range I characterize as that of about a red heat. However, depending mainly upon the composition of the material, other temperatures lying beyond and below the range mentioned and quenching from those temperatures is contemplated, the term "red heat" being intended as all inclusive with respect to the temperature utilized since this phase of the treatment of the metal depends upon the metal and can be arrived at by those skilled in the art.

I believe that the hardness of the metals such as ferrous metals is due to the preservation of the Martensite structure. It may also be that the inherent hardness, strength and toughness is due to a carburized iron present in the quenched ferrous metal in the form of Austenite and Martensite. Due to the quick cooling, some of the hardness may be existing because of the presence of a solid solution under constraint, which condition is secured by the forcible suppression of a decomposition reaction by virtue of the extremely rapid cooling. Further, the very rapid cooling, obtained by the process of my invention, possibly also induces hardness and toughness by setting up severe internal strain and by bringing about volume changes due to the allotropic transformation of the iron.

Further, photomicrographs show steel, treated in accordance with my invention, to be largely Martensite, so far as can be determined by this

means. In any case, steel quenched, in accordance with the teachings of my invention, from a bright red heat is harder and tougher, and has a greater strength than similar steel quenched by presently known means.

Solutions of compounds other than potassium hydroxide can also be successfully employed, to produce satisfactory results. Deliquescent salts and the property of being deliquescent is apparently the criterion of successful materials since this property is apparently the one common to all the materials which I have discovered as being successfully employed. The preferred salts and those which produce the best results are alkali metal hydroxides such as potassium hydroxide, sodium hydroxide and lithium hydroxide. However other alkali metal salts such as lithium chloride, and alkali earth salts such as calcium chloride, strontium chloride and magnesium chloride can be successfully employed as can trisodium phosphate. Aqueous solutions of sodium cyanide, sodium, lithium, potassium and calcium nitrate, potassium thiocyanate, cupric chloride and lithium sulphate can also be employed successfully, although less effectively as can sodium and potassium chlorates and sodium perchlorate. These salts, in general, all possess the property of being deliquescent and it is apparently this property that aids the material in securing the desirable more rapid quenching.

As previously set forth, I preferably employ as the quenching agent an aqueous solution of an alkali metal hydroxide, such as a 40% solution of potassium hydroxide, since the alkali metal hydroxide solutions produce the best results. The strength of the solution may be varied within wide limits depending upon the particular salt employed as the solute and the character of the metal being treated. In some instances, I have employed as low as a 10% salt solution. The solution is preferably maintained at room temperature; thus causing a rapid cooling of the metal, heated to red heat. Obviously, since the solution employed as the quenching agent is an aqueous solution, it can be readily maintained relatively cold with respect to the temperature of the metal to be treated, i. e., below 125° F. which is the preferred maximum temperature of the solution, because above such temperature its effectiveness as a quenching agent apparently decreases.

The process of my invention is particularly effective for increasing the strength and hardness of low carbon content steel, i. e., steel containing .4% carbon or less, such as cold rolled strip steel and ordinary building grade steel. Tests upon the ultimate strength of such steel samples, treated by the process of my invention, showed a marked increase in strength. Thus a cold rolled strip showed an increase in the tensile strength from 81,800 lbs. per square inch to 153,000 lbs. per square inch. A sample of ordinary building grade steel having a tensile strength of around 60,000 lbs. and treated by first smearing the sample, while hot, with potassium hydroxide and then quenching in a cold aqueous solution of the hydroxide showed an increase in ultimate strength to 130,000 lbs. per square inch, and another sample quenched from 1910° F. gave 161,000 lbs. per square inch. The ductility of the steel was slightly reduced but not seriously so, while the Rockwell hardness was increased from B-96.4 to B-115 on a potassium hydroxide treated sample.

The time required to quench from a heat treating temperature, by the method of my invention, is very much less than that with respect to other methods heretofore employed. In general, where a time as from 50 to 200 seconds is required in present methods and by present materials, my invention can be conducted to quench the same piece or an identical one from the same temperature in much less time.

I am aware that heretofore metals have been treated from a tempering temperature, by subjecting them to a bath of a molten salt or even to a bath of a molten alkali metal hydroxide. However, such baths must necessarily be at a relatively high temperature to maintain the bath material molten. Such treatment does not produce the same efficacious action as does the relatively cold aqueous solution of an alkali metal hydroxide, preferably employed as the quenching agent in the process of my invention; nor do such treatments heretofore employed increase the strength and hardness of low carbon content steels to the extent obtained by my method.

From the foregoing I believe it is apparent that I have disclosed a new and useful process and composition by means of which the ultimate strength of metals, such as low carbon content steels can be desirably increased while other properties such as the hardness are likewise affected. It is to be understood that the appended claims are to be accorded a range of equivalents consistent with the state of the prior art and that modifications from the disclosure herein can be made without departing from the spirit of invention within the skill of all those versed in the art.

I claim:

1. The method of increasing the hardness and strength of steel having a carbon content of 0.4% or less which comprises heating such grade of steel to about a red heat, and largely preserving the Martensitic structure of the heated steel by subjecting it to an aqueous solution of an alkali metal hydroxide having a concentration of at least 10% and maintained at a temperature below the boiling point of the water.

2. The method of increasing the toughness and strength of steel having a carbon content of 0.4% or less which comprises heating said grade of steel to a temperature within the range 600° F. to 1650° F., and then quenching the heated steel in an aqueous solution of potassium hydroxide having a concentration of at least 10% and maintained at a temperature below the boiling point of water.

3. The method of increasing the toughness and strength of steel having a carbon content of 0.4% or less which comprises heating said grade of steel to a temperature within the range 600° F. to 1650° F., and then quenching the heated steel in an aqueous solution of sodium hydroxide having a concentration of at least 10% and maintained at a temperature below the boiling point of water.

4. The method of treating steel having a carbon content of 0.4% or less to increase the toughness and strength thereof, said method comprising heating said grade of steel to about a red heat, and then quenching the heated steel with an aqueous solution of an alkali metal hydroxide having a concentration of at least 10% maintained at a temperature below the boiling point of water.

5. The method of treating steel having a carbon content of 0.4% or less to increase the tough-

ness and strength thereof which comprises heating said grade of steel to about a red heat, and then effecting a rapid cooling of the heated steel by subjecting it to an aqueous solution of an alkali metal hydroxide maintained at a temperature below the boiling point of water, the strength of such solution ranging between a 10% and a saturated solution.

6. The method of treating building or structural steel, the tensile strength of which is approximately 60,000 pounds per square inch and

the carbon content of which is approximately 0.4% or less; to increase the tensile strength thereof to an extent of 100% or better, said method comprising heating said grade of steel to a temperature ranging between 900° Fahrenheit and 1650° Fahrenheit, and then quenching the heated steel with an aqueous solution of potassium hydroxide having a concentration of at least 10% maintained at a temperature below the boiling point of water.

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