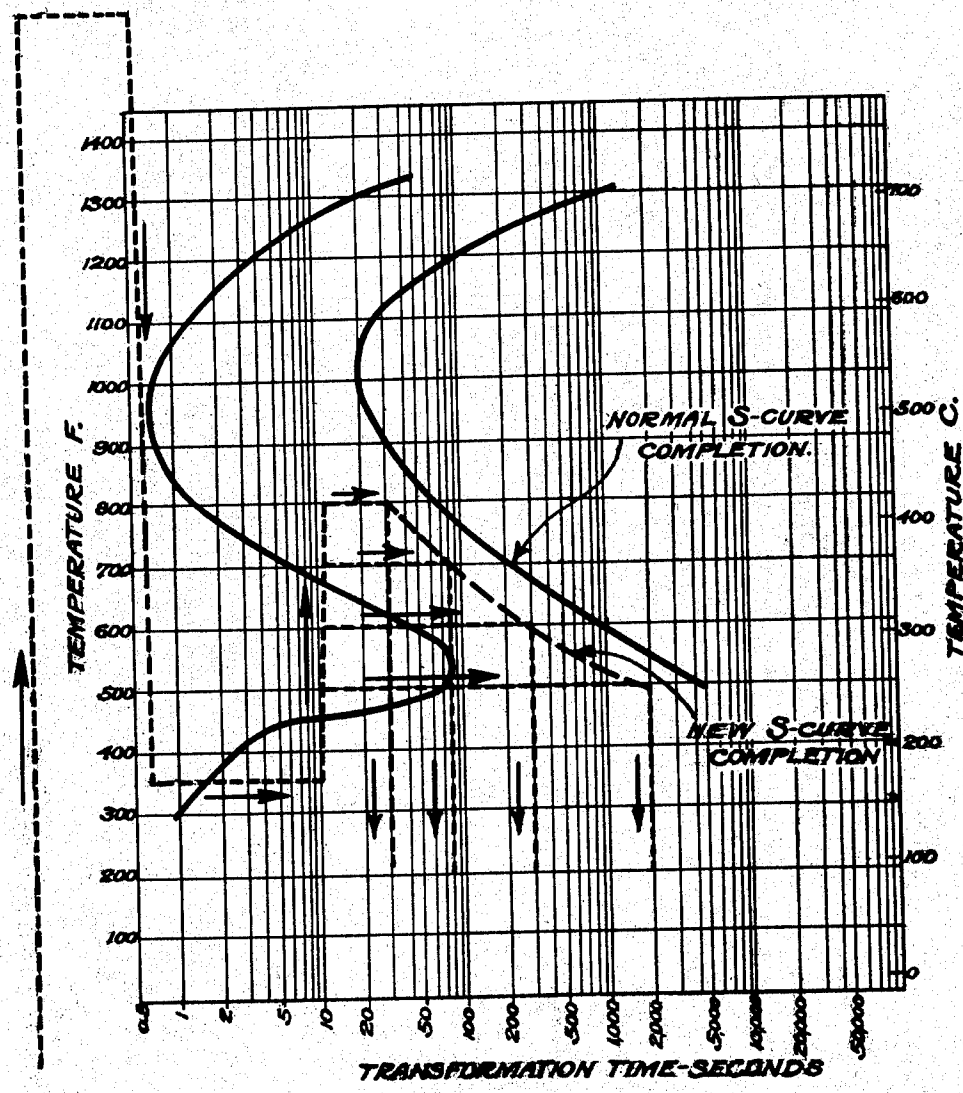
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HARDENABLE STEEL HEAT TREATMENT

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HARDENABLE STEEL HEAT TREATMENT

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4 Claims. (Cl. 148—21)

This invention is a hardenable steel heat treatment, it being understood that such steel is any containing sufficient carbon to make it hardenable in a commercial sense and that it may contain other alloying elements.

A recent prior art treatment for hardening such steel is to heat it to transform its microscopic structure to austenite and to then cool it to a subcritical temperature that causes direct transformation of austenite to a structure other than coarse pearlite or martensite, the cooling being with such speed that the steel arrives at this temperature while it retains all its austenite, it then being held at that temperature for a sufficient time to permit all its austenite to transform to the structure characteristic of this transformation temperature. The advantage of this treatment are known and need no discussion.

The above treatment has the disadvantages that its application is limited to small sections of steel and that the austenite transformation rate involved is considered too slow for some applications, the object of the present invention mainly being to alleviate these disadvantages.

This object is attained by heating the steel to transform its structure to austenite and prior to adjusting its temperature to that causing direct transformation of austenite to the structure other than coarse pearlite or martensite, cooling the steel to a different austenite transforming temperature and holding it at this temperature until minor amounts of its austenite transform, this cooling and holding being done in a sufficiently short time interval to retain at least major amounts of the steel's austenite for transformation at the holding temperature of the prior art treatment. The structure developed from the minor amounts of the austenite may range from pearlite to martensite. Prior to further material transformation of its austenite the steel's temperature is adjusted to that causing its remaining austenite to transform to a structure other than coarse pearlite or martensite.

By using different temperatures for effecting the initial transformation of the minor amounts of austenite and the subsequent transformation of the remaining austenite, it has been found that the holding time for the second named transformation is materially reduced and that larger sections can be properly treated, while retaining many of the advantages of the described prior art treatment.

Furthermore, it has been found that for any given steel composition a maximum rate of transformation during the holding at the subsequently adjusted temperature is obtained by regulating the initial transformation of austenite to a quantity characteristic for that steel, the exact quantity for a specific steel composition being determinable by experimentation. Also, the temperature of this preliminary quench determines the maximum transformation rate subsequently obtainable, temperatures lower than the subsequent holding tempearture producing faster rates than temperatures that are higher. It follows that for a specific steel the maximum possible rate is obtained by first cooling it to a temperature below that where its major amounts of austenite are to be transformed and holding it at this temperature for a time required to transform the quantity of austenite found to be critical for that steel. In all cases the amount of austenite retained for transformation during the main holding period is so great that practically all of the advantages of the described prior art treatment are retained.

As a specific example of the invention, pieces of steel containing .60% carbon, 1.15% manganese and otherwise of a composition within commercial limits common to its type were quenched from a fully austenitic condition to 350° F. in less than half a second, were held at this preliminary transformation temperature for ten seconds and then reheated in a few seconds to main transforming temperatures varying from 500° F. to 800° F. in 100° steps. The pieces were held at the main transforming temperatures only long enough to effect complete transformation as determined by microscopic examination. The holding at the stated preliminary temperature caused 10% of the austenite to transform to the product characteristic of this temperature, the 10% value having been experimentally determined as being critical of this steel composition. The results are tabulated as follows:

Completion time in seconds

Main transformation temperatures in °F.	By described prior art treatment	By holding 10 seconds at 350° F. for preliminary transformation	Percent time saved
500	4,800	2,000	58.5
600	750	300	60.0
700	290	80	72.5
800	90	30	66.6

The accompanying drawing is a graph showing the above.

In the graph, the solid curved lines show the S-curve of austenite transformation that is typical of the previously discussed steel containing .60% carbon and 1.15% manganese. The broken straight lines show the heat treatments with the arrows indicating the progress, while the broken curved line is plotted to show how the normal curve line marking the completion of austenite transformation has been shifted to the left to establish a new completion curve line representing a material time saving, since the time is given in logarithmic progression.

The term "austenite transforming temperature" as used herein is intended to mean a temperature where austenite is unstable, so that when given sufficient time it transforms to some other structure ranging from coarse pearlite to martensite.

We claim:

1. The hardenable steel heat treatment including heating the steel to transform its structure to austenite, cooling the steel to an austenite transforming temperature and holding it thereat for a time period sufficient to start transformation of said austenite but insufficient to cause transformation of more than minor amounts of said austenite, and changing the temperature of the steel to a different austenite transforming temperature that is within the range causing direct austenite transformation to a structure other than coarse pearlite or martensite and holding the steel thereat until substantially all of the remainder of said austenite transforms, said cooling and said changing being done sufficiently rapidly to retain at least major amounts of said austenite for direct transformation during the second named holding.

2. The hardenable steel heat treatment including heating the steel to transform its structure to austenite, cooling the steel to an austenite transforming temperature and holding it thereat for a time period sufficient to start transformation of said austenite but insufficient to cause transformation of more than minor amounts of said austenite, and changing the temperature of the steel to a different austenite transforming temperature that is within the range causing direct austenite transformation to a structure other than coarse pearlite or martensite and holding the steel thereat until substantially all of the remainder of said austenite transforms, said cooling and said changing being done sufficiently rapidly to retain at least major amounts of said austenite for direct transformation during the second named holding, said time period of the first named holding being adjusted to effect transformation of a predetermined amount of said austenite causing austenite transformation to proceed at a maximum rate during the second named holding.

3. The hardenable steel heat treatment including heating the steel to transform its structure to austenite, cooling the steel to an austenite transforming temperature and holding it thereat for a time period sufficient to start transformation of said austenite but insufficient to cause transformation of more than minor amounts of said austenite, and changing the temperature of the steel to a different austenite transforming temperature that is within the range causing direct austenite transformation to a structure other than coarse pearlite or martensite and holding the steel thereat until substantially all of the remainder of said austenite transforms, said cooling and said changing being done sufficiently rapidly to retain at least major amounts of said austenite for direct transformation during the second named holding, the first named austenite transforming temperature being lower than the second named austenite transforming temperature.

4. The hardenable steel heat treatment including heating the steel to transform its structure to austenite, cooling the steel to an austenite transforming temperature and holding it thereat for a time period sufficient to start transformation of said austenite but insufficient to cause transformation of more than minor amounts of said austenite, and changing the temperature of the steel to a different austenite transforming temperature that is within the range causing direct austenite transformation to a structure other than coarse pearlite or martensite and holding the steel thereat until substantially all of the remainder of said austenite transforms, said cooling and said changing being done sufficiently rapidly to retain at least major amounts of said austenite for direct transformation during the second named holding, the first named austenite transforming temperature being lower than the second named austenite transforming temperature, and said time period of the first named holding being adjusted to effect transformation of a predetermined amount of said austenite causing austenite transformation to proceed at a maximum rate during the second named holding.

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