UNITED STATES PATENT OFFICE.

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METHOD OF HEAT-TREATING STEEI

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To all whom it may concern:

Be it known that I, WALTER C. PETERSON, a citizen of the United States, and residing at Detroit, Wayne county, State of Michigan, have invented certain new and useful Improvements in Methods of Heat-Treating Steel, of which the following is a specification.

The present invention relates to the heat treatment of steel. As is well known, when a steel containing sufficient carbon is heated above a certain temperature and quenched, it is hardened. In the heating operation, when the steel reaches a certain temperature, there is a short period during which the temperature of the steel does not rise although the temperature of the furnace continues to increase. This temperature of the steel is termed the critical or decalescence point. The steel must be heated to a temperature at least slightly above the critical point before quenching in order to refine or harden the same. After the steel has been heated above the critical point, if it is cooled slowly there is a point where the temperature remains constant but heat is given out by the steel. This point is termed the recalescence point and may be from 85° F. to 215° F. lower than the decalescence point.

When a steel article is hardened in the manner outlined above, its dimensions are changed by the treatment so that they are not the same as prior to the hardening and the changes in dimensions have not been uniform. Thus after the heat treating the article may be warped, or slightly larger or smaller than the dimensions of the same after machining; or the changes in dimensions may be certain combinations of the three changes mentioned. Of course according to the present invention the treatment of the steel articles is such that in their final form there is no warping and the size is exactly that required. For this reason it has been necessary to perform a machining operation on the article after being hardened, in order to bring it to the required dimensions. It is one of the principal objects of the present invention to eliminate this machining operation. To this end, the steel is heat treated in such a manner that after hardening it assumes the dimensions required.

I have discovered the fact that if a steel is heated to a certain predetermined temperature above the critical point at a certain rate and then quenched it will assume the same dimensions as prior to the heating. The proper temperature and rate to which the steel is heated to accomplish this result vary with the different compositions of steels and consequently no general rule for determining their value can be given. The temperature and rate must be determined by experiments performed on each different kind of steel.

It is believed that steel while being heated up to the quenching temperature, expands from the time it begins to be heated to the time it enters the decalescence zone during which time it contracts. After leaving the decalescence zone it expands until quenched when it contracts once more. The two sets of forces thus set up in the process of heating and quenching a piece of steel are governed in magnitude by the rate at which the steel is heated. In other words, it is believed, that when the steel is being heated and is at its critical temperature, it contracts; and if the heating is continued to such a temperature above the critical temperature, that the expansion due to this heating above the critical temperature is equal to the contraction occuring during the critical point, then the steel when quenched will assume its original dimensions.

The present invention is of particular value in manufacturing steel wheels, such as gears used in the change gear transmissions of motor vehicles. Such gears are subjected to severe shocks and clashing and must be made with the object of standing up under such service. The complete process for manufacturing and heat treating steels to form gears for this service may be as follows:

1st: The steel is forged from 2,000° F. down to 1600° F. to form the blank.

2nd: The blank is then heated to 1650° F. and quenched in a liquid.

3rd: The blank is again heated to 1550° F. and then cooled slowly to anneal the same. These last two steps refine and equalize the internal structure of the gear so that there are no hard or soft spots.

4th: The blank is now machined to the required dimensions.

5th: The machined article is heated to a temperature above the critical point and quenched in oil.

6th: The article is again heated to a temperature above the critical point but lower than the temperature of step 5 and then quenched in oil. This last temperature is determined by experiment and is such that after the article has been quenched, its dimensions are the same as when first machined.

For the purpose of illustrating the temperatures to which the article is heated in steps 5 and 6, these temperatures will be indicated for a particular steel. A steel having the following composition has been found very satisfactory:

Carbon	.45 to .55%
Manganese	.30 to .50
Phosphorus	under .025
Sulfur	under .040
Silicon	under .25
Nickel	1.50 to 2.00%
Chromium	.90 to 1.10

After a blank of this steel has been forged and machined, the temperature to which it is heated in step 5 is 1500° F., and the temperature to which it is heated in step 6 is 1420° F. Preferably, the heating in both instances is at such a rate as to raise the temperature of the article substantially 30° F. per minute.

Although the invention has been described in connection with a particular steel, it is to be understood that the invention is not thus limited but is applicable to other steels.

Having thus described the invention what is claimed as new and desired to be secured by Letters Patent is:

1. In a process of treating steel articles the steps consisting in heating the article to a predetermined temperature above its critical point at a predetermined rate and then quenching, said temperature and rate being such that the article after being quenched assumes the same dimensions as previous to the heating.

2. In a process of treating steel articles the steps consisting in machining a blank to the desired dimensions, heating the article thus formed to a predetermined temperature above its critical point at a predetermined rate and then quenching, said temperature and rate being such that the article after being quenched assumes the same dimensions as when machined.

3. The process of treating steel articles consisting in machining a blank to the desired dimensions, heating the article thus formed to a temperature above its critical point, quenching, heating again to a predetermined temperature above its critical point at a predetermined rate but lower than the previous temperature, and then quenching, said predetermined temperature and rate being such that the article after being quenched assumes the same dimensions as when machined.

4. The process of treating steel articles consisting in heating the article to a predetermined temperature above its critical point at a predetermined rate and quenching, said temperature and rate being such that the expansion of the article when being heated above the critical point equals the contraction while at the critical point.

5. The process of treating steel articles consisting in, giving a blank a preliminary treatment to refine it, machining the blank to the desired dimensions, heating the article thus made to a predetermined temperature above its critical point at a predetermined rate and quenching, said temperature and rate being such that the expansion of the article when being heated above the critical point equals the contraction while at the critical point.

6. The process of treating steel articles consisting in, giving a blank a preliminary treatment to refine it, machining the blank to the desired dimensions, heating the article thus made to a temperature above its critical point and quenching to harden the same, heating again to a predetermined temperature above its critical point at a predetermined rate but lower than the previous heating and quenching, the temperature and rate of the second heating being such that the article after being quenched assumes the same dimensions as when machined.

7. The process of treating steel articles consisting in machining a blank to the desired dimensions, heating the article thus formed to a temperature above its critical point and quenching to harden the same, again heating the article to a temperature above its critical point but lower than the previous temperature at a rate of approximately 30° F. per minute and then quenching, said last mentioned temperature and rate being such that the article after being quenched assumes the same dimensions as when machined.

8. In a process of treating steel articles the steps consisting in heating the article to a temperature of approximately 1500° F. and quenching to harden the same, again heating the article to a temperature of approximately 1420° F., at a rate of substantially 30° per minute and quenching, said last mentioned temperature and rate being such that the article after being quenched assumes the same dimensions as at first.

In testimony whereof I affix my signature.

WALTER C. PETERSON.