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# UNITED STATES PATENT OFFICE

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## METHOD OF HEAT TREATMENT OF STEEL

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The invention is a special heat treatment of steel of all kinds, including carbon and alloy steels.

The method is a special heating treatment in three stages. In the first stage, steel is heated above the transition point $A_3$, and is quenched. In the second stage, the steel is heated up to a temperature a little higher than the point $Ac_1$, or thereabout, and cooled down to a temperature a little lower than the point $Ar_1$, or thereabout. In the third stage, following the second, it is heated to a temperature between $Ac_1$ and $Ar_1$, and then cooled down to the atmospheric temperature.

The new method, covered by the present invention, imparts to the steel under the treatment qualities of far greater superiority for all practical purposes of its technical application, compared with the ordinary annealing method known to the public.

It gives to steel greater qualities of dead-softness, toughness, elasticity and uniformity.

The purposes of this treatment of steel may be cited as follows:—(1) to remove internal strains, caused by thermal or mechanical influence, (2) to soften it so as to make it more easily machinable, (3) to secure such desirable strength and at the same time such ductility as may safely withstand any necessary practical strain, when subjected, and especially to increase elastic limit and impact value, and (4) to unify and to impart to it such fine structure as to make it immune from that weakness, which accompanies any steel of coarse structure.

For the consummation of these purposes, the only one method that has hitherto been well-known to, and generally adopted by, the public at large, is a heat treatment, wherein steel is slowly cooled down from a temperature above the transition point.

In this well-known method, however, the crystal structure is apt to aggregate and all the undesirable effects develop during the slow process and are imparted to the steel affecting and impairing its strength to a considerable degree. Nevertheless, this structural change of steel in quality can not be avoided, inasmuch as it is the natural result of this method.

The present invention is an improvement upon the old annealing method, remedying all its defects and increasing the intrinsic value of the steel under treatment, by removing the internal crystal aggregation and unifying its structure. The special method of the present invention is to subject steel firstly to quenching and next to special tempering operations twice. Speaking more fully in detail, the method is, in its first stage, the quenching of steel from a temperature above the transition point $A_3$, and in the second stage, of heating it again up to a temperature a little higher than the point $Ac_1$ or thereabout, cooling it down to a temperature a little lower than the point $Ar_1$, or thereabout, and in the third stage, of heating it up to a temperature between the point $Ac_1$ and $Ar_1$, and keeping it in the same temperature for some time, and finally cooling it down to the atmospheric temperature.

For example, the best result can be obtained by treating steel after quenching, in such a way as to heat it up to a temperature a little higher than the point $Ac_1$, cooling it down to a temperature a little lower than the point $Ar_1$, heating it again up to a temperature a little lower than the point $Ac_1$, keeping it in that same temperature for certain hours and lastly leaving it to cool down.

Here at this point of heating operation, each or the whole of the three stages above referred to may be suitably repeated, if required. It must be noted that these modified operations, being nothing more than practical applications of the invention, should be considered as perfectly within the scope of this invention.

Although the new method may appear first to be something similar to the ordinary quenching and tempering treatment, yet these two processes will be found entirely different from each other. Because the tempering operation after quenching in the latter is only once to reheat steel to a temperature not exceeding the point $A_1$ and in consequence the extent of the softening effect can not be brought beyond that of the ordinary annealing, in which steel is slowly cooled down from a temperature above the transition point.

According to the present method, the effect covering the elastic limit, softness, ductility and especially impact values will be found greatly increased, compared with the effect covering similar qualities of steel according to the ordinary annealing. Moreover, the crystal structure becomes homogeneous and fine granular pearlite, while the aggregated structure of lamellar pearlite is secured by the ordinary annealing method. Therefore, by the present method, not only the purposes of annealing are successfully accomplished, but various superior qualities are also imparted to the steel.

A like structure of granular pearlite, or divorced pearlite possessing the qualities of softness and ductility, was, it is true, already found, and investigated into by several scientists. But such structure obtained by some other methods, had unfortunately a poor impact value, due perhaps to some imperfectness of the structure, making the steel thus treated technically impossible for practical purposes.

The invention is applicable to steel of all kinds, viz, half finished and completely finished products, irrespective of whether cast or forged and of whether carbon or alloy steel.

By the new softening treatment, steel develops new properties as described above, which have not been known before. Therefore, the present invention is a new method, which is entirely different from the ordinary one.

I claim:

A method of heat treatment of steel, consisting in quenching the steel from a temperature above the transtition point $A_3$ then heating it up to a temperature a little higher than the point $Ac_1$, cooling it down to a temperature a little lower than the point $Ar_1$, heating it up to a temperature a little lower than the point $Ac_1$, maintaining that temperature for a period of time, and finally cooling it down.

In testimony whereof I affix my signature.

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