UNITED STATES PATENT OFFICE.

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HEAT TREATMENT OF STEEL.

979,113. Specification of Letters Patent. **Patented Dec. 20, 1910.**

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To all whom it may concern:

Be it known that I, SAMUEL S. WALES, of Munhall, Allegheny county, Pennsylvania, have invented a new and useful Improvement in Heat Treatment of Steel, of which the following is a full, clear, and exact description.

My invention is designed to provide an improved method of heat treatment of steel, whereby a more uniform strength is obtained throughout the piece, and is particularly designed for armor or vault plates or deck plates, though it may be applied to steel generally.

In the ordinary manner of making armor plate, the ingot is cast in the usual way, forged, annealed, then carburized on its face, then usually reforged, and then fibered by the usual process. The plate is then sometimes toughened by further treatment, and is then in a condition for final water-hardening. The heat treatments for such plates and other heat-treated steels are uniform over the extent of the plate and take no account of the variations in chemical composition of the various parts of the plate, caused by segregation of its contained metalloids during cooling and solidifying of the ingot. The carbon is most liable to segregation, and other elements may be calculated in carbon equivalents. This segregation takes place to a greater extent in the top portion of the ingot than in the lower portion, and where the bottom end or top end of the plate is hereinafter mentioned I refer to that portion of the plate which comes from the bottom portion or from the top portion, of the ingot as the case may be. By subjecting the whole plate or portion to be treated to a uniform heating, great differences in tensile strength between the top and bottom of the ingot may be developed; and I have discovered that such differences may be largely reduced and possibly eliminated by raising the plate to a temperature which varies between the two ends and preferably roughly in proportion to the segregation.

In practice a great improvement is made in the plate by modifying the last annealing process and varying the heat of different parts of the plate. Thus I first preferably raise the plate to a temperature between 800 and 900 degrees C., and quench with water or other cooling liquid to a temperature below 300 degrees. The plate is then placed in the furnace, and the heat so regulated therein that the end of the plate which is subject to the greater segregation, will be raised to a temperature higher than the other end of the plate. The variation in temperature of one end of the plate from the other may be accomplished in any desired manner, for example, the temperature of one end of the furnace in which the plates are heated, may be raised or lowered above or below that of the opposite end to a degree necessary to give the desired difference in temperature in the opposite ends of the plate, by a proper manipulation of the air and gas valves used on such furnaces. This temperature may be calculated by many well-known methods to attain a certain desired tensile strength. The average of these temperatures is preferably between 500 and 700 degrees C., and the difference in temperature between the two ends may be as high as 150 degrees. The plate is then cooled as desired. In a test on a plate twenty feet in length—showing such a segregation in carbon that the content was .37 at the top end and .27 at the bottom end,—was subjected to the varying heat treatment just described with an annealing temperature of about 620 degrees at the top end and about 520 degrees at the bottom end; and the tensile strength of test pieces taken from these ends did not differ over one per cent.

The advantages of my invention will be appreciated by those skilled in the art. The different strength in different parts of the plate or portion to be treated resulting from the uniform heat treatment heretofore given is overcome, and the plate made substantially uniform or the variation in strength greatly reduced by the variation in the temperature imparted to the various parts. My invention does not add to the cost of production, but does add materially to the value of the plate by making its strength more uniform in the different parts.

Many variations may be made in the above described treatment of the steel without departing from my invention, since

What I claim is:—

1. The method of treating steel containing metalloids in different proportions in different parts thereof, consisting in heating the

plate and raising one part of the portion to be treated to a different temperature from that of another portion at the same depth.

2. The method of heat-treating steel, consisting in heating the plate or portion to be treated and varying the heat of the different parts according to the proportion of metalloids contained therein.

3. The method of heat-treating steel having different proportions of metalloids in different parts thereof, consisting in heating the plate and raising those portions containing a greater proportion of metalloids to a higher heat than those portions containing a lower proportion of metalloids.

4. The method of treating steel, consisting in heating a plate to a hardening temperature, then quenching it, and then un-uniformly heating the length of the plate to temperatures between 500 and 700 degrees centigrade, and then cooling the same.

5. The method of treating steel, consisting in heating a plate to a hardening temperature, then quenching it, then heating it to different temperatures at different portions of the plates with relation to the difference in composition caused by segregation.

6. The method of treating steel, consisting in heating a plate to a hardening temperature, then quenching it, then heating the different portions of the plate to temperatures varying directly to the proportions of carbon contained in the said different portions of said plate.

7. The method of treating steel, consisting in annealing a plate, in which the various component elements have become segregated, by heating the different portions of the plate to temperatures between 500 degrees and 700 degrees centigrade, said different portions being subjected to heat at temperatures varying directly to the proportion of carbon contained therein, and then cooling the same.

8. The method of treating steel plate, in which the component elements are more highly segregated at one end than at the other, which consists in heating the plate to a hardening temperature, then quenching it, then heating it so that the more highly segregated end portion shall attain a higher temperature than the other end portion, subjecting the intermediate portions to a substantially uniform variation of heat, and then cooling the same.

9. The method of treating steel containing metalloids in different proportions in different parts thereof, consisting in heating the plate and raising one portion of its face to a different temperature from another portion of its face.

In testimony whereof, I have hereunto set my hand.

SAMUEL S. WALES.

Witnesses:
D. T. JONES,
C. L. WILSON.