

UNITED STATES PATENT OFFICE.

SAMUEL S. WALES, OF MUNHALL, PENNSYLVANIA, ASSIGNOR TO CARNEGIE STEEL COMPANY,
OF PITTSBURG, PENNSYLVANIA, A CORPORATION OF NEW JERSEY.

TOUGHENING STEEL.

No. 928,347.

Specification of Letters Patent.

Patented July 20, 1909.

Application filed November 11, 1907. Serial No. 401,701.

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 Toughening Steel, of which the following is a full, clear, and exact description.

My invention is designed to provide an improved method of toughening steel, and is particularly designed for armor plate 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 reformed, and then fibered by the usual process. This plate, in the ordinary practice, is now toughened by heating it to about 825 degrees C. It is then quenched in water or other cooling liquid. It is then raised to a temperature of 700 or 750 degrees C., and allowed to cool slowly in order to anneal it. I have found that a great improvement is made in the plate by modifying the last annealing process. After the fiberizing, I raise the plate to a temperature between 775 degrees and 875 degrees C., preferably to 825 degrees C. It is then quenched in water, to below 300 degrees C. I then again heat the plate to a temperature of about 500 to 650 degrees C, preferably 550 degrees C., and again quench it in water or another cooling liquid. I have found that by this improved method of annealing, I can obtain the same ultimate strength, with an improvement in the elongation and reduction of the metal. I have further found that by thus quenching, and consequently checking the annealing process at exactly the desired point, I can obtain more uniform and positive results. In the

ordinary way the annealing process continues after withdrawal from the furnace, and the results are not positive or uniform in character. By quenching in water after the first heating, above described, I am enabled to obtain the desired tensile strength at a lower temperature than would be necessary, if the same tensile strength were to be obtained by quenching in oil or other fluid, which does not give the sharp reaction given by water. Moreover, the higher the temperature to which the steel is heated, the larger will be the size of the crystals formed, and by employing water, which allows me to use a lower temperature, I can keep down the size of the grain or crystal and thus obtain a tougher material.

The process is clearly applicable to deck plates which are not carburized, in which case the steps will be substantially the same as those before recited with the carburizing and reforming omitted. It is also applicable to any type of commercial steel.

Many variations may be made in the steps of treatment prior to the annealing, without departing from my invention.

I claim:—

The method of toughening steel, consisting in heating it to a temperature between 775 and 875 degrees C., chilling the same by water, then heating the plate to between 500 and 650 degrees C., and again quenching by a cooling liquid, substantially as described.

In testimony whereof, I have hereunto set my hand.

S. S. WALES.

Witnesses:

GEO. B. BLEMING,
R. D. LITTLE.