UNITED STATES PATENT OFFICE.

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METHOD OF IMPROVING STEEL RAILS.

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To all whom it may concern:

Be it known that I, ROBERT ABBOTT HADFIELD, a subject of the King of Great Britain, residing at Sheffield, York county, England, have invented a new and useful Method of Improving Steel Rails, of which the following is a full, clear, and exact description.

The purpose of my invention is to improve the quality of steel railway rails. The severity of the work put upon such rails by reason of the increase in the weight of the cars and locomotives, and the speed of the trains, has been such, of recent years, as to cause a very large percentage of rails to be broken in service. Rails made of steel which respond well to the ordinary tests for tensile strength, &c., have been found to be subject to fracture, by reason of brittleness and lack of resistance to shock; and although many attempts have been made to overcome this difficulty, all of these have failed, so far as I know, to fulfil the requirements, either because of the undue cost of the expedients which have been proposed, or because of their inefficiency.

I have discovered that a very great improvement can be effected in the capacity of the rails to resist shock, coupled with an increased hardness of the rails, by a special heat treatment to which the rails are subjected after they are manufactured. These two qualities of resistance to shock and increased hardness have not ordinarily been regarded as possible to secure by any single treatment, for the increase of hardness has heretofore been considered to result in increased brittleness. Careful tests have, however, showed that this is not the case with rails treated by my invention.

My invention also enables excellent results to be obtained without reference to the phosphorous contents of the steel, which may vary within certain limits. For example, I have found that steel containing .12 per cent. of phosphorus, which is more than the Bessemer limit of phosphorus; .44 per cent. carbon and .84 per cent. of manganese, when treated by my invention, had a remarkably hard surface combined with a very good resistance to fracture when nicked and subjected to drop test. Phosphorus, therefore, when the rail is subjected to my treatment has the useful property of hardening in the manner in which vanadium is supposed to act upon steel.

In order that those skilled in the art may be able to practice my invention, I will now describe it in what I regard its preferable performance, premising that the details of the operation may be varied.

I take a steel rail to be treated, and having heated it, to a temperature of at least 850° C., I cool it, preferably by quenching, this quenching being done either by subjecting the rail to the quick cooling action of a liquid, or by cooling it quickly in air. I then take the rail which has been thus quenched and after it is at atmospheric temperature or while it still retains some of the temperature imparted by the original heating, anneal it by reheating to a lower temperature between 500° C. and 730° C., preferably about 700° C.; or instead of these two operations of successive heating and quenching and then reheating to a lower temperature, I may quench the heated steel so as to cool it quickly down to a certain point, say about 700° C., and then cool it slowly from this point downward, thus accomplishing in a single continuous operation what is otherwise accomplished by two successive operations; as an alternative, the rail in its heated condition as it leaves the rolls and while at the requisite high temperature, may be guided into a tank and quenched or otherwise quickly cooled. It is then reheated, being, if desired, straightened at the same time, to about 730° C., or such lower temperature as may be desired in order to give the requisite toughness or hardness. This final cooling may, if desired, take place on the rail-bed near other hot rails so as to effect slow cooling. In connection with the initial heating to at least 850° C. and the second heating to between 500 and 700° C., I wish to explain that these temperatures are not absolute but can be, of course, varied somewhat, the essential object being to obtain such an initial relatively high heat followed by such a relatively low heat as will ultimately result in increased hardness and resistance to shock of the rail which has been treated. I may also, in order to prevent warping of the rail during the cooling, cool the parts of the rail differentially, applying a quicker cooling to the head, which contains a greater mass, than to the flange, where the mass is less and the loss of heat correspondingly greater in proportion. I prefer to effect the heating of the rail by immersing it in a molten bath of metal or of a fusible salt such as barium chlorid which may be maintained at a constant temperature by the action of an electric current.

The following is a statement of some results which I have obtained by a treatment of steel in this manner: Steel containing .38 carbon, .13 silicon, .06 phosphorus and .92 manganese, and having an elastic limit of 29, tensile strength of 46, elongation of 23 and reduction of area of 43, when submitted, to a drop test to determine its brittleness or resistance to shock, and a ball test to determine its hardness, gave the following results: Nicked and subjected to drop test, 2 kilogrammeters × 3 degrees bending angle; without nick, similar test, 29 × 70. Ball test for hardness, 193. The same specimen, when heated to 970° C. and quenched in water, and then reheated to 730° C. and cooled slowly in a furnace, had the following properties: Elastic limit, 30; tensile strength, 46; elongation, 26; reduction of area, 50. When nicked and subjected to drop test, 4-1/2 kilogrammeters × 13 degrees bending angle. Subjected to ball test, 236. Another specimen having carbon .2, phosphorus .14 and manganese .86 had, when untreated, an elastic limit of 29; tensile strength of 46; elongation of 25, and reduction of area of 37; and when nicked and subjected to a drop test it gave 4-1/2 × 16 and under the ball test for hardness gave 166. The same specimen when quenched in water at 960° C., reheated to 730° C. and cooled in a furnace, had an elastic limit of 34; tensile strength of 42; elongation of 27, and reduction of area of 51; and when nicked and subjected to drop test, gave 7-1/2 × 23, and under the ball test, 187.

The advantages of my invention will be appreciated by those skilled in the art, since it effectually overcomes the difficulties which manufacturers of steel rails have met, and provides a rail which, without undue increase of cost, is very greatly improved in respect of its durability and resistance to shock.

My invention produces a rail having a tough matrix stiffened by the treatment above described to produce a material having high elastic limit and greater hardness as indicated by resistance to drop test.

I claim as my invention:

1. The method herein described of treating steel rails, which consists in heating the rail to a relatively high temperature, quickly cooling it, reheating it to a predetermined lower temperature than the initial heating, and then subjecting it to a slower cooling, the two heats being to predetermined degrees such as to concurrently produce increased hardness and resistance to shock, substantially as described.

2. The method herein described of treating steel rails, which consists in heating the rail to a temperature of at least 850° C., quickly cooling it, reheating to between 500 and 700° C., and then subjecting it to a slower cooling substantially as described.

3. The method herein described of treating steel rails, which includes the steps of heating the rail, quickly cooling from a predetermined high temperature and afterwards slowly cooling from a predetermined lower temperature, the two temperatures being such as to produce concurrent hardness of the rail and resistance to shock, substantially as described.

4. The method herein described of treating steel rails, which includes the steps of heating the rail, quickly cooling the rail from a temperature of at least 850° C. to a temperature between 500° and 700° C., and afterwards slowly cooling the rail from a temperature of between 500 to 700° C., substantially as described.

5. The method herein described of treating steel rails containing more than .1 per cent. of phosphorus which includes the steps of heating the rail, quickly cooling it from a predetermined high temperature to a predetermined lower temperature, and afterwards subjecting it to a slower cooling from said predetermined low temperature, the two temperatures being such as to concurrently produce increased hardness of the rail and resistance to shock, substantially as described.

6. The method herein described of treating steel rails, which consists in heating the rail to a predetermined high temperature by immersing it in a hot bath, quenching it to a predetermined low temperature, and afterwards subjecting it to a slower cooling from said predetermined lower temperature, the two temperatures being such as to produce concurrently increased hardness and resistance to shock, substantially as described.

7. The method herein described of treating steel rails containing more than .1 per cent. of phosphorus, which includes the steps of heating the rail, quickly cooling from a predetermined high temperature, and afterwards slowly cooling from a predetermined lower temperature, the two temperatures being such as to produce concurrent hardness of the rail and resistance to shock, substantially as described.

In testimony whereof, I have hereunto set my hand.

ROBERT ABBOTT HADFIELD.

Witnesses:
ROBERT S. KEARNEY,
A. E. WALLACE.