UNITED STATES PATENT OFFICE.

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HEAT TREATMENT AND ROLLING OF MANGANESE STEEL.

1,018,000. Specification of Letters Patent. Patented Feb. 20, 1912.

No Drawing. Application filed January 27, 1911. Serial No. 604,996.

To all whom it may concern:

Be it known that I, WINFIELD S. POTTER, a citizen of the United States, residing at New York city, county of New York, State of New York, have invented certain new and useful Improvements in Heat Treatment and Rolling of Manganese Steel; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to certain new and useful improvements in the heat treatment of manganese steel during the operation of rolling the ingot to the finished form.

The purpose of the invention is to increase the hardness, the elastic limit and the dynamic value (*i. e.*, resistance to failure by exhaustion) of the steel, particularly in the production of railroad rails of standard length and section for whose production the invention is especially designed.

In carrying out the invention, the ingot of manganese steel, from which the rail is to be made is raised to such a temperature as will bring about the absorption and redistribution throughout the mass of any carbids of iron and manganese which may have separated out during and after the freezing of the metal in the ingot mold and so that the metal, in a soft and plastic condition shall have recrystallized throughout into a substantially homogeneous austenite structure. One of the methods of obtaining this condition is described in United States Patent No. 975,371 granted to me under date of November 8th, 1910. The ingot, in this condition, is withdrawn from the furnace and subjected to the action of the rolls of a rail-forming mill, and when it has progressed through the mill to a point of delivery represented, for instance, by its issuance from the roughing rolls and is at an average temperature of about 1125° C., the average temperature is reduced as hereinafter described and the bloom is finished in the remaining passes of the mill so that, at a lower temperature, it will issue from the final pass in a condition which will nevertheless permit of its toughening by rapid cooling. The lowering of temperature referred to may be attained, with the production of the effects incident to the practice of the invention by directing upon the thicker and hotter portions of the bloom a series of jets of water, as, for instance, by directing these jets against the lower surface of the head of the partially formed rail along the line of juncture of the head with the web portion, or, by directing a like series of jets of water against the top of the head of the partially formed rail, or by similarly cooling other portions of the bloom which may be hotter than is desired. By this expedient, the temperature of the bloom is lowered to an average of say 1100° C. before the bloom enters the succeeding passes, wherein the temperature of the bloom is still further lowered, as it progresses, to an average final temperature of from 1075° C. to 800° C. according to the stiffness required in the final product. As the rail issues from the finishing pass, it is immediately quenched, or otherwise so rapidly cooled as to make permanent the condition which the steel has at that time. The water jets are preferably applied as the bloom leaves the passes in the rolls so that a suitable interval is afforded in which the internal heat may flow outward and equalize with the lowered exterior temperature, thereby avoiding too great an inequality of temperature in the bloom while it is being worked in the following pass.

Instead of employing the cooling jets of water for lowering the temperature of the blank as it passes through the rolls, the blank may be transferred to a heating furnace of a temperature lower than that of the thicker and hotter portions of the blank, in which furnace the temperature of the blank is equalized throughout to the lower temperature required for the completion of the rolling operation. As above noted, this temperature may conveniently be 1100° C. or even somewhat lower depending upon the number of passes, the character of the work involved in completing the rolling operation and the intended finishing temperature; that is to say, if the completion of the operation is to bring the rail as it issues from the final finishing pass to as low a temperature as say 800° C., and if accordingly, a greater number of passes in the finishing rolls is employed, the temperature for the reheating will be lower than if it is desired to finish the rail at say 1075° C.

It is broadly characteristic of the invention that the ingot after it enters the rolls of the mill is first rolled in a soft and plastic condition and is then lowered in temperature and so worked at the lower temperature as to increase the elastic limit of the finished product, the finishing operation being conducted at such a temperature and in such a manner that the product may nevertheless issue from the finishing pass of the mill in a condition of uniformity of distribution of its constituents, which condition may thereupon be fixed by rapid cooling. The rolling operation may begin with a temperature ranging from 1125° C. to 1225° C., and that portion of the operation prior to cooling may terminate with an average temperature in the bloom ranging say from 1075° C. to 1175° C. The cooling may be done fractionally, *i e.*, in part as it leaves each of two or more passes of the mill, the important feature being that the bloom during the finishing operation is worked at such a temperature below a certain limit that all parts of the section are thoroughly worked and compressed, so that a uniform very fine-grained and stiff condition of the steel shall exist throughout all portions of the finished product. The limit below which the metal should be cooled before the final working is a temperature usually of about 1075° C. and so far removed from the melting point of the eutectic at about 1125° C. that the eutectic is relatively stable and that the tendency of the metal to recrystallize after it is worked and to regrain with a size and character of grain corresponding to the finishing temperature is avoided. The effects due to working the metal below this temperature may be called fixed effects, and this temperature, in the sense of the present specification, the fixation point. To less advantage, the lowering of temperature to the fixation point may be effected by delaying the bloom and permitting it to cool by radiation to the desired degree upon the mill table as the bloom issues from a pass or passes of the mill and before it is subjected to the final working and compression at a temperature below the fixation point. In most instances, however, as hereinbefore described, I prefer to employ the water jets for more nearly equalizing the temperature of the thicker portions of the section, such as the head and center line of the base of the rail with the temperature of the cooler portions of the base rather than to rely upon the cooling due to air radiation, which has the tendency to accentuate the constantly increasing differences in temperature between the thicker and the thinner parts of the bloom already initiated as soon as it begins to take on its molded form.

While I have hereinbefore referred to the production of railroad rails, as an exemplification of the practice of my invention, I desire it to be understood that it is likewise applicable to the production of other similar rolled shapes and bars.

Having thus described my invention, what I claim is:

1. The method of producing rolled shapes of manganese steel, which consists in first heating a manganese steel ingot or blank to a point above the melting point of the eutectic until it is in a condition of substantial uniformity of distribution of its constituents, rolling it in that condition until the shape is partially formed, then rolling and intermittently cooling and equalizing the temperatures of the different portions of the bar, until the bar is finally finished and worked throughout at temperatures below the fixation point; substantially as described.

2. The method of producing rolled shapes of manganese steel, which consists in first heating a manganese steel ingot or blank to a point above the melting point of the eutectic, rolling to a bloom, and cooling and working to finished shape at temperatures below 1075° C., substantially as described.

3. The method of producing rolled shapes of manganese steel, which consists in first heating a manganese steel ingot or blank to a point above the melting point of the eutectic, rolling to a bloom, cooling to the fixation point, and thoroughly working the bloom, by rolling, to finished shape at temperatures below the fixation point, to produce a uniform fine-grained structure throughout; substantially as described.

4. The method of producing rolled shapes of manganese steel, which consists in first heating a manganese steel ingot or blank to a point above the melting point of the eutectic, rolling to a bloom, and cooling and working to finished shape at temperatures below 1075° C., and thereupon immediately quenching; substantially as described.

5. In the production of wrought shapes of manganese steel from metal which has been heated to a temperature above the melting point of the eutectic until in a condition of substantial uniformity of distribution of its constituents, working the metal at a temperature which, in the finishing stage, shall be within the range of 800° C. to 1075° C.; and rapidly cooling; substantially as described.

In testimony whereof I affix my signature, in presence of two witnesses.

WINFIELD S. POTTER.

Witnesses:
WILLIAM H. DAVIS,
JOHN C. PENNIE.