UNITED STATES PATENT OFFICE.

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METHOD OF PRODUCING FINISHED SHAPES OF MANGANESE STEEL.

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To all whom it may concern:

Be it known that I, WINFIELD S. POTTER, a citizen of the United States, residing at Mahwah, in the county of Bergen and State of New Jersey, have invented certain new and useful Improvements in Methods of Producing Finished Shapes of Manganese Steel; and I do 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.

Manganese steel is a material which may be given great toughness, hardness and resistance to abrasion, by subjecting it to suitable heat-treatment. It is therefore especially suited for the production of rails for railways. Heretofore, however, it has been found impossible to roll manganese steel into rails or other shapes, on account of the fact that the metal lacks cohesion when hot, so that the cast ingot is crushed into pieces instead of being elongated when subjected to the action of rolls. Such rails as are now in use are therefore produced by casting the metal in molds.

The present invention relates to a method of producing finished shapes from manganese steel, whereby an ingot may be made sufficiently coherent to elongate without crushing in the rolling or shaping thereof.

The method, generally stated, consists in heating the ingot, preferably in successive stages, up to a high temperature, cooling the heated ingot to a lower temperature, and rolling it, preferably in two stages, the ingot being first heated to a low temperature and subjected to the action of roughing and compressing rolls, and then heated to a high temperature and rolled to finished shape, with an intermediate reheating if necessary. The rolled product is then quenched, from a suitable temperature, to give it the requisite toughness.

The preferred complete mode of procedure is as follows: An ingot is cast, large end downward, in a mold of the usual form, the molten steel being preferably introduced into the mold through a fire-brick runner, to decrease piping. The ingot is then slowly and evenly heated, preferably standing on end and in a reducing atmosphere, for example to a temperature between 735° C. and 930° C., and specifically to about 870° C. The temperature is then rapidly raised to from 995° C. to 1065° C., specifically to about 1040° C., at approximately which temperature the metal becomes tender and is liable to crack if further heated rapidly, and from this point the metal is slowly heated to the maximum temperature permissible, between 1065° C. and 1260° C., specifically to about 1205° C. This high temperature gives a uniform molecular structure to the steel, removing segregation and apparently causing the particles of steel to weld together or firmly cohere. The hot ingot is now subjected to an annealing treatment, by being cooled. This cooling is preferably effected in a nonoxidizing atmosphere, the temperature being first slowly reduced to avoid rupture and then quickly lowered until recrystallization is complete, which occurs at between 650° C. and 705° C. This annealing step is of especial importance, coöperating with the high temperature previously used to produce even crystallization, high cohesion and uniform structure. The annealed ingot is now reheated to a low temperature sufficient to enable it to be rough-rolled and compressed, dependent on the size of the ingot and power of the rolls and ranging from 870° C. to 1065° C. or upward. The initial rolling is preferably effected by Gothic rolls, the reduction in the first few passes being very slight, for example one-fourth inch in the first two passes, on each side, for a twelve-inch ingot. The bloom is now reheated to the maximum temperature that is to the temperature to which it was originally heated, say from 1065° C. to 1205° C., and rolled to finished shape. In reheating, the ingot should lie on its side and should be turned through an angle of 180° several times to insure even heating. The rails should be sawed to length and punched for fish-plate bolts while hot from the rolls. The rails are now subjected to a quenching operation, either direct from the rolls, if sufficiently hot, or after reheating. The rails should be arranged base downward in the reheating furnace, and should thence be drawn into a suitable rack capable of being submerged in water.

The process as described is capable of modification in two particulars, as follows: The ingots may be taken direct from the molds to a soaking pit, wherein their tempera-

ture will become equalized. The slow preliminary heating to a temperature between 735° C. and 930° C. as heretofore mentioned may then be omitted; for example, if the ingot is taken direct from the mold with its center say at a temperature of from 1300° C. to 1200° C., and having a skin temperature of say 1000° C. to 900° C., it may be placed in the soaking pit wherein the temperatures will be equalized, for example at 1205° C., preferably not above 1260° C., and as the mass is relatively coherent at this temperature, and has not been permitted to crystallize, it is obvious that the cooling or annealing step may be omitted. In some instances, and especially with small ingots, the initial rough-rolling may be omitted, the ingots being rolled to a finish in one heat, the cooling or annealing step being omitted as above described, the ingot, in such instance, being taken direct from the mold to the soaking pit, wherein its temperatures become equalized, and is then taken to the rolls. This necessitates exact heating, accurate rolls and slight reductions in the first few passes, for example one-eighth inch in a four inch ingot at a temperature of 1095° C., using rolls with a Gothic pass. On the other hand, the reduction of large ingots to small shapes, especially to thin sheets, may necessitate intermediate reheating of the bloom during the shaping.

The cooling of the ingot for annealing and that of the finished product for toughening may be effected by subjecting the metal to the action of steam. In general, however, it is preferred to anneal either in the heating furnace or in the air; and to quench in water. Small ingots may be annealed by quenching in water.

While the reduction of the ingots by means of rolls, only, has been described, it will be understood that a hammer or press may be employed, if preferred.

I claim:—

1. The method of producing finished shapes from manganese steel which consists in slowly heating the ingot from a temperature between 995° C. and 1065° C., to the maximum temperature and until the temperatures thereof are equalized, then slightly reducing said ingot, and then shaping.

2. The method of producing finished shapes from manganese steel which consists in slowly heating an ingot in a reducing atmosphere from a temperature between 995° C. and 1065° C. to the maximum temperature and until the temperatures of the mass are equalized, then slightly reducing the ingot, and then shaping it.

3. The process of producing finished shapes from manganese steel which consists in evenly heating the ingot in a reducing atmosphere from approximately 1040° C. to approximately 1205° C., cooling the ingot until recrystallization is complete, reheating the ingot to the maximum temperature, then subjecting the ingot to slight reductions and then shaping it.

4. The method of producing finished shapes from ingots of manganese steel, which consists in evenly heating the ingot from temperatures above 1040° C. to the maximum temperature, cooling, reheating and shaping.

5. The method of producing finished shapes from ingots of manganese steel, which consists in evenly heating the ingot from temperatures above 1040° C. to the maximum temperature, cooling, reheating, compressing and shaping.

6. The method of producing finished shapes from ingots of manganese steel, which consists in slowly heating the ingot to a temperature above 705° C., rapidly heating to a somewhat higher temperature, slowly heating to the maximum temperature, cooling until recrystallization is complete, reheating and shaping.

7. The method of producing finished shapes from ingots of manganese steel, which consists in slowly heating the ingot to a temperature above 705° C., rapidly heating to a somewhat higher temperature, slowly heating to the maximum temperature, cooling until recrystallization is complete, reheating, compressing and shaping.

8. The method of producing finished shapes from ingots of manganese steel, which consists in slowly heating the ingot to a temperature between 735° C. and 930° C., rapidly heating to from 995° C. to 1065° C., slowly heating to from 1065° C. to 1260° C., cooling until recrystallization is complete, reheating, compressing and shaping.

9. The method of producing finished shapes from ingots of manganese steel, which consists in slowly heating the ingot to a temperature between 735° C. and 930° C., rapidly heating to from 995° C. to 1065° C., slowly heating to from 1065° C. to 1260° C., slowly cooling to a temperature approximating 705° C., quickly cooling until recrystallization is complete, reheating, compressing and shaping.

10. The method of producing finished shapes from ingots of manganese steel, which consists in slowly heating the ingot to about 870° C., rapidly heating to about 1040° C., slowly heating to about 1205° C., cooling until recrystallization is complete, reheating, compressing and shaping.

11. The method of producing finished shapes from ingots of manganese steel, which consists in slowly heating the ingot to about 870° C., rapidly heating to about 1040° C., slowly heating to about 1205° C., slowly cooling to about 705° C., quickly cooling until recrystallization is complete, reheating, compressing and shaping.

12. The method of producing finished shapes from ingots of manganese steel, which consists in providing an ingot heated to a temperature above 1205° C., cooling, reheating to a low temperature, compressing, heating to a high temperature and shaping.

13. The method of producing finished shapes from ingots of manganese steel, which consists in providing an ingot heated to a temperature above 1205° C., slowly cooling to about 705° C., quickly cooling until recrystallization is complete, reheating to a low temperature, compressing, heating to a high temperature and shaping.

14. The method of producing finished shapes from ingots of manganese steel, which consists in slowly heating the ingot to a temperature above 705° C., rapidly heating to a somewhat higher temperature, slowly heating to the maximum temperature, slowly cooling to a temperature above 705° C., quickly cooling until recrystallization is complete, reheating to a low temperature, compressing, heating to a high temperature and shaping.

15. The method of producing finished shapes from ingots of manganese steel, which consists in slowly heating the ingot to a temperature above 705° C., rapidly heating to a somewhat higher temperature, slowly heating to the maximum temperature, cooling until recrystallization is complete, reheating, compressing, shaping and quenching the finished shape from a suitable temperature.

16. The method of producing finished shapes from ingots of manganese steel, which consists in evenly heating an ingot to a temperature sufficient to remove segregation and cause the particles of steel to cohere, cooling, reheating and shaping.

17. The method of producing finished shapes from ingots of manganese steel, which consists in evenly heating an ingot to a temperature sufficient to remove segregation and cause the particles of steel to firmly cohere, lightly working the metal, and then shaping it.

18. The method of producing finished shapes from ingots of manganese steel, which consists in evenly heating an ingot, in a reducing atmosphere, to a temperature sufficient to remove segregation and cause the particles of steel to cohere, lightly working the metal, and shaping.

19. The hereinbefore described method of heat treatment of ingots of manganese steel, which consists in heating the ingot to a maximum temperature of about 1260° C., cooling the same until recrystallization is complete, reheating, and then reducing it.

20. The method of producing finished shapes from ingots of manganese steel, which consists in slowly and evenly heating the ingot in a reducing atmosphere to a temperature approximating 930° C., then rapidly raising the temperature to approximately 1065° C., then slowly up to a temperature about 1260° C., then cooling the ingot to a suitable temperature and shaping it.

21. The method of producing finished shapes from manganese steel, which consists in heating the metal to temperatures not exceeding 1065° C., then slowly heating the metal to a temperature not exceeding 1260° C., and subsequently shaping the same.

22. The method of producing finished shapes from manganese steel which consists in slowly heating the body of metal from a temperature between 995° C. and 1065° C. to temperatures between 1065° C. and 1260° C., and subsequently shaping the metal.

23. The method of producing finished shapes from manganese steel which consists in rapidly heating the body of metal to a predetermined temperature, then slowly heating the metal to the maximum temperature, and subsequently shaping it.

24. The method of producing finished shapes from manganese steel which consists in heating the body of metal to the maximum temperature, cooling the metal to the temperature where recrystallization is complete, immediately reheating the metal from such temperature, and then shaping it.

25. The method of treating manganese steel which comprises heating the body of metal to the maximum temperature, then slowly cooling the same to a predetermined temperature, then rapidly cooling until recrystallization is complete.

26. The method of treating manganese steel, in which the metal is subjected while hot to the action of steam, whereby to anneal and toughen the same.

27. The method of producing finished shapes from manganese steel, which consists in heating the metal to the maximum temperature, then cooling the same by subjecting it to the action of steam, and subsequently shaping it.

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

WINFIELD S. POTTER.

Witnesses:

HUGH M. STERLING,

J. H. GALLEHER.