UNITED STATES PATENT OFFICE.

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PROCESS OF TREATING MANGANESE-STEEL INGOTS.

938,892. Specification of Letters Patent. **Patented Nov. 2, 1909.**

No Drawing. Application filed January 31, 1907. Serial No. 355,082.

To all whom it may concern:

Be it known that I, WINFIELD S. POTTER, a citizen of the United States, and a resident of Mahwah, in the county of Bergen and State of New Jersey, have made and invented certain new and useful Improvements in Processes of Treating Manganese-Steel Ingots, of which the following is a specification.

My invention relates to the production of manganese steel, and more particularly to the production of ingots having a large cross sectional area. Many attempts have heretofore been made to work what is commonly known and referred to as manganese steel, by rolling or forging, but with no success in the case of large ingots, or with finished articles having a large cross sectional area, and with only partial success in the case of plain shapes, such as bars and flats having a relatively small cross sectional area.

I have discovered that the failure to roll or forge large ingots, to large and difficult shapes, such as rails, has been due to the treatment to which the metal has been subjected, and the object of my invention is to so treat the metal as will provide a manganese steel ingot of any desired dimensions and possessed of such characteristics as will enable or permit the same to be subsequently rolled, forged, pressed, or otherwise formed into any desired shapes, and of any desired dimensions, such for instance as railway rails, parts of crushing and other machines, also flats and sheets from which to form screens and bottoms and sides of chutes for sizing and handling crushed ores, etc. without danger of rupture in the subsequent heating and forming. These ingots are produced by the novel method or process hereinafter fully described, and constituting my present invention.

In practice, the ingot to be treated, if cold, is first slowly heated to a dull red heat or to a temperature between 315° C. and 540° C.; in case, however, the ingot is to be subjected to the treatment hereinafter described immediately after being cast or while still at temperatures above the recrystallization point throughout from the heat of casting, this preliminary heating step is of course unnecessary. After arriving at the dull red heat or lower temperature, the metal is heated either slowly or rapidly as desired, to a temperature somewhat below the point where the ingot begins to weaken, and which point I term the upper-critical point of the metal. The temperature of this upper-critical point, will, of course, vary according to the analysis of the metal, say from approximately 1050° C. to 1120° C. From a temperature slightly below the upper-critical point, say for example, about 1040° C., the ingot is slowly heated in a non-oxidizing fluid to a temperature well above the upper-critical point of the metal, but below its melting point. I have found in practice that it is desirable to raise the temperature at this stage of the process, to a point between 1150° C. and 1205° C., although it will be understood that this higher temperature may be greater or less according to the analysis of the steel, and the facilities at hand for quickly and expeditiously handling the metal at its different stages of treatment, and also the facilities for obtaining accurately the temperatures of the metal at all times, it being essential only that the temperature of the entire mass of metal shall be above the upper-critical point and below the melting point, that is, that the metal shall be in a soft and plastic condition.

After the ingot has been subjected to a temperature at or above the upper-critical point, preferably to a temperature between 1150° C. and 1205° C., and after the mass of metal has been uniformly heated throughout, the temperature is then lowered rapidly to a point below the upper-critical point, preferably to a temperature just above the re-crystallization point, which will, of course, vary according to the analysis of the metal from approximately 600° C. to 700° C. If desired however, the body of metal, particularly if of moderate thickness, may be cooled until at or just below a dull red heat. This rapid cooling is more economically and expeditiously done while the ingot remains in the pit or furnace, and may be accomplished by cutting off the heat and directing a stream of cold gas or steam therein, and around the metal, although of course, such cooling may be effected in a separate chamber or compartment designed for the purpose. This rapid lowering of the temperature cools the skin or outer surface of the ingot. This rapid lowering of the tempera-

ture and consequent rapid cooling of the skin or outer surface of the ingot, constitutes an important step in the treatment of the metal, in that the shrinkage of the outer portions of the metal exerts an enormous pressure and welding effect upon the interior portions of the mass of metal while in its soft and plastic condition, thereby materially and uniformly increasing the density of the metal and also the cohesion of the particles thereof, and renders the metal of such a nature as to be much better adapted for subsequent rolling or forging.

After the metal has been rapidly cooled to the desired temperature as above described, the cooling is arrested in order that the body of metal may become of uniform temperature throughout, whereupon the rapid cooling is continued if necessary until the entire mass is finely crystallized; it may then be reheated for the rolls or allowed to cool to the temperature of the atmosphere. The rapid cooling, however, should not be continued much below the dull red heat nor below 425° C. to 480° C. to avoid the setting up of internal strains in the ingot, and the cooling below the dull red heat should be carried on uniformly until the temperature of the ingot reaches the temperature of the atmosphere.

As before stated, both the heating and initial cooling steps are preferably effected in a non-oxidizing fluid, either liquid or gas, the object being to prevent the burning and consequent weakening of the outer layers of metal and to preserve a strong, tough, continuous, unbroken or unchecked skin or surface, in order that the latter shall retain the necessary strength and toughness while shrinking to cause the welding of the interior mass of metal while in its soft or plastic condition, and in order also to prevent the breaking or disintegration of the metal in its subsequent treatment of forging or rolling, which is liable to occur when the outer skin or layers of metal are cracked or checked.

I have found in practice that when an ingot of manganese steel is thus treated, it is of such a nature and possesses such characteristics as will enable it to be subsequently re-heated to a higher and more desirable temperature for the rolls, than is otherwise possible, permitting it to be rolled or forged into any desirable shapes of any suitable dimensions. The metal is of increased density, the metal being more tightly and closely welded together, and possessed of greater cohesive power, while at the same time it retains the desirable fine crystallization, and an outer strong, tough and unchecked skin.

While I have above mentioned the temperatures to which I have found in practice the metal is preferably raised or lowered, yet I would have it understood that good results may be obtained at lower temperatures and prolonging the time to which the metal should be subjected thereto; good results may also be obtained with higher temperatures, and therefore I do not limit or restrict my claims to the temperatures given, but:

Having fully described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In the treatment of manganese steel the process herein described of rapidly cooling the exterior of the metal from a temperature above the upper critical point.

2. In the treatment of manganese steel the process herein described of rapidly cooling the exterior of the metal while the interior is at a temperature above the upper critical point.

3. In the treatment of manganese steel the process herein described of rapidly cooling the exterior of the metal in a non-oxidizing fluid while the interior is at a temperature above the upper critical point.

4. In the treatment of manganese steel, the process herein described consisting in rapidly cooling the exterior of the metal from a temperature between the upper-critical point and the melting temperature to a dull red heat and above 425° C., and then uniformly cooling the metal to atmospheric temperature.

5. The treatment of manganese steel which consists in arresting the rapid cooling of the metal at the temperature described maintaining said temperature until the metal is of substantially uniform temperature throughout, and finally cooling the metal to atmospheric temperature.

6. The treatment of manganese steel which consists in heating the metal to the highest predetermined temperature, then rapidly cooling the metal to a temperature between the upper critical point and a dull red heat, then arresting the cooling, and then finally cooling the metal to atmospheric temperature.

7. In the treatment of manganese steel, the process herein described of arresting the cooling of the exterior of the metal at a temperature slightly above the re-crystallization point while the interior is in a soft and plastic condition.

8. In the treatment of manganese steel, the process herein described of rapidly cooling the exterior of the metal to a temperature slightly above the re-crystallization point while the interior is in a soft and plastic condition, and then permitting the mass of metal to become of uniform temperature throughout.

9. In the treatment of manganese steel, the process herein described of rapidly cooling the exterior of the metal to a temperature slightly above the re-crystallization

point while the interior is in a soft and plastic condition, then permitting the mass of metal to become of uniform temperature throughout, and then rapidly cooling the metal to a temperature below the re-crystallization point.

10. In the treatment of manganese steel, the process herein described of rapidly cooling the exterior of the metal to a tempera ture slightly above the re-crystallization point while the interior is in a soft and plastic condition, maintaining the temperature until the mass of metal becomes of uniform temperature throughout, then rapidly cooling the metal to a temperature above a dull red heat.

11. In the treatment of manganese steel, the process herein described of rapidly cooling the exterior of the metal to a temperature slightly above the re-crystallization point while the interior is in a soft and plastic condition, maintaining this temperature until the mass of metal becomes of uniform temperature throughout, rapidly cooling until the temperature of the exterior is at a predetermined point above 450 degrees C., maintaining this temperature until the mass of metal becomes of uniform temperature throughout, and then slowly cooling the mass of metal to atmospheric temperature.

12. The process of treating manganese steel which consists in heating the metal to a temperature below the upper critical point, then heating the metal slowly and uniformly to a temperature above the upper critical point and below the melting point and maintaining said temperature until the metal is in a soft and plastic condition throughout and then cooling the metal to the temperature desired.

13. The process of treating manganese steel which consists in heating the exterior of the metal rapidly to a predetermined temperature below the upper critical point, then heating the metal throughout to the said predetermined temperature, then heating the metal uniformly and slowly to a temperature above the upper critical and below the melting point and then cooling the metal to the desired temperature.

14. The process of treating manganese steel which consists in heating the metal in a non-oxidizing fluid uniformly throughout to a predetermined temperature below the upper critical point, then heating the metal in a non-oxidizing fluid uniformly and slowly to a temperature above the upper critical point and below the melting point, and maintaining said temperature until the metal is uniformly heated throughout and then cooling the metal to the temperature desired.

15. The process of treating manganese steel ingots which consists in heating the ingot to a temperature above the upper-critical point of the metal in a non-oxidizing medium, and then rapidly lowering the temperature in a non-oxidizing medium.

16. The process of treating manganese steel ingots which consists in heating the ingot slowly to a temperature above the upper-critical point of the metal, and lowering the temperature rapidly to below said upper-critical point of the metal, and maintaining the temperature at a predetermined point until the ingot is of uniform temperature throughout.

17. The process of treating manganese steel ingots which consists in slowly heating the ingot from a point below the upper-critical point to a temperature above said upper-critical point and below the melting point of the metal and rapidly lowering the temperature to a temperature below the upper-critical point and above the re-crystallization point in a non-oxidizing medium and maintaining said temperature until the ingot is of uniform temperature throughout, substantially as described.

18. The process of treating manganese steel which consists in heating the metal throughout to a temperature below the upper critical point, then heating the metal uniformly to a temperature above the upper critical point and then cooling the exterior of the metal rapidly to a temperature below the upper critical point and below the interior of said metal.

19. The process of treating manganese steel, which consists in heating the metal to a temperature below the upper critical point, then heating the same uniformly to a temperature above the upper critical point, then cooling the exterior of said metal rapidly below the upper critical point, causing the same to become of uniform temperature throughout, and then cooling the same to a temperature below the re-crystallization point.

20. The process of treating manganese steel which consists in heating the metal to a temperature below the upper critical point, heating the same uniformly to a temperature above the upper critical point, then rapidly cooling the exterior of said metal to a temperature below the upper critical point, causing the same to become of uniform temperature throughout, and then rapidly cooling the same to a temperature below the re-crystallization point where the metal is finely crystallized throughout.

21. The process of treating manganese steel which consists in heating the metal to a temperature below the upper critical point, heating the same uniformly to a temperature above the upper critical point, then rapidly cooling the exterior of said metal to a temperature below the upper critical point, causing the same to become of uniform temperature throughout, then rapidly cooling

the same to a temperature below the re-crystallization point where the metal body is finely crystallized, and then cooling the same to atmospheric temperature.

22. The process of treating manganese steel which consists in slowly heating the metal to a dull red heat, rapidly heating the same to a temperature just below the upper critical point, then heating the metal uniformly to a temperature above the upper critical point, then rapidly cooling the exterior of the metal to a temperature below the upper critical point, and above the re-crystallization point, arresting the cooling until the metal becomes of uniform temperature throughout, and then rapidly cooling said metal to a temperature below the re-crystallization point where the metal is finely crystallized.

23. The process of treating manganese steel ingots which consists in slowly heating the ingot to a temperature above 450° C., then rapidly heating the metal to a temperature below the upper-critical point, slowly heating the same in a non-oxidizing medium to a temperature below the melting point and then cooling the ingot to a temperature below the said upper-critical point.

24. The process of treating manganese steel ingots which consists in heating the ingot to a temperature between the upper-critical point and the melting point, rapidly cooling the same to a temperature below the upper-critical point and above the recrystallization point, then causing the same to become of an even temperature throughout and then finally rapidly cooling the same to produce a fine crystalline structure.

25. The process of treating a manganese steel ingot, which consists in heating it to a temperature above the upper critical point of the metal, rapidly cooling the ingot to a temperature above that of re-crystallization, retaining the ingot at this temperature until of equal temperature throughout, and finally lowering the temperature to a point below that of re-crystallization.

26. The process of treating manganese steel, which consists in heating the metal to a temperature below 1050° C., then uniformly heating the same in a non-oxidizing fluid to a temperature below its melting point, and then cooling the same.

27. The process of treating manganese steel, which consists in uniformly heating the metal from temperatures above 1050° C. to temperatures below the melting point, in a non-oxidizing atmosphere, then rapidly cooling the same to a temperature above 450° C., and finally cooling the metal to atmospheric temperature.

Signed at New York borough of Manhattan in the county of New York and State of New York this 24th day of January A. D. 1907.

WINFIELD S. POTTER.

Witnesses:
GEORGE COOK,
A. M. AUSTIN.