UNITED STATES PATENT OFFICE.

WINFIELD S. POTTER, OF MAHWAH, NEW JERSEY, ASSIGNOR TO MANGANESE STEEL RAIL COMPANY, OF MAHWAH, NEW JERSEY, A CORPORATION OF NEW JERSEY.

MANGANESE STEEL.

939,084. Specification of Letters Patent. Patented Nov. 2, 1909.

No Drawing. Application filed April 25, 1907. Serial No. 370,303.

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 a certain new and useful Improvement in Manganese Steel, of which the following is a specification.

My invention relates to the production of manganese steel ingots 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, or 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 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 method or process hereinafter fully described.

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 temperature 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 recrystallization point. 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 steam or cold gas 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 temperature 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. Rapid cooling 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 until the mass has been cooled considerably below the dull red heat should be carried on uniformly.

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, free from cracks due to improper heating and from columnar arrangements of crystals or other non-cemented structures resulting from improper cooling in which condition the compounds which should be crystallized as cements between the ferrites have entered in part into solid solution in the ferrites, the metal being more tightly and closely welded together, and possessed of greater cohesive power due to strong cementing material binding the ferrites, 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 and lowered, yet I would have it understood that good results may be obtained at higher and lower temperatures, and regulating the time to which the metal should be subjected thereto accordingly.

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

1. An annealed manganese steel ingot having a strong tough skin.

2. An annealed manganese steel ingot having a strong tough skin and a dense and fine crystalline structure throughout.

3. A manganese steel ingot having a substantially uniform fine crystalline structure in its outer portion.

4. A manganese steel ingot having in its outer portion a strongly cemented structure comprising crystals of well defined form.

5. A manganese steel ingot having a substantially uniform fine crystalline structure throughout.

6. A manganese steel ingot having throughout small crystals of well defined form and of substantially uniform size.

7. A non-quenched manganese steel ingot having a dense and fine crystalline structure substantially uniform throughout.

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

WINFIELD S. POTTER.

Witnesses:
M. VAN NORTURCK,
PARKER COOK.