UNITED STATES PATENT OFFICE.

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PRODUCING WROUGHT SHAPES OF MANGANESE STEEL.

1,278,207. Specification of Letters Patent. Patented Sept. 10, 1918.

No Drawing. Application filed May 11, 1914, Serial No. 837,662. Renewed June 1, 1918. Serial No. 237,821.

To all whom it may concern:

Be it known that I, WINFIELD S. POTTER, a citizen of the United States, residing at Pittsburgh, Allegheny county, State of Pennsylvania, have invented certain new and useful Improvements in Producing Wrought Shapes 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.

The present invention relates to the production of wrought shapes of manganese steel; that is to say, steel containing over 5% manganese, with or without silicon or alloying metals such as chromium or nickel, and containing any suitable proportion of carbon, (for instance, from .25% to 2.25% of carbon).

I have found that a critical point exists in manganese steel, (usually at above 825° C., or above, according to analysis) above which carbids which have previously separated out, both within and between the grains of the steel, and also the excess carbids of the separated eutectic, are re-absorbed to a greater or less extent by the mixed crystals of the metal, the completeness of the reabsorption depending upon the analysis of the steel, the extent of the separation of carbids and eutectic as determined by the conditions of the cooling of the ingot from the heat of casting, and depending upon the time employed in heating the steel up through a critical range having its upper limit at about 825° C., and depending further upon the time during which the steel is maintained at the selected temperature above said critical point.

I have also found that when a manganese steel ingot has been first cooled down in part from the heat of casting, (for example, when it has been cooled down to a temperature of say 700° C.), it may be brought into a condition suitable for forging or reduction to bloom, billet, or slab form by moderate or progressive rolling, by heating the ingot to a temperature above the said critical point lying at about 825° C., and holding it at the temperature to which it has thus been heated for a suitable number of hours, depending upon the proportion of separated carbids and eutectic present as determined by the conditions of the cooling of the ingot from the heat of casting, and also depending upon the analysis of the steel.

Where the ingot, in cooling from the heat of casting has dropped below the critical temperature lying at about 825° C., or thereabout, and enters the critical range extending downward therefrom to about 750° C., martensitic structures are developed, due to the separation of carbids within the grains of the steel. These structures are removed as the steel is heated up through and above the said critical range of temperature.

The absorption of the separated carbids and the excess carbids of the eutectic may, in accordance with the present invention, be effected, by sufficiently prolonged heating, at a temperature above the critical temperature lying at 825° C., or thereabout, and may be almost complete at temperatures within 200° C., above the said critical temperature, the time required for heating, generally speaking, being inversely proportional to the temperature. At temperatures exceeding 1025° C., the metal re-grains more rapidly and freely and becomes weaker and more ductile. It is characteristic of my present invention, therefore, that the reabsorbtion of the separated carbids and of the excess carbids of the eutectic takes place at a relatively low temperature, and that the subsequent heating to higher temperatures, after the desired reabsorption has been substantially accomplished, is for the purpose of imparting to the metal a ductility greater or less in amount according to the higher temperature selected, appropriate to the final reduction intended.

In practice, the manganese steel ingot will either be permitted to cool from the heat of casting to say 700° C., and then reheated through the critical range beginning at say 750° C., to and above the aforesaid critical temperature lying at about 825° C., or thereabout; or, the cooling of the ingot will be interrupted at an appropriate temperature within the range of 200° C., or thereabout, above the said critical temperature of 825° C. An appropriate temperature at which to begin the prolonged heating within the range above 825° C., or thereabout, will usually lie between 900° C., and 1000° C.,

but will be greater or less according to the analysis of the steel.

When the piece to be heated is at the appropriate temperature within the range of 200° C., above the critical temperature, lying at about 825° C., or thereabout, it is held at the temperature selected, for a considerable time. For instance, with a manganese steel ingot of ordinary analysis, 20 inches square, the time of heating, at say 900° C., to 950° C., in a soaking pit, would be from 10 to 15 hours, or even longer. The prolonged heating, in any case, will be continued for a greater or lesser time, according to the size and analysis of the ingot, until the greater portion of the carbids and the excess carbids of the eutectic, separated out during the time when the ingot was cooling from the heat of casting, will be re-absorbed and taken into solution by the mix crystals of the metal.

The ingot may thereupon be withdrawn from the soaking pit and immediately subjected to a moderate reducing operation, which may consist of hammer or press-forging, or rolling with a light or moderate reduction with each pass of the rolls; whereupon it may be cut into lengths, as blooms, billets, or slabs, as may be required.

The bloom, billet or slab, resulting from this first forging or rolling operation, may then be reheated to such temperature as is required for the succeeding forming operation. If the further forming required is but slight, the bloom, billet or slab, may be reheated, to an equalized temperature as low as 900° C. Ordinarily, however, it will be found more expedient to heat the bloom, billet or slab, to an equalized temperature within the range of 1025° C. to 1200° C. (or even higher), and for such time as may be necessary to freely regrain the steel and to bring it to a ductility appropriate for the forming of the bar or other final shape required.

In some instances, the ductility of the ingot, at the termination of the prolonged heating at a temperature within the range of 200° C., above the critical temperature lying at 825° C., or thereabout, will suffice for the particular final forming intended, without reheating; and, in such cases, after the initial reduction, the ingot will be immediately rolled or otherwise brought to final form.

When, in the secondary forming operation hereinbefore indicated, the steel is heated to temperatures above 1025° C., or thereabout, such of the excess carbids of the eutectic as may not have been reabsorbed during the heating for the preliminary forging or rolling operation will be brought into solution and absorbed, and the product will be correspondingly more uniform than if the heating for the secondary rolling or forging operation had been restricted to a lower temperature than 1025° C. (say 900° C. to 950° C.).

At the termination of the final reduction, the condition of the metal may be made permanent by rapidly cooling the product to ordinary temperatures,—say, for instance, by quenching the product in water; or it may be reheated slowly through the critical range located ordinarily at 750° C.–825° C., and then water-quenched; or, it may be heated to just above the critical range located ordinarily at 750° C.–825° C. (for instance, 900° C.) and held for from 15 minutes to one hour, or longer, at the maximum temperature thus selected according to the size and analysis of the product, and then water-quenched or otherwise rapidly cooling.

In some instances, if desired, the prolonged heating within the range of 200° C., or thereabout, above the critical temperature located at about 825° C.,—continued until any carbids and the excess carbids of the eutectic have been reabsorbed by the mix crystals,—will be succeeded in the same furnace operation by the further heating to the higher temperatures hereinbefore referred to, without the intermediate light reduction specified. In these instances, the ingot, when raised to the final equalized temperature, and suitably regrained, may be either subjected to reduction and then cut up into billets or slabs, or, if the ductility is sufficient for the particular final forming intended, it may be rolled to final shape.

Having thus described my invention, what I claim is:

1. The method of producing a wrought shape of manganese steel from a cast ingot wherein, during cooling, there has been a separation of eutectic within the mass of the metal, comprising heating the steel to a temperature within the range of 200° C., or thereabout, above the critical temperature located at about 825° C., for a sufficiently long period of time to permit the reabsorption by the mix crystals of the metal of the greater part of the excess carbids of the eutectic, and any carbids which may have separated, ultimately heating the metal to a temperature suitable for the ductility required, and then subjecting the metal to reduction.

2. The method of producing a wrought shape of manganese steel from a cast ingot wherein, during cooling, there has been a separation of eutectic within the mass of the metal, comprising heating the steel to a temperature within the range of 200° C., or thereabout, above the critical temperature located at about 825° C., for a sufficiently long period of time to permit the reabsorption by the mix crystals of the metal of the greater part of the excess carbids of the eutectic, and any carbids which may have

separated, ultimately heating the metal to and regraining it at a temperature suitable for the ductility required, and then subjecting the metal to reduction.

3. The method of producing a wrought shape of manganese steel from a cast ingot wherein, during cooling, there has been a separation of eutectic within the mass of the metal, comprising heating the steel at a temperature within the range of 200° C., or thereabout, above the critical temperature located at about 825° C., for a sufficiently long period of time to permit the reabsorption by the mix crystals of the metal of the greater part of the excess carbids of the eutectic and any carbids which may have separated, then subjecting the metal to an initial reduction, reheating it until it is regrained and has attained a ductility appropriate to further reduction, and then subjecting it to such further reduction.

4. The method of producing a wrought shape of manganese steel from a cast ingot wherein, during cooling, there has been a separation of eutectic within the mass of the metal, comprising heating the steel to a temperature within the range of 200° C., or thereabout, above the critical temperature located at about 825° C., for a sufficiently long period of time to permit the reabsorption by the mix crystals of the metal of the greater part of the excess carbids of the eutectic and any carbids which may have separated, subjecting the metal to an initial reduction, cutting it into preliminary lengths for subsequent reduction, reheating at a temperature suitable for the ductility required for the further reduction, and then subjecting the metal to such further reduction.

5. The method of producing a wrought shape of manganese steel from a cast ingot wherein, during cooling, there has been a separation of eutectic within the mass of the metal, comprising heating the steel to a temperature within the range of 200° C., or thereabout, above the critical temperature located at about 825° C., for a sufficiently long period of time to permit the reabsorption by the mix crystals of the metal of the greater part of the excess carbids of the eutectic, and any carbids which may have separated, ultimately heating the metal to a temperature suitable for the ductility required, then subjecting the metal to reduction, reheating the product slowly through the critical range located ordinarily at 750° C. to 825° C., and water-quenching.

6. The method of producing a wrought shape of manganese steel from a cast ingot wherein, during cooling, there has been a separation of eutectic within the mass of the metal, comprising heating the steel to a temperature within the range of 200° C., or thereabout, above the critical temperature located at about 825° C., for a sufficiently long period of time to permit the reabsorption by the mix crystals of the metal of the greater part of the excess carbids of the eutectic, and any carbids which may have separated, ultimately heating the metal to a temperature suitable for the ductility required, then subjecting the metal to reduction, reheating the product to a temperature above the critical range located ordinarily at about 750° C.–825° C., continuing the heating at the selected maximum temperature until the carbids of the steel are taken into solution, and water-quenching.

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

WINFIELD S. POTTER.

Witnesses:
M. A. Bill,
Leon W. Rosenthal.

Correction in Letters Patent No. 1,278,207.

It is hereby certified that in Letters Patent No. 1,278,207, granted September 10, 1918, upon the application of Winfield S. Potter, of Pittsburgh, Pennsylvania, for an improvement in "Producing Wrought Shapes of Manganese Steel," an error appears in the printed specification requiring correction as follows: Page 1, line 22, for the word "above" read *about;* and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of October, A. D., 1918.

[SEAL.]

R. F. WHITEHEAD,

Acting Commissioner of Patents.

Cl. 148—12.