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R. W. HUNT.

PROCESS OF PERFECTING CAST STEEL INGOTS.

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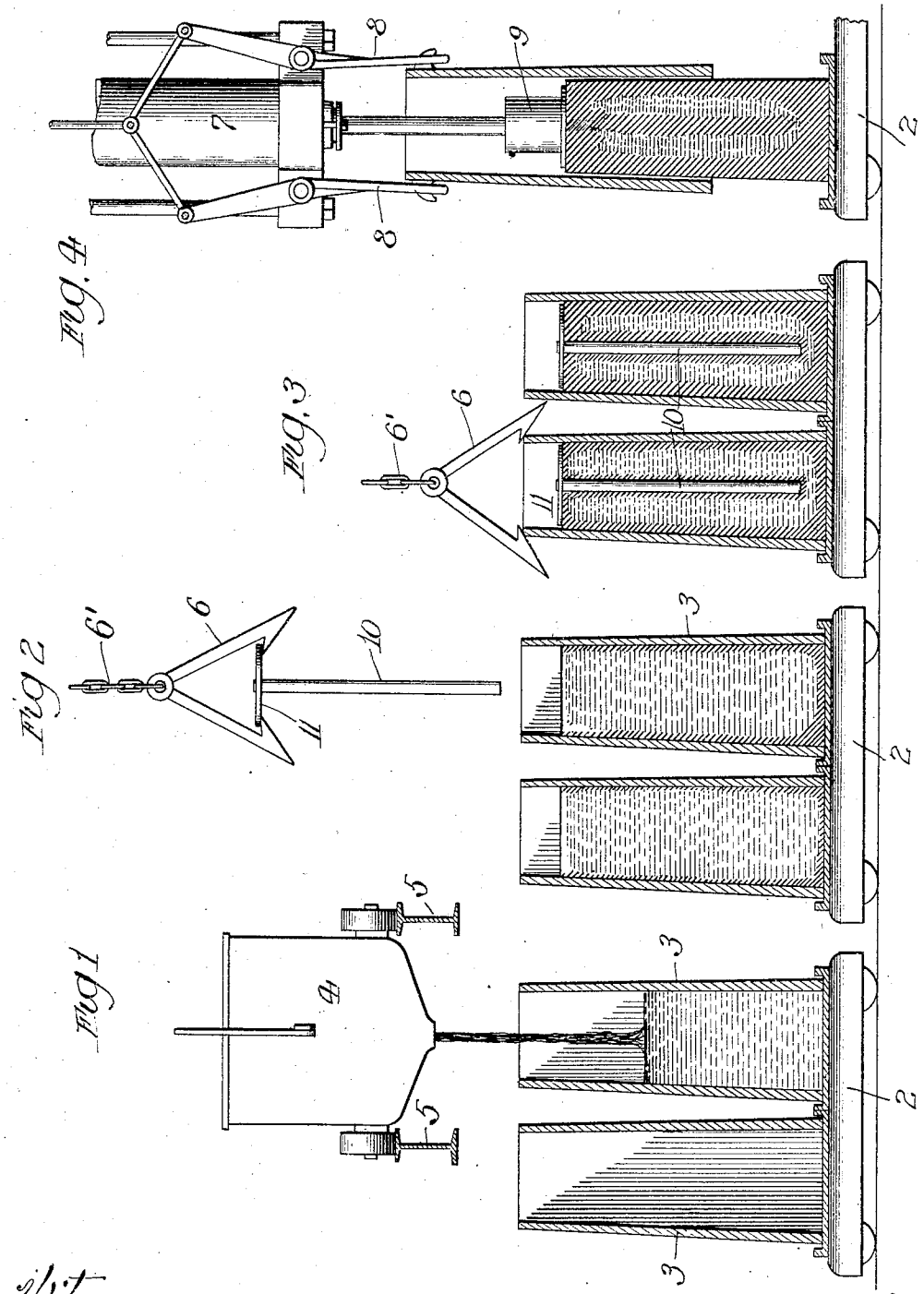

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UNITED STATES PATENT OFFICE.

ROBERT W. HUNT, OF CHICAGO, ILLINOIS.

PROCESS OF PERFECTING CAST-STEEL INGOTS.

SPECIFICATION forming part of Letters Patent No. 786,359, dated April 4, 1905.

Application filed May 20, 1903. Serial No. 158,041.

To all whom it may concern:

Be it known that I, ROBERT W. HUNT, of the city of Chicago, county of Cook, and State of Illinois, have invented a certain new, useful, and Improved Process of Perfecting Cast-Steel Ingots, of which the following is a specification.

My invention relates to improvements in the art of manufacturing cast-steel ingots, particularly those intended to be made into rails and beams. The process as commonly conducted in a rail or beam mill is as follows: The molten steel is taken from the converter and poured into the ingot-mold with the least possible delay. The filled mold then makes way for another and is allowed to stand until the ingot becomes sufficiently solid to retain its form, whereupon the mold is stripped from the ingot. Then the partially-cooled ingot is taken to the soaking-pit or reheating-furnace and is there heated until its temperature becomes uniform throughout. Upon the completion of this process the ingot is removed from the soaking-pit and is ready to be manufacted into rails. An ingot which is made and treated in this manner is apt to be piped—that is, to contain a large central cavity. By reason of the presence of impurities or metaloids upon the internal walls of a piped ingot said walls refuse to weld when the ingot is compressed or rolled, and rails made from such ingots are worthless and must be discarded. Not infrequently, however, they escape detection and being placed in use cause disastrous railroad wrecks. The present value of the manufactured product is such that the entire process of casting and rolling rail-steel ingots to be profitable must be conducted with celerity and with as little labor as possible. Although it is possible to produce sound ingots, the known precautions against extensive piping involve prohibitive outlays of time, labor, or material and are generally disregarded. Thus such measures as the slow pouring of ingots, the packing of the tops thereof, the spraying thereof, the subjection of the ingots to heavy internal and external pressure, the insertion, expansion, and welding of large masses of steel therein and therewith all require too much time, occasion too many delays, and are too expensive in labor and materials to admit of their use in a rail or beam mill.

The object of my invention is to improve the above-described process and its product in ways and by means that shall operate to improve the quality of steel ingots and which shall neither prolong the work of a steel-mill as usually performed nor materially add to the cost thereof.

The particular object of my invention is to provide a process of casting and perfecting steel ingots that shall operate to exclude the gases and metaloids from the axial or central portion of the ingot and cause them either to be retained substantially in their original states of occlusion and suspension or to accumulate in a wide shallow cavity in the extreme top of the ingot.

My novel process is coextensive with the common process, and consists in partially filling a mold with molten steel and through the medium of said mold immediately initiating the solidification of the external portions of the molten mass and simultaneously therewith by the introduction of a relatively small steel bar or rod initiating and forcing the solidification of the central or axial portion of the ingot—in other words, creating from and in the ingot mass an initially small, but increasing solid column of plastic or denser steel, thereby excluding from the central portion of the ingot the gases and metaloids that would otherwise tend to form an objectional pipe, permitting the ingot to cool until it becomes self-sustaining, then stripping the mold from the ingot, and then reheating the ingot to substantially equalize its temperature and consistency throughout, all preparatory to the working of the ingot.

A further and incidental step of my process consists in hastening the formation of the top crust of the ingot by placing a metal plate thereon to quickly inclose the molten mass and repress the liberation of the occluded gases.

Other novel features and characteristics of my invention will appear hereinafter.

My invention will be more readily understood by reference to the accompanying draw-

ings, forming a part of this specification, and in which—

Figure 1 illustrates the pouring of an ingot. Fig. 2 shows the means that I employ for initiating the solidification of the axial and upper portions of the ingot, said means being shown suspended above the mold in readiness to be lowered thereinto. Fig. 3 is a similar view showing the cooling devices in place within and upon the ingot, and Fig. 4 illustrates the mold-stripping machine.

As the soaking-pit or reheating-furnace used in my process is of well-known construction and operation, I have deemed it unnecessary to illustrate it in the drawings.

In all of the figures of the drawings the molds and their contents are shown in section for the better illustration of my invention.

In said drawings, 2 represents an ingot-stool, usually a car, upon the top of which a pair of ingot-molds 3 3 are placed. 4 represents a ladle that receives the steel from the converter and from which the ingot-molds are successively filled. 5 5 represent the parallel arms of the crane, which carries the ladle. 7 represents a stripping-machine for lifting the molds from the ingots, 8 8 being lifting-hooks and 9 the plunger of said machine. These devices, like the reheating-furnace referred to, are of common construction. The only unusual apparatus comprises the tongs 6, preferably adjacent to the pouring-station and movably suspended by a chain or cable 6′ for handling or manipulating the cooling or solidification starting devices which I use in my improved ingots and which are consumed in the process. The first of these devices is a small steel rod 10 and the second a metal plate 11 of about the size of the opening in the upper end of an ingot-mold. The rods or bars may be made from the cropped ends of steel billets or rails; but, as hereinafter more fully stated, the best results are secured by using bars of better quality than the ingot-steel. To insure their incorporation with the ingot masses, I may sometimes heat the bars before placing them in the ingot. The bar and the plate may be separate parts or may be rigidly connected. The office of the steel rod is to initiate and hasten the internal solidification of the ingot and improve the quality of the axial portion of the ingot, and the offices of the plate 11 are to hold the upper end of the rod centrally within the mold and to initiate and hasten the solidification of the top of the ingot. The ingot-molds herein shown are such as are usually employed in rail-mills. As shown, they are not completely filled with steel, and no provision is made for sprues or sinker-heads. The top of the ingot mass within the mold is therefore exposed, and the upper end of the mold is free to receive the plate 11.

In carrying out my process with the apparatus described a car or stool, with its mold, is placed beneath the ladle 4, and the mold is partially filled with molten steel, as indicated in Fig. 1, the filled mold immediately making way for another. The rapid evolution of gases from the freshly-poured steel and the violent ebullition of the steel in the mold subside soon after the mold is removed from beneath the ladle. The bottom and side walls of the ingot begin to form almost as soon as the metal is poured into the mold, and while this solidification is in progress and before a crust has formed on the top of the ingot the bar 10 is dropped or thrust into the mold. At substantially the same time the plate 11 settles upon the top of the ingot mass. The bar assumes a vertical position coincident or substantially coincident with the axis of the mold and contained ingot, the lower end of the rod usually resting in the plastic steel at the bottom of the mold, while the upper end is held in place by the plate 11. In addition to its chilling effect the metal plate 11 serves as a radiatory path for heat. It accelerates the formation of the top crust of the ingot, thereby more quickly inclosing the mass of molten metal and tending to sooner suppress the evolution or liberation of the occluded gases. As shown in the drawings, the rod or bar 10 is very small with relation to the ingot, displacing only an inconsiderable quantity of molten metal. Nevertheless, being cooler than the molten metal in contact with it, it serves to initiate the solidification of the molten steel at the axis of the ingot. Solidification having been thus initiated will progress steadily and will result in forming within the ingot a central body or column of denser or plastic steel. This column or body increases in diameter and strength as the metal parts with its heat, and inasmuch as it occupies the upper and central parts of the mass it obviously excludes therefrom both gases and metaloids, and therefore prevents the formation and development of an objectionable central pipe or cavity in the ingot. The gases and metaloids being excluded and their accumulation at the center of the ingot being prevented, it follows that the same are, in effect, held or distributed in the remote portions of the ingot mass and that the internal shrinkage-cavity, if any, will be confined to the extreme top of the ingot surrounding said column. The several figures of the drawings illustrate the formation of the pipe-preventing column and the progressive stages of ingot solidification. I permit the internal and external solidification—*i. e.*, cooling of the ingot—to continue until it becomes self-sustaining and then place the ingot beneath the stripping-machine and remove the mold. Immediately thereafter I place the ingot in the soaking-pit or reheating-furnace and there subject it to the usual heat to equalize its temperature and consistency throughout. The hastening of the formation of the top crust of the ingot for the

purpose of minimizing the evolution of gases and the creation of the central body or column of denser steel within the ingot for the purpose of preventing the development of a deep pipe or cavity are steps and results which distinctly differentiate my process from all others. The other steps—namely, the pouring of the ingot, the allowance of time for cooling, the stripping of the mold, and the reheating of the ingot—though necessary parts of my process, do not materially differ from the corresponding steps of common processes, and I have therefore deemed it unnecessary to describe such steps or their effects in detail.

It is not the purpose of this invention to form or provide a compound ingot. On the contrary, the resulting product is a sound simple ingot, the small steel rod or bar being fused, melted, or incorporated and losing its identity during the process.

To insure the incorporation of the column initiating or starting bar, it may be heated in a furnace before being placed in the filled mold—that is, the bar need not be cold—but I prefer that it shall always be a thousand or more degrees cooler than the molten steel to prevent its dissolution before the resulting column shall have served its purpose. To further improve the quality of the axial portion of the ingot, I prefer to employ in each ingot a bar that is of better quality or grade than rail-steel—such, for example, as open-hearth steel—which becoming incorporated with the mass improves the physical and chemical composition thereof, particularly that of the central portion. Thus the introduction of the bar provides a convenient means of diluting the impurities of the ingot-steel, and my ingots are distinguishable from others by reason of their better centers.

The smooth flat top of my ingot also distinguishes it from others. The primary advantage of my process is the great saving of material which is effected thereby, the wasting of material and finished rails being almost wholly avoided. It will be obvious that my process may be substituted for the usual process without prolonging the period required for the production of an ingot. In fact, the effect of my process is to shorten said period. The cost of the small metal rods and plates that are consumed is so slight that it may be said that my novel process adds nothing to the usual expense connected with the production of an ingot. As my invention is susceptible of various modifications and as it is capable of general employment, I do not confine or limit my invention to the specific steps, materials, apparatus, or uses herein shown and described.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. The herein-described improvement in the art of casting and perfecting simple ingots for rail and beam mills that consists in first casting molten metal in a metal ingot mold or chill and through the medium of said mold immediately initiating the solidification of the external portions of the ingot mass, and simultaneously therewith, by the introduction of a relatively small bar or rod of like metal, initiating and forcing the solidification of the axial portion of the ingot mass, thereby creating from and in the ingot mass an initially small but increasing solid column of denser metal, which latter occupies the center of the ingot and prevents the development of a central pipe therein, permitting the ingot to cool in the mold until it becomes self-sustaining, then stripping the mold from the ingot and then heating the ingot, substantially as and for the purpose specified.

2. The herein-described improvement in the art of casting and perfecting simple steel ingots that consists in, first, casting molten metal in a metal ingot-mold and through the medium of said mold initiating the solidification of the external portions of the ingot mass, then incorporating a small steel rod, with and in the axial portion of the mass, said rod first effecting the formation of a central column of denser steel within said mass, which column prevents the development therein of a central pipe or cavity, the ingot being finally removed from its mold and reheated, substantially as and for the purpose specified.

3. The herein-described improvement in the art of casting and perfecting simple steel ingots that consists in casting the molten steel in a metal ingot mold or chill and incorporating with the axial portion of the ingot mass a quantity of better steel, the latter being supplied in the form of a steel rod, which is placed axially within the mass and which effects the formation of a pipe-excluding column from and within said mass, the ingot being finally removed from its mold and reheated, substantially as described.

4. The herein-described improvement in the art of casting and perfecting steel ingots that consists in first casting the molten steel in an ingot-mold, then placing axially within the molten mass a bar of steel and also placing a metal plate upon the top of said mass, then permitting the ingot to cool partially, then removing the ingot from the mold and then reheating the ingot, thereby preventing the formation of a central pipe or cavity in the ingot and improving the quality of the axial portion of the ingot, substantially as and for the purpose specified.

5. The herein-described improvement in the art of casting and perfecting steel ingots that consists in partially filling an ingot-mold with molten steel, then placing axially within the molten mass a small steel bar or rod and thereby forming within the ingot mass a central column of plastic steel of sufficient size to compensate for and prevent the formation of a central pipe or cavity in the ingot, the

ingot being removed from its mold and the identity of the column-initiating bar or rod within the ingot being finally destroyed, substantially as and for the purpose specified.

6. The herein-described improvement in the art of casting and perfecting rail-steel ingots and the like that consists in partially filling an ingot-mold with molten steel, then hastening the formation of the top crust of the ingot, and hastening the solidification of the axial portion of the ingot and thereby forming from and within the ingot mass a central column of denser steel substantially coextensive with and preventing the formation of the usual central pipe or cavity, and then stripping the ingot and reheating the same, substantially as described.

7. The herein-described improvement in the art of casting and perfecting rail-steel ingots and the like that consists in partially filling an ingot-mold with molten steel and through the medium of said mold initiating the solidification of the external portions of the ingot mass, then hastening the solidification of the axial portion of the ingot and thereby forming from and within the ingot mass a central column of denser steel substantially coextensive with and preventing the formation of the usual central pipe or cavity, then stripping the ingot and finally reheating the same, substantially as described.

8. The herein-described improvement in the art of casting and perfecting simple steel ingots, that consists in casting the molten metal in a metal ingot mold or chill, and then hastening the solidification of the axial portion of the ingot mass by placing therein a slender steel rod and thereby forming from and within the ingot mass a central column of denser steel substantially coextensive with and preventing the formation of the usual central pipe or cavity, and then stripping the ingot and reheating the same, substantially as described.

In testimony whereof I have hereunto set my hand, this 11th day of May, 1903, at Chicago, Illinois, in the presence of two witnesses.

ROBERT W. HUNT.

Witnesses:
C. E. HAWLEY,
JOHN H. GARNSEY.