UNITED STATES PATENT OFFICE.

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TREATING IRON AND STEEL INGOTS.

1,150,401. Specification of Letters Patent. Patented Aug. 17, 1915.

No Drawing. Application filed May 5, 1915. Serial No. 25,994.

To all whom it may concern:

Be it known that I, BENJAMIN TALBOT, a subject of His Majesty the King of Great Britain, and a resident of Middlesbrough, in the county of York, England, have invented a certain new and useful Improvement in Treating Iron and Steel Ingots, of which the following is a specification.

For the purpose of getting a solid ingot, and to reduce as much as possible the loss entailed by the necessity of cutting off the upper part of the ingot in which there is what is known as piping and blow-holes, it has heretofore been proposed to add to the metal de-oxidizers, such as aluminium or ferro-silicon while the steel is in the liquid state and before or while it is cast into the mold. When such de-oxidizers are used, blow holes are largely avoided, but the piping or central cavity tends to increase.

To get rid of the central cavity in the body of the ingot, it is not unusual to have the top of the mold formed of fire-clay, silica, graphite, or other refractory material which is a slower conductor of heat than the rest of the metal mold. In such cases the heat at the top of the ingot is not so rapidly conducted away and the interior of the top of the ingot remains liquid for a longer period and flows down and fills the bottom of the cavity.

Heretofore it has been customary when using a composite mold, as above, to permit the center of the ingot to become solid and to cut off the top portion which has been in contact with the refractory lining before further treatment of the remainder of the ingot.

In my prior specifications, Nos. 1,055,831, 1,055,832, and 1,055,833, I have set out not only an improved method of obtaining comparatively solid ingots but also of producing finished shapes having certain characteristics. In such prior method the desired end was attained by squeezing or compressing the ingot either throughout its entire length or at all events at its upper end, while the center was still fluid, but in order to enable this to be satisfactorily done it is generally necessary to remove the ingot from the mold and place it in a soaking pit or re-heating furnace until the skin of the upper portion is sufficiently soft to be compressed without cracking, and this compressing action has been found not only to largely close the cavity or piping but also to diffuse the segregation of the impurities which usually collect in excess around or near the base of the pipe formation.

According to this invention a composite mold as before described is employed and thus some of the pipe or cavity is filled, but instead of leaving the ingot until solid or removing it to a soaking pit or heating furnace, the mold is stripped while the upper outer vertical faces of the ingot still remain at a sufficiently high temperature to permit of the upper part of the ingot being squeezed or reduced in area so as to almost completely close the cavity without the necessity of the ingot being first placed in a soaking pit or reheating furnace.

In practice, with an ingot of approximately about four tons weight when cast with its larger end at its base, and which ingot may be about 24″ in cross section at the base, and 6 ft. long, the refractory lining of the upper portion of the metal mold into which the ingot is cast, may extend down about 18″ or 24″, and after the steel is poured into the mold, it will be possible to wait as long as from 60 to 90 minutes or more before stripping the mold from the ingot, and to still find the center of the upper portion of the ingot in a liquid or semi-liquid condition, and the outer surface of this portion, which has been in contact with the non-metallic refractory lining sufficiently hot (say at least, approximately 100 degrees C. hotter than the lower portion) to be directly reduced in cross section without pre-heating, either by rolling or pressing and by so doing to reduce or eliminate the cavity which ordinarily forms in the upper portion of the ingot, and at the same time drive the excess of impurities (such as sulfur and phosphorus) and carbon from the center of the mass and distribute them in the outer areas of the upper portion of the ingot in a more desirable manner.

When it is desired to strip in less than 60 minutes from the time the steel is poured, say, for example, 45 minutes, it will be found that the temperature of the vertical sides of the upper portion of the ingot, which has been in contact with the refractory lining, will be approximately 200 degrees C. hotter than the lower portion, which has been in contact with the metallic part of the mold, when working on the same size of ingot. After reducing the area of the upper hotter portion at least of the ingot to the de-

sired extent, it is charged into a heating furnace, to obtain the necessary increased heat on the surface of the lower portion of the ingot, which has been in contact with the metallic part of the mold. When sufficiently heated throughout the ingot can be rolled or forged into any desired shape or section.

In those works where it is desired to heat the ingot, first, while the center is still liquid, semi-liquid, or plastic in its upper part, before reducing the area of the upper portion, the ingot after removal from the composite mold is charged into a soaking pit or heating furnace, the surface and interior of the upper portion of the ingot remaining considerably hotter than the lower portion, say not less than approximately 100 degrees C. higher when charged into the heating furnace, and after withdrawal from the furnace and before the center of this upper hotter portion has entirely solidified, the ingot is rolled or pressed down whereby the cavity that would form if it were left to become completely solid before reducing its area, is closed up or reduced, and at the same time there will be obtained a better distribution of the impurities which ordinarily form in excess in the center of the ingot around the base of the cavity. In this case the whole ingot may be reduced in area instead of the top portion only, and the bloom or other shape may be obtained, if desired, without again re-heating. Where it is desired to strip the mold from the ingot by means of the usual overhead stripper, it is preferred to have the mold with its larger area at its base, and have the refractory lining placed inside the upper portion of the mold, but in those cases where it is desired to cast the ingot with the smaller area at its base, then the refractory lining may be in a separate box from the iron mold, and placed upon the top of same.

The proper time of stripping the mold from the ingot will vary with the size of same, with the grade of carbon steel, or, the very pure form of ingot iron which contains approximately 99.9 per cent. of pure iron which is being treated.

What I claim is:—

1. The method which comprises pouring molten iron or steel into a mold, effecting the unequal cooling of the metal in the mold, so that the interior of the top of the ingot formed shall remain comparatively fluid when the lower part has solidified sufficiently for stripping, removing the mold from the ingot, and pressing the top of the ingot while its interior remains sufficiently fluid to permit the segregate to be diffused and the pipe reduced thereby.

2. The method which comprises pouring molten iron or steel into a composite mold, retarding the cooling of the metal in the top of the mold so that the top of the ingot formed shall remain comparatively soft with a liquid interior when the lower part has solidified enough to permit stripping, removing the mold from the ingot, and squeezing the ingot while the interior of its top remains sufficiently fluid to permit the reduction of the pipe thereby.

3. The method which comprises pouring molten iron or steel into a composite mold, retarding the cooling of the metal in the top of the mold so that the exterior temperature of the vertical faces of the top of the ingot which have been in contact with the non-metallic part of the mold, shall be approximately not less than 100 degrees C. higher than that of the lower portion when stripped from the mold, separating the mold and ingot, and squeezing the ingot while the interior of the top remains comparatively fluid with relation to the lower metal.

4. The method which comprises pouring molten iron or steel into a composite mold mechanically retarding the cooling of the metal in the top of the mold, stripping the ingot, charging the ingot into a heating furnace when the surface heat of the top portion shall be approximately not less than 100 degrees C. hotter than the lower portion, heating the stripped ingot so as to retain a more fluid or semi-fluid condition of the metal in the top than in the lower parts thereof, and squeezing the ingot while the interior of the top remains sufficiently fluid or plastic to effect the diffusion of the segregate, the reduction of the pipe, and the consolidation of the metal so that the reduced pipe is transferred toward the top surface of the ingot.

In testimony whereof I have hereunto set my hand.

BENJAMIN TALBOT.

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