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INGOT MOLD AND STOOL ASSEMBLY

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Fig. 1.

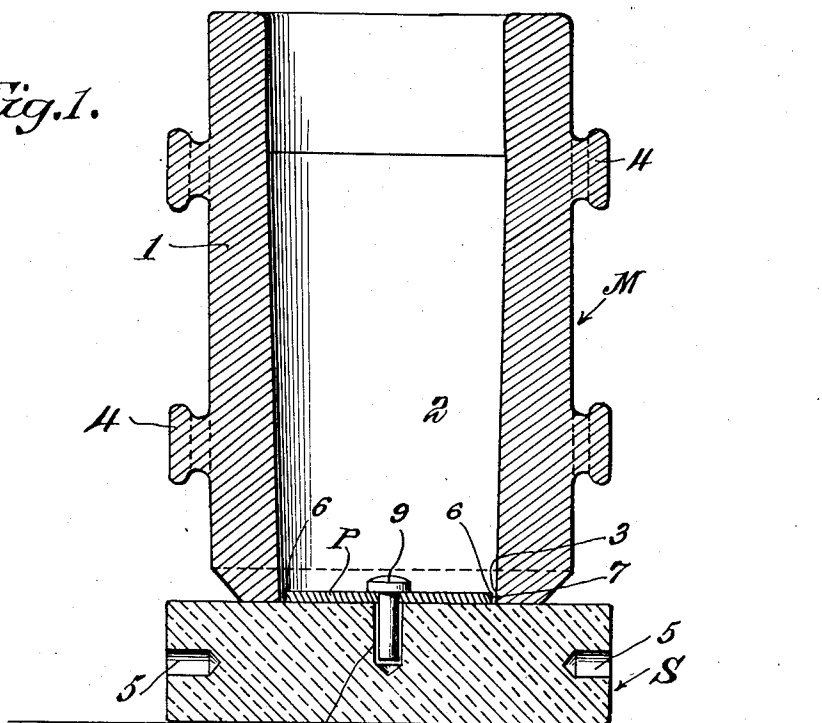


Fig. 2.

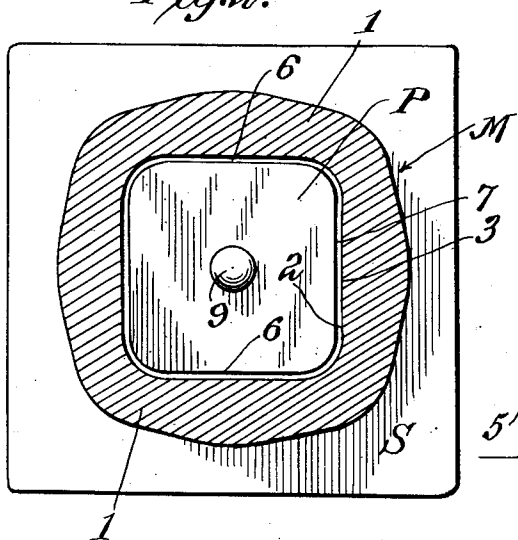
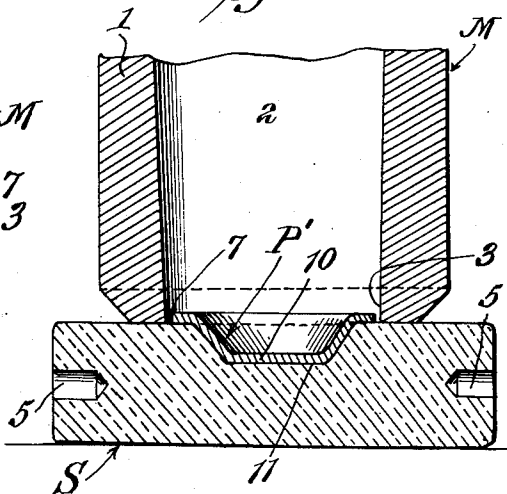


Fig. 3.



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INGOT MOLD AND STOOL ASSEMBLY

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6 Claims. (Cl. 22—139)

This invention relates to ingot mold and stool assemblies and more particularly to such assemblies in which the mold proper is of the class known in the art as the "big-end-up" mold, open at top and bottom.

The soundest, best quality commercial steel products are made from fully deoxidized or "killed" steel ingots cast in big-end-up molds. One important factor in obtaining the best results in big-end-up "killed" steel ingot practice is the extracting of the heat of the ingot metal more rapidly from the bottom portion of the ingot than from the top part thereof.

An object of my invention is to provide a big-end-up mold and stool assembly that particularly favors the extraction of heat from the extreme bottom portion of an ingot cast within the mold so as to produce a high differential cooling rate between the bottom surface and the vertical or side surfaces of the ingot, and which consequently produces an improved ingot and ultimate product.

A further object is to provide an assembly of the character referred to embodying an arrangement for preventing the welding or sticking of the stool to the ingot metal and for preventing leakage or "runouts" between the bottom of the mold and the stool upon which it rests. Other objects will be apparent from a reading of the following description, the appended claims, and the accompanying drawing, in which:

Figure 1 is a central, vertical sectional view of a mold and stool assembly embodying the invention;

Figure 2 is a horizontal section in a plane indicated by the line 2—2 of Figure 1; and

Figure 3 is a central vertical sectional view of a modified assembly, only the lower part of the mold being shown.

In accordance with my invention, I preferably employ a big-end-up mold having a large bottom opening, one form of mold adapted for use in assemblies embodying the invention being shown at M in Figures 1 and 2 as resting directly upon and being supported by a stool S. The mold M comprises generally vertical walls 1 defining a mold matrix 2 open at its top and bottom ends, the bottom opening 3 being of substantial extent. As shown, the mold is provided with lifting lugs 4 of a known kind, and the stool S is formed with recesses 5 adapted to receive pins which may be engaged by lifting cables, chains, or the like.

As previously stated, one object of the invention is to provide a mold and stool assembly which will cause the metal of the ingot cast in the mold

to cool and solidify much more rapidly at its bottom than at its top. To this end I employ a very massive stool, i. e., massive or heavy as compared to the mold proper, the stool preferably having a mass equal to at least 15% the mass of the mold proper, and the stool mass may even be 100% or more the mass of the mold proper, the specific mass ratio required for optimum cooling conditions depending upon such factors as the design of the mold, the height of the mold relative to its cross-sectional dimensions, and the ratio of the coefficient of heat conductivity of the stool material to that of the mold material. For example, if cast iron is the material employed in the construction of both the mold and the stool, it is desirable that the ratio of the stool mass to mold mass be relatively high, e. g., of the order of 1. or higher.

It is possible to reduce this mass ratio considerably by constructing the stool of material having a higher coefficient of heat conductivity than the material of the mold walls. I prefer to construct the stool of copper or of an alloy of high copper content, since, as is well known, copper has a coefficient of heat conductivity about eight times that of cast iron, of which ingot molds almost universally are made. In the preferred embodiments shown in the drawing, the stool is of copper and the mold proper of cast iron. The commercial production of thousands of tons of forging and tool steel ingots in mold and stool assemblies of this kind has resulted in much improved crystalline structure in the ingot metal.

In adapting the invention for commercial use it became necessary to provide means for preventing the copper stool from being eroded or cut away by the stream of molten metal entering the mold. Copper has a melting point about 600° F. lower than that of most carbon steels so that the stream of hot steel entering the mold under high velocity pressure has a strong tendency to melt and erode or cut away the copper stool. Copper is expensive, and furthermore, it is undesirable to permit copper to be washed away from the stool and incorporated in the ingot metal, thereby disturbing the steel analysis.

To prevent this undesired cutting away of the stool I provide a covering or protective plate P which rests upon the stool and extends up into the mold, the plate being so positioned as to receive the impact of the entering stream of molten steel. It is important that the plate P, which is constructed of material such as ferrous material more resistant to the cutting action of liquid steel than the copper stool, be as thin as com-

patible with its necessary function of protecting the copper stool. By making the plate as thin as permitted by such considerations, it will have only a minimum retarding effect upon the abstraction of heat from the ingot by the copper stool. The plate may be as thin as one-eighth inch, when used with a relatively small assembly, and should not exceed one inch in thickness, even with large assemblies. Preferably the weight of the plate should be less than about 1% of the weight of the stool. I have found that by using thin plates of ferrous material the copper stool is given full protection without interfering to any noticeable extent with the rate of heat absorption from the bottom of the ingot. The plates preferably are so thin that they actually are melted, at least partially, by the stream of molten steel so that they become welded to the bottom of the ingot.

20 A further factor requiring consideration and treatment in order to adapt the assembly for commercial use, is that of maintaining the joint between the mold and stool sealed, i. e., safe against leakage or run outs. I have found that assemblies in which the protection plate overlies the entire stool, or at least is large enough to extend under the mold walls, (an arrangement not shown in the drawing) are unsatisfactory because of the leakage of metal between the bottom of the mold and the protecting plate. Even if the leakage is only slight, resulting merely in the formation of a fin between the mold and protecting plate, serious complications result. Such a fin, lying under the bottom of the mold walls, interferes with the stripping of the ingot relatively upward through the mold. A feature of my present invention consists in the provision of a novel arrangement of stool, protecting plate, and mold which effectively prevents the formation of even a small fin under the mold walls. To this end the protecting plate P is made of such size and shape as to extend up into the mold matrix with its marginal edge 6 in close proximity to but slightly spaced from the inner lower portions of the mold walls, thereby providing a narrow channel 7, the bottom of which is constituted by a substantially annular section of the copper stool. Molten steel which enters the channel 7 will contact the copper stool and will chill very rapidly, rendering it practically impossible for any steel to leak under the bottom of the mold walls. The volume of steel which can enter the channel and directly contact the stool is so small that the latter can not possibly be damaged. Moreover, the steel entering the channel is relatively quiet as compared to the high velocity stream which impinges upon the plate substantially at its center.

Since it is important that the channel 7 be reasonably uniform in cross section, I prefer to provide means for centering the plate P on the stool. In the form shown, the stool is formed with a recess 8 which receives a centering pin 9 integral with or connected to the stool.

65 Figure 3 shows a modified assembly which may be used when it is desired that the ingot have a generally tapered, or necked-in lower end. In this form the parts are the same as those shown in Figures 1 and 2 with the exception that the plate P' is dishd as at 10 so as to fit into a depression 11 in the stool.

It will be understood that while the mold and stool assemblies shown and described embody the invention in practical and the at present preferred forms, changes may be made without de-

parting from the invention as defined in the claims.

I claim:

1. A mold and stool assembly comprising metallic walls defining a vertically extending matrix having a bottom opening, a massive metallic stool upon which the mold is adapted to rest, the mold walls engaging the stool immediately adjacent the mold bottom opening, and a relatively thin ferrous plate adapted to rest in close contact with the upper face of the stool and extending up into the mold bottom opening, said plate being of slightly less cross sectional area than the cross sectional area of the smallest part of the mold bottom opening into which it extends, the periphery of said plate being spaced inwardly from the innermost mutually contacting parts of the mold and stool.

2. A mold and stool assembly comprising ferrous walls defining a vertically extending mold matrix having a bottom opening, a massive copper stool upon which the mold is positioned, the mold walls engaging the stool immediately adjacent the mold bottom opening, and a ferrous plate adapted to rest upon and in close contact with the upper face of the stool and extending up into the mold bottom opening, said plate being of slightly less cross sectional area than the cross sectional area of the smallest part of the mold bottom opening into which it extends, the periphery of said plate being spaced inwardly from the innermost mutually contacting parts of the mold and stool.

3. A mold and stool assembly comprising walls constructed of ferrous material and defining a vertically extending mold matrix having a bottom opening, a stool upon which the mold is adapted to rest composed of copper material, the mold walls engaging the stool immediately adjacent the mold bottom opening, and an impact plate composed of ferrous material seated upon and in close contact with the upper face of the stool, said ferrous plate being of slightly less cross sectional area than the cross sectional area of the smallest part of the mold bottom and extending from the lower face of said mold bottom opening upward into said opening, the periphery of said plate being spaced inwardly from the innermost mutually contacting parts of the mold and stool, the weight of said stool being equal to at least 15% or more of the total weight of the walls of the ingot mold, and the weight of said plate being less than 1% of the weight of said stool.

4. An ingot mold and stool assembly comprising walls defining a vertically extending mold matrix open at its top and bottom ends, a massive stool supporting said mold and being made of material having a coefficient of heat conductivity several times that of the mold wall material, and a thin metallic plate seated upon said stool and extending upwardly into said mold matrix, said plate being constructed of material more resistant to the cutting action of liquid steel than said stool, and the size and shape of said plate being such that its marginal edges extend around within in close proximity to but slightly spaced inwardly from the innermost faces of the mold walls at the bottom of the mold, thereby providing a narrow marginal sealing channel between the plate and mold walls, the bottom of said channel comprising a portion of the upper face of the stool.

5. An ingot mold and stool assembly comprising walls defining a vertically extending mold

matrix, open at its top and bottom ends, a massive stool supporting said mold and being made of material having a coefficient of heat conductivity several times that of the mold wall material, a thin metallic plate seated upon said stool and extending upwardly into said mold matrix, said plate being constructed of material more resistant to the cutting action of liquid steel than said stool, and the size and shape of said plate being such that its marginal edges extend around within in close proximity to but slightly spaced inwardly from the innermost faces of the mold walls adjacent the point between the mold and the stool, thereby providing a narrow marginal sealing channel between the plate and mold walls, the bottom of said channel comprising a portion of the upper face of the stool, and means for centering said plate on said stool.

6. An ingot mold and stool assembly comprising walls defining a vertically extending mold matrix open at its top and bottom ends, a mas-

sive stool supporting said mold and being made of material having a coefficient of heat conductivity several times that of the mold wall material, and a thin metallic plate seated upon said stool and extending upwardly into said mold matrix, said plate being constructed of material more resistant to the cutting action of liquid steel than said stool, and the size and shape of said plate being such that its marginal edges extend around within in close proximity to but slightly spaced inwardly from the inner faces of the mold walls adjacent the joint between the mold and the stool, thereby providing a narrow marginal sealing channel between the plate and mold walls, the bottom of said channel comprising a portion of the upper face of the stool, said stool being formed with a depression having upwardly and outwardly tapered side walls and said thin plate being dished to conform to the shape of said depression and to fit snugly therein.

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