

Nov. 7, 1944.

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2,362,097

INGOT CASTING

Filed Sept. 28, 1943

2 Sheets-Sheet 1

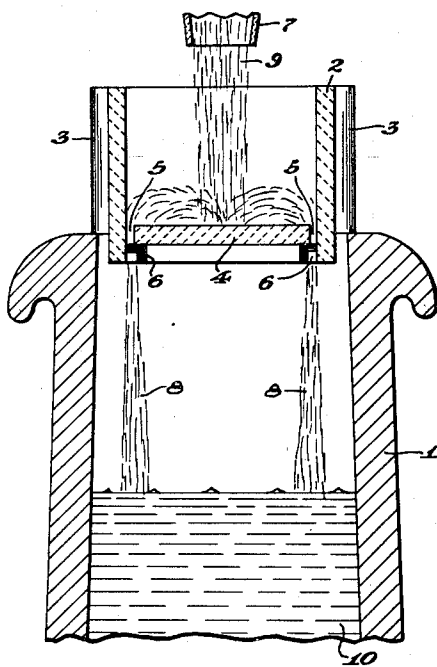


Fig. 1.

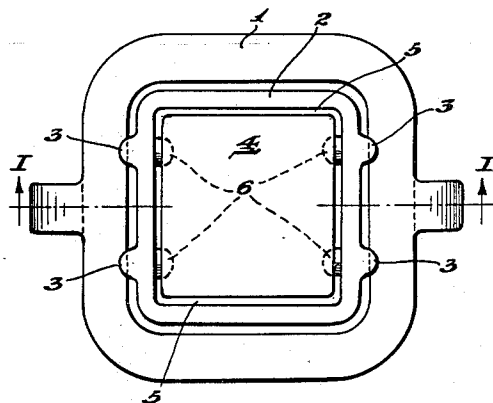


Fig. 2.

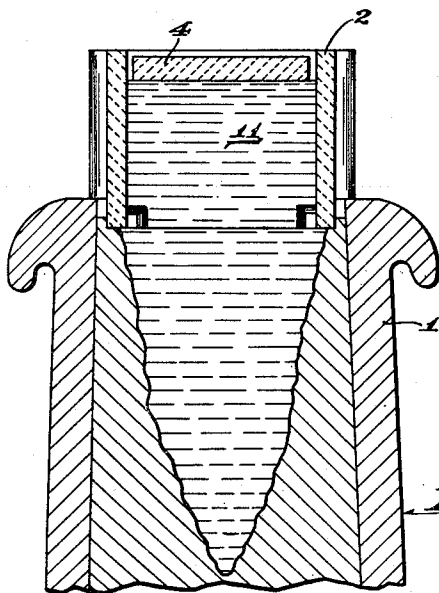


Fig. 3.

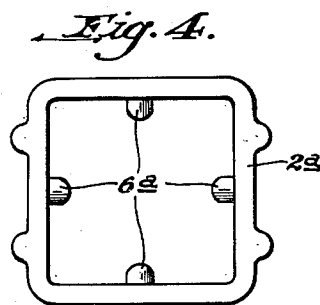


Fig. 4.

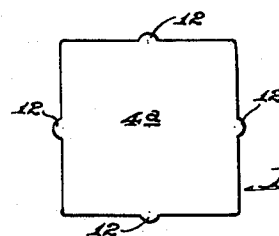


Fig. 5.

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2 Sheets-Sheet 2

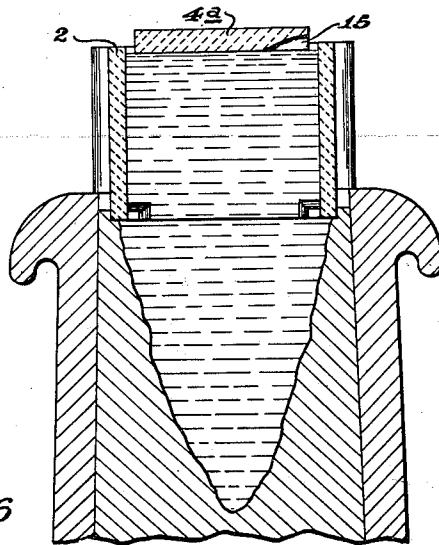


Fig. 6

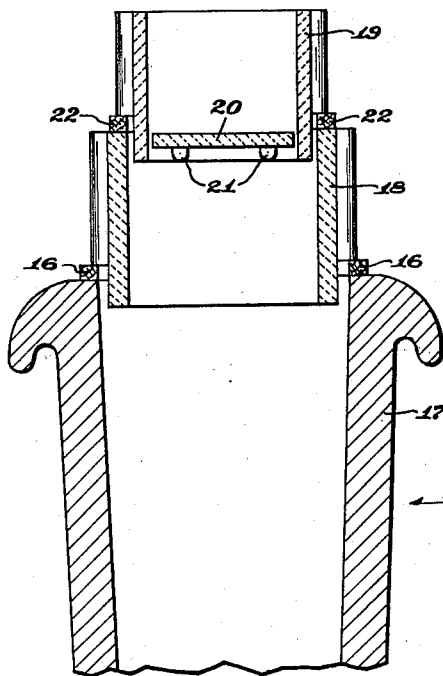


Fig. 7.

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UNITED STATES PATENT OFFICE

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INGOT CASTING

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7 Claims. (Cl. 22—147)

This invention relates to the casting of metallic ingots.

The invention is applicable particularly to the casting of ingots of iron and steel, for which reason it will be described with particular reference to steel casting practice by way of illustration, but not of limitation. The common practice in the casting of such ingots is to teem the molds from a ladle which is usually of large capacity and from which the molten metal is discharged through a relatively large nozzle so that a relatively large stream of molten steel enters the mold under a considerable head. This is disadvantageous for various reasons. Thus, the relatively great head of the metal causes the stools to be cut out rather rapidly and it produces considerable splashing which may form a scabby surface and thus result in defects in the surface of products wrought from the ingot or necessitate chipping with added expense. Particularly, however, the metal in the mold is churned vigorously and deeply by the entering stream so that slag and other non-metallic material together with gases released from the metal are forced throughout the body of the metal within the mold. Such materials may not have sufficient buoyancy to rise to the surface so that undesirable non-metallic matter and blow holes will be present in the ingot.

Another difficulty encountered in ordinary casting practice is that of pipe formation. To avoid this it is customary to provide the mold with a hot top, or feeder, which in any of its conventional forms is a tubular refractory member which constitutes an extension of the mold that acts as a reservoir for a body of the molten metal to feed the ingot as it freezes and thus to avoid piping by filling the axial shrinkage cavity. Such hot tops do not, however, avoid the foregoing disadvantages of pouring practice because the metal is teemed directly from the nozzle through the hot top into the mold.

In my Patent No. 1,399,798, granted December 13, 1921, I disclosed a method and means whose object was to reduce the foregoing difficulties and disadvantages. In accordance with that invention, a hot top, or feeder, member was provided at its lower end with inwardly projecting flanges which acted as a continuous seat for a refractory float. Either the float or the flange was perforated. The underlying concept was that by breaking up the nozzle stream into a plurality of small streams the metal would enter the mold under a relatively slight head and would not cut out the stool, splash objectionably, or

penetrate the cast metal deeply, thus permitting gases to escape freely and slag or the like to collect at the surface rather than being churned throughout the metal. Furthermore, it was intended that the float member should rise within the hot top as it was filled.

Experience has shown the ability of the hot top of that patent to achieve its intended results with some classes of steels or under some conditions, but that it was open to serious disadvantages and drawbacks. One of the most serious of those was due to the fact that the float seated closely against the supporting flange of the hot top. As a result, there was a tendency, particularly with certain classes of steels, such as low silicon steels, for the float to be frozen into place in the bottom of the hot top due to the fact that the metal could not drain freely between the side of the float and the hot top. In fact, drainage around the side of the float was not contemplated. This condition was aggravated where the metal teemed was on the low side of the pouring temperature range. Also, as the metal ran through the holes in the float member, it apparently created a downwardly acting suction which tended to hold the float member in place. Even though gas escaped freely and slag or the like rose to the metal surface, this tendency for the float to stay or freeze in the bottom of the hot top was objectionable because the hot top and float would break off during and interfere with rolling, and this was aggravated where the perforations were in the shoulder because it then had to be of considerable width. The small clearance between the float and the hot top walls or its seat prevented successful dislodging of the float by means of a bar or lever. Another disadvantage was that if the ladle was not spotted accurately the stream from the nozzle would tend to pass directly through one of the holes through the plate or lug so that the metal would enter the mold under the greater part of its normal head pressure, thus partially defeating the aim of the invention. For these and related reasons the hot top of that patent did not satisfactorily achieve its objects under the conditions which prevail in ordinary steel mills practice and therefore it was not adopted commercially.

It is among the objects of this invention to provide ingot casting means which avoids or reduces substantially the troubles and disadvantages described above.

A particular object is to provide an ingot hot top, or hot top, and the combination of an ingot

mold with a hot top, which satisfactorily breaks up the stream of metal entering the mold in such manner as to permit escape of gas from the metal before it joins the main body in the mold and to avoid strong agitation of the body of metal within the mold so that slag and the like is not entrapped within the body of the metal but rises freely to the surface, and pipe and blow hole formation together with rapid cutting out of the stool and production of scabby or cracked surface are reduced or avoided.

Yet another object is to provide an ingot hot top having a float member which cooperates to break up the ladle stream for attainment of the foregoing objects and which does not have the tendency to be frozen in place which characterized former feeders, or hot tops, provided with float members.

Other objects will be understood from the following description.

The invention may be described in connection with the accompanying drawings in which Fig. 1 is a vertical sectional view, taken on the line I—I, Fig. 2, showing the preferred embodiment of the invention applied to a small-end-up mold; Fig. 2 a plan view of the mold and feeder shown in Fig. 1; Fig. 3 a view similar to Fig. 1 showing the mold and hot top filled; Fig. 4 a plan view of another form of the tubular feeder member or hot top shown in Figs. 1 to 3; Fig. 5 a plan view of a modified form of the float member; Fig. 6 a view similar to Fig. 3 showing another form of float member; and Fig. 7 a view similar to Fig. 1 showing another mode of using the hot tops provided by the invention.

The present invention is predicated upon my discovery that the troubles described above can be repressed or overcome by the use of a hot top and a float member which are so constructed and arranged that the metal poured from the ladle passes into the mold around the sides of the float plate and drains freely between the plate and the supporting means. To this end the float plate is of such size as to provide substantial clearance between its edges and the hot top walls and it is supported by fingers or lugs formed interiorly of opposed walls of the hot top at or adjacent its lower end, whereby the metal can flow into the mold in relatively thin layers through the spaces between the float edges and the mold walls and between the supporting fingers.

Having reference now to the drawings, Fig. 1 shows a feeder in accordance with the invention associated with a small-end-up mold 1. The feeder comprises a tubular hot top member 2, made from fire clay or other refractory material, which may take any of a variety of forms and be supported on or by the mold in a variety of ways known in the art. Preferably, however, the lower end of the hot top is of such size as to enter the mold opening, and it is provided on at least two of its opposed walls with exterior ribs 3 which, as seen particularly in Fig. 1, act to support the hot top, i. e., the lower ends of ribs 3 rest upon the top of the mold and support the hot top properly positioned with respect to the mold opening.

In accordance with the present invention, and as indicated above, the float plate and hot top are so constructed relative to one another that metal poured into the hot top enters the mold by flowing around the edges of a float plate 4 which, as shown in Figs. 1 and 2, is of such size as to provide clearance spaces 5 of substantial width between its edges and the hot top walls. In the embodiment shown plate 4 is supported in the mold

by pairs of spaced fingers 6 which project inwardly from two opposed sides of the hot top. Thus, metal poured into the hot top flows over plate 4 and passes into clearance spaces 5 to fall in relatively thin sheets into the mold.

In the use of the embodiment shown in Figs. 1 to 3, the hot top with float plate 4 is supported on mold 1 in the manner shown in Fig. 1. Metal is then teemed into the hot top from the nozzle 7 of a ladle, not shown. The large stream under its normal head strikes plate 4 and flows outwardly thereover to enter the clearance spaces 5 between the edges of the plate and the walls of the hot top, whence it drains in relatively thin sheets 8 into the mold. A primary action is that the breaking up of the main stream 9 of the metal by plate 4 into a relatively thin layer which moves over the plate permits at least some portion of gas carried by the metal to escape before the metal enters the mold. This action is further enhanced by the passage of the metal from the hot top in thin sheets, which permits a more ready escape of gas than is possible from the larger stream 9. The small streams 8 do not churn up the body of metal 10 within the mold so that there is little tendency for gas bubbles to be stirred into the metal as it rises within the mold. Thus, the hot top acts to reduce or eliminate blow hole formation both by freeing much of the gas carried by the metal before it reaches the main body in the mold, and also by reducing or eliminating churning of the main body.

Furthermore, streams 8 drain into the mold under a pressure head that is substantially less than the head of stream 9 from ladle 7. Thus, there is reduced agitation of the body 10 of molten metal within the mold as compared with the stirring which results as the main stream 9 enters the mold directly. For the same reason the rate of cutting out of the stool is reduced substantially, and splashing of such intensity as to produce scabby surface is avoided and slag or other non-metallic material carried by the metal in the ladle has full opportunity to rise to the surface of the metal within the mold. These factors cooperate to improve the ingot quality.

The ingot is teemed until the lower end of the hot top member 2 is immersed within the surface of the body of metal 10 within the mold. When the metal between the hot top and the mold wall has frozen further metal is poured into the hot top to fill it and provide a reservoir 11 (Fig. 3) for feeding the ingot as solidification progresses, to reduce or eliminate piping.

A major advantage of the present invention is that the tendency of the float member to freeze to the bottom of the hot top that has been encountered in prior art structures is overcome. This action may be improved further by rounding the upper surfaces of fingers 6 so that they make substantially point contact with the under surface of plate 4.

A further advantage is that by reducing the pressure head of the metal entering the ingot, as compared with ordinary hot top practice, the incidence of sticker ingots is reduced. Likewise, the surface quality of the ingots is improved which reduces the amount of conditioning subsequently necessary. These factors combine to increase output, which is particularly important at the present time.

Various other advantages are also conferred. Thus, by using an imperforate plate spotting of the ladle will not affect the results, contrary to what was encountered with the hot top of my aforesaid patent. The clearance spaces of sub-

stantial width between the plate and the hot top walls avoid freezing where, as may happen, the metal is poured on the low side of the range of pouring temperature, or with steels which tend to freeze readily. Also, the float plate may be tilted and lifted by tongs from the hot top member after the latter has been filled as shown in Fig. 3, so that it may be reused with another member 2, thus reducing the expense of hot topping. Or, as may be preferred in some instances it may be allowed to remain in place for the purpose of keeping the body of metal within the feeder member molten to insure maximum reduction of piping. Where the float is to be removed for re-use it is desirable to use a modified form of float plate. Referring to Fig. 6, the float plate 4a is provided on its bottom surface with a notched portion 15, and enough metal is teemed into the hot top 2 to raise the float sufficiently to permit a lever to be inserted under notch 15 so that the float may be tilted upwardly to permit a peel or the like to be used to lift the float from the hot top.

An advantage of the form of hot top shown in Figs. 1 to 3 is that the operator can view the interior of the mold through the space between the outer walls of the hot top and the mold wall and thus determine when the metal has been poured to the proper height, which is not possible, or at least not convenient, with some forms of hot tops.

Various modifications are, of course, permissible without departing from the spirit of the invention. For example, instead of providing pairs of fingers 6 on two opposed walls of the hot top, one or more supporting fingers may be provided on each inner wall of the hot top. Thus, the hot top 2a of Fig. 4 is provided with four fingers 6a each disposed centrally of a hot top wall at the bottom end of the hot top. In another modification, the float 4a, Fig. 5, may be provided on its edges with bosses 12 or other projections so arranged as to cooperate with the hot top walls to automatically center the float in the hot top opening.

Also, the hot top may be blocked up with wooden blocks 16, Fig. 7, from the top of the mold in accordance with practice in some plants to avoid the formation of hanger cracks, and although the invention has been illustrated as applied to small-end-up molds of generally rectangular cross section it is to be understood that it is applicable generally to ingot casting irrespective of the type of mold or its cross sectional character.

Fig. 7 illustrates also a further advantageous feature of the invention, viz., the ability to use a hot top according to the invention, with all of its attendant advantages, with a mold too large to use the hot top in the manner shown in Figs. 1 to 3 and 6. To this end the mold 17, in this instance shown as a big-end-up mold, is provided with an ordinary tubular hot top 18 of proper size, and a hot top 19 with float plate 20 supported on fingers 21 in accordance with the present invention is then mounted on the top of hot top 18. Metal teemed into hot top 19 then enters mold 17 through hot top 18 just as described above. When molten metal has reached an appropriate height in hot top 18, hot top 19 and float 20 are removed from hot top 18 and may then be used to pour another ingot in the manner shown in Figs. 1 to 3 and 6. Thus the hot top provided by the invention may be used repeatedly and the stocking of feeders for each

size of mold opening becomes unnecessary, whereby important economies are effected. Hot top 19 may be carried on wood supports 22, if desired, as where it is too small to be supported by hot top 18.

In addition to eliminating the formation of surface scabs the invention otherwise improves the surface quality of ingots. Thus, in ordinary practice the heavy head of metal from the nozzle coupled with the relatively small area of the mold opening causes the metal in the mold to surge upwardly along the mold sides above the natural level of metal in the mold. The thin skin of metal forced up the side of the mold in this manner freezes so quickly that contraction of it may cause cracks to form which impair the surface of the ingot. Such cracks may extend as much as several inches into the ingot and effect the quality of products made from it. In the practice of the present invention the metal enters the mold under such a low head pressure that there is little or no tendency for such surface cracks to form.

Although the invention has been illustrated and described with reference to an imperforate float plate, it will be understood that the plate may be perforated without encountering disadvantages of the hot top of the aforesaid patent because the hot top of this invention provides for free drainage of metal around the sides of the plate so that the plate can not freeze in the bottom of the hot top. Of course, the supporting fingers should be of such height, or positioned at such a level in the mold, that when the ingot has been filled to its normal height the plate will be above the metal level, as shown in Fig. 3, and thus will not be frozen in place during the freezing in of the feeder by solidification of the surface metal between the hot top and the mold.

It will be understood that the supporting fingers may be provided by shoulders bridging the corners of the hot top.

According to the provisions of the patent statutes I have explained the principle and mode of use of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. A tubular refractory hot top for ingot casting having at its lower end spaced inwardly projecting finger members adapted to support a plate member and to permit free drainage of metal around the edges of the plate.

2. A tubular refractory hot top for ingot casting adapted to be carried by the top of a mold to form a continuation thereof, said hot top having at least two of its opposed sides provided adjacent the lower end with pairs of inwardly projecting fingers for supporting a plate member and to permit free drainage of metal around the edges of said plate.

3. An ingot casting apparatus comprising a tubular refractory hot top having at its lower end inwardly projecting spaced finger members adapted to support a plate member, a refractory plate member disposed within said hot top and adapted to rest upon said fingers with its edges spaced from the walls of the hot top to provide substantial clearance for molten metal poured into the hot top to pass therebetween.

4. An ingot casting apparatus comprising a refractory tubular hot top adapted to be carried

by the top of a mold, said hot top having at least two of its opposed sides provided adjacent the lower end with pairs of inwardly projecting fingers for supporting a plate member, a refractory plate member disposed within said hot top and adapted to rest upon said fingers with its edges spaced from the walls of the hot top to provide a passageway of substantial width for molten metal poured into the hot top.

5. An ingot casting apparatus comprising a refractory tubular hot top adapted to be carried by the top of a mold to form an upward extension of the mold and with its lower end disposed in the mold opening, said hot top having at its lower end opposed inwardly projecting fingers arranged to support a plate member, and a refractory imperforate plate member disposed within said hot top and adapted to rest upon said fingers with its edges spaced from the walls of the hot top to provide a passageway of substantial width for molten metal poured into the hot top.

6. The combination with an ingot mold of a refractory tubular hot top associated with the upper end and forming a continuation of the mold and having at its lower end opposed inwardly projecting finger members, and a refractory imperforate plate member disposed within said hot top and adapted to rest upon said fingers with its edges spaced from the walls of the hot top to provide a passageway of substantial width for molten metal poured into the hot top.

7. An ingot casting apparatus comprising a refractory tubular hot top adapted to be carried by the top of a mold to form a continuation thereof and having at its lower end opposed inwardly projecting finger members having rounded upper surfaces, and a refractory plate member disposed within said hot top and adapted to rest upon said fingers with its edges spaced from the walls of the hot top to provide passageway for molten metal poured into the hot top.

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