April 5, 1938. A. C. ESTEP 2,113,445

MOLD PLUG

Filed July 21, 1937

Fig. 1

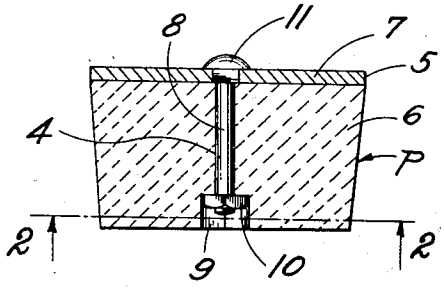


Fig. 2

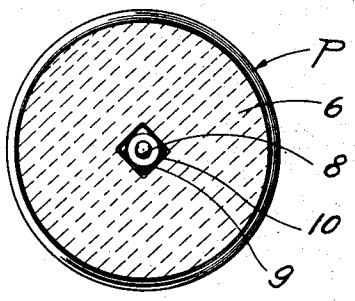


Fig. 3

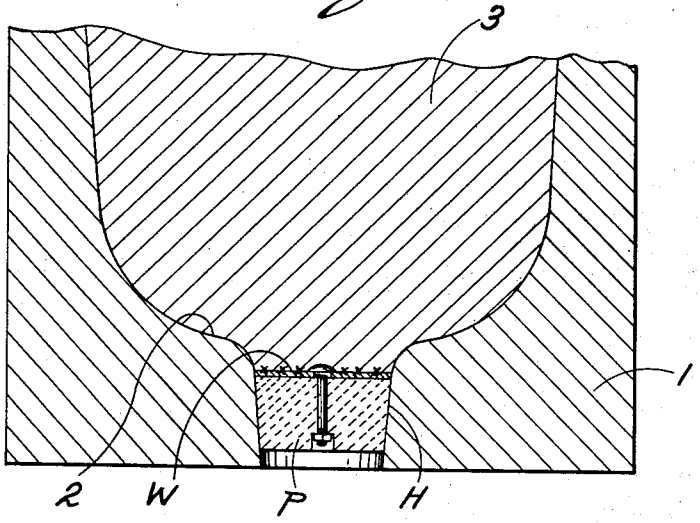


Fig. 4

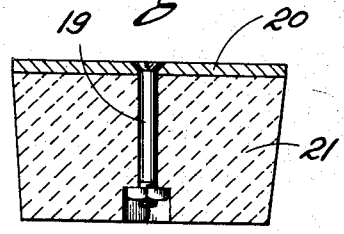
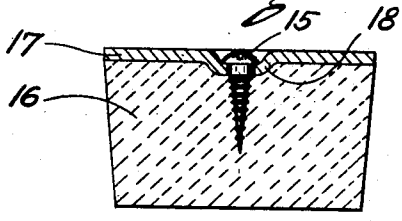


Fig. 5



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MOLD PLUG

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7 Claims. (Cl. 22—139)

This invention relates to improvements in ingot mold plugs and more particularly to a composite metal and clay mold plug structure.

It is among the objects of my invention to provide an ingot mold plug which will securely seal the bottom hole in an ingot mold, and which will substantially eliminate the risk of non-metallics getting into the ingot. A further object is to provide a mold plug having yielding qualities whereby to seat securely in the bottom hole of the ingot, which, withal, may be readily removed therefrom when the ingot is stripped from the mold, and which will satisfactorily prevent leakage of molten metal past all or any substantial portion of the plug. A further object is to provide a plug resistant to the "wash" of the molten steel and impervious to deleterious action of the molten steel thereupon. A further object of my invention is to provide in a mold plug a metallic closure for the bottom hole of the mold and a strong but yieldable support for the closure, whereby to allocate the several functions of the plug in relation to the mold to the constituent parts thereof, which are best adapted to carry out those functions and to coact with the other related elements in an advantageous way. A further object is to provide a coaction between the mold and the several constituent parts of the plug through which to carry out various of the other more specific objects herein set forth. A further object of my invention is to provide a composite unitary metal and clay mold plug constructed and arranged so that the metal part of the plug may be welded to the body of the ingot during the pouring thereof, and thus carry the clay portion of the mold plug along with the ingot as the same is stripped from the ingot mold. It is a further object of my invention to provide a composite mold plug of metal and burned clay which will become firmly secured to the ingot during the pouring thereof, and which will serve as a stool to support and protect the ingot when the same is placed in a soaking pit. It is a further object of my invention to provide a composite metal and clay ingot mold plug in which the metal portion of the plug is firmly secured to the clay portion and is supported thereby during the pouring of the ingot. It is a further object of my invention to provide a composite metal and clay mold plug in which the clay and metal parts are shaped and fitted together so that they jointly present a truncated cone shape engageable with the conical bottom hole of the mold. It is a further object of my invention to provide a composite metal and clay mold plug in which the metal portion provides a blow receiving protective cap for the clay portion of the plug to facilitate the driving of the plug into the ingot mold plug opening. Other objects relating to simplicity of construction and economies of manufacture and other advantages will appear from the following description and the appended drawing in which:—

Figure 1 is a transverse sectional view of an ingot mold plug constructed according to my invention;

Figure 2 is a sectional view taken on line 2—2 of Figure 1;

Figure 3 is a transverse sectional view with parts broken away showing an ingot mold plug of my invention positioned in an ingot mold with the ingot cast therein;

Figure 4 is a transverse sectional view of a modified form of mold plug embodying my invention;

Figure 5 is a sectional view illustrating a further modification of the mold plug of my invention.

As will be understood by those skilled in the art the ingot mold plug is employed to seal the opening at the lower end of an ingot mold I of the big-end-up type and that such plugs are forcibly driven into the opening H prior to the pouring of the ingot 3. The opening at the bottom of the ingot mold facilitates the stripping of the ingot from the mold and it is desirable that the plug seal the opening and be so constructed that the non-metallic parts of the plug will not float up into the ingot.

According to the preferred embodiment of my invention illustrated in Figure 1 the body portion 6 of the plug P is made of burned clay and is preferably made by extrusion in the direction of its axis and thereafter pressed or molded to a truncated conical form complementary to and substantially coextensive with the conical surface of the mid-portion of the conical hole H in the ingot mold. A metallic plate or disk 7, preferably about $\frac{3}{16}$'' to $\frac{1}{4}$'' thick, where the whole plug is about 3'' deep, is secured to the top or large diameter surface of the body portion of the plug by such means as a bolt 8. The plate 7 is preferably shaped at its periphery 5 to conform with theoretical accuracy to the projection of the conical surface of the body portion 6 immediately above and adjacent the top surface thereof when the plug is in use in the mold. Thus the plug in its entirety comprises a unitary structure having a metal top face and a burned clay body in which both elements coact with the con-

ical surface of the hole H in the same way and offer mutual support and protection to each other.

I recognize that in commercial practice the conical exterior surface of the clay body portion 6 will not be a true geometrical cone, nor will the conical wall of the hole H be a perfect geometrical cone, particularly after the mold has been in use for some time. One of the advantages of a refractory or burned clay mold plug is that it may be driven into the bottom hole of the mold, and with a reasonable force may fracture a little about its exterior conical surface whereby to conform more perfectly to the adjacent wall of the hole and thereby more securely bear the weight of the whole ingot. Where the mold plug is entirely made of refractory material, the plug must be stout enough to withstand the impact of being driven into the bottom hole, whereby to prevent bodily rupture thereof or spalling from the top surface thereof. These characteristics, however, are necessarily antagonistic to obtaining a desirable though limited fracture or yielding in the conical surface of the plug, and are thus antagonistic to obtaining a full bearing between the conical surfaces of the plug and the wall of the bottom hole. One of the advantages of my invention is that I may use a relatively soft clay portion adapted to yield enough to obtain a good or full bearing along its conical surface with the hole in the mold, because the impact of driving the plug into place is widely distributed through the top plate 7, which is tightly secured thereto.

Those skilled in the art will understand how relative hardness or softness can be obtained in a burned clay product in its manufacture, and I note only by way of example that for similar burning times and temperatures the hardness is measurably increased when the plastic mass is well deaerated in the course of extrusion on the one hand, and that softness, as I employ the term, is materially increased where deaeration is reduced or eliminated, and also where finely divided carbonaceous material such as powdered coal is mixed with the clay prior to extrusion, and is burned out during the burning whereby to measurably increase the porosity of the ware.

Since, as I have indicated, I desire that the metal plate or disk 7 carry out all or substantially all of the hydraulic sealing function in closing the bottom opening in the mold, I prefer that its peripheral edge have a sealing contact with the adjacent conical wall of the hole H, but I also desire that the plate 7 be supported by the body portion 6, whereby its mechanical function of supporting the weight of the ingot will be substantially limited to compression within its own thickness. In other words, I desire to avoid having the plate 7 take a load bearing engagement along its periphery whereby to tend to suspend the plug in the hole. One reason for the latter being that did the plate tend to suspend the plug, then a much thicker and stronger plate would have to be provided, and one would thus revert back to a solid metallic plug with its disadvantages of cost and its relative incapacity to obtain a tight sealing fit in the hole.

It is convenient and economical to make the plates 7 by punching or shearing them from strip stock, whereby the peripheral edge of the plate tends to be cylindrical instead of conical and slightly rough rather than of pure geometric configuration. In carrying out the objects of my invention I preferably hold the diameter of the lower peripheral edge of the plate 7, that is the edge adjacent the top surface of the clay body portion 6, very nearly to the maximum diameter of the top surface of the body portion or a little smaller than that diameter in the order of about $\frac{1}{64}$ of an inch. In this manner, when the whole plug is rammed into the bottom hole of the mold, and the surface of the clay portion gives or is scratched away somewhat, then the lower edge of the periphery of the plate 7 contacts or approaches intimate contact with the wall of the hole H. The contact between the disk and the wall of the hole tending first to be a circular line, the metal of the disk tends to give a little under the impact with which the whole plug is driven into the hole, and because of the limited area of contact and the give of the metal, the disk per se does not tend to take all or any substantially great portion of the load to be supported, nor does it interfere with an ample load bearing engagement between the plug and the wall of the hole. Even where the periphery of the plate 7 has no actual or complete contact with the wall of the hole, still the whole area of the non-metallic portion of the plug with which molten steel may contact is so small and so screened from the wash of the molten steel that the possible entrance of non-metallics into the ingot is substantially eliminated.

It will also be noted that the disk 7 is preferably secured to the clay body 6 of the plug in its central portion, whereby to permit a limited yield or give between its peripheral portion and the peripheral part of the top surface of the clay body of the plug, whereby to permit the peripheral edge of the disk to more effectively carry out its sealing function without impairing the function of the clay body portion to seat in the hole of the mold and bear the burden of the weight of the ingot.

During the formation of the clay body of the plug an aperture 4 is provided centrally thereof to receive the bolt 8 and the lower end of the bolt receiving aperture is preferably enlarged as at 9 and is preferably given a square configuration to prevent the nut 10 from turning within the body 6. The shank of the bolt immediately adjacent the head is preferably square according to carriage bolt construction and thus rotation of the disk 7 and bolt 8 relative to the nut 10, while the latter is held in the non-circular hole 9, permits ready assembly of the parts and a firm union between them. The squared aperture 9 in addition to housing the nut 10 provides a re-entrant portion to receive the head 11 of a bolt of an adjacent plug upon stacking a series of mold plugs in shipping and storage.

During the pouring of the ingot the plate 7 receives the thermal shock of the molten metal and said plate 7 is preferably proportioned with regard to its thickness so that the heat of the molten metal will effect a welding as at W (in Fig. 3) of the plug to the ingot 3. As a specific example I have found that a plate 7 having a thickness of about $\frac{1}{8}$ths of an inch operates satisfactorily to effect a welding of the plug to the ingot and yet maintain its identity as a steel plate throughout the pour so as to keep the metal of the ingot 3 out of contact with the refractory material of the plug. Subsequent to the stripping of the ingot from the mold the mold plug serves as a stool or support for the ingot when the same is placed in the soaking pit. A mold plug constructed according to my invention thus not only effectively prevents the loss of molten metal

during the pouring and prevents the floating of non-metallic particles within the ingot, but also maintains the finished ingot free of contact with the soaking pit liquid or other impurities on or adjacent the floor thereof.

Although as indicated above it is preferred to secure the plate 7 to the body of the plug 6 by a bolt 8 as shown in connection with the embodiment of Figure 1 I appreciate that other fastening means may be employed and in Figure 4 I have shown an alternative form of plug construction. In Figure 4 I have illustrated a modification in that the head of the fastening bolt 19 is flat and the steel plate 20 is counter-sunk to accommodate the same. The clay body of the plug 21 may be formed like the clay body 6 of the preferred form. Among the advantages of this is that the head of the bolt 19 is less subjected to the wash of the molten metal during the pouring of the ingot.

In Figure 5 I have shown a further modification, which is particularly feasible when the body portion 16 of the plug is made of relatively soft and workable refractory material such as porous burned clay in which powdered coal has been added to the wet mix (25% powdered coal to 75% powdered clay by weight being a workable percentage) and burned out during firing of the ware, whereby to leave the ware relatively soft and porous. Such ware is capable of receiving and holding a lag screw 15 without injury to the refractory portion 16, particularly where a small tapered hole is formed in the refractory body when the same is pressed into its conical form, the tapered hole preferably being about the shape of the cone defined by the base of the threads in the lag screw. In this form of my invention the plate or disk 17 coacts with the clay body portion 16 in substantially the way hereinabove described with reference to the other forms of my invention. In this particular modification I prefer that the mid-portion of the disk 17 be drawn downwardly as at 18, whereby to receive the head of the lag screw, keeping the top of it about flush with the top of the surface of the disk. The top surface of the clay body portion 16 is similarly indented to receive the depression or dimple 18 of the disk. In this manner the head of the screw is kept downwardly out of the wash of molten steel, and the finished and assembled plugs are readily stacked one upon another during shipping and storing. Moreover, in this form of my invention the molding of the wet extruded clay stock, in changing the initial cylindrical shape of the plug to the form of a truncated cone, is facilitated somewhat by the displacement of clay from the upper and central portion thereof outwardly in the direction of expansion of the plastic mass from its initial cylindrical diameter to its enlarged diameter at the larger end of the truncated cone.

Referring particularly to Figure 3, it will be observed that in all forms of my invention the plug P is preferably proportioned to enter the hole H, and be securely seated in that hole so that the whole upper and lower limits of the plug lie within the upper and lower limits of the conical surface of the hole H. In this manner the plug lies somewhat above the bottom of the ingot mold 1, whereby the plug engages the walls of the hole to the exclusion of the stool or other means disposed below the bottom of the mold. The top of the plug, including the metal disk, also lies within the conical wall of the hole, whereby to coact therewith as above described, and more particularly to be disposed below the adjacent interior bottom walls 2 of the mold 1, whereby to have its peripheral edges protected from the wash of molten steel, and the plate is thus freed from the tendency of the wash of the steel to separate it from the plug.

From the foregoing it will be seen that I have provided a plug having many advantages to be obtained in its operation and use; that the plug is simple in construction and lends itself to the economy of manufacture; that it guarantees a satisfactory seal of the bottom hole of the ingot molds; that it insures freedom of non-metallics in the finished ingot; that it may advantageously serve as a stool for the ingot while the same is in the soaking pits; that it can be readily and easily shipped and handled; that it is self-protective against the impact of forcing it into the hole in the mold; that it coacts with the mold in a novel and advantageous way, and otherwise facilitates and expedites the casting of ingots and advances the art thereby.

While I have indicated a perference for burned clay as the material for the body portion of my improved plugs, it should be understood that my invention may be advantageously practiced with other refractory or semi-refractory materials such as a mixture of slag and cement or dry pressed clay in the body portion of the plug.

Although I have illustrated and described certain specific forms in which my invention may be practiced, various changes and modifications will occur to those skilled in the art, all within the precepts of my invention, and I do not care to be limited to the precise embodiments herein particularly described or in any manner other than by the claims appended hereto when construed with the range of equivalents to which I may be entitled in view of the prior art.

I claim:—

1. The combination of an ingot mold having a tapered bottom hole and a tapered plug disposed therein comprising a refractory body and a metallic cap secured together, the whole of said plug being disposed within the tapered wall of said hole and the peripheral surfaces of both the body and cap portions of said plug having operative engagement therewith.

2. In combination an ingot mold having a curved interior bottom surface merging into a conical walled bottom hole, a metallic sealing plate disposed transversely of said hole having its peripheral edge in sealing relation to the conical wall of the hole, a refractory plug in said hole having load bearing engagement with the said conical wall of said hole directly below said sealing plate and supporting said plate and fixedly secured thereto.

3. An ingot mold plug having a burned clay body portion of truncated cone shape and a flat steel plate applied to the maximum diameter of said body portion, said plate having its peripheral edge within the conical surface defining the walls of said body portion whereby the body and plate as a unit may be driven into a tapered opening at the base of an ingot mold and jointly coact therewith.

4. An ingot mold plug having a burned clay body portion of truncated cone shape having a bore extending axially of said body, a flat steel plate arranged against the flat surface of said body having the maximum diameter with its edge within the surface of the cone, said plate provided with a central non-circular aperture, and means to secure said plate to said body com-

prising a bolt having a non-circular shoulder beneath the head thereof to fit non-rotatively within said plate, and a nut disposed within said body having a threaded engagement with the shank of said bolt and held against rotation in said body.

5. The combination of an ingot mold having a tapered bottom hole, and a tapered plug with its tapered surface substantially coextensive with tapered surface of said hole, said plug comprising a load bearing refractory body portion, the points or limited areas on the tapered surface of which that first contact the adjacent wall of the hole being deformable somewhat to broaden the area of load bearing contact, and said plug also comprising a metal sealing plate supported by said refractory body and secured thereto and spacing the ingot to be poured therefrom and having its peripheral edge substantially in contact with the tapered wall of the hole immediately above the body portion of said plug, whereby said plate substantially seals said hole against fluid outflow and said refractory body substantially bears the weight of the ingot.

6. A mold plug having a truncated cone shaped body portion of porous burned clay, the exterior portion of which has a zone of increased porosity formed by mixing coal with the clay prior to burning, and having a steel plate covering the circular face of the body portion having the maximum diameter and fixedly secured to the body portion with the edge of said plate lying substantially in the surface of said cone, said plug being adapted to coact with a similarly conical surface in the bottom hole of an ingot mold, the body of the plug in load bearing engagement therewith and the plate of the plug in fluid sealing relation thereto.

7. An ingot mold plug adapted to close a bottom tapered hole of an ingot mold comprising a frustro-conical non-metallic body portion, the conical surface of which substantially corresponds to at least a portion of the conical surface between the ends of said bottom hole of said ingot mold, and said plug also comprising a metallic plate covering substantially the whole area of the upper circular surface of said non-metallic body portion and adapted to be contacted by the ingot to be poured and fused thereto, and said plate being fixedly secured to said non-metallic body portion and having its peripheral edge adjacent to an extension of the conical surface defining the wall of said non-metallic body portion, whereby the peripheral edge of said plate will lie adjacent to the conical wall of said bottom hole in said ingot mold but will not engage the same in load bearing relationship before the non-metallic body portion of said plug is firmly seated in said hole.

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