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METHOD OF AND APPARATUS FOR CASTING METAL INGOTS

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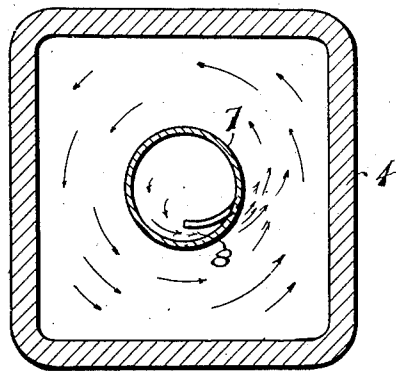


Fig. 2

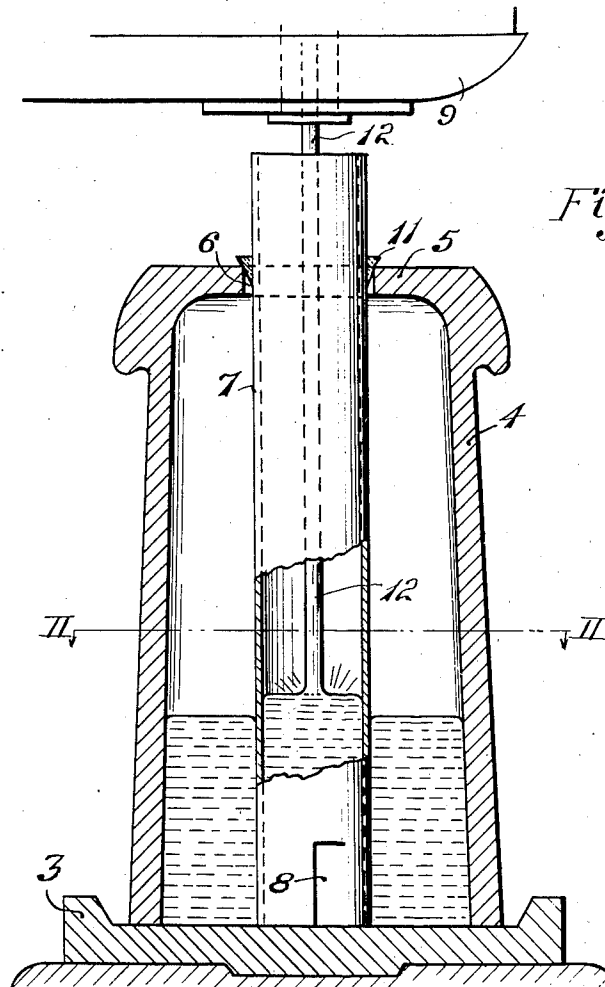


Fig. 1

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METHOD OF AND APPARATUS FOR CASTING METAL INGOTS

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My invention relates to the art of casting metal ingots and particularly to the art of casting steel ingots and ingots of steel alloys.

Heretofore ingots have been cast in cast iron or steel molds or casings, the metal either being poured into the top of the mold or forced thereinto from the bottom thereof, the latter operation requiring relatively expensive apparatus compared with that for producing top poured ingots.

When molten metal poured in at the top of the mold strikes the surface of the metal it carries air beneath the surface, and the occluded gases are released due to reduction in temperature of the metal. The air and gas bubbles are carried with the metal to the side walls of the mold and when the metal is chilled thereby, the bubbles are trapped in the vicinity of the surface of the ingot.

The cooling of the metal adjacent the mold wall further releases the occluded gases which are added to those referred to, resulting in a layer of metal near the surface of the ingot which contains innumerable bubbles. When the ingot is rolled to form a bloom or slab, the bubbles remain near the surface thereof and cause seams on or near the surface which remain in the bar or sheet rolled from the bloom or slab respectively, with the result that the surface thereof is rough and of seamy structure.

The metaloids such as carbon, manganese, sulphur, etc., have a tendency to move toward the center of the ingot, the central portion being the last to cool, and therefore they are concentrated near the central zones of the ingot. This segregation of the metaloids causes a non-uniform distribution of the metaloids and consequently the steel of the ingot is not uniform in structure or strength.

An object of my invention is to produce a method of casting ingots wherein the entrained air bubbles and the occluded gases are prevented from coming in contact with the side walls of the mold or accumulating in the vicinity of the side walls thereof.

Another object of my invention is to

produce a process of casting ingots wherein segregation of the metaloids is arrested if not entirely prevented and wherein the distribution of the metaloids is substantially uniform throughout the mass of the ingot from top to bottom and from side to side.

Another object of my invention is to produce an ingot mold that may be poured from the top and which will produce an ingot practically free of bubbles and in which the metaloids are uniformly distributed.

Another object of my invention is to produce an ingot mold wherein the molten steel is maintained under static pressure while the metal is cooling and in which piping of the metal near the top of the ingot is eliminated.

Another object of my invention is to produce an ingot mold wherein the yield of usable steel is increased and wherein the quality thereof is superior to that produced in the usually employed mold.

These and other objects that will be made apparent throughout the further description of my invention are attained by means of the process and mold hereinafter described and illustrated in the accompanying drawings, wherein

Fig. 1 is a longitudinal section through an ingot mold embodying features of my invention, and

Fig. 2 is a transverse section through the mold shown in Fig. 1 and taken on the line II—II thereof.

Referring to the drawings, the ingot mold comprises a metal base or stool 3 upon which an ingot mold casing 4 is detachably mounted. The mold casing is open at its lower end to permit removal of the ingot and may be provided with an integral cover 5 having a central opening 6 for receiving a pouring and metal cooling tube 7 that rests upon the stool 3 and extends exteriorly of the mold casing as indicated in Fig. 1.

The tube 7 may be made of steel having substantially the same composition as the metal being poured into the mold, and scrap tubing may be used to advantage, thereby eliminating the necessity of melting the scrap

tubing produced in the manufacture of steel tubing.

The tube 7 is split longitudinally near the lower end and a portion thereof is pressed inwardly to provide a vent 8 which discharges the molten metal, teemed into the upper end of the tube from the ladle 9, in a tangential direction, thereby causing the metal to be given a swirling motion as it enters the mold casing.

The thickness of the walls of the tube 7 is such that the tube remains in-tact until the casing and tube are filled with metal. The tube subsequently gradually fuses and becomes an integral part of the ingot.

In order to cast an ingot, the mold casing 4 is placed upon the stool 3 and the pouring tube 7 is inserted through the opening 6 in the top of the mold casing and centered by wooden wedges 11 which permits the escape of air from the casing during the pouring operation.

The gate of the ladle 9 is then opened and a stream 12 of molten metal is directed into the tube 7. The metal first strikes the stool and flows tangentially into the mold through the vent 8. The tube prevents splashing of the metal against the walls of the mold casing and serves to initially cool the metal and thereby release the occluded gases before the metal flows into the mold. As the level of the metal rises in the mold, the level also rises in the tube, and consequently the occluded gases are released from the metal in the tube before it is discharged therefrom through the submerged vent 8.

As the metal is given a swirling motion as it is discharged from the tube, the metal in the mold is continually moved along the cool mold walls and will not solidify during the pouring operation. Thus the temperature of the metal is maintained substantially uniform throughout its mass while the ingot is being poured. Since the air bubbles and substantially all of the occluded gases are freed within the tube 7, the mass of metal within the mold is practically free of bubbles, and consequently there is no accumulation thereof near the surface of the ingot.

When the mold is filled and metal begins flowing past the wedges 11, the metal is locally chilled at that point by pouring water on the top of the mold, thus sealing the opening. The tube 7 is then filled and the metal in the tube above the mold maintains a static pressure on the metal within the mold. At this time, the portion of the tube 7 within the mold gradually fuses and becomes an integral part of the ingot.

As the ingot cools and shrinks, the molten metal in the upper end of the tube flows into the mold and keeps it filled. The metal in the upper end of the tube may be heated with "Thermit" or by means of a gas flame or by churning with a metal rod. The usual

pipng of the ingot adjacent the top due to shrinkage is thus eliminated and the yield thereof materially increased.

Since the tube 7 cooled the central part of the ingot and the swirling motion of the molten metal maintained the temperature of the ingot throughout its mass substantially uniform, the segregation of the metaloids usually occurring in ingots cast in the usual manner has been eliminated. The projecting end of the tube may be burnt off with a cutting torch.

For the purpose of illustration I have disclosed my invention as applied to a mold having an integral top provided with a circular opening, a type of mold known in the art as a "bottle top" mold, but it will be understood that my invention is applicable to standard molds or any mold of the open top type. Where such molds are employed, the metal is poured into the mold until the level reaches almost to the top. The surface of the metal between the mold walls and the tube 7 is then chilled by pouring water thereon to solidify the surface metal and to thereby seal the top of the mold for the purpose hereinbefore described.

By reason of my improved process of casting ingots, the ingots are substantially free of bubbles and the metaloids are uniformly distributed throughout the ingot. The yield of good steel is increased and the steel is of superior quality. Scrap tubing is thus recovered without remelting in a furnace and the cost of production is reduced.

While I have illustrated but one embodiment of my invention, it will be apparent to those skilled in the art that various changes, modifications, substitutions, additions and omissions may be made in the apparatus illustrated without departing from the spirit and scope of my invention as set forth in the appended claims.

I claim as my invention:

1. An ingot mold comprising a mold casing having an opening in its upper end and a tubular member closing the opening and extending longitudinally of the casing from a point adjacent the bottom of the mold to a point exterior of the upper end of the casing for receiving molten metal and for discharging it adjacent the bottom of the mold, the said tubular member being of sufficient mass to remain intact and discharge the metal adjacent the bottom of the mold until the mold casing and tubular member have been completely filled with molten metal.

2. An ingot mold comprising a mold casing having an opening in its upper end and a tubular member closing the opening and extending longitudinally of the casing from a point adjacent the bottom of the mold to a point exterior of the upper end of the casing for receiving molten metal and for dis-

charging it adjacent the bottom of the mold, the said tubular member having means near its lower end for discharging the metal in a tangential direction to cause a swirling motion of the metal as it flows into the mold casing.

3. An ingot mold comprising a mold casing and a tubular member within the casing extending longitudinally of the casing substantially throughout its length for receiving molten metal and having means for discharging it adjacent the bottom of the mold in a tangential direction to cause a swirling motion of the metal as it flows into the mold casing.

4. An ingot mold comprising a mold casing and a tubular member within the casing extending longitudinally of the casing substantially throughout its length for receiving molten metal and discharging it adjacent the bottom of the mold, the said tubular member being provided at its lower end with an opening arranged for discharging the molten metal into the casing in a tangential direction to cause a swirling motion of the metal as it enters the mold casing.

5. An ingot mold comprising a stool, a metal mold casing for resting upon the stool and having an open bottom and a top provided with an opening, a tubular charging member extending through and closing the opening in the top and having its outer end extending above the top exteriorly thereof and its lower end provided with a vent arranged for discharging the molten metal poured into the upper end of the tube in a tangential direction for imparting a swirling movement to the metal as it enters the mold casing.

6. The process of casting ingots in a mold which consists in placing a tube within the mold, pouring molten metal into the tube and in discharging the metal from the tube adjacent the bottom of the tube in a tangential direction for causing swirling of the metal as it enters the mold.

7. The process of casting ingots in a mold which consists in pouring molten metal into the mold and in imparting a swirling motion to the metal as it enters the mold.

8. The process of casting ingots in a mold which consists in pouring molten metal into the mold and in imparting a swirling motion to the metal within the mold as the mold is being filled.

9. The process of casting ingots in a closed mold which consists in placing a charging tube within the mold having a metal containing portion extending above the mold and in pouring metal into the tube until the level of the molten metal in the tube is above that in the mold when the mold is filled, whereby the metal in the mold is maintained under pressure while the metal in the mold cools.

10. The process of casting ingots in a mold which consists in placing a charging tube within the mold having a metal containing portion extending above the mold, in filling the mold with molten metal inside and outside of the tube to a level near the top of the mold, in chilling the surface of the metal outside of the tube to solidify the surface metal and to thereby seal the top of the mold, and in pouring molten metal into the tube until the level thereof is above that of the metal in the mold outside of the tube.

11. The process of casting ingots in a mold which consists in placing a charging tube within the mold having a metal containing portion extending above the mold, in filling the mold with molten metal inside and outside of the tube to a level near the top of the mold, in chilling the surface of the metal outside of the tube to solidify the surface metal and to thereby seal the top of the mold, in pouring molten metal into the tube until the level thereof is above that of the metal in the mold outside of the tube, and in maintaining the metal in the upper end of the tube in a molten state until the metal in the mold has solidified.

In testimony whereof, I have hereunto subscribed my name this 24 day of February, 1928.

HARRY A. DEUEL.