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J. M. NELSON

METHOD OF AND APPARATUS FOR CASTING METAL

Filed Nov. 19, 1926

2 Sheets-Sheet 1

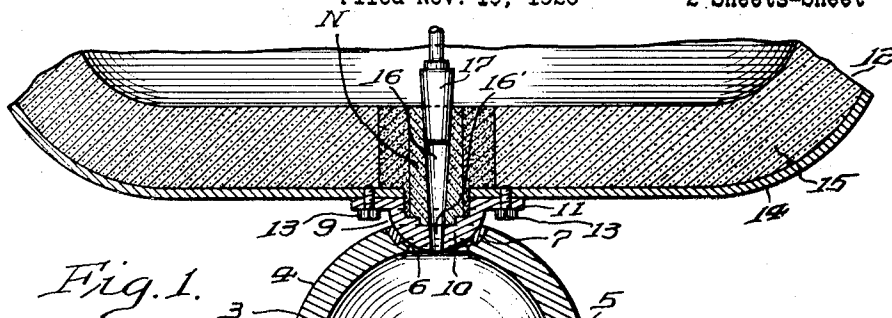


Fig. 1.

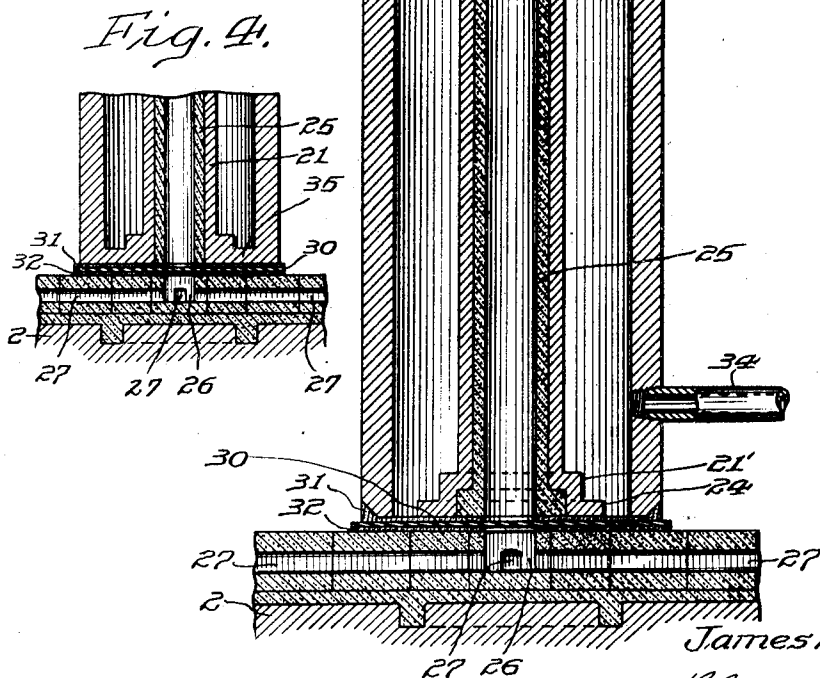


Fig. 4.

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2 Sheets-Sheet 2

Fig. 3.

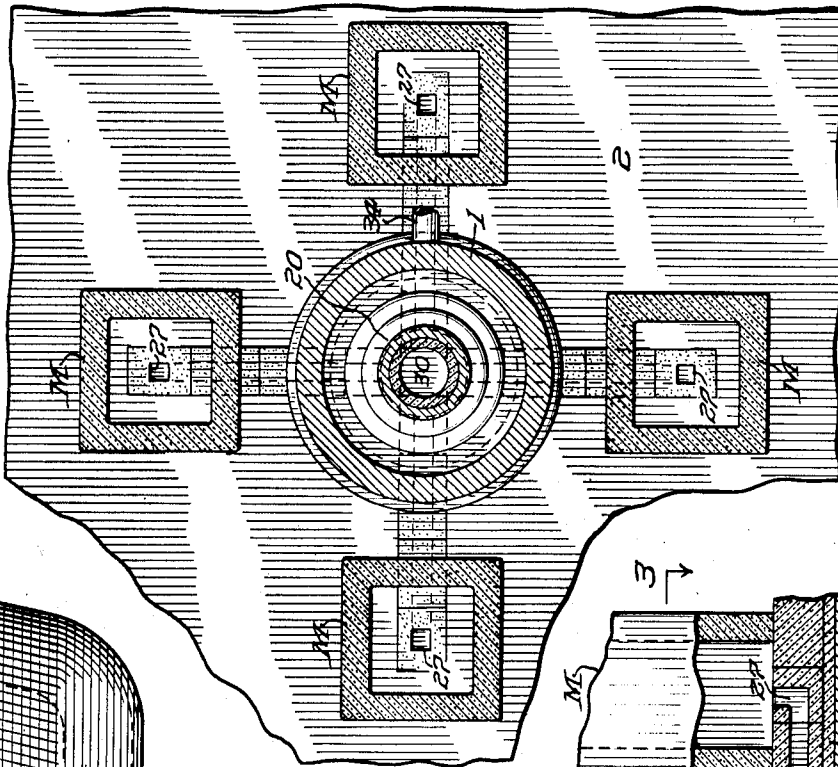
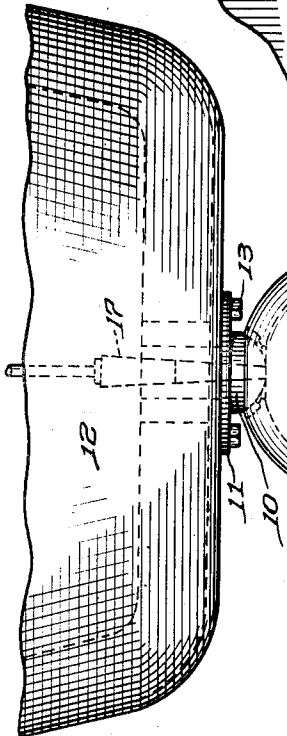
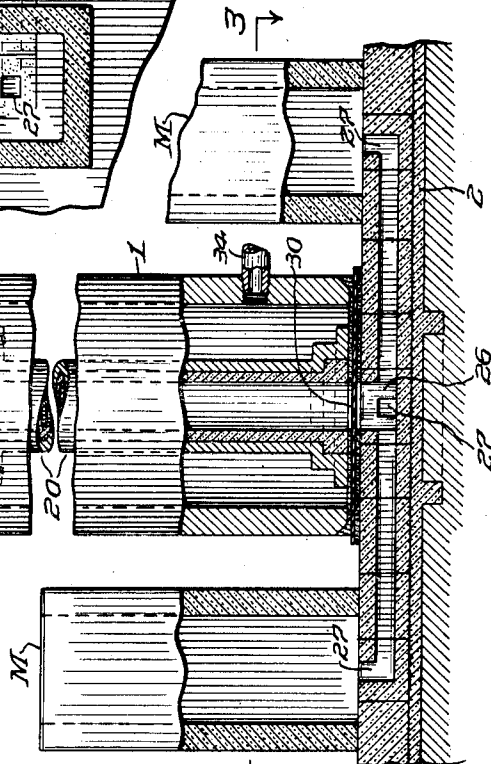


Fig. 2.



WITNESS

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UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR CASTING METAL.

Application filed November 19, 1926. Serial No. 149,289.

The present invention is for a method of and apparatus for casting metal and more particularly for casting steel ingots, the principal object of the invention being to provide a method of casting and apparatus adapted for the performance thereof by means of which ingots having a lower proportion of blow-holes and of cleaner and denser metal and smoother exterior surfaces can be obtained than by the methods of casting and apparatus hitherto generally employed.

Further objects of the invention are to remove from the metal during the casting operation the undesirable gases which are formed therein; to prevent the drawing of air into the metal while it is being teemed and to prevent the formation of slag from the reaction between the oxygen in the air when in contact with the molten metal and the metalloids in the latter.

An additional object of the invention is to provide a novel form of pouring nozzle plate adapted for operative association with the pouring ladle of such character that a tight seal may readily be effected between the nozzle plate and the hood or other receptacle into which the metal is being poured, thereby enabling a vacuum to be readily maintained in the hood or the receptacle during the casting operation as will hereafter more fully appear.

The invention further includes other objects and novel features of operation, design, construction and arrangement of parts and instrumentalities hereinafter more particularly mentioned or which will be apparent from the following description of one manner of performing my improved method and of an apparatus suitable therefor as illustrated in the accompanying drawings.

Generally speaking, my improved method comprehends the provision of an air-tight receptacle adapted to receive the molten metal from the ladle, which is connected with the receptacle through the medium of my improved pouring nozzle plate in such manner as to prevent ingress of air to the receptacle at the point of connection, the exhaustion of all or substantially all of the air from the interior of the receptacle prior to and during the pouring operation after the connection of the ladle therewith, and the distribution of the molten metal from the receptacle to a mold or molds arranged adjacent thereto in such manner that the metal

in its traverse to each mold will drive before it the air and gases contained in the passage by which the mold is connected with the receptacle and thereafter, as the teeming of the metal is continued, gradually fill the mold and form the complete ingot. Thus, as the interior of the receptacle is devoid or substantially devoid of air at the commencement of the teeming operation and as no air can thereafter enter the receptacle, the metal therein is not exposed to the effects of the oxygen in the air as when the pouring is done in the usual manner, while as the metal in its traverse from the receptacle to the mold completely fills the passage to the latter and drives before it the air initially contained in it and in the mold, the only part of the metal which is exposed to the air at all is that portion thereof which initially forms the front or leading end of the stream of metal in the passage and thereafter the upper end or surface of the ingot. It will therefore be apparent that from the time the metal leaves the ladle until the mold is filled only a very small portion thereof is ever exposed to the air while the gases generated in the metal itself are drawn out of the receptacle by the vacuum pump or escape from the mold to the external atmosphere with the result that the ingots produced are dense and homogeneous in structure, devoid of blow-holes to a very large degree and have smooth and regular outer surfaces.

It is to be understood that the present invention particularly lends itself to the simultaneous casting of a plurality of steel ingots although equally adapted for the casting of a single ingot at a time if preferred, and to enable those skilled in the art to comprehend and practise the invention I shall therefore describe one manner of performing the method so as to produce a plurality of ingots simultaneously as well as as one form of apparatus suitable therefor, reference being had to the said drawings in which Fig. 1 is a central vertical section through the main portion of one form of the apparatus; Fig. 2 a fragmentary view partially in elevation and partially in central section showing the apparatus in association with the ingot molds as arranged for casting a plurality of ingots, and Fig. 3 a fragmentary horizontal section on line 3-3 of Fig. 2. In Fig. 4 I have shown in fragmentary vertical central section a

slightly modified form of the apparatus. Like numerals are used to designate the same parts in the several figures.

The particular form of apparatus which I have chosen to illustrate is adapted for the production of ingots by "bottom pouring" as it is termed in the art, the ingot molds under such conditions being filled from the bottom instead of from the top whereby, during the teeming of the metal from the ladle, the metal is caused to gradually rise in the molds until the latter are filled to the desired point.

As shown in the drawings, the apparatus comprises a hood 1 which may consist of a hollow cylindrical tubular element conveniently of metal and open at both ends, this hood being adapted under operative conditions to rest in an upright position upon a stool 2 hereinafter more particularly described. The inner wall of the hood at its upper end may be outwardly flared or beveled as at 3 to receive the lower end of a substantially semi-spherical hollow cover 4 operative to close the upper end of the hood. Preferably the lower outer corner of the cover may be rounded off and after it is seated in position on the hood an asbestos or other suitable packing or gasket 5 may be disposed between the cover and the hood so as to hermetically seal the joint between them. The hood is provided at its center with an opening 6 which may be chamfered out at its upper end to form a seat for a ring 7 of asbestos or other suitable packing material, the inner face of which is preferably arranged to conform to the surface of the pouring nozzle plate 9. This nozzle plate comprises a central portion or boss 10 of inverted, substantially semi-spherical contour and, preferably, a supporting flange 11 integral therewith to enable the convenient attachment of the nozzle plate to the under face or bottom of the ladle 12 by means of bolts 13 extending through the flange. The ladle may be of any preferred construction, that shown comprising an outer metallic wall 14 and a lining 15 of refractory material through both of which is extended the usual nozzle N, also of refractory material, and surrounded by a packing of clay; the nozzle is provided with an outlet opening 16 in the usual manner which is continued as at 16' centrally through the nozzle plate into a depression in the upper face of which the lower end of the nozzle may be extended. This outlet may be provided with a movable stopper or plug 17 of any suitable type for controlling the flow of metal therethrough.

As it is requisite for the performance of my process of casting that ingress of air into the hood 1 be prevented from the time the ladle is brought to pouring position until the casting operation is completed and as it is extremely difficult in practice to exactly con-

trol the movement and position of a large pouring ladle filled with molten metal, I deem my improved nozzle plate having a semi-spherical exterior surface as aforesaid as of great importance since, when a nozzle plate of that character is employed, it is only necessary to bring the plate to seated position in the aperture in the hood cover to insure an air-tight connection between the parts even though the ladle be tilted considerably from a true horizontal position; moreover, this air-tight connection will be maintained throughout the casting operation even though the ladle after being seated on the hood should tilt or shift slightly from its initial position.

The hood or receptacle 1 serves to enclose a central runner 20 which may consist of a hollow cylindrical vertically extending main portion 21 desirably of smaller diameter than the hood and a flaring upper portion 22 forming a funnel-shaped element for receiving the molten metal as it issues from the nozzle and directing it into the runner. The portions 21 and 22 if formed separately may be connected as shown through the medium of cooperating flanges secured together by bolts 23. In order to afford adequate support to the runner, its lower extremity may be suitably increased in diameter as at 21' and also provided with a marginal base flange 24, while for preventing the molten metal from contacting with the metal of the runner as it passes therethrough the latter may be provided throughout its extent with an inner lining 25 of suitable refractory material. When the parts are operatively assembled the runner is preferably positioned substantially coaxially with the hood and in alignment with the opening in its cover so that the metal issuing from the nozzle will enter the runner centrally with consequent avoidance of splashing.

As hitherto stated, the hood is operatively supported on the stool or base 2, which also serves as a support for the molds M, M which may be arranged about the hood and preferably as closely adjacent thereto as may be convenient. These molds may be of any suitable form for producing the ingots or other castings desired, and I have therefore merely illustrated them in a conventional manner, it being, however, understood that whatever be the specific form of the molds they are preferably open, either wholly or in part, at their upper and lower ends and adapted to receive the molten metal at the latter. It is further to be understood that while four molds arranged symmetrically about the hood are indicated in the drawings, any desired number of molds may be utilized and arranged adjacent the hood in any desired way.

The stool, which may be formed of cast-

iron or other suitable material, may be provided with a plurality of channels diverging outwardly from a common center aligned with the central runner. These channels, which are preferably open at the top, respectively extend to the several molds and may be lined with hollow brick or other suitable refractory material while at the point of juncture of the channels may be positioned a large brick having a central opening aligned with the central runner and forming a sump 26 and horizontally disposed holes respectively communicating with the passages 27 in the bricks which line the channels. The outer ends of these passages are respectively brought to the surface of the stool in alignment with the interiors of the several molds to which they lead so that the molten metal can readily flow from the sump into the lower ends of the molds but is protected during its traverse of the passages from contact with the external atmosphere.

In accordance with the practice of my improved process of casting it is requisite to exhaust all or substantially all of the air from the interior of the hood after the pouring ladle has been brought into position thereover and the nozzle plate seated in the hood cover but before the teeming of the metal is commenced. Means must therefore be provided for temporarily cutting off the sump and passages from the interior of the hood since in the absence of such means it would be impossible to exhaust the air from the hood, for as fast as the air was removed it would be replaced by other air drawn in through the passages and the sump. Therefore for the purpose of closing the lower end of the hood against the entrance of air while a vacuum or substantial vacuum is being created therein prior to the teeming of the metal, I preferably dispose a relatively thin plate 30 of metal or other suitable fusible material between the lower end of the hood and the surface of the stool, this plate being of sufficient size to extend entirely over the end of the hood and preferably project slightly beyond the same, and for insuring a tight seal between the end of the hood, the plate and the surface of the stool, I may dispose annular gaskets 31 and 32 of asbestos or other suitable material above and below the plate, the width of these gaskets being preferably such that neither of them will overlie the open end of the sump although extending from the exterior of the hood substantially to the perimeter of the sump.

Suitable means are provided for exhausting the air from the interior of the receptacle, said means conveniently comprising an air pump of suitable form (not shown) connected with the interior of the hood by a pipe 34 threaded into a suitable aperture

disposed at any convenient point in the hood wall.

In performing my improved method of casting with an apparatus substantially of the character of that hitherto described, the hood, fusible plate 30, gaskets 31 and 32, if employed, and central runner are first assembled on the stool with the runner in alignment with the sump 26, the hood cover then placed in position and the gasket 5 inserted so as to form a tight seal between the cover and the hood. The molds are also arranged in proper position on the stool in respective alignment with the outer ends of the passages 27 and the air pump connected with the interior of the hood by the pipe 34. The ladle 12 filled with the molten metal is then brought to position over the hood and lowered until the nozzle plate 9 is seated in the aperture in the hood cover and against the packing ring 7 if the latter be employed. The interior of the hood being thus sealed against the admission of outside air, the vacuum pump is operated until all or substantially all of the air is exhausted from the interior of the hood and the stopper 17 then raised by any suitable means to allow the metal from the ladle to flow downwardly into the central runner, the vacuum pump being meanwhile continued in operation. As soon as the molten metal strikes the fusible plate 30 the central part of the plate melts away allowing the metal to pass from the runner into the sump 26 and from thence through the passages 27 to the several molds. As the teeming of the metal from the ladle is continued, the molds are gradually filled until the desired level is attained in them after which the stopper is operated to cut off the further flow of metal from the ladle, thus completing the casting operation.

It will thus be apparent that at the initiation of the teeming operation a vacuum or substantial vacuum exists within the hood and this condition is maintained throughout the teeming operation. As a sufficient body of the molten metal is present in the runner to seal the lower end of the same before the fusing of the central part of the fusible plate 30, ingress of air to the interior of the hood through the bottom of the runner is thereafter prevented, while as the molten metal flows outwardly from the sump to the several molds the air in the passages 27 and in the molds is driven before the metal and passes out through the upper ends of the molds as the latter are gradually filled along with a large proportion of the gases generated in the metal itself, no part of which is thus exposed to the atmosphere while the metal is being teemed save the relatively small portions thereof which initially form the leading ends of the streams of metal in the passages and thereafter the upper ends of the ingots as they are formed in the

molds. In consequence the main body of each ingot is formed of metal which has never been exposed to the action of the air from the time when it leaves the ladle until the completed ingot is removed from the mold.

Additionally, a very considerable portion of the gases which are held in solution in the metal while in the ladle escape into the hood from the stream of metal as it passes into the central runner. This results from the fact that an appreciable drop in the temperature of the metal occurs as it passes from the ladle to the runner which assists in the liberation of these gases, as well as because the metal passes through a zone of reduced pressure in a relatively thin stream the volume of which is small compared with its surface area. As these gases are so liberated they are continuously removed from the hood during the teeming operation by the vacuum pump so that the metal reaching the molds is to a large extent free thereof with the result that the finished ingot, save, perhaps, at its upper extremity where the metal has necessarily come into contact with the air in its traverse of the passages 17 and as it rises in the molds, is substantially devoid of blow-holes and presents a very smooth and even exterior surface, thus materially reducing the amount of metal which must be cut off from the ends of the ingot and chipped or otherwise removed from its surfaces to prepare the ingot for further operations in conformity with the usual practice.

In Fig. 4 I have shown a slightly modified form of apparatus in which the central runner is integrally joined to the hood instead of being separate from the latter as in the form of apparatus hitherto described. While I have shown this connection between the runner and hood adjacent their lower ends, it will be obvious that it may be effected with equal facility at any point below the funnel at the upper end of the former, the pipe 34 extending to the vacuum pump being, of course, inserted in the hood wall at a point above the web 35 which forms the connecting element between the parts.

It will of course be understood that prior to each cast a new fusible plate must be supplied in order to seal the hood and enable a vacuum or substantial vacuum to be formed therein and furthermore, that while I prefer to form the hood and cover separately, as shown, under certain conditions it may be found desirable to make these parts as a single unit or to otherwise modify or vary the details of design, construction and arrangement of the apparatus or specific manner of performing the method to adapt the invention to the particular conditions of operation under which it is to be employed

or for other reasons, and I therefore desire it to be understood that such modifications and variations are contemplated by me and may be made when and if desired without departing from the spirit and scope of the invention as defined in the appended claims.

Having thus described my invention, I claim and desire to protect by Letters Patent of the United States:

1. In an apparatus for casting metal, a hood, a fusible element closing the base of the hood, an aperture in the wall of the hood above the element adapted for the reception of the nozzle plate of a casting ladle, and means for exhausting the air within the hood when said aperture is closed by said nozzle plate.

2. In an apparatus for casting metal, a hood, a fusible element closing the base of the hood, an aperture in the wall of the hood above the element adapted for cooperation with the nozzle plate of a casting ladle to form an air-tight seal, means for exhausting the air in the hood when said aperture is closed by the nozzle plate, supporting means for the hood, and means for conducting the molten metal from a point beneath said fusible element to a mold disposed adjacent but outside of said hood.

3. In an apparatus for casting metal, a hood, a fusible element closing the base of the hood, an aperture in the wall of the hood above the element adapted for the reception of the nozzle plate of a casting ladle and cooperative therewith to form an air-tight seal, means for exhausting the air in the hood when said aperture is closed by the nozzle plate, supporting means for the hood, and means for conducting the molten metal from a point beneath said fusible element to a mold disposed adjacent but outside of said hood, said means comprising a passage formed in said supporting means and terminating at its outer end at the bottom of the mold.

4. In an apparatus for casting metal, a hood having an opening in its upper portion adapted for the reception of the nozzle plate of a casting ladle, a fusible element extending across the bottom of the hood, supporting means for the hood provided with a sump beneath said element, and a plurality of passages extending outwardly from the sump and respectively adapted to communicate at their outer ends with a plurality of molds arranged about the hood.

5. In an apparatus for casting metal, a hood having an opening in its upper part adapted for the reception of the nozzle plate of a casting ladle, a fusible element extending across and closing the lower end of the hood, a central runner disposed within the hood and adapted to receive metal from the ladle through said nozzle plate, the base of said runner resting on said fusible ele-

ment, supporting means for the hood disposed therebeneath and provided with a sump below said runner, and a plurality of closed passages extending outwardly from said sump and respectively adapted to communicate molds arranged about the hood.

6. An apparatus for casting metal comprising a ladle provided with a pouring nozzle, a nozzle plate adjacent said nozzle and having a substantially semi-spherical surface, a hood having an opening in its upper end adapted for the reception of the nozzle plate, the wall of said opening conforming to the contour of the nozzle plate and adapted to form an air-tight closure therewith and the lower end of the hood being open, a stool disposed beneath and affording support to the hood, a fusible element interposed between the hood and the stool and extending across and closing the lower end of the former, means for causing a substantial vacuum within the hood when the nozzle plate is positioned in the opening in the upper end thereof, and means for conducting metal from a point below said fusible plate to a mold disposed outside of the hood.

7. An apparatus for casting metal comprising a casting ladle having a pouring nozzle and a nozzle plate whose surface is of substantially semi-spherical contour disposed adjacent thereto, a hood open at the bottom and having an aperture in its upper end adapted for the reception of the semi-spherical portion of said nozzle plate to thereby form an air-tight closure therewith, a stool for supporting the hood in upright position, a fusible element interposed between the hood and the stool and extending across and closing the bottom of the hood against the admission of air, a central runner disposed within the hood extending to the fusible element and adapted to receive metal through the nozzle plate, means for creating a vacuum within the hood, and means formed in the stool for conducting molten metal from a point below said element to a mold disposed adjacent the outside of the hood.

8. An apparatus for casting metal comprising a casting ladle having a nozzle and a nozzle plate provided with a semi-spherical surface, a vertically extending hood having an opening in its upper end containing a packing ring generally conforming to the surface of said nozzle plate and adapted to form air-tight closure therewith when the plate is brought into juxtaposition with the opening, a stool forming a support for the hood and provided with a sump beneath the hood and a plurality of passages formed in its body, extending outward from the sump and respectively terminating at the surface of the stool at points beyond the wall of the hood, a fusible plate interposed

between the lower end of the hood and surface of the stool and forming an air-tight closure for the bottom of the former, a hollow central runner positioned within the hood upon said plate and adapted to receive the molten metal when teemed from the ladle through the nozzle, and means for creating a reduced pressure in the hood when the ends of the latter are respectively closed by the nozzle plate and the fusible plate.

9. The method of bottom casting an ingot which comprises the steps of supporting a body of the molten metal from which the ingot is to be formed in the vicinity of an ingot mold having openings at its upper and lower ends, creating a zone of reduced pressure below the body of metal, then teeming the metal through said zone to effect an appreciable drop in temperature during its passage from the top to the bottom of the zone, causing the metal to create an exit passage for itself from the bottom of the zone and to thereafter form a seal for the passage so created to prevent entrance of air to the zone, continuously withdrawing from the zone the gases given off by the metal during its passage therethrough, and finally conducting the metal to the bottom of the mold while preventing access of air to the stream of metal save at its leading end.

10. The method of bottom casting an ingot which comprises the steps of supporting a body of the molten metal from which the ingot is to be formed in the vicinity of an ingot mold having openings at its upper and lower ends, creating a zone of reduced pressure below the body of metal, teeming the metal through said zone in a relatively thin stream while preventing the access of air to the metal, causing the metal to create an outlet for itself from the bottom of the zone, continuously withdrawing from the zone the gases given off by the metal during its passage therethrough, and finally conducting the metal to the bottom of the mold while preventing access of air to the stream of metal save at its leading end.

11. The method of bottom casting a plurality of ingots simultaneously which comprises the steps of supporting a body of molten metal from which the ingots are to be formed in the vicinity of a group of molds respectively provided with openings in their upper and lower ends, teeming the metal in a relatively thin stream through a zone of reduced pressure while preventing access of air to the metal, continuously removing from said zone the gases given off by the metal during its passage therethrough, finally conducting the metal from said zone in individual streams to the bottoms of the several molds while preventing access of air to said streams save at their leading ends.

12. The method of bottom casting a plurality of ingots simultaneously which comprises the steps of supporting a body of the molten metal from which the ingots are to
5 be formed in the vicinity of a plurality of molds open at their upper and lower ends, creating a zone of reduced pressure below the body of metal, teeming the metal into said zone, permitting the metal to create for
10 itself an outlet from said zone and to then seal said outlet against the entrance of air into the zone, and finally conducting the metal after its exit from the zone through said outlet to the bottoms of the several
15 molds in individual streams while preventing access of air to said streams save at their leading ends.
13. The method of bottom casting a plurality of ingots simultaneously which comprises the steps of supporting a body of the
20 molten metal from which the ingots are to be formed in the vicinity of a plurality of molds respectively having openings at their tops and bottoms, creating a zone of reduced pressure below the body of metal, teeming
25 the metal into said zone in a relatively thin stream while preventing access of air thereto, permitting the metal to create for itself an outlet from said zone, thereafter utilizing the stream of metal itself to form a seal
30 against the ingress of air to said zone, continuously removing from said zone the gases given off by the metal in its passage there-through, and finally conducting the metal after its exit through said outlet to the bottoms of the several molds in individual
35 streams while preventing access of air to said streams save at their leading ends.
- In witness whereof, I have hereunto set my hand this 12th day of November, 1926.

JAMES M. NELSON.