June 26, 1945. T. C. POULTER 2,379,401

METHOD AND APPARATUS FOR CASTING METAL

Filed April 16, 1942 2 Sheets-Sheet 1

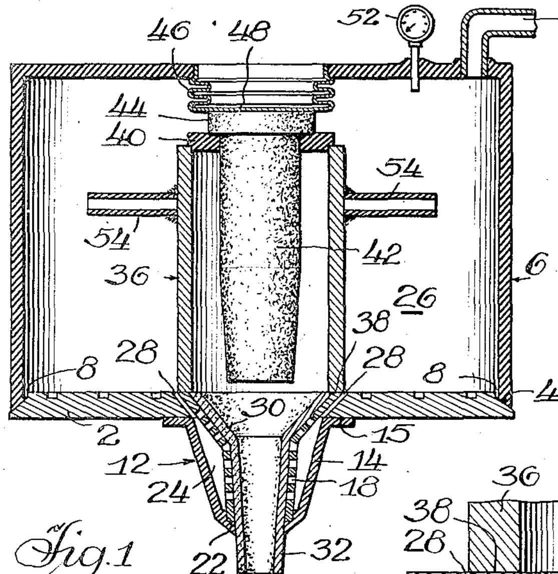


Fig.1

Fig.1A

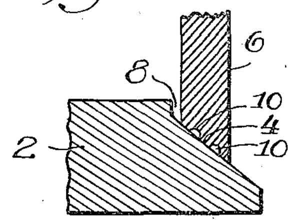


Fig.2

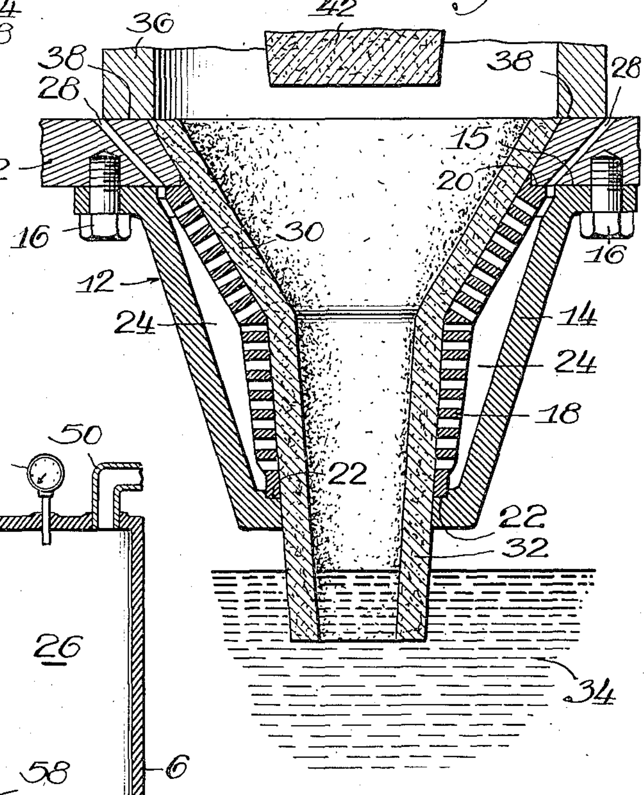
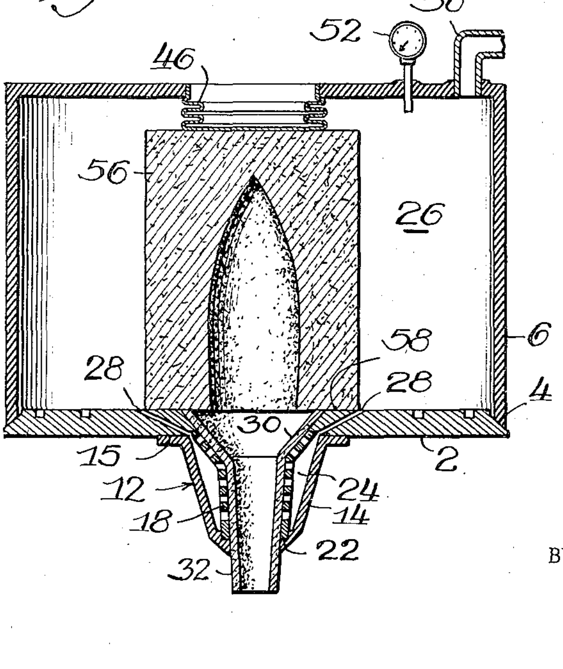


Fig.3



INVENTOR.

Thomas C. Poulter,

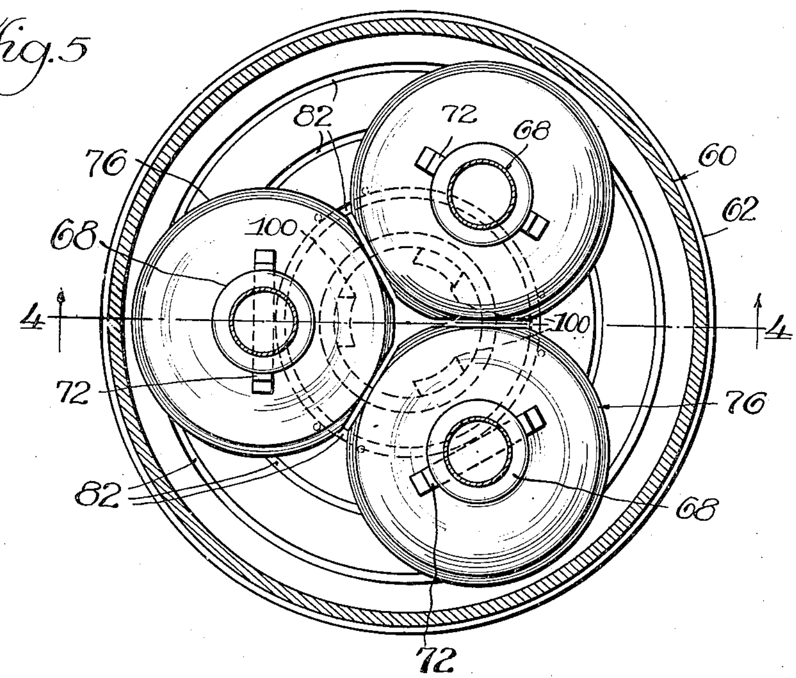
BY Dunn O. B. Garner Atty.

June 26, 1945. T. C. POULTER 2,379,401

METHOD AND APPARATUS FOR CASTING METAL

Filed April 16, 1942 2 Sheets-Sheet 2

Fig. 5



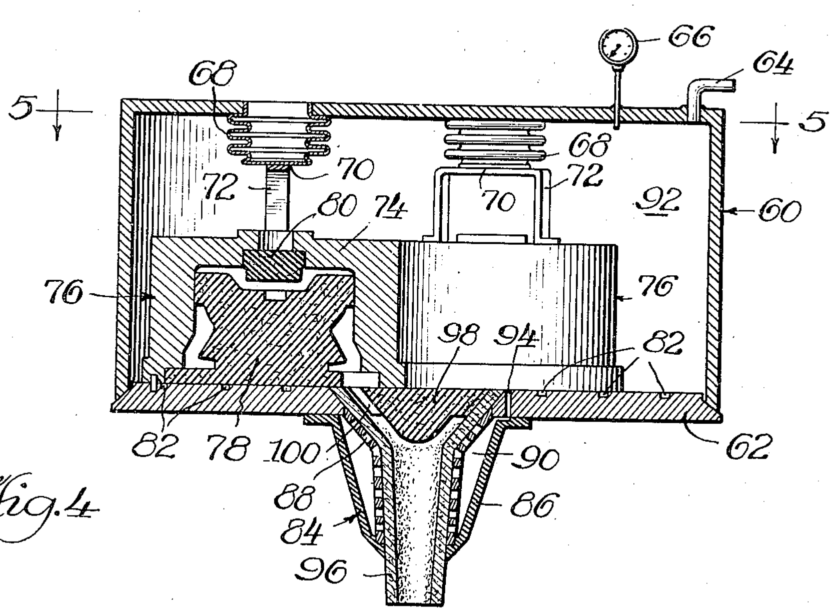


Fig. 4

INVENTOR.
Thomas C. Poulter,
BY Arvin O. B. Garner
Atty

Patented June 26, 1945 2,379,401

UNITED STATES PATENT OFFICE

2,379,401

METHOD AND APPARATUS FOR CASTING METAL

Thomas C. Poulter, Chicago, Ill., assignor to American Steel Foundries, Chicago, Ill., a corporation of New Jersey

Application April 16, 1942, Serial No. 439,186

33 Claims. (Cl. 22—73)

My invention relates to the art of casting metal and particularly to a method and apparatus which may be utilized for countergravity pouring of metal. I use the term countergravity pouring as embracing what might be described as a vacuum method in which atmospheric pressure would be the means causing the metal to flow as well as embracing direct pressure means for forcing the molten metal into a mold in which latter case vacuum means would not be required.

The general object of my invention is to devise a novel method and apparatus for casting metals. At present the most common practice of casting is to pour the molten metal into molds constructed to conform more or less to the shape of the desired finished product. In some cases a bottom gating system is used and in other cases a top gating method. In my novel arrangement as described herein I have utilized a bottom gating arrangement in conjunction with a bell which may be evacuated, thus permitting the action of atmospheric pressure to cause the metal to flow into the mold.

A specific object of my invention is to devise an arrangement for casting metals within a bell which may be evacuated in such manner as to permit atmospheric pressure to cause the metal to flow into the molds. In my novel arrangement I have provided that the evacuation of the mold take place through a core or through a number of cores for purposes which are hereinafter more particularly described.

Methods at present in use commonly utilize risers on the casting as a means of securing solidity, particularly where castings of irregular form are required. The use of risers reduces the yield, so-called, and therefore adds to the cost of the product. Another object of my invention is to devise a means of casting which will substantially eliminate the use of risers, thus greatly increasing the yield while at the same time facilitating the production of castings substantially free from shrinkage cavities.

Under ordinary conditions of producing cast articles, pouring methods are such that the molten metal frequently comes into sharp and sudden contact with portions of the mold cavity or cores therein with the result that the moving metal washes away portions of the mold structure which may be imbedded in the resultant casting and reduce the quality of the product. An object of my invention is to devise a method of pouring molten metal into a casting which will permit the flow of the metal to be controlled within predetermined limits so that it may be compelled to enter the mold at a rate which will substantially prevent abrasion of the mold surfaces and so avoid the inclusion of portions of the mold in the product as cast.

Yet another object of my invention is to devise an arrangement such as that above referred to wherein means may be utilized for drawing off the gases which normally develop as molten metal comes into contact with portions of a mold or cores which may be positioned therein. It is readily understood in the art that the sudden flow of molten metal along sand portions of the mold develop such gases sometimes so rapidly as to cause an explosive effect to be produced. My novel method provides a means of drawing off such gases and preventing their interfering with the normal flow of the molten metal into the various recesses of the mold.

In the drawings,

Figure 1 is a sectional view of my novel casting apparatus, the section being taken substantially along a diameter of the vacuum bell. Figure 1A is an enlarged view, showing the structure at the juncture of the base plate with the vacuum bell seated thereon.

Figure 2 is an enlarged view, illustrating in greater detail certain portions of the structure shown in Figure 1.

Figure 3 is a view comparable to Figure 1, illustrating the same equipment utilized in pouring a casting of different form.

Figures 4 and 5 show apparatus similar to that illustrated in Figure 1 arranged to accommodate a plurality of identical molds which may be poured simultaneously, Figure 5 being a plan view thereof with a top portion of the vacuum bell cut away along the plane indicated by the line 5—5 of Figure 4, and Figure 4 a sectional view along a diameter of the vacuum bell, said section being taken substantially in the vertical plane indicated by the line 4—4 of Figure 5.

Describing the apparatus in detail and referring first to the showing illustrated in Figures 1 and 2, it may be noted that the equipment comprises a base plate 2, circular in plan and chamfered about the outer periphery thereof to afford a convenient seat as at 4 with the vacuum bell 6 superposed thereon. In Figure 1A is illustrated the character of the engaging surfaces between the vacuum bell 6 and the base plate 2. The periphery of the base plate 2 is chamfered as already described to afford the fit at 4 with a complementary surface provided about the bottom edge of the cylindrical wall of the bell 6. A slight clearance is afforded at 8 between the bell 6 and the upper edge of the base plate 2 in order to accommodate relative expansion and contraction between the base plate and the bell. The face of the bell abutting the base plate may be formed with a plurality of annular channels or grooves 10, 10, said grooves being provided along said fitting surfaces in order to increase the turbulence in the flow of the air which may pass between the bell and the base plate when the bell is evacuated. It will be understood that the grooves 10 might be formed in the base plate instead of in the bell or indeed in both of these members. I have provided these grooves in order to increase the resistance to air flow between the bell and the base plate, such resistance being greatly augmented by any turbulence which may be created in the air stream.

In the base plate 2 may be fitted the gate assembly 12, said assembly comprising the outer gate casting 14 which may have an airtight seat as at 15 against the base plate 2 and be bolted thereto as at 16, 16 and the inner perforated gate casting 18, the upper perimeter of which may seat as at 20 against the base plate 2 and the other extremity of which may seat as at 22 within the mouth of the outer gate casting 14, a vacuum chamber 24 thus being afforded between the outer gate casting 14 and the inner gate casting 18, and vacuum chamber 24 being connected to the main vacuum chamber 26 within the vacuum bell 6 by a series of connecting channels or ducts 28, 28. The gate assembly 12 comprises also a dry sand core 30 fitted on the inside of the perforated gate casting 18 and projecting as at 32 beyond the mouth of the outer gate casting 14 for immersion in the molten metal, somewhat diagrammatically indicated at 34.

The metal mold 36, illustrated as of cylindrical form, is positioned over the gate assembly 12, the bottom periphery thereof bearing against the base plate 2 as at 38, 38, the mold 36 being so positioned over said gate assembly as to allow free passage of the molten metal from the ladle to the mold. As illustrated, the metal ring 40 forms the top of the mold and also acts as a support for the core 42 formed of sand or other air pervious material, the upper end of which may be afforded an annular flange overlying said ring as at 44. As illustrated, the vacuum bell 6, resting on the base plate 2, completely covers the mold and the cores and is sealed to the base plate 2 as already described. Integrally formed as a part of the vacuum bell 6 may be the bellows-like member 46, sometimes called a "Sylphon," said Sylphon seating as at 48 against the core 42 as a means of holding the mold and core in position over the gate assembly. The bell 6 may be evacuated through a connection as at 50 by means of a vacuum pump and control apparatus more particularly described in my co-pending application Serial No. 471.984, filed in the United States Patent Office on January 11, 1943, in the joint names of Thomas C. Poulter and Charles F. Strom. The vacuum in the bell 6 may be measured by a gauge 52 which may be fitted in the top of said bell.

The metal mold 36 may have integrally formed therewith one or more handles 54, 54 of any convenient form which may be used to strip the mold from the casting after the casting operation is completed.

In assembling my novel apparatus the dry sand gate core 30 may be placed in the gate assembly which already may be bolted to the base plate 2 as already described. The mold 36 with the internal dry sand core 42 may then be placed over the gate and the vacuum bell 6 placed in position and connected to the control mechanism and vacuum pump. The molten metal, in a suitable ladle maintained at a desired temperature, may then be elevated until the nose of the core 32 is immersed therein and preferably without contact with the outer gate casting 14. If preferable, the casting apparatus may be arranged so that the ladle is in fixed position and the vacuum bell assembly lowered sufficiently to permit the extremity of the gate assembly to be immersed in the molten metal. The control mechanism may then be operated to evacuate the bell 6, the said control mechanism being so arranged as to permit the evacuation to be accomplished at any desired predetermined speed, depending upon the character of the metal being cast and the form of the mold to be filled.

In this arrangement it will be noted that evacuation of the mold takes place through the internal core 42 within the mold 36 into the vacuum cavity 26 of the bell and thence to the vacuum pump. As a vacuum is built up within the bell cavity 26, concomitantly a vacuum is set up within the mold 36. As pressure is reduced in the bell and mold, the atmospheric pressure upon the molten metal in the ladle forces the molten metal up through the gate core 30 into the mold and after a sufficient period of time elapses to freeze the metal in the mold, the bell may be removed and the casting stripped from the mold. It will be understood by those skilled in the art that as the molten metal comes into contact with the various sand portions of the apparatus, volatile gases will be formed which might interfere with the normal operation of the equipment. The gate assembly 12 has been devised in the form described in order that the volatile gases so formed may not interfere with the smooth flow of the metal through the gate assembly and into the mold. I have accomplished this by providing the before-mentioned vacuum chamber 24 between the outer gate casting 14 and the inner perforated gate casting 18, said casting 18 being so perforated in order to permit removal of any gases so formed in the gate core 30, said gases being evacuated through the before-mentioned perforations of the inner gate casting 18 and passed into the main vacuum chamber 26 through the ducts 28, 28. It will be apparent that as evacuation takes place, some air from the atmosphere will be drawn into the gate core 30 through the protruding portion 32 and this atmospheric air will be drawn likewise into the chamber 24 and thence into the main vacuum chamber 26. It will be seen that the vacuum in the chamber 24 is maintained at the same pressure as the vacuum 26 within the bell because of the before-mentioned connecting ducts 28, 28. By this means the before-mentioned volatile core gases, which are thrown off by the gate core 30 as it comes into contact with the molten metal, are drawn off through the vacuum chamber 24.

While I have indicated it as desirable that the gate assembly be so secured to the base plate 2 as to form a substantially air-tight seal therewith as at 15, nevertheless it is not necessary for proper operation that this seal be perfectly airtight. The pressure is at a minimum in the main vacuum chamber 26 and is lower in said chamber 26 than it is in the mold because the mold must be evacuated through the core 42. This arrangement prevents any gas from being drawn into the mold at the base thereof which otherwise might cause gas pockets in the casting as formed. The same principle applies to the top of the mold.

Also, as the molten metal is drawn into the gate and upwardly into the mold, the increasing ferro-static pressure which is thus developed retards the entrance of the air at the mouth of the gate, the ferro-static pressure of course increasing as the height of the metal rises and said pressure being applied at the inner surface of the gate core.

The bellows-like member or Sylphon 46 is the means of holding the mold and the associated core in position as the mold is being filled. It will be understood that as the bell is evacuated, the air pressure on the outside of the bell tends to expand the member 46, thus urging it into tight engagement with the core 42 against which it seats. Utilization of this device makes it unnecessary to secure the bell 6 to the base plate 2 because there is no upward force exerted against the bell as might be the case, for example, if a solid block of material were substituted for said bellows member 46.

The arrangement for improving the seal at the engaging surfaces of the bell 6 and the base plate 2 is illustrated in detail in Figure 1A as heretofore referred to. The form of this seal is based upon the fact that more energy is required to force air into an opening or out of an opening than is required in traversing a pipe or a cylinder with smooth walls. The principle here followed is the creation of several passages into and out of which the escaping air must be forced and this is done by grooving the bell at 10, 10 as heretofore described, thus creating a larger number of points of maximum resistance rather than only two which would be the case if the engaging surfaces of the bell and the base plate were both perfectly smooth. As before indicated, it is not necessary for this joint to be airtight inasmuch as the leakage is into the vacuum chamber 26 and the amount of that vacuum is automatically controlled by the mechanism which evacuates the bell, said mechanism being designed to accommodate itself to that condition.

In Figures 1 and 2 above described, the mold is a composite structure consisting of the cylindrical metal portion 36, the top ring or washer 40 and the dry sand core 42. In the modification illustrated in Figure 3, however, I have shown how the abovedescribed equipment may be utilized in conjunction with an all-sand mold which may be made either of dry sand or of green sand. As illustrated in Figure 3, the other parts of the arrangement are identical with those already described including the vacuum bell 6, the base plate 2, the evacuating connection 50, the vacuum gauge 52, and the sylphon 46 operating to maintain the air pervious core 56 in position during the pouring operation. The said all-sand core 56 may be seated as at 58 over an opening in the base plate 2 about which may be positioned, as already described, the gate assembly 12. In this set-up of course the base plate 2 is provided with the ducts 28, 28 which permit exhaustion of the secondary vacuum chamber 24 into the main vacuum chamber 26.

In the arrangement shown in Figure 3 the operation of the apparatus is identical with that described for the arrangement illustrated in Figures 1 and 2 except that the mold 56 being a solid sand mold is of course evacuated not only through the top portion thereof but entirely there-around, said evacuation taking place through the entirety of the mold. Where the mold is entirely made of sand, it may be necessary to maintain the vacuum in the bell for a longer period inasmuch as solidification of the molten metal may proceed at a slower rate than would be the case where a metal chill is used such as illustrated in Figure 1.

In Figures 4 and 5 I have illustrated how my novel method and apparatus may be applied to a multiplicity of molds under a single vacuum bell. In this arrangement again the parts used are substantially identical with those already described and may comprise a vacuum bell 60 fitted over the base plate 62 and having the exhaust fitting 64 as well as the vacuum gauge 66, said bell including also a plurality of Sylphon fittings 68, 68, each of which may bear as at 70 against a U-shaped bracket or handle 72 secured in any convenient manner to the metal chill 74 forming a portion of the mold generally designated 76. As illustrated, three of the mold assemblies 76 are mounted within the vacuum bell 60, the shape of said mold assemblies conveniently accommodating that number within a circular vacuum bell such as illustrated.

Each composite mold 76 comprises the outer chill 74, the internal air pervious core 78, and an auxiliary air pervious core 80 at the top of the mold assembly through which the mold in general may be evacuated. In this case, however, the internal core 78 is evacuated from the bottom of each mold and the evacuation takes place through the plurality of concentric annular grooves 82, 82 provided in the top surface of the base plate 62.

In the set-up as illustrated, all three of the molds 76, 76 are filled from a common gate assembly 84, said gate assembly being generally similar to the gate assembly 12 previously described and comprising the outer gate casting 86, the inner perforated gate casting 88 spaced from the outer casting 84 to define therebetween the auxiliary vacuum chamber 90 which may be connected to the main vacuum chamber 92 within the bell 60 by a plurality of ducts 94, 94 in manner similar to that of the previously described arrangement. The gate assembly 84 also comprises the core 96, the extremity of which may project beyond the gate casting for immersion in the molten metal. At the top of the gate assembly 84 may be fitted a separator core 98, said separator core affording a passageway or feed 100 for flow of the molten metal into the adjacent mold 76.

It will be readily understood by those skilled in the art that a larger number of molds may be filled under one vacuum bell, the only limiting factors being the practicability of arranging the apparatus so that it may be accommodated within the space limitation ordinarily afforded in foundry practice. In actual practice I have successfully filled eighteen mold cavities under a single bell in a single pouring operation. By this means it is possible to produce large numbers of identical castings in a minimum period of time and if the molten metal is maintained at the desired temperature as long as the productive run may be maintained, it will readily be apparent that maximum efficiency may be achieved by the use of my novel method and apparatus.

Particular attention may be directed to the fact that an important feature of my invention is the manner in which such an arrangement as that described facilitates the production of solid castings without the use of risers such as are commonly used in present practice. Referring particularly to the arrangement illustrated in Figure

1, a progressive solidification of the molten metal takes place from the top of the mold downwardly toward the gate. As the metal is drawn into the mold the coldest is normally at the top, farthest from the ladle, and, moreover, the mold itself is normally cooler at the top because it is farthest from the supply of molten metal which is maintained in the ladle. As the molten metal is drawn into the mold, the conditions just referred to tend to cause the metal to freeze first at the upper extremity of the mold and then progressively downwardly toward the bottom thereof which is connected through the gate to the molten metal supply. Moreover, the gate is provided with a dry sand core which further retards the freezing of the metal as it rises from the ladle so that a supply of molten metal is maintained from the ladle and being constantly urged by atmospheric pressure in an upward direction to supply the shrinkage requirements of the casting as it progressively solidifies. By maintaining the reservoir of molten metal in the ladle at a constant temperature sufficiently high to carry out the procedure as I have directed, it is possible to secure practically perfect solid castings as has been demonstrated by frequent etchings of sectioned castings produced by this method.

It is to be understood that I do not wish to be limited by the exact embodiments of the device shown which are merely by way of illustration and not limitation as various and other forms of the device will, of course, be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

I claim:

1. In countergravity pouring apparatus for casting metal, a base, a vacuum housing fitted on said base along engaging faces, one of said faces having a plurality of recesses therein, a gate assembly fitted in said base, a mold mounted in said housing over said assembly, said assembly comprising an inner sand core and a vacuum cavity there-around, means for evacuating said sand core through said cavity, air passages between said cavity and said housing, and means for evacuating said housing, said mold comprising a metal chill and a sand core, said last-mentioned core affording means for evacuating said mold into said housing.

2. Countergravity casting apparatus comprising a base, a vacuum housing fitted over said base, a gate assembly connected at an opening in said base, a plurality of molds mounted in said housing and connected to said assembly, said assembly comprising a sand core and a vacuum chamber there-around, connections between said vacuum chamber and said vacuum housing, and means for evacuating said housing, each of said molds comprising a metal chill and a sand core, said last-mentioned core affording a gas passage between the interior of said mold and said vacuum housing.

3. A vacuum casting apparatus comprising a vacuum bell having a base plate, a gate assembly fitted in said base plate, a mold mounted in said bell over said assembly, said mold comprising a metal chill and a sand core, means for evacuating said mold through said core, said gate assembly comprising spaced annular members defining a vacuum chamber therebetween, a gate core fitted within the inner of said annular members, said inner annular member being perforated, and ducts connecting said vacuum chamber with said vacuum bell, said gate core projecting beyond said members for immersion in molten metal.

4. In countergravity pouring apparatus for casting metal, a base, a vacuum housing fitted on said base along engaging faces, one of said faces having a plurality of recesses therein, a gate assembly fitted in said base, a mold mounted in said housing over said assembly, said assembly comprising an inner sand core and a vacuum cavity there-around, means for evacuating said sand core through said cavity, air passages between said cavity and said housing, and means for evacuating said housing.

5. Vacuum casing apparatus comprising a vacuum bell having a base plate, a gate assembly in said base plate, a mold mounted in said bell over said assembly, said mold comprising a metal chill and a sand core, means for evacuating said mold through said core, said gate assembly comprising spaced annular members defining a vacuum chamber therebetween, a gate core fitted within the inner of said annular members, said inner annular member being perforated, and ducts connecting said vacuum chamber with said vacuum bell.

6. In countergravity casting apparatus, a vacuum chamber having a base, a gate fitted in said base and including a gas pervious core and vacuum supporting means surrounding said core, ducts connecting said means and said chamber, a plurality of molds mounted in said chamber, each of said molds having a cavity connected to said gate, each of said molds comprising a gas pervious core affording means for evacuating the associated mold cavity into said chamber, and means for evacuating said chamber.

7. In countergravity casting apparatus, a vacuum chamber having a base, a gate fitted in said base and including a gas pervious core and vacuum supporting means surrounding said core, ducts connecting said means and said chamber, a plurality of molds mounted in said chamber, each of said molds having a cavity connected to said gate, each of said molds comprising a gas pervious core affording means for evacuating the associated mold cavity into said chamber, and control means for evacuating said chamber at a predetermined rate.

8. Countergravity casting apparatus comprising a base, a vacuum housing fitted over said base, a gate assembly connected at an opening in said base, a plurality of molds mounted in said housing and connected to said assembly, said assembly comprising a sand core and a vacuum chamber there-around, connections between said vacuum chamber and said vacuum housing, and means for evacuating said housing, each of said molds comprising a metal chiller and a plurality of gas pervious sand cores affording means for evacuating said mold into said housing.

9. In countergravity casting apparatus, a vacuum housing comprising a base, a gate fitted in said base and including a sand core and a vacuum chamber fitted around said core, ducts connecting said chamber with said housing, and a composite mold secured in said housing and having a cavity connected to said gate, said mold comprising a plurality of gas pervious cores affording means for evacuating said mold into said housing.

10. Vacuum casting apparatus comprising a vacuum bell including a base plate, a gate assembly fitted in said base plate and comprising a sand core and a vacuum chamber enveloping said core, connections between said chamber and said vacuum bell, a mold mounted in said bell over said gate assembly, means fitted in said bell respon-

sive to atmospheric pressure for maintaining said mold in position, and means for evacuating said bell.

11. Vacuum casting apparatus comprising a vacuum bell including a base plate, a gate assembly in said base plate comprising a sand core and a vacuum chamber enveloping said core, connections between said chamber and said vacuum bell, a mold mounted in said bell over said gate assembly, and means for evacuating said bell.

12. In a casting apparatus for countergravity pouring, a vacuum bell having a base plate, a gate assembly in said base plate, a mold mounted over said assembly in said bell and comprising a sand core, and means for evacuating said mold through said core.

13. Vacuum casting apparatus comprising a vacuum bell having a base plate, a gate assembly in said base plate, a mold mounted in said bell over said assembly, said mold comprising a metal chill and a sand core, and means for evacuating said mold through said core.

14. Countergravity casting apparatus comprising a base, a vacuum housing fitted over said base, a gate assembly connected at an opening in said base, a pluurality of molds mounted in said housing and connected to said assembly, said assembly comprising a sand core and a vacuum chamber there-around, connections between said vacuum chamber and said vacuum housing, and means for evacuating said housing.

15. In countergravity casting apparatus, a vacuum housing comprising a base, a gate fitted in said base and including a sand core and a vacuum chamber fitted around sand core, ducts connecting said chamber with said housing, a composite mold comprising a gas pervious portion supported in said housing over said gate, and means for evacuating said housing.

16. In countergravity casting apparatus, a vacuum housing comprising a base, a gate fitted in said base and including a sand core and a vacuum chamber fitted around said core, ducts connecting said chamber with said housing, a gas pervious mold fitted over said gate in said housing, and means for evacuating said housing.

17. A method for vacuum casting metal comprising the steps of mounting a mold comprising gas pervious means in a vacuum chamber, affording a gate connection including gas pervious means between the interior of said mold and molten metal exterior of said chamber, providing a vacuum cavity around said gate in connection with said chamber, and evacuating said chamber.

18. A method for vacuum casting metal comprising the steps of mounting a mold in a chamber, connecting a gate with gas pervious means from the interior of said mold to molten metal exterior of said chamber, surrounding said gate with an auxiliary vacuum cavity in connection with said chamber, and evacuating said chamber.

19. A casting method comprising the steps of mounting in a vacuum chamber a mold formed of gas pervious material, affording a gate from said mold to molten metal exterior of said chamber, forming an auxiliary vacuum chamber around a portion of said gate in connection with said first-mentioned chamber, and evacuating said first-mentioned chamber.

20. A casting method comprising the steps of mounting in a main chamber a mold, affording a connection between the interior of said mold and said main chamber in the form of gas pervious material such as a sand core, providing gating means between said mold and a supply of molten metal exterior of said main chamber, mounting an auxiliary vacuum chamber around said means, affording a connection between said main and auxiliary chambers, and evacuating one of said chambers.

21. A casting process comprising the steps of mounting in a chamber a mold at least a part of which is formed of gas pervious material, affording a gate with gas pervious means from said mold to molten metal exterior of said chamber, providing a connection between said gate and said chamber independent of said mold, and evacuating said chamber.

22. A method of casting comprising the steps of mounting in a main vacuum chamber a mold at least a portion of which is formed of gas pervious material, affording gating means at least a portion of which is formed of gas pervious material between said mold and molten metal exterior of said main chamber, mounting an auxiliary vacuum chamber around said gating means, providing a connection between said chambers, and evacuating one of said chambers.

23. Casting apparatus comprising main and auxiliary vacuum chambers, a mold comprising a gas pervious portion mounted in said main chamber, a gate comprising a gas pervious portion mounted in said auxiliary chamber, and means for evacuating one of said chambers.

24. Casting apparatus comprising main and auxiliary vacuum chambers, a mold comprising a gas pervious portion mounted in said main chamber, a gate comprising a gas pervious portion mounted in said auxiliary chamber, a connection between said chambers independent of said gas pervious portions, and means for evacuating one of said chambers.

25. Casting apparatus comprising a vacuum housing, a gate assembly connected to said housing including a vacuum chamber, a mold mounted in said housing over said assembly, a connection between said chamber and said housing, and means for evacuating said housing.

26. In casting apparatus, a mold having a gas pervious portion, a gate having a gas pervious liner connecting said mold with a supply of molten metal, and means for simultaneously evacuating said mold and said gate, in part through said liner and in part independently thereof.

27. A casting apparatus comprising a mold with a gas pervious portion, a gate with a gas pervious liner connecting said mold to a supply of molten metal, a gas impervious housing surrounding said mold and a portion of said gate, and means for evacuating said housing, in part at least outwardly through said liner.

28. A casting apparatus comprising a mold with a gas pervious portion, a gate with a gas pervious liner connecting said mold to a supply of molten metal, a gas impervious housing surrounding said mold and a portion of said gate, means for evacuating said housing, and means on said housing responsive to said evacuation to maintain said mold in position.

29. In casting apparatus, a gas pervious mold mounted in a gas impervious housing, a gate connecting said mold to a supply of molten metal exterior of said housing, means for evacuating said housing, and means on said housing responsive to evacuation thereof for maintaining said mold in position.

30. In vacuum casting apparatus, a gas pervious mold mounted in a gas impervious housing, a gate having a gas pervious liner supported within

a gas impervious passageway connecting said mold to molten metal exterior of said housing, a connection between said housing and said passageway, and means for evacuating said housing.

31. In vacuum-casting apparatus, a gas pervious mold mounted in a gas impervious housing, a gate having a gas pervious liner supported within a gas impervious passageway connecting said mold to molten metal exterior of said housing, means for simultaneously evacuating said housing and said passageway, and means on said housing responsive to evacuation thereof for positioning said mold therein.

32. A method for vacuum casting metal comprising the steps of mounting a mold comprising a gas pervious core in a vacuum chamber, affording a gate from the interior of said mold to a supply of molten metal exterior of said chamber, and simultaneously evacuating said chamber and said gate along different paths, whereby matter evacuated from said gate bypasses said mold.

33. A method of casting comprising the steps of mounting in a vacuum chamber a mold having at least a part thereof formed of gas pervious material, affording a passageway with a gas pervious liner from said mold to molten metal exterior of said chamber, and evacuating said passageway directly through said chamber and indirectly through said liner.

THOMAS C. POULTER.