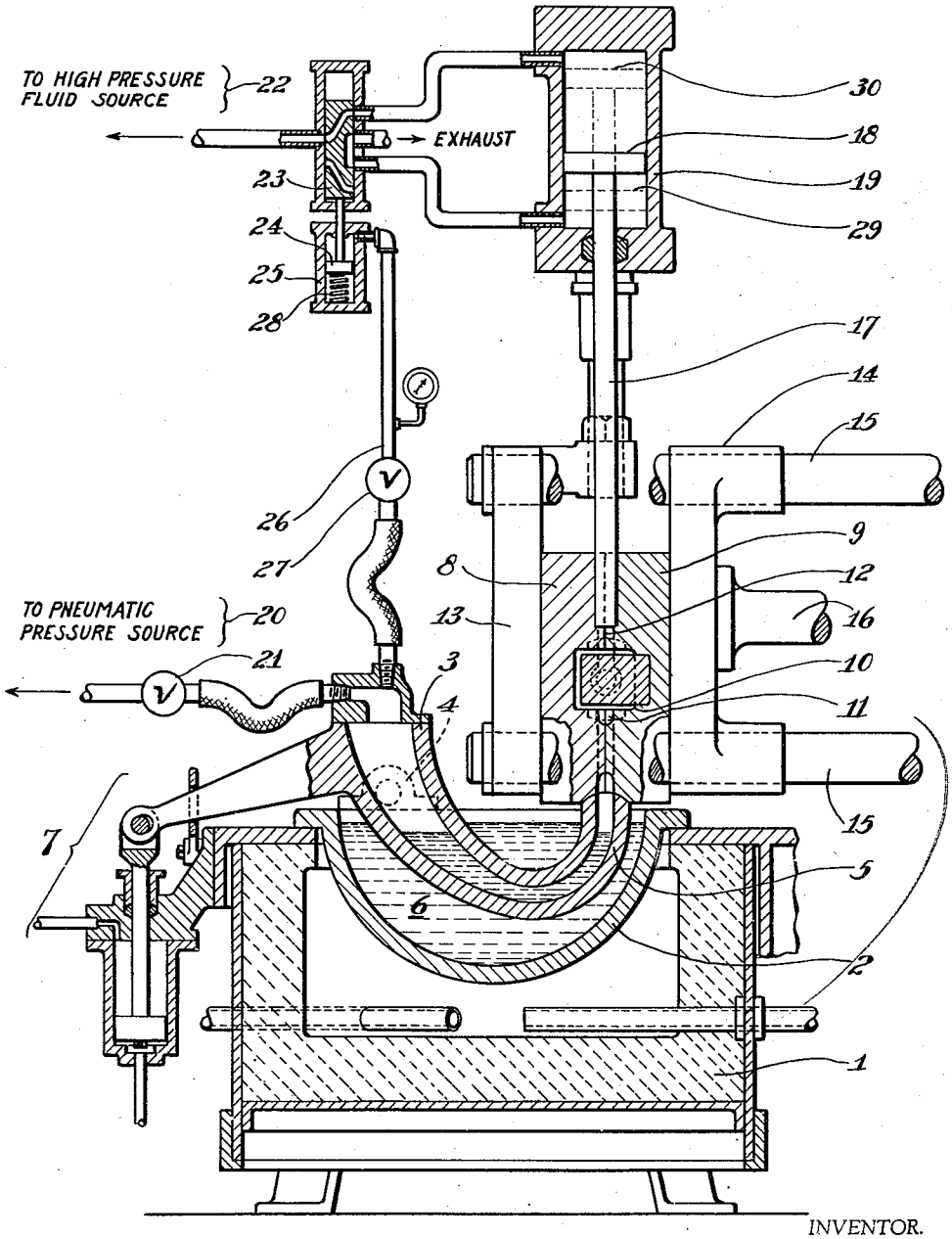
Nov. 28, 1939. J. N. SMITH 2,181,157

METHOD AND APPARATUS FOR PRESSURE CASTING

Filed Nov. 16, 1938 4 Sheets-Sheet 1

Fig. 1.



INVENTOR.
JAMES N. SMITH.

BY

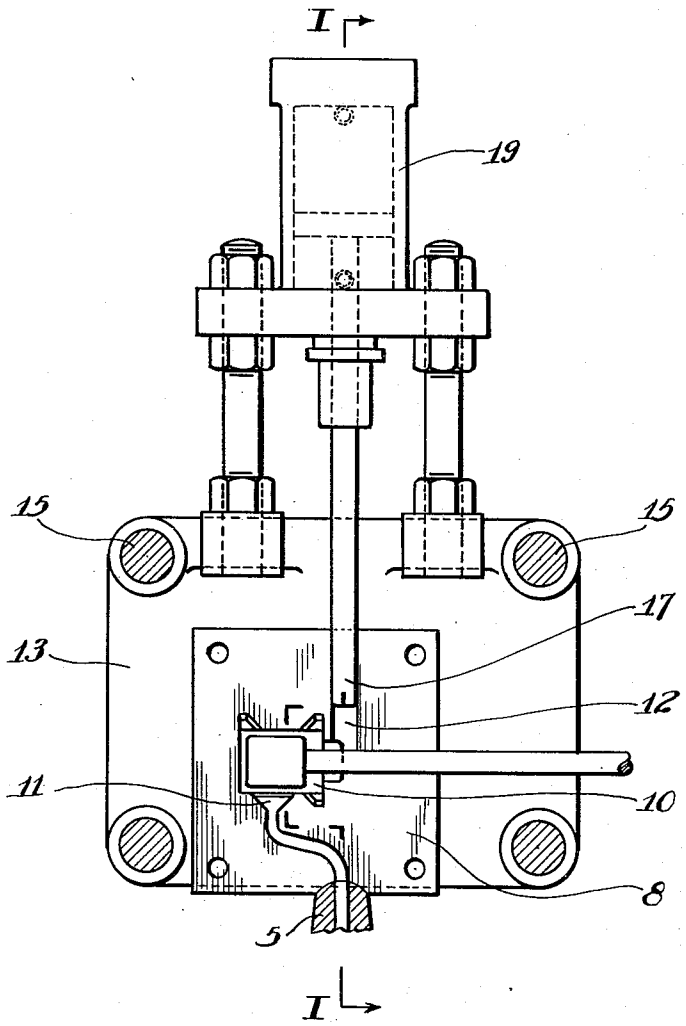
ATTORNEY.

Nov. 28, 1939. J. N. SMITH 2,181,157

METHOD AND APPARATUS FOR PRESSURE CASTING

Filed Nov. 16, 1938 4 Sheets-Sheet 2

Fig. 2.



INVENTOR.
JAMES N. SMITH.

BY

ATTORNEY.

Nov. 28, 1939. J. N. SMITH 2,181,157

METHOD AND APPARATUS FOR PRESSURE CASTING

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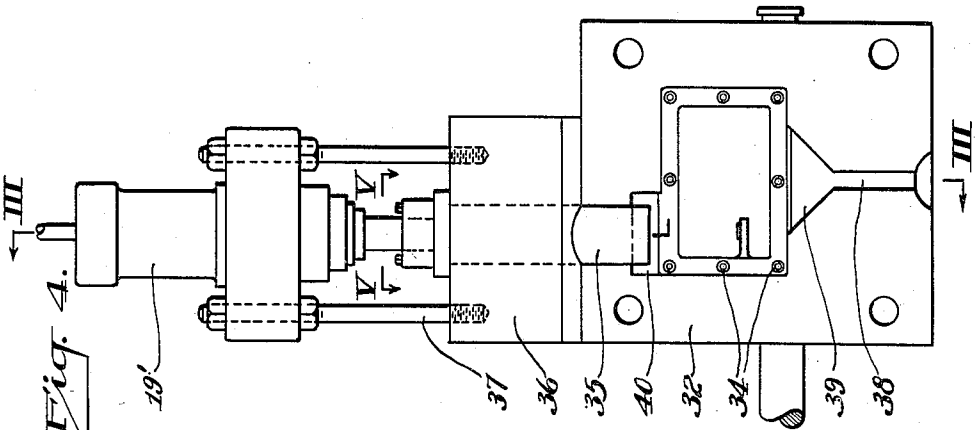


Fig. 4.

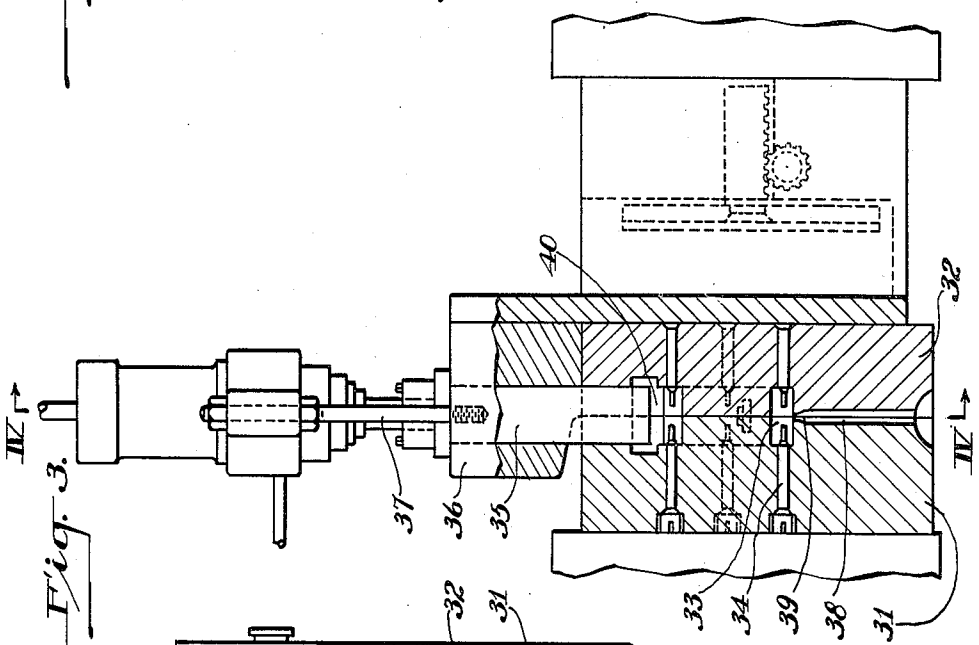


Fig. 3.

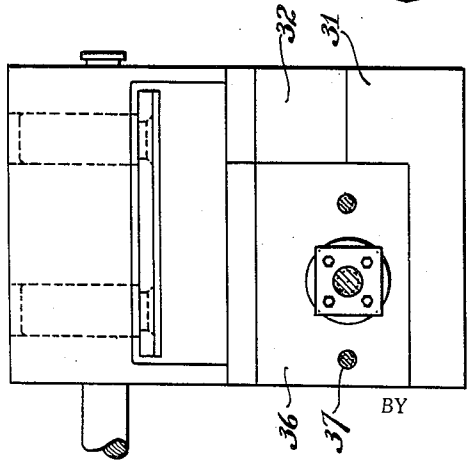


Fig. 5.

INVENTOR.
JAMES N. SMITH.
BY
ATTORNEY.

Nov. 28, 1939. J. N. SMITH 2,181,157

METHOD AND APPARATUS FOR PRESSURE CASTING

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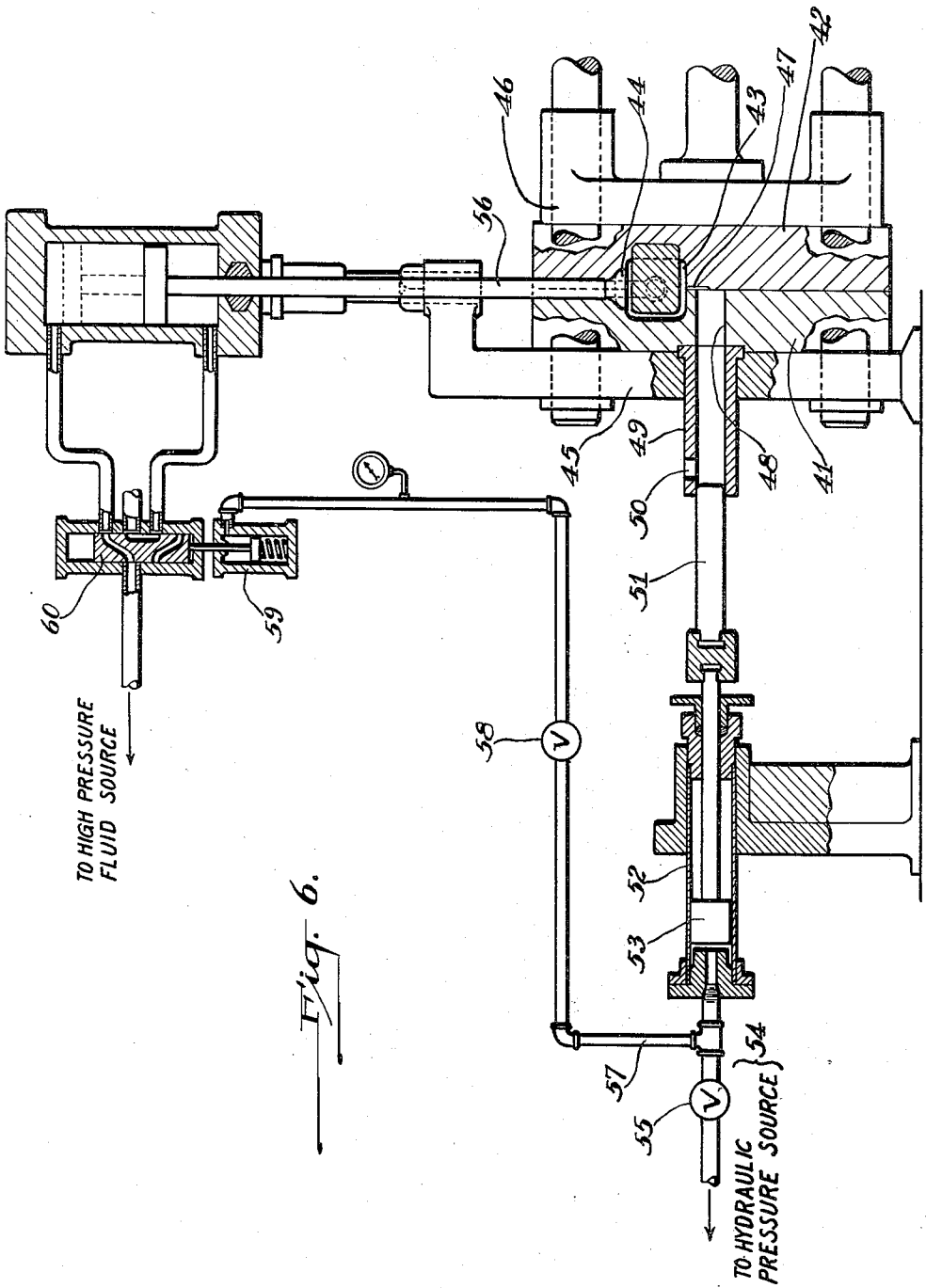


Fig. 6.

INVENTOR.
JAMES N. SMITH.

BY

ATTORNEY.

Patented Nov. 28, 1939

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UNITED STATES PATENT OFFICE

2,181,157

METHOD AND APPARATUS FOR PRESSURE CASTING

James N. Smith, Westfield, N. J., assignor to Aluminum Company of America, Pittsburgh, Pa., a corporation of Pennsylvania

Application November 16, 1938, Serial No. 240,713

16 Claims. (Cl. 22—68)

The invention relates to casting metals under pressure or die casting as distinguished from sand casting and permanent mold casting. The method and apparatus herein disclosed are useful in the pressure casting of aluminum, magnesium, tin, zinc, lead, and the like. The invention is especially applicable to the casting of the higher melting point metals in this series, aluminum and magnesium, and will be described principally with reference to the former. This application is a continuation-in-part of my application Serial No. 99,947, filed September 9, 1936.

Pressure castings of the type referred to in the art as die castings generally are produced with machines falling into one or the other of two general classes, known as the "plunger" and "gooseneck" types. The latter is the conventional type for die casting aluminum and its alloys. Machines of this type utilize a trunnioned ladle or pressure chamber shaped like a gooseneck arranged for immersion in molten metal contained in a melting pot and for movement into engagement with the inlet port or gate of the mold. Such machines usually operate at pressures of about 300 to 600 pounds per square inch, being limited in this respect by the hazards attendant upon handling air at higher pressures as well as the excessive cost of higher compression. The air pressure acts directly against the molten metal in the charging chamber or gooseneck, and the metal is thus rapidly and forcibly injected into the mold through a restricted gate opening. Casting the metal with apparatus of this type possesses recognized advantages over permanent mold casting where the castings to be produced are of intricate design, or have thin sections, or must have a smooth surface or sharp definition at the corners and edges, or must be held to close dimensional tolerances, etc. An important feature of the pneumatic die casting method is that a restricted gate opening is employed through which the metal may be fed into the mold cavity, with controlled flow, at a point adjacent a portion of the cavity which forms a thin-walled section, which is frequently desirable. When the sprue is removed from the casting the cleaning and finishing operations can be performed more economically and satisfactorily by reason of the restricted gate employed in the casting operation.

While die castings produced in the conventional manner discussed above possess advantages of definite surface structure, good definition, the rapidity with which they may be produced, and resultant low cost, the heavier sections of such castings are normally quite porous toward the center. There are several reasons for this

(1) The mold acts as a chill, and, in order to fill the mold cavity before the metal solidifies in any one portion of the cavity, the casting operation must be performed rapidly, the metal entering the die through the restricted gate at high velocity. The flow of the metal through the restricted gate at this high velocity creates turbulence in the metal stream, trapping air in the walls of the casting and resulting in the formation ofblow holes. The provision of air vents in the die is only partially effective in alleviating this condition.

(2) It is necessary to apply a lubricant to the walls of the mold cavity to prevent adhesion of the molten metal. This lubricant vaporizes, and some of the vapor is trapped in the walls of the casting, resulting in the formation of blow holes.

(3) Since the mold acts as a chill, the metal in contact with the surfaces of the mold cavity and cores solidifies first, the metal farthest from these surfaces being the last to solidify. The metal shrinks as it solidifies which results in the formation of voids in those portions of the casting which are remote from the chill surfaces. Thus, while shrink spots are seldom present on the surface of a properly gated and vented die casting, they do occur in the central portions thereof.

A considerable amount of development work has been done in an effort to decrease the interior porosity of die castings produced in the manner described. Those who have attempted the solution of the problem have recognized that the amount of pressure used has a material effect on the density of the cast metal, the density being increased as the pressure increases. The limitations upon the pressure which is practicable with the pneumatic or gooseneck type of machine have been pointed out hereinabove. Higher pressures are attainable in the type of machine which utilizes a mechanical pump submerged in a pot of molten metal, this pump consisting of a cylinder and piston arrangement in which the cylinder is provided with an inlet port located below the level of the metal in the pot and a passage leading into the gate of the mold. This type of machine usually produces metal pressures of 1,000 to 1,500 pounds per square inch, and is commonly used for low melting point metals, such as tin, lead, and zinc base alloys. It has not been found practicable for use with aluminum or other relatively high melting point die casting metals and alloys, because of the diffi-

culties experienced with the cylinder and plunger when in contact with these metals at the higher casting temperatures. Some of these higher melting point alloys have a corrosive action on the pump, which is a disadvantage.

Other forms of apparatus have been devised for casting metals under the desired higher pressures. The most successful of these have employed a cylinder into which the metal is ladled and then forced into the mold by a plunger reciprocating in the cylinder. This form of apparatus likewise possesses serious disadvantages. It is expensive to operate because it is slow, and because of the necessity of ladling the metal into the cylinder by hand for each casting operation. Furthermore, it has been found that it is necessary to use large gate and vent openings, the metal being in a "pasty" condition. These are expensive to remove from the casting, and leave objectionable blemishes. Another difficulty which has been encountered is that large or complex castings cannot be made, solidification occurring before the mold cavity is completely filled. Lastly, it has been found that heavy sections of the casting which are not in close proximity to the gate will be porous.

Thus, it will be seen that the methods and apparatuses which have been devised heretofore with view to obviating porosity in die castings in each case have either presented disadvantages of equally serious or more serious a character, or sacrificed advantages inherent in the more conventional die casting procedure. As has been noted, the latest attempt to devise a high-pressure casting machine with the object of decreasing porosity has resulted in a machine which sacrifices (1) the economy and speed of operation of the gooseneck type of machine, (2) the possibility of using restricted gate and vent openings, and (3) adaptability to the production of large and complex castings.

It is an object of my invention to provide a high-pressure die casting method and apparatus which retain the aforesaid advantages of the pneumatic or gooseneck type of machine, and yet make it possible to produce castings of decreased porosity. I aim to provide a die casting method which combines the advantages of pneumatic pressure casting (as performed with a gooseneck type of machine) with the principal advantages of applying a very high pressure to the cast metal (as accomplished with a high-pressure apparatus described hereinabove).

I am aware that it has been proposed heretofore to inject metal into a mold at low velocity by gravity feeding, or by creating a vacuum in the mold, or by applying a small pressure behind the metal, and thereafter compressing the metal in the mold by means of a plunger, thus broadly disclosing the feeding of the metal into the mold by one means and compressing it by another. These, however, are merely modified permanent mold processes in which the metal flows into the mold at low velocity through an unrestricted gate, and castings having thin-walled sections cannot be produced satisfactorily, while those which can do not possess the desirable characteristics of die castings as to surface density, sharpness of definition, and so on. These proposals are not within the purview of my invention which has the more specific object of combining the step of introducing the metal at high velocity through a restricted gate with the subsequent step of applying pressure to the metal so introduced into the mold cavity. A more specific object of the invention resides in the provision of a method comprising the steps described in which the second step of applying additional pressure is so carried out as to act directly against a thick-walled portion of the casting.

Another object is to provide a method of producing a die or pressure casting having a thin-walled section and a thick-walled section which comprises injecting molten metal under pneumatic pressure through a restricted gate into a portion of the mold cavity which is to form a thin-walled section, and after the metal in the restricted gate freezes applying a substantially greater pressure directly to a thick-walled section of the cast metal. A further specific object is to provide apparatus which is adapted to coordinate the operation of the means for injecting the metal under pneumatic pressure and the means for applying additional pressure thereafter, rendering the operation of the last-named means automatic.

Other objects and advantages will appear upon consideration of the following description of the invention as read in conjunction with the drawings in which:

Fig. 1 is a vertical sectional view, taken as indicated by the line I—I in Fig. 2, showing apparatus suitable for carrying out my novel method, including a schematic representation of means for coordinating the two pressure-applying steps of the method; Fig. 2 is a vertical sectional view of a part of the apparatus shown in Fig. 1, taken at the plane of parting of the mold;

Fig. 3 is a vertical sectional view, similar to Fig. 1 and taken as indicated by the line III—III in Fig. 4, of another embodiment of the apparatus suitable for carrying out the method wherein core members are utilized in performing the second pressure-applying step; Fig. 4 is a vertical sectional view taken on the line IV—IV of Fig. 3; Fig. 5 is a horizontal sectional view taken on the line V—V of Fig. 4; and Fig. 6 is a vertical sectional view similar to Fig. 1, but showing the invention as applied to apparatus using different means for injecting the metal into the mold cavity.

According to my invention metal is injected forcibly and at high velocity through a restricted gate into a mold cavity. The use of a restricted gate is essential to the attainment of the advantages I have enumerated. A confined body of the molten metal is thus injected into the mold cavity under a pressure (preferably pneumatic) of not less than 250 pounds per square inch. Higher pressures may be employed up to about 600 pounds per square inch, or even higher in some cases, but I prefer to use a pressure of 500 pounds per square inch. The metal in the restricted gate is then allowed to freeze. (This normally requires but a fraction of a second.) Thereafter, but before the cast metal in the mold cavity has completely solidified, the cast metal is subjected to further pressure. This further pressure may be applied by any suitable apparatus, and should be applied directly to a portion of the cast metal the position of which is removed from the gate. Preferably it should be applied to a thick-walled section of the cast metal so as to insure feeding of the metal to the interior of the thick-walled section during solidification, thereby taking care of the shrinkage which occurs as the metal cools. The pressure applied in this step of the method should be on the order of 1,000 to 10,000 pounds per square inch, or greater. There are two aspects to the

concept here involved: one is the injection of the metal at high velocity, followed by pressure feeding at a point removed from the gate, and the other is the injection of the metal at high velocity and under substantial pressure, followed by the application of a greater pressure to the cast metal.

I shall now describe one form of apparatus which is suitable for carrying out this method.

In Fig. 1 there is shown a furnace 1 in which is disposed a melting pot 2. Arranged in and above the melting pot 2 is a trunnioned ladle or pressure chamber 3 adapted for oscillation in the trunnion supports 4 alternately to submerge its nozzle 5 below the surface of the molten metal 6 in the melting pot 2, and then to bring the nozzle 5 into charging engagement with the gate of a mold. In the embodiment illustrated, the pressure chamber 3 is in the form of a conventional gooseneck, and its oscillation in the trunnion supports 4 may be accomplished by suitable actuating mechanism such as that represented generally by the reference numeral 7 and consisting of a cylinder and piston arrangement adapted for fluid operation and control.

The mold as represented comprises complementary metal dies 8, 9 providing therebetween a casting cavity 10 connected to an inlet port or gate 11 and to a riser 12 disposed adjacent a portion of the mold cavity which is to form a thick-walled portion of the casting and at a point removed from the gate 11. Dies 8, 9 are supported above the melting pot 2 in a position to register with the nozzle 5 of the gooseneck 3, the fixed die 8 being secured to the stationary platen 13, and the movable die 9 being secured to the reciprocable platen 14 mounted on the rods 15 constituting a part of the main frame assembly of the casting unit. The opening and closing of the die may be accomplished through the hydraulic plunger 16.

Arranged in communication with the riser 12 is a high-pressure plunger 17 adapted for hydraulic operation by means of the piston 18 and cylinder 19. The upper end of the gooseneck 3 is connected to a pneumatic pressure source 20, controlled by the operating valve 21. The hydraulic cylinder 19 is in communication at either end with a high-pressure fluid source 22, controlled by the slide valve 23 which alternately admits the operating fluid to the upper and lower sides of the piston 18. The slide valve 23 is arranged for operation by a piston 24 within the auxiliary cylinder 25, this auxiliary cylinder being in communication with the upper end of the gooseneck 3 through the pipe 26 and reducing valve 27. The slide valve 23 is arranged to be returned into its upper position in any convenient manner, as by the spring means 28 disposed between the piston 24 and the end of the auxiliary cylinder 25.

My novel method is performed in this embodiment of the apparatus as follows:

With the dies 8, 9 in the position shown in Fig. 1, the gooseneck 3 is lowered to submerge its nozzle 5 below the level of the molten metal 6 in the melting pot 2, whereupon it receives a charge of molten metal for delivery to the mold. The nozzle 5 is then brought into registry with the inlet port of the mold as shown. With the high-pressure plunger 17 withdrawn sufficiently to allow the metal access to the riser 12 (i. e., in the position shown in Fig. 1), the gooseneck operating valve 21 is opened to admit air into the pressure chamber above the charge of metal. The pressure used must be sufficiently high to cause rapid injection of the metal into the casting cavity 10; for aluminum, preferably at a pressure of about 500 pounds per square inch or between about 250 and 600 pounds per square inch. The application of pneumatic pressure is continued until the mold cavity 10 and riser 12 are filled. Thereafter, the slide valve 23 is brought into the position shown in Fig. 1 to admit the high-pressure operating fluid to the upper side of the piston 18, forcing the plunger 17 downwardly against the metal in the riser 12 to feed metal into the aforesaid thick-walled section of the casting.

In the embodiment illustrated in Fig. 1, the slide valve 23 is actuated by pneumatic pressure in the charging chamber, acting through the reducing valve 27. I have found that the time lag produced by the interaction of the air pressure in the chamber of the gooseneck 3 through the reducing valve 27, connecting pipes, auxiliary cylinder 25, slide valve 23, high-pressure cylinder 19, and plunger 17 ordinarily is sufficient to produce the desired timing, allowing the metal injected through the gooseneck 3 to fill completely the casting cavity 10 and riser 12 before the hydraulic plunger 17 comes down against the metal in the riser to feed and compress the metal during solidification. It will be understood, however, that suitable auxiliary mechanical or electrical delay means may be employed between the gooseneck 3 and auxiliary cylinder 25 in order to permit adjustment of the time interval to suit any given set of casting conditions, thus insuring that the hydraulic plunger is brought into operation at exactly the right moment, while retaining the feature of automatic operation of both the gooseneck and high-pressure plunger upon opening the single valve 21. With proper timing, the high-pressure plunger 17 exerts a compressing force directly against the metal in the riser 12 just as the metal in the restricted gate 11 of the mold 8, 9 freezes.

The dot-dash lines 29 in Fig. 1 indicate the lowermost position of the piston 18, and the dot-dash lines 30 indicate its uppermost position. In the operation of a given casting cycle the actual movement of the piston 18 is much less than would be indicated by the limiting positions 29 and 30. The intermediate or full line position and lowermost position for a given casting cycle are determined in accordance with the position of the casting cavity and connecting riser, and the size of the casting cavity. The uppermost position 30 of the piston 18 should be high enough to allow the lower end of the plunger 17 to clear the top of the mold 8, 9, thus to permit ready cleaning of the mold and make it convenient to change dies.

It is not always necessary that a riser—in the ordinary meaning of the term—be employed. The principal advantages of my invention may be attained with a construction in which the final high pressure is applied through the medium of a movable core. Such a modification is illustrated in Figs. 3–5, in which, to avoid duplication, the furnace, melting pot, gooseneck, and valve mechanism have been omitted. The die sections 31, 32 provide therebetween a casting cavity 33, into which project core members 34. At the top of the casting cavity 33, and adjacent a portion thereof which is to form a thick-walled section of the casting 40, there is provided a large retractable core 35. Core 35 extends upwardly through a supporting member 36 mounted above the mold. Rigidly secured to the supporting

member 36 by means of tie rods 37 is a hydraulic cylinder 19' corresponding to the cylinder 19 of Figs. 1 and 2. The casting cavity 33 is fed through the gate 38 and restricted opening 39.

The operation of this embodiment of the apparatus is the same as that described in connection with Figs. 1 and 2. At the beginning of the casting cycle, the core or plunger 35 is withdrawn a predetermined amount from the position shown in the drawings, so that the metal injected into the casting cavity 33 initially fills up the heavy section 40 of the casting cavity. Immediately this has occurred and the metal in the restricted gate 39 freezes, the core 35 is forced downwardly into the heavy section 40, compressing the metal therein to feed it into the casting cavity 33 during solidification of the casting. The extent to which the core 35 should be withdrawn at the beginning of the casting cycle is determined in accordance with the size and shape of the casting which is to be produced, and also in accordance with the amount of solidification shrinkage which is to be expected, as determined from practice. The core 35 is demountable from the hydraulic cylinder and plunger 19' so as to permit cores of other sizes and shapes to be substituted as may be desired in accordance with the form of the casting to be produced. The core 35 serves to simultaneously form a core impression in the casting and exert a substantially greater pressure on the cast metal, maintaining this greater pressure during solidification of the casting.

Although the invention has been illustrated in Figs. 1–5 as applied to the pneumatic type of die casting machine, and is particularly applicable to such machines, the invention may also be utilized advantageously in die casting machines in which the molten metal is forced into the mold by means other than pneumatic pressure. Such a modification is illustrated in Fig. 6, which is similar to Fig. 1 except that the gooseneck and other apparatus for forcing the molten metal into the mold cavity have been replaced by a cylinder and a hydraulically operated pressure plunger. In this modification the die sections 41 and 42 form the casting cavity 43 at the top of which is a riser 44, positioned adjacent to a portion of the mold cavity which is adapted to form a thick-walled portion of the casting. The fixed die 41 is secured to the stationary platen 45, and the movable die 42 is secured to the reciprocable platen 46. The casting cavity 43 is connected to a gate 47 which communicates with the orifice 48 in the fixed die 41, which orifice is in registration with the bore of the cylinder 49. The cylinder 49 is secured to the platen 45 and is provided with an opening 50 through which a charge of molten metal may be poured into the cylinder. The pressure plunger 51 is mounted for reciprocation in the cylinder 49 and is adapted to be actuated by means of the hydraulic cylinder 52 and piston 53, the hydraulic cylinder 52 being in communication with a hydraulic pressure source 54 controlled by the operating valve 55. A high-pressure plunger 56 is mounted in communication with the riser 44. The hydraulic pressure source 54 is in communication, by means of a pipe 57 and the reducing valve 58, with the auxiliary cylinder 59. The slide valve 60 controls the hydraulic operation of the plunger 56 in the same manner as has been described with reference to Fig. 1, for which reason a description of the mechanism involved is not repeated.

In this modification my method is performed as follows:

With the high-pressure plunger 56 withdrawn a predetermined amount so as to allow the molten metal being cast to have access to the riser 44, and with the plunger 51 in a retracted position, a charge of molten metal is poured into the cylinder 49. While the metal in the cylinder is still molten, the operating valve 55 is opened to admit fluid into the hydraulic cylinder 52. The pressure used may be much higher than that ordinarily used in pneumatic machines; for most purposes a pressure of between 2,000 and 10,000 pounds per square inch is sufficient. The movement of the piston 53 forces the plunger 51 to move forward and inject the molten metal into the casting cavity 43 and riser 44. When this has occurred and the metal in the gate 47 solidifies, the high-pressure plunger 56 is forced downwardly into the riser 44 by reason of the operation of the valve mechanism 60, forcing the metal from the riser into the casting cavity and compressing the metal. In this modification the pressure applied by the high-pressure plunger 56 should be substantially greater than that applied by the plunger 51 in order to obtain a denser and less porous casting than would otherwise result.

The modification of the invention described with reference to Figs. 3–5, in which the high-pressure plunger acts as a core, is, of course, adaptable to the modification which is described with reference to Fig. 6.

The embodiments which have been described are adapted to the performance of a casting cycle in which the metal is injected into the mold through a restricted gate at high velocity by the application of pressure directly to a confined body of metal, followed by the application of a substantially greater pressure at a point closely adjacent a thick-walled section of the cast metal, to feed metal thereinto during solidification of the casting. Castings can be produced in accordance with my invention which have the characteristic thin-walled sections and intricate design found only in die castings, yet with greatly decreased porosity over die castings produced in accordance with methods heretofore known. The castings have a smooth surface, sharp definition at the corners and edges, and can be held to close dimensional tolerances. The combination of these well known advantages with the speed of operation common to conventional die casting practice and the improved interior metal structure characterized by greatly decreased porosity can be achieved by following the method I have outlined, as performed with the apparatus described in connections with the specific embodiments.

The term "molten metal" as used throughout the specification and claims is intended to include metal in what is sometimes referred to as a "pasty" condition, i. e., the condition obtaining when the metal is very close to its melting point.

My invention has been described herein with reference to specific and preferred embodiments in order that it may be fully understood. It will be apparent that those skilled in the die casting art that various changes may be made without departing from the scope of the claims. For example, the valve 23 may be arranged for manual operation. The method and apparatus are adapted for application to center-gated as well as edge-gated molds.

I claim:

1. Method of making castings having a thin-walled section and a thick-walled section which comprises injecting molten metal into a metallic mold through a restricted gate by applying pneumatic pressure directly to a confined body of the molten metal, continuing the application of pneumatic pressure until the mold cavity is filled, sealing the gate by solidification of the metal therein, and thereafter applying a substantially greater pressure at a point closely adjacent a thick-walled section of the cast metal to feed metal thereinto during solidification of the casting.

2. Method of pressure casting which comprises injecting molten metal through a restricted gate into a metallic mold by applying pneumatic pressure directly to a confined body of the molten metal, continuing the application of pneumatic pressure until the mold cavity and a connecting riser are filled, sealing the gate by freezing of the metal therein, and after the metal in the restricted gate begins to freeze applying a substantially greater pressure to the metal in the mold cavity by a compressing force acting directly against the metal in said riser.

3. Method of pressure casting which comprises injecting molten metal through a restricted gate into a metallic mold by applying pneumatic pressure directly to a confined body of the molten metal, continuing the application of pneumatic pressure until the mold cavity is filled, sealing the gate by freezing of the metal therein, and after the metal in the restricted gate begins to freeze forcing a core member into the cast metal in the mold cavity to simultaneously form a core impression in and exert a substantially greater pressure on said cast metal, and maintaining said greater pressure through the force applied to said core member during solidification of the casting.

4. Method of making castings having a thin-walled section and a thick-walled section which comprises injecting molten metal into a metallic mold through a restricted gate by applying pneumatic pressure directly to a confined body of the molten metal, continuing the application of pneumatic pressure until the mold cavity and a riser directly connected to a portion of the mold which forms a thick-walled section are filled, sealing the gate by freezing of the metal therein, and after the metal in the restricted gate begins to freeze applying a substantially greater pressure to the metal in the mold cavity by a compressing force acting directly against the metal in said riser to feed metal back into said thick-walled section during solidification of the casting.

5. Method of making castings having a thin-walled section and a thick-walled section which comprises injecting molten metal into a metallic mold through a restricted gate by applying pneumatic pressure directly to a confined body of the molten metal, continuing the application of pneumatic pressure until the mold cavity is filled, sealing the gate by freezing of the metal therein, and after the metal in the restricted gate begins to freeze forcing a core member into a thick-walled section of the cast metal to simultaneously form a core impression in said thick-walled section and exert a substantially greater pressure on said cast metal, and maintaining said greater pressure through the force applied to said core member during solidification of the casting.

6. Method of pressure casting which comprises injecting molten metal into a metallic mold through a gate by applying directly to a confined body of the molten metal a pressure of 250 to 600 pounds per square inch, sealing the gate by solidification of the metal therein, and during the solidification of the metal so cast in the mold applying thereto a pressure of at least 1,000 pounds per square inch.

7. Method of making castings having a thin-walled section and a thick-walled section which comprises injecting molten metal into a metallic mold through a restricted gate by applying pressure directly to a confined body of the molten metal, continuing the application of such pressure until the mold cavity is filled, sealing the gate by solidification of the metal therein, and thereafter applying a substantially greater pressure at a point closely adjacent a thick-walled section of the cast metal to feed metal thereinto during solidification of the casting.

8. Method of making castings having a thin-walled section and a thick-walled section which comprises injecting molten metal into a metallic mold through a gate by applying pressure directly to a confined body of the molten metal, continuing the application of such pressure until the mold cavity is filled, sealing off a thick-walled section of the cast metal by solidification of the metal in a thin-walled section of the cast metal arranged between the said thick-walled section and the gate, and thereafter applying a substantially greater pressure to said thick-walled section to feed metal thereinto during solidification of the casting.

9. Apparatus for the pressure casting of metal comprising a a metallic mold having a casting cavity therein, said cavity having a portion adapted to the formation of a thin-walled section and another portion adapted to the formation of a thick-walled section, an inlet for molten metal, said inlet being connected to the cavity by a restricted gate, a feeder directly connected to said second-named portion by an unrestricted opening, said unrestricted opening being substantially larger than said restricted gate, means for rapidly introducing molten metal under pneumatic pressure acting directly thereagainst, and means for applying pressure to the metal in said feeder, said restricted gate having a cross-sectional dimension substantially smaller than the greatest cross-sectional dimension of the said second-named portion of the casting cavity, whereby the molten metal first solidifies within the restricted gate.

10. Apparatus for the pressure casting of metal comprising a metallic mold having a casting cavity therein, said cavity having a portion adapted to the formation of a thin-walled section and another portion adapted to the formation of a thick-walled section, an inlet for molten metal, said inlet being connected to the cavity by a restricted gate, means for rapidly introducing molten metal through said inlet and gate into said cavity, said means including pneumatic pressure arranged to act directly against the molten metal, and means including a core member arranged for reciprocatory movement in said second-named portion to apply pressure to the cast metal during solidification thereof, said restricted gate having a cross-sectional dimension substantially smaller than the greatest cross-sectional dimension of the said second-named portion of the casting cavity, whereby the molten metal first solidifies within the restricted gate.

11. Apparatus for the pressure casting of metal comprising a metallic mold having a casting cavity therein, said cavity having a portion adapted to the formation of a thin-walled section and

another portion adapted to the formation of a thick-walled section, an inlet for molten metal, said inlet being connected to said first-named portion of the cavity by a restricted gate having a cross-sectional dimension substantially smaller than the greatest cross-sectional dimension of the second-named portion of the casting cavity, whereby molten metal first solidifies within the restricted gate, means for rapidly introducing molten metal through said inlet and gate into said cavity, said means including pneumatic pressure arranged to act directly against the molten metal, and means connected to said second-named portion of the casting cavity for applying pressure to the cast metal during solidification thereof, said last-named means including a valve mechanism operated by pressure passing through a pressure conduit in direct communication with the pneumatic pressure of said first-mentioned means, whereby the last-mentioned means may be brought into operation automatically.

12. Apparatus for the pressure casting of metal comprising a metallic mold having a casting cavity therein, said cavity having a portion adapted to the formation of a thin-walled section and another portion adapted to the formation of a thick-walled section, an inlet for molten metal, said inlet being connected to the first-named portion of the cavity by a restricted gate having a cross-sectional dimension substantially smaller than the greatest cross-sectional dimension of the second-named portion of the casting cavity, whereby molten metal first solidifies within the restricted gate, means for rapidly introducing molten metal through said inlet and gate into said cavity, said means including pneumatic pressure arranged to act directly against the molten metal, means connected to said second-named portion of the casting cavity for applying pressure to the cast metal therein during solidification thereof, said last-named means including a valve mechanism operated by pressure passing through a pressure conduit in direct communication with the pneumatic pressure of said first-mentioned means, and adjustable means for delaying the operation of said valve mechanism, whereby the application of the final pressure to the cast metal may be effected automatically after a predeterminable time interval has elapsed following the application of said pneumatic pressure.

13. Apparatus for the pressure casting of metal comprising a mold with a casting cavity, a pneumatic pressure charging chamber, a pressure plunger communicating with said casting cavity, and means for controlling movement of said pressure plunger including a valve mechanism directly operated by pneumatic pressure passing through a pressure conduit in direct communication with the pneumatic pressure in said charging chamber.

14. Apparatus for the pressure casting of metal comprising a metallic mold having a casting cavity therein, said cavity having a portion adapted to the formation of a thin-walled section and another portion adapted to the formation of a thick-walled section, a gate for molten metal, means for introducing molten metal through said gate into said cavity, and means connected to said second-named portion for applying pressure to the cast metal at a point removed from said gate during solidification of the metal, said gate having a cross-sectional dimension substantially smaller than the greatest cross-sectional dimension of the said second-named portion of the casting cavity, whereby the molten metal first solidifies within the gate.

15. Apparatus for the pressure casting of metal comprising a metallic mold having a casting cavity therein, said cavity having a portion adapted to the formation of a thin-walled section and another portion adapted to the formation of a thick-walled section, a gate for molten metal, means for introducing molten metal through said gate into said cavity, and means connected to said second-named portion for applying pressure to the cast metal at a point removed from said gate during solidification of the metal, a portion of the casting cavity adapted to the formation of a thin-walled section being arranged between said gate and the point where said pressure is applied and having a cross-sectional dimension substantially smaller than the greatest cross-sectional dimension of the portion of the casting cavity where said pressure is applied.

16. Apparatus for the pressure casting of metal comprising a metallic mold having a casting cavity therein, said cavity having a portion adapted to the formation of a thin-walled section and another portion adapted to the formation of a thick-walled section, a gate for molten metal, means for introducing molten metal through said gate into said cavity, said means including a cylinder and a plunger reciprocable therein, and means connected to said second-named portion for applying pressure to the cast metal at a point removed from said gate during solidification of the metal, said gate having a cross-sectional dimension substantially smaller than the greatest cross-sectional dimension of the said second-named portion of the casting cavity, whereby the molten metal first solidifies within the gate.

JAMES N. SMITH.