Feb. 13, 1945. P. CAMPBELL 2,369,277

APPARATUS FOR CASTING METALS

Filed April 14, 1943 3 Sheets-Sheet 1

Fig. 1.

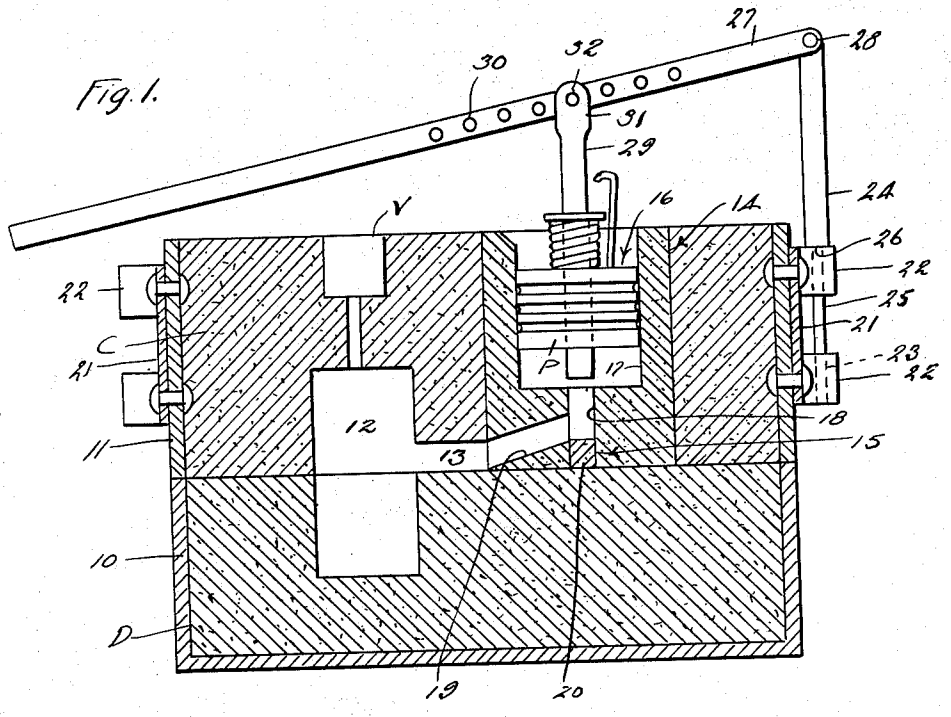


Fig. 2.

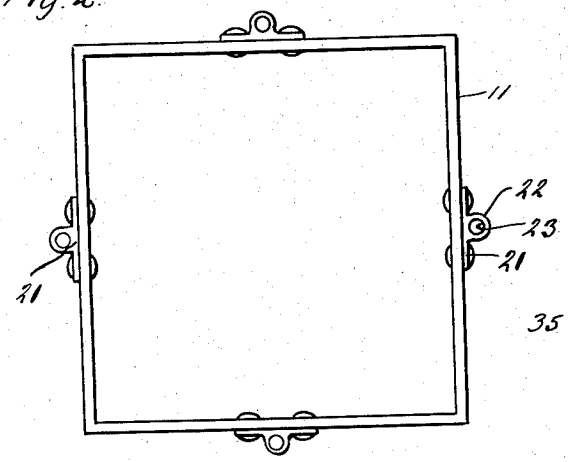
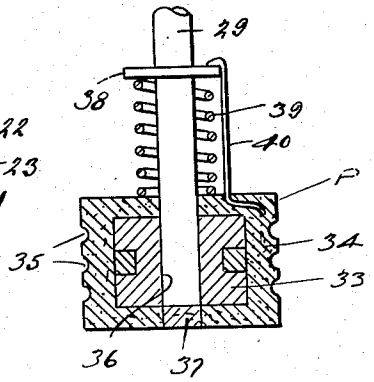


Fig. 3.



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Fig. 4.

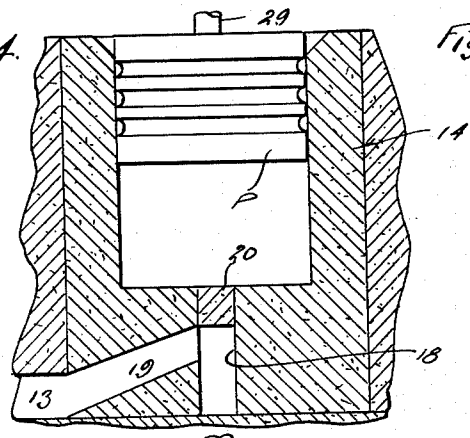


Fig. 5.

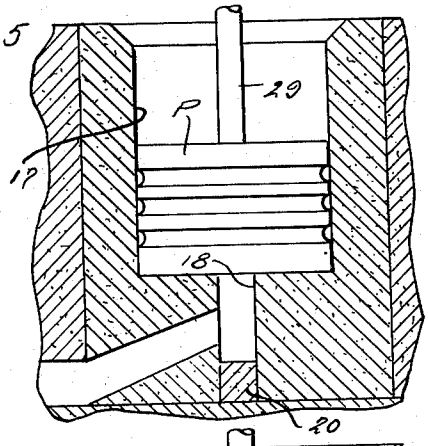


Fig. 6.

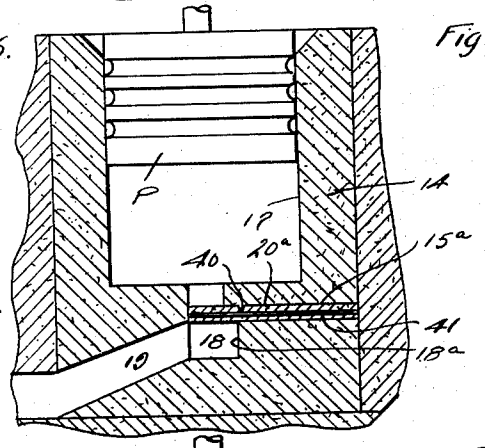


Fig. 7.

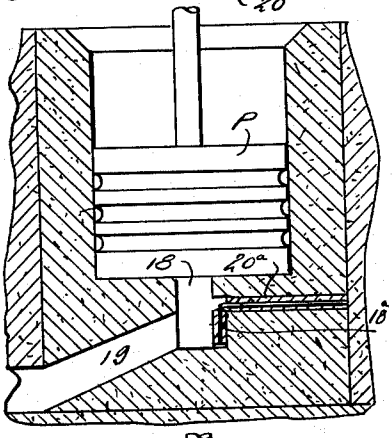


Fig. 8.

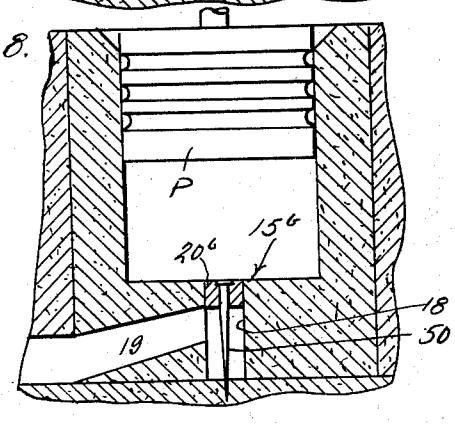
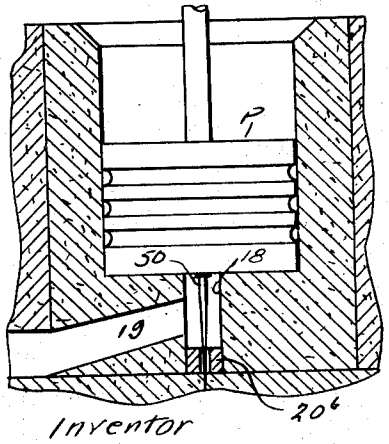


Fig. 9.



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APPARATUS FOR CASTING METALS

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Fig. 10.

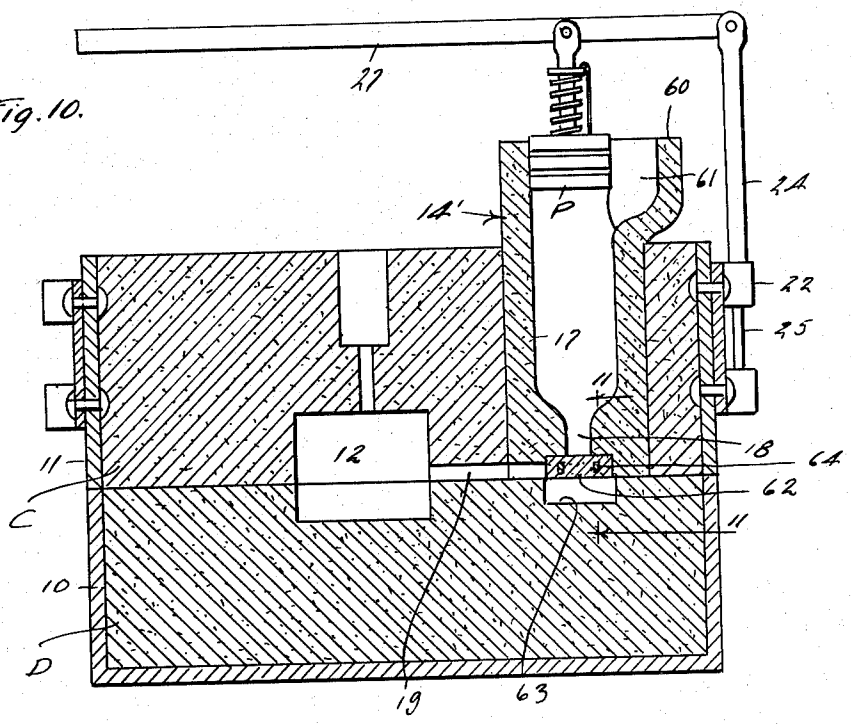
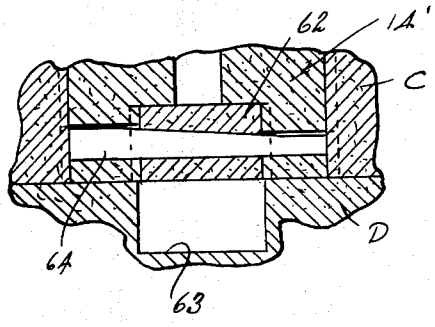


Fig. 11.



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Patented Feb. 13, 1945

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UNITED STATES PATENT OFFICE

2,369,277

APPARATUS FOR CASTING METALS

Phillip Campbell, Whittier, Calif.

Application April 14, 1943, Serial No. 482,989

11 Claims. (Cl. 22—68)

This invention relates to foundry apparatus and practices and relates more particularly to a method and apparatus useful in the casting of iron, steel, brass, bronze and other materials. A general object of the invention is to provide a rapid, economical method and a simple, practical and very effective apparatus for facilitating the successful casting of metals, etc.

In the casting of metals, etc. there is often considerable loss as a result of defective and incomplete castings. The molten metal is allowed to flow into the mold cavity under the influence of gravity only, and in many instances the metal fails to completely occupy the mold cavity, leaving voids, blowholes and incomplete parts on the casting. This is particularly true in the case of intricate castings and the above mentioned difficulty forms a definite limit on the shape and types of castings that can be successfully produced commercially. Certain methods have been developed to meet the problem but so far as I am aware none of them has been practical or successful. Such prior methods with which I am familiar do not impose any positive or applied pressure on the molten metal introduced into the mold cavity and have the marked disadvantage of necessitating the pouring of a large excess of the molten metal.

Another object of this invention is to provide a method for casting metals in which the metal in the mold cavity is subjected to positive or applied pressure so as to be forced into all parts of the cavity to completely occupy the same, thereby eliminating the possibility of voids and incomplete castings.

Another object of this invention is to provide a method of the character mentioned in which the molten metal is caused to suddenly flow into the mold cavity in a mass so that its inertia causes it to reach and occupy all parts of the cavity and the metal is simultaneously and thereafter subjected to positive applied pressure so that it forms a dense, perfect and complete casting.

Another object of this invention is to provide a method of the character mentioned that is very economical, necessitating the pouring of a minimum quantity of the metal or material.

Another object of this invention is to provide apparatus of the character referred to embodying means for initially receiving the molten metal and means for thereafter forcing or delivering the metal to the mold cavity under pressure to cause it to completely occupy the mold cavity.

Another object of this invention is to provide an apparatus of the character mentioned embodying novel means for retaining the molten metal in the initial pouring chamber or cylinder, which means is adapted to open to allow the delivery of the metal to the mold cavity without causing or allowing any foreign matter or parts of the apparatus to reach the mold cavity.

Another object of this invention is to provide an apparatus of the character mentioned that may be employed with standard or conventional foundry flasks and the pouring core or pressure cylinder may be entirely within the cope or mold section.

Another object of this invention is to provide an apparatus of the character mentioned in which the metal receiving cylinder of the device may be positioned in the cope as the same is made up and may be located as found most desirable for the particular operation and the plunger which operates in the cylinder may be adjusted in conformance with the location of the cylinder and may be operated from any selected side of the flask.

A further object of this invention is to provide an apparatus of the character mentioned that is simple and inexpensive to manufacture and that is easy and convenient to employ.

The various objects and features of my invention will be fully understood from the following detailed description of typical preferred forms of apparatus and a typical manner of carrying out the method of the invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is a vertical detailed sectional view of the apparatus of this invention. Fig. 2 is a reduced plan view of the upper mold section or flask. Fig. 3 is an enlarged vertical detailed sectional view of the piston showing the rod in elevation. Fig. 4 is an enlarged fragmentary vertical detailed sectional view illustrating the valve in the closed position. Fig. 5 is a view similar to Fig. 4 showing the valve in the opening position. Figs. 6 and 7 are views similar to Figs. 4 and 5, respectively, illustrating another form of valve means. Figs. 8 and 9 are views similar to Figs. 4 and 5, respectively, illustrating still another form of valve means. Fig. 10 is a view similar to Fig. 1 illustrating another form of the invention, and Fig. 11 is an enlarged, horizontal, detailed sectional view taken as indicated by line 11—11 on Fig. 10.

It is believed that the method will be better understood following a disclosure of the apparatus. Accordingly, I will first proceed with

a detailed description of the apparatus of the invention. The apparatus may be varied considerably to adapt it for use in the casting of metals and materials of different kinds, for use with different classes of foundry equipment and for the casting of objects of different natures and proportions. In the following detailed description I will describe the typical form of the invention illustrated in the drawings, it being understood that the invention is not to be construed as limited or restricted to the specific structure herein disclosed.

In the drawings I have shown two typical mold sections or flasks 10 and 11 arranged in the operative, superimposed relation. The drag D is made up in the lower section 10 and the cope C is made up in the upper section 11. The drag and cope may be typical foundry sand or other selected refractory material and may be made up in the flasks in the conventional manner. It is to be understood that the mold may be formed of plaster or composition. A mold cavity 12 is formed in the cope and drag and has a lateral gate 13 in the cope C at the parting line. A vent or vent device V of selected construction is provided in the cope C to vent the mold cavity. It is to be understood that the cope and drag C and D are tightly engaged and sealed at the line of parting and it may be preferred or necessary to clamp the flasks 10 and 11 together, as will be readily understood by those skilled in the art.

The apparatus of the invention may be said to comprise, generally, a cylinder or body 14 in the cope C for receiving the molten metal, means 15 controlling the discharge or delivery of the metal to the mold cavity 12, and piston means 16 operable in the body 14 to apply pressure to the metal and to force the metal into the cavity 12 under pressure.

The cylinder or body 14 may be formed of baked core sand, ceramic material such as fire clay, or other suitable refractory material. In accordance with the invention the body 14 is a simple, easily constructed part that may be formed entirely of readily available inexpensive material. In practice it will usually be found desirable to form the body 14 of baked core sand and to produce the body in the same manner as a typical core. The body 14 is in the form of a block or cylinder and is set or embedded in the cope C to be in an upright position. I have shown the body 14 of such length that it extends completely through the cope C but it is important to note that the body 14 need not project beyond the upper end of the cope C or the flask 11. The body 14 is arranged in spaced adjacent relation to the mold cavity 12. It is believed that it will be apparent how the body 14 may be readily set or located in the cope C at the selected position when the cope is made up in the flask 11.

The body 14 is provided with an opening 17 for receiving the molten metal and for receiving the piston. The opening 17 extends downwardly from the upper end of the body 14 and is preferably of substantial diameter. The size or fluid capacity of the opening 17 depends on the size of the mold cavity 12. The opening 17 has a fluid capacity somewhat greater than the capacity of the mold cavity 12. It may be preferred to flare the upper end of the opening 17 to facilitate the pouring of the metal and the introduction of the piston. The opening 17 has communication with the mold cavity 12. An opening 18 of reduced diameter continues downwardly from the lower end of the cylinder opening 17 to the lower end of the body 14. A lateral opening 19 joins the opening 18 at a point between its ends and extends to the periphery of the body 14 where it joins the gate 13 of the mold cavity 12. This passage or port system is under the control of the means 15.

The means 15 for controlling communication between the cylinder opening 17 and the mold cavity 12 is a feature of the invention. The means 15 initially closes the opening 18 to prevent the flow of the molten metal through the opening 19 and the gate 13 and prevents the discharge of the metal from the cylinder opening 17 until the metal has been put under a given pressure by the piston means 16. In the embodiment of the invention illustrated in Figs. 1 to 5, inclusive, of the drawings the means 15 comprises what I will term a valve 20. The valve 20 is in the form of a cylindrical plug or block arranged in the upper portion of the opening 18 above the opening 19. The block 20 serves to completely close or seal off the upper end of the opening 18.

Releasable means is provided for holding the valve 20 in the closed position shown in Fig. 4 until a given or sufficient pressure has been put on the molten metal in the cylinder opening 17. In the construction illustrated in Figs. 1 to 5, inclusive, the valve 20 may be releasably held in the closed position by paste, cement, or the like that is adapted to fail or release the valve when a substantial pressure has been built up in the cylinder opening 17. When the valve retaining cement or paste fails the pressure built up in the opening 17 by the piston means 16 drives the valve 20 downwardly in the opening 18 to a position below the lateral opening 19 so that the molten metal is free to flow out through the opening 19 and the gate 13 into the mold cavity 12. Figs. 1 and 5 of the drawings show the valve 20 in the open position and it will be noted that the open valve 20 leaves the opening 19 clear and entirely unobstructed.

The piston means 16 is employed to subject the molten metal in the opening 17 to pressure and to apply or maintain pressure on the metal during and after its delivery to the mold cavity 12. It is a feature of the invention that the piston means 16 is adapted to be removably mounted on the upper mold section or flask 11 at any one of a number of positions. The means 16 includes brackets 21 fixed on the side walls of the flask 11. There may be a bracket 21 on each side wall of the flask. Each bracket 21 has two vertically spaced outwardly projecting ears 22 provided with aligned vertical openings 23. The means 16 further includes a post 24 adapted to be supported by a selected bracket 21. The post 24 is provided with a reduced lower portion 25 and a shoulder 26 occurs where the reduced portion joints the body of the post. The reduced post portion 25 is adapted to be entered in the aligned openings 23 of any one of the brackets 21 and the shoulder 26 is adapted to engage against the upper ear 22 to support the post 24. An operating lever 27 is secured to the upper end of the post 24 by a horizontal pivot pin 28. A piston rod 29 depends from the operating lever 27. It is preferred to provide means whereby the piston rod 29 may be connected with the lever 27 at longitudinally spaced points to adapt the means 16 for cooperation with the body 14 with the body in various positions in the cope C. Longitudinally spaced openings 30 are provided in the lever 27 and a yoke 31 is formed on the upper end of the rod

29 to straddle the lever. A pivot pin 32 is removably engaged in the yoke 31 and any one of the openings 30 to pivotally connect the piston rod with the lever.

The means 16 further includes a plunger or piston P on the lower end of the rod 29. In accordance with the broader aspects of the invention the piston P may be of any selected construction. In the particular case illustrated the piston P comprises a core 33 of metal or the like and a shell 34 of baked core sand or other suitable refractory material such as fire clay, porcelain, or the like (see Fig. 3). The piston shell 34 is proportioned to shiftably or slidably fit the cylinder opening 17 and may be provided with spaced sealing grooves 35. In the form of the invention illustrated in Figs. 1 to 5, inclusive, of the drawings, a central opening 36 extends through the core 33 and the shell 34 and slidably receives the piston rod 29. A readily displaceable core 37 is provided in the opening 36 at the lower end of the rod 29. A flange 38 is provided on the rod 29 at a point spaced above the piston P. A coiled spring 39 is arranged under compression between the flange 38 and the upper side of the piston P. A wire 40 has one end embedded in the piston shell 34 and its other end is hooked over the flange 38. The wire 40 prevents displacement of the piston from the rod 29 but is readily disengaged from the flange 38, as will be described below.

In employing the apparatus illustrated in Figs. 1 to 5, inclusive, and in carrying out the method of the invention the drag D and the cope C are made up in their respective flasks 10 and 11 in the usual way. As described above, the body 14 is set in the cope C in spaced relation to the mold cavity 12 and is arranged so that the opening 19 communicates with the gate 13 as illustrated in Fig. 1. The valve 20 is secured in its initial closed position by cement, paste, or other releasable means. This may be done before the body 14 is set in the cope C.

When the mold is to be poured a quantity of the molten metal or other material to be cast is poured into the cylinder opening 17. The quantity of the metal thus poured into the opening 17 is somewhat greater than that required to completely fill the mold cavity 12, the gate 13 and the communicating openings 18 and 19. The valve 20 prevents the molten metal from discharging through the opening 19 and the gate 13 into the mold cavity. The reduced portion 25 of the post 24 is engaged in the ears 22 of a selected bracket 21 and the piston rod 29 is set or adjusted on the lever 27 so that the piston P may be entered in the opening 17. In this connection it is to be observed that the post 24 is turnable in the supporting bracket 21 so that the piston P may be readily brought to the position to enter the cylinder opening. When the piston P has been introduced into the opening 17 the lever 27 is swung downwardly so that the piston applies pressure to the molten metal in the opening 17. When the pressure thus applied reaches a given value the paste or other releasable means holding the valve 20 releases or fails and the valve 20 is forced down through the opening 18 by the metal under pressure and assumes a position such as illustrated in Figs. 1 and 5. The molten metal under pressure is free to flow through the opening 19 and the gate 13 into the mold cavity 12. The body of molten metal under pressure suddenly introduced into the mold cavity 12 completely occupies the cavity and the pressure may be maintained on the molten metal as it flows into the mold cavity to assure the formation of a perfect, complete and dense casting.

In the event that the piston P binds or catches in the opening 17 as it is being operated downwardly, the spring 39 may yield under the force being applied through the rod 29. When the spring 39 yields the piston rod 29 moves downwardly through the stuck or lodged piston P and the rod entering the body of molten metal operates as a displacement plunger to put the metal under pressure or under increased pressure, as the case may be, to open the valve 20 and to force the metal into the mold cavity 12 under pressure, as above described. The wire 40 may be detached from the flange 38 when these operations occur and in any case does not interfere with the movement of the rod 29 relative to the piston P, as just described.

Figs. 6 and 7 of the drawings illustrate another form of valve means 15ª for controlling the opening 18. The cylinder opening 17, the opening 18, and the opening 19 may be the same as described above, except that the opening 18 may terminate at the inner end of the opening 19. The body 14 and the piston means 16 may be the same as described above. The piston means 16 may be modified by having the piston P rigidly secured to the piston rod 29 in any selected manner.

The valve means 15ª of Figs. 6 and 7 includes a valve 20ª in the form of a sheet or strip embedded in the body 14 and projecting into the opening 18. The valve 20ª is formed of frangible refractory material such as baked core sand, fire clay, or the like. As illustrated in Fig. 6 the valve 20ª initially extends into the opening 18 above the opening 19 and is formed to completely close off the opening 18. The valve 20ª is constructed to fail or bend along a given line when substantial pressure has been built up in the cylinder opening 17 so that it leaves the opening 18 clear for the discharge of the molten metal through the opening 19. A notch or groove 40 is provided in the upper side of the valve 20ª at the point where the valve projects into the opening 18. This is illustrated in Fig. 6. The frangible valve 20ª is provided with a bendable insert 41 which allows the active portion of the valve to bend downwardly when the valve cracks or fails at the groove 40 but which prevents the active portion of the valve from flowing away with the molten metal to be carried into the mold cavity 12. This bendable insert 40 may be in the nature of a wire cast in the valve 20ª and extending longitudinally thereof. The wall of the opening 18 under the valve 20ª has a recess 18ª which is adapted to receive the active portion of the valve when the same swings downwardly. This leaves the opening 18 clear (see Fig. 7).

In the operation of the structure illustrated in Figs. 6 and 7 of the drawings the body of molten metal is introduced into the opening 17 and is put under pressure by the piston means 16, as described above. When the pressure reaches a given value the valve 20ª breaks along the groove 40 and the metal under pressure forces the active part of the valve downwardly and rearwardly. It will be seen that the active portion of the valve is forced to swing to the position illustrated in Fig. 7 of the drawings where it is received in the recess 18ª to leave the opening 18 clear. The insert 41 prevents the displaced active portion of the valve 15ª from being carried away by the

molten metal and prevents it from obstructing either the opening 19 or the gate 13.

Figs. 8 and 9 of the drawings illustrate another form of valve means 15b for controlling the opening 18. The body 14, the means 16, and the openings 18 and 19 may be the same as in the form of the invention illustrated in Figs. 1 to 5, inclusive. The valve means 15b of Figs. 8 and 9 includes a valve 20b. The valve 20b is in the form of a block or plug similar to the valve 20. The valve 20b may be formed of baked core sand, clay, or similar material and, in accordance with the invention, is molded or formed on a stem 50 of metal, or the like. In practice the stem 50 may be a nail and the plug 20b may be formed on the nail immediately under its head. The nail or stem 50 is of sufficient length to extend downwardly from the valve 20b and its lower portion may be thrust into the sand of the drag D at the lower end of the opening 18. Thus the stem 50 supports the valve 20b in the position where it closes the upper end of the opening 18 as illustrated in Fig. 8.

After the molten metal has been poured into the cylinder opening 17 the piston means 16 is employed to apply pressure to the metal. When this pressure has reached a given value the adhering engagement of the valve 20b with the stem 50 is broken or released and the valve is pushed downwardly on the stem 50 by the molten metal under pressure. The valve 20b may be pushed to a position such as illustrated in Fig. 9 of the drawings, where it is entirely clear of the opening 20. This allows the molten metal to freely discharge through the opening 19 and the gate 13 into the mold cavity. The valve 20b is positively restrained by the stem 50 and cannot flow away with the molten metal.

In the form of the invention illustrated in Figs. 10 and 11 the body 14' has the opening 17 and the openings 18 and 19, as described above. In this form of the invention a pouring lip or bead 60 is provided at the upper end of the body 14'. The bead 60 provides a lateral recess 61 at the mouth of the opening 17 into which the molten metal may be poured to flow into the main opening 17. This allows the piston P to be positioned in the upper end of the opening 17 ready for use when the metal is poured into the cylinder opening. Accordingly, the piston P may be engaged in the upper portion of the opening 17 before the metal is poured to be immediately available for use at the completion of the pouring operation. When the piston P is moved downwardly, it cuts off the recess 61 serving as a valve to prevent a reverse or upward flow of the metal through the pouring lip.

The valve means of Figs. 10 and 11 includes a valve 62 in the form of a block core. The lower portion of the opening 18 is enlarged in diameter to receive the valve 62. The lateral opening 19 may communicate with this enlarged portion of the opening 18. A socket or recess 63 is provided in the drag D at the lower end of the opening 18 to receive the valve 62 when the valve is opened or forced downwardly. The recess 63 is adapted to receive the valve 62 to leave the opening 18 entirely clear for the free passage of the molten metal therethrough.

Frangible means is provided to hold the valve 62 in the initial closed position. This means includes one or more frangible core pins 64 engaged in openings in the body 14' and extending through transverse or horizontal openings in the valve 62. The pins 64 may be tapered to hold the valve 62 in the position where it forms a tight closure to prevent the premature passage or leakage of the molten metal into the opening 19 before a sufficient pressure has been built up in the cylinder opening 17.

In the operation of the apparatus illustrated in Figs. 10 and 11, the body 14' carrying the valve 62 is made up in the cope C and the mold is assembled in the usual way. The piston P may be engaged in the opening 17 before the metal is poured. The metal is poured through the recess 61 of the pouring lip 60 to enter the opening 17. When the required quantity of metal has been poured into the opening 17 the lever 27 is swung downwardly to force the piston P against the metal. When a sufficient pressure has been developed the shear pins 64 fail and the valve 62 is moved downwardly into the recess 63. This allows the metal to flow through the opening 19 and the gate 13 into the mold cavity. The piston P may be employed to apply any desired or required pressure to the metal thus delivered to the mold cavity.

It is to be observed that in each of the several forms of the invention the valve is retained in the body 14 when the molten metal is discharged into the mold cavity and there are no parts of the apparatus that can reach the mold cavity to be embedded in the metal of the finished casting.

Where the term "sand" is employed in the specification and claims it is to be understood as meaning sand, plaster, composition, or combinations of such refractory materials, as distinguished from metal as employed in permanent molds.

Having described only typical preferred forms of apparatus and a typical manner of carrying out the method of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve for myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. Apparatus for use with a sand mold having a mold cavity comprising a body adapted to set in the mold when the same is made up so it is supported by the sand, the body having an opening adapted to receive molten metal, or the like, and a gate passage for connecting the opening with the mold cavity, a valve controlling said passage movable to a position clear of the passage, and a piston adapted to be introduced into said opening for subjecting the metal therein to pressure so that the valve is moved to said position and the metal is supplied to said cavity under pressure.

2. Apparatus for use with a sand mold having a mold cavity comprising a body adapted to set in the mold when the same is made up so it is embedded in and supported by the sand, the body having an opening adapted to receive molten metal, or the like, and a gate passage for connecting the opening with the mold cavity, a valve for controlling said passage adapted to open when subjected to a given pressure, a piston adapted to be inserted in the opening, and means detachable from the mold for operating the piston to subject the metal to pressure to open the valve and cause the metal to enter said cavity under pressure.

3. Apparatus for use with a mold flask for containing sand having a mold cavity, the apparatus

including a body adapted to be set in said sand when the mold is made up so it is supported by the sand, the body having an opening for receiving molten metal, or the like, and a passage leading from the opening to the mold cavity, a valve initially closing said passage to retain the metal in said opening and adapted to move to an open position when subjected to a given pressure, and a piston detachably mounted on the flask operable in the opening to subject the metal to pressure to open the valve and to force the metal into the cavity under pressure.

4. Apparatus for use with a mold flask for containing sand having a mold cavity, the apparatus including a body adapted to be set in said sand when the mold is made up so it is supported by the sand, the body having an opening for receiving molten metal, or the like, and a passage leading from the opening to the mold cavity, a valve initially closing said passage to retain the metal in said opening and adapted to move to an open position when subjected to a given pressure, a piston operable in the opening to subject the metal to pressure to open the valve and to force the metal into the cavity under pressure, and means attachable to the flask for operating the piston.

5. Apparatus for use with a mold flask for containing sand having a mold cavity, the apparatus including a body adapted to be set in said sand when the mold is made up so it is entirely supported by the sand, the body having an opening for receiving molten metal, or the like, and a passage leading from the opening to the mold cavity, the body being entirely within the flask, a valve movable from a closed position where it closes said passage to an open position in said body where the passage is open, piston means for subjecting the metal in the opening to pressure, and means for holding the valve in said closed position releasable when the metal is subjected to a given pressure.

6. Apparatus for use with a mold flask for containing sand having a mold cavity, the apparatus including a body adapted to be set in said sand when the mold is made up, the body having an opening for receiving molten metal, or the like, and a passage leading from the opening to the mold cavity, the body being entirely within the flask to be supported by the sand therein, a valve movable from a closed position where it closes said passage to an open position in said body where the passage is open, piston means for subjecting the metal in the opening to pressure, and frangible means for holding the valve in the closed position adapted to fail when the metal in the opening is subjected to a given pressure.

7. Apparatus for use with a mold flask for containing sand having a mold cavity, the apparatus including a body adapted to be set in said sand when the mold is made up, the body having an opening for receiving molten metal, or the like, and a passage leading from the opening to the mold cavity, a piston in said opening adapted to subject the metal therein to pressure, and valve means for controlling said passage including a plug for closing the passage and movable to a position in the body where the passage is open, and frangible paste for holding the plug in the position where it closes the passage.

8. Apparatus for use with a mold flask for containing sand having a mold cavity, the apparatus including a body adapted to be set in said sand when the mold is made up, the body having an opening for receiving molten metal, or the like, and a passage leading from the opening to the mold cavity, a piston in said opening adapted to subject the metal therein to pressure, and valve means for controlling said passage including a stem extending into the passage, and a plug releasably adhering to the stem in a position where it closes the opening and adapted to break free and move along the stem to an open position when the metal in the opening is subjected to a given pressure.

9. Apparatus for use with a mold flask for containing sand having a mold cavity, the apparatus including a body adapted to be set in said sand when the mold is made up, the body having an opening for receiving molten metal, or the like, and a passage leading from the opening to the mold cavity, a piston in said opening adapted to subject the metal therein to pressure, and valve means for controlling said passage including a blade of frangible material fixed in the body to project into and close the passage and adapted to fail when a given pressure is applied to the metal in the opening, and a bendable member embedded in the blade and which bends upon failure of the blade and retains the blade in the body.

10. Apparatus for use with a mold flask for containing sand having a mold cavity, the apparatus including a body adapted to be set in said sand when the mold is made up, the body having an opening for receiving molten metal, or the like, and a passage leading from the opening to the mold cavity, a piston in said opening adapted to subject the metal therein to pressure, and valve means for controlling said passage including a blade of frangible material fixed in the body to project into and close the passage and adapted to fail when a given pressure is applied to the metal in the opening, the blade being reduced in thickness to fail at a given point, and a bendable member embedded in the blade and which bends upon failure of the blade and retains the blade in the body.

11. Apparatus for use with a mold flask for containing sand having a mold cavity, the apparatus including a body adapted to be set in said sand when the mold is made up, the body having an opening for receiving molten metal, or the like, and a passage leading from the opening to the mold cavity, valve means closing said passage and adapted to open when the metal in the opening is subjected to a given pressure, a piston adapted to be introduced into said opening, a piston rod slidably passing through the piston, means for operating the piston rod, a collar on the rod, and a spring engaged between the collar and piston for transmitting movement from the rod to the piston and adapted to yield in the event the piston binds in the opening so that the rod may move through the piston to subject the metal in the opening to pressure.

PHILLIP CAMPBELL.