Aug. 30, 1966 G. R. MORTON 3,268,960

METHOD OF AND MEANS FOR PRODUCING DENSE ARTICLES FROM MOLTEN MATERIALS

Filed Sept. 8, 1964

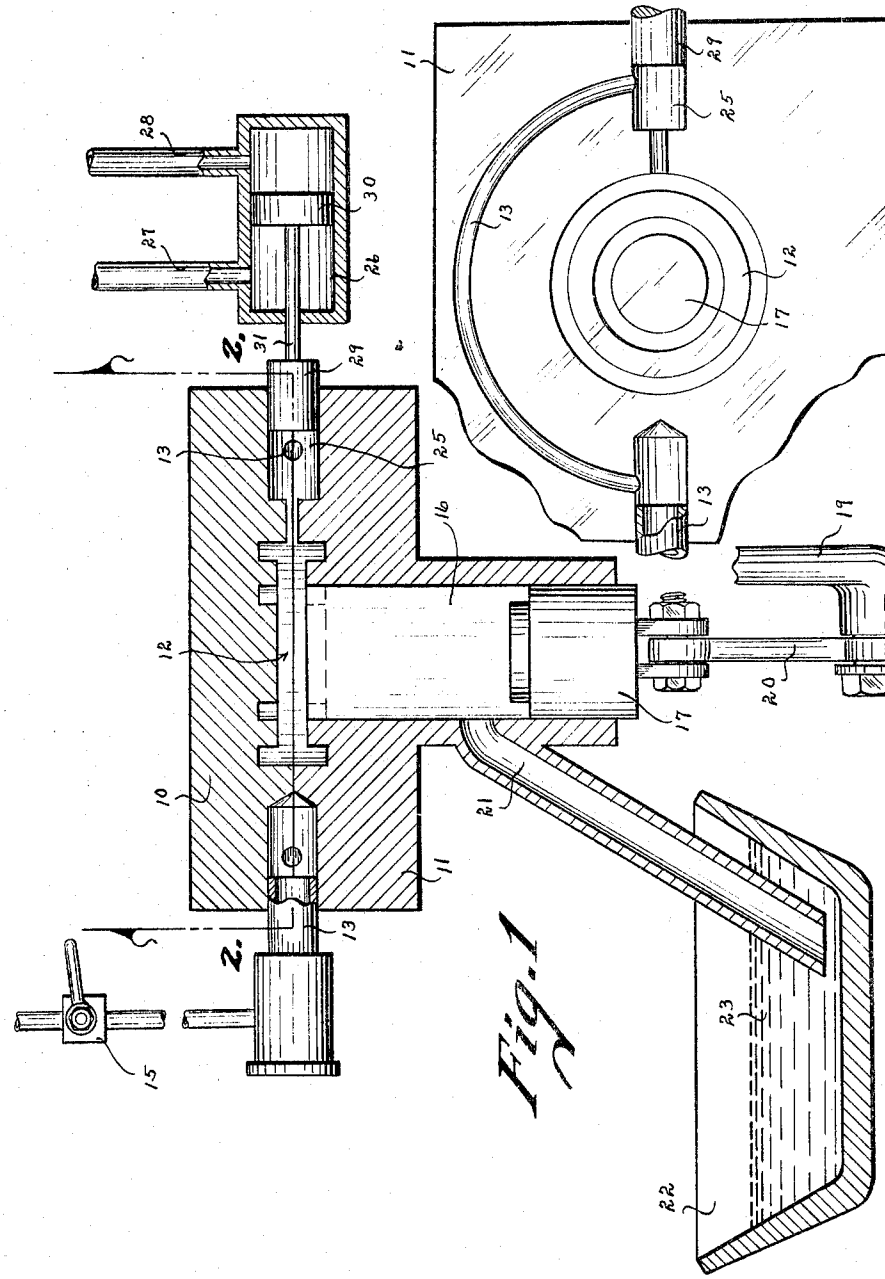

Fig. 1

Fig. 2

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United States Patent Office 3,268,960 Patented August 30, 1966

3,268,960

METHOD OF AND MEANS FOR PRODUCING DENSE ARTICLES FROM MOLTEN MATERIALS

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Filed Sept. 8, 1964, Ser. No. 395,983
2 Claims. (Cl. 22—68)

This is a continuation-in-part application of my application entitled Method of and Means for Producing Dense Articles From Molten Materials, Serial No. 51,903, under the filing date of August 25 1960, now abandoned.

This invention relates to the method of and means for producing articles from molten materials and more particularly to equipment which will compress the molten material into a dense product during its cooling phase.

Both metal and plastic mold casting is old. Also the forging of material into articles is old. In general, forgings are compressed and have dense characteristics while many castings are objectionable porous in character. However, many manufactured items must be produced by injecting into a casting mold cavity a quantity of molten material or like. The relatively recent method of vacuum die casting has contributed much to the art but even by the employment of this method many castings are unsatisfactory. Much of this trouble has been experienced if a part of the casting is relatively large in mass and other parts are small in thickness such as protruding flanges or like. The reason for this is that the smaller extensions of the casting cool and harden first and while the core of the larger portion is still molten. As the core of the larger mass cools and hardens it obviously shrinks in size thereby pulling on and affecting the smaller portions. Obviously this results not only in imperfect castings but castings that may well be objectionable porous and without the necessary strength to function for the uses intended.

Therefore, one of the principal objects of my invention is to provide a method of and means for producing a closely knit dense casting regardless of its shape or size.

More specifically the object of this invention is to provide casting equipment wherein at least one face of the mold moves toward the other after the injection of the molten material into the mold cavity and with the further step that even after the movable face of the mold has completed its forward movement, pressure will still be exerted on the casting material until it has congealed and solidified.

A further object of this invention is to provide a method of and means for preventing the cooling and hardening of the major mass of the casting from affecting the smaller portion or portions of the casting that have already substantially cooled and hardened.

A still further object of my invention is to provide a method of maintaining the molten material entrance passageway clear for the subsequent entrance flow of the material for producing additional castings.

Still further objects of this invention are to provide a means for producing articles of high density character that is economical in manufacture, and durable in use.

These and other objects will be apparent to those skilled in the art.

My invention consists in the construction, arrangements, and combination of the various parts of the device, whereby the objects contemplated are attained as hereinafter more fully set forth, specifically pointed out in my claims, and illustrated in the accompanying drawing, in which:

FIG. 1 is a vertical side sectional view of my equipment for forming articles from molten materials, and

FIG. 2 is a horizontal cross-sectional view of the device taken on line 2—2 of FIG. 1 and more fully illustrates its construction.

In the drawing I have used the numeral 10 to designate one side of a mold block. The second mold block is generally designated by the numeral 11. These two blocks are separable for the purpose of discharging the solidified casting but are detachably held together by any suitable means during the actual casting phase. The adjacent faces of the blocks are cut away to provide, when the blocks are secured together, the mold cavity 12. Communicating with the mold cavity is a conduit 13 adapted to be in communication with a suction producing means (not shown). Imposed in the conduit 13 is a shutoff valve 15. Such structure thus far described is standard. The valve 15 is opened and a minus atmospheric pressure is caused to exist within the mold cavity after which the molten material is passed into the mold cavity. The valve 15 is then closed. It is to such equipment that the invention is applied and which will now be described in detail.

In the block 11 is formed a relatively large vertical cylinder or passageway 16 communicating with and forming a part of the mold cavity as shown in FIG. 1. Slidably mounted in this cylindrical portion 16 is a vertical piston ram 17 having its top surface forming at least a portion of the under side of the mold cavity 12. This member 17 may be power reciprocated by any suitable means. Shown in the drawings are a powered crank shaft 19 and a connecting rod 20 having one end rotatably mounted on the crank arm 19 and its other end hingedly secured to the bottom of the member 17. By this arrangement of parts at least a part of one side or face of the mold cavity will be movable. The numeral 21 designates the molten material inlet conduit communicating with the inside of the cylinder 16 at a point between the extreme movement of the piston member 17 in both directions. Therefore, when the piston member 17 is in a lowered position the conduit 21 will communicate directly with the inside of the cylinder 16 but when the piston 17 is elevated in its sliding movement, the point of communication between the conduit 21 and the cylinder 16 will be closed by the side wall of the member 17. The numeral 22 designates a container having the molten material 23, and into which the conduit 21 extends. The numeral 25 designates a horizontal cylinder formed by the two molds and communicating at its forward end with the mold cavity. The numeral 26 designates a hydraulic power cylinder having the two conduits 27 and 28 communicating with the inside of its two ends, respectively. These two conduits are adapted to be controllable adjustable comunication with a source of hydraulic pressure (not shown) or selectively individually denied hydraulic pressure. The numeral 29 designates the piston slidably mounted in the cylinder 250. The numeral 30 designates the piston in the hydraulic cylinder 26. The piston 29 and the piston 30 are secured together by a shaft 31. The practical operation of the device is as follows:

With the two mold sections 10 and 11 closed together and with the piston ram 17 held in a lowered position, the valve 15 is opened thereby producing a semi-vacuum within the mold cavity. At this time the piston 29 is being held to the right in its sliding movement by hydraulic pressure in the forward end of the cylinder 26. Due to the minus atmospheric pressure within the mold cavity and the upper end of the cylinder 16, the molten material 22 will flow into the upper end of the cylinder 16 and mold cavity. After a suitable amount of the molten material has entered the mold the valve 15 is closed and the piston ram 17 is moved upwardly to its maximum elevated position within the cylinder 16 as shown by broken lines in FIG. 1. Next the piston 29 is caused to move toward the mold cavity under pressure by releasing pressure in the conduit 27 and inducing pressure in the conduit 28, and this pressure by virtue of the piston 29 will

continue on the molten material until the molten material has solidified. After the pressurized casting has cooled, the two mold halves are separated and the casting taken therefrom. The vacuum conduit and the conduit **25** should be at the parting line of the two mold portions as shown in the drawing. If the conduit **13** is extended around to indirectly communicate with the mold cavity through the cylinder **25**, the piston **29**, will, when moved forwardly, cut off the conduit from the interior of the mold cavity. Obvously different castings and different molten materials will require different treatment and with this apparatus such necessary adjustments are easily obtained. As an illustration, the ram piston **17** may be moved upwardly and held under a force of two ton while the pressure on the piston **29** may be of five ton. Therefore, by increasing or decreasing the relative compressing forces of the two pistons **17** and **29** different types of castings may be obtained even though the molten material be the same. Also it will be found that some molten materials will require different relative pressures than that of other molten materials. Regardless, however, of the pressures and/or the molten materials used, the finished casting will have been hot liquid form forged. This forging is accomplished by initial and continuing pressure on the molten material until it has solidified and cooled. The first stage in the compressing of the molten material is caused by the initial upward movement of the piston ram **17** which also automatically closes the molten metal inlet conduit. As the upper end of the piston ram **17** forms at least a part of one face of the mold cavity its upward sliding movement must be limited and this can be accomplished by any suitable means such as shown by the crank assembly as shown in FIG. 1. After the piston ram **17** has reached its maximum height, it is held in such position until the casting has been formed. Inasmuch as the member **17** is a movable side of the cavity wall and held in a fixed position during the solidifying of the casting, it is obvious that different shaped castings would require different elevated positions of the member **17** and this is accomplished by using different length pistons **17**.

From the foregoing it will be appreciated that I have provided a method of producing articles, by first having a mold wherein one side of the mold cavity is movable, the creating of a minus pressure within the mold cavity to draw in thereto the molten material, the compressing of the molten material first by the moving of the part that forms a portion of the side of the mold cavity and by an auxiliary controllable pressure on the molten material within the mold cavity until it has solidified. It will also be appreciated that by my construction and arrangement of parts I have made possible successful vertical casting. By the upward movement of the member **17** is will insure the entire successful filling of the mold cavity with the molten material.

The piston **29** may be synchronized to move inwardly towards the mold cavity **12** at the appropriate time to close the evaluation conduit **13** from communication with the mold cavity **12** and thereby prevent the conduit **13** from being filled with molten metal. At the same time the piston serves to exert pressure at the most vital area of the die cavity **12**, its horizontal mid section which is in a plane normal to the line of travel of the piston ram **17**. Only by exerting pressure at this point can the desired casting be produced.

Some changes may be made in the construction and arrangement of by method of and means for producing dense articles from molten materials without departing from the real spirit and purpose of my invention, and it is my intention to cover by my claims, any modified forms of structure or use of mechanical equivalents which may be reasonably included within their scope.

I claim:

1. In a vacuum die casting machine, comprising a pair of mold sections with adjacent facing surfaces, each of said surfaces having a recess formed therein, cooperating to form a mold cavity disposed on a plane extending parallel to said surfaces, said surfaces each having an arcuate recess formed therein and extending around said die cavity and cooperating to form a conduit, said surfaces each having half of a cylinder formed therein and cooperating to form a full cylinder, said conduit opening into said cylinder, a piston disposed in said cylinder and movable to an inward position to close said conduit, a vacuum source in communication with said conduit, and said conduit being in communication with said mold cavity when said piston is in a retracted position exposing said conduit opening to said cylinder, a hydraulic power means connected to said piston for selectively moving said piston between said inward position and said retracted position, one of said mold sections having an enlarge opening formed therethrough in direct alignment with said mold cavity, a shot cylinder in communication with said enlarged opening and disposed at 90 degrees to said first mentioned cylinder, a ram piston in said shot cylinder, power means for reciprocating said ram piston to a position closely adjacent said mold cavity to a position remote therefrom, a conduit in communication at one end with the interior of said shot cylinder, a container having molten material and the other end of said last mentioned conduit in communication with said molten material.

2. The structure of claim **1** wherein said piston in said full cylinder has a piston rod connected to its outer ends and extends into a hydraulic cylinder included in said hydraulic power means, a hydraulic piston in said hydraulic cylinder, a hydrualic conduit in communication with said hydraulic cylinder at opposite ends thereof on opposite sides of said hydraulic piston, said hydraulic power means adapted to selectively force fluid into said hydraulic cylinder on either side of said hydraulic piston whereby said first mentioned piston is moved between said inward position and said retracted position.

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