Dec. 15, 1942. E. G. FAHLMAN 2,305,071

PERMANENT MOLD

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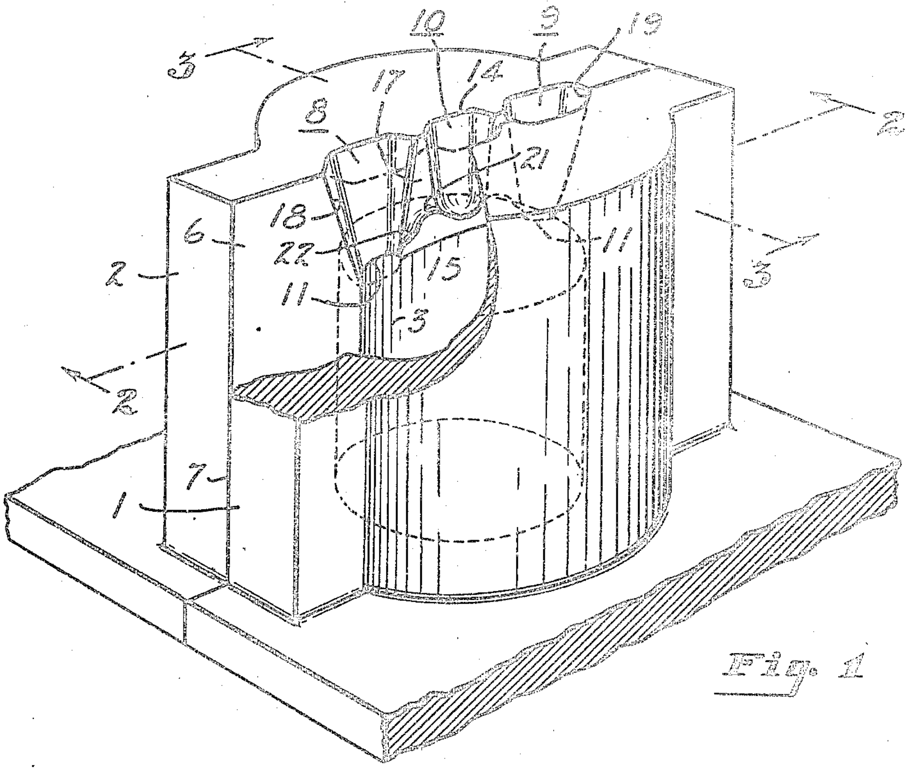

Fig. 1

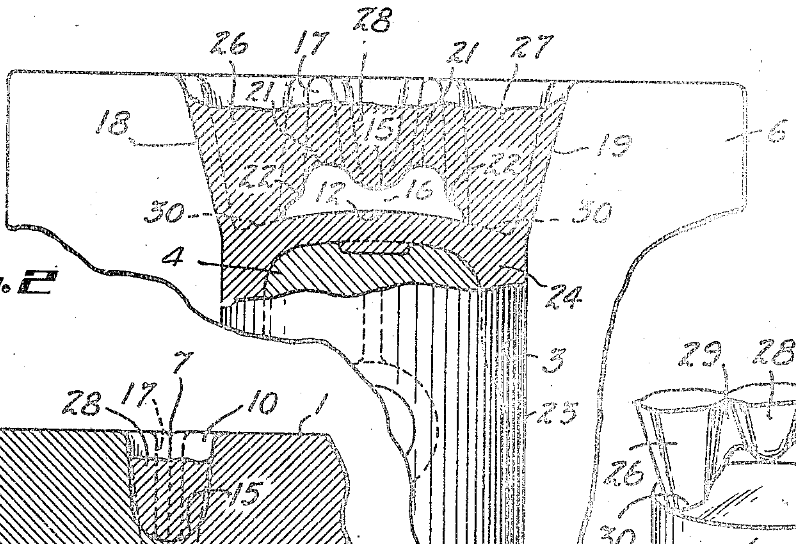

Fig. 2

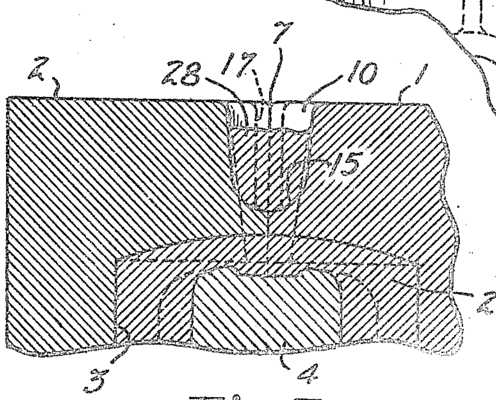

Fig. 3

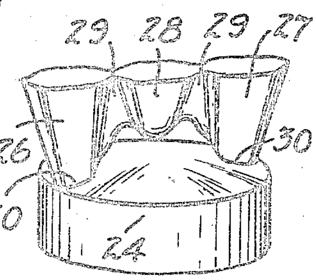

Fig. 4

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PERMANENT MOLD

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5 Claims. (Cl. 22—153)

This invention relates to permanent molds, and more particularly to molds of this character for the casting of metals having a high crystallization shrinkage, such as aluminum and its alloys.

An object of the invention is to provide an improved mold, simple in design and construction, and inexpensive to manufacture, which facilitates the introduction of molten metal into the mold cavity in a smooth, continuous and uniform flow, so that the resulting casting has desirable physical properties and is substantially free from inclusions of air and other gases.

Another object is to provide a mold of this character in which the poured metal has its initial velocity arrested before flowing into the sprues which distributes the metal to the casting cavity.

A further object is to provide a mold having one or more risers for holding metal in the molten state during solidification of the casting in which the pouring sprues are arranged so that metal introduced into the casting cavity heats the walls of the risers so that the metal retained therein after completion of the pouring of the casting solidifies subsequently to the solidification of the metal of the casting.

A still further object is to provide a mold for the casting of metallic articles in which the quantity of metal in the sprues, gates and risers is minimized, so that there is a larger proportion of metal in the finished casting with respect to the amount of scrap to be trimmed and remelted, and which produces a casting having the sprues, gates and risers so positioned as to facilitate their removal and the trimming of the rough casting.

More specifically, the invention provides a mold for the casting of hollow, cup-shaped articles having a relatively thick head section in a position such that the opening of the cup is faced downwardly.

Other objects and advantages will become apparent from the following detailed description of the invention, which is illustrated as applied to the casting of a piston, such, for example, as an aluminum piston for use in an internal combustion engine. In the casting of this article it is desirable that the relatively thick section of metal at the head of the piston be uppermost in the mold, and that one or more risers be provided in communication with this thick section of metal to feed it during solidification. According to the present method the functions of pouring sprue and riser are advantageously combined to keep the metal in the riser molten until solidification of the metal in the casting cavity is complete and to produce a casting which may be readily removed from the mold.

In the drawing:

Figure 1 is a perspective view, with parts removed and with parts broken away, of a permanent mold for casting an aluminum piston in an upright position;

Fig. 2 is a fragmentary elevational view, in section, taken on the parting line of the mold, indicated at 2—2 of Fig. 1;

Fig. 3 is a fragmentary sectional view taken substantially on the line 3—3 of Fig. 1; and

Fig. 4 is a fragmentary detail view, in perspective, illustrating the appearance of the scrap metal comprising the sprues and risers at the top of the casting, and which is to be trimmed therefrom in finishing the latter.

Referring to the drawing by numerals of reference, which indicate like parts in the several views, the mold comprises a pair of mating mold sections 1 and 2, which rest upon a mold base (not shown) in accordance with the usual practice in permanent mold foundries. These sections cooperatively define a casting cavity 3 corresponding in shape to the outer surface or contour of the article or piston to be cast.

Indicated at 4 is a multi-part core, which extends upwardly through an aperture in the mold base and is positioned centrally in the cavity 3. This core is constructed in accordance with standard practice, and mounted for vertical movement in the mold so that it may be retracted after completion of the casting operation to release the casting. The mold sections 1 and 2 have faces 6 which meet one another at a parting line 7 of the mold.

A plurality of depressions are formed in the faces 6 of the mold sections, above the casting cavity 3. When the mold is closed the depressions on one face cooperate with those on the opposing mold section face to define a pair of risers 8 and 9 and a pouring chamber or distributing sprue 10. The risers 8 and 9 are spaced apart from one another, and each has an opening of relatively large cross-sectional area at the top of the mold. From the top of the mold the risers taper downwardly toward their lower extremities, which communicate with the cavity 3 through round or oval-shaped openings 11 in the top wall of the cavity at diametrically opposite margins thereof.

Preferably the pouring chamber or distributing sprue 10 is located between the risers 8 and

9. This chamber has a mouth 14 which opens upwardly through the top of the mold, and a closed, substantially spherical-shaped bottom 12, which, in the present instance, is disposed a short distance above the top wall 12 of the casting cavity, and separated therefrom by small portions of the faces 6, which form lands 16.

Each of the risers 8 and 9 communicates with the pouring chamber 10 through a relatively narrow, elongated and vertically extending passage 17. These passages are formed by removal to a relatively slight depth of portions of the face 6 of one or both of the mold sections 1 and 2, positioned between the side walls of the pouring chamber 10 and risers 8 and 9. As shown in Figs. 3 and 4, the width of the passages 17 is considerably less than the width of the risers 8 and 9 and the pouring chamber 10. However, the passages are of considerable depth and communicate with the pouring chamber 10 throughout the greater portion of its depth. If desired, the passages may extend to the top of the mold, thus forming a continuous opening across the top of the mold from an outer marginal wall 18 of the riser 8 to an outer marginal wall 19 of the riser 9. The bottoms of the passages 17 are defined by portions of the land 16, which preferably has rounded upper margins 21 merging into a downwardly sloping portion 22 extending to the openings 11 at the bottom of the risers 8 and 9. Preferably, the rounded upper margins 21 of the lands 16 are disposed above the level of the bottom 15 of the pouring chamber 10, so that molten metal poured into the latter has its initial pouring velocity substantially arrested before flowing into the risers 8 and 9.

In operating the mold, the cavity 3 is prepared in accordance with usual permanent mold foundry practice and the sections 1 and 2 brought to a suitable operating temperature. With the mold sections together, so that their faces 6 meet at the parting line 7, and the core 4 properly positioned in the cavity 3, molten metal is introduced into the pouring chamber 10 through its mouth 14 in the usual manner, such as by pouring from a ladle. The downward velocity of the poured metal is arrested by the bottom wall 15 of the pouring chamber, and as the pouring continues molten metal flows sideways or radially from the pouring chamber through the passages 17 over the bottom wall 21 thereof and the gradually sloping surface 22 into marginal portions of the casting cavity through the openings 11.

On account of the bottom 21 of the passages 17 being above the level of the bottom 15 of the pouring chamber, the relatively high velocity of the metal being poured is checked by impact in the pouring chamber, so that the radial flow through the passages 17 is relatively smooth and even, and caused primarily by a differential in the height of the metal in the pouring chamber 10 relative to the height of the metal in the passages 17 and risers 8 and 9.

During the flow through the passages 17 the molten metal is quieted and smoothed to effect a more uniform flow, and the turbulence present in the pouring chamber is considerably diminished. The outer or radial velocity imparted to the metal in flowing through the passages 17, and over the sloping wall portions 22, is effective to direct it against the outer or circumferential wall of the casting cavity 3, to effect a smooth and even movement of the molten metal first into skirt 23 and then gradually, with an evenly rising level, upwardly into head 24 of the piston. Such a flow minimizes the inclusion of air and other gases, so that sound castings, having uniform and improved physical properties, are produced.

After the mold cavity 3 is filled, continuous pouring of molten metal into the pouring chamber 10 fills the latter and the risers 8 and 9 to provide relatively heavy sectioned bodies of metal 26 and 27 in the risers 8 and 9 in a similar heavy-sectioned body 28 in the pouring chamber 10, which is connected to the portions 26 and 27 through the relatively thin-sectioned portions 29 in the passages 17.

On account of the relatively thin sections of the metal forming the skirt 23 of the piston, and because this portion of the metal was that which was first introduced into the cavity and gave up considerable of its heat in flowing to the bottom of the casting cavity, it freezes or solidifies before the relatively thick-sectioned head 24, so that there is a progressive upward freezing of the metal in the casting cavity. Because of the relatively high crystallization shrinkage of metal, such as aluminum and its alloys, employed in the casting of pistons of the character contemplated by this invention, the relatively large body of metal indicated by the numerals 26 through 29, and disposed in the risers and pouring chamber of the mold, is drawn upon to feed the shrinking metal in the casting chamber during the solidification of the piston.

In connection with this feeding of the casting from the risers during solidification, there is a feature of the present mold which is of particular advantage. During the flow of molten metal over the curved portion 22 at the bottom of each of the risers 8 and 9, and through the openings 11, the adjacent portions of the mold absorb considerable heat from the metal and become elevated in temperature. Accordingly, when the metal is substantially at the level indicated in Fig. 2, the mold surfaces surrounding the relatively thin section of metal, indicated at 30, through which the risers 8 and 9 communicate with the casting cavity, are at relatively high temperatures so that the probability of these portions of the metal freezing and preventing feeding of the casting by the risers during solidification of the former is minimized.

The arrangement of a pouring chamber, communicating radially with riser sprues which conduct the molten metal from the pouring chamber into the casting cavity, enables castings to be poured with greater uniformity. Since the rate of flow of molten metal of like composition and temperature through the passages 17 is fixed for any given height of metal in the pouring chamber 10 with respect to the height thereof in the risers 8 and 9, the molder or operator can, by pouring the metal to maintain a substantially uniform height of molten metal in the pouring chamber 10, produce a succession of castings under substantially identical conditions of time and rate of pour. Furthermore, on account of the variable capacity of the passages 17, the molder can, by alternately raising or lowering the effective height of the molten metal in the pouring chamber 10 during the pouring of a single casting, regulate the rate of feed of the molten metal into the cavity, as desired. As the height of metal in the pouring chamber 10 increases, the rate of flow through the passages 17 likewise increases. Conversely, as the height of molten metal in the pouring chamber decreases, the rate of flow through the passages 17 proportionately decreases. This latter feature is utilized, for example, when it is desired to initially pour at a relatively slow rate during the filling of the lower portion of the casting cavity 3 which forms the skirt 23 of the piston. Thus, as the level of metal which gradually rises uniformly in the casting cavity reaches the relatively thick sections at the head 24, it may be advantageous to increase the rate of flow and hasten the completion of the casting operation.

On account of the relatively small surface area of the scrap metal in the rough casting produced in the above described mold, and which is represented by the portions of metal numbered 26 through 29, the separation of the mold sections 1 and 2, after the setting of the metal, is accomplished with a minimum of effort. Also, these portions of scrap metal are a relatively small proportion of the total metal poured into the mold, on account of the elimination of long feeding sprues and the combining of the function of sprue and riser, thus effecting a substantial economy in scrap losses. Another economy is realized in trimming the rough castings. The relatively small section portions, indicated at 30, of the risers 8 and 9, which connect the risers to the top of the piston head, need only be severed to separate the scrap metal from the cast article.

The method and mold of the present invention, illustrated in the drawing and described above, are given for purposes of illustration. They are subject to considerable variations and numerous modifications and alterations are contemplated and intended to be included within the scope of the appended claims.

What I claim is:

1. In a permanent mold having a cavity for casting cup shaped articles with their openings directed downwardly, a plurality of risers extending upwardly from gates into the cavity at substantially the outer periphery of the cavity and opening through the top of the mold, a pouring chamber formed in the mold above the cavity and centrally disposed between the risers, said chamber also opening through the top of the mold and having a closed bottom, and narrow passages of greater height than width extending between the pouring chamber and the risers, said passages each being of less width than the chamber and the risers and sufficiently narrow to retard the flow of molten metal from the pouring chamber into the risers whereby the poured metal accumulates in the pouring chamber during the pouring operation to a height substantially above the level of the metal in the risers.

2. In a permanent mold having a cavity for casting cup shaped articles with their openings directed downwardly, a plurality of risers extending upwardly from gates into the cavity at substantially the outer periphery of the cavity and opening through the top of the mold, a pouring chamber formed in the mold above the cavity and centrally disposed between the risers, said chamber also opening through the top of the mold and having a closed bottom, and narrow passages of greater height than width extending between the pouring chamber and the risers, said passages each being of less width than the chamber and the risers and sufficiently narrow to retard the flow of molten metal from the pouring chamber into the risers whereby the poured metal accumulates in the pouring chamber during the pouring operation to a height substantially above the level of the metal in the risers, the bottoms of the narrow passages being inclined downwardly in continuous runs substantially from the pouring chamber to the openings of the risers into the top of the cavity whereby the molten metal flowing into the mold cavity is directed by the inclination of the passages to flow across said risers and gates to the outermost portions of the cavity.

3. In a permanent mold having a cavity for casting articles of high crystallization shrinkage metal, a riser extending upwardly from a gate into the cavity adjacent the periphery of the latter and opening upwardly through the top of the mold, a pouring chamber formed in the mold above the cavity and to one side of the riser, said chamber also opening through the top of the mold and having a closed bottom, and a narrow passage of greater height than width extending between the pouring chamber and the riser, said passage opening into the chamber through one side thereof and having a bottom inclined downwardly in a continuous run substantially from the pouring chamber to the gate into the top of the cavity whereby the molten metal flowing into the mold cavity is directed by the inclination of the passage to flow across the riser and gate to the outermost portion of the cavity.

4. In a permanent mold having a cavity for casting articles of high crystallization shrinkage metal, a riser extending upwardly from a gate into the cavity and opening through the top of the mold. a pouring chamber formed in the mold above the cavity and to one side of the riser, said chamber also opening through the top of the mold and having a closed bottom, and a narrow passage of greater height than width extending between the pouring chamber and the riser, said passage opening into the sides of the chamber and the riser and being of less width than the chamber and the riser to retard the flow of molten metal from the chamber into the riser, the top of said passage opening through the top of the mold to provide a continuous mold opening across the tops of the pouring chamber, flow-retarding passage and riser for continuous visual observation of molten metal poured into the chamber and flowing thence into the riser through the narrow passage, said retarding of the flow by the narrow passage effecting an accumulation of molten metal in the pouring chamber and a variation in the height of metal flowing in the narrow passage which varies directly with the rate of pouring into said chamber.

5. A permanent mold for casting a substantially cylindrical piston comprising metal mold sections cooperatively formed to provide a piston defining cavity in which the longitudinal axis of the piston is vertical and the head portion of the piston is uppermost, said sections having meeting faces above the cavity cooperatively formed to provide an open top pouring chamber having a closed bottom disposed directly above the head forming portion of the cavity and at least one riser spaced laterally from the pouring chamber above the head forming portion of the cavity and communicating with the upper part of the cavity to feed metal directly into the head forming portion of the cavity, a relatively narrow passage of greater height than width extending between the pouring chamber and the riser and opening into the chamber through one side of the latter to effect a change of direction in the flow of metal poured into the mold from substantially vertical in the chamber to substantially horizontal in the passage, and said passage being of less width than the pouring chamber and the riser to retard the flow of molten metal from the pouring chamber into the riser, the location of the pouring chamber, riser, and passage serving to maintain the

parts of the mold sections surrounding the head forming portion of the cavity at the highest temperatures in the mold and substantially uniform across the diameter of the head forming portion by the conduction of heat directly from molten metal poured into the mold whereby the head portion of the cast piston freezes last and the pouring chamber, riser, and passage providing a reservoir for a body of molten metal directly above the head of a cast piston to supply heat directly to the piston head by conduction during freezing of the casting and to feed the head thereby compensating for crystallization shrinkage.

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