Oct. 18, 1949. F. C. BENNETT 2,485,526

DIE CASTING APPARATUS

Filed Jan. 8, 1948

2 Sheets-Sheet 1

Fig. 1

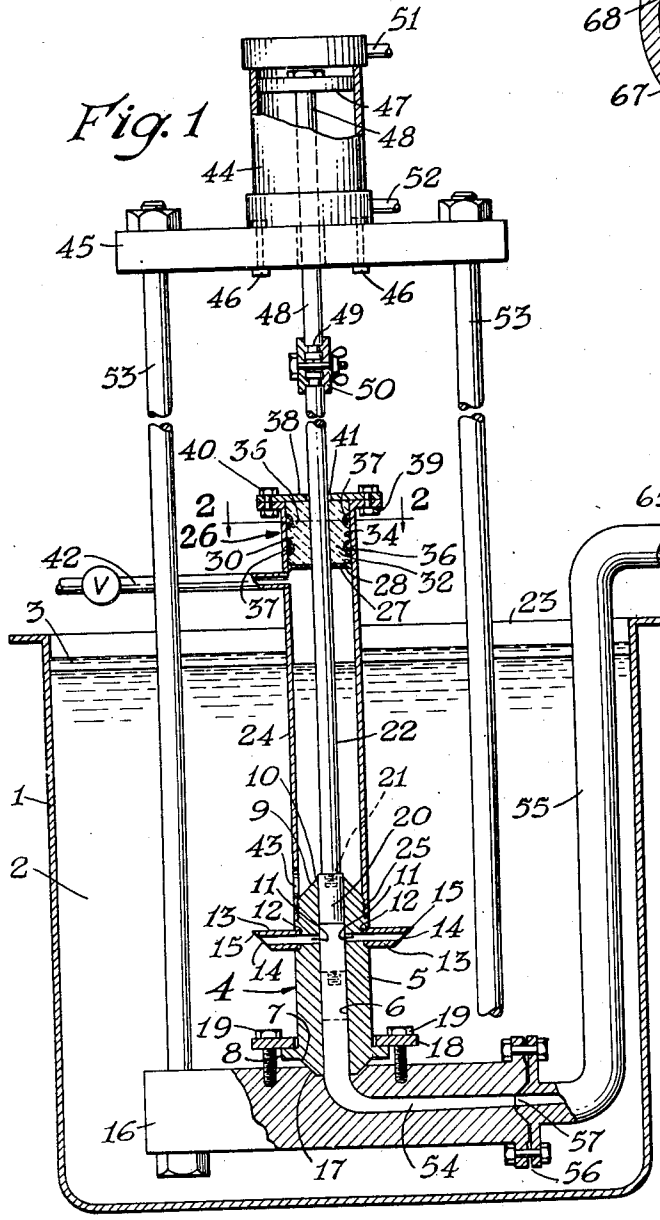
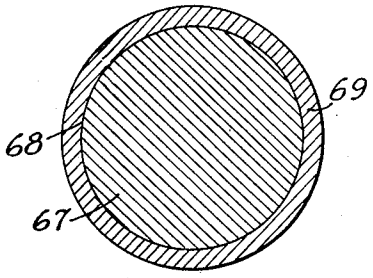
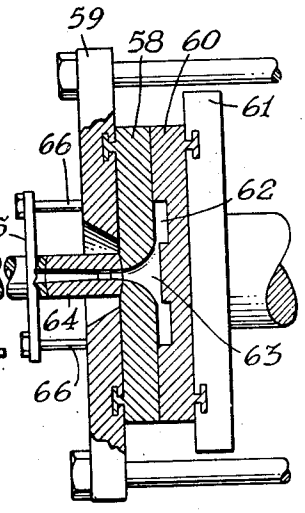


Fig. 4





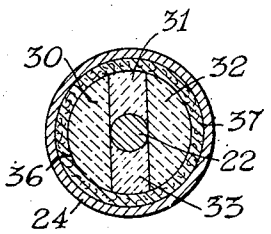


Fig. 2

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DIE CASTING APPARATUS

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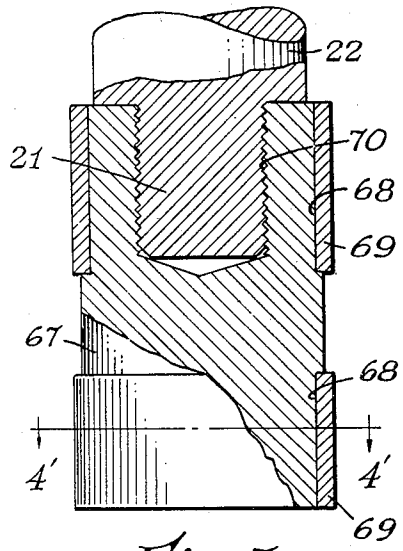


Fig. 3

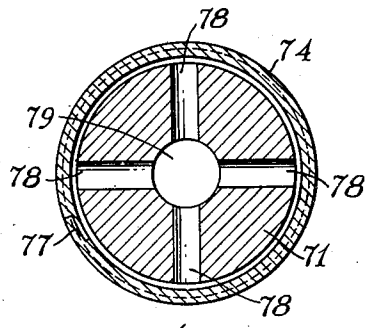


Fig. 6

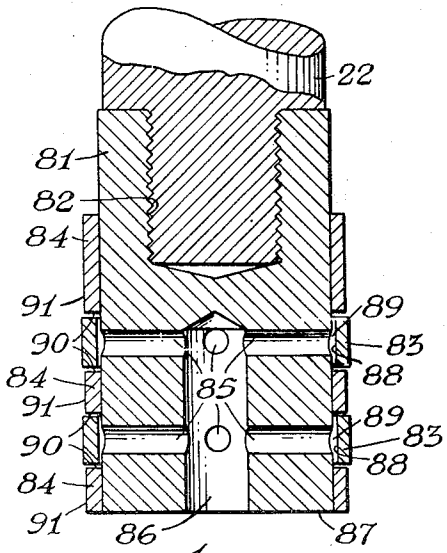


Fig. 7

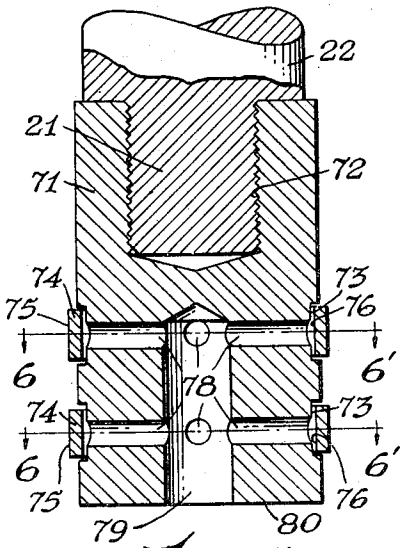


Fig. 5

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2,485,526

DIE CASTING APPARATUS

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Application January 8, 1948, Serial No. 1,099

1 Claim. (Cl. 22—70)

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The invention relates to die casting apparatus. It more particularly concerns an improved die casting apparatus of the type employing a piston operating in a shot cylinder submerged in the molten metal for forcing molten metal into a die where the casting is made. In the usual arrangement of apparatus of this kind the piston is operated by a rod which is vertically reciprocated in the molten metal in loading the shot cylinder and forcing the shot from the cylinder into the die.

I have found that upon attempting to make die castings of magnesium-base alloys using conventional apparatus of the type indicated above various difficulties arise that preclude the production of satisfactory die castings of these metals. One of the difficulties is that the piston tends to bind and seize in the shot cylinder on prolonged operation because contaminants in the melt become lodged between the piston and the cylinder wall. Another difficulty is that the castings are oftentimes contaminated with flux which is used over the body of the molten metal to protect it from attack by the atmosphere. Still another difficulty is that the conventional pistons wear rapidly and permit an excessive amount of by-passing of molten metal in the shot cylinder which results in imperfect filling of the mold or die and additional contamination of the molten metal.

It is the principal object of the invention to provide improved apparatus obviating difficulties attendant upon the use of conventional die casting apparatus of similar type.

In brief, my invention is predicated upon an improved piston and shot cylinder assembly, a complete understanding of the invention being had by reference to the following detailed description, together with the accompanying drawings in which:

Fig. 1 is a side elevation largely in section of a die casting apparatus embodying the invention.

Fig. 2 is a cross section on the line 2—2′ of Fig. 1.

Fig. 3 is an elevation largely in section of a form of piston suitable for use in the apparatus.

Fig. 4 is a cross section on the line 4—4′ of Fig. 3.

Fig. 5 is an elevation largely in section of another form of piston for use in the apparatus.

Fig. 6 is a cross section on the lines 6—6′ of Fig. 5.

Fig 7 is a sectional elevation of a modification of the piston of Fig. 5.

Throughout the drawings, like numerals designate like parts.

Referring to the drawings, particularly Fig. 1, 1 designates a melting pot or container for the body 2 of molten metal from which the die castings are to be made. The pot is provided with a furnace setting (not shown) which maintains the pot and molten metal therein at a suitable casting temperature. The body 2 of molten metal is covered with a layer 3 of a suitable flux for magnesium-base alloys, as known in the art, for protection against atmospheric attack. Shown submerged in the body of molten metal is the shot cylinder assembly designated generally by numeral 4. It comprises the shot cylinder 5 having a cylindrical bore 6. The lower end 7 of the cylinder is in the form of a truncated cone as shown, and a flange 8 is formed above the cone integrally with the cylinder. The upper end of the cylinder is beveled to provide the beveled surface 9, which slopes downwardly from the bore 6 forming a sharp edge 10 adjacent to the upper end of the bore 6. About ¾ of the way up from the lower end 7 of the cylinder and in the side wall thereof, ports 11 are provided for the admission to the cylinder 5 of molten metal from the molten body 2. The outside 12 of the ports are recessed and secured in the recesses are inlet pipes 13 projecting outwardly from the cylinder. The inlet pipes 13 convey molten metal from the metal body to the ports 11. The outer ends are cut with an oblique face 14 which slopes upwardly and away from the cylinder 5 so that the outermost point 15 is above the bore of the tube.

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Again referring particularly to Fig. 1, the cylinder 5 is mounted on the block 16 so that the lower end 7 of the cylinder fits into the conical recess 17 in the block. The cylinder is clamped in place by the clamp ring 18 and bolts 19. Operating in the bore 6 of the cylinder is a piston 20 (which may have optional forms, later herein described in detail) secured to the boss 21 on the lower end of the pump rod 22 which extends well above the rim 23 of the pot 1. Surrounding the pump rod is the shroud in the form of a tubular member 24, which prevents flux, floating on the metal, as well as air, from coming in contact with the pump rod 22. The lower end of the shroud is secured, as by thread means 25, to the upper end of the shot cylinder 5. The upper end of the shroud comprises a suitable stuffing box designated generally by 26 for preventing passage of air or gas to or from the shroud along the pump rod 22 while allowing free reciprocating motion for the pump rod 22. One form of stuffing box is shown in Figs. 1 and 2. It comprises a bottom in the form of the annulus 27, the outer edge of which is secured to the inner wall of the shroud as by the weld 28. A central opening 29 is provided to allow free reciprocation of the pump rod 22. Resting upon the annulus 27 are four graphite sealing blocks 30, 31, 32, and 33, respectively, which make a snug fit against the shroud wall

34 and the pump rod 22. As a further seal, grooves 36 are provided around the outside of the blocks and a suitable packing 37 such as asbestos rope filled therein, thereby sealing the space between the periphery of the blocks and the upper end of the shroud so that significant leakage of gas past the outside of the blocks is prevented. The blocks are held in place by the cover plate 38. This is bolted to the flange 39 on the upper end of the shroud by the flange bolts 40, the plate being provided with the central opening 41 for passage of the pump rod 22.

The tubular connection 42, referring to Fig. 1, is provided in the side wall of the shroud for the admission of an inert gas thereto. The side wall of the shroud is provided with an opening 43 just above the lower edge of the bevel surface 9 to admit molten metal to the shroud and provide a liquid seal of molten metal for the upper end of the piston 20 where it enters the bore 6 of the cylinder 5.

As shown in Fig. 1, the pump rod 22 is actuated by the means comprising cylinder 44 attached to the plate 45 by bolts 46. The cylinder contains the piston 47 to which the upper end of the piston rod 48 is secured. The piston rod 48 extends downwardly and its lower end 49 is clamped by means of the clamp 50 to the upper end of the pump rod 22. Oil pipe connections 51 and 52 are provided for the cylinder for the admission or exhaustion of oil above and below the piston 47, respectively, thereby to reciprocate the piston rod 48, as desired.

The plate 45 is tied to the block 16 by the tie bolts 53. The block 16 is provided with the passage 54 for conveying molten metal from the shot cylinder 5 to the goose-neck 55, the lower end of which is connected by means of the flange union 56 to the block opposite the discharge opening 57 of the passage 54.

The upper end of the goose-neck 55 may be connected to a conventional die casting die or mold (split) and mold operating apparatus. In the drawings, this is exemplified schematically in Fig. 1 by the stationary half 58 of a casting mold shown secured to a platen 59, and the movable half 60 of the mold shown secured to the movable platen 61. The two mold halves, when brought together as shown, form the mold cavity 62. The mold cavity 62 is connected by the sprue 63 and nozzle 64 to the goose-neck 55, the goose-neck being clamped against one end of the nozzle 64 by the flange 55 and tie bolts 66. The complete means for moving the movable platen 61, so as to either bring together or separate the mold halves, are not shown, not being a part of the invention.

Referring to the piston 20 attached to the pump rod 22, it will be seen that it may take any one of the optional forms as aforesaid shown most completely in Figs. 3, 5, and 7. As to the form shown in Fig. 3, the piston comprises a cylindrical body member 67 having a cylindrical groove 68 at each end. Each groove is filled with a band 69 of a hard facing material comprising tungsten carbide particles in a ferrous metal matrix. I have found that tungsten carbide is not wetted by molten magnesium-base alloys and that it is highly resistant to erosion by these molten metals. The filling of the grooves with the tungsten carbide containing matrix is readily accomplished in conventional manner as by welding, so that the hard facing material is integrally bonded to the cylindrical surface of the body member, using conventional composite filler rods of crushed

tungsten carbide and a suitable ferrous metal such as mild or alloy steel. Composite filler rods are commercially available in at least two forms. In one, the filler rod is in the form of a ferrous metal tube filled with the crushed carbide. In the other form, a mixture of the crushed carbide and ferrous metal is formed into a rod. The crushed tungsten carbide may be in various sizes. For example, the particles may pass through 8 mesh screen and 90 per cent or more may be retained on 200 mesh, although other sizes may be used. A preferred composite filler rod of the facing material is one having crushed tungsten carbide of particle sizes below about 30 mesh dispersed in a ferrous alloy matrix in the proportion of about 40 to 60 per cent of the weight of the composite rod, the balance consisting of 4 to 6 per cent of cobalt, 0.5 to 2 per cent of chromium, and the remainder iron. As a specific example of a hard facing composition which may be used in the form of welding rod, the following is cited: cobalt, 4.7 per cent; 40 mesh crushed tungsten carbide, 48.3 per cent; chromium, 2 per cent; impurities including carbon, silicon, nickel, manganese, aluminum, sulfur and phosphorous, not over 1 per cent; the balance being iron. The external diameter of the bands 69 is preferably slightly larger (e. g. 0.005–0.050 inch) than the diameter of the cylindrical member 67 and slightly smaller than the internal diameter of the cylindrical bore 6. For example, a clearance of 0.005 inch is generally satisfactory for a 2 inch cylindrical bore. One end of the cylindrical member 67 is provided with a threaded bore 70 so that the piston may be screwed onto the threaded boss 21 on the end of the pump rod 22.

The form of piston shown in Fig. 5 comprises a cylindrical body member 71 provided with a threaded bore 72 in one end adapted to receive the threaded boss 21 on the end of the pump rod 22. Piston ring grooves 73 are provided around the circumference of the body member 71. The grooves are relatively wide compared to their depth. For example, the grooves may be 0.375 inch wide and 0.10 inch deep. Each ring groove is fitted with a conventional expansible piston ring 74 which is slightly narrower than the groove and about 50 per cent thinner than the depth of the groove so that the external face 75 of the rings projects beyond the circumference of the body member 71, and a clearance of about 0.025'' to 0.045'' is provided between the bottom of the groove and the underside 76 of the rings. The outside diameter of the piston rings is slightly less than the internal diameter of the bore 6 of the shot cylinder 5 (i. e. about 0.001 inch clearance is satisfactory) in which the piston is designed to operate. As shown in Fig. 6, the ends of the rings may have a lap joint 77, preferably, although other forms of joint may be used, such as square cut abutting ends, thereby permitting the rings to expand outwardly to engage the bore 6. The rings are best made of a special tool steel such as one having the following composition: tungsten, 18 per cent; chromium, 4 per cent; vanadium, 1.2 per cent; carbon, 0.73 per cent; the balance being iron. Although other steels may be used, a steel of the foregoing analysis is commercially available under the trade name "Rex AA." Each groove is connected by passages 78 to a central passage 79 drilled into the end of the cylindrical member opposite to the end attached to the pump rod 22 so as to provide a continuous passage for fluid from the underside

80 of the piston to the underside 76 of each piston ring.

The piston shown in Fig. 7 is similar in form to that shown in Fig. 5. It comprises a body member 81 having a threaded recess 82 adapted for screw threaded attachment to the boss 21 on the pump rod 22. The body member is encircled with two conventional piston rings 83 of similar material, dimensions, and form to the rings designated 74 in Fig. 5. The rings 83 are kept in place on the piston by the bands 84 which are of the same material as the bands 69 of Fig. 3. These bands are welded onto the surface of the body member 81 autogenously as in the case of bands 69. Passages 85 are drilled under the rings 83 and communicate with the axial bore 86, thereby forming a fluid passage from the underside 87 of the piston to the underside 88 of the rings 83. With this design, the bands 84 together with the body member 81 form ring grooves 89 having extremely hard sides or edges 90. In addition, the bands form the wearing guide surface 91 for operating the piston in the cylinder bore 6.

In operation, the shot cylinder assembly 4 is submerged in the body of molten metal 2, which is covered with conventional flux 3, and inert gas such as helium is supplied to the shroud 24 through the connection 42. Another suitable gas, and one I prefer, is a mixture of 99 per cent of argon and 1 per cent of sulfur dioxide by volume. The piston 20 (which may be of the form of that shown either in Fig. 3, Fig. 5, or Fig. 7) is raised to the top of its stroke, as shown in Fig. 1, by operating the piston 47 whereupon a charge of molten metal enters the shot cylinder 5 through ports 11 and inlet pipes 13. Owing to the form of the inlet pipes, clean metal enters the shot cylinder 5. The charge or shot of metal is forced from the shot cylinder 5 by moving the piston 20 downwardly, the downward push being obtained from the piston 47. As the piston 20 descends below the ports 11, the charge in the shot cylinder 5, while being prevented by the piston from escaping from the bore 6, is forced therefrom through the passage 54 and goose-neck 55 to the mold cavity 62 and there cast, the bottom of the stroke being indicated by the dotted outline of the piston in the bore 6. After removing the casting from the cavity 62, the casting operation may be repeated.

Several advantages exist with the foregoing apparatus, among these may be mentioned the following: The pump rod 22 does not come in contact with both flux and molten metal so that the intermixing of flux and metal, and, hence, contamination of the metal by flux, as a result of the motion of the pump rod, is avoided; oxidation of molten metal in the vicinity of the pump rod is avoided because the molten metal in the shroud, although not covered by flux, is protected from atmospheric attack by inert gas in the shroud above the surface of the molten metal therein; the face of the piston 20 in contact with the bore 6 is kept clean because the mouth of the shot cylinder is sharply beveled and the sharp upper edge 10 causes any matter adhering to the surface of the pump rod 22 to be sheared off when the piston moves into the cylinder; binding and seizing of the piston in the shot cylinder is obviated; dross which normally forms in the flux layer, and in part at least settles through the melt to the bottom, is not readily drawn into the inlet pipe of the shot cylinder because of the oblique cut of their outer ends; flux which tends to creep over the surface of the apparatus in contact with the flux also is deterred from entering the shot cylinder due to the long surface travel which must be made before such entry is possible; by-passing of the molten metal between the pump cylinder wall and the piston is effectively prevented with any of the three embodiments shown of the piston, in those employing tungsten carbide containing bands (Figs. 3 and 7), the bands are not wetted by molten magnesium-base alloy as a consequence piston wear or erosion is negligible; for example, more than 15,000 die castings of a drawer handle weighing 0.2 pound in a magnesium-base alloy were cast using a pressure on the molten metal of 2000 pounds per square inch in the shot cylinder without significant piston wear; in the embodiments of Figs. 5 and 7 employing the fluid expanded piston rings, wear is automatically taken up and a good seal obtained at all times during the pumping stroke because the fluid pressure which is generated in the shot cylinder below the piston on the down or pumping stroke is transmitted to the underside of the piston rings forcing them against the cylinder wall.

I claim:

A die casting apparatus adapted to make die castings by delivering shots of molten metal from a molten body thereof to a die comprising in combination a shot cylinder having a cylindrical bore axially thereof and adapted to be disposed in the molten body of metal, a piston adapted to be reciprocated longitudinally in the cylindrical bore, said shot cylinder having a port in the side wall thereof for the admission of molten metal to the bore below the piston when at the top of the cylinder, the upper end of said shot cylinder having a beveled surface sloping downwardly from the bore of the shot cylinder so as to form a sharp edge on the upper end thereof adjacent to the said bore, an inlet pipe on the outside of the port projecting outwardly from the cylinder for conveying molten metal from the molten body thereof to the said port, the outer end of said inlet pipe being cut obliquely with respect to the axis of the inlet pipe, a rod for actuating the said piston extending above the molten body of metal and having its lower end secured to the upper end of said piston, a shroud around the piston rod having its upper end extending above the body of molten metal and its lower end secured to the lower edge of the beveled portion of the said shot cylinder, said shroud having a port in the lower end of its side wall, a stuffing box on the upper end of the shroud adapted to form a seal for the rod, and tubular means having its bore communicating with the lower end of the bore of the shot cylinder adapted to convey molten metal from the shot cylinder to the die.

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