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DIE CASTING

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1 Claim. (Cl. 22—70)

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The invention relates to die casting. It more particularly relates to an improved apparatus of the type employing a piston operating in a heated shot cylinder for forcing the molten metal through a gooseneck into a die where the casting is made. In the usual arrangement of apparatus of this kind, the molten metal to be cast is maintained in an open top melting pot under a cover of saline flux and the shot cylinder and most of the gooseneck is submerged in the molten metal which maintains these parts at working temperature. In making a casting, the molten metal from the melting pot enters the shot cylinder on the upward stroke of the piston and is forced from the shot cylinder through the gooseneck into the die by the downward stroke of the piston.

I have found upon attempting to make die castings of magnesium-base alloys, using conventional apparatus of the type indicated above, that numerous difficulties arise which adversely affect the quality of the castings obtained. Among these difficulties are that the temperature of the metal delivered to the die cannot be accurately controlled; there is dripping and burning of the molten metal when the die is opened to remove the casting; an excessive amount of manual labor is required to remove burned metal and oxide accumulations in the gooseneck; an excessively large amount of molten metal is maintained in the gooseneck and there is a relatively long passage for metal to pass from the shot cylinder through the gooseneck to the die, necessitating operating the apparatus at excessive pressure and temperature in order to deliver the molten metal to the die before the metal coagles; an excessive amount of air enters the gooseneck after the shot is made when the die is opened and the molten metal in the gooseneck recedes; there may be oxide as well as flux contamination of the castings; die life is relatively short; a considerable portion of the castings made are rejected due to various imperfections including the presence of non-metallic contaminants; once started the apparatus cannot be easily shut down and restarted without considerable risk of breakage due to contraction and expansion of metal in the pot especially between the shot cylinder and gooseneck.

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

In brief, the invention is predicated upon an improved gooseneck and shot cylinder arrangement which is compact and operates in conjunc-

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tion with an intermediate supply of molten metal maintained apart from and at a substantially constant level with respect to the shot cylinder and gooseneck, the intermediate supply being derived from a separate melting pot in which the metal to be cast is melted. A complete understanding of the invention will be had by reference to the following detailed description, together with the accompanying drawing.

In the said drawing, the single figure is a side elevation largely in section of a die casting apparatus embodying the invention.

Referring to the drawing, the apparatus shown comprises four major units, indicated generally by numerals 1, 2, 3, and 4, respectively. These comprise: 1 a melting apparatus for providing a supply of molten metal to be cast; 2 casting dies and associated mechanism for operating the dies in which a succession of castings may be made; 3 a shot cylinder and gooseneck assembly with associated mechanism for delivering a shot of molten metal to the dies for casting therein; and 4 a metal level control apparatus and associated mechanism for providing the shot cylinder assembly with molten metal from the supply at a constant level for each shot.

As shown, the melting apparatus 1 comprises a conventional open top melting pot 5 which may be supported in a furnace setting (not shown) by the rim 6. A siphon indicated generally by numeral 7, comprising a pipe 8, has a valve 9 on one end, 10, which is adapted to operate submerged in molten metal 11 in the pot 5. The other end 12 of the siphon is at a lower level and discharges into the level control apparatus 4. Heat loss from the siphon is prevented by the electrical resistance heating element 13 embedded in refractory insulation 14 which envelops the pipe 8. Metal sleeves 15 and 16, respectively, are provided around the refractory insulation over the portions of the pipe to be submerged in molten metal to prevent molten metal from coming into contact with the refractory insulation.

The level control apparatus 4 comprises the molten metal reservoir 17 provided with a cover 18 having an opening 19 for the admission of the lower end 12 of the siphon. The side 20 and bottom 21 are kept hot by the electrical resistance heating element 22 embedded in the refractory insulation 23 which encases the sides and bottom of the reservoir. Refractory insulation 24 is placed over the cover 18 to restrain heat loss. Near the top of the side of the reservoir 17, an opening 25 is provided to which pipe 26 is connected for conveying mol-

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ten metal from the reservoir 17 to the shot cylinder assembly 3. The level 27 of the molten metal 28 in the reservoir 17 is maintained substantially constant, in spite of withdrawals of metal therefrom, through the action of valve 9, the operation of which is subject to automatic control by means of the level controller 29. Level controller 29 responds to changes in the elevation of the molten metal in reservoir 17 with respect to the level detector 30 and closes the electric circuit 31 to valve motor 32, thereby opening or closing the valve 9 according to whether the level 27 is below or above, respectively, an assigned level.

The shot cylinder and gooseneck assembly 3 comprises a main body member 33 which may be cast in a single piece and has formed therein the gooseneck 34. As shown, the upper end 35 of the gooseneck terminates in a recess 36 in the side of the main body member. The recess 36 is provided with an internal thread which receives the externally threaded end of the nozzle 37 in fluid-tight engagement. The lower end of the gooseneck turns upwardly and communicates with the bottom 38 of the shot cylinder 39. As shown, the lower portion of the main body member 33 is bored out to form a cylinder 40 which is provided with an internal thread 41 at its lower end. Into the cylinder 40 fits the lower portion of shot cylinder 39, as shown, which forms a liner for the cylinder 40. The lower end of the shot cylinder is externally threaded, the threads engaging those of the bottom of cylinder 40 and holding the shot cylinder in place. Ports 42 are provided in the side wall of the shot cylinder 39 near its upper end. The main body member 33 is bored out above the bottom of the ports 42 to form a well 43 for holding molten metal to be supplied to the shot cylinder. The bottom of the well communicates with the ports 42. The well has a volume sufficient to hold somewhat more molten metal than that required for a single casting.

An opening 44 is provided in the side wall of the well 43 to admit, in fluid-tight engagement, pipe 26 which provides a passage for molten metal to enter the well 43 from the reservoir 17.

A piston 45, secured to the lower end of the piston rod 46, operates in the shot cylinder 39 for ejecting metal therefrom through the gooseneck. The piston rod extends through a stuffing box 47 secured to the top of the main body member 33 and forms therefor a closure.

The rods 48 secured to the top of the main body member 33 support the header 49 carrying hydraulic cylinder 50. In cylinder 50 operates piston 51. Piston 51 is attached to the upper end of the piston rod 46 which is vertically reciprocated by movement of piston 51.

The space 52 above the molten metal 53 in the well 43 is connected by conduit 54 to the space 55 above the molten metal in the reservoir 17 to equalize the gas pressure in these spaces. A T 56 in the conduit is connected by conduit 57 to a gas holder or gasometer 58 for maintaining a suitable inert gas pressure, e. g. atmospheric, in the space above the metal in well 43 and the reservoir 17. A suitable inert gas which may be tolerated by the molten metal without adverse effect is supplied to the gasometer through the inlet 59. The gasometer allows gas to enter or leave the spaces above the molten metal in the well 43 and reservoir 17 without significant variation in pressure.

The external surfaces of pipe 26, the main body

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member 33, and the nozzle 37 are covered with refractory insulation 60 in which is embedded an electrical resistance element 61 for maintaining these parts at a suitable working temperature.

Nozzle 37, which slopes upwardly and away from the gooseneck, projects through opening 62 in the fixed header 63. The outlet 64 of the nozzle is smaller than the passage 65 there-through and placed at an elevation just above the level at which molten metal is carried in well 43 and is above the opening 44. The nozzle outlet 64 is pressed against the sprue opening 66 in the die half 67 which is secured to the header 63. The other half 68 of the die is secured to a movable platen 69. The complete means for moving the movable platen 69, which is carried by ram 70, so as to either bring together or separate the die halves, are conventional and not shown.

In operation, metal to be die cast is melted in the melting pot 5 and a supply of molten metal is maintained therein at an elevation sufficient to provide gravity flow to the reservoir 17, as through the siphon pipe 8. When valve 9 is open, molten metal is siphoned from the melting pot into the level control reservoir 17, filling it to a level just below the nozzle outlet 64. When the level of the molten metal in the reservoir 17 rises to the level just below outlet 64, and the level detector 30 is positioned to detect the surface 27 when at this level, the level controller 29 energizes circuit 31 to the valve motor 32 closing valve 9 which stops the flow of metal through the siphon but leaves the siphon filled with molten metal. The molten metal in the siphon is maintained at a suitable operating temperature by the heating element 13. While the molten metal thus passes into and fills the level control reservoir 17 molten metal overflows through pipe 26 into well 43, the level in which becomes the same as that in the level control reservoir. The level control reservoir is placed at an elevation such that the well 43 may be filled to a level above the top of the shot cylinder and just below the outlet 64 of the nozzle so that molten metal does not drip from the nozzle. The main body member 33, pipe 26, and nozzle 37 are maintained at a suitable working temperature by the electrical resistance heating element 61. When well 43 becomes filled to the level of the molten metal in the level control reservoir 17 as indicated by the fact that valve motor 32 has closed valve 9, the piston may be drawn upward to the top of its stroke, by actuating piston 51 in hydraulic cylinder 50, thereby uncovering ports 42 and permitting molten metal to pass from the well 43 into shot cylinder 39 and gooseneck 34. As metal flows from the well into the shot cylinder and gooseneck, and the metal level in well 43 tends to drop, additional metal flows in to replace it from the level control reservoir 17, the level in which then falls. The falling of the liquid level in the reservoir 17 with respect to the liquid level indicator 30, causes the level controller 29 to energize valve motor 32 for opening valve 9. The opening of valve 9 permits metal to pass from the melting pot 5 into the reservoir 17 until the level therein is restored to the level of the detector 30 which then, through the level controller, again brings about closing of the valve 9. After allowing time for the shot cylinder 39 to fill with molten metal (a time interval of but a fraction of a second in normal operation), and closing the dies by actuating ram 70 so as to press die half

68 against die half 67, the piston 45 is forced downwardly by actuating piston 51 in the hydraulic cylinder 50. The downward movement of piston 45 displaces the molten metal from the shot cylinder 39 through the gooseneck 34 and nozzle 37 into the die cavity 71 between the die halves, leaving molten metal in the gooseneck. After the molten metal hardens in the die, the movable die half 68 is withdrawn allowing the casting to be removed. On removing the casting, 10 molten metal recedes in the nozzle 37 below the outlet 64 to a level corresponding to that in well 43 which level follows and is determined by the level of the molten metal in the reservoir 17. The piston 45 is drawn up above ports 42 in readiness for repeating the casting operation. 15

When the piston 45 is at the top of its stroke (as shown), there is a continuous passage for molten metal from the level control reservoir 17 to the nozzle outlet 64 so that when the level detector 30 is set at the proper level (i. e. just below the level of outlet 64) the molten metal will lie in the nozzle, as indicated at 72, without running out when the nozzle is not closed by a casting. The upper end 35 of the gooseneck is made so that it is sufficiently above the bottom 73 of the well 43 to permit the well to hold enough molten metal for at least one and preferably not more than 2 fillings of the shot cylinder. The shot cylinder should have a volume substantially greater than the volume of metal required for a single casting to allow for leakage past the piston on the shot stroke. 20

With this arrangement of the nozzle outlet and level control reservoir, not only is dripping and its attendant disadvantages obviated but also only a small amount of air may enter the casting ahead of each shot. This has the advantage of simplifying the venting of the dies and results in sounder castings. The purity of the metal entering the dies is high since contaminants tend to be retained in the melting pot and level control reservoir instead of being carried into the dies. Contaminating sediments which may reach the well 43 are washed out with each refill of the shot cylinder, thereby becoming attenuated beyond defect producing dimensions. 25

By making the gooseneck, metal well, and shot cylinder container in one piece, as shown, compactness is achieved and the usual surrounding metal melting pot is eliminated. As a result, temperature control is improved, sounder castings may be obtained at lower pressures and temperatures, and the apparatus may be shut down and restarted, although filled with metal without danger of breakage. 30

Although a siphon is the preferred means for conveying molten metal from the melting pot 5 to the level control reservoir 17, other means may be used, e. g. a conduit, indicated in dotted lines 74 which permits flow by gravity from the one vessel to the other. 35

In production runs of the machine making thousands of die castings of a conventional magnesium-base alloy, the average proportion of commercially acceptable castings obtained exceeded 98 per cent. 40

It is to be understood that the foregoing de-

scription is illustrative rather than strictly limitative, and that the invention is coextensive in scope with the following claim.

I claim:

In a die casting apparatus for making a succession of castings by delivering shots of molten metal to casting dies, the combination of a one piece elongated body member having its long axis vertically disposed, said body member having wholly therein and enclosed thereby a vertically disposed well having a volume at least sufficient to hold a charge of molten metal for a casting; a shot cylinder vertically disposed in and enclosed by the body member; a gooseneck in the body member having its lower end in communication with the bottom of the shot cylinder and its upper end in communication with the dies, said upper end being above the top of the shot cylinder; a piston operable in the shot cylinder to displace molten metal through the gooseneck into the dies, said upper end of the shot cylinder projecting through the bottom of the well a distance at least as great as the length of the piston and having a port in the side of the cylinder forming a passageway between the bottom of the well and the inside of the shot cylinder when the piston is retracted; a molten metal reservoir adjacent to the body member, said reservoir having its working level above the top of the shot cylinder; conduit means connecting the well with the reservoir adapted to supply molten metal to the well at the same level as that in the reservoir; a melting pot for melting and holding a supply of molten metal to be cast, said melting pot having its working level above that of the reservoir; a pipe means adapted to convey molten metal from the melting pot to the reservoir; a valve in the pipe means within the melting pot; and level detecting means responsive to the level of molten metal in the reservoir, said level detecting means being adapted to operate the said valve to release molten metal from the melting pot through the said pipe means to maintain molten metal in the reservoir at a level to fill the well to a depth above the top of the shot cylinder. 45

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