May 18, 1954 J. LAPIN 2,678,480

DEVICE FOR DELIVERING METERED SHOTS OF MOLTEN METAL FOR CASTINGS

Filed Jan. 24, 1952 2 Sheets-Sheet 1

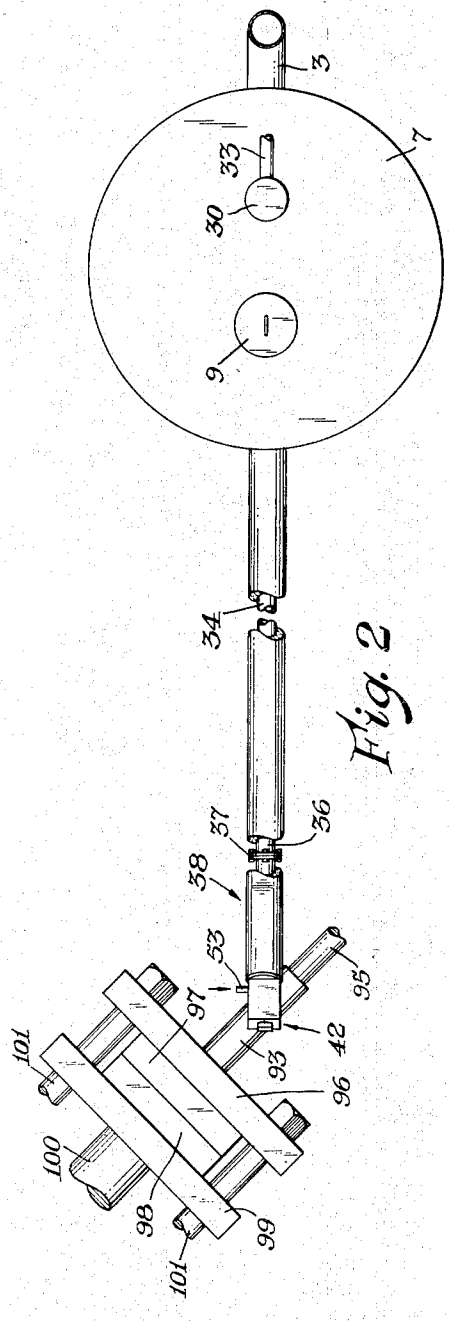

Fig. 2

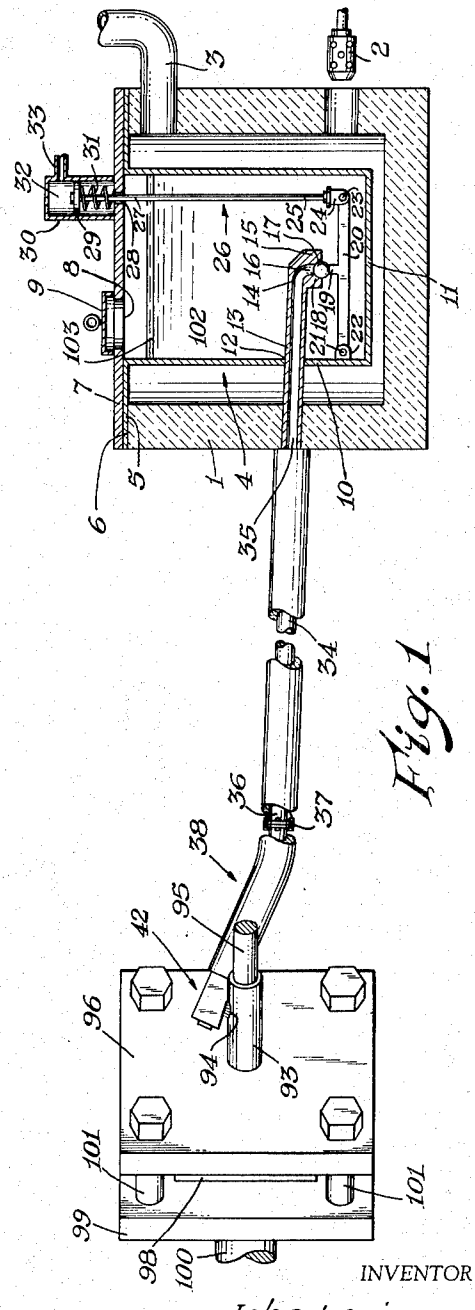

Fig. 1

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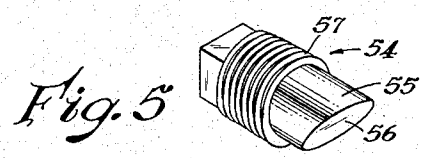

Fig. 5

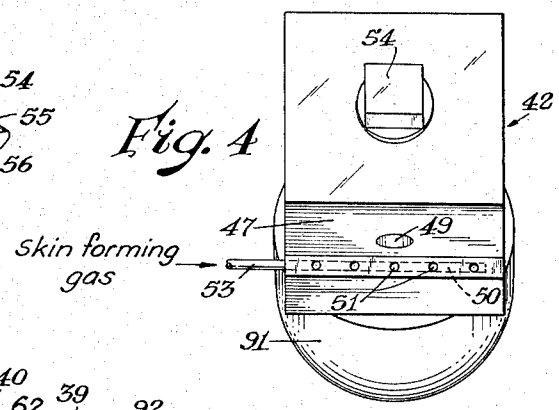

Fig. 4

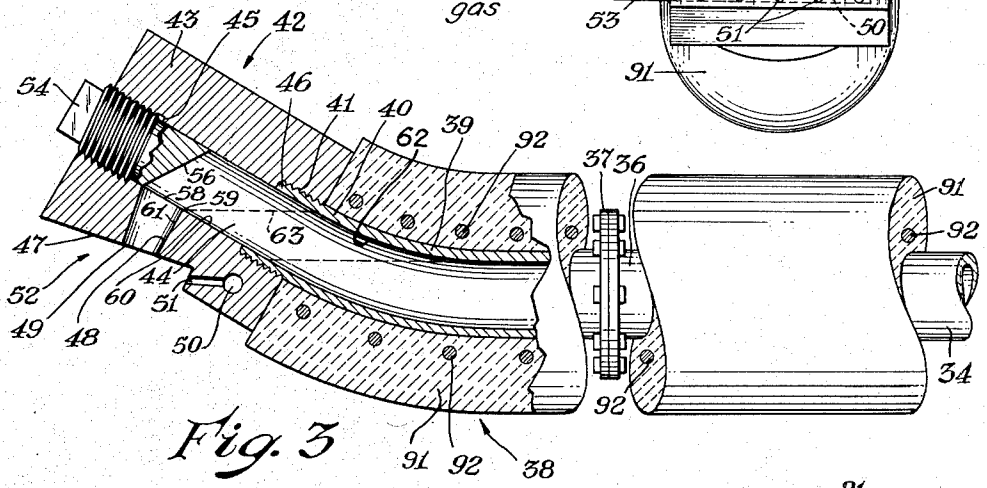

Fig. 3

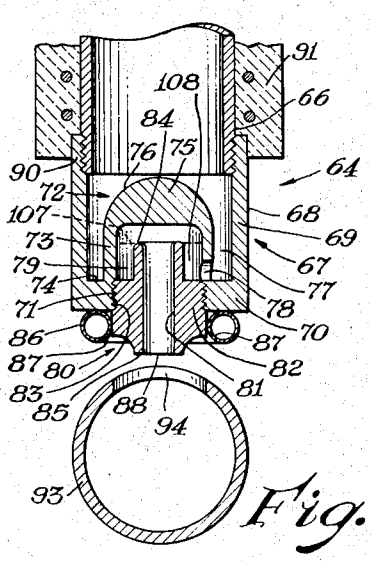

Fig. 7

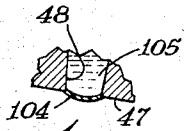

Fig. 8

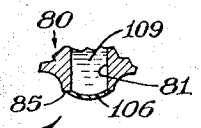

Fig. 9

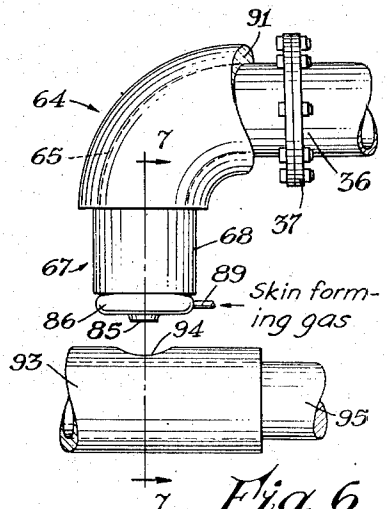

Fig. 6

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DEVICE FOR DELIVERING METERED SHOTS OF MOLTEN METAL FOR CASTINGS

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Application January 24, 1952, Serial No. 268,001

3 Claims. (Cl. 22—79)

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The invention relates to improved apparatus for delivering accurately metered shots of molten metal particularly to a casting device such as a die casting machine.

An object of the invention is to provide means of the foregoing character including a pipe, having an open delivery end, for conveying by gravity flow a succession of metered amounts of molten metal from a source of molten metal, such as a melting pot, to the point of delivery, such as a shot cylinder of a die-casting machine, without dripping or dribbling from the delivery end after the shot is made. The inlet end of the pipe has a valve means for regulating the volume, i. e. metering the amount, of metal entering the pipe for each shot. The delivery end of the pipe has a trap to prevent ingress of air and maintain the pipe filled with molten metal between deliveries and orifice means at the delivery end in connection with the trap adapted to prevent dripping and dribbling from the delivery end after the said valve is closed so that the volume of metal delivered in each shot is precisely metered by the duration of the opening and closing of the said valve.

Other objects and advantages of the invention will become apparent as the description of the invention proceeds.

The invention will be more readily understood from a reading of the following specification and reference to the accompanying drawing showing an example of the invention wherein:

Fig. 1 is a side elevation partly in section showing a preferred embodiment of the apparatus of the invention in position to deliver metered shots of molten metal to a die-casting machine.

Fig. 2 is a plan view of a portion of Fig. 1.

Fig. 3 is a side elevation largely in enlarged vertical section of one form of the delivery end of the apparatus.

Fig. 4 is an end elevation of the delivery end of the apparatus shown in Fig. 3.

Fig. 5 is a fragmentary view of the plug in the delivery end of the apparatus shown in Fig. 3.

Fig. 6 is a side elevation of a modification of the delivery end of the apparatus.

Fig. 7 is a vertical section on the line 7—7 of Fig. 6.

Fig. 8 is a fragmentary view of Fig. 3 showing the orifice thereof.

Fig. 9 is a fragmentary view of Fig. 7 showing the orifice thereof.

Referring to the drawing in detail, there is shown a furnace setting 1 provided with a heating burner 2 and flue 3. Shown in the furnace

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setting is the melting pot 4 or metal supply vessel having a rim 5 which rests upon the top 6 of the setting. The melting pot is provided with a cover 7 having a charging opening 8 closed with a removable cover 9. The side wall 10 of the pot near the bottom 11 is provided with an opening 12 through which passes the outlet pipe 13, the outside of which is welded or otherwise sealed to the wall of the pot around the opening 12. The end 14 of the outlet pipe within the pot is provided with a thick walled elbow 15 having its open end 16 extending downward. As shown, the open end is provided with a bevel 17 which forms a valve seat for the ball valve 18. The ball valve is carried on the support 19 which is mounted on the lever arm 20. One end of the lever arm 20 carries a pivot 21 which turns in the bearing 22 secured to the side wall 10 of the pot. The other end of the lever arm carries a pivot 23 which turns in the bearing 24 carried by the lower end 25 of the piston rod 26. The upper end 27 of the piston rod extends through the opening 28 in the cover and carries the piston 29. The piston 29 operates in the inverted cylinder 30 which is mounted on the cover 7. A compression spring 31 is provided around the upper end of the piston rod and extends between the cover and underside of the piston and urges the piston upwardly. The upper end 32 of the cylinder above the piston communicates with the pipe 33 which is connected to a source of fluid pressure not shown.

Pipe 34 connects with outlet pipe 13 and extends from the wall of the pot through the furnace setting close to the point of delivery of the molten metal from the pot. Both pipe 34 and pipe 13 are preferably arranged to slope upwardly from the elbow 15 at a slight angle to the horizontal, e. g. 1° to 10°, so that there is an upwardly inclined continuous passage 35 from the valve seat 17 in the elbow 15 to the outer end 36 of the pipe, although the pipe 34 may be horizontal or even slope the other way.

The outer end 36 of the pipe is provided with a union 37 by which the delivery end means, e. g. 38, are secured to the pipe 34. As shown in Figs. 1 through 5, the delivery end means 38 comprises a section of pipe 39 having an upturned end 40 with an external thread 41 thereon by means of which the discharge outlet, having the form of an elbow, indicated generally by numeral 42, is screwthreadedly thereto secured. The said elbow comprises a body 43 which may be formed in a more or less rectangular oblong block of metal. Through the long axis of the block is

formed, the cylindrical bore 44 having the same internal diameter as that of the pipe 39 which may have an I. D. of 1 to 2 inches. Each end of the cylindrical bore 44 is reamed out and threaded leaving shoulder 45 and 46, respectively. The block is secured at one end to the upturned end 40 of the pipe by engaging the thread on the pipe with that in one end of the block, as shown. The upturned end 40 of the pipe is thereby brought into engagement with the shoulder 46 so that the wall of the cylindrical bore 44 of the block and the bore of the pipe are flush with each other forming a continuous smooth passage. The lower side of the block has a flat face 47 so-formed as to lie in a plane which does not depart from the horizontal by more than 10°. A conical bore 48 is formed in the block intermediate its ends and extends from the face 47 into the block to intersect the bore 44. The outer and smaller end of conical bore 48 terminates in a circular orifice 49 having a diameter of ¼ to ½ inch. It will be noted that the larger end of the conical bore 48 has the same diameter as the bore 44 which may have a diameter of 1 to 2 inches as aforesaid. The center of the orifice 49 and the long axis of the bore 48 lie in a vertical plane which also passes through the long axis of the bore 44.

A manifold 50 for the distribution of a skin-forming gas adjacent to the orifice 49 is provided as by drilling a passage into the block perpendicular to the aforesaid plane near the orifice and providing a series of openings 51 connecting the passage with the space 52 below and adjacent to the orifice. A pipe 53 connects the gas distribution manifold with a source (not shown) of a suitable skin-forming gas, exemplified later.

The outer end of the bore 44 in the block is closed with a removable plug 54, shown in enlarged perspective in Fig. 7. The plug is essentially cylindrical in shape, one end 55 having a diameter permitting a snug fit in the bore 44. This end is cut at an oblique angle forming the face 56. As shown, the other end of the plug is provided with an enlarged diameter portion in which a thread 57 is cut enabling the plug to be screw threadedly secured in the block as shown in Fig. 3. The plug, as in place, streamlines the intersection 58 of the bore 44 with the passage 48. The plug being removable also provides access to the passages through the elbow for cleaning.

The point of intersection 59 where the lower side 60 of the bore 44 meets the wall 61 of the bore 48 is arranged to be at an elevation substantially above the top side 62 of the bore of the pipe section 39 beyond the outer upturned end 40. This arrangement may be achieved by bending the outer end 40 of the pipe section 39 upwardly (as shown) so that a horizontal plane 63 passing through the point 59 will be above substantially all the top side 62 of the pipe 39 adjacent to its upturned end 40. The plane of the face 47 is machined off or otherwise formed so as to be in a substantially horizontal plane (i. e. within 10° of horizontal), as already indicated, after providing for the aforesaid upturn. It will be noted that the highest point in the upturned portion of the pipe is within the elbow 42 adjacent to the orifice 49.

In the alternate form of outlet orifice arrangement shown in Figs. 6 and 7, the delivery end means 38, already described, are removed at the union 37 and replaced by the alternate form 64. In this form, a downwardly turned elbow 65 which is secured to pipe 34 by the union 37 has screwthreadedly secured to it at the downturned end 66 the outlet orifice body 67. As shown, this consists of a chamber 68 having a vertical cylindrical side wall 69 and a bottom 70 on the lower end. An internally threaded opening 71 is provided in the bottom concentric with the side wall 69, the axis of the thread being coincident with the vertical axis of the chamber. Arranged within the chamber is an inverted cup 72 with the cylindrical side wall 73 sealed to the inside 74 of the bottom all around the open end of the cup 72. The closed end 75 of the cup (bottom of the cup 72 inverted) is preferably rounded or dome-shaped on the outside so as to form the convex surface 76 streamlining the entrance to the annular space 77 between the outside wall of the cup and the inside wall of the chamber 68. Openings 78 in the side wall of the cup provide communication between the inside 79 of the cup and the aforesaid annular space. The said openings 78 are placed near the open end of the inverted cup adjacent to the inside 74 of the bottom 70. Screwthreadedly secured in the said internally threaded opening is the orifice member 80. This consists of a tube-like member having an axial bore 81, ¼ to ½ inch in diameter, extending from end to end of the member, and an enlarged middle portion 82 which is provided with an external thread 83 by which the member 80 is screwthreadedly secured in the bottom 70. The upper end 84 of the tube-like member extends above the openings 78 into the inverted cup. The lower end 85 extends below the bottom 70. The length of the orifice member 80 does not exceed 4 to 6 times the diameter of the bore 81. A gas distributing manifold 86 in the form of a ring-shaped pipe is placed around the lower end 85 and openings 87, in the inner periphery of the manifold 86, are provided which are directed toward the outlet orifice 88 at the lower end 85 of the orifice member 80. A pipe 89 provides an inlet to the manifold 86 for a skin-forming gas. The upper end 90 of the chamber is internally threaded and secured by means of this thread to the lower end 66 of the elbow. Pipe 34, and either of the two forms of the delivery means 38 and 64, may be suitably lagged with thermal insulation 91, and, if desired, an electrical resistance heating element 92 may be embedded in it for maintaining the apparatus at operating temperature.

As already indicated, the device is particularly adapted to metering shots of molten metal and delivering the metered shots to a die-casting machine. A portion of a machine of this type is shown in Figs. 1, 2, 6, and 7 in operative relation to the two forms of discharge orifices 49 and 88, respectively, of the device. The portion shown of the die-casting machine is conventional and consists of a shot cylinder 93 having an opening 94 thereto for receiving the shot and is placed close to and directly below either form of the molten metal delivery means, as indicated in Figs. 1 and 6, respectively. A piston 95 is reciprocally operable in the shot cylinder 93 to force the shot of metal delivered thereto into the cavity of a mold or die. In the usual arrangement of casting apparatus of this kind the shot cylinder 93 is mounted on a fixed platen 96 which carries one-half 97 of the mold or die. The other half 98 of the mold or die is mounted on a movable platen 99 by which the two mold halves may be brought together for casting and separated for the removal of the casting. The

movable platen is actuated by the ram 100 and slides on the tie bars 101.

In Fig. 1, the orifice 49 of the modification indicated by 42 is shown placed directly over and close to the shot cylinder opening 94; with the modification of Figs. 6 and 7, the orifice opening 88 is shown likewise placed directly over and close to the shot cylinder opening 94.

The apparatus described is particularly suitable for making metered shots of molten magnesium and the magnesium-base alloys (i. e. alloys of magnesium in which the magnesium content exceeds 80 per cent by weight) as in die casting these metals and the operation of the apparatus will be described in connection with metering shots of these metals.

In starting, valve 18 is in the closed position against the beveled valve seat 17 (as shown) being held by the spring 31, the upward urge of which exerts an upward pressure on piston 29. This in turn pulls up the rod 26 which raises the lever arm 20, thereby forcing the ball valve 18 onto its seat 17. With this valve thus closed, a supply of molten metal 102 is provided and maintained in the melting pot using conventional procedures for preventing atmospheric attack such as the application of a layer of a floating saline flux 103. The depth of the metal 102 in the melting pot is made sufficient to provide a head of molten metal of at least 6 inches above the outlet orifice 49 or 88, according to the modification used. The burner 2 is adjusted to maintain the molten metal 102 at suitable casting temperatures which are ascertainable by trial.

Pipe 34 and either delivery end means, whichever is used, is maintained at a suitable operating temperature by means of the electrical resistance heating element 92 or by the passage of molten metal when the apparatus is in full operation. Molten metal is released from the pot by opening valve 18. This is accomplished by applying fluid pressure through pipe 33 onto the top side of piston 29 in amount sufficient to overcome the upward urge of the spring 31. The piston 29 is thereby moved downwardly and this in turn lowers rod 26 and causes lever arm 20 to swing downwardly and move the ball valve 18 downwardly off its seat 17. As the molten metal enters the outlet pipe 13 and travels therefrom into the bore 35 of pipe 34, it displaces therefrom the air which escapes through the discharge outlet means. In the case of the modification illustrated in Fig. 3, the molten metal passes through pipe 39 into the cylindrical bore 44 and thence through the bore 48 to the outlet orifice 49. In the modification shown in Figs. 6 and 7, the molten metal from pipe 34 passes through the elbow 65 into chamber 68 and thence through the annular space 77 and openings 78 into the annular space 108. Molten metal passes from the annular space 109 over the upper end 84 of the bore 81 and thence to the outlet orifice 88. Flow is allowed to continue until the passage from the valve seat 17 to the outlet orifice 49 or 88 (whichever is used) is purged of gases. Valve 18 is then seated on the seat 17 by releasing the fluid from the upper end 32 of the cylinder above piston 29 allowing it to move upwardly under the action of the spring 31. A skin-forming gas, such as So_2, BCl_3, BF_3, dichlorodifluoromethane, etc., which is capable of forming a tenacious skin on the surface of molten magnesium and the magnesium-base alloys, is released from openings 51 or 87 (whichever form is used) so as to form an atmosphere essentially of skin-forming gas adjacent to the molten metal at the orifice 49 or 88, respectively.

It will be observed that once the air or other gas has been purged from the passage from the valve seat 17 to the outlet orifice 49 or 88, whichever is used, and the flow of metal is stopped by the closure of valve 18, the said passage remains filled with metal all the way from the valve 18 to the orifice 49 or 88, whichever is used, and a skin forms on the molten metal at the respective orifices as shown in Figs. 8 and 9, respectively. In Fig. 8, the skin is shown as 104 over the metal 105 retained in bore 48; in Fig. 9, the skin is shown as 106 over the metal retained in bore 81. With the orifice sizes given and liquid metal head involved in the apparatus, the skin is sufficiently strong to retain the metal in the respective passage immediately above it, i. e. the passage between the outlet orifice 49 and the plane 63 in the case of the modification of Fig. 3, or the passage between the orifice 88 and the plane 107 of the upper end 84 of the bore 81 in the case of the modification of Fig. 7, so that no dripping or dribbling occurs after the valve 18 is closed and atmospheric attack on the molten metal under the skin is substantially prevented. It will be observed also that with either modification, the molten metal is trapped in the pipe 34 close to the discharge orifice so that ingress of air is prevented and there is no danger of the whole passage from the valve to the respective orifice emptying, when valve 18 is closed, in the event that vibration or other inadvertent act should cause the skin to break. In the modification shown in Fig. 3, it will be seen that only a very small volume of metal can escape in the event that the skin 104 should break while valve 18 is closed. The volume of molten metal which might thus escape is that which occupies the passage which extends from the orifice 49 through bore 48 and bore 44 to the level of the plane 63 which is determined by the elevation of the point 59. In the modification shown in Figs. 6 and 7, the volume of molten metal which might escape in the event that the skin 106 over the metal 109 in the bore 81 breaks is that occupying the bore 81 and the portion of the space 79 above the plane 107 which passes through the upper end 84 of the bore 81. The upper end of the orifice member 69 thus functions as a trap which traps molten metal in the annular space 108 below the plane 107 and prevents ingress of air into the apparatus beyond the level of the upper end 84 of the bore 81.

With the passage from the valve seat 17 to the outlet orifice completely filled with molten metal, metered shots thereafter are made by opening valve 18 for specific lengths of time according to the size of the shot desired. The molten metal thus delivered from the discharge orifice may fall directly into the opening 94 of the shot cylinder of a die-casting machine as shown.

In using a die-casting machine in connection with the molten metal delivery apparatus, the movable platen 98 is brought tightly up against the fixed platen 97 and the piston 95 is retracted as shown and then a shot is made by opening valve 18 for a length of time sufficient to deliver the desired volume of metal. The valve 18 is then caused to be closed. Closure of the valve 18 stops the flow of metal from the orifice 49 or 88 and thereupon a skin, 104 or 106, respectively, as the case may be, forms over the surface of the metal at the orifice 49 or 88, as the case may

be, as shown in Figs. 8 and 9, respectively, preventing dripping or dribbling. As a result, no more than the metered amount of metal enters the shot cylinder 93 at each shot. As soon as the metered shot of molten metal is delivered to the shot cylinder piston 95 is moved (by means not shown) into the shot cylinder 93 so as to force the shot quickly from the cylinder into the die. Therein the molten metal solidifies as a casting. The resulting casting is then removed by retracting the ram 100 which moves the platen 99 and die-half 98 away from die-half 97 exposing the casting for removal. After the removal of the casting, the ram 100 is again actuated so as to bring die-half 98 up against die-half 97 in preparation for the next shot which is made as described. Thus, the operations of delivering accurately metered shots of molten metal may be made repetitiously as desired.

Among the advantages of the invention are dripping or dribbling of molten metal from the orifice is eliminated; oxidation or burning of the molten metal leading to the formation of clogging deposits adjacent to the orifice is virtually eliminated; gas which may be released from the molten metal within the passage from the outlet of the supply vessel to the orifice cannot accumulate in detrimental amount in the passages to interfere with metering; air cannot enter the delivery pipe even in the event that the skin at the orifice is accidentally broken allowing molten metal immediately above the orifice to fall out; the apparatus is rugged and allows long trouble-free operation; because the passageway from the supply vessel to the orifice remains filled with molten metal during operation and there is no dripping or dribbling from the orifice when the valve is closed, the amount of metal discharged from the orifice is precisely metered merely by the length of time the valve is allowed to remain open; the valve, being submerged in the molten metal, is maintained at operating temperature at all times and is not subject to contamination by air.

I claim:

1. An apparatus for delivering metered shots of molten metal from a supply thereof to a casting apparatus comprising the combination of a vessel for holding a supply of the molten metal; a pipe having one end extending into the vessel to a point near the bottom thereof and the other end outside the vessel at a level between the bottom of the vessel and the operating level of the molten metal in the vessel, the said other end being turned upwardly; a valve on the end of the pipe within the vessel adapted to start and stop flow of molten metal from inside the vessel through the pipe to meter the shots; a downturned pipe elbow on the upturned end of the said pipe, the downturned end of the said pipe elbow being open and forming an orifice ¼ to ½ inch in diameter, the periphery of said orifice lying in a plane which is not inclined to the horizontal more than 10°, the said pipe elbow and delivery pipe forming a continuous passage from the vessel to the orifice, said elbow forming a gas trap in the bore above the orifice; and pipe means having an outlet adjacent to the orifice below the said plane adapted to deliver a skin-forming gas below the said orifice.

2. An apparatus according to claim 1 in which the passage through the downturned portion of the elbow increases in diameter from the said orifice toward the bore of the pipe, and the highest point of the said continuous passage is within the said elbow.

3. An apparatus for delivering metered shots of molten metal from a supply thereof to a casting apparatus comprising the combination of a vessel for holding a supply of the molten metal; a pipe having one end extending into the vessel to a point near the bottom thereof and the other end outside the vessel at a level between the bottom of the vessel and the operating level of the molten metal in the vessel, the said other end being tilted upwardly; a valve on the end of the pipe within the vessel adapted to start and stop flow of molten metal from inside the vessel through the pipe to meter the shots; a downturned pipe elbow on the tilted end of the said pipe; a pipe nipple in the downturned end of the elbow forming an extension of the bore thereof; an orifice tube having a bore ¼ to ½ inch in diameter fitted into the lower end of the pipe nipple and extending upwardly therein the inside of the pipe nipple being spaced from the outside of the orifice tube to form therebetween an annular pocket; an inverted cup disposed within the nipple over the upper end of the orifice tube with the rim of the cup extending downwardly into the pocket, said cup having an opening in its side wall near the rim to permit passage of molten metal from the pipe nipple through the side wall of the cup to the orifice tube; and pipe means having an outlet adjacent to the orifice adapted to deliver a skin-forming gas below the said orifice.

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