

May 23, 1967

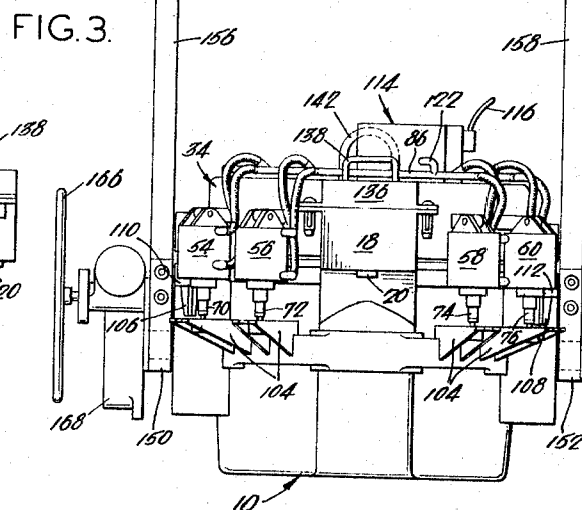
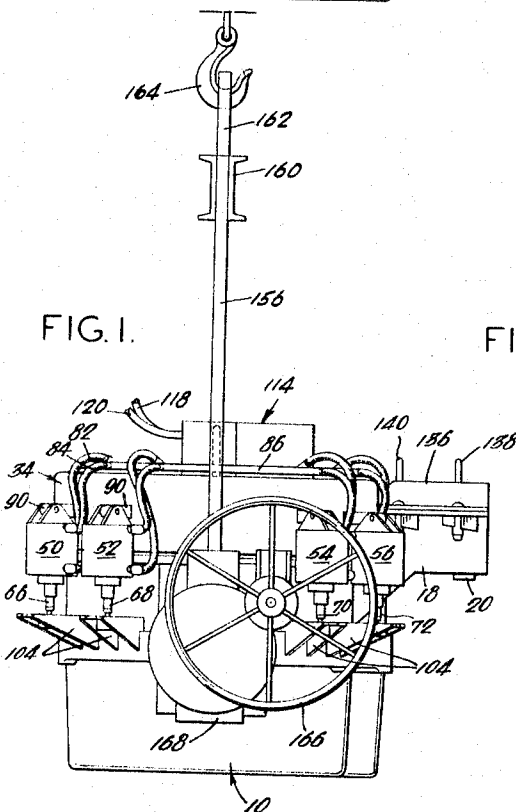
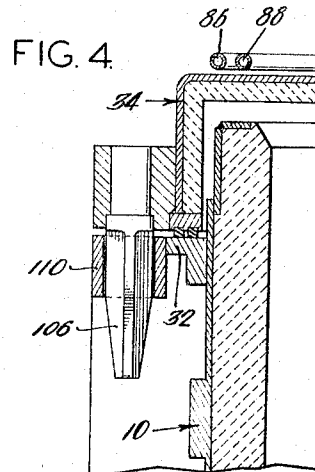
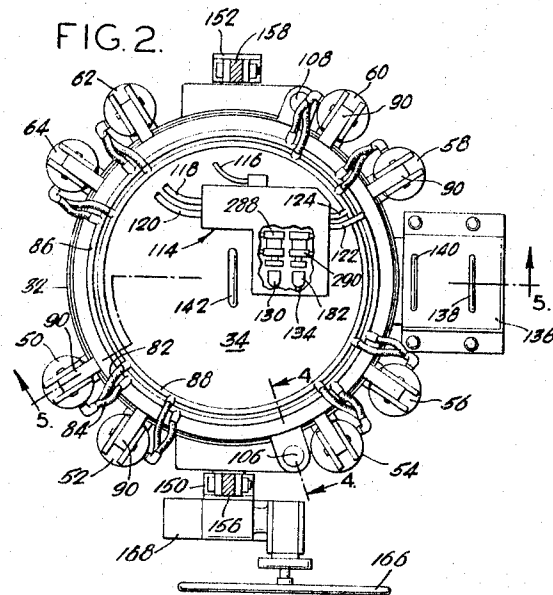
G. E. LOFTIN

3,321,116

DISPENSING LADLE WITH REMOVABLE FRANGIBLE DRAIN TROUGH

Filed April 28, 1964

3 Sheets-Sheet 1



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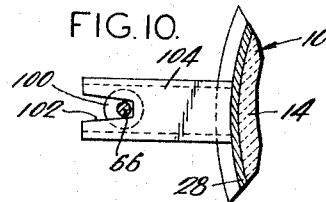
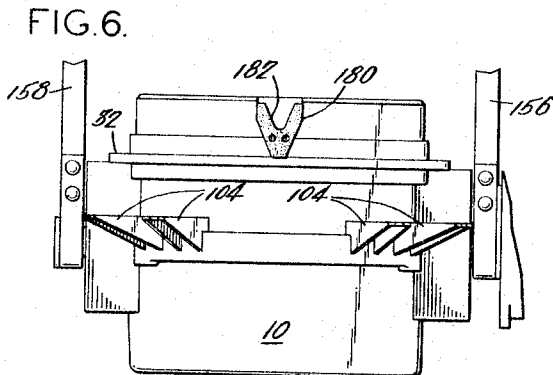
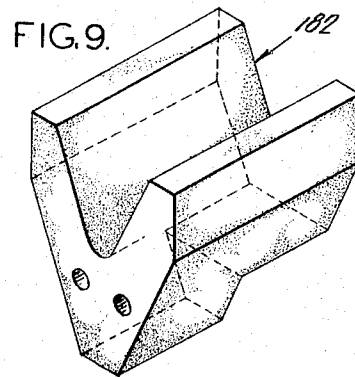
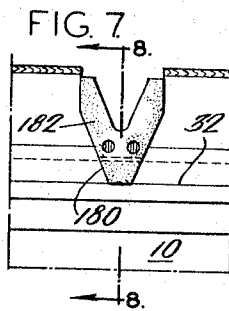
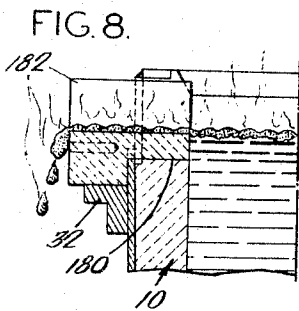
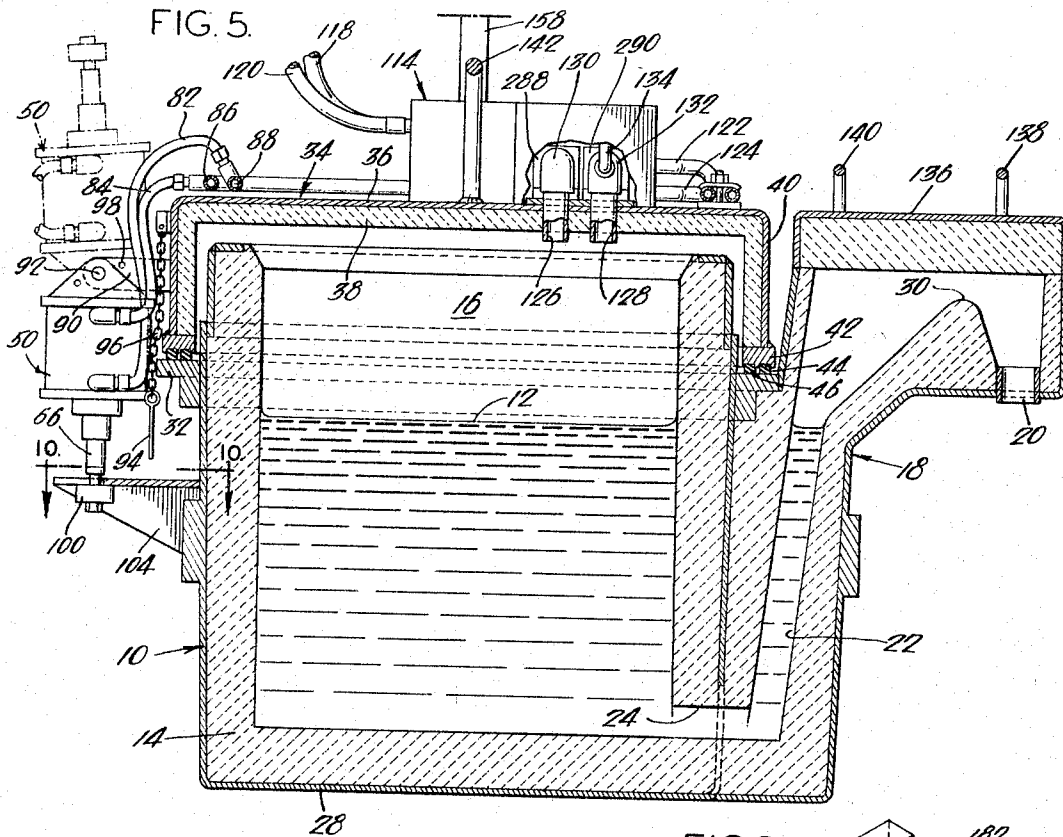
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DISPENSING LADLE WITH REMOVABLE FRANGIBLE DRAIN TROUGH

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3 Sheets-Sheet 2



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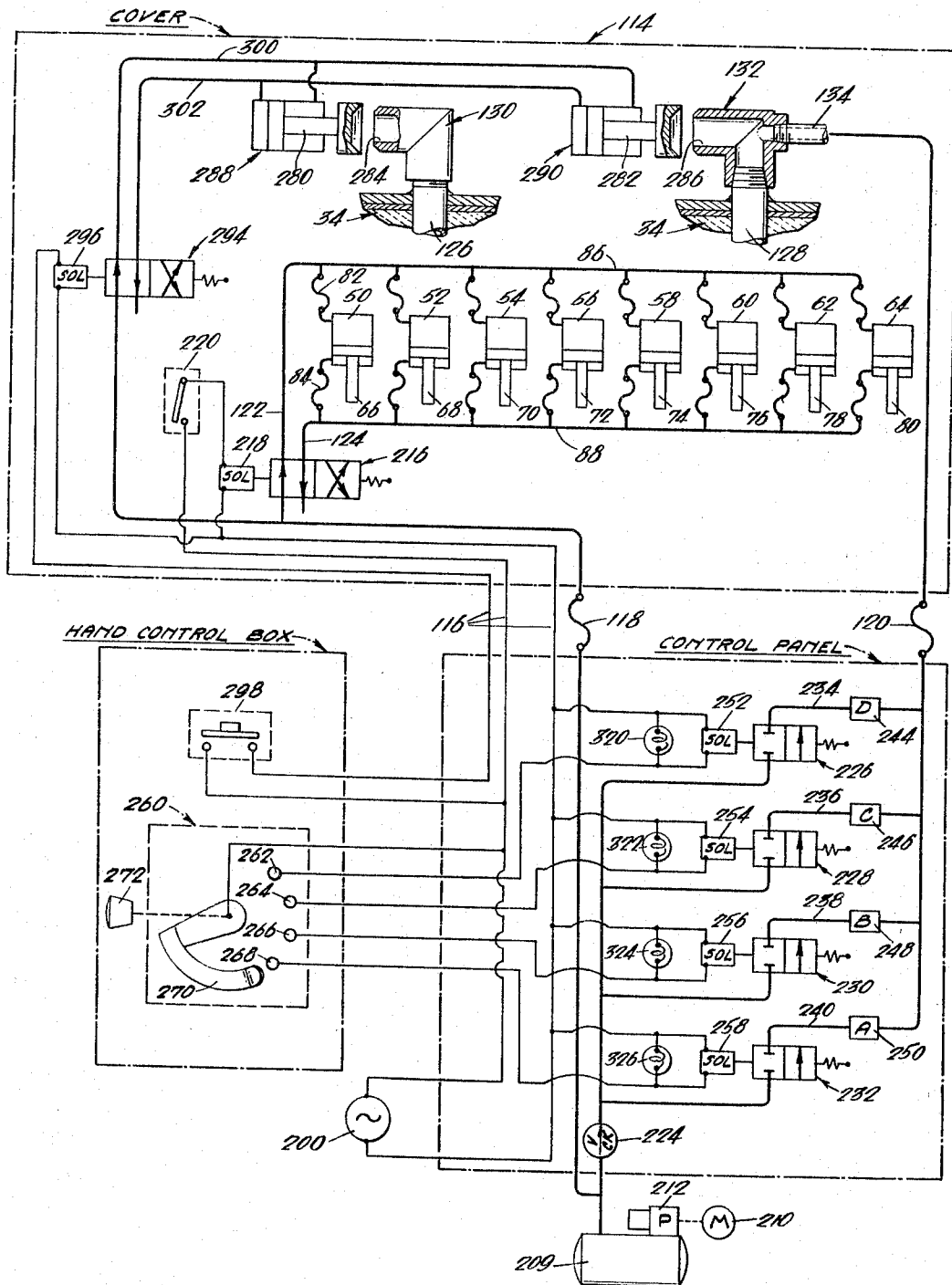
3,321,116

DISPENSING LADLE WITH REMOVABLE FRANGIBLE DRAIN TROUGH

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3 Sheets-Sheet 3

FIG. 11.



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3,321,116

DISPENSING LADLE WITH REMOVABLE FRANGIBLE DRAIN TROUGH

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Filed Apr. 28, 1964, Ser. No. 363,184
2 Claims. (Cl. 222-564)

The present invention relates to pressurized ladles for holding and dispensing liquids, and particularly to such apparatus for holding molten metals and controllably dispensing them into molds or the like.

There are a variety of applications, particularly in the iron and steel industry, in which it is desired to dispense molten materials, such as molten metals, from a container in a controllable manner. For example, where castings are to be made it is desired to dispense molten metal into one or more molds, and it is desirable that the rate of flow and the position of the molten metal as it is dispensed be accurately controllable. For example, it is commonly desired to fill one particular mold from the dispensing ladle, cut off the flow of the molten metal from the ladle when that mold is filled, and then reinitiate the flow of the molten metal from the ladle when another mold is to be filled.

It is known in the prior art to provide a pressurized receptacle having an upwardly-extending conduit and an outlet thereon, to provide in the receptacle a mass of molten metal to be dispensed, and to provide controlled dispensing of the molten metal through the conduit and outlet by varying the pressure of a gas at the top surface of the molten metal in the storage chamber, thereby to force the molten metal upwards through the conduit and outlet at a rate determined by the magnitude of the applied gas pressure.

It is an object of the present invention to provide a new and useful gas-pressure operated ladle for liquids such as molten metal.

Another object is to provide such a ladle in which the flow of the dispensed liquid can be accurately and quickly controlled by an operator.

It is also an object to provide such a ladle which can be disassembled sufficiently to permit the pouring into it of molten metal to be dispensed and rapidly reassembled into operating condition, thereby not only to reduce the cost of the time involved in such partial disassembly and reassembly but also to reduce the time during which the molten metal need be in the ladle and hence reduce temperature drop of the molten metal while in the ladle without requiring heating elements on the ladle.

A further object is to provide a ladle by means of which the top portion of molten material contained therein may be drained off to remove undesired contaminants therein, for example to remove slag near the surface of molten steel.

Still another object is to provide an effective sealing arrangement for providing a pressure seal between a main storage chamber of a molten-metal containing receptacle and a cover therefor, despite the possibility of contamination of outer surfaces of the receptacle during the initial pouring of molten metal into it or during the above-mentioned slag removing operation.

Still another object is to provide a pressurized dispensing ladle which is adapted to be moved from place to place, for example from a furnace position at which it is filled with molten metal to a number of different positions at which the molten metal is dispensed to the different molds.

It is also an object to provide such a ladle in which clamping of the cover to the receptacle and the dispensing of the molten metal therefrom are readily and ac-

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curately controllable by an operator through electrical means.

It is also an object to provide such a ladle having a "fail-safe" control for the pressure in the main chamber of the receptacle, whereby gas pressure in the main chamber is automatically relieved rapidly unless an operator is actuating a control which prevents such exhausting.

These and other objects and features of the invention are achieved by the provision of a pressure-operated ladle having a number of novel features which cooperate with each other to produce improved operation, although at least some of these features constitute new and useful improvements in themselves and may be used by themselves to produce certain improvements in operation.

More particularly, in accordance with the invention there is provided a receptacle for molten metal having a main chamber serving as a reservoir for storing the molten material, having a dispensing outlet through which molten material from the main chamber is dispensed, and having a conduit which extends from a lower portion of the main chamber to the dispensing outlet along an upwardly-extending path. A cover is provided over the main chamber of the receptacle to seal it, and means are provided for varying the gas pressure applied to the top of the molten material in the main chamber thereby to control the extent to which the molten material flows upwardly through the conduit to the dispensing outlet.

In accordance with one feature of the invention the cover is drawn tightly against, and sealed to, the main chamber of the receptacle by means of a plurality of hydraulically-operated pistons spaced around the periphery of the cover, preferably symmetrically, and pivotably mounted from either the receptacle or the cover to cooperate with piston-receiving means for each of the pistons located on the other of the cover and receptacle; preferably the pistons are pivotably mounted from the cover, and the piston-receiving means are aligned therewith on the outside of the main chamber of the receptacle. Each piston can be pivoted from a position at which it is free of its corresponding receiving means to a position in which it engages its corresponding receiving means; when all pistons are in the latter engaged position, hydraulic pressure is applied to cause each piston to move in a direction to draw the cover and receptacle tightly against each other. Application or removal of this hydraulic pressure is preferably provided by means of a solenoid-controlled hydraulic valve which solenoid in turn is controllable by an electrical manually-operable switch. Accordingly to assemble the cover to the receptacle, the cover need only be placed in position on top of the receptacle so that the pistons are vertically aligned with their corresponding receiving means, the pistons pivoted downwardly to lock with their corresponding receiving means, and an electrical switch actuated to draw the cover and receptacle together with a predetermined pressure. Deactuation of the electrical switch removes the hydraulic pressure and permits pivoting of the pistons away from their corresponding receiving means to free the cover for removal.

Preferably the hydraulic operators for the various pistons are supplied with hydraulic pressure from a common source, and therefore produce substantially equal pressures at all points around the periphery of the cover. The symmetrical arrangement of the pistons around the cover also aids in this uniformity of sealing pressure.

To provide for removal of undesired material near the top of the molten material in the receptacle, for example slag disposed along the top surface thereof, a drain outlet is provided in one side wall of the main chamber of the receptacle, preferably toward the top of the side wall

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of the main chamber, through which outlet the top portion of the liquid may be removed by overflow or dewatering.

In order to provide a pressurized main chamber despite the existence of such a drain outlet in the side walls thereof, the pressurized seal between the cover and the receptacle is made along a line extending below the bottom end of the drain outlet. In accordance with the invention this is accomplished by providing an outwardly-extending flange on the outer surface of the side walls of the main chamber of the receptacle, and providing on the underside of the cover a downwardly-extending flange having a shape and dimension so as to bear upon and mate with the outwardly-extending flange throughout its entire periphery when the cover is in position on the receptacle. Preferably resilient pressure-sealing means are employed between the downwardly-extending flange and the outwardly extending flange, and preferably this sealing means is retained in the undersurface of the downwardly-extending flange so that it is not exposed to contamination and damage by the molten material either during pouring of the molten material into the receptacle or during the slagging operation.

As a further feature, the receptacle portion of the ladle with the cover removed is provided with a trough member which fits into the drain outlet in the side wall of the main chamber when the cover is removed, and extends outwardly at least beyond the outer edge of the outwardly-extending flange, thereby to permit the molten material removed by way of the drain outlet to flow outward beyond the edge of the flange without contaminating the flange. In this way a suitable bearing surface for providing a proper pressure seal is maintained. The trough member is preferably shaped so that it can be rested on and retained by the walls of the drain outlet and the flange on the side wall of the main chamber during the slag removing operation, but readily removed thereafter to permit placing of the cover in position on the receptacle.

Other features of the invention relate to the nature of the control system for controlling the application of pressure and the exhausting of gas from the main chamber. In one aspect, normally-open exhaust valve means of very low impedance to gas flow are provided on the receptacle cover, together with solenoid means for operating the valve means and a momentary-contact normally-open control switch for operating the solenoid means. To apply gas pressure to the inside of the receptacle for producing dispensing of liquid, it is necessary to hold the switch in its closed position, and the switch therefore serves as a "fail-safe" control to exhaust the receptacle and stop liquid flow when the switch is not operated.

Another feature resides in the provision of a simple means for accurately and easily controlling the rate at which liquid is dispensed from the ladle, which means employs a plurality of gas lines connected in parallel between a source of gas under pressure and the portion of the receptacle above the liquid therein, together with electrical means for controlling flow through various combinations thereof as determined by the setting of the control. Preferably the gas lines have different resistances to fluid flow, and contain gas valves which are capable of being turned on or off by solenoids connected to a manually-operable electrical control.

The receptacle is also preferably portable, as by means of a crane or the like, and both the liquid flow rate control and the "fail-safe" exhaust control are preferably connected to flexible lines so that the ladle can readily be moved to different dispensing positions and dispensing controlled accurately by an operator accompanying the moving ladle.

By virtue of the cooperation of these various features of the invention, molten metal from a furnace can be poured into the receptacle of the ladle, slag drained off, the cover applied and sealed, the ladle moved to a plu-

rality of successive dispensing positions, and molten metal dispensed from the ladle accurately and safely by means of manually-operable electrical controls.

Other objects and features of the invention will be more readily comprehended from a consideration of the following detailed description taken in connection with the accompanying drawings, in which:

FIGURE 1 is an elevation view of a liquid-dispensing ladle and means for moving it, constructed according to the invention;

FIGURE 2 is a plan view of the ladle of FIGURE 1;

FIGURE 3 is a side elevation view of the ladle and moving means of FIGURE 1;

FIGURE 4 is an enlarged fragmentary sectional view of a portion of the ladle taken along the line 4-4 of FIGURE 2;

FIGURE 5 is an enlarged sectional view of a ladle constructed in accordance with the invention, taken along the line 5-5 of FIGURE 2;

FIGURE 6 is a side elevational view of the ladle of FIGURE 5 with the cover removed;

FIGURE 7 is an enlarged fragmentary view of a portion of the ladle as shown in FIGURE 6;

FIGURE 8 is a sectional view of the construction shown in FIGURE 7, taken along the line 7-7;

FIGURE 9 is a perspective view of a removable trough utilized in accordance with one aspect of the invention and shown in position in FIGURES 6, 7 and 8;

FIGURE 10 is an enlarged fragmentary section of a portion of the ladle of FIGURE 5 taken along the line 9-9; and

FIGURE 11 is a schematic diagram illustrating a control system for the ladle, arranged in accordance with the invention is one aspect thereof.

Referring now to the mechanical features of the ladle as particularly illustrated in FIGURES 1, 2, 3, 4 and 5, there is provided a liquid receptacle 10 for containing and storing a liquid 12 such as molten metal, and for this purpose it is provided with a lining 14 of refractory material. The receptacle comprises a main chamber 16 and a spout or nozzle 18 comprising a fluid-dispensing outlet 20 and an upwardly-extending liquid conduit 22 communicating at its lower end 24 with the bottom of main chamber 16 and at its upper end with the outlet 20. The receptacle 10 has its main chamber 16 constructed in the form of an upstanding cylinder, its outer jacket 28 being made of a suitable rigid, high melting-point material such as iron. In this example the upper part of the main chamber of the receptacle is of slightly reduced diameter, as may be provided by welding it in overlapping engagement with the interior walls of the lower part of the lower part of the main chamber as shown, thereby to provide a form which facilitates applying of the cover to the receptacle. The main purpose of the apparatus is to provide a controllable pressure to the region in receptacle 10 above the liquid 12 so as to force the surface of the liquid 12 in the main chamber 16 downwardly, and the liquid in the spout 18 upwardly, until the liquid in the spout rises above the interior peak 30 of the spout and is dispensed through outlet 20 at a controllable rate.

To accomplish this, the main chamber 16 must be pressure sealed, which is accomplished in the following manner. An outwardly-extending flange 32, which may be of steel for example, is provided in a horizontal plane around the outside jacket of main chamber 16. The upper surface of the flange is preferably smooth and plane. A cover 34 is provided, which may have an outer jacket 36 of iron and is lined with refractory material 38, and has a downwardly-extending peripheral flange 40 the lower end of which terminates in a metal ring 42 having a smooth, plane bottom surface, a circular shape, and a diameter equal to that of the outwardly-extending flange 32 on the outside of the main chamber. Retained in recesses in the bottom surface of ring 42 are pressure-sealing means in the form of resilient O-rings 44 and 46 of a suitable high-temperature resistant material. Pres-

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sure sealing is accomplished by drawing the cover 34 and the outwardly-extending flange 32 together to compress the O-rings. This drawing together of the cover and the flange is provided in the following manner.

A plurality, in this case eight, of hydraulic cylinders 50, 52, 54, 56, 58, 60, 62 and 64 are mounted symmetrically around the periphery of the cover 34 and have associated therewith corresponding hydraulically-actuated pistons 66, 68, 70, 72, 74, 76, 78 and 80. Each cylinder, such as 50, is connected to a pair of hydraulic pressure-supplying control lines such as 82 and 84 in the case of cylinder 50, and is responsive to one polarity of pressure difference between the control lines to move its associated piston downwardly and responsive to the opposite polarity of pressure difference to draw its associated piston upwardly into its cylinder with a force proportional to the applied hydraulic control pressure. Each pair of hydraulic control lines is supplied with pressure difference from the same pair of circular pressure-supplying lines 86 and 88 mounted on the top of the cover 34. The two common pressure-supplying lines 86 and 88 are in turn supplied with controlled pressures, in the manner described in detail hereinafter.

As is shown particularly clearly in FIGURE 5, each of the pistons such as 66 and its associated hydraulic cylinder such as 50, is pivotably mounted on the cover 34, and the pressure control lines therefor are flexible so that the cylinder and piston can be rotated between the downward position shown in full line in FIGURE 5 and the upward position shown in broken line in FIGURE 5. The pivoting motion is in a plane radial of the vertical axis of the main chamber 16, and is provided by means of a simple bracket such as 90 and axle such as 92 for each cylinder and piston mounted on the outside jacket of the cover. For each cylinder and piston assembly a pin such as 94 retained by a chain such as 96 is suspended on the cover near the bracket 90, an aperture such as 98 being provided in bracket 90 through which pin 94 can be inserted to hold the cylinder and piston assembly in its upward position when the cover is being removed or applied.

The lower end of each piston is provided with an enlarged-diameter stop means such as 100, and each piston and cylinder assembly is so located that when in its downward position the portion of the piston immediately above the stop means lies within a slotted channel such as 102 in an outwardly-extending bracket such as 104 on the outside of the main chamber of the receptacle 10, as shown in FIGURE 10. A separate bracket is provided directly below each of the cylinder and piston assemblies, so that each piston member is capable of being received by its corresponding bracket and restrained against upward longitudinal motion by the bearing of its associated stop means with the undersurface of the corresponding bracket.

Accordingly, with each piston and its associated cylinder in its downward position, application of differential pressure of a given polarity to the common pressure-supplying lines 86 and 88 causes each hydraulic cylinder to act on its associated piston in such a manner as to draw the cover 34 tightly down against outwardly-extending flange 32 of receptacle 10. In this manner an efficient and effective pressure seal is provided between the cover and the receptacle in response to an hydraulic control pressure; when the cover is to be removed, the hydraulic pressure differential can be reversed in polarity to move each of the pistons downwardly, freeing it from its associated bracket and permitting it to be manually pivoted to its upward position for removal of the cover 34.

As shown particularly in FIGURES 2 and 4, cover 34 is also provided at its periphery with a pair of downwardly-extending fixed locating pins 106 and 108 and a corresponding pair of locating cylinders 110 and 112 are fixed to the outer surface of outwardly-extending flange 32 on receptacle 10, the inner diameter of the locating cylinders being such that the pins 106 and 108 fit snugly

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therein when the cover is in its proper circumferential position with respect to receptacle 10. Both the locating pins and the locating cylinders are so positioned about the periphery of the receptacle and cover that, when the cover is applied by turning it until the pins line up with their corresponding cylinders and dropping the cover into place so that the pins slide downwardly into their corresponding locating cylinders, the cover is then so positioned angularly that the hydraulic cylinders and pistons such as 50 and 66 are accurately aligned with their corresponding channels in the piston-receiving brackets such as 104.

The cover 34 also has mounted thereon a control apparatus assembly 114 which is supplied with an electrical power cable 116 and a pair of flexible hydraulic pressure supply lines 118 and 120. The circular pressure supplying lines 86 and 88 fixed on the top of the cover 34 are supplied with control pressure for operating the hydraulic cylinders and pistons by way of hydraulic lines 122 and 124, which communicate with pressure supply line 118 of the pair 118 and 120 by way of control apparatus contained within assembly 114. Assembly 114 also includes a pair of pipes 126 and 128 each extending through the top cover 34, by way of which pressure is applied to and exhausted from the interior of receptacle 10 when cover 34 is sealed in place. To accomplish this, pipes 126 and 128 are provided with remotely-controllable valves 130 and 132 which serve as exhaust valves for the ladle. Exhaust valve 130 is normally in its open, or exhaust, position, and when actuated to its closed position seals off pipe 126 from the atmosphere. Exhaust valve 132 is also normally in its open, or exhaust, position and when actuated to its closed position prevents exhaust action but leaves pipe 128 connected to an input gas-pressurizing line 134.

In the present example the hydraulic system may be pneumatic throughout, and pressure supply line 120 is connected to control apparatus assembly 114 to supply the gas pressure which is delivered by valve 132 to the interior of the ladle for producing dispensing of the liquid therein.

The detailed nature of the control apparatus assembly 114 and remote control equipment therefor will be described more fully hereinafter in particular connection with FIGURE 11.

A removable spout cover 136 is also provided, which is removably bolted to the lower portion of spout 18. Appropriate handles 138 and 140 for lifting the spout cover are provided on the top thereof, whereby the spout cover can readily be lifted and removed for observation or cleaning of the interior of the spout. A main cover handle 142 is also provided on the cover 34 by means of which the latter cover can be lifted and removed.

The receptacle 10 is rotatably supported, by means of bearings 150 and 152, from an upwardly-extending yoke 154 comprising a pair of upright parallel arms 156 and 158 and a cross piece 160, the cross piece 160 having an apertured upwardly-extending flange member 162 adapted to be engaged by the hook 164 which in turn is suspended from a lifting mechanism such as a crane or derrick for example (not shown). A hand-operable wheel 166 is also provided which is connected through appropriate gearing 168 so that by turning the wheel by hand the receptacle can be tilted or turned over by rotation parallel to a plane extending along a diameter of receptacle 10 and through the center of spout 18.

As shown particularly in FIGURES 6, 7 and 8, the upper side wall of receptacle 10 opposite spout 18 is provided with a shaped channel 180 extending from the top of the receptacle to the top of outwardly-extending flange 32. Because the bottom end of the channel terminates at the top of flange member 32 where the pressure seal with the cover is formed, no pressure leakage occurs by way of the channel.

The purpose of the channel 180 is to provide an outlet

for removing from receptacle 10 the top portion of the liquid contained therein prior to application of the cover 34, and to hold, support and fit snugly against the trough 182 of refractory material shown in perspective in FIGURE 9. The channel 180 has a generally downwardly-converging shape which conforms generally with the cross section of the outer surface of trough 182, so that when the trough is driven downwardly into channel 180 to rest against the bottom of the channel and the top of the flange 32, it seats securely against the side walls of the channel and also provides a seal against leakage of the liquid between trough and channel walls. The trough is sufficiently long so that its outer end, when in position on receptacle 10, extends outwardly beyond the outer edge of flange 32. Hence when liquid flows outwardly from receptacle 10 through trough 182, as in response to overflowing receptacle 10 originally and/or tipping downwardly the side of the receptacle containing the trough, the outflowing liquid is conveyed by the trough beyond the outer edge of the flange before being discharged so that the upward surface of the flange which is used for a part of the pressure seal as described above is not adversely affected by the hot liquid either during the removal of the top portion of the liquid or during the original filling of the receptacle 10 with the liquid. This assures maintenance of the top surface of flange 32 in a condition which is proper for providing appropriate pressure seal.

FIGURE 11 illustrates the arrangement of control equipment utilized to control the hydraulic cylinders and pistons which produce the sealing of the cover to the receptacle, to control the pressure applied to the top of the liquid in the receptacle 10 during the dispensing operation, and also to control the exhaust system by which dispensing is arrested and the system evacuated. As indicated by the legends associated with the three broken-line blocks in FIGURE 11, the control apparatus is advantageously divided, as to geometric location, between the apparatus mounted on the cover 34, the apparatus which may be mounted on a fixed control panel, and the apparatus mounted on a portable hand control box.

The power for operating the system is supplied from a conventional A.C. power source 200, such as a 110-volt A.C. generator, and a suitable source 209 of gas under pressure, such as a prime mover 210 and compressor 212.

Pressure from source 209 is supplied by way of flexible pneumatic supply line 118 to solenoid-operated gas flow reversing valve 216 located in the control apparatus assembly 114 on cover 34, and thence to the two pressure supplying lines 86 and 88 on cover 34. The solenoid valve 216 is normally spring-biased to the position shown so that the pneumatic control pressure is applied to pressure supplying line 86, while the pressure supplying line 88 is exhausted through the valve. However the solenoid element 218 of the valve is connected across electrical power source 200 by way of the single-pole single-throw manually-operable switch 220 which is normally open but which, when closed, operates valve 216 to its other state in which positive pressure is supplied to pressure supplying line 88 and line 86 is exhausted. The eight hydraulic cylinders 50, 52, 54, 56, 58, 60, 62 and 64 and the associated respective pistons 66, 68, 70, 72, 74, 76, 78 and 80 are so constructed that when the pressure is applied to line 86 all of the pistons are urged outwardly of their cylinders and when the pressure is supplied instead to line 88 the pistons are urged inwardly of their associated cylinders. Accordingly, to seal the cover 34 to receptacle 10 the switch 220 is closed, causing the eight pistons to draw the cover and receptacle together, while to release the cover the switch is opened causing the pistons to move downwardly and release the cover.

Pressure from source 209 is also supplied by way of check valves 224 to each of four parallel-connected and solenoid-operated gas valves 226, 228, 230 and 232, the outlet lines 234, 236, 238 and 240 respectively of the latter valves being connected together and through flexible pneu-

matic supply line 120 to the input pressurizing line 134 of valve 132 and cover 34. Each of the solenoid-operated gas valves 226, 228, 230 and 232 is spring-biased so as normally to be in the position shown in which flow through each of the valves is prevented, so that no gas pressure is supplied to receptacle 10 through pipe 128. However, any of the latter valves the solenoid control element of which is actuated is switched to its alternate condition in which gas flows freely through the valve. Preferably constrictive orifices 244, 246, 248 and 250 are provided in series in the outlet lines 234, 236, 238 and 240 respectively, the size of the orifices being graded upwardly from a small opening to a large opening in the alphabetical order of the legends A, B, C and D indicated thereon, A being the smallest and D the largest orifice. The control solenoids 252, 254, 256 and 258 for valves 226, 228, 230 and 232 respectively are controllably actuated by means of the manually-operable switching control 260 located on the hand control box. Switching control 260 comprises four contacts 262, 264, 266 and 268 connected respectively to one side of solenoids 252, 254, 256, and 258 respectively, the other terminal of each of the control solenoids being connected to one side of the A.C. power source 200. The other side of power source 200 is connected to a rotatable segmental electrical contactor 270 which is rotatable by manual operation of a control knob 272 mechanically linked thereto. In the position shown for the contactor 270, all solenoids are open circuited. However, as the knob 272 is progressively actuated so as to contact cumulatively the contacts 268, 266, 264 and 262 in that order, the electrical circuits are completed in sequence for solenoid control elements 258, 256, 254 and 252. Accordingly, with the above-described continuous advance of contactor 270 the inlet line 134 of valve 132 is supplied with pressure first by way of valve 232 and then by way of both valves 232 and 230, next by way of all of valves 232, 230 and 228 and finally by way of all four of the valves 232, 230, 228 and 226. Accordingly, with switching control 260 in the position shown no gas pressure will be applied to inlet line 134 of valve 132 but by controllably actuating control knob 272 a controlled amount of pressure is supplied to inlet line 134.

In the conditions of valves 130 and 132 shown in FIGURE 11, however, application of such pressure to inlet line 134 does not result in pressurizing the receptacle 10 because both of valves 130 and 132 are open to the atmosphere. Before pressure can be so applied both valves must be closed. The required opening and closing of the valves 130 and 132 is accomplished by moving pistons 280 and 282 of valves 130 and 132 sufficiently to the right to seal the exhaust openings 284 and 286 in valves 130 and 132 respectively, in response to hydraulic control pressure supplied to hydraulic cylinders 288 and 290 respectively. To provide the necessary hydraulic control, pressure source 209 is connected by way of flexible pneumatic supply line 118 through solenoid-actuated valve 294 to both of cylinders 288 and 290 in parallel. The solenoid control element 296 of valve 294 is connected across the A.C. power source 200 by way of the momentary-contact push button switch 298. Switch 298 is normally open as shown, so that the valve 294 is deactuated and is in the position shown for which pressure is supplied to the upper pneumatic control line 300 and thence to each of the cylinders 288 and 290. However, so long as switch 298 is held closed, A.C. power will be supplied to solenoid control element 296 to change valve 294 to its alternate condition in which the upper control line 300 is exhausted to the atmosphere and the lower control line 302 is supplied with control pressure. This application of control pressure to line 302 provides the above-described closing of exhaust openings 284 and 286 of valves 130 and 132, thereby permitting the application of pressure to receptacle 10 by way of inlet line 134. As soon as switch 298 is released, it automatically returns to its open condition thereby to return valve 294 to its normal deactu-

ated position and thus open the two exhaust valves 130 and 132 and release the pressure in the receptacle.

Lamps 320, 322, 324 and 326 are connected across solenoid control elements 252, 254, 256 and 258 respectively to provide a visual indication of which of the gas valves 226, 228, 230 and 232 are operated at any time.

Typical use and operation of the embodiment of the invention described in detail is as follows.

Empty receptacle 10, with its cover removed, is positioned upright and moved to a location in which a liquid such as hot steel is poured therein, the refractory trough 182 having first been seated in position in channel 180. If the receptacle is filled above the bottom of the interior of trough 182, the excess top portion of the liquid will be discharged. Pouring is then discontinued and the wheel 166 manually operated to tilt the receptacle in a direction to decant the top portion of the liquid therein, thus removing undesirable slag at the surface of the liquid which would adversely affect the quality of the final solidified steel product. Preferably sufficient decanting is performed so that the level of the liquid lies below the bottom of channel 180 when the receptacle is returned to its upright position, for example at the liquid level shown in FIGURE 5, so that when trough 182 is then knocked out of position there will be no additional overflow of liquid from the receptacle outward through channel 180 onto the surfaces of flange 32. Accordingly the latter flange is protected both during the initial pouring process and during decanting.

The cover 34 carrying the sealing O-rings is then moved to a position over the receptacle 10 and gradually lowered, with slight angular motion thereof, until the locating pins 106 and 108 extend into their corresponding locating cylinders 110 and 112, at which time the cover is further lowered into position so that its downwardly-extending flange 40 and the O-rings 44 and 46 thereon rest against the top of outwardly-extending flange 32.

Up to this point the hydraulic cylinders 50, 52, 54, 56, 60, 62 and 64 and their associated pistons have been held in their upward position on cover 34 by means of the pins such as 94. However, with the cover now in proper position the pins such as 94 are removed and the cylinders pivoted downwardly so that the pistons thereof rotate into the channels such as 102 on the piston receiving brackets such as 104, with the stop means such as 100 at the lower end of each piston being located just below the undersurface of the receiving bracket. Now switch 220 located on the top of cover 34 is actuated to its closed position, whereby each of the eight pistons is urged upwardly to exert a uniform closing pressure at eight symmetrically-spaced points around the periphery of the cover, drawing cover and receptacle together and providing pressure upon the O-rings 44 and 46 so as to provide the desired seal between cover and receptacle at a point below the bottom end of the channel 180 in the side wall of receptacle 10.

The receptacle is now lifted by means of a crane or the like, acting by way of yoke 154, and moved to a position in which the molten liquid in receptacle 10 is to be dispensed into a mold for example. Outlet 20 of spout 18 is positioned above the mold, and the operator, carrying the hand control box, actuates momentary contact switch 298 to close both exhaust valves 130 and 132 and, while holding switch 298 closed, actuates control knob 272 to cause application of pressure to the top of the liquid in receptacle 10, the extent of actuation of knob 272 determining the rate at which pressure builds up in the receptacle. As the pressure builds up in the receptacle, the level of the liquid in the main chamber therein is depressed, while the level in the spout 18 rises until it is sufficiently high to flow out of the outlet 20 into the mold. The entire ladle may be moved if desired while it is thus dispensing the liquid into the mold in order to achieve any desired effect. When the mold is sufficiently filled, the momentary-contact switch 298 is

released and immediately the two exhaust valves 130 and 132 are opened to atmosphere, thereby rapidly reducing the pressure in the container and quickly terminating the dispensing of the liquid into the mold.

The entire ladle assembly may then be moved to another mold, where the process may be repeated. When the dispensing operation is entirely finished, switch 298 is released and control knob 272 is returned to its start position, after which switch 220 is opened to release the sealing pressure applied by the clamping cylinders and pistons which draw the cover and receptacle together; the eight cylinders and associated pistons are then rotated to their upward position and locked therein by the pins provided for that purpose as described above, and the cover removed, after which the process may be repeated as desired.

With this arrangement, the filling of the ladle with liquid, its assembly into an operating pressurized unit, and the dispensing of the fluid into the molds can be accomplished very quickly and conveniently, so that the temperature of the liquid does not drop appreciably in the process. The control system operates effectively to provide manual control of variation in the rate of liquid dispensing, operates quickly and easily, and is readily portable, so that an operator observing the liquid flow may control it very accurately and quickly. The cover sealing arrangement not only is quick to operate but is also extremely efficient in providing a uniform pressure around the seal, due to the symmetrical location of the pistons and cylinders and their operation from a common pressure source which assures uniform pressure around the periphery of the cover. The resilient sealing means carried on the cover provides effective pressure sealing without deterioration of the sealing means which would occur if they were subjected to contamination during filling of the receptacle or decanting of the top of the liquid in the receptacle. At the same time, effective provision is made for decanting the liquid to provide a slagging operation, as is highly advantageous in providing a satisfactory end product. The arrangement of exhaust valves is such that exhaust occurs very rapidly, so as to cut off dispensing of the liquid immediately, and is also effective in providing rapid reduction in pressure for safety purposes. The momentary-contact switch arrangement for operating the exhaust valves, being such as to require affirmative operation by the operator in order to avoid exhausting of the receptacle, constitutes in effect a "fail-safe" pressure control, adding to the safety of the apparatus. The specific arrangement of parallel supply lines for the gas supplied to the receptacle 10, the arrangement of graded constrictive orifices in the supply lines, and the combination therewith of the cumulatively-acting control switch are all such as to provide a very convenient, flexible and accurate control of the rate of flow of the dispensed liquid.

While the invention has been described with particular reference to specific embodiments thereof in the interests of complete definiteness of exposition, it will be understood that it may be embodied in any of a large variety of diverse forms differing substantially from those shown, without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. A dispensing ladle for molten metal comprising a receptacle having a main chamber for molten metal and adapted to receive a cover having a sealing surface detachably securable in position over the top of the main chamber to provide a gas pressurized seal therebetween during dispensing of molten metal from the ladle, said receptacle comprising a dispensing outlet for said molten metal, a conduit for molten metal communicating at one of its ends with said outlet and at its other end with said storage chamber below the top thereof and extending upwardly from said other end to said one end thereof,

a drain outlet in a side wall of said main chamber, an outwardly extending flange on said side wall of said main chamber below said drain outlet for providing a surface for receiving the sealing surface of the pressurized cover for said chamber and a removable trough made of a frangible material on the outside of said main chamber contiguous to said drain outlet for conducting away from said side wall the portion of said liquid removed by way of said drain outlet, said trough extending outwardly from said side wall beyond the outer edge of said flange to protect said flange from said removed liquid.

2. Apparatus in accordance with claim 1 in which said drain outlet comprises a channel extending downwardly from the top of said side wall of said main chamber, and in which said trough has a shape to fit snugly into said channel and to rest upon and be removably retained by the bottom of said channel and the top of said flange.

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