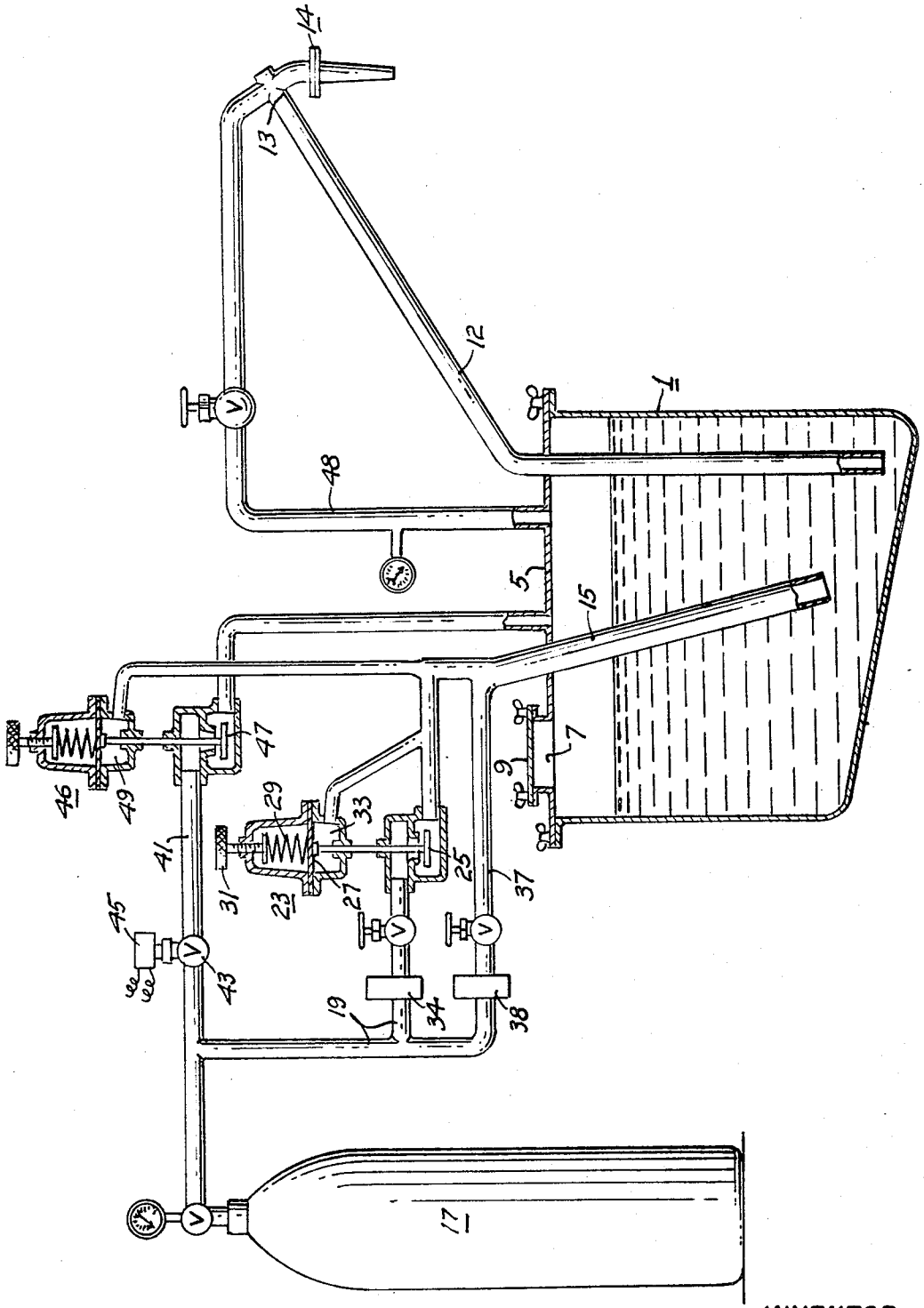
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GAS FEED TO PRESSURE POUR APPARATUS

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GAS FEED TO PRESSURE POUR APPARATUS

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My invention relates to liquid dispensing apparatus and more particularly to apparatus wherein the dispensing of the liquid is accomplished by gas under pressure acting upon the surface of the liquid to be dispensed.

This application is an improvement in the pressure pour apparatus constituting the subject matter of an application of Wilfred E. Willis, Ser. No. 524,955, now Patent No. 3,347,427, filed Nov. 30, 1965 for Pressure Pour Apparatus.

In such apparatus, gas under pressure is fed into a closed receptacle and released at a point substantially below the level of liquid to be dispensed from such receptacle. The gas as it is thus released, bubbles up through the liquid to establish a gas cushion in the receptacle above the liquid level therein and builds up a pressure against the liquid.

The pressure of the gas at the point of release is equal to the gas cushion pressure plus the pressure of liquid down to that point. Accordingly, as long as the incoming gas is released at that below level point and at a certain pressure, the sum total of the gas cushion pressure and liquid pressure will remain a constant, regardless of any change in the liquid level. By selecting an incoming gas pressure sufficient to force liquid up into a pouring tube or discharge passageway, to a level approaching the discharge end of such passageway, one can then effect pouring by adding an increment of pressure to the incoming gas, and a steady rate of pour can be maintained so long as the new gas pressure is maintained, despite any lowering of the liquid level during pouring. The new incoming gas pressure may be designated the pour pressure, while the former pressure might be termed the ready-to-pour pressure.

Completion of a pouring operation may be accomplished by dropping the incoming pressure from the pour value to the ready-to-pour value, which will naturally be accompanied by a drop in the gas cushion pressure until the liquid in the discharge passageway drops back to the level supported by the ready-to-pour pressure. This may be hastened by a sudden release of gas through a control valve, or by a continual leak flow from the gas cushion chamber.

Such system offers many advantages. For one thing, it enables pouring operations by utilizing but two discrete pressures, despite changing liquid level within the receptacle during pouring. For another thing, the release of the incoming gas at a point below the liquid level, results in the gas bubbling through the liquid to ultimately free itself at the surface of the liquid and form the gas cushion in the chamber above the liquid. If the liquid be in the form of molten metal, this enables the use of inert gas capable of cleansing the molten metal of impurities without the use of fluxes, thereby simplifying the purification of the molten metal while maintaining a clean set up.

The foregoing arrangement, however, does offer some minor disadvantages, one of which is the slight delay incurred in establishing pour pressure conditions, which, though not serious, would be advantageous to avoid, if possible. Also, in changing over from the ready-to-pour condition to the pour condition, the increasing pressure developed at the below level point, results in the creation of larger bubbles, and as they emerge from the surface of the liquid, they can cause spattering of the liquid

throughout the interior of the receptacle, and this, in many instances, should be avoided, if possible, particularly where the liquid is in the form of molten metal.

The same formation of larger gas bubbles, as the gas enters the liquid at the below level point, also develops greater forces at that point, and as they break away to move upward through the liquid, they produce undesirable jarring or pounding, which can at times, become quite noticeable.

Among the objects of the present invention are:

(1) To provide novel and improved pressure pour apparatus;

(2) To provide novel and improved pressure pour apparatus having improved gas feed in the operation of such apparatus;

(3) To provide novel and improved gas feed in pressure pour apparatus, which will enable a more rapid transition from the ready-to-pour condition to the pour condition;

(4) To provide novel and improved gas feed in pressure pour apparatus, which will minimize spattering at the surface of liquid in such apparatus during the transition from the ready-to-pour condition to the pour condition; and

(5) To provide novel and improved gas feed in pressure pour apparatus, which will minimize turmoil within the apparatus during the transition from the ready-to-pour condition to the pour condition.

Additional objects of my invention will be brought out in the following description of a preferred embodiment of same, taken in conjunction with the accompanying drawings, wherein the figure is a schematic view depicting the pressure pour apparatus of the present invention.

Referring to the drawings for a description of my invention in the preferred form disclosed, I have illustrated it in a form particularly applicable to the dispensing of metal in its molten condition for casting purposes.

The apparatus may involve a sealable receptacle **1** which may take the form of a crucible or furnace, such receptacle including a cover or roof **5** provided with a fill opening **7**, capable of being sealed by a closure **9**.

Extending from said receptacle, at a level close to the bottom, is a discharge passageway **12** preferably in the form of a pouring tube, which reaches a level above the maximum contemplated level of liquid to be dispensed from said receptacle, where it terminates in a pouring lip **13**. For many purposes, a nozzle assembly **14** may be added. Extending into the receptacle, preferably through the roof thereof, and terminating at a point substantially below the maximum contemplated level of liquid in such recetpacle, but preferably above the lower end of the discharge passageway or pouring tube, is an inlet tube **15**, which may also be designated a degas tube by reason of an added degassing function attaching thereto.

In the ready-to-four condition of the apparatus, the liquid, which in the present case is molten metal, is preferably maintained at a level in the pouring tube just below the discharge lip, and this condition is realized by maintaining a gas pressure at the lower end of the inlet tube, which corresponds to the below liquid level point, of a value which will be sufficient for this purpose.

Such pressure, designated the ready-to-pour pressure, is derived from a source **17** of gas under pressure, by way of a flow line **19** leading from such source to the upper end of the inlet tube. In this line is connected means, preferably in the form of a pressure regulator **23**, for variably controlling gas flow in said line in accordance with changing conditions elsewhere in the apparatus.

Such pressure regulator includes a valve **25** in the flow path of the gas through the line. This valve is connected to a diaphragm **27** and is normally biased in the opening direction by an internal spring **29** pressing against

the diaphragm in that direction, the spring being adjustable by an accessible adjusting screw **31**.

Movement of the valve in the direction of closing is made possible by building up of gas pressure in a chamber **33** on the side of the diaphragm opposite that of the spring, and such chamber is connected downstream of the valve to place the pressure regulator in gas communication with the inlet tube **15**, thereby enabling it to sense the gas pressure at the lower end of the tube and be made responsive thereto in controlling the closing movement of the valve.

Accordingly, as gas under pressure is fed through the open valve of the ready-to-pour pressure regulator, pressure will build up in the inlet tube, thereby forcing the liquid level in the pouring tube toward the ready-to-pour level. As the pressure in the inlet tube approaches the ready-to-pour pressure, the valve **25** in this pressure regulator will gradually approach its closing position to ultimately block flow through the associated flow line when the ready-to-pour pressure is reached in the inlet tube. A meter **34** in the line upstream of the regulator **23** would be desirable.

Were the receptacle free of leaks, the situation would remain status quo. However, should a leak prevail, or should a leak flow path be provided, as would be desirable, particularly where the apparatus is to be employed in the casting of metal, the slow drop in gas cushion pressure would reflect itself as a slow drop in the gas pressure in the inlet tube, and this in turn would bring about a slight opening of the valve in the ready-to-pour pressure regulator to admit gas until the ready-to-pour pressure were again restored. Thus under these conditions, the valve in the ready-to-pour pressure regulator would fluctuate sufficiently to maintain the pressure conditions characteristic of the ready-to-pour status of the apparatus.

Such fluctuation may be reduced by providing a continually open, but highly restricted, bypass flow line **37** from the source of gas under pressure, to the inlet tube, whereby a minimal flow of gas to the inlet tube will be continually maintained. When such bypass flow line is utilized, however, it should offer higher resistance to flow than any leak flow from the receptacle, whereby the rate of flow to the inlet tube via this bypass flow line will always be less than any leak flow from the receptacle.

Having established a ready-to-pour condition, with the liquid level in the pouring tube in proximity to the lip thereof, only a small additional pressure in the gas cushion is required to effect pouring, but this small additional pressure will vary in accordance with the prevailing level of the liquid in the receptacle. The apparatus itself, however, can be made to determine this value automatically, if the gas pressure at the below level point at the lower end of the inlet tube is raised to the pour pressure value. A meter **38** in the by-pass line could be employed to advantage.

A pour control flow line **41** is accordingly provided which connects from the source of gas under pressure, to the gas cushion chamber of the receptacle. In this flow line is a normally closed solenoid-actuated valve **43** having solenoid winding **45**, the valve being followed on the downstream side thereof by a pour regulator **46** with a normally open-biased valve **47** therein. This regulator may be similar in all respects to the ready-to-pour regulator **23** except that it is adapted for sensing at some point in a system other than downstream in the same flow line in which its valve is located.

Instead therefor, of being connected downstream of its associated valve, the pour regulator has its sensing chamber **49** gas connected to the inlet tube **15** where it may sense the pressure at the lower end thereof and respond thereto. By adjusting the pour regulator to respond to gas pressure in the inlet tube and close when such pressure becomes equal to the pour pressure, its valve will close the pour control line to the gas cushion chamber and thus prevent further build up of pressure in the gas cushion.

The change in pressure in the inlet tube from the ready-to-pour value to the pour value is the result of a combination of factors. The restricted flow line **37**, for one thing enables a low rate continual flow of gas into the inlet tube. The ability of said gas to leave the end of the inlet tube and enter the liquid will gradually decrease as the gas cushion pressure increases due to the direct intake of gas through the pour control flow line, and gas pressure in the inlet tube will, as a result, build up to maintain the balance between this pressure and the sum of the gas cushion pressure and the liquid pressure down to the below level point. As the pressure thus builds up in the inlet tube, the valve **47** in the pour regulator, will gradually approach closing position until the pressure in the inlet tube reaches the pour pressure value for which the pour regulator is pre-set, at which instant the valve will close and prevent further build up of pressure in the gas cushion.

Should the gas cushion pressure drop slightly, either due to leakage, or the presence of a leak flow path **48** from the receptacle, or a lowering of the liquid level, the resistance to release of gas at the lower end of the inlet tube will decrease slightly to produce a corresponding decrease in the prevailing pressure within the inlet tube, and this will be sensed by the pour regulator, whose valve will then open slightly or just sufficient to bring the gas cushion pressure back to what it should be under the circumstances. Thus what is actually happening, is that the valve in the pour regulator will fluctuate from its closed position as often as may be necessary to maintain pour conditions within the receptacle.

Inasmuch as during a pour cycle, any fluctuations in pressure within the inlet tube will be above the ready-to-pour value of pressure, such fluctuations will have no effect on the ready-to-pour regulator **23**, the valve component of which will remain in its closed position.

The pour cycle is terminated by de-energizing the solenoid actuated valve **43**, which then closes the pour control line to the gas cushion chamber and blocks further supply of gas thereto. The gas cushion pressure then drops until the liquid level in the pouring tube falls to a level where pouring ceases, and this terminal portion of the pour cycle will shorten in the presence of a leak flow path from the gas cushion chamber, and may be rendered sharp and practically instantaneous when provisions are made for effecting a sudden release of gas cushion pressure at the instant the solenoid actuated valve is deenergized, such means being disclosed in the aforementioned Willis application.

The present invention, accordingly, not only makes it possible to speed up change of pressure to effect pouring, but as the gas cushion pressure is increased in the manner previously described, to develop pouring conditions within the receptacle, it should be noted that the gas flowing directly into the gas cushion chamber to build up pressure therein, minimizes the bursting effect of such bubbles as they break through the surface of the liquid, and at the same time, reduces the turbulence and noise occasioned by such bubbles as they break away from the lower end of the inlet tube. Thus the splattering of liquid due to bursting gas bubbles and the noise and turbulence attributed to the bubbles breaking away from the lower end of the inlet tube are both minimized.

While the piping has been illustrated as devoid of couplings, it will be understood that wherever convenient, conventional means for connecting pipe sections will be employed.

It will be apparent from the foregoing description of my invention in its preferred form, that the same will fulfill all the objects attributed thereto, and while I have illustrated and described the same in considerable detail, the invention as illustrated and described, is subject to alteration and modification without departing from the underlying principles involved.

As one example, a pressure regulator such as that which is connected in the pour control line, may also be em-

ployed in lieu of the pressure regulator in the ready-to-pour line, and when such substitution is made, the flow line through the included valve will connect directly to the gas cushion chamber, in the same manner as the pour control line, while the sensing chamber of the pressure regulator will be gas connected to the inlet tube. With such changes made, the inlet tube will only handle a small flow of gas, still less than any leak flow from the gas cushion chamber, but sufficient to maintain the inlet tube free of liquid at all times.

The gas employed in the apparatus of the present invention may be any gas suitable for the purpose, and thus may include inert gases under conditions where such gases are deemed desirable, as when, for instance, the liquid may be a non-ferrous metal in molten condition.

I, accordingly, do not desire to be limited in my protection to the specific details illustrated and described as constituting the preferred embodiment of my invention, except as may be necessitated by the appended claims.

I claim:

1. Pressure pour apparatus for dispensing of liquid comprising,

a sealable receptacle for holding liquid and providing a chamber in association with such liquid,

a discharge passageway extending upwardly from said receptacle with its lower end below normal liquid levels in said receptacle and having at its upper end, a discharge lip,

means for introducing gas at a ready-to-pour gas pressure into said receptacle at a point below normal liquid level, and of a value sufficient to establish a liquid level in said discharge passageway below said lip, said ready-to-pour pressure being equal to the sum of the resulting gas cushion pressure per square inch on the surface of liquid in said receptacle and the pressure of liquid per square inch at said below level point,

means for increasing said gas cushion pressure by a more direct route while simultaneously increasing the gas pressure at said below level point until said latter gas pressure reaches a pour pressure sufficient to cause discharge of liquid from said discharge passageway.

and means responsive to such increase in pressure, from said ready-to-pour pressure to said pour pressure at said below level point, for substantially halting further increase in gas cushion pressure via said more direct route.

2. Pressure pour apparatus in accordance with claim 1 characterized by said gas introducing means as including a tube entering said receptacle and terminating at said below level point, and said means for increasing the gas cushion pressure by a more direct route as including a gas flow line into said receptacle and terminating in said chamber.

3. Pressure pour apparatus in accordance with claim

2, characterized by said gas introducing means as additionlly including a gas flow line to said tube and adapted for connection to a source of gas under pressure, and means in said line for controlling gas flow from such source to said tube, and having pressure responsive means set to respond to a pressure equal to said ready-to-pour pressure and close said line, said pressure responsive means being gas coupled to said tube to close said line when pressure at said below level point reaches ready-to-pour pressure, and a restricted flow line to said tube and adapted for connection to a source of gas under pressure, to maintain a restricted supply of gas to said below level point.

4. Pressure pour apparatus in accordance with claim 1 characterized by said means for increasing the gas cushion pressure by a more direct route, as including a pour control flow line to said chamber and adapted for connection to a source of gas under pressure, means in said pour control flow line and having pressure responsive means set to respond to a pressure equal to said pour pressure and close said pour control flow line, said pressure responsive means being gas coupled to said tube to close said pour control flow line when gas pressure at said below level point reaches pour pressure.

5. Pressure pour apparatus in accordance with claim 1 characterized by a leak flow line from said chamber.

6. Pressure pour apparatus in accordance with claim 3 characterized by a leak flow line from said chamber, and said restricted flow line to said tube having greater flow resistance than said leak flow line.

7. Pressure pour apparatus in accordance with claim 3 characterized by said means for increasing the gas cushion pressure by a more direct route, as including a pour control flow line to the chamber of said receptacle and adapted for connection to a source of gas under pressure, a pressure regulator in said pour control flow line and having pressure responsive means set to respond to said pour pressure and close said pour control flow line, said pressure responsive means being gas coupled to said tube to close said pour control flow line when gas pressure at said below level point reaches pour pressure.

8. Pressure pour apparatus in accordance with claim 7 characterized by a leak flow line from said chamber, and said restricted flow line to said tube having a greater flow resistnce than said leak flow line.

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