

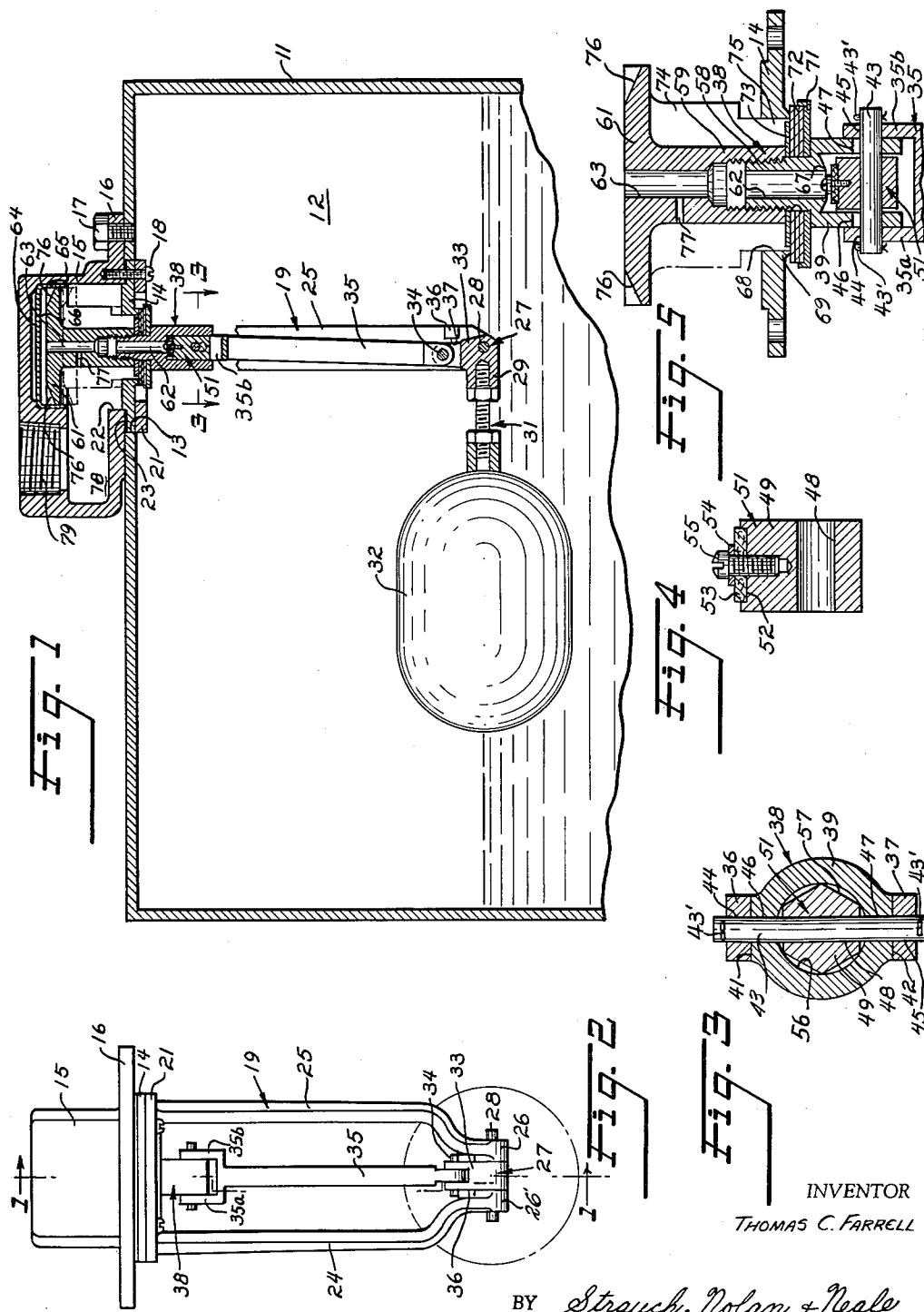
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GAS SEPARATION

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This invention relates to apparatus for continuously separating air and other gases from a liquid system and particularly to a novel valving arrangement for separating and automatically venting accumulated gas from the system.

Apparatus of this general kind has been proposed and used in fuel oil, water and other liquid conveying systems. The present invention comprises a sequentially acting compound valve arrangement that is an improvement over hitherto suggested and used apparatus, and which is reliable and efficient in action.

It is therefore the major object of the invention to provide a novel apparatus for separating and automatically discharging gas from a liquid system.

A further object of the invention is to provide a novel association of liquid level responsive pilot valve and main valve assemblies in apparatus for separating gas from a liquid system.

A further object is to provide novel constructional and operational details in a valving arrangement in a gas venting system wherein a liquid level responsive pilot valve admits separated gas under pressure to the actuating chamber of a main valve controlling discharge of the separated gas to atmosphere.

Further objects of the invention will appear as the description proceeds in connection with the appended claims and the annexed drawings wherein:

FIGURE 1 is a fragmentary sectional view showing a preferred embodiment of the invention and substantially on line 1-1 of FIGURE 2;

FIGURE 2 is a front elevation of the removable float and valve assembly;

FIGURE 3 is a section on line 3-3 of FIGURE 1 especially showing the passages around the pilot valve;

FIGURE 4 is a section through the pilot valve assembly; and

FIGURE 5 is a section through the main valve assembly showing the pilot valve open.

The vessel 11 is provided with inlet and outlet conduits whereby it is located in a liquid circuit and the liquid flowing therethrough is adapted to attain at least a predetermined level leaving a space 12 above it into which air or other gas or gases separating from the liquid may collect.

An opening 13 is provided in the upper wall of vessel 11, and a combination float and valve mechanism is mounted suspended through that opening. This mechanism comprises a valve seat plate 14 for fitting within the opening 13, an external housing cover 15 having a flange 16 secured to the vessel wall as by machine screws 17 and to which the plate 14 is secured as by screws 18, and a support bracket 19 having an upper annular flange 21 secured flush with valve seat plate 14 by the same screws 18.

Housing 15 has a bottom opening 22 that interfits with an annular shouldered pilot recess 23 on the top of valve seat plate 14, and suitable gaskets and seals are provided whereby when screws 17 and 18 are tight the opening 13 is sealed against escape of gas or liquid from the vessel 11.

As shown in FIGURE 2, bracket 19 comprises two spaced arms 24 and 25 rigid with flange 21 that bend toward each other at their lower ends to terminate in bosses 26 and 26' respectively having flat parallel inner side faces

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between which is pivotally mounted a flat sided bell crank lever 27 on an arbor 28 that extends through the bosses and the lever on a horizontal axis.

Lever 27 has a horizontally extending arm 29 to which is fixed, as by an adjustable length rod 31, a hollow metal float 32 resting on the surface of the water in vessel 11. The upright arm 33 of lever 27 is bifurcated to pivotally receive an arbor 34 carried by the lower end of a vertical valve actuating lever 35 which extends upwardly between the bracket arms.

Across their lower ends bracket arms 24 and 25 are bridged by a rigid stop bar 36 having an inclined face 37 adapted to be engaged by and limit clockwise turning of lever 27.

At its upper end lever 35 is bifurcated to provide flat sided arms 35a and 35b pivotally embracing a main valve assembly 38 which is shown enlarged in FIGURE 5. Valve assembly 38 comprises a tubular stem 39 which is generally cylindrical as shown in FIGURE 3 and formed with parallel flat sides 41 and 42 slidably engaging the flat inner sides of arms 36 and 37 respectively. A cylindrical pivot and motion transmitting pin 43 extends rotatably through suitable closely fitting apertures 44 and 45 respectively in the arms 35a and 35b respectively, being held against axial displacement by cotter keys 43'. Pin 43 extends through similar aligned apertures 46 and 47 respectively in the opposite sides of valve stem 39, these apertures for example being sized about equal to the diameter of pin 43 horizontally and slightly more than the diameter of pin 43 vertically so that a small lost motion connection, the purpose of which will be described, is provided between lever 35 and the main valve assembly 38. Alternatively instead of being slots apertures 46 and 47 may be cylindrical openings sufficiently larger than pin 43. For example I have used a pin 43 of $\frac{5}{32}$ " diameter and apertures 46 and 47 of $\frac{1}{2}$ " diameter.

The intermediate part of pin 43 passes snugly rotatably through bore 48 in the solid body 49 of pilot valve assembly 51 which has at its upper end a recess 52 to receive a circular valve seat 53 of compressible material secured thereon by a washer 54 and screw 55. As illustrated in FIGURE 3 the interior of valve stem 39 is a cylindrical bore 56 in which the hexagonal or other non-circular cross-section pilot valve body 49 is vertically slidably mounted and provides with the bore 56 one or more vertical passages 57 for a purpose to be described.

Valve stem 39 has a reduced upper end threaded at 58 into the hub 59 of a guide piston 61, the stem and guide piston having through bores 62 and 63 respectively. Guide piston 61 is slidably disposed in a cylinder comprising a shallow cylindrical sheet metal liner 64 pressed or otherwise fixed within a corresponding chamber 65 of housing 15, and the cylinder space 66 above piston 61 is open to the bore 63.

At the lower end of bore 62, valve stem 39 is formed with an annular internal pilot valve seat rib 67 against which the compressible seat 53 is urged in closed position of the pilot valve. Plate 14 is formed with a large circular opening 68 surrounded by an annular depending valve seat rib 69 against which the main valve seat is urged when closed. The main valve seat consists of a rigid metal disc 71 shouldered on the valve stem, and a stack 72 of compressible discs overlaid by a smaller diameter metal washer 73. When stem 39 is threaded into the guide piston hub it tightly clamps the main valve discs in place leaving the outer annulus of the compressible portion 72 open to seat on valve seat 69.

Guide piston 61 is formed on its hub with three equally spaced longitudinal ribs 74 each having a lower portion 75 slidable in opening 68. The upper end of piston 61 is formed with one or more inclined slots 76 for a pur-

pose to appear and the piston hub is provided at 77 with a radial drain opening.

Housing 15 has its internal chamber 78 connected through a threaded wall opening 79 to a suitable gas withdrawal conduit.

In operation the liquid passing through vessel 11 attains a normal level shown in FIGURE 1 wherein float 32 buoyed on it rocks lever 27 to the FIGURE 1 position wherein lever 35 urges both the pilot and main valves closed and there is no escape of gas from space 12 to chamber 78. Under these conditions the pin 43 is substantially at the upper end of slotted apertures 46 and 47 and transmits force through the closed pilot valve to urge the main valve against seat 69.

As soon as sufficient air or other gas collects under superatmospheric pressure in space 12 to forcibly lower the liquid level in the vessel, float 32 will correspondingly lower and rock lever 27 counterclockwise, and this acts through lever 35 to move the pilot valve assembly down sufficiently to separate pilot valve seats 53 and 67. As soon as the pilot valve is cracked open gas pressure is transmitted up passages 57 and bores 62 and 63 into the cylinder space 66 where the pressure increases above that of chamber 78 which is substantially atmospheric and starts to exert a downward force on the piston 61 and therefore the main valve assembly which is displaced downwardly to sufficiently separate main valve seats 69 and 72 to allow the gas pressure of space 12 to escape directly into chamber 78 from which it exhausts to atmosphere. Even when chamber 78 is opened to the pressure of space 12 the main valve stays open because the area of piston 61 exposed to space 66 is greater than that exposed to chamber 78. Furthermore should the pressure buildup in space 12 cause further drop in the liquid level after a predetermined travel of pin 43 through apertures 46 and 47 it will engage the bottoms of those apertures as shown in FIGURE 5 and exert an added positive downward pull on the valve assembly to speed opening of the main valve. Usually however, the main valve is opened by piston 61 before such a pull is effected. Downward movement of piston 61 is limited by engagement of piston ribs 74 with plate 14 so that the piston does not leave liner 64.

As soon as chamber 12 is relieved of excess gas pressure and drops to the atmospheric pressure of chamber 78 the liquid level rises thereby moving float 32 up to cause clockwise rocking of lever 27 and upward displacement of lever 35 which first closes the pilot valve and then moves the main valve assembly up to its FIGURE 1 position by the time float 32 reaches the FIGURE 1 position. During the most part of the return upward movement of piston 61, slots 76 function to permit gas displacement from space 66 in chamber 78 to prevent an air lock within space 66. The downward displaced position of piston 61 is indicated in dotted lines in FIGURE 1. By using a sheet metal cylinder liner at 64 the housing 15 may be directly cast and the smooth surfaced liner pressed into place to form the cylinder without expensive machinery. Here the parts will remain until excess pressure accumulates in space 12, and small transient fluctuations in gas pressure in space 12 do not affect them.

It will be noted that the entire float and valve assembly unit is supported in the vessel from the external housing 15 attached to the vessel.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. Apparatus for venting the space above the surface of a liquid in a vessel having a top opening comprising housing means detachably secured to said vessel at said opening and defining a vent chamber having an outlet opening, a valve seat plate carried by said housing and projecting into said opening in said apparatus, a main valve element selectively engageable with said valve seat plate, a piston rigid with said main valve element and slidable within a cylinder formed in said housing means, means defining a constantly open passage connecting the interior of said cylinder above said piston to atmosphere, a bore extending through said piston and said main valve element and open at its upper end into the interior of said cylinder, said bore having an enlarged portion at its lower end to provide an internal axially facing pilot valve seat, a pilot valve element slidably mounted in said enlarged bore portion for selectively engaging said pilot valve seat, a bracket assembly depending from the lower side of said housing, a bell crank pivotally mounted on the lower end of said bracket assembly, said bell crank having a pair of angularly related arms, a link pivotally connected at one end to one of said arms and pivotally connected at its opposite end directly to said pilot valve element and through a lost-motion connection to said main valve element, a float mounted on the other of said arms whereby said pilot valve element is moved away from said pilot valve seat when the liquid in said apparatus falls below a predetermined level to thereby connect said interior of said cylinder to the interior of said apparatus, and means defining passage means in said piston independent of said constantly open passage for establishing substantially free communication between said interior of said cylinder and the atmosphere after said main valve is partially opened.

2. In a gas and liquid separation device:

- (a) a valve housing having a depending bracket;
- (b) a main valve in said housing;
- (c) a fluid pressure responsive actuator for said main valve;
- (d) a pilot valve mounted on said main valve for controlling the admission of gas under pressure through a passageway in said main valve to said fluid pressure responsive actuator;
- (e) a bell crank pivotally mounted on said bracket;
- (f) said bell crank having a pair of angularly related arms;
- (g) a link pivotally connected at one end to one of said arms and pivotally connected at its opposite end to said pilot valve;
- (h) a float mounted on the other of said arms independent of said pilot valve; and
- (i) a lost-motion connection between said link and said main valve.

3. Apparatus for venting the space above the surface of a liquid in a gas and liquid separation apparatus comprising:

- (a) housing means defining a vent chamber having an inlet opening and an outlet opening;
- (b) a main valve element for closing said inlet opening;
- (c) a piston rigid with said main valve element and slidable within a cylinder formed in said housing means;
- (d) means defining a constantly open passage connecting the interior of said cylinder above said piston to atmosphere;
- (e) a bore extending through said piston and main valve element and opening at its upper end into said interior of said cylinder;
- (f) means defining a pilot valve seat at the end of said bore remote from said cylinder;
- (g) a pilot valve element slidably mounted on said

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- main valve element for engaging said pilot valve seat;
- (h) a bell crank pivotally mounted on a depending portion of said housing;
- (i) said bell crank having a pair of angularly related arms; 5
- (j) a link pivotally connected at one end to one of said arms and pivotally connected at its opposite end to said pilot valve element;
- (k) a float mounted on the other of said arms whereby said pilot valve element is opened when the liquid in said apparatus falls below a predetermined level to thereby connect said interior of said cylinder to the interior of said apparatus; 10
- (l) means defining passage means in said piston independent of said constantly open passage for establishing substantially free communication between said interior of said cylinder and the atmosphere after said main valve is partially opened; and 15

(m) means independent of said pilot valve providing a lost-motion connection between said link and said main valve element.

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