

Sept. 27, 1955

I. E. NUTTER

2,718,901

ANGULATED FLOW CONTROL MEANS PROVIDED WITH LOUVER OPENINGS

Filed July 14, 1953

2 Sheets-Sheet 1

FIG. 1.

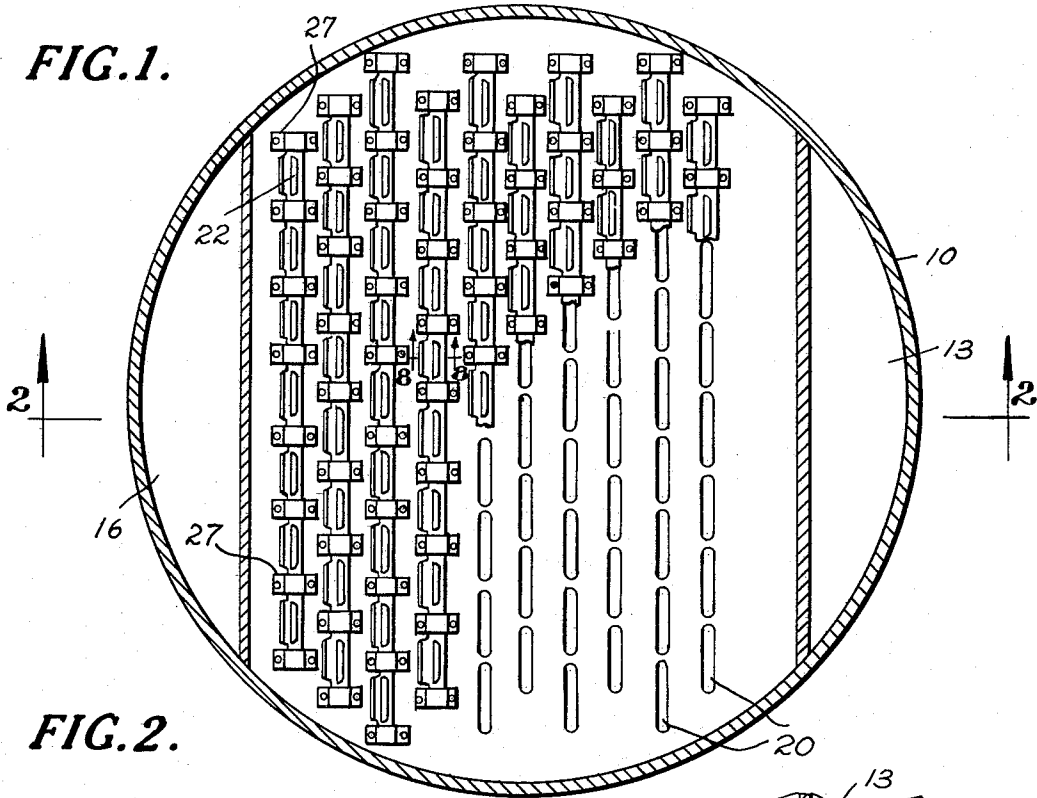
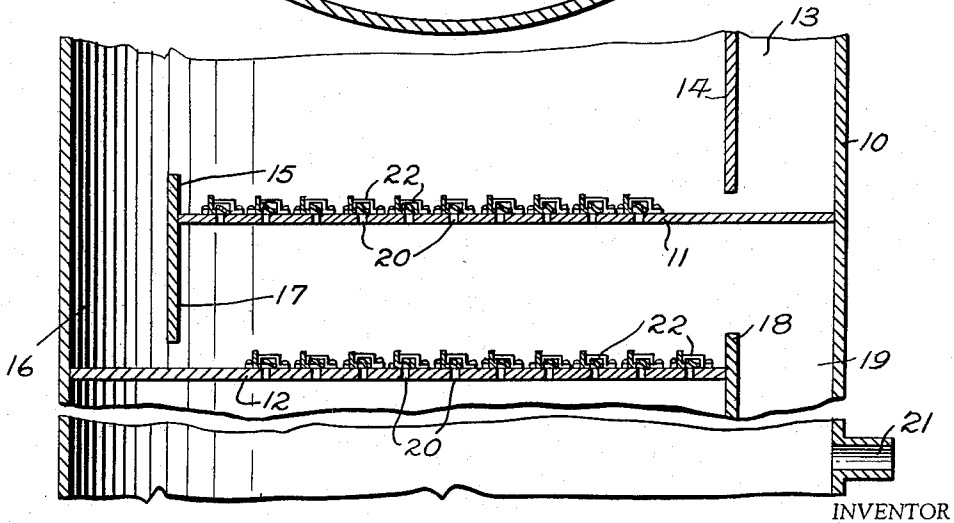


FIG. 2.



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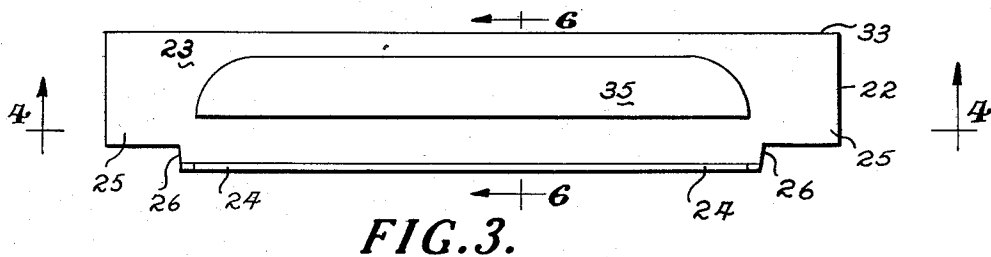


FIG. 4.

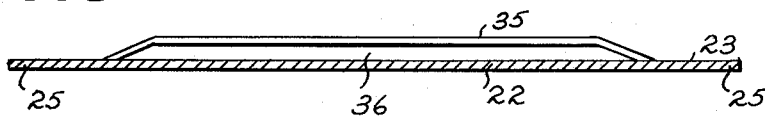


FIG. 5.

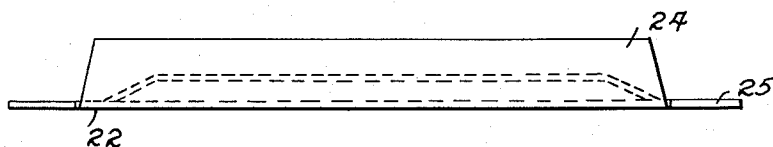


FIG. 6.

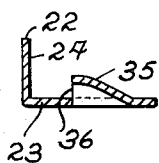


FIG. 7.

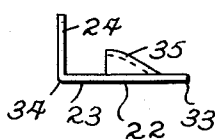


FIG. 8.

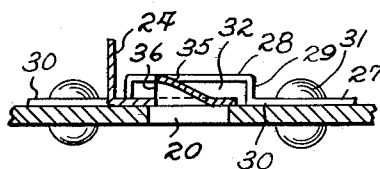


FIG. 9.

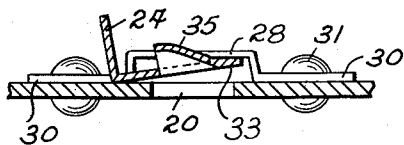
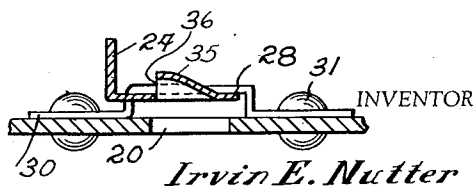


FIG. 10.



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2,718,901

ANGULATED FLOW CONTROL MEANS PROVIDED WITH LOUVER OPENINGS

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5 Claims. (Cl. 137—512.1)

The present invention relates to gaseous and liquid contact apparatus and, more particularly, to improved means for regulating the flow of gas or vapor through a bubble tray or the like. The invention is an improvement over the floating pivoted valve mechanism embodied in my co-pending application, Serial No. 274,524, filed March 3, 1952.

An important object is to provide the flow openings of bubble tray and the like, with flow regulating means in the form of angulated floating pivoted valves, each of the floating pivoted valves having a horizontal portion and a vertical portion and the horizontal portion being provided with means in the form of louvers so as to increase the gas or vapor passage capacity of the bubble tower or the like, and to stabilize the initial movement of each of the floating pivoted valves.

Other objects and advantages of the invention will become apparent from the following description when taken in conjunction with the accompanying claims and drawings.

Referring to the drawings in which a preferred embodiment is shown:

Figure 1 is a sectional plan view of a bubble tower or the like provided with a gaseous and liquid contact apparatus constructed in accordance with the present invention.

Figure 2 is a vertical sectional view taken substantially along the line 2—2 of Figure 1.

Figure 3 is a detail plan view of a louvered floating pivoted valve constructed in accordance with the present invention.

Figure 4 is a longitudinal sectional view taken substantially along the line 4—4 of Figure 3.

Figure 5 is a front view of Figure 3.

Figure 6 is a sectional view taken along the line 6—6 of Figure 3.

Figure 7 is a vertical end view of Figure 3.

Figure 8 is an enlarged sectional view taken substantially along the line 8—8 of Figure 1 showing the valve in its normally closed position.

Figure 9 is a view similar to Figure 8 showing the light side of the valve raised, and

Figure 10 is a view similar to Figure 8 showing the valve in its full open position.

Referring to the drawings, the gaseous and liquid contact apparatus is shown in the form of a bubble tower 10 which may be provided with any suitable number of vertically spaced trays such as 11 and 12 (Fig. 2). With each tray is associated an entrance downspout 13, formed by transverse baffle 14, positioned on one side of the bubble tower for conveying descending liquid to one side of the tray, thence, across same and over overflow weir 15 into an exit downspout 16 similar to spout 13, but positioned on the opposite side of the tower 10. The spout 16 is formed by transverse baffle 17 and is located so as to convey the liquid to and across tray 12 and over overflow weir 18 similar to weir 15 and discharge same into the downspout 19 so as to insure the circulation of the

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liquid in a sinuous path through the tower during the contact operation. The exit, or overflow, weir 15 preferably extends above the bottom of downspout 13 so as to form a liquid seal for the downspout 13 on the opposite or liquid entrance side of the tray 11 in order to prevent the upward flow of gas or vapor through the downspout 13 when the flow is initiated. In other words, the gas or vapor is forced to take its normal course, through flow regulating apparatus on the tray intermediate entrance downcomer 13 and exit-weir 15 of tray 11 or entrance downcomer 16 and exit-weir 18, tray 12, and entrance downcomers and exit-weirs of all other trays of the tower, when passing through the bubble tower.

Each of the trays between the entrance-downcomer and the overflow weir has one or more flow openings or passages 20 (Fig. 1), preferably arranged in spaced transverse rows that allow the gas or vapor to flow from below each of the trays to points above the same during the operation of the apparatus, so as to provide intimate contact and thorough mixing of the upwardly flowing gas or vapor with the descending liquid as the latter traverses the tray. The gas or vapor may be introduced under pressure into the tower 10 through an inlet 21 (Fig. 2) positioned in one side of the apparatus and below the bottom tray. This gas or vapor, after vertically traversing upwardly through each tray, discharges from the tower through an opening not shown and positioned above the uppermost tray.

The rows of flow openings 20 in each of the trays are covered by a flow regulating means, preferably in the form of an angulated or substantially L-shaped valve member 22 (Fig. 7), which may preferably correspond in number to the number of flow openings or may be of such length as to cover one or more of the openings. Each of the valve members 22 has a horizontal leg or portion 23 and a vertical leg 24 (Figs. 6 and 7) and may vary in size, length and shape to meet the particular operating requirements of the bubble tower or apparatus with which it is associated. The horizontal legs 23 of each of the valve members 22 is preferably provided with reduced end portions 25 (Fig. 3). Thus, each control member 22 is constructed and arranged to constitute a floating or movably pivotal valve of such length that its horizontal leg preferably overlaps one of the slotted openings 20 and normally engages by gravity, the top of its associated tray to cover one of the flow passages 20 although each control member 22 may desirably cover several slotted openings 20 and function in the same manner with its associated tray. The reduced ends 25 are formed by inwardly tapered shoulders 26 on horizontal leg 23 adjacent to the same side and at the ends of vertical leg 24 of valve members 22. Each of the spaced floating pivoted valves 22 is held within desirable limits on its associate tray by transversely disposed retaining members or brackets 27, which may vary in accordance with the number of rows of flow openings and floating pivoted valves. Each of the retaining members 27 is preferably formed with an intermediate raised or substantially U-shaped portion 28 (Fig. 8) having parallel depending sides or arms 29 that terminate in horizontally disposed flanges 30 that extend outwardly from opposite sides of the retaining member. The flanges 30 rest on the top of an associated tray and may be secured thereto in any suitable manner such as by the rivets or bolts 31 that extend through aligned openings in the flanges 30. The reduced ends 25 of each of the angulated valves 22 are arranged to be movably mounted within a space 32 formed between the adjacent top surface of a tray and the transverse portion 28 of the retaining member 27 so that the valve may move a limited distance upwardly relative to the tray during the operation of the apparatus. The inclined shoulders 26 coact with the edges of depend-

ing sides 29 to provide stop means for limiting longitudinal movement of the valves 22 relative to the retaining members 27.

The horizontal leg 23 is wider than the vertical leg 24 of each of the angulated valves 22, and valves 22 may be considered as provided with a light edge 33 and a heavy edge 34 (Fig. 7). The horizontal leg 23 has formed therefrom a raised portion or louver 35 that extends lengthwise and terminates short of the reduced ends 25 (Fig. 3). The raised portion 35 is shaped so as to form a louver opening 36 substantially co-extensive in length therewith and which faces the vertical leg 24 (Figs. 3 and 6). The louver opening 36 is positioned so as to be located directly above the opening 20 (Fig. 8) so as to allow the free and uninterrupted escape of gas or vapor through each of the valves 22 in advance of movement of valves 22 and resultant flow from underneath and along the sides thereof.

In operation, normally the liquid passes downwardly through the bubble tower across one tray in one direction and onto and across the next lower tray in an opposite direction and upon starting liquid flow, in advance of gas or vapor flow, liquid will also flow through the louver openings 36 in addition to its regular course. Thus, it will be seen that with the exception of the top tray, liquid flows to each tray through the louver openings 36 of the tray above and at approximately the same rate as the liquid passes the opening 36 to the next lower tray. Thus, except for the top tray, a normal flow of liquid follows its regular course across all trays and through all downspouts or downcomers, even in the absence of gas or vapor flow. Since the overflow or exit weir 15 extends slightly above the bottom of downspout 13, there is formed a liquid seal on spout 13 at the liquid entrance side of the trays 11, which would prevent the flow of gas or vapor from passing upwardly through the downspout 13 in an abnormal course. Consequently, when the flow of gas or vapor starts, it is forced to take its normal course of flow upwardly through the floating pivoted valves 22 including the floating pivoted valves in the uppermost tray of the tower since gas or vapor flow is sealed from flowing upward through the downspout from the top tray by the liquid seal formed by the exit-weir of the next lower tray.

It will be manifest, of course, that initially gas or vapor flows upwardly through the louver openings 36 before any movement of valves 22 occurs and at some minimum flow, at a low pressure differential across the tray 11, gas or vapor is flowing through all the louver openings 36 before any valve 22 is moved from position. In other words, the valves 22 partly close the openings 20 and at some low pressure differential the flow of gas or vapors occurs through all the louver openings 36 before the pressure differential is of sufficient magnitude to move any of valves 22 from their position of rest in contact with tray 11. After a moderate further differential pressure increase, the light sides 33 of the floating pivoted valves 22 open gradually in unison throughout each tray, thus providing additional flow requirements, at such differential pressure increases, through which the gas or vapor discharges to contact and intermingle with the liquid passing downward through the bubble tower 10. After the light sides 33 of valves 22 are fully open and as the pressure differential is moderately increased, additional rates of flow are automatically accomplished through the fixed openings 36 and the fully opened light sides 33 of valves 22 depending upon the demands required. Finally at some established pressure differential increase, the heavy sides 34 start throttling additional rates of flow of the gas or vapor in unison without any further appreciable increase in pressure differential as the flow rates increase to the point where the heavy sides of the floating pivoted valves are moved to their fully opened position (Fig. 10). As both sides open and become wide open they coact with the louver openings 36 to supply

increase flow of vapor and gas as the pressure differential continues to increase. All floating pivoted valves 22 on tray 11 are in essentially a horizontal plane. As liquid traverses the tray, the head of liquid above the tray is higher on the liquid entrance side of tray than on the liquid exit side, thus a liquid gradient exists across tray to produce free liquid flow and the floating pivoted valves 22 are submerged in increasing heads of liquid from the liquid exit side of tray towards the liquid entrance side. Therefore, as gas or vapor flow starts, each of the louver openings 36 of the floating pivoted valves 22, in the row nearest the exit weir 15, is submerged in the lowest liquid head due to the decreasing liquid head across the tray 11 from the liquid entrance side of the tray.

Thus, it will be seen that as gas or vapor flow starts, due to sufficient differential pressure exerted by the gas or vapor on the underside of each of the valve regulating means, the gas or vapor passes upwardly through the louver openings 36 of the row of floating pivoted valves nearest to exit-weir 15 (Fig. 8) when the pressure differential exceeds the liquid head over this row of valves. As gas or vapor flow is increased by small increments, flow of the gas or vapor through additional louver openings 36 of the angulated valves 22 starts progressively by rows from this row of valves adjacent the liquid exit side of tray toward the liquid entrance side of the tray 11, until finally and at a pressure differential across the tray just in excess of the liquid head on the liquid entrance side of the tray 11, all louver openings 36 of floating pivoted valves 22 on the tray are passing gas or vapors therethrough. At this gas or vapor flow rate, the liquid throughout the tray 11 and all other trays of tower has become frothed and any prior existing liquid gradient across the trays has been eliminated. Thus, all floating pivoted valves 22 on the trays are submerged in an equalized liquid head when this rate of gas or vapor flow is reached. Prior to reaching this gas or vapor rate louver openings 36 not yet passing gas or vapor allow the downflow of liquid from each successive upper tray 11 to the adjacent lower tray in a shortcircuit fashion and inefficient operation results. The area of louver openings 36 is only approximately 30% of the full area of opening of floating pivoted valves 22, including the combined area of opening of the louvers and areas provided along the sides of the floating pivoted valves when in full open position (Fig. 10) and louver openings 36 are all brought into operation throughout the tray at a pressure differential, in addition to liquid head above the tray, of about one-half inch of water pressure. Thus, when it is considered that full loading of tray 11 is accomplished at approximately five inches of water pressure differential across tray, with full operation of 100 percent of the provided area in floating pivoted valves 22, the foregoing initial efficient operation of tray is accomplished at approximately 9% of maximum loading conditions while operating at one-half inch of water pressure differential through 30% of the area of opening of valves. With more loading and with the floating pivoted valves 22 in their normal position at rest on the associated tray, additional rates of flow of gas or vapor are accomplished through louver openings 36 until finally at some moderate increase in pressure differential, and with the openings 36 continuing to pass increased rates of gas or vapor with increased pressure differential, the light edges of floating pivoted valves 22 start opening in unison in a mild unstable throttling movement by pivoting around heavy edges 34 of float valves 22. Upon still further loading, accompanied by increased rates of gas or vapor flow and pressure differential across tray 11, the upper sides of light edges 33 finally come in contact with the underneath sides of the U-shaped bracket members 27 at a pressure differential of about three quarters of an inch water pressure to assume a half-open position (Fig. 9). At this loading of the valves in half-open position and with the louver openings continuing to pass increased volumes of

gas or vapor, approximately 65% of the total area of floating pivoted valves 22 are in operation. At this capacity rate of 65% of the valve areas in operation at three quarters of an inch water pressure differential the loading is approximately 25% of full loading previously specified and with additional loading beyond this rate all further action or movement of the floating pivoted valves 22 is completely stable. The valves in half-open position (Fig. 9), together with the fixed openings of the louvers, pass increased volumes of gas or vapor upon further increase of pressure differential and finally the heavy edges or sides 34 of floating pivoted valves 22 start opening in unison with each other in a fully stabilized throttling fashion until wide open with the upper sides of heavy edges 34 also in contact with the underneath sides of the U-shaped bracket members 27 (Fig. 10). Full loading results as the pressure differential and corresponding flow of gas or vapors increase beyond the point at which both edges of valves 22 are wide open.

The fixed opening 36 in each of the louver curved flanges 35 may desirably be constructed to provide the same gap or width of opening as is provided for flow from underneath each side of the floating pivoted valve 22 when in full open position. Thus the flow accomplished through each louver opening 36 is essentially in direct proportion to the relation its length bears to the sum of lengths of opening underneath and along both sides of the floating pivoted valve in wide open position. As for example, if a one-eighth inch gap or width is provided in the open side or louver opening 36 and the floating pivoted valve lifts the same amount in full open position and the length of opening 36 is three inches and the total length of opening along both sides of the floating pivoted valve is seven inches, then the area and capacity for flow through the louver 35 is 30% and the area and capacity of flow from underneath the floating pivoted valve is 70% of the total flow through the floating pivoted valve as a unit.

The flow of gas or vapor through the louver openings 36 has the effect of urging each floating pivoted valve toward its light side 33, which is neutralized by the impingement of gas against the vertical leg 24 of the valve 22. The effect of these two opposed actions of gas or vapor tends to partially stabilize the heretofore somewhat unstable initial opening of the floating pivoted valve as its light side 33 opens and also affords means for providing greater gas or vapor passage capacity than heretofore obtainable.

It will be understood that the form of the invention is merely illustrative and that such changes may be made as come within the scope of the following claims.

I claim:

1. In a gas and liquid contact apparatus of the class described, a tray having a flow opening, an angulated floating pivoted valve having a horizontal leg and a vertical leg extending from the edge of one side of the horizontal leg so that the horizontal leg has one side heavier than the opposite side thereof, said horizontal leg having a raised portion provided with a louver opening facing said vertical leg, retaining means movably mounting the floating pivoted valve on the tray so that the horizontal leg normally covers said flow opening, said floating pivoted valve being operable upon variation in the differential gas pressure from below the tray to above the same, so as to initially allow passage of gas through said louver and upon increase of upward differential pressure, to cause the horizontal leg first to be rocked on its heavy side to raise the opposite side away from said opening to allow further passage of gas and finally upon further increase of the upward differential gas pressure to raise the heavy side also away from said flow opening to allow additional further passage of gas through said flow opening.

2. In a gas and liquid contact apparatus as called for in claim 1 in which the retaining means includes a mem-

ber having a raised portion arranged to be engaged by the floating pivoted valve when the latter is moved away from the flow opening.

3. In a gas and liquid contact apparatus as called for in claim 1 in which the retaining means includes spaced inverted U-shaped members arranged to be engaged by the floating pivoted valve when the latter is moved away from the flow opening.

4. In a gas and liquid contact apparatus of the class described, a tray having a row of spaced flow openings, angulated floating pivoted valves for covering said openings, each of said valves having a horizontal leg and a vertical leg extending upwardly from the edge of one side of the horizontal leg, each horizontal leg having reduced ends extending outwardly beyond the ends of the vertical leg, said horizontal leg having an elongated raised louver extending lengthwise thereof and provided with a louver opening facing and co-extensive with said vertical leg, transversely disposed retaining members connected to the tray and having raised portions overlapping the reduced ends of the horizontal leg, each raised portion of said retaining members being normally spaced from the adjacent reduced end of the horizontal leg and arranged to limit the upward movement of the floating pivoted valves relative to the tray, said floating pivoted valves normally engaging the tray to cover the flow openings, and operable upon variation of the differential gas pressure from below the tray to above the same to initially allow passage of gas through said louvers and upon further increase of the upward differential gas pressure to cause the floating pivoted valves to be raised relative to said flow openings to engage the retaining members.

5. In a gas and liquid contact apparatus of the class described, a tray having spaced transverse rows of flow openings, spaced angulated floating pivoted valves for covering said openings, each of said valves having a horizontal leg and a vertical leg extended upwardly from the edge of one side of the horizontal leg so that said side of the horizontal leg is heavier than the opposite side, said horizontal leg having reduced ends extending outwardly beyond the ends of said vertical leg and an upwardly curved louver extending lengthwise therein and forming an opening facing said vertical leg, spaced retaining members above the reduced ends of said horizontal leg and positioned transversely thereof, each of said retaining members including a substantially U-shaped intermediate portion having horizontally disposed end flanges extending in opposite directions from the U-shaped portion, means connecting said flanges to the tray, the U-shaped portion of each retaining member coacting with the tray to provide a space into which extend from opposite sides the reduced ends of the horizontal legs of the floating pivoted valves, said floating pivoted valves normally engaging the tray to cover the flow openings and operable upon variation in the differential gas pressure from below the tray to above the same to initially allow passage of gas through the louvers and upon increase of differential gas pressure to cause the light side of the horizontal leg of the valves to be raised relative to the flow openings to allow additional passage of gas through said flow openings and upon further increase of the upward differential gas pressure, to move the heavy side of the valves also away from said openings to allow further additional passage of gas through same, the upward movement of the floating pivoted valves being limited by engagement of the reduced ends of the horizontal portions of the valves with the underside of the U-shaped portions of the retaining members.

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UNITED STATES PATENTS

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