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3,287,004

VALVE MECHANISM FOR FLUID AND LIQUID CONTACT APPARATUS

Filed March 25, 1960

2 Sheets-Sheet 1

FIG. 1.

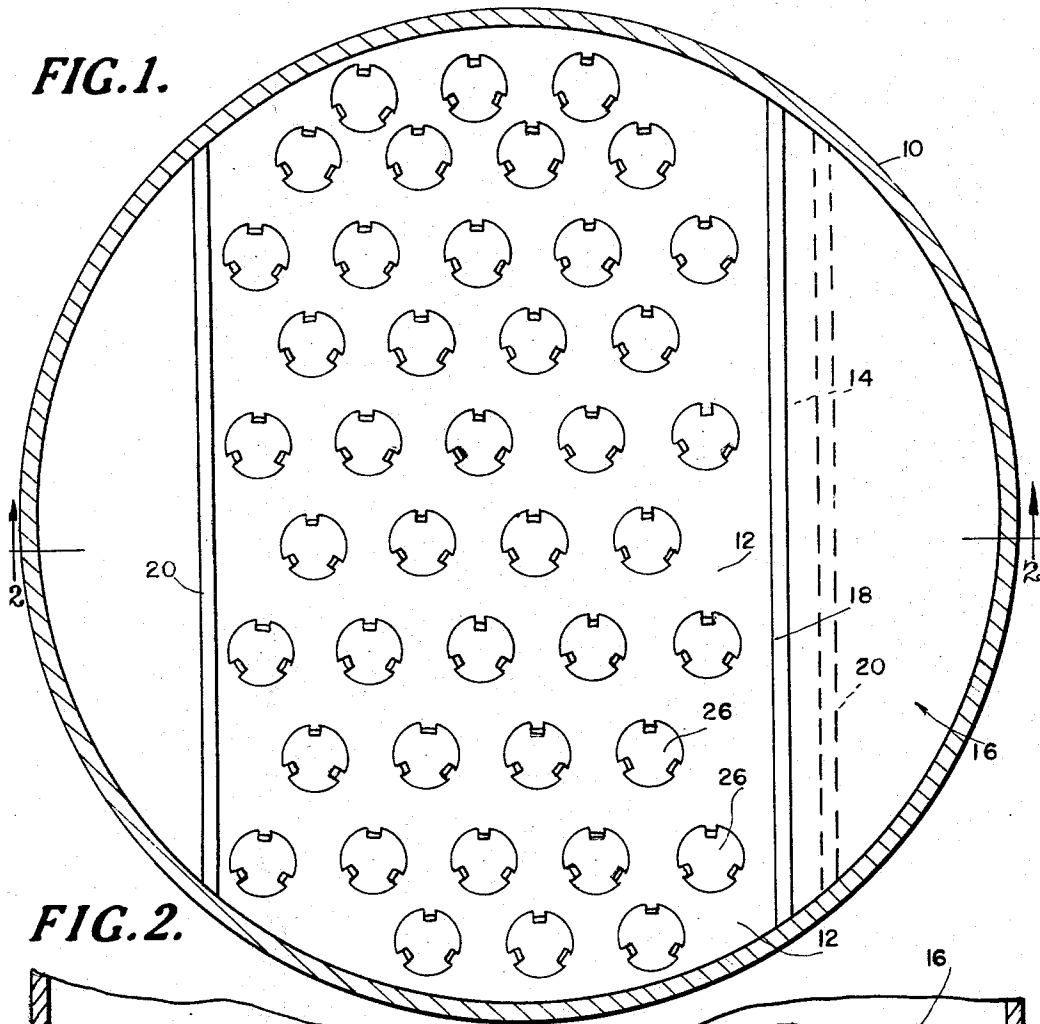
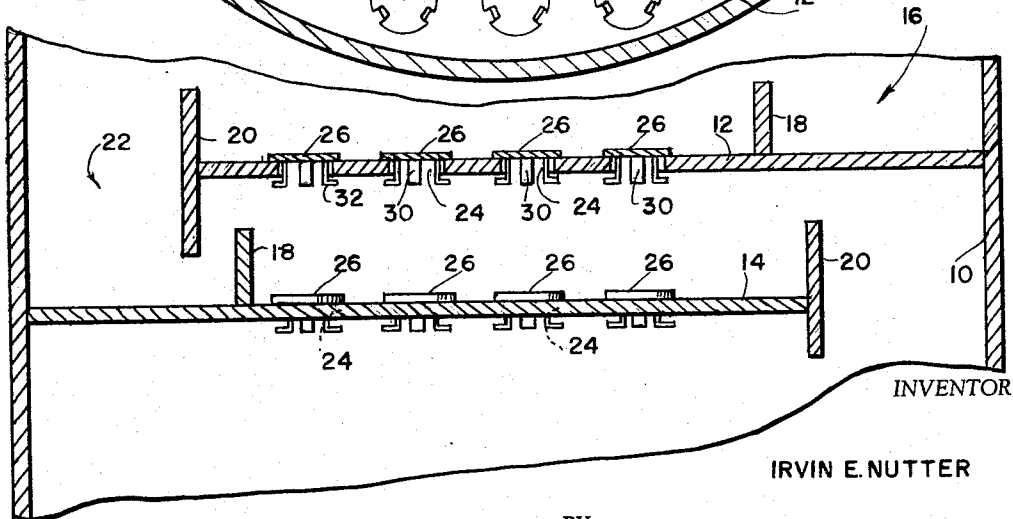


FIG. 2.



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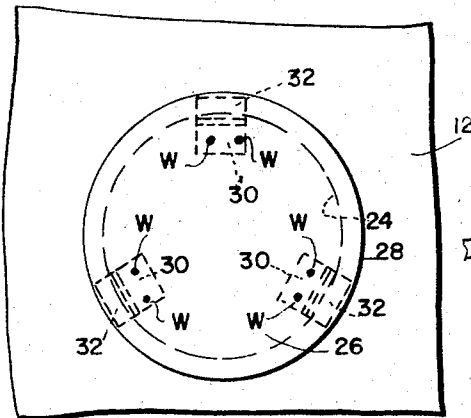
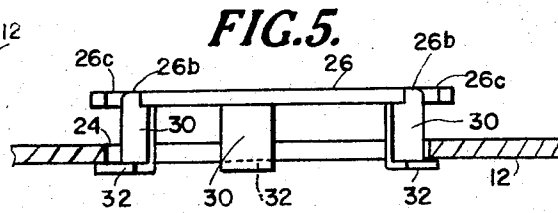
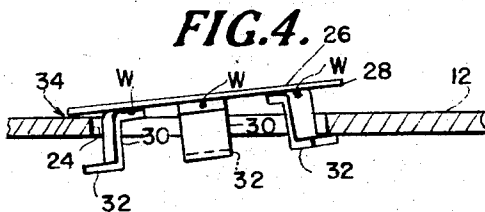
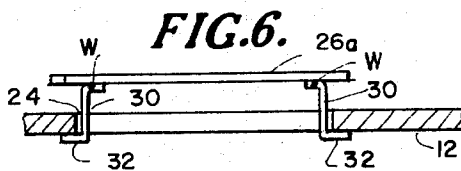
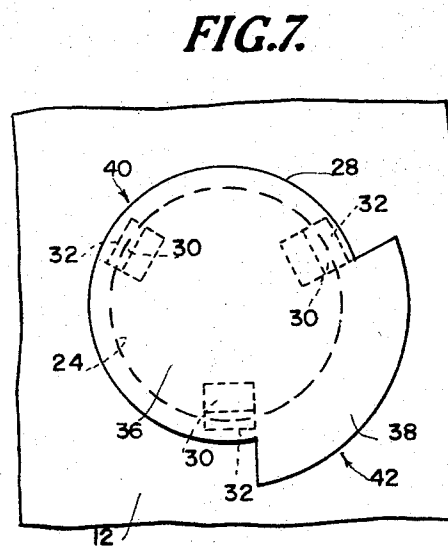
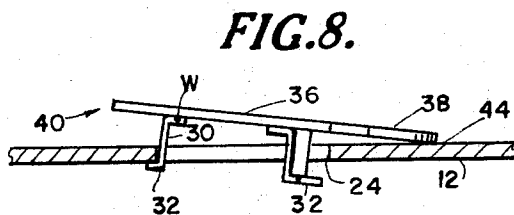
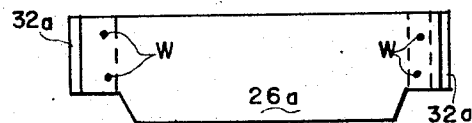
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VALVE MECHANISM FOR FLUID AND LIQUID CONTACT APPARATUS

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2 Sheets-Sheet 2



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3,287,004

VALVE MECHANISM FOR FLUID AND LIQUID CONTACT APPARATUS

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Filed Mar. 25, 1960, Ser. No. 17,653
12 Claims. (Cl. 261—114)

This application is a continuation-in-part of my prior application, filed June 26, 1956, Serial No. 594,049; now Patent No. 2,951,691, issued September 6, 1960.

The present invention relates to a gas and liquid contact apparatus and, more particularly, to an improved valve assembly, associated with the bubble tray of a refining tower or the like, to produce a uniform distribution of the flow of gas or vapor by contact, and thorough mixing of the gas or vapor with the liquid. The invention is also directed to simplification in the valve control means disclosed in my Patents 2,718,900, dated September 27, 1955, and 2,718,901, dated September 27, 1955.

Generally, the control means essentially includes one or more self-retaining floating pivoted valves which may be of elongated flat shape, as in my prior patents, or a suitably curved or circular configuration, so as to overlap and normally close a flow opening in the tray. Each valve has depending means preferably integrally attached and extending through a flow opening and provided with a stop flange or lug, which engages the underside of the tray, when the valve is raised a predetermined distance relative to the tray in order to limit the upward movement of the valve relative to the tray without requiring the use of separate stop members or straps, or the use of retaining bolts, nuts, or rivets for securing the stop members in a fixed position on the tray.

An important object of this invention is to provide a simple, efficient, compact, and economical valve means composed of a minimum number of parts and which automatically regulates the upward flow of gas or vapor through bubble tray openings and the like, in accordance with differential ranges of pressure across each tray.

Another object of this invention consists in forming the tray with circular or noncircular flow openings which are normally closed by similarly formed disc or flat valves having outer peripheral marginal edges which overlap and engage the tray when the valve is in its closed position. The disc valve may be either symmetrical or have a sector or segmental portion thereof heavier than the remaining portion of the valve, so as to have a heavy edge portion and an opposite lighter edge portion.

These and further objects and advantages will become readily apparent to those skilled in the art upon reading the following detailed description taken in conjunction with the appended drawings in which:

FIGURE 1 is a top plan view of a bubble tower tray and valves of this invention;

FIGURE 2 is a cross-sectional view taken along line 2—2 of FIGURE 1;

FIGURE 3 is a top plan view of one form of valve of this invention;

FIGURE 4 is a side elevational view of the valve of FIGURE 3, but shown in its tilted position;

FIGURE 5 is a side elevational view of the valve of FIGURE 3 in its fully raised position, but showing modified stop means;

FIGURE 6 is a side elevational view of an elongated flat valve;

FIGURE 6a is a plan view of the valve of FIGURE 6;

FIGURE 7 is a view corresponding to FIGURE 3, but showing a modification thereof; and

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FIGURE 8 is a side elevational view of the valve of FIGURE 7.

Referring to the drawings, the gas and liquid contact apparatus is shown in the form of a cylindrical refining or bubble tower 10 which may be provided with any desired number of vertically spaced trays alternately arranged laterally, such as tray 12 with respect to tray 14 (FIGURE 2), so as to provide a transverse passage for the liquid from one side of the tower 10 to the opposite side thereof. Liquid is directed onto each tray into the area 16 either from an outside source through the wall of the tower 10, if said tray is the uppermost tray in the system, or from a downcomer (not shown), of the next tray above, for receiving the descending liquid and directing the same over a seal and distribution weir 18 (FIGURE 2) onto and across the tray 12 and over an overflow weir 20 into a downspout 22 on the opposite sides of the tower 10.

Each tray, between the seal-weir 18 and the overflow weir 20, has one or more flow openings 24, preferably arranged in spaced transverse offset rows, that allows the gas or vapor to flow from below each of the trays to points above the same during the operation of the tower to provide intimate contact and mixing of the upwardly flowing gas or vapor with the descending liquid as the latter laterally traverses each of the trays. Gas or vapor under pressure may be introduced into the tower 10 through an inlet (not shown) positioned below the bottom tray of the tower. The gaseous material is emitted from the tower through a similar exit opening (not shown) positioned above the uppermost tray after traversing upward through each tray.

In one form of the invention, shown in FIGURES 1 and 2, each of the trays 12 may be provided with rows of spaced, curved or circular openings 24, each of which may be closed by a circular or disc-shaped valve 26, rather than the usual elongated valve 26a as shown in FIGURE 6, having a marginal peripheral edge 28 of larger diameter than the opening 24, so as to overlap the adjacent top portion of the tray 12 (FIGURE 3), and provide a symmetrical or balanced closure. Additionally, each of the valves 26 is provided with circumferentially and uniformly spaced depending integral arms or legs 30, three of which are shown but any number may be employed. The legs 30 may be punched from the marginal edge 28 of the valve 26 (FIGURE 5) or be formed separately and secured to the valve 26 by spot welding W (FIGURES 3 and 4). Each of the arms 30 terminates at its lower end in an outwardly and laterally extending stop flange 32 that engages the underside of the tray 12, so as to limit the upward movement of the valve 26 when the latter is raised relative to the opening 24. The valve 26 is made of rigid material, and the depending arms 30 are first inserted through a flow opening 24 so that the valve covers the opening. The lower end of each of the arms 30 is then bent outwardly to form the stop flanges 32. Such construction of legs 30 and valve 26 may also be employed in the elongated flat type valve 26a shown in FIGURES 6 and 6a and described in detail in my prior Patent No. 2,951,691. The valve is much easier and more economically produced with integrally formed legs or arms, as shown in FIGURE 1. However, in some cases, this type of construction leaves voids at each leg or arm location and the purpose of the construction of the spot welded legs or arms 30a, shown in FIGURES 3, 4, 6, 6a and 8 at W, is to provide a full cover valve.

In operation, when the circular valve 26 is in its closed position, its periphery 28 overlaps opening 24 and engages the top surface of tray at the opening 24, so as to close the opening. Upon variation in the differential gas pressure below the tray to above the same, the valve 26

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is initially rocked or tilted about either of three or more positions, depending upon the number of legs or arms 30. Since there is no weight differential in the circular valve 26, no side or portion thereof is heavier than any other. Consequently, the direction the valve will initially tilt is unpredictable. As particularly shown in FIGURE 4, the valve 26 is shown with its periphery 28 in contact with the top of the tray 12, so as to rock about a fulcrum or pivotal point 34 in order to raise the opposite side of the valve away from the flow opening 24 until the stop 32 of its adjacent leg 30, opposite fulcrum point 34, engages the underside of the tray 12. As the differential gas pressure increases, it causes the disc valve 26 to be moved from its initially rocked position, as shown in FIGURE 4, past its intermediate open position and be raised or moved bodily upwardly until limited by the engagement of all the stop lugs 32 with the underside of the tray 12 (FIGURE 5), so as to maintain the valve in its fully open position.

In the modified form of the invention, shown in FIGURES 7 and 8, a curved valve 36 instead of being circular or symmetrical shaped, as valve 26 (FIGURE 3), has a segmental flat portion or section 38 positioned between an adjacent pair of the spaced depending arms or legs 30, so as to form a light edge or side 40 and a diametrically disposed heavy edge 42. Of course, one sector of the valve may be weighted by other means, such as increasing its thickness or adding a small weight to the desired sector. Thus, the curved valve 36, being heavier on one edge than on its opposite edge, when it is initially rocked about its fulcrum or pivot point 44, by increase in the gas or vapor pressure below the tray 12, will be initially raised on its light edge 40 from its closed position to its intermediate open position (FIGURE 8). Upon increase in the differential gas pressure from beneath the tray 12 through the flow openings, the valve 36 will be raised from its inclined position to its completely open position, corresponding to FIGURE 5 of the symmetrical valve 26, and its upward movement will be limited by engagement of the lugs or stops 32 with the underside of the tray 12. Otherwise, the construction and operation of the valve 36 is substantially similar to the circular or disc valve 26, previously described. Generally, upon application of sufficient gas pressure on the underside and differential pressure from underneath to above the tray, the valves are uniformly raised or tilted throughout the trays to an initial or half open position (FIGURE 4) at approximately 20% of the maximum allowable flow capacity. This pressure differential is relatively small yet of sufficient magnitude to accomplish complete distribution of the gas or vapor through all of the flow openings 24 associated with each tray. As the pressure differential increases when the valves 26 are in a tilted position (FIGURE 4), the rates of gas or vapor through all of the flow openings increase. At approximately 40% of the maximum allowable flow capacity, the fulcrum 34 of each of the non-raised edges is moved away from the tray so as to raise the valve to its fully open position corresponding to FIGURE 5 without any further appreciable increase in pressure differential across the tray. Flow actually increases through any given opening in a proportion to the square root of the differential rather than in a direct proportion. However, the flow increases with some greater differential pressure, but proportionately to the increase in differential pressure. The upward movement of the valve 26 relative to the tray is limited by the engagement of the stop flanges or lugs 32 with the underside of the tray adjacent the periphery of the opening 24.

The preferred embodiment is the disclosure represented by FIGURE 5 where the legs are struck out, as shown at 26b, leaving peripherally opening spaced recesses 26c. That is, the legs are formed from the valve without spot welding, in which instance the appearance of such arrangement is disclosed in FIGURE 1 of the complete

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tray, where the valve is notched at the point 26c of each leg. The purpose for spot welding the legs to the valve is to leave the periphery of the valve whole to provide for complete coverage of the circular opening 24. This latter design, with spot welded legs, is only used in some instances where there is a minimum of liquid flow and a tight closure of the tray is necessary to inaugurate liquid circulation through its proper course. In these respects, FIGURE 5 corresponds to the general plan of FIGURE 1, and FIGURES 3 and 4 having welded legs correspond to the form shown by FIGURES 7 and 8. Referring further to FIGURE 5, this is a general view for showing the valve in its fully open position; whereas the form shown by FIGURES 7 and 8 with the spot welded legs is a special alternate arrangement of the preferred form of valve shown in FIGURE 1.

Any circular valve should desirably have three depending legs, which are sufficient to keep it properly centered over the tray opening. Less legs have a tendency to bind the action of the valve, while more legs would add extra weight as well as a more complicated construction. I do not wish to limit the device to a construction with three legs but this number is preferred in equally spaced peripheral relation. In any event, the valve pivots upwardly relative to the tray about a point on its periphery in contact with the upper side of the tray upon initial gas pressure differential until the stop means on one of the legs opposite the point of contact engages the underside of the tray and upon further increase of gas pressure differential the valve pivots upwardly about the stop means on the one leg until the stop means on all of the legs engage the underside of the tray.

It will thus be seen that there has been provided by this invention a device in which the various objects hereinbefore set forth, together with many practical advantages, are successfully achieved. As various possible embodiments may be made of the mechanical features of the above invention, all without departing from the scope thereof, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A gas and liquid contact apparatus comprising: a tray having a flow opening therethrough; means to introduce a liquid across the upper sides of said tray; means to introduce a gas to the underside of said tray; a generally circular disk valve of larger area than said flow opening loosely mounted on said tray and covering said flow opening and in closed position lying on said tray; a weighted sector on said valve comprising an arcuate portion which is integral with and concentric with said valve but of a larger radius whereby said valve initially pivots upwardly about said weighted sector in engagement with said tray upper side; annularly spaced and depending legs on said valve extending through said flow opening; stop means on said legs to engage the underside of said tray when said valve is raised, whereby said valve pivots upwardly relative to said tray about a point on its periphery in contact with the upper side of said tray upon initial gas pressure differential until said stop means on one of said legs opposite said point engages the underside of said tray, and whereby upon increase of gas pressure differential said valve pivots upwardly about said stop means on said one leg until said stop means on all of said legs engage the underside of said tray.

2. The structure defined in claim 1 in which said legs are welded to the underside of said valve.

3. The structure defined in claim 1 in which said depending legs are equally spaced about said periphery of said valve.

4. The structure defined in claim 1 in which said weighted sector is disposed diagonally opposite from one of said depending legs.

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5. The structure defined in claim 1 wherein said sector extends substantially about the periphery of said valve between two adjacent depending legs.

6. In a contact apparatus comprising a plurality of superposed plates having a series of apertures therein and a series of reciprocally movable check valves for said series of apertures movable relative thereto by gaseous pressure exerted from beneath said plates, the improvement comprising a unitary check valve for at least some of said apertures, each of said valves having a head portion, peripheral portions of said valve head portion resting over supporting plate portions when said check valve is in the lowermost position of its reciprocal movement, leg portions formed integrally with and depending from peripheral portions of said head portion, said depending leg portions being receivable within one of said plate apertures and occupying a minute portion of said aperture cross-section when said said valve is in a raised position whereby an insignificant obstruction is afforded by said leg portions to the gaseous pressure rising from beneath said plate, and retaining portions connected to said leg portions extending outwardly away from the center of said valve head portion, said retaining portions extending beneath undersurface portions of said plates defining said apertures when said valves are in the raised position whereby said valves are retained to said plates, portions of each of said leg portions being disposed adjacent to the periphery of the aperture in which disposed in the normal course of valve reciprocal movement whereby jamming of the valve within the plate aperture is substantially obviated.

7. In a tray of a contact apparatus having a series of apertures therein and check valves for said series of apertures movable relative thereto by means of gaseous pressures exerted from beneath said tray against undersurface portions of said check valves, the improvement comprising a reciprocally movable, unitary check valve disposed in at least some of said apertures, each of said check valves comprising a disc portion, said disc portion having recesses formed in the periphery thereof, annularly spaced legs depending from the undersurface of said disc portion and formed integrally with and extending from portions of the disc portion periphery which define at least some of said recesses so as to be joined to said disc periphery and to enable gaseous pressure rising to strike the undersurface of said valve disc portion to be substantially unobstructed by said legs, and stop means connected to said legs extending outwardly from said legs relative to said valve disc portion.

8. A valve assembly for a contact tray having elongated substantially rectangular fluid flow apertures, the assembly comprising a substantially rectangular valve member adapted to overlap and regulate the flow of fluid through such an aperture, oppositely disposed spaced leg members depending transversely from each end of said valve member through said aperture adjacent opposite ends of said aperture, each of said leg members having opposite side edge portions respectively situated adjacent opposite side edge portions of said aperture, each of said opposite side edge portions of said leg members being respectively engageable with adjacent side edge portions of said aperture to limit lateral and rotational movement of said valve member relative to said tray, each of said leg members including outwardly projecting retaining members spaced transversely from said valve member in position to engage the tray so as to limit transverse movement of the valve member relative to said tray.

9. In a contact apparatus comprising a plurality of superposed plates having a series of apertures therein and a series of check valves reciprocally movable in the vertical plane for said series of apertures movable relative to said plates by gaseous pressure exerted from beneath said plates, the improvement comprising a unitary check valve for at least some of said plate apertures comprising a head portion having a greater surface area than that of the

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plate aperture over which disposed, a plurality of leg portions integrally formed with peripheral portions of said head portion angularly disposed thereto at the junctures therewith, foot portions formed integrally with said leg portions outwardly disposed relative to the center of said head portion, said foot portions projecting outwardly a sufficient distance to prevent removal of said check valve with which formed from the aperture in which disposed when said valve is at an upper position of its reciprocal movement, said leg portions being readily bendable relative to said head portion whereby removal of said unitary check valve from the aperture in which disposed is facilitated, said leg portions occupying a minute portion of the aperture cross-section when said valve is in the raised position whereby an insignificant obstruction is afforded by said leg portions to the gases rising from beneath said plate; said leg-head portion junctures lying in vertical planes within the periphery of the plate aperture in which disposed whereby said legs may reciprocally move within the periphery of the aperture in which disposed; said leg portions being of substantially equal length whereby said valve head portion is disposed substantially parallel to said plate in the normal upper most position; portions of each of said leg portions being disposed adjacent to the periphery of the aperture in which disposed in the normal course of valve reciprocal movement whereby jamming of the valve within the plate aperture is substantially obviated.

10. In a contact apparatus comprising a plurality of superposed plates having a series of apertures therein and a series of check valves for said series of apertures reciprocally movable relative thereto by gaseous pressure exerted from beneath said plates, the improvement comprising a unitary check valve for at least some of said apertures, each valve having a head portion, said head portion having a greater area than that of the plate aperture over which disposed, leg portions formed integrally with and forming junctures with peripheral portions of said head portion and depending therefrom, said leg portions affording an insignificant obstruction to the gases rising from beneath said plate when said valve is in the raised position, and foot portions formed integrally with said leg portions extending outwardly away from the center of said valve head portion, said foot portions having outermost distal end limits defining points on a periphery larger than that of the aperture in which disposed whereby said valve is retained to said plate when in the uppermost position of its reciprocal movement in the normal course of use, said leg-head portion junctures defining points on a periphery disposed within the aperture in which said valve is disposed whereby said valve legs may reciprocally move therein, said leg portions being of substantially equal length whereby said valve head portion is disposed substantially parallel to said plate in the normal uppermost position; portions of each of said leg portions being disposed adjacent to the periphery of the aperture in which disposed in the normal course of valve reciprocal movement whereby jamming of the valves within the plate apertures is substantially obviated.

11. In a contact apparatus of the character described, the combination comprising a plate having a plurality of apertures therein, a reciprocally movable check valve disposed in at least some of said apertures, each of said check valves comprising a head portion having peripheral portions resting over supporting plate peripheral portions adjacent said aperture over which said valve head portion is disposed when said check valve is in the lowermost position of its reciprocal movement, said valve head portion having notches formed in the periphery thereof, a plurality of leg portions formed integrally with said head portion and depending from portions of the valve head portions defining at least some of said notches, said leg portions being of substantially equal length whereby said valve head portion is disposed substantially parallel to said plate in the normal uppermost

position; portions of each of said leg portions being disposed adjacent to the periphery of the aperture in which disposed in the normal course of valve reciprocal movement whereby jamming of the valve within the plate aperture is substantially obviated, projecting foot portions 5 formed integrally with said leg portions and projecting outwardly away from the center of said head portion, said foot portions extending outwardly a sufficient distance to prevent removal of said check valve from the aperture in which disposed when said check valve is in the raised position. 10

12. In a contact apparatus comprising a plurality of superposed plates having a series of apertures therein and a series of reciprocally movable check valves for said series of apertures movable relative thereto by gaseous pressure exerted from beneath said plates, the improvement comprising a unitary check valve for at least some of said apertures, each of said valves having a head portion, peripheral portions of said valve head portion resting over supporting, aperture-defining plate portions when said check valve is in the lowermost position of its reciprocal movement, leg portions formed integrally with and depending from peripheral portions of said head portion, the junctures of said leg portions with said valve head portions defining thin crack-like openings with said plate in which disposed when said valves are in the lowermost position of their reciprocal movement whereby rising gases may bleed therethrough at low gaseous pressures, 15

said depending leg portions being receivable within one of said plate apertures and affording an insignificant obstruction to the gaseous pressure rising from beneath said plate when said valve is forced into a raised position, and retaining portions connected to said leg portions extending outwardly away from the center of said valve head portion, said retaining portions extending outwardly beyond under-surface portions of said plates when said valves are in the raised position whereby said valves are retained to said plates; portions of each of said leg portions being disposed adjacent to the periphery of the aperture in which disposed in the normal course of valve reciprocal movement whereby jamming of the valve within the plate aperture is substantially obviated. 20

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