June 5, 1962 H. C. GLITSCH 3,037,754

CLOSURES FOR FLUID CONTACT APPARATUS

Filed March 23, 1959 2 Sheets-Sheet 1

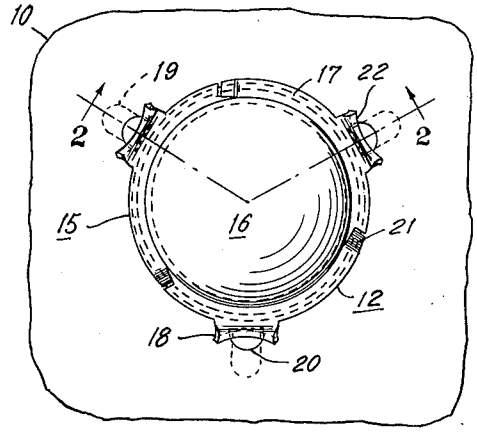


Fig. 1

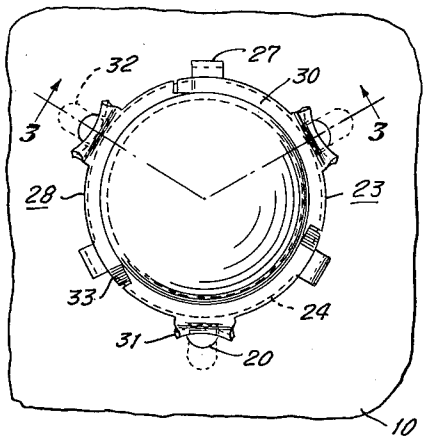


Fig. 3

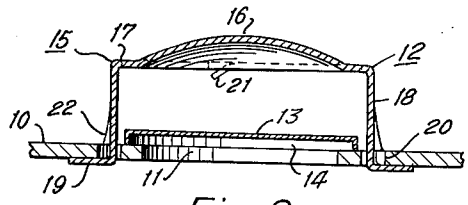


Fig. 2

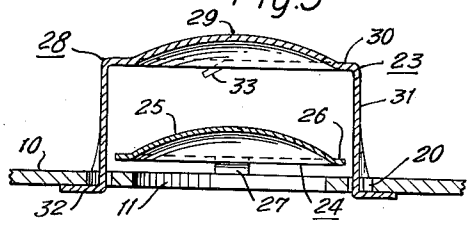


Fig. 4

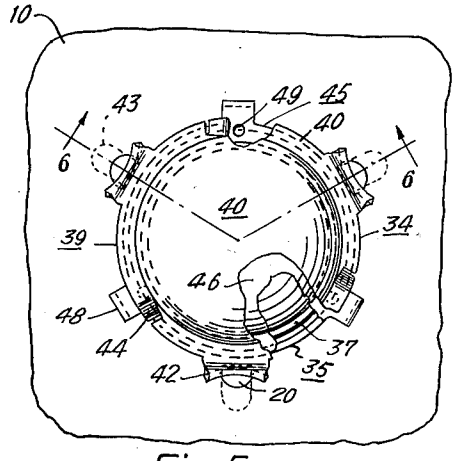


Fig. 5

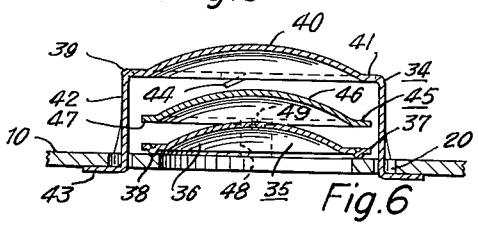


Fig. 6

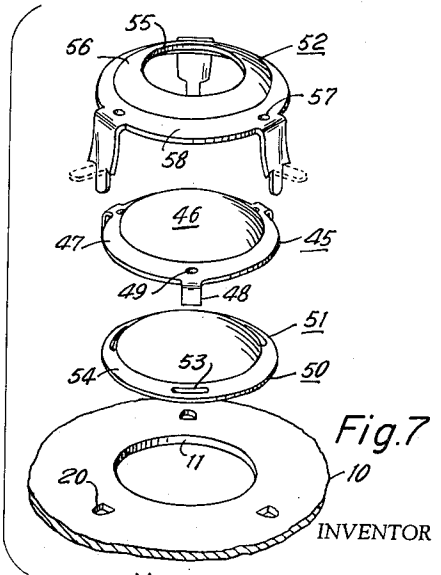


Fig. 7

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June 5, 1962 H. C. GLITSCH 3,037,754

CLOSURES FOR FLUID CONTACT APPARATUS

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2 Sheets-Sheet 2

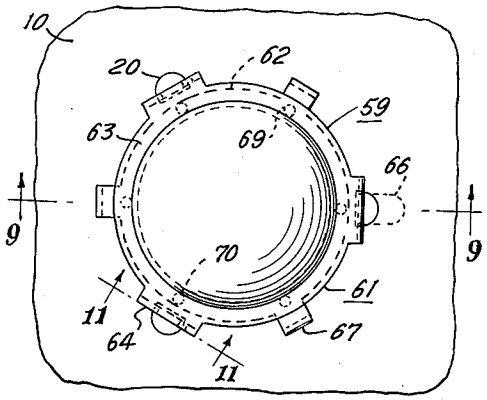


Fig. 8

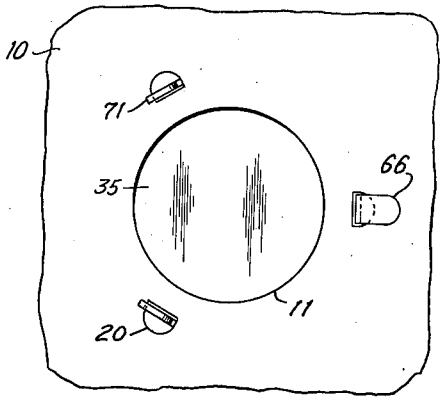


Fig. 12

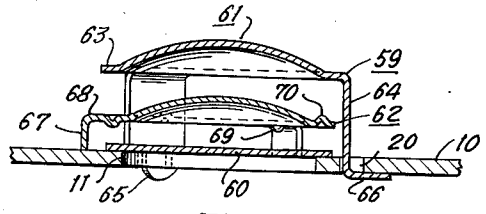


Fig. 9

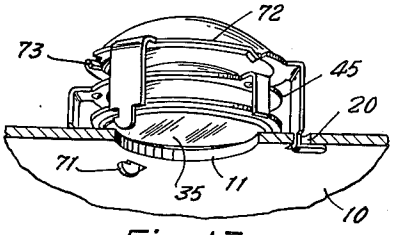


Fig. 13

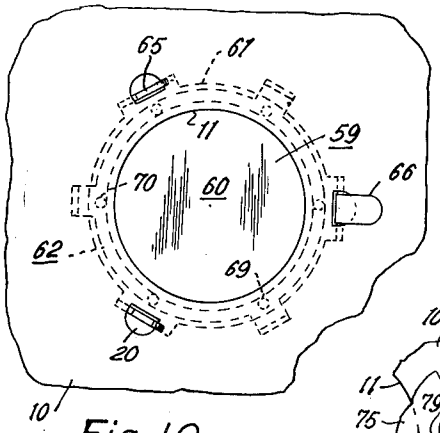


Fig. 10

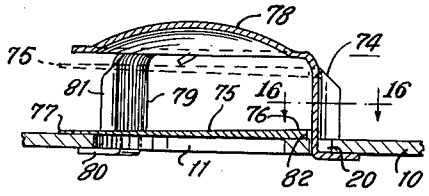


Fig. 14

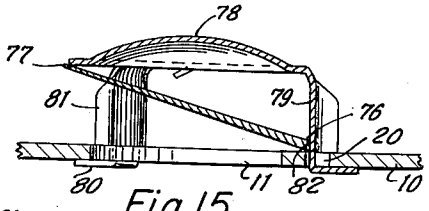


Fig. 15

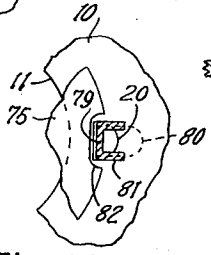


Fig. 16

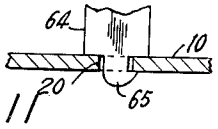


Fig. 11

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United States Patent Office

3,037,754

Patented June 5, 1962

3,037,754

CLOSURES FOR FLUID CONTACT APPARATUS

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Filed Mar. 23, 1959, Ser. No. 801,276
3 Claims. (Cl. 261—114)

This invention relates to new and useful improvements in closures for fluid contact apparatus and more particularly for the vapor orifices of fluid contact trays.

One object of the invention is to provide improved closures for the vapor orifices of fluid contact trays and similar apparatus having means overlying the closures for limiting the lifting of said closures by the pressure of the fluid therebelow so as to control the effective areas of the orifices for accommodating predetermined minimum and maximum fluid flow rates.

Another object of the invention is to provide improved closures, of the character described, wherein each closure includes a cover element overlying one of the orifices and a travel stop detachably connected to the tray to limit the upward travel of said cover element and the area of the flow passage produced by the coaction of the orifice and element, the travel stop being readily removable to permit the characteristics of the tray to be changed in accordance with performance requirements as well as cleaning of the tray and replacement of parts, the construction and/or arrangement of the closures being capable of being altered whenever desired to vary the closed and opened positions of the cover elements and the travel of said elements.

A further object of the invention is to provide improved closures, of the character described, wherein the cover elements may vary in weight, size and/or thickness and the travel stop may vary in length in accordance with desired operating conditions and range of capacities as well as the position and nature of the tray, the variance being between adjacent closures, closures at different portions of the tray and/or from tray to tray.

An important object of the invention is to provide improved closures, of the character described, wherein the cover elements are in the form of relatively thin plates which are light in weight so as to be readily liftable by the ascending fluid but which may range from substantially zero to any practicable weight and some or all of which may seat on the tray for sealing the orifices against the leakage of liquid or some or all of which may be spaced from said tray so as to substantially close the orifices without sealing the same.

A particular object of the invention is to provide improved closures, of the character described, which includes means for limting the movement of some or all of the cover elements to at least two stages or steps whereby said cover elements are lifted initially to provide restricted flow passages of predetermined areas for permitting minimum and maximum rates of flow through the orifices, said elements being lifted additionally to enlarge the areas of the flow passages for accommodating larger minimum and maximum flow rates.

Another object of the invention is to provide improved closures, of the character described, wherein ballast members of uniform or different weights may be associated with some or all of the cover elements for limiting the movement of said elements to at least two stages whereby a predetermined pressure differential above and below the tray lifts said elements into engagement with the ballast members and opens the closures partially to provide restricted flow passages for accommodating minimum and maximum fluid flow rates through the orifices and whereby an increased pressure differential lifts said elements and ballast members and opens said closures additionally or fully to enlarge the areas of the flow passages for accommodating greater minimum and maximum fluid flow rates through the orifices.

An object of the invention is to provide improved closures, of the character described, wherein one edge portion of each or some of the cover elements is of greater weight than its opposite edge portion whereby each element initially is pivoted or rocked about its heavier edge portion as a fulcrum so as to raise its opposite lighter edge portion away from the underlying orifice of the tray and open the closure partially for directing a portion of the ascending fluid laterally to prolong its contact with the liquid on the tray as well as restrict the flow passages of the tray orifices for accommodating predetermined minimum and maximum rates of flow, and whereby an increased pressure differential above and below the tray pivots or rocks the element about its lighter edge portion as a fulcrum so as to lift the heavier edge portion of the element away from the orifice and open said closure fully for accommodating maximum flow rates as well as predetermined minimums.

A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, wherein examples of the invention are shown, and wherein:

FIG. 1 is a plan view, partly in section, of a closure overlying one of the vapor orifices of a fluid contact tray and constructed in accordance with the invention,

FIG. 2 is a transverse, vertical, sectional view, taken on the line 2—2 of FIG. 1,

FIG. 3 is a view, similar to FIG. 1, of a modified closure,

FIG. 4 is a transverse, vertical, sectional view, taken on the line 4—4 of FIG. 3,

FIG. 5 is a view, similar to FIGS. 1 and 3, and partly in section, of a closure having a ballast member,

FIG. 6 is a transverse, vertical, sectional view, taken on the line 6—6 of FIG. 5,

FIG. 7 is a perspective view of the closure shown in FIGS. 5 and 6 removed from the vapor orifice and having a slight modification,

FIG. 8 is a view, similar to FIGS. 1, 3 and 5, of another closure having a ballast member,

FIG. 9 is a transverse, vertical, sectional view, taken on the line 9—9 of FIG. 8,

FIG. 10 is an underside plan view of the closure shown in FIGS. 8 and 9,

FIG. 11 is a transverse, vertical, sectional view, taken on the line 11—11 of FIG. 8, showing the engagement of one of the travel stop legs with the tray,

FIG. 12 is a view, similar to FIG, 10, showing a modified closure and the attachment of its travel stop to the tray,

FIG. 13 is a perspective view, partly in section, of the closure shown in FIG. 12,

FIG. 14 is a transverse, vertical, sectional view of another closure seated on the tray in overlying relation to the vapor orifice, the closure being shown fully opened in broken lines,

FIG. 15 is a view, similar to FIG. 14, showing the closure canted to a partially opened position, and

FIG. 16 is a horizontal, cross-sectional view, taken on the line 16—16 of FIG. 14, showing a portion of the cover plate and one of the travel stop legs.

In the drawings, the numeral 10 designates one of the superimposed decks or trays which extend transversely across the interior of a tower or vessel (not shown) of the type used in petroleum and chemical processes, such as fractionation, absorption and distillation, wherein gas or

vapors and liquids or liquids and liquids are contacted for separation, recovery, refinement or purification. The construction and arrangement of the tower and its trays are shown in greater detail in my copending application, Serial No. 759,803, filed September 8, 1959, and this application relates to an improvement of the closures disclosed therein. Although not shown herein, it is conventional to maintain a desired level of liquid on each tray for contact with ascending gas, vapor or other fluid. The tray **10** has a multiplicity of openings, ports or orifices **11**, which usually are equally spaced and which may be arranged in rows, to accommodate the upward flow of gas into contact with the liquid on said tray (FIG. 2). The orifices **11** may be of any desired contour and may vary in size, being shown as circular. A closure **12** is provided for each orifice to control its flow area in accordance with differentials in pressures across, i.e., above and below, the tray whereby the distribution of the flow of the ascending fluid is substantially uniform to insure intimate contact and thorough mixing of said fluid with the liquid on said tray.

Each closure **12** includes a light-weight, relatively-thin, substantially-flat cover element or plate **13** which is complementary to its orifice **11** and has a slightly greater diameter or dimensions. An annular or circumferential, continuous flange or rim **14** depends axially from the margin of the cover plate **13** for overlying and sealing engagement with the margin of the tray surrounding the orifice. For limiting upward movement of the cover plate, a travel stop **15** overlies said plate and is of slightly greater diameter or dimensions. The travel stop **15** is in the form of a disk or plate which is strengthened by its major portion **16** being dished or concavo-convex and by a narrow, flat perimetrical margin or lip **17**, the convex side of the portion **16** being directed upwardly. A plurality of upright legs or supports **18** depends from the exterior of the lip **17** for resting on the tray **10** to support and space the travel stop above the orifice and its cover plate. Each leg **18** has a lower end portion **19**, in the form of an ear or lug of reduced width, which is adapted to project through an opening **20** in the margin of the tray surrounding the orifice and be bent outwardly into engagement with the underside of said tray for clenching the travel stop thereto. A plurality of lugs or projections **21** are struck from the lip and bent downwardly for engagement by the cover plate to limit upward movement thereof. In addition to preventing adherence of the cover plate due to surface tension, the projections **21** may be bent upwardly or downwardly to permit accurate adjustment of the upward travel of said plate.

Although the length of the legs **18** is subject to variation, said length controls the vertical movement or travel of the cover plate **13** in the open position of the closure. As shown by the numeral **22**, it is preferable to arc or curve the lower portions of the legs transversely so as to minimize the resistance to flow between the cover plate and the margin of the tray surrounding the orifice **11**. It is noted that the openings **20**, which receive the ears **19** of the legs, are semi-circular and have straight portions adjacent the orifice whereby said ears underlie and substantially close the major portions of said openings to minimize leakage. Manifestly, the travel stop confines the closure against displacement without interfering with rotation or turning of the cover plate.

Frequently, it may be essential for the cover plate to seal its underlying orifice **11** by engaging the entire surrounding margin of the tray **10**. In many instances, however, this seal is not necessary and the cover plate may be spaced a slight distance from the tray so as to substantially close the orifice without sealing the same. A modified closure **23** of this type is shown in FIGS. 3 and 4 and includes a cover element or plate **24** having a concavo-convex or dished major portion **23** and a narrow, flat perimetrical margin or lip **26** which are similar to the major portion **16** and lip **17** of the travel stop **15**. In order to minimize the effect of surface tension and facilitate initial opening of the closure **23**, a plurality of upright lugs or projections **27** depends from the exterior of the lip **26** for engaging the tray **10** to space the cover plate **24** from said tray and its orifice. A travel stop **28** overlies the cover plate and includes a similar concavo-convex portion **29**, marginal lip **30**, legs **31**, ears **32** and projections **33** so as to be substantially identical to the travel stop **15**. Although the legs **31** may be of the same length as the legs **18**, said legs **31** have been shown as being of greater length so as to permit a longer travel of the cover plate **24** and a flow passage of larger area through the orifice.

A modified closure **34** is shown in FIGS. 5 and 6 and includes a cover element or plate **35** similar to the cover plate **24** and having a substantially identical concavo-convex major portion **36** and marginal lip **37**. Instead of the plurality of the projections **27**, the cover plate **35** has an annular or circumferential, depending bead or continuous projection **38** concentric to and adjacent the perimeter of its lip **37**. As shown in FIG. 6, the bead **38** is arcuate in cross-section and is adapted to seat on the margin of the tray **10** surrounding the orifice **11** so as to seal said orifice in the same manner as the flanged cover plate **13** while reducing the effect of surface tension in much the same way as the projections **27** of the cover plate **24**. A travel stop **39**, substantially identical to the travel stops **15** and **28**, overlies the cover plate **35** and includes a similar concavo-convex major portion **40**, marginal lip **41**, legs **42**, ears **43** and projections **44**. The legs **42** are shown as being of the same length as the legs **18** but may be of greater or less length. A ballast member **45**, which may be associated with any one of the closures for providing more than one stage of movement as well as prolong the initial contact of the fluid with the liquid on the tray, is adapted to be interposed between the cover plate **35** and travel stop **39** and is in the form of a disk or plate of a diameter or dimensions slightly greater than said cover plate and slightly less than said travel stop. Preferably, the ballast member **45** is complementary to the cover plate and is strengthened by its major portion **46** being concavo-convex or dished upwardly and by a narrow, flat, perimetrical margin or lip **47** which overlies the perimeter of said cover plate. A plurality of upright legs or supports **48**, equally spaced, depends from the exterior of the lip **47** for engaging the tray **10** to space the ballast member from the cover plate. It is noted that the length of the legs **48** may be varied to alter the spacing between the cover plate and ballast member. For minimizing the effect of surface tension, the lip **46** has a plurality of downwardly-directed dimples or projections **49** for engagement with the lip **37** of the cover plate.

In FIG. 7, the ballast member **45** is shown associated with a modified closure **50** which is most similar to the closure **34** and which includes a cover element or plate **51** and travel stop **52**. Instead of the bead **38** of the cover plate **35**, the cover plate **51** has a plurality of downwardly-directed dimples or projections **53** in its marginal lip **54** and elongated circumferentially thereof for spacing the lip from the tray in the same manner as the lugs **27** of the cover plate **24**. An axial opening **55**, of relatively large diameter, may be formed in the dished portion **56** of the travel stop **52** and dimples **57**, similar to the dimples **49** of the ballast member, may be formed in the flat margin **58** of said travel stop to perform the function of the depending projections **21**, **33** and **44**. Otherwise, the closure **50** is identical to the closure **34**.

A more readily removable closure **59** is shown in FIGS. 8–11 and includes a cover element or plate **60**, travel stop **61** and ballast member **62**. For sealing engagement with the margin of the tray **10** surrounding the orifice **11**, the cover plate **60** is relatively thin and substantially flat throughout its area. Although the travel stop **61** is similar to the travel stops **15**, **28** and **39**, its margin or lip **63** and

its upright legs or supports 64 are flat. As shown most clearly in FIG. 11, two of the legs 64 have hook-type lugs or ears 65 on their lower ends for detachable connection with two of the semi-circular openings 20. The lugs 65 are of reduced width and are directed toward the other leg (FIG. 10) which has an ear 66, similar to the ears 19, 32 and 43 of the travel stop legs 18, 31 and 42, for underlying and substantially closing the major portion of the remaining opening 20. Due to this arrangement, the travel stop 61 is readily attachable and detachable by turning the same to engage and disengage its lugs 65 from the openings 20, the ears 66 being engaged first and disengaged last and the legs 64 being sufficiently flexible to permit this insertion and removal. Thus, the cover plate 60 and ballast member 62 may be removed for cleaning or replacement. The ballast member is very similar to the ballast member 45 and has similar upright legs 67 depending from the exterior of its marginal lip 68 for resting on the tray and spacing said member above the cover plate. In order to minimize the effect of surface tension, the lip 68 has a plurality of depending and upstanding dimples or projections 69 and 70 for respective engagement with the cover plate and travel stop lip 63.

As shown by the numeral 71 in FIGS. 12 and 13, the hook-type lugs may extend toward each other and away from the ear 66. The cover element or plate 35 or any of the other cover plates may be substituted for the cover plate 60, while the ballast member 45 may be substituted for the ballast member 62. For limiting upward movement of the ballast member and its adherence to the travel stop due to surface tension, the marginal lip 72 of said travel stop may be provided with depending lugs or projections 73 similar to the projections 21, 33 and 44.

Another closure 74, which provides more than one stage of movement as well as prolongs the initial contact of the fluid with the liquid on the tray 10, is shown in FIGS. 14–16. This modified closure includes a substantially-flat, relatively-thin cover element or plate 75 which is wedge shaped in cross-section so that opposed edge portions or sides 76 and 77 thereof are of different thickness and weight. The upper surface of the cover plate 75 is inclined relative to its underside and converges from the heavier or thicker edge portion 76 toward the lighter or thinner edge portion 77. Since it is lighter in weight than the thicker portion, the thinner edge portion offers less resistance to the pressure of the fluid below the tray and is lifted from engagement therewith by said fluid prior to lifting of said thicker edge portion so as to partially open the orifice 11 and provide a restricted flow passage for accommodating predetermined minimum and maximum rates of flow of the fluid and liquids. A travel stop 78, similar to the travel stops 15, 28 and 39, is provided for confining the cover plate against displacement and has similar upright legs 79 for resting on the tray and similar ears 80 on the legs for extending through and underlying the openings 20. As shown in FIG. 16, the legs 79 are U-shaped in cross-section and have outwardly-directed, substantially parallel flanges 81. For preventing rotation of the cover plate 75 and imparting initial movement to the liquid on the tray in a given direction, such as toward the downstream portion of said tray, said plate has a substantially equal or greater diameter or dimensions than the travel stop 78 so as to extend laterally beyond the inner margins of the legs 79. Suitable recesses 82 are formed in the perimeter of the cover plate to accommodate the legs and prevent interference with the opening and closing movement of said plate.

As shown in FIG. 15, the cover plate 75 pivots or rocks about the heavier edge portion 76 as a fulcrum so as to raise its opposite lighter edge portion 77 away from the tray 10 and its orifice 11. This canting or tilting of the cover plate continues until the lighter edge portion strikes the travel stop 78. When the flow rate of the fluid increases sufficiently to create a pressure drop across the tray in excess of the predetermined maximum of the initial stage, the cover element is pivoted or rocked about its point of engagement with the travel stop as a fulcrum so as to lift the heavier edge portion of the plate away from the orifice and thereby fully open the closure for accommodating maximum flow rates as well as predetermined minimums (FIG. 14).

It is noted that the cover plates are extremely light in weight so as to be capable of being lifted by a predetermined minimum pressure differential across the tray and this weight may range from substantially zero to any practicable amount. When there is insufficient pressure differential across the tray, the cover plates are seated to prevent the excessive leakage of liquid through the orifices 11. Due to the lightness of the cover plates, only a small pressure drop or differential is required to lift the same. It is noted, however, that it may be desirable for the cover plates and/or ballast members to be heavier than the absolute minimum. In the event that the pressure differential becomes insufficient to hold the cover plate open, due to decrease of the fluid flow rate and/or increase of the liquid flow rate, said plates drop or return to their closed or seated positions.

When a ballast member is employed, the initial area of the flow passage provided by the orifice is controlled by the length of the legs of said member and predetermined minimum and maximum rates of flow of the ascending fluid is accommodated by said initial area. The weight of the ballast member is imposed on the underlying cover plate and halts its upward movement until the fluid flow rate exceeds the predetermined maximum. Since the ballast member is supported by its legs, the weight of said member is prevented from assisting the closing movement of the cover plate whereby such movement is not sufficiently sudden to cause the trapping or "pumping" of liquid through the orifice to the tray therebelow. This provides a "cushion" effect which permits a continued upward flow of fluid through a passage of reduced area, under conditions tending to close the orifice, so as to eliminate or minimize the possibility of creating a harmonic pulsation. Since the velocity of the fluid entering the liquid on a tray or the velocity head and the pressure drop or differential across the tray have direct bearings on its efficiency of operation, it is desirable, if not essential, to attain the optimum vapor velocity at the point of contact or mixing of said fluid with said liquid without causing an excessive pressure drop. Accordingly, the cover plate is lifted or opened in stages to provide a flow passage of fixed area which makes possible greater efficiency throughout predetermined ranges of tray capacity.

The ballast member is lifted when the flow rate of the fluid through the orifice 11 increases sufficiently to create a pressure drop across the tray in excess of the predetermined maximum of the initial stage. The cover plate travels upwardly with the ballast member so as to enlarge the area of the flow passage provided by the orifice for accommodating flow rates having a greater minimum and maximum, and the distance of travel and area of said flow passage are regulated by the length of the legs of the travel stop. If desired, one or more additional stages or steps of closure movement may be provided by employing additional ballast members. The cover plate returns to its closed position whenever the pressure drop is insufficient to support the weight of the ballast member. Due to variations in the pressure drop, the cover plate may descend or ascend from one stage to the other but remains in one position through a more or less fixed range of operation to provide the optimum velocity head or velocity of the fluid through the liquid for flow rates within such range. The length of the travel stop legs determines the maximum travel of the cover plate for the desired amount of full opening of the orifice and the calculated maximum flow conditions and the optimum velocity head desired. Of course, the length of the legs of

the ballast member and travel stop controls the stages of movement.

In designing a fluid contact tray for selected operating conditions and range of capacities, the desired number and areas of successive stages of fluid passages can be established by the proper combination of closures, with and/or without ballast members, leg heights, cover plate and ballast member weights and maximum travel permitted by the stops. Manifestly, the weights of the ballast members determine the loads imposed on their respective closures subsequent to initial opening and, with the respective leg heights, contribute to the establishment of a number of stages of flow passage areas throughout the range of capacities of the tray. Since the travel stop and ballast member legs may vary in length to increase or decrease the spacing between the elements of the closure and the extent of stages of movement so as to enlarge or reduce the flow passage areas, it is obvious that said stages and areas need not be of the same magnitude. The closures or any part thereof may be formed of corrosion and/or erosion resistant material regardless of the material of the tray.

The invention facilitates the designing of towers and trays having wide ranges of capacities with respect to fluid and liquid flow rates and these rates may extend from low fluid-high liquid rates to high fluid-low liquid rates. The type of closure, the type, travel and weights of the cover plates, the number and weights of the ballast members, and the spacing of the travel stops and ballast members may vary from orifice to orifice, from location to location on the same tray or from tray to tray as well as from stage to stage of movement of a single closure. It is readily apparent that an infinite number of combinations is possible for obtaining optimum vapor velocities at the point of contact or mixing of the fluid with the liquid on the trays without creating excessive pressure drops across said trays whereby intimate contact and thorough mixing is insured to provide greater efficiency of operation over wider ranges of capacities. It is contemplated that one or more different weights of cover plates and/or ballast members may be employed and that various combinations of weights may be utilized with travel stop and ballast member legs of different lengths. Manifestly, one or more different closures and one or more stages of closure movement may be used in any desired arrangement. Additional total or combined flow passage areas and stages of closure movement may be obtained by employing closures of different types on the same tray. Even when identical, all of the cover plates and ballast members do not function simultaneously or in the same manner. If the tray is not level or has unequal liquid levels or has a portion or portions exposed to greater vapor velocity than another or other portions, some of the cover plates and ballast members are lifted prior to others and some of said cover plates ascend or descend from one stage to another without similar movement by other closures.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. A fluid contact apparatus including a tray for supporting liquid flowing thereacross adapted to be mounted in a vapor-liquid contact vessel, the tray having a multiplicity of circular orifices providing passages for the flow of fluid upwardly through said tray and the liquid supported thereupon, a loosely confined and freely movable circular closure plate overlying each orifice and liftable by a predetermined fluid pressure below said tray, a loosely confined ballast member complementary to and overlying the closure plate and having an annular peripheral portion engageable by the peripheral portion of said plate to limit initial upward movement thereof, the ballast member being movable upwardly with said plate to permit additional lifting thereof when the pressure of the fluid below said tray increases sufficiently, integral legs depending from the periphery of said ballast member and resting on said tray to space said member a predetermined distance above said plate so as to permit independent initial opening and closing movement of said plate, a travel stop complementary to and overlying said ballast member and having an annular peripheral portion engageable by the peripheral portion of said member to limit upward movement thereof with said plate, integral legs depending from the periphery of the travel stop and resting on said tray to space said stop a predetermined distance above said member, the margin of said tray surrounding each orifice having openings therein and lugs of reduced width on the lower ends of the travel stop legs extending through the openings and having laterally directed portions underlying said tray margin so as to connect said stop to said tray, the legs of said ballast member and travel stop being disposed in upright planes at substantially right angles to the periphery of said closure plate, said ballast member legs being disposed between and spaced from said travel stop legs for engagement therewith to limit rotational movement of said ballast member.

2. A fluid contact apparatus as set forth in claim 1 wherein a plurality of equally spaced relatively narrow legs depend from the ballast member and the travel stop.

3. A fluid contact apparatus as set forth in claim 1 wherein at least some of the laterally directed portions of the lugs of the travel stop legs are hook shaped for passing through the openings of the tray and engaging the underside of said tray.

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