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GAS/LIQUID CONTACTING APPARATUS

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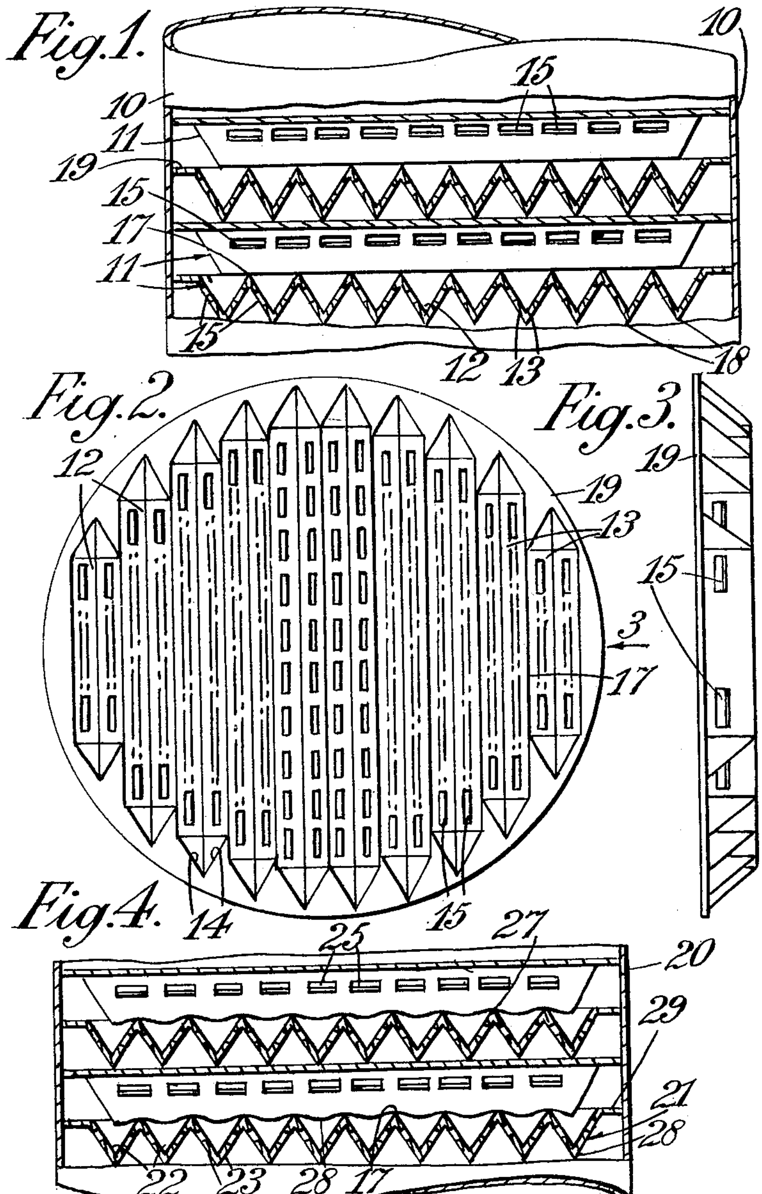

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GAS/LIQUID CONTACTING APPARATUS

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The invention relates to gas/liquid contacting apparatus, and is an improvement in or modification of the invention which is the subject of United States Patent No. 2,885,195.

The invention is concerned with apparatus designed primarily as fractionating apparatus for use in the treatment of mixed gases such as are met with in the manufacture of oxygen by distillation of liquid air, but the apparatus is capable of many other applications.

In United States Patent No. 2,885,195 there is described and claimed a fractionating column comprising a wall or walls (which need not be straight but can be of curved configuration), and a series of superposed partitions within said wall or walls, each succeeding partition extending both upwardly and across the column and being sloped in a different direction to the partition preceding it, and wherein each partition has at least one fluid flow aperture through its upper portion permitting the sinuous upward flow of gas through the column, the part of the partition below said aperture constituting the wall of a liquid-collecting pocket or trough from which liquid flows over the top edge of said pocket or trough wall through the lower portion of said aperture and runs down the underface of the partition as a thin film, on which the gas issuing upwards in a state of turbulent flow from the aperture or apertures in the partition below impinges.

According to the present invention, there is provided a gas/liquid contacting apparatus comprising a column and a plurality of removable, superposed packing elements within the column, each packing element comprising a plate having a plurality of pockets or troughs, and each pocket or trough being provided with at least one fluid flow aperture through the upper portion of its wall or one of its walls, so that liquid can collect in the pockets or troughs and overflow through the lower portions of the apertures, and gas can also pass through the apertures.

Preferably, each plate has a substantially flat rim surrounding the pockets or troughs, the rim being shaped to suit the column so that the plate is a close fit in the column.

In one form of the invention, wherein the column is of circular cross-section, each plate is circular in plan and the troughs are disposed parallel to a diameter of the plate, rows of fluid flow apertures being formed through the upper portions of the longitudinal trough walls.

Two constructions of apparatus in accordance with the invention will now be described by way of example, reference being made to the accompanying drawings in which:

FIGURE 1 is a sectional elevation, part broken away, of one construction;

FIGURE 2 is a plan view of a packing element of the construction shown in FIGURE 1;

FIGURE 3 is a view in the direction of the arrow 3 in FIGURE 2; and

FIGURE 4 is a sectional elevation, part broken away, of the other construction.

Referring firstly to FIGURE 1, the apparatus shown is a fractionating apparatus comprising a column 10 of circular cross-section with a plurality of superposed packing elements or plates 11 (see also FIGURES 2 and 3) disposed within it. The plates 11 are circular in plan, and are a sliding fit in the column 10. Each plate has ten troughs 12 of generally triangular cross-section disposed side-by-side parallel to a diameter of the plate, and each trough extends almost to the periphery of the plate. The troughs 12 give the plate a generally corrugated form, and the corrugated part of the plate is bounded by a flat rim 19 having its upper face in the same plane as the uppermost parts of the upper apices 17 of the corrugations. The upper apices 17 and lower apices 18, considered in the longitudinal direction, are straight. Each trough 12 has longitudinal walls 13 and end walls 14, and the thickness of the trough walls 13, 14 is substantially the same as the thickness of the rim 19. It will be seen that the length of the troughs 12 decreases as their distance from the centre of the plate increases. A row of rectangular fluid flow apertures 15 is formed in the upper portion of each longitudinal trough wall 13, just below the respective upper apex 17 of the corrugations.

The plates are disposed in the column with the corrugations of each plate at right angles to the corrugation of the preceding plate, although it is not essential that the plates should be arranged in this way. The plates are shown in direct contact, with the lower apices 18 of the corrugations of each succeeding plate resting on the upper apices 17 of the plate immediately below it, and this is preferred, but the plates could be separated by spacing rings located between their rims 19. Reflux liquid is supplied to the column through a perforated pipe or a trough (not shown) extending across the column above the uppermost plate 11 and at right angles to the direction of the corrugations of the said plate. Liquid flowing down the column collects in the troughs 12 at each level, overflows through the apertures 15 and runs as a thin film down the undersides of the trough walls, finally dripping and/or draining into the troughs below. Meanwhile, gas passing upwards through the column impinges repeatedly on the liquid films running down the undersides of the trough walls and flows upwards through the apertures 15 at each level. Intimate contact between vapour and liquid is thereby promoted, so facilitating effective fractionation. A gaseous product is withdrawn from the top of the column, and a liquid product is collected at the bottom of the column.

Referring now to FIGURE 4, this shows a fractionating apparatus comprising a column 20 of circular cross-section with a plurality of superposed packing elements or plates 21 disposed within it. The plates 21 are generally similar to the corrugated plates 11 shown in FIGURES 1 to 3, and are disposed in the column with the corrugations of each plate at right angles to the corrugation of the preceding plate. Each plate 21 has a plurality of parallel troughs 22 bounded by a flat rim 29, and rows of rectangular fluid flow apertures 25 are provided in the upper portions of the longitudinal trough walls 23. The upper apices 27 of the corrugations, considered in the longitudinal direction, are straight, like the upper apices 17 of the corrugations of plates 11 (FIGURES 1 to 3), but the lower apices 28 are of shallow wave-form with the same wave-length as the main corrugations. In this construction the elements of plates fit together more rigidly, provided that each plate is arranged with its corrugations at right angles to the corrugations of the preceding plate, and the drainage of liquid running down the undersides of the trough walls is facilitated since most of the down-flowing liquid collects at the lowermost points of the wave-form apices 28 and drips into the troughs below. It will be appreciated that it is not essential for the wave-length of the wave-form apices 28 to be the same as the wave-length of the main corrugations, but the two wave-lengths are preferably the same. Reflux liquid is supplied to the column in the manner described above.

The total area of the fluid flow aperture in each plate is of the order of 30 to 40 percent of the area of the cross-section of the column. The fluid flow apertures are not uniformly distributed on the plates but are concentrated near the apices of the corrugations so that the liquid overflows through them, as aforesaid, and flows as a film down the unperforated lower part of the plate. The flow mechanism throughout for the liquid is a film-type flow and the vapour does not at any point bubble through the liquid. The orientation of the fluid flow apertures causes the gas to flow with a definite pattern and to impinge upon the liquid film produced by the packing.

The constructions described may be modified by making the apertures **15**, **25** of some convenient form other than rectangular. Moreover, the trough walls **13**, **23** may be provided, at or just below the lower edges of some or all of the apertures **15**, **25** respectively, with subsidiary openings adapted to permit local increases in the liquid flow from the troughs down the undersides of the trough walls, as described and claimed in co-pending patent application Ser. No. 720,369. The subsidiary openings may comprise notches or serrations in the lower edges of the apertures **15**, **25**. If desired, additional fine holes may be provided at or near the bottoms of the troughs **12**, **22** to allow the fractionating apparatus to be drained. Furthermore, the plates can conveniently be made with the upper face of the rim in a plane slightly below the uppermost parts of the upper apices of the corrugations. If the plates are of large diameter the troughs could, if desired, be interrupted in order to make levelling of the fractionating column less critical.

The columns and packing elements described may be made of any suitable material such as metal, glass, or a synthetic plastic material, and the elements may be formed by any convenient method such as pressing or moulding. The packed columns are suitable for normal distillation operations over a wide temperature range and with many different fluids. Moreover the constructions described can be employed for any gas-liquid contacting operation, such as gas absorption or scrubbing, and their use is not restricted to fractionating apparatus. The packing elements can be readily removed from the column for cleaning. The shape of the elements is chosen to suit the column in which they are to be used, and although the plates in the examples given are circular, they could alternatively be rectangular (e.g. square) or of any other convenient shape.

I claim:

1. A gas/liquid contacting apparatus comprising a column and a multiplicity of removable, superposed packing elements within the column, each packing element comprising a plate having a plurality of elongated depressions formed in it providing liquid collecting troughs, each trough being provided with a series of substantially horizontally aligned flow apertures through the upper portion of its wall, the lower edges of the apertures being spaced upwardly from the bottom of the depression and each of said apertures being of such a size that, in flowing down the column, liquid overflows from each trough through the lower part of each aperture and, in flowing up the column, gas passes through the upper part of the aperture to impinge against liquid films on the underside of the next superposed plate.

2. A gas/liquid contacting apparatus comprising a column and a multiplicity of removable, superposed packing elements within the column, each packing element comprising a unitary insert formed of fluid-impervious sheet material, comprising a flat margin extending around the whole periphery of the insert and having a plurality of depressions formed in it within the compass of the margin providing liquid collecting troughs, and each trough being provided with a series of substantially horizontal flow apertures through the upper portion of its wall, the lower edges of the apertures being spaced upwardly from the bottom of the depression and each of said apertures being of such a size that, in flowing down the column, liquid overflows from each trough through the lower part of each aperture and, in flowing up the column, gas passes through the upper part of the aperture to impinge against liquid films on the underside of the next superposed insert.

3. A gas/liquid contacting apparatus comprising a column and a plurality of removable, superposed packing elements within the column, each packing element being provided as a unitary insert formed of fluid-impervious sheet material and comprising a plurality of open-topped liquid-collecting troughs formed by deforming portions of the sheet out of the initial plane of the sheet, the rim of each of said troughs being spaced away from the periphery of said insert so that the deformed portion of the sheet provides the entire bounding wall of the trough, the wall of each trough being provided with a series of substantially horizontal flow apertures through the upper portion of its wall, the lower edges of the apertures being spaced upwardly from the bottom of the depressions and each of said apertures being of such a size that, in flowing down the column, liquid overflows from each trough through the lower part of each aperture and, in flowing up the column, gas passes through the upper part of the aperture to impinge against liquid films on the underside of the next superposed insert.

4. A gas/liquid contacting apparatus comprising a column and a plurality of removable, superposed packing elements within the column, each packing element being provided as a unitary insert formed of fluid impervious sheet material and comprising a plurality of open-topped elongated parallel, liquid-collecting troughs formed by deforming portions of a sheet out of the initial plane of the sheet, the wall of each trough being provided with a series of substantially horizontal flow apertures through the upper portion of its wall, the lower edges of the apertures being spaced upwardly from the bottom of the depressions and each of said apertures being of such size that, in flowing down the column, liquid overflows from each trough through the lower part of each aperture and, in flowing up the column, gas passes through the upper part of the aperture to impinge against the liquid films on the underside of the next superposed insert, said inserts being stacked so that the lengths of the troughs in one insert extend in a transverse direction to the lengths of the troughs in the next consecutive insert.

5. A gas/liquid contacting apparatus as claimed in claim 4, in which said inserts are stacked in contact with one another, the deformed portions of one insert engaging against the undeformed portions of the next preceding insert.

6. A gas/liquid contacting apparatus comprising a column and a plurality of removable, superposed packing elements within the column, each packing element comprising a plate having a flat margin extending around the whole periphery and having the portion within its margin corrugated to form a series of liquid collecting troughs, the end portions of the corrugations being tapered in width and depth to form closed ends for the troughs, the walls of the corrugations being apertured adjacent the upper apices of the corrugations to provide fluid flow apertures through the upper portions of the walls of the troughs, the lower edges of the apertures being spaced upwardly from the lower apices of the corrugations and each of said apertures being of such a size that, in flowing down the column, liquid overflows from each trough through the lower part of an aforesaid aperture and, in flowing up the column, gas passes through the upper part of the aperture.

7. Apparatus as claimed in claim 1, in which each plate has a substantially flat rim surrounding the troughs, the rim being shaped to suit the column so that the plate is a close fit in the column.

8. Apparatus as claimed in claim 1, in which the col-

umn is of circular cross section, each plate is circular in plan and the troughs are disposed parallel to the diameter of the plate, said series of fluid flow apertures being formed through the upper portion of the longitudinal trough walls.

9. Apparatus as claimed in claim 1, in which the total area of the fluid flow apertures of each plate is between 30 and 40 percent of the area of the cross-section of the column.

10. Apparatus as claimed in claim 1, in which the plates are in contact with each other.

11. Apparatus as claimed in claim 1, in which the orientation of the fluid flow apertures directs the gas

to impinge on the liquid film on the underside of the plate above.

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