PATENT SPECIFICATION

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(19)

(54) ORIENTATED PACKING MEMBERS FOR MASS TRANSFER COLUMNS

(71) We, SULZER BROTHERS LIMITED, a Company organised under the laws of Switzerland, of Winterthur, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to orientated packing members for mass transfer columns, the members comprising corrugated plates which contact one another and which are when in use, disposed parallel to the column axis, the plates being so disposed that the corrugations of adjacent plates cross one another, the plates being formed with rows of spaced orifices which, when in use, extend transversely of the column axis.

Such packing members are used in mass transfer columns used for rectification, absorption, extraction and the performance of chemical reactions, such as the separation of isotope elements from a substance by a chemical exchange reaction, e.g. the separation of deuterium from hydrogen.

The plates can be made of metal, such as stainless steel, or of plastics or of a self-wetting woven or knitted fabric.

Hitherto, the plates constituting such orientated packing members have been cut to size from pieces of strip material and have been apertured before being corrugated so that the plain—i.e. uncorrugated—strips are formed with a number of rows of spaced orifices, the rows being distributed over the strip width, the orifices in adjacent rows also being disposed in orifice rows which extend perpendicularly to the strip axis. The reasons for the presence of the orifices are improved gas exchange over the cross-section of the packing member and reduction of the pressure drop along the column axis.

Other kinds of orifice arrangements have been proposed for trickle packings having vertical trickle surfaces. For instance, adjacent rows of orifices may be offset from one another by half the between-orifices spacing lengthwise of the strip. As will be described hereinafter, this orifice arrangement probably improves the spreading-out of the liquid.

When the strips are corrugated with the axes of the corrugations inclined to the edges of the strips the orifice rows which in the uncorrugated strip were disposed perpendicularly to the strip axis become inclined thereto. Consequently, with the corrugated strip positioned vertically, the orifices of any row are at a horizontal offset from the orifices of the adjacent row.

This feature makes this form of perforation seem very advantageous, for if the orifices are arranged in the "plain" strip in any other way, it would seem that the orifices may finish up after corrugation in rows which extend vertically of the column axis.

Unfortunately, it has been found that with such packing members the liquid phase descending the column is not satisfactorily distributed over the plate surfaces. When a "plain" vertical strip has rows of orifices perpendicular to the length of the strip, the liquid tends to become channelled into paths of descent extending between the vertically superjacent orifices of the rows, for the liquid descends without hindrance in such paths along the vertical lines of dip (i.e. lines of maximum gradient) and fails to spread out laterally. When the strips are formed with inclined corrugations—i.e., when the strips are converted into the plates which will be disposed parallel to the column axis—the orifice rows which extended vertically in the "plain" strip are at an inclination to the column axis; hence it has previously been assumed that the liquid spreads out laterally over the plate surface since the originally vertically superjacent orifices of adjacent rows are offset from one another in the corrugated plate. Unfortunately, it has been revealed in practice that such is not the case, and it has now been discovered that the circumstances involved in the formation of free paths of descent causing unwanted channelling of the liquid remain the same even after the plates have been formed with their inclined corrugations. The lines of dip which extend vertically in the "plain" strip follow the direction of the channel flank planes in the corrugated plates. Consequently, the inclination of the lines of dip in projection on a plane parallel to the plate is the same as that of the vertical rows of orifices in the "plain" strip. The flow relationships of the liquid are therefore the same in both cases. This state of affairs will be referred to again hereinafter with reference to an example shown in the drawings.

It is an object of the invention to improve the lateral spreading-out of the liquid supplied to the entry cross-section of the packing member by an appropriate construction of the plates — i.e., it is an object of the invention to reduce channelling effects and to enable liquid to spread out laterally over the plate surfaces to ensure good uniformity of wetting. Of course, for practical reasons it is impossible to have uniform distribution of the liquid over the top edge of all the plates right from the beginning. Also, it must always be borne in mind that random disturbances may cause the liquid to recombine and form relatively large rivulets or streams or the like.

According to one aspect of the present invention, an orientated packing member for a mass transfer column comprises substantially planar corrugated plates which contact one another and which are, when in use, disposed parallel to the column axis with the corrugations of the plates being at an inclination to the column axis, adjacent plates being so disposed that their corrugations are transverse to one another, the plates being formed with rows of spaced orifices which, when in use, extend transversely of the column axis and which are so located that if the corrugations in the plates were flattened the orifices of vertically adjacent orifice rows would be so staggered relative to one another that the dip path extending between any two orifices of an upper row encounters orifices in the row immediately below.

According to another aspect, a mass transfer column includes a plurality of packing members according to the first aspect, the plates being parallel to the column axis and the corrugations of the plates being inclined to the column axis.

Preferably, the liquid should not flood over the orifices, and so orifice diameters of between 2mm and 6mm are thought to be satisfactory.

Preferably, if the corrugations in the plates were flattened, orifices of vertically adjacent rows would be offset from one another by an interval greater than the diameter of a single orifice. Very advantageously, each orifice (other than the end orifices) of each row except the top row would be located symmetrically between and below two orifices in the row immediately below.

Because of the manner in which the orifices are arranged in accordance with the invention in the flattened plate, orifices of rows disposed below the rows above are always located in the paths of descent. Consequently, there is a lateral deflection of the liquid at the edges of the orifices concerned even on a "plain" vertical plate. As previously explained, these flow circumstances remain the same even after a plate has been formed with inclined corrugations—i.e., a satisfactory lateral spreading-out of the liquid over the surfaces of the plates forming the packing member is achieved.

To achieve the effect obtained by the invention it is not necessary for all the orifices to be of the same diameter or for the vertical interval between vertically adjacent orifice rows to be everywhere the same.

As experiments have shown, it is advantageous for the total perforate area of a plate to be of the order of from 5% to 20% of the imperforate plate area to provide an adequately large wetted surface on which effective mass transfer depends.

To make very sure that there is substantially no risk of the liquid being channelled along the channel troughs as a result of possible capillary action in the troughs, it is advantageous for the between-orifice spacings of the orifice rows which extend transversely of the column axis not to be in a simple relationship to the pitch of the channelling—i.e., for the quotient of such spacing to such pitch not to be 1, 2, 3 and so on, for it then becomes certain that a number of the orifices which are disposed in a statistical distribution over the plate surface are always near the channel troughs.

The invention may be carried into practice in various ways but one packing member according to the invention, one of the plates of the member, the strip from which the plate is formed, and a mass transfer column comprising a number of packing members according to the invention will now be described by way of example with reference to the accompanying drawings. The description will be preceded by a description of a previously proposed strip and a plate made therefrom. In the drawings:

Figure 1*a* is an elevation in diagrammatic form of a strip showing the previously proposed arrangement of orifices;

Figure 1*b* is an elevation of the strip after corrugation;

Figure 1*c* is a longitudinal section of the strip on the line 1*c*—1*c* in Figure 1*b*;

Figures 2*a*, 2*b* and 2*c* are similar views of a strip having orifices arranged according to the invention;

Figure 3 is a diagrammatic perspective and exploded view of the plates of a packing member; and

Figure 4 shows part of a mass transfer column comprising three orientated packing members.

The portion shown in Figure 1*a* of a conventionally perforated strip 1 is formed with vertically associated rows of orifices 2; if the strip is regarded as a vertically upright unchannelled or "plain" plate, the orifices of adjacent rows are in vertical alignment, the orifices of the horizontal rows being disposed at equidistant intervals *a*. As the drawings show, vertical dip paths *s* arise between the orifices along the lines of dip *f* (i.e. lines of maximum gradient) and the liquid can descend in the paths *s* unhindered and without spreading out laterally. Therefore, the zones between vertically adjacent orifices remain at least substantially unwetted.

Figures 1*b* and 1*c* show a portion 1′ of a plate formed from the "plain" strip 1 shown in Figure 1*a*, the plate having corrugations 3 which are at an inclination to the vertical and which have a horizontal pitch *w*. As can be gathered from Figure 1*b*, the flow conditions on the corrugated plate 1′ remain similar to those for the "plain" strip 1—i.e., although the lines of dip *f*′ of Figure 1*b* are at an angle to the vertical, paths of descent *s* occur beween the orifices while between these paths there are zones containing the orifices.

Figure 2*a* shows, in a view similar to Figure 1*a*, a perforated strip which may be used to make a packing member in accordance with the invention. By contrast with the strip shown in Figure 1*a*, the orifices of each horizontal row are staggered with respect to the orifices of the rows below and above. The use of a strip 4 which has been perforated in this way reduces or avoids the continuous paths of descent *s* shown in Figures 1*a* and 1*b* since in the paths of descent disposed between any two orifices 5 of any upper row, there are orifices of lower rows. The flowing liquid undergoes lateral deflection at the orifice edges, as indicated by arrows, and spreads out over the imperforate surface of the strip.

Since the flow conditions remain similar after the strip has been formed with inclined corrugations, the surface of the corrugated plate 4′ is wetted completely or almost completely. In the embodiment shown in Figures 2*a* and 2*b* the corrugations have the same inclination and pitch as the corrugations 3′ of Figures 1*b* and 1*c*.

Figure 3 shows an orientated packing member 7 made from plates 4′ of the construction shown in Figures 2*b* and 2*c*; the plates 4′ are shown separated but in the sequence in which they will subsequently be brought together and combined to form a packing member 7 which has a flat circular top and bottom and a circular cylindrical outer periphery. The packing member 7 is introduced into the mass transfer section of a cylindrical column. Figure 3 makes clear the fact that the various plates differ in size, plate size so increasing from the two outsides towards the centre that the plates when brought together form a cylindrical member.

Figure 4 shows a portion 8 of the mass transfer part of a column in which there are three packing members 7 each having the planes of its plates at a 90° offset from the planes of the plates of the adjacent member or members. The plates can be made of sheet metal, for example.

WHAT WE CLAIM IS:—

1. An orientated packing member for a mass transfer column, the member comprising corrugated substantially planar plates which contact one another and whose planes are, when in use, disposed parallel to the column axis with the corrugations of the plates being at an inclination to the column axis, adjacent plates being so disposed that their corrugations are transverse to one another, the plates being formed with rows of spaced orifices which, when in use, extend transversely of the column axis and which are so located that if the corrugations in the plates were flattened the orifices of vertically adjacent orifice rows would be so staggered relative to one another that the dip path extending between any two orifices of an upper row encounters orifices in the row immediately below.

2. A packing member as claimed in Claim 1 in which, if the corrugations in the plates were flattened, orifices of vertically adjacent rows would be offset from one another by an interval greater than the diameter of a single orifice.

3. A packing member as claimed in Claim 2 in which, if the corrugations in the plates were flattened, each orifice (other than the end orifices) of each row except the top row would be located symmetrically between and below two orifices in the row immediately below.

4. A packing member substantially as described herein with reference to Figures 2*a*, 2*b*, 2*c* and 3 of the accompanying drawings.

5. A mass transfer column including a plurality of packing members each as claimed in any of the preceding claims, the plates being parallel to the column axis and the corrugations of the plates being inclined to the column axis.

6. A column as claimed in Claim 5 in which the plates of vertically adjacent packing members are offset relative to one another about vertical axes.

7. A mass transfer column substantially as described herein with reference to Figures 2*a*, 2*b*, 2*c*, 3 and 4 of the accompanying drawings.

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Fig. 1a

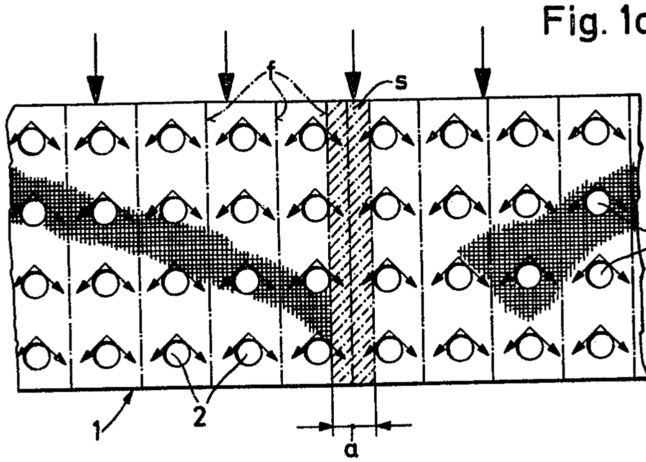


Fig. 1b

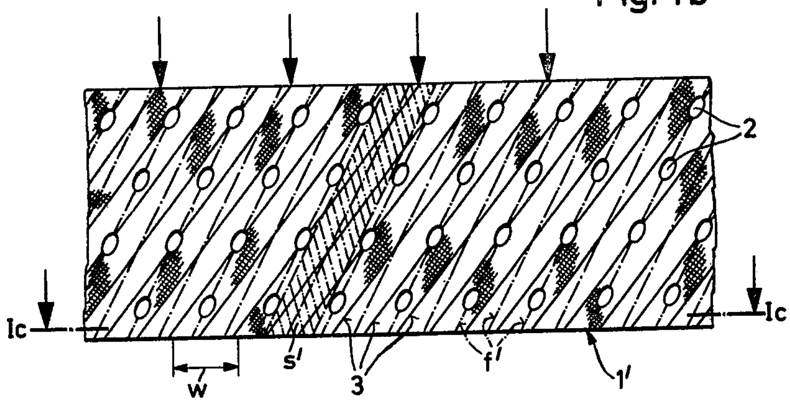


Fig. 1c

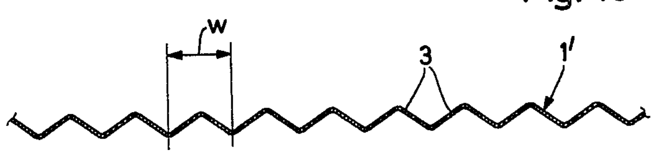


Fig. 2a

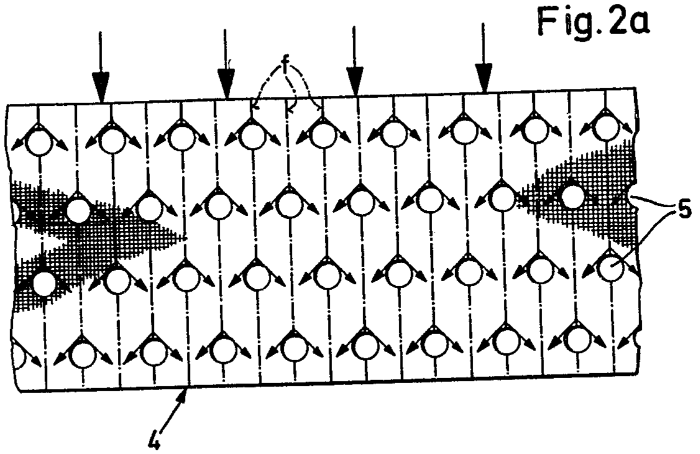


Fig. 2b

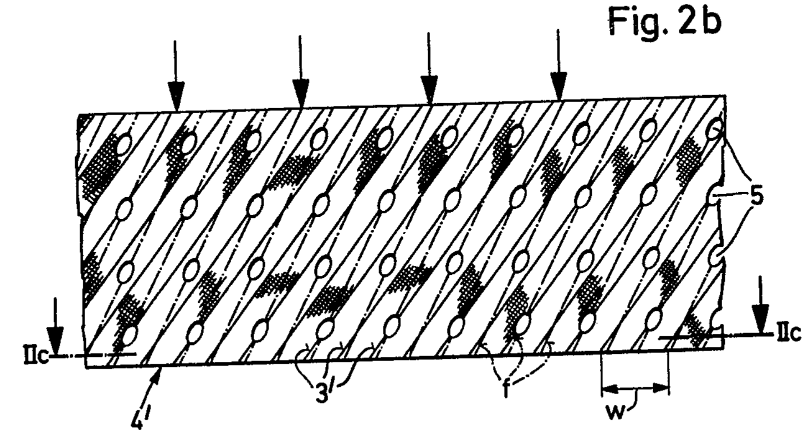
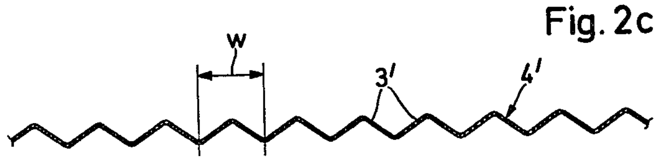


Fig. 2c



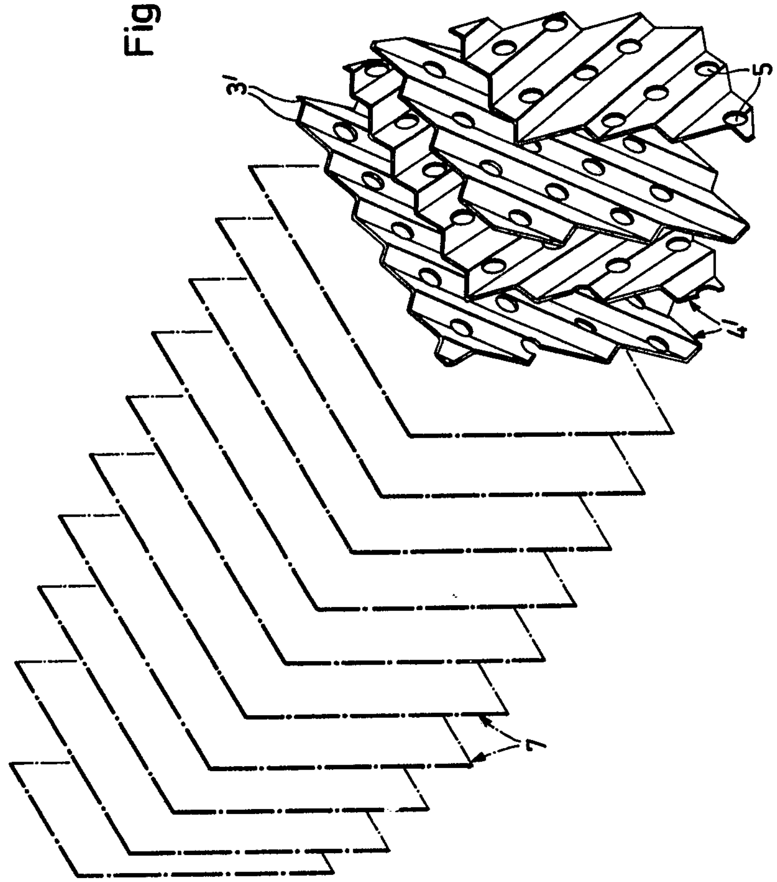


Fig. 3

Fig. 4