

April 11, 1967

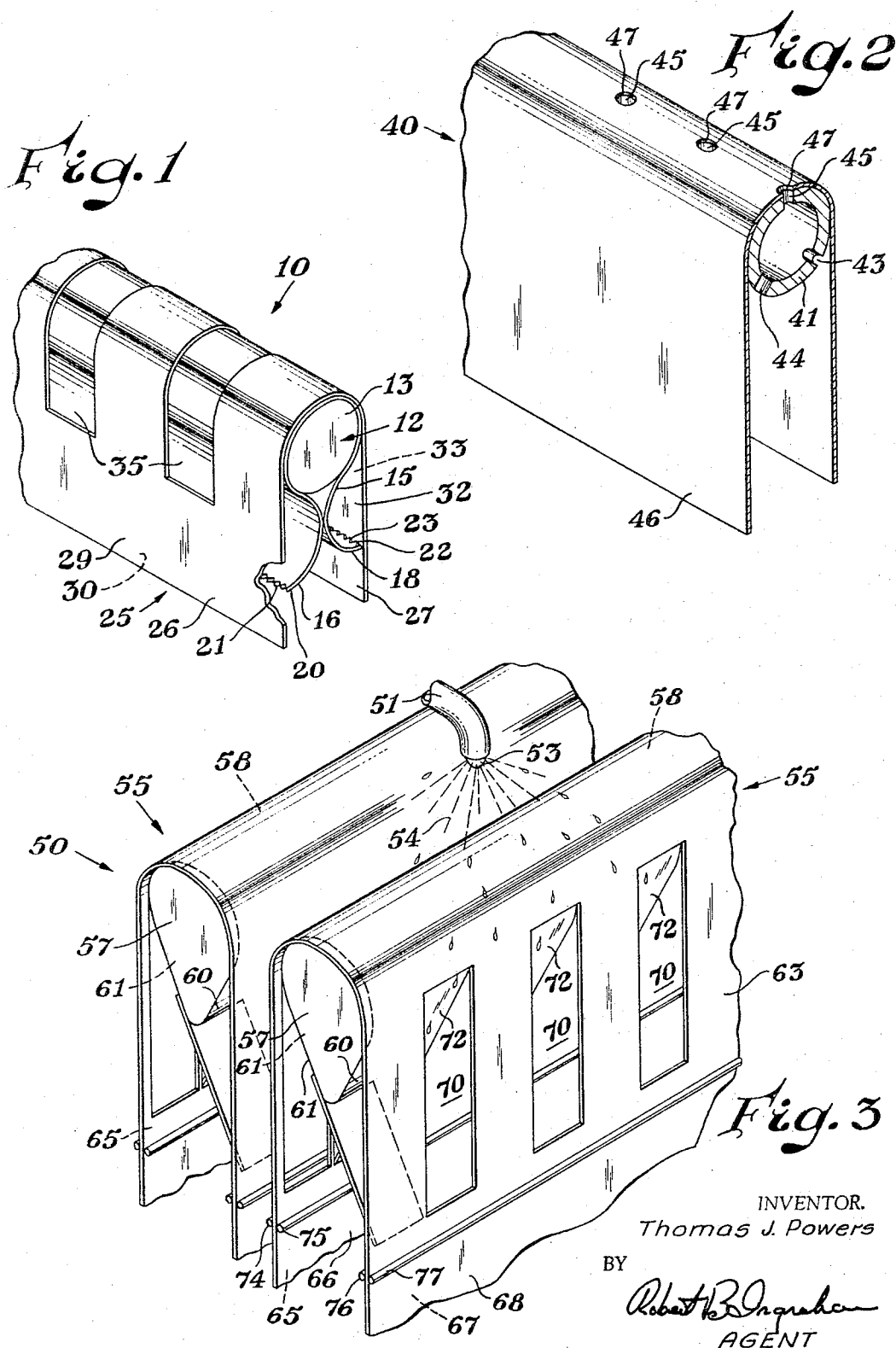
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3,313,533

GAS-LIQUID CONTACT APPARATUS HAVING SHEET LIKE-SURFACES

Filed Sept. 12, 1963

2 Sheets-Sheet 1



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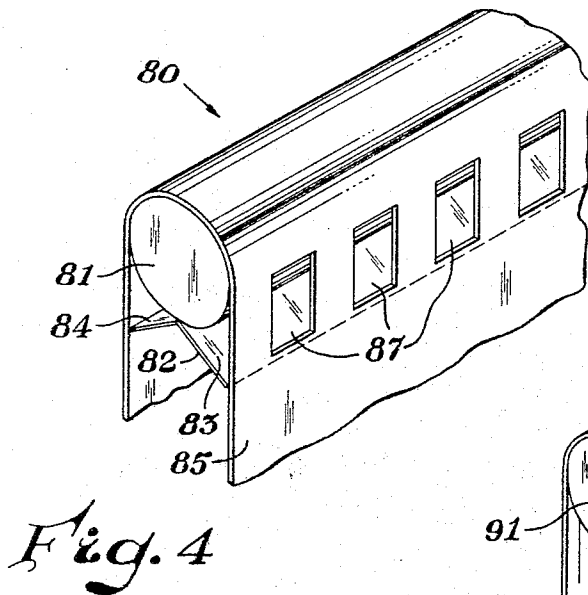
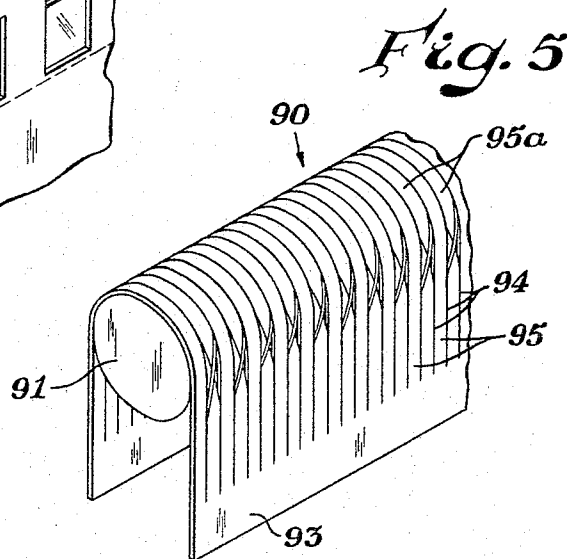
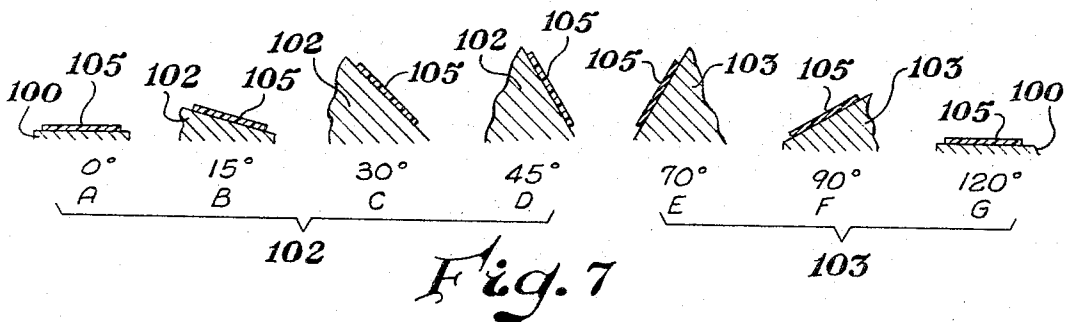
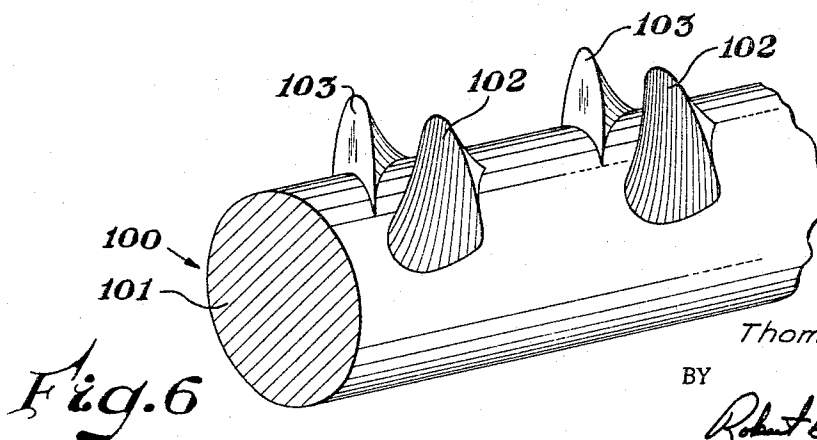
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2 Sheets-Sheet 2



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3,313,533

GAS-LIQUID CONTACT APPARATUS HAVING SHEET-LIKE SURFACES

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4 Claims. (Cl. 261—103)

This invention relates to gas-liquid contact apparatus. It more particularly relates to gas-liquid contact surfaces.

Gas-liquid contact apparatus using sheet-like surfaces has been used for a number of purposes including distillation, biological oxidation, cooling, and the like. Generally, such sheets are hung from a support and the liquid is introduced in such a manner that it runs down on either side and contacts the gas in the spaces between the sheets. This technique of hanging sheets requires that each sheet be provided with a separate support. The separate support generally is costly and adds considerably to the investment in the installation and to the labor of preparing such an apparatus.

It is an object of this invention to support sheets in a gas-liquid contact apparatus using a minimum number of supports.

It is a further object of this invention to provide an improved gas-liquid contact apparatus in which a possible free fall of a liquid is minimized.

It is a further object of this invention to provide an improved support for sheets in a gas-liquid contact apparatus.

These objects and other benefits and advantages in accordance with the present invention are achieved by providing a support member, the support member carrying a sheet adapted for gas-liquid contact purposes, said sheet hanging on either side of the elongated support and means provided to contact the liquid with both sides of the sheet.

Further features and advantages of the present invention will become more apparent from the following specification when taken in connection with the drawing wherein:

FIGURE 1 depicts one embodiment of the sheet hung in accordance with the invention;

FIGURE 2 depicts an alternate mode of supporting a sheet;

FIGURE 3 is a schematic representation of a plurality of sheets supported within a gas-liquid contact apparatus;

FIGURE 4 is an alternate method of supporting sheets;

FIGURE 5 is an alternate embodiment of a sheet hung in accordance with the invention; and

FIGURE 6 is a device for the rigid installation of sheets such as are shown in FIGURE 5.

In FIGURE 1 there is schematically illustrated a portion of a support and sheet assembly generally designated by the reference numeral 10. The assembly 10 comprises a support 12. The support 12 consists of an elongated body portion 13 having dependent therefrom a distributor 15. The distributor 15 comprises two lip-like members 16 and 18 which are downwardly and outwardly depending from the body 13. The distributor member terminates in an outer edge 20 which is provided with a plurality of protrusions 21. Similarly, the distributor 18 terminates in an edge 22 and having a plurality of protrusions 23. Carried by the support assembly 12 is a draped sheet 25. The sheet 25 has two generally equal and dependent portions 26 and 27. The portion 26 has an outer surface 29 and an inner surface 30. The portion 27 has an inner surface 32 and an outer surface 33. Within the body of the sheet generally centrally disposed are formed a plurality of openings 35. The openings 35 provide access to the inner surface of the sheet adjacent

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the support assembly 12. In operation of the embodiment in accordance with FIGURE 1, a liquid is distributed to the sheet assembly by spraying, trickling, or pouring the liquid onto the central portion of the sheet overlying the support member 12. A portion of the liquid by gravity will be forced to run down the outer surfaces 29 and 33 while a portion of the liquid will enter the apertures 35 and contact the distributor lips 16 and 18. The liquid will then flow towards the edges 20 and 22 and will be distributed on the inner surfaces by means of the teeth or serrations 21 and 23.

FIGURE 2 depicts an alternate embodiment of the invention generally designated by the reference numeral 40. The embodiment 40 comprises a support member 41. The support member 41 is comprised of a hollow conduit having formed in the wall thereof a plurality of apertures 43, 44 and 45. The apertures 43 and 44 are downwardly and outwardly directed whereas the apertures 45 are upwardly directed. Over the support member 41 is draped a sheet 46. Within the sheet 46 are formed a plurality of openings 47. The openings 47 are so arranged as to provide communication between the openings 45 and the outer surfaces of the sheet 46. Beneficially, the support member 41 is prevented from sagging by the vertical column not shown. In operation of the embodiment of FIGURE 2, the liquid to be contacted with the gas is continuously forced into conduit 41 and out of the apertures 43 and 44 to contact the inner surface of the sheet 46 and out of the apertures 45 through the aperture 47 in the sheet 46 to contact the outer surface of the sheet 46.

In FIGURE 3 there is illustrated a fractional fragmentary view of a gas-liquid contact apparatus in accordance with the present invention. The apparatus is generally designated by the reference numeral 50 and comprises a liquid distributing means 51. The distributing means 51 is provided with a nozzle 53 from which there is flowing a liquid 54. A plurality of like gas-liquid contact elements 55 are provided beneath the distributor 51. The elements 55 comprise an elongated support means 57. The support means 57 has an upper curved surface 58 and lower sloping surfaces 60 and 61. A sheet 63 is supported on the support means 57. The sheet 63 has 4 gas-liquid contact surfaces, 65, 66, 67 and 68. A plurality of apertures 70 are provided in the sheet 63 generally adjacent the support member 57. The apertures 70 are alternately disposed in staggered relationship along the support member. Each of the apertures 70 is provided with a dependent surface 72 which connects the upper portion of the aperture 70 to the inner surface of the opposite portion of the sheet and provides a path for a liquid to travel. The sheet 63 is provided with four beads or distributors. A bead or ridge 74 disposed on the surface 65, bead 75 on the surface 66, a bead 76 on the surface 67 and a bead 77 on the surface 68. The beads 74, 75, 76 and 77 are generally below and adjacent to the openings 70. They provide a means of assuring even hydraulic distribution of the flowing liquid over the respective surfaces to which they are attached. In operation of the embodiment of FIGURE 3, the liquid 54 is distributed onto a plurality of assemblies 55 wherein a portion of the liquid striking the uppermost surfaces flows down the outside surfaces, that is, the surfaces 65 and 68, whereas the liquid entering the apertures 70 and following the deflecting surfaces 72 is transferred and distributed on the inner surfaces 66 and 67.

In FIGURE 4 there is illustrated a schematic representation of an alternate embodiment of the invention generally designated by the reference numeral 80. The assembly 80 comprises a support member 81 having affixed to its lower surface a generally V-shaped deflection plate 82. The deflection plate 82 provides downwardly

sloping deflection surfaces 83 and 84. The surfaces 83 and 84 terminate adjacent a sheet 85 which is supported by the support bar 81. The sheet 85 is provided with a plurality of apertures 87 which are disposed generally adjacent the uppermost portion of the support bar 81 and permit a liquid falling on the portion of the sheet 85 in contact with the bar 81 to enter the apertures 87 follow the surface of the support bar 81 and contact the distributing surfaces 83 and 84 which deflect the liquid onto the inner opposed surfaces of the sheet 85.

In FIGURE 5 there is illustrated an alternate embodiment of the invention generally designated by the reference numeral 90. The embodiment 90 comprises a support bar 91 and a sheet 93. Centrally disposed within the sheet 93 are a plurality of slits 94 formed in such a manner that they are substantially normal to the direction of the support bar 91. The presence of the slits 94 generates a plurality of ribbons 95 and 95a. The ribbons 95 pass over the support bar and join the dependent portions of the sheet. The ribbons 95a are similarly disposed with the exception that the original outer surface of the ribbon has been placed against the bar and the original inner surface is now uppermost, i.e., the ribbons have been twisted about 180°. Thus, a liquid falling on the exposed upwardly facing surface of the sheet on the support bar follows the ribbons 95 and 95a. The exposed surface of the ribbons 95 leads the liquid to the outer surfaces of the sheet 93 and the ribbons 95a lead the liquid to the inner surface of the sheet 93.

In FIGURE 6 there is illustrated a portion of an installation bar for the embodiment of FIGURE 5. The installation bar 100 comprises an elongated body portion 101 having disposed on its surfaces in closely adjacent pairs flights 102 and 103. The multiplicity of flights 102 and 103 are in identical radial alignment with each other and are spaced in such a manner as to engage the alternate ribbons in a sheet cut as illustrated in FIGURE 5.

FIGURE 7 depicts a plurality of cross sectional views of the flights 102 and 103 as the rod 100 of FIGURE 6 is rotated illustrating the manner in which a ribbon 105 is twisted into the configuration shown in FIGURE 5.

Section A illustrates a portion of one of the ribbons 105 in contact with the generally cylindrical surface of the bar 100 which for purposes of reference may be considered to have been rotating 0°.

Section B shows the flight 102 engaging the film 105 and raising one edge thereof after the rod 100 has been rotated about 15°.

Section C depicts the 30° rotation of the rod wherein the flight 102 has raised one edge of the ribbon 105 to a relatively steep angular position relative to the rod 100.

Section D depicts the configuration of flight 102 when 45° rotation of the rod 100 has occurred and the ribbon 105 is almost vertical with respect to the surface of the rod. Further rotation of the rod results in the transfer of the ribbon 105 to the flight 103 wherein the ribbon 105 has now been twisted or turned through an angle greater than 90° as shown in section E.

Section F depicts a cross section throughout the flight 103 after the rod has been rotated about 90° whereas section G illustrates the configuration of the flight and the ribbon after a rotation of about 120°. In this position, the ribbon 105 has been rotated about 180° from its original position as shown in section A.

In the practice of the present invention, the embodiment illustrated in FIGURE 1 is particularly advantageous wherein particularly long spans are required and the added stiffening of the distributor plate is required. Further, this embodiment permits the ready positioning of the sheet on the support without the necessity of separate ties.

The embodiment illustrated in FIGURE 2 is particularly advantageous for use in applications where the ultimate simplicity in construction is required and little

growth will occur on the sheet or deposits form within the distributor head. Further, by the use of the vertical supports, long spans are readily bridged.

FIGURE 3 represents an arrangement wherein the maximum rigidity of the sheet is provided and also extremely high reliability of the even hydraulic distribution of the liquid over the sheet. This is provided primarily between beads 74, 75, 76 and 77. As portions of the sheet are secured directly to the support, no shifting of the sheet is possible. Thus, symmetrical operation and particularly in installations where erratic gas currents might be expected, the embodiment of FIGURE 3 is quite reliable.

The embodiment of FIGURE 4 is particularly suited for relatively short spans where heavy growth is to be expected on the sheet. Maximum strength is provided for support of the sheet and the distributor plate 82 is simply and easily attached without a complicated manufacturing procedure.

The embodiment of FIGURE 5 provides the maximum in simplicity of manufacture as well as providing a readily installed unit. The sheet for use in FIGURE 5 is readily prepared by providing a plurality of generally parallel slits in the center portion thereof and as alternate ribbons are readily inverted to provide access to the opposite side of the sheet no distributor or deflector plates, fins, or other devices are needed.

Structures in accordance with the present invention are readily prepared from conventional constructional materials which are suitable for the particular application for which the gas-liquid contact apparatus is being used. Beneficially, for many applications, particularly those involving relatively low temperatures, such as temperatures below about 130° Fahrenheit, the sheets of the present invention are conveniently and economically prepared from plastic sheeting, such as Saran sheeting, polyvinyl chloride sheeting, and the like. Where exceptional resistance and higher temperature are required, materials, such as polytetrafluoroethylene, and various corrosion resistant metals, such as stainless steel, nickel, and the like, may be employed. Beneficially, supporting members may be prepared from the materials ranging from wood, plastic, steel, brass, stainless steel, and the like according to the particular application.

As is apparent from the foregoing specification, the apparatus of the present invention is susceptible of being embodied with various alterations and modifications which may differ particularly from those that have been described in the preceding specification and description. For this reason, it is to be fully understood that all of the foregoing is intended to be merely illustrative and is not to be construed or interpreted as being restrictive or otherwise limiting of the present invention, excepting as it is set forth and defined in the hereto appended claims.

I claim:

1. In a gas-liquid contact apparatus employing a plurality of supports having sheets dependent therefrom, the improvement which comprises a sheet disposed over a support member wherein a portion of the sheet is dependent on each side of the support member, means defining a path for liquid from an uppermost portion of the sheet to inner faces of dependent portions of the sheet; the sheet defining a plurality of openings adjacent the support member and the openings being alternately positioned on either side of the support member, and adjacent each opening is disposed a liquid deflecting means to lead entering liquid on the surface opposite the surface in which the opening occurs.

2. The apparatus of claim 1 wherein said sheets are thermoplastic resinous sheets.

3. In a gas-liquid contact apparatus employing a plurality of supports having sheets dependent therefrom, the improvement which comprises a sheet disposed over a support member in such a manner that a portion of the sheet is dependent on each side of the support member,

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and means provided to form a path for a liquid from the uppermost portion of the sheet to the inner surfaces of the dependent portions; the sheet defining a plurality of elongated openings adjacent the support member, the openings being sufficient in length to extend over the support means; a distributor means disposed beneath the support means and between the dependent sheet adjacent the upper portion thereof to provide distribution of liquid entering the openings over the inner surface of the sheet.

4. In a gas-liquid contact apparatus employing a plurality of supports having sheets dependent therefrom, the improvement which comprises a sheet disposed over a support member in such a manner that a portion of the sheet is dependent on each side of the support member and means provided to form a path for a liquid from the uppermost portion of said sheet to the inner faces of the dependent portions, the sheet having a plurality of openings adjacent the support member, said sheet defining a plurality of slits disposed generally normal to the direction of the support member and thereby forming a plurality of ribbons therebetween, said ribbons being centrally disposed and integral with said sheet, the ribbons

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passing over the support member and of sufficient length to extend below the level of the support member, alternate ribbons being twisted about 180° about their longitudinal axis adjacent the uppermost portion of the support means.

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