channel surface features. **FIG. 54** shows an alternate embodiment wherein a fine pore size porous wicking material separates the liquid and vapor channels (or the surface thru features of those channels).

[**0122**] **FIG. 55** shows an alternate embodiment of arrangements of liquid and vapor layers of surface features, fine pore size porous wicking material, and open channels. Advantages of this embodiment include the openness of the liquid/vapor interface at one edge of the vapor channel, and the depth of the liquid channel which is possible with this arrangement. The surface features in between the open liquid flow channels provide good "side to side" mixing (left to right in **FIG. 55**). This embodiment may have the advantage of being able to turn down the flow or deal with variable flow rates (internal flow rates can vary along the length of the column) with better resistance to dry out and flooding.

[**0123**] **FIG. 56** shows dual depth features to promote capillary retention and mixing. As shown in **FIG. 56**, surface features that are narrowly spaced (in width) and aligned parallel with the direction of flow to permit counter-current flow of gas and liquid. The surface features may extend from the microchannel wall to the gas-liquid interface. A second set of surface features is embedded within the first and is aligned non-parallel with the direction of flow. Flow enters the surface features and is forced up into the liquid stream resulting from the feature oblique angle. A slow rotation and or swirl of the liquid stream occurs within its bulk flow path. The flow path may also be similar to a rip tide that is moving the flow beneath the surface, but with more rotation.

[**0124**] Although only one microchannel distillation unit is illustrated in **FIGS. 1-3**, **14-19**, **45**, **46** and **52-55**, there is practically no upper limit to the number of microchannel distillation units into and out of these figures and from left to right in these figures that may be used in a microchannel distillation column or apparatus for conducting the inventive process. For example, one, two, three, four, five, six, eight, ten, twenty, fifty, one hundred, hundreds, one thousand, thousands, ten thousand, tens of thousands, one hundred thousand, hundreds of thousands, millions, etc., of the microchannel distillation units described above may be used. The microchannels and associated liquid channels and heat exchange channels may be aligned side-by-side or stacked one above another. In embodiments where more than one microchannel distillation unit is present, the feed may be distributed among the microchannel distillation units and introduced into each microchannel distillation unit at a location that is intermediate between the microchannel reboiler and condenser. This can be accomplished through the addition of feed channels to carry the distributed feed fluids to each microchannel distillation unit or by partitioning off unused portions of existing microchannel distillation units (such as heat exchange channels) which are not used in the region of the microchannel distillation unit where feed is to be distributed and introduced. Those skilled in the art can determine desirable locations along the length of the microchannel distillation unit at which the feed might be introduced. The feed distribution might be accomplished through the aid of a wick distribution structure if a liquid, or through other means, such as distribution through an array of orifices.

[**0125**] Although **FIGS. 1-12**, **14-19** and **52-55** depict essentially vertical flow through the channels, these distillation units may be aligned horizontally to provide for horizontal flow through the channels, or they may be aligned at an inclined angle from the horizontal.

[**0126**] In one embodiment, each of the microchannel distillation sections (eg., microchannel distillation sections **220**) may be in the form of a bubble cap and liquid removal structure such as the bubble cap and liquid removal structure **700** illustrated in **FIG. 20**. The bubble cap and liquid removal structure **700** includes liquid region **710**, vapor region **720** which is positioned above liquid region **710**, and bubble cap tray **730** which is positioned above vapor region **720**. The liquid region includes liquid outlets **712**. The bubble cap tray **730** includes bubble caps **732**, platform structures **734**, capture structures **735** and **736**, and openings **740**, **741**, **742** and **743**. The vapor region **720** includes capture structures **722** and **724**. In operation, liquid **711** is contained within liquid region **710** and vapor flows upwardly through the liquid **711** in the form of bubbles **721** in the direction indicated by arrows **723**. The bubbles **721** pass through the liquid **711** into the vapor region **720** and then through the bubble caps **732** into the next adjacent downstream bubble cap and liquid removal structure. Liquid collects on the bubble cap tray **730** and flows downwardly along the sidewalls of the vapor region **720** into the liquid region **710**. The liquid then flows from the liquid region **710** through liquid outlets **712** into the next adjacent upstream bubble cap and liquid removal structure. In the liquid region **710** the vapor bubbles **721** and the liquid **711** contact each other and the less volatile component X transfers from the vapor phase to the liquid phase, and the more volatile component Y transfers from the liquid phase to the vapor phase.

[**0127**] In one embodiment, each of the microchannel distillation sections (e.g., microchannel distillation section **220**) may comprise a distillation tray such as the distillation trays positioned in the microchannel **750** illustrated in **FIG. 21**. The microchannel **750** may include sidewalls **752** and **754**. Distillation trays **760** and **760*b*** may project inwardly into the process microchannel **750** from microchannel wall **752**, and distillation tray **760*a*** may project inwardly into the process microchannel **750** from microchannel wall **754**. Open spaces **762**, **762*a*** and **762*b*** are positioned adjacent to the distillation trays **760**, **760*a*** and **760*b***, respectively. Distillation trays **760**, **760*a*** and **760*b*** include reservoirs **761**, **761*a*** and **761*b*** for collecting liquid. The distillation trays **760**, **760*a*** and **760*b*** include capture structures **762**, **762*a*** and **762*b*** which depend from distillation trays **760**, **760*a*** and **760*b***, respectively. In operation, the vapor phase flows upwardly through the process process microchannel **750** in the direction indicated by arrows **764**. The liquid phase flows through the process microchannel **750** in the direction indicated by arrows **766**. The vapor phase contacts the capture structures **762**, **762*a*** and **762*b*** as it flows through the process microchannel **750** and liquid in the vapor phase is captured by the capture structures **762**, **762*a*** and **762*b*** as the vapor flows through the capture structures. The liquid flows downwardly from the capture structures **762**, **762*a*** and **762*b*** to the tray reservoirs positioned below such capture structures. The vapor phase flowing in the direction indicated by arrows **764** and the liquid phase flowing in the direction indicated by arrows **766** contact each other in the capture structures as well as in the liquid reservoirs with the result being the transfer of the more volatile component Y from the