rior wall **451***b* as a thin film, as indicated by arrow **453***b*, until it contacts capture structure **452***b*. A vapor phase containing components X and Y flows through capture structure **452***a* into microchannel distillation section **450***b*, as indicated by arrow **413**, and flows through microchannel distillation section **450***b* until it contacts capture structure **452***b*. The flow of the liquid phase along the interior wall **451***b* may be driven by capillary force and/or drag from the flow of the vapor phase through the microchannel distillation section **450***b*. The flow of liquid may also be driven by an external pump that either pushes or pulls the liquid through the microchannel distillation unit. This mode of force, liquid pumping, may be broadly applied to other structures described herein. In the microchannel distillation section **450***b* the liquid phase and the vapor phase contact each other. Part of the more volatile component Y transfers from the liquid phase to the vapor phase to form a component Y rich vapor phase. Part of the less volatile component X transfers from the vapor phase to the liquid phase to form a component X rich liquid phase. The vapor phase flows through capture structure **452***b*, as indicated by arrow **414**. The liquid phase flows from capture structure **452***b* through liquid outlet **454***b*. The flow of the liquid phase through the liquid outlet **454***b* may be as a result of capillary force. The liquid phase flows through flow passages in the wicking region **432**, as indicated by arrow **434**, and then through liquid inlet **456***a*. The flow of the liquid phase through the liquid inlet **456***a* may be driven by gravitational force, a pressure differential as a result of the flow of the vapor phase near the liquid inlet **456***a*, and/or a wetting effect resulting from the flow of the liquid phase along the interior wall **451***a*. The liquid phase flowing through liquid inlet **456***a* enters microchannel distillation section **450***a* and flows along interior wall **451***a* as a thin film, as indicated by arrow **453***a*, until it contacts capture structure **452***a*. The vapor phase flows through capture structure **452** into microchannel distillation section **450***a*, as indicated by arrow **412**, and flows through microchannel distillation section **450***a* until it contacts capture structure **452***a*. The vapor phase flow may be driven by a pressure differential. Within microchannel section **450***a*, the liquid phase and the vapor phase contact each other. Part of the more volatile component Y transfers from the liquid phase to the vapor phase to form a component Y rich vapor phase. Part of the less volatile component X transfers from the vapor phase to the liquid phase to form a component X rich liquid phase. The vapor phase flows through capture structure **452***a* into microchannel distillation section **450***b*, as indicated by arrow **413**. The liquid phase flows from capture structure **452***a* through liquid outlet **454***a* through flow passages in the wicking region **432** in liquid channel **430**, as indicated by arrow **435**, into liquid inlet **456**. The liquid phase flows through liquid inlet **456** into microchannel distillation section **450** and along interior wall **451** as a thin film, as indicated by arrow **453**, until it contacts capture structure **452**. The vapor phase flows into microchannel distillation section **450**, as indicated by arrow **411**, and flows through microchannel distillation section **450** until it contacts capture structure **452**. Within the microchannel distillation section **450** the liquid phase and the vapor phase contact each other. Part of the more volatile component Y transfers from the liquid phase to the vapor phase to form a component Y rich vapor phase. Part of the less volatile component X transfers from the vapor phase to the liquid phase to form a component X rich liquid phase. The component X rich liquid phase flows from capture structure **452** through liquid outlet **454** into liquid channel **430**, as indicated by arrow **436**. The liquid phase flowing along line **436** has a higher concentration of component X and a lower concentration of component Y than the liquid phase flowing downwardly through liquid channel **430** into liquid inlet **456***b*, as indicated by arrow **433**. The vapor phase flowing through capture structure **452***b*, as indicated by arrow **414**, has a higher concentration of component Y and a lower concentration of component X than the vapor phase entering microchannel distillation section **450**, as indicated by arrow **411**. Within the liquid channel **430** the more volatile component Y may vaporize and form vapor bubbles that rise upwardly through the wicking region in the liquid channel **430**. This vapor may be drawn into one or more of the microchannel distillation sections (**450**, **450***a*, **450***b*) through the liquid inlets (**456**, **456***a*, **456***b*) and combined with the vapor phase flowing through the microchannel distillation sections (**450**, **450***a*, **450***b*).

[**0108**] The microchannel distillation unit **400**A depicted in **FIG. 15** is identical to the microchannel distillation unit **400** depicted in **FIG. 14** with the exception that heat exchange channel **460** is adjacent to process microchannel **410** and heat exchange channel **465** is adjacent to liquid channel **430**. Heat exchange fluid flows through heat exchange channels **460** and **465** in a direction that may be co-current or counter-current to the flow of the vapor phase through the process microchannel **410**. In one embodiment, the flow of heat exchange fluid through heat exchange channel **460** may be in one direction and the flow of heat exchange fluid through heat exchange channel **465** may be in the opposite direction. The heat exchange fluid heats or cools the process fluids in the process microchannel **410** and the liquid channel **430**.

[**0109**] The microchannel distillation unit **400**B illustrated in **FIG. 16** is identical in design and operation to the microchannel distillation unit **400**A illustrated in **FIG. 15** with the exception that the heat exchange fluid flows in a cross-current direction relative to the flow of the vapor phase through the process microchannel **410**. The heat exchange fluid flows through heat exchange channels **461** and **466** and provides heating or cooling to the process fluids in the process microchannel **410** and liquid channel **430**.

[**0110**] The microchannel distillation unit **400**C illustrated in **FIG. 17** is identical in design and operation to the microchannel distillation unit **400**A illustrated in **FIG. 15** with the exception that the microchannel distillation unit **400**C includes supplemental vapor channels **480** and **486**, and compressor **490**. Vapor channel **486** is adjacent to heat exchange channel **460**. Vapor channel **480** is adjacent to vapor channel **486**. Each of the microchannel distillation sections (**450**, **450***a*, **450***b*) has a supplemental vapor inlet, for example, a channel or tube (**482**, **482***a*, **482***b*) extending from the vapor phase channel **480** to the microchannel **410**. Each of the microchannel distillation sections (**450**, **450***a*, **450***b*) also has a supplemental vapor outlet, for example, a channel or tube (**484**, **484***a*, **484***b*) extending from the microchannel **410** to the vapor phase channel **486**. The vapor phase channels **480** and **486** may be microchannels, and each may have the same dimensions as the microchannel **410** or the liquid channel **430**. The operation of the microchannel distillation unit **400**C is the same as the microchannel distillation unit **400**A with the exception that the vapor