



patent-heat-pump-and-orc-turboshaft-for-process-cooling-and-hydraulic-power

Modular fluid handling device II Patent

Cavgenx a division of Infinity Turbine LLC



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PDF Version of the webpage (first pages)

Modular fluid handling device II Patent US7726331B1

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4/21/2024

FIELD OF THE INVENTION

This document concerns an invention relating generally to devices for processing and sampling of gases and liquids, and more specifically to devices allowing rapid construction of fluid reactors, distillers, extractors, homogenizers, filtration/separation devices, process models (e.g., devices for modeling engine cycles, refrigeration cycles, etc.), and other devices for handling fluids.

BACKGROUND OF THE INVENTION

Fluid handling devices including fermenters, distillers, filtration tanks, evaporators, etc. (or combinations of these components) are exceedingly common in industry and in research labs. Researchers and engineers also often need to experiment with models for common thermodynamic cycles, e.g., refrigeration cycles (vapor compression cycle, Einstein cycle, etc.) and power cycles (Otto cycle, Diesel cycle, Brayton cycle, Rankine cycle, etc.). While it is often desirable to generate prototypes or small-scale versions of such devices, they are usually time-consuming, difficult, and expensive to construct. One approach commonly used in laboratories is to connect glassware vessels (e.g., flasks, towers, heat exchangers, etc.) with rubber tubing so that the vessels form some desired fluid process model. Even apart from the significant time and expense required for their construction, these are quite fragile, are unsuitable for pressurized processes, and are also usually unsuitable for processes involving extreme temperatures or corrosive materials owing to the weakness of the tubing. In some cases, more durable fluid handling devices can be formed from metal vessels connected with (for example) brazed copper tubing, but these involve even greater time, cost, and fabrication burdens.

A prior patent (U.S. Pat. No. 7,146,999 to Giese et al., which is incorporated by reference herein) describes a modular fluid handling system wherein modular blocks bear passageways for carrying fluids, and wherein inserts having different functionality—e.g., valve inserts, filter inserts, turbine inserts, pump inserts, heating/cooling inserts, sensor inserts, flow routing/diverting inserts, etc.—can be inserted into selected blocks. The blocks, with or without inserts, can be affixed together to construct a durable fluid handling device. This document relates to improvements and additions to the modular fluid handling system described in U.S. Pat. No. 7,146,999 to Giese et al.

SUMMARY OF THE INVENTION

To enhance the reader's understanding, the following summary will make reference to the accompanying FIGS. 1-3, which illustrate an exemplary version of the modular fluid handling device. The device includes a number of blocks—more particularly, fluid passage blocks 100 and fluid intake/outlet blocks 200, as will be discussed below—which each include a block top face 102/202, an opposing block bottom face (not shown), and a series of block sides 104/204 therebetween. The block faces 102/202 are preferably shaped as tessellating regular polygons, whereby the blocks 100/200 may be arrayed together in side-to-side abutting relationship to form a two-dimensional array of blocks (as best seen in FIG. 1). Each block 100/200 includes a central block bore 106/206 extending between the block faces 102/202, whereby the blocks 100/200 may also (or alternatively) be arrayed together in face-to-face abutting relationship to form a stacked array of blocks wherein abutting blocks have their block bores 106/206 coaxially aligned (as seen in the stack of blocks 100/200 shown at the left side of FIGS. 1-3). The foregoing arrangement allows a user to horizontally array and vertically stack blocks 100/200 together into some desired arrangement which is suitable for the user's intended use, e.g., for purposes of experiment, prototyping, or production.

The blocks 100/200 include some means for allowing horizontally adjacent blocks 100/200 to be affixed together, with a preferred horizontal affixment means being best seen in FIG. 3. Here, the block faces 102/202 include semi-annular depressions 108/208 extending from the block sides 104/204, whereby adjacent blocks 100/200 arrayed together in side-to-side abutting relationship may receive an annular side fastener 300 in their adjacent semi-annular depressions 108/208 to affix the adjacent blocks 100/200 together.

The blocks 100/200 additionally include some means for allowing vertically stacked blocks 100/200 to be affixed together, with a preferred vertical affixment means being best seen in FIGS. 2-3. The blocks 100/200 here include face fastener openings 110/210 in their block faces 102/202, with the face fastener openings 110/210 being situated such that blocks 100/200 situated in face-to-face stacked relationship have their face fastener openings 110/210 coaxially aligned. This arrangement allows the blocks 100/200 to be affixed together in face-to-face abutment by extending a fastener 302 between the aligned face fastener openings 110/210 of the abutting blocks 100/200.

To provide a stable base for a fluid handling device assembled from a series of blocks 100/200, a mounting plate 304 is preferably provided upon which the affixed blocks 100/200 may rest. The mounting plate 304 has a mounting surface with plate fastener openings 306 arrayed therein, such that when several blocks 100/200 are received thereon in side-to-side abutting relationship, the plate fastener openings 306 coaxially align with the block face fastener openings 110/210. Fasteners 302 can then be extended through the block face fastener openings 110/210 and into the plate fastener openings 306 to affix a block to the mounting plate 304.

One or more of the blocks then takes the form of a fluid passage block 100 (see particularly FIGS. 2-3), wherein each fluid passage block 100 further includes one or more fluid passages 112 which extend between the opposing block faces 102, and which are situated between the block bore 106 and the block sides 104. These fluid passages 112 are preferably regularly arrayed about the block bore 106 such that a stacked array of fluid passage blocks 100 having their block bores 106 coaxially aligned will also have their fluid passages 112 coaxially aligned, such that fluid may travel between the fluid passages 112 of adjacently stacked fluid passage blocks 100.

One or more of the blocks also preferably takes the form of a fluid intake/outlet block 200 which includes the features of a fluid passage block 100 (i.e., it includes fluid passages 212 similar to the fluid passages 112 described above), but also includes ducts 214 extending from the fluid passages 212 to the block bore 206, whereby fluid may travel between the fluid passages 212 and the block bore 206. These ducts 214 may assume a variety of forms, but are preferably formed as shown in FIGS. 2-3, wherein the ducts 214 are defined as slotted openings which extend from the block bore 206 to the fluid passages 212. These ducts 214 are preferably oriented in directions extending both radially and tangentially with respect to the block bore 206, and which also extend between the opposing block faces 202 in a direction oriented along the axis of the block bore 206. By orienting the ducts 214 in an at least partially tangential direction (i.e., in an at least partially clockwise or counterclockwise direction), and by providing all ducts 214 with the same tangential orientation, fluid flowing from the fluid passages 212 to the block bore 206 (or conversely flowing from the block bore 206 to the fluid passages 212) will assume a circular or whirling motion in the block bore


