US 20090126915A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2009/0126915 A1**

Nibler et al.

(43) **Pub. Date: May 21, 2009**

(54) **HEADER FOR HEAT EXCHANGER**

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(21) Appl. No.: **12/357,297**

(22) Filed: **Jan. 21, 2009**

Related U.S. Application Data

(62) Division of application No. 12/246,397, filed on Oct. 6, 2008.

(60) Provisional application No. 60/978,047, filed on Oct. 5, 2007, provisional application No. 60/988,711, filed on Nov. 16, 2007.

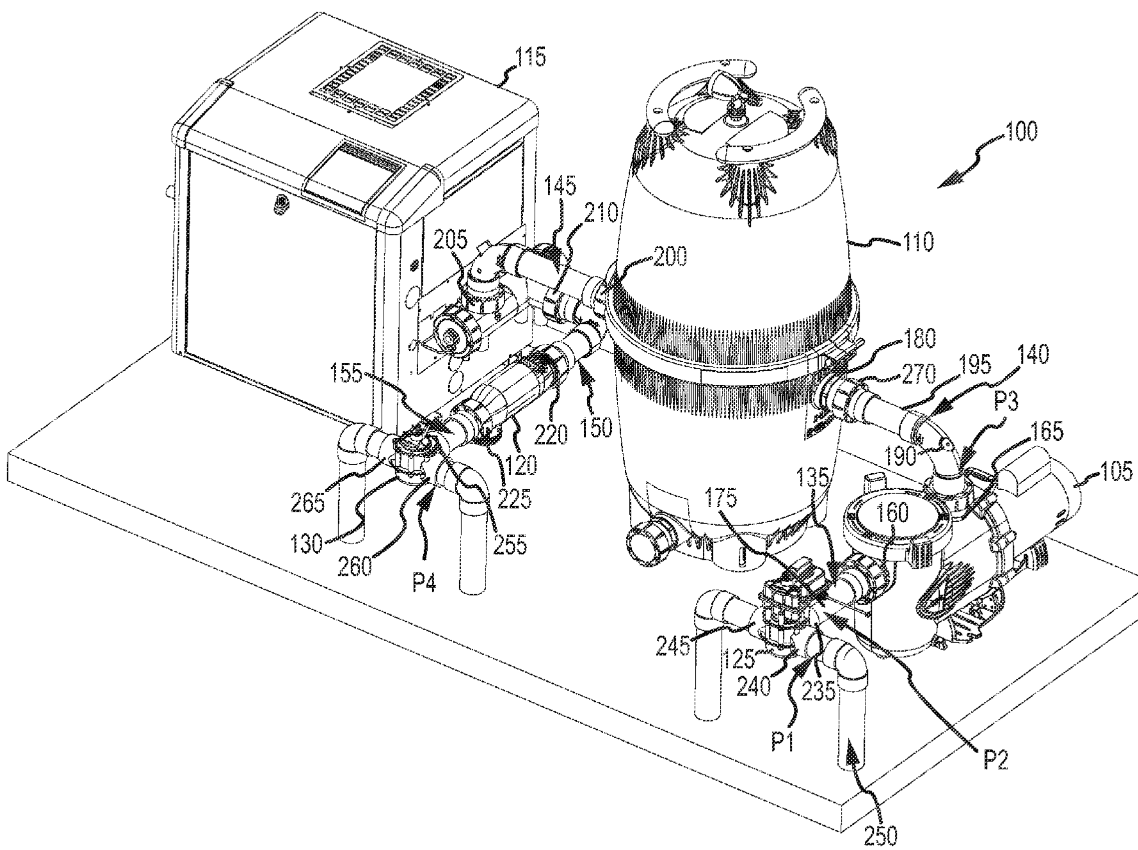
Publication Classification

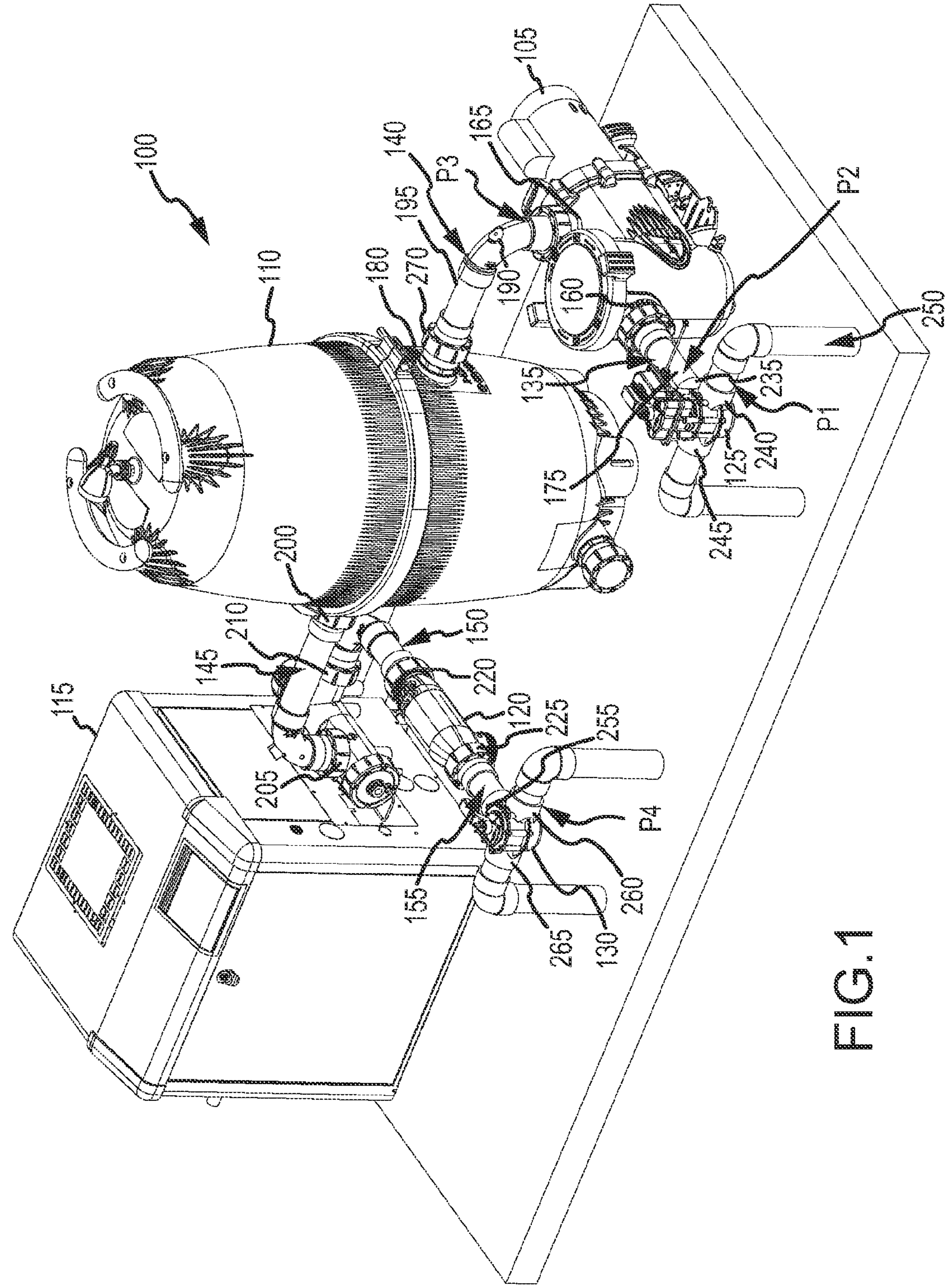
(51) **Int. Cl.**
F28D 1/06 (2006.01)

(52) **U.S. Cl.** **165/132**

(57) **ABSTRACT**

A header for a heat exchanger orients the position of an inlet port at an angle offset from the position of the outlet port on the header body in order to simplify the plumbing of the header within a system. In one implementation of a header for a heat exchanger, the header forms a header cavity defined by an external wall and which is separated into an inlet chamber and an outlet chamber by a dividing wall. An inlet port is defined within the external wall and is in fluid communication with the inlet chamber. Similarly, an outlet port is defined within the external wall and is in fluid communication with the outlet chamber. The inlet port is oriented on the external wall at an offset angle with respect to a position of the outlet port.




100
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115
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190
195
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225
235
240
245
250
255
260
265
270
P1
P2
P3
P4

FIG. 1

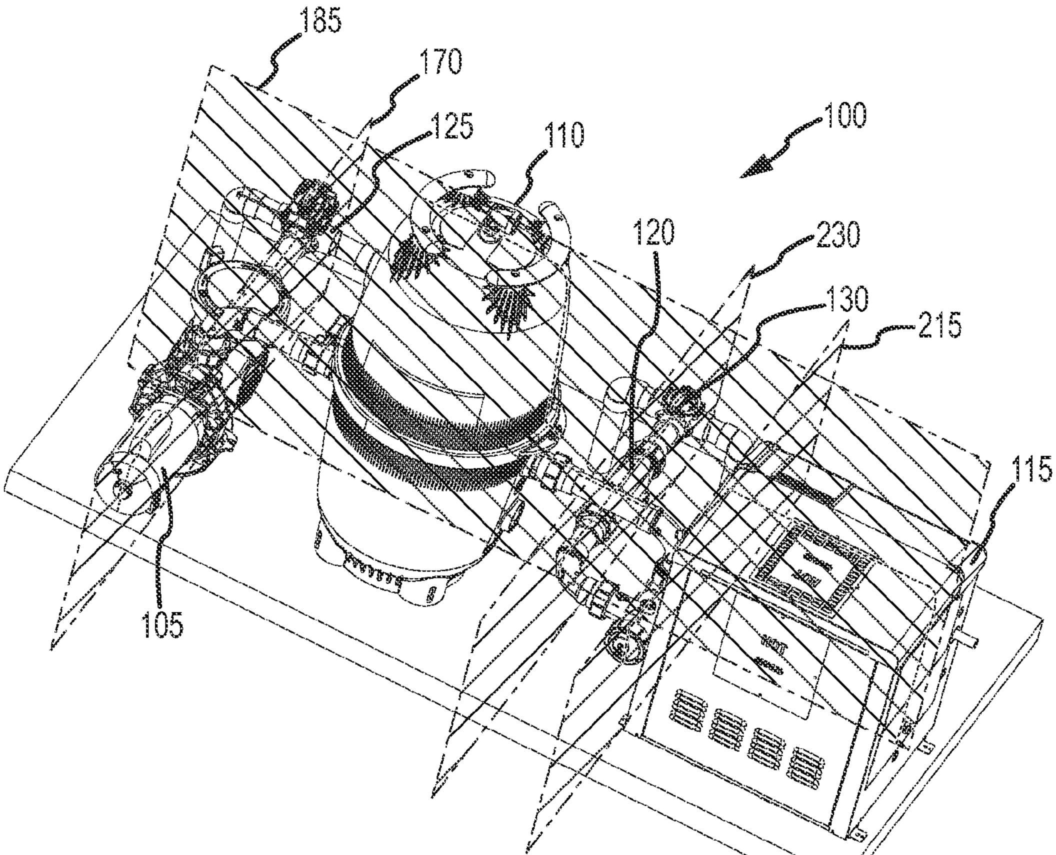


FIG.2

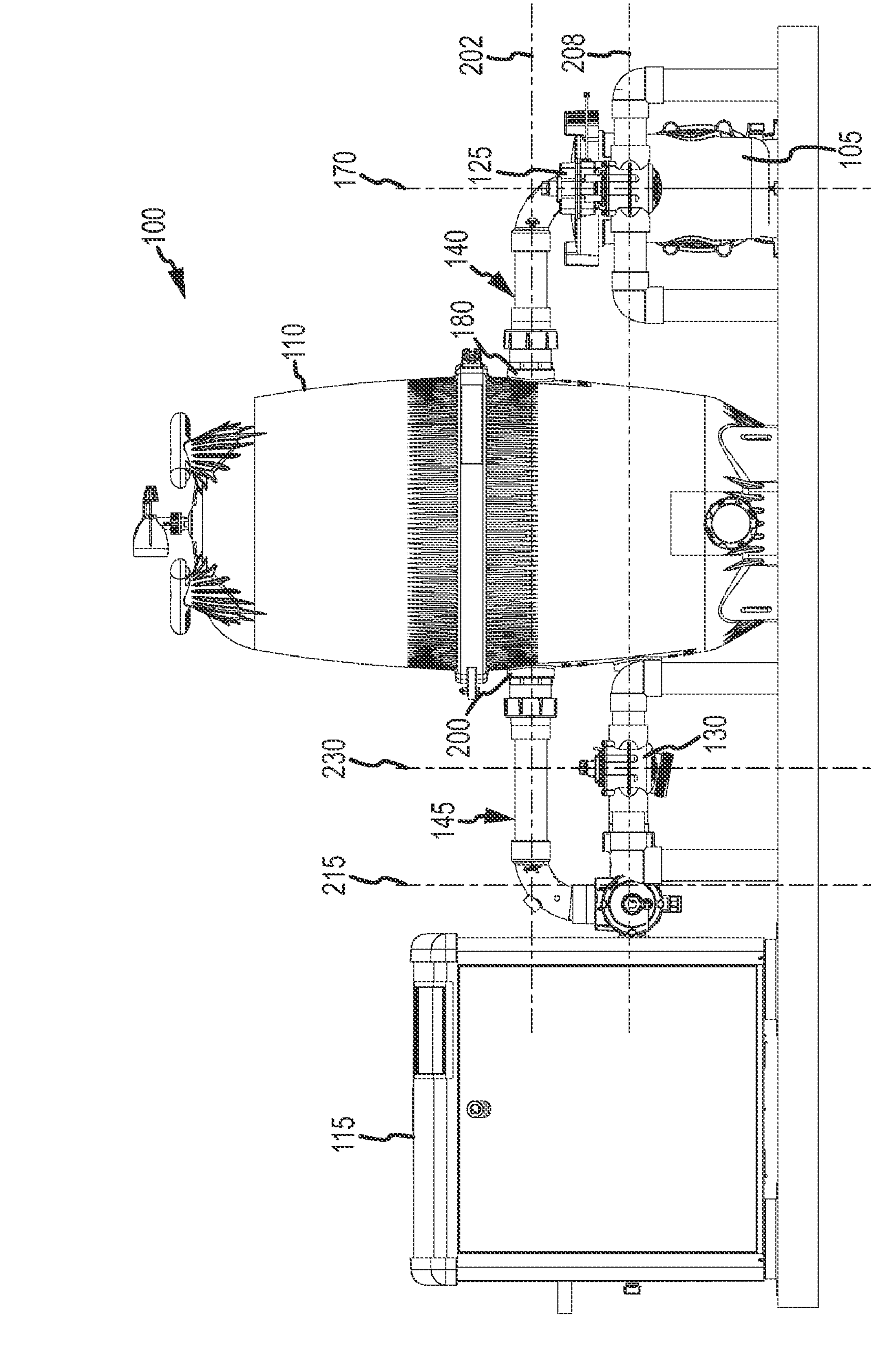


FIG. 3

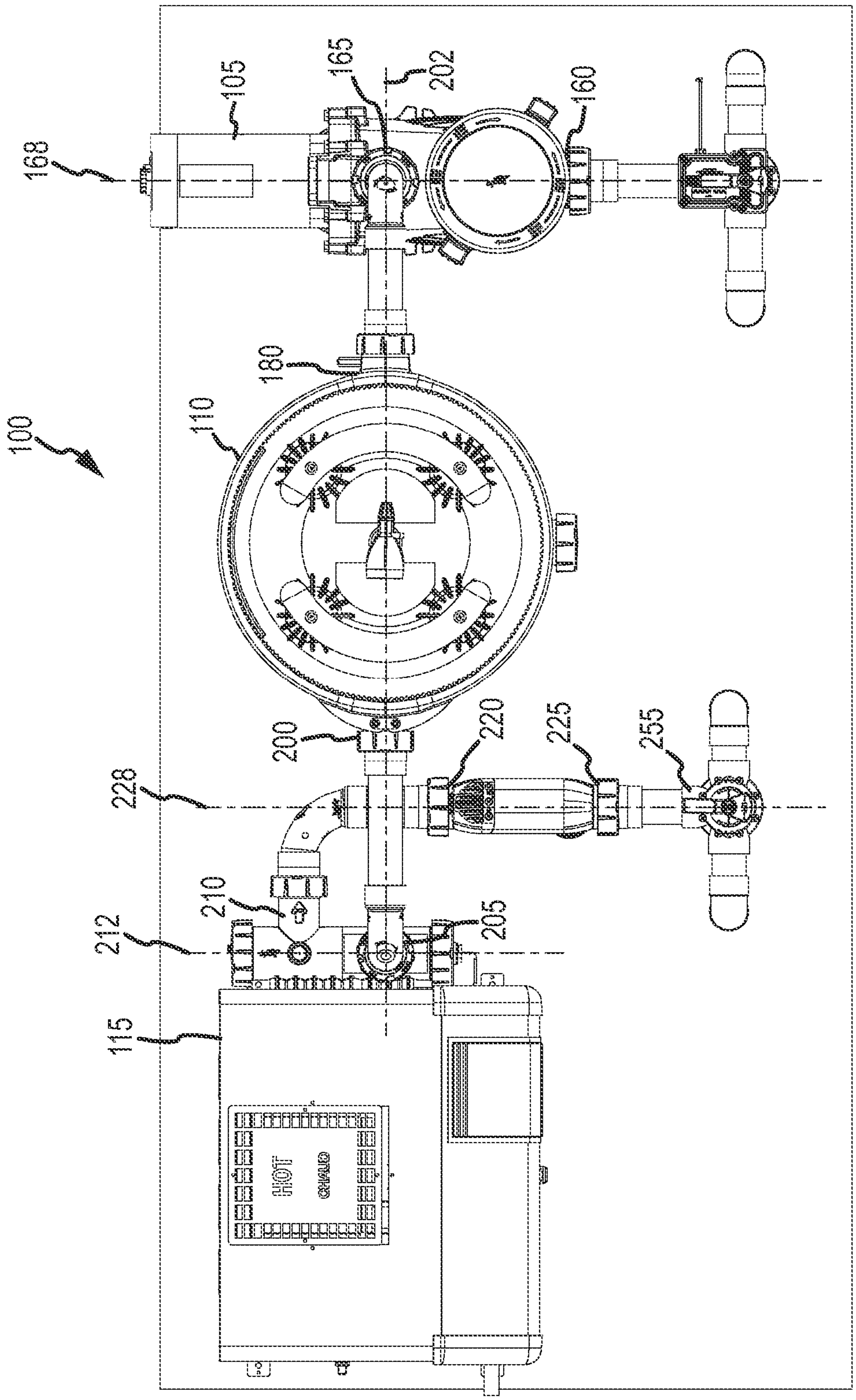

100
105
110
115
160
165
168
180
200
202
205
210
212
220
225
228
255
HOT
CHAUD

FIG. 4

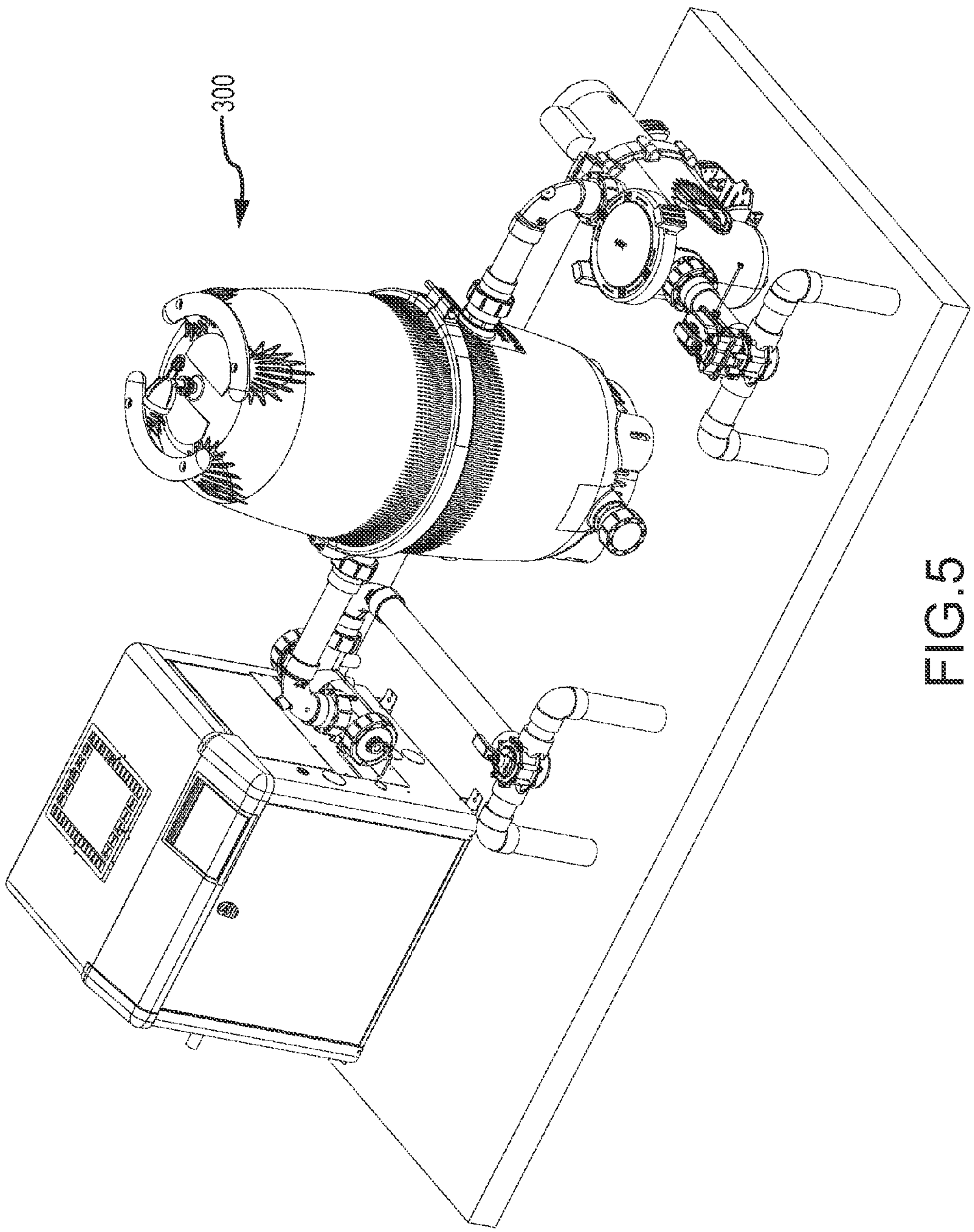


FIG.5

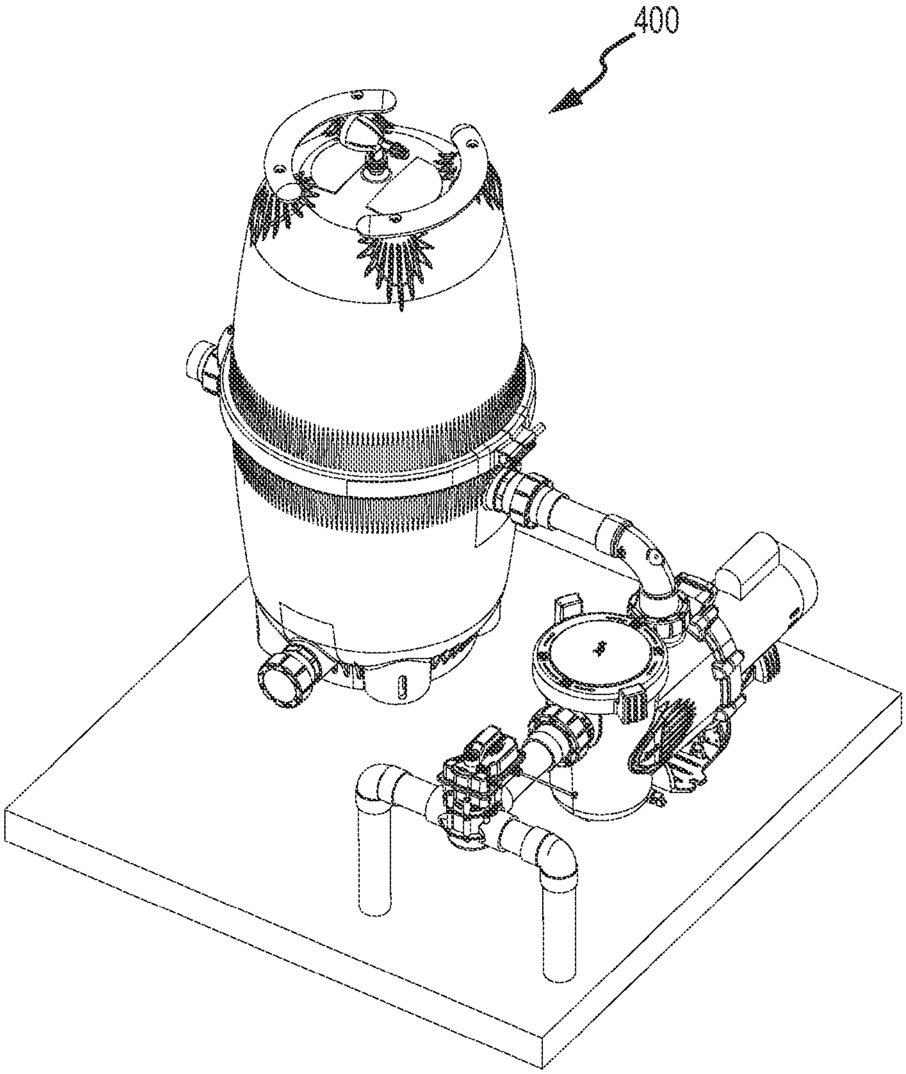
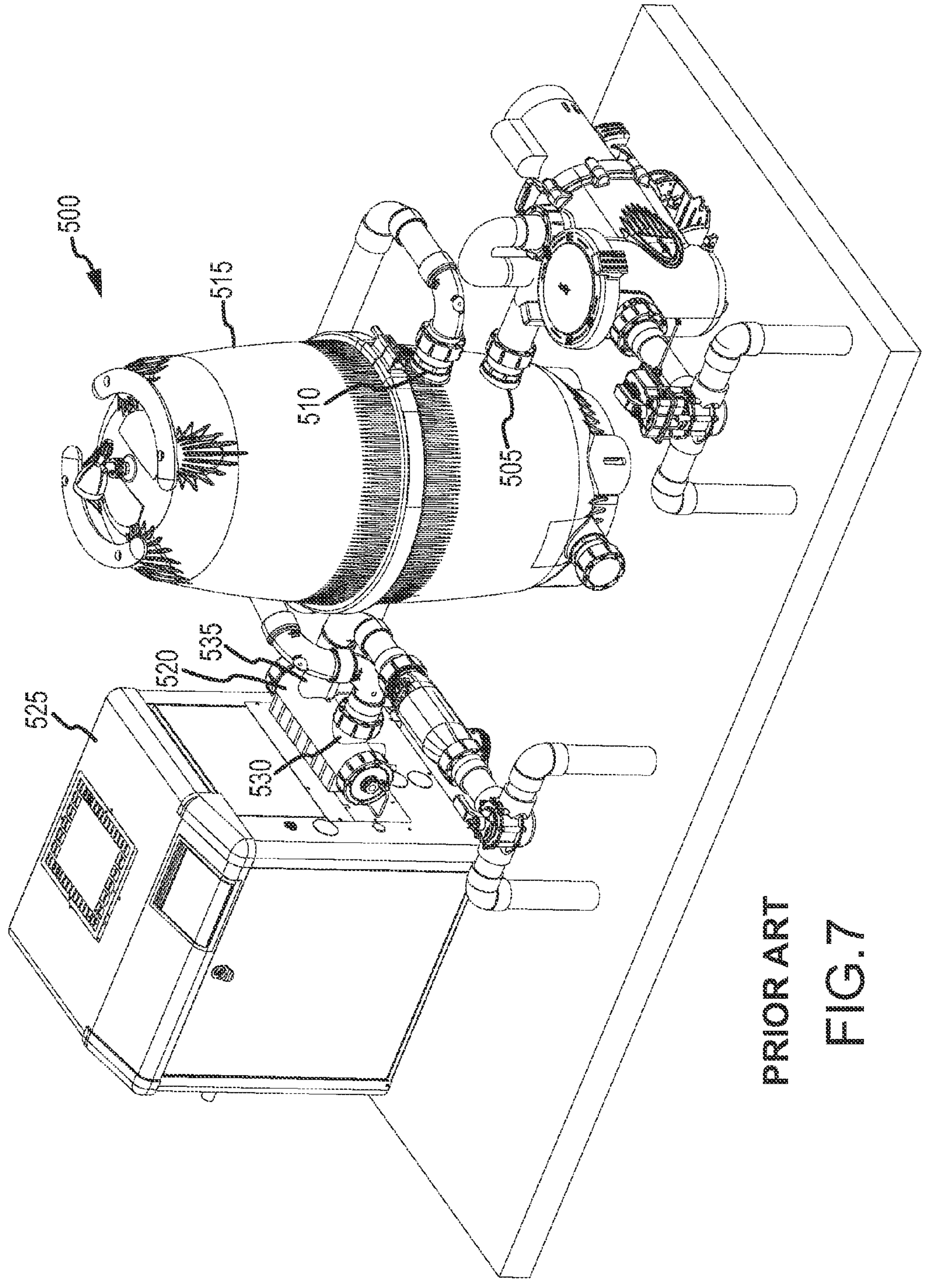


FIG.6



PRIOR ART

FIG.7

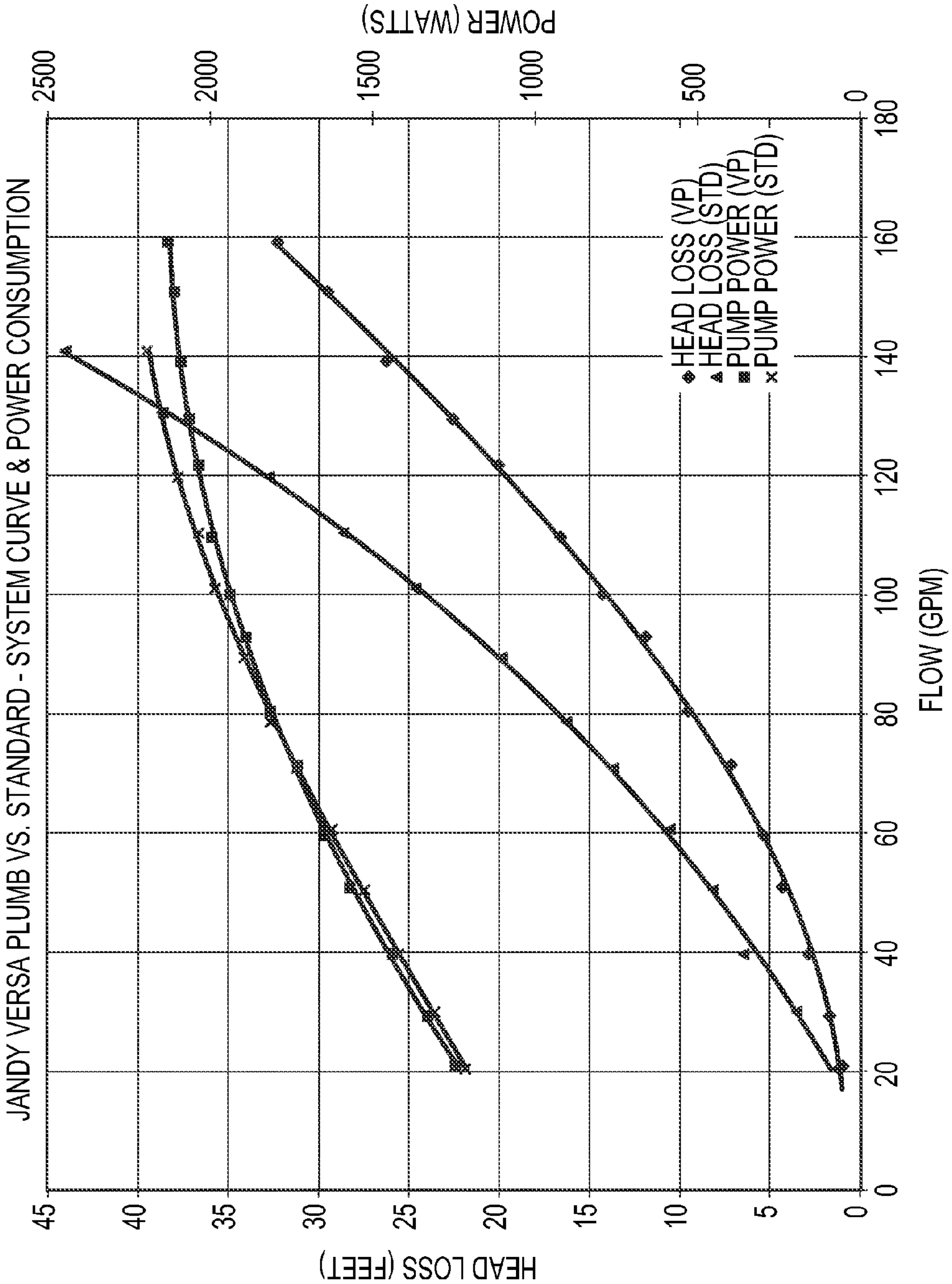
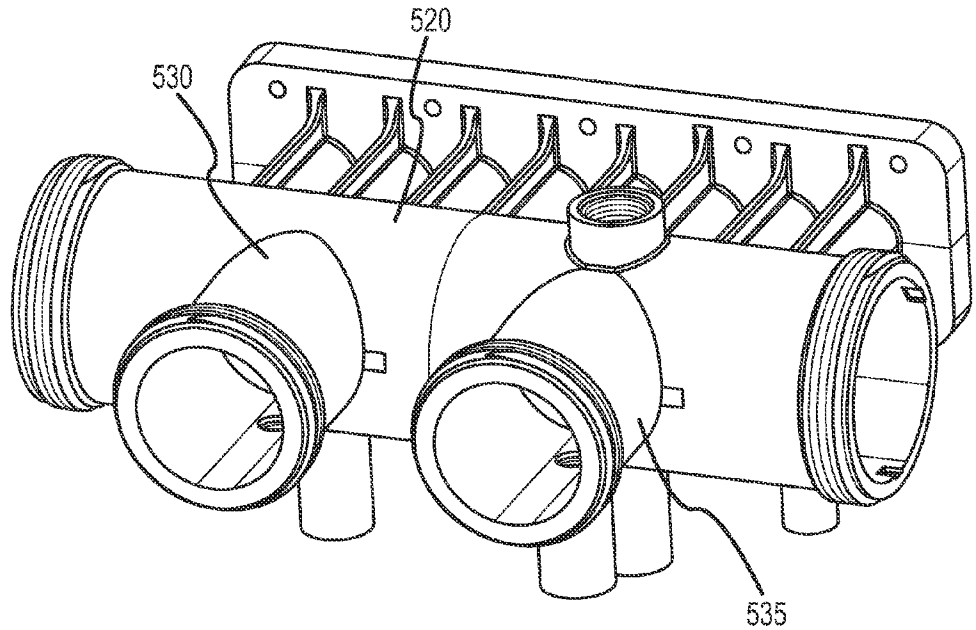

JANDY VERSA PLUMB VS. STANDARD - SYSTEM CURVE & POWER CONSUMPTION
HEAD LOSS (FEET)
POWER (WATTS)
FLOW (GPM)
HEAD LOSS (VP)
HEAD LOSS (STD)
PUMP POWER (VP)
PUMP POWER (STD)
0
5
10
15
20
25
30
35
40
45
0
500
1000
1500
2000
2500
0
20
40
60
80
100
120
140
160
180

FIG.8



PRIOR ART

FIG.9

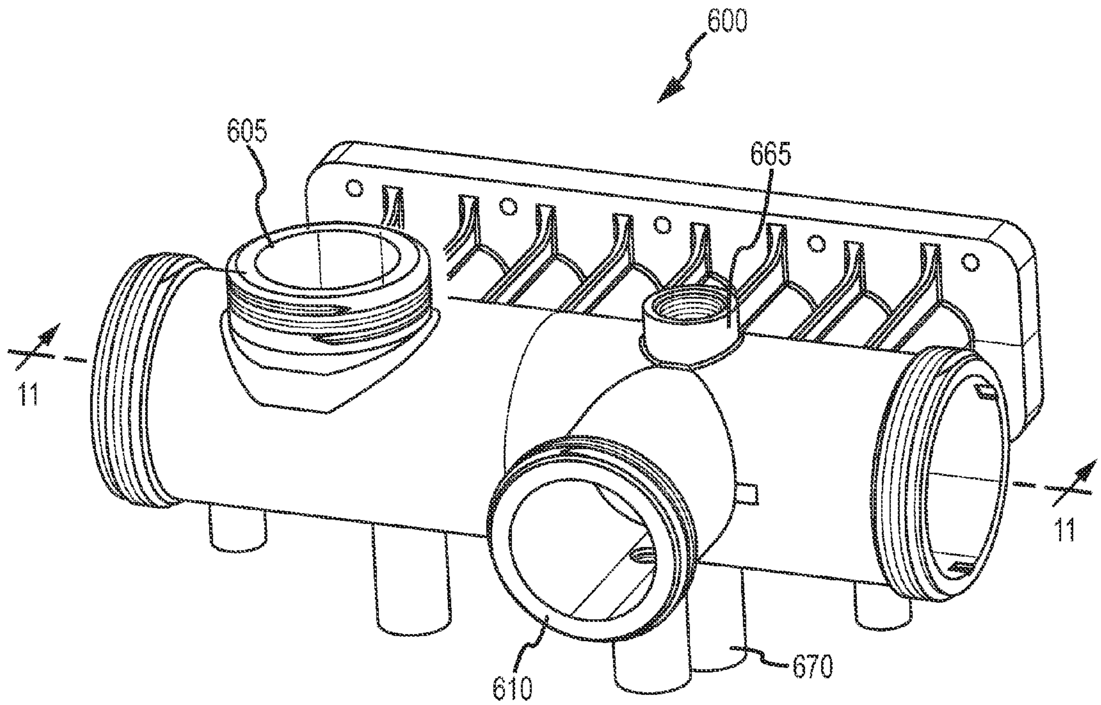


FIG.10

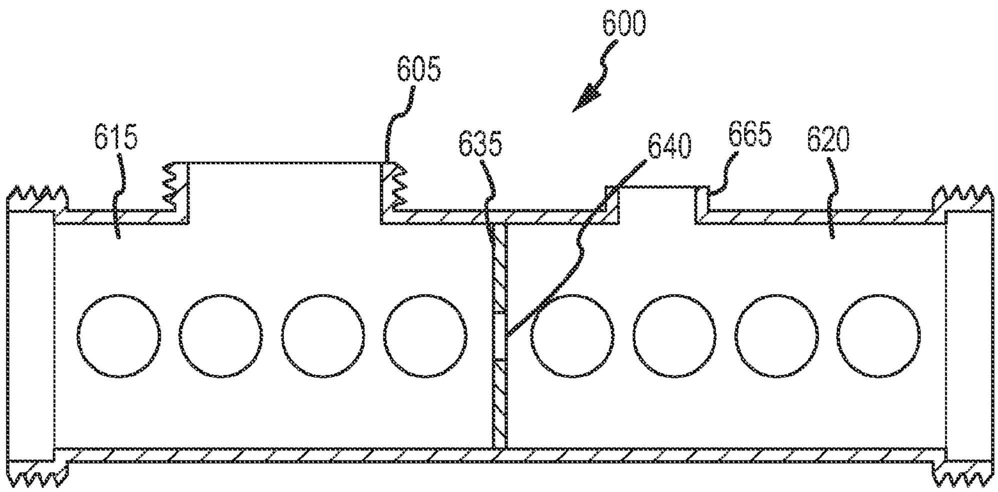


FIG.11

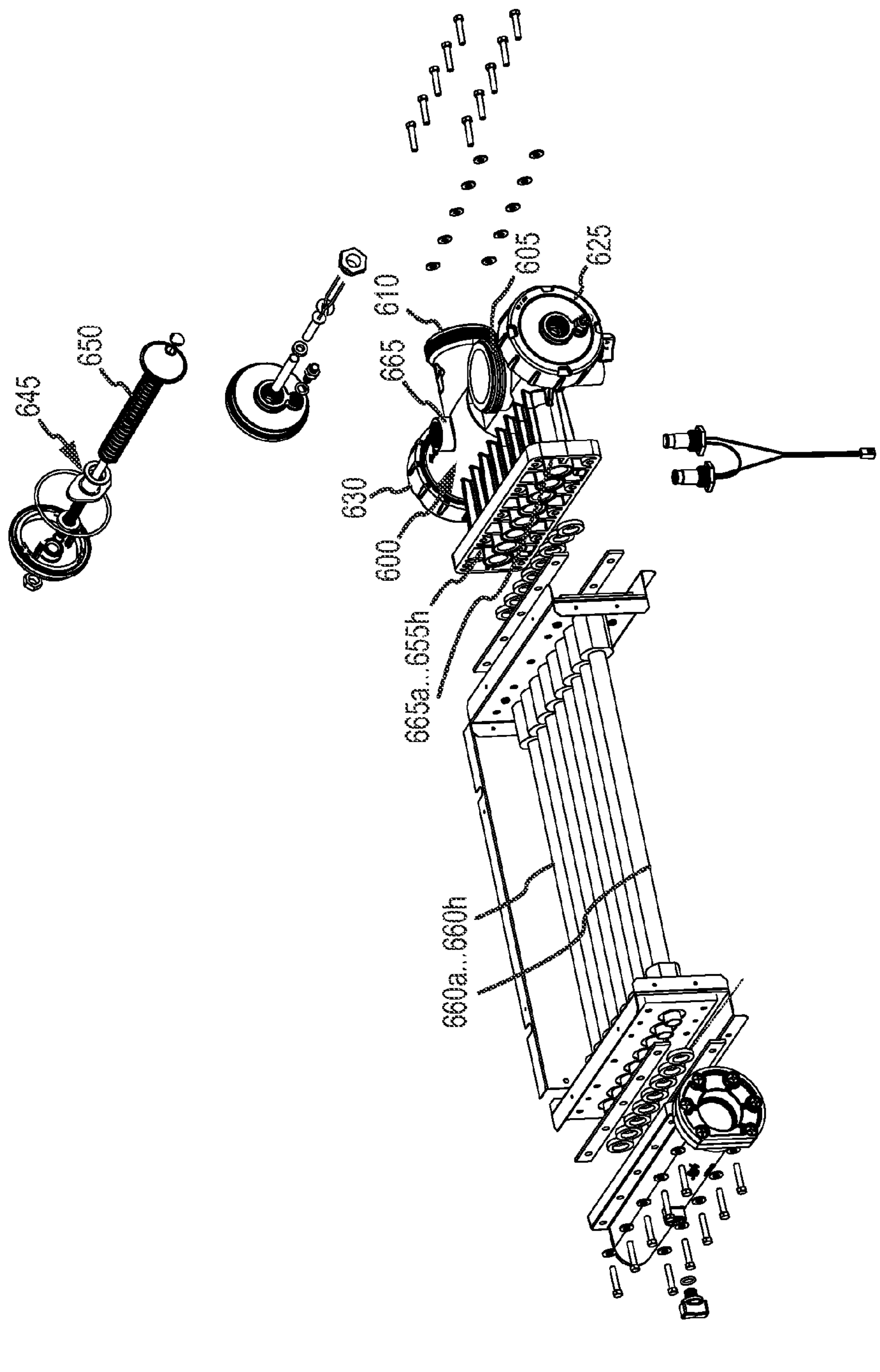


FIG.12

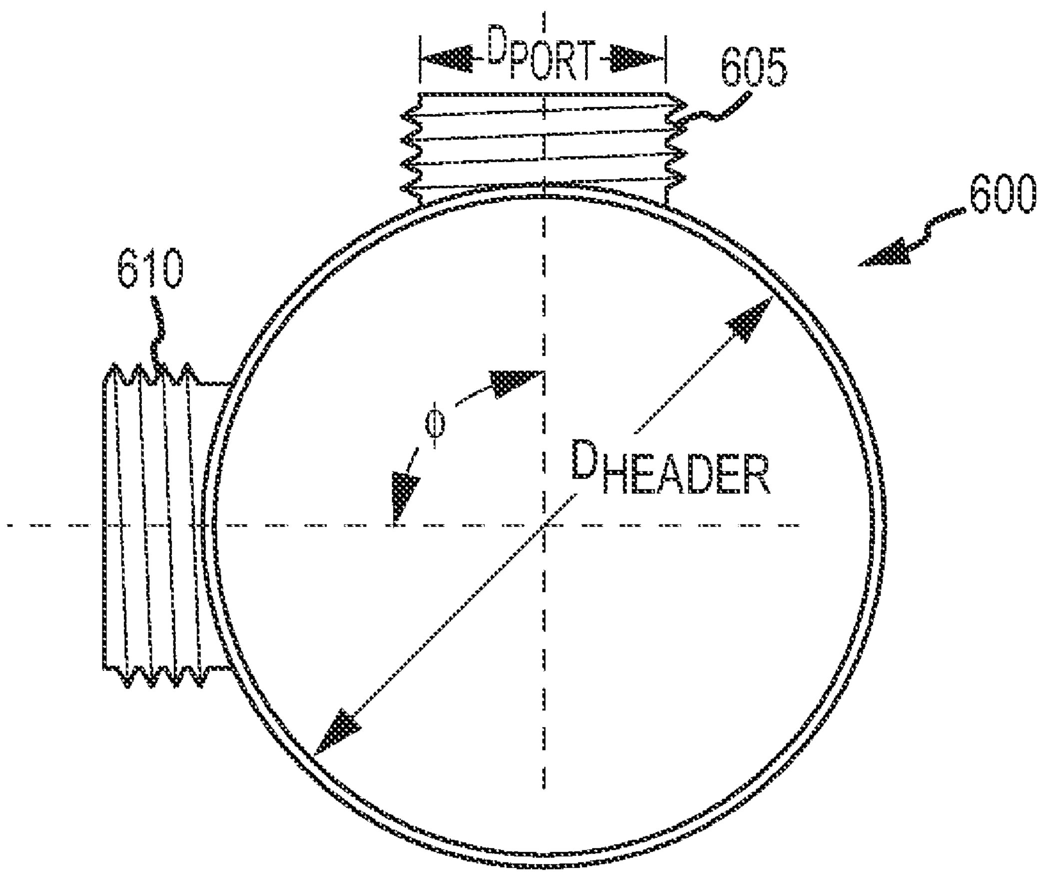


FIG.13

HEADER FOR HEAT EXCHANGER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a divisional of U.S. patent application Ser. No. 12/246,397 filed 6 Oct. 2008 entitled "Methods and apparatus for a pool treatment and water system," which is hereby incorporated by reference in its entirety.

[0002] This application is related to U.S. provisional application No. 60/978,047 filed 5 Oct. 2007 entitled "Methods and apparatus for a pool treatment system", and U.S. provisional application No. 60/988,711 filed 16 Nov. 2007 entitled "Header for heat exchanger," each of which is hereby incorporated by reference herein in its entirety.

BACKGROUND

[0003] The present disclosure generally relates a header design and configuration for a heat exchanger, primarily for use in conjunction with pool and spa water treatment and handling systems.

[0004] In a plumbing system for a pool or spa, many components may be fluidly connected together, including a pool filter, a water heater, heat exchanger, salt chlorine generators and various valves and controllers. The components are fluidly connected together by piping, such as PVC pipe. In operation, the water in the pool flows from the pool, through the plumbing system, including the filter, various valves and pump(s), the water heater, and the chlorine generator (if one is necessary) and other components, and back to the pool.

[0005] There are many ways to connect the components to one another. In many systems, however, the design of individual components, such as the pump, filter, valves, heaters and so on, are often not considered within the context of the overall plumbing system, thus leading to an inefficient layout and joining of the components. For example, traditional heat exchanger header structures for pool and spa heaters, such as the one shown in prior art FIG. **9**, often have the inlet and outlet ports on the same side and in a common geometric plane with one another. As another example, traditional pool filters also often have the inlet and outlet ports on the same side. These configurations make it more likely to have to use cross-over tubing layouts, and extra angles in the tubing to fluidly connect the heat exchanger and pool filter to the surrounding components.

[0006] In other words, little coordination, if any, has previously existed in the pool equipment market to ensure the exit point of one piece of equipment either aligns or matches the entrance point of any other piece of equipment. Hence, the pool plumber has been required to make the connections with custom cut-to-length pipe and a multitude of fittings. The various elevations of plumbing connection points results in the need for additional bends and turns with the associated required fittings, and often reduces hydraulic flow.

SUMMARY

[0007] Headers for heat exchangers as disclosed herein orient the position of an inlet port at an angle offset from the position of the outlet port on the header body in order to simplify the plumbing of the header within a system, for example, a pool or spa water treatment system. In one implementation of a header for a heat exchanger, the header forms a header cavity defined by an external wall and which is separated into an inlet chamber and an outlet chamber by a dividing wall. An inlet port is defined within the external wall and is in fluid communication with the inlet chamber. Similarly, an outlet port is defined within the external wall and is in fluid communication with the outlet chamber. The inlet port is oriented on the external wall at an offset angle with respect to a position of the outlet port.

[0008] In another implementation, a header for a heat exchanger has a tubular body defining a header cavity. The header also has a dividing wall separating the header cavity into an inlet chamber and an outlet chamber. A first end cap is removably attached to a first end of the tubular body to seal the inlet chamber. Similarly, a second end cap is removably attached to a second end of the tubular body to seal the outlet chamber. An inlet port is defined within the tubular body and is in fluid communication with the inlet chamber. Similarly, an outlet port is defined within the tubular body and is in fluid communication with the outlet chamber. The inlet port is oriented at a first offset angle with respect to a position of the outlet port. One or more heater outlet ports are in fluid communication with the inlet chamber and one or more heater inlet ports are in fluid communication with the outlet chamber. The heater outlet ports are positioned in a common plane with the heater inlet ports, and the heater outlet ports and the heater inlet ports are positioned at a second offset angle with respect to a position of the inlet port and a third offset angle with respect to the position of the outlet port.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a front isometric view of an implementation of a pool/spa water treatment system.

[0010] FIG. **2** is a rear isometric view of the pool/spa water treatment system shown in FIG. **1**.

[0011] FIG. **3** is a front elevation view of the pool/spa water treatment system shown in FIG. **1**.

[0012] FIG. **4** is a top plan view of the pool/spa water treatment system shown in FIG. **1**

[0013] FIG. **5** is a front isometric view of another embodiment of a pool/spa water treatment system.

[0014] FIG. **6** is a front isometric view of yet another embodiment of a pool/spa water treatment system.

[0015] FIG. **7** is a front isometric view of a prior art pool/spa water treatment system with a conventional layout.

[0016] FIG. **8** is a graph showing the head loss and power required for a pool/spa water treatment system of FIG. **1** as described herein compared to the prior art pool/spa water treatment system of FIG. **7** for various flow rates.

[0017] FIG. **9** is an isometric view of a prior art heat exchanger header having a conventional configuration.

[0018] FIG. **10** is an isometric view of an implementation of a heat exchanger header with offset inlet and outlet ports.

[0019] FIG. **11** is a schematic-style cross section taken along line **11-11** of FIG. **10**, and shows a schematic of the interior of the heat exchanger header of FIG. **10**.

[0020] FIG. **12** is an exploded view of an embodiment of a heat exchanger structure depicting the connection of inlet and outlet ports between the heat exchanger header of FIG. **10** and the heat exchanger structure and a bypass valve housed in the heat exchanger header.

[0021] FIG. **13** is a schematic end view representing the offset nature of the inlet and outlet ports for the heat exchanger header of FIG. **10**, and one range of degrees of variance therebetween.

DETAILED DESCRIPTION

[0022] Water treatment systems are described herein that may be used for a pool, spa, or other systems requiring the pumping, filtering, and/heating of water through a fluid conduit system. These treatment systems may involve incorporating any or all of the following into a pool or spa water system:

[0023] 1. Controlling inlet and outlet port elevations of the various pieces of pool equipment;

[0024] 2. Aligning the horizontal dimensions (fore and aft) to minimize crossing of plumbing;

[0025] 3. Minimizing the overall footprint of the equipment when plumbed to fit on pre-fabricated equipment pads;

[0026] 4. Providing options (multiple ports, changeable entrance and exit ports, optional plumbing sizes) to ease plumbing for the various equipment pad configurations; and

[0027] 5. Increasing the size of plumbing between equipment to allow for improved hydraulic performance (e.g., allowing up to 2½ inch plumbing connections compared to standard 2" fittings).

[0028] FIG. **1** depicts a front perspective view of first embodiment of a pool/spa water treatment system **100**, and FIG. **2** depicts a rear perspective view of the pool/spa water treatment system **100** depicted in FIG. **1**. FIG. **3** depicts a front elevation view of the pool/spa water treatment system **100** depicted in FIG. **1**, and FIG. **4** depicts a top plan view of the pool/spa water treatment system **100** depicted in FIG. **1**. With reference to FIGS. **1-4**, the pool/spa water treatment system may include a pump **105**, a pool filter **110**, a heater **115**, a chlorine generator **120**, piping, and valves **125**, **130**. An upstream valve **125** may be fluidly connected to one or more water sources, such as a pool or spa (not shown), using piping. The pump **105** may be fluidly connected to the upstream valve **125** via a pump inlet conduit assembly **135** to receive water from the one or more water sources via the upstream valve **125**. Further, the pump **105** may be fluidly connected to the pool filter **110** via a pool filter inlet conduit assembly **140**. The pool filter **110**, in turn, may be fluidly joined to the heater **115** via a heater inlet conduit assembly **145**, and the heater **115** may be in fluid communication with the chlorine generator **120** via a chlorine generator inlet conduit assembly **150**. The chlorine generator **120** may be in fluid communication with a downstream valve **130** via a chlorine generator outlet conduit assembly **155**. The downstream valve **130** may be in fluid communication with one or more fluid receiving bodies or reservoirs, such as pools or spas, via piping.

[0029] In operation, the pump **105** draws a fluid, such as water, from one or more fluid sources, such as a pool or spa, in fluid communication with the pump **105** and delivers the fluid to the pool filter **110** for filtering. Within the pool filter **110**, sediment and other particles are separated from the fluid to create a filtered fluid. The filtered fluid then flows from the pool filter **110** to the heater **115** for heating the filtered fluid to a desired temperature. The heated and filtered fluid then flows from the heater **115** to the chlorine generator **120**. Within the chlorine generator **120**, the heated and filtered fluid is chlorinated to disinfect the heated and filtered fluid. The now filtered, heated, and disinfected fluid is then delivered to one or more fluid receiving bodies or reservoirs, such as a pool or spa. The fluid receiving bodies or reservoirs may be the same, or different, than the fluid sources.

[0030] The pump **105** may take the form of any pump suitable for use in a pool, spa, or other water system, including, but not limited to, a Stealth pump, a PlusHP pump, or a MaxHp pump, all of which are sold by Jandy Pool Products, Inc. of Moorpark, Calif. and are described in the Jandy Pump Reference Guide, the Stealth Series Pumps Installation and Operation Manual, the Plus HP Series Pumps Installation and Operation Manual, and the Max HP Series Pumps Installation and Operation Manual, which are hereby incorporated herein by reference in their entireties. The pump **105** may be a variable, multiple, or fixed speed pump. The pump **105** may include a pump inlet **160** and a pump outlet **165**, which may be aligned along a first axis **168**, or within a first vertical plane **170**. Further, the pump inlet **160** may be positioned at a first elevation. The pump outlet **165** may be positioned at approximately the first elevation. The pump outlet **165** may be offset from the pump inlet **160** by ninety degrees.

[0031] The pump inlet conduit assembly **135** may include a pump inlet pipe **175**, or other fluid conduit. One end of the pump inlet pipe **175** may be joined to the pump inlet **160** for delivering fluid, such as water, to the pump **105** from a fluid source, such as a pool or spa. The opposite, or distal end, of the pump inlet pipe **175** may be joined to the upstream valve **125**, which receives fluid from one or more fluid sources for delivery to the pump inlet pipe **175**.

[0032] The pump outlet **165** may be joined to the pool filter inlet conduit assembly **140**, which delivers fluid to the pool filter **110**. The pump outlet **165** may be aligned with a pool filter inlet **180** within a second vertical plane **185**, as shown, for example, in FIG. **3**. This second vertical plane **185** may be transverse to the first vertical plane **170**. In some embodiments, the second vertical plane **185** may be perpendicular to the first vertical plane **170**. Such alignment combined with the pump outlet **165** defined on an upper portion of the pump **105** simplifies the piping connection between the pump outlet **165** and the pool filter inlet **180** since the piping plumbs within a common vertical plane. Further, such alignment helps to minimize the number of curved or bent pipe segments required to join the pump outlet **165** to the pool filter inlet **180**, which helps to reduce the head/energy losses when transporting the fluid through the piping. More particularly, generally only one sweep elbow **190** is necessary to position one or more linear pipes **195** of the pool filter inlet conduit assembly **140** at the proper elevation for connection to the pool filter inlet **180** in order to fluidly join the pump **105** to the pool filter **110**. Yet further, such alignment also minimizes the potential for this piping to cross-over other piping for a given system, thus creating a piping system that is easier to maintain.

[0033] The pool filter **110** may take the form of any fluid filter for separating solids and/or particulates from water, including, but not limited to, cartridge, sand, screen and other filters. One possible cartridge-type filter is the pool filter described in U.S. Provisional application Ser. No. 12/053,446, entitled “Pool Filter” and filed on Mar. 21, 2008, the disclosure of which is hereby incorporated herein by reference in its entirety.

[0034] The pool filter **110** may include the pool filter inlet **180** and a pool filter outlet **200**. The pool filter inlet **180** and pool filter outlet **200** may be positioned on diametrically opposite sides of the pool filter **110**. Further, the pool filter inlet **180** and pool filter outlet **200** may be positioned along a second axis **202** and/or within the second vertical plane **185**.

Yet further, the pool filter inlet **180** and the pool filter outlet **200** may be positioned at approximately a second elevation on the pool filter **110**. When the pool/spa water treatment system **100** is assembled, the difference between the first elevation for the pump outlet **165** and the second elevation of the pool filter inlet **180** and outlet **200** may be approximately the height of the elbow **190** joined to the pump outlet **165**, thus allowing for one sweep elbow to be used to position a pool filter inlet pipe **195** (or pipes) at the second elevation for fluidly joining the pool filter inlet **180** to the pump outlet **165** via the pool filter inlet conduit assembly **140**.

[0035] The pool filter inlet **180** may be joined the pool filter inlet conduit assembly **140** to receive fluid from the pump **105**. The pool filter outlet **200** may be joined to the heater inlet conduit assembly **145** to deliver filtered water to the heater **115**. As shown in FIG. **3** and as discussed above, the pool filter inlet **180** and outlet **200** may be positioned at approximately the same elevation on the pool filter **110**. Further, the pool filter inlet **180** and outlet **200** may be approximately the same size. Such a configuration and arrangement allows for the pool filter inlet **180** and outlet **200** to be, with appropriate changes to the internal connections, interchanged, thus providing flexibility in plumbing other components of a pool/spa water treatment system **100**, such as a heater **115** or pump **105**, to the pool filter **110**. Further, similar to the alignment of the pump outlet **165** with the pool filter inlet **180**, the pool filter outlet **200** may be aligned with the heater inlet **205** within the second vertical plane **185**, as shown, for example, in FIG. **2**. As described in more detail above with respect to the pump outlet **165** and the pool filter inlet **180**, such an alignment simplifies the piping connection between the pool filter outlet **200** and the heater inlet **205**, helps to reduce head/energy losses within the pool/spa water treatment system **100** (i.e., results in a system that is more efficient and/or requires less energy to pump water through it), and potentially creates an easier to maintain piping system.

[0036] The heater **115** may take the form of any suitable water heater for a pool, spa, or other fluid system. One possible heater is the LXi gas-fired pool and spa heater, sold by Jandy Pool Products, Inc. of Moorpark, Calif. The LXi gas-fired pool and spa heater is described in the Model LXi Natural Gas and LP Installation and Operation Manual, which is hereby incorporated herein by reference in its entirety.

[0037] The heater **115** may include the heater inlet **205** for receiving fluid from the pool filter **110** and a heater outlet **210**. As described above, the heater inlet **205** and the pool filter outlet **200** may be aligned within the second vertical plane **185**. Further, the heater inlet **205** may be positioned at a third elevation. Yet further, the heater inlet **205** may be aligned with the pump outlet **165** along a third axis **208**. This third axis **208** may be parallel to and vertically offset from the second axis **202**. When the system is assembled, the third elevation for the heater inlet **205** may be at approximately the same elevation as the first elevation for the pump outlet **165** as shown, for example, in FIG. **3**.

[0038] By positioning the heater inlet **205** and pump outlet **165** at a common elevation, and by also positioning the pool filter inlet **180** and the pool filter outlet **200** at the second elevation, similarly sized elbows or other curved piping for the pool filter inlet conduit assembly **140** and the heater inlet conduit assembly **145** that redirect the fluid flow from a substantially horizontal flow to a substantially vertical flow, or vice versa, may be used. The ability to use similar sized components results in cost efficiencies since multiple components of the same size can be reproduced rather than requiring either field modification or multiple tooling to be used to create different sized components. The use of similarly sized components also creates installation efficiencies since the installer can use any component of the same type rather than potentially install differently sized, but similar components, at the wrong place in the system, thus requiring undoing the installation in order to install the right component at the right location.

[0039] The heater outlet **210** may be positioned at approximately the same elevation as the heater inlet **205** (i.e., at approximately the third elevation). Positioning the heater outlet **210** at approximately the third elevation allows for ease in installing pool/spa water treatment system components downstream of the heater outlet **210**, such as a chlorine generator **120**, since the chlorine generator inlet conduit assembly **150**, as shown, for example, in FIG. **1**, will generally be at a different elevation than the heater inlet conduit assembly **145**. Further, the heater inlet **205** and the heater outlet **210** may be positioned along a fourth axis **212**, or within a third vertical plane **215**. The fourth axis **212** or third vertical plane **215** may be transverse to the second axis **202** or second vertical plane **185**, respectively. In some embodiments, the fourth axis **212** or third vertical plane **215** may be perpendicular to the second axis **202** or second vertical plane **185**, respectively. In such embodiments, the fourth axis **212** or third vertical plane **215** may be generally parallel to the first axis **168** or first vertical plane **170**, respectively.

[0040] The chlorine generator **120** may take the form of any suitable system for chlorinating fluid in a pool, spa, or other fluid system. One possible chlorine generator is the chlorine generator described in U.S. patent application Ser. No. 11/346,650, entitled "Multi-Port Chlorine Generator" and filed on Feb. 3, 2006, the disclosure of which is incorporated herein by reference in its entirety.

[0041] The chlorine generator **120** may include a chlorine generator inlet **220** for receiving fluid from the heater **115**. The chlorine generator **120** may further include a chlorine generator outlet **225** for delivering chlorinated fluid from the chlorine generator to the downstream valve **130** for distribution to water bodies or reservoirs, such as pool or spa reservoirs. The chlorine generator inlet **220** and the chlorine generator outlet **225** may be positioned at a fourth elevation. When the pool/spa water treatment system **100** is assembled, the fourth elevation may be approximately the same as the first and/or third elevations. When the third and fourth elevations are approximately the same, elbows or other bent piping elements are not needed to change to elevation of the piping for the chlorine generator inlet conduit assembly **155** used to join the chlorine generator inlet **220** to the heater outlet **210**. Yet further, the chlorine generator inlet **220** and the chlorine generator outlet **225** may be aligned along a fifth axis **228**, or within a fourth vertical plane **230**. The fifth axis **228** or fourth vertical plane **230** may be transverse to the second axis **202** or second vertical plane **185**, respectively. In some embodiments, the fifth axis **228** or fourth vertical plane **230** may be generally perpendicular to the second axis **202** or second vertical plane **185**, respectively. In such embodiments, the fifth axis **228** or fourth vertical plane **230** may be generally parallel to either or both of the first and fourth axes **168**, **212** or the first and third vertical planes **170**, **215**, respectively.

[0042] The upstream valve **125** may take the form of a diverter valve. A possible diverter valve for use in the pool/spa water treatment system **100** is described in U.S. patent application Ser. No. 11/681,015, entitled "Diverter Valve" and filed on Mar. 1, 2007, the disclosure of which is hereby incorporated herein by reference in its entirety. However, any type of diverter or other suitable valve may be used. Further, the number of inlets and outlets may be more or less than three. Yet further, the valve may be closed manually, or may be configured to close automatically used an actuator, such as a Jandy Valve Actuator manufactured by Jandy Pool Products of Moorpark, Calif. Still yet further, the valve may operatively connected to a controller or other control system for controlling the opening and closing of the various fluid communications within the pool/spa water treatment system **100** using the diverter valve or the like.

[0043] With continued reference to FIGS. **1** and **2**, the diverter valve may include a diverter valve outlet **235** or port fluidly connected to the pump inlet pipe **175** for delivering fluid from the diverter valve to the pump inlet pipe **175**. The diverter valve may also include two diverter valve fluid inlets **240**, **245** with each diverter valve fluid inlet fluidly connected to a diverter valve inlet conduit assembly **250** for delivering fluid to the diverter valve from fluid sources remote from the diverter valve. The diverter valve may further include a handle joined to a valve closing member (not shown) contained with a fluid chamber (also not shown) defined by a diverter valve body. The handle may be selectively moved to open or close fluid communication, using the valve closing member, between the fluid chamber and the various inlets and/or outlets that receive and deliver fluid to and from the diverter valve via the fluid chamber.

[0044] The diverter valve inlets **240**, **245** and outlet **235** may be positioned at a fifth elevation. When the pool/spa water treatment system **100** is assembled, the fifth elevation may be approximately the same as the first elevation. Such positioning allows the diverter valve outlet **235** to be joined to the pump inlet **160** without the use of any elbows or the like to change the vertical location of the pump inlet pipe **175** (or pipes) that fluidly join the diverter valve outlet **235** to the pump inlet **160**. Yet further, the diverter valve outlet **235** and the pump inlet **160** may be aligned along the first axis **168** or within the first vertical plane **170**.

[0045] Valves other than diverter valves may also be used for the upstream valve **125**. For example, the diverter shown in the figures may be replaced with a check valve. Possible check valves for use in the pool/spa water treatment system **100** are described in U.S. Pat. Nos. 4,470,429 and 6,247,489, the disclosures of which are incorporated herein by reference in their entireties. However, any type of check valve, or other type of valve, may be used.

[0046] The downstream valve **130** may be substantially similar to the upstream valve **125**. However, the downstream valve **130** may include one inlet **255** for receiving fluid from the chlorine generator **120** (or from another component of the pool/spa water treatment system, such as the heater **115** as shown in FIG. **5**, or the pool filter **110**), and two outlets **260**, **265** in fluid communication with a pool, spa or other water receiving system. The downstream valve inlet **255** and outlets **260**, **265** may be positioned at a sixth elevation. When the system is assembled, the sixth elevation may be approximately the same as the fourth elevation for the chlorine generator inlet **220** and outlet **225**. Such positioning allows the downstream valve inlet **255** to be joined to the chlorine generator outlet **225** without the use of any elbows or the like to change the vertical location of the piping for the chlorine generator outlet conduit assembly **155** that fluidly joins the downstream valve inlet **255** to the chlorine generator outlet **225**. Yet further, the downstream valve inlet **255** and the chlorine generator outlet **225** may be aligned along the fifth axis **228** or within the fourth vertical plane **230**.

[0047] The pool filter inlet conduit assembly **145** may include two or more piping components or segments, with one end portion of the pool filter inlet conduit assembly **140** joined to the pump outlet **165** and the other end portion joined to the pool filter inlet **180**. With reference to FIGS. **1** and **2**, the pool filter inlet conduit assembly **140** may include the sweep elbow **190** and the linear pipe **195**. A first substantially linear portion of the sweep elbow **190** extends upward from the pump outlet **165** and then curves in a sweeping arc to place a second substantially linear portion of the sweep elbow **190** at substantially the same elevation as the pool filter inlet **180**. From this curved portion, the sweep elbow **190** extends laterally away from the pump **105** and towards the pool filter inlet **180**, where it is joined to the linear pipe **195**. The linear pipe **195**, which may be positioned at substantially the same vertical elevation as the pool filter inlet **180** (i.e., at the second elevation), extends from the sweep elbow **190** to the pool filter inlet **180**. At the pool filter inlet **180**, the linear pipe **195** is joined to the pool filter inlet **180** using a coupling member **270**, such as a threaded coupling nut, or by any other suitable connection method, including, but not limited to, press fitting, heat or sonic welding, adhering, and so on.

[0048] The heater inlet conduit assembly **145** may be similar to the pool filter inlet conduit assembly **140** (i.e., the heater inlet conduit assembly **145** may include an elbow, such as a 90 degree or sweep elbow, or other curved piping component, one or more linear pipes and one or more coupling members) except one end portion is joined to the pool filter outlet **200** and the other end is joined to the heater inlet **205**. The chlorine generator inlet conduit assembly **150** may also be similar to the pool filter inlet conduit assembly **140** (i.e., the chlorine generator inlet conduit assembly **150** may include an elbow, such as a 90 degree or sweep elbow, or other curved piping component, one or more linear pipes and one or more coupling members) except one end portion is joined to the heater outlet **210** and the other end portion is joined to the chlorine generator inlet **220**. The chlorine generator outlet conduit assembly **155** may include a linear pipe and coupling members for joining the linear pipe to the chlorine generator outlet **225** and the downstream valve inlet **255**.

[0049] The inlets and outlets for the valves **125**, **130**, the pump **105**, the pool filter **110**, the heater **115**, and the chlorine generator **120** may each be approximately the same size. By using a similar size for each of the inlets and outlets, the piping and other plumbing fluidly joining the various components of the pool/spa water treatment system **100** may be standardized. Such standardization may result in both manufacturing and installation efficiencies for similar reasons described above with respect to the elbows used for changing fluid direction. Further standardization results by arranging the components of the pool/spa water treatment system **100** within a predetermined area (or on a predetermined pad size) in a consistent and repeatable layout, which allows for the same number and length of piping components to be used to join the components together for each installed pool/spa water treatment system **100**.

[0050] FIG. **5** depicts a second embodiment of a pool/spa water treatment system **300**. The second embodiment is similar to the first embodiment except the chlorine generator and associated plumbing/piping are omitted. FIG. **6** depicts a third embodiment of a pool filter treatment system **400**. The third embodiment is similar to the first embodiment, except the chlorine generator, the heater, and associated plumbing/piping are omitted.

[0051] FIG. **7** depicts a prior art pool/spa water treatment system **500** showing the piping in a conventional layout. In particular, the inlet **505** and outlet **510** for the pool filter **515** are located on the same side of the pool filter **515**, and the header **520** for the heater **525** is a conventional header, such as the header **520** shown in FIG. **9**. Because of the location of these pool filter inlet **505** and outlet **510** on the pool filter **515** and the orientation of the header inlet **530** and outlet **535**, additional elbows and piping are required to deliver water from the pool filter outlet **510** to the heater inlet **530** as compared to the first embodiment of the pool/spa water treatment system **100**.

[0052] To compare the efficiencies of these two pool/spa water treatment systems **100**, **500**, each system was modeled using the same components for the pump, pool filter, heat exchanger, chlorine generator, valves, and using the same diameter openings and fluid passages for piping and elbows. However, in the conventional system **500** setup, a conventional header **520**, as shown in FIG. **9**, for the heater was used, while in the first embodiment **100** setup, a header as shown in FIGS. **1** and **10** and as described in more detail below was used to supply and receive water from the heater. Further, in the conventional system **500** setup, the pool filter inlet and outlet were positioned on the same side of the pool filter. As a result of these differences between the two systems, the conventional system required nine elbow or curved pipe components compared to three elbow or curved pipe components for the first embodiment of the pool/spa water treatment system **100** in order to fluidly connect the pump, pool filter, heater, and chlorine generator. Further, to fit the components of the conventional system **500** within an area similar to that of the first embodiment of the pool/spa water treatment system **100**, the conventional system required extensive use of ninety degree elbows. In contrast, sweep elbows rather than ninety degree elbows could generally be used in the first embodiment of the pool/spa water treatment system **100** for the area available for setting up the pool/spa water treatment system.

[0053] To determine the head loss in each system, pressure gauges were placed upstream of the upstream valve (P**1**), between the upstream valve and the pump inlet (P**2**), between the pump outlet and the pool filter inlet (P**3**), and downstream of the downstream valve (P**4**). The pressure at these points were measured for each system at various flow rates. The head loss for each flow rate was calculated using the following equation: [(P**1**−P**2**)+(P**3**−P**4**)]×2.3067. Table 1 below summarizes the measured pressures and the calculated head loss at various flow rates for the first embodiment of the pool/spa water treatment system **100**, and Table 2 below summarizes the measured pressures and the calculated head loss at various flow rates for the conventional pool/spa water treatment system **500**. The head loss vs. flow rate for each system as shown in Tables 1 and 2 is plotted on the graph shown in FIG. **8**.

TABLE 1

Flow Rate vs. Head Loss
1st Embodiment of Pool/Spa Water Treatment System

Flow (gpm)	P1 (psi)	P2 (psi)	P3 (psi)	P4 (psi)	Head Loss (feet)
159.2	0.04	−0.52	17.00	3.57	32.3
150.9	0.04	−0.50	18.78	6.54	29.5
139.2	0.04	−0.49	21.01	10.17	26.2
129.5	0.15	−0.36	23.89	14.61	22.6
121.7	0.33	−0.11	25.82	17.58	20.0
109.7	0.58	0.26	28.24	21.37	16.6
100.1	0.78	0.49	30.37	24.49	14.3
92.9	0.92	0.69	31.74	26.81	11.9
80.5	1.10	0.97	33.53	29.53	9.5
71.4	1.25	1.19	35.00	31.96	7.2
59.6	1.38	1.36	35.99	33.70	5.3
50.9	1.48	1.45	36.50	34.67	4.3
39.7	1.59	1.64	37.09	35.80	2.9
29.3	1.66	1.73	37.13	36.32	1.7
20.8	1.69	1.75	36.75	36.27	1.0

TABLE 2

Flow Rate vs. Head Loss
Conventional Pool/Spa Water Treatment System

Flow (gpm)	P1 (psi)	P2 (psi)	P3 (psi)	P4 (psi)	Head Loss (Feet)
141.0	−0.38	−2.03	20.80	3.39	44.0
130.6	−0.08	−1.84	23.51	8.50	38.7
119.8	0.17	−1.29	26.03	13.29	32.8
110.4	0.40	−0.94	28.27	17.22	28.6
101.0	0.59	−0.42	30.33	20.67	24.6
89.5	0.80	0.14	32.48	24.53	19.8
78.6	0.96	0.40	33.99	27.51	16.3
70.9	1.11	0.63	35.12	29.66	13.7
60.6	1.22	0.92	35.93	31.68	10.5
50.5	1.32	1.14	36.45	33.09	8.1
39.6	1.41	1.24	36.73	34.09	6.5
29.9	1.50	1.45	36.39	34.91	3.5
20.3	1.54	1.58	36.62	36.00	1.3

[0054] Additionally, the power required to move fluid through each system was also recorded at various flow rates for each system. Table 3 below summarizes the power required at various flow rates for the first embodiment of the pool/spa water treatment system **100**, and Table 4 below summarizes the power required at various flow rates for the conventional pool/spa water treatment system **500**. The required power vs. flow rate for each system as shown in Tables 3 and 4 is also plotted on the graph shown in FIG. **8**.

TABLE 3

Flow Rate vs. Power
1st Embodiment of Pool/Spa Water Treatment System

Flow (gpm)	Power (watts)
159.2	2130
150.9	2110
139.2	2090
129.5	2065
121.7	2035
109.7	1995
100.1	1940
92.9	1890
80.5	1815

TABLE 3-continued

Flow Rate vs. Power 1st Embodiment of Pool/Spa Water Treatment System	
Flow (gpm)	Power (watts)
71.4	1730
59.6	1650
50.9	1570
39.7	1440
29.3	1330
20.8	1245

TABLE 4

Flow Rate vs. Power Conventional Pool/Spa Water Treatment System	
Flow (gpm)	Power (watts)
141.0	2195
130.6	2145
119.8	2100
110.4	2035
101.0	1985
89.5	1895
78.6	1815
70.9	1735
60.6	1625
50.5	1525
39.6	1420
29.9	1310
20.3	1215

[0055] With reference to FIG. **8** and Tables 1 and 2, the head loss in the conventional pool/spa water treatment system **500** is greater than the head loss in the first embodiment of the pool/spa water treatment system **100** for all flow rates. Further, as the flow rate increases, the difference in head loss between the conventional system and first embodiment increases. With reference to FIG. **8** and Tables 3 and 4, the required power for the conventional pool/spa water system **500** and the first embodiment of the pool/spa water treatment system **100** is approximately the same for flow rates less than 80 gallons per minute ("g.p.m."). At flow rates above 80 g.p.m., the first embodiment of the pool/spa water treatment system **100** requires less power than the conventional pool/spa water treatment system **500**.

[0056] In other words, it takes less power for the first embodiment of the pool/spa water treatment system **100** to achieve the same flow rate as the conventional pool/spa water treatment system **500**, especially for larger flow rates. Another way of stating this is that at the same power, the first embodiment of the pool/spa water treatment system **100** provides a greater flow rate than the conventional pool/spa water treatment system **500**. This, in turn, means that a pool or spa owner can use less overall power to turn-over the water in their pool or spa using the first embodiment of the pool/spa water treatment system **100** compared to the conventional pool/spa water treatment system **500**. For example, it is recommended that a pool owner turn-over the water in their pool twice a day. Continuing with the example, for a fixed speed pump, the amount of power supplied by the pump is constant. Because the first embodiment of the pool/spa water treatment system **100** that uses this pump has a higher flow rate for turning over the water in the pool at the given power for the pump than the conventional pool/spa water treatment system **500** that uses the same pump, the first system **100** will turnover the pool water faster, thus reducing the amount of time and hence the overall power consumed by the pump. As yet another example, for a variable or multiple speed pump, because the pump can supply more water at a given speed in the first embodiment of the pool/spa water treatment system **100** compared to the conventional pool/spa water treatment system **500**, the pump can be operated using less overall energy when turning over water at the same rate in each system. Moreover, because pool water should be turned-over twice a day, these time and power savings achieved in the first embodiment of the pool/spa water treatment system **100**, whether it utilizes a fixed, multiple or variable speed pump, may be substantial over time.

[0057] FIG. **10** shows one implementation of a heat exchanger header **600** for a heater. In this implementation, the heat exchanger header **600** has the inlet and outlet **605**, **610** ports aligned at right angles to one another. This offset orientation facilitates more efficient layout of the inlet and outlet tubing connected to these ports **605**, **610**, respectively, allowing for less cross-over tubing, fewer right-angles, and other possible efficiencies. This layout benefit likely allows the components upstream and downstream of the heat exchanger to be positioned more closely together with simpler piping layouts, allowing for easier access and thus more efficient maintenance and replacement of components.

[0058] To obtain this advantage, the offset in the inlet and outlet ports **605**, **610** do not need to be separated by ninety degrees only. Greater or fewer degrees of separation may provide the same benefit, depending on the size of the header structure, the size of the ports, and the size of the tubing used in the layout.

[0059] The header **600** defines two chambers separated by an internal wall **635** as shown in FIG. **11**. With reference to FIGS. **10** and **11**, the inlet chamber **615** is on the left and the outlet chamber **620** is on the right. The lateral ends of the inlet chamber **615** and the outlet chamber **620** are sealed off by selectively removable caps **625**, **630** (see FIG. **12**). In this embodiment the caps **625**, **630** are received on the lateral ends by a screw-thread engagement. Other types of engagement may be used, such as press fit, plastic welding, adhesive, epoxy, or other means which may or may not allow the cap(s) to be removed.

[0060] The internal wall **635** that separates the inlet and outlet chambers **615**, **620** may have an aperture **640** therein (shown in FIG. **11**). A bypass valve **645** may be operably associated with the aperture **640** to allow for water to flow directly from the inlet chamber **615** to the outlet chamber **620**, bypassing the heat exchanger all together. The bypass valve **645**, such as that shown in FIG. **12**, may be actuated automatically by reacting to water pressure, water flow speed, or external control by a user or automated control system. The bypass valve **645** sensitivity and response characteristics may be altered to adjust its performance. The bypass valve structure **645** in FIG. **12** utilizes a spring force that can be adjusted to affect when the bypass valve **645** is actuated. The bypass valve **645** is attached to the outlet cap **630** used to close off the outlet chamber **620**. The bypass valve **645** is positioned over the aperture **640** in the wall when the outlet cap **630** is positioned on the header **600** to enclose the outlet chamber **620**. The bypass valve **645** can be adjusted by a user or by an automatic control system by increasing or decreasing the spring force of the spring **650**, as is known in the art. One suitable bypass valve **645** is by Jandy Pool Products, Inc. The bypass valve **645** may be associated with the inlet cap **625**, or may not be operably associated with either cap, and instead may be configured independent of either the inlet or outlet caps **625**, **630**.

[0061] The inlet cap **625** may include various sensors, such as pressure sensors, temperature sensors, and the like to monitor the flow of water and the condition of the water flowing into the header **600**. The outlet cap **630** may include similar sensors.

[0062] A plurality of ports **655** *a-h* extend off the rear wall of each chamber **615**, **620**. For the ports **655** *a-d* associated with the inlet chamber **615**, each of these ports **655***a-d* aligns with a particular inlet tube **660***a-d* in the heat exchanger. For the ports **655***e-h* associated with the outlet chamber **620**, each of these ports **655***e-h* aligns with a particular outlet tube **660***e-h* from the heat exchanger. This particular header **600** includes four ports each for the inlet and outlet chambers **615**, **620**, and is for use on a C-Fin heat exchanger by Jandy Pool Products, Inc. Other configurations of the header **600** may include ports **655** designed to mate with the particular heat exchanger with which the header **600** is to be used.

[0063] Other ports may be formed in the header **600** and associated with either or both of the inlet and outlet chambers **615**, **620** for various purposes. For instance, the collar **665** formed above the output port **610** from the header **600** is threaded internally (or externally) for receipt of a pressure relief valve. If this collar **665** is to be used, an aperture must be formed through the sidewall of the header **600**, inside the collar, to communicate with the outlet chamber **620**. The other ports **670** formed in the bottom of the header **600** may be used as drain plugs or for the insertion of other sensors or devices for use with the inlet and/or outlet chambers **615**, **620**.

[0064] The offset inlet and outlet ports **605**, **610** on the header **600** allow the piping attached to each port **605**, **610** to be laid out in a more efficient manner, allowing the use of fewer right-angle corner tubes, and more sweep tubes. Also, the configuration of the inlet and outlet ports **605**, **610** allows for a piping layout having fewer turns. FIG. **13** shows one example of the range of offset for the inlet and outlet ports. Angle ϕ in FIG. **13** is shown as 90 degrees. However, angle ϕ may be less or more than 90 degrees depending on the layout. One benefit of the angle ϕ being sufficient to keep the inlet port **605** from overlapping the outlet port **610** in this view is that the piping extending from each port can pass by one another without using any additional bends or curves. If the angle ϕ is small enough (or large enough if angle ϕ were obtuse in FIG. **13**) so that the ports overlapped any amount (hereafter "minimum angle ϕ"), in this view, this benefit would not be present, however it would still be superior to an arrangement where the inlet and outlet ports were parallel to one another in the same plane as in FIG. **9**. The minimum angle ϕ is dependent upon the size and shape of the port (typically the diameter dimension for a circular port (D_{port})), and the size and shape of the header body (if cylindrical, then the diameter dimension (D_{header})) as in FIG. **13**). The ports **605**, **610** do not have to have the same diameter, and the header **600** may have a varying cross section along its length, or may not be cylindrical. Either port, the inlet **605** or the outlet **610**, may extend directly forward in the configuration of FIG. **10**, and the other may be offset. Also, there may be more than one inlet port, or more than one outlet port, or both, on a header **600**. The plurality of inlet and outlet ports in this case may be all offset relative to one another, or may be in partial or full alignment based on function.

[0065] Some of the benefits of the offset header inlet and outlet ports include, but are not limited to the following:

[0066] a) the ability to control the inlet and outlet port elevations of the various pieces of the pool equipment, in this case the heater equipment, in relation to the filter and/or the salt chlorine generator, and pool valves;

[0067] b) align where possible the horizontal dimensions (fore and aft) to ensure the inlet and outlet connections are in different planes so that the plumbing does not need to cross, and special field adjustments are not made; and

[0068] c) allow for the use of "sweep" elbows for improved hydraulic performance. Sweep elbows are tubing having a smooth curve of 90 degrees (or more or less) with a relatively large radius of curvatures as opposed to a small, tight right-angle shape. The sweep elbows are believed to provide less backpressure and are believed to be more hydraulically efficient.

[0069] The piping and plumbing connection for the pool/spa water treatment system may be made from any suitable material, including, but not limited to, plastic (e.g., PVC), metal, fiberglass, and so on.

[0070] All directional references (e.g., upper, lower, upward, downward, left, right, leftward, rightward, top, bottom, above, below, vertical, horizontal, clockwise, and counterclockwise) are only used for identification purposes to aid the reader's understanding of the embodiments of the present invention, and do not create limitations, particularly as to the position, orientation, or use of the invention unless specifically set forth in the claims. Joinder references (e.g., attached, affixed, coupled, connected, and joined) are to be construed broadly and may include intermediate members between a connection of elements and relative movement between elements. As such, joinder references do not necessarily infer that two elements are directly connected and in fixed relation to each other.

[0071] In some instances, components are described with reference to "ends" having a particular characteristic and/or being connected with another part. However, those skilled in the art will recognize that the present invention is not limited to components which terminate immediately beyond their points of connection with other parts. Thus, the term "end" should be interpreted broadly, in a manner that includes areas adjacent, rearward, forward of, or otherwise near the terminus of a particular element, link, component, part, member or the like. In methodologies directly or indirectly set forth herein, various steps and operations are described in one possible order of operation, but those skilled in the art will recognize that steps and operations may be rearranged, replaced, or eliminated without necessarily departing from the spirit and scope of the present invention. It is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative only and not limiting. Changes in detail or structure may be made without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. A header for a heat exchanger comprising

a header cavity defined by an external wall and separated into an inlet chamber and an outlet chamber by a dividing wall;

an inlet port defined within the external wall in fluid communication with the inlet chamber; and

an outlet port defined within the external wall in fluid communication with the outlet chamber; wherein the inlet port is oriented on the external wall at an offset angle with respect to a position of the outlet port.

2. The header for the heat exchanger of claim **1**, wherein the offset angle is 90 degrees.

3. The header for the heat exchanger of claim **1**, wherein the offset angle is 180 degrees.

4. The header for the heat exchanger of claim **1** further comprising

one or more heater outlet ports in fluid communication with the inlet chamber; and

one or more heater inlet ports in fluid communication with the outlet chamber.

5. The header for the heat exchanger of claim **4**, wherein the heater outlet ports are positioned at a second offset angle with respect to a position of the heater inlet ports.

6. The header for the heat exchanger of claim **4**, wherein the heater outlet ports are positioned in a common plane with the heater inlet ports.

7. The header for the heat exchanger of claim **6**, wherein the heater outlet ports and the heater inlet ports are positioned at a second offset angle with respect to a position of the inlet port and a third offset angle with respect to the position of the outlet port.

8. The header for the heat exchanger of claim **1**, wherein

the dividing wall further defines an aperture; and

the header further comprises a bypass valve operably associated with the aperture to allow water to flow directly from the inlet chamber to the outlet chamber upon actuation of the bypass valve.

9. The header for the heat exchanger of claim **8**, wherein the bypass valve is actuated by one or more of fluid pressure, fluid temperature, fluid flow speed, manual actuation, or control system actuation.

10. The header for the heat exchanger of claim **1**, wherein the offset angle is dependent upon a diameter of each of the inlet port, the outlet port, and the header cavity and is selected to prevent overlap in position between the inlet port and the outlet port on the external wall.

11. A header for a heat exchanger comprising

a tubular body defining a header cavity;

a dividing wall separating the header cavity into an inlet chamber and an outlet chamber;

a first end cap removably attached to a first end of the tubular body to seal the inlet chamber;

a second end cap removably attached to a second end of the tubular body to seal the outlet chamber;

an inlet port defined within the tubular body in fluid communication with the inlet chamber;

an outlet port defined within the tubular body in fluid communication with the outlet chamber; wherein

the inlet port is oriented at a first offset angle with respect to a position of the outlet port;

one or more heater outlet ports in fluid communication with the inlet chamber; and

one or more heater inlet ports in fluid communication with the outlet chamber, wherein

the heater outlet ports are positioned in a common plane with the heater inlet ports; and

the heater outlet ports and the heater inlet ports are positioned at a second offset angle with respect to a position of the inlet port and a third offset angle with respect to the position of the outlet port.

12. The header for the heat exchanger of claim **11**, wherein the first offset angle is 90 degrees, the second offset angle is 180 degrees, and the third offset angle is 90 degrees.

13. The header for the heat exchanger of claim **11**, wherein

the dividing wall further defines an aperture; and

the header further comprises a bypass valve operably associated with the aperture to allow water to flow directly from the inlet chamber to the outlet chamber upon actuation of the bypass valve.

14. The header for the heat exchanger of claim **13**, wherein the bypass valve is actuated by one or more of fluid pressure, fluid temperature, fluid flow speed, manual actuation, or control system actuation.

15. The header for the heat exchanger of claim **11**, wherein the first offset angle is dependent upon dimensions of each of the inlet port, the outlet port, and the header cavity and is selected to prevent overlap in position between the inlet port and the outlet port on the tubular body.

16. The header for the heat exchanger of claim **11**, wherein one or both of the first end cap and the second end cap further comprises one or more sensors to monitor a condition of a fluid within one or both of the inlet chamber and the outlet chamber, respectively.

17. The header for the heat exchanger of claim **11** further comprising one of more drain apertures defined in the tubular body in fluid communication with either or both of the inlet chamber and the outlet chamber.

18. The header for the heat exchanger of claim **11** further comprising a pressure release aperture in the tubular body in fluid communication with the outlet chamber.

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