US 20060021745A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0021745 A1**

Fritze et al. (43) **Pub. Date: Feb. 2, 2006**

(54) **HEAT EXCHANGER AND FLUID RESERVOIR**

(76) Inventors: **Karl Fritze**, Denmark Township, MN (US); **William J. Meuleners**, Webster, MN (US)

Correspondence Address:
CUNO INCORPORATED
400 RESEARCH PARKWAY
P. O. BOX 1018
MERIDEN, CT 06450-1018 (US)

(21) Appl. No.: **11/191,608**

(22) Filed: **Jul. 28, 2005**

Related U.S. Application Data

(60) Provisional application No. 60/591,646, filed on Jul. 28, 2004. Provisional application No. 60/604,952, filed on Aug. 27, 2004. Provisional application No. 60/634,621, filed on Dec. 9, 2004.

Publication Classification

(51) **Int. Cl.**
F28F 1/10 (2006.01)

(52) **U.S. Cl.** **165/172**; 62/903

(57) **ABSTRACT**

Improved fluid reservoir designs providing for little or no dead volume or un-swept volume while providing efficient heat exchange are disclosed. Representative fluid reservoirs can have a serpentine flow passage with a cross-section selected such that fluid flow sweeps the entire cross-sectional volume while reducing or eliminating dead volume. The cross-sectional shape of the flow passage can be selected to have a larger surface contact with the cooling environment relative to circular cross-sections. The fluid reservoirs can be molded from two sheets of polymer material that are joined to form the fluid reservoir. Alternatively, the fluid reservoir can be formed from flexible polymer materials that are bonded along seams to demarcate a flow channel. Fluid reservoirs can be located either upstream or downstream of a filtering system to provide chilled filtered liquid. Fluid reservoirs can be associated with an appliance, such as a refrigerator. Methods of fabricating the fluid reservoirs are also disclosed.

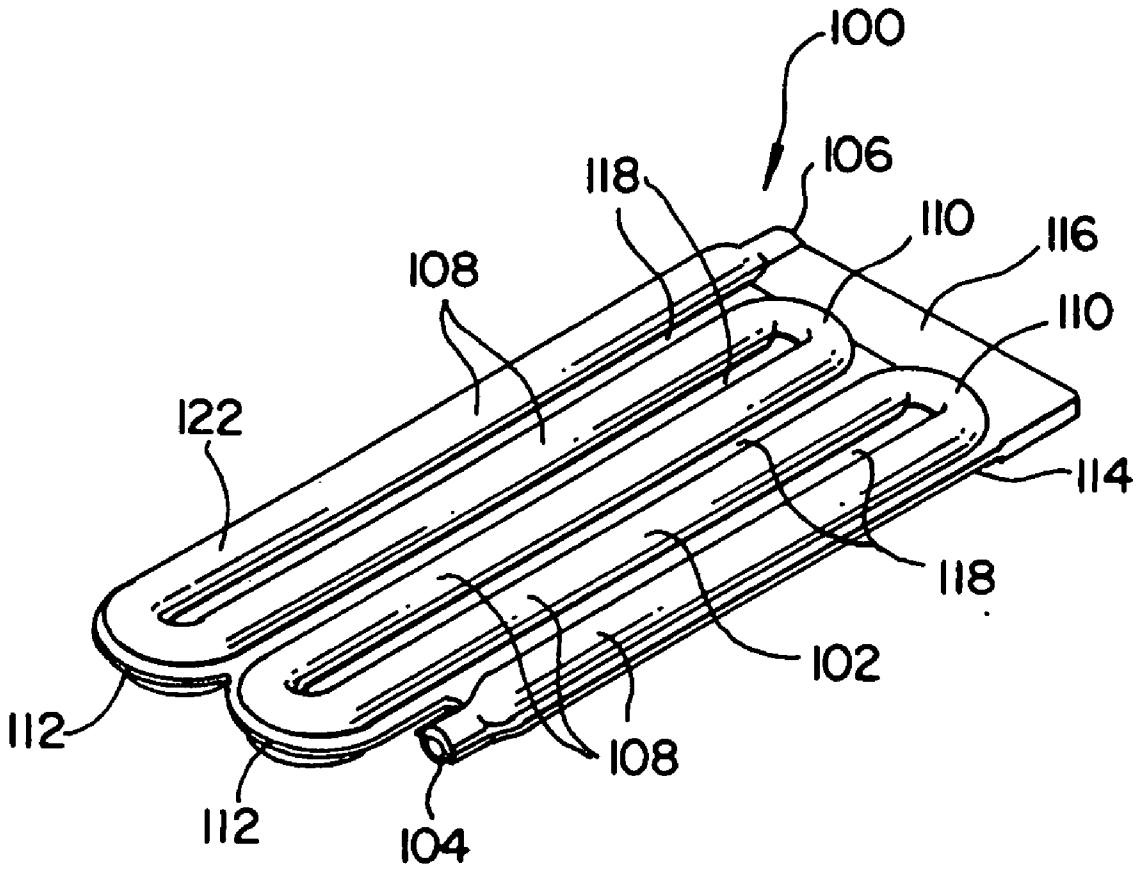
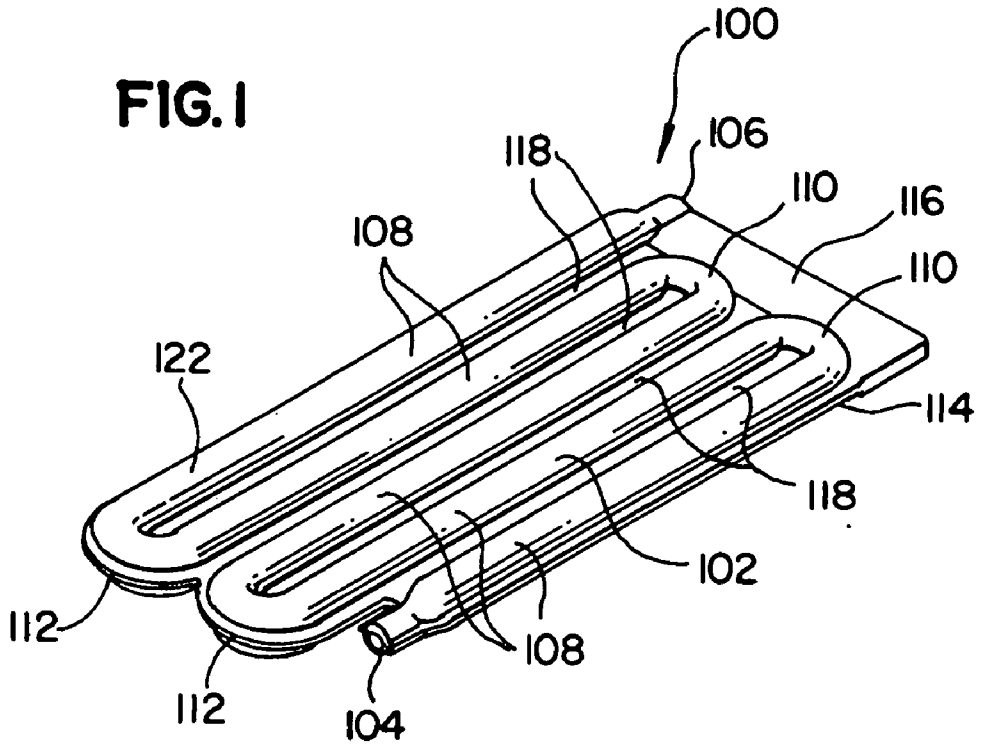


FIG. 1


100
106
118
110
116
108
110
122
114
118
102
112
108
112
104

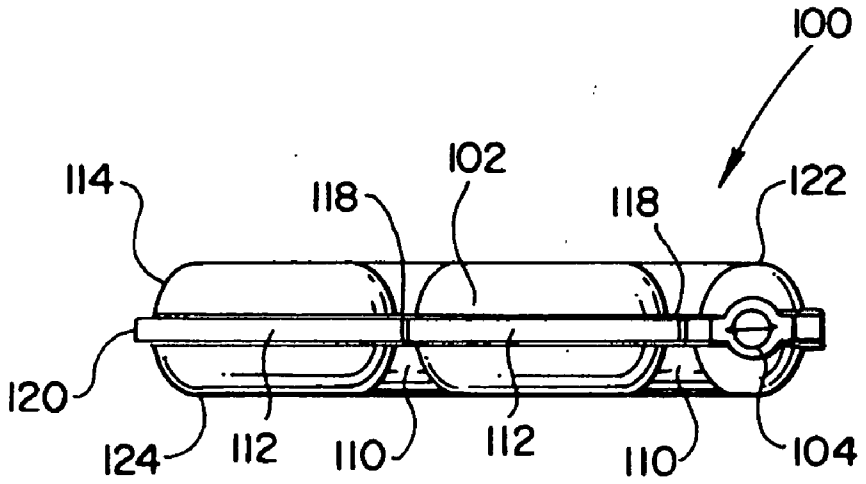

100
114
102
118
118
122
120
124
112
110
112
110
104

FIG. 2

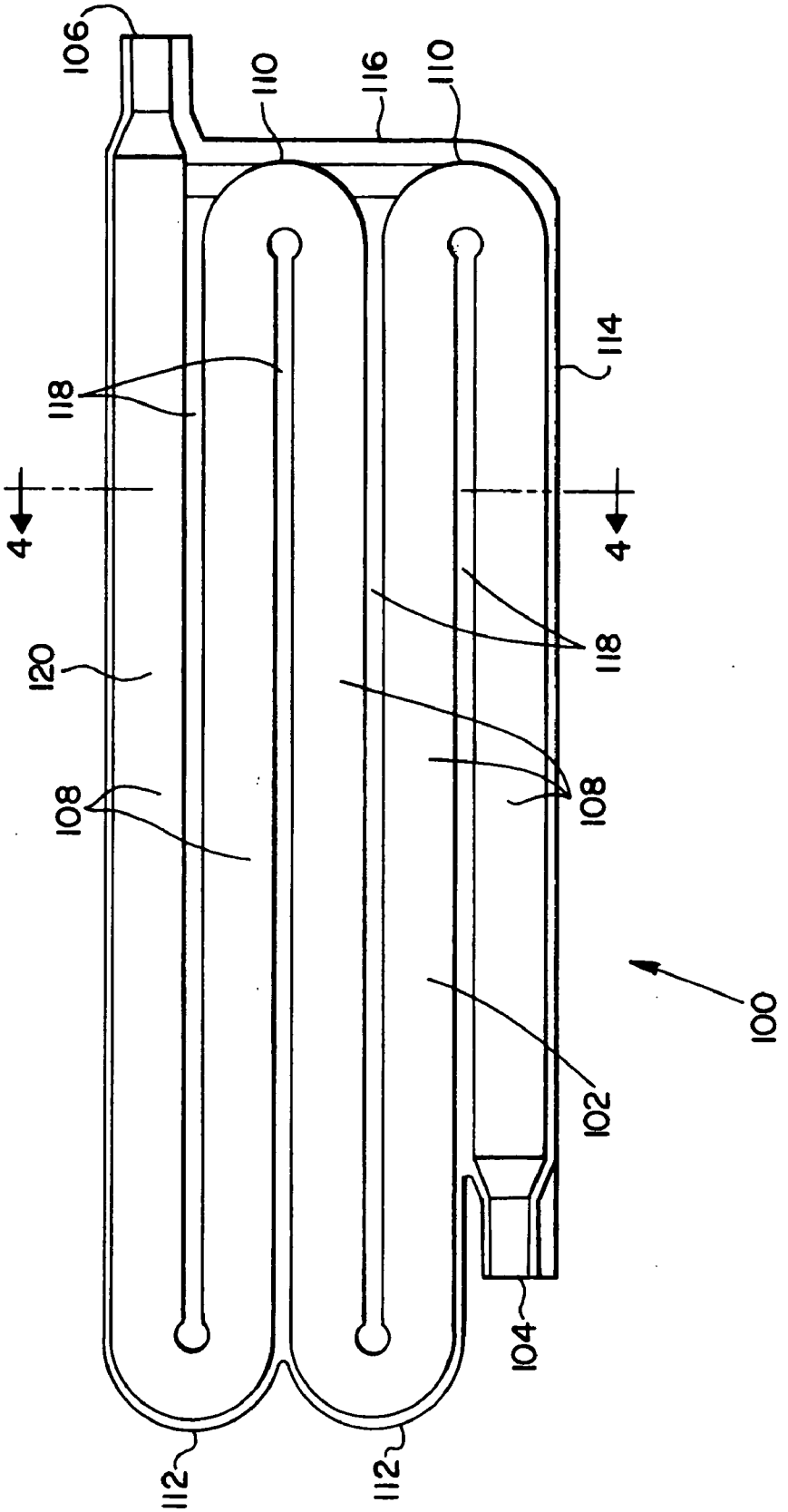


FIG. 3

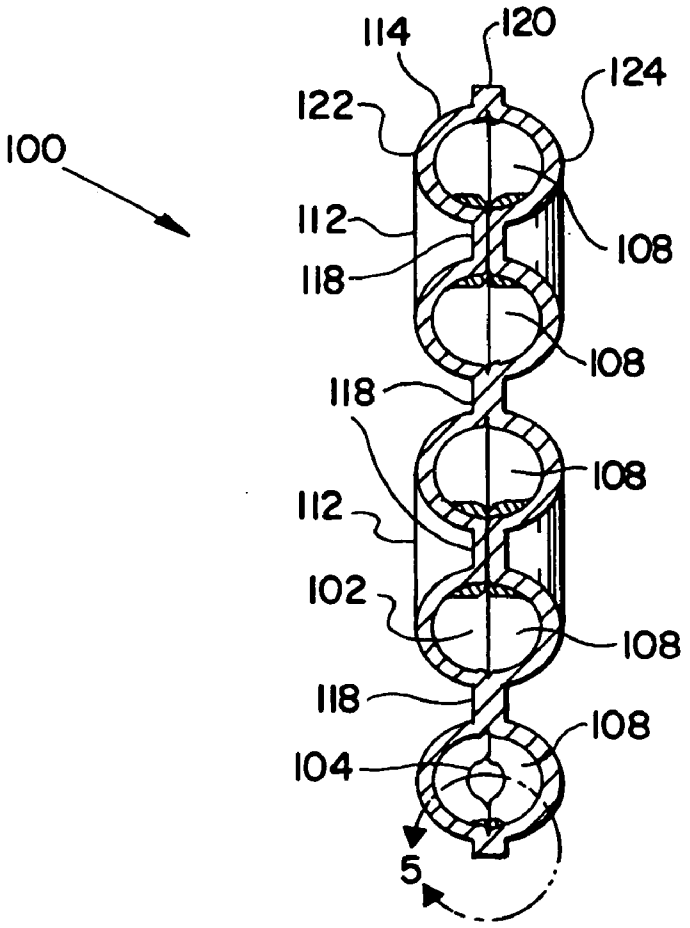

100
114
120
124
122
112
108
118
108
118
108
112
102
108
118
108
104
5

FIG. 4

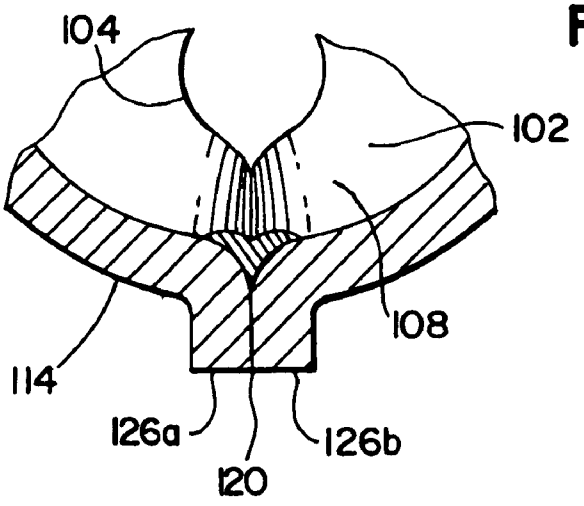

104
102
108
114
126a
126b
120

FIG. 5

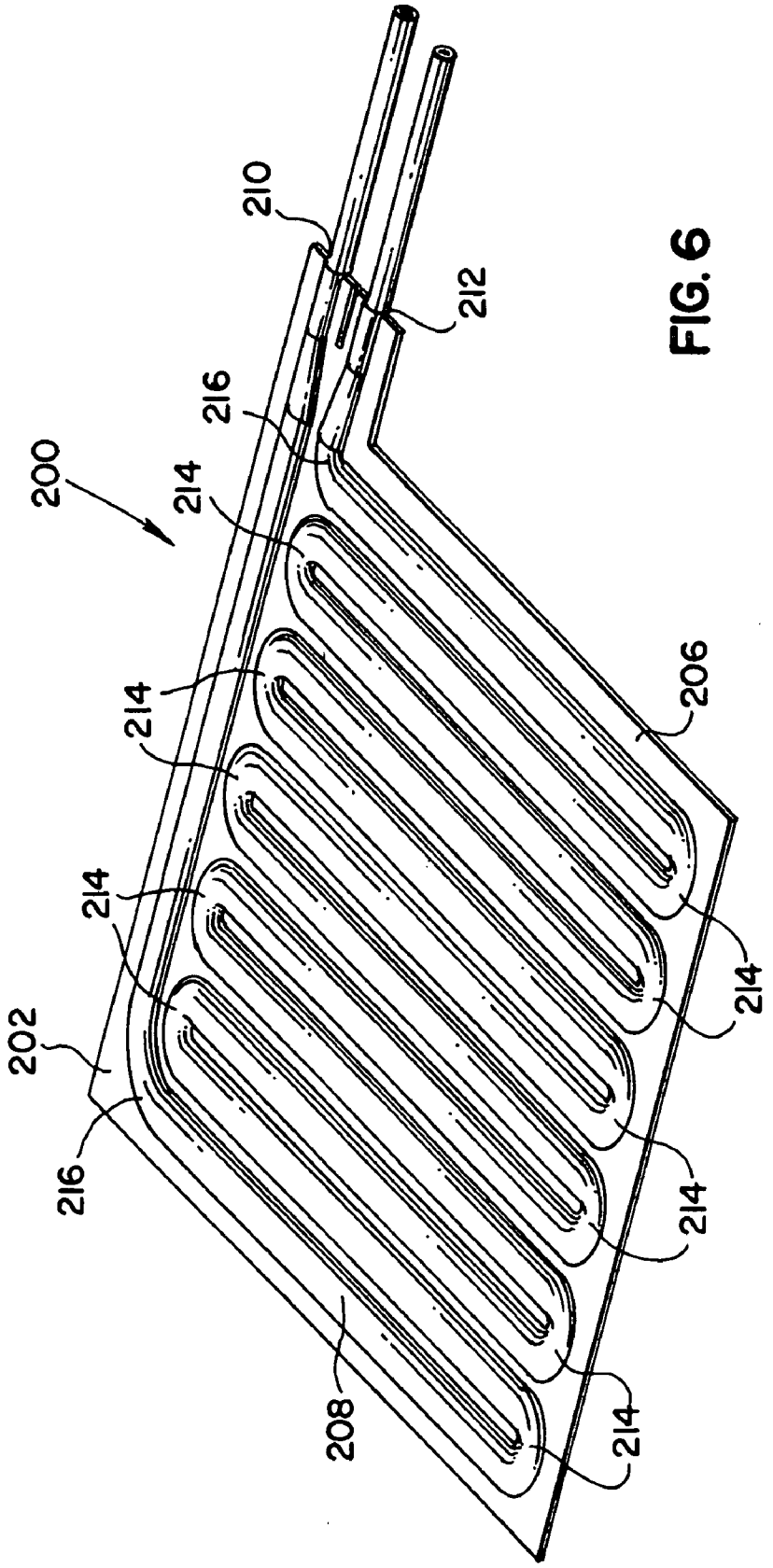
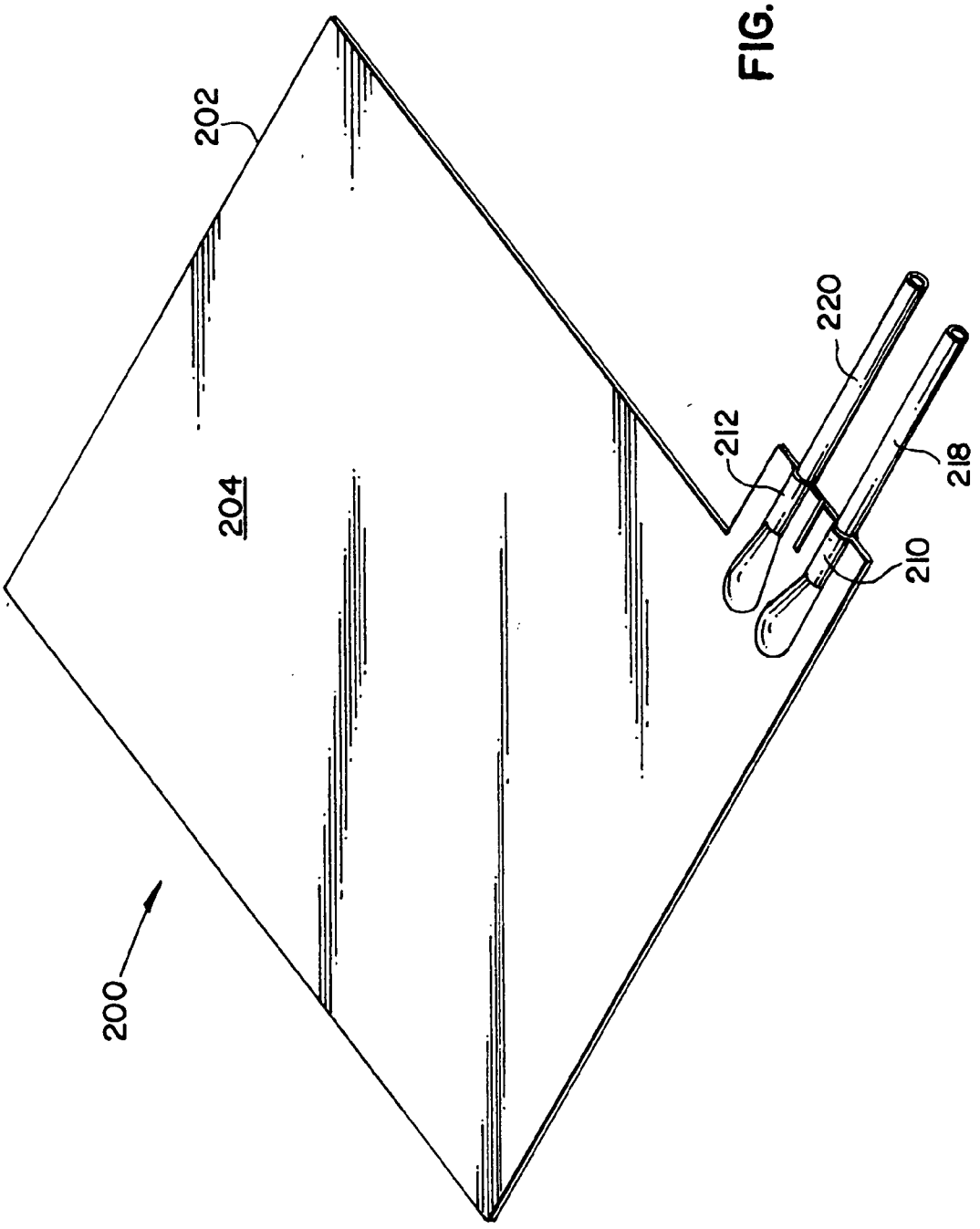


FIG. 6

FIG. 7



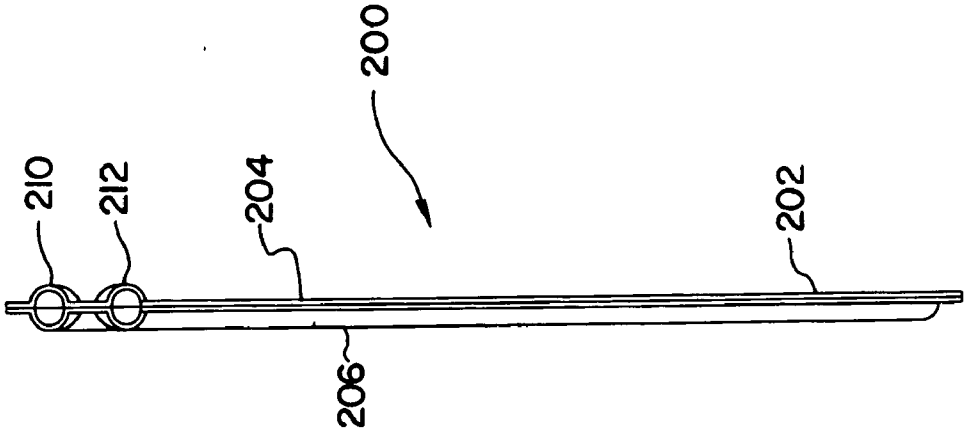


FIG. 9

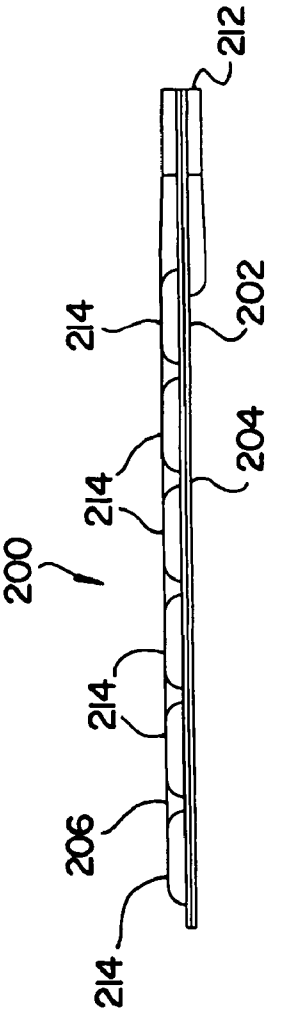


FIG. 8

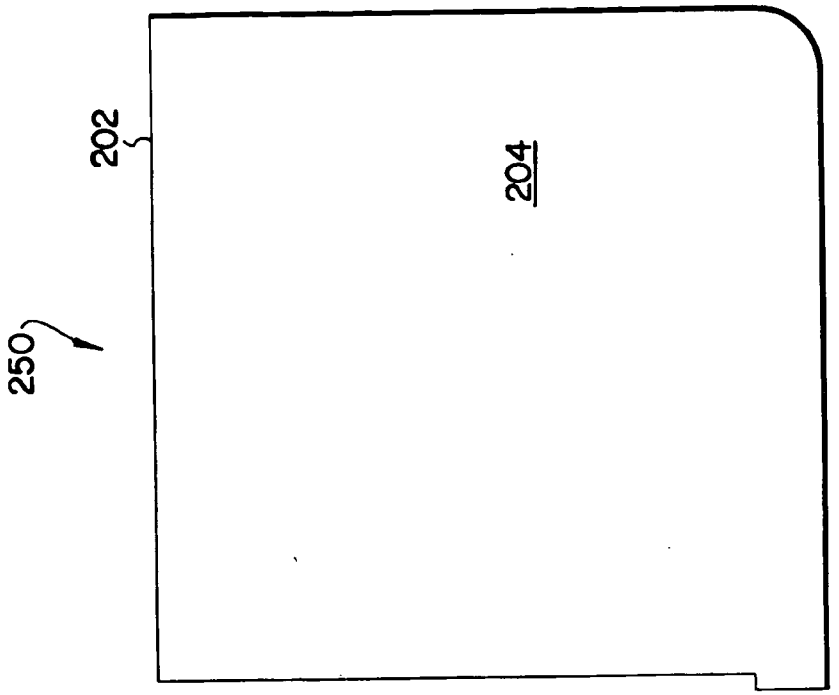


FIG. 11

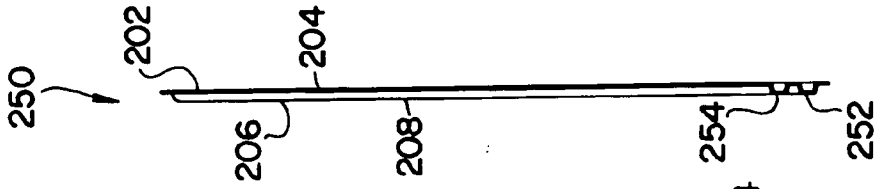


FIG. 12

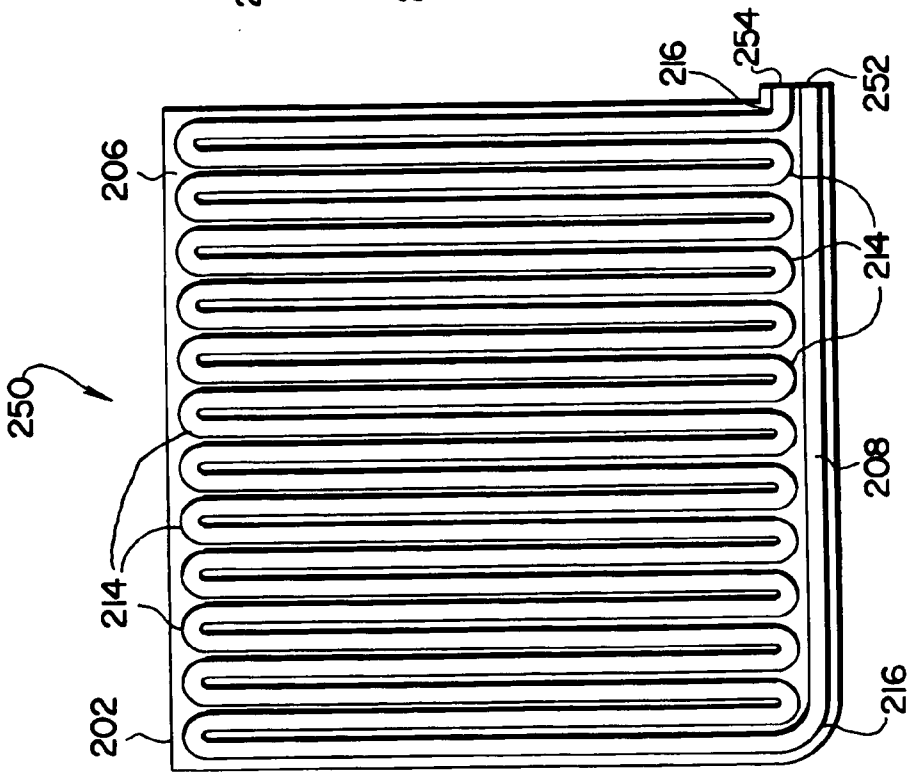


FIG. 10

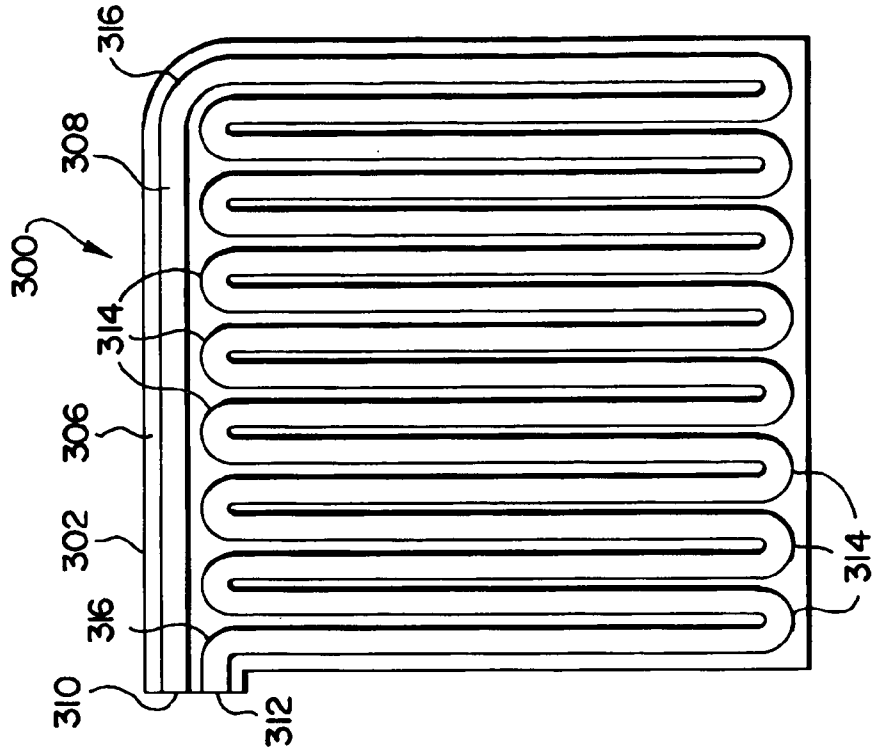


FIG. 14

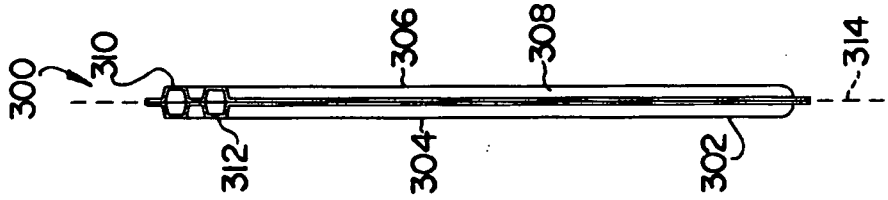


FIG. 15

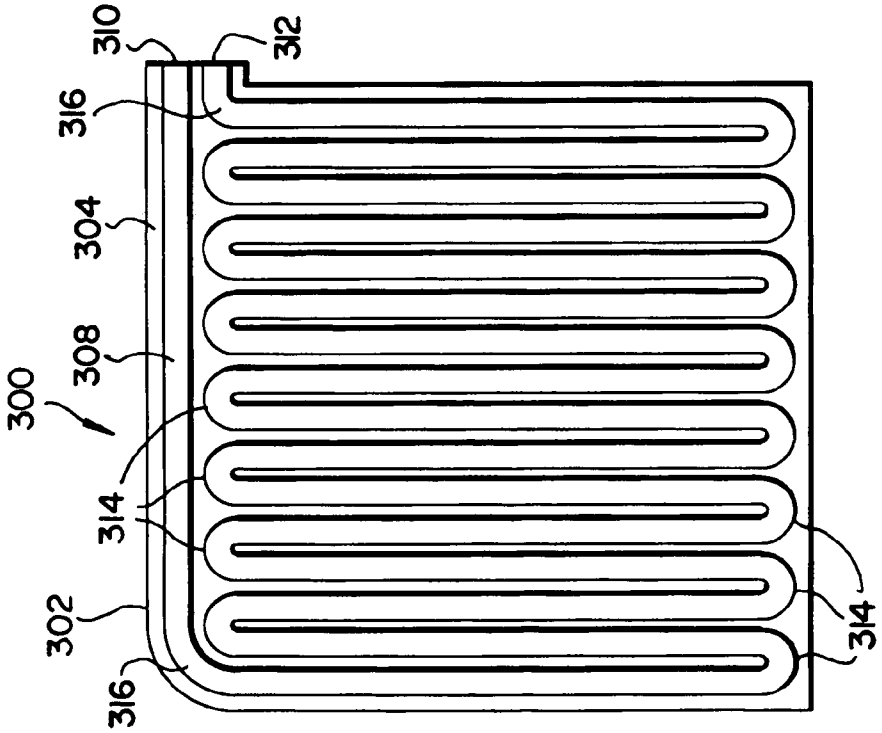


FIG. 13

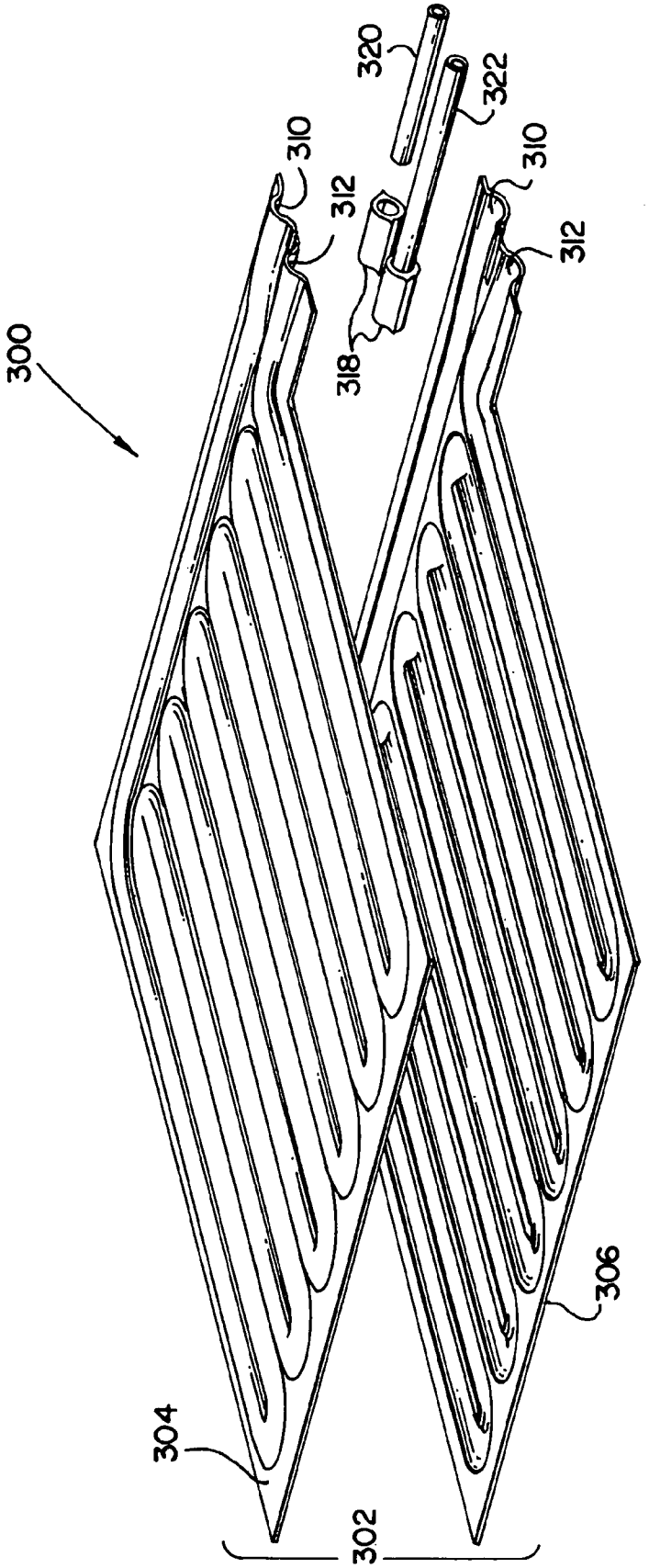
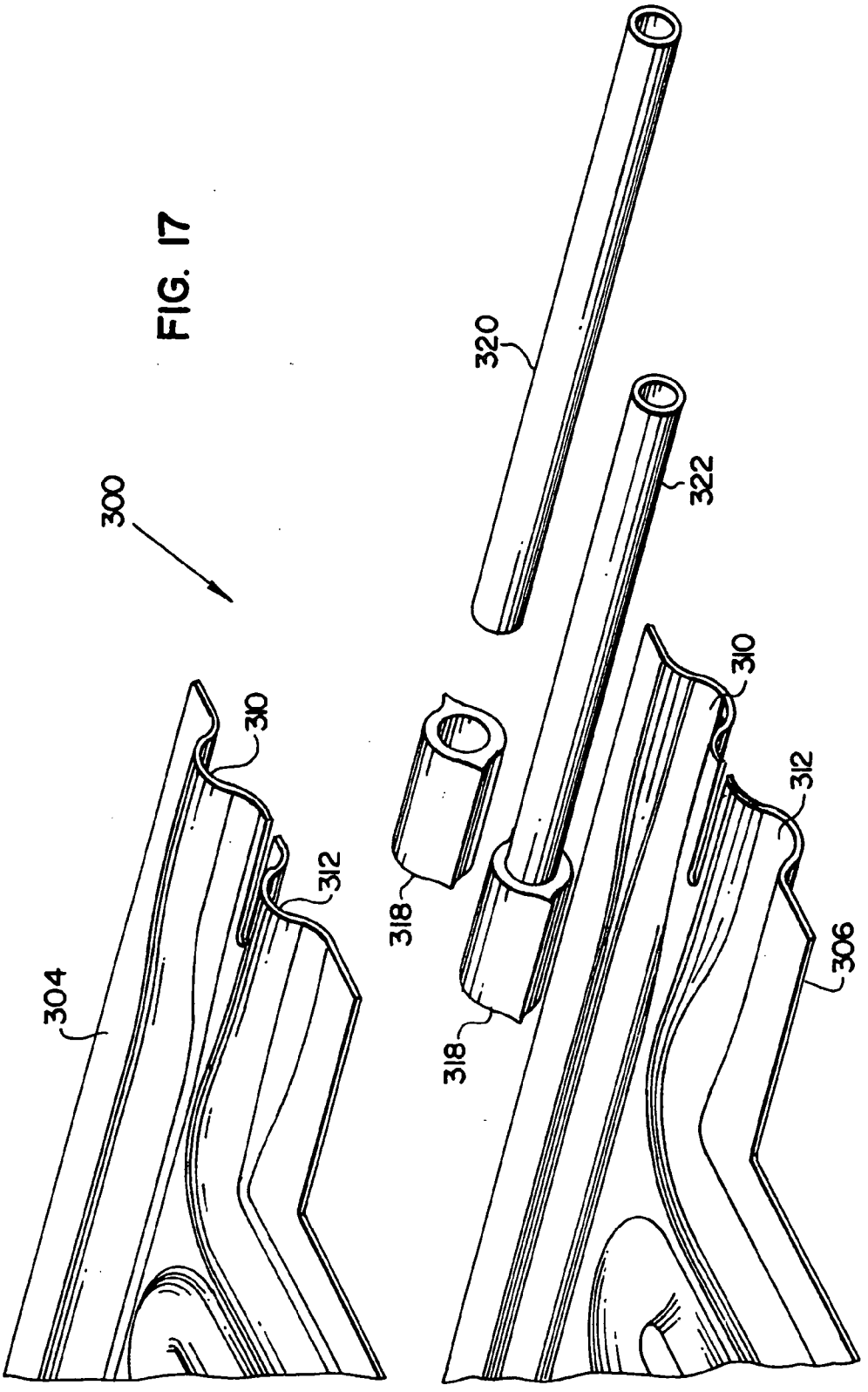


FIG. 16

FIG. 17



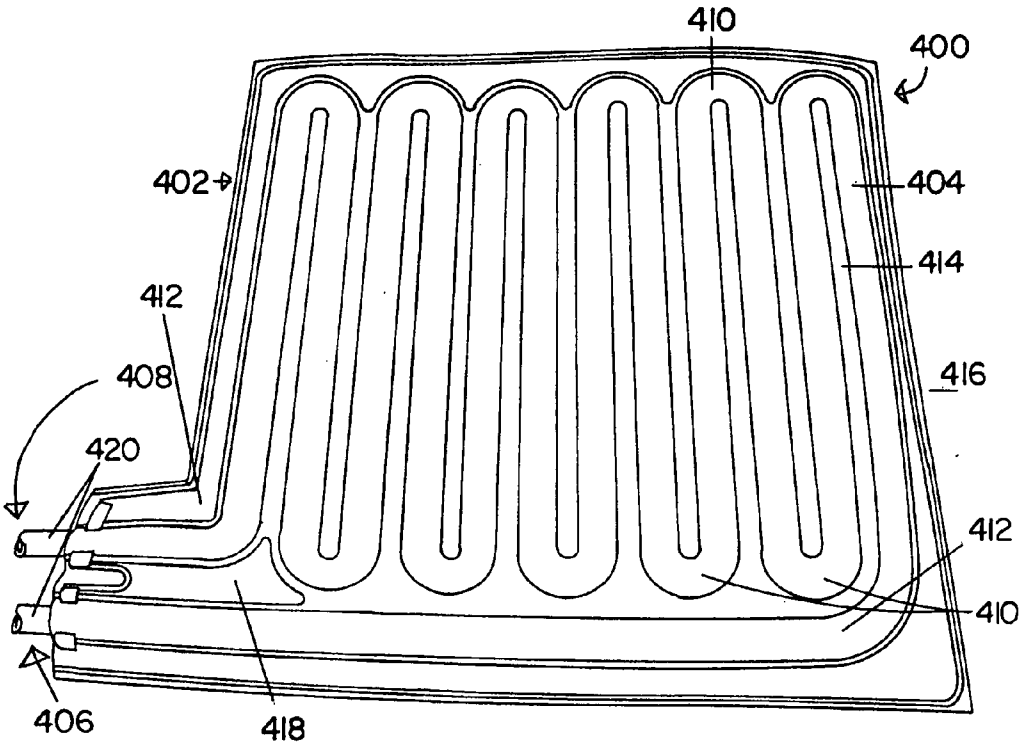

410
400
402
404
414
412
408
416
420
412
410
406
418

FIG. 18

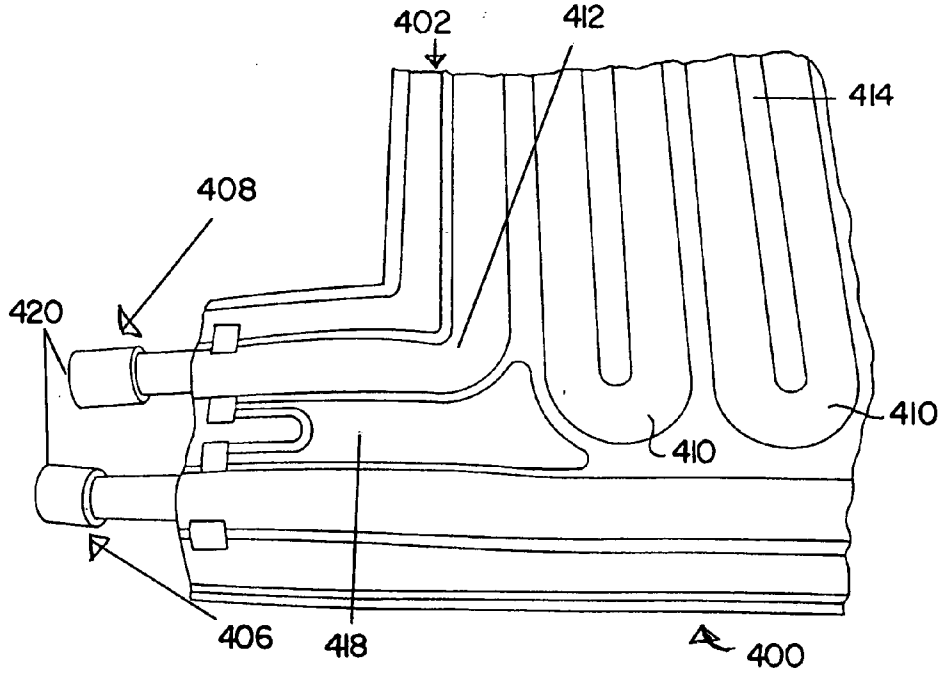
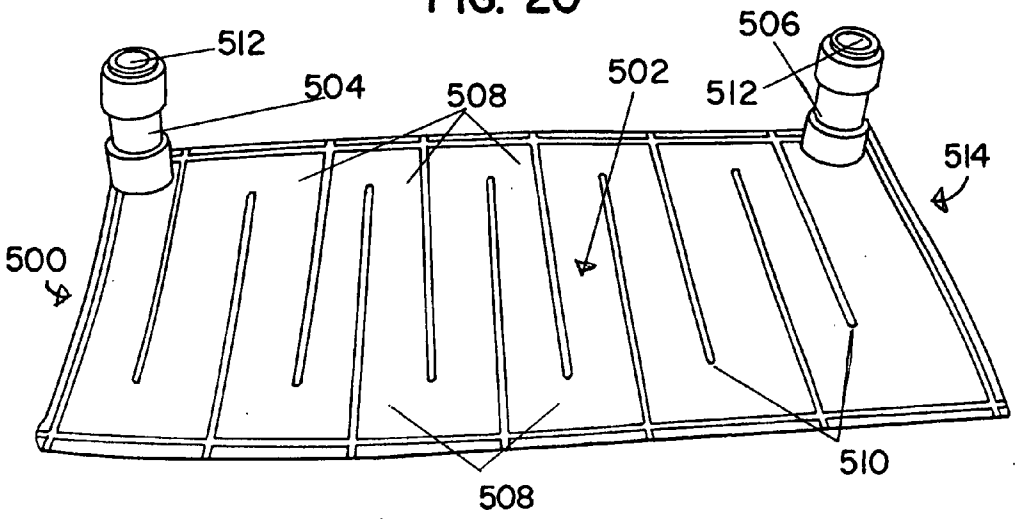

402
412
414
408
420
410
410
406
418
400

FIG. 19

FIG. 20


512
504
508
502
506
512
514
500
508
510

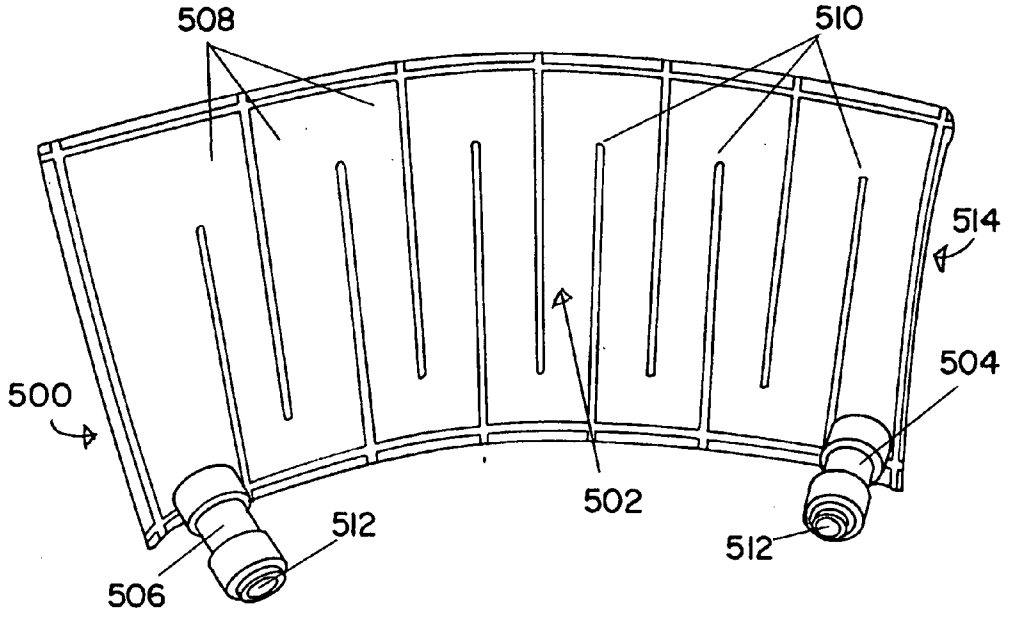

508
510
514
500
504
502
512
506
512

FIG. 21

FIG. 22

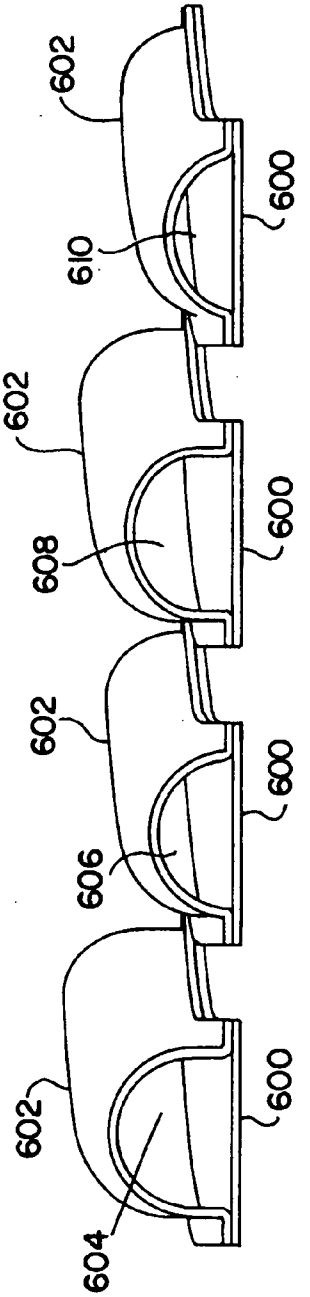

602
610
600
602
608
600
602
606
600
602
604
600

FIG. 23

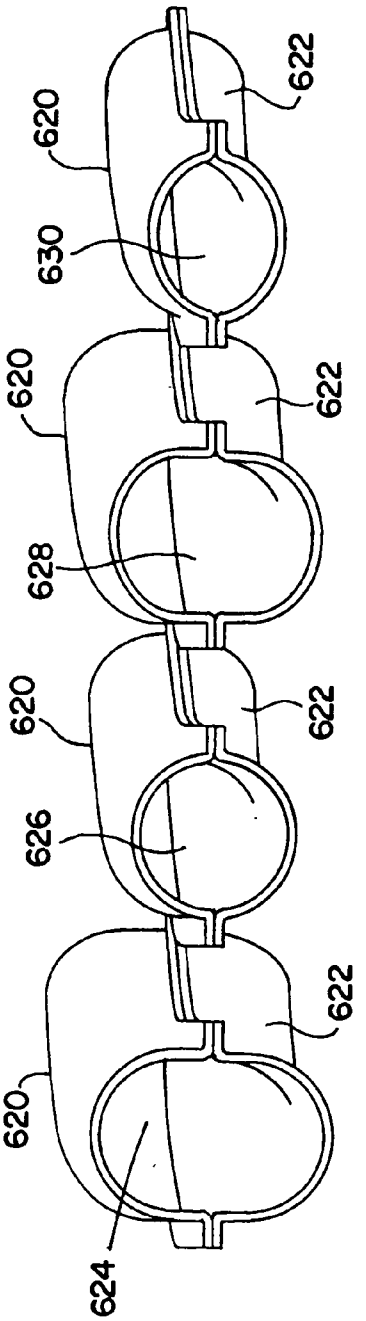

620
630
622
620
628
622
620
626
622
620
624
622

FIG. 24

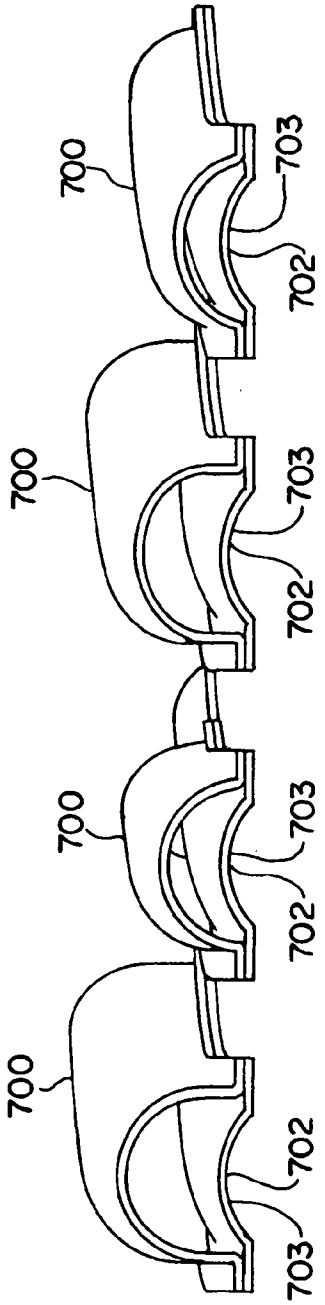
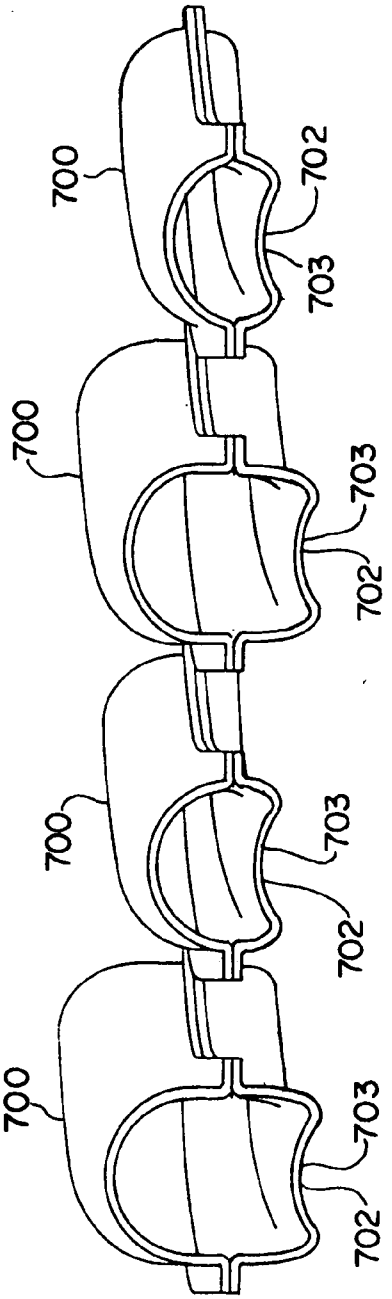

700
703
702
700
703
702
700
703
702
700
702
703

FIG. 25


700
702
703
700
703
702
700
703
702
700
703
702

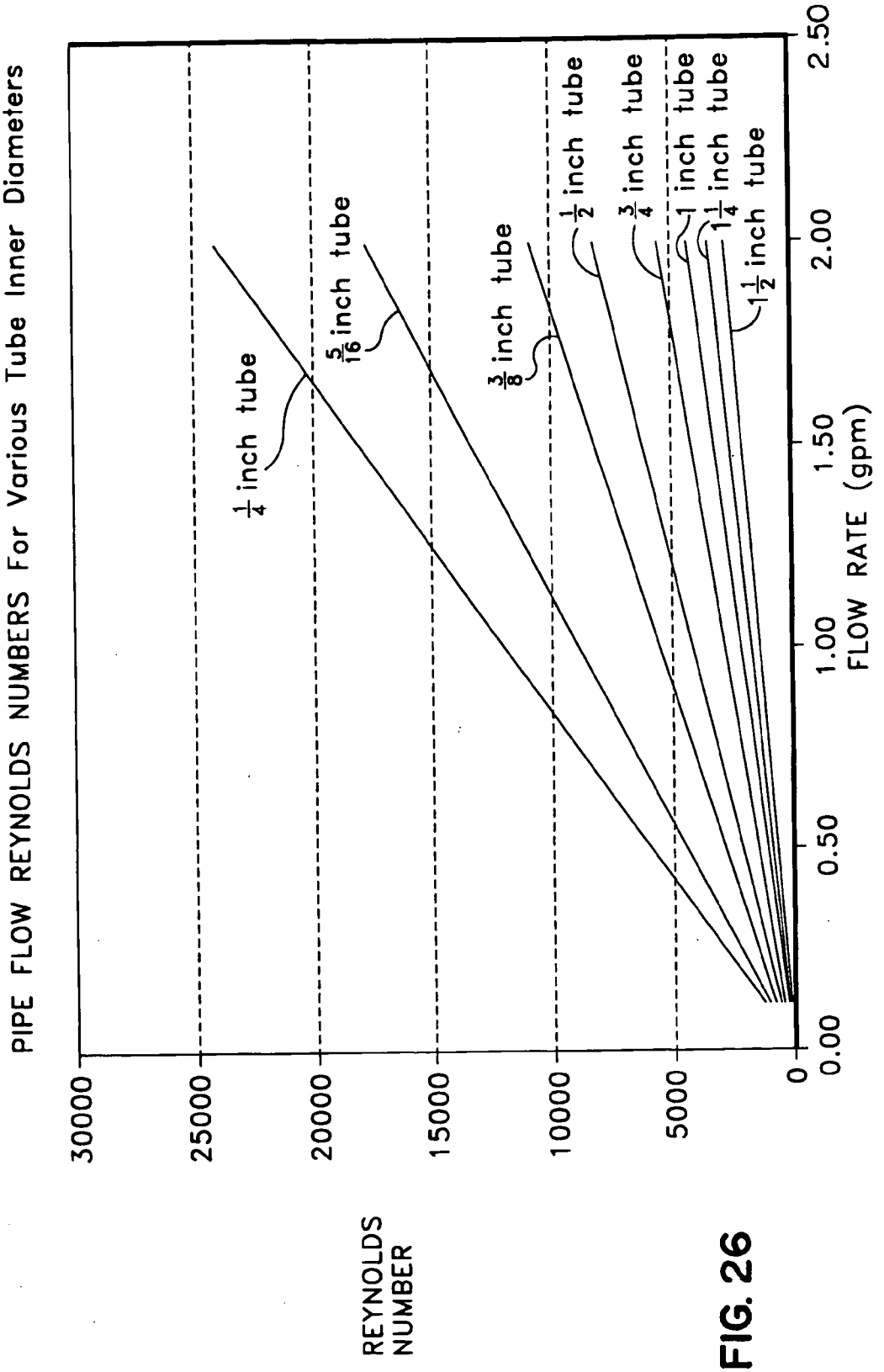

PIPE FLOW REYNOLDS NUMBERS For Various Tube Inner Diameters
REYNOLDS NUMBER
30000
25000
20000
15000
10000
5000
0
0.00
0.50
1.00
1.50
2.00
2.50
FLOW RATE (gpm)
1/4 inch tube
5/16 inch tube
3/8 inch tube
1/2 inch tube
3/4 inch tube
1 inch tube
1 1/4 inch tube
1 1/2 inch tube

FIG. 26

HEAT EXCHANGER AND FLUID RESERVOIR

RELATED APPLICATIONS

[0001] The present application is a continuation-in-part of and claims priority under 35 U.S.C. § 119(e) to U.S. Provisional Applications Nos. 60/591,646, filed Jul. 28, 2004, entitled, "HEAT EXCHANGER AND LIQUID RESERVOIR," 60/604,952, filed Aug. 27, 2004, entitled, "HEAT EXCHANGER AND LIQUID RESERVOIR," and **60/634,621**, filed Dec. 9, 2004, entitled, "HEAT EXCHANGER AND LIQUID RESERVOIR," all three of the aforementioned applications being incorporated herein by reference to the extent not inconsistent with the present disclosure.

BACKGROUND OF THE DISCLOSURE

[0002] The present disclosure relates generally to the field of fluid reservoirs and more particularly, to use of the fluid reservoirs in appliances having water systems. Fluid reservoirs of the present disclosure can provide for first-in/first-out flow providing beneficial performance characteristics such as, for example, prevention of stagnant flow and improved heat transfer for providing chilled water.

[0003] For the interface of a water reservoir with an appliance, such as a refrigerator, there are a number of design tradeoffs. Such tradeoffs include, but are not limited to, the fluid reservoirs placement within the appliance, the avoidance of contamination of the water in the fluid reservoirs, the fluid reservoirs fluid capacity, and the efficiency of a heat exchange component are balanced in the design of a fluid reservoir. Among the design criteria for the placement of a water or other liquid reservoir within an appliance such as a refrigerator generally is the desire to occupy the least amount of the storage space within the appliance as possible.

[0004] For example, prior water system designs have made use of tank-style fluid reservoirs and coiled tube-type fluid reservoirs. One disadvantage of prior known tank-style fluid reservoirs can be the creation of significant un-swept or "dead" volumes with little or no flow. These dead volumes can lead to stagnant flow conditions that can result in stale, poor tasting liquid and/or microbial contamination of the liquid. One known disadvantage of prior coiled tube tanks is that they can have a relatively poor thermal exchange efficiency due to the small portion of the tank surface that is accessible to thermal exchange when mounted in certain configurations. Coil tube fluid reservoirs can also be difficult to manufacture, require large amounts of polymer or other material to manufacture, and can result in bad tasting water due to fluid contact with the large surface area associated with prior known coil tube fluid reservoir materials. Further, prior coil tube fluid reservoirs often exhibit significant internal friction that can result in large pressure drops during operation.

SUMMARY OF THE DISCLOSURE

[0005] Improved fluid reservoirs of the present disclosure comprise structure to eliminate low flow conditions so as to have little or no un-swept or dead volumes within the fluid reservoir. In addition, the improved fluid reservoirs of the present disclosure can provide for relatively high efficient thermal exchange so as to provide a desirable chilled fluid product for use and consumption. In some representative, presently preferred, embodiments, improved fluid reservoirs can comprise a serpentine fluid flow passage having a cross-section configured such that the fluid flow within the flow passage sweeps the entire cross-sectional volume of the flow passage without leaving significant amounts of dead or un-swept volume therein. The cross-sectional shape of the flow passage can be configured to have a larger heat transfer surface than known prior coiled tube reservoirs, which can allow the fluid to be chilled through placement of improved fluid reservoir in proximity to a cooling environment such as, for example, within or in proximity to a refrigeration or freezer compartment in a refrigerator.

[0006] In some representative embodiments, the improved fluid reservoirs can be operatively assembled, such as, for example, from two sheets of molded polymer material that are operatively joined to form the fluid reservoir, as will be described below. In other representative embodiments, the fluid reservoir can be operatively assembled, such as, for example, from flexible polymer materials that are bonded along seams to establish a flow channel. In some representative embodiments, improved fluid reservoirs can comprise non-rigid designs in which, contours of a flow channel or flow passage may not form until fluid flow deforms the flexible polymer along the flow channel. In further representative embodiments, the fluid reservoir can be operatively assembled, such as, for example, through the use of blow molding techniques or the like, as is known in the art. The fluid reservoir can be connected to a filtering system to provide chilled filtered liquid. The fluid reservoir and/or filtration systems can be associated with an appliance, such as a refrigerator.

[0007] In one aspect, the fluid reservoirs of the present disclosure can have a thin profile for convenient placement along and/or within the walls/floor/ceiling and/or mullions of an appliance. This thin profile is consistent both with very good thermal exchange and flow with little or no dead volume. The fluid reservoir can be placed in thermal contact with the cooling compartment. Due to the thermal contact, liquid delivered from the fluid reservoir can be chilled, and the configuration provides for good chilling efficiency. Fluid Reservoir design of the present disclosure combine some of the advantages of a coil tube fluid reservoir with those of a tank-style fluid reservoir, while eliminating many of the drawbacks associated with either the coil tube fluid reservoir or the tank-style fluid reservoir.

[0008] In another aspect, the fluid reservoirs of the present disclosure can be designed and fabricated to yield desirable flow properties through the fluid reservoir so as to provide for a fully swept area with little or no dead volume, while at the same time possessing a wider flow area than a tube tank or the like, as would be understood by those skilled in the art. More specifically, representative fluid reservoirs of the present disclosure can be fabricated to have desirable cross-sectional configurations wherein the fluid reservoir conduit comprises a Reynolds number of about 800 to about 2500 at a flow rate of about 0.50 gallons per minute, in other representative embodiments the fluid reservoir can comprise a Reynolds number from about 1000 to about 2000 at a flow rate of about 0.50 gallons per minute, and in further representative embodiments the fluid reservoir can comprise a Reynolds number from about 1300 to about 1900 at a flow rate of about 0.50 gallons per minute.

[0009] Generally, presently preferred representative embodiments of fluid reservoirs of the present disclosure

comprise an inlet, an outlet and an elongated passageway connecting the inlet and the outlet. In some presently contemplated representative embodiments, the elongated passageway has a serpentine shape in order to compactly configure the elongated passageway. The elongated shape and the corresponding length of the passageway generally comprises many times the diameter across the cross-section of the passageway providing for the desired fluid storage volume while having little or no dead volume with first in-first out flow.

[0010] In some representative embodiments, the passageway is operatively assembled, such as, for example, from two contoured sheets of material that are then operatively joined together by appropriate methods known in the art. The contoured sheets can be operatively formed from a generally rigid material, such as, for example, a plastic that maintains the shape of the contour to form flow channels with a selected shape. A seam between the sheets separates adjacent sections of passageway. In some representative embodiments, one sheet can comprise a generally planar surface wherein the generally planar sheet and a contoured sheet can be operatively connected to form the flow passages. In other presently contemplated representative embodiments, the top and/or bottom sheets of the fluid reservoir can be operatively formed from a flexible material, such as, for example, from a flexible polymer or other resilient material that is capable of performing the required function, as would be understood by those skilled in the art. In these flexible representative embodiments, the shape of the flow channel can result from the fluid pressure within the flow channels. Generally, the flow channel configuration with fluid present in the channel is, presently preferably, roughly circular with some distortion near the seam, although the thickness of the flow channel walls can be varied radially along the cross-section of the flow channel so that the flow channel configuration expands to a different shape upon exposure to the fluid pressure, if desired.

[0011] In some presently preferred representative embodiments based on contoured rigid materials, fluid reservoirs of the present disclosure can have a generally planar expanse with a thickness no more than, presently preferably, about 10 percent of the longest edge-to-edge distance across the generally planar surface of the fluid reservoir, in other representative embodiments no more than about 5 percent and in further representative embodiments from about 0.2 percent to about 3 percent of the longest edge-to-edge distance. If both surfaces are contoured, the planar projection of the surface with the greatest area can be used for evaluating distances across the surface. The elongated passageway, presently preferably, generally has a length at least a factor of three times the longest edge-to-edge distance across the planar surface. More details of suitable cross-sectional properties of the passageway with respect to rigid materials are described below.

[0012] For some presently contemplated representative embodiments based on flexible polymers, the shape of the fluid reservoir can be similarly evaluated in the expanded form with fluid pressure within the fluid reservoir. In the expanded form, the fluid reservoir would generally have comparable dimensions as the fluid reservoirs formed with contoured rigid materials as described herein. While the flexible materials may be somewhat elastic such that the shape can vary depending on the pressure, the difference in shape generally is not significant over the range of standard residential water pressures. For evaluating the shape and properties of a flexible fluid reservoir as described herein, the fluid reservoir flow channels are subjected to a pressure that supplies a fluid flow rate of about 0.5 gallon per minute. Suitable dimensions for providing desired flow properties are described. Also, for mounting in a desired location, a flexible fluid reservoir can be bent providing that the flow channel is not blocked. However, it is to be noted that the dimensions and other properties of the fluid reservoir are evaluated in the flat configuration for convenience and definitiveness.

[0013] In some presently contemplated representative embodiments, the fluid reservoirs of the present disclosure can operatively interface with an appropriate dispenser. Generally, operation of the dispenser can be triggered by a user requesting a desired amount of fluid such as, for example, water. In some presently contemplated representative embodiments, water can be dispensed through a dispenser in an appliance door such as, for example, a refrigerator door. In some alternative representative embodiments, the dispenser can be located internal to an appliance such as, for example, within a refrigerated compartment of a refrigerator, as described further in copending U.S. Provisional Application No. 60/537,781 to Meuleners et al., entitled "WATER FILTER AND DISPENSER ASSEMBLY," the disclosure of which is herein incorporated by reference to the extent not inconsistent with the present disclosure. Placement and orientation of the fluid reservoirs of the present disclosure within an appliance can allow for practical considerations during installation as well as providing effective venting of air that may be contained within a fluid filtration system and/or the fluid reservoir itself prior to connection to a fluid supply. Fluid reservoirs of the present disclosure can have flow passage cross-sections selected to be small enough as to allow air to be pushed out of the flow passage due to the surface tension of the fluid regardless of the fluid reservoir orientation.

[0014] In another aspect, representative fluid reservoirs of the present disclosure can be connected to a filtration system. For example, water from a city water supply, well or other water supply into a house or other structure can be filtered prior to being dispensed to the user. Generally, the fluid reservoir can be operatively positioned either upstream or downstream from the filtration system. If placed upstream, the fluid reservoir would then contain water or other liquid along with any anti-microbial agents, such as chlorine, found in the water/liquid supply, although these agents may be removed from the liquid by subsequent filtration prior to being dispensed. Thus, proliferation of microbes, such as bacteria or molds, may be inhibited prior to use and/or consumption by the user. Examples of representative filtration systems having a water fluid reservoir upstream from a filtration system are described further in copending U.S. patent application Ser. No. 10/445,372 to Fritze et al., entitled, "WATER FILTER ASSEMBLY," filed on May 23, 2003 and claiming priority to U.S. Provisional Application 60/383,187, filed on May 23, 2002, the disclosure of each is herein incorporated herein by reference to the extent not inconsistent with the present disclosure. When the fluid reservoir is placed upstream from a filter system and the fluid reservoir is located between two valves, the fluid reservoir can be subjected to constant or intermittent house line pressure.

[0015] Alternative representative configurations providing relatively more flexibility and versatility with respect to placement of the filtration system can be realized when fluid reservoirs of the present disclosure are located downstream from a water filtration system. In some representative presently contemplated embodiments, the water filtration system can be located externally of a refrigeration unit, such that the potential for water flow blockage due to complete or partial liquid freezing within the filtration system, and more specifically internal of the filter element itself, is effectively, if not completely, eliminated. In these representative embodiments, the fluid reservoir can be subjected to intermittent fluid line pressure, if located between two valves, or the fluid reservoir can be always at lower pressures than line pressure by exposure to an open line to atmosphere, for example, as described in copending U.S. Patent Publication No. 2005/0103721A1 to Fritze, entitled, "Reduced Pressure Water Filtration System," file Sep. 23, 2004 and claiming priority to U.S. Provisional Application 60/505,152, filed Sep. 23, 2003, the disclosure of each is herein incorporated herein by reference to the extent not inconsistent with the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] **FIG. 1** is a perspective view of one possible representative fluid reservoir, in accordance with the present disclosure, having a serpentine flow passage with a cross-sectional area larger than a cross-sectional area of an inlet port and an outlet port.

[0017] **FIG. 2** is an end view of the representative fluid reservoir of **FIG. 1**.

[0018] **FIG. 3** is a top view of the representative fluid reservoir of **FIG. 1**.

[0019] **FIG. 4** is a section view of the representative fluid reservoir of **FIG. 1** taken at line **4-4** of **FIG. 3**.

[0020] **FIG. 5** is a detail view of the representative fluid reservoir of **FIG. 1** taken at detail **5** of **FIG. 4**.

[0021] **FIG. 6** is a bottom perspective view of one possible representative embodiment of a fluid reservoir having a serpentine flow passage with a cross-sectional area larger than a cross-sectional area of an inlet port and an outlet port.

[0022] **FIG. 7** is a top perspective view of the representative fluid reservoir of **FIG. 6**.

[0023] **FIG. 8** is a side view of the representative fluid reservoir of **FIG. 6**.

[0024] **FIG. 9** is a side view of the representative fluid reservoir of **FIG. 6** depicting an inlet port and an outlet port.

[0025] **FIG. 10** is a top view of one possible representative embodiment of a fluid reservoir having a serpentine flow passage with a cross-sectional area equal to a cross-sectional area of an inlet port and an outlet port.

[0026] **FIG. 11** is a bottom view of the representative fluid reservoir of **FIG. 10**.

[0027] **FIG. 12** is a side view of the representative fluid reservoir of **FIG. 10**.

[0028] **FIG. 13** is a bottom view of one possible representative embodiment of a fluid reservoir having a constant cross-sectional area for a serpentine flow passage, an inlet port and an outlet port.

[0029] **FIG. 14** is a top view of the representative fluid reservoir of **FIG. 13**.

[0030] **FIG. 15** is a side view of the representative fluid reservoir of **FIG. 13**.

[0031] **FIG. 16** is an exploded, perspective view of one possible representative embodiment of a fluid reservoir having tube fittings integral to an inlet port and an outlet port.

[0032] **FIG. 17** is a detail exploded, perspective view of the inlet port and the outlet port of the representative fluid reservoir of **FIG. 16**.

[0033] **FIG. 18** is a bottom view of one possible representative embodiment of a flexible fluid reservoir having a serpentine flow passage with a cross-sectional area larger than a cross-sectional area of an inlet port and an outlet port.

[0034] **FIG. 19** it a detail bottom view of the inlet port and the outlet port of the representative flexible fluid reservoir of **FIG. 18**.

[0035] **FIG. 20** is a bottom view of one possible representative embodiment of a flexible fluid reservoir having an integral inlet port and an integral outlet port oriented generally perpendicular to the plane of the flexible fluid reservoir.

[0036] **FIG. 21** is a bottom view of the representative flexible fluid reservoir of **FIG. 20**.

[0037] **FIG. 22** is a section view of possible representative flow channels for use with representative embodiments of either a rigid fluid reservoir or a flexible fluid reservoir.

[0038] **FIG. 23** is a section view of possible representative flow channels for use with representative embodiments of either a rigid fluid reservoir or a flexible fluid reservoir.

[0039] **FIG. 24** is a section view of possible representative flow channels for use with representative embodiments of either a rigid fluid reservoir or a flexible fluid reservoir.

[0040] **FIG. 25** is a section view of possible representative flow channels for use with representative embodiments of either a rigid fluid reservoir or a flexible fluid reservoir.

[0041] **FIG. 26** is a graph of Reynolds numbers for possible representative flow channel diameters suitable for use in household fluid flow applications.

DETAILED DESCRIPTION OF REPRESENTATIVE EMBODIMENTS

[0042] Improved fluid reservoirs described herein combine features of coiled tubes and tank fluid reservoirs to achieve desirable features of both types while exhibiting fewer drawbacks that are representative of each. New, improved, desirable processing approaches have made these previously commercially impractical fluid reservoirs practical on a commercial scale. In some presently preferred representative embodiments, the fluid reservoirs are designed to have flow that provides first in-first out flow without low flow or dead volume areas that can lead to stale liquid. At the same time, some presently preferred representative embodiments of fluid reservoirs can have a larger flow passage cross section than conventional coiled tubes so that less material is used and the pressure drop is less for a given tank volume. In some representative embodiments, the

fluid reservoirs are in the form of a monolithic structure with a curved flow path and adjacent flow channels separated with a seam or the like. The monolithic structures can be formed through a molding process or through the joining of two or more sheets of material. The improved fluid reservoirs can be incorporated into a filtration system and/or within an appliance, such as a refrigerator, to supply cooled water.

[0043] In some representative embodiments, the fluid reservoirs described herein involve a monolithic polymer structure with two ports and a flow passage between the ports. The flow passage can form a circuitous passage. Seams formed within the polymer structure can establish boundaries between adjacent sections of the flow passage. In some representative embodiments, the flow passage has an approximately constant diameter over most of the passage relating to contours of a material to establish desired flow properties through the passage. With respect to monolithic structures formed from rigid materials, the flow passages correspond with contours of the rigid material. In other representative embodiments, the flow passage corresponds to expandable sections of flexible materials with seams forming boundaries of the flow passage. The overall monolithic structure can have a generally planar aspect with at least one contoured surface forming the flow passage. Furthermore, the structure can be attached to a filtration system via appropriate fluid connections such as, for example, tubing fittings or other suitable connection methods known to one of skill in the art. The fluid reservoir with or without a filtration system can be mounted within an appliance, such as a refrigerator, and/or the fluid reservoir can be connected to a household water supply.

[0044] In some representative embodiments, fluid reservoirs can be incorporated into an appliance having a liquid supply fluidly connected to a flow passage defined within the fluid reservoir. Fluid reservoirs can be fabricated such that the flow passage has a Reynolds number from about 800 to about 2500 at a flow rate of about 0.5 gallons per minute. In addition to having advantageous flow characteristics, the fluid reservoir of the present disclosure can simultaneously serve a dual function as a heat exchanger where the fluid reservoir can be positioned within an appliance wall, mullion or partition so as to be in thermal contact with a refrigeration compartment allowing for cooling of the fluid as it flows through and/or resides within the flow passage. The flow rate of 0.5 gallons per minute is specified for evaluation purposes, although the liquid fluid reservoir can be used at alternative flow rates.

[0045] In some representative embodiments, a monolithic fluid reservoir structure can be formed by bonding two generally rigid polymeric sheets, wherein at least one sheet is contoured. When joined, the contour defines a flow passage between two ports in the resulting monolithic fluid reservoir structure. The bonding of the two sheets can be accomplished with a variety of fabrication methods such as, for example, using sonic welding, heat bonding, RF bonding or adhesive bonding, or any other connecting means that is capable of effectively accomplishing the intended function. The contour can be formed, such as, for example, by vacuum forming and/or pressure forming. In other representative embodiments, the contouring of at least one of the sheets and the bonding of the sheets is accomplished without requiring repositioning of the sheets between fabrication steps.

[0046] In other representative embodiments, a monolithic fluid reservoir can be formed by joining a first flexible polymer surface to an adjacent flexible polymer surface so as to define a continuous flow channel fluidly interconnecting at least two flow ports. The adjacent flexible polymer surfaces can be arranged for bonding by stacking two flexible polymer sheets, or by folding a single polymer sheet to form the first flexible polymer surface and the second flexible polymer surface. The adjacent flexible polymer surfaces can be operatively attached using a suitable bonding process such as, for example, using sonic welding, heat bonding, RF bonding or adhesive bonding or any other connecting means that is capable of effectively accomplishing the intended function. Through the use of adjacent flexible polymer surfaces, the monolithic fluid reservoir structure can be inherently flexible allowing for ease of installation and assembly when used with an appliance.

[0047] As illustrated in **FIGS. 1-5**, a presently preferred representative embodiment of a fluid reservoir **100** can comprise a monolithic structure with a flow channel **102** operably, fluidly interconnecting a flow inlet **104** and a flow outlet **106**. Flow channel **102** comprises a generally serpentine flow arrangement defined by a plurality of flow legs **108** operably interconnected through a plurality of left hand bends **110** and a plurality of right hand bends **112**. In this representative embodiment, the bends are round, although other shapes of the bends can yield suitable flow properties. While other passage configurations can be used for flow channel **102**, the generally serpentine structure provides for compact placement of the extended passages while providing for little or no dead volume, large overall volumes and high surface areas for thermal exchange. Fluid reservoir **100** comprises a fluid reservoir body **114** providing a generally rigid structure to fluid reservoir **100** so as to assist in manufacturing, storing, handling and installing fluid reservoir **100** within a fluid circuit. Fluid reservoir body **114** can comprise a handling portion **116** and a plurality of seams **118**. Handling portion **116** provides for a convenient grasping or handling location during fabrication and/or installation of the fluid reservoir **100**. Seams **118** can provide for interconnection and attachment of adjacent flow legs **108** to provide strength and rigidity to fluid reservoir **100**. Seams **118** are fluid-tight so as to prevent flow directly between adjacent flow legs **108** but instead forcing flow to sequentially, serpentine through the flow channel **102**.

[0048] As illustrated in **FIGS. 1 and 3**, flow channel **102** forms a generally serpentine passage that involves bends back on itself. In contrast with coiled tubes, the flow channel resides substantially within the same plane and does not cross or double-up itself. However, if desired, the monolithic structure can comprise a flow channel that crosses or doubles up on itself while having flow with desired properties such as, for example, little or no dead volume, large overall volumes and high surface areas for thermal exchange. Nevertheless, flow channels that cross themselves are not presently preferred since they generally involve more complex processing approaches and can present complications for mounting due to the increased thickness at the crossing point. The serpentine passage can be configured to have any of a range of structures with a plurality of segments that may or may not have the same lengths and the number of segments can be selected to yield a desired volume consistent with the footprint of the structure for mounting.

[0049] As illustrated in **FIGS. 2 and 4**, seams **118** can be arranged in a substantially planar orientation defining a medial plane **120** residing substantially parallel to and between a top surface **122** and a bottom surface **124** in which said top and bottom surfaces are generally defined by the flow channel **102**. In other words, the flow channel corresponds with the contours of the monolithic structure. It should be noted that the designation of top and bottom surfaces throughout the disclosure is for convenience and ease of understanding and may not relate to the mounting orientation of fluid reservoir **100** during use.

[0050] Fluid reservoir **100** as well as other representative embodiments of the fluid reservoir described herein can be formed from one or more appropriate materials, as described below. Generally, it is desirable to form fluid reservoir **100** from a polymer, although metals including blends thereof can be suitable. Selection of an suitable material, such as, for example, polymer may be based on a variety of factors such as, for example, cost, processing ability, durability and compatibility with potable liquids. Suitable polymers include, but are not limited to, for example, polyolefins, such as polyethylene, polypropylene, and polyethylene copolymers, Dowlex®, polyurethane, polystyrene, nylons (polyamides), and polyesters (such as polyethylene terephthalate, including, for example, Mylar®. The particular molecular weights of the polymers and particular formulations can be selected by methods known to those skilled in the art. In some instance, polymers can be selected that possess either rigid, semi-rigid or flexible characteristics based upon the manufacturing methods employed and the desired physical or installation characteristics of the fluid reservoir such as, for example, wall thickness and overall dimensions. With respect to rigid materials, suitable metals including blends thereof, such as, for example, stainless steel, can be used in place of polymers.

[0051] Suitable fittings can be incorporated into the flow inlet **104** and flow outlet **106** for connection of the fluid reservoir to piping, tubing or the like. Fittings can be selected to be compatible with respect to process and composition with the material of fluid reservoir **100** and the material of the tubing connecting fluid reservoir **100** to an associated fluid system. In particular, if crosslinked polyethylene or PEX tubing (generically referring to either PEX-a, PEX-b or PEX-c tubing) is used, a fitting that mechanically grips the tubing is desirable since the crosslinked nature of the polymer in the tubing is not conducive to thermal or sonic welding. However, an adhesive can also be used to fix the tubing at the flow inlet **104** and flow outlet **106**. Other materials can be selected to provide for thermal or sonic welding.

[0052] While the polymers used to form the fluid reservoir **100** may or may not be initially crosslinked, the polymer can be further crosslinked following the forming process. In general, physical process such as, for example, an electron beam as used to crosslink PEX-c, ultraviolet radiation and/or a corona discharge as well as other physical processes, including, but not limited to, for example, other processes known in the art, can be used to perform the crosslinking. In some representative embodiments, chemical crosslinking agents such as, for example, liquid peroxide used to crosslink and form PEX-a with the Engel method, as well as catalysts and/or exposure to air and moisture can trigger crosslinking of the polymer such as, for example, the use of a tin catalyst and moisture curing (water bath or steam sauna) in silane crosslinking technology to crosslink and form PEX-b.

[0053] While polymers are convenient, cost effective and efficient materials for forming fluid reservoirs, many polymers have low thermal conductivity. The thermal conductivity of selected polymers can be increased by loading the polymer with a material with increased thermal conductivity. Suitable thermally conductive materials include, but are not limited to, for example, particles/powders of metal, such as copper flakes, aluminum and/or iron powders, and/or carbon particles, such as carbon black and/or graphite and any other materials capable of performing the intended function in the intended environment. The particles can have any reasonable shape and size that results in suitable mechanical properties of the resulting composite. For some representative embodiments, the loading of the particles can be no more than about 40 weight percent and in other representative embodiments from about 2 weight percent to 35 weight percent. A person of skill in the art will recognize that additional ranges within the above specified ranges of particle loading are contemplated by the present disclosure. With respect to the description herein of sheets or the like, such references can refer to laminates comprising a plurality of layers that may or may not have different compositions from each other.

[0054] Another representative embodiment of a fluid reservoir **200** based on rigid materials is shown in **FIGS. 6-9**. Fluid reservoir **200** can comprise a monolithic rigid body **202** having a bottom surface **204** which, can be a generally flat, planar surface while a top surface **206** can be contoured to form a fluid flow passage **208** between fluid inlet **210** and fluid outlet **212**. Rigid body **202** can comprise similar materials and be manufactured using similar fabrication techniques, as well as other manufacturing processes known to one skilled in the art, as previously described with respect to fluid reservoir **100**. While being generally planar, bottom surface **204** can be partially contoured to form fluid inlet **210** and fluid outlet **212** as illustrated in **FIG. 7**. In this representative embodiment, fluid flow passage **208** has a serpentine shape with eleven 180-degree bends **214** and two 90-degree bends **216** for connection to fluid inlet **210** and fluid outlet **212**. Though described as fluid inlet **210** and fluid outlet **212**, it will be understood that either port can be used interchangeably as the fluid inlet **210** and fluid outlet **212** based upon ease of orientation and installation of fluid reservoir **100**. As illustrated in **FIGS. 6 and 7**, inlet tubing **218** and outlet tubing **220** can be secured at fluid inlet **210** and fluid outlet **212** to provide for flow into and out of the fluid reservoir **100**. If formed from appropriate materials, inlet tubing **218** and outlet tubing **220** can be welded to fluid inlet **210** and fluid outlet **212**, although other bonding approaches can be used, such as adhesive bonding, heat bonding, mechanical gripping and the like. Other positions of fluid inlet **210** and fluid outlet **212** along either bottom surface **204** or top surface **206** can be used, and, in particular, it will be understood that fluid inlet **210** and fluid outlet **212** need not be positioned next to each other. When fluid reservoir **200** is positioned and mounted in an appliance such as, for example, within an appliance wall, mullion or partition as described in U.S. patent application Ser. No. 10/975,193 to Meuleners et al., filed Oct. 28, 2004 and entitled, "IMPROVED DESIGNS FOR FILTRATION SYSTEMS WITHIN APPLIANCES", which is herein incorpo-

rated by reference to the extent not inconsistent with the present disclosure, or in a refrigerated portion of an appliance, generally flat bottom surface **204** can be placed directly against an appliance wall to maximize the amount of physical contact between the fluid reservoir **200** and the appliance so as to increase overall heat transfer between the appliance and fluid reservoir **200**, which can ultimately chill the fluid in fluid flow passage **208** prior to use and consumption of the fluid.

[**0055**] An alternative variation on fluid reservoir **200** is illustrated as a fluid reservoir **250** in **FIGS. 10, 11** and **12**. Fluid reservoir **250** can substantially resemble fluid reservoir **200** with the inclusion of similar features such as, for example, rigid body **202** having generally flat bottom surface **204** and contoured top surface **206**. Fluid reservoir **250** can further comprise fluid flow passage **208** having effectively 180-degree bends **214** and effectively 90-degree bends **216**. Of course, suitable designs can incorporate bends with other angles. Fluid reservoir **250** can differ from fluid reservoir **200** in that a fluid inlet **252** and fluid outlet **254** each have a cross-sectional area that is substantially, approximately constant from fluid inlet **252** to fluid outlet **254** including the fluid flow passage **208**. In contrast, fluid flow passage **208** as illustrated in **FIGS. 6, 7, 8** and **9** flares out to a larger cross-sectional area between fluid inlet **210** and fluid outlet **212**. Fluid reservoir **250** can comprise similar materials and be manufactured using similar fabrication processes as previously described with respect to the previously discussed representative embodiment of fluid reservoir **100**.

[**0056**] Another representative, alternative embodiment of a fluid reservoir **300** based on the selection and fabrication of rigid materials is illustrated in **FIGS. 13, 14, 15, 16** and **17**. In this representative embodiment, fluid reservoir **300** can comprise a fluid reservoir body **302** having both a contoured top surface **304** and a contoured bottom surface **306** to form a fluid flow passage **308** between a fluid inlet **310** and a fluid outlet **312**. Thus, fluid reservoir **300** comprises a flow passage cross-section that is generally symmetric through a central plane **314** of the fluid reservoir body **302**, although alternative representative embodiments can have asymmetric contoured surfaces. As depicted, fluid flow passage **308** has a generally uniform cross-section between fluid inlet **310** and fluid outlet **312**, though it will be understood that the cross-section of fluid flow passage **308** could alternatively be larger than similar cross-sections of fluid inlet **310** and fluid outlet **312** depending upon design considerations such as, for example, fluid flow rate, desired fluid reservoir storage capacity, desired fluid velocities within fluid flow passage **308** and overall heat transfer properties of fluid reservoir **300**. Fluid flow passage **308** comprises a generally serpentine configuration with fifteen 180-degree bends **314** and two 90-degree bends **316**.

[**0057**] Referring to the exploded views of fluid reservoir **300** illustrated in **FIGS. 16 and 17**, appropriate tube fittings **318** can be secured into fluid inlet **310** and fluid outlet **312** to facilitate connection to and gripping of inlet tubing **320** and outlet tubing **322**. Tube fittings **318** can comprise any of a variety of suitable tube fitting known one skilled in the art such as, for example, push-style tube fittings available from a variety of manufacturers including John Guest International, Ltd., of Middlesex, United Kingdom, or barb-less style tubing fittings such as, for example, those described in copending U.S. Patent Publication No. 2004/0201212A1 filed on Apr. 11, 2003, to Marks, entitled, "Plastic Tube Joint." Tube fittings **318** can be appropriately secured within fluid inlet **310** and fluid inlet **312** through the use of suitable attachment methods such as, for example, integral molding, adhesive bonding and or thermal and sonic welding methods. Tube fittings **318** can be used to securely hold inlet tubing **320** and outlet tubing **322** formed from a tubing material that does not easily directly bond to the heat exchanger material, such as highly crosslinked polymers.

[**0058**] A representative embodiment of a flexible fluid reservoir **400** is illustrated in **FIGS. 18 and 19**. Flexible fluid reservoir **400** has a fluid reservoir body **402** having a primarily serpentine flow channel **404** between a fluid inlet **406** and a fluid outlet **408**. Flow channel **404** is generally defined by eleven 180-degree bends **410** and two 90-degree bends **412**. Welded seams or sections **414** mark the boundaries between adjacent sections of the flow channel **404**. A perimeter seam **416** is provided near the outer edge of the fluid reservoir body **402** in the roughly planar structure of the un-inflated configuration illustrated in **FIGS. 18 and 19**. In this representative embodiment, the overall shape of fluid reservoir **400** is generally rectangular with an extension portion **418** at one corner to provide for fluid inlet **406** and fluid outlet **408**, although any convenient shape generally can be used as appropriate.

[**0059**] With reference to the detailed view illustrated in **FIG. 19**, tubes **420** can be operably connected, for example by welding or adhesive bonding, to fluid inlet **406** and fluid outlet **408** for operably interconnecting flow channel **404** with a supply fluid source and an outlet point-of-use. As discussed with respect to previous representative embodiments, fluid reservoir **400** can be configured and fabricated to incorporate tubing connectors similarly welded and/or bonded into fluid inlet **406** and fluid outlet **408** for fluidly interconnecting flow channel **404** with a supply fluid source and an outlet point-of-use.

[**0060**] Another representative, alternative embodiment of a flexible fluid reservoir **500** is illustrated in **FIGS. 20 and 21**. Flexible fluid reservoir **500** comprises a generally serpentine flow channel **502** fluidly interconnecting a fluid inlet **504** with a fluid outlet **506**. Flow channel **502** is generally defined by eleven "squared" corners **508** at eleven 180-degree bends **510**. Both fluid inlet **504** and fluid outlet **506** include an integral flow port **512** attached directly through a wall **514** of fluid reservoir **500** such that the integral flow ports **512** are generally perpendicular to a generally planar surface defined by wall **514**. Integral flow ports **512** can be formed by welding and/or bonding a tubing connector, such as those previously described with respect to other fluid reservoir representative embodiments, into the fluid inlet **504** and fluid outlet **506**. Thus, apart from having openings in fluid inlet **504** and fluid outlet **506** to connect with the integral flow ports **512**, flow channel **502** is not otherwise shaped to form the integral flow ports **512**, in contrast with the representative embodiment of flexible fluid reservoir **400** illustrated in **FIGS. 18 and 19**.

[**0061**] In addition to the aforementioned and described fluid reservoirs, alternative representative fluid reservoir embodiments can be fabricated so as to comprise both rigid and flexible components in a single monolithic fluid reservoir. For example, a representative monolithic fluid reservoir

can comprise a combination of monolithic rigid body **202** and fluid reservoir body **402** so as to fine a rigid first surface and a flexible second surface. A rigid first surface and a flexible second surface can be operably joined to define a continuous, serpentine fluid channel using suitable fabrication processes such as, for example, adhesive bonding, thermal welding and a variety of molding processes, as would be understood by those skilled in the art.

[**0062**] The flow passageways associated with the various previously discussed fluid reservoirs can comprise a wide range of cross-sectional shapes and sizes. While these shapes can especially be applicable with respect to the fluid reservoirs formed with rigid materials such as, for example, fluid reservoir **100**, fluid reservoir **200** and fluid reservoir **300**, some of these cross-sectional shapes can also be formed for the flexible fluid reservoirs such as, for example, flexible fluid reservoir **400** and flexible fluid reservoir **500**, in addition to roughly circular cross-sections by selectively varying the sheet thickness of the flexible fluid reservoir. Some representative examples of cross-sectional shapes are illustrated in **FIGS. 22, 23, 24** and **25**. Referring to **FIG. 22**, these flow passages have a flat bottom **600** and a curved top **602** corresponding to fluid reservoir **200** and fluid reservoir **250** discussed previously with respect to **FIGS. 6-12** above. Four contoured shapes are illustrated in **FIG. 22** as follows: stretched semi-circle **604**, semi-circle **606**, stretched ellipse **608** and ellipse **610**. Referring to **FIG. 23**, representative embodiments of the flow passage have a contoured top surface **620** and a contoured bottom surface **622**. As illustrated in **FIG. 23**, contoured top surface **620** and contoured bottom surface **622** share substantially the same contour which generally corresponds to the contours of **FIGS. 1-5, 13-17** depicting fluid reservoir **100** and fluid reservoir **300** respectfully. The respective top and bottom shapes illustrated in **FIG. 23** are as follows: stretched semi-circle **624**, semicircle **626**, stretched ellipse **628** and ellipse **630**. Alternatively, contoured top surface **620** and contoured bottom surface **622** can comprise different contours such as, for example, contoured top surface **620** comprising stretched semi-circle **624** while contoured bottom surface **622** comprises ellipse **630**.

[**0063**] Alternative representative embodiments of cross-sectional shapes and sizes for increasing surface area and thermal transfer efficiency of fluid passages are illustrated in **FIGS. 24 and 25**. The flow passage illustrated in **FIG. 24** comprises a curved top surface **700** and a curved bottom surface **702**. Curved bottom surface **702** can be contoured as shown in the various frames of **FIGS. 24 and 25**. Curved top surface **702** can be similarly arched to the configurations depicted for curved bottom surface **702**, which can have advantages for certain flow applications such as, for example, inward dimples **703** of the contours of curved top surface **700** and curved bottom surface **702** can help to prevent rupture upon freezing through the outward bulging of the inward dimple **703** in response to expansion of freezing water. Depending upon the material selected for curved top surface **700** and curved bottom surface **702**, the inward dimples **703** can reform upon release of the expansion pressure as frozen water melts to form a liquid. Various alternative cross-sectional shapes of the passage can be formed based on the representative examples illustrated in **FIGS. 22, 23, 24** and **25**. A particular shape can be selected to have desired heat exchange and fluid flow properties, as well as convenience for processing.

[**0064**] In some presently preferred representative embodiments, the fluid reservoir can be formed as a single integral piece. For example, the fluid reservoir can be formed using blow molding. Blow molding is generally accomplishing by inflating a softened tube of polymer within a mold wherein the polymer expands against the mold walls thereby causing the polymer to assume the shape of the mold. The polymer is then cooled so as to retain this molded shape. However, in alternative processing approaches, the fluid reservoir can be formed from two sheets, for example, contoured top surface **304** and contoured bottom surface **306** as illustrated in **FIG. 16**, that are bonded together. Thus, in these representative embodiments, there are two steps to the process, a contouring step for one or both sheets and a bonding step, although the steps may or may not be separated in time. Other additional steps can be used. The contouring can be performed, for example, using blow molding or pressure molding. In these approaches, a sheet of polymer is thermally softened and contoured on a form. In vacuum forming, softened sheets are sucked onto a male or female form. In pressure molding, the softened sheet is blown onto the male or female form. A combination of suction and pressure can be used. The two sheets can be sealed together using sonic welding, heat welding/staking, radio-frequency RF heating/bonding, adhesive bonding or the like. Various tools for performing these bonding processes are known in the art. The contoured pieces are positioned and sealed. After bonding the sheets, the structure can be trimmed, smoothed or similarly finished.

[**0065**] Manufacturing of representative fluid reservoirs of the present disclosure can be accomplished in a generally continuous and simultaneous twin sheet forming process with respect to the sheets being essentially positioned for bonding at the time of the contouring. In this twin sheet forming process, the sheets can be positioned together at the start of the process with one or two forms adjacent the appropriate sheet(s). The sheets can then be heated wherein the contouring step, accomplished with vacuum/suction, and the heat boding step are performed in combination. The precise timing of the bonding and contouring steps can be generally simultaneous. The significant feature of the twin sheet forming process is that the sheets are aligned one time for both the contouring and bonding of the sheets without requiring significant translation and repositioning of the sheets once the processing is underway. This improves reproducibility while making the processing more efficient.

[**0066**] Furthermore, with a twin sheet forming process, the sheets can comprise a plurality of layers. In some representative embodiments, the layers can provide different functionalities to the composite sheet. For example, a layer can provide antimicrobial functionality, resist favor migration, limit oxygen migration, and/or increase thermal conductivity. The plurality of layers can be laminated together prior to performing the twin sheet forming process.

[**0067**] When manufacturing flexible fluid reservoirs, the fluid reservoir structure can be formed, for example, from two sheets or from a single folded sheet, although more sheets can be used to form the fluid reservoir if the edges between the sheets are positioned along seems. The forming process involves the bonding of adjacent sheets to form the seams between flow channels. For many flexible polymers, the bonding can be performed with heat bonding or other

thermal bonding process. However, adhesive bonds or other bonding processes can be similarly used to form the seams.

[0068] In some representative embodiments, the cross-sectional area can be selected to yield desired flow properties for the fluid reservoir so as to provide for a continually swept area having little or no dead volume, but have a wider area than a tube tank or the like. In some representative embodiments of interest, the fluid reservoir can be manufacture to have a flow passageway with a Reynolds number of about 800 to about 2500 at a flow rate of about 0.50 gallons per minute, in other representative embodiments from about 1000 to about 2000, and in further representative embodiments from about 1300 to about 1900 at a flow rate of about 0.50 gallons per minute.

[0069] The Reynolds number is a parameter that is related to the character of a fluid flow. It is defined as the product of the density, the velocity and a characteristic length divided by the viscosity. The flow rate of 0.50 gallons per minute is within standard ranges for household use and is a convenient reference point for evaluating the flow. The flow passages can be evaluated at a flow rate of 0.50 gallons per minute, although in actual use they may be used at different flow rates. These evaluations can be similarly performed for fluid reservoirs formed with rigid or flexible materials. Evaluation of the flow passages based on a selected flow is a convenient approach for evaluating the flow passages without reference to specifics of the cross-sectional shape. Calculated Reynolds numbers are tabulated in Table 1 below and plotted in **FIG. 26** for various diameter tubes for water at a viscosity at 40 degrees F.

TABLE 1

Reynolds Numbers For Various Flow Passage Diameters

Flow Rate	Reynolds Number at various diameters							
gpm	0.17"	0.23"	0.375"	0.5"	0.75"	1.0"	1.25"	1.5"
0.10	1203	889	**545**	**409**	**273**	**204**	**164**	**136**
0.20	2406	1778	1090	818	**546**	**408**	**328**	**272**
0.30	3609	2667	1635	1227	819	**612**	**492**	**408**
0.40	**4812**	3556	2180	1636	1092	816	**656**	**544**
0.50	**6015**	**4445**	2725	2045	1365	1020	820	**680**
0.60	**7218**	**5334**	3270	2454	1638	1224	984	816
0.70	**8421**	**6223**	3815	2863	1911	1428	1148	952
0.80	**9624**	**7112**	**4360**	3272	2184	1632	1312	1088
0.90	**10827**	**8001**	**4905**	3681	2457	1836	1476	1224
1.00	**12030**	**8890**	**5450**	**4090**	2730	2040	1640	1360
1.10	**13233**	**9779**	**5995**	**4499**	3003	2244	1804	1496
1.20	**14436**	**10668**	**6540**	**4908**	3276	2448	1968	1632
1.30	**15639**	**11557**	**7085**	**5317**	3549	2652	2132	1768
1.40	**16842**	**12446**	**7630**	**5726**	3822	2856	2296	1904
1.50	**18045**	**13335**	**8175**	**6135**	**4095**	3060	2460	2040
1.60	**19248**	**14224**	**8720**	**6544**	**4368**	3264	2624	2176
1.70	**20451**	**15113**	**9265**	**6953**	**4641**	3468	2788	2312
1.80	**21654**	**16002**	**9810**	**7362**	**4914**	3672	2952	2448
1.90	**22857**	**16891**	**10355**	**7771**	**5187**	3876	3116	2584
2.00	**24060**	**17780**	**10900**	**8180**	**5460**	**4080**	3280	2720

[0070] For comparison, at a flow rate of 0.5 gallons per minute, a standard commercial tank with cross-sectional inner diameters of 1.25 to 1.5 inches have Reynolds numbers of about 680. Reynolds numbers for commercial tanks are calculated and listed in Table 1 in bold font in the upper right-hand portion of the table. These tanks also can have un-swept volume and thermal stratification resulting in mixing. Thus, these tanks generally do not have first-in-first-out flow, which can result in undesirable properties with respect to taste and contamination. However, tube tanks generally have Reynolds numbers above 4000 and are calculated and listed in Table 1 in bold font in the lower left-hand portion of the table. While tube tanks generally have first-in-first-out flow, these can have other undesirable features relating to excessive surface area, for example, large pressure drops, high manufacturing costs, and undesirable taste with respect to stored fluid. The designs described herein overcome these issues through a fluid reservoir design that combines many of the desirable features of the tank design and the coil tube design. For example, fluid reservoirs can be specifically designed to have first-in-first-out flow similar to the coil tube design while having engineered conduit cross-sections for increasing storage volume similar to the tank design, all while maintaining the Reynolds number within the range of about 680 to about 4000.

[0071] The representative embodiments above are intended to be illustrative and not limiting. Additional embodiments are within the inventive concepts herein. Although the present inventive concepts has been described with reference to particular representative embodiments, workers skilled in the art will recognize that a variety of changes, modifications and substitutions may be incorporated without departing from the spirit and scope of the concepts described herein and the present claimed in the present disclosure.

What is claimed is:

1. A fluid reservoir comprising:

a structure having a fluid passageway fluidly connecting a fluid inlet with a fluid outlet, the fluid passageway having at least two bends positioned between the fluid inlet and fluid outlet wherein the fluid passageway has a Reynolds number from about 680 to about 4000 for about 0.5 gpm of water at about 40° F.

2. The fluid reservoir of claim 1, wherein the fluid passageway comprises:

a plurality of effectively 180 degree bends defining a serpentine fluid passageway.

3. The fluid reservoir of claim 1, wherein the fluid passageway comprises:

a passageway cross-sectional area exceeding the cross-sectional area of the fluid inlet and the fluid outlet.

4. The fluid reservoir of claim 1, wherein the fluid passageway comprises:

a top polymeric sheet and a bottom polymeric sheet, wherein the top polymeric sheet and the bottom polymeric sheet are operably joined to form a monolithic structure.

5. The fluid reservoir of claim 1, wherein the inlet port and the outlet port each comprise:

a tube fitting.

6. The fluid reservoir of claim 1, wherein the fluid structure comprises:

a rigid, monolithic fluid structure.

7. The fluid reservoir of claim 6, wherein the rigid, monolithic fluid structure comprises:

a material selected from the group comprising: a polyolefin polymer and a metal.

8. The fluid reservoir of claim 1, wherein the fluid structure comprises:

a flexible, monolithic fluid structure.

9. The fluid reservoir of claim 8, wherein the flow passage expands to a full-open position under the influence of a pressurized fluid.

10. The fluid reservoir of claim 8, wherein the flexible, monolithic fluid structure comprises a polyolefin polymer selected from the group comprising: polyethylenes, polypropylenes, polyethylene copolymers, polyurethanes, polystyrenes, polyamides and polyesters.

11. The fluid reservoir of claim 1, wherein the fluid passageway has a Reynolds number from about 820 to about 2725 for about 0.5 gpm of water at about 40° F.

12. An appliance comprising the fluid reservoir of claim 1.

13. The appliance of claim 12 wherein the appliance comprises:

a refrigerator.

14. The appliance of claim 13 further comprising:

a water filtration system operatively, fluidly attached to the fluid reservoir.

15. A method for forming a fluid reservoir structure comprising the acts of:

operatively fabricating a top surface and a bottom surface, each surface having a plurality of seams formed therein; and

operatively joining the top surface and bottom surface at the plurality of seams to define a flow passage having at least two bends, wherein at least one of the top surface and the bottom surface have a contoured surface.

16. The method of claim 15 wherein the operatively joining act comprises:

a bonding process selected form the group comprising:

sonic welding, thermal bonding, radio frequency bonding, adhesive bonding and combinations thereof.

17. The method of claim 15, wherein the forming act comprises a molding process selected from the group comprising:

blow molding, pressure molding and vacuum forming.

18. The method of claim 15 further comprising the act of:

folding a polymer sheet to define the top surface and the bottom surface.

19. The method of claim 15 further comprising the act of:

placing a tube fitting in a fluid inlet and a fluid outlet wherein the fluid inlet and fluid outlets are at fluidly opposing ends of the flow passage.

20. A fluid reservoir comprising:

a monolithic structure having a flow passage along a serpentine path between an inlet and an outlet, wherein adjacent flow passages are separated by a seam.

* * * * *