US Patent & Trademark Office
Patent Public Search | Text View

United States Patent Application Publication 20250257835
Kind Code A1
Publication Date August 14, 2025
Inventor(s) SHOR; Richard et al.

FLUID DISTRIBUTION JUNCTIONS AND ASSEMBLY METHODS

Abstract

There are disclosed apparatus including fluid distribution junctions and methods of assembly therefor. Flexible conduits connect to the junctions, and a consumable subsystem of the junction, conduits and receptacle caps or other connectors may be pre-assembled for ease of use. A subassembly is formed by coupling a plurality of flexible tubular conduits to a plurality of fluid connectors of a fluid junction, the fluid junction having an inner fluid plenum chamber leading to the fluid connectors. Two shells are sandwiched on opposite sides of the subassembly, the shells having mating concave receiving surfaces that together conform around each of the fluid connectors and clamp the tubular conduits onto the circular beads. Juxtaposed joint surfaces on each pair of mating concave receiving surfaces are bonded together such as with sonic welding to make the fluid distribution junction assembly.

Inventors: **SHOR; Richard (Thousand Oaks, CA), BALLEW; Chris (Moorpark, CA), TRINH; Xin-Xin (Reseda, CA)**

Applicant: **SaniSure, Inc.** (Camarillo, CA)

Family ID: **1000008560672**

Appl. No.: **19/193714**

Filed: **April 29, 2025**

Related U.S. Application Data

parent US continuation 18895756 20240925 PENDING child US 19193714
parent US continuation 18661592 20240511 parent-grant-document US 12111002 child US 18895756
us-provisional-application US 63501760 20230512

Publication Classification

Int. Cl.: **F16L41/02** (20060101); **F16L13/02** (20060101); **F16L41/03** (20060101); **F16L43/02** (20060101)

U.S. Cl.:

CPC **F16L41/02** (20130101); **F16L13/0281** (20130101); F16L41/021 (20130101); F16L41/023 (20130101); F16L41/03 (20130101); F16L43/02 (20130101)

Background/Summary

RELATED APPLICATION INFORMATION
[0002] This application is a continuation of application Ser. No. 18/895,756, filed Sep. 25, 2024, entitled FLUID DISTRIBUTION JUNCTIONS AND ASSEMBLY METHODS, which claims the benefit of application Ser. No. 18/661,592, filed May 11, 2024, issued as U.S. Pat. No. 12,111,002, which claims the benefit of Application No. 63/501,760, filed May 12, 2023, the disclosure of which are all incorporated herein by reference.
BACKGROUND
Field
[0003] This disclosure relates to sterile consumable fluid flow subsystems.
Description of the Related Art
[0004] Processing of fluids in chemical and biological reactors often results in valuable fluid product which must be distributed to various receptacles for further processing, delivery to customers or sampling. Current junctions for distribution of fluids from one place to one or more others are inefficient to assemble.
[0005] Current systems make use of linear manifolds leading from a source of fluid to which cross and tee junctions are connected. Fluid enters from one end of the manifold and flows in a linear fashion over each cross or tee branch along the header of the manifold. When liquid flows in this manner, it takes the path of least resistance, and since most of the branches (drops) are smaller in diameter than the manifold header, they receive liquid until hydraulic pressure builds to the point of pressure equalization. Moreover, assembling a large fluid distribution system with conduits leading to various destinations is time-consuming and prone to error.
[0006] There is a need for fluid distribution junctions and methods of assembly for distribution of fluid between various locations.
SUMMARY
[0007] Apparatus including fluid distribution junctions for distributing fluid between various locations and methods of assembly are disclosed. Flexible conduits connect to the junctions, and a consumable subsystem of the junction, conduits and receptacle caps or other connectors may be pre-assembled for ease of use. A subassembly is formed by coupling a plurality of flexible tubular conduits to a plurality of fluid connectors of a fluid junction, the fluid junction having an inner fluid plenum chamber leading to the fluid connectors. Two shells are sandwiched on opposite sides of the subassembly, the shells having mating concave receiving surfaces that together conform

around each of the fluid connectors and clamp the tubular conduits onto the circular beads. Juxtaposed joint surfaces on each pair of mating concave receiving surfaces are bonded together such as with sonic welding to make the fluid distribution junction assembly.

[0008] Methods for forming the pre-assembled fluid junction and flexible conduits are disclosed. One of the junctions having flexible tubular conduits pressed onto fluid connectors is sandwiched between two of the bonding shells. The sandwiched stack is then placed between a base and an ultrasonic vibration horn. When the ultrasonic energy is applied by the horn, the bonding shells melt at their joint surfaces and secure the flexible conduits to the fluid connectors. Energy directors or concentrators such as narrow features along the joint surfaces of one of the shells facilitates rapid melting and good and reliable coupling of the shells.

[0009] One fluid distribution system that utilizes the improved junction has a distribution manifold with a single inlet and a plurality of outlets arrayed around a circumferential outer periphery. The outlets may be directed to the different receptacles which each have their own vent filter, or each receptacle connects back to the distribution manifold for common venting. The system is especially useful for distributing fluid products from chemical or biological reactors while assuring an integrally closed system.

Description

DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a schematic view of a sampling receptacle having a number of flexible conduits extending from a cap thereof, one of which couples to a prior art 4-way junction with additional flexible conduits connected on all three outlets.

[0011] FIG. **2** is an elevational view of the prior art 4-way junction showing barbs for connecting to the flexible conduits.

[0012] FIG. **3** is an exploded perspective view of a 4-way junction assembly of the present application in the process of being integrated with flexible conduits.

[0013] FIG. **4** is an exploded elevational view of the 4-way junction assembly integrated with flexible conduits in a process of pressing and bonding the components together.

[0014] FIG. **5** is a barbed T-junction of the prior art with one flexible conduit connected thereto.

[0015] FIG. **6** is an exploded perspective view of a T-junction of the present application.

[0016] FIG. **7** is an assembled perspective view of the T-junction of FIG. **6** integrated with three flexible conduits.

[0017] FIG. **8** is a barbed Y-junction of the prior art with one flexible conduit connected thereto.

[0018] FIG. **9** is an exploded perspective view of a Y-junction of the present application.

[0019] FIG. **10** is an assembled perspective view of the Y-junction of FIG. **9** integrated with three flexible conduits.

[0020] FIG. **11** is a perspective view of an alternative fluid distribution system for quickly filling eight smaller receptacles from a single source, all supported by a support stand.

[0021] FIG. **12** is an enlarged perspective view of the alternative fluid distribution and vent manifold assembly for the fluid distribution system with inlet and outlet conduits coupled thereto, and FIG. **13** shows the fluid distribution and vent manifold assembly with the inlet and outlet conduits removed.

[0022] FIG. **14** is an exploded perspective view of the fluid distribution and vent manifold assembly including shells that sandwich together the fluid distribution and vent manifold along with inlet and outlet connectors.

[0023] FIGS. **14**A and **14**B are enlargements of two of the shells showing raised joint surfaces that bond with the joint surfaces of the adjacent shell(s).

[0024] FIG. **15** is an exploded elevational view of the fluid distribution and vent manifold

assembly.
[0025] FIGS. **16**A and **16**B are elevational views of the fluid distribution and vent manifold assembly in slightly different rotational positions.
[0026] FIGS. **17**A and **17**B are axial sectional views through the fluid distribution and vent manifold assembly taken along the respective section lines in FIGS. **16**A and **16**B.
[0027] FIG. **18**A is a bottom plan view of a fluid distribution manifold portion of the assembly of FIG. **15**.
[0028] FIG. **18**B is a radial sectional view through the fluid distribution manifold taken along the section line in FIGS. **18**A.
[0029] FIGS. **19**A and **19**B are perspective views of a fluid distribution manifold and vent distribution manifold, respectively, of the assembly of FIG. **14** during intermediate steps in the integration with flexible conduits.
[0030] FIG. **20** is an exploded elevational view of the fluid distribution and vent manifold assembly integrated with flexible conduits in a process of pressing and bonding the components together.
[0031] FIG. **21** is a perspective view of a deliverable/consumable sterile fluid distribution subsystem for attaching to receptacles enabling filled with fluid from a single source.
[0032] FIG. **22** is an exploded view of a typical ultrasonic bonding stack for joining the parts to form the fluid distribution and vent manifold assembly of FIG. **13**.
[0033] FIG. **23** is an exploded perspective view of a base and nesting cavity for receiving the stacked fluid distribution and vent manifold assembly of FIG. **22**.
[0034] FIG. **24** is an exploded perspective view of a reducing straight junction flanked by two bonding shells for connecting the junction with flexible tubes.
[0035] FIG. **24**A is an enlargement of one of the shells showing an ultrasonic concentrator rib.
[0036] FIG. **25** is an exploded perspective view of an elbow junction flanked by two bonding shells for connecting the junction with flexible tubes.
[0037] FIG. **25**A is an enlargement of one of the shells showing an ultrasonic concentrator rib.
[0038] FIG. **26** is an exploded perspective view of a reducing elbow junction flanked by two bonding shells for connecting the junction with flexible tubes.
[0039] FIG. **26**A is an enlargement of one of the shells showing an ultrasonic concentrator rib.
[0040] FIG. **27** is an exploded perspective view of a reducing T-junction flanked by two bonding shells for connecting the junction with flexible tubes, and FIG. **27**A is an enlargement of one of the shells showing an ultrasonic concentrator rib.
[0041] FIG. **28** is an exploded perspective view of a reducing cross-junction flanked by two bonding shells for connecting the junction with flexible tubes, and FIG. **28**A is an enlargement of one of the shells showing an ultrasonic concentrator rib.
[0042] FIG. **29** is an exploded perspective view of a reducing Y-junction flanked by two bonding shells for connecting the junction with flexible tubes, and FIG. **29**A is an enlargement of one of the shells showing an ultrasonic concentrator rib.
[0043] FIG. **30** is an exploded elevational end view of the reducing straight junction and shell assembly of FIG. **24**.
[0044] FIG. **31**A is an enlargement of an edge one of the shells showing an ultrasonic concentrator rib from the end.
[0045] FIG. **31**B is an enlargement of an edge of the other one of the shells having a flat contact surface.
[0046] FIG. **32** is a schematic view of the presumed melt pattern that occurs when the two shells of FIGS. **31**A and **31**B are joined together using ultrasonic energy.
[0047] FIGS. **33-36** are schematic views of alternative configurations of ultrasonic concentrators between two edges being bonded together.
DETAILED DESCRIPTION

[0048] Referring now to FIG. **1**, an exemplary fluid distribution system **20** is illustrated for collecting fluid from a source and distributing the fluid to other locations. It should be understood that the illustrated system **20** is just one example, and the concepts disclosed herein can be modified for different systems.

[0049] The system **20** comprises a flask or receptacle **22** having a cap **24** and a plurality of flexible conduits connected thereto. An inlet conduit **26** supplies fluid from a source (not shown) into the hollow receptacle **22**. A second conduit **28** may be connected to the cap **24** and provided with a vent filter **30**. Gases which may build up within the receptacle **22** can then be safely vented. The fluid distribution system **20** is especially useful for dividing fluid flow from a larger vessel into smaller individual receptacles **22**, such as the flask shown. For instance, a third conduit **32** extends from the cap **24** to a conventional 4-way junction **34**, which is shown isolated in FIG. **2**. The 4-way junction **34** distributes the fluid removed from the receptacle **22** to different destinations via three flexible conduits **36**.

[0050] The conduit **32** leading from the receptacle **22** and the additional three flexible conduits **36** attach to the barbed fittings **38** provided by the junction **34**. The 4-way junction **34** and others of its kind are standard components of conventional fluid distribution systems. In the illustrated example, the barbed fittings **38** include a short length of rigid tubing **40** having a frusto-conical outward bead **42** (often referred to as a barb or barbed bead) which gets wider towards a central housing **44** in which is located a plenum chamber joining the inner lumens of all four fittings. The junction **34** is typically molded of a rigid plastic such as polypropylene, and the flexible conduits **32**, **36** are a thermoplastic elastomer (TPE), silicone or the like that can be pressed onto each fitting **38**. The inner diameter of the conduits **32**, **36** are approximately the same as the diameter of the rigid tubing **40** such that the conduits flex and slide over the tapered ramp provided by the outward beads **42** to the central housing **44**. The sharp step provided on the inner end of the outward beads **42** then impedes removal of the conduits **32**, **36**. The single barb provided by the outward beads **42** can be replaced with a series of such beads in alternative junction configurations.

[0051] The arrangement of the 4-way junction **34** with attached flexible conduits **32**, **36** is extremely common in the chemical and biological processing field, and is typically done at the time of setting up the particular process. Often, this same setup is duplicated many times over for a single process, and the task of connecting all of the flexible conduits to all of the junctions can be time-consuming and thus costly. Moreover, pressing the conduits **32**, **36** onto the barbed fittings **38** can require significant force, which over time may manifest as injuries such as carpal tunnel syndrome for the workers. Finally, having to assemble every one of the separate conduits to such barbed fittings introduces the potential of contamination to sometimes extremely sensitive chemical or biological processing. There is a need for a better system for connecting the flexible conduits to such junctions.

[0052] In one solution, FIG. **3** is an exploded perspective view of a 4-way junction assembly **50** of the present application in the process of being integrated with flexible conduits **52**. The junction assembly **50** comprises three components: an inner 4-way junction **54** and two outer covers or shells **56**. The 4-way junction **54** is constructed much like the 4-way junction **34** of the prior art shown and described above, with a central housing **60** having four tubular fittings **62** extending outward therefrom in a cross pattern. As before, the central housing **60** defines a central plenum chamber that communicates equally with lumens **64** of each of the tubular fittings **62**. Rather than a frusto-conical bead, each one of the fittings **62** has an outwardly projecting circular bead **66** having a somewhat semi-circular cross-section. As will be shown, the assembly of the 4-way junction **54** with the two outer shells **56** provides enough friction to hold the flexible conduits **52** in place on the fittings **62**. As before, the junction **54** is typically molded of a rigid plastic such as polypropylene, and the flexible conduits **52** are a thermoplastic elastomer (TPE), silicone or the like that can be pressed onto each fitting **62**. The outer shells **56** are also molded of a rigid plastic such as polypropylene.

[0053] FIG. **3** shows two of the flexible conduits **52** mounted over associated tubular fittings **62**, with a third fitting in the process of receiving a flexible conduit, and the fourth fitting having no conduit. This represents a step in putting the junction assembly **50** together. The sequence involves first pre-assembling the flexible conduits **52** onto the tubular fittings **62** of the junction **54**, and then sandwiching that sub-assembly with the outer shells **56**. Each of the outer shells **56** has a cross-pattern of inwardly concave walls that fit closely around the sub-assembly of the conduits **52** and junction **54**. More specifically, each of the four legs of the outer shells **56** has a concave semi-cylindrical inner wall portion **70** with a semi-circular inward rib **72** provided on a radially outward extent thereof. A diameter of the semi-cylindrical inner wall portions **70** preferably matches an outside diameter of the flexible conduits **52**. When the two shells **56** are closed around the sub-assembly of the conduits **52** and junction **54**, the inner wall portions **70** compress the flexible conduits **52** against the circular beads **66** of the tubular fittings **62**. Moreover, the semi-circular inward rib **72** compress inwardly against the flexible conduits **52**. This combination of compression from the outer shells **56** effectively holds the flexible conduits **52** in place.
[0054] FIG. **3** shows that each of the shells **56** has a planar joint surface **74** that matches up with the joint surface of the other shell. The joint surfaces **74** extend along the edges of the concave inner wall portions **70**, and are thus arranged in a cross pattern as well. Juxtaposition of these joint surfaces **74** of both shells **56** enables them to be bonded together. The bonding can be done in a number of ways, including adhesives, fusion or electro-fusion welding, and sonic welding. The present application contemplates an assembly process that utilizes sonic welding to avoid the use of chemical adhesives.
[0055] FIG. **4** is an exploded elevational view of the 4-way junction **54** integrated with flexible conduits **52** in a process of pressing and bonding the frames or shells **56** together. The components of the 4-way junction assembly **50** are stacked as seen. Opposing presses **80** are used to compress this stacked assembly of components together, applying pressure and vibration or heat/current to fuse the contacting components. The opposing presses **80** have pressing surfaces that mate closely with the stacked shells **56**, such as having a cross pattern of recesses **82**. A preferred method for fusing is sonic welding, though thermal or electro-thermal welding may be used as an alternate or accompanying method.
[0056] Sonic welding, also known as ultrasonic welding, is a technique used to join thermoplastic materials together, and is widely used in various industries, including automotive, electronics, medical, and packaging. The process utilizes high-frequency mechanical vibrations to create frictional heat at the interface of the plastic parts, causing them to melt and fuse together.
[0057] Sonic welding involves first preparing plastic parts to be joined by ensuring that their surfaces are clean and free from contaminants. Any protective coatings, films, or adhesives are removed from the joining areas. The plastic parts are positioned between the opposing presses **80**, which are designed to hold them securely during the welding process. The two presses **80** consist of a stationary anvil and a movable horn (also called an ultrasonic stack) that applies the ultrasonic vibrations to the parts. The opposing presses **80** applying a consistent pressure to ensure proper mating of the surfaces of the plastic parts into contact with each other (i.e., joints), in this case the juxtaposed joint surfaces **74** of the stacked outer shells **56**, as seen in FIG. **3**. The amount of pressure applied depends on the specific materials and their thickness. Narrowed physical aspects or ultrasonic energy directors may be used to focus or concentrate the ultrasonic energy in a smaller region for faster heating. For instance, FIG. **4** shows narrow ribs **75** visible below the joint surface **74** of the upper one of the stacked shells **56**. These narrow ribs **75** contact the colinear and planar joint surfaces **74** on the lower one of the stacked shells **56** and direct the energy along more of a line as opposed to an area for faster heating and melting. A rigid plastic such as polypropylene used for the stacked shells **56** quickly melts and provides a solid joint. Particular arrangements of such ultrasonic energy directors will be shown and described later.
[0058] The horn part of the opposing presses **80** transmits high-frequency ultrasonic vibrations

(typically in the range of 20 kHz to 70 kHz) to the joint interface between the plastic parts. The vibrations are generated by a transducer, which converts electrical energy into mechanical vibrations. Consequently, the ultrasonic vibrations create rapid back-and-forth movements at the joint interfaces, causing frictional heat to build up between the plastic surfaces. This localized heat softens the plastic material, melting it at the contact points. As the plastic materials reach their melting points, the pressure applied to the joint forces the melted material to flow and interdiffuse, creating molecular bonds between the parts. Once the vibrations stop, the melted plastic resolidifies, forming a strong and durable bond.

[0059] After the ultrasonic vibrations cease, the joint is allowed to cool down. The cooling time depends on the specific plastic material and the size of the welded part. Cooling can be accelerated by methods such as air or water cooling. Once the joints have cooled and solidified, the welding process is considered complete. The welded parts can be inspected for any defects, such as incomplete fusion, voids, or flash. Additional trimming or post-weld processing may be required depending on the specific application.

[0060] By utilizing the method represented in FIG. **4**, the conduits **52** can be rapidly pre-assembled with the 4-way junction **54** for subsequent connection within the fluid distribution system **20** of FIG. **1**, for example. If a given chemical or biological process is known to require a particular number of junctions attached to flexible conduits, these can be procured pre-assembled from the manufacturer and simply plugged into the particular process arrangement. The pre-assembly has a significant advantage in that it arrives sterile in sterile packaging, and there is no need to separately connect conduits to junctions, which can result in contamination. Moreover, the pre-assembled conduits **52** and 4-way junction **54** can be further joined by the manufacturer to components, such as the cap **24** of the receptacle **22**, for even easier assembly and the laboratory or process facility. Saving time, money, and potentially injurious repetitive assembly steps is a significant advantage.

[0061] Another such arrangement is shown in FIG. **5**, where a barbed T-junction **90** of the prior art with one flexible conduit **92** connected thereto is shown. Once again, the barbed T-junction **90** has frusto-conical beads or barbs **94** over which the flexible conduits **92** are pressed. Each barbed T-junction **90** thus requires three separate steps of attaching the conduits **92**, potentially introducing contamination and requiring time and thus money.

[0062] FIG. **6** is an exploded perspective view of an equivalent T-junction assembly **100** of the present application comprising an inner T-junction **102** sandwiched between two outer covers or shells **104**. The T-junction **102** has three legs or fittings with barbs or beads **106**, as described above with respect to the 4-way junction **54**. Likewise, the outer shells **104** have concave inner surfaces **108** that mate together along planar joint surfaces **110**. Flexible conduits **112** are first integrated with the inner T-junction **102**, and then that sub-assembly is sandwiched between the two outer shells **104** which are bonded together, as seen in FIG. **7**. Once again sonic welding is the preferred method of bonding.

[0063] FIG. **8** is a barbed Y-junction **120** of the prior art with one flexible conduit **122** connected thereto. Once again, the barbed Y-junction **120** has frusto-conical beads or barbs **124** over which the flexible conduits **122** are pressed. Each barbed Y-junction **120** thus requires three separate steps of attaching the conduits **122**, potentially introducing contamination and requiring time and thus money.

[0064] FIG. **9** is an exploded perspective view of an equivalent Y-junction assembly **130** of the present application comprising an inner Y-junction **132** sandwiched between two outer covers or shells **134**. The Y-junction **132** has three legs or fittings with barbs or beads **136**, as described above with respect to the 4-way junction **54**. Likewise, the outer shells **134** have concave inner surfaces **138** that mate together along planar joint surfaces **140**. Flexible conduits **142** are first integrated with the inner T-junction **132**, and then that sub-assembly is sandwiched between the two outer shells **134** which are bonded together, as seen in FIG. **10**. Once again sonic welding is the preferred method of bonding.

[0065] FIG. **11** is a perspective view of more complex alternative fluid distribution system **220** for quickly filling eight receptacles **222** from a single source, all supported by a support stand **224**. The alternative fluid distribution system **220** includes a lower inlet **226** leading to a fluid distribution and vent manifold assembly **228** that separates an inlet fluid flow for delivery to eight individual receptacles **222**, all supported by the support stand **224**. Although not shown, a source for the inlet flow may comprise a larger vessel, such as a bioreactor vessel or other such chemical processing equipment. The fluid distribution system **220** is especially useful for dividing fluid flow from such a larger vessel into smaller individual receptacles **222**, such as the flasks shown. The lower inlet **226** of the manifold assembly **228** located on its underside connects to a larger inlet pipe **230**.
[0066] Fluid distribution and vent manifold assembly **228** is seen in the enlarged perspective and elevational views of FIGS. **12** and **13**. Namely, FIG. **12** is an enlarged perspective view of the manifold assembly **228** with eight fluid outlet and inlet tubes or conduits **232**, **234** coupled thereto, and FIG. **13** shows the manifold assembly with the conduits removed. The manifold assembly **228** comprises a compact cylindrical frame **236** and a central inlet connector **238** projects below the cylindrical frame **236** and central outlet connector **240** projects upward. The manifold assembly **228** includes a plurality of lower outlet fittings **242** that couple to the outlet conduits **232**, and a plurality of upper inlet fittings **244** are coupled to the inlet conduits **234**. The fluid conduits **232**, **234** may be fused, bonded or otherwise fixed to the outlet fittings **242** and inlet fittings **244** which are recessed within the cylindrical manifold assembly **228**, as described below.
[0067] As illustrated, there are eight outlet fittings **242** and outlet conduits **232** distributed evenly (45° increments) around the circumference of the cylindrical manifold assembly **228**. Likewise, there are shown eight inlet fittings **244** and inlet conduits **234** distributed evenly (45° increments) around the circumference of the cylindrical manifold assembly **228**. As will be explained below, primary internal channels within the manifold assembly **228** direct fluid flowing in through the inlet connector **238** evenly outward through the outlet fittings **242** and fluid outlet conduits **232**. When configured to provide a common vent, secondary internal channels within the manifold assembly **228** direct fluid flowing in through the inlet conduits **234** and inlet fittings **244** evenly inward to a central plenum and central outlet connector **240** to be vented upward.
[0068] With reference now to the exploded view of FIG. **14**, the components of the fluid distribution and vent manifold assembly **228** can be better explained. The generally cylindrical frame **236** seen in FIG. **13** is formed by three disk-shaped members coupled together. Namely, upper and lower shells **250***a*, **250***b* sandwich a central shell **252** therebetween. The shells **250**, **252** contain and conceal a pair of fluid distribution junctions or manifolds **254**, **256**. More particularly, as seen by the exploded elevational view of FIG. **15**, a lower fluid distribution manifold **254** is positioned between the lower shell **250***b* and the central shell **252**, and an upper vent distribution manifold **256** is positioned between the upper shell **250***a* and the central shell **252**. The fluid distribution manifold **254** has the radially oriented outlet fittings **242**, and the vent distribution manifold **256** has the radially oriented inlet fittings **244**. The radially-projecting outlet and inlet fittings **242**, **244** are recessed within the shells **250**, **252** that axially sandwich the fluid distribution manifold **254** and vent distribution manifold **256** and define the outer compact cylindrical shape. Each manifold **254**, **256** has at least four outlet and inlet fittings **242**, **244**, respectively, but preferably eight as shown.
[0069] The terms “junction” and “manifold” are used herein to refer to single-piece members that have a number of fluid inlet and outlet connectors or fittings for distributing fluid between locations, such as in the manifolds **254**, **256**. “Fluid” in this sense means liquid or gas. The term “junction” is conventionally used to describe the T-, Y-, and 4-way junctions (and others not mentioned) with inner channels that intersect within the junction, while a manifold is more accurate when discussing a member which has one channel or port opening to an inner plenum chamber which communicates with two or more other ports. In this sense, a manifold is a more complex subset of a junction, and the term “junction” encompasses both devices.

[0070] The fluid distribution manifold **254** and the vent distribution manifold **256** are preferably identical, and simply inverted vertically with respect to one another, and thus will be described together with like elements being given like reference numbers. As seen in FIG. **14**, as well as with reference to FIGS. **18**A and **18**B, the fluid distribution manifold **254** has a cylindrical outer wall **260** from which the outlet fittings **242** project radially outward. A solid radially-oriented plenum floor **262** extends across the manifold **254** within and is stepped axially downward from an upper edge of the cylindrical outer wall **260**. The remaining features of the fluid distribution manifold **254** are also seen in the top view of the vent distribution manifold **256** in FIG. **14**, as the two manifolds are identical.

[0071] The cylindrical outer wall **260** circumscribes a smaller inner circular wall **264** with a radially-oriented inner bulkhead **266** extending therebetween. The inner circular wall **264** extends axially until interrupted by a stepped cylindrical plenum chamber wall **268** through which a plurality of radial passages **270** open to a central plenum chamber **272**. The radial passages **270** extend outward through the inlet fittings **244** of the vent distribution manifold **256** (or the outlet fittings **242** of the fluid distribution manifold **254**). FIGS. **16**A and **16**B are elevational views of the fluid distribution and vent manifold assembly **228** in slightly different rotational positions. As mentioned, the various components seen in FIG. **15** are combined into the compact cylindrical frame **236** with the inlet connector **238** projecting downward, and the outlet connector **240** projecting upward therefrom. The circular array of outlet fittings **242** are seen below the circular array of inlet fittings **244**.

[0072] FIGS. **17**A and **17**B are axial sectional views through the fluid distribution and vent manifold assembly **228** taken along the respective section lines in FIGS. **16**A and **16**B. By virtue of the slightly different rotational orientation of FIGS. **16**A and **16**B, fluid and gasses flowing through the manifold assembly **228** can be seen. The inlet connector **238** and the outlet connector **240** both have stepped ends that engage the respective manifolds **254**, **256** and open to respective central plenum chambers **272**. Namely, the innermost end of each connector **238**, **240** fits closely within the circular walls **264** and abuts the stepped cylindrical plenum chamber wall **268**. Outward flanges on each connector **238**, **240** contact outer faces of respective shells **250***a*, **250***b*, best seen in FIGS. **13** and **16**A/**16**B. Fluid or gasses thus flow directly to or from the plenum chambers **272** and through the connectors **238**, **240**.

[0073] First off, FIG. **16**A is a section through one of the radial passages **270** in the fluid distribution manifold **254**. Fluid introduced into the inlet connector **238** travels upward into the central plenum chamber **272** and is then evenly distributed outward through the radial passages **270**, as indicated in FIG. **17**A. FIGS. **11** and **12** show the subsequent connection of the outlet conduits **232** to the outlet fittings **242**, eventually leading to the fluid vessels or receptacles **222** held in the stand **224**. Each receptacle **222** has a closure or cap **222***a* with an opening with which the outlet conduits **232** communicate. The cap **222***a* has a second opening with which the inlet conduits **234** communicate. The inlet conduits **234** extend upward and couple with the inlet fittings **244** of the manifold assembly **228**.

[0074] Accordingly, FIG. **16**B is a section through one of the radial passages **270** in the vent distribution manifold **256**. Gases which are displaced from the receptacles **222** upon filling with liquid are vented upward through the conduits **234**, through the inlet fittings **244** and into the radial passages **270** in the vent distribution manifold **256**, as indicated in FIG. **17**B. The gases flow inward to the central plenum chamber **272**, and from there turn upward to exit through the outlet connector **240**. Although not shown in FIG. **11**, one or more common vent filter(s) may be attached to the outlet connector **240**, such as shown at **60** in FIGS. **1** and **2**.

[0075] The fluid distribution and vent manifold assembly **228** in the alternative system **220** exemplifies an advantageous assembly technique which greatly reduces assembly time and expense. Fluid distribution systems which are used to convey fluid in bulk from a single source to a plurality of separate vessels inevitably must utilize flexible tubing, such as the conduits **232**, **234**.

Such conduits are typically coupled in the end-user processing facility to hose barbs on each end, with or without bonding or hose clamps and the like to prevent leakage. When assembling such a fluid distribution system, the time required to make each of these connections is significant, adding to assembly costs. Moreover, mistakes in the lab can occur when connecting numerous conduits to receptacles.

[0076] The fluid distribution and vent manifold assembly **228** is assembled in much less time than previous systems and with a greatly reduced margin for mistakes. In general, the assembly method involves pre-attaching the flexible tubing to manifold components in the manufacturing facility, and then joining the manifold components and flexible tubing together using shells and fusion. Because the tubing can be more rapidly attached to the manifold components, as opposed to connecting the tubing between a manifold assembly and vessels after the fact, the entire process is speeded up.

[0077] To illustrate the exemplary assembly method, reference is made to the perspective views of FIGS. **19**A and **19**B of the fluid distribution manifold **254** and vent distribution manifold **256**. Initially, flexible outlet conduits **232** are attached to each of the outlet fittings **242** of the fluid distribution manifold **254**. Simultaneously, or sequentially, flexible inlet conduits **234** are attached to each of the inlet fittings **244** emanating outward from the vent distribution manifold **256**. In the illustrated embodiment, each of the fittings **242**, **244** are configured similar to hose barbs, though instead of a series of circular beads only one may be necessary. Each of the circular beads is sized slightly larger than the inner diameter of the associated flexible conduit, such that the conduits can be pushed onto the fittings in an interference fit.

[0078] Subsequently, the various components of the manifold assembly **228** are stacked as seen in FIG. **20**. Opposing presses **280** are used to compress this stacked assembly of components together, applying pressure and vibration or heat/current to fuse the contacting components. Again, the opposing presses **280** have pressing surfaces that mate closely with the stacked shells **250***a*, **250***b*. A preferred method for fusing is sonic welding, though adhesives or thermal or electro-thermal welding may be used as an alternate or accompanying method.

[0079] Sonic welding involves first preparing plastic parts to be joined by ensuring that their surfaces are clean and free from contaminants. Any protective coatings, films, or adhesives are removed from the joining areas. The plastic parts are positioned between the opposing presses **80**, which are designed to hold them securely during the welding process. The two presses **280** consist of a stationary anvil and a movable horn (also called an ultrasonic stack) that applies the ultrasonic vibrations to the parts. The opposing presses **280** applying a consistent pressure to ensure proper mating of the surfaces of the plastic parts into contact with each other (i.e., joints), in this case the stacked shells **250***a*, **250***b*, as seen in FIGS. **13** and **16**A/**16**B. The amount of pressure applied depends on the specific materials and their thickness. The rest of the process may be as described above with respect to FIG. **4**.

[0080] It should be noted that the various components of the manifold assembly **228** are shaped to nest together so that when they are bonded together they form the compact cylindrical body **236** seen in FIG. **13**. For instance, with reference to FIG. **14**, the upper and lower shells **250***a*, **250***b* have flat outer faces but define a plurality of radially-oriented channels or grooves **290** on their inner faces. These grooves **290** fit around each of the projecting fittings **242**, **246** in the manifolds **254**, **256**. Similarly, the central shell **252** has a circular array of radially-oriented channels or grooves **292** on both its faces which also receive the projecting fittings **242**, **246**. FIG. **13** shows the resulting assembly **228** in which the fittings **242**, **244** remain within the cylindrical outer boundary. This serves the purpose of protecting the integrity of the fittings **242**, **244** from damage, but more importantly clamps the inner ends of the flexible conduits **232**, **234** around the fittings. That is, the curvature of the radial grooves **290**, **292** is matched to or slightly less than the outer diameter of the conduits **232**, **234**, which compresses the conduits around the circular beads on each of the fittings **242**, **246**. This ensures a good fluid-tight fit between the conduits and fittings, much like a hose clamp or the like. Moreover, the compression provided by sandwiching the conduits between the grooves **290**, **292** ensures that the conduits cannot be pulled loose from the respective fitting.

[0081] When the upper and lower shells **250***a*, **250***b* and central shell **252** sandwich the manifolds **254**, **256** in between, the shells contact each other along pie-shaped raised segments **294** therebetween for bonding the assembly together. The pie-shaped raised segments **294** border the radially-oriented grooves **290**, **292** and have outer edges at the outer circumference of the respective shells **250***a*, **250***b*, **252**.

[0082] As best seen in FIGS. **14**A and **14**B, each of the shells **250***a*, **250***b*, **252** has joint surfaces **296** along the raised segments **294** that match up with and contact the joint surfaces of the adjacent shell. That is, the upper shell **250***a* has joint surfaces **296** on a lower face, the lower shell **250***b* has joint surfaces **296** on an upper face, and the central shell **252** has joint surfaces **296** on both upper and lower faces. The joint surfaces **296** extend along the raised edges of the segments **294**. Juxtaposition of these joint surfaces **296** on the shells **250***a*, **250***b*, **252** enables them to be bonded together. As described herein, bonding can be done in a number of ways, including adhesives, fusion or electro-fusion welding, and sonic welding. The present application contemplates an assembly process that utilizes sonic welding to avoid the use of chemical adhesives.

[0083] Again with reference to FIGS. **14**A and **14**B, one of each contacting pair of raised segments **294** has narrow ribs **298** that contact the colinear and planar joint surfaces **296** on the second one of the pair to direct the energy along more of a line as opposed to an area for faster heating and melting. The narrow ribs **298** in the illustrated embodiment are triangular in cross-section, though other shapes may be used, as detailed below.

[0084] FIG. **21** is a perspective view of a deliverable/consumable sterile fluid distribution subsystem **220***a* for attaching to receptacles, enabling filling with fluid from a single source. The subsystem **220***a* forms a part of the larger fluid distribution system **220** seen in FIG. **11**. The subsystem **220***a* can be rapidly and efficiently assembled in the manufacturing facility, as explained above, and packaged in a sterile form for instant integration into the larger system **220** in the lab.

[0085] The fluid distribution subsystem **220***a* comprises the manifold assembly **228** having the inlet connector **238** and outlet connector **240**, as described above. Fluid outlet conduits **232** and a fluid inlet conduits **234** are pre-assembled with the manifold assembly **228**, as described above. Finally, the conduits **232**, **234** are coupled to the receptacle caps **222***a*. By producing and shipping the subsystem **220***a* in this form in a sterile packaging, the end-user need only connect the remaining elements of the overall system **220** such as screwing sterile receptacles **222** onto the caps **222***a* and attaching a fluid source to the inlet connector **238**, and a common vent to the outlet connector **240**. These final assembly steps take a matter of minutes, and are nearly fool-proof in terms of making the right connections, after which the end-user can begin filling the receptacles with fluid. Once processing within the receptacles **222** is complete, the conduits **232**, **234** to each may be closed off, such as with the clamps or flow control valves **110**, **112** seen in FIG. **5**, and then severed to disconnect the closed receptacles **222** from the larger fill system. The subsystem **220***a* is relatively inexpensive to manufacture, and thus is a consumable product which can be disposed of after use.

[0086] FIG. **22** is an exploded view of a typical ultrasonic bonding stack for joining the parts to form the fluid distribution and vent manifold assembly of FIG. **13**. The bonding stack begins with an ultrasonic vibration horn **300** positioned above an upper nesting block **302**. The ultrasonic vibration horn **300** is typically formed of stainless steel or titanium, or other similar metals. The stack of upper and lower shells **250***a*, **250***b* and middle shell **252** with the manifolds **254**, **256** and flexible tubes interpose therebetween remains the same as described above. The central inlet connector **238** and central outlet connector **240** seen in FIG. **20** may also be accommodated and bonded with the assembly, but are not shown for the sake of brevity. The stack parts are supported on a lower nesting block **304** that rests on a stable foundation **306**, such as a table.

[0087] FIG. **23** is an exploded perspective view of the foundation **306** and lower nesting block **304** thereon showing a nesting cavity **308** for receiving the stacked fluid distribution and vent manifold assembly. The lower bonding shell **250***b* is seen in an upturn orientation so as to view the contours on its lower surface **312** which rests on a floor **310** of the nesting cavity **308**. The nesting cavity further includes a plurality of raised block **314** which fit within similarly-sized cavities **316** in the bottom surface of the lower bonding shell **250***b*. The nesting cavity **308** may be machined in the lower nesting block **304**, which may be formed of aluminum, stainless steel, or the like.

[0088] Although not shown, the underside of the upper nesting block **302** has a similar shaped to mate with the top surface of the upper bonding shell **250***a*, seen in FIG. **14**. The close-fitting or "nesting" contact between the nesting blocks **302**, **304** and the bonding shells **250***a*, **250***b* ensures excellent contact therebetween so that the ultrasonic energy directed from the horn **300** above through the stack is absorbed mainly in the contacting surfaces between the manifold assembly parts, as opposed to creating incidental vibrations or energy losses between the parts and the flanking bonding equipment. That is, the stacked assembly seen in FIG. **22** creates an extremely stable stack of the manifold assembly parts which is thus prone to vibrate at the contact surfaces between the shells **250***a*, **250***b*, **252**.

[0089] FIG. **24** is an exploded perspective view of an assembly **400** of a reducing straight junction **402** flanked by two bonding shells **404**, **406** for connecting the junction with flexible tubes (not shown) in the manners described previously. The reducing straight junction **402** has a smaller fitting **408** at one end and a large fitting **410** on the other end. The bonding shells **404**, **406** have concave receiving surfaces that together conform around each of the fluid fittings and clamp the tubular conduits onto the circular beads and juxtaposed joint surfaces that come into contact with each other. The inner contours of the flanking shells **404**, **406** thus reflect the different sized fittings **408**, **410**, and differently-sized flexible tubes will be joined to the fittings. FIG. **24**A is an enlargement of the shell **404** showing ultrasonic concentrator ribs **412** running along joint surfaces thereof. Each of the concentrator ribs **412** has a triangular cross section so that it contacts a flat edge on the other shell **406** along a line, as opposed to across an area. This directs the ultrasonic energy along the apex of the concentrator rib **412** in order to provide quicker melting.

[0090] FIG. **25** is an exploded perspective view of an assembly **420** of two bonding shells **422**, **424** flanking a standard elbow junction **426** for connecting the junction with flexible tubes (not shown) in the manners described previously. The elbow junction **426** has two equal-sized fittings **428**, **430** on opposite ends. The bonding shells **422**, **424** have concave receiving surfaces that together conform around each of the fluid fittings **428**, **430** and clamp the tubular conduits onto the circular beads and juxtaposed joint surfaces that come into contact with each other. FIG. **25**A is an enlargement of the shell **422** showing an ultrasonic concentrator rib **432** running along joint surfaces thereof. Each of the concentrator ribs **432** has a triangular cross section so that it contacts a flat edge on the other shell **424** along a line, as opposed to across an area. This directs the ultrasonic energy along the apex of the concentrator rib **432** in order to provide quicker melting.

[0091] FIG. **26** is an exploded perspective view of an assembly **440** of two bonding shells **442**, **444** flanking a reducing elbow junction **446** for connecting the junction with flexible tubes (not shown) in the manners described previously. The reducing elbow junction **446** has a smaller fitting **448** opposite a larger fitting **450** on the other end. The inner contours of the flanking shells **442**, **444** thus reflect the different sized fittings **448**, **450**, and differently-sized flexible tubes will be joined to the fittings. The bonding shells **442**, **444** have concave receiving surfaces that together conform around each of the fluid fittings **448**, **450** and clamp the tubular conduits onto the circular beads and juxtaposed joint surfaces that come into contact with each other. FIG. **26**A is an enlargement of the shell **442** showing an ultrasonic concentrator rib **452** running along joint surfaces thereof. Each of the concentrator ribs **452** has a triangular cross section so that it contacts a flat edge on the other shell **444** along a line, as opposed to across an area. Again, this directs the ultrasonic energy along the apex of the concentrator rib **452** in order to provide quicker melting.

[0092] FIG. **27** is an exploded perspective view of an assembly **460** of two bonding shells **462**, **464** flanking a reducing T-junction **466** for connecting the junction with flexible tubes (not shown) in the manners described previously. The reducing T-junction junction **466** has a large fitting **468** arranged perpendicular to two co-linear smaller fittings **470** on opposite ends. The bonding shells **462**, **464** have concave receiving surfaces that together conform around each of the fluid fittings **468**, **470** and clamp the tubular conduits onto the circular beads and juxtaposed joint surfaces that come into contact with each other. As before, the inner contours of the flanking shells **462**, **464** thus reflect the different sized fittings **468**, **470**, and differently-sized flexible tubes will be joined to the fittings. FIG. **27**A is an enlargement of the shell **462** showing an ultrasonic concentrator rib **472** running along joint surfaces thereof. Each of the concentrator ribs **472** has a triangular cross section so that it contacts a flat edge on the other shell **464** along a line, as opposed to across an area. This directs the ultrasonic energy along the apex of the concentrator rib **472** in order to provide quicker melting.

[0093] FIG. **28** is an exploded perspective view of an assembly **480** of two bonding shells **482**, **484** flanking a reducing cross-junction **486** for connecting the junction with flexible tubes (not shown) in the manners described previously. The reducing cross-junction junction **486** has a pair of co-linear large fittings **488** arranged perpendicular to two co-linear smaller fittings **490** on opposite ends. The bonding shells **482**, **484** have concave receiving surfaces that together conform around each of the fluid fittings **488**, **490** and clamp the tubular conduits onto the circular beads and juxtaposed joint surfaces that come into contact with each other. As before, the inner contours of the flanking shells **482**, **484** reflect the different sized fittings **488**, **490**, and differently-sized flexible tubes will be joined to the fittings. FIG. **28**A is an enlargement of the shell **482** showing an ultrasonic concentrator rib **492** running along joint surfaces thereof. Each of the concentrator ribs **492** has a triangular cross section so that it contacts a flat edge on the other shell **484** along a line, as opposed to across an area, to direct the ultrasonic energy along the apex of the concentrator rib **492** in order to provide quicker melting.

[0094] FIG. **29** is an exploded perspective view of an assembly **500** of two bonding shells **502**, **504** flanking a reducing Y-junction **506** for connecting the junction with flexible tubes (not shown) in the manners described previously. The reducing Y-junction junction **506** has a large fitting **508** extending along an axis that bisects two angled smaller fittings **510** on the opposite end of the junction. The bonding shells **502**, **504** have concave receiving surfaces that together conform around each of the fluid fittings **508**, **510** and clamp the tubular conduits onto the circular beads and juxtaposed joint surfaces that come into contact with each other. The inner contours of the flanking shells **502**, **504** reflect the different sized fittings **508**, **510**, and differently-sized flexible tubes will be joined to the fittings. FIG. **29**A is an enlargement of the shell **502** showing an ultrasonic concentrator rib **512** running along joint surfaces thereof. Each of the concentrator ribs **512** has a triangular cross section so that it contacts a flat edge on the other shell **504** along a line, as opposed to across an area. This directs the ultrasonic energy along the apex of the concentrator rib **512** in order to provide quicker melting.

[0095] FIG. **30** is an exploded elevational end view of the assembly of the reducing straight junction **406** and flanking shells **402**, **404** of FIG. **24**. Concentrator ribs **412** are shown on the joint surfaces of the upper shelf **402**, while the lower shell **404** has flat joint surfaces. These are seen in enlargement in FIG. **31**A and FIG. **31**B. Finally, FIG. **32** is a schematic view of the presumed melt pattern that occurs when the two shells **402**, **404** are joined together using ultrasonic energy. That is, the apex of the concentrator rib **412** is in contact with the flat edge **414** and thus all of the ultrasonic energy in between the two parts is focused at the apex. The concentrator rib **412** then melts very quickly and spreads out between the two contact edges, as shown schematically by stippling.

[0096] FIGS. **33-36** are schematic views of alternative configurations of ultrasonic concentrators between two edges being bonded together. It should be understood that these are not the only configurations of concentrators or energy or directors possible. An energy director is either a

special angle that intersects with a flat surface or a small projection that rises from a flat surface. When the sonic resonance is focused into the part, this tiny point or line will melt instantly creating a cascade effect throughout both of the surfaces that will be bonded. Without an energy director, the chances of getting a good and repeatable weld are reduced. Triangular cross-sections are good for concentrating energy along a line, though curved shapes that narrow to a generatrix or other narrowing shapes such as described below are also contemplated.
[0097] In a first example of an alternative energy director, FIG. **33** a shows the contact edges of a pair of shells **520**, **522**. The lower shell **522** has a triangular-shaped projection **524** as an energy director that fits within a rectangular-shaped cavity **526** in the upper shelf **520**. When the two shells are brought together, ultrasonic vibrations will heat up the triangular projection **524** first which thus melts quickly and spreads out between the contact surfaces, as indicated schematically by stippling.
[0098] FIG. **34** shows the contacting edges of a pair of shells **530**, **532** coming together. The lower shell **532** features a generally rectangular projection **533** with upper corners that fits within a triangular cavity **534** in the upper shelf **530**. The corners of the rectangular projection **533** thus contact the size of the triangular cavity **534** and melt first. The presumed area of melted material is indicated schematically with stippling.
[0099] FIG. **35** shows an upper shelf **540** at a lower shell **542** having a different energy director configuration. Upper shell **540** has a rectangular cavity that defines corners **544**. The lower shell **542** has a projection **546** that is trapezoidal, such that the upper corners of the trapezoid contact the corners **544** of the rectangular cavity on the upper shell **540**, thus concentrating the ultrasonic energy along these contact lines. Again, the presumed area of melting is shown schematically with stippling.
[0100] Finally, FIG. **36** shows an asymmetric arrangement where the edge of an upper shell **550** is brought together with the edge of a lower shell **552**. The upper shell **550** has a generally triangular projection **554** extending downward on one lateral side which fits into a rectangular step **556** on the lower shell **552**. The apex of the triangular projection **554** thus heats up first, and the presumed areas that melt and bond together are indicated schematically with stippling.
[0101] Terms such as top, bottom, left and right are used herein, though the fluid manifolds may be used in various positions such as upside down. Thus, some descriptive terms are used in relative terms and not absolute terms.
[0102] Throughout this description, the embodiments and examples shown should be considered as exemplars, rather than limitations on the apparatus and procedures disclosed or claimed. Although many of the examples presented herein involve specific combinations of method acts or system elements, it should be understood that those acts and those elements may be combined in other ways to accomplish the same objectives. Acts, elements and features discussed only in connection with one embodiment are not intended to be excluded from a similar role in other embodiments.
[0103] As used herein, “plurality” means two or more. As used herein, a “set” of items may include one or more of such items. Use of ordinal terms such as “first”, “second”, “third”, etc., in the claims to modify a claim element does not by itself connote any priority, precedence, or order of one claim element over another or the temporal order in which acts of a method are performed, but are used merely as labels to distinguish one claim element having a certain name from another element having a same name (but for use of the ordinal term) to distinguish the claim elements.

Claims

1. An apparatus comprising a sterile consumable fluid flow subsystem, comprising: a first manifold having a first central fluid connector opening to a central plenum chamber in fluid communication with at least four radially outwardly-directed generally tubular fluid fittings, each of the fluid fittings having an external circular bead; a plurality of flexible tubular conduits each fitting over and being coupled to an associated one of the plurality of fluid fittings defining a subassembly; and two opposing shells sandwiched on opposite sides of the subassembly, the shells having mating concave receiving surfaces that together conform around each of the fluid fittings and clamp the tubular conduits onto the circular beads, the opposing shells having juxtaposed joint surfaces in permanent contact with one another.

2. The apparatus of claim 1 wherein the circular beads are selected from a group consisting of a rounded bead and a barbed bead.

3. The apparatus of claim 1 wherein the circular bead of each fluid fitting has a diameter larger than an inner diameter of the associated tubular conduit.

4. The apparatus of claim 1 wherein the mating concave receiving surfaces comprise semi-cylindrical inner wall portions each with a semi-circular inward rib provided on a radially outward extent thereof.

5. The apparatus of claim 1 wherein the juxtaposed joint surfaces on each pair of opposing shells are co-planar.

6. The apparatus of claim 1 further including a second manifold having a central plenum chamber and at least four radially outwardly directed fluid fittings in fluid communication with the plenum chamber.

7. The apparatus of claim 6 wherein the fluid fill subsystem comprises, stacked from top to bottom, an upper one of the shells bonded to an upper face of the second manifold, a central one of the shells is bonded to the lower face of the second manifold and the upper face of the manifold, and a lower one of the shells bonded to a lower face of the manifold.

8. The apparatus of claim 1 wherein the subsystem further comprises receptacle caps attached to ends of each of the tubular conduits.

9. The apparatus of claim 1 further comprising sterile packaging for transit, wherein the subsystem is placed in the sterile packaging for transit and removable therefrom.

10. An apparatus comprising sterile consumable fluid fill subsystem comprising: a first manifold having a first central fluid connector opening to a central plenum chamber which fluidly communicates with at least four radially outwardly directed generally tubular fluid fittings, each of the fluid fittings having an external circular bead; a plurality of flexible tubular conduits each fitting over and being coupled to an associated one of the plurality of fluid fittings defining a subassembly; two opposing shells sandwiched on opposite sides of the subassembly, the shells having mating concave receiving surfaces that together conform around each of the fluid fittings and clamp the tubular conduits onto the circular beads, the opposing shells having juxtaposed joint surfaces that come into contact with each other and are welded together; and receptacle caps attached to ends of each of the tubular conduits.

11. The apparatus of claim 10 further including a second manifold having a central plenum chamber and at least four radially outwardly directed fluid fittings in fluid communication with the plenum chamber, wherein the fluid fill subsystem comprises, stacked from top to bottom, an upper one of the shells, the second manifold, a central one of the shells, the first manifold, and a lower one of the shells.

12. The apparatus of claim 11 wherein the first and second manifolds have the same number of fluid fittings.

13. The apparatus of claim 12 wherein the first and second manifolds each have eight fluid fittings.

14. The apparatus of claim 11 further including a second central fluid connector opening to the central plenum chamber of the second manifold.

15. The apparatus of claim 11 wherein the first central fluid connector is bonded to a lower face of the first manifold and the second central fluid connector is bonded to an upper face of the second manifold.

16. The apparatus of claim 11 further including a common vent filter connected to the second central fluid connector.

17. The apparatus of claim 11 wherein the upper one of the shells, the central one of the shells, and the lower one of the shells are disk-shaped members that when stacked together form a cylindrical frame.

18. The apparatus of claim 10 wherein the circular beads are selected from a group consisting of a rounded bead and a barbed bead.

19. The apparatus of claim 10 wherein the juxtaposed joint surfaces on each pair of opposing shells are co-planar.

20. The apparatus of claim 10 further including a sterile packaging for transit, wherein the subsystem is placed in the sterile packaging for transit and removable therefrom.