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Schachet

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[54] **MODULAR THORACIC DRAINAGE DEVICE**

[75] Inventor: **Eli Schachet**, St. Louis, Mo.

[73] Assignee: **Sherwood Medical Industries, Inc.**, St. Louis, Mo.

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[52] **U.S. Cl.** **128/276**

[51] **Int. Cl.** **A61m 1/04**

[58] **Field of Search** ..... 128/2 F, DIG. 24, 275–278

[56] **References Cited**

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Primary Examiner—Richard A. Gaudet
Assistant Examiner—J. C. McGowan
Attorney, Agent, or Firm—Stanley N. Garber; William R. O'Meara

[57] **ABSTRACT**

A modular thoracic drainage device having one or more preformed plastic "bottles" or chamber members which can be selectively connected together to provide "one-bottle," "two-bottle," "three-bottle" and "four-bottle" systems. The members can be connected together in a "four-bottle" system which includes a preformed drainage collector chamber, a liquid seal chamber, a pressure regulating manometer chamber, and a second liquid seal and direct reading manometer chamber. Each member has an integral connector for use in effecting fluid communication with another chamber and the chambers are provided with complementary coupling portions for receiving locking pins to secure adjacent members in fixed relationship.

6 Claims, 6 Drawing Figures

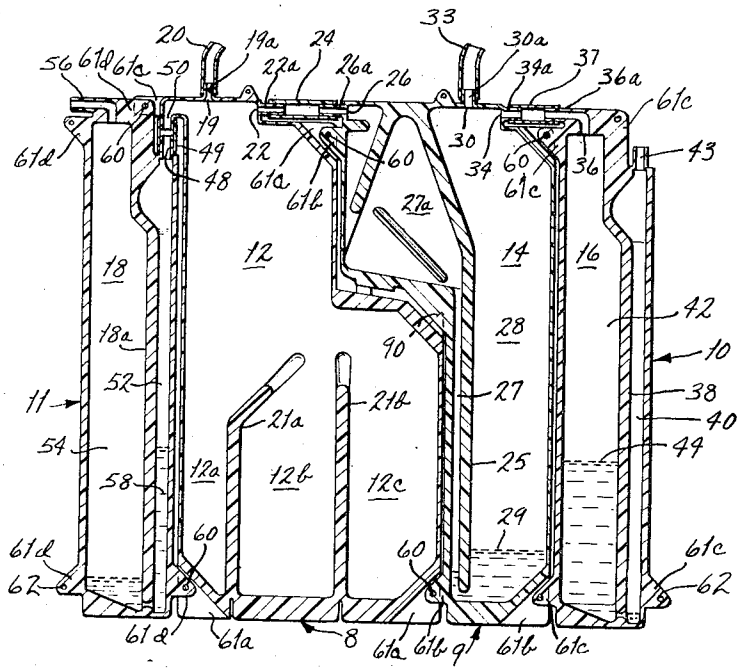


FIG. 1

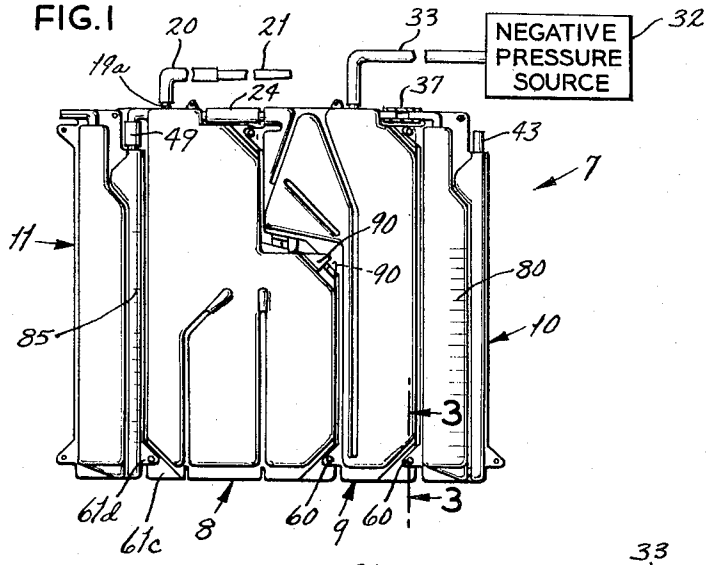


FIG. 3

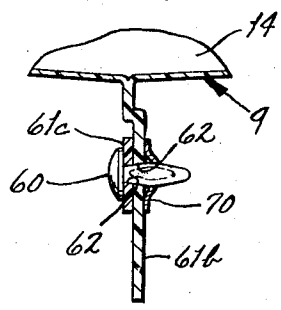


FIG. 2

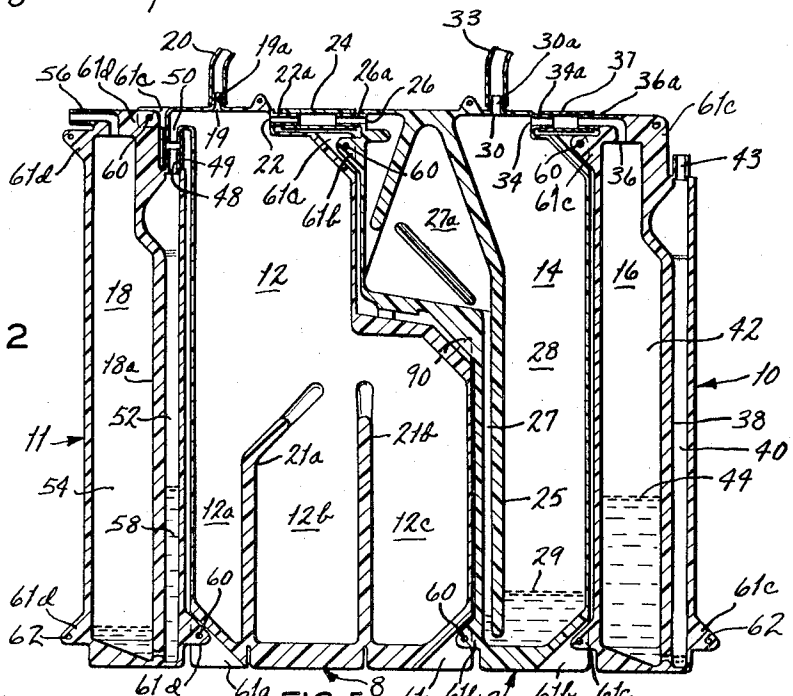


FIG. 4

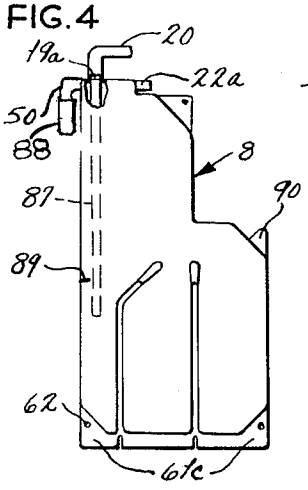


FIG. 5

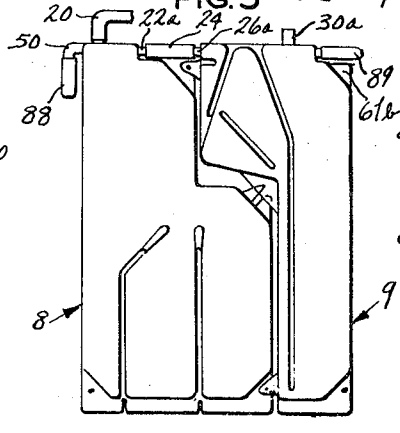
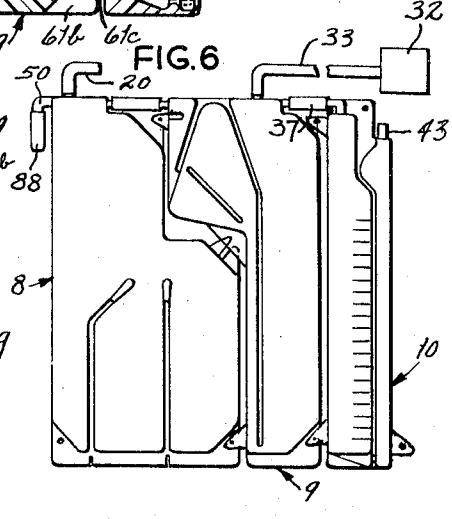


FIG. 6



MODULAR THORACIC DRAINAGE DEVICE

BACKGROUND OF THE INVENTION

This invention relates to thoracic drainage devices and more particularly to thoracic drainage devices of the disposable plastic type.

Thoracic drainage devices of the one, two, three and four-bottle types are described in copending application Ser. No. 183,332, filed Sept. 24, 1971, now U.S. Pat. No. 3,757,783, which is assigned to the same assignee as the present application. Also, copending application Ser. No. 212,075, filed Dec. 27, 1971, now U.S. Pat. No. 3,783,870, describes a plastic disposable drainage device of the four-bottle type. Reference to these applications may be had for a basic explanation of drainage devices.

In the past, glass bottles or jars have been provided with suitable stoppers and tube connectors adapted to be arranged to perform fluid drainage from the pleural cavity. Preformed plastic disposable drainage devices have also been used in order to overcome some of the disadvantages of the glass bottle type. For example, plastic thoracic devices do not break, and since they are formed as an integral or single unit, are readily connected with a patient. They are also light weight, and cannot separate during use. However, such plastic drainage devices have certain disadvantages, for example, they cannot be economically used to selectively provide various systems such as the one, two, three and four-bottle systems mentioned above without employing the entire device for each of the various systems.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a drainage device wherein the above-mentioned disadvantages are substantially obviated.

More specifically, it is an object of the present invention to provide thoracic drainage apparatus having a plurality of preformed hollow plastic members which are quickly and easily interconnected together by simple and reliable means to provide an efficient and economical drainage system and wherein they can be selectively connected to form "one," "two," "three" or "four-bottle" chamber type thoracic drainage systems while using only the desired number of chamber members.

In accordance with one aspect of the present invention, drainage apparatus is provided which includes a plurality of preformed plastic chamber members having means for interconnecting the chambers thereof in fluid communication and in substantially fixed relation with each other, and which are adapted to be connected with a cavity of a patient for draining fluids from the cavity. In accordance with another aspect, a single chamber member having channels therein may be used with a tube in a one-bottle system.

These, as well as other features and advantages of the present invention, will become apparent from the following detailed description and accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of a drainage apparatus in accordance with the present invention shown connected as a "four-bottle" thoracic device;

FIG. 2 is a vertical section of the device of FIG. 1 on an enlarged scale;

FIG. 3 is an enlarged cross-sectional view taken along line 3—3 of FIG. 1;

FIG. 4 is an elevational view of a "one-bottle" thoracic device utilizing one of the chamber members of FIG. 1;

FIG. 5 is an elevational view of a "two-bottle" thoracic device utilizing two of the chamber members of the device shown in FIG. 1; and

FIG. 6 is an elevational view of a "three-bottle" thoracic device utilizing three of the chamber members of the device of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, and particularly to FIGS. 1 and 2, there is shown drainage apparatus, indicated generally at 7, which includes four separate "bottles" or chamber members 8, 9, 10 and 11 having internal chambers 12, 14, 16 and 18, respectively, that are interconnected to form a "four-bottle" or four-chamber thoracic drainage device. Chamber 12 is a drainage collector chamber for receiving and collecting drainage from a patient; chamber 14 is an underwater seal or series liquid seal which passes gas from the patient; chamber 16 is a liquid pressure control or regulating manometer; and chamber 18 is a liquid direct reading manometer and secondary seal.

Drainage collector chamber 12 is preformed with a drainage inlet port 19 connected to an integral inlet tube coupling member 19*a* which receives tubing 20 connected with a catheter 21, the distal end of which is adapted for insertion within the pleural cavity of a patient for draining fluids and gases. Chamber 12 is partitioned by integral walls 21*a* and 21*b* into three channels or columns 12*a*, 12*b*, and 12*c* which fill successively with drainage liquids from a patient. Inlet port 19 is located directly above channel 12*a* so that this channel is first to fill with drainage fluid. Adjacent the upper end of chamber 12 is a gas outlet 22 connected to an integral outlet tube coupling member 22*a* coupled by a short length of tubing 24, for example, pastic tubing, to an inlet port 26 of chamber 14 by means of an integral inlet coupling member 26*a* of chamber 14.

The liquid seal chamber 14 is preformed with an integral partition wall 25 dividing the chamber into a relatively narrow vertically extending column or channel 27 of relatively small volume, and a relatively wide column or channel 28 of relatively large volume. The upper end of channel 27 is connected in fluid communication with the inlet 26 at its upper end by means of an enlarged circuitous path or liquid trap 27*a*, and at its lower end to the chamber 28. A predetermined amount of liquid, such as water 29, is disposed in the chamber 28 so that the lower end of the partition 25 extends into the water, the lower ends of the columns 27 and 28 defining a liquid reservoir for the water. Channel 28 is provided with an outlet port 30 connected with an integral outlet connector or coupling member 30*a* which is adapted to be connected in fluid communication with a negative pressure pump or vacuum source 32 by means of a tube, such as plastic tubing 33 connected to member 30*a*.

The liquid seal chamber 14 is also provided with a fluid pressure relief gas or air inlet port 34 connected

with an integral connector **34***a* at the top of the column **14** adjacent the outlet **30.** The pressure relief port **34** is connected to an air inlet port **36** of the chamber **16** by an integral connector **36***a* adjacent the top of the control manometer chamber **16.** The connector **34***a* is shown connected to connector **36***a* of the regulating manometer chamber **14** by means of a plastic connecting tube **37.**

The regulating manometer chamber **14** is provided with an integral partition **38** which divides it into a relatively narrow vertically extending column or channel **40** of relatively small volume and a relatively wide column or channel **42** of relatively large volume. The channel **42** is connected in fluid communication with the connector **36***a* and therefore with the negative pressure outlet **30** at the upper end of the liquid seal chamber **14** and the pump **32** (FIG. **1**). The relatively narrow channel **40** is connected in fluid communication at the upper end thereof to a vent or air inlet port **43** open to atmosphere. Channel **40** is connected with the relatively large chamber **42** adjacent its lower end. The lower end of columns **40** and **42** define a liquid reservoir for water **44.** The height of water in the liquid control manometer determines the maximum pressure available at the outlet **19** regardless of pump pressures above a predetermined amount, as is well known by those skilled in the art.

The direct reading manometer and secondary seal chamber **18** is identical to the control manometer chamber **16.** Chamber **18** is provided with an upper integral inlet connector **48** which is connected by means of plastic tubing **49** to another integral connector **50** in the upper portion of the drainage collector chamber **12.** The chamber **18** is divided by an integral partition wall **18***a* into a relatively narrow vertical column or channel **52** and a relatively large column or channel **54.** Channel **52** is connected in fluid communication with the inlet connector **48** at the top and with the channel **54** at the bottom. The lower ends of channels **52** and **54** serve as a liquid reservoir for liquid such as water **58.** Channel **54** is open to atmosphere by means of an integral connector **56** at its upper end. The chamber **18** serves as a direct reading liquid manometer which is connected directly in fluid communication with the collector chamber **12,** and hence the pleural cavity of the patient, and to atmosphere so as to provide a continuous precise reading of the pressure in the cavity of the patient. Chamber **18** also serves as a secondary liquid seal which is connected to atmosphere in by-pass relation with the liquid seal chamber **14,** whereby a patient may, under surge conditions, expel air from the pleural cavity, for example, without the necessity of requiring substantial pressures necessary to move air through the series liquid seal chamber **14** and the liquid regulating manometer **16** should the pump fail and close the outlet **30.** The function and advantages of the liquid seal feature of chamber **18** are described in greater detail in applicant's previously mentioned application Ser. No. 183,332, now U.S. Pat. No. 3,757,783, and the funtion of the chamber **18** as a direct reading liquid manometer is given in greater detail in applicant's previously mentioned application Ser. No. 212,075, now U.S. Pat. No. 3,783,870

As described above, the chambers **12, 14, 16** and **18** are interconnected in fluid communication by means of integral connectors and relatively short pieces of tubing in the illustrated embodiment. However, these connections may be formed by integral connectors fitting one within the other, for example, by making each such piece of tubing an integral portion of one of the chamber members. For example, tubing **24** may be formed integrally with the connector **22***a* as a relatively flexible part of chamber **12,** and the connector **26***a*, integral with liquid seal chamber **14** may be inserted directly into the integral flexible part. The integral connectors and tubing elements provided a simple and effective means for manually releasably connecting the chambers in fluid communication with each other.

While these integral connectors and tubing connections tend to hold the chamber members **8, 9, 10** and **11** together, the present device provides additional means by which the members are securely held together to avoid any possible inadvertent opening in any of the fluid paths. This is accomplished in the illustrating embodiment by providing a plurality of locking or clamping elements shown as connecting pins **60** extending between adjacent portions of the chambers.

The chambers **8, 9, 10** and **11** are shown provided with integral tabs or extensions indicated respectively at **61***a*, **61***b*, **61***c* and **61***d*, and each tab is provided with a hole **62.** When an adjacent pair of chamber members are in proper orientation and in fluid communication with each other, each of the tabs **61** on one of the members extends over a portion or tab **61** of the adjacent chamber member with the holes **62** in aligned relation to receive a connector pin **60,** for example, as shown in FIG. **3.** In FIG. **3,** a pin **60** is shown extending through a tab **61**c of the regulating manometer chamber member **10** and tab **61***b* of the liquid seal chamber member **9.** Each pin **60** is enlarged intermediate its ends so that when pushed through the aligned holes **62** in the adjacent chambers, the enlarged portion forms a tight frictional engagement with hole **62** tending a hold the adjacent overlapping portions or tabs in tight frictional engagement. However, it is preferable to also position a pin locking member **70,** such as a star locking washer which may be formed of a resilient metal, over the end of each pin opposite the head with the locking member digging into the pin to further insure that the pin cannot fall out.

In illustrated embodiment, the liquid seal chamber member **9** is connected in fixed relation with the collector chamber member **8** by means of a pin **60** at the upper end thereof adjacent the inlet **26** and also by a pin **60** at the bottom ends of the two chambers. The liquid manometer chamber member **10** is similarly connected by pins **60** with the liquid seal chamber member **9.** Likewise, the direct reading manometer and secondary liquid seal chamber member **11** is connected by a pair of pins **60** adjacent opposite ends thereof to the member **8.** By connecting the chambers by means of integral fluid flow connectors and tubing, and pins **60** extending through adjacent overlapping portions or tabs on adjacent chamber members, the chambers are maintained secured in fixed relationship with each other and in fluid communication for proper operation. The chamber members **8–11** may be disassembled, of course, by removing the pins and the fluid coupling tubing elements between members.

In the four-bottle thoracic drainage system shown in FIGS. **1** and **2,** the liquid regulating manometer **10** provides a desired negative fluid pressure at the outlet connector **30** so that drainage from the pleural cavity of the patient flows into the collector chamber **12** and air

or gas from the cavity flows through the liquid **29** in seal **14** to the outlet **30** and pump **32.** The iquid manometer **16** and **18** are provided with indicia or calibration marks **80** and **85,** respectively so that the liquid in the columns may be read. The pressure of the regulating manometer will be somewhat different from that of the direct reading liquid manometer **18** because of the pressure drop across the liquid seal.

In FIG. **4,** chamber member **8** is used alone, the collector chamber **12** being provided with a predetermined amount of water such as to a level indicated by a level mark **89.** A connecting tube **87** is shown in fluid communication with tube **20** and connector **19***a* and has its lower end disposed below the surface of the liquid. The upper connector **22**a is open to atmosphere to allow air or gas to escape through the liquid to atmosphere. The connector **50** may be closed by a closure cap **88.** With this arrangement liquid in the chamber **12** provides a seal and drainage flows into chamber **12** due to gravity. In the "one-bottle" system of FIG. **4,** the lower end of tube **87** is positioned a predetermined distance below the water fill level **89** so that drainage liquid first fills channel **12***a* and then flows over partition **21***a* to fill the next successive channel **12***b*. In this way, the lower end of tube **87** is disposed a constant distance below the liquid level in channel **12***a* after it is filled to provide a substantially constant reaction force to the flow of fluid from the patient. In the prior art "one-bottle" systems, the force opposing the flow of fluid from the cavity increased as the liquid in the collector chamber filled. Thus, this one-bottle system provides a substantially constant, relatively small reaction force of the flow of fluid from the patient.

In FIG. **5,** a "two-bottle" system is illustrated. In this embodiment, the collector chamber **12** and the liqud seal chamber **14** are connected together in fluid communication with each other by means of connectors **22***a*, **26***a* and tube **24,** as in the device of FIG. **1.** The outlet **30***a* is open to atmosphere in the case, and the connectors **50** and **34***a* are closed by cap **88** and another cap **89,** respectively. Chamber **12** is not filled with water in this case since liquid seal chamber **14** is connected to it. Fluids drain by gravity into collector chamber **12** of member **8** and gas or air passes through liquid seal chamber **14** to atmosphere.

In the "three-bottle" system of FIG. **6,** the chambers **12, 14** and **16** are interconnected and the outlet **50** is sealed off the cap **88** since the direct reading manometer is not used. In this case, the outlet **30***a* is connected to the negative source of pressure **32** by tube **33,** and the pressure regulating manometer is connected to the liquid seal to limit the pressure applied to the collector chamber. The operation of this system is similar to that previously mentioned herein connection with the drive shown in FIG. **1** except for the function of member **11**

In each of the various systems it will be apparent that each chamber is easily connected to each other in fixed relationship and in the desired fluid communication connection, and that the various one-bottle, two-bottle, three-bottle, and four-bottle thoracic drainage devices can be selectively assembled while using only the necessary chamber member or members. Since the members **10** and **11** are identical, a "four-bottle" arrangement such as shown in FIG. **1** can be assembled from only three different kinds of chamber members which reduces cost. The members **10** and **11** can be made, for example, from the same mold and subsequently provided with different calibration marks (**80, 85**).

To further stiffen the assembled chambers, the pair of tabs **90** integral with member **8** are shown extending over opposite surfaces of an extension on chamber member **9** to clamp the extension, further stabilize the device and make it even more rigid.

Each of the chamber members **8, 9, 10** and **11** is formed of a plastic material, such as polypropylene, and each is formed individually as a separate unitary member. Each member is preferably transparent of translucent so that the liquid in them can be seen. Each may be formed by a blow molding process or, alternatively, may be formed from a pair of mirror image plastic elements molded separately and then sealed together, such as by heat sealing or other suitable means.

While a preferred form of the invention has been described herein, it will be apparent that various changes and modifications thereto may be made without departing from the spirit of the invention or scope of the invention as defined in the appended claims.

What is claimed is:

1. A thoracic drainage apparatus comprising first and second hollow plastic members each having an internal chamber, each of said members having integral connector means connecting the chambers of said members in fluid communication with each other, the chamber of said first member having an inlet adapted to be connected in fluid communication with a cavity of a patient for receiving drainage fluid from the cavity, the chamber of said second member being partitioned by an integral wall into first and second channels interconnected at the lower ends thereof for receiving a liquid, a gas outlet, means for connecting a source of negative pressure to said gas outlet, said first channel being connected in fluid communication with the chamber of said first member and said second channel being connected in fluid communication with said gas outlet whereby gas from the cavity can pass through the liquid to the outlet, a third hollow plastic member defining a pressure regulating manometer chamber with an integral wall dividing it into first and second channels interconnected at the lower ends thereof for receiving a liquid, integral connector means on said third member for connecting said first manometer channel in fluid communication with said second channel of second member, said second manometer channel being open to atmosphere whereby said third member is adapted to limit the pressure at the gas outlet, a fourth hollow plastic member having a chamber divided by an integral wall into first and second channels interconnected at the lower ends thereof and adapted to receive a liquid, said first channel of said fourth member having integral connector means for connection with said chamber of said first member, said second channel of said fourth member being connected to atmosphere, and means for locking said members together to prevent separation thereof.

2. The apparatus of claim **1** wherein said third and fourth members are identical in configuration.

3. The apparatus of claim **1** wherein each of said plastic members has a portion which overlaps a portion of a member adjacent thereto, and said locking means includes locking elements for clamping the overlapping portions of adjacent members together to thereby provide a relatively rigid four-member apparatus.

4. The apparatus of claim 3 wherein tube means connects each of said chambers with an adjacent one of said chambers.

5. The apparatus of claim 3 wherein each of said locking elements includes a pin and a locking washer.

6. The apparatus of claim 1 wherein each of said members comprises a pair of opposed shell elements sealed together at their margins.

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