July 26, 1955 J. E. POTTHARST, JR 2,713,996

HEAT EXCHANGER

Filed Oct. 23, 1952

FIG. 1.

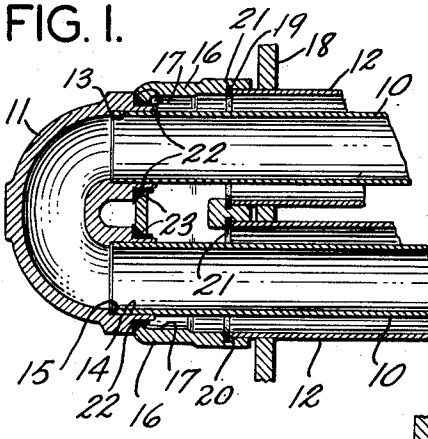


FIG. 2.

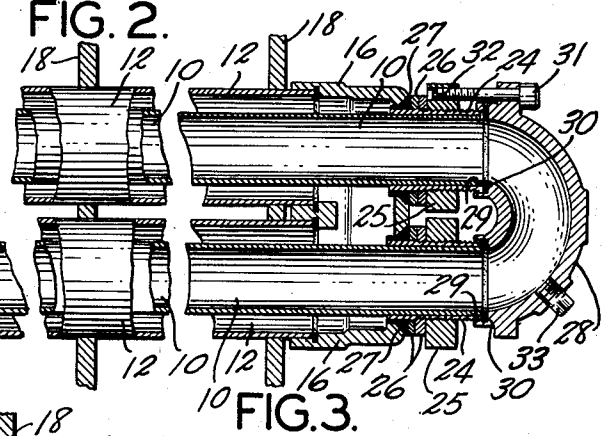


FIG. 3.

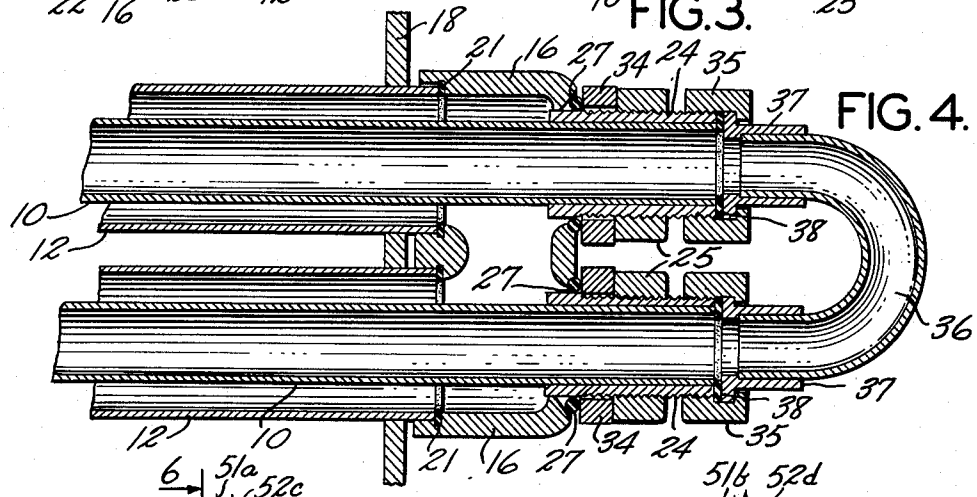


FIG. 4.

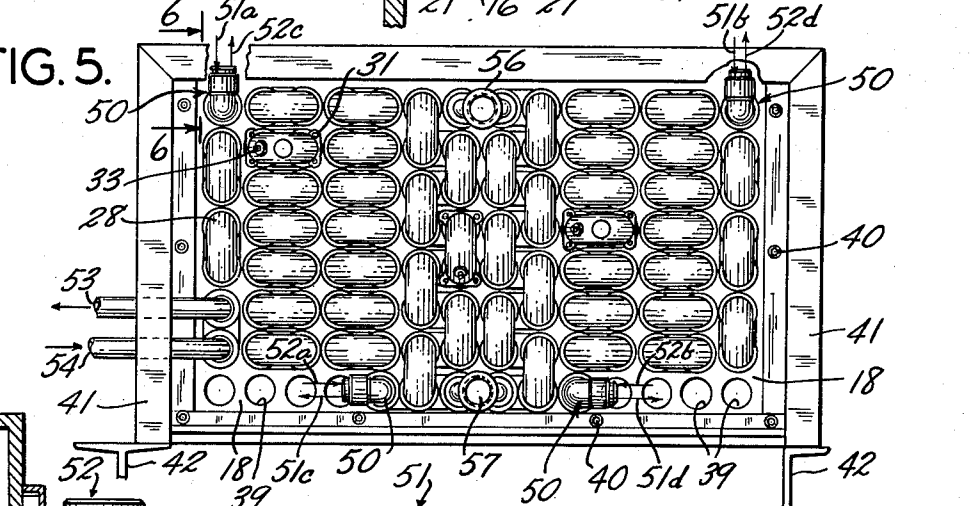


FIG. 5.

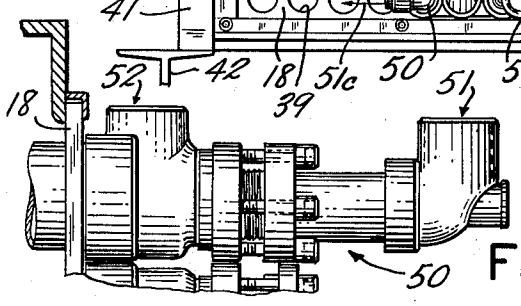


FIG. 6.

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HEAT EXCHANGER

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13 Claims. (Cl. 257—247)

This invention relates generally to heat exchangers and in particular to heat exchangers which may be readily adapted and assembled to meet heating and cooling requirements over a wide range and which further may be modified without difficulty as such requirements are changed from time to time.

The heat exchanger of my invention is composed of parts which may be standardized and made interchangeable, facilitating assembly and replacement of parts.

Also the component parts of my heat exchanger may be combined to meet the heat exchange requirements of an installation without the necessity for a specially built unit of fixed capacities for each installation. It is of considerable advantage in meeting the requirements for various types of processing equipment having heat exchange problems, to avoid the necessity if possible, of making each heat exchanger custom built and permanent, particularly if the heat exchange requirements subsequently may be modified or varying requirements must be met by a manufacturer. The heat exchanger disclosed herein makes it possible to meet with exactitude, a wide range of heating or cooling requirements inasmuch as it is only necessary to add or subtract units providing a given amount of heating or cooling surface. And in addition each unit may be easily assembled or disassembled as will be subsequently disclosed.

A common problem in prior heat exchangers has been the difficulty of inspection and the disassembling of the various tubular and connecting members for repairs and cleaning. These problems are even more serious in systems involving the use of corrosive liquids, such as sea water and chemicals. Corrosion problems are amplified where there is contact between metal surfaces or restricted areas in the flow paths within the system. For that reason heat exchangers which permit the normally concentric tubes to come into substantial contact as a result of bowing, or which restrains bowing by the use of fins or supporting members placed in contact with a corrosive liquid, are particularly subject to this hazard.

One of the objects of the present invention is to provide a novel type of heat exchanger in which the parts are interchangeable and which may be built up or compounded substantially as units to meet the heat exchange requirements of a given installation.

Another object of the present invention is to provide a heat exchanger which permits easy assembly and disassembly and replacement of tube parts as well as easy cleaning. A further object is to provide a heat exchanger in which corrosion and the problems of corrosion may be kept at a minimum.

For a better understanding of my invention reference may be had to the following detailed descriptions taken in conjunction with the accompanying illustrative drawings:

Figure 1 is a view in longitudinal section of one assembled end of connected pairs of concentric tubes;

Figure 2 is an intermediate section of a pair of concentric tubes and external supporting plate;

Figure 3 is a view in longitudinal section of the assembly connecting one of the tube ends of an assembled pair of concentric tubes (Figure 1) with one of another assembled pair of concentric tubes;

Figure 4 is an alternative form of assembly similar to Figure 3;

Figure 5 illustrates a bank of heat exchange units showing the assembly end, as in Figure 3; and

Figure 6 is a side elevation on a larger scale taken along lines 6—6 of Figure 5, looking in the direction of the arrows.

In general, with regard to the heat exchange assembly illustrated for example in Figure 1, it will be understood that the two inner tubes **10**, suitable for carrying the inner fluid, are fixedly seated by soldering, brazing or other suitable means within the return bend **11**, forming in effect a forked assembly. This assembly in conjunction with the two outer concentric tubes **12** carrying the outer fluid is held in fluid tight relationship by the assembly illustrated in Figure 3, which connects each forked assembly (Figure 1) with another.

With this general arrangement in mind, we refer now more specifically to Figure 1 in which it will be noted the inner tubes **10** fit snugly within the respective openings **13** and **14** of the return bend **11**, which openings have shoulders **15** against which the tubes **10** may bear. These tubes are fixedly retained within the openings **13** and **14** by soldering, brazing or other suitable means. Soft solder or silver solder may be used for example, depending upon the type of liquid passing through the tubes. The inner tubes **10** may be of soft bronze and may be tinned if desired. Preferably there is no rolling or expanding of the tubes within the return bends. This permits replacement of the tubes **10** or bends **11** without destruction of the parts. It is one of the advantages of my construction that the unit may be made of special metals or compositions to meet precise processing conditions and may be assembled and disassembled without cause for injury to any such special materials.

The open ended tubes **10** of the forked assembly of Figure 1, comprising the two tubes **10** and return bend **11**, are positioned in an outer tube return bend **16** by passing them through the openings **17** thereof into the outer concentric tubes **12**.

The outer tubes **12** are held in spaced relationship by a series of spaced supporting plates **18**; the outermost may be disposed adjacent to (and between) the outer tube return bends **16** to prevent the endwise movement of the tubes after the various parts are assembled. This arrangement is particularly suitable when constructing portable units, however, it is to be understood that the supporting plates **18** may be disposed differently if so desired. In addition, the plates **18** are spaced at suitable intervals to prevent the sagging or bowing of the outer tubes **12**, as can be seen in Figs. 1, 2 and 3. A more detailed description of the plates **18** will be given in connection with Fig. 5.

The collar or return bend **16** for the outer tubes **12** has in it, two shouldered openings **19** and **20** for receiving and seating firmly two outer tubes **12**. The ends of the outer tube **12** are preferably square cut and bear against a suitable gasket **21**, of synthetic rubber for example. It is of importance to note that the outer tubes **12** are not expanded, welded or otherwise deformed in any way when they are mounted in the supporting plates or fitted into the return bends.

A fluid tight connection between the several parts of the assembly of Figure 1 is provided for by the shoulders **22** on the return bend **11** acting to seat the circular gaskets **23**. These gaskets in turn provide seats for the inner beveled edges of the openings **17** of the return bend **16**. These gaskets preferably have the cross section of a right

angle triangle. The right angle portions fits against the shoulder so as to present a slanting face to the beveled edge of the openings 17 of the return bend 16. As will be subsequently described, when tension is imposed upon the forked assembly comprising tubes 10 and their return bend 11, the assembly of Figure 1 becomes fluid tight as the return bends 16 and 11 are drawn tightly against the gaskets 23 and the outer tubes 12 are drawn into and firmly seated in the return bend 16 and against the gasket 21.

Figure 2 shows an intermediate tube supporting plate 18 for the surrounding outer tubes 12 and the inner tubes 10.

Figure 3 discloses an assembly for drawing together and holding in fluid tight relationship several of the forked assemblies of Figure 1. The inner tubes 10 of Figure 3, for example, represent one tube each of two different forked units of the type illustrated in Figure 1. The ends of the tubes 10 of Figure 3 are fitted with threaded collars or sleeves 24, which collars are fixedly attached by soldering, brazing or other suitable means, but preferably without expanding for deformation of the tube itself. Each of these sleeves 24 carries an internally threaded collar or tube nut 25 which bears preferably against one or more washers 26 carried on the inner tubes, which washers in turn are forced by a threading on of the tube nuts 25, against gaskets 27. These gaskets are of the same construction as the gaskets 23 of Figure 1 and return bend or collar 16 and related assembly for the outer tube construction, is also similar to that illustrated in Figure 1. The tube nuts 25, which are turned by a fork wrench against the washers 26, provide suitable protection for the gaskets 27 during the tightening operation.

As the tube nuts 25 are screwed on to the threaded sleeves 24, tension is imposed upon the inner tubes 10 and act to bring the assemblies of Figures 1 and 3 into liquid tight relationship and also serves to prevent the inner tubes from bowing when subjected to heat. In addition the act of tightening the tube nuts 25 insures a further centering of the inner tube within the outer tube because of the previously described gasket and shoulder construction of the several units.

The open ends of the inner tubes 10 are closed by connecting or return bend 28, which have recess openings 29 to receive the tubes 10 and sealing gaskets 30 disposed therebetween.

The return bend 28 may be retained in position by bolts 31 passing through them and threaded into tapped openings 32 extending through the side of the tube nuts 25. This arrangement permits the tube nuts 25 to serve as holding means without undue limitation on their rotational adjustment even when the tube assemblies are closely spaced. In addition this arrangement acts to lock the tube nuts 25 in a fixed position preventing any loosening thereof as the result of vibration for example. The return bend 28 may be provided with a test plug or drain cock 33 which permits the fluid contained therein to be tested.

Figure 4 discloses an alternative form of assembly to that disclosed in Figure 3. In this figure, the inner tubes 10 are positioned within the concentric outer tubes 12 in a manner similar to that described in connection with Figures 1, 2 and 3. The return bend or collar 16 of the outer tube 12 and the related gasket construction 21 and 27 is also similar to the construction described in connection with Figure 3, except that it will be noted that the gasket 27 is illustrated as substantially circular in cross section. Of course, a gasket of triangular cross section may be used instead.

The inner tubes 10 extend through the suitable openings in the collar 16, and have attached to their surface by soldering or brazing, a threaded collar or sleeve 24 about which are passed washers 34 which are forced against the gasket 27 by the threaded collar or tube nuts 25, when the latter is tightened. Any means may be used

to attach the threaded collar or sleeve 24 to the tube but it is preferably done without expanding or distorting the tube within the sleeve.

The threaded sleeves 24 in the construction of Figure 4 are also utilized to carry internally threaded collars or pipe couplings 35 disposed about the ends of the inner tube return bend 36. The threaded couplings 35, in conjunction with shouldered collars 37, attached by suitable means such as soldering or brazing to the ends of the return bends 36, serve to draw the ends of the inner tubes 10 and shouldered collars against the gaskets 38 and into liquid tight relationship.

The inner tubes 10, of the assembly of Figure 4, are brought under tension and the entire assembly maintained in fluid tight relationship (with the exception of the open ends of the tubes 10 subsequently to be closed by the return bend 36) by the tightening of the tube nuts 25. This construction in that respect is similar to the assembly shown in Figures 1 to 3.

It can be appreciated that the various units can be readily disassembled by simply removing the inner tube return bends and unscrewing the tube nuts, which thereby permits the withdrawal of the fork assembly and the outer pipes and return bends associated therewith. If found defective, any of the various parts can be easily replaced for none are expanded or deformed in any way in assembling. Another important advantage in this arrangement is that if a leak develops in one of the inner or outer tubes, the defective tube may be removed and temporarily repaired by soldering or brazing and then reused in the system until a new part is obtained.

Figure 5 shows a bank of the units assembled for heat exchange purposes, the return bends 28, the removable plug 33 and the retaining bolts 31 being noted.

The tube support plate 18 has a suitable number of evenly spaced openings 39 through which the outer tubes extend and are thereby disposed in a parallel and equidistant relationship. Extra openings may also be provided for supporting additional heat exchange assemblies of the type illustrated in Figures 1 to 4, inclusive.

The supporting plate is preferably made of a fiber-reinforced plastic capable of having sufficient strength when placed at intervals to support the tubes, but which will not scratch an assembly made of bronze or other soft materials. Furthermore, a plate of this construction has been found to be very satisfactory to minimize the effect of corrosion in the event there is leakage. The tube plate, however, can be made of other materials, even metal, or combination of metal and plastic, if so desired.

The plates 18 are placed at suitable intervals along the length of the outer tubes (as illustrated in Figures 1, 2 and 3) and as shown in Figure 5, are secured by bolts 40 to a metal frame 41, which frame may be carried by suitable supports 42.

Referring to Figure 5 wherein is disclosed a multiple tube assembly which may be used in connection with the distillation of salt water, to cool the saline-free distillate and the blow down (salt concentrate), and to preheat the incoming brine. It is to be understood, of course, that my invention is not to be limited to this use alone and may be used in connection with many other industrial operations wherein a heat exchange is required.

It will be noted that the various fluids are fed into and discharged from the system through a conventional inner and outer tube connection 50 of the type illustrated in Figure 6, in which the outer opening 51 communicates with the inner tubes, and the inner opening 52 communicates with the concentric portions between the inner and outer tubes. It is to be understood, of course, that other types or designs of inner and outer tube connections may be used if conditions so require it.

The heat exchanger illustrated in Fig. 5 comprises fourteen vertical rows of tubes. Distillate is admitted to the inner tubes at the left (as viewed in Fig. 5) through the inner tube connection at 51*a* and the distillate flows

in succession from one inner tube to the next through the inner tubes of the five vertical rows at the left, finally emerging from the discharge connection at **51***c*; also distillate is admitted to the inner tubes at the right through the inner tube connection at **51***b* and flows in succession from one inner tube to the next through the inner tubes of the five vertical rows at the right, finally emerging from the discharge connection at **51***d*. For additional cooling, the distillate flowing through the left-hand bank of inner tubes, is diverted (at **53**) and conducted through the engine oil cooler (not shown) from where it is returned to the system (at **54**) and makes several more passes before being discharged therefrom.

The salt water (cool) is fed into the outer tubes (the concentric spaces between the inner and outer tubes) through the outer tube connections **52***a* and **52***b* situated at the lower part of the tube assembly. The brine entering the connection **52***a* flows through the outer tubes of the seven leftward vertical rows of tubes and is finally discharged at **52***c*, and the brine entering the connection **52***b* flows through the outer tubes of the seven rightward vertical rows of tubes and is finally discharged at **52***d*. It will be noted that the distillate and brine flow in opposite directions through the system (see arrows in Figure 5).

The heat contained by the blow down (salt water concentrate) after leaving the evaporator (not shown) may also be utilized in this assembly to preheat the incoming brine. The blow down is fed into the center bank of inner tubes (rows **6**, **7**, **8** and **9**) through the upper Y connection **56** communicating with two inner tubes, and it is then passed through the center rows of inner tubes in the opposite direction to the flow path of the incoming brine and finally discharged through the lower Y inner tube connection **57**.

The importance of the fact that the flow path of the inner tubes need not necessarily coincide with the outer tubes is apparent from the above description of one use of my invention. For if this were not possible, the distillate and blow down which flow through three independent banks of inner tubes could not all be cooled by the incoming brine flowing through all of the outer tubes.

It will also be appreciated that should it become necessary to modify the heat exchange conditions, this can easily be done by changing the flow paths of the various liquids and by adding or subtracting the number of assemblies of the type illustrated in Figures 1 to 4, carried by the supporting plates **18**.

Another advantage of my heat exchanger construction is that the assembly is of such a design that there is no necessity for providing access to the sides thereof in order to remove or replace the various parts. As a result, it is possible to place the tube assemblies, as described in Figures 1 to 4, in a very close relationship, as is seen in Figure 5. In this connection, it will be noted in Figures 3 and 5, that no part of the inner tube return bends or the various fastening means, such as the tube nuts **25** or the screws **31**, project beyond the collar or inner return bend **16**.

It will be understood, of course, that the various structural parats of this apparatus are susceptible to modification. Therefore, the form of the invention described above should be considered as illustrative and not as limiting the scope of the following claims.

I claim:

1. A heat exchanger comprising, a plurality of concentrically mounted inner and outer tubes, connecting means between the ends of pairs of outer tubes, connecting means between the ends of pairs of inner tubes, threaded means adjustable to produce relative axial movement between the inner and outer tubes to secure the outer tubes and the outer tube connecting means associated therewith in fluid tight relationship and to exert tension on said inner tubes.

2. In a heat exchanger as described in claim 1, a plurality of perforated plates to support said outer tubes in a parallel and equidistant relationship.

3. A heat exchanger comprising, a plurality of inner tubes, a plurality of outer tubes of shorter length concentrically disposed about each of said inner tubes, fluid conveying members slidably mounted on the ends of pairs of inner tubes connecting in fluid flow relationship the ends of pairs of outer tubes, threaded members on at least one end of each of said inner tubes adjustable to produce relative axial movement between the inner and outer tubes to secure the outer tubes and fluid conveying members associated therewith in fluid tight communication and to exert tension on said inner tubes and fluid conveying member connecting said inner tubes.

4. In a heat exchanger as described in claim 3, in which at least one of the inner tube fluid conveying members connecting the ends of said pairs of inner tubes have locking means operative with said threaded members to secure said inner tube fluid conveying members in fluid tight communication with said inner tubes.

5. In a heat exchanger as described in claim 3, a series of perforated plates to support said outer tubes in a parallel and equidistant relationship.

6. A heat exchanger comprising a plurality of tubes, connecting means to join the ends of pairs of said tubes, a plurality of inner tubes concentrically mounted within said tubes and extending through openings in the connecting means associated therewith, fluid conveying means to connect the ends of pairs of inner tubes, threaded means on the opposite ends of said inner tubes adjustable to produce relative axial movement between the inner and outer tubes to secure the outer tubes and connecting means associated therewith in a fluid tight relationship and to exert tension on said inner tubes.

7. In a heat exchanger as described in claim 6, fluid conveying members to connect said opposite ends of pairs of said inner tubes and fastening means to secure said fluid conveying members in liquid communication with said inner tubes.

8. In a heat exchanger as described in claim 6, a plurality of perforated plates to support a varying number of said tubes in a parallel and equidistant relationship, the outermost of said plates being adjacent to and between said connecting means to prevent the endwise movement of said tubes.

9. In a heat exchanger a fluid conveying assembly comprising, a plurality of tubes, fluid connecting means to join the ends of pairs of said tubes, a plurality of U-shaped fluid conveying members the arms of which extend through openings in said fluid connecting means and are concentrically disposed within said tubes, threaded means on the ends of said U-shaped fluid conveying members adjustable to produce relative axial movement between the arms and the tubes to secure said tubes and fluid connecting means associated therewith in fluid tight relationship and to exert tension on said arms of said U-shaped fluid conveying members.

10. A heat exchanger comprising a plurality of tubes, removable connecting means to join the ends of pairs of said tubes, a plurality of U-shaped fluid conveying members the arms of which extend through openings in said removable connecting means and are concentrically disposed within said tubes, threaded means on the ends of said U-shaped fluid conveying members adjustable to produce relative axial movement of said arms relative to the tubes to secure said tubes and removable connecting means associated therewith in fluid tight relationship and to exert tension on said arms of said U-shaped fluid conveying members, removable fluid conveying members to connect pairs of ends of said U-shaped fluid conveying members and fastening means to maintain said removable fluid conveying members in liquid tight communication therewith.

11. In a heat exchanger as described in claim 9, a

plurality of parallel perforated plates to support a varying number of said tubes in a parallel and equidistant relationship, the outermost plates being adjacent to and between said removable connecting means associated therewith to prevent the endwise movement of said tubes.

12. In a heat exchanger assembly, a plurality of tubes, removable fluid connecting means to connect the ends of said tubes, a plurality of inner tubes substantially concentrically disposed within said tubes with the ends thereof extending through openings in said removable fluid connecting means, sealing rings having a right triangle cross section snugly fitted about the ends of said inner tubes, the right-angle corner thereof being disposed adjacent to the ends of said inner tubes and with its hypotenuse facing the inner edge of said openings in said removable fluid connecting means, threaded means on the ends of said inner tubes abutting the exposed portion of said rings, said threaded means being adjustable to produce axial movement of the inner tubes within the outer tubes to maintain said tubes and the removable fluid connecting means associated therewith in fluid tight relationship.

13. A heat exchanger comprising, a plurality of tubes, a plurality of plates to support a varying number of said tubes in a parallel and equidistant relationship, removable connecting means to join the ends of adjacent pairs of said tubes, a plurality of inner tubes concentrically mounted within said tubes and extending through

openings in said removable connecting means associated therewith, fluid conveying means to connect the ends of adjacent pairs of inner tubes, a threaded portion at the opposite ends of said inner tubes, fastening means on said threaded portions to secure said outer tubes and said removable connecting means associated therewith in fluid tight communication and to exert tension on said inner tubes, flanged fluid conveying members to connect the opposite ends of different adjacent pairs of said inner tubes, threaded means extending through openings in the flanged portion of the said last-mentioned fluid conveying members and into aligned openings in said fastening means to secure the former in liquid tight communication with said opposite ends of said inner tubes.

References Cited in the file of this patent

UNITED STATES PATENTS

444,533	Holden	Jan. 13, 1891
477,813	Nelson	June 28, 1892
1,826,253	Marshall	Oct. 6, 1931
2,085,677	Thayer	June 29, 1937
2,120,498	Key	June 14, 1938
2,424,221	Brown	July 22, 1947

FOREIGN PATENTS

980,414	France	Dec. 27, 1950