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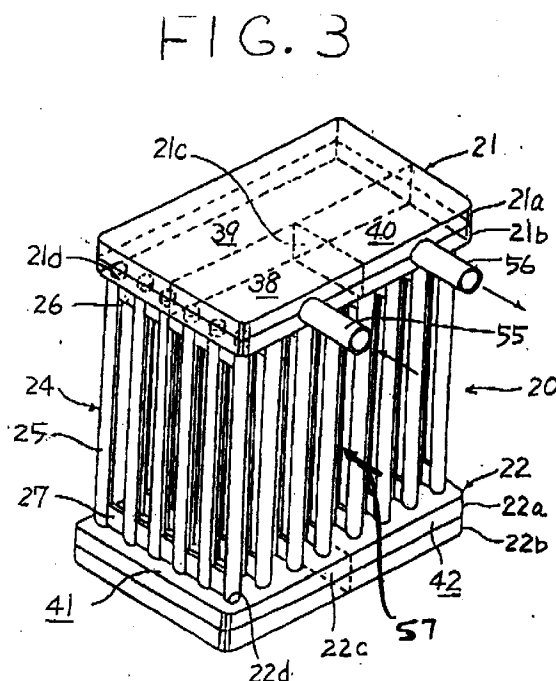
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(54) **Heat exchanger and method of making heat exchangers.**

(57) A heat exchanger (20) comprises a first tank (21) and a second tank (22) spaced from the first tank (21). The first tank (21) and the second tank (22) include a plurality of connection holes aligned in rows. The heat exchanger further includes a plurality of pipe portions (25) aligned in a row and fluidly interconnected between the first tank and the second tank, and at least one connecting portion (26,27) connected with the plurality of pipe portions (25). The plurality of pipe portions (25) are simultaneously inserted into the connection holes of the first and second tanks (21,22) so that the at least one connecting portion (26,27) contacts either the first tank (21) or the second tank (22).



This invention relates to a heat exchanger for use in an air conditioning system for a vehicle and a method to facilitate assembly of such a heat exchanger.

Fig. 1 shows a conventional heat exchanger used in an air conditioning system, for example, an evaporator or a condenser. In **Fig. 1**, the heat exchanger comprises an upper tank, a lower tank and a heat exchanger core disposed between the upper tank and the lower tank. The heat exchanger core comprises a plurality of heat transfer tubes spaced from one another and disposed in parallel to one another. The upper tank is divided into two chambers by a partition portion. A lower wall of upper tank and an upper wall of lower tank are provided with a plurality of connection holes for, connecting a plurality of heat transfer tubes therebetween and, thereby, placing upper and lower tank in communication. An inlet pipe and an outlet pipe are connected to the upper tank.

Thereby, a heat exchanger medium is introduced from the inlet pipe into one chamber of the upper tank and down through heat transfer tubes and reaches the chamber to the lower tank, and flows back to other chamber of the upper tank through heat transfer tubes. When the heat exchanger medium flows through heat transfer tubes, heat exchange occurs between the heat exchanger medium and air flow passing over heat transfer tubes.

Generally, a heat exchanger uses numerous heat transfer tubes to obtain a high heat exchange efficiency. In order to assemble such a heat exchanger, numerous heat transfer tubes are inserted, generally one by one, into connection holes of the upper tank and the lower tank. This assembly process is both complicated and time consuming. As a result, the operational productivity of the assembly process is low.

Referring to **Fig. 2**, one attempt to avoid the above disadvantage involved reducing the diameter of opposite end portions of the tubes and embossing the circumference of the connection holes to limit the length by which the tubes are inserted into the tank. However, these process steps are costly and complicated which increases the cost of heat exchanger.

It is an object of the invention to provide a heat exchanger wherein the assembly is accomplished by a simple process.

To achieve this object, one preferred embodiment of a heat exchanger comprises a first tank and a second tank spaced vertically from said first tank. Each of said first tank and said second tank includes a plurality of connection holes aligned in rows. A plurality of panel units extend between the first tank and the second tank. Each panel unit comprises a plurality of pipe portions aligned in a row and about equally spaced from each other and at least one connecting portion integrally connected with the pipe portions aligned in a row. The plurality of pipe portions in a panel are fixedly disposed between, and in fluid communication with, the first tank and the second tank so that the at

least one connecting portion contacts either the first tank or the second tank.

A method of manufacturing a heat exchanger according to one preferred embodiment comprises the steps of providing a plate member from molding material by extrusion, the plate member having a plurality of pipe portions and planar portions; cutting out portions of the plate member so that a plurality of pipe portions and at least one connecting portion remains, inserting opposite ends of each pipe portion into respective connection holes of a first tank and a second tank so that the at least one connecting portion contacts either the first tank or the second tank; and sealing the first tank and the second tank to the pipe portion with a sealing material.

According to another embodiment, a method of manufacturing a heat exchanger comprises the steps of forming a plurality of rectangular plate members having a plurality of half circular portions equally spaced from each other. This method further comprises inserting tubes into each half circular portion; inserting opposite ends of the tubes into respective holes of the first tank; and the second tank so that each connecting member contacts either the first tank or the second tank, and sealing the first tank and the second tank to the tubes with a sealing material.

In the heat exchanger according to the preferred embodiments, assembly time is reduced, manufacturing is simplified and cost is lowered as compared to the prior art.

Further objects, features and advantages of the invention will be understood from the following detailed description of the preferred embodiments of the invention including the annexed drawings, in which:

Fig. 1 is a perspective view of a prior art heat exchanger.

Fig. 2 is an enlarged, sectional view of the tank shown in **Fig. 1**.

Fig. 3 is a perspective view of a heat exchanger in accordance with a present invention.

Fig. 4 is a cutaway, side view of a heat exchanger shown in **Fig. 3**.

Fig. 5 is a perspective view of a heat exchanger unit in accordance with a first embodiment of the present invention.

Fig. 6 is a perspective view of a heat exchanger unit in accordance with a second embodiment of the present invention.

Figs. 7-9 are views illustrating steps of a method for manufacturing the heat exchanger unit of **Fig. 5**.

Figs. 10-12 are views illustrating steps of a method for manufacturing the heat exchanger unit of **Fig. 6**.

Fig. 13 is a perspective view of a heat exchanger unit in accordance with a third embodiment of the present invention.

Fig. 14 is a perspective view of a heat exchanger unit in accordance with a fourth embodiment of the

present invention.

Fig. 15 is a perspective view of a heat exchanger unit in accordance with a fifth embodiment of the present invention.

A heat exchanger in accordance with a first embodiment of the present invention is illustrated in **Fig. 3**, heat exchanger 20 comprises upper tank 21, lower tank 22, and a plurality of heat exchange units 24 disposed between upper tank 21 and lower tank 22. Heat exchange occurs between the heat exchange units and a flow 57 passing through the heat exchanger. Upper and lower tanks 21 and 22 may be made of an aluminum alloy or the like, and may be rectangular parallel-piped in shape. Upper tank 21 comprises upper wall 21a and lower wall 21b which are joined with each other at the sides of the tank. Upper tank 21 is divided by partition portion 21c, into three chambers, for example, first upper chamber 38, second upper chamber 39, and third upper chamber 40. Lower tank 22 is divided by partition portion 22c into two chambers, for example, first lower chamber 41 and second lower chamber 42. Lower wall 21b of upper tank 21 and upper wall 22a of lower tank 22 are provided with a plurality of connection holes 21d and a plurality of connection holes 22d, respectively, for connecting a plurality of heat exchange units 24 to tanks 21 and 22, thereby placing tanks 21 and 22 in fluid communication. Inlet pipe 55 and outlet pipe 56 are connected to upper tank 21.

A heat exchanger medium is introduced into first upper chamber 38 via inlet pipe 55 and flows through the heat exchanger through pipe portions 25. The medium may flow through the heat exchanger by the following path: first upper chamber 38 to first lower chamber 41, and then to second upper chamber 39. From second upper chamber 39, the medium may flow to second lower chamber 42 and finally back to third upper chamber 40. While the heat exchanger medium flows through pipe portions 25, heat exchange occurs between the heat exchanger medium and flow 57 passing over pipe portion 25.

Referring to **Fig. 4** and **5**, each heat exchange unit 24 may be made of an aluminum alloy or the like. Each heat exchange unit 24 includes a plurality of circular pipe portions 25 spaced from one another at about equal intervals, and connected to each other via a plurality of first connection portions 26 and second connection portions 27. First and second connection portions 26 and 27 are integrally connected with pipe portions 25 and align pipe portions 25 in a row. First and second connection portions are respectively positioned to be slightly spaced from upper and lower ends of heat exchange unit 24. Heat exchange units 24 are substantially planar and are arranged to be substantially parallel to heat exchange air flow 57. Thus, each heat exchange unit 24 includes a plurality of rectangular openings 26c between pipe portions 25. Each rectangular opening 26c is framed by ridge

lines of adjacent pipe portions 25, lower end portion 26b of first connection portion 26, and upper end portion 27a of second connection portion 27. Ridge lines of pipe portions 25 comprise trace surfaces 25a which are formed when rectangular openings 26c are cut out from an extruding plate. A row of pipe portions 25 is connected with upper tank 21 and lower tank 22 by inserting respective ends of pipe portions 25 into connection holes 21d and 22d. Upper end portion 26a of first connection portion 26 contacts lower wall 21b of upper tank 21 and lower end portion 27b contacts upper wall 22a of lower tank 22. Assembly of heat exchanger 20 is completed by, for example, brazing the components together.

The heat exchanger according to the above embodiment enables a simplified manufacturing process to be used, thereby reducing the cost and time associated with manufacturing as compared with the prior art.

Fig. 6 illustrates a second embodiment of the present invention. Each heat exchange unit 34 includes a plurality of circular pipe portions 35 spaced from one another at about equal intervals. Pipe portions 35 are connected to each other via a plurality of first connection portions 36, formed between adjacent pipe portions 35. The heat exchange unit 34 also includes second portions 37, formed at both ends of unit 34. Each end of pipe portions 35 projects substantially beyond upper end portion 36a and lower end portion 36b of first connection portion 36 for insertion into connection holes 21d and 22d. A plurality of first connection portions 36 and second connection portions 37 are integrally connected with pipe portions 35 and align a plurality of pipe portions 35 in a row. Heat exchange units 34 are substantially planar and are arranged to be substantially parallel to heat exchange air flow 57.

Further, each first connection portion 36 includes rectangular opening 36c at the center thereof. The width of rectangular opening 36c is smaller than the distance between pipe portions 35 and the height of rectangular opening 36c is smaller than the height of first connection portion 36. Preferably, each rectangular opening 36c is designed to be substantially parallel to the longitudinal axis of pipe portion 35.

The heat exchanger structure according to the second embodiment has substantially the same advantages as those of the first embodiment. Moreover, in the second embodiment, the mechanical strength of heat exchange unit 34 is substantially increased. The net weight of the heat exchanger is also increased.

Referring to **Figs. 7-9**, a method of forming heat exchanger unit 24 of the first embodiment is depicted. As illustrated in **Figs. 7** and **8**, plate 124 includes a plurality of pipe portions 25 spaced from one another at about equal intervals by plane portions 126 and pipe portions 25 at both sides thereof. Plate 124 may

be integrally formed from a material such as, for example, an aluminum alloy, by a process such as, for example, extrusion (not shown). Referring to Fig. 9, lower end portion 28, upper end portion 29 and center portion 26c maybe removed from each plane portion 126 to form connection portions 26 and 27. Removal of these portions may be accomplished by any suitable cutting process, for example, pressing. The removal may be done either simultaneously or in steps e.g., removal of upper sections, followed by removal of lower section, followed by removal of center section.

Referring to Figs. 10-12, a method of making a heat exchanger according to the second embodiment is depicted. Plate 224 includes a plurality of pipe portions 35 spaced from one another at about equal intervals by plane portions 126, and further includes plane portions 126 at both sides thereof. Plate 224 may be integrally formed from a material such as aluminum alloy, by a process such as extrusion (not shown). Referring to Fig. 12, lower end portion 38, upper end portion 39, and center portion 36c maybe removed from each plane portion 126 to form connection portions 36 and 37. The removal may be accomplished by any suitable cutting process such as, for example, pressing. Removal may be done either simultaneously or in steps, e.g. removal of upper section, followed by removal of lower section, followed by removal of center section.

Fig. 13 illustrates a third embodiment of a heat exchanger unit. The third embodiment is a modification of the first embodiment with similar elements having the same reference numerals for ease of description.

Each heat exchange unit 44 of the third embodiment includes first connection portions 26 integrally connected between pipe portions 25 aligned in a row. First connection portions 26 are spaced slightly from upper ends of pipe portions 25. Thus, each heat exchange unit 44 includes a plurality of hollow portions 144 between adjacent pipe portions 25.

The structure of **Fig. 13** has substantially the same advantages as those of the first embodiment. Additionally, in this embodiment, the net weight of heat exchange unit 44 is substantially decreased in comparison to the first embodiment. Heat exchange unit 44 does not limit the length by which pipe portions 25 are inserted into one of the tanks.

Fig. 14 illustrates a fourth embodiment of a heat exchanger unit. The fourth embodiment is a modification of the first embodiment with similar elements having the same reference numerals for ease of description.

Each heat exchange unit 54 includes connection portions 28 integrally connected between pipe portions 25 aligned in row. Connections portions 28 are positioned substantially at the center of heat exchange unit 54. Each heat exchange unit 54 includes

a plurality of first hollow portions 154 and second hollow portions 155 between adjacent pipe portions 25.

The structure of **Fig. 14** has substantially the same advantages as those of the first embodiment. Additionally, in this embodiment, as in the third embodiment, the net weight of heat exchange unit 54 is substantially decreased in comparison to the first embodiment. Heat exchange unit 54 does not limit the length by which pipe portions 25 are inserted into either tank.

Fig. 15 illustrates a fifth embodiment of heat exchange unit according to the invention. Each heat exchange unit 64 includes a plurality of circular pipes 31 spaced from one another at about equal intervals, first connection member 29 and second connection member 30. First connection member 29 includes a plurality of half ring portions 29a spaced from one another at about equal intervals. Second connection member 30 includes a plurality of half ring portions 30a spaced from one another at about equal intervals. Each half ring portion 29a and 30a is formed so that its inner diameter is about equal to or preferably smaller than outer diameter of circular pipes 31. First connection member 29 and second connection member 30 are respectively spaced slightly from upper end and lower end of circular pipes 31 so that each pipe 31 projects beyond upper end 29c and lower end 30c of first connection portion 29 and second connection portion 30. Each pipe is inserted into half ring portions 29a and 30a of connection members 29 and 30 and fixed thereto by a process such as brazing.

Heat exchange unit 64 is connected with upper tank 21 and lower tank 22, so that respective ends of each pipe 31 are inserted into respective connection holes 21d and 22d. Further, upper end portion 29c of first connection member 29 contacts lower wall 21b of upper tank and lower end portion 30c contacts upper wall 22a of lower tank 22. Heat exchange unit 64 is substantially planar and is arranged to be substantially parallel to heat exchange flow 57.

Heat exchange unit 64 may be formed by the following method. First, a plurality of rectangular plate members 29 and 30 are provided, each plate member having a plurality of half ring portions 29a and 30a spaced from each other at equal intervals. The half ring portions are formed by a process such as pressing. Each tube 31 is inserted into a respective half ring portion 29a and 30a of plate members 29 and 30. Opposite ends of tubes 31 are inserted into respective holes 21d and 22d of first tank 21 and second tank 22 so that each of plate member 29 and 30 contacts either first tank 21 or second tank 22. First tank 21 and second tank 22 are sealed to pipe portions 25 with a sealing material.

The heat exchange unit 64 of the fifth embodiment has substantially the same advantages as those of the first embodiment.

Claims

1. A heat exchanger comprising:

a first tank and a second tank, spaced vertically from said first tank, each of said first tank and said second tank including a plurality of connection holes aligned in rows,

a plurality of panel units respectively extending between said first tank and said second tank, each said panel unit comprising a plurality of pipe portions aligned in a row, and spaced at equal intervals from each other, and at least one connecting portion, said at least one connecting portion integrally connected with said pipe portions; and,

said plurality of pipe portions fixedly disposed between, and in fluid communication with, said first tank and said second tank so that said at least one connecting portion contacts either said first tank or said second tank.

2. The heat exchanger of claim 1, wherein said at least one connecting portion is formed adjacent an end of said plurality of pipe portions aligned in a row.

3. The heat exchanger of claim 1, wherein said at least one connecting portion is substantially parallel to a flow direction of air which passes through said heat exchanger.

4. The heat exchanger of claim 1, wherein said at least one connecting portion is substantially perpendicular to a longitudinal axis of said pipe portions.

5. The heat exchanger of claim 1, wherein said at least one connecting portion is formed substantially at a center of said plurality of pipe portions aligned in row.

6. The heat exchanger of claim 1, wherein each one of said plurality of pipe portions is a circular pipe.

7. The heat exchanger of claim 6, wherein said at least one connecting portion is a connecting member including a plurality of half circular portions spaced from each other at equal intervals, said connecting member fixedly disposed between said plurality of pipes aligned in rows so that each of said plurality of pipes is inserted into one of said plurality of half circular portions.

8. A method of manufacturing a heat exchanger, said heat exchanger including:

a first tank and a second tank, spaced vertically from said first tank, each of said first tank and said second tank including a plurality of

connection holes aligned in rows;

a plurality of panel units respectively extending between said first tank and said second tank, each said panel unit comprising a plurality of pipe portions aligned in a row and spaced from each other at equal intervals and at least one connecting portion, said at least one connecting portion integrally connected with said pipe portions; and

said plurality of pipe portions fixedly disposed between, and in fluid communication with, said first tank and said second tank so that said at least one connecting portion contacts either said first tank or said second tank,

the method comprising the steps of:

forming a plate member, said plate member including a plurality of pipe portions aligned in a row and a plurality of planar portions therebetween;

cutting out portions of said planar portions of said plate member, the remaining portions of said planar portions forming at least one connecting portion;

inserting opposite ends of said pipe portions into respective holes of said first tank and second tank so that said at least one connecting portion contacts either said first tank or said second tank; and

sealing said first tank and said second tank to said pipe portions with a sealing material.

9. The method of claim 8 wherein said plate member is formed by extrusion.

10. A method of manufacturing a heat exchanger, said heat exchanger including:

a first tank and a second tank, spaced vertically from said first tank, each of said first tank and said second tank including a plurality of connection holes aligned in rows,

a plurality of tubes, aligned in a row, disposed between and in fluid communication with said first tank and said second tank,

at least one connecting member including a plurality of half circular portions spaced from each other at equal intervals and fixedly disposed between said plurality of tubes, each of said plurality of tubes being inserted into one of said plurality of half circular portions,

the method comprising the steps of:

forming a plurality of rectangular shaped plate members, each of said plate members having a plurality of half circular portions spaced from each other at equal intervals;

inserting each of said tubes into one of said plurality of half circular portions;

inserting opposite ends of each of said tubes into respective holes of said first tank and

said second tank so that said at least one connecting member contacts either said first tank or said second tank;

sealing said first tank and said second tank to said pipe portions with a sealing material. 5

11. The method of manufacturing a heat exchanger of claim 10 wherein the step of forming said plurality of rectangular shaped plate members are formed by pressing. 10

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FIG. 1
(Prior Art)

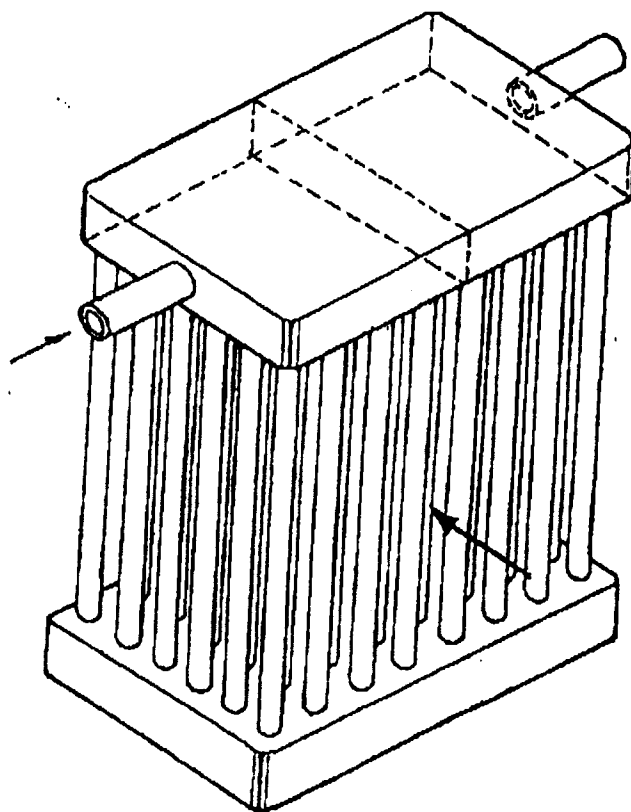


FIG. 2
(Prior Art)

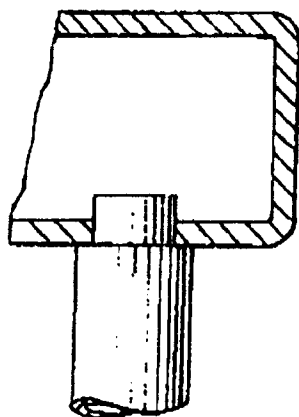


FIG. 3

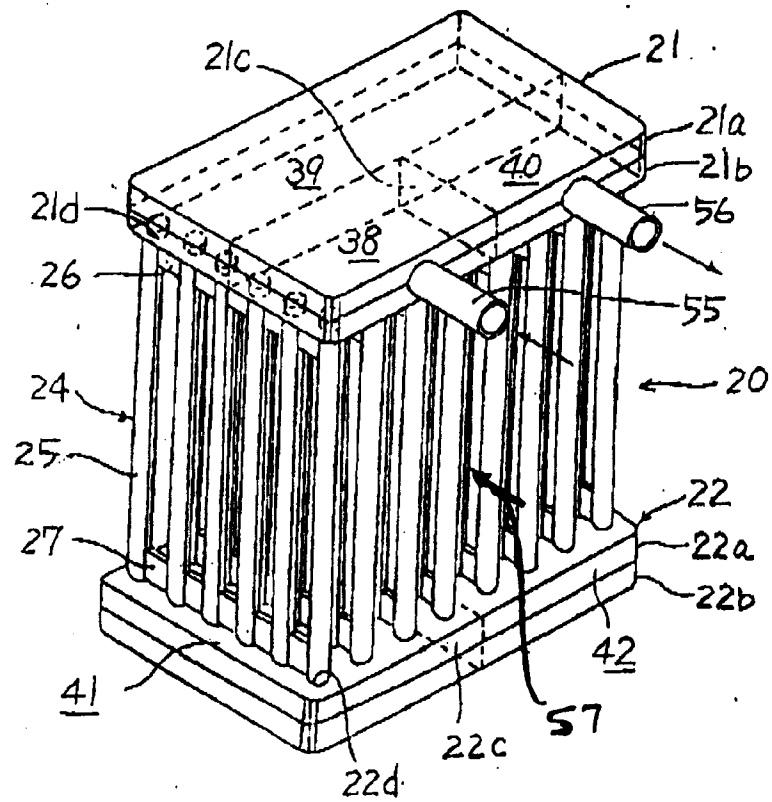


FIG. 4

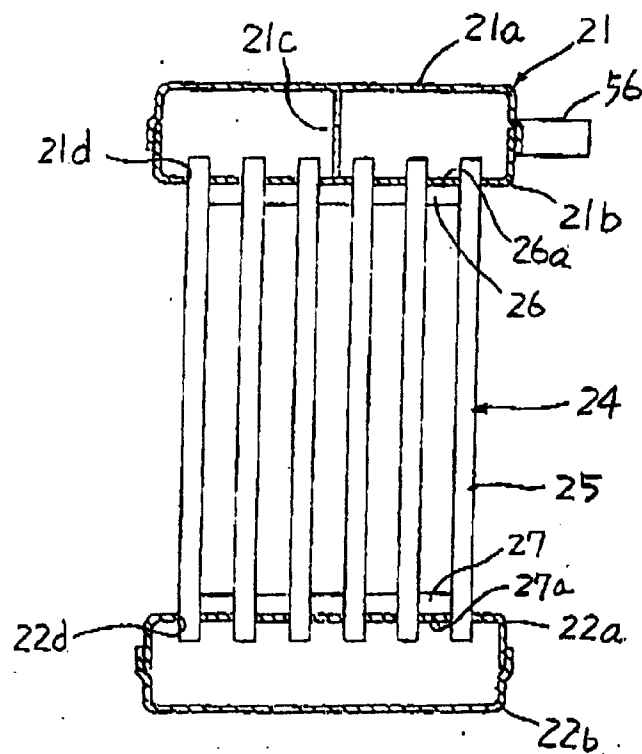


FIG. 5

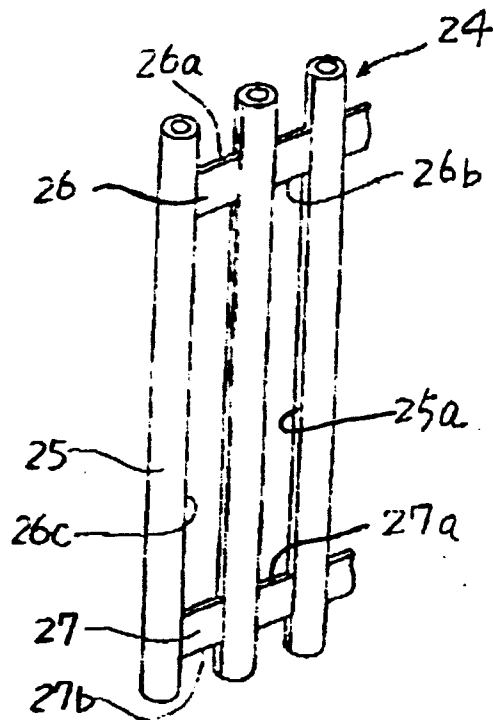


FIG. 6

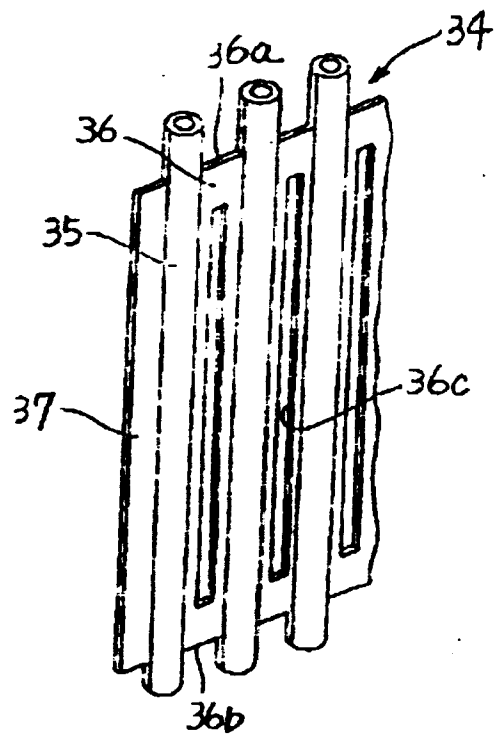


FIG. 7

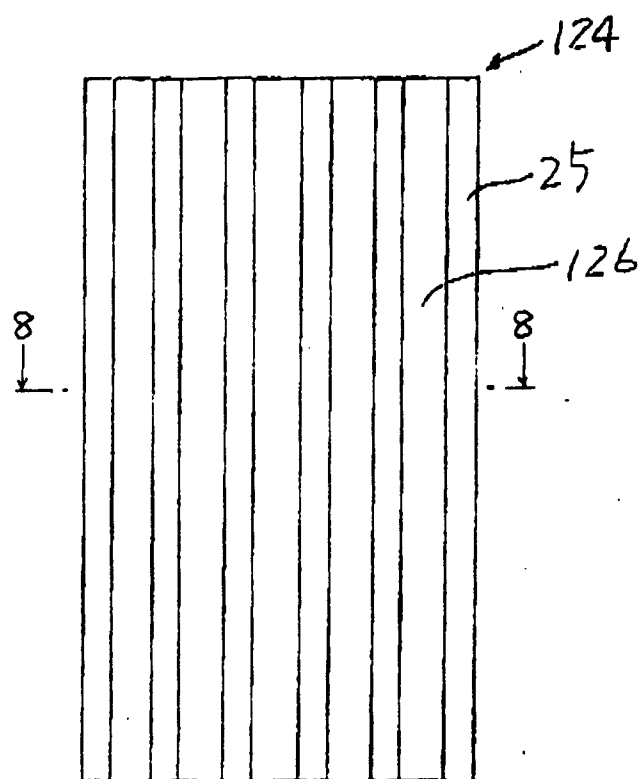


FIG. 8

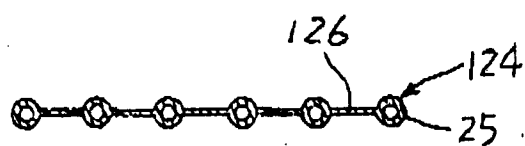


FIG. 4

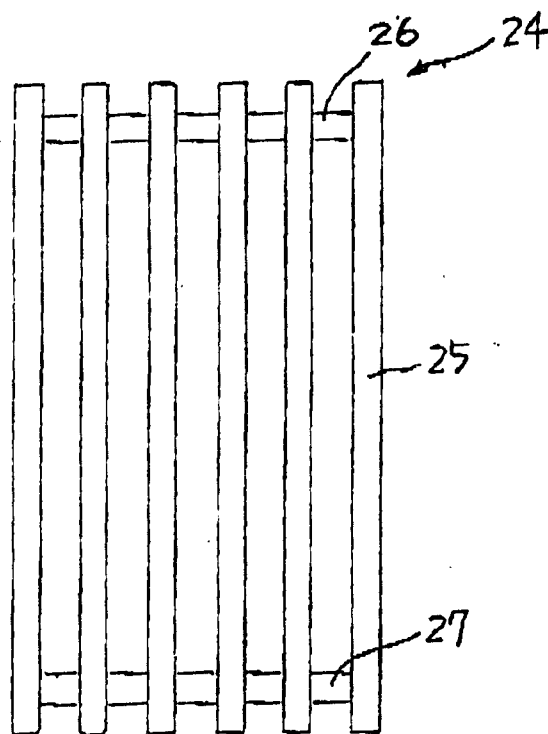


FIG. 10

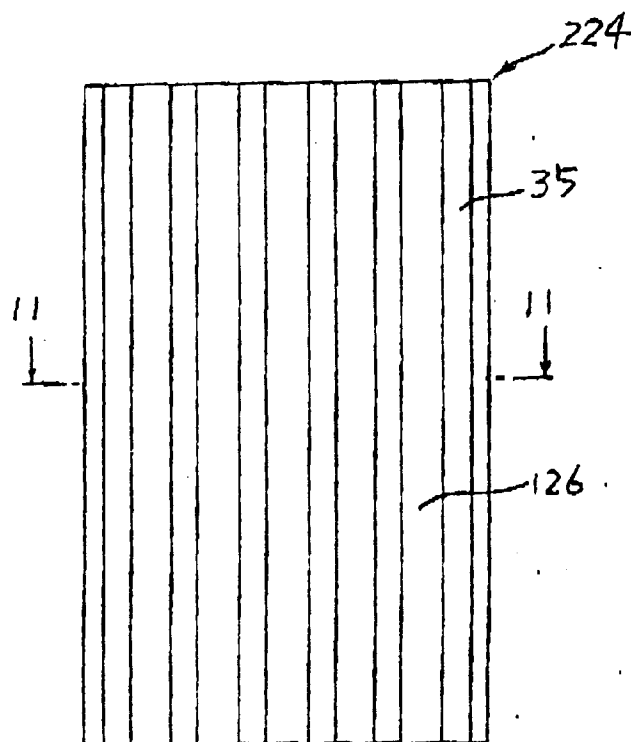


FIG. 11

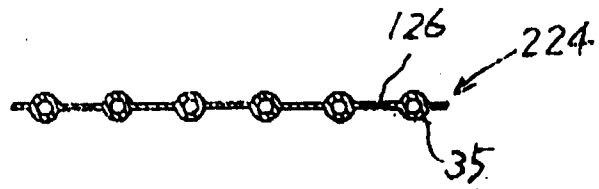


FIG. 12

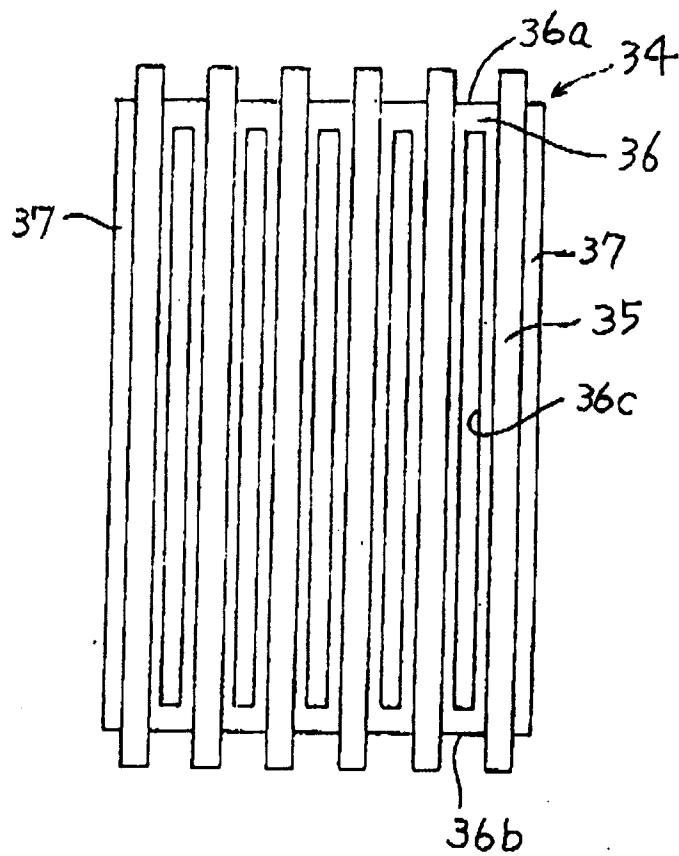


FIG. 13

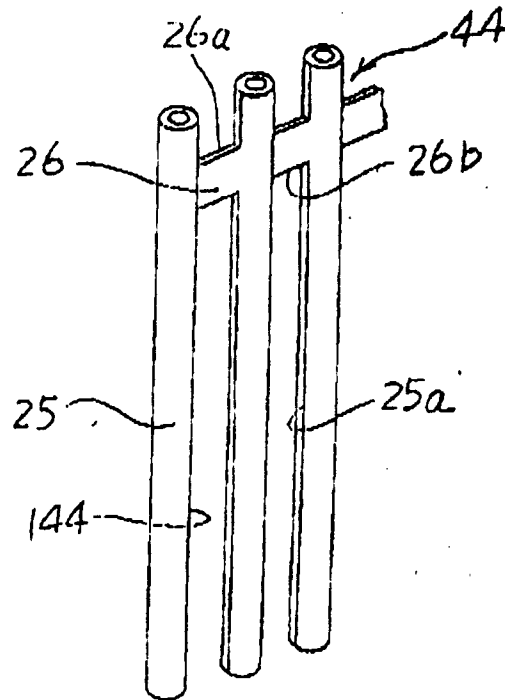


FIG. 14

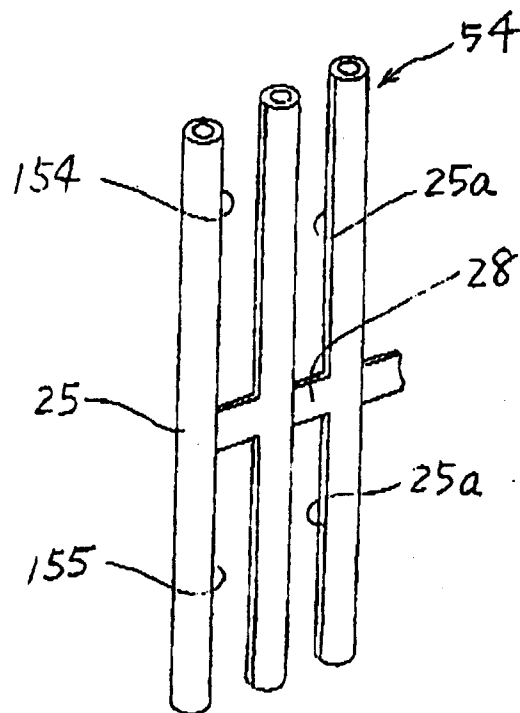
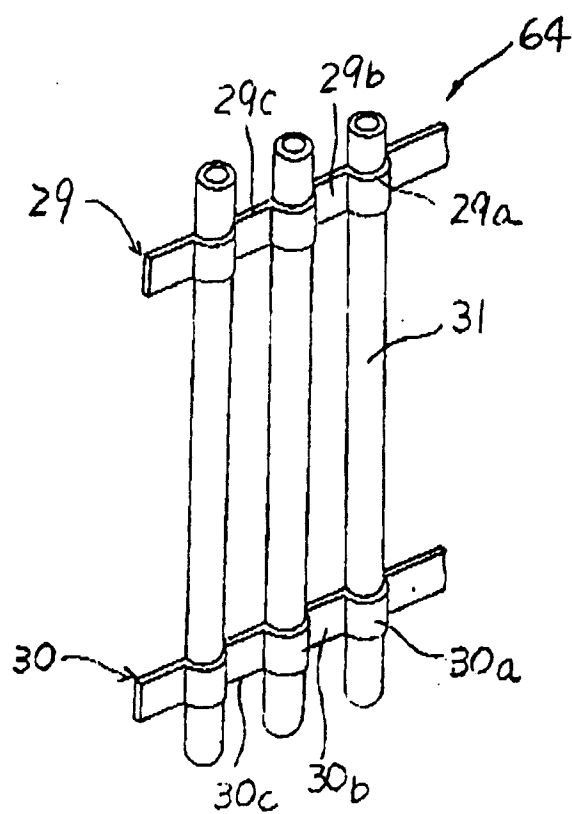


FIG. 15





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 3180

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP-A-0 572 187 (CESARONI ANTHONY JOSEPH) 1 December 1993 * column 3, line 5 - column 5, line 51; claim 9; figures *	1,3-6	F28F9/013 F28D1/053 B21D53/08
Y	---	7,8,10	
Y	EP-A-0 539 638 (INST FRANCAIS DU PETROL) 5 May 1993 * column 2, line 26 - column 3, line 11; claims 9-15; figures 2A,2B,7 *	7,8,10	
A	DE-A-19 26 187 (SCHÖLL) 26 November 1970 * page 3, paragraph 2 - page 4, paragraph 2; claim 1; figures 1-4 *	1,3-6,9	
A	US-A-4 657 069 (EASTON DAVID J) 14 April 1987 * abstract; figures *	1,2	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F28F F28D B21D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 23 August 1995	Examiner Eccetto, M
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