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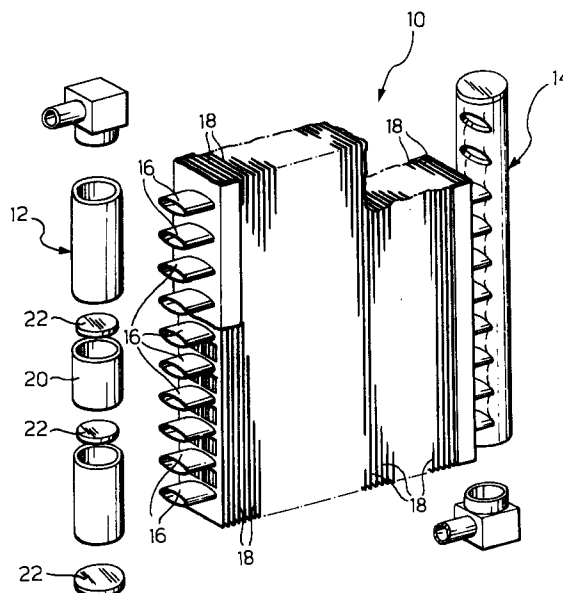
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(54) **A method for the manufacture of a heat exchanger, particularly for the manufacture of a condenser for vehicle air-conditioning systems**

(57) The heat exchanger (10) includes a pair of parallel distributors (12, 14) and a plurality of tubes (16) for the passage of fluid. Each distributor (12, 14) comprises a tubular element (20) and a plurality of partitions (22) which divide the interior of the tubular element (20) into a plurality of chambers aligned with each other along the axis of the distributor (12, 14). The partitions (22) are inserted from an open end of the tubular element (20) and are positioned at predetermined points by being slid along the longitudinal axis of the tubular element. Subsequently, a series of apertures (42) is formed in the wall of the tubular element to act as couplings for the ends of tubes (16) for the passage of fluid.

FIG. 1



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Description

The present invention relates to a method for the manufacture of a heat exchanger, particularly for the manufacture of a condenser for vehicle air-conditioning systems.

More precisely, the invention relates to a method for the manufacture of a heat exchanger including a pair of parallel distributors and a plurality of tubes for the fluid flow extending between the distributors, in which each distributor houses a plurality of partitions which divide the interior of the distributor into a plurality of chambers aligned with each other along the axis of the distributor.

Heat exchangers of this type are normally used as condensers in vehicle air-conditioning systems and are known in the art as "parallel-flow" condensers. The partitions are provided within the distributors to create obligatory pathways so that the entire fluid flow passes in succession through various arrays of tubes in succession in its path from the inlet to the outlet of the heat exchanger. The presence of the partitions within the distributors means that the tubes that interconnect the two distributors are divided into a number of sets in series with each other while the tubes in each set are connected in parallel with each other.

A first known system for locating the partitions within the distributor starts with two half-shells, each of which is essentially in the form of a tube cut along a plane through its longitudinal axis. The partitions are arranged at predetermined positions in one of the two half-shells and the two half-shells are then welded together along their peripheral line of joining.

The main disadvantage of this system is the need to provide two separate half-shells for each distributor, these not generally being available as standard components. Moreover this system is difficult to automate and the welding along the join line between the two half-shells is critical from the point of view of the reliability of the heat exchanger since it increases the risk of fluid loss, particularly in conditions of use at high temperatures and pressures.

Another known system for the introduction of the partitions into a distributor starts with a circular-section, extruded tube and forms incisions in the wall of the tube at the points at which the partitions are to be located. The partitions are then introduced into the tube through these cuts which are subsequently closed by welding.

The problem with this second system is that the finished distributor has a rather large number of possible points of fluid loss adjacent the incisions through which the partitions are inserted.

US patent 4762152 describes a system in which the partitions are inserted from an open end of the distributor and are slid axially until they reach a predetermined position. The fluid-flow tubes are fixed to integral appendages projecting from the outer surface of the distributor, these being formed by chip-forming machining or plastic deformation. Although the system for fixing the partitions described in US 4762152 reduces the risk

of fluid loss effectively, the fact that it is necessary to form appendages integral with the distributor for fixing the tubes adds unacceptably to the production costs.

In order to overcome these problems, the present invention provides a method having the characteristics which form the subject of the main claim.

According to the present invention, the distributor is constituted by a standard extruded or drawn tubular element into which the partitions are inserted from an open end. The partitions are located at predetermined points by being slid along the longitudinal axis of the tubular element. After the partitions have been positioned, a plurality of apertures is formed in the wall of the tubular element through which the ends of the tubes for the circulation of fluid are inserted. The apertures are formed by upsetting material inwardly of the distributor, without producing swarf so as to form collars which serve to hold the ends of the tubes and to retain the partitions in the axial direction.

The method of the invention achieves a considerable reduction in the cost of production of the finished heat exchanger as well as a considerable reduction in the areas of fluid loss. Consequently there is less wastage from the distributor by fluid loss and the heat exchanger is more reliable.

Although the invention has been developed particularly for use as a condenser for air-conditioning systems, it will be understood that the method of the invention may be applied to the production of distributors for heat exchangers of various types.

Further characteristics and advantages of the present invention will become apparent from the detailed description which follows, given purely by way of non-limitative example, with reference to the appended drawings, in which:

Figure 1 is a partially exploded, schematic perspective view of a heat exchanger according to the present invention,

Figure 2 is a schematic illustration showing the division of flow of fluid in a heat exchanger with distributors with aligned chambers, and

Figures 3 to 6 are schematic illustrations of several phases in the method of the invention.

With reference initially to Figure 1, a heat exchanger generally indicated 10 comprises, for example, a condenser for a vehicle air-conditioning system, and includes a pair of distributors 12 and 14 arranged parallel to each other. A plurality of tubes 16 extends between the two distributors 12, 14 with their ends communicating with the interiors of the distributors 12, 14. The tubes 16 are fixed to a pack of metal fins 18 so as to form a network for heat exchange between the fluid which circulates within the tubes and the air which flows over the fins 18. Preferably the tubes 16 are oblong in cross-section and are fixed to the fins 18 by a mechanical expansion process: that is, the tubes are inserted with clearance within aligned holes in the pack of fins 18

and the mechanical connection between the tubes 16 and the fins 18 is achieved by radial expansion of the tubes by a mechanical expanding process.

As can be seen from Figure 2, each distributor 12, 14 comprises a tubular element 20 within which are a plurality of partitions 22 arranged so as to divide the interior of the tubular element 20 into a series of chambers aligned with each other along the longitudinal axis of the distributor.

In the schematic view shown by way of example in Figure 2, each distributor 12, 14 has two partitions which divide the interior of the tubular element 20 into three chambers indicated 24a, 24b and 24c, in the case of the distributor 12, and 26a, 26b, 26c in the case of the distributor 14. The partitions 22 divide the tubes 16 into sets, indicated 16a, 16b, 16c, 16d and 16e, which are in series with each other with respect to the direction of circulation of the fluid. The tubes in each set are, on the other hand, connected in parallel with each other. The number of tubes in each set reduces progressively from one set to the next in the direction of flow of the fluid since, in the case of a condenser, the fluid enters as a vapour and leaves in the liquid state and, in changing state, reduces substantially in volume.

With reference now to Figures 3 to 6, the sequence by which the distributors 12, 14 are assembled will be described. With reference initially to Figure 3, the manufacture of a distributor starts with the cutting of a predetermined length of tubular element 20 from a commercial extrusion. The tubular element 20 is usually of aluminium and may, for example, have a diameter of 20 mm and a wall thickness of 1.5 mm. Naturally, the dimensions of the tubular element 20 may vary according to its use. Figure 3 illustrates how the partitions 22 are inserted into the tubular element 20 from one of its open ends 28 and are slid along the longitudinal axis 30 in the direction indicated by the arrow 32 until they reach a predetermined axial position.

Each partition 22 may have a substantially C-shaped cross-section, as illustrated in Figure 3, or may be constituted by a solid disc. In the case of a C-section element, the peripheral wall 34 of the partition 22 constitutes a guide as it has sufficient length in the direction of the longitudinal axis 30 to avoid jamming during its sliding movement. This C-shape thus allows a thin sheet (for example 1 mm thick) to be used for the partition. When the partition 22 is a solid disc, the thickness must be greater (for example 3-4 mm) to give a peripheral bearing surface which is sufficiently thick.

Each partition 22 has a peripheral wall 34 which is made to tight tolerances to the diameter of the inner surface 36 of the tubular element 20 and is thrust along the axis 30 by means of a rod 38 until it reaches its final position. Naturally, the partitions which are to be positioned furthest from the open end 28 are inserted first.

After all the partitions 22 have been positioned within the tubular element 20, a series of incisions is made in the wall of the tube to form the apertures for the connection of the ends of the tubes 16. Figure 4 illus-

trates schematically the step in which the incisions are made. The tubular element 20 is held stationary by a suitable tool provided with a series of cutting bits 40 which can be advanced in a direction perpendicular to the longitudinal axis 30 of the tubular element 20. The bits 40 form the incisions and upset the material towards the inside of the tube without producing shavings or swarf, which is particularly important since the presence of the partitions 22 does not allow any swarf to be removed. In order to avoid the collapse of the tube, the apertures 42 may be formed in two or more steps. For example, all the even apertures could be formed in a first step by the advance of their respective bits 40 and then the odd apertures could be formed by the advance of the remaining bits. The bits 40 upset the sheet metal edges towards the interior so as to form collars 43 (Figure 5) which are shaped and dimensioned so as to house the end portions of the tubes 16.

Figure 5 illustrates the tubular element 20 at the end of the step in which the incisions 42 are made. It will be seen that each partition 22 is housed in the space between two adjacent apertures 42 and is prevented from moving axially in the tubular element 20 by the upset material constituting the collars 43.

In the subsequent steps, as illustrated in Figure 6, the ends of the tubes 16 are inserted in the apertures 42 and braze welded around the perimeter of the incisions 42 to connect the tubes 16 firmly to the tubular element 20.

Finally, to complete the distributor, an inlet/outlet connector for the fluid is fitted to one end of the tubular element 20 and the opposite end is sealed in known manner. Alternatively the inlet and outlet connectors for the fluid could be formed in the peripheral wall of the distributor and, in this case, both ends of the distributor would be sealed.

Claims

1. A method for the manufacture of a heat exchanger, particularly for the manufacture of a condenser for vehicle air-conditioning systems, in which the heat exchanger (10) includes a pair of parallel distributors (12, 14) and a plurality of tubes (16) for the fluid flow extending between the distributors (12, 14), in which each distributor (12, 14) comprises a tubular element (20) and a plurality of partitions (22) which divide the interior of the tubular element (20) into a plurality of chambers (24a, 24b, 24c; 26a, 26b, 26c) aligned with each other along the axis of the distributor (12, 14), in which the partitions (22) are inserted from an open end (28) of the tubular element (20) and are positioned at predetermined points by being slid along the longitudinal axis (30) of the tubular element (20), characterised in that, after the insertion of the partitions (22), a plurality of apertures (42) is formed in the wall of the tubular element (20) with upset edges forming collars which retain the partitions in position in the longitudi-

dinal direction and then end portions of the fluid-flow tubes (16) are inserted in the respective apertures (42), and the end portions are welded to the distributor.

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2. A method according to Claim 1, characterised in that the partitions (22) are made to tight dimensional tolerances to fit the internal diameter (36) of the tubular element (20).

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3. A method according to Claim 1 or Claim 2, characterised in that the apertures (42) are formed by tools with cutting bits (40) which are movable in a direction perpendicular to the longitudinal axis of the tubular element (20) to effect the incisions and upset the material without producing swarf.

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4. A method according to Claim 3, characterised in that the apertures (42) are divided into at least two groups which are formed in successive steps.

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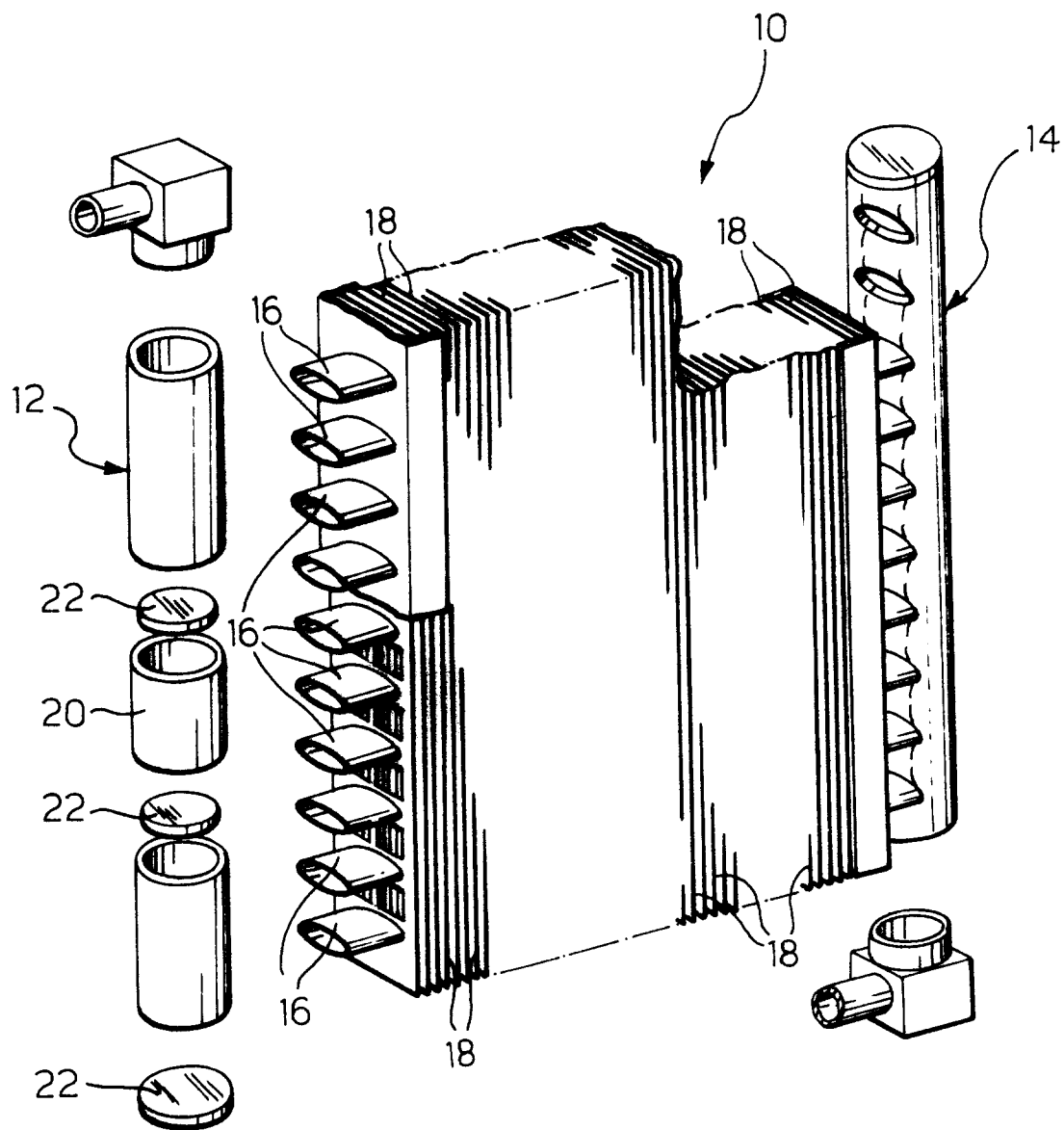
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FIG. 1



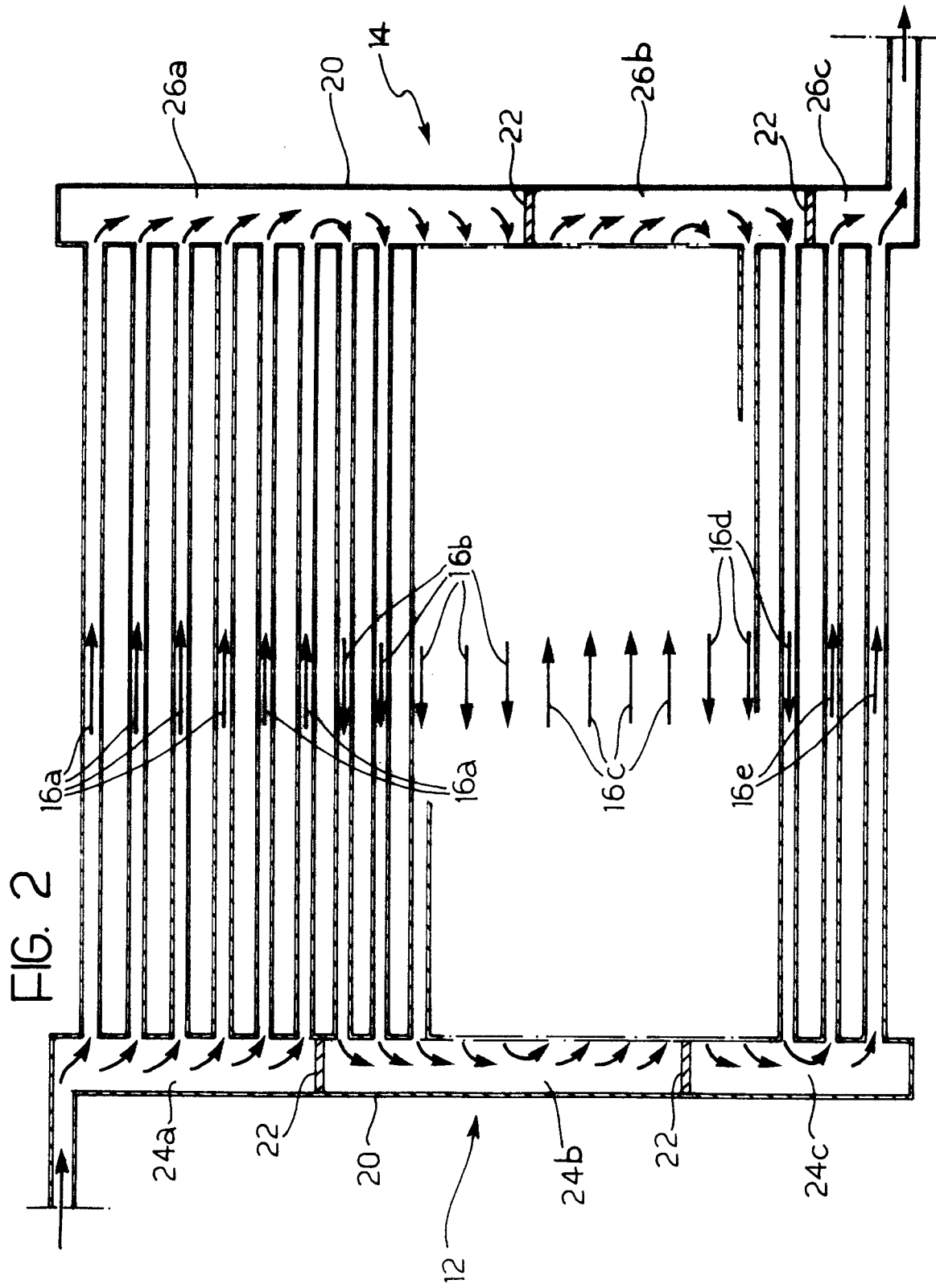


FIG. 3

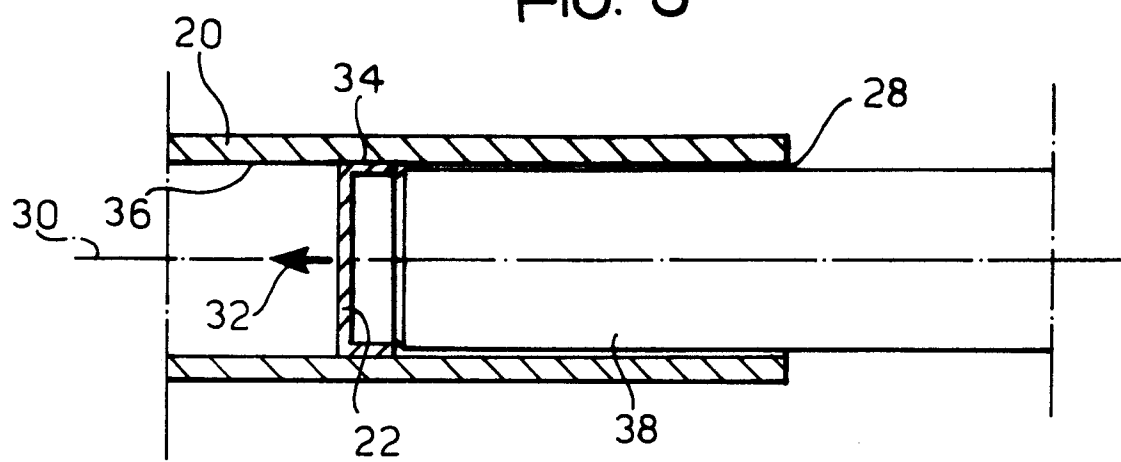


FIG. 4

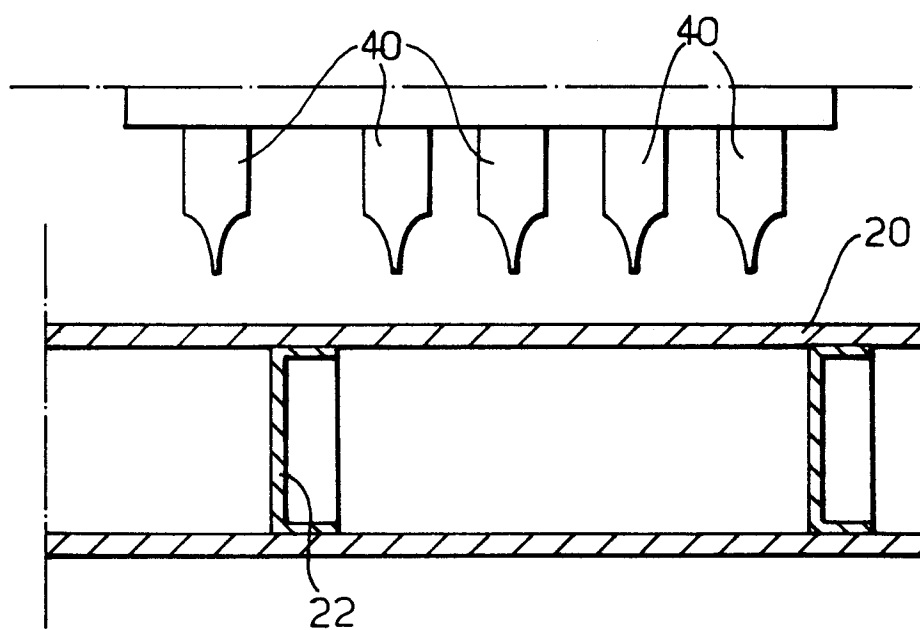


FIG. 5

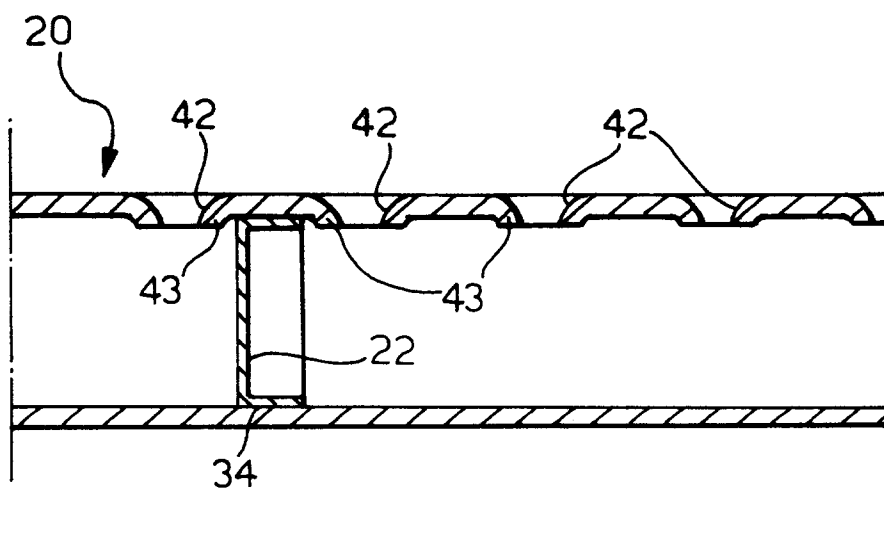
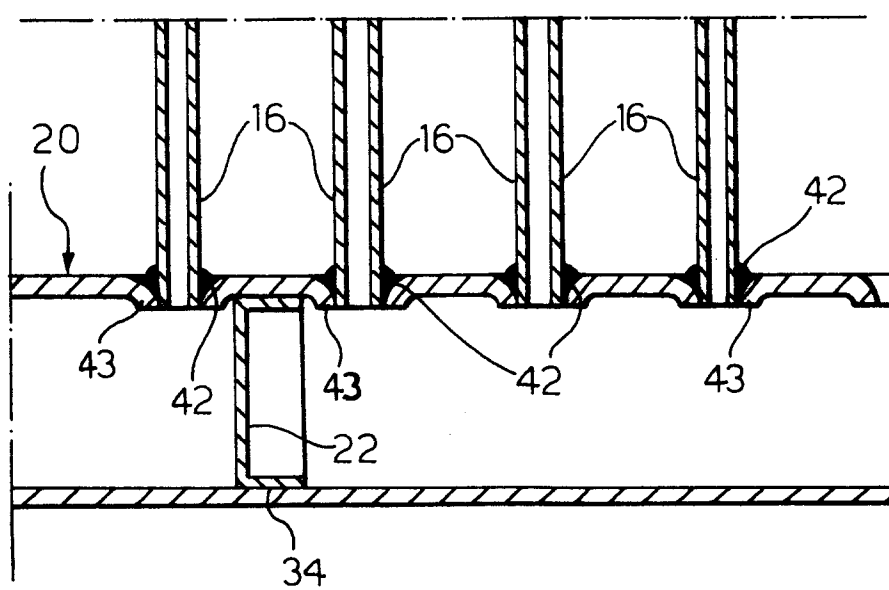


FIG. 6





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EUROPEAN SEARCH REPORT

Application Number
EP 96 11 1912

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)
Y	FR-A-2 713 114 (VALEO THERMIQUE MOTEUR) 9 June 1995 * the whole document *	1-4	B21D53/08
Y	US-A-4 679 289 (MILLER DONALD E) 14 July 1987 * the whole document *	1-4	
A	US-A-5 052 480 (NAKAJIMA ICHIO ET AL) 1 October 1991		
A	DE-A-19 59 913 (OLOFSTROEM) 18 June 1970		
A	EP-A-0 576 725 (WALLIS) 5 January 1994		
A	US-A-4 582 127 (MORANNE JEAN-PIERRE) 15 April 1986		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B21D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		30 August 1996	Peeters, L
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