(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 330 288 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **89200459.9**

(51) Int. Cl.[4]: **F25B 39/02 , F28D 3/00**

(22) Date of filing: **23.02.89**

(30) Priority: **26.02.88 NL 8800504**

(43) Date of publication of application:
30.08.89 Bulletin 89/35

(84) Designated Contracting States:
AT BE CH DE ES FR GB GR IT LI LU NL SE

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(54) Cooling device or heat pump.

(57) Cooling device or heat pump, comprising a number of vertical, hollow cooling plates (2, 3, 4, 5), a supply pipe for the infeed of cooling medium to the interior of the plates, and a discharge pipe for the discharge of evaporated cooling medium, a trickling device for the supply of the liquid to be cooled to the outer surface of the plates and a collecting tank. To minimize heat stresses and to obtain a compact device the supply pipe (6) is located below the centre of the plates, the discharge pipes are located at the top sides and the connecting tubes (13, 14) are elbows in staggered relation.

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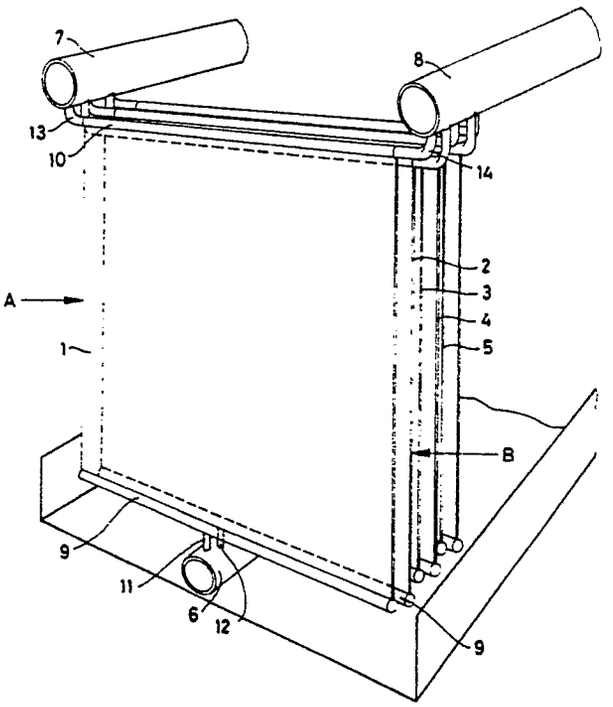
fig-1



Cooling device or heat pump

The invention relates to a cooling device or heat pump, comprising a number of vertical, hollow cooling plates which are placed in planes parallel to each other and which are connected near the bottom edge of the cooling plates to a supply pipe for the infeed of evaporable cooling medium to the interior of the cooling plates, and near their top edge are connected to a pipe which runs parallel to the supply pipe and is for the discharge of evaporated cooling medium, while provision is made above the top edges of the cooling plates for a trickle device out of which the liquid to be cooled can flow in the form of a thin film over the outer surfaces of the cooling plates and can finally reach a collecting tank under the bottom edges of the cooling plates.

Such a device is known, for example from DE-A-3306865.

This known device has a number of hollow plates which at the top and bottom are integral with collecting pipes which are all closed at one end, while at the other end they are connected near the bottom edge of the plates to a supply pipe, and are connected near the top edge at the same side to a discharge pipe.

A device is provided above the cooling plates for feeding in, at the outside of the cooling plates, the liquid which has to give off heat, said feed device in general comprising a tank with a large number of apertures situated above the top edges of the plates, so that the liquid emerging therefrom can flow downwards in the form of a thin film over the plates and is collected in a tank underneath for discharge or further use.

In the known device the plates are placed at a relatively great distance from each other. The device is therefore bulky.

Very great stresses can occur in the cooling plates and in the connections between these cooling plates and the feed or discharge pipes, in particular in the connections with the latter pipes, due to the fact that temperature differences of the order of 40 °C can occur within a few minutes, namely from +20 to -20 °C. This leads to heat stresses and vibrations, and means that there is a risk of fatigue fractures, in particular at the connections with the discharge pipes. In the above-mentioned known device the connection between the top discharge pipe and the collecting pipes formed at the top edges of the plates is a straight axial extension of these collecting pipes. Such a design cannot absorb heat stresses very well, but leakage of the cooling medium, for example Freon, definitely must not occur. In order to ensure a reliable design all the same, it is known to make plates and tubes of the required wall thickness using high-quality material. This is at the expense of the heat transfer, and makes the device expensive. The device must be able to withstand pressure changes which can go as high as 30 bars.

The object of the invention is then to produce a cooling device which takes up less space, is capable of absorbing heat stresses and can therefore be made of thinner material, and in which the volume of cooling medium can be smaller. The discharge pipe for evaporated cooling medium opens into a separator for separating vapour and liquid from each other. Reducing the amount of cooling medium affects the size of the separator.

This object is achieved according to the invention in the first place by the fact that:

the supply pipe for cooling medium is situated essentially centrally below the bottom edges of the cooling plates and is connected to the inside of each cooling plate by means of vertical pipe lengths;

the discharge for evaporated cooling medium comprises two discharge pipes, one near each top corner of the cooling plates;

the discharge pipes are connected to the cooling plates at the corners by elbow-type pipe lengths;

the elbow-type pipe lengths are connected to the discharge pipes so that they are staggered relative to each other;

the vertical pipe lengths between supply pipe and bottom side of the cooling plates are connected to the supply pipe in staggered fashion;

all this being in such a way that the vertical pipe lengths and the elbow-type pipe lengths belonging to one cooling plate lie between those of the preceding or following plate.

Instead of one discharge pipe for evaporated cooling medium, one now uses two pipes, which preferably have a diameter considerably greater than that of the collecting chambers or collecting pipes on the top of the plates. This already makes it possible to absorb pressure peaks caused by the evaporation of the cooling medium. Heat stresses can be absorbed by using elbow-type pipe lengths between the discharge pipes and the top ends of the plates.

Since all pipe lengths are connected staggered relative to each other to the discharge pipes, but also to the supply pipe, the cooling plates can be placed close together, which makes the whole device smaller.

Placing the supply pipe for the cooling medium centrally below the cooling plates means that uniform distribution is achieved in the spread of the cooling medium occurring in the plates from the

bottom. This again is an advantage as regards the heat stresses occurring.

A further simplification of the design can be obtained if according to the invention the supply pipe and the discharge pipe are essentially the same as regards their diameter and the connection points of the respective pipe lengths. A single type of pipe can be used to permit placing of the cooling plates close to each other.

These cooling plates can have alternately differing measurements. It is, however, preferable to have a cooling device in which the cooling plates are identical and are alternately displaced laterally relative to each other. This lateral displacement is then in keeping with the staggered connection points, i.e. displaced in the same direction, to the discharge pipe(s), so that the elbow-type pipe lengths can be essentially equal to each other and the straight pipe lengths at the bottom edge can be located precisely in the centre of the bottom edge of each cooling plate.

It is also possible according to the invention to use cooling plates which are identical to each other, but which are displaced in the vertical direction alternately relative to each other, with or without lateral displacement. The elbow-type and straight pipe lengths then do have alternately differing measurements, but the number of types is limited. It is, however, possible here to place the plates closer together, in particular if these plates have collecting chambers or pipes at the top and/or bottom whose diameter is greater than the horizontal external thickness of the plates.

A very expedient design of the cooling plates is obtained if they are thin plates, which are connected to each other along the vertical edges to form one unit, for example by welding, which are connected along the top and bottom edge to collecting pipes, forming a continuous connection between the inside of the cooling plates and said pipes, and which have weld points between them, uniformly distributed over the surface of the two plates, these plates being pressed apart by means of internal excess pressure in the areas between the connection points after the joins have been made.

It is pointed out that it is known per se, for example from European Patent Specification 0,112,513, in a heat exchanger such as a radiator to connect the vertical ribbed pipes through which medium to be cooled flows in a staggered arrangement to a collecting pipe (see Figs. 4 and 5 in particular). However, in this case it is not a question of avoiding heat stresses, but the idea is to place pipes provided with cooling ribs as closely together as possible. Heat stresses of any significance do not, however, occur here.

The invention will now be explained in greater detail with reference to the drawings.

Fig. 1 shows in perspective and very schematically the main part of a device according to the invention.

Fig. 2 is a cross section through the front cooling plate shown in Fig. 1, and indicated by the arrow A.

Fig. 3 is a cross section which is comparable to that of Fig. 2 through the plate which is displaced relative to the plate A, and which is indicated by the arrow B.

Fig. 4 shows a view of a corner of a plate, with the connecting pipe length omitted.

Fig. 5 is a longitudinal section through the succession of cooling plates shown in Fig. 1, at the line V-V of Fig. 4.

Fig. 6 is a longitudinal section which shows the positioning of the cooling plates relative to each other in a slightly different way, and which is made through the area of the successive plates which is indicated by the line VI-VI in Fig. 4.

Fig. 7 shows a view of a supply or discharge pipe.

The device shown in Fig. 1 comprises a number of cooling plates which are placed in vertical planes parallel to each other, and the first five of which are indicated by the numbers 1 to 5. These cooling plates are identical to each other, i.e. height and width are the same. The plates 1, 3 and 4 take up exactly the same space in the device in the crosswise and vertical direction. The plates 2, 4 and subsequent plates (not shown) are displaced both laterally, i.e. to the right in Fig. 1, and vertically, i.e. downwards in Fig. 1, relative to the plates 1, 3 and 5.

A supply pipe 6 for liquid cooling medium is provided under the plates. Discharge pipes 7, 8 for evaporated cooling medium are provided near the top corners.

All plates have a collecting pipe 9 at the bottom edge and a collecting pipe 10 at the top edge. The diameter of these collecting pipes is about 1/5th of that of the supply pipe 6 or discharge pipes 7 and 8.

The connection between the supply pipe 6 and the collecting pipes 9 is made with straight pipe lengths 11, 12 which are in the centre of the bottom edge of the cooling plates and are connected to the supply pipe 6 in staggered fashion.

The top collecting pipes 10 are connected by means of elbow-type pipe lengths 13, 14 to the discharge pipe 7, 8, the upward-facing ends of said pipe lengths 13, 14 connecting in a staggered manner to the discharge pipes 7, 8.

Fig. 7 shows a view of a pipe which is suitable for use as a supply pipe 6 or discharge pipe 7 or 8. This pipe, which can have a diameter of, say, 10

cm, is provided with connection points for the pipe lengths, said connection points being indicated by 15, 16 respectively, and being staggered relative to the central plane. In the case of the supply pipe 6 they are at the top, and in the case of the discharge pipes they are at the bottom.

Fig. 4 shows a corner part of a single cooling plate, for example plate 1, with a collecting pipe at the top edge. The cool ing plate comprises two thin plates which are connected along the vertical edges, such as the edge 17, either by welding edges to each other or by folding over, and which have weld points 18 further distributed over the surface to connect the individual plates.

Fig. 6 shows these weld points 18 in cross section and also shows that a throughflow space 19 has been created between the plates. Slit-type connections with the collecting pipe 9, 10 are provided between the top weld points and bottom weld points.

Fig. 6 also shows that the collecting pipes 10 are staggered relative to each other, which means that the plates can be placed closer together. In addition, Fig. 6 shows by line 20 the shape of the bottom of a liquid supply device with outflow aperture 21, 22, from which liquid can finally reach the outer surface of the collecting pipes 10, and from there can flow along the outside walls of the plates.

Fig. 5 shows yet another longitudinal section, omitting non-relevant parts, and this figure shows how the collecting pipes 9, 10 connect in staggered fashion with the pipe lengths 11 and 12 to the supply pipe 6 and with the elbow-type pipe lengths 13, 23 to the top discharge pipe, such as the pipe 7.

A compact unit is achieved by placing the cooling plates staggered relative to each other and by the staggered connection to feed and discharge pipe(s). The symmetry from supply to discharge and the pipe lengths used in the process make it possible to keep the heat stresses under control. This again makes it possible to design the device with a smaller volume for the cooling medium.

Claims

1. Cooling device or heat pump, comprising a number of vertical, hollow cooling plates (2, 3, 4, 5) which are placed in planes parallel to each other and which are connected near the bottom edge of the cooling plates to a supply pipe (6) for the infeed of evaporable cooling medium to the interior of the cooling plates, and near their top edge are connected to a pipe (7) which runs parallel to the supply pipe and is for the discharge of evaporated cooling medium, while provision is made above the top edges of the cooling plates (2, 3, 4, 5) for a trickle device out of which the liquid to be cooled can flow in the form of a thin film over the outer surfaces of the cooling plates and can finally reach a collecting tank under the bottom edges of the cooling plates, characterized in that:
the supply pipe (6) for cooling medium is situated essentially centrally below the bottom edges of the cooling plates and is connected to the inside of each cooling plate by means of vertical pipe lengths (11, 12);
the discharge for evaporated cooling medium comprises two discharge pipes (7, 8), one near each top corner of the cooling plates;
the discharge pipes are connected to the cooling plates at the corners by elbow-type pipe lengths (13, 14);
the elbow-type pipe lengths are connected to the discharge pipes so that they are staggered relative to each other;
the vertical pipe lengths (11, 12) between supply pipe and bottom side of the cooling plates are connected to the supply pipe in staggered fashion;
all this being in such a way that the vertical pipe lengths and the elbow-type pipe lengths belonging to one cooling plate lie between those of the preceding or following plate.

2.Cooling device according to Claim 1, characterized in that the supply pipe and the discharge pipe are essentially the same as regards their diameter and the connection points of the respective pipe lengths.

3.Cooling device according to Claim 1 or 2, characterized in that the cooling plates are identical and are alternately displaced laterally relative to each other.

4.Cooling device according to Claim 1, 2 or 3, characterized in that the cooling plates are identical and are alternately displaced relative to each other in the vertical direction.

5.Cooling device according to Claim 4, in which the cooling plates have collecting chambers or pipes at the top and/or bottom, characterized in that these are staggered relative to each other.

6.Cooling device according to one or more of the preceding claims, characterized in that the cooling plates are two thin plates, which are connected to each other along the vertical edges to form one unit, for example by welding, which are connected along the top and bottom edge to collecting pipes, forming a continuous connection between the inside of the cooling plates and said pipes, and which have weld points between them, uniformly distributed over the surface of the two plates, these plates being pressed apart by means of internal excess pressure in the areas between

the connection points after the joins have been made.

fig-1

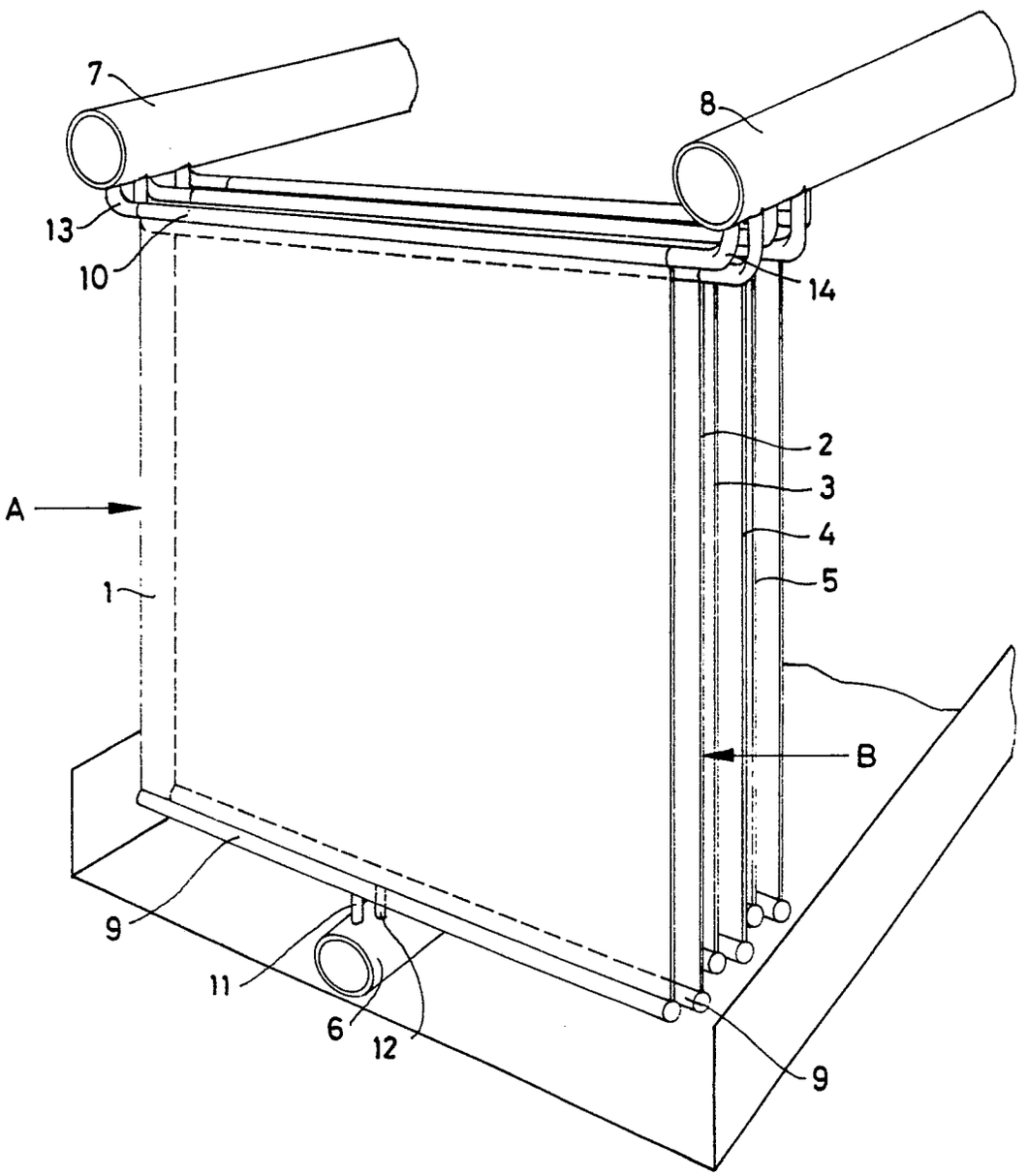


Fig-2

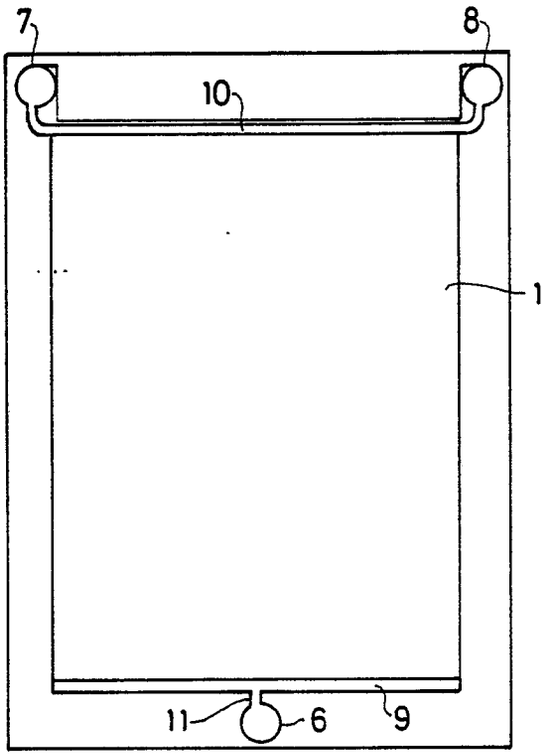


Fig-3

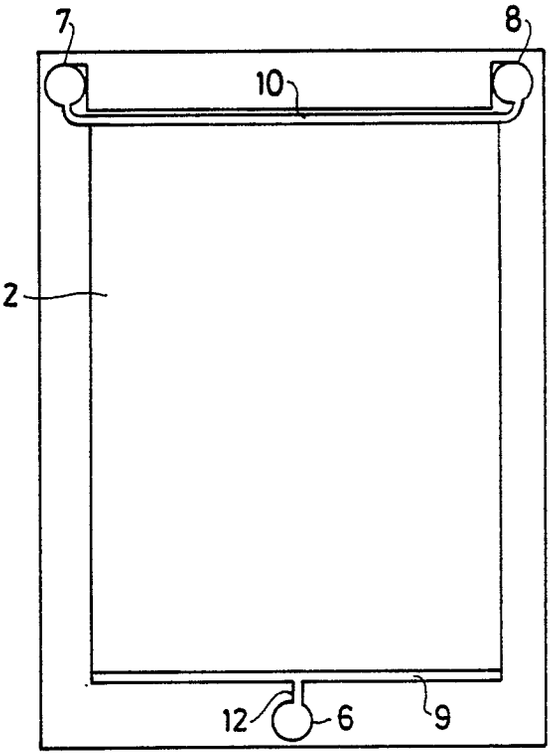


Fig-4

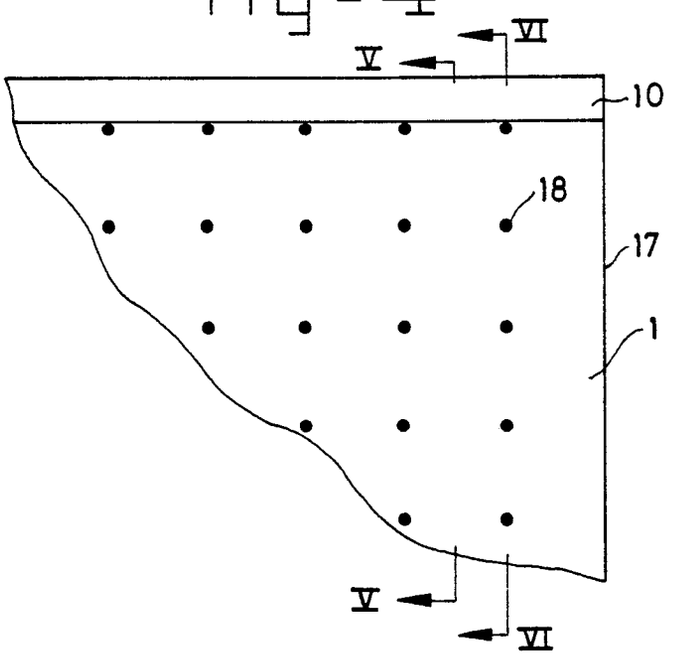


Fig-5

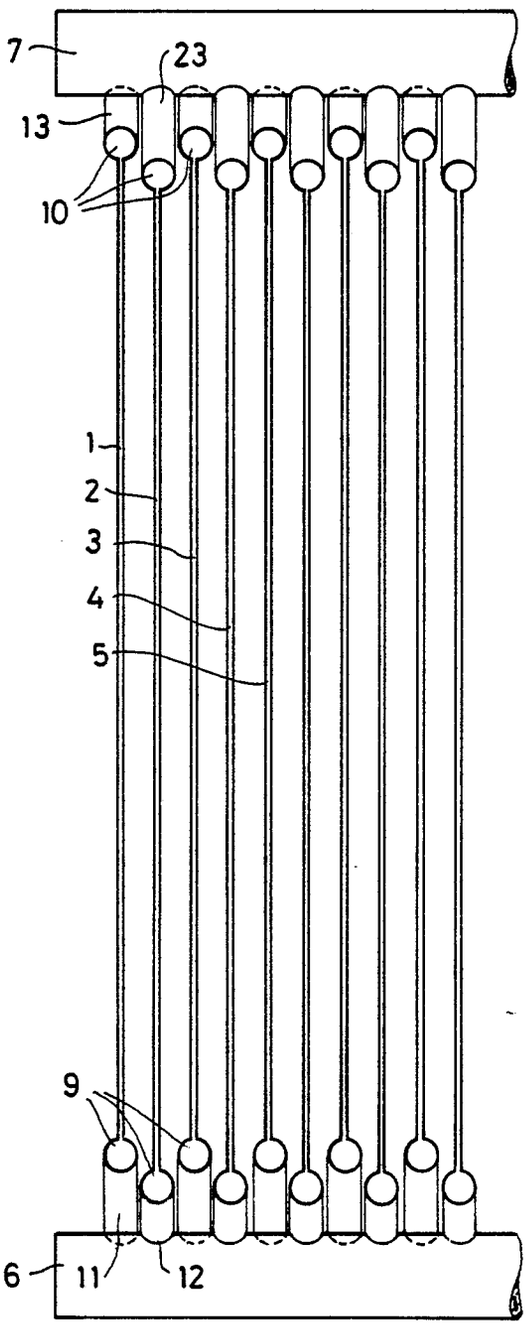


Fig-6

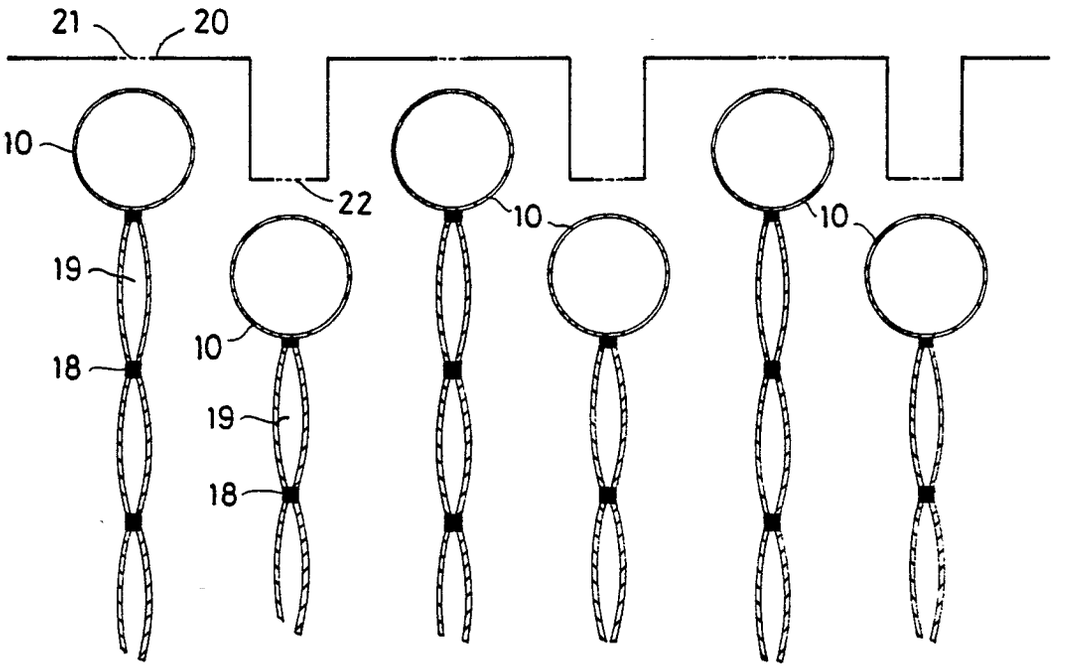
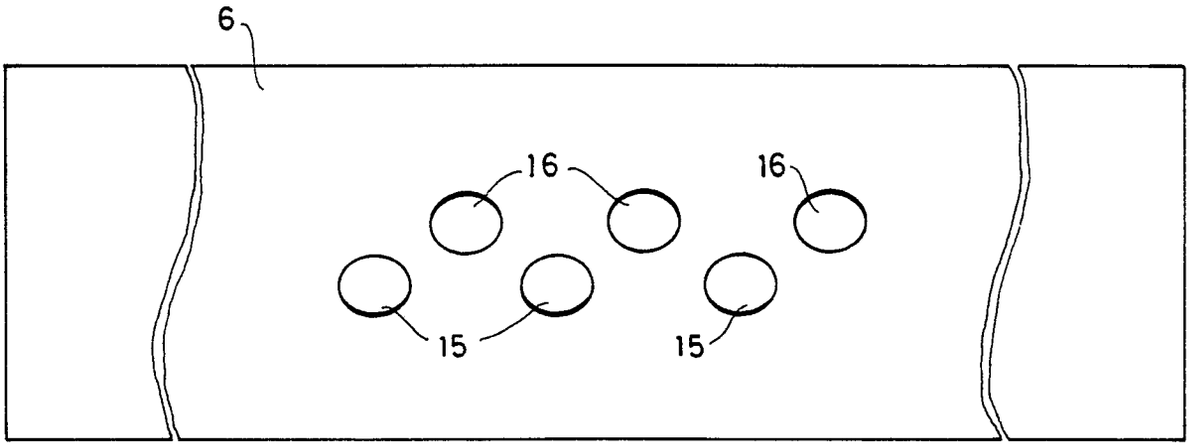


Fig-7



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EUROPEAN SEARCH REPORT

Application Number

EP 89 20 0459

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.4)
D,A	DE-A-3 306 865 (BURMESTER) * Pages 13-20; figures 1-3 *	1,6	F 25 B 39/02 F 28 D 3/00
A	FR-A-2 013 898 (LINDE) * Page 6, line 8 - page 11, line 4; figures 3-9 *	1,3,5	
A	DE-B-1 139 136 (BURMESTER) * Column 3, line 16 - column 4, line 38; figures 1-9 *	1,3	
A	DE-A-3 147 373 (BURMESTER) * Page 8, paragraph 2 - page 9, last paragraph; figures 1,2 *	1,6	
A	FR-A-2 334 932 (USSI) * Page 3, line 3 - page 8, line 37; figures 1-12 *	1	
A	DE-C-3 507 203 (DEC ENGINEERING) * Column 4, lines 6-37; figures 1,2 *	1,6	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A	US-A-1 712 085 (LITLE) * Page 1, lines 43-93; figures 1-9 *	6	F 25 B F 28 D F 28 F
A	US-A-2 383 292 (DALZELL)		
A	DE-B-1 063 616 (BURMESTER)		
A	US-A-1 743 896 (KUSEL)		
A	DE-C- 667 596 (WENZL)		
A	GB-A-1 286 446 (BURMESTER)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26-05-1989	BOETS A.F.J.

CATEGORY OF CITED DOCUMENTS

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