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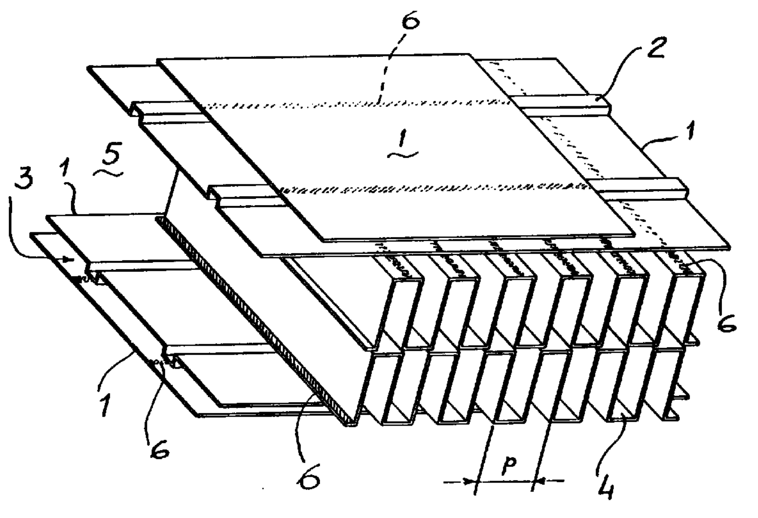
(54) A plate-type heat exchanger

(57) Each couple of plates (1) defines a first canal (3) for a fluid under pressure by means of welded ribbing (2) that distance and reinforce the plates (1) and are parallel to the flow of said fluid and bears a continuous fin with a wave shape (4) perpendicular to the direction of said fluid, welded on each of its external surfaces, to define a second canal (5) for a second fluid associated to an opposite and equal fin (4) borne on a plate (1) of an adjacent couple, each couple of plates being free from the others and hence that can be singly extracted from the exchanger.

Fig. 2



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Description

The invention concerns a plate-type heat exchanger.

Heat exchangers for fluids comprise an exchange surface that has the task of separating two fluids at different temperatures and to allow the passage of heat from the warmer fluid to the colder one. Generally, said exchange surface must be non permeable and ensures an adequate mechanical and corrosion resistance.

The state of the art includes exchange surfaces in the form of plane or undulated plates and in the form of plates and pipes sometimes finned to improve the heat exchange function. When a heat exchanger comprises batches of plates between which canals are defined, it is necessary to contrast the forces deriving from the presence of fluids under pressure within these canals by means of one or the other of these two solutions: the plates that define a canal under pressure may be linked together by welding round their perimeter and inside the canals; the plates may be bonded externally to the batch in various ways, for example by means of braced containment plates. With the first solution the plates become inseparable, while with the second the disassembly of single plates is possible.

Regarding the disadvantages of heat exchangers with plates, one must state that their use is often limited to cases with low pressure fluids, within a few kPa; when only one of the fluids reaches pressures up to 3000 kPa it is possible to conveniently realize large heat exchangers, but 1) with brazing-welded plates, also finned, but that cannot be disassembled, 2) or else with non finned plates in which couples of welded plates are stacked so as to be disassembled; in fact, in the latter case the fins cannot be realized because the plates are convex and the fins cannot be welded to them; consequently the compactness and weight of such heat exchangers is penalized.

Regarding the disadvantages of pipe heat exchangers, note that they have a relatively low ratio between heat exchange surface and their global volume unless one accepts the high economic costs for the production of highly compact finned pipe nests.

The invention as characterized in the claims herein, obviates such disadvantages of the state of the art.

The following description will intend - fluid under pressure - as a first fluid at pressures up to 3000 kPa, higher than that of a second fluid at a pressure of only a few kPa.

The plate-type heat exchanger invented conventionally comprises a number of parallel plates within casing to define a group of first canals for the passage of a first fluid under pressure and, in a novel way, a group of second canals for the passage of a second fluid and each couple of plates that define a first canal bear ribbings on the internal surface that define the flow path of the first fluid, distanced from one another and solid with both plates of the couple and welded to each external surface of the two plates bear a continuous welded fin the section of which is sensibly in the shape of a wave set perpendicularly to the flow of the second fluid and extends within a second canal towards a similar fin borne by an opposite plate of an adjacent couple of plates.

The peaks of the fins that extend into the same second canal barely touch or are slightly distanced.

It is clear, in this way, that the heat exchanger includes within its casing a "batch" made up of single couples of plates with internal ribbing and two fins borne externally, each couple of plates being mechanically independent from the adjacent ones and, hence, free to be removed from the casing.

It is also understood that the width of the first and second canals, that is the layers of fluids or the distance between plates, may be freely chosen in order to achieve an optimum speed for each fluid; it is also understood that the shape of the fin wave is preferably in the form of an "aligreek" and that the offset between the two facing fins will preferably correspond to the p/2 half-pitch, but that said shape may also be different and the offset may also differ from the p/2 half-pitch.

The main advantages offered by the heat exchanger invented are a solution to the adoption of this type of heat exchanger in some large industrial applications. These main advantages are listed below.

- Although the plates are very large, up to about ten square meters, are able to withstand high pressures, up to some tens of bar, thanks to the fact that they are coupled by means of internal welded ribbings and to the fact that they are further reinforced by the external ribbing made up by the fins that are also welded;
- for the first time in the history of large industrial heat exchangers, these may be completely and easily extracted in couples from their casing;
- the fins also perform a mechanical function being welded to the plates; the flexing of the plates is impeded and, therefore, they may be less thick than the corresponding conventional plates, or, keeping the thicknesses of the conventional plates, the pitch of the ribbings can be increased;
- the plates mainly perform the task of separating the fluids and providing the mechanical and corrosion resistance, while the fins mainly provide the heat transmission; this allows the use of economical carbon steels with high heat transmission coefficient for the fins, while the plates will be made in stainless steels with a dilation coefficient sensibly equal to that of the carbon steel used for the fins (e.g. AISI 400 series stainless steel);
- the use of relatively economical materials strongly cut down the costs for this type of exchangers, thus, in a manufacturing context, making them more economical than those currently common;
- a further reason of convenience, in addition to economic ones, lies in the fact that at equal powers exchanged, this exchanger implies significantly

smaller sizes and weights compared to solutions generally adopted.

The invention will be described in further detail below with an embodiment and with reference to the figures in which

- Fig. 1 is a first cross-section,
- Fig. 2 is a second cross-section,
- Fig. 3 is a front view perspective,
- Fig. 4 illustrates a construction detail.

Fig. 1 shows finned plates 1 that define three canals 3 for water under pressure and two canals 5 for gas or liquid fuels combustion smokes, perpendicular to one another;on one side of one of the two plates 1 that define a canal 3 there are ribbings 2 that define the three canals 3 vertically for the water under pressure and, on the other side, fins 4 are welded that, associated with equal fins 4 welded to an opposite plate, define the two horizontal canals 5 for the smoke; in this case the canals 3 for water under pressure have a very small thickness, defined by the vertical ribbings 2 that, being solid with the opposite plates 1, ensure that the couple of plates resist the water pressure. The fins 4 on the gas-side ensure that the plates do not deform between the ribs 2 on the water-side. Each fin 4 gas-side is brazing-welded on a single plate 1, so as to ensure the possibility of slipping out from the batch of plates each single water canal 3 with the relative fins 4 on the two sides. The contact between opposite fins 4 facing onto the same canal for gas under pressure is not necessary. Rather, it might be an obstacle to extracting the elements making up the single canals for water under pressure 3 if it weren't possible to slightly "open" the batch of plates.

Also the shape of the fins 4 is of little importance. The rectangular or "aligreek" shape illustrated is the simplest one that might minimize the production costs of gas canals 5.

Fig. 2 highlights the brazing-welds 6 required for the production of the exchanger plates. The welds bear on:

- the joining zones between the plate couples 1 that define the canals 3 for water under pressure (joining zones defined by the ribbings 2 made on the same plates),
- the contact surface of fins 4 on the relative plates 1.

As can be noted, there is no weld joining opposite fins 4.

With p̲ the pitch of fins 4 has been defined and one can note that fins opposite one another, that is facing one towards the other in a canal 5, are offset by p̲/2. The offset of opposite fins 4 is useful with the rectangular geometry illustrated, but may be superfluous with other geometries, for example if the peaks of the fins were markedly concave or convex, rather than flat.

Fig. 3 shows a small size plate-type heat exchanger 1 complete with casing 7, the thermo-insulating pad of material 8 that covers the batch of plates 9, the pipes 11 for the intake of water under pressure, pipes 12 for the outlet of water under pressure and flange 13 for connecting to the plant. Each of the pipes 11, 12 has a cap 14 at one end. In the plate batch 9 the canals 3 for water under pressure and smoke canals 5 are outlined.

Fig. 4 shows a sketch of one method for realizing the hydraulic connection between a pipe 11 for the intake of water under pressure and each, single, canal 3 between two plates 1; on the external side of each plate 1 the fins 4 are visible; the pipe 11 bears a loop-hole 15 corresponding to each opening 16 between said two plates 1; from loop-hole 15 and through opening 16 the water under pressure flows into canal 3.

Claims

1. A plate-type heat exchanger (1) comprising a number of plates (1) parallel to one another within a casing (7) so as to define a group of first canals (3) for the passage of a first fluid under pressure and a group of second canals (5) for the passage of a second fluid, the inclination between the two groups of canals can be any, but preferably at 90°, **characterized** in that each couple of plates (1) that define a first canal (3) bears on its internal surface of the same canal ribbings (2) parallel to one another and to the flow of the first fluid, distanced from one another and solid to both plates (1) and welded on each external surface bears a continuous fin (4) that has a wave shaped section generally in a direction perpendicular to the direction of the first fluid and extends into a second canal (5) towards an equal fin (4) borne on an opposite plate (1) of an adjacent couple of plates.

2. A plate-type heat exchanger according to claim 1 characterized in that the peaks of the two fins (4) facing each other within each second canal (5) are simply in contact with one another.

3. A plate-type heat exchanger according to claim 1 characterized in that the peaks of the two fins (4) facing one another within each second canal (5) are slightly distant from one another.

4. A plate-type heat exchanger according to claims 1, 2, and 3 characterized in that the peaks of the two fins (4) facing one another within each second canal (5) are offset.

5. A plate-type heat exchanger according to claim 4 characterized in that the shape of the fin (4) wave has a constant pitch (p̲) and the peaks of the fins (4) facing one another within each second canal (5) are offset by half of the wave pitch (p̲).

6. A plate type heat exchanger according to the previous claims characterized in that the fins (4) are made of high heat conductivity carbon steel and the plates (1) are of stainless steel with an expansion coefficient sensibly equal to that of said carbon steel.

Fig. 1

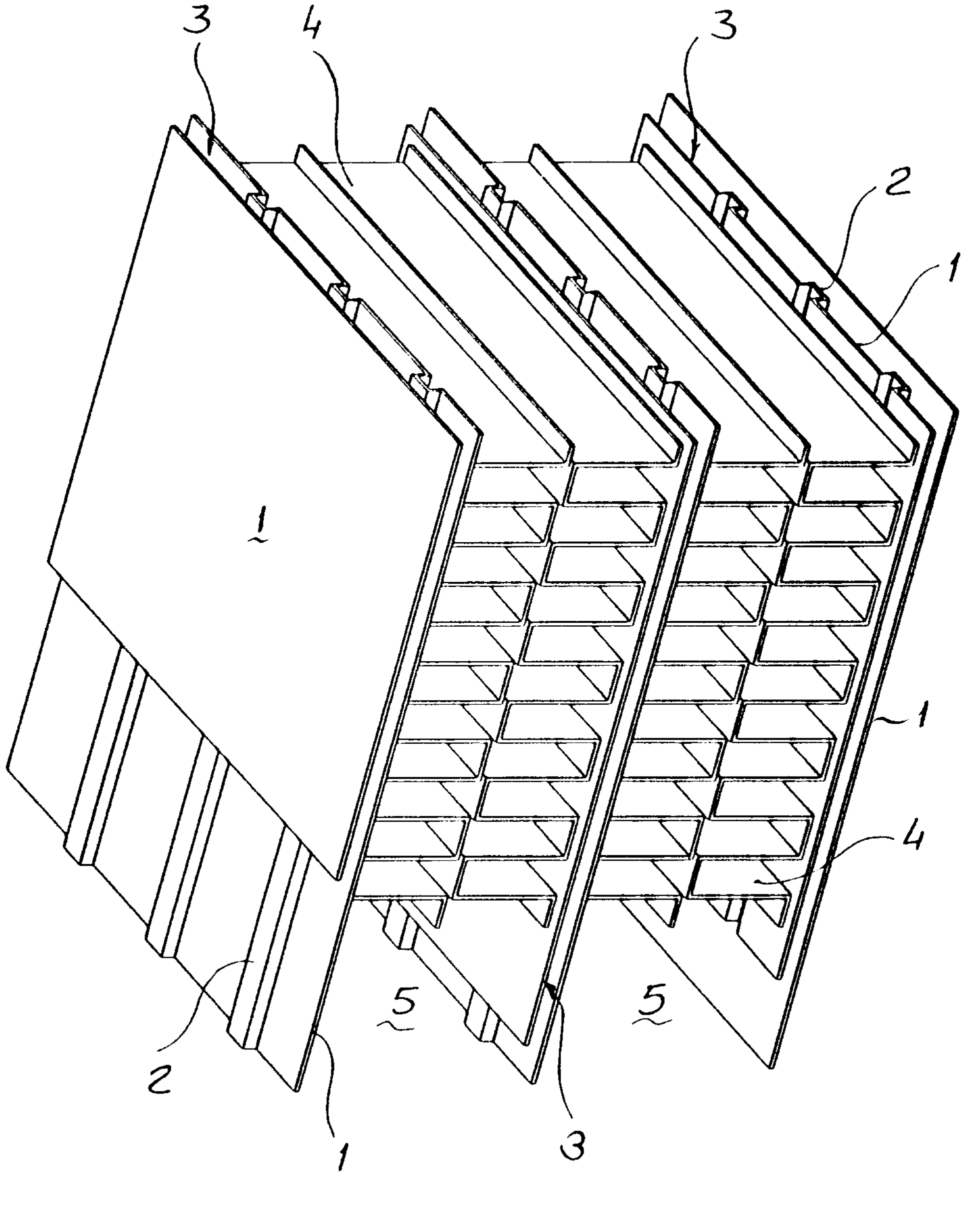
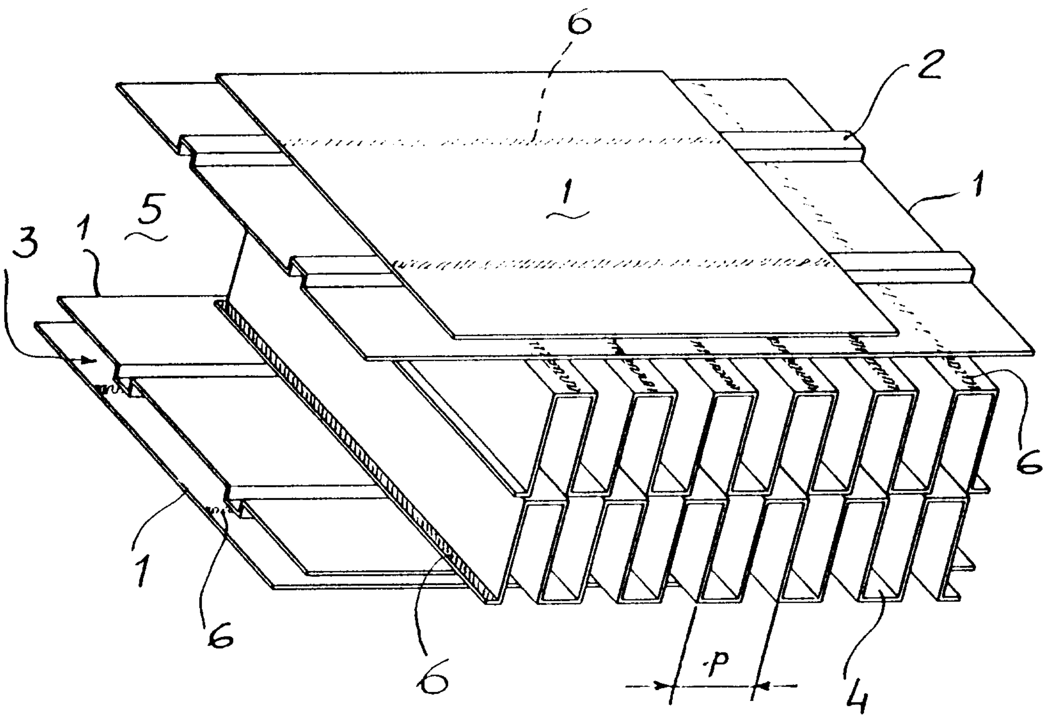


Fig. 2



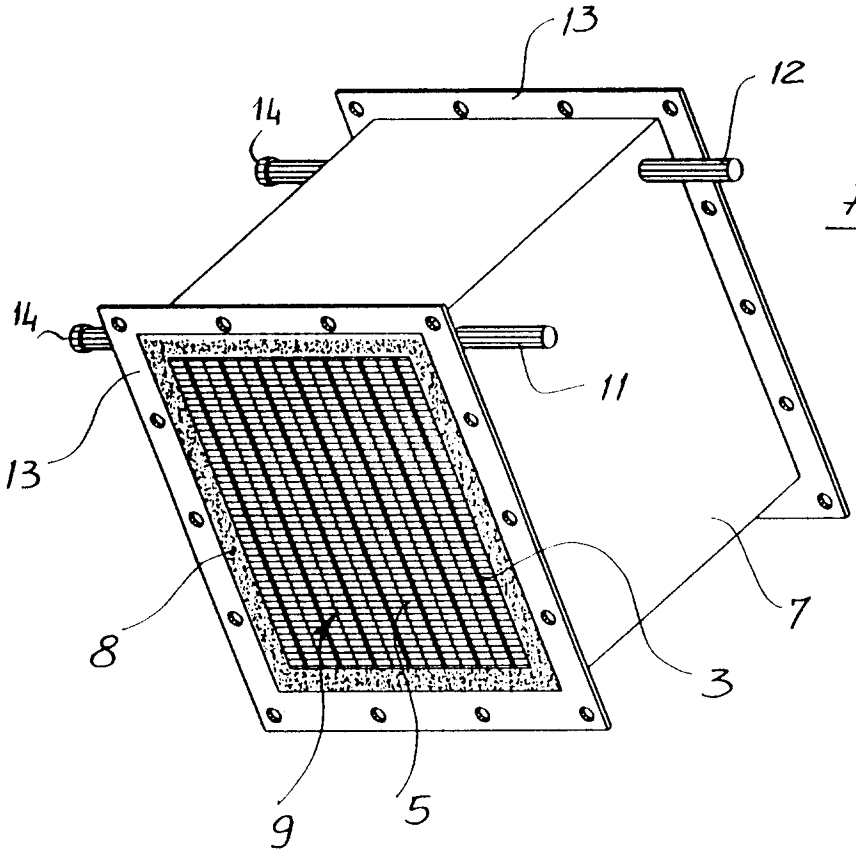


Fig. 3

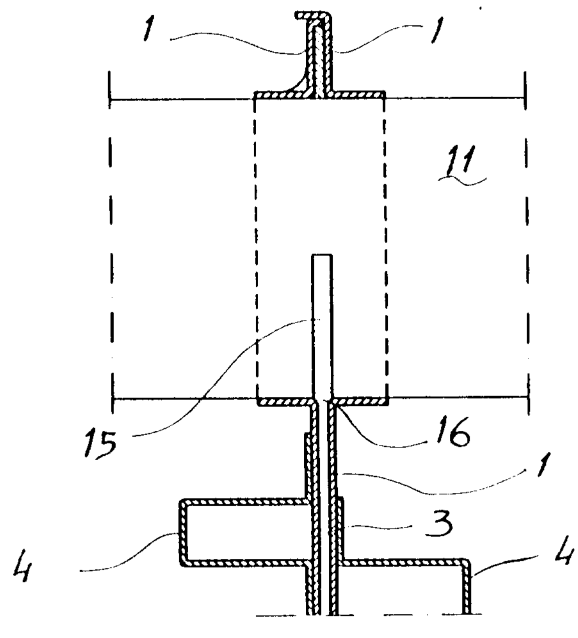


Fig. 4