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PLATE TYPE HEAT EXCHANGERS WITH PAIRS OF SPACED
PLATES AND CORRUGATED INSERTS

3,166,122

Filed March 11, 1963

2 Sheets-Sheet 1

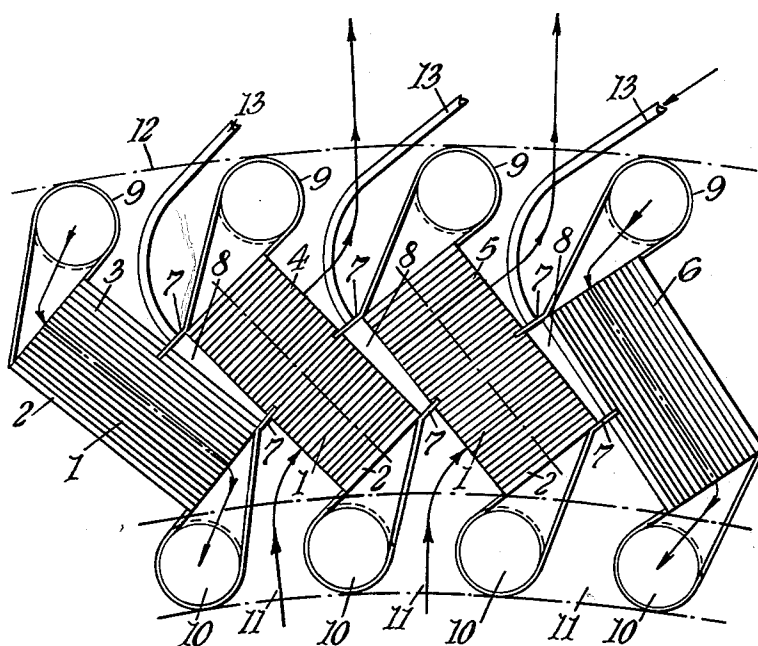


Fig. 1.

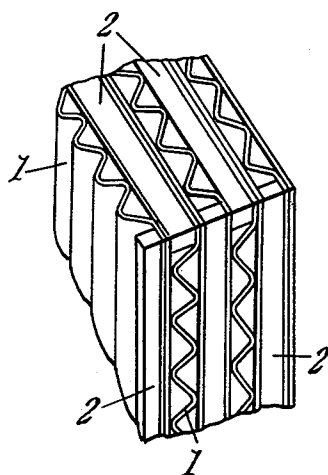


Fig. 3.

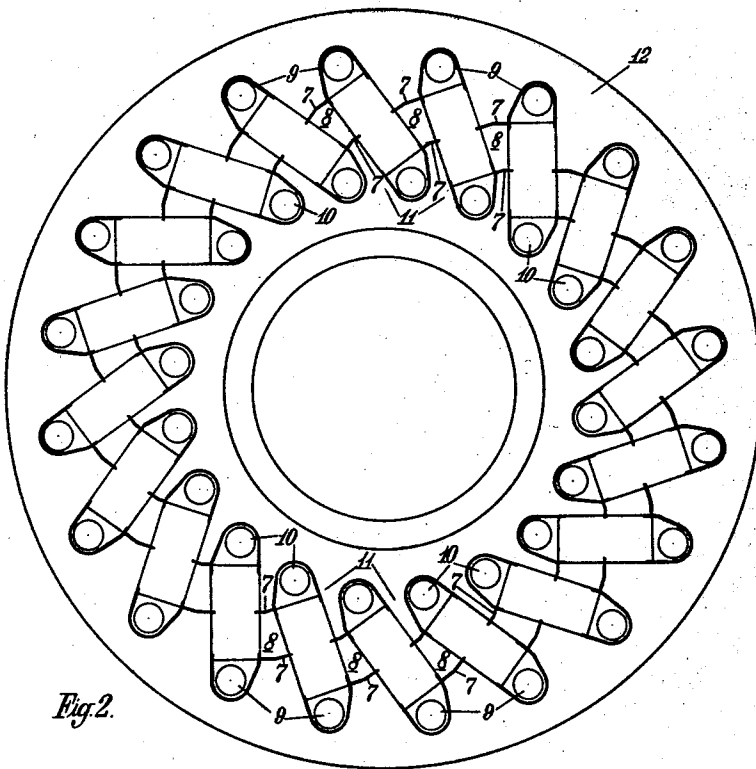
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PLATE TYPE HEAT EXCHANGERS WITH PAIRS OF SPACED PLATES AND CORRUGATED INSERTS

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5 Claims. (Cl. 165—139)

This invention relates to plate-type heat exchangers of the kind in which pairs of spaced plates or sheets have corrugated inserts located between them, flow channels for heat exchanging fluids being formed between each pair of sheets, flow channels for hot fluid alternating with flow channels for cold fluid.

Such heat exchangers can be classified into two main groups, namely (a) those in which the heat exchanging fluids flow through the main heat exchanging part of the respective flow channels in directions substantially at right angles to one another usually called "cross-flow" and (b) those in which the fluids flow through the main heat exchanging part of the flow channels in directions substantially parallel to one another but in opposite sense, usually called "counterflow" heat exchangers.

The cross flow type lends itself to simple construction from the manufacturing view point, especially by making the shape rectangular or square as in this case inlet and outlet headers for one fluid can be on two opposed sides of the rectangle or square whilst those for the other fluid can be on the other two opposed sides of the rectangle or square. With the counterflow type the header arrangements are not so straightforward. Considering the rectangular or square form, which is the best from the point of view of ease of manufacture and economy in the use of material, inlet and outlet headers must be arranged on only two opposed faces.

The cross-flow type is therefore simpler to make, although it does not give such good heat transfer as the counterflow type. This disparity in heat transfer between the two types can be reduced by causing one of the fluids in the cross-flow type to flow in a "double pass" arrangement. In this arrangement the flow channels for one fluid are each divided into two separate channels parallel to the direction of flow. In a conventional double pass cross flow heat exchanger fluid flows through one half of the channel, has its direction of flow reversed and then flows through the other half of the channel.

The adoption of the conventional double pass arrangement does complicate the construction of the heat exchanger, and the need to reverse the flow of fluid leads to an increased pressure drop which may be critical if the heat exchanger is to be used say with gas turbines for vehicles.

The object of the present invention is to provide a plate type heat exchanger of the cross flow type in which a double pass arrangement is achieved in effect, but in which the need for a reversal of flow direction is avoided.

The invention, which is hereinafter defined in the claims, in brief consists of a plate type heat exchanger comprising a plurality of separate plate type heat exchanger elements each element comprising pairs of spaced plates or sheets with flow channels between each pair of sheets, corrugated inserts being disposed between each pair of sheets, the direction of the corrugations between one pair of sheets being at right angles to those between adjacent pairs of sheets, channels for hot fluid alternating with channels for cold fluid characterised in that the elements are disposed in a ring, and means directing one fluid through portions of two consecutive elements said fluid passing

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first through one element and then through the other element whilst the other fluid flows through only one element in a direction at right angles to the other fluid.

Referring to the accompanying drawings:

FIGURE 1 is a plan view of part of a plate type heat exchanger built up in accordance with one form of the present invention the heat exchange elements being shown in section,

FIGURE 2 shows the complete heat exchanger thereof but with slightly modified headers, and

FIG. 3 shows an oblique view of the plates of an element of FIG. 1, as assembled.

In carrying the invention into effect in the form illustrated by way of example and referring first to FIGURE 1 each heat exchange element is built up in a known way using a series of spaced flat sheets or plates a flow channel being formed between each pair of sheets. The sheets are spaced from one another by corrugated inserts 1. The corrugations of adjacent flow channels are at right angles to one another. The element thus becomes a cross-flow element with hot fluid flow channels alternating with cold fluid flow channels the two fluids flowing in directions at right angles to one another. The corrugated inserts shown in FIGS. 1 and 3 have side walls 2 along their ends, but this is not essential. The element thus formed is a conventional cross-flow element.

The heat exchanger is built up with a number of heat exchange elements arranged in a ring in staggered relationship as shown. Four elements 3-6 are shown in FIGURE 1 but as shown in FIGURE 2 other elements are disposed in similar fashion to complete a ring of elements. In FIGURE 2 each element lies at an angle to a radial plane and the plates lie in planes perpendicular to radial planes.

The elements are shown in section, the sections on elements 3 and 6 being through channels for one fluid and the sections on elements 4 and 5 being through channels for the other fluid. The elements are shown as having side walls 2 but as pointed out above this is not essential. With the staggered arrangement, part of element 4 overlaps a portion of element 3, part of element 5 overlaps a part of element 4, part of element 6 overlaps part of element 5 and so on. In this way one fluid flows through two consecutive elements whilst the other fluid flows through only one element in a direction at right angles to the direction of flow of the first mentioned fluid.

In this way the double pass system is achieved for one of the fluids without having to reverse its direction of flow.

The fluid may be directed in the desired path by the formation of walls 7 in adjacent sides of the elements. Each wall 7 extends from one end of the element and intersects one side of an adjacent element intermediate its ends as shown to form ducts 8 for the passage of fluid through a portion of one element and a portion of the next element.

Each element in the form shown has headers 9, 10 formed at each end thereof for the inlet and outlet of the fluid which flows through only one element. These headers may be formed from sheet material bent to the shape shown and brazed or otherwise bonded to the element. In one arrangement cold high pressure fluid would enter each element through inlet header 9 flow through flow channels of each element of the kind illustrated in elements 3 and 6 and leave via outlet header 10. Hot, low pressure fluid would enter spaces 11 from which it would flow through a portion of the flow channels of the kind shown in section in elements 4 and 5 and thence pass to a successive element. Thus fluid leaving a portion of element 4, the lower portion on the drawing, passes through duct 8 to enter flow channels of a portion of element 5 before leaving the heat exchanger through out-

let 12. Similarly hot fluid entering inlet 11 between elements 5 and 6 flows through a portion of element 5 and thence through a portion of element 6.

By arranging the elements in a ring the whole of each element is used as can be seen in FIGURE 2.

Provision may be made for cleaning air to be introduced into the flow channels through ducts 13 shown in FIGURE 1 opening into walls 7 if so desired.

The elements shown in FIGURE 2 are the same as those in FIGURE 1 except that the shapes of the headers 9 and 10 are slightly different. This, however, is not a critical feature. The headers 9 could be connected in parallel with a common duct and likewise the headers 10 could be connected in parallel with a common duct.

The heat exchanger by virtue of its ring or annular form is particularly suitable for use with gas turbine plants. The basic simplicity of the cross flow heat exchanger is maintained with the arrangement described and in addition a double pass arrangement is possible without reversal of flow direction.

The elements may be constructed using metal or ceramic materials.

While the elements have been described as arranged in a ring, this is not to be construed as in any way limiting the arrangement to a true circle, since almost any closed configuration such as an ellipse, a rectangle or a many sided polygonal configuration as well as a circle may be employed.

I claim:

1. A plate type heat exchanger comprising a plurality of separate plate type heat exchanger elements each element comprising pairs of spaced plates or sheets with flow channels between each pair of sheets, corrugated inserts being disposed between each pair of sheets, the direction of the corrugations between one pair of sheets being at right angles to those between adjacent pairs of sheets, channels for hot fluid alternating with channels for cold fluid, the elements being disposed in a ring, and means directing one fluid in substantially parallel streams through portions of two adjacent elements, each stream

passing first through one element and then through the other element in a substantially straight line, and means directing the other fluid only through each element connected in parallel with one another in a direction at substantially right angles to the first fluid.

2. A plate type heat exchanger as claimed in claim 1 in which the fluid directing means for said one fluid comprise walls formed between adjacent sides of the elements which walls extend from one end of an element to intersect one side of an adjacent element intermediate its ends to form ducts for the passage of fluid between a portion of an element and a portion of the next element.

3. A plate type heat exchanger as claimed in claim 1 in which each element is disposed at an angle to a radial plane with the sheets forming each element lying in a plane at right angles to the radial plane.

4. A plate type heat exchanger as claimed in claim 1 in which when the heat exchanger fluids are at different pressures, the high pressure fluid flowing through only one element and the lower pressure fluid through two consecutive elements between their respective inlet and outlets.

5. A plate type heat exchanger as claimed in claim 1 in which the fluid flowing through one element only is conveyed to and from an element by ducts bonded to the element.

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