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(54) PLATE HEAT EXCHANGER

5 (71) We, ALFA-LAVAL AB, a Swedish Corporate Body, of Postfack, S-147 00 Tumba, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

10 This invention relates to a method for the heat treatment of a fluid using a plate heat exchanger. It is known for a plate heat exchanger to have inlet and outlet passages formed by holes provided in the plates of the heat exchanger. A draw back of such
15 plate heat exchangers is that the inlet and outlet passages formed by holes in the plates present a relatively large flow resistance to the heat exchange medium.

20 According to the present invention there is provided a method for the heat treatment of a fluid medium in which the medium is passed without changing its phase through a plate heat exchanger, the plates of the heat exchanger having holes defining inlet and
25 outlet passage means through which the medium flows, the outlet passage means having throughout the length thereof a cross-sectional area larger than that of the inlet passage means, whereby resistance to
30 flow of the medium through the heat exchanger is reduced.

35 Compared with a known heat exchanger having inlet and outlet passages of the same cross-sectional areas, it has been found possible with a heat exchanger as required by the method in accordance with the invention to decrease the pressure drop across the heat exchanger by up to 25%
40 without the heat exchanging properties of the heat exchanger being substantially changed, and with the size of the heat exchange areas of the plates remaining unchanged. The medium under treatment may be heated or cooled during its passage
45 through the heat exchanger. The inlet and

outlet passage means preferably comprises passages having cross-sectional areas which are substantially constant along the lengths of the passages, whereby all the heat exchange plates have inlet holes of the same size and outlet holes of the same size, which is an obvious advantage in the production of the heat exchange plates. 50

The outlet passage means may comprise two or more passages, which allows all the inlet and outlet holes of the heat exchange plates to be of the same size, which can be of further advantage in the production of the heat exchange plates. 55

U. S. Patent 3,117,624 shows a plate heat exchanger in which the outlet holes of the heat exchange plates are made larger than the inlet holes because the heat exchange medium is evaporated, i.e. its phase is changed, between the inlet and outlet passages and the medium quite naturally requires passages of greater through flow area for the medium in evaporated state than in liquid state. 60

The invention in its presently preferred form is described in more detail below, by way of example, with reference to the accompanying drawings, in which: 70

Figure 1 is a longitudinal sectional view through a plate heat exchanger of a known structure; 75

Figure 2 is a longitudinal sectional view through a heat exchanger for use in the method according to the invention and taken along the line II-II in *Figure 3*; 80

Figure 3 shows a heat exchange plate as seen in the direction of arrows III-III in *Figure 2*;

Figure 4 is a graph illustrating how the pressure drop in the heat exchanger varies with the ratio between the cross sectional areas of the outlet and inlet passages; 85

Figure 5 shows an alternative form of heat exchange plate; and

Figure 6 shows a further form of heat 90

exchange plate with six holes.

The plate heat exchanger of known construction shown in Figure 1 comprises a plurality of heat exchange plates 1, which are arranged between two end elements 2 and 3, respectively, and which confine a number of first heat exchange passages 4 for a first medium and a number of second heat exchange passages 5 for a second medium, heat being exchanged between the media through the plates 1. The first medium is introduced into the heat exchanger through an inlet conduit 6 and is then distributed among the different heat exchange passages 4 by an inlet passage 7, which is formed by inlet holes 8 in the plates and, along its length, has a substantially constant cross sectional area. When the first medium has passed through the passages 4 it is collected in an outlet passage 9 formed by outlet holes 10 in the plates and also having a substantially constant cross sectional area along its length. The first medium leaves the outlet passage 9 and heat exchanger through an outlet conduit 11. The second medium flows in analogous way through an inlet conduit, an inlet passage, the heat exchange passages 5, an outlet passage and an outlet conduit, only the passage 5 being shown in Figure 1. Seals 12 are arranged in a known way between the plates to distribute the media between the different heat exchange passages and to prevent the media leaking out of the heat exchanger. The inlet passage 7 has the same cross sectional area as the outlet passage 9 and in use of the known heat exchanger, the medium under treatment is not intended to change its phase during its passage through the heat exchanger, e.g. to remain in liquid state.

The heat exchanger of Figures 2 and 3 differs from that of Figure 1 insofar as the outlet passage 9A, and hence each outlet hole 10A, has a cross sectional area which is substantially larger than the cross sectional area of the inlet passage 7A, and the inlet holes 8A. By this the pressure drop in the medium across the heat exchanger can be reduced while the heat exchange area of the plates 1 is maintained, the medium passing through the heat exchanger without changing its phase.

Figure 4 shows how the pressure drop Δp can vary, when the ratio $\frac{A_2}{A_1}$ is changed. Δp decreases by about 25% when $\frac{A_2}{A_1}$ increases to about 1.8. At $\frac{A_2}{A_1} = 2.8$ Δp has again increased to the same value as at $\frac{A_2}{A_1} = 1$. A_2 is the cross sectional area of the outlet passage 9A and A_1 is the cross sectional area of the inlet passage 7A. The curve in Figure 4 applies where $A_1 + A_2 = C$, where C is a constant, and the flow rate of the medium, through the heat exchanger is the same for all A_1 and A_2 .

The plates of the heat exchanger can be of

different configuration. Figure 5 shows a plate arrangement, in which the inlet holes 8A and the outlet holes 10A for each medium are located at adjacent corners rather than diagonally opposite ones. A first medium flow 13 exchanges heat with a second medium flow 14 through plates 1, the outlet holes 10A of which are of the same size for the two media and are substantially larger than the inlet holes 8A, which are also of the same size for the two media. The heat exchange passages between the plates are confined laterally by the seals 12.

In the plate arrangement of Figure 6, each plate 1 is provided with six holes of the same size. At outlet passage of larger area than the inlet passage is obtained by arranging the seals 12 so that two holes 10A serve as outlet holes and one hole 8A as inlet hole for each medium. As a result the cross sectional area of the outlet passage, which thus consists of two channels, is twice that of the inlet passage, which consists of one channel.

The arrangements shown in Figures 2, 3, 5 and 6 lead to decreased pressure drops across the heat exchanger both heat exchanging media, passed through the heat exchanger without changing in phase, although it is possible to arrange for the outlet passage for only one of the media to be greater in through flow area than its inlet passage. For instance in the described heat exchangers the roles of the inlet and outlet passages for the second medium could be reversed, e.g. if this second medium enters the heat exchanger in a vapour state and then leaves the heat exchanger in liquid state.

In known heat exchangers, as shown in Figure 1, special pipe couplings 15 and 16 are often required at the inlet and outlet, respectively, of the heat exchanger to ensure a smooth transition with the inlet and outlet conduits 6 and 11, respectively, which usually are dimensioned for a flow velocity of 2-4 m/s, whereas the connections of the heat exchanger are usually dimensioned for a higher flow velocity, of 5-8 m/s. A larger outlet passage will be better adapted to the diameter of the outlet conduit, and in many cases a special pipe coupling between the conduit 11 and the heat exchanger is no longer required, as seen in Figure 2.

WHAT WE CLAIM IS:-

1. A method for the heat treatment of a fluid medium in which the medium is passed without changing its phase through a plate heat exchanger, the plates of the heat exchanger having holes defining inlet and outlet passage means through which the medium flows, the outlet passage means having throughout the length thereof a cross-sectional area larger than that of the

inlet passage means, whereby resistance to flow of the medium through the heat exchanger is reduced.

5 2. A method according to claim 1, wherein the inlet and outlet passage means comprise passages of constant cross-sectional area.

10 3. A method according to claim 1 or 2, wherein the outlet passage means consists of a plurality of passages.

4. A method for the heat treatment of a fluid medium according to claim 1 and substantially as herein described.

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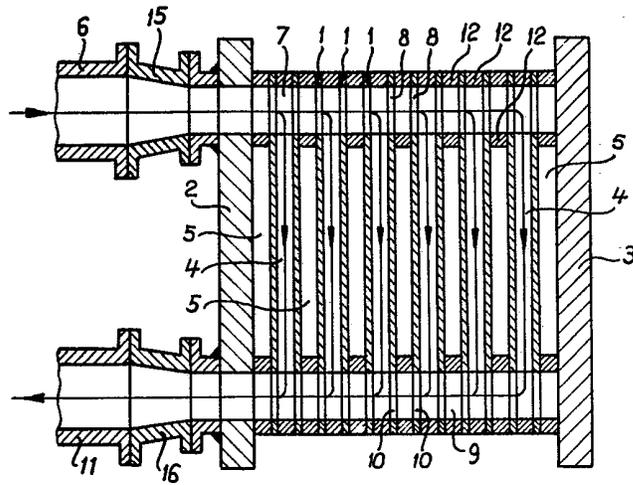


Fig. 1

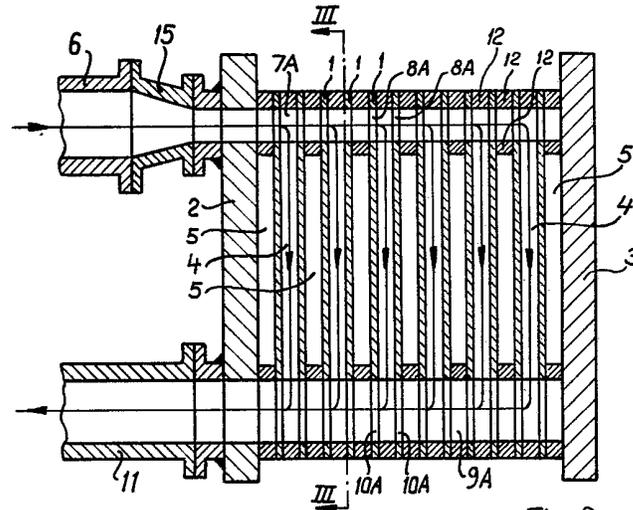


Fig. 2

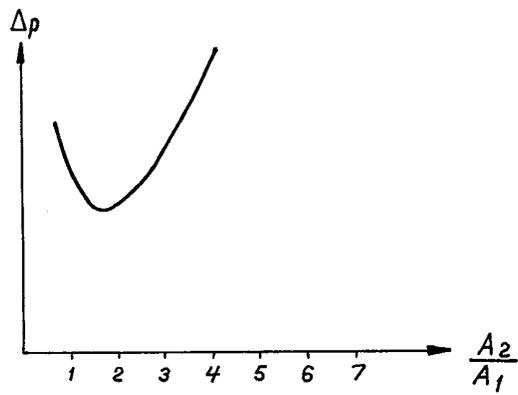
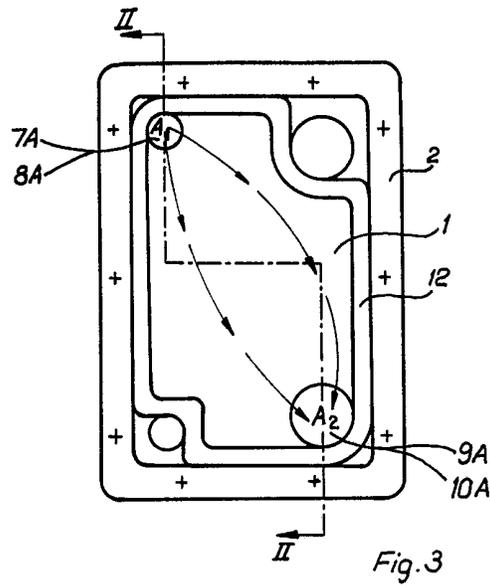


Fig. 4

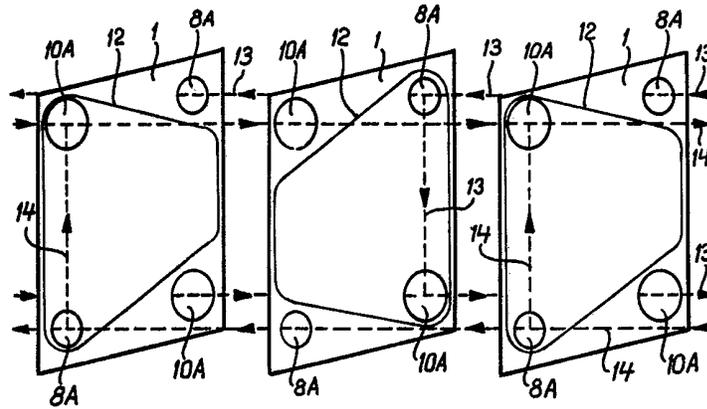


Fig. 5

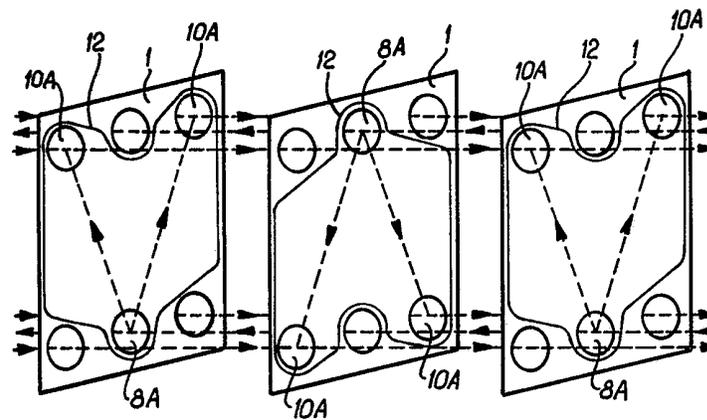


Fig. 6