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(54) **HEAT EXCHANGER**

(57) A heat exchanger module (2) is disclosed. The heat exchanger module (2) is configured to exchange heat between a first fluid and a second fluid. The heat exchanger module (2) comprises an array (12) comprising a plurality of pairs of pipe members (4, 6). Each pair of pipe members (4, 6) comprises a first pipe member (4) and a second pipe member (6) arranged in thermal contact with each other for heat exchange between a first

fluid flowing in the first pipe member (4) and a second fluid flowing in the second pipe member (6). The array (12) comprises a plurality of rows each comprising a pair of pipe members (4, 6). The heat exchanger module (2) comprises a number of connection members (14, 14') connecting pipe members (4, 6) of different rows. The connection members (14, 14') do not protrude radially from the array (12).

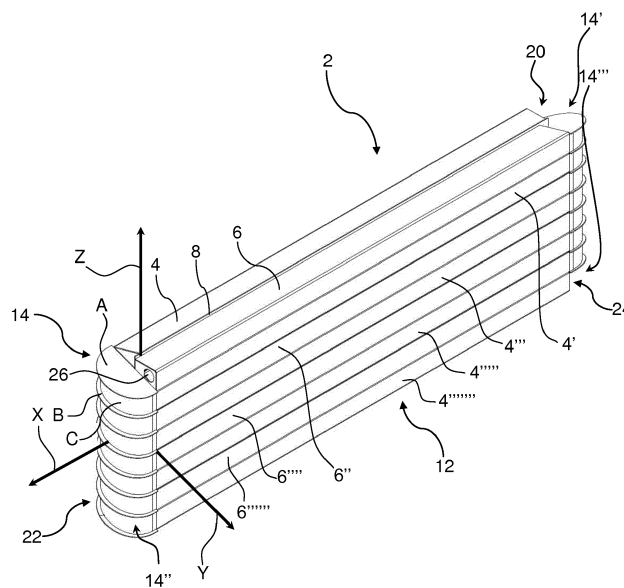


Fig. 1

Description**Field of invention**

[0001] The present invention relates to a heat exchanger module and a heat exchanger system comprising it. The heat exchanger module and the heat exchanger system are configured to exchange heat between a different media (a first fluid and a second fluid). The heat exchanger module may be used for preheating media, such as liquid manure, industrial process water, sludge and/or ooze, intended to be used in a process e.g. for biogas production.

Prior art

[0002] Since energy is a limited resource, it is important that industrial companies reduce the energy waste in their production pipeline. Heat exchangers are normally applied to reuse energy and the use of heat exchangers therefore limits the amount of energy wasted in production pipelines. Heat exchangers may exchange heat between different media in such a manner that heat energy from waste materials may be used to heat starting materials or products before entering the production pipeline. Accordingly, the application of heat exchangers can reduce the energy needed for carrying out the production.

[0003] It is known to build heat exchangers that comprise pipes having rectangular cross sections as disclosed in EP 1957924. However, it is a great challenge to connect the distal ends of these rectangular pipes in such a manner that the media flowing inside the pipes does not clog within the connection members inside the pipes. The invention disclosed in EP 1957924 overcomes this obstacle by connecting connection members (connection pipes) to the distal portions of the rectangular pipes. These connection pipes, however, protrude radially outwards from the heat exchanger. Accordingly, this solution increases the width of the heat exchanger in an unintentional manner. Moreover, the solution presented in EP 1957924 is rather complex to produce.

[0004] Thus, it would be advantageous to provide a heat exchanger module having a smaller width and a construction that prevents the pipes from clogging.

[0005] It is an object of the invention to provide a heat exchanger module that is thinner than the prior art heat exchangers and that comprises no protruding parts.

[0006] It is also an object of the present invention to provide a heat exchanger in which the cross-sectional area of the connection members equals the cross-sectional area of the pipes.

[0007] Furthermore, it is an object of the present invention to provide a heat exchanger that can be electro-polished and in which all weldings are controllable.

Summary of the invention

[0008] The object of the present invention can be achieved by a heat exchanger module having the features as defined in claim 1. Preferred embodiments are defined in the dependent sub claims and explained in the following description and illustrated in the accompanying drawings.

[0009] The heat exchanger module according to the invention is a heat exchanger module configured to exchange heat between a first fluid and a second fluid, in which the heat exchanger module comprises an array comprising a plurality of pairs of pipe members, where each pair of pipe members comprises a first pipe member and a second pipe member is arranged in thermal contact with each other for heat exchange between a first fluid flowing in the first pipe member and a second fluid flowing in the second pipe member, where the array comprises a plurality of rows each comprising a pair of pipe members, where the heat exchanger module comprises a number of connection members connecting pipe members of different rows, where the connection members do not protrude radially from the array.

[0010] Hereby it is possible to provide a heat exchanger module that is thinner than the prior art heat exchangers and that comprises no protruding parts.

[0011] Moreover is possible to provide a heat exchanger module that can be electro-polished due to the design of the connection members. Furthermore, all weldings of the heat exchanger module can be controlled.

[0012] The term first fluid and second fluid is understood as any substance that flows. The fluid may be a liquid, gasses, or plasma or a combination. If the fluid is a liquid particles or gasses may be suspended in the liquid. Examples of fluids are water, liquid manure, industrial process water, sludge and ooze. The composition of the first fluid and the second fluid may be identical, but in some embodiments, it is advantageous to have a different composition of the first fluid and the second fluid.

[0013] The term array is understood as the arrangement of pipe members. Advantageously, the pipe members are arranged in such a manner that the array comprises two columns and at least two sets of rows each having a pair of pipe members.

[0014] It may be an advantage that the pipe members in each row extend parallel to each other.

[0015] Beneficially, the pipe members are arranged in such a manner that the array comprises two columns and at least four, preferably eight or more rows. Each pipe member comprises a first end and a second end.

[0016] In one embodiment the array comprises eight rows each comprising a pair of pipe members.

[0017] The pipe members may consist of either a first pipe member or a second pipe member. Each row comprises a first pipe member and a second pipe member. The pipe members in each column are arranged in such a manner that no first pipe member is located adjacent to another first pipe member, and no second pipe member is located adjacent to another second pipe member. This arrangement creates a pattern in the two columns of the array in which a first pipe member is arranged diagonally to another first pipe member, and a second pipe member is arranged diagonal to another second pipe member.

[0018] A first fluid is flowing in the first pipe members, whereas a second fluid is flowing in the second pipe members. In order to carry out heat exchange, the two fluids need to have different temperatures.

[0019] The first fluid may have a higher temperature than the second fluid. Likewise, the second fluid may have a higher temperature, than the first fluid.

[0020] The first pipe member and the second pipe member are arranged in thermal contact with each other in order to facilitate optimum heat exchange between the first pipe member and the second pipe member.

[0021] To ease the production of the heat exchange, a center plate may be arranged between the two columns.

[0022] It may be an advantage that the heat exchanger module comprises a center plate arranged between the first pipe member and the second pipe member in each row.

[0023] Preferably the center plate is plane.

[0024] It may be advantageous that the center plate is made in a heat conducting material, for example a metal, and that the center plate is provided between each pair of pipes or constitutes a wall shared by the pipe members in each row.

[0025] It may be beneficial that the center plate is made of steel.

[0026] In a preferred embodiment, the center plate is planar and extends along the longitudinal axis of the heat exchanger module. Hereby, it is achieved that the heat exchanger module has an optimum overall shape.

[0027] It may be an advantage that the heat exchanger module comprises a center plate comprising one metal sheet, which is planar and extends both along the longitudinal axis of the array and through the central portion of the array of the heat exchanger module. The center plate may constitute part of the pipe members.

[0028] Beneficially, the first pipe members and/or the second pipe members are attached to the center plate by welding or moulding.

[0029] Advantageously, the first pipe member and/or the second pipe member have a rectangular cross section.

[0030] Hereby, pipe members are easy to stack onto each other and a large contact area between adjacent pipe members is achieved. Accordingly the efficiency of the heat exchanger may be improved.

[0031] It may be an advantage that the center plate constitutes a portion of each pipe member in such a manner that one of the sides of each pipe member is a portion of the center plate.

[0032] It may be an advantage that the heat exchanger module is constructed by welding a plurality of mutually distanced pipe member portions having a U-shaped cross-sectional area to the center plate and connecting the adjacent pipe members by plates welded to the pipe members.

[0033] Both the first pipe member and the second pipe member are attached to a connection member. The connection members ensure that the first fluid enters a first pipe member from another first pipe member (or the inlet) and that the second fluid enters a second pipe member from another second pipe member (or an inlet). Hereby the two fluids are prevented from mixing within the pipe members.

[0034] When the connection members do not protrude radially from the array it means that the width of the heat exchanger module is not increased at the region of the connection members.

[0035] Compared to the prior art heat exchanger modules this is a major advantage.

[0036] It may be an advantage that the cross-sectional area within the end section of the pipe members and the connection members are essentially constant.

[0037] It may be an advantage that the cross-sectional area within the end section of the pipe members and the connection members are constant.

[0038] The pipe members are hereby prevented from clogging due to the resistance a reduced cross-sectional area would cause.

[0039] It may be beneficial that the connection members comprise a first plane plate, a second plane plate and a connection plate, where the first plane plate and the second plane plate extend parallel, where the connection plate extends between the two plane plates, where the connection plate has an arced internal geometry.

[0040] Hereby it is achieved that the connection member provides a passageway in which the fluid may flow from one pipe member to another pipe member without clogging the passageway in the connection member.

[0041] By the term, internal geometry is meant the passageway within the connection member. This is the passageway in which the fluid flows. The outside of the connection member, which is not in connection with the fluid may have an arch shape, but may also have any other shape.

[0042] An arced internal geometry may e.g. be a circular arc or an elliptical arc.

[0043] It is preferred that the arced internal geometry is concave.

[0044] It may be advantageous that the connection members have an arced internal geometry, because such geometry does not have any corners or kinks. Corners and kinks may cause unintended clogging of the connection members.

[0045] The connection member may be attached to the pipe members by either welding or moulding. Hereby it is possible to attach the connection members to the pipe members in a manner that reduces the risk of fluid leakage (leaking of the fluids from the connection between the connection member and the pipe members).

[0046] In a preferred embodiment of the invention, the heat exchange module comprises a number of attachment members attached to the first plane plate or to the second plane plate of the connection member, where the attachment members have a triangular shape.

[0047] In another preferred embodiment of the invention, the two attachment members each comprise a plane plate. It may be an advantage that the plane plate of each attachment member has a non-zero angle relative to the first plane plate or to the second plane plate.

[0048] The connection members do not protrude radially from the array. The connection members may preferably extend in the longitudinal direction of the array. Advantageously, the connection members have a width equal to the width of the array.

[0049] It may be advantageous to insert turbulence generating members into the first pipe members and/or into the second pipe members. Turbulence generating members are configured to generate turbulence in the fluid.

[0050] Hereby it is achieved that the thermal heat exchange between the two fluids can be increased because the turbulence generating members prevents laminar flows of the fluid.

[0051] Beneficially, the turbulence generating members decrease the cross sectional flow area within the pipe members. Hereby an effective turbulence can be generated.

[0052] Advantageously, the turbulence generating members have a circular or partly circular cross section.

[0053] It may be an advantage that the heat exchanger module comprises at least two first ports and two second ports, wherein

- the first port forms an inlet for the first pipe members and the second port forms an outlet for the first pipe members, and
- the first port forms an inlet for the second pipe members and the second port forms an outlet for the second pipe members.

[0054] Hereby it is possible to provide a heat exchanger module comprises two circuits that are prevented from being mixed with each other.

[0055] In one embodiment of a heat exchanger module according to the invention, the flow in the two circuits has the same.

[0056] In another embodiment of a heat exchanger module according to the invention, the flows in the two circuits have opposite directions. Hereby it a more efficient thermal energy exchange between the fluids in the two circuits may be achieved.

[0057] It may be an advantage that the array comprises two columns each comprising a plurality of rows. It may be beneficial that each connection member connects a pipe member of a first row of a first column of the array to a pipe member of an adjacent row above and/or below the first row of the opposite column of the array.

[0058] A heat exchanger system according to the invention may comprise one or more heat exchanger modules.

[0059] Hereby it is achieved that the heat exchanger system may increase the efficiency of the thermal energy exchange process by comprising one or more heat exchanger modules.

[0060] In a preferred embodiment, the heat exchanger system comprises more than one heat exchanger module, wherein the heat exchanger module is combined in serial. Hereby it is achieved an optimum method for increasing the efficiency of the thermal energy exchange process.

Description of the Drawings

[0061] The invention will become more fully understood from the detailed description given herein below. The accompanying drawings are given by way of illustration only, and thus, they are not limitative of the present invention. In the accompanying drawings:

- Fig. 1 shows a schematic perspective view seen from above a heat exchanger module according to the invention;
- Fig. 2 shows a schematic perspective view of a heat exchanger module seen from above with turbulence generating members;
- Fig. 3a) shows a side view of the array in which the connection plates have been removed;
- Fig. 3b) shows a side view of a heat exchanger module according to the invention;

- Fig. 4 shows different views of a connection member of a heat exchanger module according to the invention;
 Fig. 5 shows two schematic perspective side view of a heat exchanger module without connection plates and
 Fig. 6 shows four schematic views of how an array of a heat exchanger module according to the invention is constructed.

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Detailed description of the invention

[0062] Referring now in detail to the drawings for the purpose of illustrating preferred embodiments of the present invention, a heat exchanger module 2 of the present invention is illustrated in Fig. 1.

10 **[0063]** Fig. 1 illustrates a schematic perspective view seen from above a heat exchanger module 2 according to the invention. The heat exchanger module 2 comprises an array 12 and fourteen connection members 14, 14'. The connection members 14, 14' may be attached to the array 12 by a welding or a moulding process.

[0064] The array 12 comprises sixteen pipe members 4, 4', 6, 6', 6'' and the array 12 comprises eight rows arranged on the top of each other. The uppermost row comprises a first pipe member 4 and a second pipe member 6. Each row
 15 comprises a first pipe member 4 and a second pipe member 6 extending parallel to each other.

[0065] The pipe members 4, 6 are arranged in the array 12 in such a manner that the array 12 comprises two columns extending along the height axis Z of the array 12 and eight rows each extending along the radial axis Y of the array 12. Each row comprises a first pipe member 4 and a second pipe member 6 extending along the longitudinal axis X of the array 12.

20 **[0066]** The first pipe member 4 and the second pipe member 6 are arranged in such a manner that in each row the first pipe member 4 is connected to a corresponding first pipe member 4' arranged in the opposite column in the row below or above.

[0067] Likewise in each row the second pipe member 6 is connected to a corresponding second pipe member arranged in the opposite column in the row below or above like show in Fig. 3 a.

25 **[0068]** Each pipe member 4, 6 has a rectangular cross section, and comprises four (rectangular) plates (see Fig. 6 for a detailed view). The top plate and the bottom plate extend parallel to each other along the plane spanned by the radial axis Y of the array 12 and the longitudinal axis X of the array 12. Similarly, the two side plates extend parallel to each other along the plane spanned by the height axis Z of the array 12 and the longitudinal axis X of the array 12.

30 **[0069]** A center plate 8 is arranged between the two columns. The center plate 8 may be made of steel or another heat conducting material. The center plate 8 extends parallel to the plane spanned by the height axis Z of the array 12 and the longitudinal axis X of the array 12.

[0070] The heat exchanger module 2 comprises two circuits providing flow passages for two separated fluids. The first circuit has a first port 20 and a second port 24. These ports 20, 24 may be an inlet port, an outlet port or a port connecting two heat exchanger modules 2 (not shown).

35 **[0071]** The fluid in the first circuit may enter the heat exchanger module 2 through the first port 20 and may exit the heat exchanger module 2 through the second port 24. The fluid in the second circuit may enter the heat exchanger module 2 through the port 22 and may exit the heat exchanger module 2 through the second port 26.

[0072] On the other hand if the fluid in the first circuit enters the heat exchanger module 2 through the first port 20 and leaves the heat exchanger module 2 through the second port 24 the fluid in the second circuit may alternatively enter
 40 the heat exchanger module 2 through the port 24 and exit the heat exchanger module 2 through the second port 20.

[0073] In order to carry our heat exchange between the fluids in the two circuits a temperature difference between the fluids is required. In this way the fluid in the first circuit can exchange thermal energy with the fluid in the second circuit. The fluid in the first circuit may have a higher temperature than the fluid in the second circuit or *vice versa*.

45 **[0074]** When a first fluid enters the heat exchanger module 2 through the first port 20 the fluid flows into and through the pipe member 4 along the longitudinal axis X of the array 12. Hereafter the fluid enters the connection member 14 and is transported through the connection member 14 into the pipe member 4' and so forth, until the fluid leaves the heat exchanger module 2 through the second port 24.

50 **[0075]** When a second fluid enters the heat exchanger module 2 through the first port 22 the fluid flows into and through the lower most pipe member (6'''''' in Fig. 3) of the heat exchanger module 2. Hereafter the fluid enters the connection member 14 and is transported through the connection member 14 into the pipe member 6'''''' and so forth until the second fluid leaves the heat exchanger module 2 through the second port 26.

[0076] In a preferred mode of operation the first fluid in the first circuit flows in the opposite direction than the fluid in the second circuit.

55 **[0077]** The connection members 14, 14', 14'', 14''' in the heat exchanger module 2 have the same shape and design. Each connection member 14, 14', 14'', 14''' comprises a first plane plate A, a second plane plate B, and a connection plate C.

[0078] The first plane plate A and the second plane plate B extend parallel to each other. The plane plates A, B basically have a semi-circular shape.

[0079] The two plane plates A, B are attached to the array 12 in such a manner that they are angled relative to the radial axis Y of the array 12. This means that the plane plates A, B are arranged with a non-zero angle relative to the radial axis Y of the array 12 like illustrated in more detail in Fig. 3 a.

[0080] By arranging the plane plates A, B in this manner, the connection members 14, 14', 14'', 14''' connects the corresponding pipe members (e.g. the first pipe members 4 and 4' or the second pipe members 6 and 6') arranged diagonal to each other.

[0081] The connection plate C extends between and connects the two plane plates A, B. The connection plate C has an arched shape and thus no corners or kinks are present in the internal part of the connection plate C.

[0082] By the term "the internal part" is meant the part that is being in direct contact with the fluid during use of the heat exchanger module. It is important that the internal part of the connection plate C is designed without corners or kinks because these may cause clogging of the pipe members 4, 6.

[0083] The first plane plate A and the second plane plate B are identically shaped. The first plane plate A and the second plane plate are basically semi-circular shaped.

[0084] Fig. 2 illustrates a schematic perspective view of a heat exchanger module 2 according to the invention seen from above. The heat exchanger module 2 corresponds to the heat exchanger module 2 shown in Fig. 1. In Fig. 2, three turbulence generating members 16 are inserted into each of the pipe members 4, 6 of the array 12 of the heat exchanger module 2.

[0085] Another number (fewer or more) of turbulence generating members 16 may be inserted into each of the pipe members 4, 6.

[0086] The center plate 8, the connection members 14, 14', the plates A, B, C as explained with reference to Fig. 1 are also indicated in Fig. 2.

[0087] The turbulence generating members 16 prevent generation of laminar flows. The turbulence generating members generate turbulence in the pipe members 4, 6. It is desirable to obtain turbulence in the pipes, because it ensures a more efficient heat exchange between the two circuits in the heat exchanger module 2.

[0088] It can be seen that the turbulence generating members 16 are plane plate members evenly distributed along the length of the pipe members 4, 6. In each pipe member 4, 6 the turbulence generating members 16 extend parallel to each other.

[0089] Fig. 3 a) illustrates a side view of the array 12 in which the connection plates C (see Fig. 3 b) have been removed. The array 12 comprises eight rows each comprising two pipe members 4, 6. Each row comprises a pair of pipe members 4, 6. Accordingly, the array 12 comprises two columns of pipe members arranged on the top of each other.

[0090] While each row comprises two pipe members 4, 6, each column comprises eight pipe members 4, 6.

[0091] Each column comprises four first pipe members 4 and four second pipe members 6. In each column, the pipe members 4, 6 are arranged in such a manner that the corresponding pipe members (e.g. 4 and 4') are arranged in each side of adjacent rows.

[0092] Corresponding pipe members (e.g. 4 and 4' or 6 and 6') are connected to each other by means of connection members extending diagonally between the corresponding pipe members (e.g. 4 and 4' or 6 and 6').

[0093] The array 12 comprises a first row having a first pipe member 4 and a second pipe member 6. The array 12 moreover comprises a second row having a first pipe member 4' and a second pipe member 6'. The array 12 furthermore comprises a third row having a first pipe member 4'' and a second pipe member 6''.

[0094] The array 12 moreover comprises a fourth row having a first pipe member 4''' and a second pipe member 6''' and a fifth row having a first pipe member 4'''' and a second pipe member 6''''', a sixth row having a first pipe member 4''''' and a second pipe member 6''''', a seventh row having a first pipe member 4'''''' and a second pipe member 6'''''' and a last, eighth row (bottom row) having a first pipe member 4''''''' and a second pipe member 6'''''''.

[0095] The fluid in the first circuit may enter the array 12 through the first port 20 in the pipe member 4 and leaves the array 12 through the second port 24 in the pipe member 4''''''.

[0096] The fluid in the second circuit enters the array 12 through the first port 22 in the pipe member 6'''''' and leaves the array 12 through the second port 26 in the pipe member 6.

[0097] To ensure a high thermal energy transfer, turbulence generating members 16 are inserted into the pipe members 4, 6.

[0098] The connection members 14, 14'' ensure that the fluid from the pipe members 4, 6 are transported to the corresponding pipe member 4', 6'.

[0099] By way of example the connection member 14 connects the pipe member 4 to the corresponding pipe member 4' and the connection member 14'' connects the pipe member 4'''''' to the corresponding pipe member 4''''''.

[0100] In Fig. 3 b) it can be seen that the connection members 14, 14'' comprise a first plane plate A, a second plane plate B, and a connection plate C. In Fig. 3 b) the heat exchange module 2 comprises the connection plates C of the connection members 14, 14'' that are removed in Fig. 3 a).

[0101] The first plane plate A and the second plane plate B extend parallel to each other. The first plane plate A and the second plane plate B are angled relative the radial axis Y of the array 12. The angle θ between the first plane plate

A and the radial axis Y of the array 12 is indicated in Fig. 3 b). The angle φ between the second plane plate C and the radial axis Y of the array 12 corresponds to the angle θ between the first plane plate A and the radial axis Y of the array 12 since the first plane plate A and the second plane plate B extend parallel to each other.

[0102] The first plane plate A and the second plane plate B of each connection member 14, 14" are connected by a connection plate C. The connection plate C extends between and is attached to the first plane plate A and the second plane plate B. The first plane plate A and the second plane plate B may be attached to the array 12 by a welding process.

[0103] Fig. 4 illustrates different views of a connection member of a heat exchanger module according to the invention.

[0104] Fig. 4 a) illustrates a side view of an array 12 of a heat exchange module 2 according to the invention, in which the connection plates have been removed.

[0105] Fig. 4 b) illustrates a side view of a plane plate A/B (meaning A or B) and two attachment members 30, 30' attached thereto.

[0106] Fig. 4 c) illustrates a side view of the plane plate A/B shown in Fig. 4 b).

[0107] Fig. 4 d) illustrates a perspective view of a section of a heat exchange module 2 according to the invention, in which the connection plates have been removed.

[0108] Fig. 4 e) illustrates another side view of the plane plate A/B shown in Fig. 4 b) and in Fig. 4 c).

[0109] Fig. 4 f) illustrates a perspective view of the plane plate A/B shown in Fig. 4 b), Fig. 4 c) and Fig. 4 e).

[0110] The attachment of the first plane plate A and the second plane plate B to the pipe members 4, 6 is illustrated in Fig. 4. Each plane plate A, B is attached to two attachment members 30, 30', or 32, 32'.

[0111] The attachment members 30, 30', 32, 32' make it possible to attach the plane plate A or B to the array 12. The attachment members 30, 30', 32, 32' have a triangular shape, wherein the three vertex (34, 34', 34'') lies within the same plane.

[0112] In this plane, the line connecting vertex 34' and vertex 34'' is angled relative to the plane plates A, B. The attachment members 30, 30', 32, 32' are angled relative to both the radial axis Y of the array 12, the longitudinal axis X of the array 12 and the height axis Z of the array 12.

[0113] The angle between the two attachment members 30, 30' or 32, 32' is 90° (as shown in Fig. 4 e), but may take any other appropriate value.

[0114] When the plane plates A and B are seen from the side, the two attachment members 30, 30' or 32, 32' extend in different directions as shown in Fig. 4 b) and Fig. 4 f).

[0115] The plane plates A and B are plane plates having a basically semi-circular shape. This is best seen in Fig. 4. c), Fig. 4 d), and Fig. 4 f).

[0116] As shown in Fig. 4 a) and in Fig. 4 d) the plane plates A and B are attached to the pipe members 4 or 6 through the attachment members 30, 30' or 32, 32'. The area 36 between the two attachment members 30, 30' or 32, 32' is configured to be attached to the center plate 8.

[0117] The plane plate A is attached to the first pipe member 4 and the second pipe member 6 by attaching the attachment member 30 to the first pipe member 4 and attaching the attachment member 30' to the second pipe member 6. The attachment member 30 is attached to the first pipe member 4, whereas the attachment member 30' is attached to the second pipe member 6.

[0118] The plane plate B is attached to the first pipe member 4' and to the second pipe member 6'. The attachment member 32 is attached to the second pipe member 6', whereas the attachment member 32' is attached to the first pipe member 4'.

[0119] The cross-sectional area of the connection member pathway is larger corresponds to the cross-sectional area of the pipe members 4, 6. In this way the connection members cause no significant pressure loss and thus the risk for clogging is reduced.

[0120] Fig. 5 illustrates a schematic perspective side view of the heat exchanger module 2 without connection plates C. Fig. 5 a) shows how the first plane plate A and the second plane plate B are attached to the pipe members 4, 6.

[0121] The array 12 comprises a plurality of rows each comprising two pipe members 4, 6. Each row comprises a first pipe member 4 and a second pipe member 6. The rows constitute two adjacent columns.

[0122] A center plate 8 is arranged between the two. The array 12 is configured to be connected to two fluid circuits, wherein each circuit comprises a fluid flowing through either the first pipe members 4, 4' or the second pipe members 6, 6'.

[0123] At the end of each pipe member 4, 6 the fluid needs to be connected to another pipe member 4', 6'. The connection of corresponding pipe members (e.g. 4 and 4'') is carried out by means of connection members (only partly shown).

[0124] In Fig. 5 b) it can be seen that the connection members comprise a first plane plate A, a second plane plate B, while the connection plate C (shown in Fig. 3 b)) is not shown.

[0125] Two attachment members 30, 30' are attached to the first plane plate A and the second plane plate B. The two attachment members 30, 30' have a triangular shape.

[0126] The attachment members 30, 30' are angled relative to the plane plate A or B (as shown in Fig. 4 e).

[0127] Fig. 6 a) illustrates a cross-sectional view of a section of an array 12 of a preferred embodiment of a heat

exchanger module according to the invention. The array 12 has not yet been assembled and comprises a central center plate 8 arranged between a plurality of first pipe members 4, 4', 4'', 4''', 4''''.

[0128] Fig. 6 b) illustrates a cross-sectional view of a section of the array 12 shown in Fig. 6 a). In Fig. 6 b) the first pipe members 4, 4', 4'', 4''', 4'''' have been attached to the center plate 8 by welding (not shown). These pipe members 4, 4', 4'', 4''', 4'''' are extending parallel to each other and are configured to be connected by connection members to form a first circuit for a first fluid as previously explained.

[0129] Fig. 6 d) illustrates a cross-sectional view of a section of the array 12 shown in Fig. 6 a) and Fig. 6 b). A number of side members 38, 38', 38'' are arranged next to the first pipe members 4, 4', 4'', 4''', 4''''.

[0130] In Fig. 6 d) the side members 38, 38', 38'' have been attached to the center plate 8 by welding (not shown) hereby forming three second pipe members 6', 6'', 6''' configured to be connected by connection members to form a second circuit for a second fluid.

List of reference numerals

[0131]

2	Heat exchanger module
4, 4', 4'', 4''', 4''''	First pipe member
4''''', 4''''''	First pipe member
6, 6', 6'', 6''', 6''''	Second pipe member
6''''', 6''''''	Second pipe member
8	Center plate
12	Array
14, 14', 14'', 14'''	Connection member
16	Turbulence generating member
20, 22	First port
24, 26	Second port
30, 30', 32, 32'	Attachment member
34, 34', 34''	Vertex
36	Area
38, 38', 38''	Side member
A	First plane plate
B	Second plane plate
C	Connection plate
X	Longitudinal axis
Y	Radial axis
Z	Axis
θ , φ	Angle

Claims

1. A heat exchanger module (2) configured to exchange heat between a first fluid and a second fluid, in which the heat exchanger module (2) comprises an array (12) comprising a plurality of pairs of pipe members (4, 6), where each pair of pipe members (4, 6) comprises a first pipe member (4) and a second pipe member (6) arranged in thermal contact with each other for heat exchange between a first fluid flowing in the first pipe member (4) and a second fluid flowing in the second pipe member (6), where the array (12) comprises a plurality of rows each comprising a pair of pipe members (4, 6), where the heat exchanger module (2) comprises a number of connection members (14, 14') connecting pipe members (4, 6) of different rows, **characterised in that** the connection members (14, 14') do not protrude radially from the array (12).
2. A heat exchanger module (2) according to claim 1, **characterised in that** the cross-sectional area within the end section of the pipe members (4, 6) and the connection members are essentially constant.
3. A heat exchanger module (2) according to claim 1 or 2, **characterised in that** the connection members (14, 14') comprise a first plane plate (A), a second plane plate (B) and a connection plate (C), where the first plane plate (A) and the second plane plate (B) extend parallel, where the connection plate (C) extends between the two plane plates (A, B), where the connection plate (C) has an arch internal geometry.

4. A heat exchanger module (2) according to one of the preceding claims, **characterised in that** the heat exchanger module (2) comprises a number of attachment members (30, 30' or 32, 32') attached to the first plane plate (A) or to the second plane plate (B) of the connection member (14, 14'), where the attachment members (30, 30' or 32, 32') have a triangular shape.
5. A heat exchanger module (2) according to claim 4, **characterised in that** the connection member (14, 14') is attached to the pipe members (4, 6) by either welding or moulding.
6. A heat exchanger module (2) according to one of the preceding claims, **characterised in that** the pipe members (4, 6) have a rectangular cross section.
7. A heat exchanger module (2) according to one of the preceding claims, **characterised in that** the pipe members (4, 6) comprise turbulence generating members (16).
8. A heat exchanger module (2) according to one of the preceding claims, **characterised in that** the heat exchanger module comprises a center plate (8) that is planar and extends along the longitudinal axis (X) of the heat exchanger module (2).
9. A heat exchanger module (2) according to one of the preceding claims, **characterised in that** the heat exchanger (2) comprises at least two first ports (20, 22) and two second ports (24, 26), wherein
 - the first port (20) forms an inlet for the first pipe members (4) and the second port (24) forms an outlet for the first pipe members (4), and
 - the first port (22) forms an inlet for the second pipe members (6) and the second port (26) forms an outlet for the second pipe members (6).
10. A heat exchanger module (2) according to one of the preceding claims, **characterised in that** each connection member (14, 14') connects a pipe member (4', 6') of a first row of a first column of the array (12) to a pipe member (4, 6) of an adjacent row above and/or below the first row of the opposite column of the array (12).
11. A heat exchanger system comprising one or more heat exchanger modules (2) according to one of the preceding claims.

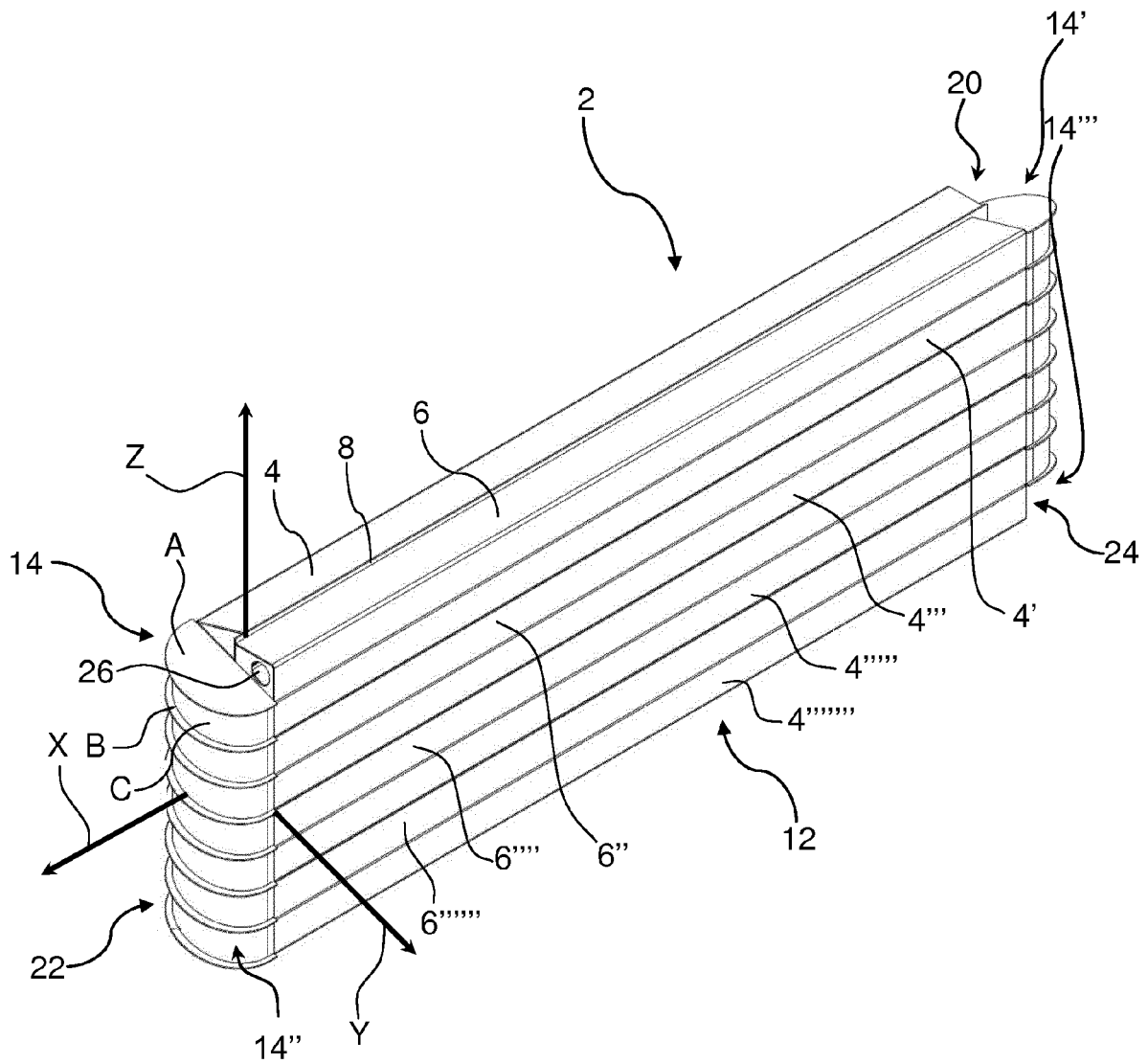


Fig. 1

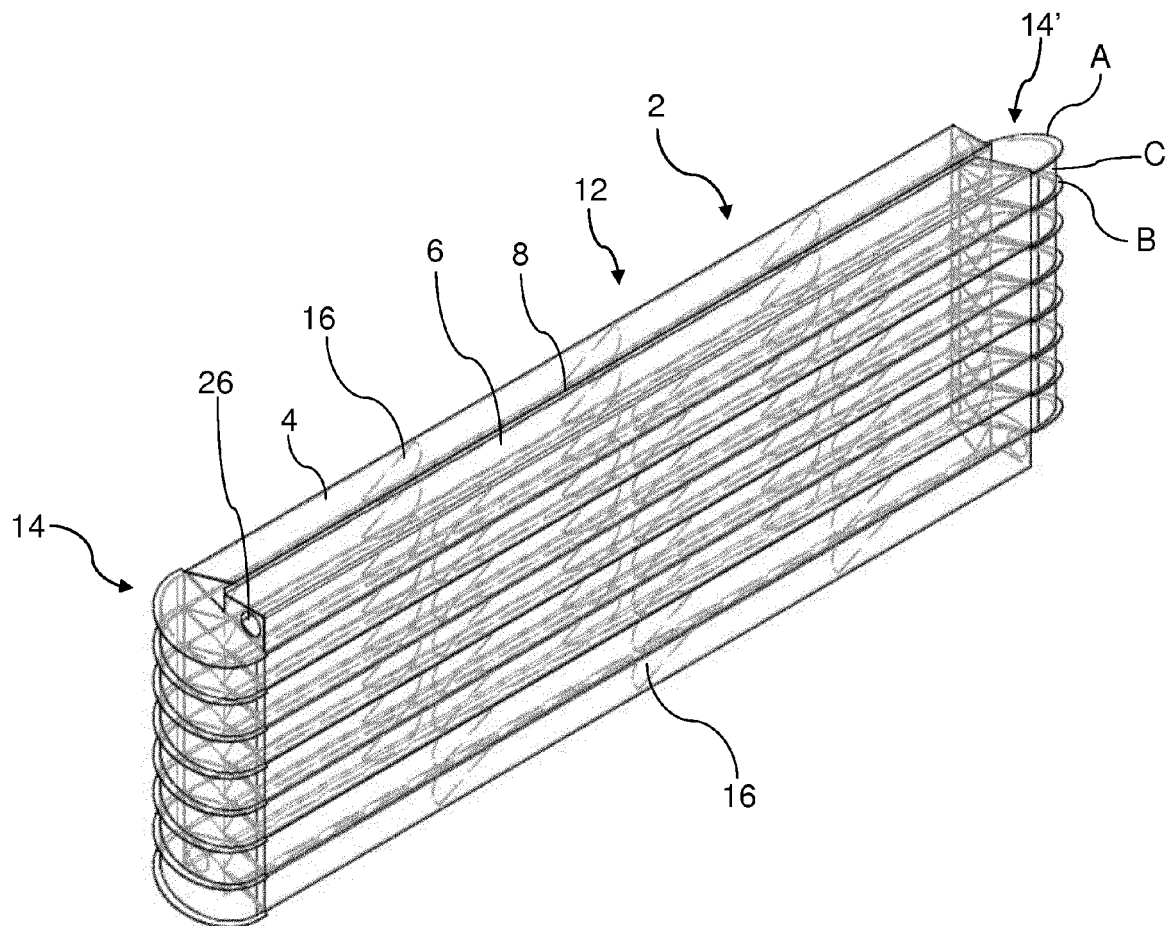


Fig. 2

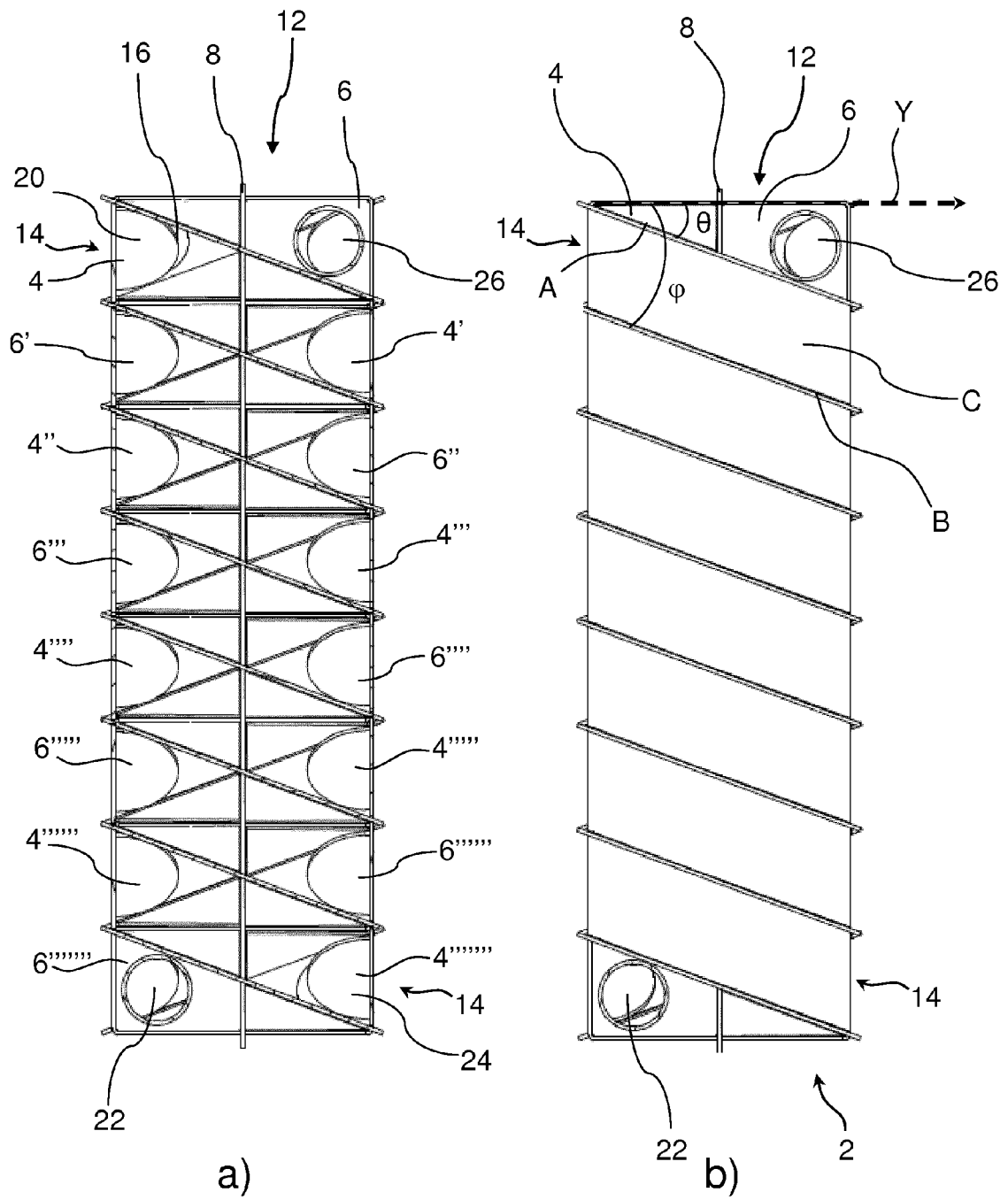


Fig. 3

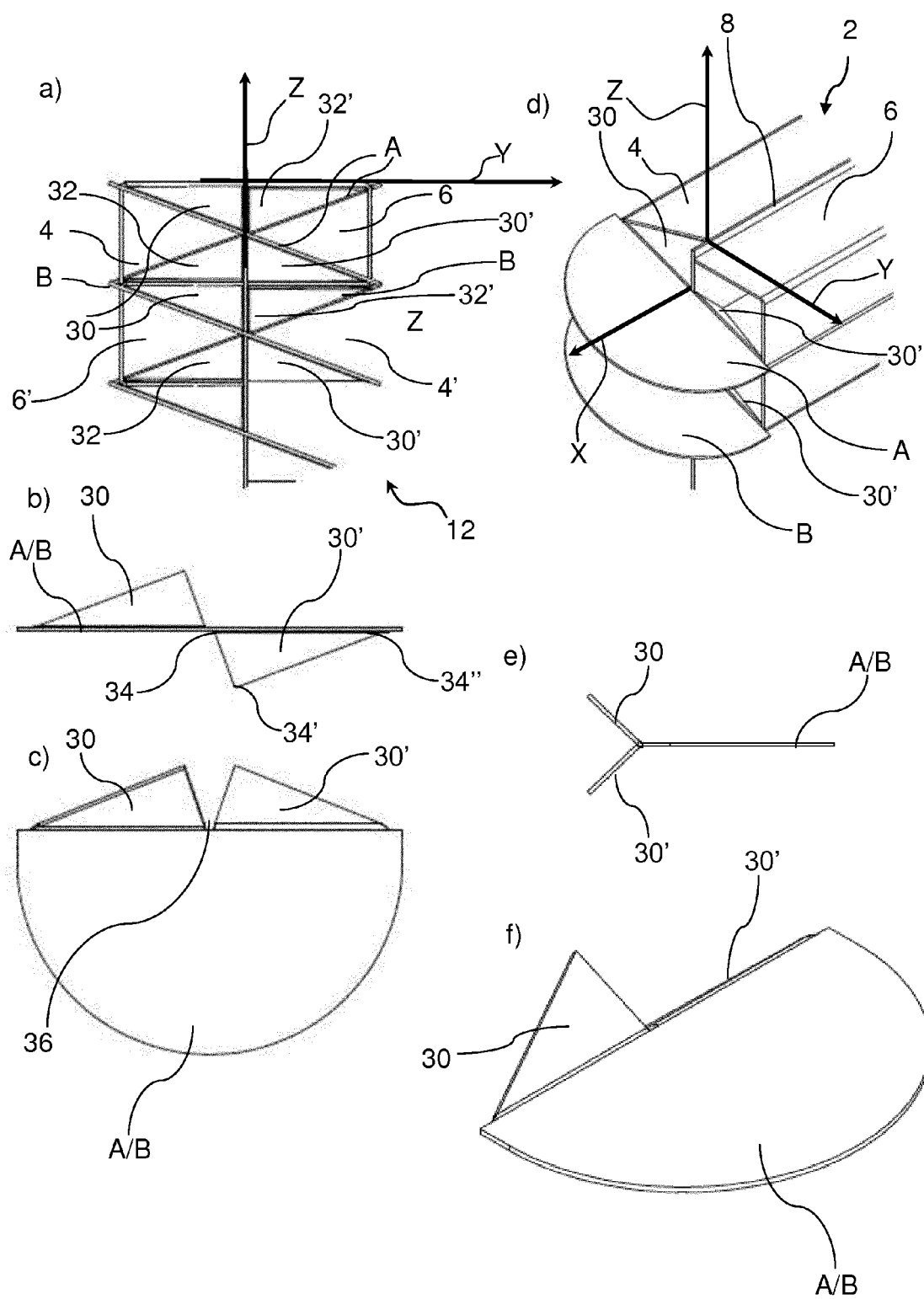


Fig. 4

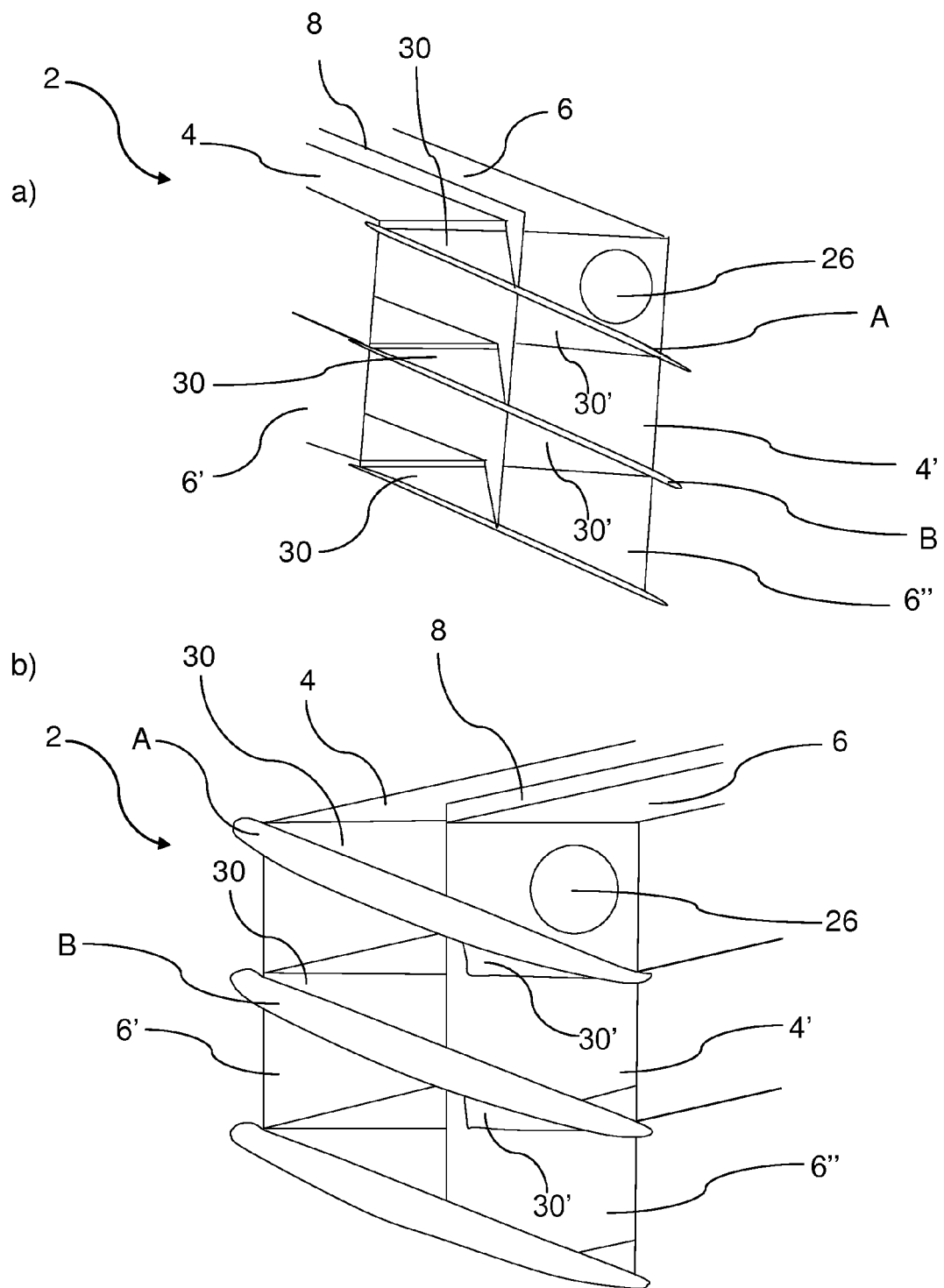


Fig. 5

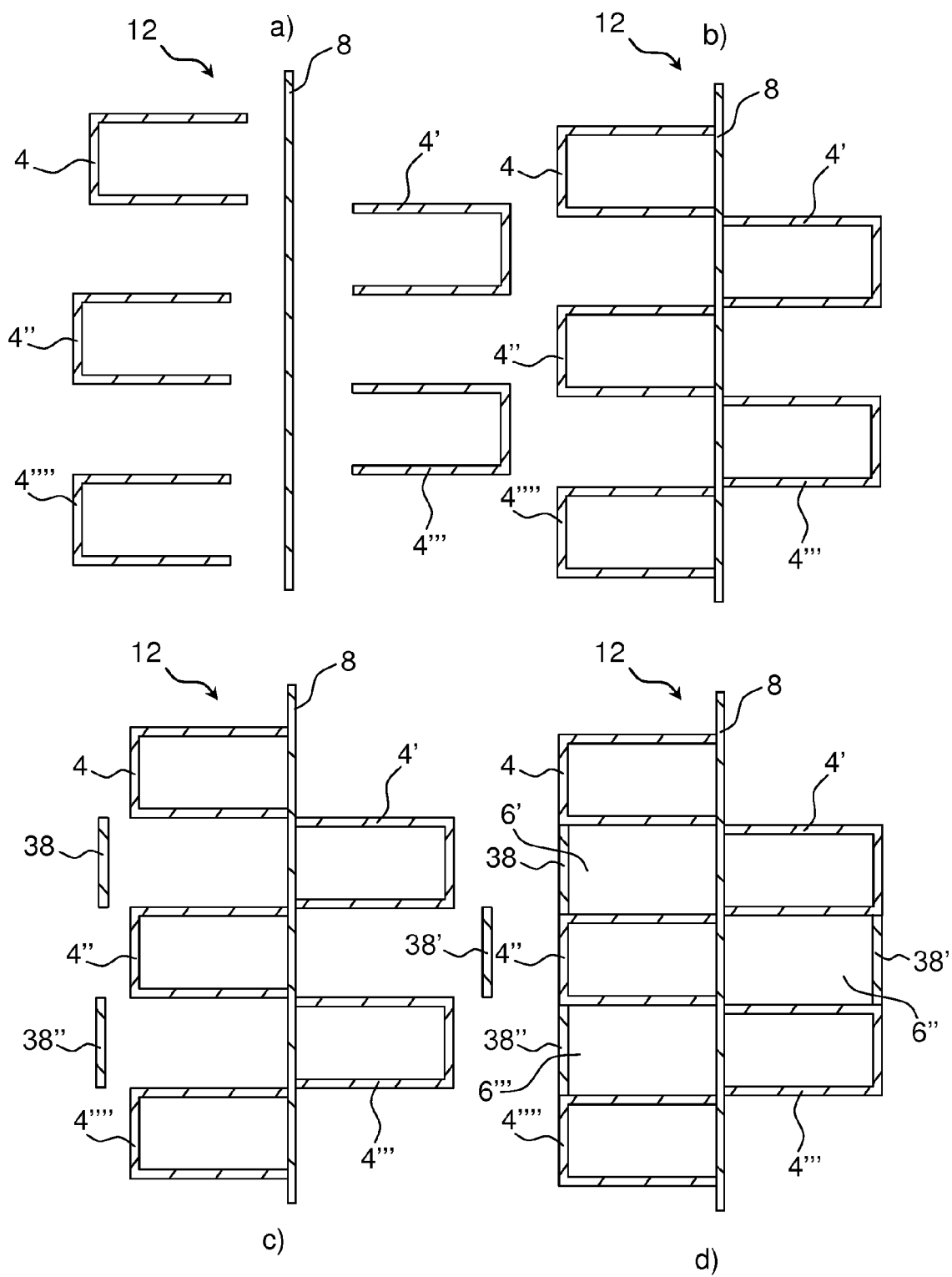


Fig. 6



EUROPEAN SEARCH REPORT

Application Number
EP 15 17 6567

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			F28D F28F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 24 May 2016	Examiner Mellado Ramirez, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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