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(54) **DISTRIBUTION ARRANGEMENT**

(57) A distribution arrangement (69a, 69b, 121a, 123a, 125a, 127a) configured to be positioned between two corrugated heat transfer plates (5) is provided. The distribution arrangement (69a, 69b) comprises a base portion (71) including a slab (73) with opposing front and back surfaces (79, 81). A front surface (89) and a back surface (93) of the base portion (71) comprise at least a part of the front surface (79) and the back surface (81), respectively, of the slab (73). The base portion (71) is provided with a through secondary hole (85) which extends through the front and back surfaces (89, 93) of the base portion (71) so as to form a direct secondary flow path (DS) through the base portion (71), a non-through first secondary cavity (97) which extends through the front surface (89) of the base portion (71), and at least one first secondary channel (101) extending inside the slab (73). Said at least one first secondary channel (101) connects the secondary hole (85) and the first secondary cavity (97) to form a first transferred secondary flow path (TS1) through the base portion (71).

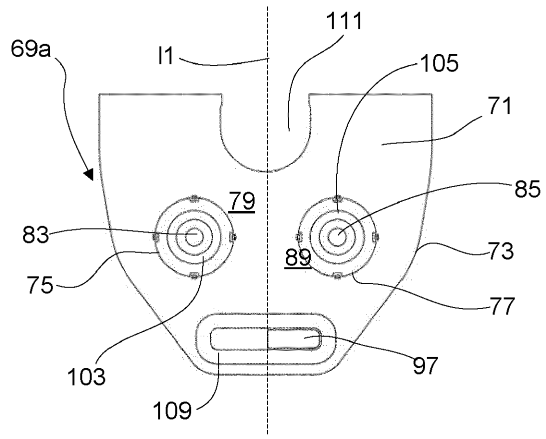

Fig. 4a

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Description

Technical Field

[0001] The invention relates to a distribution arrangement configured to be positioned between two corrugated heat transfer plates. The heat transfer plates and the distribution arrangement may be comprised in a device used for a heat generating process, such as electrolysis.

Background Art

[0002] Electrolysis is a well known process of using electricity to chemically decompose an electrolyte. For example, electrolysis can be used to split water confined in an electrolyte into hydrogen and oxygen. During electrolysis, heat may be generated, which heat may have to be diverted for maintained electrolysis efficiency.

[0003] EP 4012070 discloses a heat exchanger comprising a stack of heat transfer plates. The heat exchanger is adapted for connection to an electrolyzing device such that fluids circulating in the electrolyzing device are made to pass the heat exchanger for regulation of their temperatures. Typically, the temperature of the fluids gradually increases inside the electrolyzing device. Thus, the heat exchanger receives fluids of relatively high temperature from the electrolyzing device and delivers fluids of relatively low temperature to the electrolyzing device, which means that there will be a temperature difference across the electrolyzing device. This may result in an uneven and non-optimal electrolysis process inside the electrolyzing device. The heat exchanger in EP 4012070 is a so called plate-and-shell heat exchanger. Several other types of heat exchangers exist, for example so-called plate heat exchangers. A plate heat exchanger typically comprises a number of corrugated heat transfer plates arranged aligned in a stack or pack. Sealings between the heat transfer plates define parallel flow channels between the heat transfer plates, one flow channel between each pair of adjacent heat transfer plates. Two fluids of initially different temperatures can be fed alternately through every second flow channel for transferring heat from one fluid to the other.

Summary

[0004] An object of the present invention is to provide a distribution arrangement for positioning between two corrugated heat transfer plates so as to enable realization of a reliable and mechanically uncomplicated device comprising said heat transfer plates as part of a stack of corrugated heat transfer plates forming alternately arranged first and second plate interspaces, which device may be used for a heat generating process, such as electrolysis, and which device may allow a more uniform and effective cooling of a fluid, such as an electrolyte, and the products formed therefrom, so as to enable a maintained high process efficiency. The basic concept of the invention is to offer a distribution arrangement that may be arranged in the first interspaces dedicated for cooling, such that a heat generating process can be effectively maintained in the second interspaces, which distribution arrangement allows use of the first interspaces to feed fluid into, and out of, the second interspaces. Thus, the basic concept of the invention is to offer a distribution arrangement that enables a device for performing a heat generating process, such as electrolysis, which device, at the same time, may function as a traditional heat exchanger so as to provide cooling "integrated" in the heat generating process.

[0005] The distribution arrangement may be used in a device for production of hydrogen.

[0006] Since the distribution arrangement according to the invention is not arranged for use on its own, but as a component of a device as described above, the advantages of different features and embodiments of the distribution arrangement appears first when the distribution arrangement is installed in the device.

[0007] As said above, the distribution arrangement may be used in a device of the above described type to feed fluid, here a second fluid, into and out of a second interspace via a first interspace. Unless stated otherwise, the distribution arrangement as used for feeding the second fluid *into* the second interspace is described in the rest of this "Summary". Then, the distribution arrangement is arranged for flow diversion in an advantageous way, as will be further describe below. The distribution arrangement as used for feeding the second fluid *out* of the second interspace is instead arranged for flow collection in a corresponding advantageous way, which will be further discussed in the "Detailed Description".

[0008] A distribution arrangement according to the invention is for positioning between two corrugated heat transfer plates which may be of the same or different types. It comprises a base portion which includes a slab having opposing front and back surfaces arranged to face a respective one of the heat transfer plates. An intermediate extension plane of the slab extends between the front and back surfaces of the slab. A front surface and a back surface of the base portion comprises at least a part of the front surface and the back surface, respectively, of the slab. The base portion comprises a through secondary hole which extends through the front and back surfaces of the base portion so as to form a direct secondary flow path through the base portion. The base portion also comprises a non-through first secondary cavity which extends through the front surface of the base portion. Further, the base portion comprises at least one first secondary channel which extends inside the slab. Said at least one first secondary channel connects the secondary hole and the first secondary cavity to form a first transferred secondary flow path through the base portion. An annular secondary sub-surface of the front surface of the base portion encloses the secondary hole.

[0009] It should be stressed that, herein, "annular" and "ring" is not necessarily circular but may be any "closed" shape, such as oval, polygonal or any combination thereof.

[0010] When the distribution arrangement is properly arranged between the heat transfer plates, the intermediate extension plane of the slab may extend essentially parallel to the heat transfer plates.

[0011] The intermediate extension plane of the slab may extend essentially parallel to the front and back surfaces of the slab. The intermediate extension plane may, or may not, extend halfway between the front and back surfaces of the slab.

[0012] Said at least one first secondary channel which extends inside the slab may, or may not, extend essentially parallel to the intermediate extension plane of the slab.

[0013] In that the first secondary cavity is non-through, it will extend only partly through the base portion, i.e. not through the back surface of the base portion.

[0014] Thus, there is a direct secondary flow path, defined by the secondary hole, and a first transferred secondary flow path, defined by the secondary hole, the first secondary channel and the first secondary cavity, for a second fluid through the base portion. This makes it possible for the distribution arrangement to divide a first secondary sub flow from a second secondary fluid flow. Thereby, if the distribution arrangement is arranged in a first interspace of a device as described above, it may convey the first secondary sub flow of the second fluid into an adjacent second interspace via the first interspace, as will be further described below.

[0015] The distribution arrangement can be made of one ore more materials. For example, the base portion of the distribution arrangement, and particularly the front and back surfaces of the base portion, may be made of one or more insulating materials. Thereby, the base portion may prevent short circuiting within a device for performing a heat generating process, such as electrolysis, which short circuiting could cause malfunctioning of the device.

[0016] The distribution arrangement may further comprise a secondary hole gasket. The secondary hole gasket may enclose the secondary hole and seal against the secondary sub-surface of the front surface of the base portion. The secondary hole gasket may enable a tight seal between the secondary sub-surface and another surface, which surface may be comprised in another distribution arrangement according to the invention. Additionally/alternatively, the distribution arrangement may comprise a first secondary cavity gasket. The first secondary cavity gasket may enclose the first secondary cavity and seal against the front surface of the base portion. The first secondary cavity gasket may enable a tight seal between the front surface of the base portion and another surface, which surface may be comprised in a heat transfer plate.

[0017] The distribution arrangement may be so designed that the secondary sub-surface is elevated in relation to the rest of the front surface of the base portion. Thereby, the base portion will have an increased thickness around the secondary hole. Such a design may enable for the distribution arrangement to project through a heat transfer plate to prevent short circuiting within a device for performing a heat generating process, such as electrolysis.

[0018] The base portion may further comprise a through primary hole. The primary hole may extend through the front and back surfaces of the base portion so as to form a direct primary flow path through the base portion. The base portion may further comprise a non-through first primary cavity which extends through the back surface of the base portion, and at least one first primary channel extending inside the slab. Said at least one first primary channel may connect the primary hole and the first primary cavity to form a first transferred primary flow path through the base portion. An annular primary sub-surface of the front surface of the base portion may enclose the primary hole.

[0019] Said at least one first primary channel which extends inside the slab may, or may not, extend essentially parallel to the intermediate extension plane of the slab.

[0020] In that the first primary cavity is non-through, it will extend only partly through the base portion, i.e. not through the front surface of the base portion.

[0021] Thus, there is a direct primary flow path, defined by the primary hole, and a first transferred primary flow path, defined by the primary hole, the first primary channel and the first primary cavity, for the second fluid through the base portion. This makes it possible for the distribution arrangement to divide a first primary sub flow from a second primary fluid flow. Thereby, if the distribution arrangement is arranged in a first interspace of a device as described above, it may it may convey the first primary sub flow of the second fluid into an adjacent second interspace via the first interspace, as will be further described below.

[0022] The distribution arrangement may further comprise a primary hole gasket. The primary hole gasket may enclose the primary hole and seal against the primary sub-surface of the front surface of the base portion. The primary hole gasket may enable a tight seal between the primary sub-surface and another surface, which surface may be comprised in another distribution arrangement according to the invention. Additionally/alternatively, the distribution arrangement may comprise a first primary cavity gasket. The first primary cavity gasket may enclose the first primary cavity and seal against the back surface of the base portion. The first primary cavity gasket may enable a tight seal between the back surface of the base portion and another surface, which surface may be comprised in a heat transfer plate.

[0023] The distribution arrangement may be so designed that the primary sub-surface is elevated in relation to the rest of the front surface of the base portion. Thereby, the base portion will have an increased thickness around the primary hole.

[0024] The distribution arrangement may be such that the first secondary cavity is aligned with the first primary cavity. Then, a normal axis extending perpendicular to the intermediate extension plane of the slab may extend through both the first secondary cavity and the first primary cavity. Such a configuration may be advantageous in that it enables for said at least one first secondary channel and said at least one first primary channel to cross each other.

[0025] Alternatively, the distribution arrangement may be such that the first secondary cavity is displaced from the first primary cavity. Then, a normal axis extending perpendicular to the intermediate extension plane of the slab may not extend through both the first secondary cavity and the first primary cavity. Such a configuration may be advantageous in that it enables for said at least one first secondary channel, as well as for said at least one first primary channel, to extend at any level between the front and back surfaces of the slab.

[0026] The distribution arrangement may be so designed that said at least one first secondary channel extends between the front surface of the slab and the intermediate extension plane of the slab. Further, said at least one first primary channel may extend between the back surface of the slab and the intermediate extension plane of the slab. Such a configuration may be advantageous in that it enables for said at least one first secondary channel and said at least one first primary channel to cross each other.

[0027] The base portion of the distribution arrangement may comprise a non-through second secondary cavity which extends through the front surface of the base portion, and at least one second secondary channel extending inside the slab. Said at least one second secondary channel may connect the secondary hole and the second secondary cavity to form a second transferred secondary flow path through the base portion. Additionally/alternatively, the base portion may comprise a non-through second primary cavity which extends through the back surface of the base portion, and at least one second primary channel extending inside the slab. Said at least one second primary channel may connect the primary hole and the second primary cavity to form a second transferred primary flow path through the base portion.

[0028] Said at least one second secondary channel and/or said at least one second primary channel which extend inside the slab may, or may not, extend essentially parallel to the intermediate extension plane of the slab.

[0029] In that the second secondary cavity is non-through, it will extend only partly through the base portion, i.e. not through the back surface of the base portion.

[0030] In that the second primary cavity is non-through, it will extend only partly through the base portion, i.e. not through the front surface of the base portion.

[0031] Thus, besides for the direct secondary flow path and the first transferred secondary flow path, there may be a second transferred secondary flow path, defined by the secondary hole, the second secondary channel and the second secondary cavity, for the second fluid through the base portion. This makes it possible for the distribution arrangement to divide a second secondary sub flow from the second secondary fluid flow. Thereby, if the distribution arrangement is arranged in a first interspace of a device as described above, it may it may convey the second secondary sub flow of the second fluid into an adjacent second interspace via the first interspace. The first and second secondary sub flows may be conveyed into the second interspace at different positions which may improve the distribution of the second fluid in the second interspace.

[0032] Further, besides for the direct primary flow path and the first transferred primary flow path, there may be a second transferred primary flow path, defined by the primary hole, the second primary channel and the second primary cavity, for the second fluid through the base portion. This makes it possible for the distribution arrangement to divide a second primary sub flow from the second primary fluid flow. Thereby, if the distribution arrangement is arranged in a first interspace of a device as described above, it may it may convey the second primary sub flow of the second fluid into an adjacent second interspace via the first interspace. The first and second primary sub flows may be conveyed into the second interspace at different positions which may improve the distribution of the second fluid in the second interspace.

[0033] The distribution arrangement may be so designed that the first secondary cavity and the second secondary cavity are aligned with the second primary cavity and the first primary cavity, respectively. Such a configuration may be advantageous in that it enables for said at least one first secondary channel and said at least one second primary channel to cross each other, and for said at least one second secondary channel and said at least one first primary channel to cross each other.

[0034] Alternatively, distribution arrangement may be so designed that the first secondary cavity and the second secondary cavity are displaced from the second primary cavity and the first primary cavity. Such a configuration may be advantageous in that it enables for said at least one first secondary channel, said at least one second secondary channel, said at least one first primary channel and said at least one second primary channel to extend at any level between the front and back surfaces of the slab.

[0035] The distribution arrangement may be such that said at least one first secondary channel and said at least one second secondary channel extend between the front surface of the slab and the intermediate extension plane of the slab. Further, said at least one first primary channel and said at least one second primary channel may extend between the back surface of the slab and the intermediate extension plane of the slab. Such a configuration may be advantageous in that it enables for said at least one first secondary channel and said at least one second primary channel to cross each other, and for said at least one second secondary channel and said at least one first primary channel to cross each other.

[0036] The distribution arrangement may be so designed that the slab comprises an inner wall enclosing, i.e. defining, the secondary hole. The inner wall may comprise first and second halves which extend on opposite sides of a hole center plane dividing the secondary hole in half, which hole center plane extends perpendicular to the intermediate extension plane of the slab. The first half of the inner wall of the slab may be arranged further away from the first secondary cavity than the second half of the inner wall of the slab. Said at least one first secondary channel may extend from an opening in the first half of the inner wall of the slab. Such a design may be advantageous when the distribution arrangement is arranged to be used with such an orientation that the first half of the inner wall is arranged above the second halv of the inner wall. Then, such a design may facilitate separation of a gas phase and a liquid phase of the second fluid in the secondary hole, as will be further described below. The primary hole of the distribution arrangement may have a similar construction.

[0037] The slab of the distribution arrangement may be provided with a bar engagement recess. As indicated by the name, the bar engagement recess may be arranged for engagement with a bar of a device as described above, which bar is arranged to support the heat transfer plates of the device. Thus, the bar engagement recess may be used to secure the distribution arrangement, and any heat transfer plate engaging therewith, in the device. The bar engagement recess may be formed as a hole, cavity or hollow through the slab, defined by an annular inner wall of the slab. As another example, the bar engagement recess may extend from an outer edge of the slab, for example from a center portion of the outer edge. The bar engagement recess, which may be insulating, and the first secondary cavity may be arranged on opposite sides of the secondary hole. The recess may have any suitable shape.

[0038] The distribution arrangement may further comprise snap fitting means projecting from the front surface of the slab around said annular secondary sub-surface, and possibly also around said annular primary sub-surface, of the front surface of the base portion. Said snap fitting means may be arranged to engage with locking means of one of said heat transfer plates to attach the distribution arrangement to said one of the heat transfer plates. Such snap fitting means may enable a simple and stable assembly of a device comprising the distribution arrangement and said heat transfer plates.

[0039] Still other objectives, features, aspects and advantages of the invention will appear from the following detailed description as well as from the drawings.

Brief Description of the Drawings

[0040] The invention will now be described in more detail with reference to the appended schematic drawings, in which

Figs. 1a and 1b are essentially similar perspective views schematically illustrating a part of a device, which comprises a plurality of distribution arrangements according to the invention, in a disassembled state, and different fluid paths through the device,

Fig. 2 is a schematic plan view of a heat transfer plate of the device in Fig. 1a,

Fig. 3 is a schematic plan view of a part of the device in Fig. 1a,

Fig. 4a is a schematic front plan view of an upper distribution arrangement of the device in Fig. 1a,

Fig. 4b is a schematic back plan view of the upper distribution arrangement in Fig. 4a,

Fig. 4c is a schematic partial perspective view of the upper distribution arrangement in Fig. 4a,

Fig. 4d is a schematic cross sectional view of the upper distribution arrangement in Fig. 4a,

Fig. 4e-4h schematically illustrates different flow paths through the upper distribution arrangement in Fig. 4a,

Fig. 5a is a schematic perspective view of the upper distribution arrangement in Fig. 4a,

Fig. 5b schematically partly illustrates an electrolyzer cell comprising the upper distribution arrangement illustrated in Fig. 5a,

Fig. 6 schematically illustrates engagement between a plurality of electrolyzer cells according to Fig. 5b,

Fig. 7a is a schematic front plan view of an upper distribution arrangement according to an alternative embodiment,

Fig. 7b is a schematic back plan view of the upper distribution arrangement in Fig. 7a,

Fig. 7c is a schematic cross sectional view of the upper distribution arrangement in Fig. 7a,

Fig. 7d is another schematic cross sectional view of the upper distribution arrangement in Fig. 7a,

Figs. 8a and 8b are essentially similar perspective views schematically illustrating a part of a device, which comprises a plurality of distribution arrangements according to another embodiment of the invention, in a disassembled state, and different fluid paths through the device,

Fig. 9 is a schematic plan view of a heat transfer plate of the device in Fig. 8a,

Fig. 10 is a schematic plan view of a part of the device in Fig. 8a,

Fig. 11a is a schematic front plan view of an upper distribution arrangement of the device in Fig. 8a,

Fig. 11b is a schematic back plan view of the upper distribution arrangement in Fig. 11a,

Fig. 12a is a schematic front plan view of an upper distribution arrangement according to an alternative embodiment,

Fig. 12b is a schematic back plan view of the upper distribution arrangement in Fig. 12a,

Fig. 12c is a schematic cross sectional view of the upper distribution arrangement in Fig. 12a,

Fig. 13a is a schematic front plan view of an upper distribution arrangement according to another alternative embodiment, and

Fig. 13b is a schematic back plan view of the upper distribution arrangement in Fig. 13a.

Detailed Description

[0041] Fig. 1a illustrates a part of a device 1 used for producing hydrogen through electrolysis, here alkaline water electrolysis. The device 1 comprises a stack 3 (only partly illustrated) of similar heat transfer plates 5 which each has a front side 7 and an opposing back side 9. In the stack 3, the heat transfer plates 5 are flipped in relation to each other, i.e. arranged front side 7 to front side 7 and back side 9 to back side 9 with every second one of the heat transfer plates 5 turned upside down with respect to the rest of the heat transfer plates 5. This means that every second one of the heat transfer plates 5 is rotated 180 degrees around a respective heat transfer plate longitudinal center axis L, and then rotated 180 degrees around a respective heat transfer plate normal axis N (Fig. 2), with respect to the rest of the heat transfer plates 5.

[0042] One of the heat transfer plates 5 is separately illustrated in Fig. 2 and described in further detail below. It has a first end portion 11, a center portion 13 and a second end portion 15 arranged in succession along the longitudinal center axis L of the heat transfer plate 5, which longitudinal center axis L extends perpendicular to a transverse center axis T of the heat transfer plate 5. The first end portion 11 comprises a first porthole 17, a third porthole 19, a fifth porthole 21, a seventh porthole 23 and a first transfer hole 25, while the second end portion 15 comprises a second porthole 27, a fourth porthole 29, a sixth porthole 31, an eighth porthole 33 and a second transfer hole 35.

[0043] As heat transfer plates normally are, the heat transfer plate 5 is pressed with corrugation patterns of ridges and valleys in relation to a respective central extension plane of the heat transfer plate 5, which central extension plane is parallel to the figure plane of Fig. 2. The corrugation patterns within different areas of the heat transfer plate 5 are different. For example, the center portion 13 is pressed with a corrugation pattern of so-called herringbone type. As another example, an edge portion 37 of the heat transfer plate 5 is pressed with alternately arranged ridges and valleys extending from an outer edge 39 of the heat transfer plate 5.

[0044] With reference again to Fig. 1a, the stack 3 of heat transfer plates 5 is arranged between two frame plates F, of which only one is illustrated. The heat transfer plates 5 within the stack 3 are arranged in pairs, wherein heat transfer plates 5b and 5c form one of these pairs, while heat transfer plate 5d forms one of the heat transfer plates of another adjacent one of these pairs. The heat transfer plates of each pair form between them a first interspace I1. Further, a second interspace I2 is formed between each two adjacent pairs of heat transfer plates 5. An outer heat transfer plate 5x, which is similar to the heat transfer plates 5 except for that it lacks the first and second transfer holes 25 and 35, is arranged between the stack 3 and the frame plate F visible in Fig. 1a to form an additional first interspace I1, denoted I1X, as well as a plate pair, with the heat transfer plate 5a. An additional second interspace I2, denoted I2X, is thus formed between the heat transfer plate 5a and the heat transfer plate 5b. An outer heat transfer plate completely lacking holes may be arranged between the stack 3 and the other frame plate which is not visible in Fig. 1a. Further, gaskets, which are not illustrated, may be arranged on the inside of the frame plates F.

[0045] An annular field gasket part 41 of rubber is arranged within each of the first interspaces I1 to define a first flow channel C1 therein. Arranged within each of the first interspaces I1 are also an upper distribution arrangement 69a and a lower distribution arrangement 69b. An annular field sealing part 43 is arranged within each of the second interspaces I2 to define a second flow channel C2 therein. A separation means, which closes a field sealing area enclosed by the field sealing part 43, comprises a hydroxide ion permeable membrane 45. The membrane 45 extends within the field sealing part 43 and essentially parallel to the heat transfer plates 5 to split the corresponding second flow channel C2 in a second primary sub channel C2P and a second secondary sub channel C2S, which sub channels are parallel and extend on opposite sides of the membrane 45. The field sealing part 43 and the separation means comprising the membrane 45 are parts of a sealing arrangement S of rubber (except for the membrane) which also comprises four annular ring sealing parts 47 formed integrally with the field sealing part 43 and an insulating rubber sheet (not illustrated herein). The rubber sheet extends on an outside of the field sealing part 43 and the ring sealing parts 47 and is arranged to prevent contact between the heat transfer plates arranged on the opposite sides of the rubber sheet.

[0046] With reference to Fig. 3, the field gasket part 41 encloses a field gasket area A1 having a transverse center axis T1 and a longitudinal center axis L1. The field gasket part 41 comprises first and second long side portions ls1 and ls2, which extend essentially parallel to the longitudinal center axis L1 of the field gasket area A1, and first and second short side portions ss1 and ss2. The first short side portion ss1 connects the long side portions ls1 and ls2 at a first end E1 of the field gasket part 41, while the second short side portion ss2 connects the long side portions ls1 and ls2 at a second end E2 of the field gasket part 41. The first and second short side portions ss1 and ss2 are bulging towards each other so as to form a first recess R1 on an outside of the first short side portion ss1 and a second recess R2 on an outside of the second short side portion ss2. The upper distribution arrangement 69a is partly arranged within the recess R1 of the field gasket part 41 while the lower distribution arrangement 69b is partly arranged within the recess R2 of the field gasket part 41.

[0047] The upper distribution arrangement 69a is separately illustrated in Figs. 4a-4d. It comprises a base portion 71 which is made of an insulating material such as a polymer. The base portion 71 consists of a slab, plate or disc 73 and two similar projections in the shape of thick-walled cylinders 75 and 77. The slab 73 has opposing front and back surfaces 79 and 81 of which the front surface 79 is visible in Figs. 4a and 4c and the back surface 81 is visible in Fig. 4b. Two holes h extend through the slab 73 on opposite sides of a longitudinal center axis I1 of the upper distribution arrangement 69a. The cylinders 75 and 77 project from the front surface 79 of the slab 73 and enclose a respective one of the holes h through the slab 73 to define a primary hole 83 and a secondary hole 85, respectively, through the base portion 71. As illustrated in Fig. 4b, the slab 73 comprises two inner walls 84 enclosing a respective one of the primary and secondary holes 83 and 85. Each of these inner walls 84 comprises a first half 86 and a second half 88 which extend on opposite sides of a hole center plane CP dividing the primary and secondary holes 83 and 85 in half. As illustrated in Figs. 4a and 4c, a free end surface of the cylinder 75 forms an elevated annular primary sub-surface 87 of a front surface 89 of the base portion 71. A free end surface of the cylinder 77 forms an elevated annular secondary sub-surface 91 of the front surface 89 of the base portion 71. Thus, the front surface 89 of the base portion 71 comprises this primary sub-surface 87 and this secondary sub-surface 91 and the portion of the front surface 79 of the slab 73 extending outside the cylinders 75 and 77. A back surface 93 of the base portion 71 comprises the back surface 81 of the slab 73.

[0048] Further, the base portion 71 comprises a non-through first primary cavity 95 extending through the back surface 93, and a non-through first secondary cavity 97 extending through the front surface 89, of the base portion 71. As is clear from Figs. 4a-4d, the first primary cavity 95 and the first secondary cavity 97 are displaced from each other, i.e. they are arranged on opposite sides of the longitudinal center axis I1 of the upper distribution arrangement 69a. Fig. 4d illustrates a cross section through the upper distribution arrangement 69a at an intermediate extension plane IP of the slab 73, which plane coincides with the figure plane of Fig. 4d and extends halfway between the front and back surfaces 79 and 81 of the slab 73. Further, the intermediate extension plane IP extends perpendicular to the hole center plane CP (Fig. 4b) of the slab 73. With reference to Fig. 4d, the base portion 71 further comprises a plurality of first primary channels 99 and a plurality of first secondary channels 101. The first primary channels 99 and the first secondary channels 101 all extend in the intermediate extension plane IP. Each of the first primary channels 99 connects the primary hole 83 and the first primary cavity 95. Each of the first secondary channels 101 connects the secondary hole 85 and the first secondary cavity 97. With reference also to Fig. 4b, each of the first primary channels 99 extend from a respective opening 100 in the first half 86 of the inner wall 84 enclosing the primary hole 83. Similarly, each of the first secondary channels 101 extend from a respective opening 102 in the first half 86 of the inner wall 84 enclosing the secondary hole 85.

[0049] With reference now also to Figs. 4e-4h, there are a plurality of different flow paths through the base portion 71 and the upper distribution arrangement 69a. More particularly, the primary hole 83 defines a direct primary flow path DP, while each of the first primary channels 99 together with the primary hole 83 and the first primary cavity 95 defines a respective first transferred primary flow path TP1. Further, the secondary hole 85 defines a direct secondary flow path DS, while each of the first secondary channels 101 together with the secondary hole 85 and the first secondary cavity 97 defines a respective first transferred secondary flow path TS1.

[0050] With reference again to Figs. 4a-4c, the distribution arrangement 69a further comprises an annular primary hole gasket 103, which extends around the primary hole 83 and seals against the primay sub-surface 87, and an annular secondary hole gasket 105, which extends around the secondary hole 85 and seals against the secondary sub-surface 91, of the front surface 89 of the base portion 71. Further, the distribution arrangement 69a comprises an annular first primary cavity gasket 107, which extends around the first primary cavity 95 and seals against the back surface 93 of the base portion 71, and an annular first secondary cavity gasket 109, which extends around the first secondary cavity 97 and seals against the front surface 89 of the base portion 71.

[0051] With reference to Figs. 4a and 4b, a bar engagement recess 111 is provided in the slab 73 of the distribution arrangement 69a. The bar engagement recess 111 extends from an outer edge 113 of the slab 73 and it is arranged to receive a bar for supporting the heat transfer plates 5x, 5 of the device 1, which bar is not illustrated herein.

[0052] As illustrated in Figs. 5a and 5b, the upper distribution arrangement 69a is further provided with snap fitting means 115 in the form of essentially L-shaped projections projecting from the front surface 79 of the slab 73. Four snap fitting means 115 are equidistantly positioned around each of the primary and secondar holes 83 and 85 within corresponding recesses 117 formed in the cylinders 75 and 77. With reference to Figs. 1a, 2 and 5b, the snap fitting means 115 and the cylinders 75 and 77 are arranged to project through two of the third, fifth, fourth and sixth portholes 19, 21, 29 and 31 of two adjacent ones of the heat transfer plates 5 of the device 1 forming between them one of the second interspaces I2. Further, the front surface 79 of the slab 73 of the upper distribution arrangement 69a is arranged to face an inner heat transfer plate 5' of the two adjacent heat transfer plates 5 and the first secondary cavity gasket 109 is arranged to abut the inner heat transfer plate 5' around one of the first and second transfer holes 25 and 35 thereof. The heat transfer plates 5 are provided with locking means 119 which are equidistantly positioned around the third, fifth, fourth and sixth portholes 19, 21, 29 and 31. The snap fitting means 115 of the upper distribution arrangement 69a are arranged to interlock with a respective one of the locking means 119 of an outer heat transfer plate 5" of the two adjacent heat transfer plates 5 so as to connect with the two adjacent heat transfer plates 5', 5" and the sealing arrangement S arranged between them and form an electrolyzer cell EC.

[0053] The lower distribution arrangement 69b is similar to the upper distribution arrangement 69b except for as regards the extension of the first primary channels 99 and the first secondary channels 101. With reference to Figs. 4b and 4d, for the lower distribution arrangement 69b, each of the first primary channels 99 extend from a respective opening (not illustrated) in the second half 88 of the inner wall 84 enclosing the primary hole 83. Similarly, each of the first secondary channels 101 extend from a respective opening (not illustrated) in the second half 88 of the inner wall 84 enclosing the secondary hole 85. In an alternative embodiment, the upper and lower distribution arrangements could instead be identical resulting in a device containing one type of distribution arrangements only.

[0054] With reference to Fig. 1a, in the device 1, each of the heat transfer plates 5 engages with a field gasket part 41, an upper distribution arrangement 69a and a lower distribution arrangement 69b on the back side 9, and with a sealing arrangement S on the front side 7. The field gasket parts 41 and the sealing arrangements S are, at least partly, arranged in grooves of the heat transfer plates 5, which are not illustrated or further described herein. With reference also to Fig. 2, the four annular ring sealing parts 47 of the sealing arrangement S enclose a respective one of the first, second, seventh and eight portholes 17, 27, 23 and 33 of the heat transfer plate 5. Further, with reference also to Fig. 3, the field gasket part 41 encloses the first, second, seventh and eight portholes 17, 27, 23 and 33 of the heat transfer plate 5. Further, with reference also to Figs. 4a and 4b, the back surface 81 of the slab 73 of each of the upper and lower distribution arrangements 69a and 69b faces the heat transfer plate 5 with the primary holes 83 and the secondary holes 85 of the upper and lower distribution arrangements 69a and 69b aligned with a respective one of the third, fourth, fifth and sixth portholes 19, 29, 21 and 31 of the heat transfer plate 5 and the first primary cavity gaskets 107 abutting the heat transfer plate 5 around a respective one of the first and second transfer holes 25 and 35 thereof. Further, in line with the above described, the cylinders 75 and 77 of the upper and lower distribution arrangements 69a and 69b project through the two adjacent heat transfer plates 5 arranged on the front surface 79 of the slab 73 so as to abut the back surface 93 of the base portion 71 of the adjacent upper and lower distribution arrangements 69a and 69b.

[0055] Fig. 6 illustrates, in a highly simplified way, what it looks like when several (here four) electrolyzer cells EC engage properly with each other in the device 1. With reference also to Figs. 4a and 4b, the primary hole gasket 103 and the secondary hole gasket 105 of an upper distribution arrangement 69a' seal against the back surface 93 of the base portion 71, around the holes h, of another upper distribution arrangement 69a", while the primary hole gasket 103 and the secondary hole gasket 105 of the upper distribution arrangement 69a" seal against the back surface 93 of the base portion 71, around the holes h, of yet another upper distribution arrangement 69a‴, etc. Thereby, the upper distribution arrangements 69a, just like the lower distribution arrangements 69b, and more particularly the cylinders 75 and 77 thereof, form two insulated tunnels or ports p (only one of them illustrated in Fig. 6) through the device 1, more particularly a second primary inlet port 57p, a second secondary inlet port 57s, a second primary outlet port 59p and a second secondary outlet port 59s, which will be further discussed below.

[0056] When the device 1 is ready for use, the heat transfer plates 5 and 5x and the interposed field gasket parts 41 and sealing arrangements S are compressed between the frame plates F so as to form the first and second flow channels C1 and C2 and also port means for conveying first and second fluids through the device 1. Compressed like that, the heat transfer plates 5 of each of the pairs, such as the heat transfer plates 5b and 5c, abut each other in contact areas, while contact between adjacent pairs of heat transfer plates 5, such as the heat transfer plates 5c and 5d, is prevented by the presence of the sealing arrangements S between the plate pairs. This separation or insulation between the plate pairs is necessary for the device 1 to work properly for electrolysis, which will be further discussed below. The compression is achieved by some kind of tightening means, such as bolts and nuts, which are not illustrated or further described herein. With reference to Fig. 3 which illustrates the heat transfer plates 5 of the device 1 of which only one is visible, the port means comprise first inlet port means 53 and first outlet port means 55 for the first fluid and second inlet port means 57 and second outlet port means 59 for the second fluid. In turn, the first inlet port means 53 comprises a first primary inlet port 53p and a first secondary inlet port 53s, the first outlet port means 55 comprises a first primary outlet port 55p and a first secondary outlet port 55s, the second inlet port means 57 comprises the second primary inlet port 57p and the second secondary inlet port 57s, and the second outlet port means 59 comprises the second primary outlet port 59p and the second secondary outlet port 59s.

[0057] With reference to Fig. 1a, the first fluid, which is a cooling fluid, for example deionized water, is fed into the device 1 via first inlet means 61 and out of the device 1 via first outlet means 63. The first inlet means 61 comprises a first primary inlet 61p and a first secondary inlet

61s, while the first outlet means 63 comprises a first primary outlet 63p and a first secondary outlet 63s. With reference to Fig. 1b, the second fluid, which is an electrolyte, for example a mixture of water and an alkaline agent, such as potassium hydroxide, is fed into the device 1 via second inlet means 65 and out of the device 1 via second outlet means 67. The second inlet means 65 comprises a second primary inlet 65p and a second secondary inlet 65s, while the second outlet means 67 comprises a second primary outlet 67p and a second secondary outlet 67s.

[0058] A first fluid path P1 for conveying the first fluid through the device 1 comprises a first primary fluid path P1p and a first secondary fluid path P1s. With reference to Figs. 1a and 3, and the dashed lines, the first primary fluid path P1p extends from the first primary inlet 61p, into the first primary inlet port 53p, through the first flow channels C1, into the first primary outlet port 55p and to the first primary outlet 63p. The first secondary fluid path P1s extends from the first secondary inlet 61s, into the first secondary inlet port 53s, through the first flow channels C1, into the first secondary outlet port 55s and to the first secondary outlet 63s. A second fluid path P2 for conveying the second fluid through the device 1 comprises a second primary fluid path P2p, which comprises the direct primary flow path DP and the first transferred primary flow paths TP1 (Figs. 4e and 4f) through each of the upper and lower distribution arrangements 69a and 69b, and a second secondary fluid path P2s, which comprises the direct secondary flow path DS and the first transferred secondary flow paths TS1 (Figs. 4g and 4h) through each of the upper and lower distribution arrangements 69a and 69b. With reference to Figs.1b and 3, and the dashed lines, the second primary fluid path P2p extends from the second primary inlet 65p, through the second primary inlet port 57p, i.e. through the lower distribution arrangements 69b along the direct primary flow path DP, through the lower distribution arrangements 69b and into the first interspaces I1 outside the first flow channels C1 along the first transferred primary flow paths TP1, through the respective first transfer hole 25 of every second one of the heat transfer plates, i.e. plates 5a, 5c,..., into the second primary sub channels C2P, through the second primary sub channels C2P, through the respective second transfer hole 35 of every second one of the heat transfer plates, i.e. plates 5a, 5c..., into the first interspaces I1 outside the first flow channels C1, through the upper distribution arrangements 69a along the first transferred primary flow paths TP1, through the upper distribution arrangements 69a along the direct primary flow path DP, i.e. through the second primary outlet port 59p, and to the second primary outlet 67p. The second secondary fluid path P2s extends from the second secondary inlet 65s, through the second secondary inlet port 57s, i.e. through the lower distribution arrangements 69b along the direct secondary flow path DS, through the lower distribution arrangements 69b and into the first interspaces I1 outside the first flow channels C1 along the first transferred secondary flow paths TS1, through the respective second transfer hole 35 of every second one of the heat transfer plates, i.e. plates 5b, 5d,..., into the second secondary sub channels C2S, through the second secondary sub channels C2S, through the respective first transfer hole 25 of every second one of the heat transfer plates, i.e. plates 5b, 5d,..., into the first interspaces I1 outside the first flow channels C1, through the upper distribution arrangements 69a along the first transferred secondary flow paths TS1, through the upper distribution arrangements 69a along the direct secondary flow path DS, i.e. through the second secondary outlet port 59s, and to the second secondary outlet 67s.

[0059] With reference again to Fig. 3, the first fluid, i.e. the cooling fluid, is conveyed through the device 1 in the ports 53s, 53p, 55s and 55p, while the second fluid, i.e. the electrolyte, is conveyed through the device 1 in the ports 57p, 57s, 59p and 59s. The ports 53s, 53p, 55s and 55p are arranged on a larger distance from a longitudinal center plane P of the device 1 than the ports 57p, 57s, 59p and 59s. This means that the cooling fluid is conveyed on the outside of the electrolyte.

[0060] Thus, a method for electrolysis is performed by means of the device 1. The method comprises the step of applying a current to the device 1 to turn every second one of the heat transfer plate of the device 1, including the heat transfer plates 5a and 5c, into anodes and the rest of the heat transfer plates of the device 1, including the heat transfer plates 5b and 5d, into cathodes. As mentioned above, sealing arrangements S insulating between the heat transfer plates 5 are arranged in the second interspaces I2 of the device 1, i.e. between the heat transfer plates 5a and 5b, and between the heat transfer plates 5c and 5d, etc., and split the second flow channels C2 into second primary sub channels C2P and second secondary sub channels C2S. Thereby, electrolysis may be performed within the second flow channels C2 of the device 1. As also explained above, the ports 57p, 57s, 59p and 59s for the second fluid, i.e. the electrolyte, are "lined" with plastic which minimizes the risk of short circuits between the heat transfer plates 5, which short circuits could cause malfunctioning of the device 1.

[0061] As described above, there are two fluid paths for the second fluid, i.e. the electrolyte, through the device 1. Accordingly, the method comprises the step of feeding a first part of the second fluid into the the first interspaces I1 outside the first flow channels C1 and through the first transfer holes 25 of the heat transfer plates 5a, 5c, etc., into the second primary sub channels C2P, and feeding a second part of the second fluid into the the first interspaces I1 outside the first flow channels C1 and through the second transfer holes 35 of the heat transfer plates 5b, 5d, etc., into the second secondary sub channels C2S. Further, the method comprises the step of feeding the first and second parts of the second fluid through the second flow channels C2, whereby water in the electrolyte is split into hydrogen and oxygen and a primary fraction is formed in the second primary sub channels C2P and a secondary fraction is formed in the second secondary sub channels C2S, the primary fraction containing more oxygen and less hydrogen than the second fraction. The primary fraction of the second fluid is fed through the second transfer holes 35 of the heat transfer plates 5a, 5c, etc. into the first interspaces I1 outside the first flow channels C1, while the secondary fraction of the second fluid is fed through the first transfer holes 25 of the heat transfer plates 5b, 5d, etc. into the first interspaces I1 outside the first flow channels C1. The primary and secondary fractions are separately discharged from the device 1 via the second primary outlet 67p and the second secondary outlet 67s, respectively. When electrolysis is performed in the second flow channels C2, heat is generated. The method comprises the step of feeding the first fluid, i.e. the deionized water, through the first flow channels C1, i.e. on both sides of the electrolysis channels C2, to effectively and uniformly divert the heat generated through the electrolysis from the device 1.

[0062] The primary and secondary fractions will typically contain a mixture of liquid and gas. By letting the first primary and secondary channels 99 and 101 join the primary and secondary holes 83 and 85 of the upper distributions arrangement 69a from above, the gas may be separated from the liquid already inside the second primary outlet port 59p and the second secondary outlet port 59s, which may improve the final gas-liquid separation of the primary and secondary fractions.

[0063] It should be stressed that the second fluid is referred to as second fluid even if its characteristics changes when it is fed through the device, and that both the primary fraction and the secondary fraction of the second fluid are referred to as second fluid even if their separate compositions vary and differ from each other and from the original second fluid.

[0064] It should be stressed that all components necessary to make the device work properly, such as power sources, connections, wiring, control units, valves, pumps, gaskets, sensors, pipes, dosing equipment, etc., are not described herein or illustrated in the figures. Further, characteristics of the different components of the device which are not relevant to the present invention are not described or illustrated herein.

[0065] Figs. 7a-7d illustrate an upper distribution arrangement 121a according to an alternative embodiment of the invention. The upper distribution arrangements 69a and 121a are quite similar. The main difference between them is as follows. The first primary cavity 95 and the first secondary cavity 97 of the upper distribution arrangement 121a are aligned with each other, i.e. arranged directly opposite one another in the back surface 93 and the front surface 89 of the base portion 71. The first primary channels 99 extend between the back surface 81 of the slab 73 and the intermediate extension plane IP while the first secondary channels 101 extend between the front surface 79 of the slab 73 and the intermediate extension plane IP, which allows them to cross each other, as is illustrated in Fig. 7d.

[0066] Fig. 8a illustrates a part of another device 2 used for producing hydrogen through electrolysis. There are a lot of similarities between the devices 1 and 2 and the above description is, to a large extent, valid also for the device 2. Therefore, hereinafter, the differences of the device 2 as compared to the device 1 will be focused on. The device 2 comprises a stack 3 (only partly illustrated) of heat transfer plates 5 of first and second types of which one is separately illustrated in Fig. 9. A first end portion 11 of the heat transfer plate 5 comprises a first porthole 17, a third porthole 19 a fifth porthole 21 and a first transfer hole 25, while a second end portion 15 of the heat transfer plate 5 comprises a second porthole 27, a fourth porthole 29, a sixth porthole 31 and a second transfer hole 35. Every second one of the heat transfer plates 5 in the stack 3 is of the first type illustrated in figure 9, while the rest of the heat transfer plates 5 in the stack 3 are of the second type which is similar to the first type except for that it has the first and second transfer holes 25 and 35 arranged on the opposite side of the longitudinal center axis L.

[0067] With reference again to Fig. 8a, just like in the device 1, the heat transfer plates 5 of the device 2 define first interspaces I1 and second interspaces I2. An annular field gasket part 41 is arranged within each of the first interspaces I1 to define a first flow channel C1 therein. Arranged within each of the first interspaces I1 are also two upper distribution arrangements 123a and two lower distribution arrangement 123b which are all similar. An annular field sealing part 43 is arranged within each of the second interspaces I2 to define a second flow channel C2 therein. A membrane 45 within each of the second interspaces I2 splits the second flow channel C2 in a second primary sub channel C2P and a second secondary sub channel C2S. The field sealing part 43 and the separation means comprising the membrane 45 are parts of a sealing arrangement S which also comprises two annular ring sealing parts 47 formed integrally with the field sealing part 43 and an insulating rubber sheet (not illustrated herein). The rubber sheet extends on an outside of the field sealing part 43 and the ring sealing parts 47 and is arranged to prevent contact between the heat transfer plates arranged on the opposite sides of the rubber sheet.

[0068] With reference to Fig. 10, the field gasket part 41 comprises first and second long side portions ls1 and ls2, and first and second short side portions ss1 and ss2 connecting the first and second long side portions ls1 and ls2 at a first end E1 and a second end E2, respectively, of the field gasket part 41. At the first end E1, the field gasket part 41, or more particularly the first short side portion ss1 thereof, is bent so as to extend between the two upper distribution arrangements 123a. At the second end E2 , the field gasket part 41, or more particularly the second short side portion ss2 thereof, is bent so as to extend between the lower distribution arrangements 123b.

[0069] One of the upper distribution arrangement 123a is separately illustrated in Figs. 11a and 11b. It comprises a base portion 71 consisting of a slab 73 and a cylinder 77. A hole h extends through the slab 73 and the cylinder 77 project from a front surface 79 of the slab 73 and enclose the hole h to define a secondary hole 85 through the base portion 71. A free end surface of the cylinder 77 forms an elevated annular secondary sub-surface 91 of a front surface 89 of the base portion 71.

[0070] Further, the base portion 71 comprises a non-through first secondary cavity 97 extending through the front surface 89, of the base portion 71. The base portion 71 further comprises a plurality of first secondary channels 101 (one of which is schematically illustrated with a dashed line) extending in an intermediate extension plane located halfway between the front surface 79 and a back surface 81 of the slab 73. Each of the first secondary channels 101 connects the secondary hole 85 and the first secondary cavity 97. There are a plurality of different flow paths through the upper distribution arrangement 123a; a direct secondary flow path DS defined by the secondary hole 85, and first transferred secondary flow paths TS1 defined by each of the first secondary channels together with the secondary hole 85 and the first secondary cavity 97.

[0071] The distribution arrangement 123a further comprises an annular secondary hole gasket 105, which extends around the secondary hole 85 and seals against the secondary sub-surface 91, and an annular first secondary cavity gasket 109, which extends around the first secondary cavity 97 and seals against the front surface 89 of the base portion 71.

[0072] With reference to Figs. 8a, 9 and 10, in the device 2, the two annular ring sealing parts 47 of the sealing arrangement S, and the field gasket part 41 enclose the first and second portholes 17 and 27 of each of the heat transfer plates 5 on opposite sides thereof. Further, with reference also to Figs. 11a and 11b, the upper distribution arrangements 123a, just like the lower distribution arrangements, are so arranged that one of them faces the heat transfer plates 5a, 5c, etc. with the back surface 81 of the slab 73, and the other one with the front surface 79 of the slab 73. The secondary holes 85 of the upper and lower distribution arrangements 123a and 123b are aligned with a respective one of the third, fourth, fifth and sixth portholes 19, 21, 29 and 31. Further, the first secondary cavities 97 of one of the upper and one of the lower distribution arrangements 123a and 123b are aligned with, with the corresponding first secondary cavity gasket 109 surrounding, a respective one of the first and second transfer holes 25 and 35. Further, each of the upper and lower distribution arrangements 123a and 123b projects, with the cylinder 77 and the gasket 105, through the heat transfer plate 5 facing the front surface 79 of the slab 73 and the next heat transfer plate 5 so as to abut the next upper and lower distribution arrangements 123a and 123b and form a total of four insulated ports through the device 2, more particularly a second primary inlet port 57p, a second secondary inlet port 57s, a second primary outlet port 59p and a second secondary outlet port 59s.

[0073] The device 2 comprises port means for conveying first and second fluids through the device 2. With reference to Fig. 10, the port means comprise first inlet port means 53 and first outlet port means 55 for the first fluid and second inlet port means 57 and second outlet port means 59 for the second fluid. Here, the first inlet port means 53 do not comprise first primary and secondary inlet ports, but only one single inlet port. Similarly, here, the first outlet port means 55 do not comprise first primary and secondary outlet ports, but only one single outlet port. However, the second inlet port means 57 comprises the second primary inlet port 57p and the second secondary inlet port 57s, and the second outlet port means 59 comprises the second primary outlet port 59p and the second secondary outlet port 59s.

[0074] With reference to Fig. 8a, the first fluid is fed into the device 2 via first inlet means 61 and out of the device 2 via first outlet means 63. Here, the first inlet means 61 do not comprise first primary and secondary inlets, but only one single inlet. Similarly, here, the first outlet means 63 do not comprise first primary and secondary outlets, but only one single outlet. With reference to Fig. 8b, the second fluid is fed into the device 2 via second inlet means 65 and out of the device 1 via second outlet means 67. The second inlet means 65 comprises a second primary inlet 65p and a second secondary inlet 65s, while the second outlet means 67 comprises a second primary outlet 67p and a second secondary outlet 67s.

[0075] There is one single first fluid path P1 for conveying the first fluid through the device 2. With reference to Figs. 8a and 10, and the dashed lines, the first fluid path P1 extends from the first inlet 61, into the first inlet port 53, through the first flow channels C1, into the first outlet port 55 and to the first outlet 63. A second fluid path P2 for conveying the second fluid through the device 1 comprises a second primary fluid path P2p and a second secondary fluid path P2s. A second fluid path P2 for conveying the second fluid through the device 2 comprises a second primary fluid path P2p, which comprises the direct secondary flow path DS and the first transferred secondary flow paths TS1 through, as seen from the frame plate F, each of the right upper and right lower distribution arrangements 123a and 123b, and a second secondary fluid path P2s, which comprises the direct secondary flow path DS and the first transferred secondary flow paths TS1 through, as seen from the frame plate F, each of the left upper and lower distribution arrangements 123a and 123b. With reference to Figs.8b and 10, and the dashed lines, the second primary fluid path P2p extends from the second primary inlet 65p, through the second primary inlet port 57p, i.e. through the right lower distribution arrangements 123b along the direct secondary flow path DS, through the right lower distribution arrangements 123b and into the first interspaces I1 outside the first flow channels C1 along the first transferred secondary flow paths TS1, through the respective first transfer hole 25 of every second one of the heat transfer plates, i.e. plates 5a, 5c,..., into the second primary sub channels C2P, through the second primary sub channels C2P, through the respective second transfer hole 35 of every second one of the heat transfer plates, i.e. plates 5a, 5c..., into the first interspaces I1 outside the first flow channels C1, through the right upper distribution arrangements 123a along the first transferred secondary flow paths TS1, through the right upper distribution arrangements 123a along the direct primary flow path DS, i.e. through the second primary outlet port 59p, and to the second primary outlet 67p. The second secondary fluid path P2s extends from the second secondary inlet 65s, through the second secondary inlet port 57s, i.e. through the left lower distribution arrangements 123b along the direct secondary flow path DS, through the left lower distribution arrangements 123b and into the first interspaces I1 outside the first flow channels C1 along the first transferred secondary flow paths TS1, through the respective second transfer hole 35 of every second one of the heat transfer plates, i.e. plates 5b, 5d,..., into the second secondary sub channels C2S, through the second secondary sub channels C2S, through the respective first transfer hole 25 of every second one of the heat transfer plates, i.e. plates 5b, 5d,..., into the first interspaces I1 outside the first flow channels C1, through the left upper distribution arrangements 123a along the first transferred secondary flow paths TS1, through the left upper distribution arrangements 123a along the direct secondary flow path DS, i.e. through the second secondary outlet port 59s, and to the second secondary outlet 67s.

[0076] With reference again to Fig. 10, the first fluid is conveyed through the device 2 in the ports 53 and 55, while the second fluid is conveyed through the device 2 in the ports 57p, 57s, 59p and 59s. The ports 57p, 57s, 59p and 59s are arranged on a larger distance from a longitudinal center plane P of the device 2 than the ports 53 and 55. This means that the second fluid is conveyed on the outside of the first fluid.

[0077] Figs. 12a and 12b schematically illustrates an upper distribution arrangement 125a, from a front and a back, respectively, according to an alternative embodiment of the invention, which may be used in connection with a heat transfer plate 5 according to Fig. 9. Just like the upper distribution arrangement 69a, the upper distribution arrangement 125a comprises a plastic base portion 71 provided with a primary hole 83, a secondary hole 85, a first primary cavity 95, a first secondary cavity 97, first primary channels 99 (one of them schematically illustrated with dashed line) and first secondary channels 101 (one of them schematically illustrated with dashed line). Additionally, the upper distribution arrangement 125a comprises a non-through second primary cavity 96 which extends through the back surface 93 of the base portion 71, and a non-through second secondary cavity 98 which extends through a front surface 89 of the base portion 71. A plurality of second primary channels 104 (one of them schematically illustrated with dashed line) connect the primary hole 83 and the second primary cavity 96 so as to form a respective second transferred primary flow path TP2 through the upper distribution arrangement 125a. A plurality of second secondary channels 106 (one of them schematically illustrated with dashed line) connect the secondary hole 85 and the second secondary cavity 98 so as to form a respective second transferred secondary flow path TS2 through the upper distribution arrangement 125a. All the first primary channels 99, the second primary channels 104, the first secondary channels 101 and the second secondary channels 106 extend in an intermediate plane extending halfway between the front and back surfaces 79 and 81 of a slab 73 of the base portion 71. With reference also to Fig. 12c, the first primary channels 99 and the second primary channels 104 extend on one side of a partition wall W while the first secondary channels 101 and the second secondary channels 106 extend on another side of the partition wall W. As is clear form Fig. 12b, the first and second primary cavities 95 and 96 are arranged on opposite sides of a longitudinal center axis I1 of the upper distribution arrangement 125a so as to enable a uniform distribution of the second fluid in the second primary sub channels C2P of a device similar to the device 2. Similarly, as is clear from Fig. 12a, the first and second secondary cavities 97 and 98 are arranged on opposite sides of the longitudinal center axis I1 of the upper distribution arrangement 125a so as to enable a uniform distribution of the second fluid in the second secondary sub channels C2S of a device similar to the device 2.

[0078] Figs. 13a and 13b schematically illustrates an upper distribution arrangement 127a, from a front and a back, respectively, according to an alternative embodiment of the invention. The upper distribution arrangements 125a and 127a are quite similar. The main difference between them is as follows. The first primary cavity 95 and second secondary cavity 98 of the upper distribution arrangement 127a are aligned with each other, i.e. arranged directly opposite one another in the back surface 93 and the front surface 89 of the base portion 71. Further, the second primary cavity 96 and first secondary cavity 97 of the upper distribution arrangement 127a are aligned with each other. The first primary channels 99 and the second primary channels 104 extend between the back surface 81 of the slab 73 and the intermediate extension plane while the first secondary channels 101 and the second secondary channels 106 extend between the front surface 79 of the slab 73 and the intermediate extension plane.

[0079] Naturally, also the upper distribution arrangements 125a and 127a comprises gaskets, etc., necessary for their proper functioning, even if not illustrated or further discussed herein.

[0080] The above described embodiments of the present invention should only be seen as examples. A person skilled in the art realizes that the embodiments discussed can be varied in a number of ways without deviating from the inventive conception.

[0081] As an example, the cylinders 75 and 77 of the upper distribution arrangement 69a have a height enough for the the cylinders 75 and 77 to be able to project through two heat transfer plates 5. The upper distribution arrangement 69a could instead be so configured that the two cylinders 75 and 77 are half as high, and that two additional equally high cylinders, arranged aligned with a respective one of the cylinders 75 and 77, project from the the back surface 81 of the slab 73. These four cylinders could be arranged to pairwise project through the heat transfer plates 5 arranged on the opposite sides of the upper distribution arrangement 69a.

[0082] The secondary and/or primary holes of the distribution arrangements need not be circular but may have any suitable form, such as oval or polygonal. The cavity or cavities of the distribution arrangement need not be elongate but may have any suitable form, such as circular.

[0083] The distribution arrangement may be comprised in a device used for another type of electrolysis than alkaline water electrolysis, for example chlor-alkali electrolysis. Further, the distribution arrangement may be comprised in a device for other applications than electrolysis, for example a device in the form of a fuel cell. It should be stressed that the attributes first, second, third, ... , primary, secondary, upper, lower, and A, B, C, ... , etc. are used herein just to distinguish between species and not to express any kind of mutual order between, or attribute any special characteristics to, the species. Thus, as is clear from the above, a distribution arrangement according to the invention may comprise a secondary hole and a first secondary cavity but no primary hole and no first primary cavity, etc.

[0084] It should be stressed that "receiving", "feeding", "communicating" etc., throughout the text, means "receiving directly or indirectly" and "feeding directly or indirectly" and "communicating directly or indirectly", respectively.

[0085] It should be stressed that all axes and planes referred to herein are imaginary.

[0086] It should be stressed that a description of details not directly relevant to the present invention has been omitted and that the figures are just schematic and not drawn according to scale. It should also be said that some of the figures have been more simplified than others. Therefore, some components may be illustrated in one figure but left out on another figure.

Claims

1. A distribution arrangement (69a, 69b, 121a, 123a, 125a, 127a) configured to be positioned between two corrugated heat transfer plates (5), the distribution arrangement (69a, 69b) comprising a base portion (71) including a slab (73) with opposing front and back surfaces (79, 81) arranged to face a respective one of the heat transfer plates (5), an intermediate extension plane (IP) of the slab (73) extending between the front and back surfaces (79, 81) of the slab (73), a front surface (89) and a back surface (93) of the base portion (71) comprising at least a part of the front surface (79) and the back surface (81), respectively, of the slab (73), the base portion (71) being provided with a through secondary hole (85) which extends through the front and back surfaces (89, 93) of the base portion (71) so as to form a direct secondary flow path (DS) through the base portion (71), a non-through first secondary cavity (97) which extends through the front surface (89) of the base portion (71), and at least one first secondary channel (101) extending inside the slab (73), said at least one first secondary channel (101) connecting the secondary hole (85) and the first secondary cavity (97) to form a first transferred secondary flow path (TS1) through the base portion (71), an annular secondary sub-surface (91) of the front surface (89) of the base portion (71) enclosing the secondary hole (85).

2. A distribution arrangement (69a, 69b, 121a, 123a, 125a, 127a) according to claim 1, wherein the base portion (71) at least partly is made of at least one insulating material.

3. A distribution arrangement (69a, 69b, 121a, 123a) according to any of the preceding claims, further comprising a secondary hole gasket (105) enclosing said secondary hole (85) and sealing against the secondary sub-surface (91) of the front surface (89) of the base portion (71), and a first secondary cavity gasket (109) enclosing said first secondary cavity (97) and sealing against the front surface (89) of the base portion (71).

4. A distribution arrangement (69a, 69b, 121a, 123a) according to any of the preceding claims, wherein said secondary sub-surface (91) is elevated in relation to the rest of the front surface (89) of the base portion (71).

5. A distribution arrangement (69a, 69b, 121a, 125a, 127a) according to any of the preceding claims, wherein the base portion (71) is provided with a through primary hole (83) which extends through the front and back surfaces (89, 93) of the base portion (71) so as to form a direct primary flow path (DP) through the base portion (71), a non-through first primary cavity (95) which extends through the back surface (93) of the base portion (71), and at least one first primary channel (99) extending inside the slab (73), said at least one first primary channel (99) connecting the primary hole (83) and the first primary cavity (95) to form a first transferred primary flow

path (TP1) through the base portion (71), an annular primary sub-surface (87) of the front surface (89) of the base portion (71) enclosing the primary hole (83).

6. A distribution arrangement (69a, 69b, 121a) according to claim 5, further comprising a primary hole gasket (103) enclosing said primary hole (83) and sealing against the primary sub-surface (87) of the front surface (89) of the base portion (71), and a first primary cavity gasket (107) enclosing said first primary cavity (95) and sealing against the back surface (93) of the base portion (71).

7. A distribution arrangement (121a) according to any of claims 5-6, wherein the first secondary cavity (97) is aligned with the first primary cavity (95).

8. A distribution arrangement (69a, 69b, 125a, 127a) according to any of claims 5-6, wherein the first secondary cavity (97) is displaced from the first primary cavity (95).

9. A distribution arrangement (121a, 127a) according to any of claims 5-8, wherein said at least one first secondary channel (101) extends between the front surface (79) of the slab (73) and the intermediate extension plane (IP) of the slab (73), and said at least one first primary channel (99) extends between the back surface (81) of the slab (73) and the intermediate extension plane (IP) of the slab (73).

10. A distribution arrangement (125a, 127a) according to any of claims 5-9, wherein the base portion (71) is provided with a non-through second secondary cavity (98) which extends through the front surface (89) of the base portion (71), and at least one second secondary channel (106) extending inside the slab (73), said at least one second secondary channel (106) connecting the secondary hole (85) and the second secondary cavity (98) to form a second transferred secondary flow path (TS2) through the base portion (71), and wherein the base portion (71) is provided with a non-through second primary cavity (96) which extends through the back surface (93) of the base portion (71), and at least one second primary channel (104) extending inside the slab (73), said at least one second primary channel (104) connecting the primary hole (83) and the second primary cavity (96) to form a second transferred primary flow path (TP2) through the base portion (71).

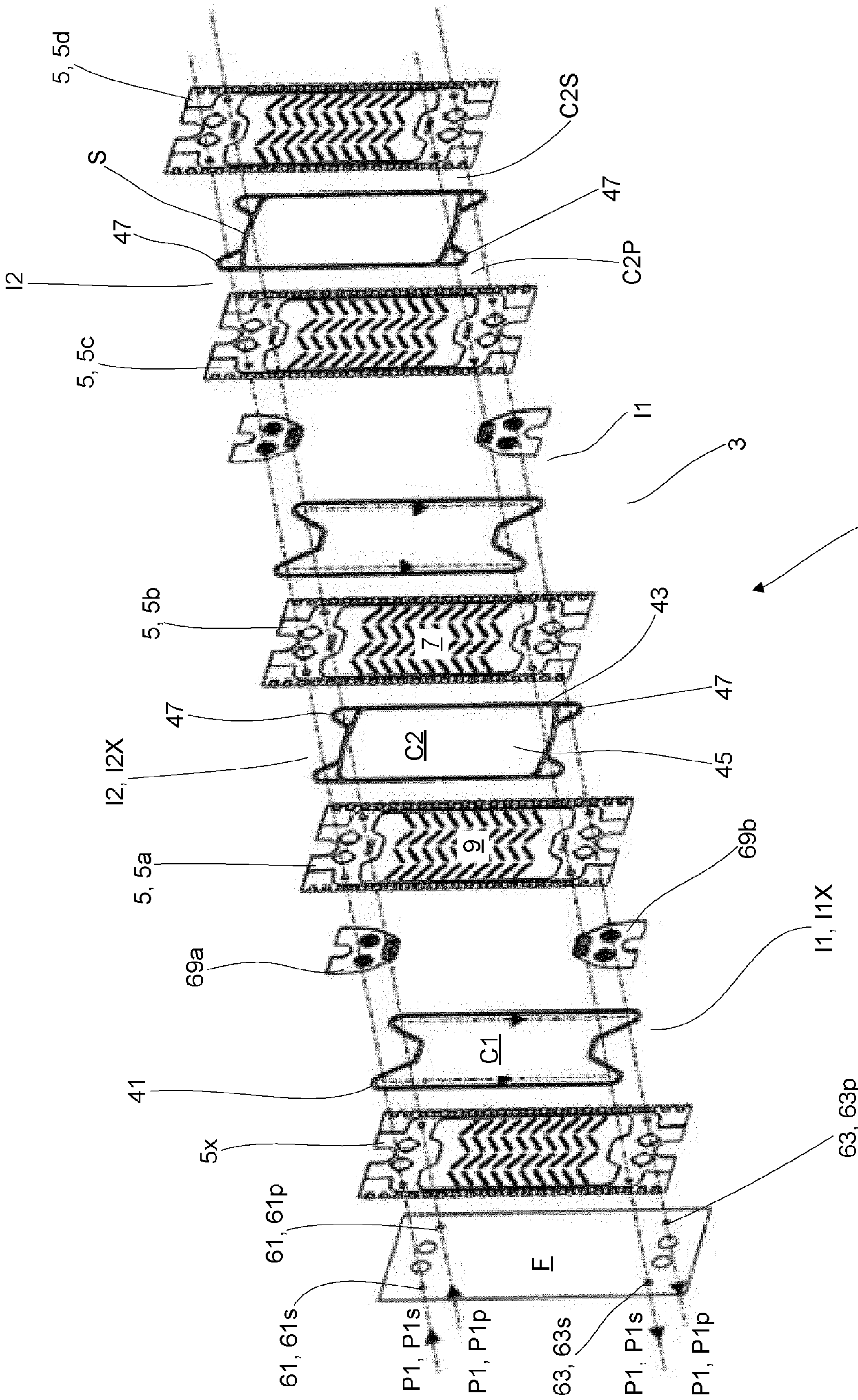
11. A distribution arrangement (127a) according to claim 10, wherein the first secondary cavity (97) and the second secondary cavity (98) are aligned with the second primary cavity (96) and the first primary cavity (95), respectively.

12. A distribution arrangement (127a) according to any of claims 10-11, wherein said at least one first secondary channel (101) and said at least one second secondary channel (106) extend between the front surface (79) of the slab (73) and the intermediate extension plane (IP) of the slab (73), and said at least one first primary channel (99) and said at least one second primary channel (104) extend between the back surface (81) of the slab (73) and the intermediate extension plane (IP) of the slab (73).

13. A distribution arrangement (69a) according to any of the preceding claims, wherein the slab (73) comprises an inner wall (84) enclosing the secondary hole (85), which inner wall (84) comprises first and second halves (86, 88) which extend on opposite sides of a hole center plane (CP) dividing the secondary hole (85) in half, which hole center plane (CP) extends perpendicular to the intermediate extension plane (IP) of the slab (73), the first half (86) of the inner wall (84) of the slab (73) being arranged further away from the first secondary cavity (97) than the second half (88) of the inner wall (84) of the slab (73), and wherein said at least one first secondary channel (101) extends from an opening (100) in the first half (86) of the inner wall (84) of the slab (73).

14. A distribution arrangement (69a, 69b, 121a) according to any of the preceding claims, wherein the slab (73) comprises a bar engagement recess (111).

15. A distribution arrangement (69a, 69b) according to any of the preceding claims, further comprising snap fitting means (115) projecting from the front surface (79) of the slab (73) around said annular secondary sub-surface (91) of the front surface (89) of the base portion (71), said snap fitting means (115) being arranged to engage with locking means (119) of one of said heat transfer plates (5) to connect the distribution arrangement (69a, 69b) to said one of the heat transfer plates (5).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I2
C2S
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C2P
5, 5c
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5, 5b
7
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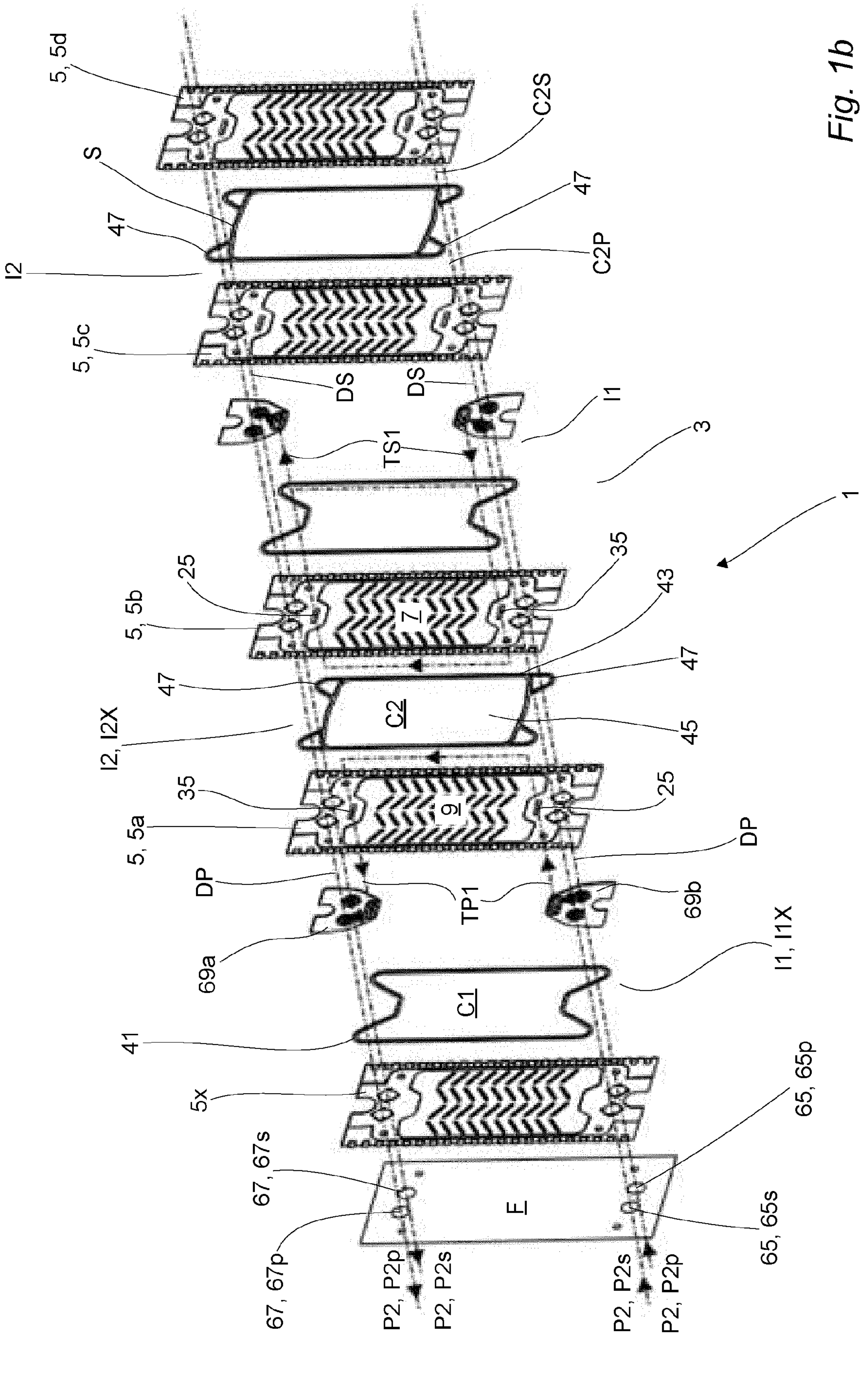
47
C2
I2, I2X
45
5, 5a
9
69b
69a
I1, I1X
C1
41
5x
63, 63p
61, 61p
E
61, 61s
63, 63s
P1, P1s
P1, P1p
P1, P1s
P1, P1p

Fig. 1a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Z
35
43
47
47
I2, I2X
C2
45
35
5, 5a
9
25
DP
DP
TP1
69b
69a
I1, I1X
C1
41
5x
65, 65p
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P2, P2s
P2, P2s
P2, P2p

Fig. 1b

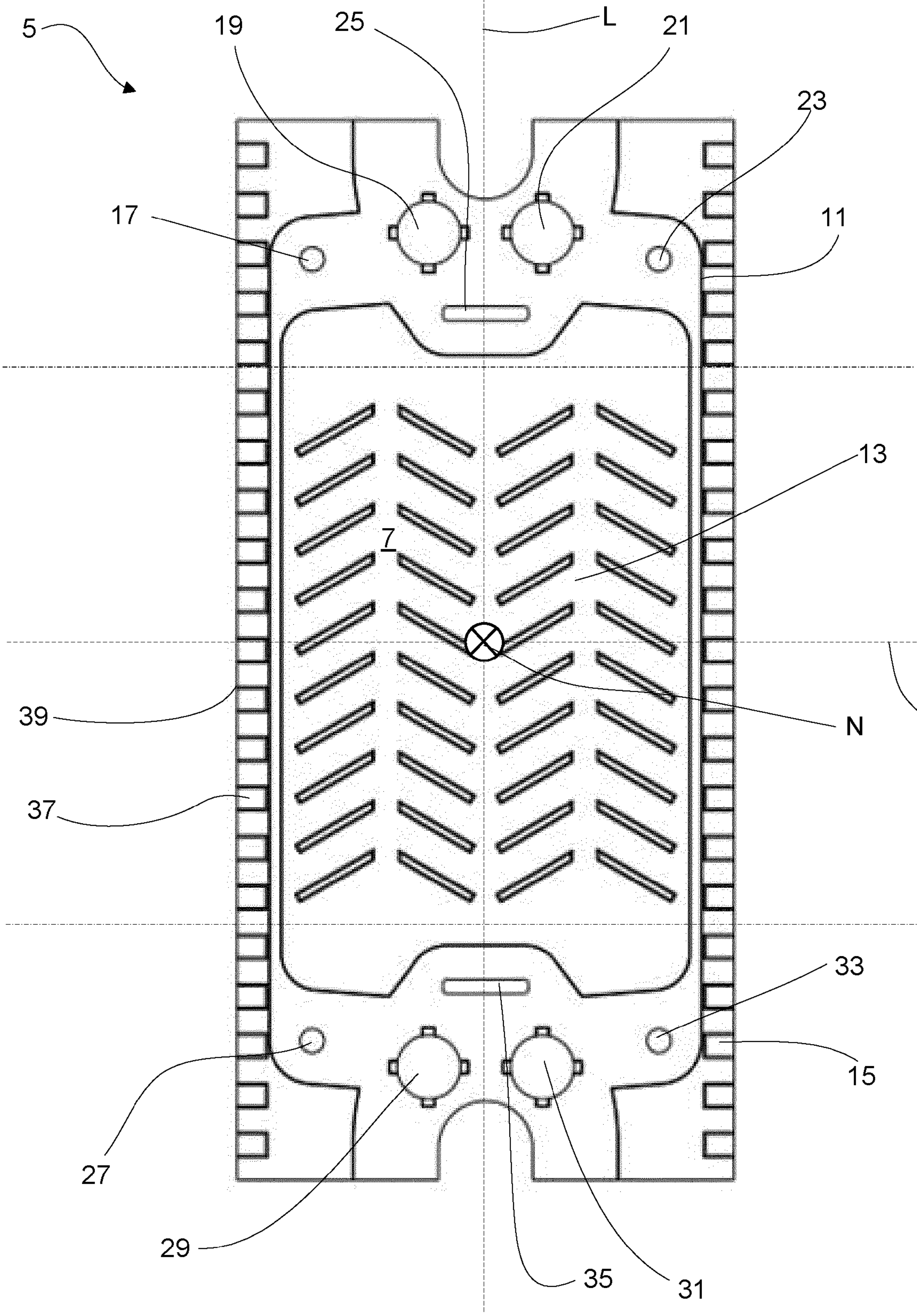
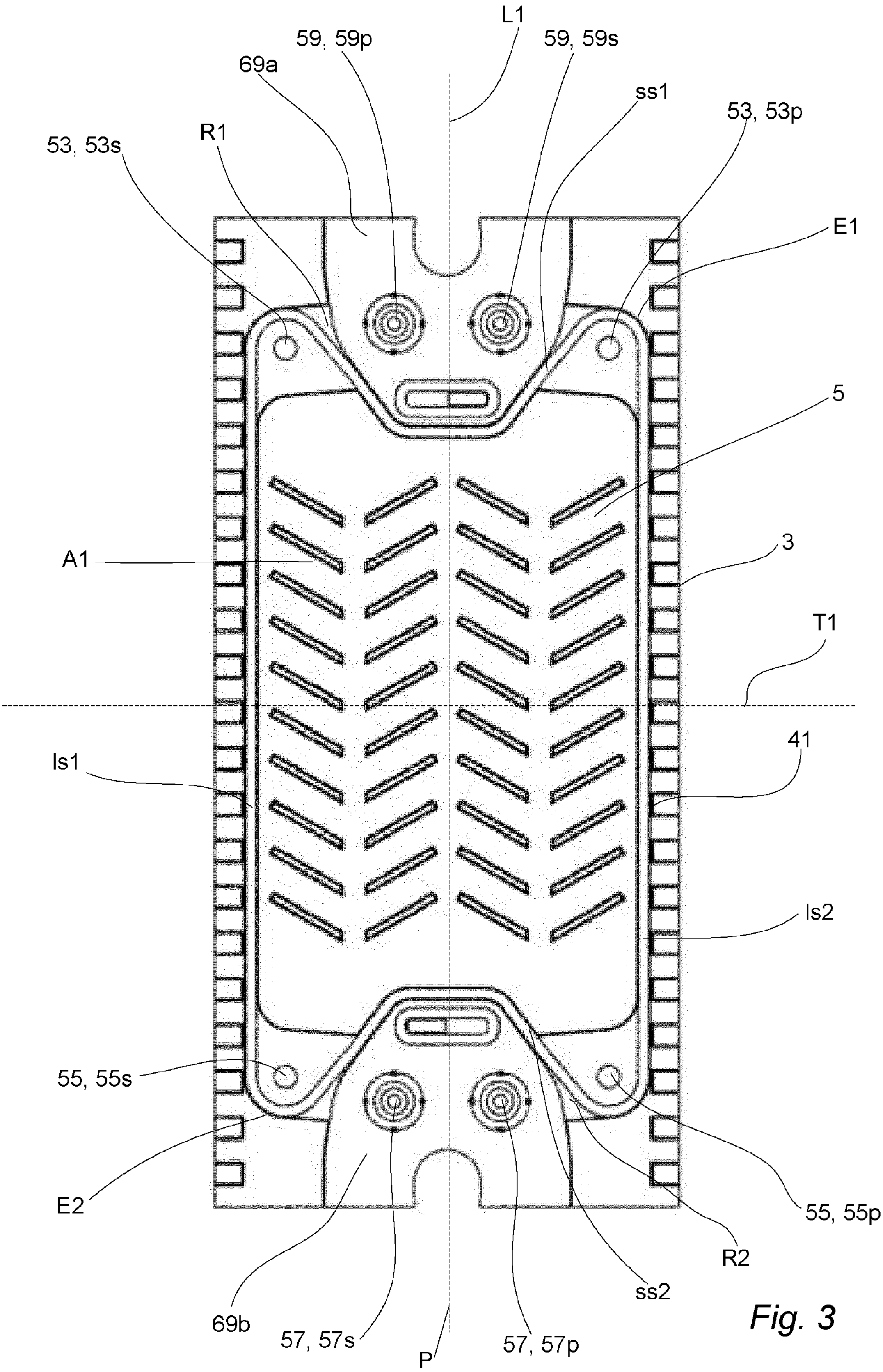


Fig. 2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R1
E1
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A1
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T1
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ls2
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E2
55, 55p
R2
ss2
69b
57, 57s
P
57, 57p

Fig. 3

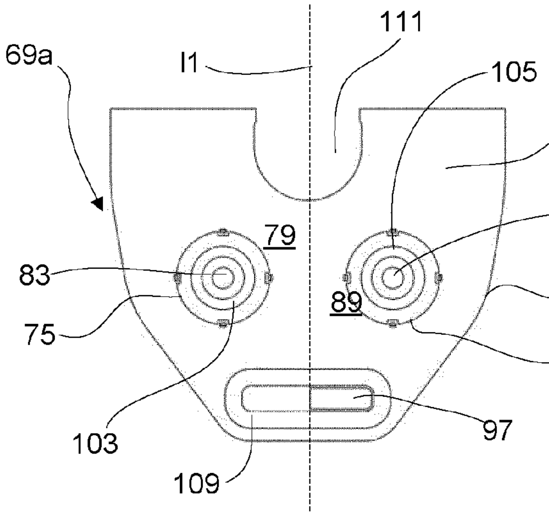


Fig. 4a

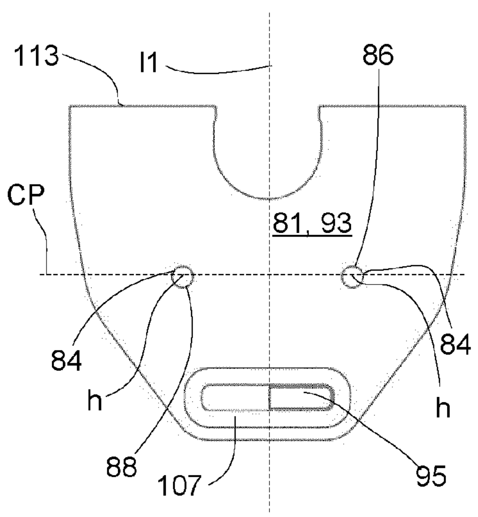


Fig. 4b

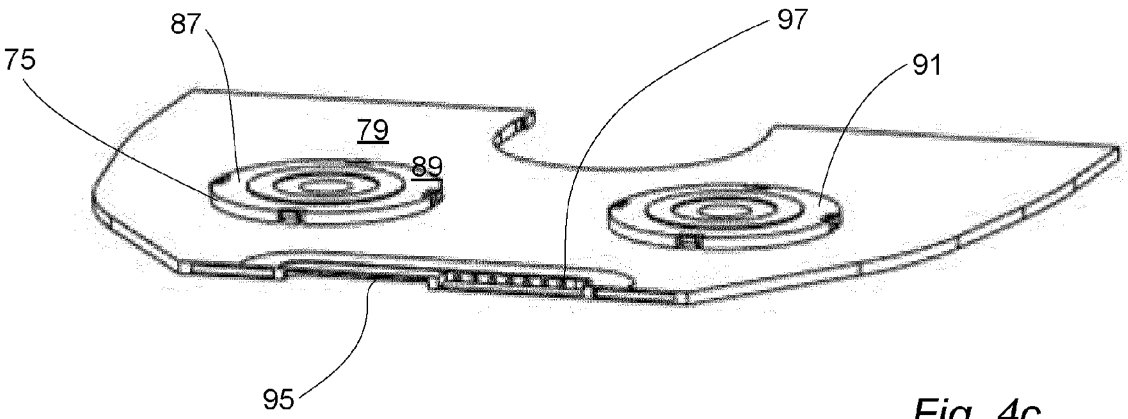


Fig. 4c

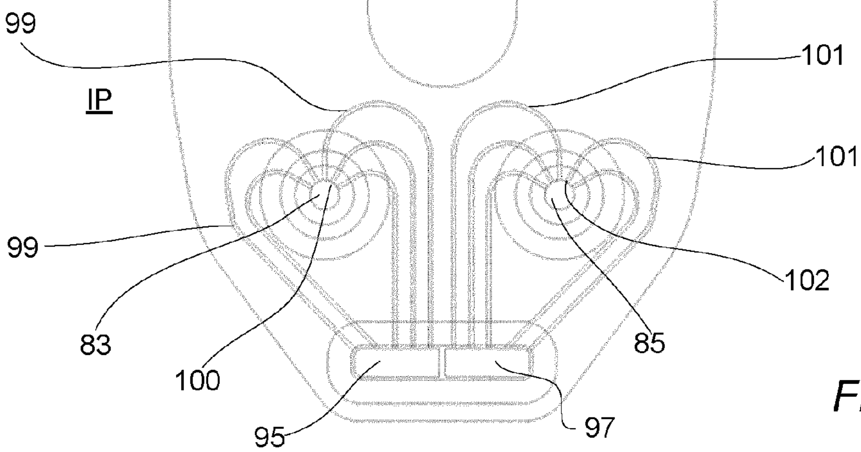


Fig. 4d

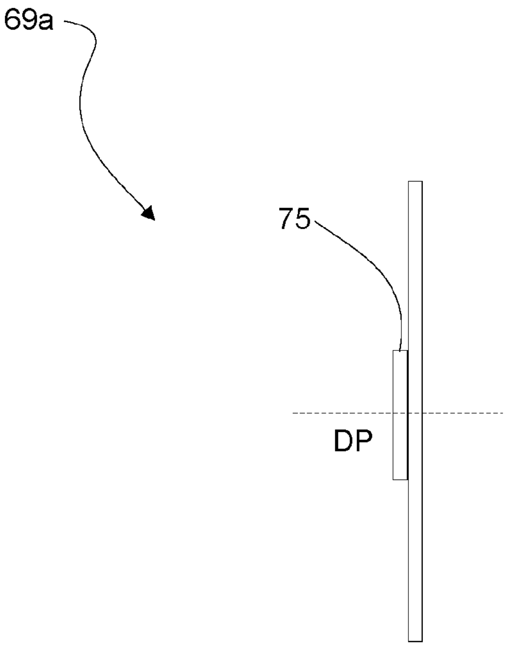


Fig. 4e

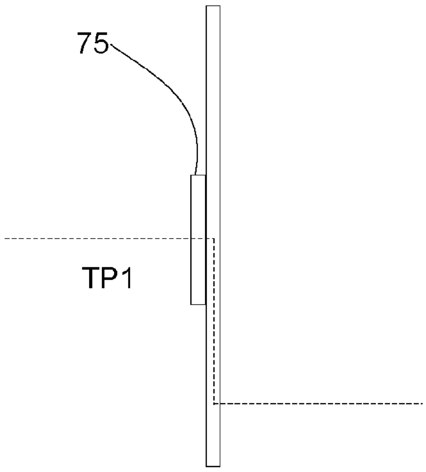


Fig. 4f

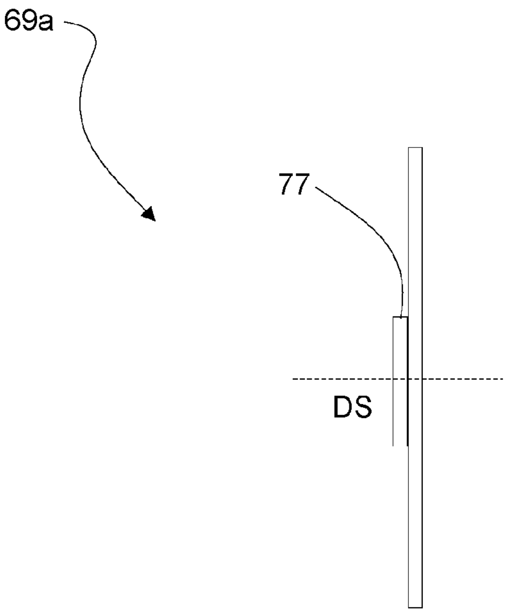


Fig. 4g

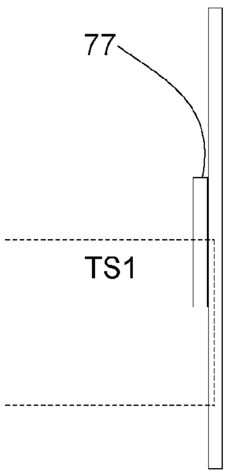


Fig. 4h

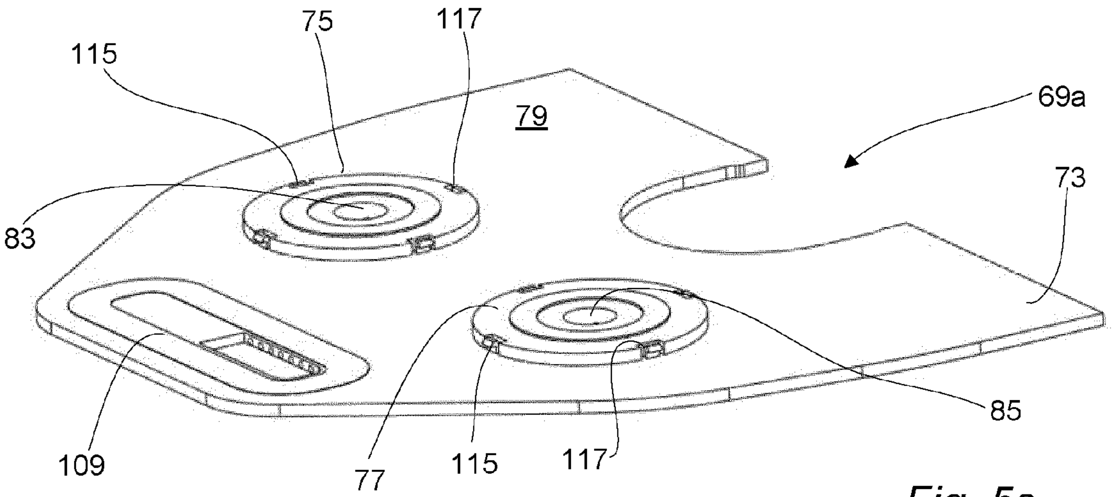


Fig. 5a

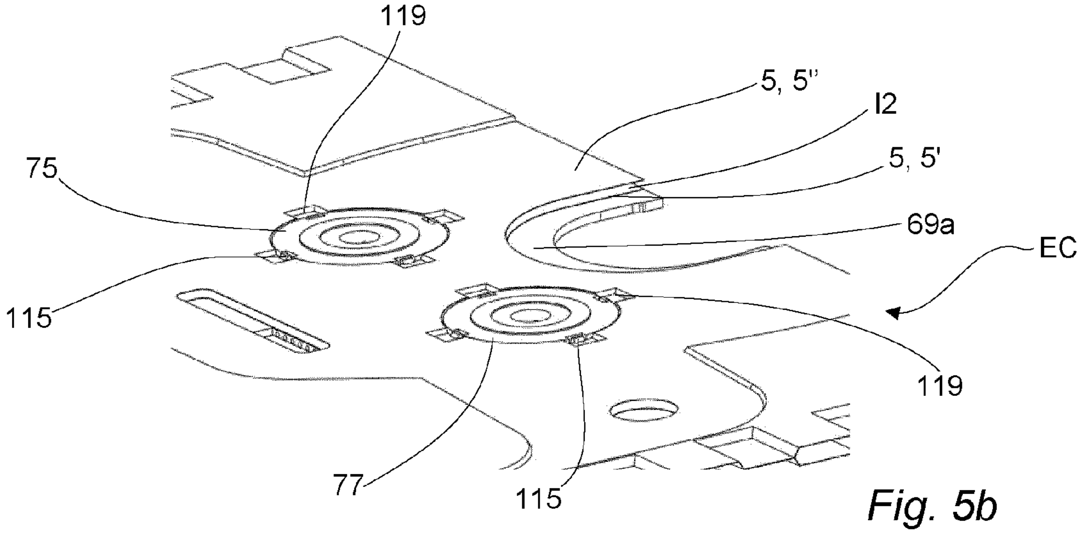


Fig. 5b

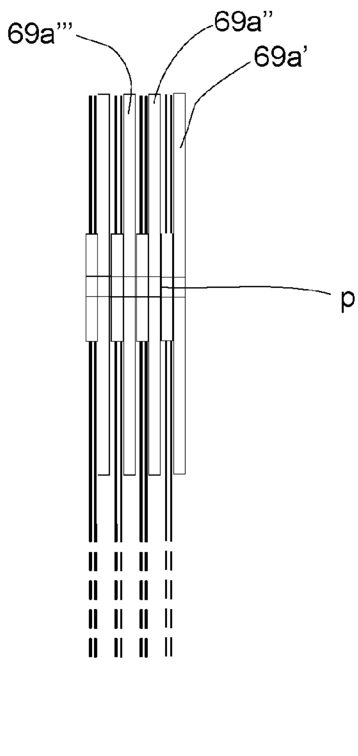
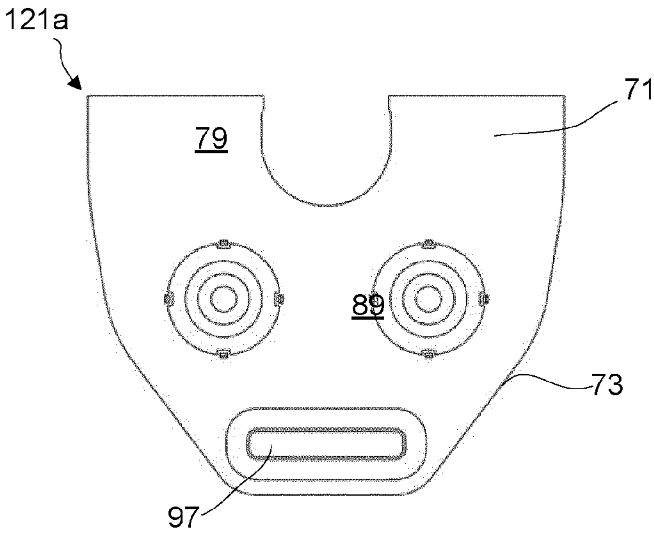


Fig. 6



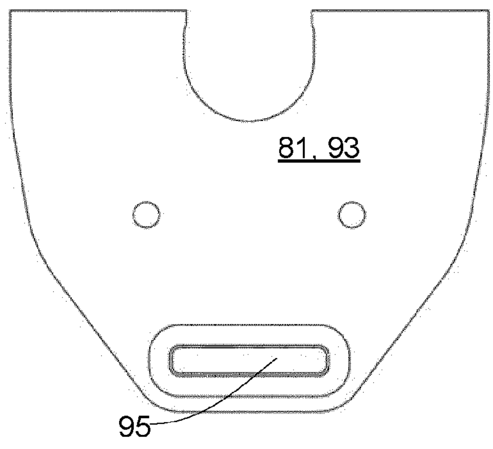


Fig. 7a

Fig. 7b

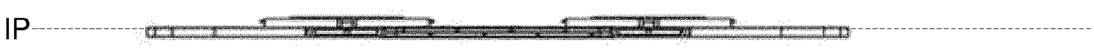


Fig. 7c

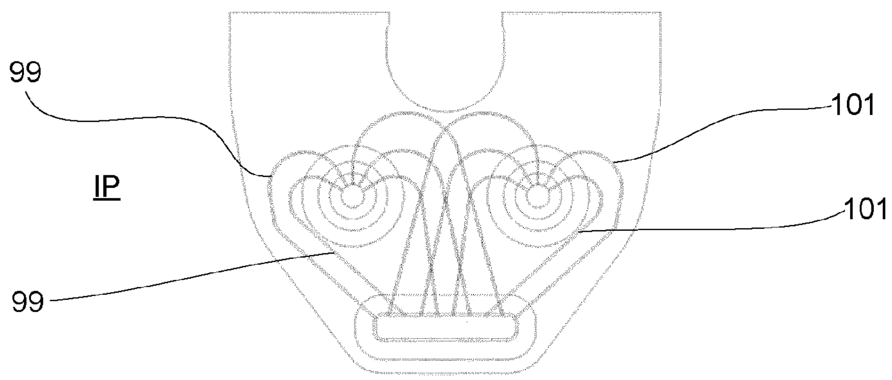
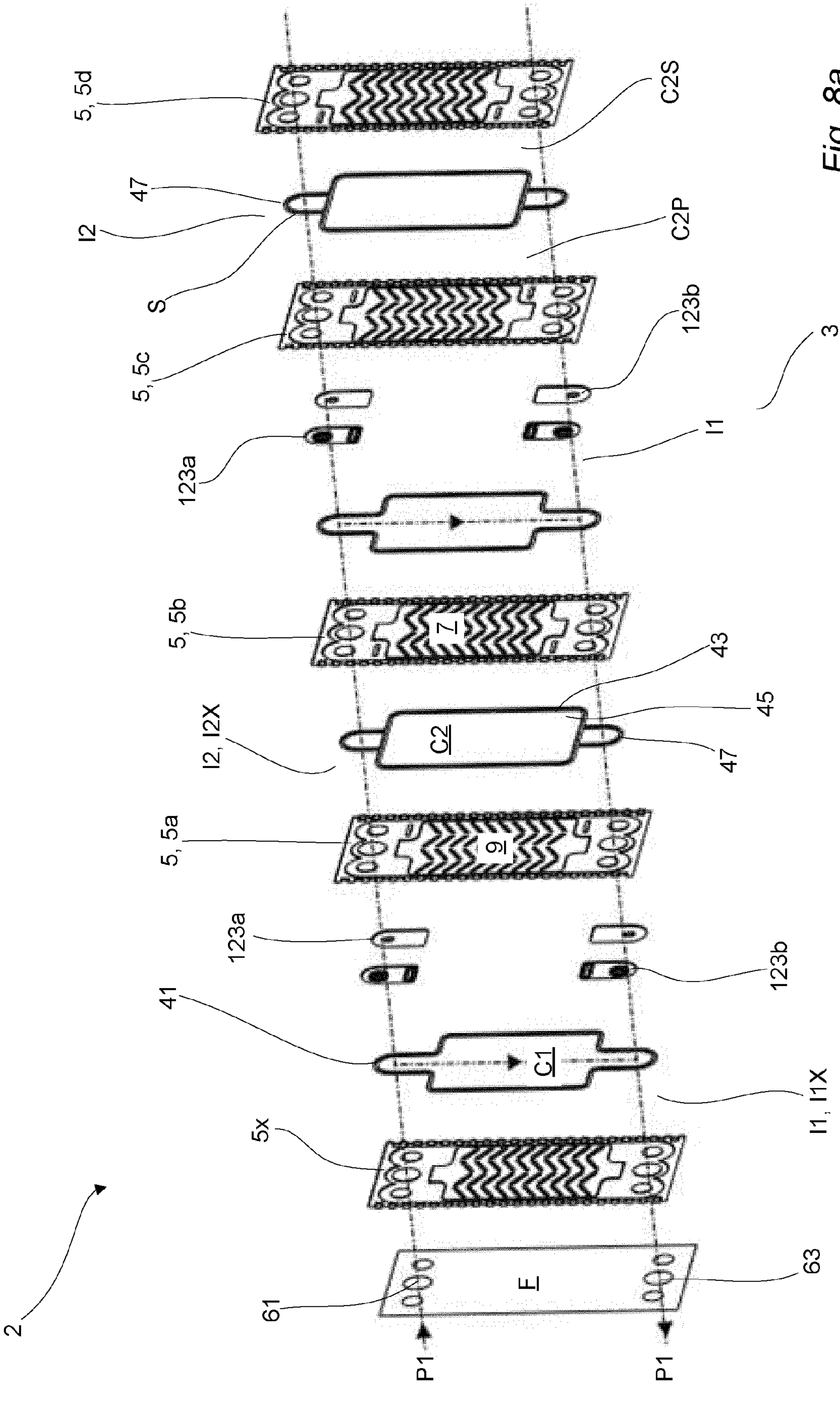


Fig. 7d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C2
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5x
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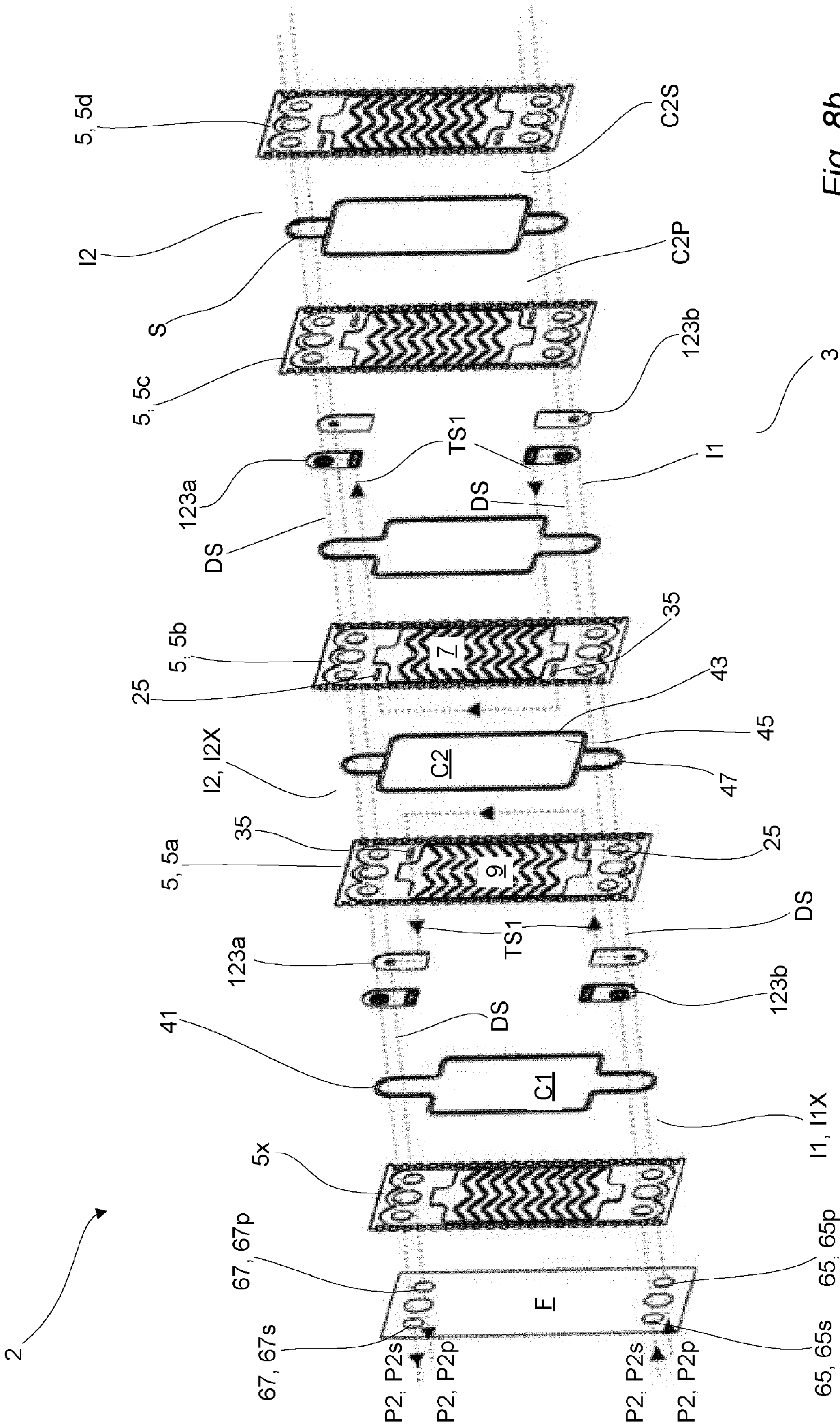
E
61
63
P1
P1

Fig. 8a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5x
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P2, P2p
P2, P2s
P2, P2p
2

Fig. 8b

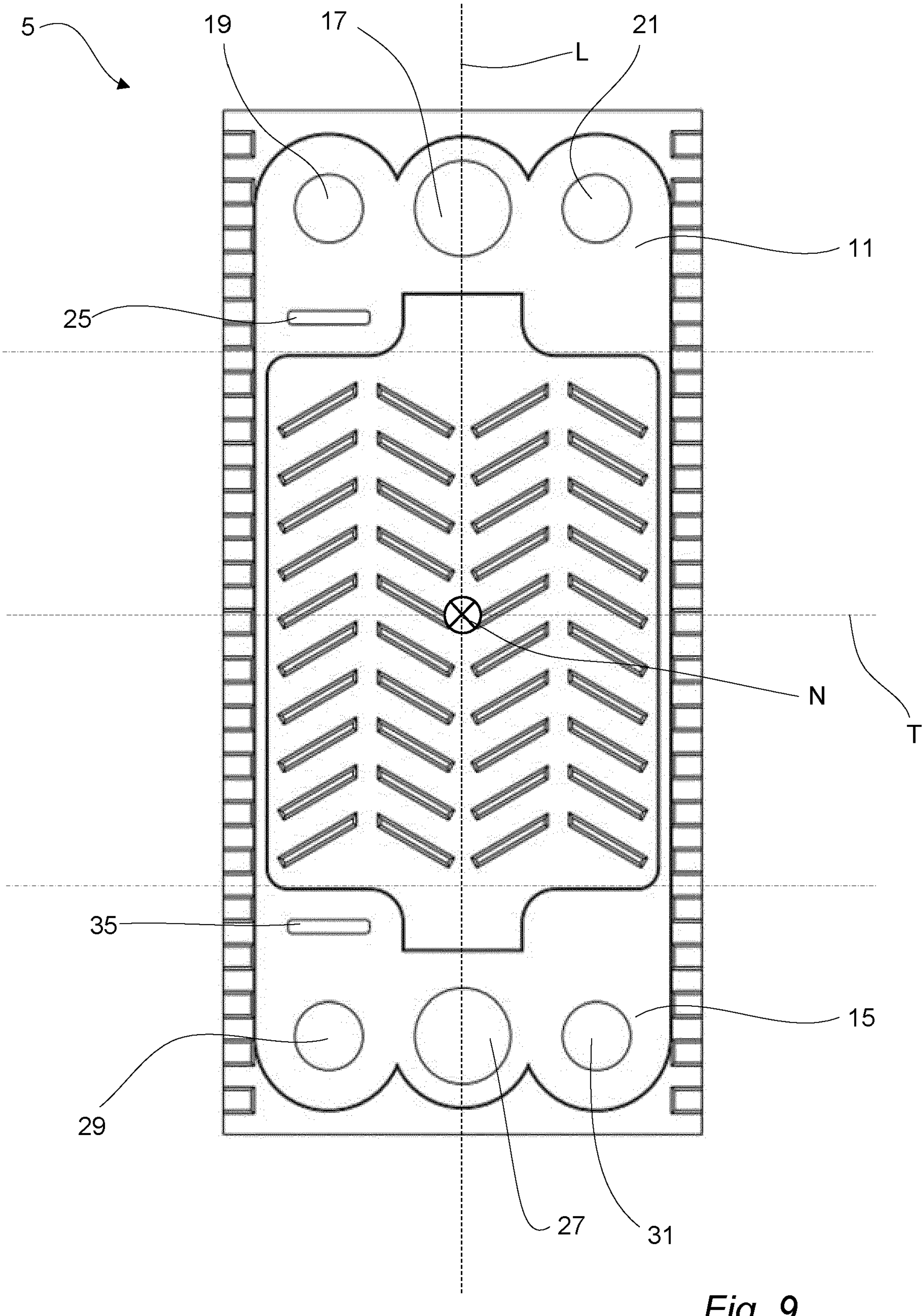
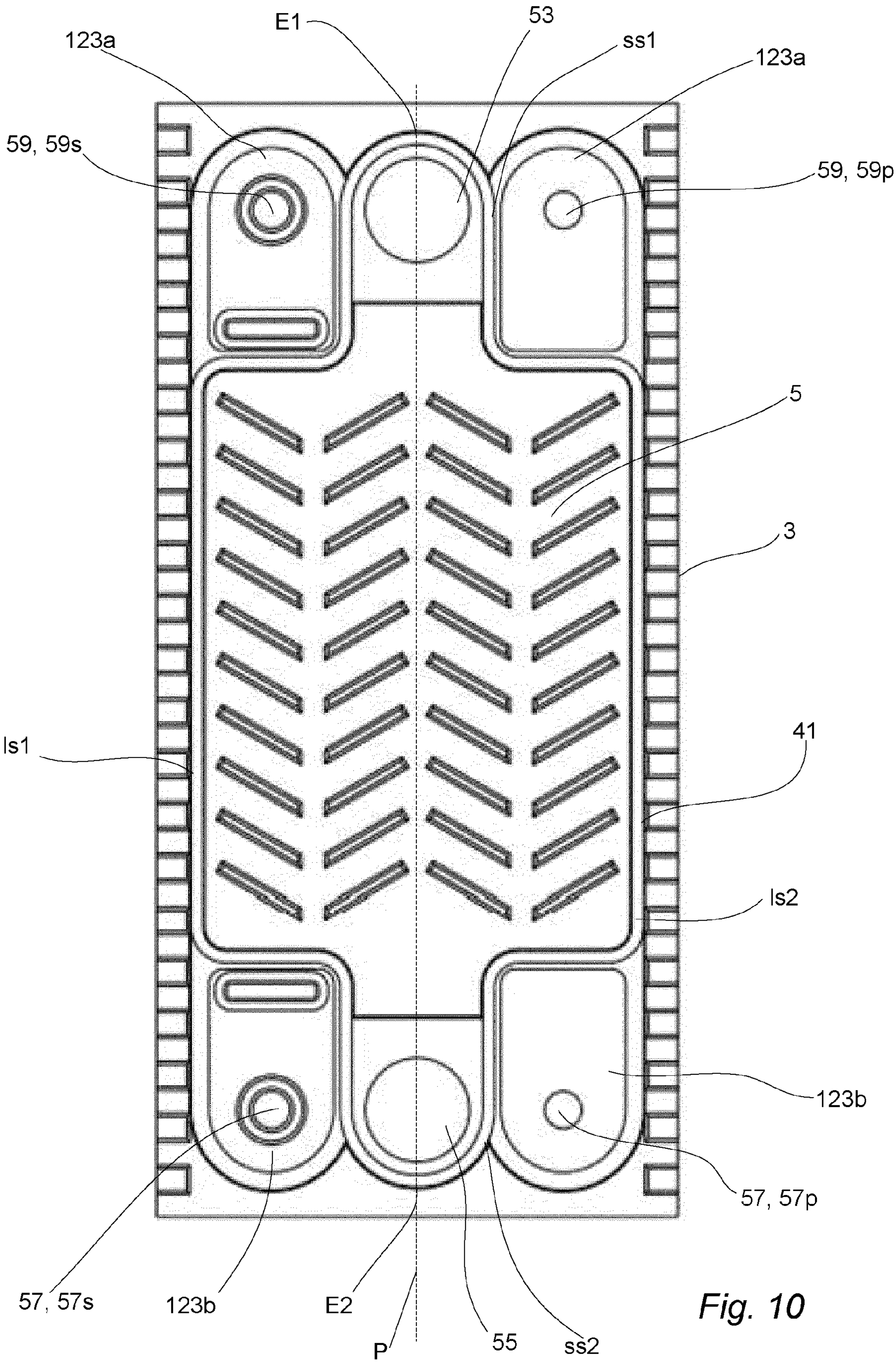


Fig. 9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57, 57s
123b
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P
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ss2

Fig. 10

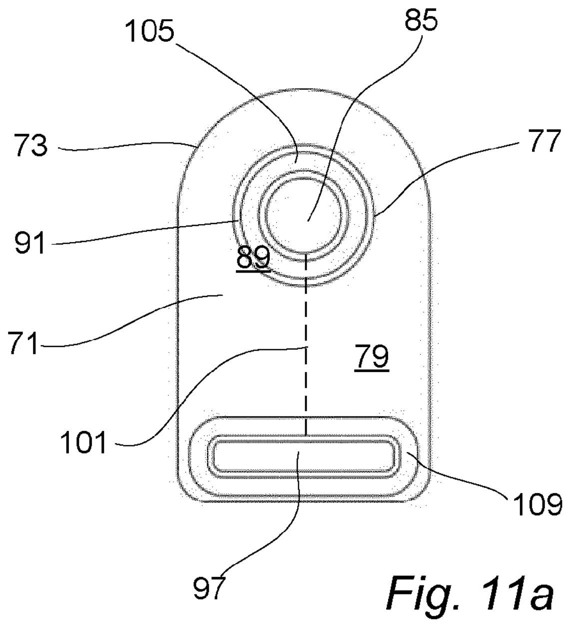

Fig. 11a

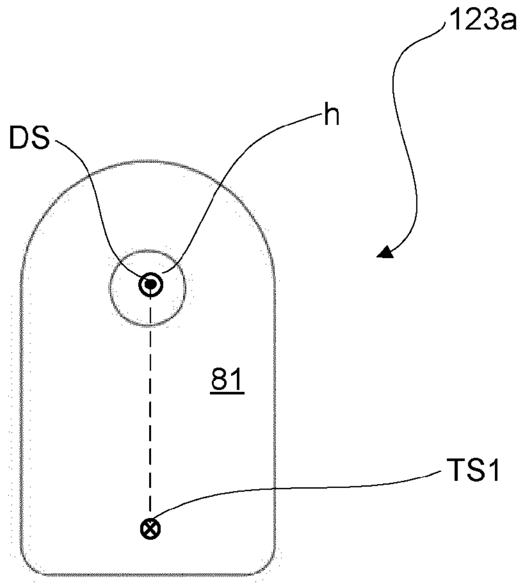

Fig. 11b

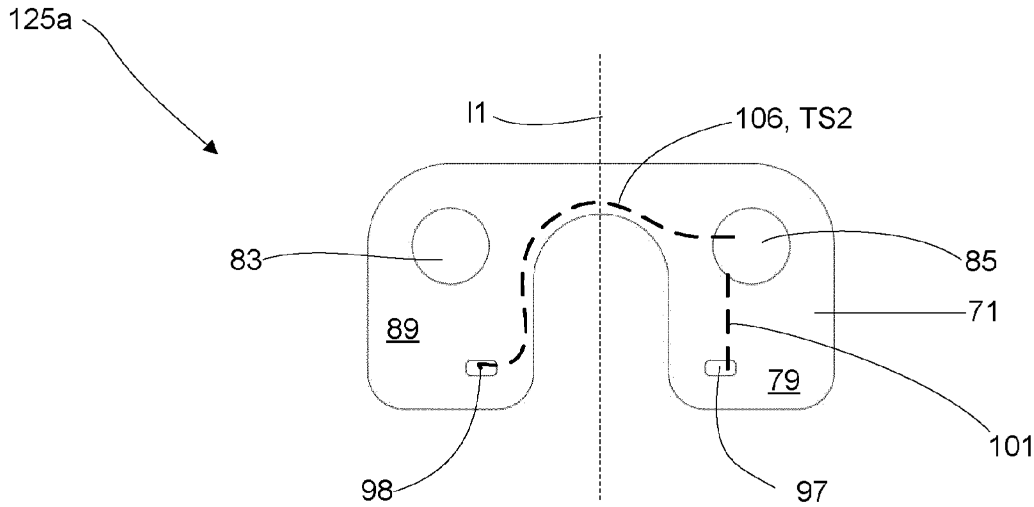

Fig. 12a

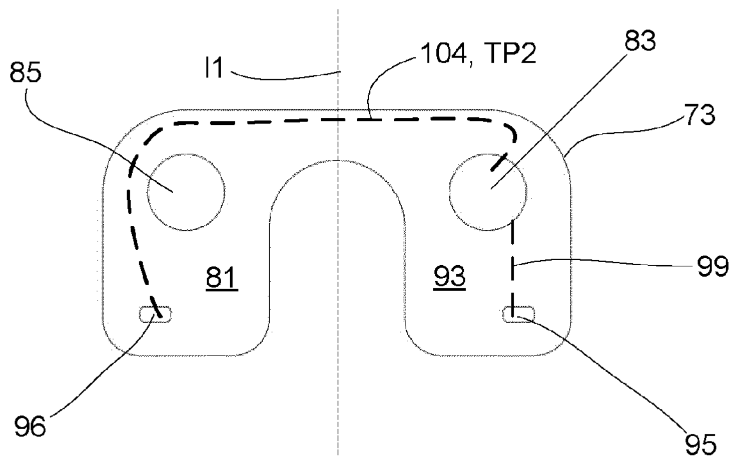

Fig. 12b

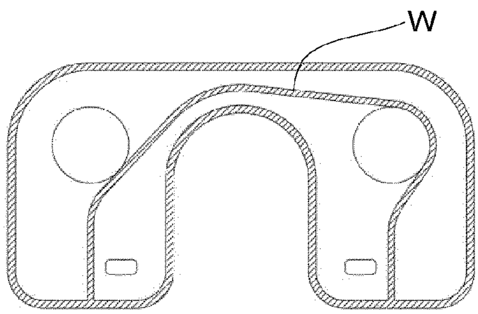

Fig. 12c

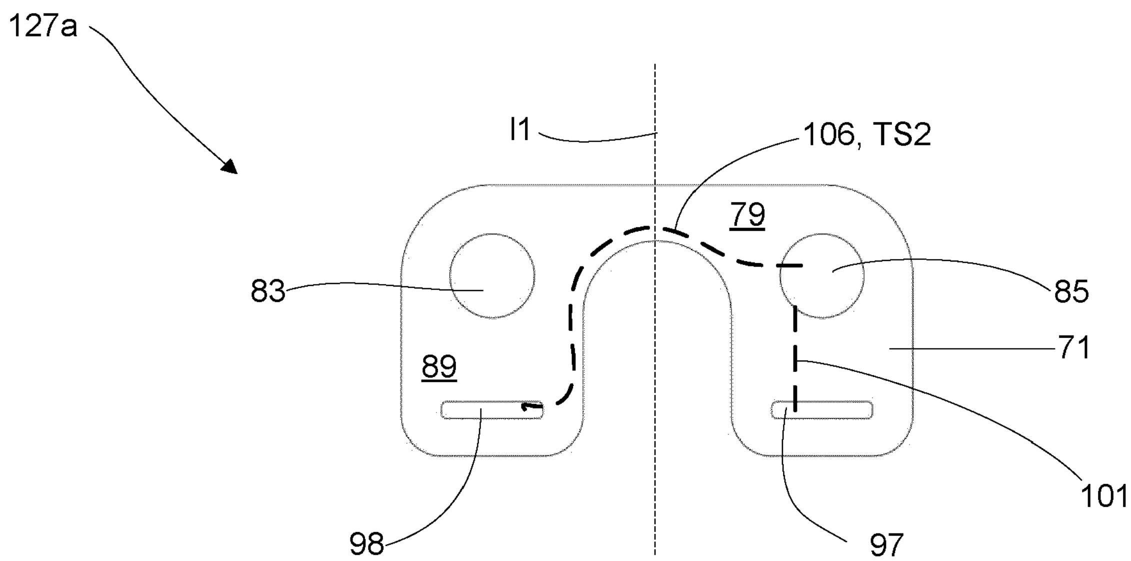

Fig. 13a

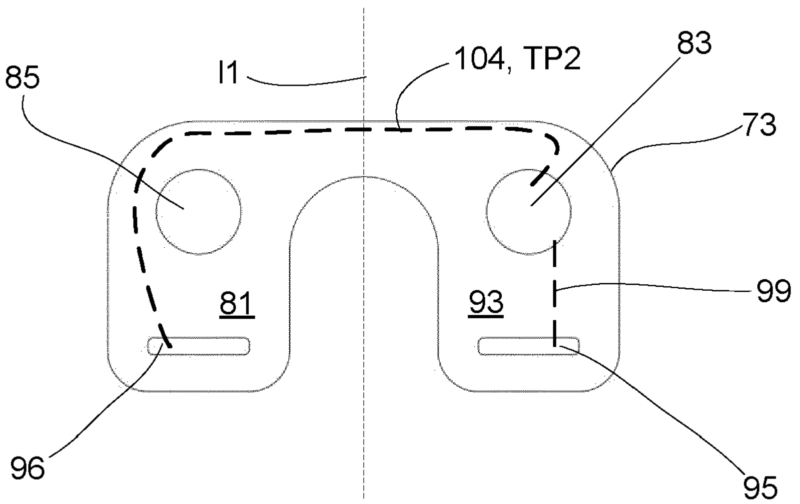

Fig. 13b

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 22 21 5789

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	EP 4 012 070 A1 (DANFOSS AS [DK]) 15 June 2022 (2022-06-15) * the whole document * -----	1-15	INV. C25B1/04 F28F3/10 F28F9/02 F28F3/08 C25B9/70 C25B9/73 F28F3/04 C25B9/67 F28D9/00 C25B11/02 C25B15/08 H01M8/08 F28D21/00
A	US 2017/279134 A1 (REYTIER MAGALI [FR] ET AL) 28 September 2017 (2017-09-28) * the whole document * -----	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

C25B
H01M

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	17 October 2023	Thorner, Gentien

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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17-10-2023

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