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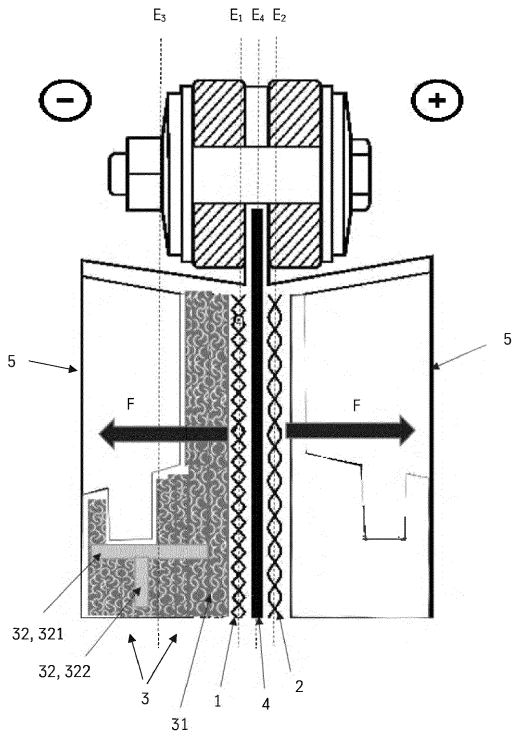
(54) ELECTROLYZER, AND METHOD FOR MANUFACTURING AN ELECTROLYZER

(57) The present invention relates to an electrolyzer comprising a first plate-shaped electrode (1), a second plate-shaped electrode (2), and an elastic buffer element (3), the buffer element (3) comprising an elastic structure (31) and a support structure (32), the support structure (32) comprising a plurality of support elements (321) made of plastic or metallic or metal with plastic, and a method for producing an electrolyzer according to the invention, characterized by the following method steps:
- Producing the support structure (32), in particular the support elements (321), by injection molding, in particular from polysulfone (PSU), polypropylene random copolymer (PP-R), polyphenylene ether (PPE) or other suitable plastics;
- Joining the support structure (32) into an elastic structure (31) building the elastic buffer element (3), wherein the elastic structure has preferably an undulating shape in cross-section and is preferably made of a nickel wire mesh;
- arranging the resulting elastic buffer element (3) in front of the at least one electrode (1, 2), in particular between the housing (5), bipolar plate (51) or end plate (52), and at least one electrode (1, 2) in such a way that the support elements (321) are aligned perpendicular to the at least one electrode (1, 2).

Fig. 1



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Description

[0001] The present invention relates to an electrolyzer, in particular an alkaline water electrolyzer according to the generic term of claim 1, as well as a method for manufacturing an electrolyzer according to claim 14.

[0002] The electrolyzer can also be addressed as an electrolysis cell within an electrolysis system, which typically includes a plurality of electrolysis cells.

[0003] In an alkaline water electrolyzer in zero-gap configuration, it is highly desirable to press the electrodes, i.e. anode and cathode, as uniformly as possible and with optimum force onto a separator in order to achieve very good electrical contact. In addition, the separator should be very well supported mechanically to maintain the pressure differences between the anode and cathode half cells. It turns out that there is a trade-off between, on the one hand, elastic elements for uniform and large-area electrical contact and, on the other hand, stiff and rigid elements that can support differential pressures.

[0004] Typically, in half-cells, a rigid metal structure, especially nickel, is used as a stiff and rigid support and an elastic element, consisting of woven nickel wires, is used as a soft and elastic component on top of it to ensure the zero-gap configuration and to allow a very good electrical contact.

[0005] This structure solves the task described above very well, but leads to two problems in particular. On the one hand, a high material consumption of metal, especially nickel, is to be expected. Furthermore, the elastic element can be overpressed at higher pressure differences, so that it deforms plastically and does not spring back elastically. This reduces electrical conductivity and mechanical support. Also large deflections of the elastic elements can be a source of danger to the separator placed in between the two electrodes. The separator is usually also clamped in the outer housing. Once the separator now has to the follow a high deflection of the one electrode side, mechanical damage of the separator might occur. A mechanical damage of the Separator is a severe hazard and can lead to explosion.

[0006] Due to the relatively large span of the support, the bending stress causes plastic deformation, which also has a detrimental effect on electrical conductivity and mechanical support.

[0007] From DE202012009119U1, for example, a spring of an apparatus has become known which, in the installed state, produces the flexible connection between a base plate and a functional plate and is characterized in particular by the fact that the adjoining components are connected by welding.

[0008] A process for the gas-tight insertion of bipolar sheet metal electrodes into the annular cell frames of pressure electrolyzers of the open filter press type has become known from CH333905, which is characterized in particular by the fact that the diameter of the disc-shaped electrode sheets is reduced by conically bending their edge to the inner diameter of a plate provided in the cell frame, The process is characterized in particular by the fact that the diameter of the disc-shaped electrode plates is reduced to the inside diameter of an annular groove provided in the cell frame by conical bending of their edge, their edge is then brought into the plane of this annular groove, and in this position the bent edge is pressed flat again so that the edge of the sheet metal disc is inserted into the annular groove of the frame, and the aforementioned annular groove is then closed.

[0009] From WO002021256472A1, a bipolar zero-gap electrolyzer for water electrolysis has further become known. The electrolyzer includes a plurality of bipolar elements, each of which includes an anode chamber, a cathode chamber, a conductive partition provided between the anode chamber and the cathode chamber, and outer frames surrounding the conductive partition. The conductive partition has protrusions on at least one surface. A conductive elastic body is disposed between one surface of the conductive partition opposite the one surface and one of the electrodes. One and the other of the electrodes form a conduction with the conductive partition at least through the protrusions and at least through the conductive elastic body, respectively. The membrane is sandwiched between the cathode and the anode of the adjacent bipolar elements by elastic stress of the conductive elastic body.

[0010] Furthermore, an electrode assembly for an electrolysis block, in particular for alkaline water electrolysis, comprising an electrode cell frame and a one-piece prefabricated electrode package having a bi-polar plate, a cathode current transfer structure and an anode current transfer structure has become known from WO2014044749A2, which are each arranged on one side of the bipolar plate and fixed thereto, a cathode pre-electrode arranged on the side of the cathode current transfer structure facing away from the bipolar plate and fixed thereto, and an anode pre-electrode arranged on the side of the anode current transfer structure facing away from the bipolar plate and fixed thereto.

[0011] Although useful electrolyzers have already been described here, there is still room for improvement. For example, in the solutions proposed according to DE202012009119U1, CH333905A, WO2021256472A1 or WO2014044749, there is a risk that there is only uneven electrical contact between the electrodes.

[0012] Also, in the solutions proposed according to CH333905A or WO2021256472A1, a little elastic bearing of separator and electrodes may result.

[0013] Furthermore, expensive nickel spring elements with travel limiters are used, especially in the device according to DE202012009119U1, for use in membrane electrolysis cells and apparatus with hot, corrosive media. Such materials are expensive and generate high manufacturing costs.

[0014] This is where the present invention comes in and makes it its task to propose an improved electrolyzer, in particular to propose an electrolyzer in which improved electrical contact between the electrodes, improved elas-

tic mounting of separator and electrodes and/or inexpensive manufacture is possible.

[0015] According to the invention, this task is solved by an electrolyzer having the characterizing features of claim 1. By the fact that the buffer element comprises an elastic structure and a support structure, wherein the support structure comprises a plurality of support elements, made of plastic or metallic or metal with plastic, an improved electrolyzer can be provided. In principle the support elements, in particular designed as rods, could also be metallic or metal with plastic. Also it must not be necessarily rods. The support structure could also be a sphere, cone, rib or "wing shaped", depending on mechanics, hydrodynamics and manufacturability.

[0016] The proposed solution prevents plastic deformation of the elastic structure by proposing finely distributed end stops over the entire cell area to absorb large pressure differences by limiting deflection. In this context, the use of plastic for the rods, in particular the support structure, reduces the material consumption of nickel of an electrolytic cell and equally counteracts plastic deformation of the elastic structure. Overall, improved electrical contact and/or improved elastic support of the elastic buffer element, separator and electrodes can be made possible.

[0017] Further advantageous embodiments of the proposed invention result in particular from the features of the subclaims. The objects or features of the various claims can in principle be combined with one another in any desired manner.

[0018] In an advantageous embodiment of the invention, it can be provided that the electrode is a plate-shaped or woven mesh type electrode or nickel foam.

[0019] In a further advantageous embodiment of the invention, it can be provided that the Elektrolyzer comprises a housing, bipolar plate and/or end plate, whereas the buffer element is arranged between the at least one electrode and the housing, bipolar plate and/or end plate. At this point, the buffer element can be effectively used to appropriately cushion the forces acting on the with respect to the electrode.

[0020] In a further advantageous embodiment of the invention, it may be provided that the at least one electrode forms a respective plane, wherein the rods are aligned perpendicular to the plane. In this orientation, the entire length of the rods can be used as a stop.

[0021] In a further advantageous embodiment of the invention, it may be provided that the support structure is housed within or interwoven with the elastic structure. This results in a compact elastic buffer element, which can be arranged accordingly between the electrode and the separator.

[0022] In a further advantageous embodiment of the invention, it may be provided that the support structure is arranged between two elastic structures. In this way it is rather easy to arrange the support structure e.g. stoppers in between them.

[0023] In a further advantageous embodiment of the invention, it may be provided that the support elements are connected by connecting elements to form a mat. Accordingly, this results in an easily manageable support structure in which the rods are arranged at predetermined positions and orientations and which can be connected or woven into the elastic structure in one piece. In other words, the rods, i.e., the plastic end stops, are connected to each other in a kind of mat so that they can be easily unrolled for assembly in the electrolyzer.

[0024] In a further advantageous embodiment of the invention, it may be provided that the elastic structure is wave-shaped in cross-section. In such an elastic structure, the undulating elastic structure acts like an array of springs that can be compressed perpendicular to the plane spanned by the elastic structure.

[0025] In a further advantageous embodiment of the invention, it may be provided that the elastic structure comprises woven nickel wires.

[0026] In a further advantageous embodiment of the invention, it may be provided that the support structure, in particular the rods or connecting elements, is made of a plastic, such as polysulfone (PSU), polypropylene random copolymer (PP-R) or polyphenylene ether (PPE). Such plastics are particularly suitable because they can be expected to withstand KOH and oxygen at about 88°C, especially 80°C to 95°C.

[0027] The higher the temperature, the better the efficiency of the electrolysis process (e.g. improved electrical conductivity of the liquid). An ambitious target would be close to 100°C. But, especially the high temperature limits the choice of suitable plastics.

[0028] In a further advantageous embodiment of the invention, it may be provided that the supporting structure, in particular the rods and connecting elements, are metal supports and/or metal supports coated with plastic.

[0029] In a further advantageous embodiment of the invention, it may be provided that the elastic structure has a height (h_e) in a relaxed state, whereas the elastic structure has a height (h_k) in a compressed state, whereas the support structure, in particular the support element, have a height (h_s), whereas the height (h_k) of the elastic structure in the compressed state approaches or is equal to the height of the support structure, in particular the support element, in particular the proportion of the heights is: height of the elastic structure in a relaxed state (h_e) > height of the support structure, in particular the height of the support element (h_s) > 0,3* height of the elastic structure in a relaxed state (h_e).

[0030] In a further advantageous embodiment of the invention, it may be provided that the elastic buffer element, in particular the support structure, is composed of smaller units, in particular smaller support structure elements, with connecting elements being provided between the smaller support structure elements. In this way, large-area elastic buffer elements, in particular support structures, can be produced with comparatively small and thus inexpensive injection molds.

[0031] In a further advantageous embodiment of the

invention, it may be provided that the support element is designed as ribs or rib-shaped, as wings or wing-shaped, as spheres or sphere-shaped or as cones or cone-shaped.

[0032] The invention further relates to an advantageous process for producing an electrolyzer according to the invention.

[0033] According to the invention, the following process steps are proposed for this purpose:

- Producing the support structure, in particular the rods, by injection molding, in particular from polysulfone, polypropylene random copolymer, polyphenylene ether or other suitable plastics;
- Joining the support structure into an elastic structure building the elastic buffer element, wherein the elastic structure has preferably an undulating shape in cross-section and is preferably made of a nickel wire mesh;
- arranging the resulting elastic buffer element in front of the at least one electrode, in particular between the housing and the at least one electrode, in such a way that the rods are aligned perpendicularly to the electrode.

[0034] Further advantageous embodiments of the proposed invention result in particular from the features of the subclaims. The objects or features of the various claims can in principle be combined with one another in any desired manner.

[0035] In an advantageous embodiment of the invention, it may be provided that the support structure is composed of at least two support structure elements in order to obtain a shape corresponding to the electrodes.

[0036] In a further advantageous embodiment of the invention, it may be provided that the support structure elements are provided with coupling means for connection to other support structure elements.

[0037] Further features and advantages of the present invention will become apparent from the following description of preferred embodiments with reference to the accompanying figures. Therein show

Fig. 1 an embodiment of an electrolyzer according to the invention with an elastic buffer element in a sectional view;

Fig. 1a an embodiment of an electrolyzer according to the invention, in particular a non-welded structure;

Fig. 2 an embodiment of an elastic structure in a top view;

Fig. 3 an embodiment of an elastic element in a side view, partially sectioned, in a relaxed state;

Fig. 4 an embodiment of an elastic element in a lateral, partially sectioned view, compressed at the level of the rods;

Fig. 5 an embodiment of an elastic structure in a top view;

Fig. 6 an embodiment of an elastic structure in a lateral perspective view;

Fig. 7 an embodiment of a support structure in a perspective view;

Fig. 8 an embodiment of a support structure in a top view;

Fig. 9 an embodiment of elastic buffer element with an electrode, preferably cathode side, in a top view;

Fig. 10 an embodiment of elastic buffer element with an electrode of Fig. 9 in a front view (section A-A);

Fig. 11 an elastic buffer element with an electrode of Fig. 9 in a cut side view (section B-B);

Fig. 12 an elastic buffer element with an electrode of Fig. 9 in a perspective view;

Fig. 13 a detail "Z" of Fig. 12;

Fig. 14 one embodiment of a support structure, in particular support elements are configured as ribs or rib-shaped;

Fig. 15 one embodiment of a support structure, in particular support elements are configured as wings or wing-shaped;

Fig. 16 one embodiment of a support structure, in particular support elements are configured as spheres or sphere-shaped;

Fig. 17 one embodiment of a support structure, in particular support elements are configured as cones or cone-shaped;

Fig. 18 one embodiment of an elastic buffer element with an electrode, preferably cathode side, in a top view;

Fig. 19 the elastic buffer element with an electrode of Fig. 18 in a front view (section A-A);

Fig. 20 the elastic buffer element with an electrode of Fig. 18 in a cut side view (section B-B);

Fig. 21 the elastic buffer element with an electrode of Fig. 18 in a perspective view;

Fig. 22 a detail "Z" of Fig. 21;

Fig. 23 an embodiment of an electrolyzer according to the invention with an elastic buffer element in a sectional view, in particular a filter press configuration;

Fig. 24 an embodiment of an electrolyzer according to the invention with an elastic buffer element in a sectional view, in particular the structure of a sandwich.

[0038] The following reference signs are used in the figures:

E_1 plane spanned by electrode 1.
E_2 plane defined by electrode 2
E_3 plane spanned by buffer element 3
E_4 plane defined by separator 4
E_e plane defined by the elastic structure 31
E_S plane spanned by the support structure 32

h_e height in relaxed state
h_k height in compressed state
hs height of the rod
F force

1 (first) electrode, in particular plate-shaped electrode
2 (second) electrode, in particular plate-shaped electrode
3 elastic buffer element
4 separator

5 housing
6 conductive support structure
7 sandwich

31 elastic structure
31a (second) elastic structure
32 support structure
32' support structure element
32" support structure element

51 bipolar plate
52 end plate

311 wave crest
312 wave trough

321 support element
322 connecting element
323 coupling means

[0039] In this context, features and details described in connection with a method naturally also apply in connection with the device according to the invention and vice versa, so that with regard to the disclosure concerning the individual aspects of the invention, reference is or can always be made mutually. In addition, a process according to the invention, if described, can be carried out with the apparatus according to the invention.

[0040] The terminology used herein is for the purpose of describing specific embodiments only and is not intended to limit the disclosure. As used herein, the singular forms "a/one" and "the/the/that" are also intended to include the plural forms unless the context otherwise clearly indicates. It will also be clear that the expressions "features" and/or "comprising," when used herein, specify the presence of said features, integers, steps, operations, elements, and/or components, but do not exclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed elements.

[0041] It should also be noted that the geometric relationships, such as "perpendicular", "orthogonal", etc., are subject to technical aspects of series production, i.e., variations due to technical reasons must be taken into account.

[0042] First, reference is made in particular to Fig. 1.

[0043] An electrolyzer according to the invention essentially comprises a first plate-shaped electrode 1, a second plate-shaped electrode 2. The electrolyzer further comprises an elastic buffer element 3 to be described in more detail.

[0044] The aforementioned components are advantageously housed in a housing 5, which may comprise further components, such as inlets and outlets for electrolyte, gas, current guides, etc., which, however, are not absolutely necessary for the understanding of the present invention. The elastic buffer element 3 is arranged preferably in front of one of the electrodes 1, 2, in particular between one of the electrodes 1, 2 and the housing 5. There maybe also a separator 4 arranged between the electrodes 1, 2.

[0045] It should be noted, however, that the electrolyzer usually forms one cell of many in an overall system in which the electrolyzer is clamped in such a way that a force acts on the package of electrodes, buffer element, and separator.. The force is indicated by the arrows F.

[0046] In a zero-gap configuration to be aimed at, i.e. the smallest possible spacing of the electrodes, corresponding forces also act on the buffer element. The following comments concern improvements to the buffer element in particular.

[0047] For geometrical orientation, it shall be assumed that the electrodes 1, 2 form respective planes E_1 and E_2. The electrodes 1, 2 are oriented orthogonally to each other. Also, the separator 4 forms a plane E_4 oriented orthogonally to the aforementioned planes E_1 and E_2, respectively. Also, the elastic buffer element 3 each form a plane E_3 oriented orthogonally to the electrode planes E_1 and E_2, respectively. In other words, the plate-shaped electrodes 1, 2, the, elastic buffer element 3 and the separator 4 form a sandwich structure or an envelope structure.

[0048] In the following, reference is made in particular to Fig. 2.

[0049] The elastic buffer element 3 of an electrolyzer according to the invention comprises an elastic structure 31 and a support structure 32. The support structure comprises a plurality of support elements 321, for example rods, wave-like structure, rib-shaped, wing-shaped, sphere-shaped or cone-shaped, made of plastic or metallic or metal with plastic a plurality of rods made of plastic. In principle the rods could also be metallic or metal with plastic. Also it must not be necessarily rods. The support structure 32 could also be a sphere, cone, rib or "wing shaped", depending on mechanics, hydrodynamics and manufacturability. According to a preferred embodiment of the invention, the support structure 32 comprises preferably a plurality of rods 321 made of plastic.

[0050] The invention will first be described with reference to the rods as support elements 321, even if the support elements 321 can have other configurations.

[0051] It can be seen that the support elements 321 are connected by connecting elements 322, in particular to form a kind of mat. The support structure 32 can also be addressed as a rod mat. The support elements 321 can also be addressed as support rods. The support structure 32 is received within or interwoven with the elastic structure 31. The elastic structure 31 may, for example, be corrugated in cross-section. The elastic structure 31 preferably consists of woven nickel wires.

[0052] In the following, reference is made in particular to Figs. 3 and 4.

[0053] The wave-like shape of the elastic structure 31 can be seen. In a relaxed state, as shown in Fig. 3, the elastic structure 31 has a height h_e in the relaxed state. In the cross-sectionally undulating elastic structure 31 shown here, this height is set between the wave crest 311 and wave trough 312.

[0054] The elastic structure 31 forms a plane which is designated by the reference sign E_e. The support structure 32, in particular the connecting elements 322, also forms a plane which is designated by the reference sign E_S. It can be seen that the rods 321 are arranged perpendicular to the plane E_e of the elastic structure 31. The planes E_S and E_e, respectively, are oriented orthogonally to the planes E_1 and E_2, respectively, of the electrodes. Accordingly, the rods 321 are also oriented perpendicular to the planes E_1 and E_2 of the electrodes, respectively.

[0055] Looking at Fig. 3 and Fig. 4 together, it can be seen that the height h_K of the elastic structure 31 in a compressed state approaches or is equal to the height h_S of the rods 321. A proper proportion of hs and he could be he > hs > 0,3*he. In other words: height of the elastic structure in a relaxed state (h_e) > height of the support structure, in particular the height of the support element (h_s) > 0,3* height of the elastic structure in a relaxed state (h_e).

[0056] The compression is caused by force influence, which is symbolized by arrows with reference sign F. In this case, the support elements 321, in particular the rods, act as stops that prevent further compression of the elastic structure 31.

[0057] In the following, particular reference is made to Figs. 5 and 6.

[0058] For clarification of the elastic structure 31, it is shown here separately, without the support structure 32.

[0059] In the following, reference is made in particular to Figs. 7 and 8.

[0060] For clarification of the support structure 32, this is shown here separately, without the elastic structure 31. Furthermore, coupling means 323 between individual support structure elements 32', 32", 32‴ can be seen here.

[0061] Further details of the present invention arise in particular from a manufacture of the elastic element 3 for an electrolyzer according to the invention. It is understood that only some selected process steps are shown here, as they are helpful for understanding the process according to the invention. The method may comprise further steps or intermediate steps known to the person skilled in the art.

[0062] For example, the support structure 32, in particular the rods 321 or connecting elements 322, could be injection molded from a plastic that can withstand KOH and oxygen at 88 °C, such as polysulfones (PSU), polypropylene random copolymer (PP-R), polyphenylene ether (PPE), or others.

[0063] For ease of handling and assembly, the rods 321 are connected by fasteners 322 of the same material. Ideally, this network of rods 321 and connecting elements 322 has the same external shape as electrodes 1, 2 and particular separator 4. Furthermore it is possible to create different outer shapes with one and the same rod map.

[0064] In order to keep the injection mold small and inexpensive, the elastic buffer element 3, in particular the support structure 32, can be composed of smaller units 32', 32", etc., in particular mats, cf. in particular Fig. 8. The circles in this figure illustrate the connections or coupling means 323 between smaller units to form a large unit, i.e. support structure 32, of the same size as the electrode 1 or 2. In other words, the support structure 32 is composed of at least two support structure elements 32', 32" to obtain a shape corresponding to the electrodes. For this purpose, it may be provided that the support structure elements 32', 32" are provided with coupling means 323 for connection to other support structure elements.

[0065] Next, the support structure 32, in particular the rods 321, is combined with the elastic structure 31, which preferably consists of woven nickel wires. The rods 321 are arranged between the corrugations 311 or 312 of the woven elastic structure 31. An alternative arrangement is that the rods 321 are symmetrically arranged between two elastic structures 31.

[0066] An advantageous embodiment of the elastic element 3 is characterized in particular by:

- approx. 4000 support elements 321, especially rods,
- approx. 3mm rod diameter,
- 1 bar surface pressure especially "difference pressure" between the two electrodes, the higher the better, minimum 1bar,
- support structure material = PSU (polysulfone) (70MPa yield stress) and/or PPS (polyphenylene sulfide)
- 11 MPa stress per rod

[0067] Further details of the present invention arise, in particular, from a fabrication of the electrolyzer according to the invention. It is understood that only some selected process steps are shown here, as they are helpful for understanding the process according to the invention. The process may comprise further steps or intermediate steps known to the person skilled in the art.

[0068] The elastic element 3 is preferably arranged between the housing 6 and an electrode 1.

[0069] The elastic element 3 ensures electrical contact to the electrodes 1, 2 and has a certain spring stiffness. In

the relaxed state, the elastic element 3 has a significantly greater height he than the support elements 321, especially rods 321. If a pressure difference occurs between the half cells, the elastic element 3 is compressed to the height of the plastic rods ($h_K = h_S$), but no further. In this way, they serve as a mechanical end stop and protect the elastic element 3 from plastic deformation while providing very uniform mechanical support (all support elements 321, especially rods 321 are preferably the same height) to the separator and electrodes. This allows the electrolyzer to withstand high differential pressures without damaging the separator. In this way, the safety of the electrolyzer is increased.

[0070] It is possible to apply the buffer element 3 on the cathode side or on the anode side or on both electrode sides simultaneously. In this case, both sides work as "non-welded" half-cells. It is also possible to solder or even spot weld the elastic element to a bipolar plate 51 in filter press configuration.

[0071] The bipolar plate 51 is usually metallic and serves as an transmitter of electric current. In a usual setup the bipolar plate and separator are alternating. E.g: Endplate 52 - - (first) electrode 1 - several bipolar cell sets, consisting of separator 4 - (second) electrode 2- bipolar plate 51 - (first) electrode 1, -separator 4 - (second) electrode 2 - bipolar plate 51 again. Whereas the electrodes are connected to the bipolar plate or end plate via conductive support structures 6.

[0072] The current is preferably passed on by contact only. There is usually no material limitation (welding) between the current-carrying cell internals.

[0073] Fig. 1a shows a sketch of a cell cross section and without a web. The web is not meant to be a mechanical buffer. It is a stiff structure that provide direct electric supply to the electrode or support structure (direct path = low ohmic drop).

[0074] The electrolyzer can also be equipped with housing 5 and a sandwich 7.

[0075] The sandwich 7 directly contacts the housing 5 (single element configuration) or the bipolar plates 51 or end plates 52 (filter press configuration).

[0076] However, the support structure 32 can also be used in conventional cell designs to increase differential pressure capability by placing it between the housing 5, bipolar plate 51, or end plate 52 and the electrode.. This option is preferably limited to half-shells that are not subjected to severe thermal treatment during their lifetime. In such constellations, the use of plastics would be of little use due to the thermal limitations of the material. Especially because of this, there is a possibility that it is not welded. In case thermal treatment of e.g. pans of single element cells is required, the sandwich can be removed prior to the required treatment.

[0077] The buffer element 3 can also be used in chlor alkali cells, in particular on the cathode side of chlor alkali cells.

[0078] Figs. 9 to 13 show a further embodiment of the electrolyzer, in particular of the elastic element 3.

[0079] In this embodiment of the invention, it is provided, that the support structure 32 is arranged between two elastic structures 31, 31a. In this way it is rather easy to arrange the support structure e.g. stoppers in between them.

[0080] The elastic buffer element is shown together with an electrode 1(2). The reference sign 1(2) is intended to make it clear that the electrode can basically be an electrode on the anode side or cathode side.

[0081] Figs. 14 to 17 show further embodiments of the support structure 32, in particular the elements 321. Different patterns or orientations are conceivable.

[0082] In Fig. 14, it can be seen that the supporting elements 321 are configured as ribs or rib-shaped.

[0083] In Fig. 15, it can be seen that the supporting elements 321 are designed as wings or wing-shaped.

[0084] In Fig. 16 it can be seen that the supporting elements 321 are designed as spheres or sphere-shaped.

[0085] In Fig. 17, it can be seen that the supporting elements 321 are designed as cones or cone-shaped.

[0086] Figs. 18 to 22 show a further embodiment of the electrolyzer, in particular of the elastic element 3.

[0087] In this embodiment of the invention, it is provided that the support elements 321 are wave-shaped, in particular as wave-shaped elongated elements. The wave-shaped elements 321 of the support structure 32 are arranged parallel to one another and are connected to one another by means of the connecting elements 322. Preferably, the support structure 32 in this embodiment is arranged between two elastic structures 31, 31a. In this way, it is relatively easy to arrange the support structure 32 between them.

Claims

1. Electrolyzer comprising a first plate-shaped electrode (1), a second plate-shaped electrode (2) and an elastic buffer element (3) are accommodated, **characterized in that** the buffer element (3) comprises an elastic structure (31) and a support structure (32), the support structure (32) comprising a plurality of support elements (321), made of plastic or metallic or metal with plastic.

2. Electrolyzer according to claim 1, **characterized in that** the electrode (1, 2) is a plate-shaped or woven mesh type electrode or nickel foam.

3. Electrolyzer according to at least one of the preceding claims, **characterized in that** the Elektrolyzer comprises a housing (5), bipolar plate (51) and/or end plate (52), whereas the buffer element (3) is arranged between at least one electrode (1 or 2) and housing (5), bipolar plate (51) and/or end plate (52).

4. Electrolyzer according to at least one of the preceding claims, **characterized in that** the at least one electrode (1 or 2) forms a plane (E1 or E2), the rods (321) being oriented perpendicular to the plane (E1 or E2).

5. Electrolyzer according to at least one of the preceding claims, **characterized in that** the support structure (32) is accommodated within or interwoven with the elastic structure (31).

6. Electrolyzer according to at least one of the preceding claims, **characterized in that** the support structure (32) is arranged between two elastic structures (31, 31a).

7. Electrolyzer according to at least one of the preceding claims, **characterized in that** the support elements (321) are connected by connecting elements (322) to form a mat.

8. Electrolyzer according to at least one of the preceding claims, **characterized in that** the elastic structure (31) is corrugated in cross section.

9. Electrolyzer according to at least one of the preceding claims, **characterized in that** the elastic structure (31) consists of woven nickel wires.

10. Electrolyzer according to at least one of the preceding claims, **characterized in that** the supporting structure (32), in particular the support elements (321) and/or connecting elements (322), is made of a plastic, such as polysulfone (PSU), polypropylene random copolymer (PP-R), polyphenylene ether (PPE), polyphenylene sulfide (PPS) or glass fiber reinforced polyphenylene sulfide (PPS GF), or made of metal or metal coated with plastic.

11. Electrolyzer according to at least one of the preceding claims, **characterized in that** the elastic structure (31) has a height (h_e) in a relaxed state, whereas the elastic structure (31) has a height (h_k) in a compressed state, whereas the support structure (32), in particular the support elements (321), have a height (hs), whereas the height (h_k) of the elastic structure (31) in the compressed state approaches or is equal to the height (h_S) of the support structure (32), in particular the support elements (321), in particular the proportion of the heights is $h_e > h_s > 0{,}3*h_e$.

12. Electrolyzer according to at least one of the preceding claims, **characterized in that** the elastic buffer element (3), in particular the support structure (32), is composed of smaller units, in particular smaller support structure elements (32', 32", 32‴, etc.) , coupling means (323) being provided between the smaller units.

13. Electrolyzer according to at least one of the preceding claims, **characterized in that** the support element (321) is designed as a rod, wave-like structure, rib-shaped, wing-shaped, sphere-shaped or cone-shaped.

14. Method of manufacturing an electrolyzer according to at least one of the preceding claims, **characterized by** the following method steps:

- Producing the support structure (32), in particular the support elements (321), by injection molding, in particular from polysulfone (PSU), polypropylene random copolymer (PP-R), polyphenylene ether (PPE) polyphenylene sulfide (PPS) or glass fiber reinforced polyphenylene sulfide (PPS GF) or other suitable plastics;
- Joining the support structure (32) into an elastic structure (31) building the elastic buffer element (3), wherein the elastic structure has preferably an undulating shape in cross-section and is preferably made of a nickel wire mesh;
- Arranging the resulting elastic buffer element (3) in front of the at least one electrode (1, 2), in particular between the housing (5), bipolar plate (51) or end plate (52), and at least one electrode (1, 2), in such a way that the support elements (321) are aligned perpendicular to the at least one electrode (1, 2).

15. Method according to claim 14, **characterized in that** the support structure (32) is composed of at least two support structure elements (32', 32") to obtain a shape corresponding to the at least one electrode (1 or 2).

16. Method according to at least one of the preceding claims, **characterized in that** the support structure elements (3', 3") are provided with coupling means (323) for connection to other support structure elements (3', 3").

Fig. 1

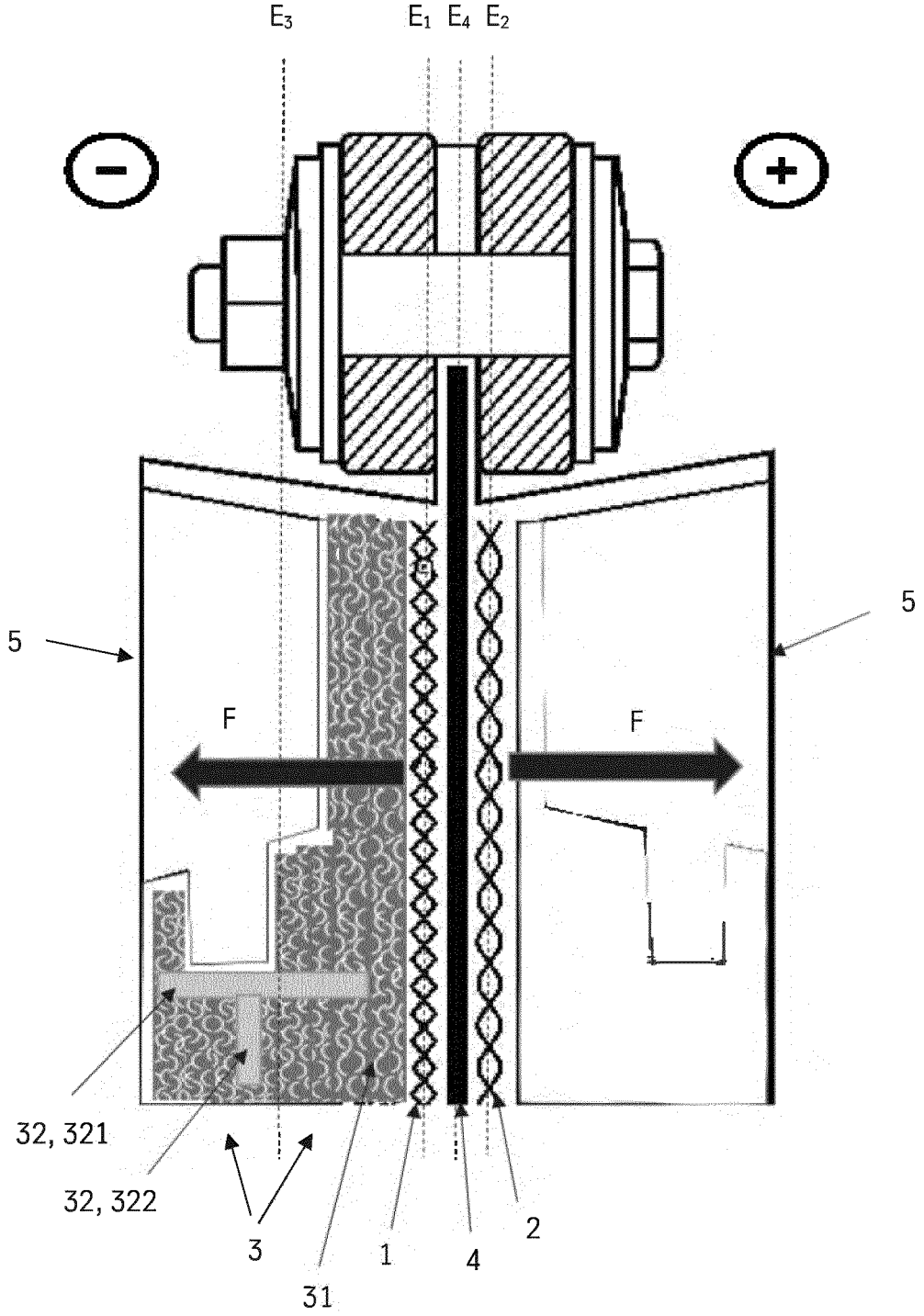


Fig. 1a

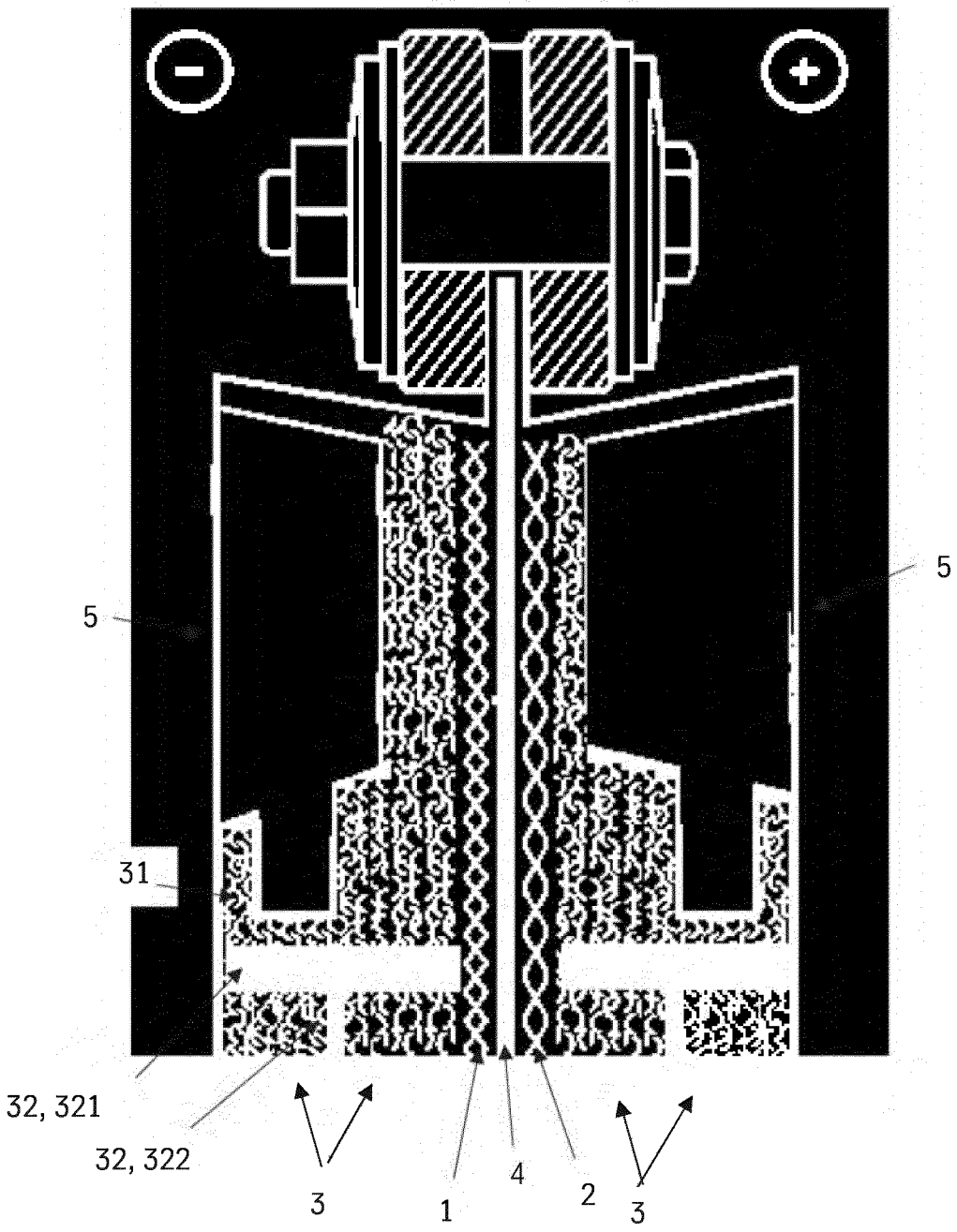


Fig. 2

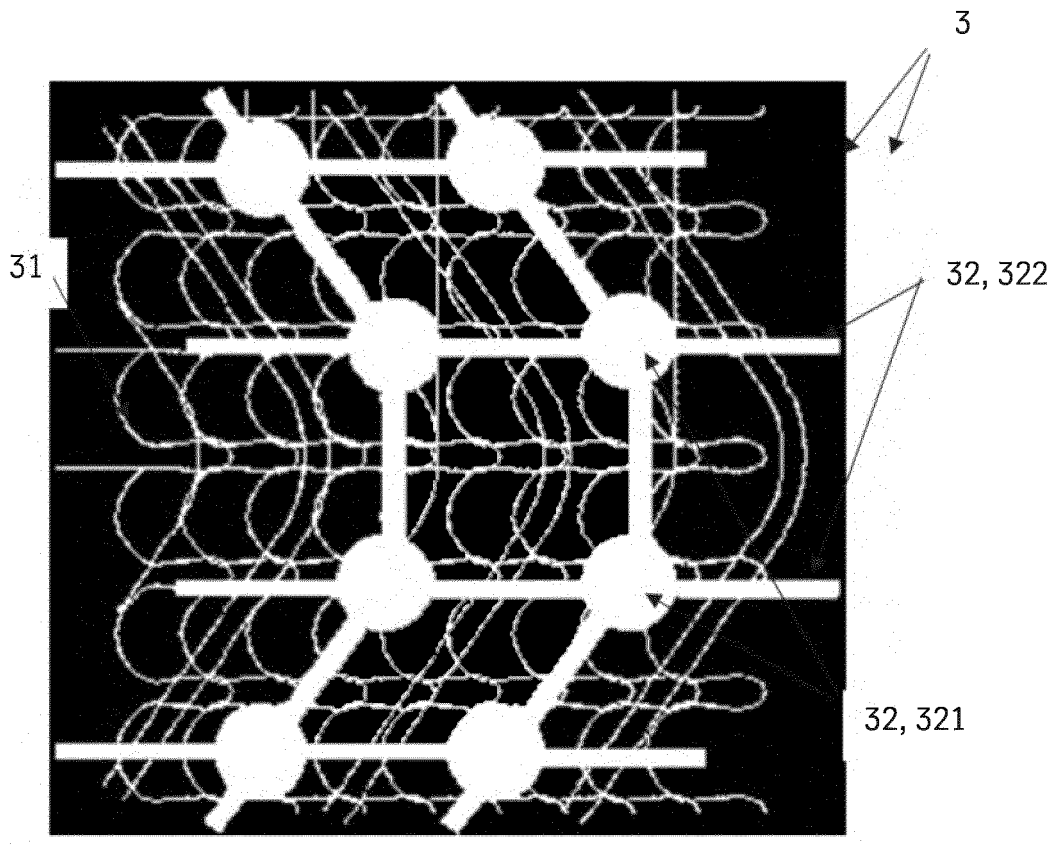


Fig. 3

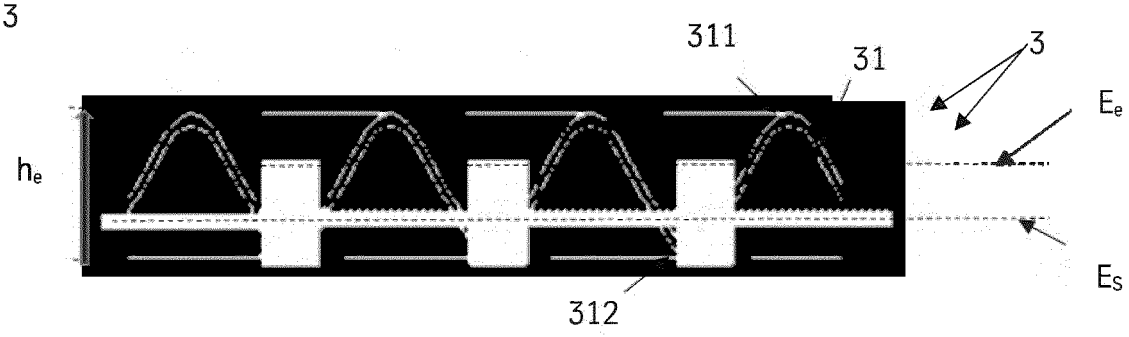


Fig. 4

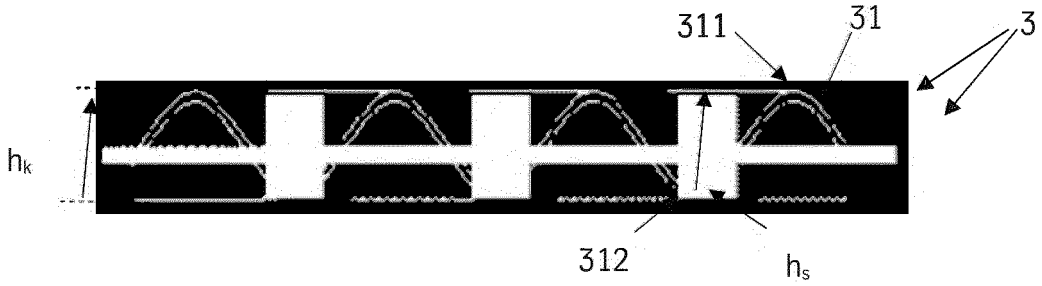


Fig. 5

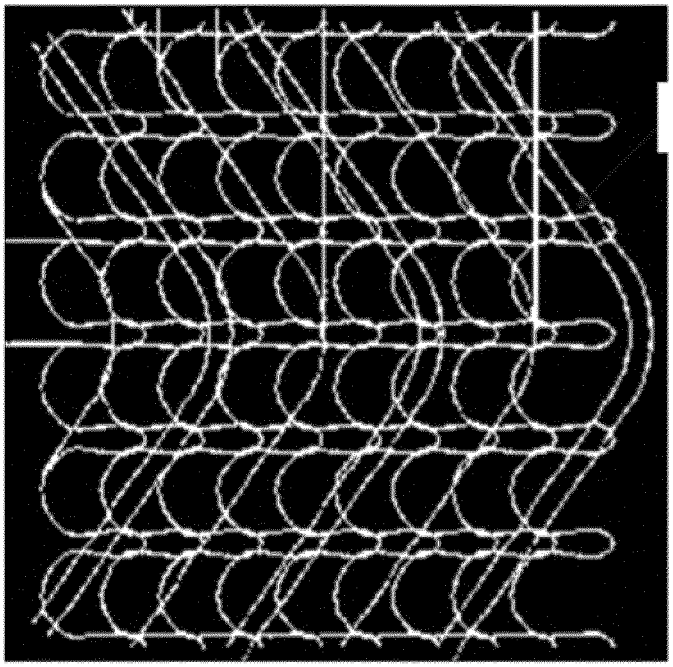


Fig. 6

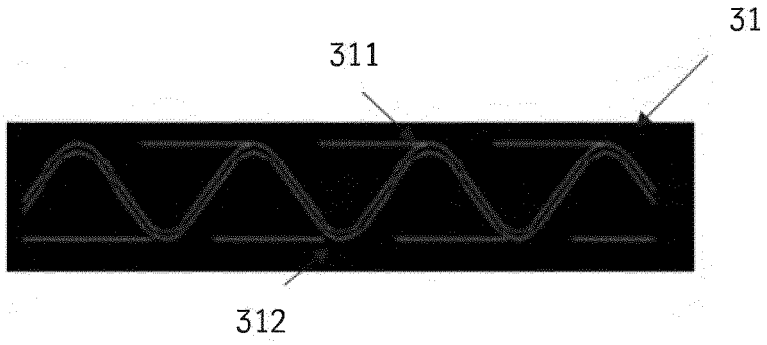


Fig. 7

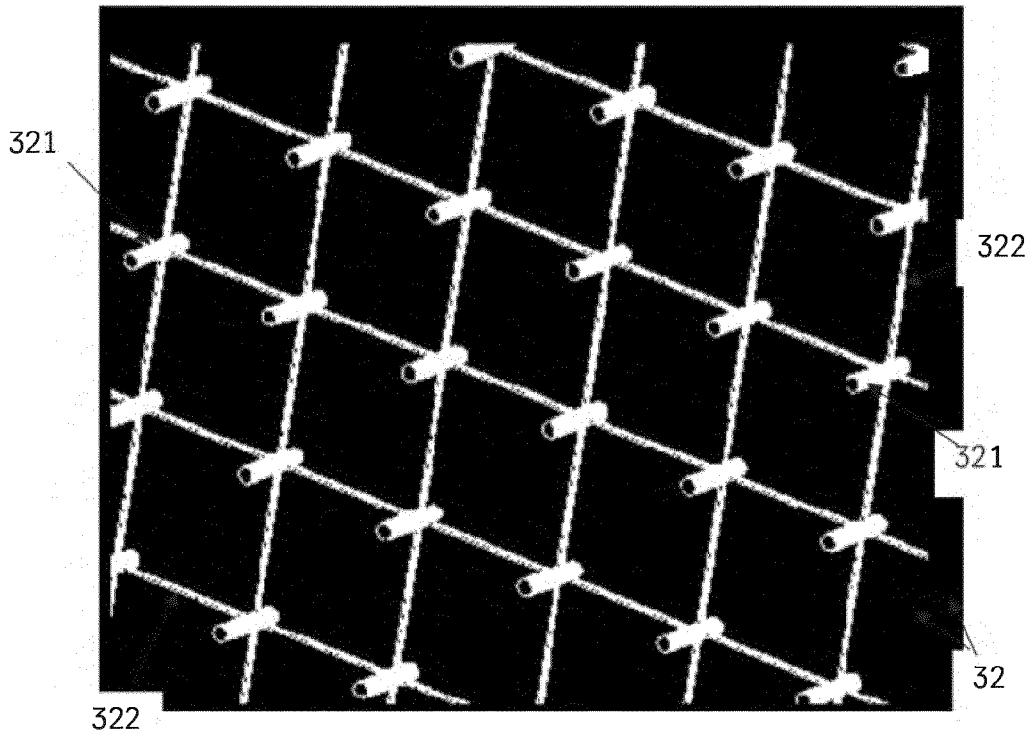


Fig. 8

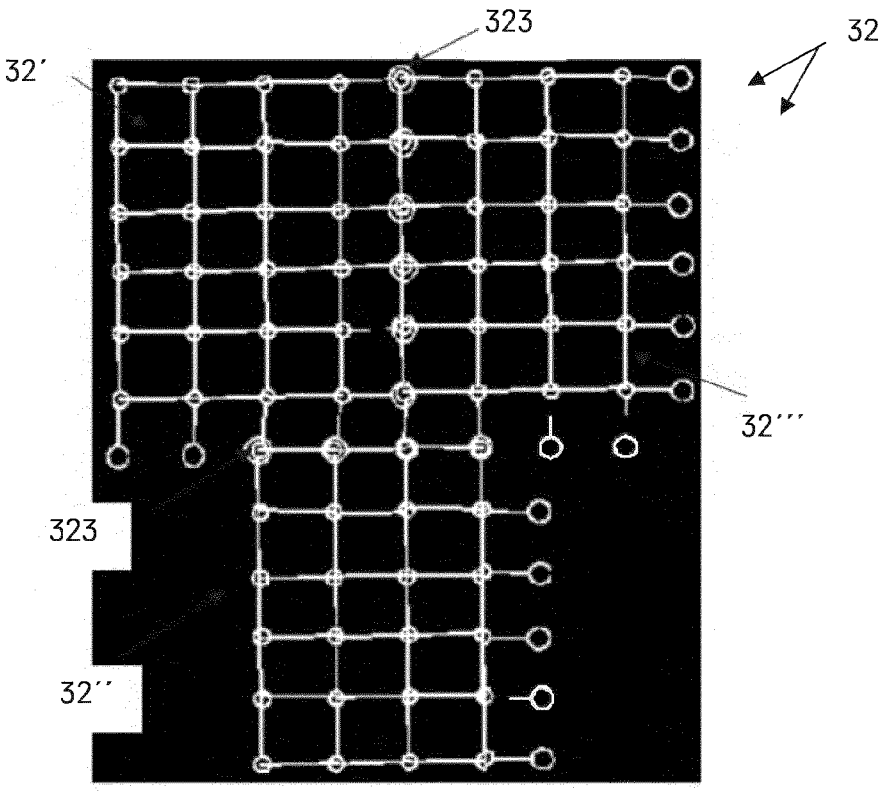


Fig. 9

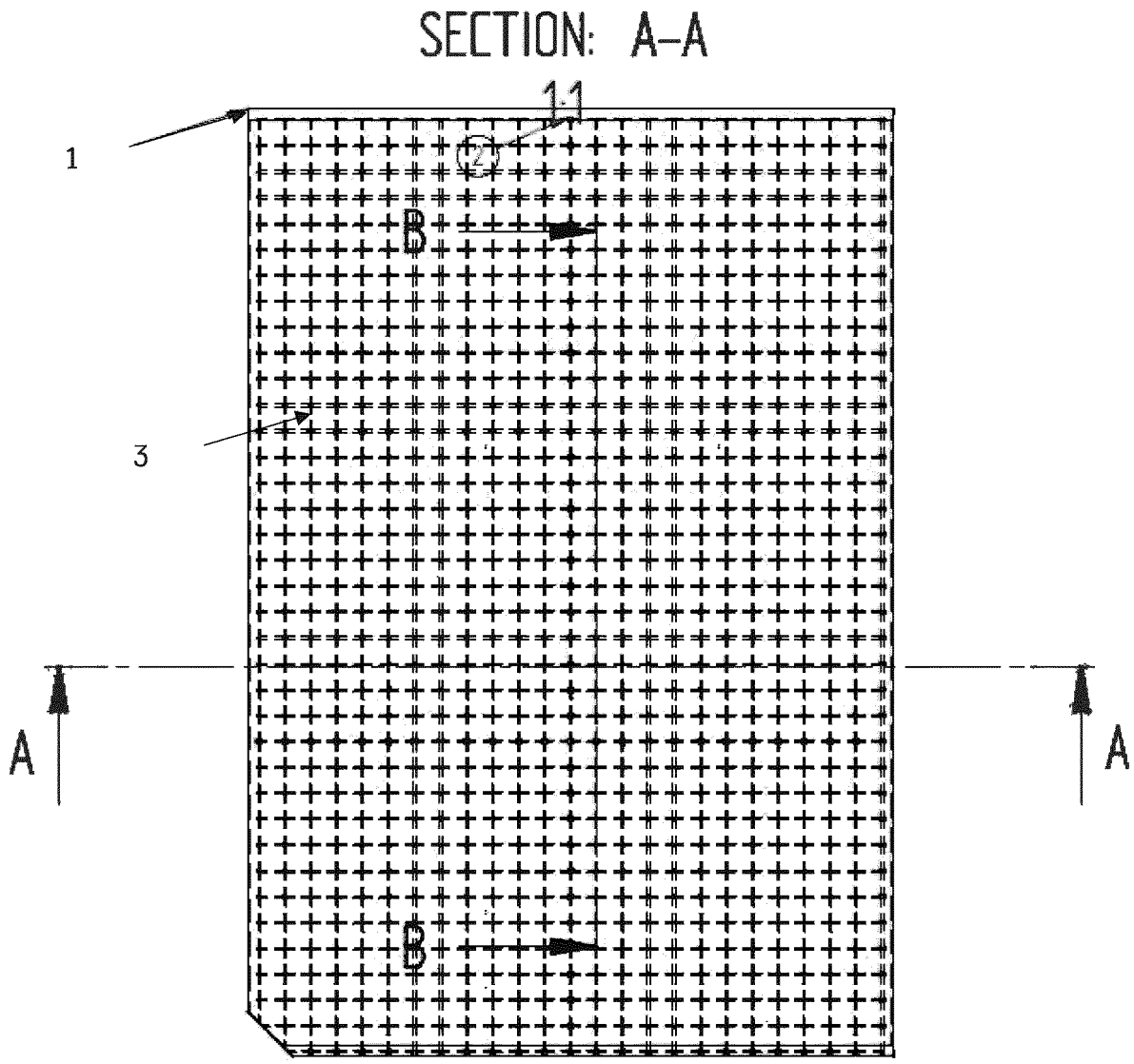


Fig. 10

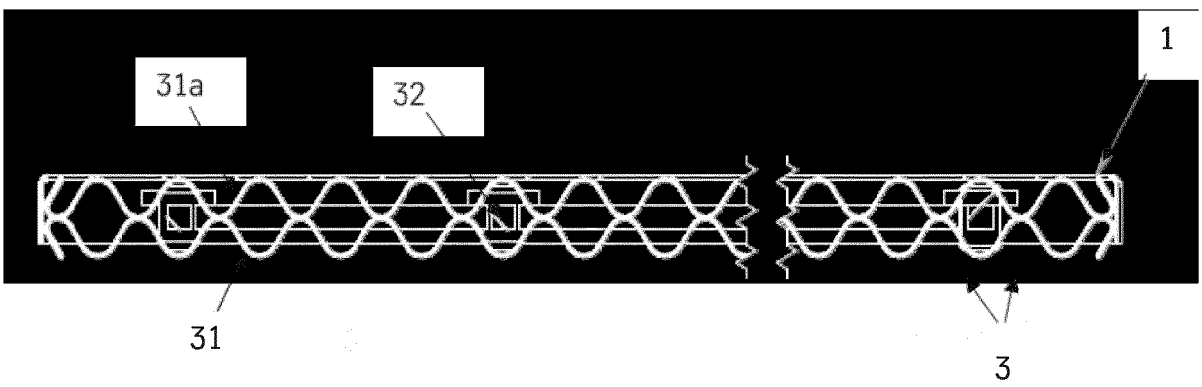


Fig. 11

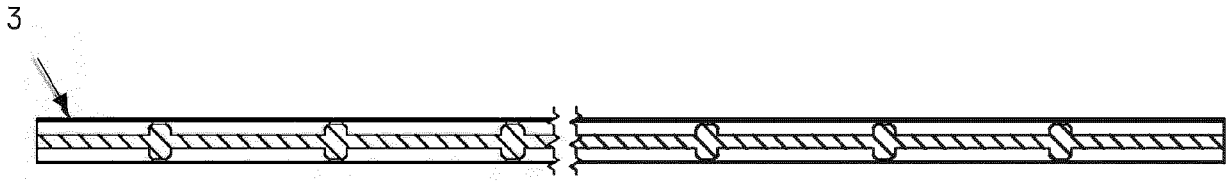


Fig. 12

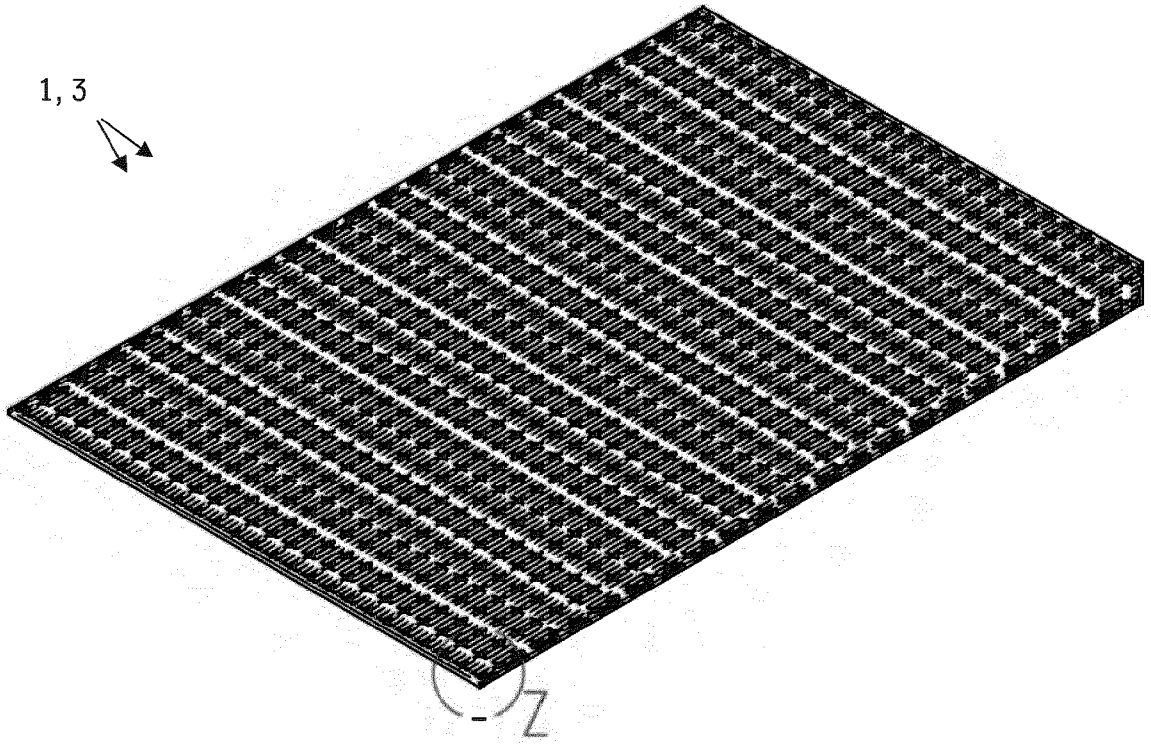
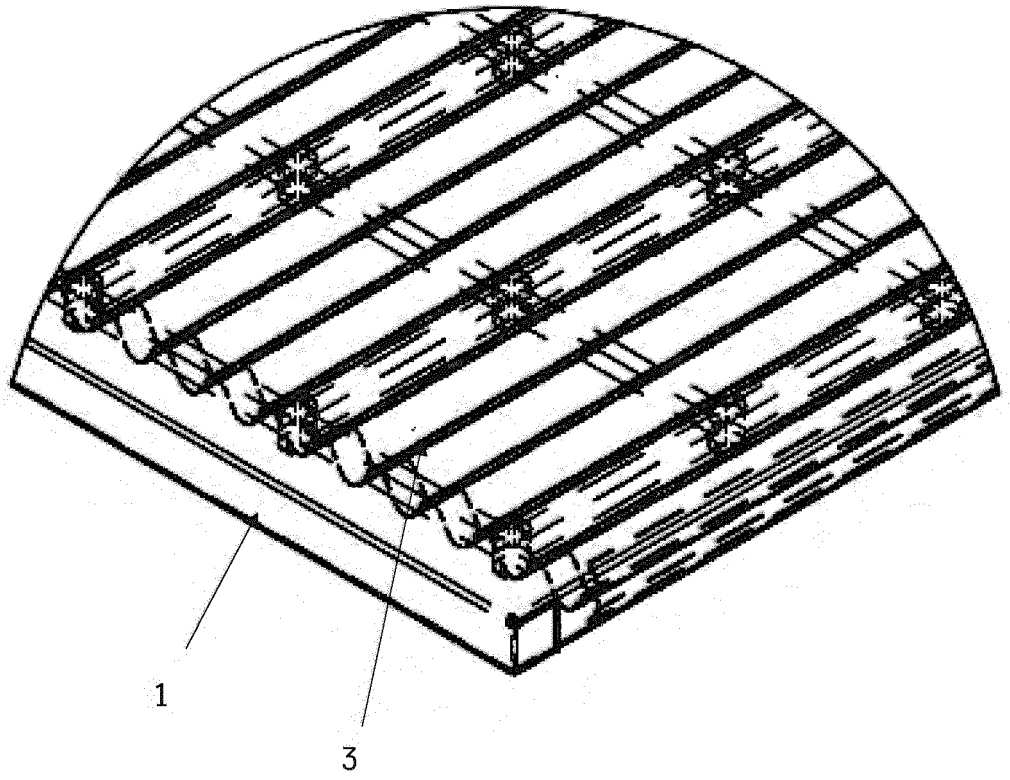


Fig. 13



DETAIL: Z

1:2

Fig. 14

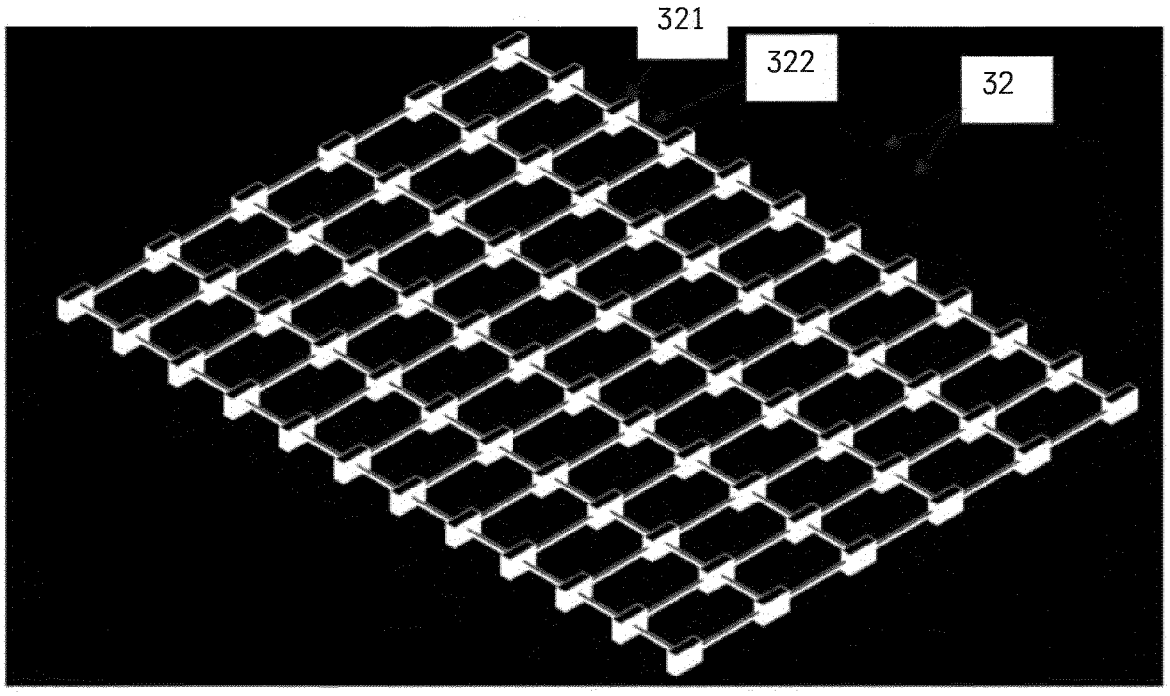


Fig. 15

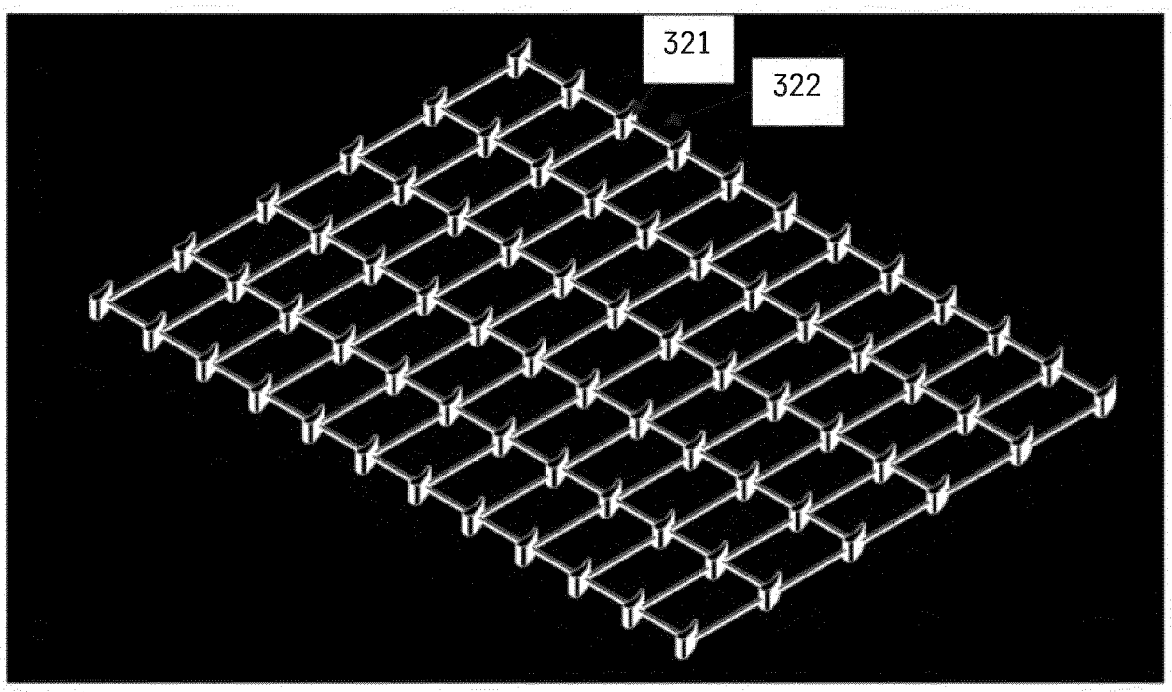


Fig. 16

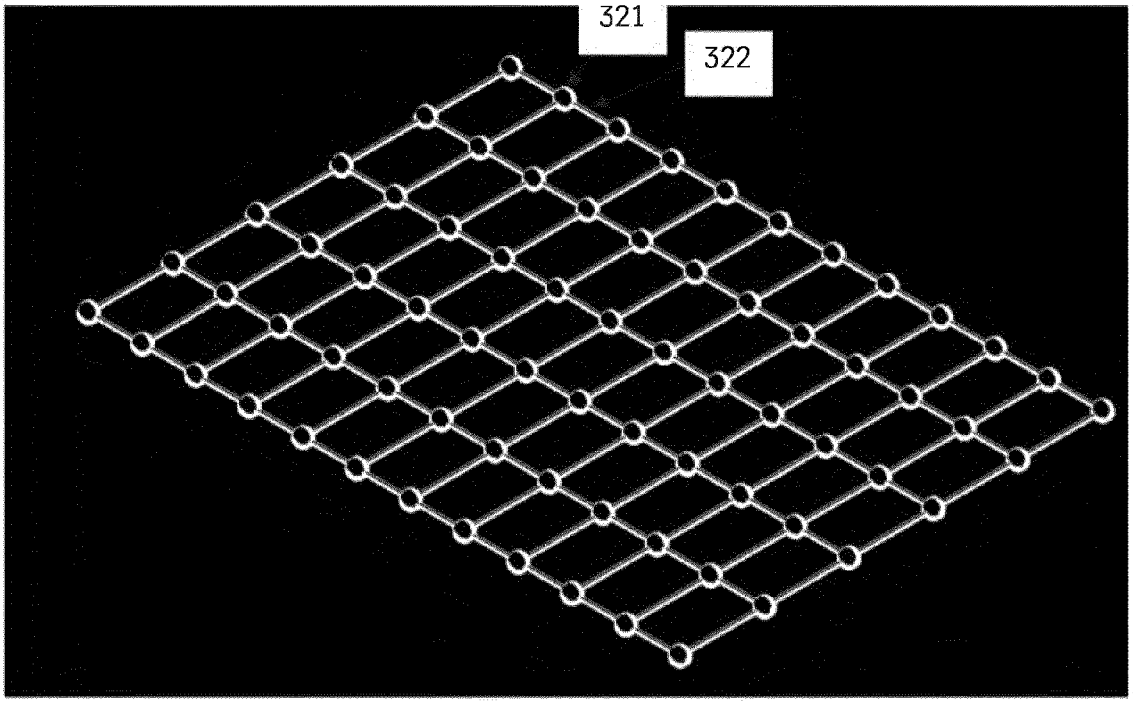


Fig. 17

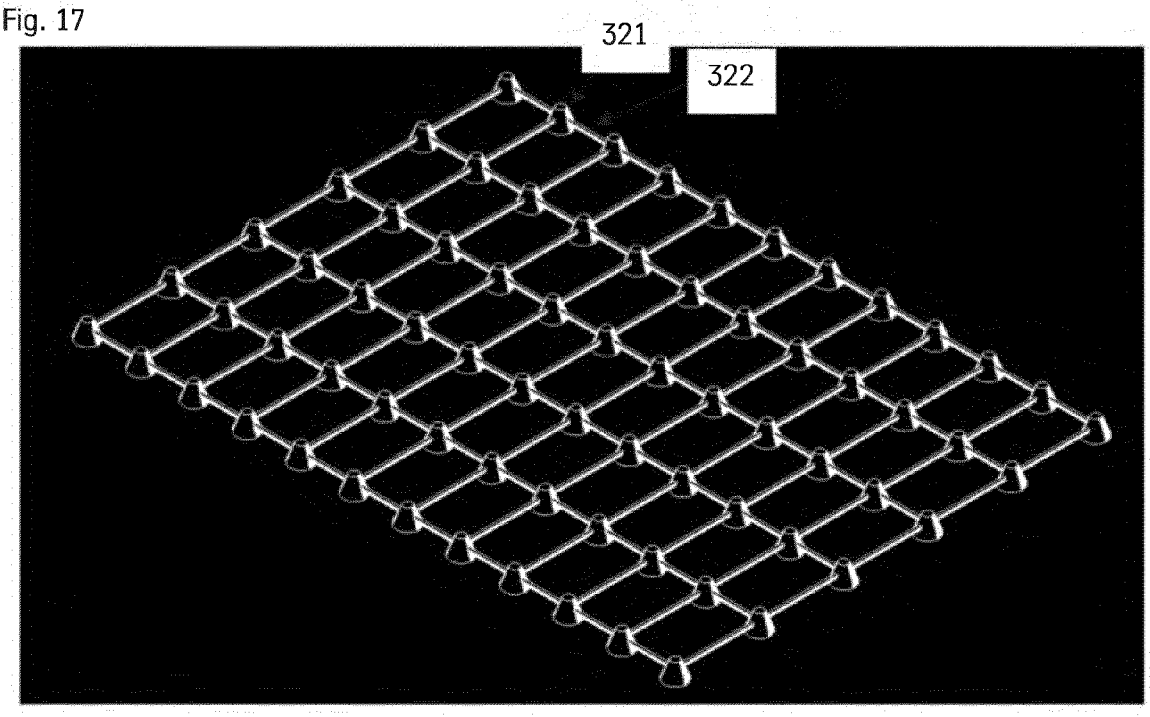


Fig. 18

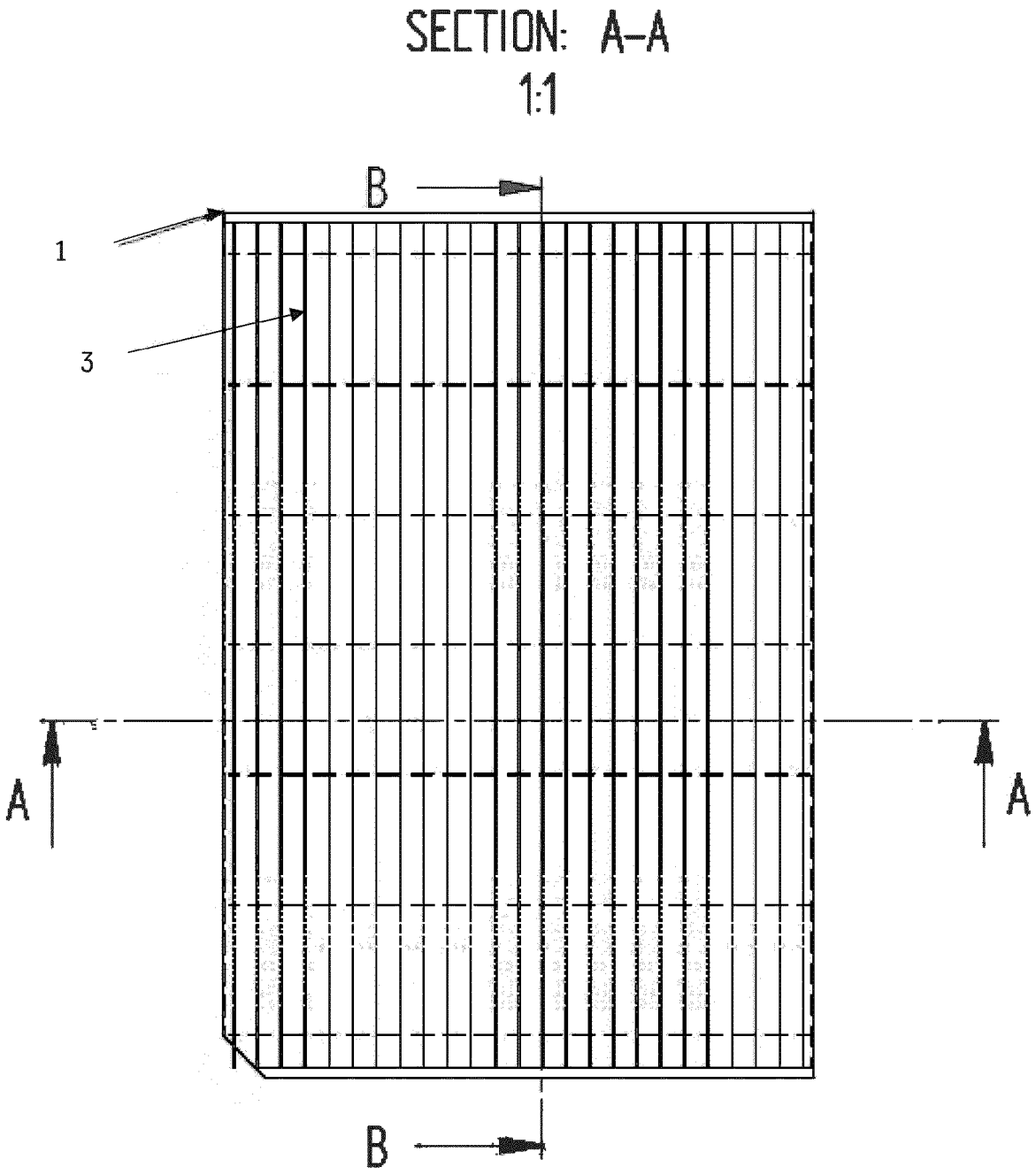


Fig. 19

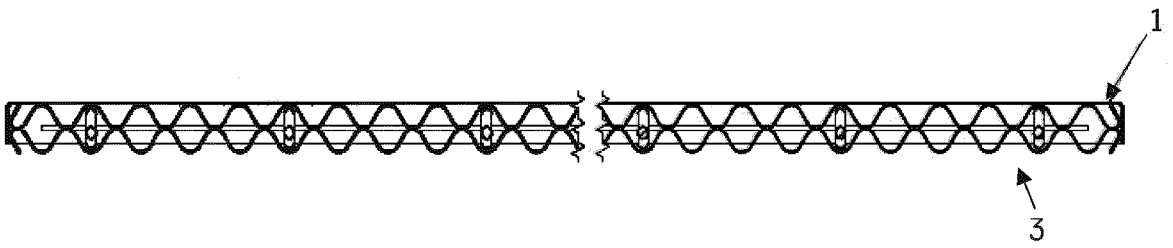


Fig. 20

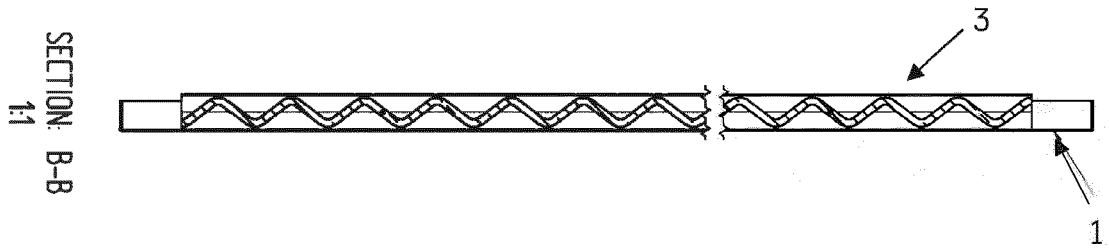
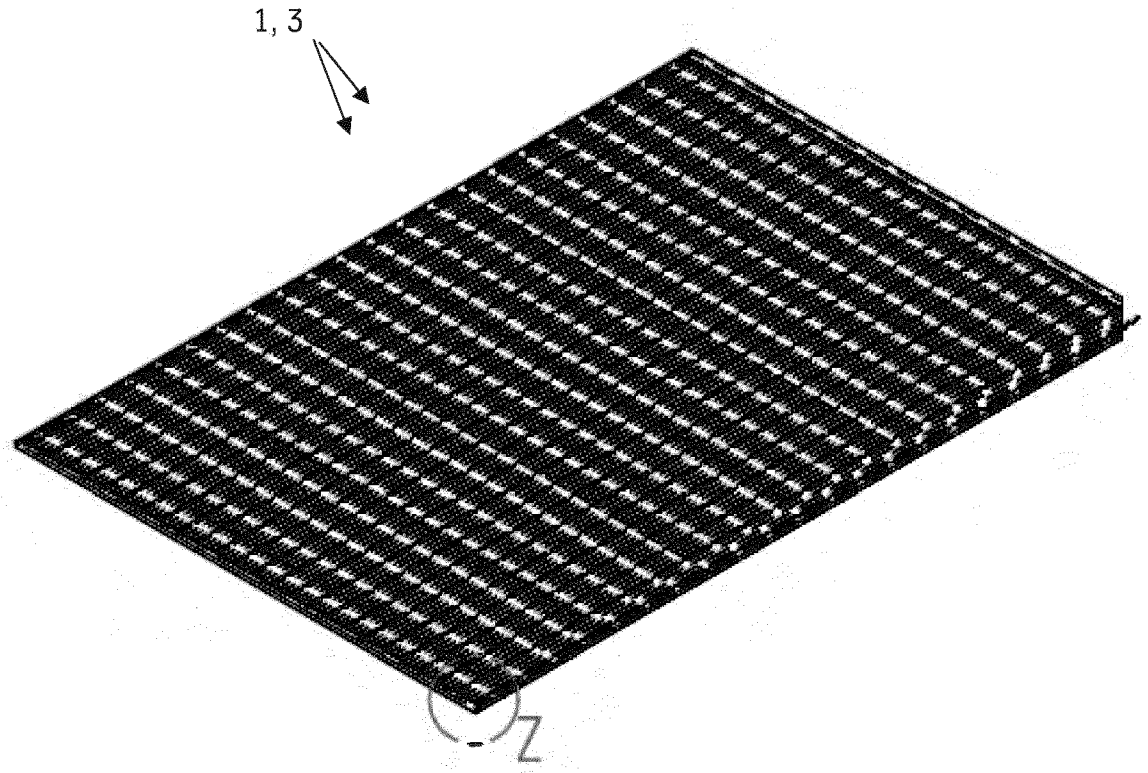


Fig. 21



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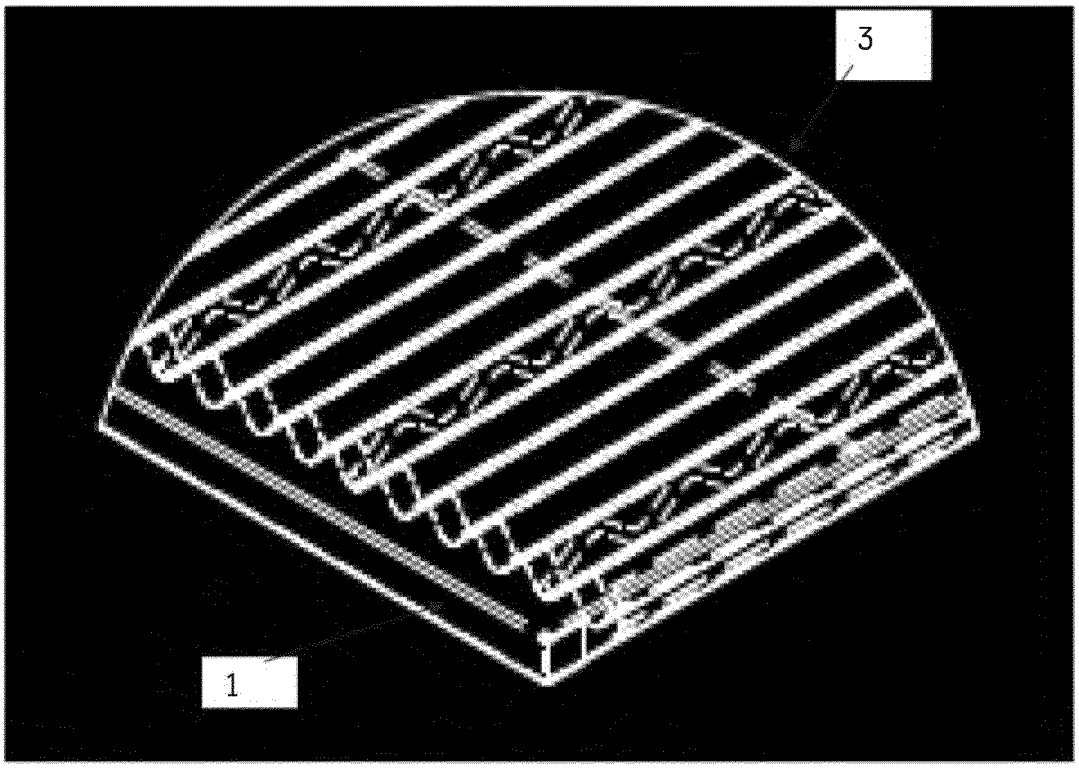

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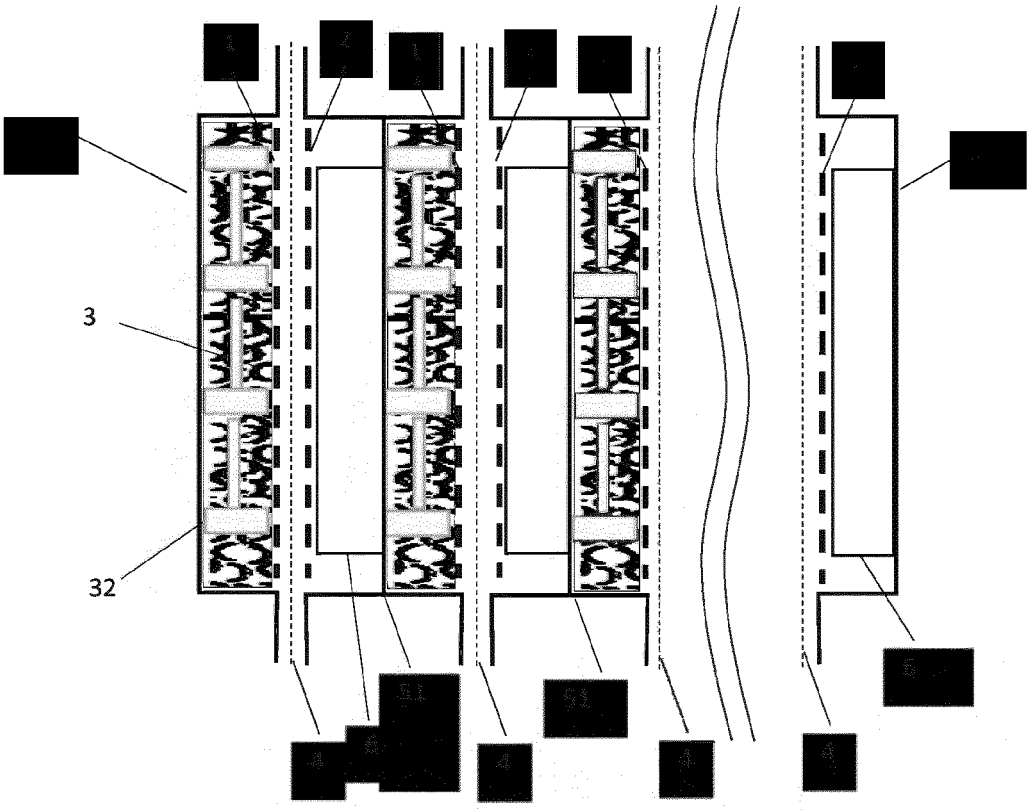
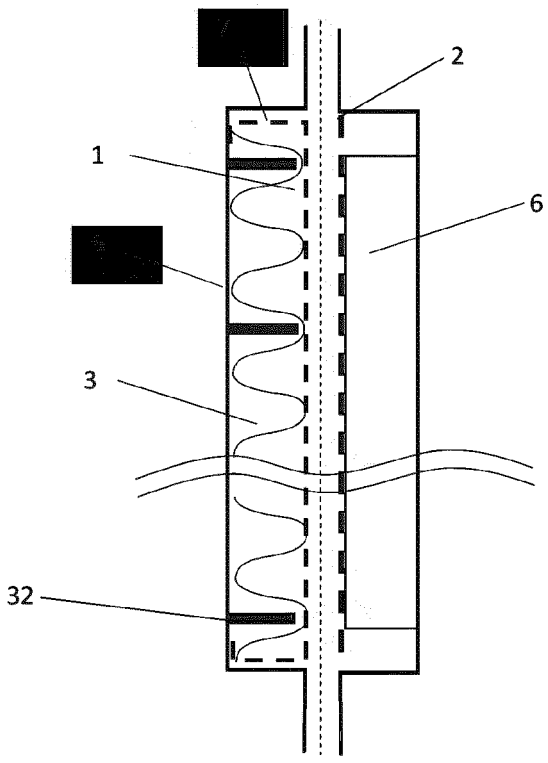


Fig. 24



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EUROPEAN SEARCH REPORT

Application Number
EP 23 21 4042

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C25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 June 2024	Schild, Jérémy

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26-06-2024

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