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(54) **ELASTIC SUPPORT MEMBER, ELECTROLYTIC CELL, MANUFACTURING APPARATUS AND MANUFACTURING METHOD**

(57) The present disclosure relates to an elastic support, an electrolytic cell having the elastic support, a manufacturing apparatus and manufacturing method for manufacturing the elastic support. The elastic support comprises a substrate, elastic region portions and middle support legs. Each of the elastic region portions comprise an elastic sheet punching hole, a first row of elastic sheets and a second row of elastic sheets. A contour line of the elastic sheet punching hole is closed on the substrate, and the contour line comprises a first contour line and a second contour line parallel to each other; the elastic sheets in the first row of elastic sheets and elastic sheets in the second row of elastic sheets are all in elastic contact with the cathode member. The middle support legs are formed between two adjacent elastic region portions. The elastic support according to the present disclosure has good strength and stability, and can provide stable and uniform elastic supporting for the cathode assembly in the electrolytic cell, to improve the performance of the electrolytic cell in use on the whole.

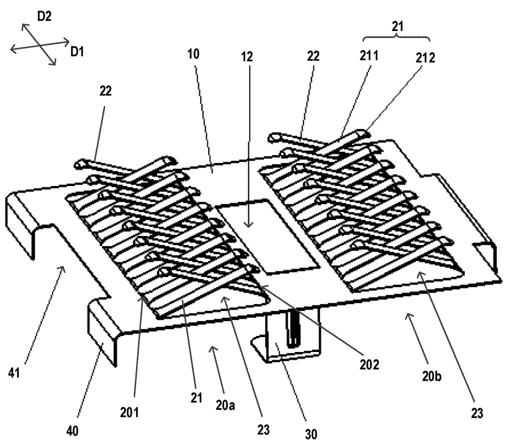

FIG. 2

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Description

FIELD

[0001] The present disclosure related to the field of electrolytic cells, and particularly to an elastic support, an electrolytic cell having the elastic support, a manufacturing apparatus and manufacturing method for manufacturing the elastic support.

BACKGROUND

[0002] Common electrolytic cells in industry usually include an anode chamber and a cathode chamber. An anode structure is disposed in the anode chamber, and a cathode structure is disposed in the cathode chamber. The anode structure and the cathode structure are respectively located on both sides of an ion exchange membrane and form a certain pole distance. In the ionic membrane electrolytic cell, an ionic membrane is also disposed between the cathode structure and the anode structure.

[0003] The size of the electrode spacing (pole distance) between the anode structure and the cathode structure in the electrolytic cell has a great influence on the voltage of the electrolytic cell. The voltage of the electrolytic cell may be reduced by reducing the pole distance, thereby reducing the consumption of electric energy. In some cases, there is a non-rigid connection between the cathode structure in the electrolytic cell and a cell body of the electrolytic cell, and the cathode structure can be mounted in the cell body of the electrolytic cell through an elastic support. Such an arrangement not only facilitates the adjustment of the pole distance, but also avoids the case that the cathode structure might cause damages to the ionic membrane due to rigid contact.

[0004] However, there are some deficiencies in the existing elastic supports, for example: the contact between elastic force-applying portions and the cathode structure is uneven, so that the voltage of the electrolytic cell cannon be reduced well, and the cathode structure cannot be supported evenly, which might also cause damages to the ionic membrane due to the fluctuation of the electrolyte; there is usually a lack of supporting between adjacent force-applying portions of the elastic support, so that the rigidity at this position is poorer than other positions, which is also not conducive to the even contact between the elastic support and the cathode structure.

[0005] Therefore, it is necessary to provide an elastic support, an electrolytic cell having the elastic support, a manufacturing apparatus and manufacturing method for manufacturing the elastic support, to at least partly solve the above-mentioned problems.

SUMMARY

[0006] The objective of the present disclosure is to provide an elastic support, an electrolytic cell having the elastic support, a manufacturing apparatus and manufacturing method for manufacturing the elastic support. The elastic support has good strength and stability, and can provide stable and uniform elastic supporting for the cathode assembly in the electrolytic cell, to improve the performance of the electrolytic cell in use on the whole.

[0007] According to one aspect of the present disclosure, there is provided an elastic support for an electrolytic cell, the elastic support being configured to support a cathode member of the electrolytic cell in a cell body of the electrolytic cell, the elastic support comprising:

a substrate which is a flat plate structure and spaced apart from the cathode member, and which is formed with a plurality of elastic region portions so that each of the elastic region portions comprises:

an elastic sheet hole whose contour line is closed on the substrate, the contour line comprising a first contour line and a second contour line parallel to each other;

a first row of elastic sheets, each of which extends from the first contour line toward the cathode member and toward the second contour line;

a second row of elastic sheets, each of which extends from the second contour line toward the cathode member and toward the first contour line,

wherein all elastic sheets in the first row of elastic sheets and the second row of elastic sheets are all in elastic contact with the cathode member;

middle support legs formed on a side of the substrate away from the cathode member and located between two adjacent elastic region portions, the middle support legs being fixedly connected between the substrate and a wall of the cell body.

[0008] According to the solution, the arrangement of the middle support legs makes the elastic supports have good stability. Furthermore, since the contour line of the elastic sheet punching hole is closed on the substrate, the elastic sheet hole does not extend from the substrate to the edge support legs and middle support legs outside the substrate, so that the elastic support will not lose rigidity and stability due to the presence of the hole, and the occurrence of deformation during use can also be avoided.

[0009] In one embodiment, the elastic sheets in the first row of elastic sheets and the elastic sheets in the second row of elastic sheets are arranged alternately, and on a projection plane perpendicular to the first contour line and the second contour line, projections of the first row of elastic sheets and the projections of the second row of elastic sheets intersect one another in an X shape.

[0010] According to the solution, the elastic supports can provide a more powerful, stable and uniform elastic supporting for the cathode assembly in the electrolytic cell.

[0011] In one embodiment, the elastic region portions are formed by punching, and the elastic sheet holes are punching holes; and

the middle support legs are formed by punching the substrate at predetermined positions, to simultaneously form support leg punching holes and the middle support legs on the substrate.

[0012] In one embodiment, the elastic support is adapted for an electrolytic cell with a rib plate being provided on the wall of the cell body, and the elastic support further comprises edges support legs formed by bending from an edge of the substrate towards the wall of the cell body so that the rib plate can be snap-fitted at an inner side of the edge support legs.

[0013] According to the above two solutions, firm mounting of the elastic support in the cell body is enabled.

[0014] In one embodiment, the substrate is rectangular, a plurality of edge support legs are provided on each of a first longitudinal edge and a second longitudinal edge of the substrate extending in a longitudinal direction of the substrate, and the edge support legs at the first longitudinal edge and the edge support legs at the second longitudinal edge are staggered from one another in a transverse direction of the substrate.

[0015] In one embodiment, notches inwardly recessed along a plane where the substrate lies are formed between two adjacent edge support legs, along each of the first longitudinal edge and the second longitudinal edge of the substrate, and

> at least two elastic supports are jointly used in a same electrolytic cell, and the at least two elastic supports are arranged in the transverse direction of the substrate, so that in a projection plane parallel to the substrate, the edge support legs and the notches of the adjacent elastic supports fit with one another in an embedded manner.
>
> according to the above two solutions, the arrangement of the adjacent elastic supports is more compact, makes full use of the limited space in the cell body, and provides elastic supporting for the cathode assembly in a larger area.

[0016] In one embodiment, each of the elastic sheets comprises a straight wall section connected with the substrate and an arc section bent from an end of the straight wall section, and the arc section is used to elastically contact the cathode member.

[0017] In one embodiment, the substrate is rectangular, the plurality of elastic region portions are arranged on the substrate in an array in a longitudinal direction and a transverse direction of the substrate, and the middle support legs are plural and respectively disposed between the elastic region portions adjacent one another in the transverse direction of the substrate.

[0018] In one embodiment, each of the elastic sheet punching holes is shaped as a rectangle that is consistent with the horizontal and longitudinal directions of the substrate, the first contour line and the second contour line of the elastic sheet punching hole are the longitudinal edges thereof, and each of the elastic sheets is formed as a strip-shaped structure extending in the transverse direction of the elastic sheet punching hole.

[0019] According to the above two solutions, such elastic sheets are more flexible and have better elasticity.

[0020] According to another aspect of the present disclosure, there is provided an electrolytic cell comprising a cell body, a cathode member disposed in the cell body and the elastic support according to any of the above solutions.

[0021] In one embodiment, the electrolytic cell further comprises an anode member and an ionic membrane disposed between the cathode member and the anode member.

[0022] According to a further aspect of the present disclosure, there is provided an apparatus for manufacturing the elastic support for the electrolytic cell according to any of the above solutions, the apparatus comprising a punching die for processing a sheet material, the punching die comprising:

> a series of punching dies for processing elastic sheets on the sheet material, comprising:
>
> an elastic sheet gap punching die configured to punch out gaps between the elastic sheets on the sheet material;
>
> a thinning and widening punching die configured to thin and widen the elastic sheets;
>
> an elastic sheet forming punching die configured to bend and form the elastic sheets relative to a main body of the sheet material;
>
> a blanking and punching die configured to perform blanking processing for outer shapes of the elastic sheets,
>
> wherein the punching dies in the series of punching dies for processing the elastic sheets on the sheet material form progressive punching dies for continuous punching in the above order;
>
> a series of punching ides for processing middle support legs on the sheet material, comprising:
>
> a middle support leg punching die configured to punch a shape and contour of the middle support legs on the sheet material;
>
> a middle support leg bending and punching die con-

figured to bend and form the middle support legs relative to the main body of the sheet material,

wherein the punching dies in the series of punching dies for processing the middle support lets on the sheet material form progressive punching dies for continuous punching in the above order.

[0023] According to the above solution, complete elastic supports are processed on the sheet material by the punching process, the manufacturing process is efficient and convenient, and the processed elastic supports have good stability.

[0024] In one embodiment, the apparatus further comprises a measuring and calibrating device comprising:

a positioning base configured as a substrate fixedly support the elastic support;

a distance measuring device configured to obtain a value of distance between an end of each of the elastic sheets away from the substrate and a reference plane in a direction perpendicular to the reference plane, the reference plane being a plane where the substrate lies or a plane parallel to the substrate;

a calibrating device configured to provide the elastic sheets with an acting force perpendicular to the reference plane;

a control module configured to communicate with the distance measuring device and the calibrating device, and configured to:

receive a signal comprising the value of distance from the distance measuring device;

determine whether the value of distance is within a pre-stored threshold range;

if a determination result is NO, control the calibrating device to provide the corresponding acting force to the elastic sheet to calibrate the value of distance between the elastic sheet and the reference plane;

control the distance measuring device and the calibrating device to repeat the above distance measuring step, determining step and calibrating step until the obtained value of distance falls within the threshold range.

[0025] According to the above solution, it can be ensured that each elastic sheet on the elastic support has a consistent protruding height, so that elastic forces provided by the elastic regions of the elastic support are consistent.

[0026] In one embodiment, the calibrating device further comprises a top frame and a bottom frame, wherein the positioning base is configured as a straight wall protruding from the bottom frame toward the top frame, so that the elastic support can be supported midair by the straight wall, and the distance measuring device is disposed on the top frame and towards the bottom frame.

[0027] In one embodiment, the calibrating device is configured to apply a force to a position of the elastic sheet connected with the substrate.

[0028] According to the above solution, according to the principle of leverage, it can be seen that for a cantilever structure of the elastic sheet, a force arm at the position of the elastic sheet close to the substrate is relatively small, so applying a force here is not prone to cause the elastic sheet to be greatly raised or lowered, thereby facilitating precise adjustment of the height of the elastic sheet.

[0029] In one embodiment, the calibrating device comprises:

a top electric push rod protruding from the top frame toward the elastic sheet, to directly or indirectly exert a force on the elastic sheet;

a bottom electric push rod protruding from the bottom frame toward the elastic sheet, to directly or indirectly exert a force on the elastic sheet.

[0030] In one embodiment, an end of the top electric push rod is provided with a top airbag which abuts against the elastic sheet to directly apply a force to the elastic sheet; an end of the bottom electric push rod is provided with a bottom airbag which abuts against the elastic sheet to directly apply a force to the elastic sheet.

[0031] In one embodiment, the apparatus comprises an ultrasonic generator which is connected to the top airbag and the bottom airbag through an ultrasonic vibrator, and the ultrasonic generator is configured to correct the vibration of the elastic sheet through the top airbag and the bottom airbag.

[0032] In one embodiment, the substrate of the elastic support is rectangular, each of the elastic sheets extends in the transverse direction of the substrate and towards the top frame, and the top airbag and the bottom airbag acting on each of the elastic sheets are staggered in the transverse direction.

[0033] According to the above solution, such an arrangement may prevent the top airbag and the bottom airbag from interfering with each other, to improve the flexibility and effectiveness of adjustment.

[0034] In one embodiment, the distance measuring device comprises an infrared distance measuring device or an ultrasonic distance measuring device, and the control module is integrated in a PLC control system or an MCU single-chip microcomputer control system.

[0035] According to a further aspect of the present disclosure, there is provided a method for manufacturing the elastic support for the electrolytic cell according to any of the above solutions, the method comprising the following steps:

selecting a sheet material in a flat sheet form;

forming elastic sheets on the sheet material by a punching process, and bending the elastic sheets relative to a main body of the sheet material in a due shape;

forming the middle support legs on the sheet material by the punching process, and bending the middle support legs in a due shape relative to the main body of the sheet material,

the main body of the sheet material constitutes the substrate of the elastic support.

[0036] In one embodiment, the method further comprises: bending the edge of the sheet material to form the edge support legs.

[0037] In one embodiment, the method further comprises a detecting and correcting step after the step of processing the elastic support, the detecting and correcting step comprising:

obtaining a value of distance between an end of each of elastic sheets away from the substrate and a reference plane in a direction perpendicular to the reference plane, the reference plane being a plane where the substrate lies or a plane parallel to the substrate;

determining whether the value of distance is within a threshold range;

if a determination result is NO, applying a force perpendicular to the substrate to the elastic sheet, to calibrate the value of distance between the elastic sheet and the reference plane;

repeating the above distance measuring step, the determining step and the calibrating step until the obtained value of distance falls within the threshold range.

[0038] According to the solution, it can be ensured that each elastic sheet on the elastic support has a consistent protruding height, so that elastic forces provided by the elastic regions of the elastic support are consistent.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039] In order to better understand the above and other objectives, features and advantages of the present disclosure, preferred embodiments as shown in the accompanied drawings are provided. Throughout the drawings, the same or similar reference symbols refer to the same or similar elements. It would be appreciated by those skilled in the art that the drawings are provided to illustrate the preferred embodiments of the present disclosure, without suggesting any limitation to the scope of the present disclosure, and respective components therein are not drawn to scale.

FIG 1 is a top view of an elastic support according to a preferred embodiment of the present disclosure;

FIG 2 is a three-dimensional schematic view of part of the structure of the elastic support shown in FIG 1;

FIG 3 is a front view of the structure in FIG 2;

FIG 4 is a top view of two elastic supports shown in FIG 1 in a combined state;

FIG 5 is a front view of a plurality of elastic supports shown in FIG 1 when they are mounted in a cell body of an electrolytic cell;

FIG 6 is a structural schematic view of a measuring and calibrating device in an apparatus for manufacturing the elastic support in FIG 1;

FIG 7 is a flowchart of a method for manufacturing the elastic support shown in FIG 1.

Listing of reference numbers:

[0040]

100 elastic support

10 substrate

20 Elastic region portion

20a First elastic region portion

20b Second elastic region portion

30 middle support leg

40 edge support leg

12 support leg punching hole

21 A first row of elastic sheets

221 The straight wall section of the first row of elastic sheets

222 The arc section of the first row of elastic sheets

22 The second row of elastic sheets

212 The straight wall section of the second row of

elastic sheets

211 The arc section of the second row of elastic sheets

23 elastic sheet punching hole

201 first contour line

202 second contour line

41 notch

400 electrolytic cell bottom wall

401 rib plate

300 measuring and calibrating device

301 top frame

302 bottom frame

303 top electric push rod

304 bottom electric push rod

305 top airbag

306 bottom airbag

307 ultrasonic vibrator

308 ultrasonic generator

309 distance measuring device

310 bolt

311 positioning base.

DETAILED DESCRIPTION OF EMBODIMENTS

[0041] Reference will now be made to the drawings to describe in detail the embodiments of the present disclosure. The description here is only about preferred embodiments of the present disclosure, and those skilled in the art would envision, on the basis of the preferred embodiments described herein, other manners that can implement the present disclosure, which also fall into the scope of the present disclosure.

[0042] The present disclosure provides an elastic support for an electrolytic cell, an electrolytic cell having the elastic support, a manufacturing apparatus and manufacturing method for manufacturing the elastic support. A cathode member and an anode member are disposed in a cell body of the electrolytic cell. The cathode member is for example configured as a cathode mesh, and the anode member is for example configured as an anode mesh. The elastic support is mounted in the cell body and is positioned on a side of the cathode member facing away from the anode member and used to support the cathode member.

[0043] FIGS. 1-7 show some preferred embodiments of the elastic support according to the present disclosure. First of all, it should be appreciated that the depictions of directions and positions etc. mentioned in the present disclosure can be appreciated with reference to the specific implementations shown in FIGS. 1-7, and each direction, position, etc. should be appreciated as a relative direction and a relative position between members other than an absolute direction and an absolute position.

[0044] Referring first to FIGS. 1-2, an elastic support 100 comprises a substrate 10, which is a flat plate structure and spaced apart from a cathode member. The substrate 10 is punched at predetermined positions to form a plurality of elastic region portions 20. Referring to FIG 1, each elastic region portion 20 comprises an elastic sheet punching hole 23, a first row of elastic sheets 21 and a second row of elastic sheets 22, a contour line of the elastic sheet punching hole 23 being closed on a substrate 10, and the contour line comprising a first contour line 201 and a second contour line 202 parallel to each other. Each of the first row of elastic sheets 21 extends from the first contour line 201 toward the cathode member and toward the second contour line 202, and each of the second row of elastic sheets 22 extends from the second contour line 202 of the substrate 10 toward the cathode member and toward the first contour line 201, the elastic sheets in the first row of elastic sheets 21 and the elastic sheets in the second row of elastic sheets 22 are arranged alternately.

[0045] It may be appreciated that the first row of elastic sheets 21 and the second row of elastic sheets 22 are part of a sheet material constituting the substrate 10 before being processed, and the elastic sheets are obtained by processing using a punching and cutting process in a punching process. The elastic sheet punching hole 23 is formed at original positions of the elastic sheets on the sheet material; then the elastic sheets are bent by a bending process in the punching process.

[0046] FIG 2 shows a pair of adjacent elastic region portions 20, namely, a first elastic region portion 20a and a second elastic region portion 20b, in a transverse direction D1 from a perspective view. It may be appreciated with reference to FIG 2 that all elastic sheets in the first row of elastic sheets 21 and the second row of elastic sheets 22 are in elastic contact with the cathode member, to provide uniform elastic support for the cathode member. Further, the substrate 10 is parallel to a surface of the cathode member facing the substrate 10, and each of the elastic sheets elastically supports the surface of the cathode member.

[0047] Further referring to FIG 1 and FIG 2, in this embodiment, the substrate 10 is substantially rectangular, and the elastic sheet punching hole 23 is also substantially rectangular. The substrate 10 and the elastic sheet punching hole 23 have consistent horizontal and longitudinal directions, and they both have a pair of edges (namely, the width of the rectangle) extending along the transverse direction D1 and a pair of edges (namely, the length of the rectangle) extending along a longitudinal direction D2. The first contour line 201 and the second contour line 202 defining the elastic sheet punching hole 23 are edges extending along the longitudinal direction D2 of the elastic sheet punching hole 23. Preferably, a plurality of elastic region portions 20 are arranged on the substrate 10 in an array along the longitudinal direction D2 and the transverse direction D1, and there are a plurality of middle support legs 30 which are respectively between adjacent elastic region portions 20 in the transverse direction D1 of the substrate 10.

[0048] For ease of description, the direction perpendicular to the substrate 10 is referred to as a height direction D3, and the height direction D3, the transverse direction D1 and the longitudinal direction D2 are orthogonal in a three-dimensional coordinate system.

[0049] The specific structure of the elastic sheets on the elastic support 100 is shown in FIG 2 and FIG 3. Referring to FIG 2 and FIG 3, the elastic sheets in the first row of elastic sheets 21 and the elastic sheets in the second row of elastic sheets 22 are consistent in structure and shape. Each of the first row of elastic sheets 21 comprises a straight wall section 221 connected with the substrate 10 and an arc section 222 bent from an end of the straight wall section 221, and the arc section 222 is used to elastically contact the cathode member; each of the second row of elastic sheets 22 comprises a straight wall section 212 connected with the substrate 10 and an arc section 211 bent from an end of the straight wall segment 212, and the arc section 211 is used to elastically contact the cathode member. The first row of elastic sheets 21 and the second row of elastic sheets 22 are arranged oppositely, and each elastic sheet is formed as a strip extending in the transverse direction D1 towards the anode assembly of the electrolytic cell. The first row of elastic sheets 21 and the second row of elastic sheets 22 together form a comb-shaped structure. In the front view as shown in FIG 3, the first row of elastic sheets 21 and the second row of elastic sheets 22 cross each other to form an X shape. That is to say, on a projection plane perpendicular to the longitudinal direction D2, the projections of the first row of elastic sheets 21 and the projections of the second row of elastic sheets 22 intersect one another in an X shape.

[0050] Preferably, for each elastic region portion 20, there is a gap between two adjacent elastic sheets in the longitudinal direction D2 of the elastic sheet punching hole. When the elastic sheets are processed from the sheet material constituting the substrate 10, the gap may be first punched and cut by a punching and cutting die in the punching apparatus, and then the elastic sheets are bent in a due shape by a bending die in the punching apparatus. More preferably, before being bent, the elastic sheets may also be thinned and widened, so that the thickness of the elastic sheets is smaller than that of the substrate 10. Such elastic sheets are formed into a soft strip shape, are more flexible and have better flexibility.

[0051] Further referring to FIG 3, the elastic support 100 further comprises middle support legs 30 and edge support legs 40 formed by punching. The middle support legs 30 are formed on a side of the substrate 10 away from the cathode member and located between two adjacent elastic region portions 20, the middle support legs 30 are fixedly connected between the substrate 10 and a bottom wall of the cell body. Since the middle support legs 30 are formed by punching the substrate 10 at predetermined positions, the support leg punching hole 12 adjacent to the middle support legs 30 is also simultaneously formed on the substrate 10.

[0052] The edge support legs 40 are formed by bending from the edge of the substrate 10 toward the bottom wall of the cell body. The edge support legs 40 are used to engage with rib plates in the cell. Specifically referring to FIG 5, a plurality of elastic supports 100 can be located together in the same electrolytic cell, and the bottom wall 400 of the cell body of the electrolytic cell is provided with rib plates 401 extending toward the substrate 10, and the rib plates 401 can be snap-fitted inside the edge support legs 40 to further achieve affixation of the elastic support 10 relative to the cell body. Referring to FIG 3 and FIG 5, a dimension of the edge support leg 40 in the height direction D3 is smaller than that of the middle support leg 30 in the height direction D3.

[0053] In the present embodiment, since the contour line of the elastic sheet punching hole 23 is closed on the substrate 10, the elastic sheet punching hole 23 does not extend from the substrate 10 to the edge support legs 40 and the middle support legs 30 outside the substrate 10. Such an arrangement enables the elastic support 100 to avoid the reduction of rigidity and stability caused by the arrangement of the punching hole, and also avoid deformation during use.

[0054] Turning back to FIG 1 below, preferably, a plurality of edge support legs 40 are respectively provided on each of two longitudinal edges (referred to as a first longitudinal edge and a second longitudinal edge) extending in the longitudinal direction D1 of the substrate 10, and furthermore, notches 41 inwardly recessed in the extension direction of the substrate 10 are provided between adjacent edge support legs 40 on each of the longitudinal edges. The edge support legs 40 at the first longitudinal edge and the edge support legs 40 at the second longitudinal edge are staggered from one another in the transverse direction D1 of the substrate 10, so that in the transverse direction D1: the edge support legs 40 on the first longitudinal edge are aligned with the notches 41 on the second longitudinal edge; the notches 41 on the first longitudinal edge are aligned with the edge support legs 40 on the second longitudinal edge.

[0055] Such arrangement of the edge support legs 40 and the notches 41 facilitates the cooperation between at least two elastic supports 100. As already mentioned above, for example with reference to FIG 5, at least two elastic supports 100 can be jointly used in the same electrolytic cell. FIG 4 shows a top view of two adjacent elastic supports 100 in a combined state. In FIG 4, at least two elastic supports 100 are arranged in the transverse direction D1 of the substrate 10, so that in the projection plane parallel to the substrate 10, the edge support legs 40 and the notches 41 of the adjacent elastic supports 100 fit with one another in an embedded manner. Such an arrangement makes the arrangement of adjacent elastic supports 100 more compact, makes full use of the limited space in the cell body, and provides elastic supporting for the cathode assembly in a larger area.

[0056] In the present embodiment, the elastic region portions are formed by punching, and the elastic sheet holes are elastic sheet punching holes. In other embodiments not shown, however, the elastic region portions may also be shaped by other processes.

[0057] In addition, in other embodiments not shown, the elastic sheets may also have other various arrangements. For example, as an alternative to the arrangement manner that "the first row of elastic sheets and the second row of elastic sheets are arranged alternately", the first row of elastic sheets and the second row of elastic sheets may be arranged as one being aligning with one in the transverse direction D1. In this case, on the projection plane perpendicular to the longitudinal direction D2, the projections of the first row of elastic sheets and the second row of elastic sheets can jointly form a "-" shape.

[0058] A preferred embodiment of the present disclosure also provides an electrolytic cell, which comprises the elastic support 100 shown in FIGS. 1-5. As mentioned above, the electrolytic cell further comprises a cathode member such as a cathode mesh, an anode member such as an anode mesh. The elastic support 100 is used to support the cathode member.

[0059] The electrolytic cell in the present embodiment may be an ionic membrane electrolytic cell, and an ionic membrane between the cathode member and the anode member may be disposed in the electrolytic cell.

[0060] The present disclosure further provides a manufacturing apparatus and a manufacturing method for manufacturing the elastic support 100 as shown in FIGS. 1-5. The manufacturing apparatus comprises a punching die for processing the sheet material. The punching die comprises a first series of punching dies for processing the elastic sheets on the sheet material, a second series of punching dies for processing the middle support legs on the sheet material, and edge support leg punching dies that bend portions of the edge of the sheet material to form the edge support legs.

[0061] The first series of punching die comprises: an elastic sheet gap punching die configured to punch out gaps between the elastic sheets on the sheet material, the punching die being for example a punching and cutting die; a thinning and widening punching die configured to thin and widen the elastic sheets; an elastic sheet forming punching die such as a bending die configured to enable the elastic sheets to be bent and formed relative to the main body of the sheet material; a blanking and punching die configured to perform blanking processing for outer shapes of the elastic sheets. The punching dies in the first series of punching dies form progressive punching dies for continuous punching in the above order.

[0062] The second punching die comprises: a middle support leg punching die, for example, a punching and cutting die, configured to punch a shape and contour of the middle support legs on the sheet material; a middle support leg bending and punching die, for example a bending die, configured to bend and form the middle support legs relative to the main body of the sheet material, wherein the punching dies in the series of punching dies for processing the middle support lets on the sheet material form progressive punching dies for continuous punching in the above order.

[0063] Preferably, the manufacturing apparatus further comprises a measuring and calibrating device 300 for measuring and calibrating a protruding height of the elastic sheets after the processing is completed. The measuring and calibrating device 300 comprises a positioning base 311, a distance measuring device 309, a calibrating device and a control module. The positioning base 311 is configured as the substrate 10 fixedly supporting the elastic support 100; the distance measuring device 309 is configured to obtain a value of distance between an end (a top end of the arc section of the elastic sheet in FIG 6) of each elastic sheet (e.g., the first row of elastic sheets 21 and second row of elastic sheets 22) away from the substrate 10 and a reference plane in the height direction D3, the reference plane being a plane where the substrate 10 lies or a plane parallel to the substrate 10; the calibrating device is configured to provide the elastic sheets with a force perpendicular to the reference plane, that is, a force in the height direction D3; the control module is configured to communicate with the distance measuring device 309 and the calibration device.

[0064] The control module can be integrated in a PLC control system or an MCU single-chip microcomputer control system, and is further configured to: receive a signal comprising the value of distance from the distance measuring device 309; determine whether the value of distance is within a pre-stored threshold range; if the determination result is NO, control the calibrating device to provide a corresponding acting force to the elastic sheet to adjust the height of the elastic sheet relative to the substrate 10, thereby calibrating the value of distance between the elastic sheet and the reference plane; control the distance measuring device 309 and the calibrating device to enable them to repeat the above distance measuring step, determining step and calibrating step until the obtained value of distance falls within the threshold range.

[0065] Specifically, in the present embodiment, the calibrating device further comprises a top frame 301 and a bottom frame 302, wherein the positioning base 311 is configured as a straight wall protruding from the bottom frame 302 toward the top frame 301, so that the elastic support 100 can be supported midair by the straight wall. The elastic support 100 is fixed on the bottom frame 302 through bolts 310 passing through the elastic sheet punching holes 23 and the support leg punching holes 12 respectively.

[0066] The distance measuring device 309 is, for example, an infrared distance measuring device or an ultrasonic distance measuring device, and is disposed on the top frame 301 and faces the bottom frame 302. In such an embodiment, the reference plane is roughly a plane where a transmitting head of the distance measuring device 309 is located, for example, the reference plane may be roughly a bottom surface of the top frame 301. However, in other embodiments not shown, the distance measuring device may be installed on the bottom frame and located below the arc section of the elastic sheet, and the distance measuring device sends out an infrared or ultrasonic signal upwards. In such an embodiment, the reference plane for example may be the plane on which the substrate is located or may be a top surface of the bottom frame.

[0067] The calibrating device comprises a top electric push rod 303 and a bottom electric push rod 304. The top electric push rod 303 protrudes from the top frame 301 toward the elastic sheet, to directly or indirectly exert a force on the elastic sheet. The bottom electric push rod 304 protrudes from the bottom frame 302 toward the elastic sheet, to directly or indirectly exert a force on the elastic sheet. In the present embodiment, the top electric push rod 303 and the bottom electric push rod 304 indirectly apply a force to the elastic sheet through an airbag, but in other embodiments not shown, respective ends of the top electric push rod 303 and the bottom electric push rod 304 may act directly on the elastic sheet.

[0068] Returning to the present embodiment, the end of the top electric push rod 303 is provided with a top airbag 305 which abuts against the top surface of the elastic sheet to directly apply a force to the elastic sheet; the end of the bottom electric push rod 304 is provided with a bottom airbag 306 which abuts against the bottom surface of the elastic sheet to directly apply a force to the elastic sheet. In such an embodiment, the top airbag 305 and the bottom airbag 306 are used to adjust the protruding height of the elastic sheet, whereas the top electric push rod 303 and the bottom electric push rod 304 are used to adjust the position of the airbag. Specifically, the top electric push rod 303 is configured to telescope in the height direction D3 to adjust an initial position of the top airbag 305; the bottom electric push rod 304 is configured to telescope in the height direction D3 to adjust an initial position of the bottom airbag 306; the top airbag 305 and the bottom airbag 306 are configured to adjust the value of distance by changing the pressure of the airbags (that is, to adjust the extension height of the elastic sheet). In order to ensure accurate distance measurement, the top airbag 305 and the bottom airbag 306 are out of contact with the elastic sheet during the distance measuring step. Certainly, the top electric push rod 303 and the bottom electric push rod 304 can also be directly used to adjust the height of the elastic sheet.

[0069] Preferably, the top airbag 305 and the bottom airbag 306 are located at a position where the elastic sheet is connected to the substrate 10, that is to say, the calibrating device exerts a force on the elastic sheet at the position. According to the principle of leverage, it may be seen that for a cantilever structure of the elastic sheet, a force arm at the position of the elastic sheet close to the substrate 10 is relatively small, so applying a force here is not prone to cause the elastic sheet to be greatly raised or lowered, thereby facilitating precise adjustment of the height of the elastic sheet.

[0070] Also preferably, the top airbag 305 and the bottom airbag 306 acting on the same elastic sheet are slightly staggered in the transverse direction D1. Such an arrangement may prevent the top airbag 305 and the bottom airbag 306 from interfering with each other, to improve the flexibility and effectiveness of adjustment.

[0071] Furthermore, the apparatus comprises an ultrasonic generator 308 which is connected to the top airbag 305 and the bottom airbag 306 through an ultrasonic vibrator 307. The ultrasonic generator 308 is configured to correct the elastic sheet by vibration through the top airbag 305 and the bottom airbag 306. The top airbag 305 and the bottom airbag 306 are respectively connected to a compressed air source through a pneumatic pipeline. An electric deflation valve, an electric cut-off valve and an electric pressure regulating valve are disposed in sequence on the pneumatic pipeline in a direction from a pressurized airbag to the compressed air source, and are all in communication with the control module.

[0072] Devices such as the distance measuring device 309, the top electric push rod 303, the bottom electric push rod 304, the top airbag 305 and the bottom airbag 306 are all plural, and are arranged in an array on the top frame 301 and the bottom frame 302 respectively, and correspond one to one with the elastic sheets.

[0073] A preferred embodiment of the present disclosure further provides a method for manufacturing the elastic support 100 shown in FIGS. 1-5. The method may be implemented by the above-mentioned manufacturing apparatus. With reference to FIG 7, the method comprises a processing step S1 which comprises the following sub-steps: selecting the sheet material in a flat sheet form; processing elastic sheets on the sheet material by using the punching and cutting die in the punching die, thinning or widening the elastic sheets by using a planar punching head, bending the elastic sheets in a due form relative to the main body of the sheet material by using the bending die in the punching die, and performing blanking processing for the outer shape of the elastic sheets; forming the middle support legs on the substrate by the punching process, and bending the middle support legs in a due form relative to the main body of the sheet material; bending the edge of the sheet material to form the edge support legs. The main body of the sheet material constitutes the substrate of the elastic support. In the present disclosure, complete elastic supports are processed on the sheet material by the punching process, the manufacturing process is efficient and convenient, and the processed elastic supports have good stability.

[0074] Further referring to FIG 7, the method further comprises a detecting and correcting step S2 after the step S1 of processing the elastic support 100. The detecting and correcting step S2 may be implemented by the detecting and calibrating device 300 shown in FIG 6. The detecting and correcting step S2 comprises:

[0075] Step S21: obtaining a value of distance between an end of each elastic sheet away from the substrate 10 and a reference plane in a direction perpendicular to the reference plane, the reference plane being a plane where the substrate 10 lies or a plane parallel to the substrate 10. This step may be implemented for example by the distance measuring device 309 in FIG 6. The distance measuring device 309 sends a signal containing a distance measurement result to the control module after completing the distance measurement.

[0076] Step S22: determining whether the value of distance is within a threshold range, the determination being implemented in the control module.

[0077] If a determination result is YES (Y), the manufacturing ends up; if the determination result is NO (N), the flow enters step S23 (for example, implemented by the measuring and calibrating device 300 shown in FIG 6): the control module sends a control signal to the calibrating device to control the calibrating device to apply a force perpendicular to the substrate 10 to the elastic sheet, to calibrate the distance between the elastic sheet and the reference plane. The calibrating device for example comprises the top electric push rod 303, the bottom electric push rod 304, the top airbag 305, and the bottom airbag 306 in FIG 6.

[0078] That is to say, step S23 is to perform ultrasonic correction for the strip-shaped elastic sheet whose height position error exceeds the threshold value. Further referring to FIG 6 simultaneously, the ultrasonic correction goes in a way that the control module controls the top electric push rod 303 and bottom electric push rod 304 to adjust the positions of the top airbag 305 and the bottom airbag 306, then the control module controls to activate the top airbag 305 and the bottom airbag 306, so that they may be pressed and clamped from a top surface and a bottom surface of a root of the elastic sheet respectively, and adjust the height of the arc section of the elastic sheet by adjusting an airbag pressure of the top airbag 305 and the bottom airbag 306 respectively, so that the elastic sheet performs a certain reverse pre-deformation relative to the height error direction, and then turn on the ultrasonic generator 308 to perform correction by vibration to reduce the amount of rebounding deformation of the elastic sheet 4.

[0079] The above step S21, step S22 and step S23 are repeated. Specifically, after step S23, the control module controls the top airbag 305 and the bottom airbag 306 to deflate, so that the top airbag 305 and the bottom airbag 306 are out of contact with the strip-shaped elastic sheet, and then re-detects the height error of the arc section of the elastic sheet. If the height position errors still exceed the threshold value, the reverse pre-deformation amount is adjusted through the top airbag 305 and bottom airbag 306 according to the difference, and then correction by vibration is performed again to reduce the amount of rebounding deformation of the elastic sheet. Then, the above step S21, step S22 and step S23 continue to be repeated until the obtained value of distance falls within the threshold range.

[0080] As mentioned above, the top airbag 305 and the bottom airbag 306 are used to adjust the height of the arc section of the elastic sheet, while the top electric push rod 303 and the bottom electric push rod 304 are used to adjust the initial positions of the top airbag 305 and the bottom airbag 306. However, when necessary" the amount of reverse pre-deformation of the elastic sheet may also be adjusted by synchronously adjusting an telescoping amount of a telescopic rod of the top electric push rod 303 and the bottom electric push rod 304 through the control module, and a proper clamping force on the strip-shaped elastic sheet is maintained by controlling the pressure of the top airbag 305 and the bottom airbag 306.

[0081] The distance measuring and calibrating step provided by the present disclosure can ensure that each elastic sheet on the elastic support has a consistent protruding height, so that elastic forces provided by the elastic regions of the elastic support are consistent.

[0082] The above method may further include other steps, for example, a step of designing the punching die before starting the processing. The designed punching die comprises the above-mentioned first series of punching dies and the second series of punching dies etc.

[0083] The elastic supports provided by the present disclosure have good strength and stability, and can provide stable and uniform elastic supporting for the cathode assembly in the electrolytic cell, to improve the performance of the electrolyte cell in use on the whole. For example, the arrangement of the middle support legs makes the elastic supports have good stability. Furthermore, since the contour line of the elastic sheet punching hole is closed on the substrate, the elastic sheet punching hole does not extend from the substrate to the edge support legs and middle support legs outside the substrate, so that the elastic support will not lose rigidity and stability due to the presence of the punching hole, and the occurrence of deformation during use can also be avoided.

[0084] The foregoing description on the various embodiments of the present disclosure has been presented to those skilled in the relevant fields for purposes of illustration, but are not intended to be exhaustive or limited to a single embodiment disclosed herein. As aforementioned, many substitutions and variations will be apparent to those skilled in the art. Therefore, although some alternative embodiments have been described above, those skilled in the art can envision or develop other embodiments more easily. The present disclosure is intended to cover all substitutions, modifications and variations of the present disclosure as described herein, as well as other embodiments falling into the spirits and scope of the present disclosure.

Claims

1. An elastic support for an electrolytic cell, the elastic support being configured to support a cathode member of the electrolytic cell in a cell body of the electrolytic cell, wherein the elastic support (100) comprises:

    a substrate (10) which is a flat plate structure and spaced apart from the cathode member, and which is formed with a plurality of elastic region portions (20) so that each of the elastic region portions comprises:

        an elastic sheet hole (23) whose contour line is closed on the substrate, the contour line comprising a first contour line (201) and a second contour line (202) parallel to each other;
        a first row of elastic sheets (21), each of which extends from the first contour line toward the cathode member and toward the second contour line;
        a second row of elastic sheets (22), each of which extends from the second contour line toward the cathode member and toward the first contour line,
        wherein each elastic sheet in the first row of elastic sheets and the second row of elastic sheets is in elastic contact with the cathode member;

    middle support legs (30) formed on a side of the substrate away from the cathode member and located between two adjacent elastic region portions, the middle support legs being fixedly connected between the substrate and a wall of the cell body.

2. The elastic support according to claim 1, wherein the elastic sheets in the first row of elastic sheets and the elastic sheets in the second row of elastic sheets are arranged alternately, and on a projection plane perpendicular to the first contour line and the second contour line, projections of the first row of elastic sheets and the projections of the second row of elastic sheets intersect one another in an X shape.

3. The elastic support according to claim 1, wherein the elastic region portions are formed by punching the substrate, and the elastic sheet holes are punching holes; and
   the middle support legs are formed by punching the substrate, to simultaneously form support leg punching holes (12) and the middle support legs on the substrate.

4. The elastic support according to claim 1, wherein the elastic support further comprises edges support legs (40) formed by bending from an edge of the substrate towards the wall of the cell body so that a rib plate (301) can be snap-fitted at an inner side of the edge support legs.

5. The elastic support according to claim 4, wherein the substrate is rectangular, a plurality of edge support legs are provided on each of a first longitudinal edge and a second longitudinal edge of the substrate extending in a longitudinal direction (D2) of the substrate, and the edge support legs at the first longitudinal edge and the edge support legs at the second longitudinal edge are staggered from one another in a transverse direction (D1) of the substrate.

6. The elastic support according to claim 5, wherein notches (41) inwardly recessed along a plane where the substrate lies are formed between two adjacent edge support legs, along each of the first longitudinal edge and the second longitudinal edge of the substrate, and
   at least two elastic supports are jointly used in a same electrolytic cell, and the at least two elastic supports are arranged in the transverse direction of the substrate, so that in a projection plane parallel to the substrate, the edge support legs and the notches of the adjacent elastic supports fit with one another in an embedded manner.

7. The elastic support according to claim 1, wherein each of the elastic sheets comprises a straight wall section connected with the substrate and an arc section bent from an end of the straight wall section, and the arc section is used to elastically contact the cathode member.

8. The elastic support according to claim 1, wherein the substrate is rectangular, the plurality of elastic region portions are arranged on the substrate in an array in a longitudinal direction and a transverse direction of the substrate, and the middle support legs are plural and respectively disposed between the elastic region portions adjacent one another in the transverse direction of the substrate.

9. The elastic support according to claim 8, wherein each of the elastic sheet holes is shaped as a rectangle that is consistent with the horizontal and longitudinal directions of the substrate, the first contour line and the second contour line of the elastic sheet hole are the longitudinal edges thereof, and each of the elastic sheets is formed as a strip-shaped structure extending in the transverse direction of the elastic sheet hole.

10. An electrolytic cell, wherein the electrolytic cell comprises a cell body, a cathode member disposed in the cell body and the elastic support according to any of claims 1-9.

11. The electrolytic cell according to claim 10, wherein the electrolytic cell further comprises a cathode member and an ionic membrane disposed between the cathode member and the anode member.

12. An apparatus for manufacturing the elastic support for the electrolytic cell according to any of claims 1-9, wherein the apparatus comprises a punching die for processing the sheet material, the punching die comprising:

a series of punching dies for processing elastic sheets on the sheet material, comprising:

an elastic sheet gap punching die configured to punch out gaps between the elastic sheets on the sheet material;
a thinning and widening punching die configured to thin and widen the elastic sheets;
an elastic sheet forming punching die configured to bend and form the elastic sheets relative to a main body of the sheet material;
a blanking and punching die configured to perform blanking processing for outer shapes of the elastic sheets,
wherein the punching dies in the series of punching dies for processing the elastic sheets on the sheet material form progressive punching dies for continuous punching in the above order;

a series of punching ides for processing middle support legs on the sheet material, comprising:

a middle support leg punching die configured to punch a shape and contour of the middle support legs on the sheet material;
a middle support leg bending and punching die configured to bend and form the middle support legs relative to the main body of the sheet material,
wherein the punching dies in the series of punching dies for processing the middle support lets on the sheet material form progressive punching dies for continuous punching in the above order.

13. The apparatus according to claim 12, wherein the apparatus further comprises a measuring and calibrating device comprising:

a positioning base (311) configured as a substrate fixedly support the elastic support;
a distance measuring device (309) configured to obtain a value of distance between an end of each of the elastic sheets away from the substrate and a reference plane in a direction (D3) perpendicular to the reference plane, the reference plane being a plane where the substrate lies or a plane parallel to the substrate;
a calibrating device configured to provide the elastic sheets with an acting force perpendicular to the reference plane;
a control module configured to communicate with the distance measuring device and the calibrating device, and configured to:

receive a signal comprising the value of distance from the distance measuring device;
determine whether the value of distance is within a pre-stored threshold range;
if a determination result is NO, control the calibrating device to provide the corresponding acting force to the elastic sheet to calibrate the value of distance between the elastic sheet and the reference plane;
control the distance measuring device and the calibrating device to repeat the above distance measuring step, determining step and calibrating step until the obtained value of distance falls within the threshold range.

14. The apparatus according to claim 13, wherein the calibrating device further comprises a top frame (301) and a bottom frame (302), wherein the positioning base is configured as a straight wall protruding from the bottom frame toward the top frame, so that the elastic support can be supported midair by the straight wall, and the distance measuring device is disposed on the top frame and towards the bottom frame.

15. The apparatus according to claim 13, wherein the calibrating device is configured to apply a force to a position of the elastic sheet connected with the substrate.

16. The apparatus according to claim 14, wherein the calibrating device comprises:

a top electric push rod (303) protruding from the

top frame toward the elastic sheet, to directly or indirectly exert a force on the elastic sheet;
a bottom electric push rod (304) protruding from the bottom frame toward the elastic sheet, to directly or indirectly exert a force on the elastic sheet.

17. The apparatus according to claim 16, wherein an end of the top electric push rod is provided with a top airbag (305) which abuts against the elastic sheet to directly apply a force to the elastic sheet; an end of the bottom electric push rod is provided with a bottom airbag (306) which abuts against the elastic sheet to directly apply a force to the elastic sheet.

18. The apparatus according to claim 17, wherein the apparatus comprises an ultrasonic generator (308) which is connected to the top airbag and the bottom airbag through an ultrasonic vibrator, and the ultrasonic generator is configured to send an ultrasonic wave to enable the top airbag and the bottom airbag to perform correction for the elastic sheets by vibration.

19. The apparatus according to claim 17, wherein the substrate of the elastic support is rectangular, each of the elastic sheets extends in the transverse direction of the substrate and towards the top frame, and the top airbag and the bottom airbag acting on each of the elastic sheets are staggered in the transverse direction.

20. The apparatus according to claim 13, wherein the distance measuring device comprises an infrared distance measuring device or an ultrasonic distance measuring device, and/or
the control module is integrated in a PLC control system or an MCU single-chip microcomputer control system.

21. A method for manufacturing the elastic support for the electrolytic cell according to any of claims 1-9, wherein the method comprises a processing step (S 1), and the processing step comprises the following steps:

selecting a sheet material in a flat sheet form;
forming elastic sheets on the sheet material by a punching process, and bending the elastic sheets relative to the main body of the sheet material in a due shape;
forming the middle support legs on the sheet material by the punching process, and bending the middle support legs in a due shape relative to the main body of the sheet material,
wherein the main body of the sheet material constitutes the substrate of the elastic support.

22. The method according to claim 21, wherein the method further comprises: bending the edge of the sheet material to form the edge support legs.

23. The method according to claim 21, wherein the method further comprises a detecting and correcting step (S2) after the processing step, the detecting and correcting step comprising:

obtaining a value of distance between an end of each of elastic sheets away from the substrate and a reference plane in a direction perpendicular to the reference plane, the reference plane being a plane where the substrate lies or a plane parallel to the substrate (S21);
determining whether the value of distance is within a threshold range (S22);
if a determination result is NO, applying a force perpendicular to the substrate to the elastic sheet, to calibrate the value of distance between the elastic sheet and the reference plane (S23);
repeating the above distance measuring step, the determining step and the calibrating step until the obtained value of distance falls within the threshold range.

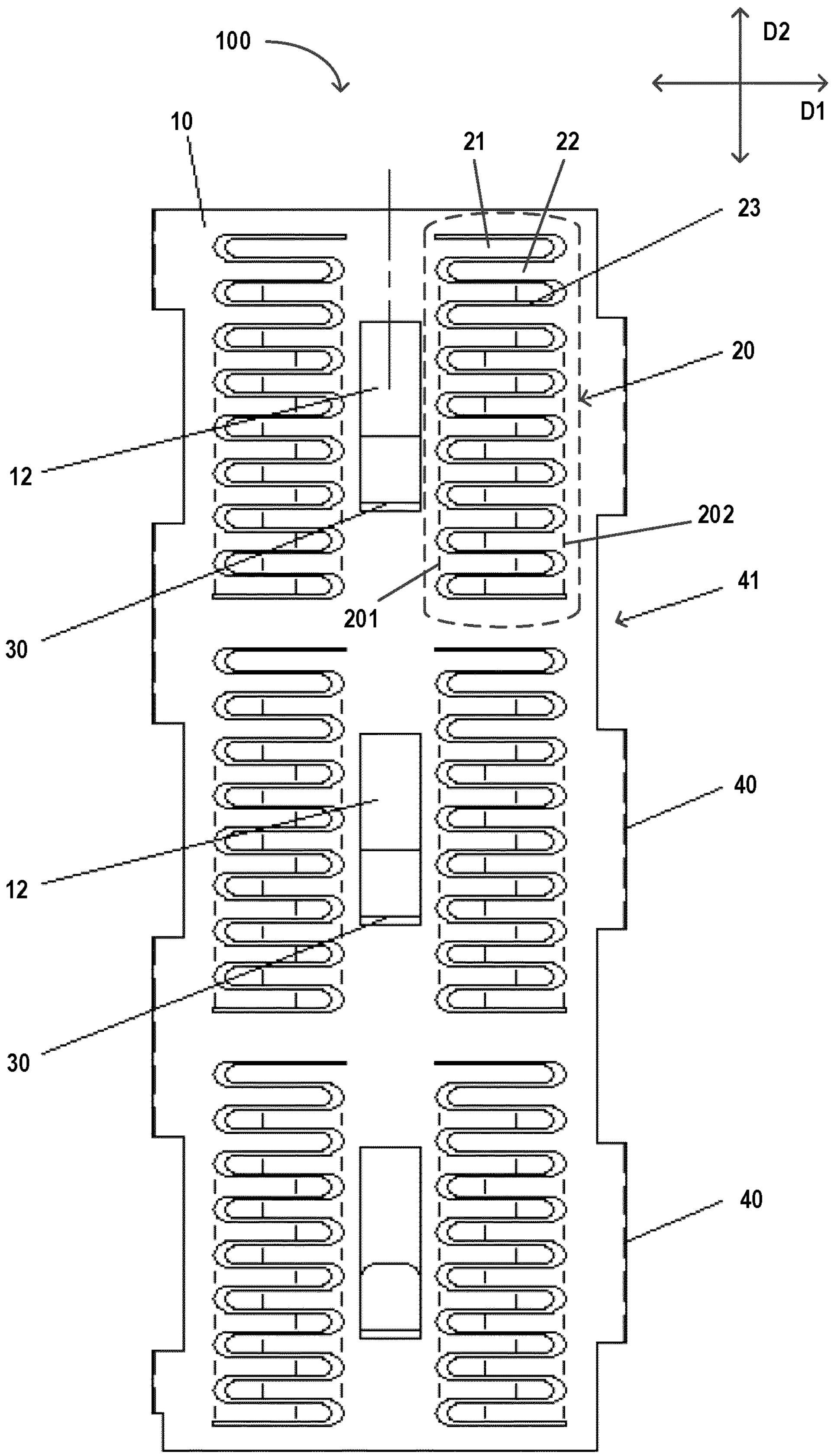

FIG. 1

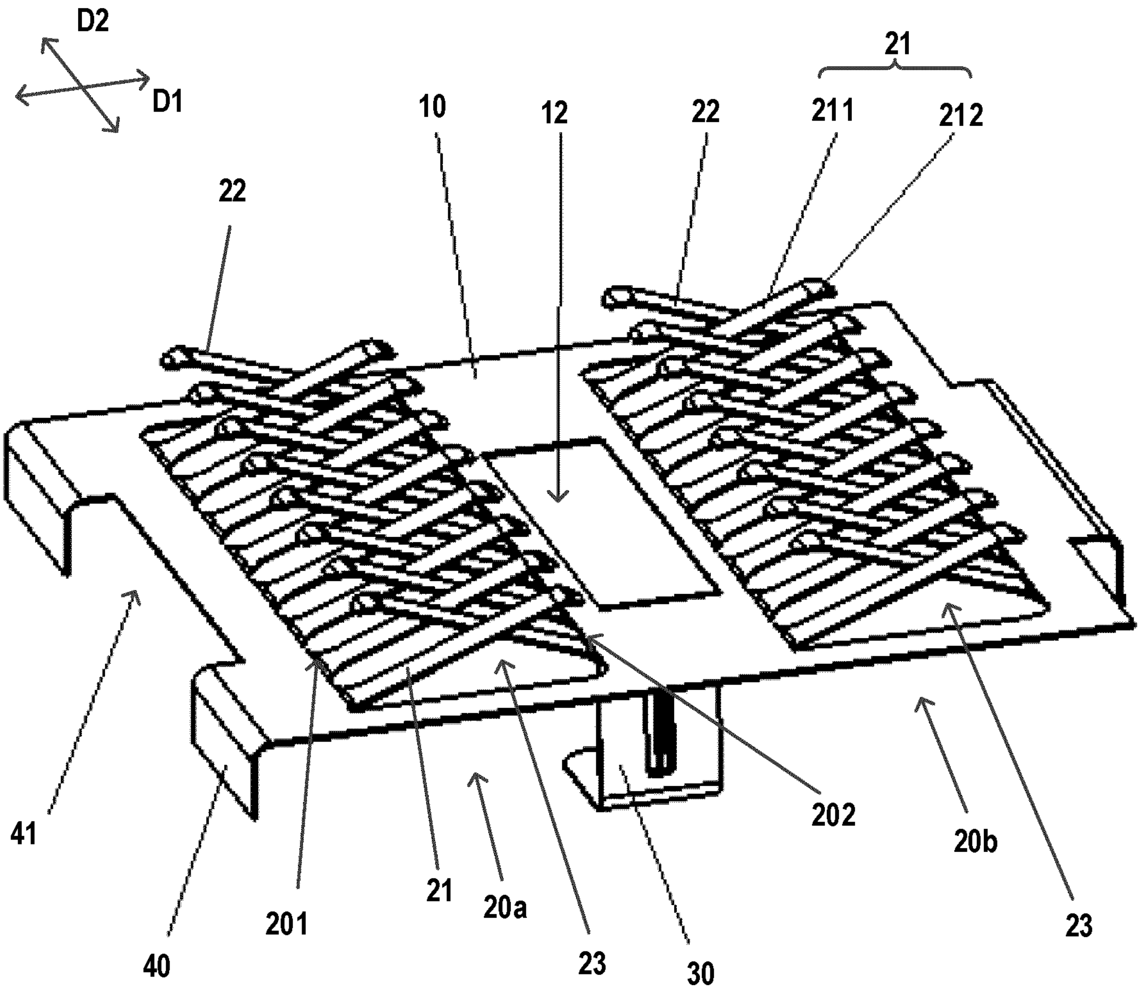

FIG. 2

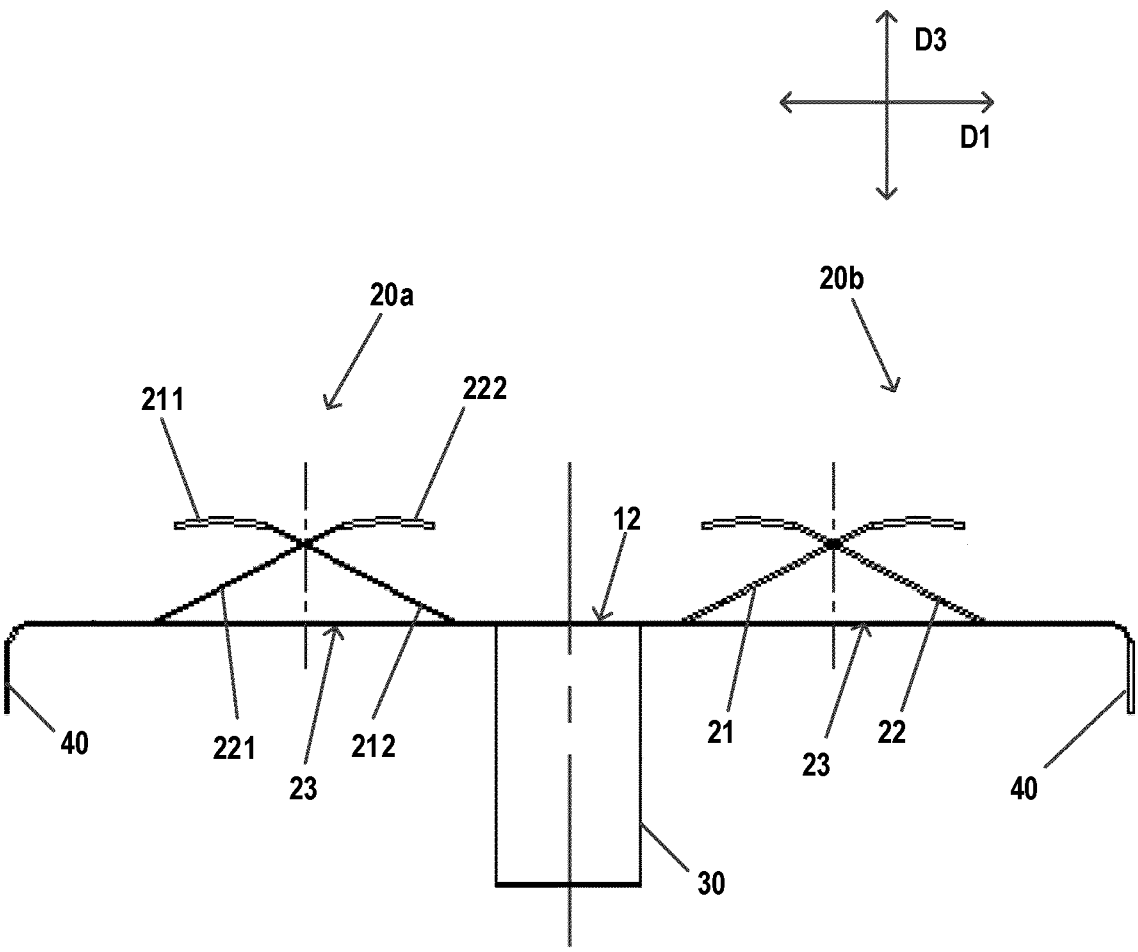

FIG. 3

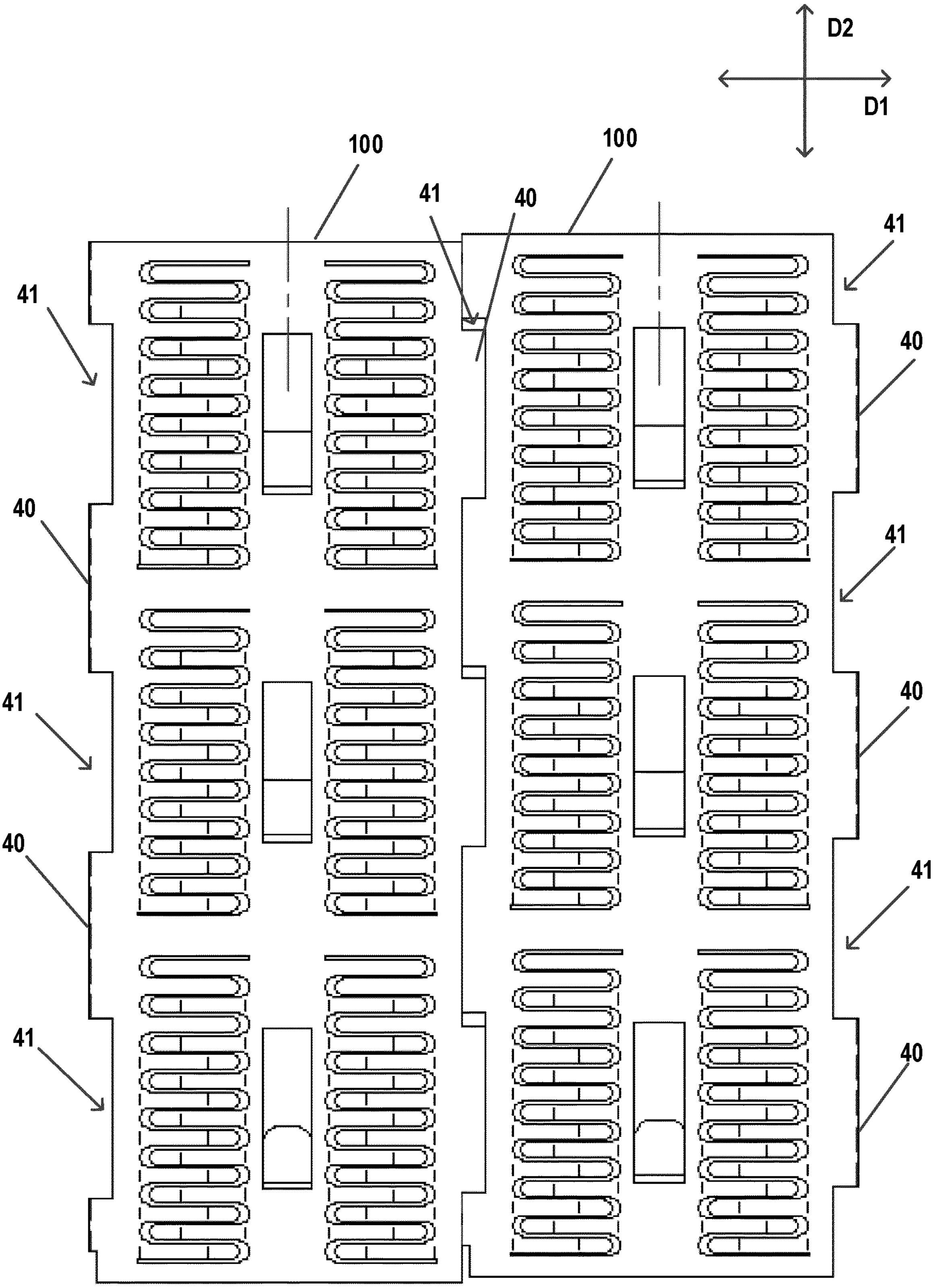

FIG. 4

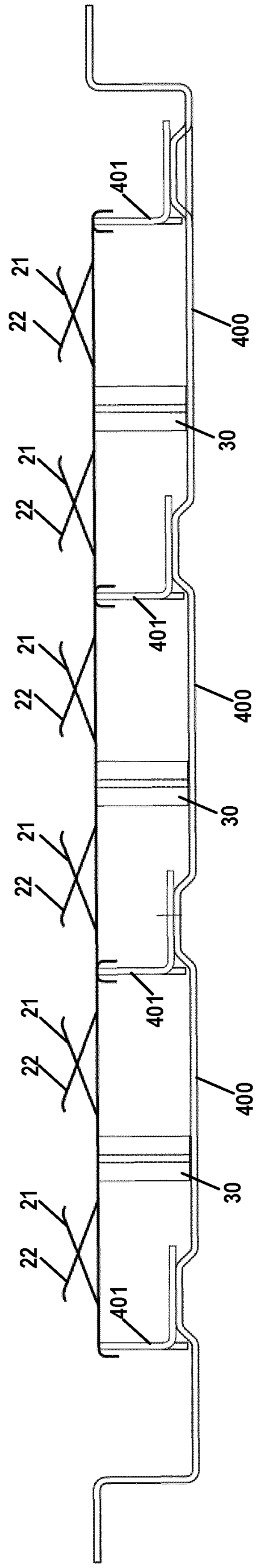
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FIG. 5

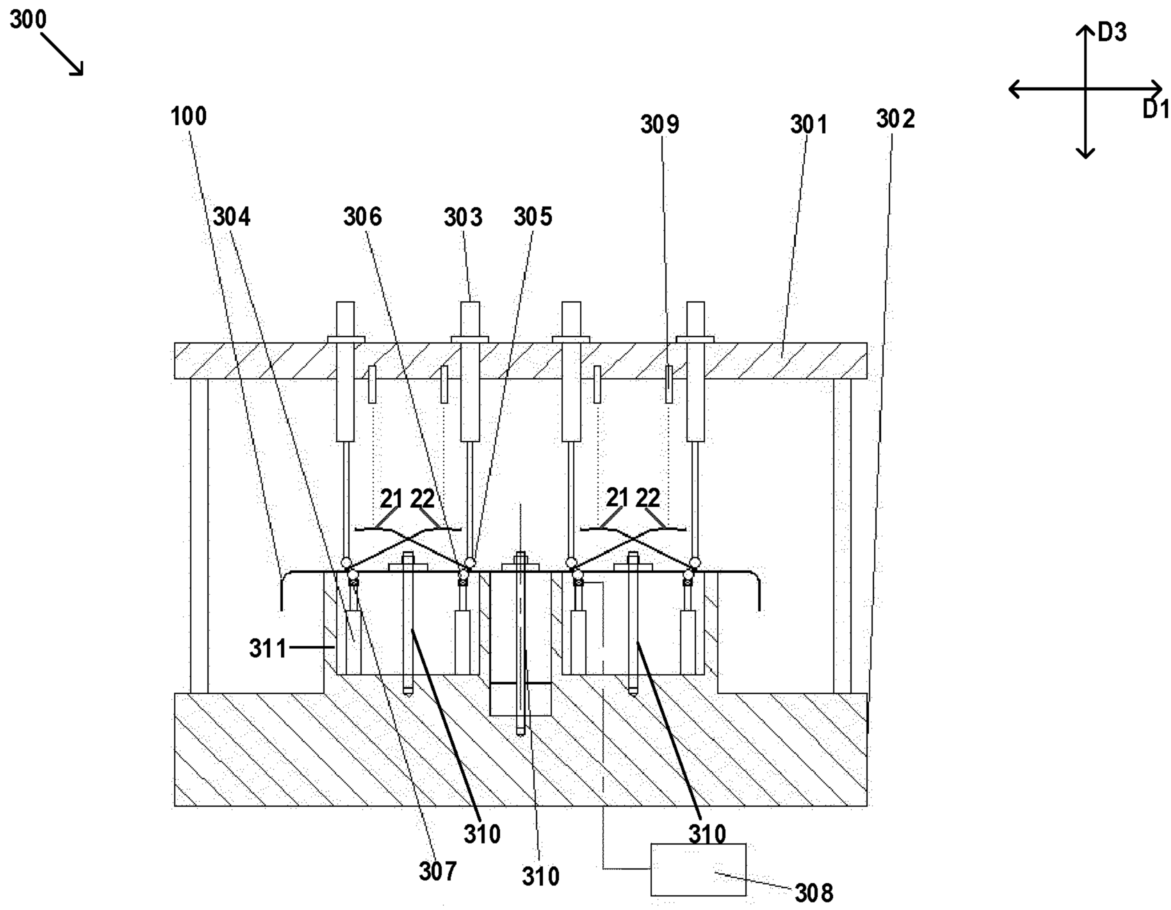
300
D3
D1
100
309
301
302
304
306
303
305
21
22
21
22
311
310
310
307
310
308

FIG. 6

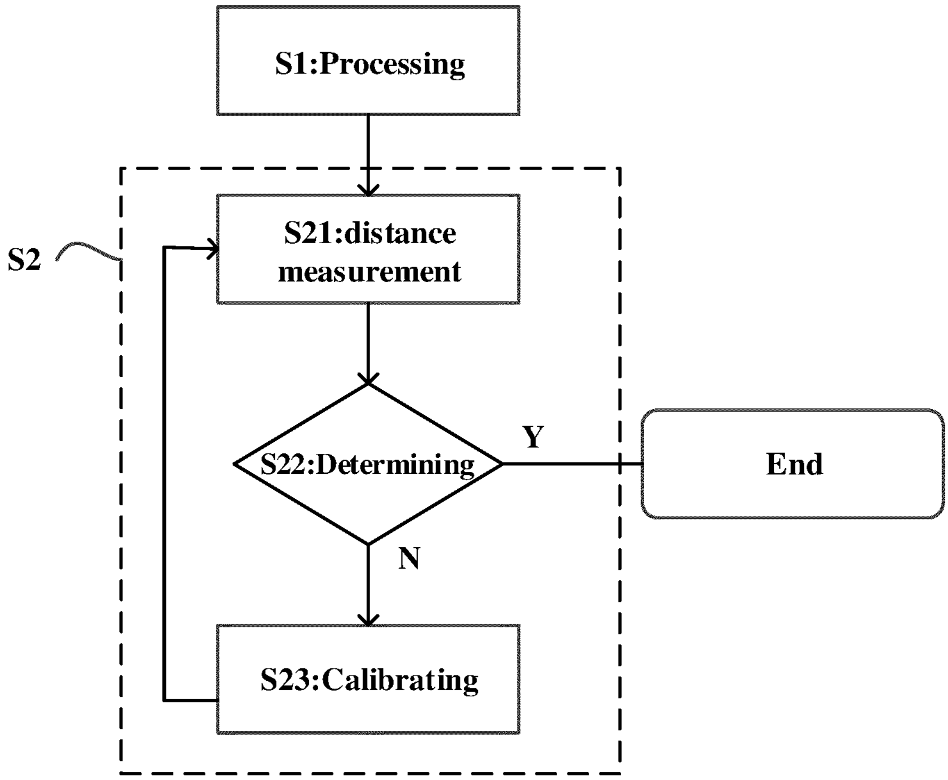
S1:Processing
S2
S21:distance measurement
S22:Determining
Y
End
N
S23:Calibrating

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/080228

A. CLASSIFICATION OF SUBJECT MATTER

C25B 9/63(2021.01)i；C25B 9/19(2021.01)i；B21D 22/02(2006.01)i；B21D 37/10(2006.01)i；B21C 51/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C25B9/-；B21D22/-；B21D37/-；B21C51/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, CNTXT, CNKI, VEN, WPABSC, USTXT, WOTXT, Web of Science: 江苏安凯特科技股份有限公司, 徐文新, 唐宏, 杨国华, 朱立人, 吴彬, 刘维, 赵建超, 朱俊, JIANGSU ANCAN TECHNOLOGY, Xu wenxin, Tang hong, Yang guohua, Zhu liren, Wu bin, Liu wei, Zhao jianchao, Zhu jun, 弹性体, 弹性结构, 弹性支撑件, 弹性网, 电解槽, 稳定, 稳固, 气囊, 冲压, 冲裁, 校准, 测量, 测距, elastic, support+, electrolytic cell, stamp+, calibrat+, adjust+, measur+, gasbag

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 113584510 A (JIANGSU ANCAN TECHNOLOGY CO., LTD.) 02 November 2021 (2021-11-02) claims 1-23	1-23
Y	CN 213266726 U (JIANGYIN HONGZE CHLOR-ALKALI EQUIPMENT MANUFACTURE CO., LTD.) 25 May 2021 (2021-05-25) description, paragraphs 0057-0067, embodiment 3, and figures 10-12	1-16, 20-23
Y	CN 202072770 U (LIU GUOZHEN) 14 December 2011 (2011-12-14) description, paragraphs 0023-0027, and figures 1 and 6	1-16, 20-23
Y	WO 2006045511 A1 (DAIMLER CHRYSLER AG. et al.) 04 May 2006 (2006-05-04) description, page 13, paragraph 2-page 17, paragraph 2, and figures 1-16	12-16, 20-23
A	CN 207244011 U (JIANGSU YANHAI CHEMICAL CO., LTD.) 17 April 2018 (2018-04-17) entire document	1-23
A	CN 202415695 U (JIANGYIN ANCAN ELECTROCHEMICAL EQUIPMENT LTD.) 05 September 2012 (2012-09-05) entire document	1-23

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 May 2022	**26 May 2022**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China**	
Facsimile No. **(86-10)62019451**	Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/080228

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2019226100 A1 (THYSSENKRUPP UHDE CHLORINE ENGINEERS GMBH.) 25 July 2019 (2019-07-25) entire document	1-23

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/080228

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 113584510 A	02 November 2021	None	
CN 213266726 U	25 May 2021	None	
CN 202072770 U	14 December 2011	None	
WO 2006045511 A1	04 May 2006	DE 102004051454 A1	27 April 2006
CN 207244011 U	17 April 2018	None	
CN 202415695 U	05 September 2012	None	
US 2019226100 A1	25 July 2019	JP 2017222897 A	21 December 2017
		CN 109312477 A	05 February 2019
		CA 3021831 A1	21 December 2017
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		ES 2792104 T3	10 November 2020
		EP 3469116 A1	17 April 2019
		WO 2017217427 A1	21 December 2017

Form PCT/ISA/210 (patent family annex) (January 2015)