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(54) MODULAR SHEET-PILE PLATE-ELEMENT AND METHOD OF INSTALLING A SHEETPILING

MODULARES STAHLSPUNDWANDPLATTENELEMENT UND VERFAHREN ZUR INSTALLATION EINER STAHLSPUNDWAND

ÉLÉMENT MODULAIRE EN FORME DE PLAQUE ET À PALPLANCHE ET PROCÉDÉ D'INSTALLATION D'UNE PALPLANCHE

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Description

[0001] The invention relates to a modular sheet-pile plate-element, as well as to a method of installing a sheet-piling.

[0002] In a sheet-piling a relatively thin wall is applied to retain soil, wherein said wall is kept in place by posts or in other ways. Sheet-piling systems are mostly applied to retain soil relative to a water, in which case one may refer to a waterside sheet-piling.

[0003] An example of a known sheet-piling is shown in appended Fig. 11. This figure shows an installed waterside sheet-piling system 100 which retains soil 110 relative to a water 120. In this known system 100 the vertical sheet-piling wall, shown in transverse cross-section, is formed by tongued-and-grooved planks 101, whose longitudinal directions are extending horizontally. Therein, the sheet-piling wall is kept in place by a plurality of posts 102, which are arranged with mutual distances in the longitudinal directions of the planks 101. Fig. 11 shows one such post 102. Fig. 11 further shows a horizontal covering 103 of the known waterside sheet-piling system. This known sheet-piling system has some drawbacks.

[0004] A first drawback is that the installation of the system is difficult, heavy and time-consuming. The reason is that during installation one has to work in complicating in-situ circumstances, that is, near to a yet unsupported wall, and often partly underwater. Thereby, various parts of the system are easily fouled by soil, silt, mud, and other defilements. As a result, it is for example difficult to reliably slide the fouled tongued-and-grooved parts of the planks 101 into one another.

[0005] Another drawback occurs during the life span of an already installed sheet-piling system. Then, an alternating extension-and-shrinkage behaviour occurs, especially of the parts of the sheet-piling wall. If the tongued-and-grooved planks are from plastic, said extension-and-shrinkage behaviour especially occurs under influence of temperature differences, like day/night differences and summer/winter differences. And if the tongued-and-grooved planks are from wood, said extension-and-shrinkage behaviour also occurs under influence of alternating levels of humidity of the planks.

[0006] To allow for such extension-and-shrinkage behaviour, the planks may be placed in-line with some inter-spaces in each others extensions. Thereby, expansion spaces arise between the short sides of planks, which are arranged in-line. However, in the course of time these expansion spaces become clogged up by soil, plants, and the like, in which case the extension of the planks is still impeded. As a result, the planks will damage and/or distort.

[0007] Another way for allowing such extension-and-shrinkage behaviour, is to not only interconnect the planks at their long sides by means of tongued-and-grooved joints (as shown in Fig. 11), but also at their short sides. To allow for extension in the longitudinal direction of the planks, one may apply, as compared to the protrusion lengths of the tongues, relatively deeper grooves in the short sides. However, also the application of such tongued-and-grooved joints at the short sides of the planks has drawbacks. That is, as a result of the additional tongued-and-grooved parts at the short sides, it becomes yet more difficult, heavy and time-consuming to install the sheet-piling system in the in-situ circumstances in which, not only the tongued-and-grooved parts at the long sides of the planks, but also the tongued-and-grooved parts at the short sides of the planks are easily fouled by soil, silt, mud, and other defilements.

[0008] It is an object of the invention to provide a solution according to which a sheet-piling can be installed easier, lighter and faster in complicating in-situ circumstances, while during the life span of an already installed sheet-piling system damage and/or distortion due to alternating extension-and-shrinkage behaviour of sheet-piling parts is prevented.

[0009] For that purpose the invention provides a modular sheet-pile plate-element according to appended independent claim 1, as well as a method of installing a sheet-piling according to appended independent claim 4. Specific embodiments of the invention are defined by the appended dependent claims 2, 3 and 5.

[0010] Therefore, the invention provides a modular sheet-pile plate-element, comprising:

- two exterior plate surfaces lying mutually opposed along a thickness axis of the sheet-pile plate-element,
- two first plate sides lying mutually opposed along a first plate-longitudinal-axis of the sheet-pile plate-element, and
- two second plate sides lying mutually opposed along a second plate-longitudinal-axis of the sheet-pile plate-element,

wherein one of the first plate sides is provided with a tongue, and the other of the first plate sides is provided with a groove, in such manner that between a first specimen of the sheet-pile plate-element and a second specimen of the sheet-pile plate-element a tongued-and-grooved joint can be established by interlocking of the tongue of the first specimen with the groove of the second specimen,

characterized in that

the tongue, as seen at different positions along the second plate-longitudinal-axis, has at least one thick tongue part and at least one thin tongue part, wherein the thick tongue part, measured along said thickness axis, has higher thickness than the thin tongue part,

the groove, as seen at different positions along the second plate-longitudinal-axis, has at least one wide groove part and at least one narrow groove part, wherein the wide groove part, measured along said thickness axis, has higher width than the narrow groove part, and

during said interlocking the first specimen and the second specimen of the sheet-pile plate-element are reciprocally moveable relative to one another, with at least respective components being parallel to the respective second plate-longitudinal-axes of the first specimen and the second specimen, respectively, between at least one temporary interlocking condition and at least one permanent interlocking condition, wherein in the permanent interlocking condition gripping parts of the at least one thick tongue part are restrained by the at least one narrow groove part, while said gripping parts in the temporary interlocking condition are not, or to a lesser extent, restrained by the at least one narrow groove part in that said gripping parts in the temporary interlocking condition are located at least partly in the at least one wide groove part.

[0011] In addition, the invention therefore provides a method of installing a sheet-piling, which sheet-piling comprises said first specimen of a modular sheet-pile plate-element and said second specimen of a modular sheet-pile plate-element, and which method comprises establishing said tongued-and-grooved joint between said first specimen and said second specimen.

[0012] Therefore, in a sheet-pile plate-element according to the invention the two first plate sides are provided with said tongue and said groove, respectively. In said permanent interlocking condition, which is meant to last during the life span of an installed sheet-piling, the most restraining interlocking between the tongue of said first specimen and the groove of said second specimen occurs. For that most restraining interlocking, as seen along the second plate-longitudinal-axis, only the one or more local thickenings of the tongue need to be restrained in the one or more local narrowings of the groove. Thanks to these only local restraints it does not require much force to establish said permanent interlocking condition. During the establishing of said permanent interlocking condition the then occurring defilements of the tongue and groove, such as soil, silt, mud, etc., can easily disappear to places where local narrowings of the tongue interlock with local widenings of the groove. In these respects a sheet-piling according to the invention can therefore be installed easier, lighter and faster.

[0013] Since with the invention also during the life span of a yet installed sheet-piling there can hardly or not arise, at the location of the local restraints, defilements, such as soil, silt, mud, etc., and since such defilements also during the life span can easily disappear to places where local narrowings of the tongue interlock with local widenings of the groove, the sheet-pile plate-elements, which in the sense of the first plate-longitudinal-axis are mutually connected, can freely extend and shrink in directions parallel to the first plate-longitudinal-axis. Because of this, damage and distortion of the installed sheet-piling is prevented.

[0014] Said only local restraints furthermore enable that the sheet-pile plate-element according to the invention can be designed with larger lengths of the first plate sides, without the consequence that too much force would be needed to establish said permanent interlocking condition. If for example for the known waterside sheet-piling system 100 shown in Fig. 11 the planks 101, arranged in the three shown rows, at their short ends would have tongues and grooves of the kind as known per se, that is to say without the local thickenings and narrowings of the tongue and without the local widenings and narrowings of the groove as in the present invention, then one could according to the invention for example apply only one row of sheet-pile plate-elements instead of the three rows of planks 101, wherein the height of such a sheet-pile plate-element is equal to the total height of three planks 101 placed above one another. Thus, the invention then requires that less parts of the sheet-piling wall need to be assembled. So, also in that additional respect a sheet-piling according to the invention can be installed easier, lighter and faster.

[0015] It is remarked that US527469A shows a sheet-piling of wooden planks, vertically placed side-by-side, which planks are overlapping sideways, wherein the lap joints are held together by metal clamps, which have been fastened to the planks. The aim of the wooden planks with metal clamps, known from US527469A, is to provide sheet-piling planks, which are easy to produce, and wherein savings can be obtained with respect to the amount and quality of the wood of the planks. Therefore, in fact, the lap joint connection technique of US527469A provides an alternative connection technique as compared to the present invention. Furthermore it is noted that, insofar as one would see between the wooden flange a² and the metal clamp B of a section A of the sheet-piling of US527469A a very local "groove of a tongued-and-grooved joint" of the section A, wherein the "groove" is extending with its groove longitudinal direction over a very restricted groove length in vertical direction, this groove over its entire groove length always has the same transverse cross-section. In other words, in that case US527469A does not disclose a wide groove part and a narrow groove part in the sense of the present invention. Also, US527469A does not provide any suggestion for the application of a wide groove part and a narrow groove part in the sense of the present invention.

[0016] Preferably, in a method according to the invention, the said establishing of said tongued-and-grooved joint comprises a first step of mutually bringing the first specimen and the second specimen of the sheet-pile plate-element in the temporary interlocking condition, with at least respective movement components parallel to the respective first plate-longitudinal-axes of the first specimen and the second specimen, respectively, as well as a successive second step, performed according to said reciprocal moveability, of bringing the first specimen and the second specimen into the permanent interlocking condition.

[0017] This preferable embodiment of a method according to the invention, which embodiment is enabled thanks to a sheet-pile plate-element according to the invention, makes the connecting, in the sense of the first plate-longitudinal-

axis, of the sheet-pile plate-elements with one another extraordinarily easy, light and fast. If, for example, in installed condition the first plate-longitudinal-axis corresponds to the horizontal direction, it is possible to bring the sheet-pile plate-elements with very little force exertion by means of horizontal displacement into the temporary interlocking condition. Then, from that temporary interlocking condition the permanent interlocking condition can be established by means of vertical displacement, for example by a vertical hit exerted with a hammer at the upper second plate side of one of the two sheet-pile plate-elements concerned. Thereby, effective benefit is taken from the gravity of the sheet-pile plate-element concerned for supplying the required force exertion for said vertical displacement, which required force exertion in fact is already relatively low.

[0018] Preferably, a modular sheet-pile plate-element according to the invention further comprises at least one first local stop in the groove and/or at least one second local stop being part of the tongue, which at least one first local stop and at least one second local stop act as stops during the establishing of said tongued-and-grooved joint between said first specimen and said second specimen, with at least respective movement components parallel to the respective first plate-longitudinal-axes of the first specimen and the second specimen, respectively, of the sheet-pile plate-element.

[0019] During the installing, the tongued-and-grooved joint can be established with manual force until reaching such local stops. During the life span of an already installed sheet piling, the extension forces, which occur during extension of the sheet-pile plate-elements and which exceed said manual force, will deform and/or break the local stops, and/or will locally deform the tongue and/or the groove walls under the pressure of the local stops acting thereon. Thanks to such local stops the sheet-pile plate-element is therefore designed to resist during the installing a threshold corresponding to a certain manual force, however, to allow for extension in case of exceeding such a threshold value. Therefore, thanks to such local stops a reliable installation is possible which guarantees a predetermined extension behaviour.

[0020] In the following, the invention is further elucidated with reference to some non-limiting embodiments and with reference to the schematic figures in the attached drawing.

Fig. 1A shows an example of an embodiment of the abovementioned first specimen and a second specimen, being identical thereto, of a sheet-pile plate-element according to the invention, wherein the two specimens are arranged vertically and, as seen in horizontal direction, are mutually in line, and wherein the view is taken parallel to the (horizontal) thickness axes of the two specimens, and wherein the abovementioned tongued-and-grooved joint has not yet been established.

Fig. 1B shows the situation of Fig. 1A again, however wherein starting from the situation of Fig. 1A the first specimen has been moved somewhat, vertically upwards relative to the second specimen.

Fig. 1C shows the situation of Fig. 1B again, however wherein starting from the situation of Fig. 1B the first specimen has been moved somewhat, horizontally towards the second specimen, in such manner that the abovementioned tongued-and-grooved joint has been established, i.e. in the abovementioned temporary interlocking condition.

Fig. 1D shows the situation of Fig. 1C again, however wherein starting from the situation of Fig. 1C the first specimen has been moved somewhat, vertically downwards, in such manner that the abovementioned tongued-and-grooved joint is still established, however this time in the abovementioned permanent interlocking condition.

Fig. 2A shows the part, which is indicated in Fig. 1A by boxing II-A, in more detail.

Fig. 2B shows the part, which is indicated in Fig. 1B by boxing II-B, in more detail.

Fig. 2C shows the part, which is indicated in Fig. 1C by boxing II-C, in more detail.

Fig. 2D shows the part, which is indicated in Fig. 1D by boxing II-D, in more detail.

Fig. 3 shows the first specimen of Fig. 2A in a view which is taken in the direction of the arrows III, which are shown in Fig. 2A.

Fig. 4 shows the second specimen of Fig. 2A in a view which is taken in the direction of the arrows IV, which are shown in Fig. 2A.

Fig. 5 shows the situation of Fig. 2C in a transverse cross-section according to the plane, which in Fig. 2C is indicated by arrows V, wherein the view is taken in the direction of the arrows V.

Fig. 6 shows the situation of Fig. 2D in a transverse cross-section according to the plane, which in Fig. 2D is indicated by arrows VI, wherein the view is taken in the direction of the arrows VI.

Fig. 7 shows the situation of Fig. 2A in a view according to a plane, indicated in Fig. 2A by arrows VII, wherein the view is taken in the direction of the arrows VII.

Fig. 8A shows the situation of Fig. 8B in a transverse cross-section according to the plane, indicated in Fig. 8B by arrows VIII-A, wherein the view is taken in the direction of the arrows VIII-A, and wherein the view is at least partly in throughsight.

Fig. 8B shows the situation of Fig. 2A in a transverse cross-section according to the plane, indicated in Fig. 7 by arrows VIII-B, wherein the view is taken in the direction of the arrows VIII-B, and wherein the view is at least partly in throughsight.

Fig. 9A shows the situation of Fig. 9B in a transverse cross-section according to the plane, indicated in Fig. 9B by arrows IX-A, wherein the view is taken in the direction of the arrows IX-A, and wherein the view is at least partly in

throughsight.

Fig. 9B shows a situation similar to that of Fig. 8B, however, wherein Fig. 9B is not based on the situation of Fig. 2A, but on that of Fig. 2D, in which situation the tongue of the first specimen is extending upto local stops in the groove of the second specimen.

5 Fig. 10A shows the situation of Fig. 10B in a transverse cross-section according to plane, indicated in Fig. 10B by arrows X-A, wherein the view is taken in the direction of the arrows X-A, and wherein the view is at least partly in throughsight.

10 Fig. 10B shows a situation similar to that of Fig. 9B, however, wherein Fig. 9B is not based on the situation of Fig. 2D, but on a situation in which starting from the situation of Fig. 9B the tongue of the first specimen, as a result of extension of the first specimen and of the second specimen, is extending deeper in de groove of the second specimen, which in the shown example has gone along with deformations of the shown tongue and/or of the local stops in the shown groove.

15 Fig. 11, which has already been discussed in the above introduction, shows an example of an installed known waterside sheet-piling which retains soil relative to a water 120.

[0021] The reference numerals used in Figs. 1 through 10B are referring to the abovementioned parts and aspects of the invention, in the following manner.

20	1	first specimen of the sheet-pile plate-element
	1A	second specimen of the sheet-pile plate-element
	2	tongue
	3	groove
25	4	thick tongue part
	5	thin tongue part
	6	wide groove part
	7	narrow groove part
30	8	first local stop
	9	additional rib
	10	thickness axis
35	11	first plate-longitudinal-axis
	12	second plate-longitudinal-axis
	20, 30	exterior plate-surfaces
	21, 31	first plate sides
40	22, 32	second plate sides
	70	reciprocal moveability
45	80	sheet-piling

[0022] Based already on Figs 1 through 10B, and with the aid of the recited meanings of the reference numerals, the abovementioned aspects of the invention will be clear. Some further elucidation is given below.

[0023] Now reference is first made to Figs. 1 through 6.

50 [0024] In the shown example the thick tongue parts 4 are designed as twelve ribs of the tongue 2, which ribs are extending parallel to the first plate-longitudinal-axis 11, and which ribs all substantially have the same transverse cross-section, which is substantially constant over the entire rib length, that is to say in the direction of the first plate-longitudinal-axis 11. As seen along the second plate-longitudinal-axis 12, there have been applied four groups, each having three such ribs 4. The groove 3 has four narrow groove parts 7, which also all substantially have the same transverse cross-section, which is substantially constant in the direction of the first plate-longitudinal-axis 11. As best seen in Figs. 5 and 6, the four groups of ribs 4 in the permanent interlocking condition (Fig. 6) are respectively restrained by the four narrow groove parts 7, while in the temporary interlocking condition (Fig. 5) they are not restrained by the four narrow groove parts 7, because in the temporary interlocking condition they are at least partly located in the wide groove parts 6. As

can be seen in Fig. 5 the narrow groove parts 7 in the temporary interlocking condition, shown there, only contain the thin tongue parts 5, also in a not restrained manner.

[0025] As an aside it is noted that in the shown example the tongue 2 is furthermore provided with one additional rib 9, which is extending parallel to the second plate-longitudinal-axis 12. Such a rib 9 can optionally be applied, for example to further prevent fouling of the tongued-and-grooved joint.

[0026] The transition from Fig. 1B to Fig. 1C (and also the transition from Fig. 2B to Fig. 2C) illustrates the abovementioned first step of mutually bringing the first specimen 1 and the second specimen 1A of the sheet-pile plate-element into the temporary interlocking condition. The transition from Fig. 1C to Fig. 1D (and also the transition from Fig. 2C to Fig. 2D) illustrates the abovementioned second step of mutually bringing the first specimen 1 and the second specimen 1A into the permanent interlocking condition. The abovementioned reciprocal moveability, lying at the base of this second step, has been indicated in Figs. 1C, 1D, 2C, 2D, 5 and 6 by two-way arrows 70. To get from the temporary interlocking condition of Fig. 1C into the permanent interlocking condition of Fig. 1D, one can for example hit with a hammer at the upper second plate side 32 of the first specimen 1 of the sheet-pile plate-element. By this, effective benefit is taken from gravity of that first specimen 1.

[0027] It will now be clear that according to the invention a sheet-piling can be installed easy, light and fast. Also, the used tongued-and-grooved joint allows for extension-and-shrinkage behaviour of sheet-piling parts during the life span.

[0028] Reference is now made to Figs. 7 through 10B.

[0029] In the shown example, six first local stops 8 are provided in the shown groove 3 of the second specimen 1A. In the situation of Figs. 9A and 9B the tongue 2 of the first specimen 1 is lying against these local stops 8. In the situation of Figs. 10A and 10B, as a result of extension of the sheet-pile plate-elements, the tongue 2 of the first specimen 1 has penetrated deeper into the groove 3 of the second specimen 1A. The latter can go along with deformations of the shown tongue, as shown in Fig. 10B, and/or can go along with deformations of the first local stops 8, as shown in Fig. 10A.

[0030] It is remarked that the abovementioned examples of embodiments of the invention do not limit the invention, and that various alternatives are possible within the scope of the appended claims.

[0031] For example, for the installed sheet-piling of the shown example, the sheet-pile plate-elements being interconnected in the horizontal direction are connected with one another by means of the special tongued-and-grooved joints according to the invention. Instead of that, or in addition thereto, for an installed sheet-piling according to the invention also the sheet-pile plate-elements being interconnected in the vertical direction may be connected with one another by means of the special tongued-and-grooved joints according to the invention. Additionally, therefore, according to the invention also one of the second plate sides can be provided with a second tongue, and the other of the second plate sides can be provided with a second groove, in such manner that between a first specimen of the sheet-pile plate-element and a second specimen of the sheet-pile plate-element a tongued-and-grooved joint can be established by interlocking of the second tongue of the first specimen with the second groove of the second specimen, characterized in that

the second tongue, as seen at different positions along the first plate-longitudinal-axis, has at least one thick second tongue part and at least one thin second tongue part, wherein the thick second tongue part, measured along said thickness axis, has higher thickness than the thin second tongue part,

the second groove, as seen at different positions along the first plate-longitudinal-axis, has at least one wide second groove part and at least one narrow second groove part, wherein the wide second groove part, measured along said thickness axis, has higher width than the narrow second groove part, and

during said interlocking the first specimen and the second specimen of the sheet-pile plate-element are reciprocally moveable relative to one another, with at least respective components being parallel to the respective first plate-longitudinal-axes of the first specimen and the second specimen, respectively, between at least one temporary second interlocking condition and at least one permanent second interlocking condition, wherein in the permanent second interlocking condition second gripping parts of the at least one thick second tongue part are restrained by the at least one narrow second groove part, while said second gripping parts in the temporary second interlocking condition are not, or to a lesser extent, restrained by the at least one narrow second groove part in that said second gripping parts in the temporary second interlocking condition are located at least partly in the at least one wide second groove part.

[0032] Furthermore, the sheet-pile plate-elements can be made of various kinds of materials, such as for example various kinds of wood or various kinds of plastic. Also combinations of different such various kinds of materials are possible. For example, a sheet-pile plate-element according to the invention can be substantially made of wood, while the parts of the sheet-pile plate-element which are forming the tongue and the groove can be made of plastic and be connected to the wood of the sheet-pile plate-element. Advantages of the application of plastic in the sheet-pile plate-element are, amongst others, that plastic is durable and that it allows for efficiently producing the products in large numbers and with accurate shapes.

[0033] Furthermore for a sheet-pile plate-element according to the invention various variations are possible in the numbers, the locations, the shapes, and the dimensions of the thick tongue parts, the thin tongue parts, the wide groove parts and the narrow groove parts.

[0034] However, other variations or modifications are also possible. These and similar alternatives are deemed to fall within the scope of the invention as defined in the appended claims.

5 **Claims**

1. Modular sheet-pile plate-element, comprising:

- 10 - two exterior plate-surfaces (20, 30) lying mutually opposed along a thickness axis (10) of the sheet-pile plate-element,
- two first plate sides (21, 31) lying mutually opposed along a first plate-longitudinal-axis (11) of the sheet-pile plate-element, and
- 15 - two second plate sides (22, 32) lying mutually opposed along a second plate-longitudinal-axis (12) of the sheet-pile plate-element,

wherein one of the first plate sides is provided with a tongue (2), and the other of the first plate sides is provided with a groove (3), in such manner that between a first specimen (1) of the sheet-pile plate-element and a second specimen (1A) of the sheet-pile plate-element a tongued-and-grooved joint can be established by interlocking of the tongue of the first specimen with the groove of the second specimen, wherein the tongue, as seen at different positions along the second plate-longitudinal-axis, has at least one thick tongue part (4) with gripping parts and at least one thin tongue part (5), wherein the thick tongue part, measured along said thickness axis, has higher thickness than the thin tongue part, wherein during said interlocking the first specimen and the second specimen of the sheet-pile plate-element are reciprocally movable (70) relative to one another, with at least respective movement components being parallel to the respective second plate-longitudinal-axes of the first specimen and the second specimen, respectively, between at least one temporary interlocking condition and at least one permanent interlocking condition, **characterized in that** the groove, as seen at different positions along the second plate-longitudinal-axis, has at least one wide groove part (6) and at least one narrow groove part (7), wherein the wide groove part, measured along said thickness axis, has higher width than the narrow groove part, and wherein in the permanent interlocking condition said gripping parts of the at least one thick tongue part are restrained by the at least one narrow groove part, while said gripping parts in the temporary interlocking condition are not, or to a lesser extent, restrained by the at least one narrow groove part **in that** said gripping parts in the temporary interlocking condition are located at least partly in the at least one wide groove part.

2. Modular sheet-pile plate-element according to claim 1, further comprising at least one first local stop (8) in the groove (3) and/or at least one second local stop being part of the tongue, which at least one first local stop and at least one second local stop act as stops during the establishing of said tongued-and-grooved joint between said first specimen and said second specimen, with at least respective movement components parallel to the respective first plate-longitudinal-axes (11) of the first specimen (1) and the second specimen (1A), respectively, of the sheet-pile plate-element, wherein, for said acting as stops, the at least one first and/or second local stop are resisting a threshold corresponding to a certain manual force during said establishing of said tongued-and-grooved joint, and wherein, in case said threshold is exceeded, extension of said first specimen and of said second specimen is allowed by deformation and/or breakage of the at least one first and/or second local stop and/or by local deformation of the tongue walls and/or groove walls under the pressure of the at least one first and/or second local stop acting thereon.

3. Sheet-piling comprising:

- said first specimen (1) of a modular sheet-pile plate-element according to claim 1 or 2; and
- said second specimen (1A) of a modular sheet-pile plate-element according to claim 1 or 2;

wherein said first specimen and said second specimen are mutually connected by means of said tongued-and-grooved joint.

4. Method of installing a sheet-piling (80), which sheet-piling is a sheet-piling according to claim 3, comprising establishing said tongued-and-grooved joint between said first specimen (1) and said second specimen (1A).

5. Method according to claim 4, wherein the said establishing of said tongued-and-grooved joint comprises a first step of mutually bringing the first specimen and the second specimen of the sheet-pile plate-element in the temporary interlocking condition, with at least respective movement components parallel to the respective first plate-longitudinal-

axes (11) of the first specimen (1) and the second specimen (1A), respectively, as well as a successive second step, performed according to said reciprocal moveability (70), of bringing the first specimen and the second specimen into the permanent interlocking condition.

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Patentansprüche

1. Modulares Stahlspundwandplattenelement, umfassend:

- 10 - zwei äußere Plattenoberflächen (20, 30), die entgegengesetzt zueinander entlang einer Dickenachse (10) des Stahlspundwandplattenelements liegen,
 - zwei erste Plattenseiten (21, 31), die entgegengesetzt zueinander entlang einer ersten Plattenlängsachse (11) des Stahlspundwandplattenelements liegen, und
 15 - zwei zweite Plattenseiten (22, 32), die entgegengesetzt zueinander entlang einer zweiten Plattenlängsachse (12) des Stahlspundwandplattenelements liegen,

wobei eine der ersten Plattenseiten mit einer Feder (2) versehen ist und die andere der ersten Plattenseiten mit einer Nut (3) versehen ist, sodass zwischen einem ersten Exemplar (1) des Stahlspundwandplattenelements und einem zweiten Exemplar (1A) des Stahlspundwandplattenelements eine Nut-Feder-Verbindung durch Ineinandergreifen der Feder des ersten Exemplars und der Nut des zweiten Exemplars hergestellt werden kann,
 20 wobei die Feder, gesehen an verschiedenen Positionen entlang der zweiten Plattenlängsachse, mindestens ein dickes Federteil (4) mit Greifteilen und mindestes ein dünnes Federteil (5) aufweist, wobei das dicke Federteil, gemessen entlang der Dickenachse, eine größere Dicke als das dünne Federteil aufweist,
 wobei, während des Ineinandergreifens das erste Exemplar und das zweite Exemplar des Stahlspundwandplattenelements gegenseitig beweglich (70) zueinander sind, mit mindestens entsprechenden Bewegungskomponenten
 25 parallel zu den entsprechenden zweiten Plattenlängsachsen des ersten Exemplars bzw. des zweiten Exemplars zwischen mindestens einem temporären Ineinandergreifzustand und mindestens einem permanenten Ineinandergreifzustand, **dadurch gekennzeichnet, dass** die Nut, gesehen an verschiedenen Positionen entlang der zweiten Plattenlängsachse mindestens ein breites Nutteil (6) und mindestens ein schmales Nutteil (7) aufweist, wobei das breite Nutteil, gemessen entlang der Dickenachse, eine größere Breite als das schmalere Nutteil hat, und wobei in dem permanenten Ineinandergreifzustand die Greifteile des mindestens einen dicken Federteils durch das mindestens eine schmale Nutteil zurückgehalten werden, während die Greifteile in dem temporären Ineinandergreifzustand nicht oder in geringererem Maß von dem mindestens einen schmalen Nutteil zurückgehalten werden, weil die Greifteile in dem temporären Ineinandergreifzustand mindestens teilweise in dem mindestens einen breiten Nutteil angeordnet sind.
 30 35

2. Modulares Stahlspundwandplattenelement nach Anspruch 1, ferner umfassend mindestes einen ersten lokalen Anschlag (8) in der Nut (3) und/oder mindestes einen zweiten lokalen Anschlag, der Teil der Feder ist, welcher 40 mindestens eine erste lokale Anschlag und mindestes eine zweite lokale Anschlag als Anschläge bei der Schaffung der Nut-Feder-Verbindung zwischen dem ersten Exemplar und dem zweiten Exemplar dienen, mit mindestens entsprechenden Bewegungskomponenten parallel zu den entsprechenden ersten Plattenlängsachsen (11) des ersten Exemplars (1) bzw. des zweiten Exemplars (1A) des Stahlspundwandplattenelements, wobei, um als Anschläge zu dienen, der mindestens eine erste und/oder zweite lokale Anschlag einem Schwellenwert entsprechend einer gewissen manuellen Kraft während der Schaffung der Nut-Feder-Verbindung widerstehen, und wobei, im Fall 45 eines Überschreitens des Schwellenwerts, die Verlängerung des ersten Exemplars und des zweiten Exemplars erlaubt ist durch Verformung und/oder Brechen des mindestens einen ersten und/oder zweiten lokalen Anschlags und/oder durch lokale Verformung der Federwände und/oder Nutwände unter dem Druck, den der mindestens eine erste und/oder zweite lokale Anschlag darauf ausüben.

3. Stahlspundwand, umfassend:

- 50 - das erste Exemplar (1) eines modularen Stahlspundwandplattenelements nach Anspruch 1 oder 2; und
 - das zweite Exemplar (1A) eines modularen Stahlspundwandplattenelements nach Anspruch 1 oder 2;

55 wobei das erste Exemplar und das zweite Exemplar mittels der Nut-Feder-Verbindung miteinander verbunden sind.

4. Verfahren zur Installation einer Stahlspundwand (80), welche Stahlspundwand eine Stahlspundwand nach Anspruch 3 ist, umfassend die Schaffung einer Nut-Feder-Verbindung zwischen dem ersten Exemplar (1) und dem zweiten

Exemplar (1A).

5. Verfahren nach Anspruch 4, wobei das Schaffen der Nut-Feder-Verbindung einen ersten Schritt, in dem das erste Exemplar und das zweite Exemplar des Stahlspundwandplattenelements in den temporären Ineinandergreifzustand gebracht werden, mit mindestens entsprechenden Bewegungskomponenten parallel zu den entsprechenden ersten Plattenlängsachsen (11) des ersten Exemplars (1) bzw. des zweiten Exemplars (1A), sowie einen nachfolgenden zweiten Schritt, durchgeführt gemäß der gegenseitigen Beweglichkeit (70), in dem das erste Exemplar und das zweite Exemplar in permanenten Ineinandergreifzustand gebracht werden, umfasst.

Revendications

1. Élément de plaque d'empilement de feuilles modulaire comprenant :

- deux surfaces de plaque extérieures (20, 30) mutuellement opposées le long d'un axe d'épaisseur (10) de l'élément de plaque d'empilement de feuilles,
- deux premiers côtés de plaque (21, 31) mutuellement opposés le long d'un premier axe longitudinal de plaque (11) de l'élément de plaque d'empilement de feuilles et
- deux deuxièmes côtés de plaque (22, 32) mutuellement opposés le long d'un deuxième axe longitudinal de plaque (12) de l'élément de plaque d'empilement de feuilles,

un des premiers côtés de plaque étant muni d'une languette (2) et l'autre des premiers côtés de plaque étant muni d'une rainure (3), de façon à ce que, entre un premier spécimen (1) de l'élément de plaque d'empilement de feuilles et un deuxième spécimen (1A) de l'élément de plaque d'empilement de feuilles, une jonction par rainure et languette puisse être réalisée par l'enclenchement de la languette du premier spécimen avec la rainure du deuxième spécimen, la languette, vue à différents endroits le long du deuxième axe longitudinal de plaque, comprenant au moins une partie de languette épaisse (4) avec des parties de serrage et au moins une partie de languette mince (5), la partie de languette épaisse, mesurée le long dudit axe d'épaisseur, présentant une épaisseur supérieure à la partie de languette mince,

pendant ledit enclenchement, le premier spécimen et le deuxième spécimen de l'élément de plaque d'empilement de feuilles étant mobiles réciproquement (70) l'un par rapport à l'autre, au moins des composantes de mouvement respectives étant parallèles aux deuxièmes axes longitudinaux de plaque du premier spécimen et du deuxième spécimen, respectivement, entre au moins un état d'enclenchement temporaire et au moins un état d'enclenchement permanent, **caractérisé en ce que** la rainure, vue à différents endroits le long du deuxième axe longitudinal de plaque, comprend au moins une partie de rainure large (6) et au moins une partie de rainure étroite (7), la partie de rainure large, mesurée le long dudit axe d'épaisseur, présentant une largeur supérieure à celle de la partie de rainure étroite et, dans l'état d'enclenchement permanent, lesdites parties de serrage de l'au moins une partie de languette épaisse étant freinées par l'au moins une partie de rainure étroite, tandis que lesdites parties de serrage, dans l'état d'enclenchement temporaire, ne sont pas ou sont, dans une moindre mesure, freinées par l'au moins une partie de rainure étroite, **en ce que** lesdites parties de serrage, dans l'état d'enclenchement temporaire, sont situées au moins partiellement dans l'au moins une partie de rainure large.

2. Élément de plaque d'empilement de feuilles modulaire selon la revendication 1, comprenant en outre au moins une première butée locale (8) dans la rainure (3) et/ou au moins une deuxième butée locale qui fait partie de la languette, cette au moins une première butée locale et cette au moins une deuxième butée locale agissant comme des butées pendant l'établissement de ladite jonction à rainure et languette entre ledit premier spécimen et ledit deuxième spécimen, avec au moins des composantes de mouvement respectives parallèles aux premiers axes longitudinaux de plaque (11) respectifs du premier spécimen (1) et du deuxième spécimen (1A), respectivement, de l'élément de plaque d'empilement de feuilles, dans lequel, pour ladite action en tant que butées, l'au moins une première et/ou deuxième butée locale résistent à un seuil correspondant à une force manuelle déterminée pendant ledit établissement de ladite jonction à rainure et languette et dans lequel, dans le cas où ledit seuil est dépassé, l'extension dudit premier spécimen et dudit deuxième spécimen est permise par la déformation et/ou la rupture de l'au moins une première et/ou deuxième butées locale et/ou par la déformation locale des parois de la languette et/ou des parois de la rainure sous la pression de l'au moins une première et/ou deuxième butée locale qui agit sur celles-ci.

3. Empilement de feuilles comprenant :

- ledit premier spécimen (1) d'un élément de plaque d'empilement de feuilles modulaire selon la revendication

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1 ou 2 ; et

- ledit deuxième spécimen (1A) d'un élément de plaque d'empilement de feuilles modulaire selon la revendication 1 ou 2 ;

5 ledit premier spécimen et ledit deuxième spécimen étant reliés entre eux au moyen de ladite jonction à rainure et languette.

10 **4.** Procédé d'installation d'un empilement de feuilles (80), cet empilement de feuilles étant un empilement de feuilles selon la revendication 3, comprenant l'établissement de ladite jonction à rainure et languette entre ledit premier spécimen (1) et ledit deuxième spécimen (1A).

15 **5.** Procédé selon la revendication 4, dans lequel ledit établissement de ladite jonction par rainure et languette comprend une première étape consistant à amener le premier spécimen et le deuxième spécimen de l'élément de plaque d'empilement de feuilles dans l'état d'enclenchement temporaire, avec au moins des composantes de mouvement respectives parallèles aux premiers axes longitudinaux de plaque (11) respectifs du premier spécimen (1) et du deuxième spécimen (1A), respectivement, ainsi qu'une deuxième étape suivante, exécutée selon ladite mobilité mutuelle (70), consistant à amener le premier spécimen et le deuxième spécimen dans l'état d'enclenchement permanent.

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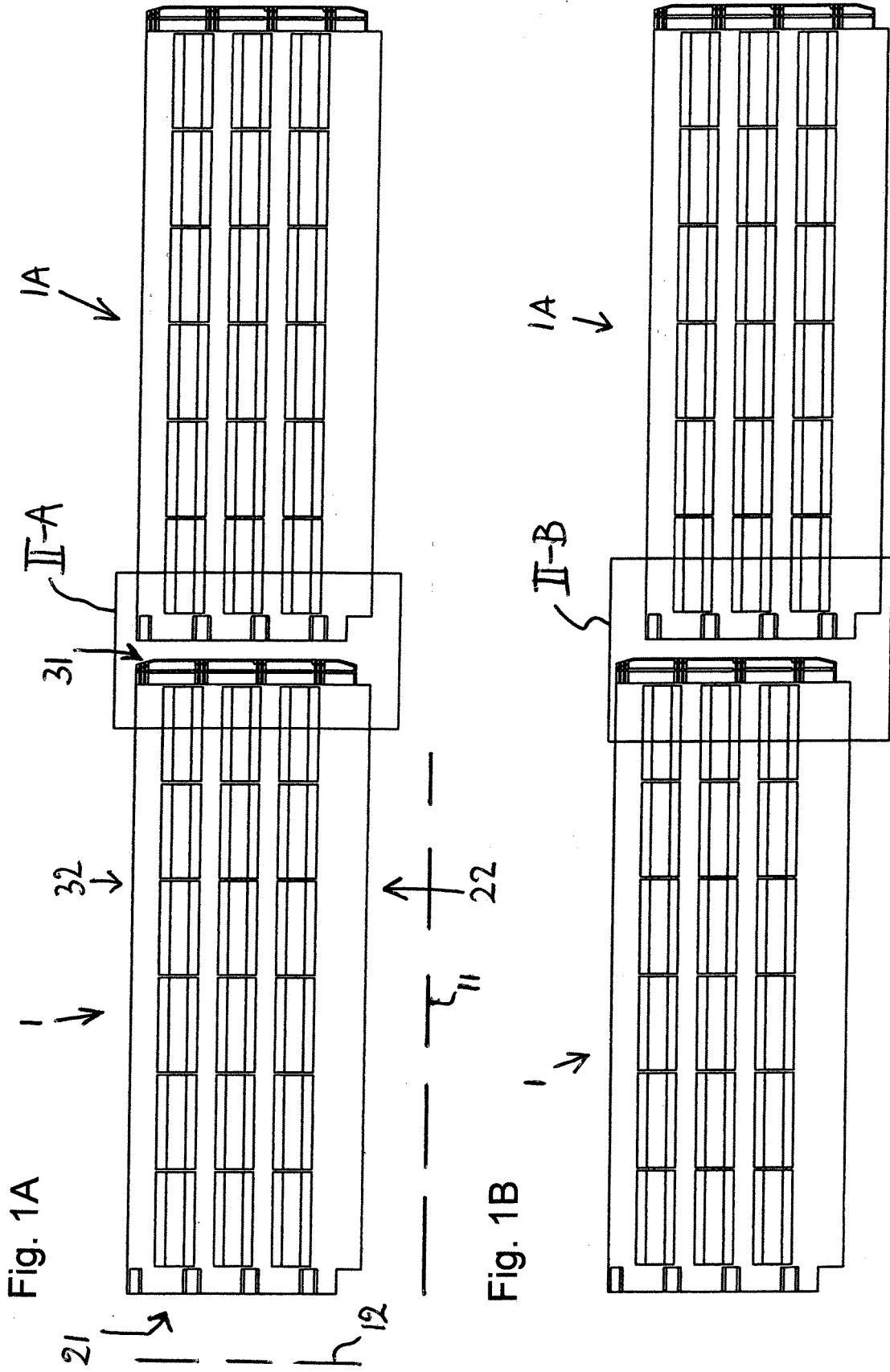
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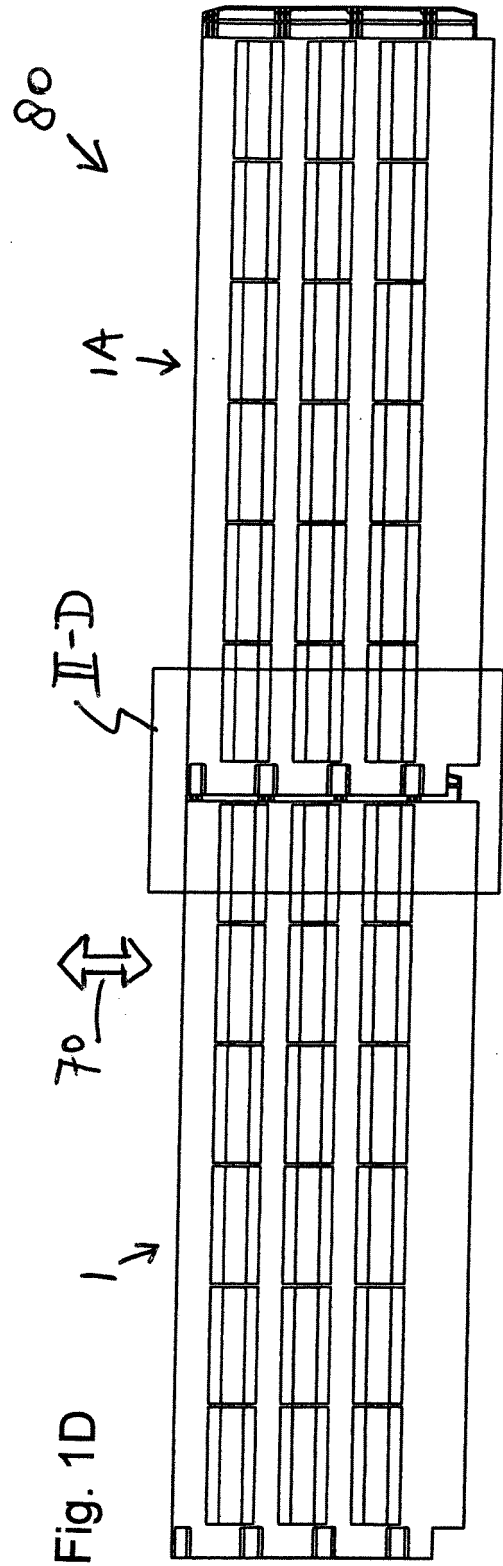
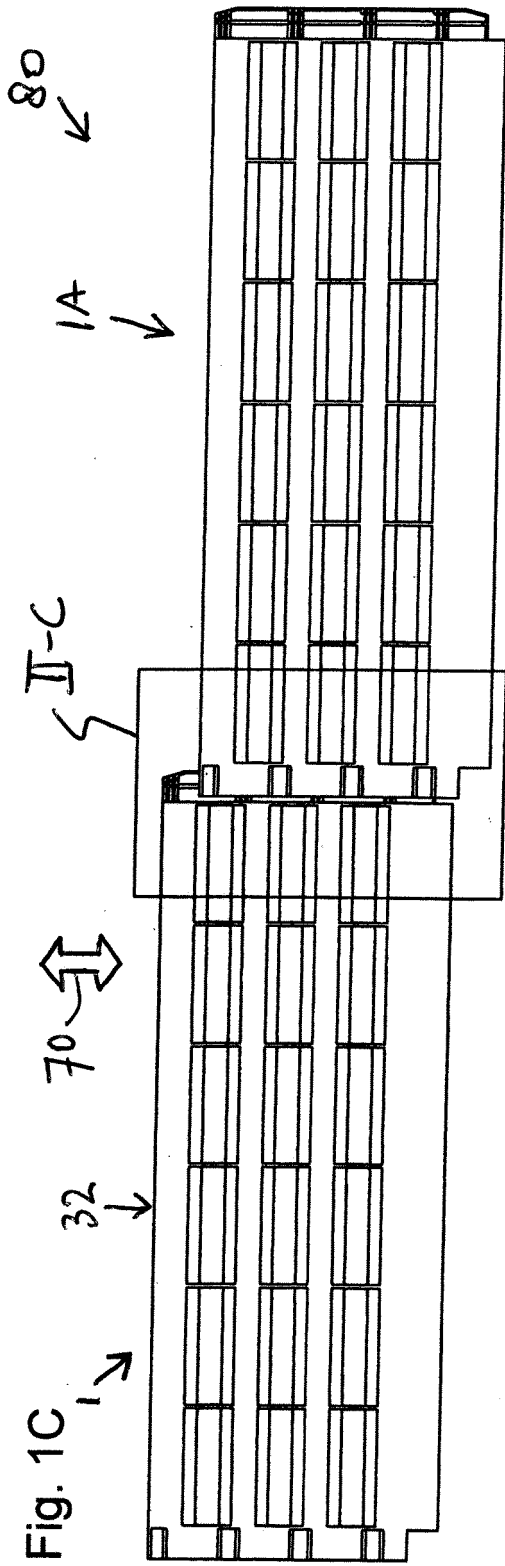


Fig. 2A

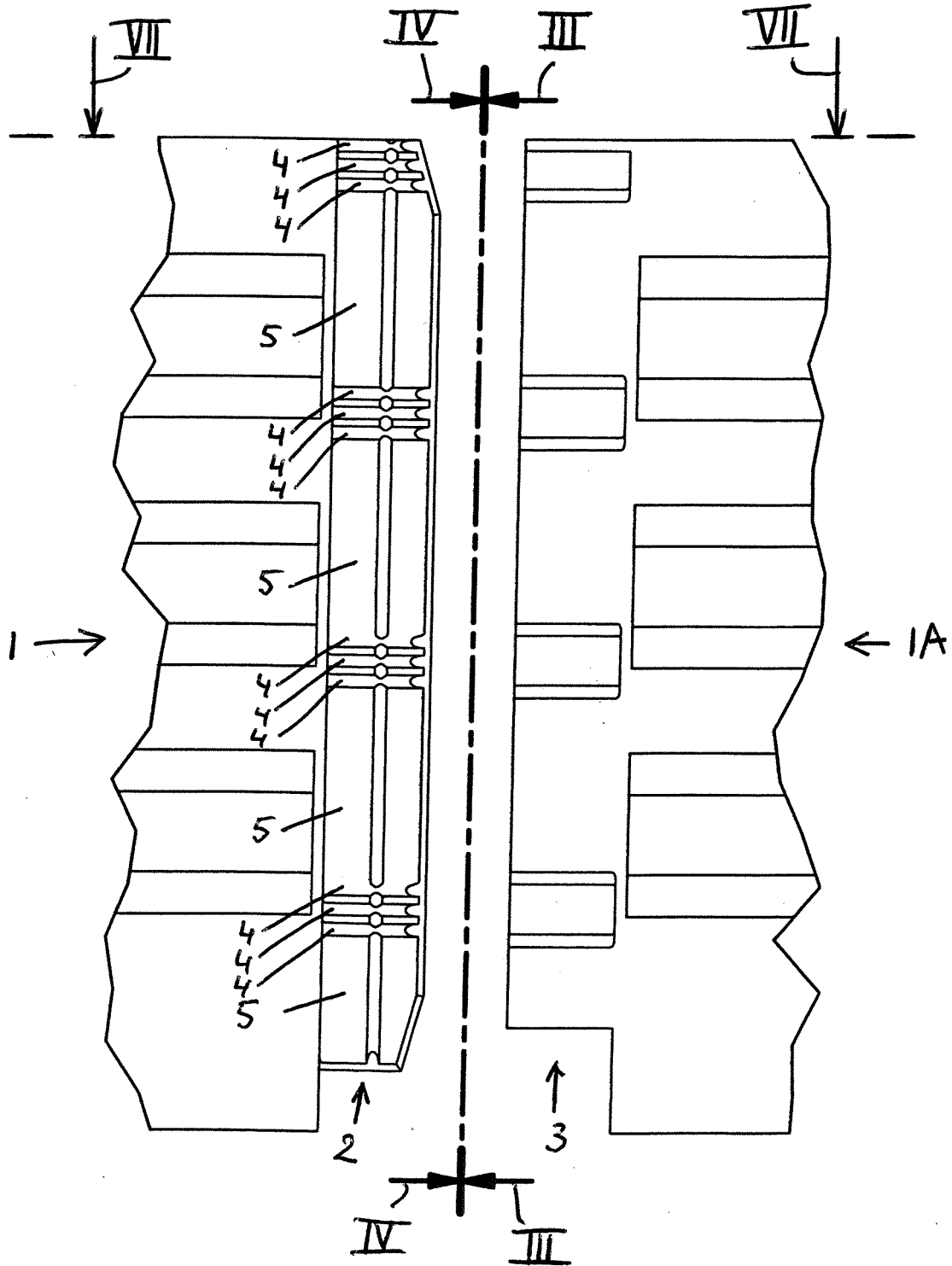


Fig. 2B

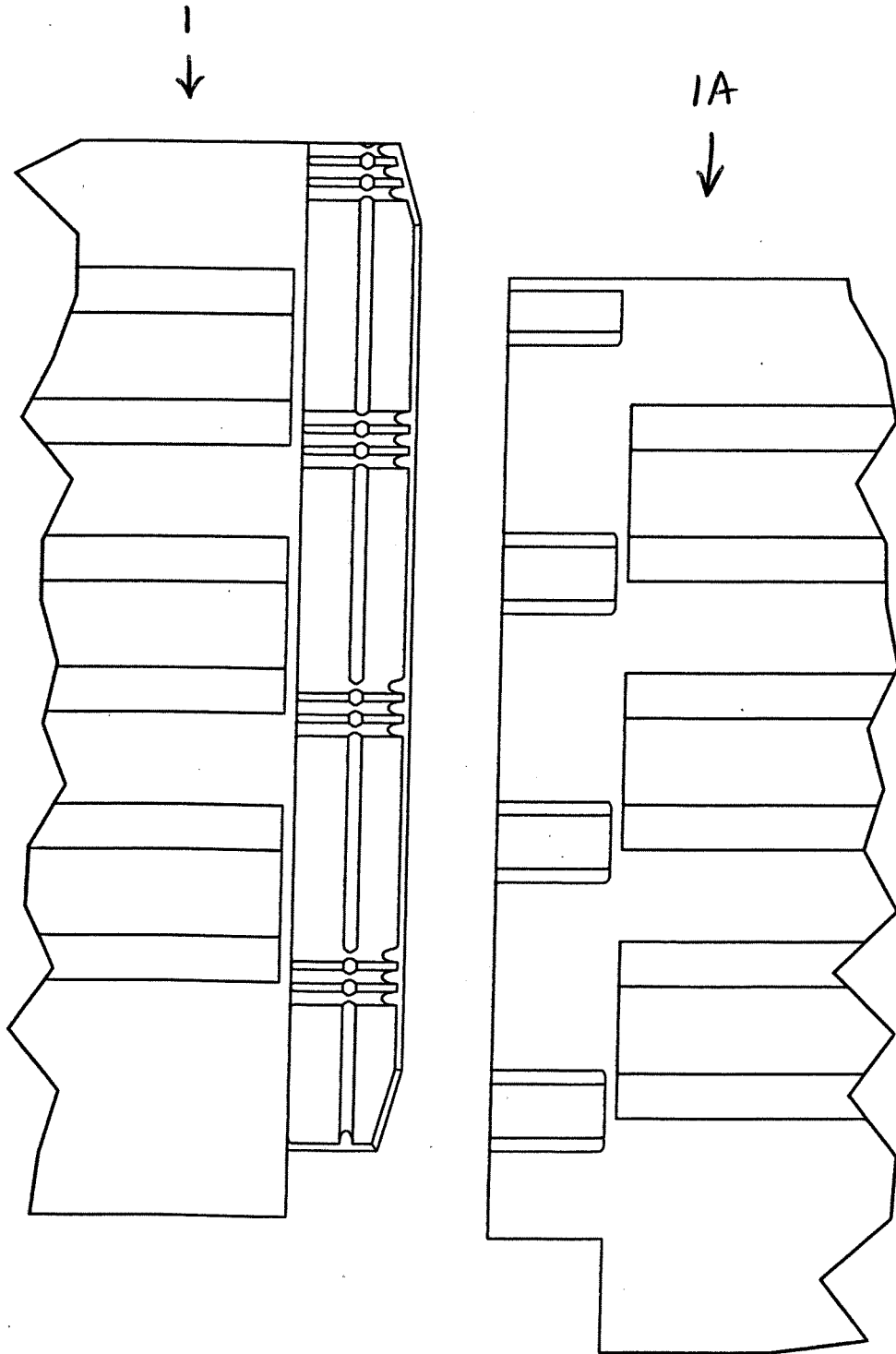


Fig. 2C

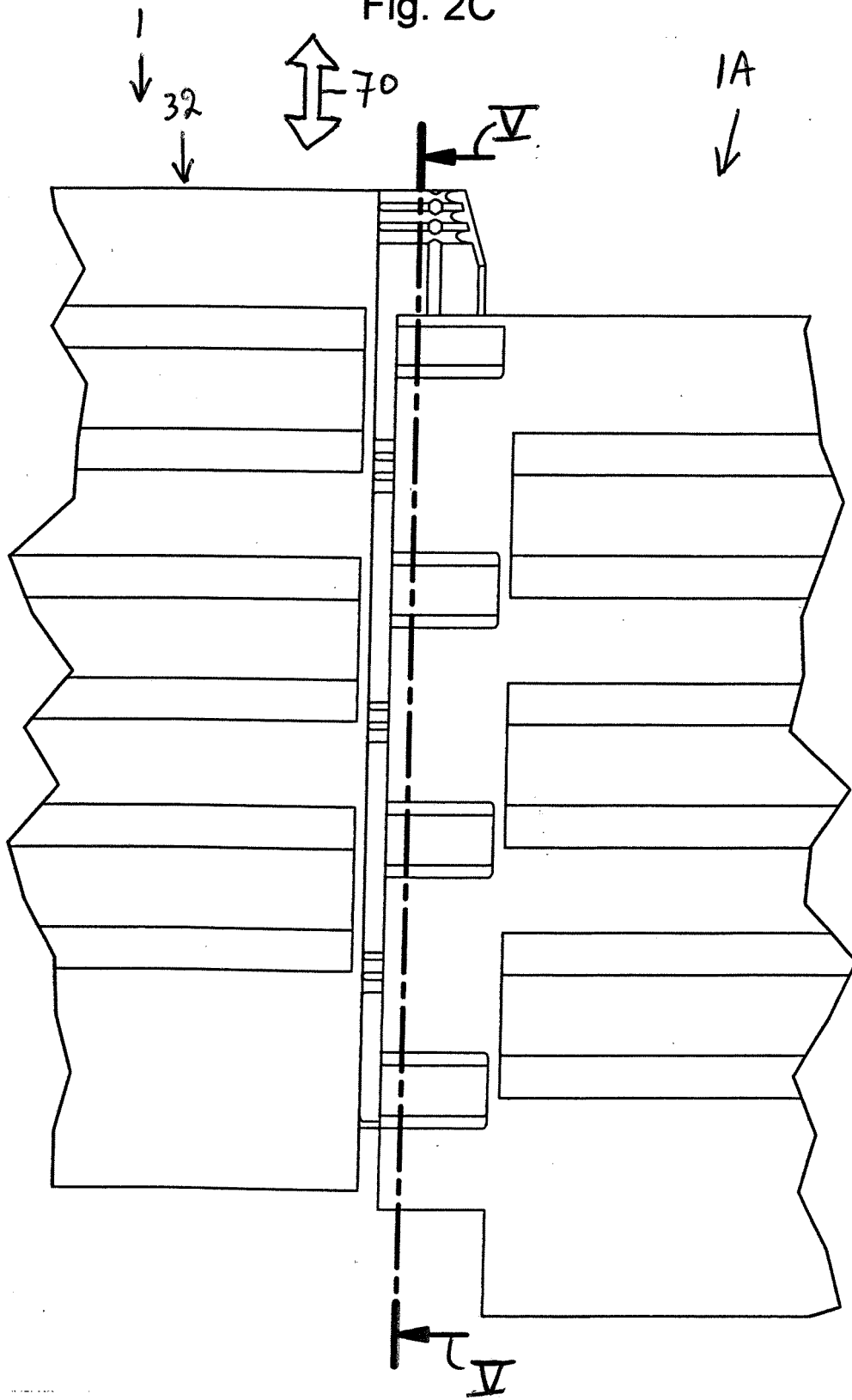


Fig. 2D

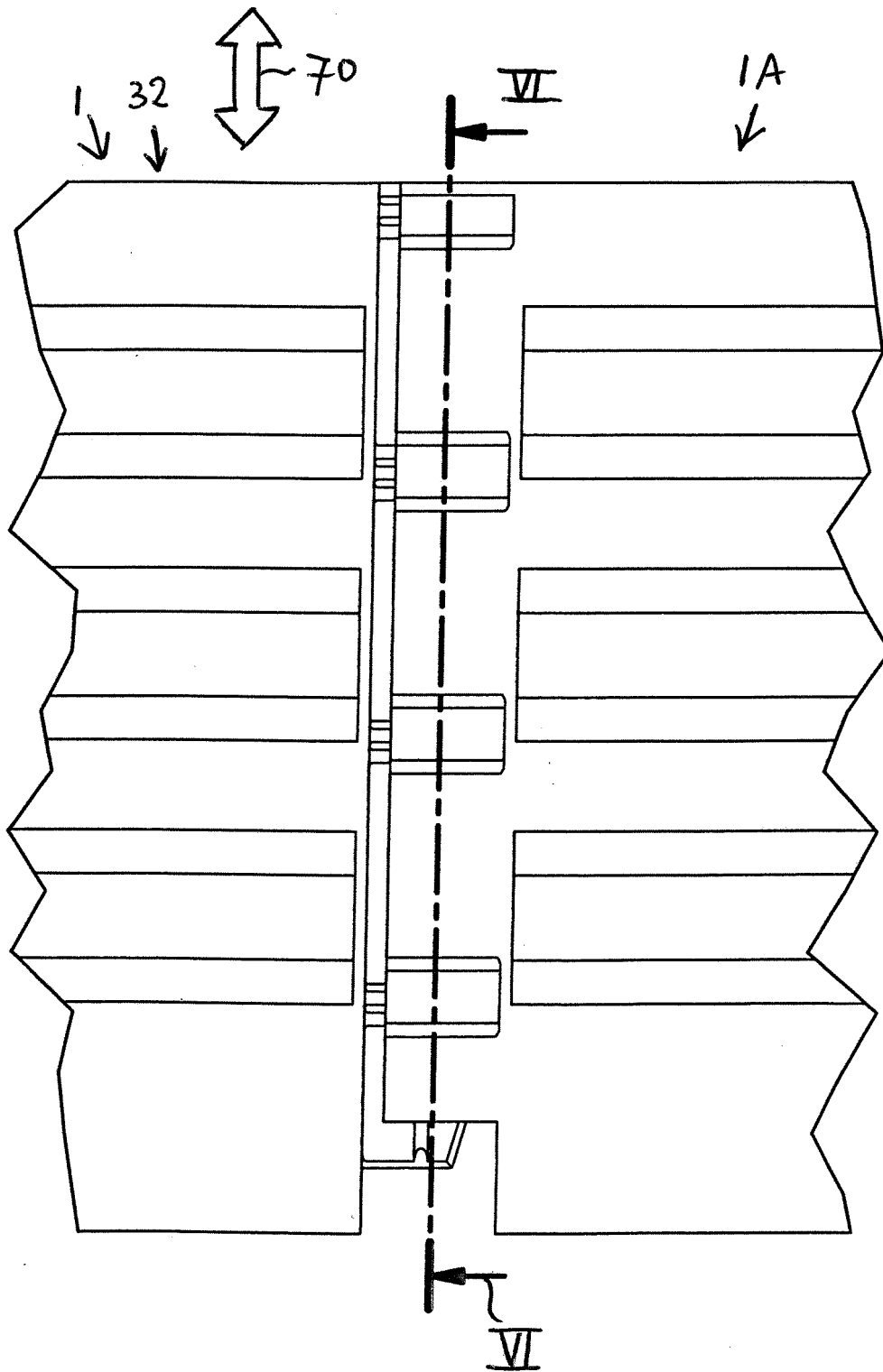


Fig. 3

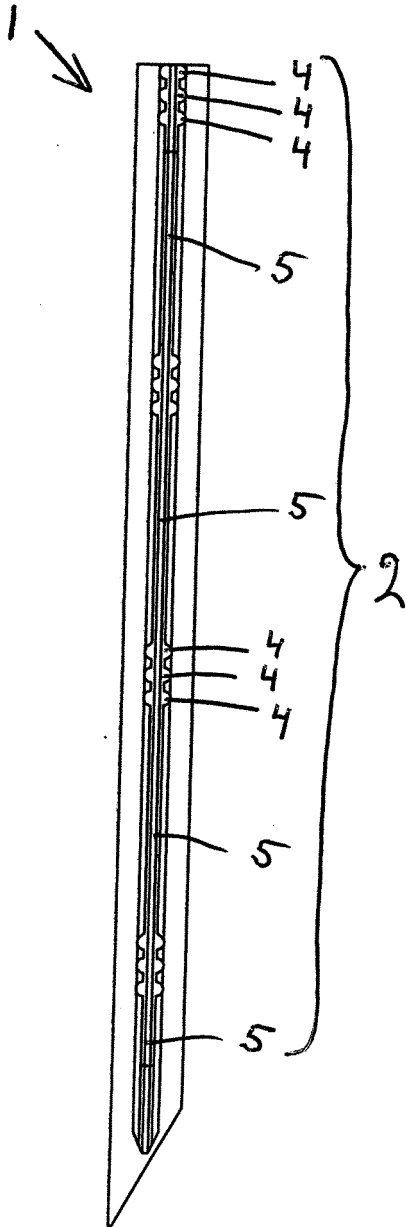


Fig. 4

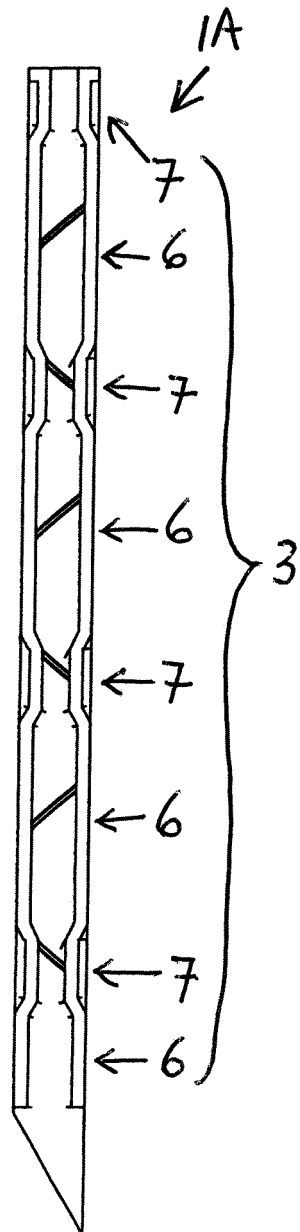


Fig. 5

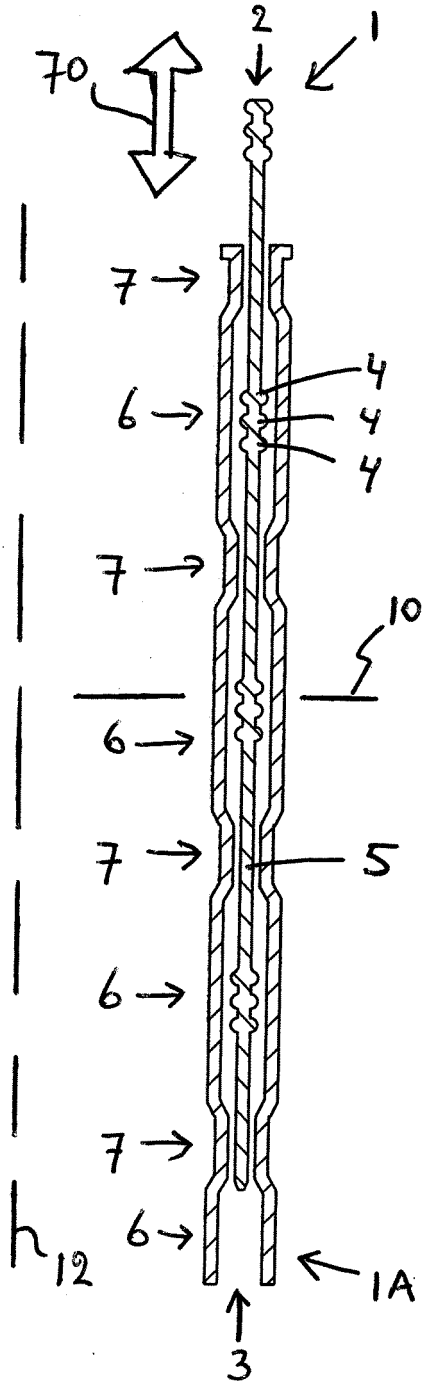


Fig. 6

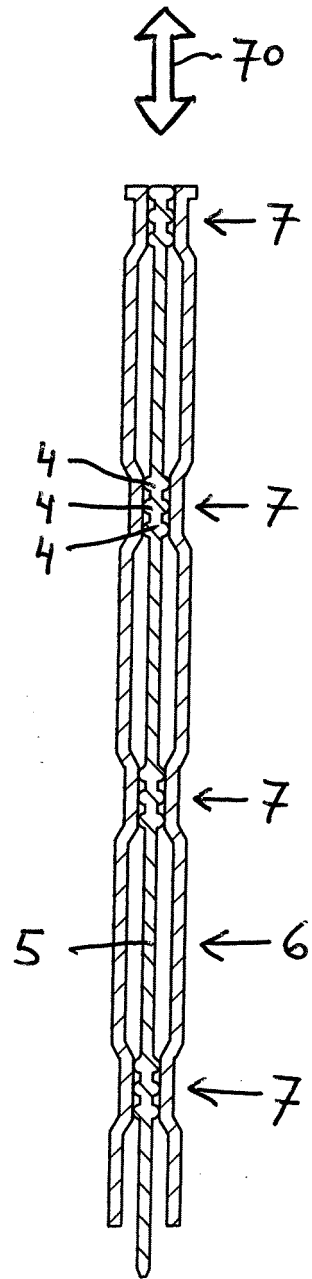


Fig. 7

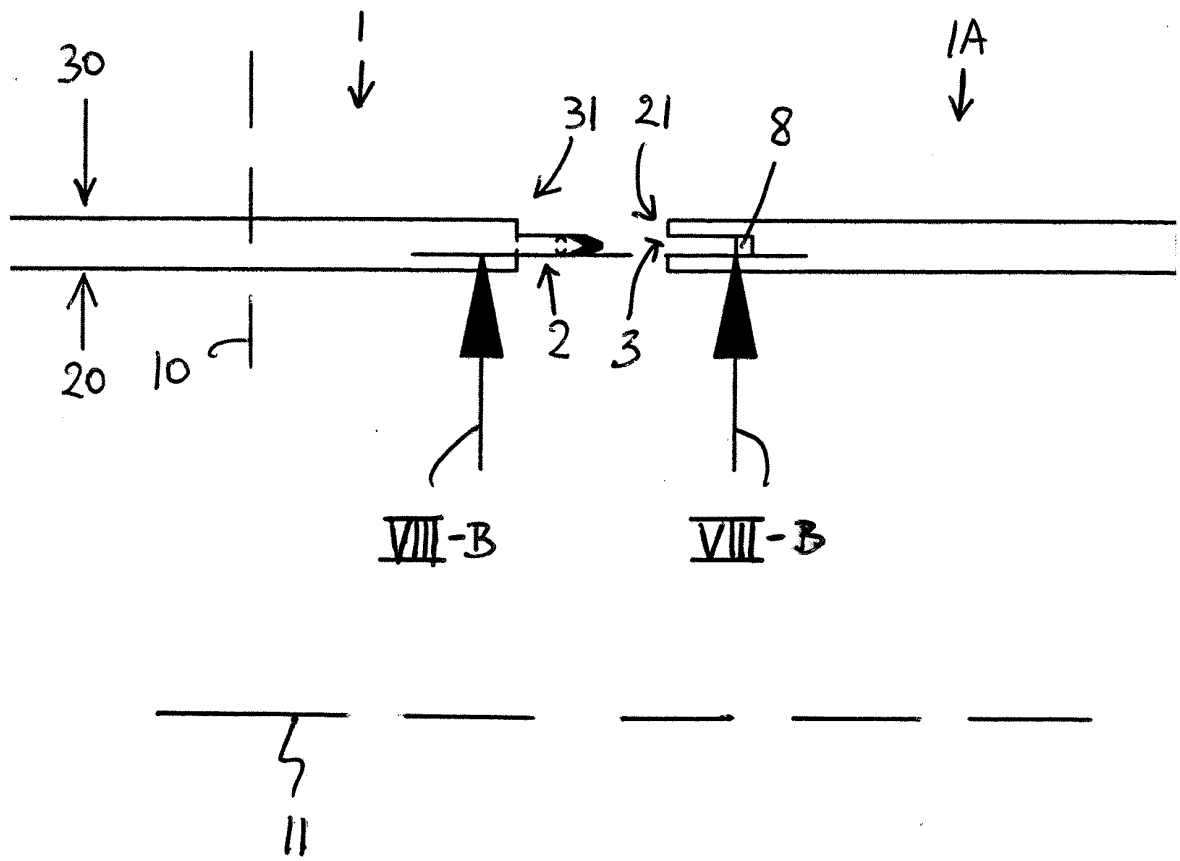


Fig. 8A

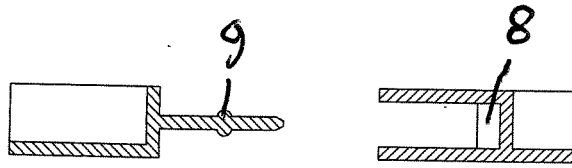


Fig. 8B

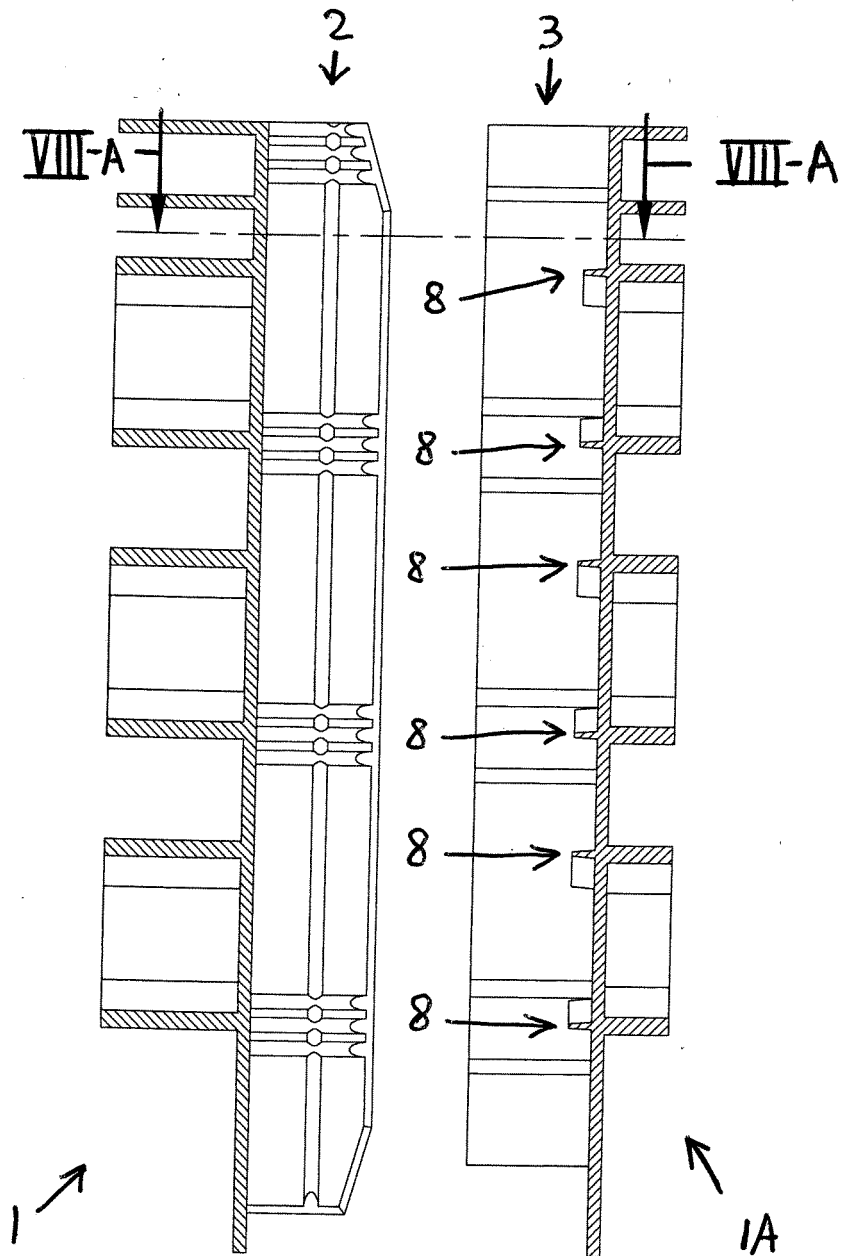


Fig. 9A

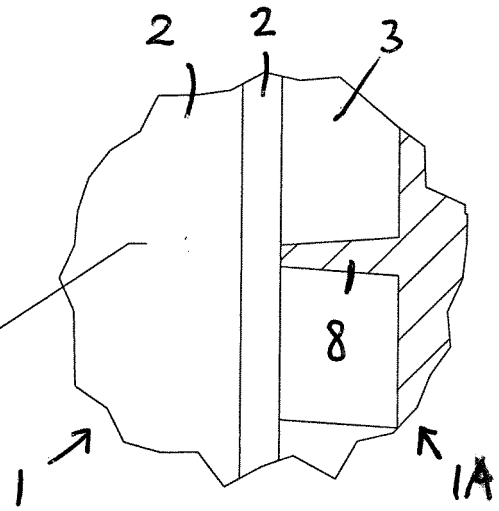
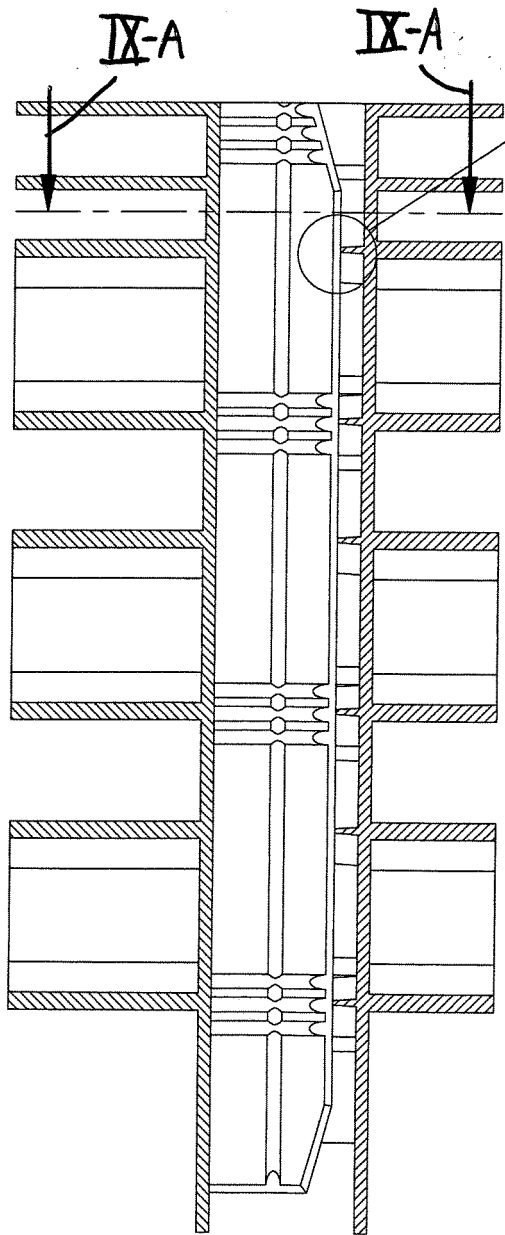
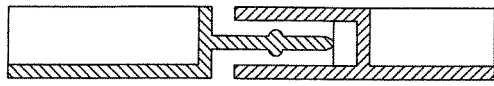


Fig. 9B

Fig. 10A

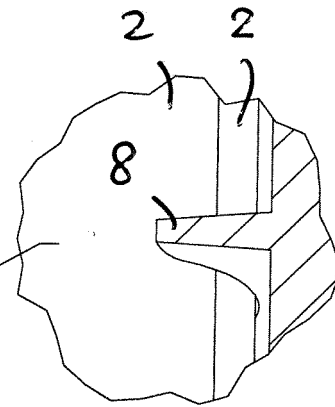
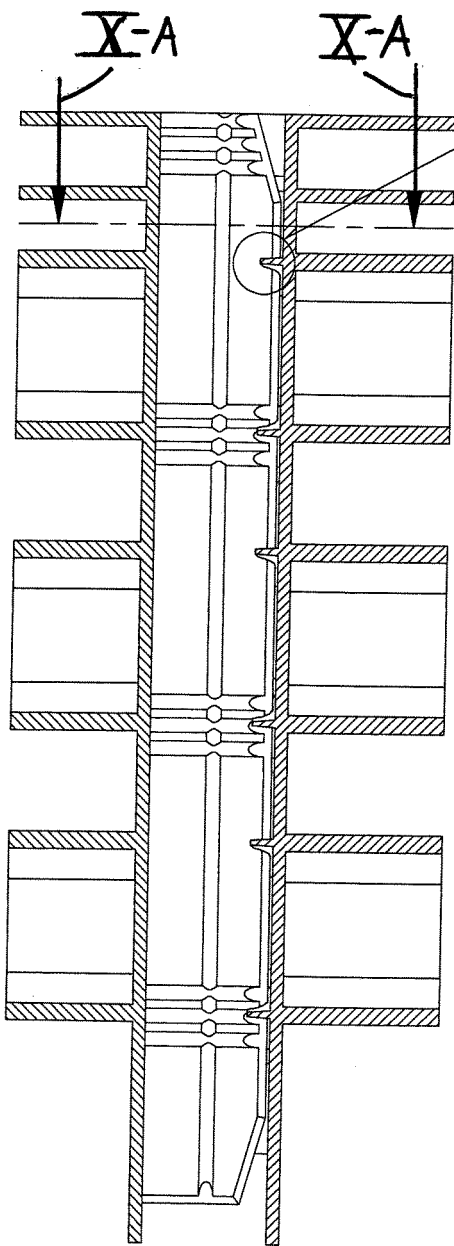
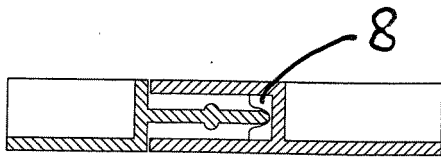


Fig. 10B

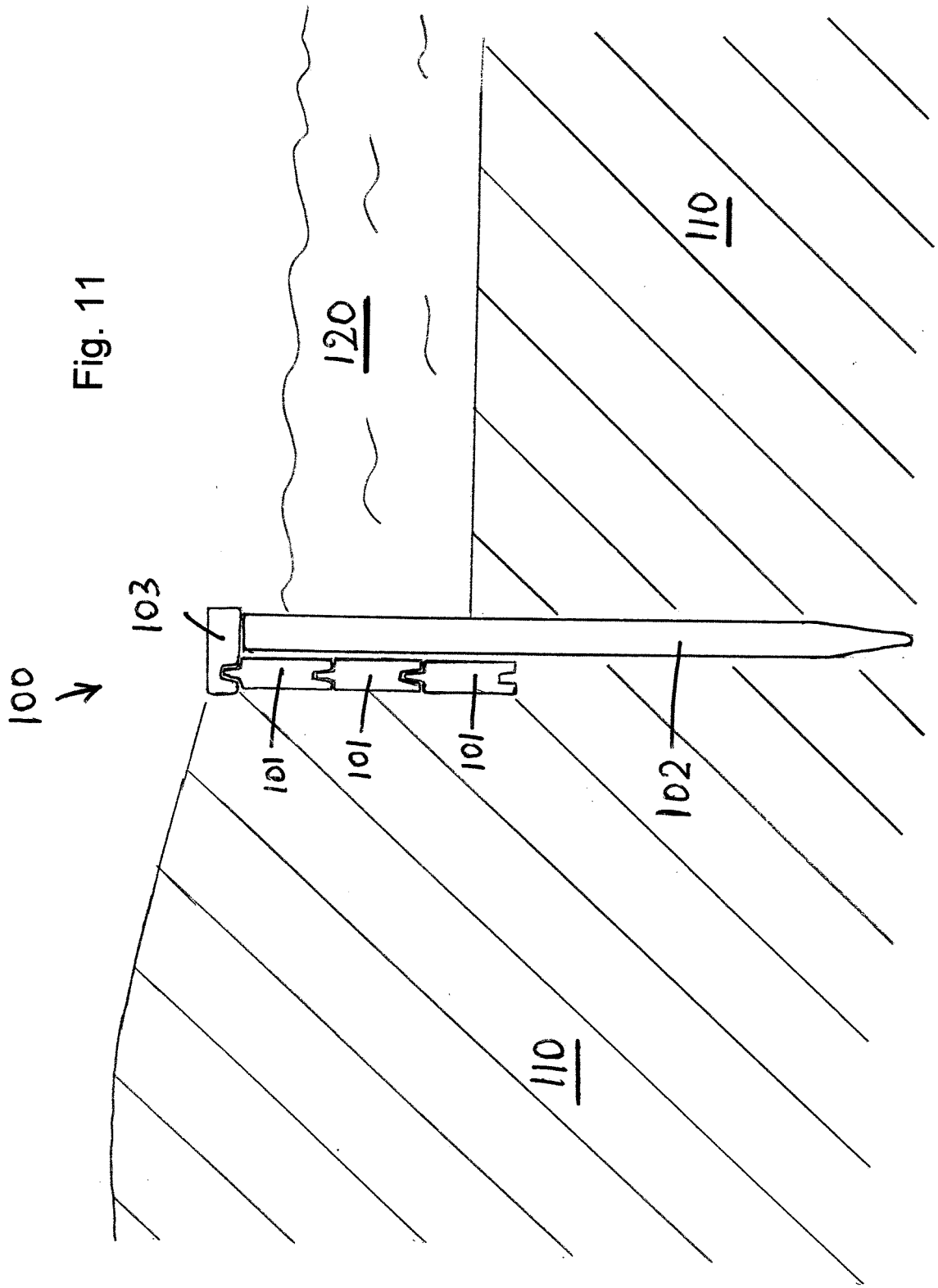


Fig. 11

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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