

(19)



(11)

EP 3 024 985 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

15.11.2017 Bulletin 2017/46

(51) Int Cl.:

E02B 3/14 (2006.01)

(86) International application number:

PCT/NL2014/050500

(21) Application number: **14753321.0**

(22) Date of filing: **22.07.2014**

(87) International publication number:

WO 2015/012687 (29.01.2015 Gazette 2015/04)

(54) **WATER CONTROL STRUCTURE AND CLADDING ELEMENT THEREFOR**

WASSERSTEUERUNGSSTRUKTUR UND VERKLEIDUNGSELEMENT DAFÜR

STRUCTURE DE RÉGULATION DES EAUX ET ÉLÉMENT DE COUVERTURE CORRESPONDANT

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(72) Inventor: **HILL, Hans**

3001 DE ROTTERDAM (NL)

(30) Priority: **22.07.2013 NL 2011206**

(74) Representative: **Nederlandsch Octrooibureau**

P.O. Box 29720

2502 LS The Hague (NL)

(43) Date of publication of application:

01.06.2016 Bulletin 2016/22

(56) References cited:

WO-A1-2011/108931 DE-A1- 3 530 186

DE-A1- 10 327 484 DE-U1- 8 707 657

US-A- 6 158 922 US-A1- 2002 154 950

(73) Proprietor: **Hill Innovations B.V.**
3011AA Rotterdam (NL)

EP 3 024 985 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

[0001] The invention relates to a water-control structure, comprising a control structure body which is exposed, at least on one side, to the effects of a body of water, and adjacent cladding elements which cover the control structure body and which each comprise a base, and adjacent bases of the cladding elements between themselves define passages for allowing water through, wherein the adjacent cladding have projections, wherein the cladding elements are covered by a covering layer which is provided between and above the projections. Such a water-control structure is known from US-A-2002/154950. The cladding elements which could be made, for example, from concrete, ensure that the control structure body is better protected against the effects of the water, in particular against the effects of waves. The control structure body may be made of, for example, sand, clay or mixtures thereof with hard core, and would run the danger of being swept away or eroded if it were directly exposed to water.

[0002] The base of the cladding elements is usually configured such that a certain percentage of open spaces are left between adjacent bases, so that water which has entered the control structure body is able to escape without the cladding being forced upwards from below as a result of water pressure. These open spaces may comprise a filling of, for example, hard core or gravel. This hard core results in the cladding elements performing a clamping action on each other. As a result thereof, the stability of the layer of cladding elements is increased, while the water-permeability is maintained. The upper side of the cladding elements has a shape which is adapted to the circumstances determined by the body of water, and may, for example, in particular be suitable for dissipating wave energy.

[0003] Water-control structures may be configured in various ways. By way of example, water-control structures whose free surface is formed by the top of the cladding elements are mentioned. Other water-control structures have a soil layer which determines the top surface. In the latter cases, it is very important that this soil layer is securely anchored with respect to the control structure body. It is an object of the invention to provide an improved stabilizing action for this latter type of water-control structures.

[0004] This object is achieved by a water-control structure according to claim 1. With the water-control structure according to the invention, the covering layer, such as a soil layer, is stabilized by the fact that it is anchored on the underside by means of the projections of the cladding elements which protrude therein. As a result thereof, the covering layer is securely fixed, even when it is subjected to the effects of water currents, waves and the like. It is not readily possible to make the complete covering layer slide with the water, not even as a result of the inclined position which the soil layer often has. This retaining effect is partly due to the projections each being embedded

in the covering layer around the entire periphery thereof. According to the invention, the cladding elements are configured such that they have one and only one projection which is upright with respect to the base. As a result thereof, the production is facilitated. The projections are embedded in the soil layer on all sides, thus ensuring a good retaining action on the soil layer. In this connection, each projection is according to the invention at a distance from every other projection and does not touch any other projection.

[0005] The cladding elements with covering layer may be situated on the side which faces the body of water, and/or on the side which faces away from the body of water. In the latter case, the covering layer also offers protection against water which swaps over the water-control structure. Usually, this leads to the unprotected covering layer, such as a soil layer, being washed away, resulting in a weakening of the water-control structure from the rear and consequently giving way. However, due to the stabilizing action of the cladding elements according to the invention, crumbling can be prevented.

[0006] Preferably, the cladding consisting of adjacent cladding elements and/or adjacent damping elements extends across the crown of the control structure body and across at least one side in an uninterrupted manner. Preferably, the cladding extends across both sides and the crown in an uninterrupted manner. Such a continuous cladding has various advantages. Firstly, such a cladding forms a skin which stabilizes the climate in the dike. As a result thereof, the control structure body is prevented from becoming too wet in the winter and too dry in the summer. This stabilizing effect is particularly important in the case of peat dikes, since the formation of cracks due to the control structure body drying out can thereby also be prevented. It is found that, in practice, problems occur mainly in the locations at the transitions in the cladding. This may affect transitions between surfaces which are arranged at different angles, such as from oblique to horizontal, with stepped transitions and the like. Due to the locally higher flow rates, these transitions may suffer from weakening phenomena. By means of a continuous cladding consisting of closely adjoining cladding elements, such phenomena can be prevented. The cladding element may be configured in different ways. For example, the base may have an approximately substantially square periphery. According to the invention, the sides of the base are convexly curved and adjoin one another via an obtuse internal angle. In other words, the cladding element has a basic shape which is square, with the sides of the base being slightly convexly curved to the outside. Due to these slightly convexly shaped sides, adjacent cladding elements only contact one another to a limited degree and mutually enclose open spaces. As has already been mentioned, these open spaces may contain gravel or hard core which promotes the mutual retaining action of the cladding elements. Such a series of adjacent cladding elements has an acceptable percentage of open spaces, so that no great water pressures can occur un-

derneath the cladding.

[0007] In a further advantageous embodiment, the sides of the base are directed obliquely towards one another, in an upward direction. For example, the cross section of the base in the upward direction may decrease monotonously up to and including the attachment of the projection at the base. Hard core can be dumped in the gaps which are thus created between the bases of the cladding elements, and exert a clamping action and consequently a retaining action on the cladding elements.

[0008] The projection may have different shapes; thus, the cross section of the projection may be circular. Alternatively, the cross section of the projection may be approximately square, but other shapes, such as triangular, are also possible. Furthermore, the surface of the cross section of the projection may decrease in the upward direction. As a result thereof, the soil layer can penetrate well up to and around the cladding elements. In this connection, the surface of the top of the projection may be smaller than any cross section of the projection; optionally, the cross section of the projection in the upward direction may decrease monotonously up to and including the top.

[0009] The above-described water-control structure offers a multiple, fail-safe protection. This is the result of the construction which consists of, successively, the cladding elements, the soil layer dumped on top thereof and the grass layer, which together form a continuous top layer. This top layer provides the desired water-control properties. However, if the grass layer were to be washed away for some reason, followed by the soil layer, the layer of cladding elements still offers stable protection. As a result thereof, the control structure body remains protected against attacks by water sweeping over the dike.

[0010] Finally, the invention relates to a cladding element for a water-control structure as described above, comprising a base and one and only one projection which is upright with respect to the base, wherein the surface of the cross section of the projection decreases in the upward direction up to the top of the projection. Such a cladding element is preferably made of concrete. The shape of the cladding element is preferably detachable, that is to say that the cladding element which is produced in a mould can be removed from said mould in one piece. This can be achieved if the cross section of the projection decreases monotonously from the base in the upward direction up to the top of the projection. The base itself may likewise have such a detachable shape.

[0011] The invention will now be explained in more detail by means of exemplary embodiments which are illustrated in the figures, in which:

Fig. 1 shows a longitudinal section through a dike.

Fig. 2 shows an enlarged view of the longitudinal section from Fig. 1.

Fig. 3 shows a perspective view of a section of the dike with the soil layer partly removed.

Fig. 4 shows a first variant of the cladding elements in perspective.

Fig. 5 shows a second variant of the cladding elements in perspective.

Fig. 6 shows a second embodiment of a dike.

Fig. 7 shows a third embodiment of a dike.

[0012] The water-control structure illustrated in Figs. 1 and 2 consists of the control structure body 1, made of for example sand, clay and the like, and the cladding 2. This cladding 2 in turn consists of the cladding elements 3, as illustrated on a larger scale in Fig. 2, with the soil layer 4 on top. This soil layer may be covered with grass 5. The water-control structure has a side 10 which faces a body of water 12 and a side 11 which faces away from the latter.

[0013] The cladding elements 3 each consist of a base 6 and a projection 7 which is vertical with respect to the base, as is also shown in perspective in Figs. 3 and 4. The projection 7 has smaller cross sections than the base 6; as a result of which there is a leap in the cross sections of the cladding element 3 at the transition between the projection and the base. In the embodiment of these Figs. 3 and 4, the projection 7 has circular cross sections whose radius becomes increasingly smaller from the base 6. As a result thereof, the soil layer 4 can readily penetrate as far as between the projections 7. The roots 19 of the grass 5 could also penetrate between the projections 7 and also between the bases 6 of the cladding elements 3 as far as into the control structure body 1, which is advantageous for the stability of the cladding 2. In the variant from Fig. 4, the projections 7 have circular cross sections. The gaps between the cladding elements taper upwardly, although this cannot be seen in Figs. 3-5.

[0014] The base 6 of the cladding elements 3 has sides 8 which are curved slightly convexly, so that gaps 9 between adjacent sides 8 of neighbouring cladding elements 3 are prevented. Furthermore, the sides may recede slightly in the upward direction, so that the gaps between the sides 8 of neighbouring cladding elements 3 taper downwardly in the shape of a wedge. By introducing hard core 13 in the form of fine granular material into these gaps, the stability of the cladding layer is greatly improved due to mutual clamping of the cladding elements. In addition, the water-permeability is maintained due to the gaps, so that a build-up of pressure from water behind the cladding elements is prevented or limited. This also has an advantageous effect on the stability of the layer of cladding elements 3.

[0015] Fig. 6 shows a further possible embodiment of a dike, in which cladding 2 comprising cladding elements 3 with a soil layer 4 on top is only present on the side facing the body of water 12. This cladding 2 is only provided in the area which is influenced by the body of water 12. The other parts of the dike are constructed in a traditional style.

[0016] Fig. 7 shows a dike which is provided with the cladding elements 6 according to the invention on the

side 11 facing away from the body of water. These cladding elements retain the soil layer 4, even if water were to pour over the dike. On the side 10 facing the body of water damping elements 15 are provided, each consisting of a base 6, a neck 16 and a head 17. These damping elements 15 are suitable for damping the waves to which the dike is exposed. The water which strikes the side 10 of the dike is tempered in the damping spaces 14 which are situated between the heads 17 and necks 16 of the damping elements 15.

List of reference numerals

[0017]

1. Control structure body
2. Cladding
3. Cladding element
4. Soil layer
5. Grass layer
6. Base
7. Projection
8. Side
9. Gap
10. Side
11. Side
12. Body of water
13. Hard core
14. Damping space
15. Damping element
16. Neck
17. Head
18. Crown
19. Root

Claims

1. Water-control structure, comprising a control structure body (1) which is exposed, at least on one side (10, 11), to the effects of a body of water (12), and adjacent cladding elements (3) which cover the control structure body (1) and which each comprise a base (6), and adjacent bases (6) of the cladding elements (3) between themselves define passages for allowing water through, wherein the adjacent cladding have projections (7), wherein the cladding elements (3) are covered by a covering layer (5) which is provided between and above the projections (7), **characterized in that** the sides (8) of the base (6) are convexly curved and adjoin one another via an obtuse internal angle, **in that** the cladding elements (3) have one and only one free projection (7) which is upright with respect to the base (6), **in that** each projection (7) is situated at a distance from every other projection (7) and does not touch any other projection (7) and **in that** the projections (7) are each embedded in the covering layer (5) around the entire

periphery thereof.

2. Water-control structure according to Claim 1, wherein a side (10) which is provided with cladding elements (3) faces the body of water (12).
3. Water-control structure according to one of the preceding claims, wherein a side (11) which is provided with cladding elements (3) faces away from the body of water (12).
4. Water-control structure according to one of the preceding claims, wherein the base (6) has an approximately substantially square periphery.
5. Water-control structure according to one of the preceding claims, wherein the sides (8) of the base (6) are directed obliquely towards one another, in an upward direction.
6. Water-control structure according to one of the preceding claims, wherein the cross section of the projection (7) is circular.
7. Water-control structure according to one of Claims 1-5, wherein the cross section of the projection (7) is approximately square.
8. Water-control structure according to one of the preceding claims, wherein the surface 5 of the cross section of the projection (7) decreases in the upward direction.
9. Water-control structure according to one of the preceding claims, wherein the surface of the top of the projection (7) is smaller than the cross section of the projection which adjoins the base (6) and is preferably smaller than any cross section of the projection.
10. Water-control structure according to one of the preceding claims, wherein the cross section of the projection (7) decreases monotonously in the upward direction up to and including the top.
11. Water-control structure according to one of the preceding claims, wherein the cross section of the base (6) decreases monotonously in the upward direction up to and including the attachment of the projection (7) at the base.
12. Water-control structure according to one of the preceding claims, wherein the control structure body (1) has a side (10) which faces the body of water (12) and a side (11) which faces away from the body of water.
13. Water-control structure according to Claim 12, wherein the side (11) facing away from the body of

water (12) is provided with the cladding elements (3) and the side (10) facing the body of water is provided with damping elements (15).

14. Water-control structure according to one of the preceding claims, wherein the control structure body (1) is covered with cladding (2) consisting of adjacent cladding elements (3) and/or adjacent damping elements (15), which cladding (2) extends across the crown (18) of the control structure body (1) and at least one side (10, 11) in an uninterrupted manner.
15. Water-control structure according to Claim 14 where dependent on Claims 2 and 3, wherein the cladding (2) from adjacent cladding elements (3) and/or adjacent damping elements (15) extends across the crown (18) and both sides (10, 11) in an uninterrupted manner.

Patentansprüche

1. Wasserregelungsstruktur, umfassend einen Regelungsstrukturkörper (1), der auf mindestens einer Seite (10, 11) den Auswirkungen einer Wassermasse (12) ausgesetzt ist, und angrenzende Verkleidungselemente (3), die den Regelungsstrukturkörper (1) bedecken, und die jeweils eine Basis (6) umfassen, und angrenzende Basen (6) der Verkleidungselemente (3) zwischen sich definieren Durchgänge zum Durchlassen von Wasser, wobei die angrenzenden Verkleidungen Vorsprünge (7) aufweisen, wobei die Verkleidungselemente (3) mit einer Abdeckungsschicht (5) bedeckt sind, die zwischen und über den Vorsprüngen (7) bereitgestellt ist, **dadurch gekennzeichnet, dass** die Seiten (8) der Basis (6) konvex gebogen sind und unter einem stumpfen Winkel nach innen aufeinandertreffen, dadurch, dass die Verkleidungselemente (3) einen einzigen und nur einen freien Vorsprung (7) aufweisen, der im Verhältnis zu der Basis (6) aufrecht ist, dadurch, dass sich jeder Vorsprung (7) in einer Entfernung von jedem anderen Vorsprung befindet und mit keinem anderen Vorsprung (7) in Kontakt ist, und dadurch, dass die Vorsprünge (7) jeweils in die Abdeckungsschicht (5) um die gesamte Peripherie herum davon eingebettet sind.
2. Wasserregelungsstruktur nach Anspruch 1, wobei eine mit Verkleidungselementen (3) versehene Seite (10) zu dem Wassermasse (12) zugewandt ist.
3. Wasserregelungsstruktur nach einem der vorhergehenden Ansprüche, wobei eine mit Verkleidungselementen (3) versehene Seite (11) vom Wassermasse (12) abgewandt ist.
4. Wasserregelungsstruktur nach einem der vorherge-

henden Ansprüche, wobei die Basis (6) eine ungefähr im Wesentlichen quadratische Peripherie aufweist.

5. Wasserregelungsstruktur nach einem der vorhergehenden Ansprüche, wobei die Seiten (8) der Basis (6) schräg zueinander in einer Aufwärtsrichtung gerichtet sind.
6. Wasserregelungsstruktur nach einem der vorhergehenden Ansprüche, wobei der Querschnitt des Vorsprungs (7) kreisförmig ist.
7. Wasserregelungsstruktur nach einem der Ansprüche 1 bis 5, wobei der Querschnitt des Vorsprungs (7) ungefähr quadratisch ist.
8. Wasserregelungsstruktur nach einem der vorhergehenden Ansprüche, wobei die Oberfläche (5) des Querschnitts des Vorsprungs (7) in die Aufwärtsrichtung abnimmt.
9. Wasserregelungsstruktur nach einem der vorhergehenden Ansprüche, wobei die Oberfläche der Oberseite des Vorsprungs (7) kleiner als der Querschnitt des Vorsprungs ist, der an die Basis (6) angrenzt und vorzugsweise kleiner als jeder Querschnitt des Vorsprungs ist.
10. Wasserregelungsstruktur nach einem der vorhergehenden Ansprüche, wobei der Querschnitt des Vorsprungs (7) monoton in die Aufwärtsrichtung bis zu und einschließlich der Oberseite abnimmt.
11. Wasserregelungsstruktur nach einem der vorhergehenden Ansprüche, wobei der Querschnitt der Basis (6) monoton in die Aufwärtsrichtung bis zu und einschließlich der Befestigung des Vorsprungs (7) an der Basis abnimmt.
12. Wasserregelungsstruktur nach einem der vorhergehenden Ansprüche, wobei der Regelungsstrukturkörper (1) eine dem Wassermasse (12) zugewandte Seite (10) und eine dem Wassermasse (12) abgewandte Seite (11) aufweist.
13. Wasserregelungsstruktur nach Anspruch 12, wobei die von dem Wassermasse (12) abgewandte Seite (11), mit den Verkleidungselementen (3) versehen ist und die dem Wassermasse zugewandte Seite (10) mit Dämpfungselementen (15) versehen sind.
14. Wasserregelungsstruktur nach einem der vorhergehenden Ansprüche, wobei der Regelungsstrukturkörper (1) mit Verkleidung (2) bedeckt ist, die aus angrenzenden Verkleidungselementen (3) und/oder angrenzenden Dämpfungselementen (15) besteht, wobei sich die Verkleidung (2) über die Krone (15)

des Regelungsstrukturkörpers (1) und mindestens eine Seite (10, 11) auf ununterbrochene Weise erstreckt.

15. Wasserregelungsstruktur nach Anspruch 14, wenn er von den Ansprüchen 2 und 3 abhängt, wobei sich die Verkleidung (2) von angrenzenden Verkleidungselementen (3) und/oder Dämpfungselementen (15) über die Krone (18) und beide Seiten (10, 11) auf ununterbrochene Weise erstreckt.

Revendications

1. Structure de maîtrise de l'eau, comprenant un corps de structure de maîtrise (1) qui est exposé, au moins d'un côté (10, 11), aux effets d'une masse d'eau (12), et des éléments de parement (3) adjacents qui recouvrent le corps de structure de maîtrise (1) et qui comprennent chacun une base (6), et les bases (6) adjacentes des éléments de parement (3) entre elles définissent des passages pour permettre le passage d'eau à travers ceux-ci, dans laquelle les parements adjacents comprennent des protubérances (7), dans laquelle les éléments de parement (3) sont recouverts d'une couche de recouvrement (5) qui est prévue entre les protubérances (7) et au-dessus de celles-ci, **caractérisée en ce que** les côtés (8) de la base (6) sont incurvés de manière convexe et sont adjacents l'un à l'autre par un angle interne obtus, **en ce que** les éléments de parement (3) ont une seule et unique protubérance libre (7) qui est verticale par rapport à la base (6), **en ce que** chaque protubérance (7) est située à distance de chacune des autres protubérances (7) et n'est en contact avec aucune autre protubérance (7), et **en ce que** les protubérances (7) sont intégrées chacune dans la couche de recouvrement (5) autour de leur périphérie entière.
2. Structure de maîtrise de l'eau selon la revendication 1, dans laquelle un côté (10) qui est pourvu d'éléments de parement (3) est orienté vers la masse d'eau (12).
3. Structure de maîtrise de l'eau selon l'une des revendications précédentes, dans laquelle un côté (11) qui est pourvu d'éléments de parement (3) est orienté à l'opposé de la masse d'eau (12).
4. Structure de maîtrise de l'eau selon l'une des revendications précédentes, dans laquelle la base (6) a une périphérie à peu près sensiblement carrée.
5. Structure de maîtrise de l'eau selon l'une des revendications précédentes, dans laquelle les côtés (8) de la base (6) sont dirigés obliquement les uns vers les autres, dans une direction vers le haut.

6. Structure de maîtrise de l'eau selon l'une des revendications précédentes, dans laquelle la section transversale de la protubérance (7) est circulaire.
7. Structure de maîtrise de l'eau selon l'une des revendications 1 à 5, dans laquelle la section transversale de la protubérance (7) est à peu près carrée.
8. Structure de maîtrise de l'eau selon l'une des revendications précédentes, dans laquelle la surface (5) de la section transversale de la protubérance (7) diminue dans la direction vers le haut.
9. Structure de maîtrise de l'eau selon l'une des revendications précédentes, dans laquelle la surface du sommet de la protubérance (7) est plus petite que la section transversale de la protubérance qui est contiguë à la base (6) et est de préférence plus petite que n'importe quelle section transversale de la protubérance.
10. Structure de maîtrise de l'eau selon l'une des revendications précédentes, dans laquelle la section transversale de la protubérance (7) diminue de façon monotone dans la direction vers le haut jusqu'à et y compris le sommet.
11. Structure de maîtrise de l'eau selon l'une des revendications précédentes, dans laquelle la section transversale de la base (6) diminue de façon monotone dans la direction vers le haut jusqu'à et y compris la fixation de la protubérance (7) au niveau de la base.
12. Structure de maîtrise de l'eau selon l'une des revendications précédentes, dans laquelle le corps de structure de maîtrise (1) a un côté (10) qui est orienté vers la masse d'eau (12) et un côté (11) qui est orienté à l'opposé de la masse d'eau.
13. Structure de maîtrise de l'eau selon la revendication 12, dans laquelle le côté (11) orienté à l'opposé de la masse d'eau (12) est pourvu des éléments de parement (3) et le côté (10) orienté vers la masse d'eau est pourvu d'éléments d'amortissement (15).
14. Structure de maîtrise de l'eau selon l'une des revendications précédentes, dans laquelle le corps de structure de maîtrise (1) est recouvert d'un parement (2) consistant en des éléments de parement (3) adjacents et/ou des éléments d'amortissement (15) adjacents, lequel parement (2) s'étend sur la couronne (18) du corps de structure de maîtrise (1) et au moins un côté (10, 11) d'une manière ininterrompue.
15. Structure de maîtrise de l'eau selon la revendication 14 lorsqu'elle dépend des revendications 2 et 3, dans laquelle le parement (2) des éléments de parement

(3) adjacents et/ou des éléments d'amortissement
(15) adjacents s'étend sur la couronne (18) et les
deux côtés (10, 11) d'une manière ininterrompue.

5

10

15

20

25

30

35

40

45

50

55

Fig. 1

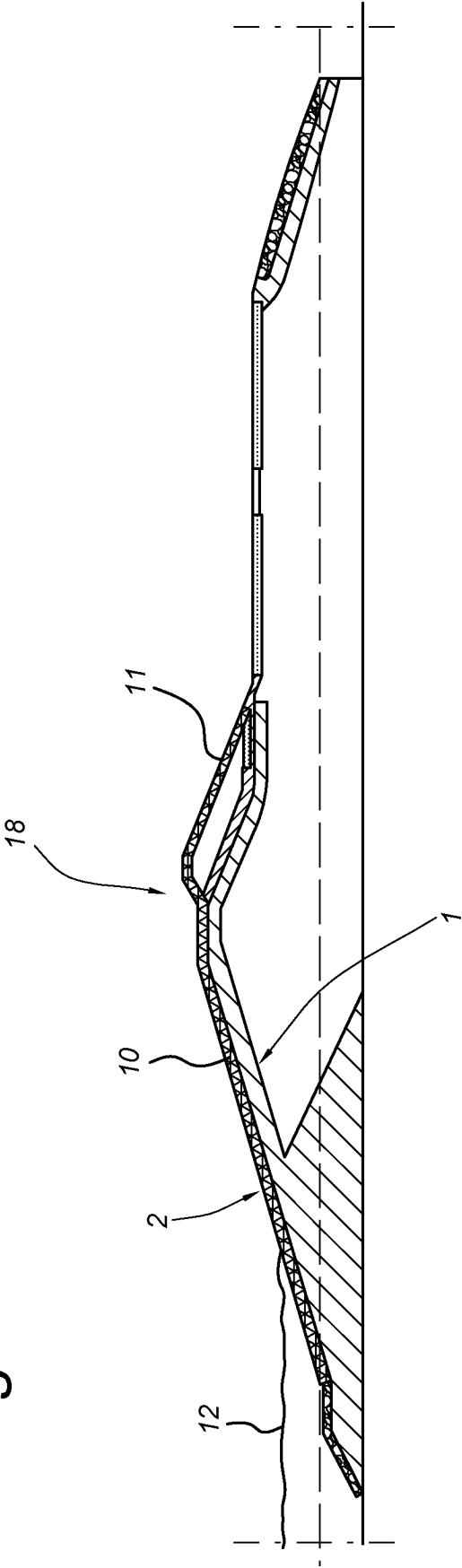


Fig. 2

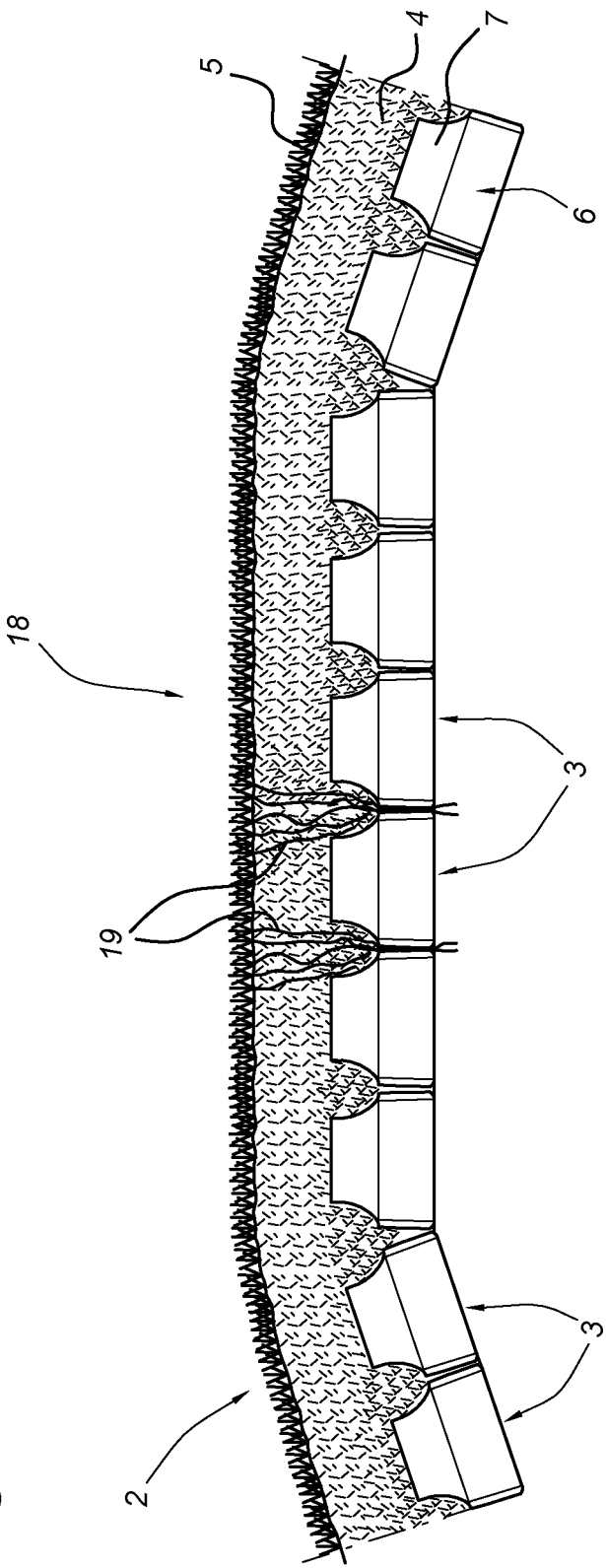


Fig. 3

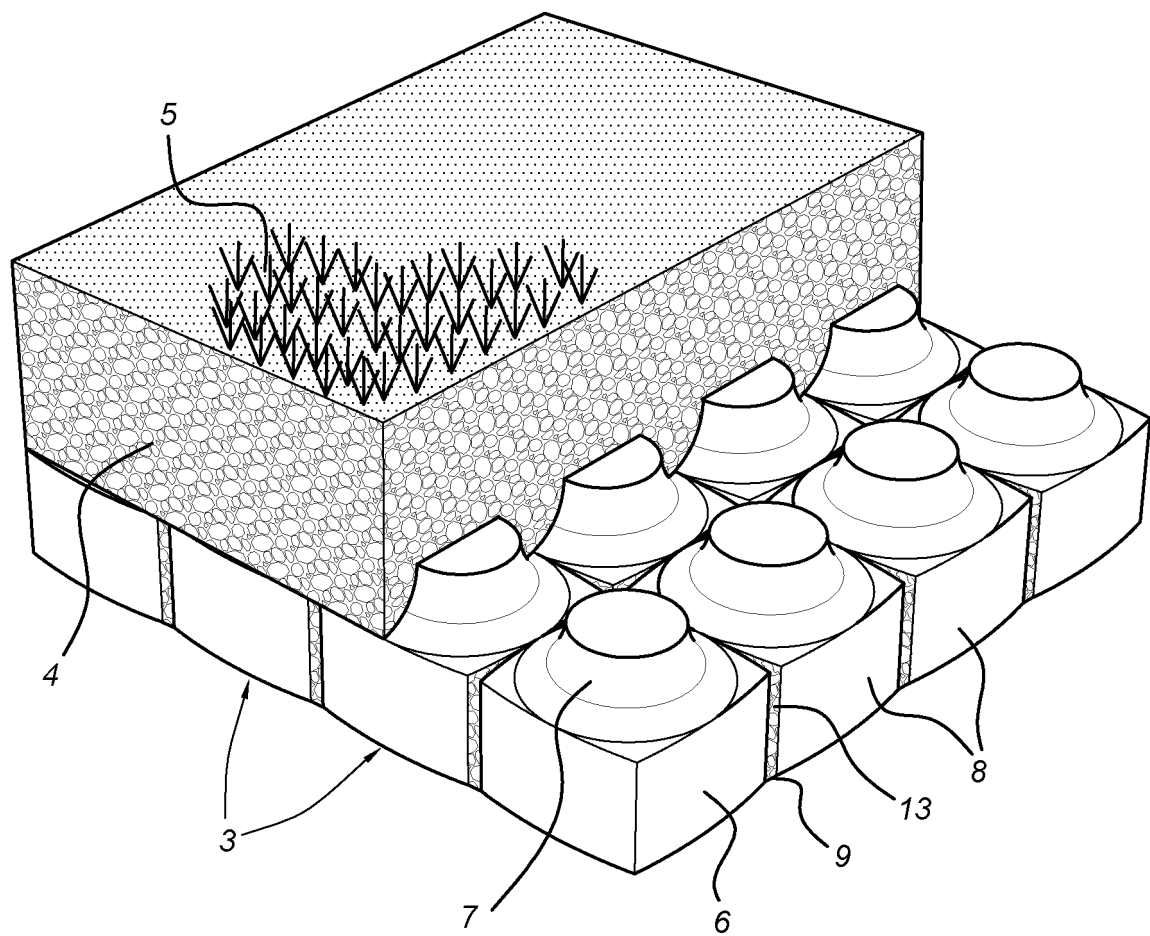


Fig. 4

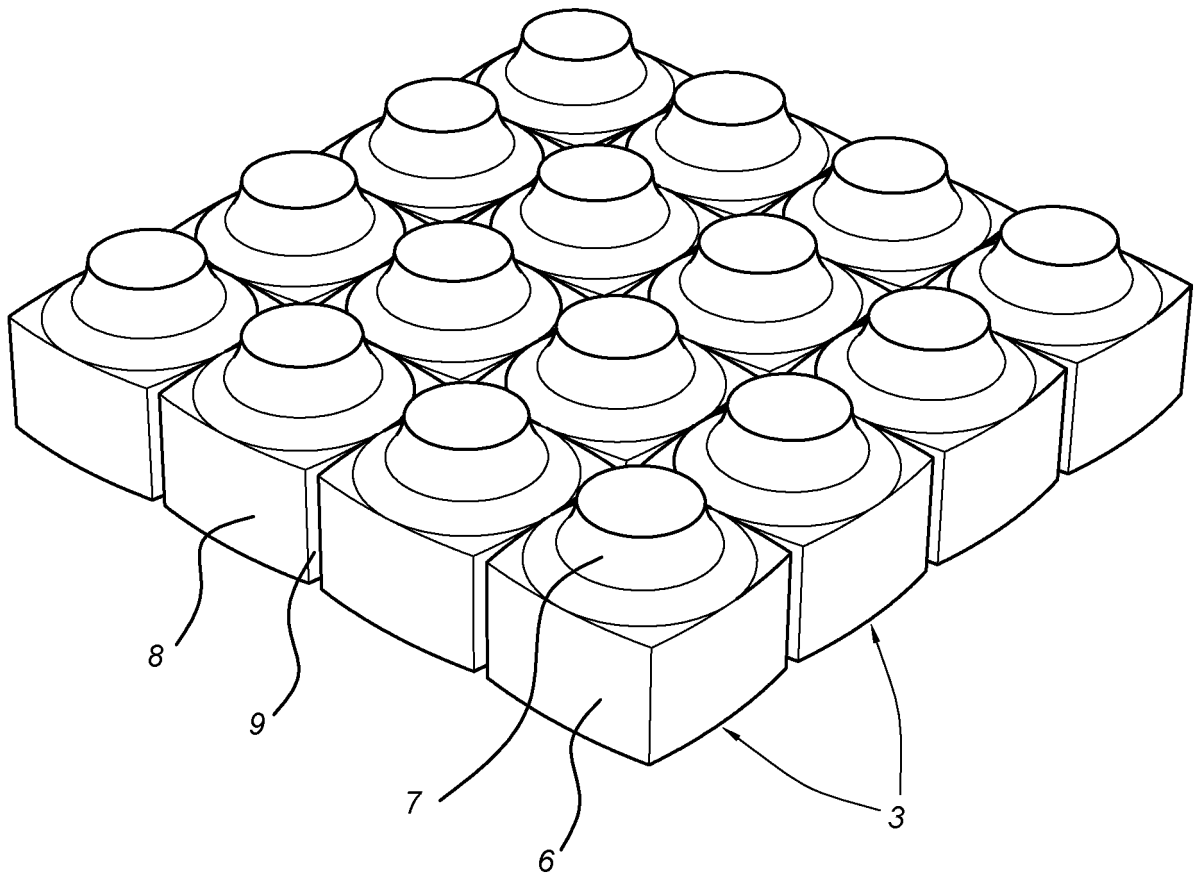


Fig. 5

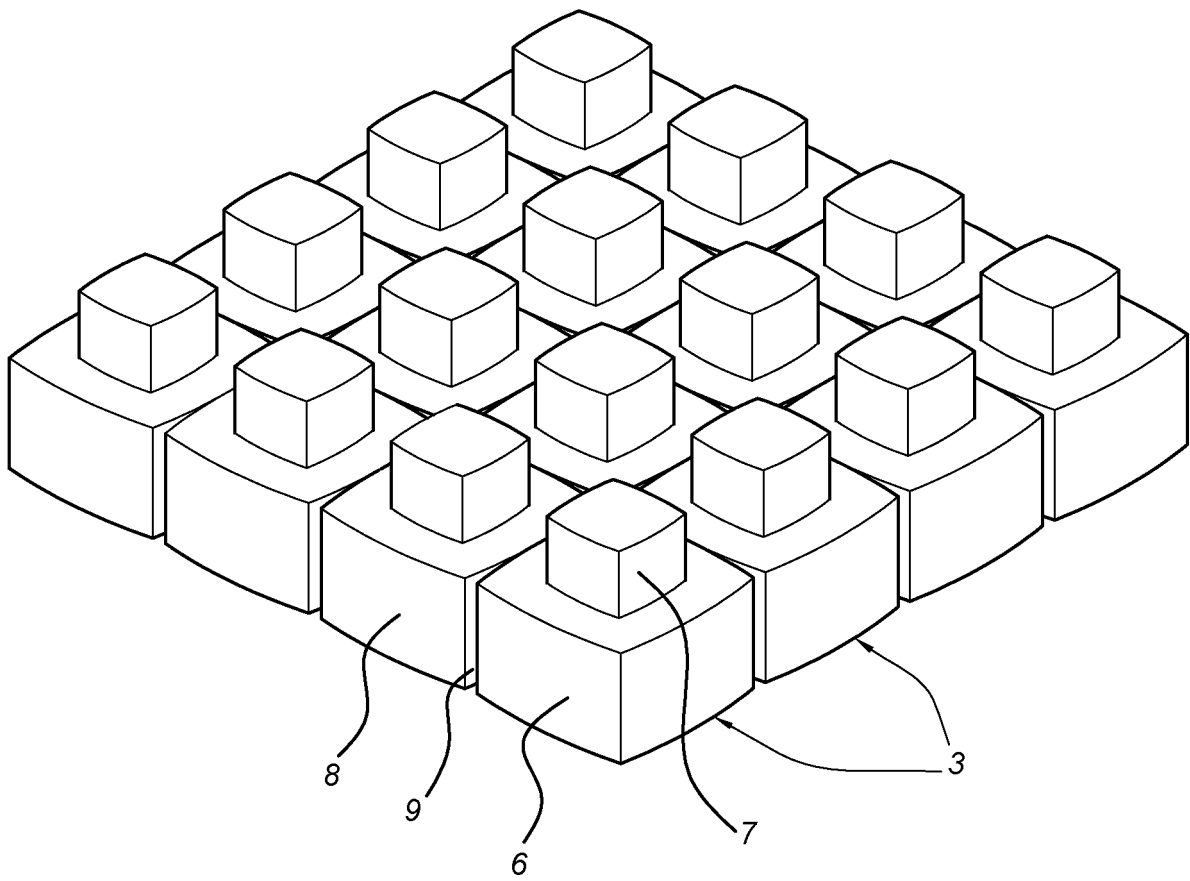


Fig. 6

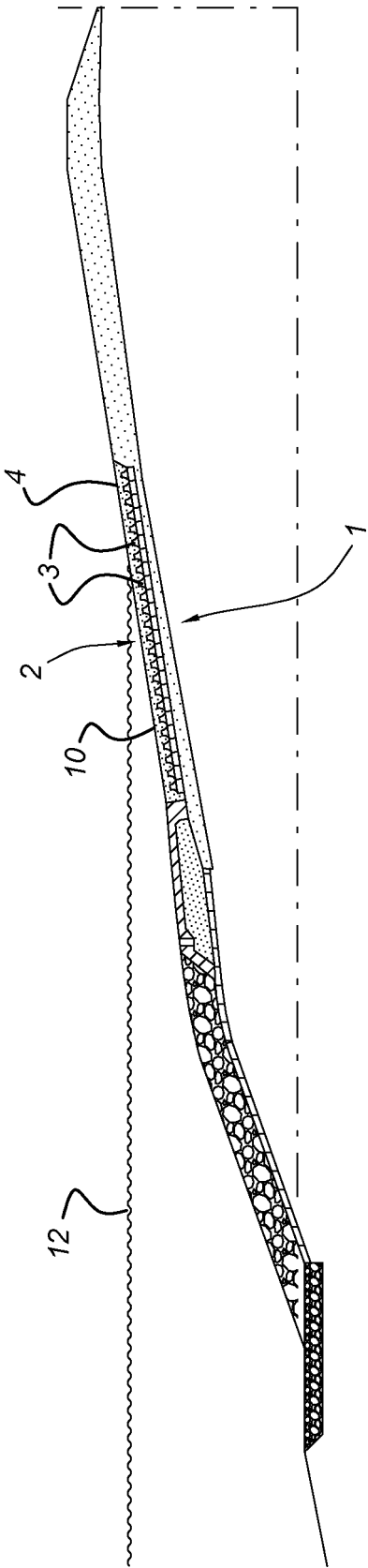
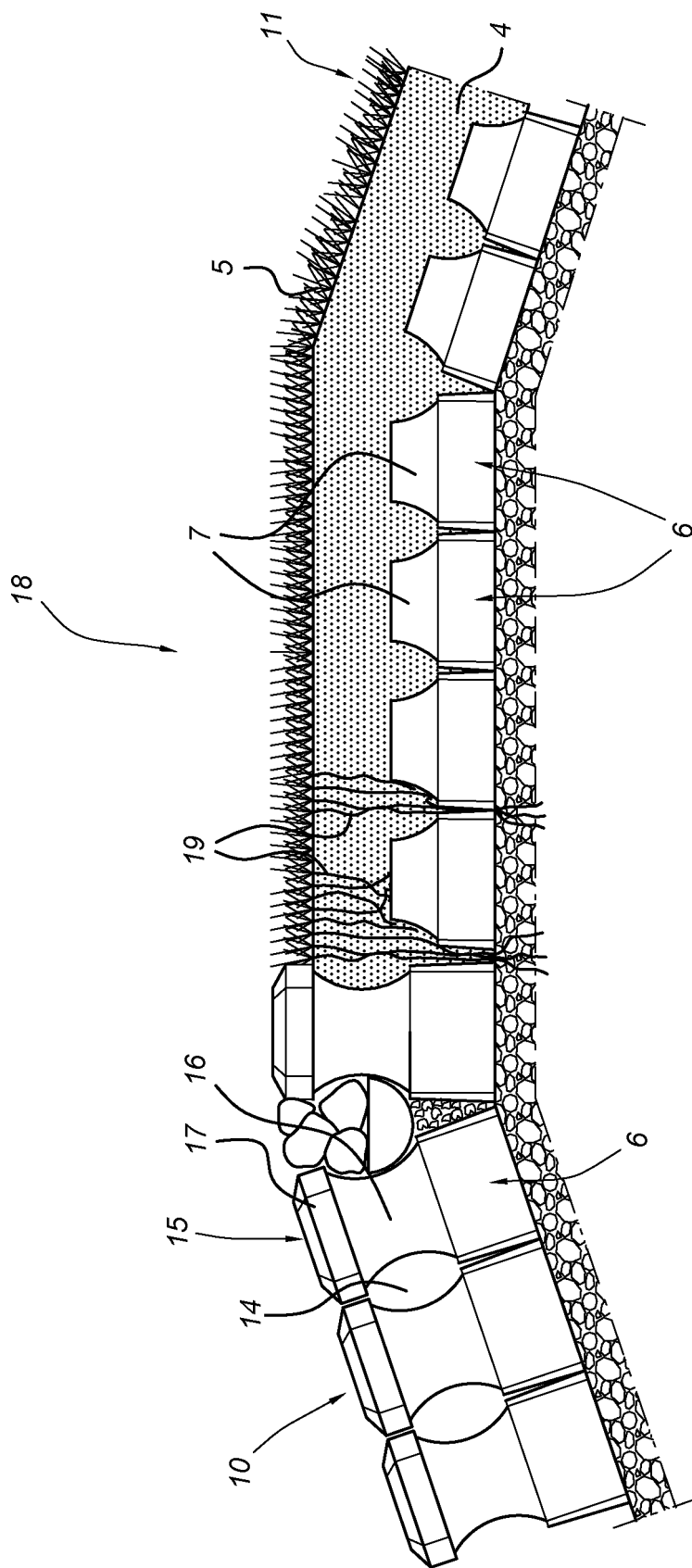


Fig. 7



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 2002154950 A [0001]