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(54) **Improved element for bank protection**

Verbessertes Element zur Verwendung als Böschungssicherung

Elément amélioré pour protection des berges

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## Description

**[0001]** The invention relates to an element for a bank/shore protection, as well as to a covering built up from such elements.

**[0002]** Such elements and coverings are generally known. An example is the covering with basalt blocks or basalt columns, that are placed flat on a sub-base or filter layer of granular material. Said filter layer or sub-base itself lies on a filtering geotextile. In a comparable arrangement concrete elements, such as those available under the brand names Basalton and Hydroblock, are also used instead of basalt blocks or basalt columns.

**[0003]** From NL-A- 75.03285 a concrete column-shaped covering element, having an irregular cross-section, is known.

**[0004]** From NL-C- 1003138 a covering element is known that is provided with a concave side and a convex side opposite it. The convex side of the one element fits in the concave side of a next element. The concave and the convex sides are rotatable with respect to each other so as to follow a curve in the slope. The convex side is furthermore provided with a vertical continuous cavity for water discharge.

**[0005]** With the known covering elements one has to work in an accurate and calculated manner when traversing the curve in the route to be covered. The possibilities for a fluent course in a curve are limited. Fitting difficulties can moreover be experienced in curves with the elements according to aforementioned Dutch patent.

**[0006]** With coverings of the above-mentioned types, slopes of banks and dikes are protected against wave attacks, but the lifting powers exerted by the water in the bank or dike body on the separate elements are a source of concern. According to an approach the weight of the elements is provided with continuous horizontal holes for passage of securing cables. However, this has the drawback of additional parts, which render the covering per se rather costly, and requires additional labour as well.

**[0007]** In another approach the weight of the elements is chosen to be high. This has the drawback of rather a lot of concrete is necessary, and that per unit of surface a large mass has to be supplied and placed.

**[0008]** In order to provide a covering element with which at least some of the afore mentioned points are improved upon and with which a regular and limited permeability of the covering is realised in a simple manner, retaining the strength of the covering element and with improved laying possibilities, FR-A-2 252 451 provides an element for a bank/shore or dike covering intended to form a top covering layer in a bank/shore or dike protection structure with several identical elements, which element comprises an at upper side, a lower side and a circumferential side, the element, considered in a plane of cross section parallel to the lower side, having the shape of a regular or substantially regular hexagon and having six circumferential planes, being at least partly provided with an inward recess extending from the lower

side to at least near the upper side.

**[0009]** In order to improve the drainage of water from the cavities between the elements, the invention provides an element of the type described in the previous paragraph, which is characterized in that the recess is obtained by forming the surface of said circumferential plane concave; said circumferential planes are only alternately provided with an inward recess; and the lower side is provided with at least one slot which at one end ends in a circumferential plane heaving an inward recess, and the upper side being at least substantially closed.

**[0010]** The elements according to the invention can be fitted into each other or placed against each other in several directions, as a result of which it is easy to make a curve or angle in the slope covering. When placing one only needs to make sure that a flat circumferential plane of the next element at all time lies against a circumferential plane having a recess of the one element. Thus a regularly distributed pattern of drain apertures is provided in a simple manner. By alternately arranging the recesses they can acquire a reasonable cross-section, without the percentage of surface of drain apertures becoming too large. A percentage of approximately 8-15% of the total surface is recommended. Because of the limitation of the position or the recesses with respect to circumferential planes the strength of the covering elements is not reduced. The drain apertures formed in bond are also divers in orientation. The recesses are furthermore an aid when picking up the elements with a tool, the gripping members of said tool being able to extend into or through the recesses.

**[0011]** After placing on a slope, the slot or recess -preferably semicircular in cross-section- in the lower side of the element forms a horizontal or sideward channel for water, parallel to the water line, as a result of which the water is able to move sideward more quickly than through the sub-base. As a result the water in the bank or dike body is able to follow the retreating water on the slope more quickly, as a result of which pressure differences over the covering are reduced. An additional advantage of this is that the elements can be less heavy, which results in a considerable reduction of material and transport costs, as well as placing costs. The slot in the lower side limits the supporting surface of the element, as a result of which it will adapt to the substratum sooner. Subsides in the substratum will become obvious sooner because an element situated on top of it will come to lie recessed with respect to the adjacent elements. Because of the direction of the slots on the slope no erosion of the sub-base will occur at that location.

**[0012]** In case the usual slot between two adjacent elements has become clogged up, for instance with clay, the water is able to quickly flow sideward in order to then come out via the next slot.

**[0013]** Preferably the slot is straight, and preferably has a width of the order of magnitude of the width of the inward recess.

**[0014]** It is noted that in the aforementioned NL-A-

75.03285 it is suggested to provide the upper end of the concrete elements shown in there with bevelled planes, by arranging a square upper surface, the vertices of which coinciding with the gentle corners in the cross-section of the octagonal circumferential side.

**[0015]** In the embodiment having recesses in the circumferential side it may be advantageous that the upper surface extends radially past the recesses with one or more vertices, as a result of which not only inclined planes are offered to the water flowing over the elements, but also vertical striking planes in between them, that also form an entrance to a vertical channel, formed by the recess. The energy dissipating capacity of the covering is thus further increased.

**[0016]** In a further preferred embodiment of the covering element according to the invention the circumferential side, near the lower side at the location of the corners is provided with spacing cams, preferably running around the corner in question. As a result the upper surface is given a large openness in a simple manner, which openness might be useful when washing in grit.

**[0017]** Preferably the spacing cams on both sides of the angle are upwardly continued in column-shaped cams, defining a recess in between them. Said blind preferably slightly tapering recesses may get filled up with washed-in grit, the interaction between grit and elements being able to realise a clamping-in.

**[0018]** The column-shaped cams preferably end at a distance from the upper side, in order to define an increased space for grit above it.

**[0019]** From a further aspect the invention provides a covering for protection of a bank or dike, comprising a substratum of water-permeable material and a layer of elements according to the invention placed on it.

**[0020]** From yet a further aspect the invention provides a covering for protection of a bank or dike, comprising a substratum of water-permeable material and a layer of elements according to the invention placed on it, the covering elements defining in between them at least locally slightly in downward direction tapering preferably almost blind accommodation spaces, which have been washed in with grit for forming clamping connections between the covering elements.

**[0021]** The invention will be elucidated on the basis of an exemplary embodiment shown in the attached in drawings, in which:

Figure 1 shows a first possible embodiment of a covering element according to the invention;

Figure 2 shows a cross-section of the covering element of figure 1;

Figure 3 shows a top view of a covering of a slope with covering elements of figure 1;

Figures 4A-C show a second embodiment of a covering element according to the invention, in perspec-

tive view in a group, in top view and in side view;

Figure 5 shows a number of covering elements according to figures 5A-C placed in bond, seen from above;

Figures 6A-C show some cross-sections of a group of covering elements, along planes parallel to their lower planes, at different heights; and

Figure 7 shows a vertical cross-section of an arrangement with covering elements of figures 5A-C on a slope.

**[0022]** In figure 1 a concrete covering element 2 is shown, which has the shape of a regular hexagon, having circumferential planes 7a - f, the circumferential planes or side planes of which 7a, 7c and 7e being entirely flat and the circumferential planes 7b, 7d and 7f being provided with a gentle cavity continuing over the entire height, bounded by concave surface 8. Near the vertices the concave surface changes into flat portions 10, in which at the location of the transition placing cams 9, the size of some millimetres, have been provided. In figure 2 this is further elucidated. It can be seen that the concave surface 8 extends from the lower side 5 up to the upper side 6 of the element 2.

**[0023]** The element as shown in figure 1 can be placed in a simple manner in a covering as shown. In figure 3, a slope covering 1 is shown, having concrete elements 2. Because of their hexagonal shape, the elements 2 can be placed against each other in six directions, as a result of which after laying in direction A, laying can easily take place in the direction B or the direction C, or D by way of example.

**[0024]** For obtaining straight edges use can be made of confining elements 3 and 4, which correspond to half an element 2, or according to middle intersecting planes respectively, that are perpendicular one to the other, the adjacent elements 2 each time being rotated over one side with respect to each other, so that each element 2 on all sides has a continuous slot 11, as a result of which a good permeability, regularly distributed over the covering is obtained. The fit of the regular polygons is here maintained because the corner areas are adjacent to a recess and define the circumference/outermost form of the element in accordance with the invention.

**[0025]** The largest dimension of the slot 11 is 5 cm, in accordance with the standards prevailing in the Netherlands. 10 to 30 stones per m<sup>2</sup> can be placed here, with 8 - 15 % open spaces, the height of the elements being 12 to 50 cm. The elements 2 taper slightly upwards, as shown in figure 2.

**[0026]** As shown in figures 1 and 2 one or more slots 12a, b can be provided in the lower surface 5, which slots extend from the one circumferential plane to the other circumferential plane, each time from, as considered in horizontal direction, the centre of the side or circumfer-

ential plane in question. As a result, in the pattern of figure 3, continuous water guiding slots can be realised in the lower side of the covering, the slot 12a then each time extending between the edges of the planes 7a and 7b and connecting to the slot 11 formed near the planes 7d or 7b of the next element 2.

**[0027]** The concrete covering element 32 in figures 4A-C and 6 has a cross-section with a substantially regular hexagonal shape, the circumferential planes 37a, c, e again being flat and the circumferential planes 37b, d, f being provided with a recess 38 extending over the entire height. In the flat lower surface 35 a dewatering slot 49 has then been provided which extends from the recess 38 in the flat plane 37e situated opposite.

**[0028]** Near the lower side of the covering element 32 the placing cams 39 have been integrally formed, which to either side run around the corners up into the adjacent circumferential planes that have been provided with recesses 38. The corners 40 of the cams 39 have been rounded off. The cams 39 end at some distance from the lower side with a step 45, but at the edges have been continued in column 46 which end in steps 47. Between the columns 46 a recess 48, which is bounded in downward direction by steps 45, has thus been formed and which is as it were situated at the corner.

**[0029]** At the upper side of the covering element 32 an upper surface 36 has been provided, which is a substantially regular hexagon, and which is rotated over an angle of 30° with respect to the hexagon formed by the circumferential planes 37a-f. In this example the diameter D1 of the hexagon of the upper plane 36 may be 23 or 25 cm, and the diameter D2 of the hexagon defined by the circumferential planes 29 cm (also see figure 5). The hexagon formed by the upper surface 36 here ends with three vertices at a distance from the planes 37a, c, e and with the other three vertices falling in the recesses 38.

**[0030]** Between the upper surface 36 and the circumferential planes 37a - f inclined planes 41, 42 have been provided. Between the flat planes 37a, c, e and the upper surface 36 two inclined planes 41 and 42 and a more or less vertically adjacent small plane 44 are thus present, where the water flowing transversely over the covering elements 32 can be altered in direction. At the location of the planes 37b, d, f a flow moving perpendicular to it will hit the planes 41 and 42, as well as the plane 43 lying in between there, which is part of the recess 38 and has a concave shape. As a result the energy dissipation is enhanced.

**[0031]** The special design at the location of the corners of the covering elements 32 is advantageous in view of the washing-in of grit after placing the covering elements on a slope.

**[0032]** As can be seen in figures 6A-C the dimensions of the intermediate spaces varies in vertical direction at the location of the corners where the covering elements 32 meet each other.

**[0033]** Thus, at the location of the placing cams 39, there is question of a closed corner area. In a cross-

section made just above the step 45 only the "columns" 46 contact each other. The recesses 48 leave a more or less triangular passage 60 free, which however is bounded in downward direction by the steps 45.

**[0034]** As can be seen in figure 6C the circumferential planes of the covering elements 32 placed against each other are free from each other above the upper ends 47 of the "columns" 46, and open slot-shaped spaces 61 are left free in horizontal direction.

**[0035]** Due to the special design of the covering elements 32 optimal use can be made of clamping-in forces, when using the correct grit gradations for washing-in. Washing-in with grit may for instance take place in two courses, a first course with crude grit, for instance 16 - 32 mm and a second course with finer grit, for instance 10-20 mm. The relatively large openings 38 are here filled by the crude material, whereas the more downward and sideward bounded spaces 60 accommodate finer grit, for achieving a clamping-in effect.

**[0036]** Due to the settling of the columns during the washing in or afterwards due to external, mechanical forces (for instance beating of the waves) the grit attaches deeply into the covering. Wedging here ensures a maximal clamping-in.

**[0037]** In case of newly laid slope coverings in which the covering elements have not yet been washed-in, said elements are able to move slightly, which property is advantageous in the fixation of the grit.

**[0038]** Because the combination of the spacing cams and the slight tapering of the covering elements and using the wash-in grit, arch formation / bridge formation can be prevented despite clamping-in.

**[0039]** In figure 7 an arrangement is shown of covering elements 32 on a slope, in which on sand layer 50 and a geotextile 52 a granular filter layer 51 and a number of covering elements 32 have been placed. The slots 49 at the lower side of the elements 32 extend in horizontal direction along the slope. The slots 49 form a channel in that direction, and due to their horizontal placing, prevent possible erosion. The blind openings 60 are filled with crushed stones 62, as a result of which the covering elements 32 are as it were clamped-in against each other.

**[0040]** Water can flow through the slots D and escape upwards via the recesses 38 in the direction B.

**[0041]** In case of wave run back A, a considerable pressure difference can be present between the water in the bank and the water above and outside of the covering elements 32. Water will then want to exit through the geotextile 52, in the directions indicated, but is retained by the covering elements 32. Water can flow out in the directions B through the spaces 38. However it may happen that a space 38 has been clogged up with clay. The water will then have difficulty flowing away at that location, as a result of which at the lower side of the covering elements an overpressure arises. The water against the lower side of the covering elements 32 however flows away easily in the direction D. The water is able to spread quickly through the slots or the channels 49. The water

is then able to exit at a next still open space 38 between the covering elements 32.

**[0042]** Because the lower sides of the covering elements 32 are not completely flat, small irregularities in the broken stone layer 51 have less influence on the levelness of the structure.

**[0043]** Furthermore possible disruptions of the foundation will more easily be visible at the surface, because the covering elements 32, due to their smaller support surface, will go down locally more quickly.

**[0044]** Due to the improvement of the water discharging capacity the quality of the filter structure will be less determining.

## Claims

1. Element (2, 20, 32) for a bank/shore or dike covering intended to form a top covering layer in a bank/shore or dike protection structure with several identical elements, which element (2) comprises an upper side (6), a lower side (5) and a circumferential side (7), the element (2), considered in a plane of cross section parallel to the lower side (5), having the shape of a regular or substantially regular hexagon and having six circumferential planes (7a - f), being at least partly provided with an inward recess (8, 28) extending from the lower side (5) to at least near the upper side (6),

### characterized in that

the recess (8) is obtained by forming the surface of said circumferential plane (7b, d, f) concave; said circumferential planes (7a - f) are only alternately provided with an inward recess (8, 28); and the lower side (5) is provided with at least one slot (12, 44, 49) which at one end ends in a circumferential plane (7b, d, f) having an inward recess (8, 28, 38), and the upper side (6) being at least substantially closed.

2. Element (2, 20) according to claim 1, wherein the slot (12) is straight and has a width of the order of magnitude of the width of the inward recess (8).
3. Element (2, 20) according to claim 1 or 2 wherein the upper surface changes into the circumferential side via inclined planes, sloping to the vertices of the circumferential side.
4. Element (2, 20, 32) according to any one of the preceding claims wherein the upper surface (6, 36) extends radially past the recesses (8, 28, 38) with one or more vertices.
5. Element (32) according to any one of the preceding claims, wherein the circumferential side (7, 27, 37) near the lower side (5) at the location of the corners is provided with spacing cams (39), preferably run-

ning around the corner in question.

6. Element (32) according to claim 5, wherein the spacing cams (39) on both sides of the angle are upwards continued in column shaped cams (46), defining a recess (48) in between them.
7. Element (32) according to claim 6, wherein the column shaped cams (46) end at a distance from the upper side (6).
8. Element (32) according to claim 5, 6 or 7, wherein the spacing cams (39) and/or column shaped cams (46) change into the circumferential side(s) (37a - f) at the upper end via a step (47).
9. Element (2, 20, 32) according to any one of the preceding claims, wherein the element (2, 20, 32) is made of concrete.
10. Covering for protection of a bank or dike, comprising a substratum of water permeable material and a layer of elements (2, 20, 32) according to any one of the preceding claims placed on it, wherein the elements (2, 20, 32) are regular hexagonal and the circumferential planes (7a - f, 27a - f, 37a - f) are placed against each other, wherein one of the circumferential planes is provided with a recess (8, 28, 38).
11. Covering for protection of a bank or dike, comprising a substratum of water permeable material and a layer of elements (2, 20, 32) according to any one of the preceding claims placed on it, the covering elements (2, 20, 32) defining a in between them at least locally slightly in downward direction tapering preferably almost blind accommodations spaces (61) which have been washed in with grit for forming clamping connections between the covering elements (2, 20, 32).

## Patentansprüche

1. Element (2, 20, 32) für eine Böschungs-/Ufer- oder Deichabdeckung, gedacht um eine obere Abdeckungsschicht in einer Böschungs-/Ufer- oder Deichschutzstruktur mit mehreren identischen Elementen auszubilden, welches Element (2) aufweist eine obere Seite (6), eine untere Seite (5) und eine Umfangsseite (7), wobei das Element (2) in einer Ebene des Querschnitts parallel zu der unteren Seite (5) betrachtet die Gestalt eines regelmäßigen oder im Wesentlichen regelmäßigen Hexagons hat und sechs Umfangsflächen (7a - f) hat, welche zumindest teilweise mit einer einwärts gerichteten Aussparung (8, 28) versehen sind, die sich von der unteren Seite (5) aus bis zumindest nahe der oberen Seite (6) erstreckt,

**dadurch gekennzeichnet, dass**

- die Aussparung (8) durch konkaves Ausbilden der Oberfläche der Umfangsfläche (7b, d, f) erzielt ist, die Umfangsflächen (7a - f) nur abwechselnd mit einer einwärts gerichteten Aussparung (8, 28) versehen sind und die untere Seite (5) mit zumindest einem Schlitz (12, 44, 49) versehen ist, welcher an einem Ende in einer Umfangsfläche (7b, d, f) endet, die eine einwärts gerichtete Aussparung (8, 28, 38) hat, wobei die obere Seite (6) zumindest im Wesentlichen geschlossen ist.
2. Element (2, 20) gemäß Anspruch 1, wobei der Schlitz (12) gerade ist und eine Breite in der Größenordnung der Breite der einwärts gerichteten Aussparung (8) hat.
  3. Element (2, 20) gemäß Anspruch 1 oder 2, wobei die obere Fläche, abfallend zu den Scheiteln der Umfangsseite, über geneigte Flächen in die Umfangsseite übergeht.
  4. Element (2, 20, 32) gemäß irgendeinem der vorhergehenden Ansprüche, wobei sich die obere Fläche (6, 36) mit einem oder mehr Scheiteln radial über die Aussparung (8, 28, 38) hinaus erstreckt.
  5. Element (32) gemäß irgendeinem der vorhergehenden Ansprüche, wobei die Umfangsseite (7, 27, 37) nahe der unteren Seite (5) an dem Ort der Ecken mit Abstandsnocken (39) ausgestattet ist, welche bevorzugter Weise um die betreffende Ecke herum verlaufen.
  6. Element (32) gemäß Anspruch 5, wobei die Abstandsnocken (39) an beiden Seiten von dem Winkel aufwärts in säulenförmigen Nocken (46) fortgesetzt sind, welche eine Aussparung (48) zwischen einander definieren.
  7. Element (32) gemäß Anspruch 6, wobei die säulenförmigen Nocken (46) in einem Abstand von der oberen Seite (6) enden.
  8. Element (32) gemäß Anspruch 5, 6 oder 7, wobei die Abstandsnocken (39) und/oder die säulenförmigen Nocken (46) an dem oberen Ende über eine Stufe (47) in die Umfangsseite(n) (37a - f) übergehen.
  9. Element (2, 20, 32) gemäß irgendeinem der vorhergehenden Ansprüche, wobei das Element (2, 20, 32) aus Beton hergestellt ist.
  10. Abdeckung zum Schutz einer Böschung oder einem Deich, aufweisend eine Unterlage aus wasserdurchlässigem Material und eine Schicht von Elementen

(2, 20, 32) gemäß irgendeinem der vorhergehenden Ansprüche, die darauf angeordnet ist, wobei die Elemente (2, 20, 32) regelmäßig hexagonal sind und die Umfangsflächen (7a - f, 27a - f, 37a - f) aneinander platziert sind, wobei eine von den Umfangsseiten mit einer Aussparung (8, 28, 38) versehen ist.

11. Abdeckung zum Schutz einer Böschung oder einem Deich, aufweisend eine Unterlage aus wasserdurchlässigem Material und eine Schicht von Elementen (2, 20, 32) gemäß irgendeinem der vorhergehenden Ansprüche, die darauf angeordnet ist, wobei die abdeckenden Elemente (2, 20, 32) zwischen einander zumindest lokal leicht in Richtung nach unten sich verjüngende, bevorzugt fast als Blindloch vorliegende Aufnahmeräume (61) definieren, in welche Kies hinein gewaschen wurde, um Klemmverbindungen zwischen den abdeckenden Elementen (2, 20, 32) auszubilden.

**Revendications**

1. Élément (2, 20, 32) pour un revêtement de berge/rivage ou digue prévu pour former une couche de revêtement supérieure dans une structure de protection de berge/rivage ou digue avec plusieurs éléments identiques, lequel élément (2) comprend un côté supérieur (6), un côté inférieur (5) et un côté circonférentiel (7), l'élément (2), pris en considération dans un plan de coupe transversale parallèle au côté inférieur (5), ayant la forme d'un hexagone régulier ou sensiblement régulier et ayant six plans circonférentiels (7a - f), étant au moins partiellement prévus avec un évidement vers l'intérieur (8, 28) s'étendant à partir du côté inférieur (5) jusqu'au moins à proximité du côté supérieur (6),  
**caractérisé en ce que**  
l'évidement (8) est obtenu en formant la surface dudit plan circonférentiel (7b, d, f) concave ;  
lesdits plans circonférentiels (7a - f) sont uniquement prévus en variante avec un évidement vers l'intérieur (8, 28) ; et  
le côté inférieur (5) est prévu avec au moins une fente (12, 44, 49) qui, au niveau d'une extrémité, se termine dans un plan circonférentiel (7b, d, f) ayant un évidement vers le haut (8, 28, 38), et le côté supérieur (6) étant au moins sensiblement fermé.
2. Élément (2, 20) selon la revendication 1, dans lequel la fente (12) est droite et a une largeur de l'ordre de grandeur de la largeur de l'évidement vers l'intérieur (8).
3. Élément (2, 20) selon la revendication 1 ou 2, dans lequel la surface supérieure se transforme en côté circonférentiel via des plans inclinés, descendant vers les sommets du côté circonférentiel.

4. Elément (2, 20, 32) selon l'une quelconque des revendications précédentes, dans lequel la surface supérieure (6, 36) s'étend radialement au-delà des évidements (8, 28, 38) avec un ou plusieurs sommets. 5
5. Elément (32) selon l'une quelconque des revendications précédentes, dans lequel le côté circonférentiel (7, 27, 37) à proximité du côté inférieur (5) à l'emplacement des coins est prévu avec des cames d'espacement (39), de préférence s'étendant autour du coin en question. 10
6. Elément (32) selon la revendication 5, dans lequel les cames d'espacement (39) des deux côtés de l'angle continuent vers le haut dans des cames en forme de colonne (46), définissant un évidement (48) entre elles. 15
7. Elément (32) selon la revendication 6, dans lequel les cames en forme de colonne (46) se terminent à une distance du côté supérieur (6). 20
8. Elément (32) selon la revendication 5, 6 ou 7, dans lequel les cames d'espacement (39) et/ou les cames en forme de colonne (46) se transforment en côté(s) circonférentiel(s) (37a - f) au niveau de l'extrémité supérieure via un échelon (47). 25
9. Elément (2, 20, 32) selon l'une quelconque des revendications précédentes, dans lequel l'élément (2, 20, 32) est réalisé à partir de béton. 30
10. Revêtement pour la protection d'une berge ou d'une digue comprenant un substrat de matériau perméable à l'eau et une couche d'éléments (2, 20, 32) selon l'une quelconque des revendications précédentes, placée sur ce dernier, dans lequel les éléments (2, 20, 32) sont un hexagone régulier et les plans circonférentiels (7a - f, 27a - f, 37a - f) sont placés les uns contre les autres, dans lequel l'un des plans circonférentiels est prévu avec un évidement (8, 28, 38). 35 40
11. Revêtement pour la protection d'une berge ou d'une digue, comprenant un substrat de matériau perméable à l'eau et une couche d'éléments (2, 20, 32) selon l'une quelconque des revendications précédentes, placée sur ce dernier, les éléments de revêtement (2, 20, 32) définissant entre eux au moins localement dans la direction légèrement descendante, des espaces de logement se rétrécissant progressivement, de préférence presque borgnes (61) qui ont été nettoyés avec du gravillon, pour former des raccords de serrage entre les éléments de revêtement (2, 20, 32). 45 50 55

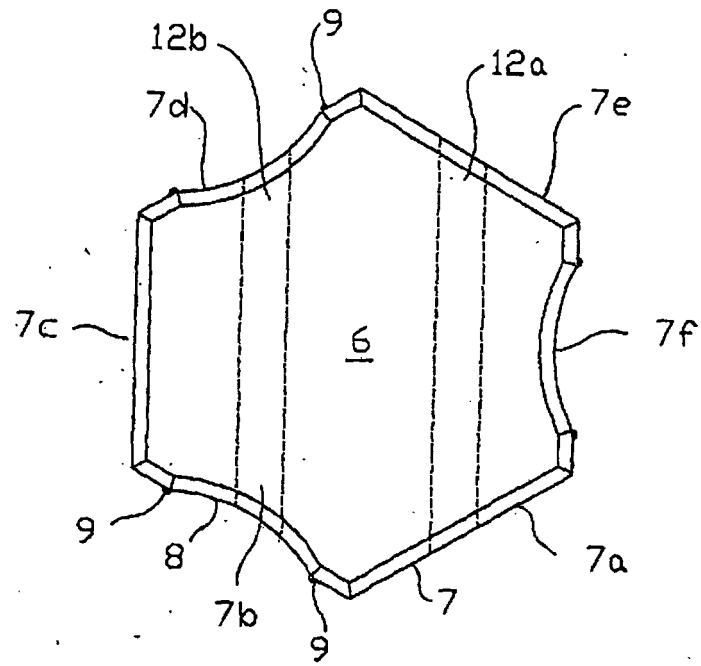


FIG. 1

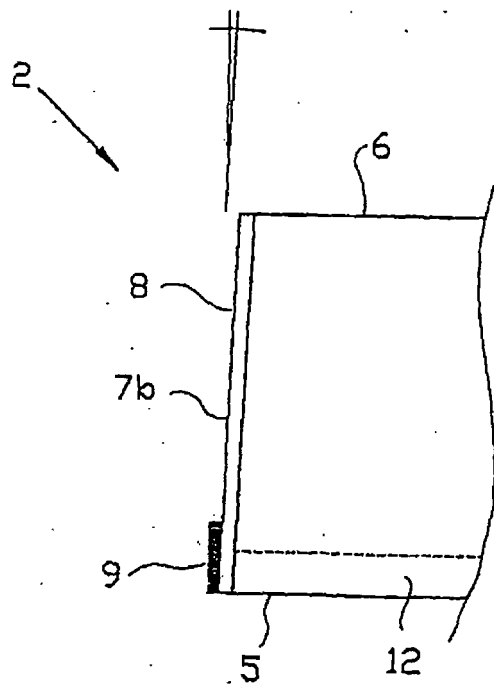


FIG. 2



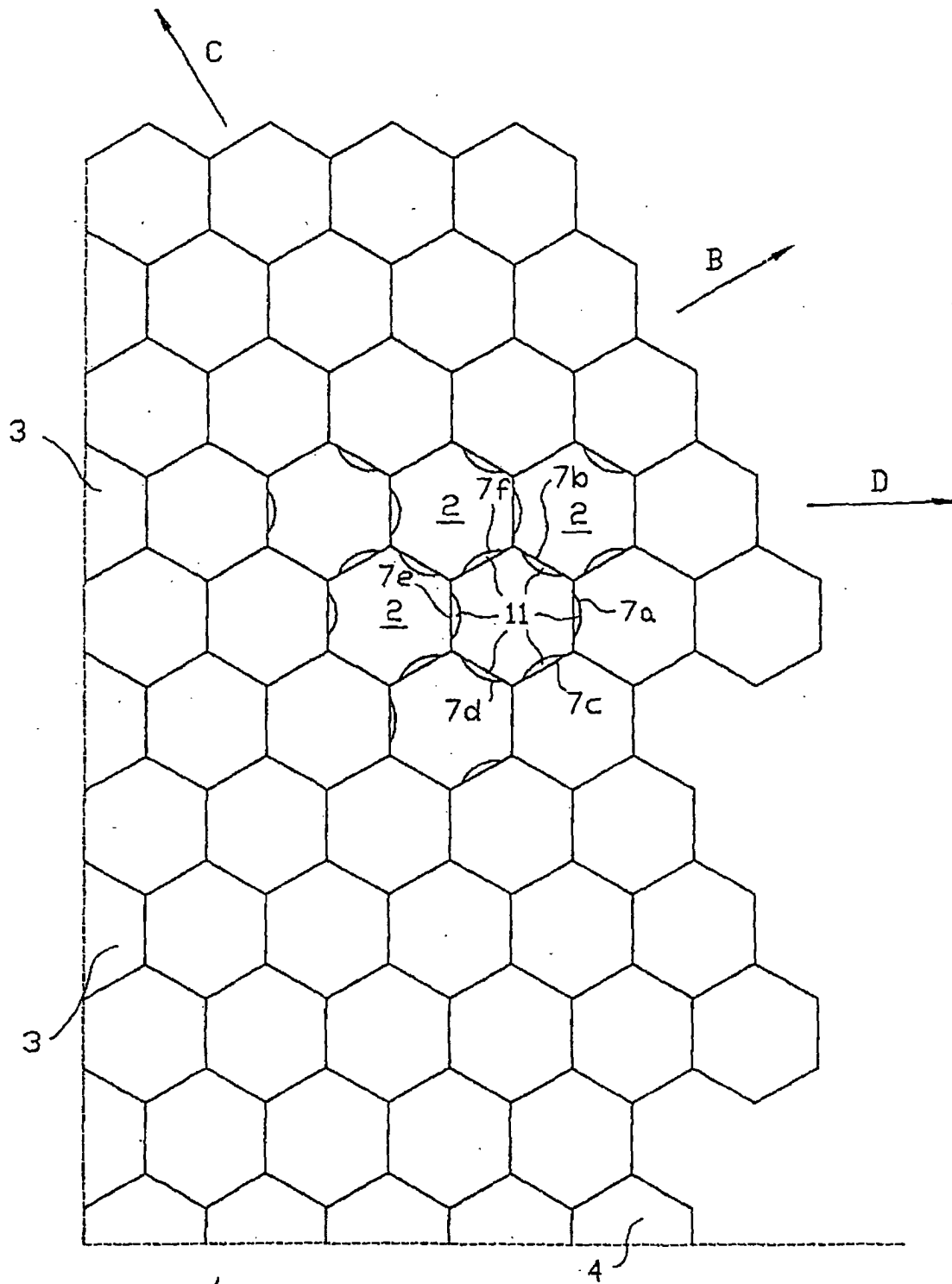


FIG. 3

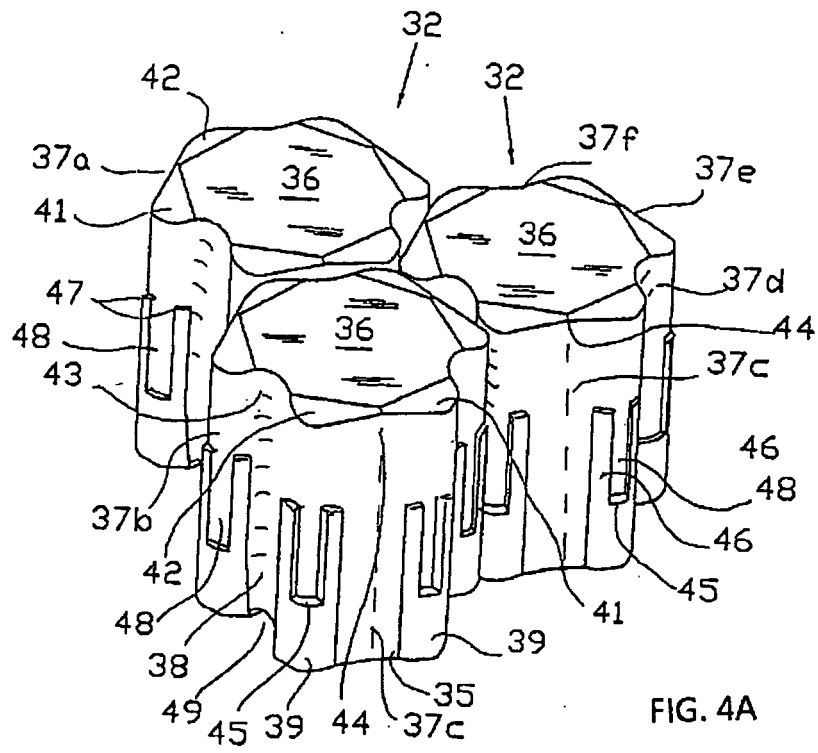


FIG. 4A

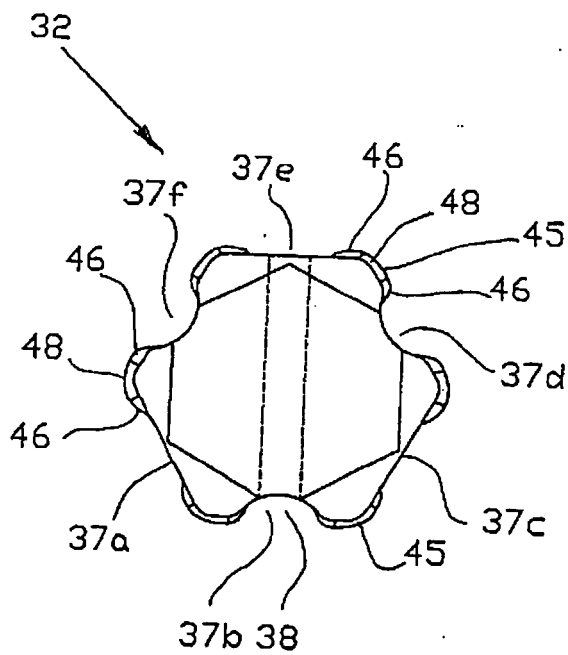


FIG. 4B

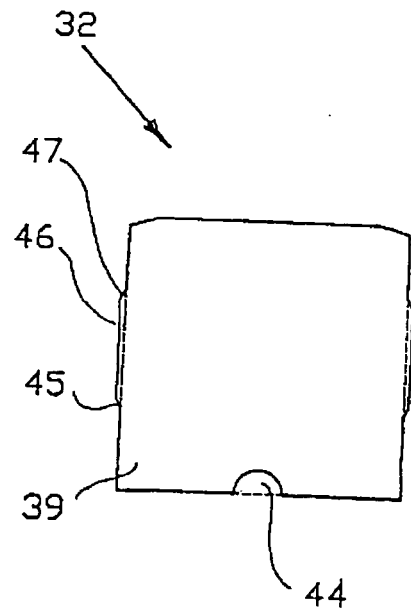


FIG. 4C

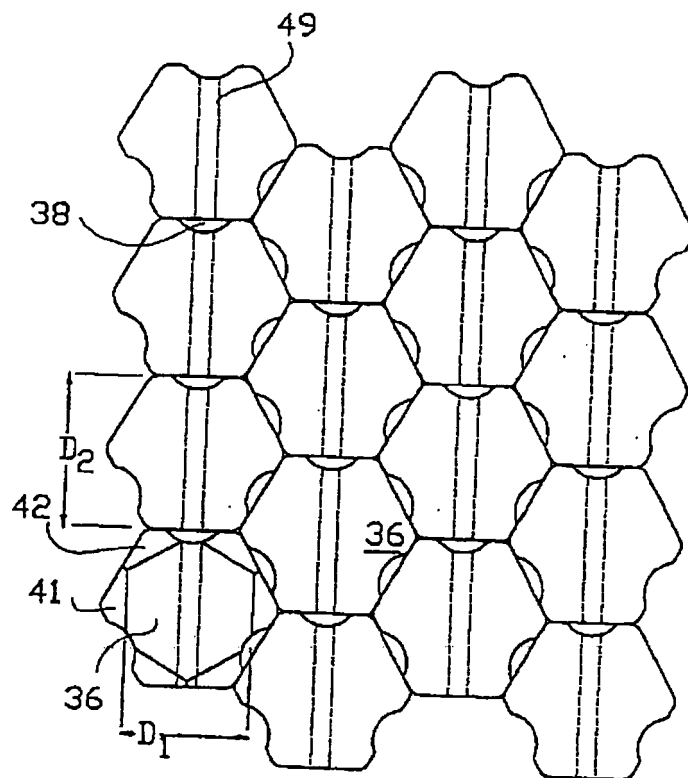


FIG. 5

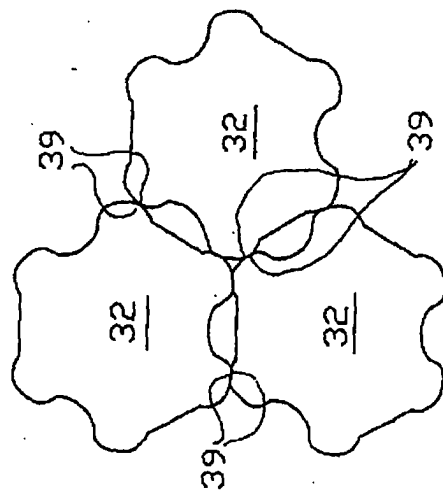


FIG. 6A

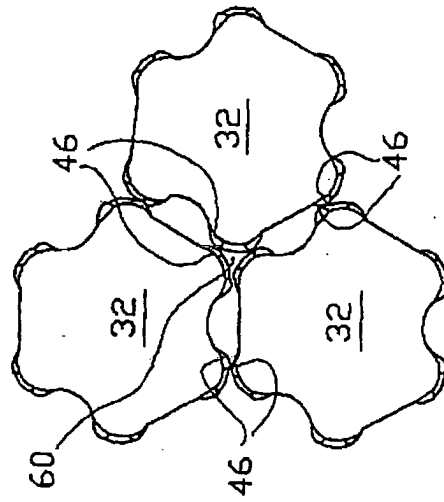


FIG. 6B

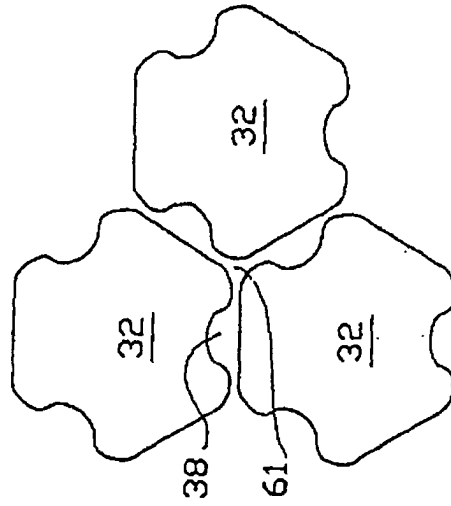


FIG. 6C

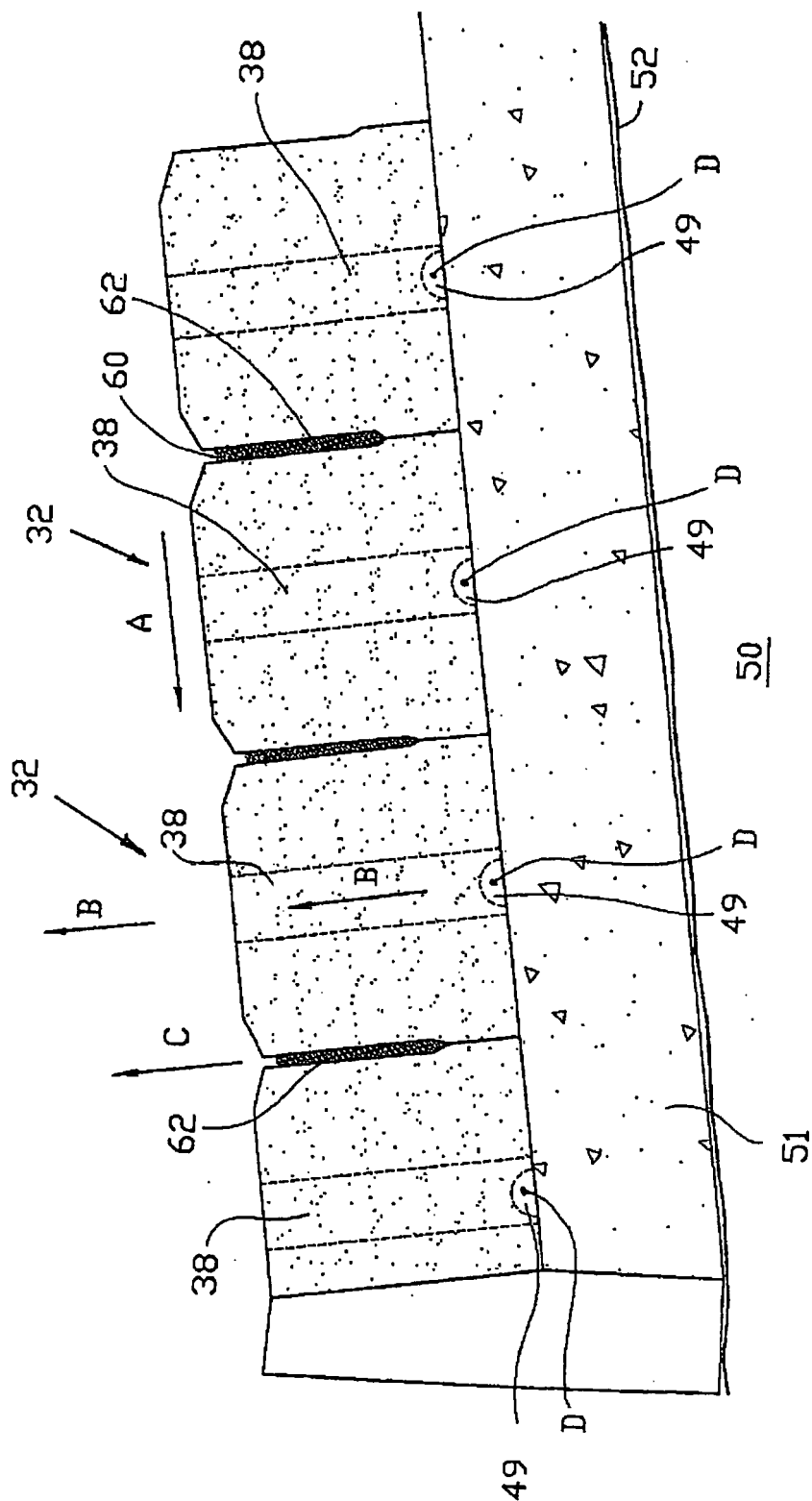


FIG. 7

**REFERENCES CITED IN THE DESCRIPTION**

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