(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 275 784 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
15.01.2003 Bulletin 2003/03

(51) Int Cl.[7]: **E02B 3/14**

(21) Application number: **02077572.2**

(22) Date of filing: **26.06.2002**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **26.06.2001 NL 1018393**
26.06.2001 NL 1018394
15.10.2001 NL 1019174

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(54) Improved element for bank protection

(57) 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 least substantially closed 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 polygon of equal sides, the polygon having an even number of circumferential planes and the circumferential planes being alternatingly provided with an inward recess extending from the lower side up to at least near the upper side.

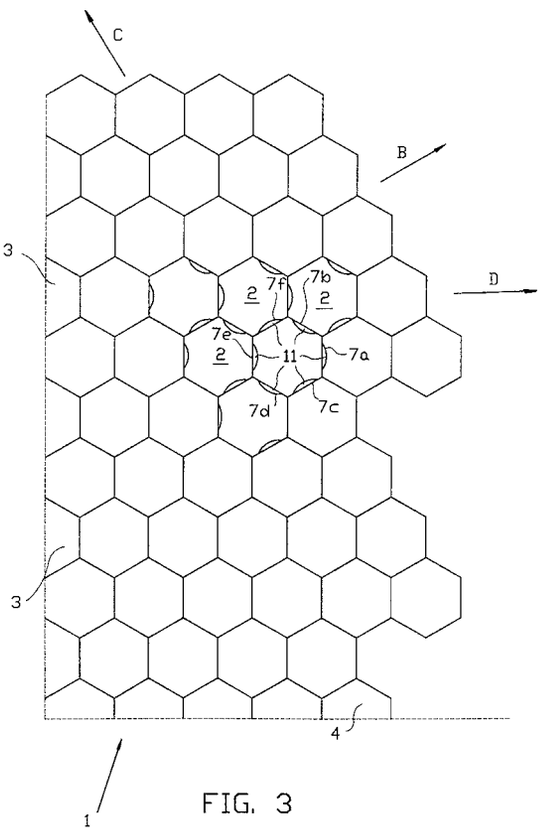

FIG. 3

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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 Dutch patent application 75.03285 a concrete column-shaped covering element, having an irregular cross-section, is known.

[0004] From Dutch patent 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 elements are 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] A further drawback of existing coverings built up from elements is that subsidences in the subgrade cannot be noticed quickly.

[0009] It is an object of the invention to provide a covering element with which at least some of the aforementioned 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.

[0010] To that end the invention provides from a first aspect a -preferably concrete- 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 least substantially closed 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 polygon of equal sides, the polygon having an even number of circumferential planes and the circumferential planes being alternatingly provided with an inward recess extending from the lower side up to at least near the upper side.

[0011] 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 alternatingly 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.

[0012] Preferably the recess is obtained by forming the surface of said circumferential plane concave.

[0013] The water discharging capacity is further improved when the lower side is provided with at least one slot which at one end ends in a circumferential plane having an inward recess.

[0014] 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. Subsidences 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.

[0015] 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.

[0016] Preferably the slot is straight, and preferably

has a width of the order of magnitude of the width of the inward recess.

[0017] Preferably the angle between the sides connecting to each other along the circumference is constant in absolute value, as a result of which a large number placing possibilities is achieved.

[0018] In a first further development the angle between the sides connecting to each other along the circumference is constant in dimension and sign, in other words the corners are always inwardly oriented, such as is the case with a regular hexagon in particular.

[0019] In another further development the angle between the sides connecting to each other along the circumference is constant in dimension and alternating in sign, so that a kind of zig-zag form is obtained. The polygon in profile can here be built up from a number of regular polygons according to the further development mentioned first, that are formed as a unity with each other.

[0020] In order to increase the energy dissipation in case of flow over the covering elements, like in case of wave run-up, it is preferred that the upper side forms a flat upper surface forming a regular polygon having a same number of vertices as the plane of cross-section, though in circumferential direction rotated over 360/2n degrees, n being the number of corners. Thus a same degree of roughness of the upper side of the covering is provided in several directions, so that during placing no particular attention needs to be paid to the orientation of the elements. The degree of hydraulic roughness can be determined in tests if necessary. Preferably the upper surface changes into the circumferential side via inclined planes, sloping to the vertices of the circumferential side.

[0021] It is noted that in the aforementioned Dutch patent application 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.

[0022] Preferably the polygon is situated in the upper side with the vertices at a distance within the sides of the polygon of the plane of cross-section, so that the inclined planes can be larger.

[0023] 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.

[0024] 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.

[0025] 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.

[0026] The column-shaped cams preferably end at a distance from the upper side, in order to define an increased space for grit above it.

[0027] 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.

[0028] 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.

[0029] 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;

Figure 4 shows a second embodiment of a covering element according to the invention;

Figures 5A-C show a third embodiment of a covering element according to the invention, in perspective view in a group, in top view and in side view;

Figure 6 shows a number of covering elements according to figures 5A-C placed in bond, seen from above;

Figures 7A-C show some cross-sections of a group of covering elements, along planes parallel to their lower planes, at different heights; and

Figure 8 shows a vertical cross-section of an arrangement with covering elements of figures 5A-C on a slope.

[0030] 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 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.

[0031] 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 covering 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 directions B or the direction C, or D by way of example.

[0032] 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.

[0033] 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^2 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.

[0034] 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 circumferential 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.

[0035] In figure 4 an alternative embodiment is shown, in which in fact there is question of a combination of three regular hexagons. These elements 20 as well can be placed in many positions with respect to each other so as to easily follow curves in the covering of a slope. The circumferential planes 27a-f here are in fact themselves provided with a corner, and are consecutively buckled in a concave and convex manner. The "concave" circumferential planes 27a, 27c and 27e have been provided with recesses or cavities 28 that are continuous over the entire height, so that for instance in case of a connection of a side 27b of a next element 20 to side 27a of the element shown, a vertical passage is left for the water to the outside.

[0036] The concrete covering element 32 shown in figures 5A-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 to in the flat plane 37e situated opposite.

[0037] 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 columns 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.

[0038] 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 6). 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.

[0039] 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.

[0040] 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.

[0041] As can be seen in figures 7A-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.

[0042] 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.

[0043] As can be seen in figure 7C 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.

[0044] 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.

[0045] 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.

[0046] 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.

[0047] Because of 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.

[0048] In figure 8 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 is it were clamped-in against each other.

[0049] Water can flow through the slots D and escape upwards via the recesses 38 in the direction B.

[0050] 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.

[0051] 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.

[0052] 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.

[0053] Due to the improvement of the water discharging capacity the quality of the filter structure will be less determining.

Claims

1. 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 least substantially closed 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 polygon of equal sides, the polygon having an even number of circumferential planes and the circumferential planes being alternatingly provided with an inward recess extending from the lower side up to at least near the upper side.

2. Element according to claim 1, the recess being obtained by forming the surface of said circumferential plane concave.

2. Element according to claim 1 or 2, the lower side being provided with at least one slot which at one end ends in a circumferential plane having an inward recess.

3. Element according to claim 2, one straight slot always being present, which preferably has a width of the order of magnitude of the width of the inward recess.

4. Element according to claim 1, 2 or 3, the angle between the sides connecting to each other along the circumference being constant in absolute value.

5. Element according to claim 4, the angle between the sides connecting to each other along the circumference being constant in dimension and sign.

6. Element according to claim 5, the polygon being a regular hexagon.

7. Element according to claim 1, 2 or 3, the angle between the sides connecting to each other along the circumference being constant in dimension and alternating in sign, the polygon in profile preferably being assembled from a number of regular polygons according to claim 3, that are formed as a unity with each other.

8. Element according to any one of the preceding claims, the upper side forming a flat upper surface forming a regular polygon having a same number of vertices as the plane of cross-section, though in circumferential direction rotated over 360/2n degrees, n being the number of corners.

9. Element according to claim 8, the upper surface changing into the circumferential side via inclined planes, sloping to the vertices of the circumferential side.

10. Element according to claim 8 or 9, the polygon being situated in the upper side with the vertices at a distance within the sides of the polygon of the plane of cross-section.

11. Element according to claim 8, 9 or 10, the upper surface extending radially past the recesses with one or more vertices.

12. Element according to any one of the preceding claims, the circumferential side, near the lower side at the location of the corners being provided with spacing cams, preferably running around the corner in question.

13. Element according to claim 12, the spacing cams on both sides of the angle being upwardly continued in column-shaped cams, defining a recess in between them.

14. Element according to claim 13, the column-shaped cams ending at a distance from the upper side.

15. Element according to claim 12, 13 or 14, the spacing cams and/or column-shaped cams changing into the circumferential side(s) at their upper end via a step.

16. Element according to any one of the preceding claims, made of concrete.

17. Covering for protection of a bank or dike, comprising a substratum of water-permeable material and a layer of elements according to any one of the preceding claims placed on it, the elements being regular hexagonal and the circumferential planes being placed against each other, one of those circumferential planes each time being provided with a recess.

18. Covering for protection of a bank or dike, comprising a substratum of water-permeable material and a layer of elements according to any one of the preceding claims 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.

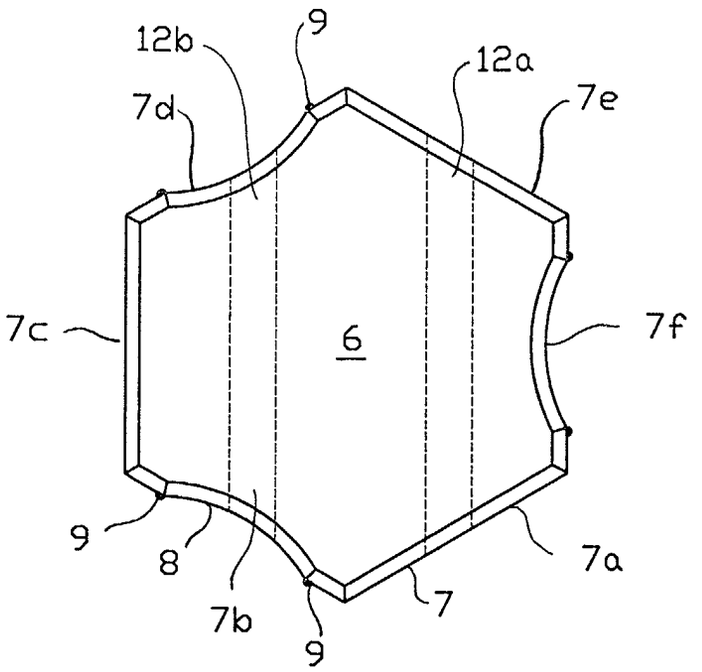

FIG. 1

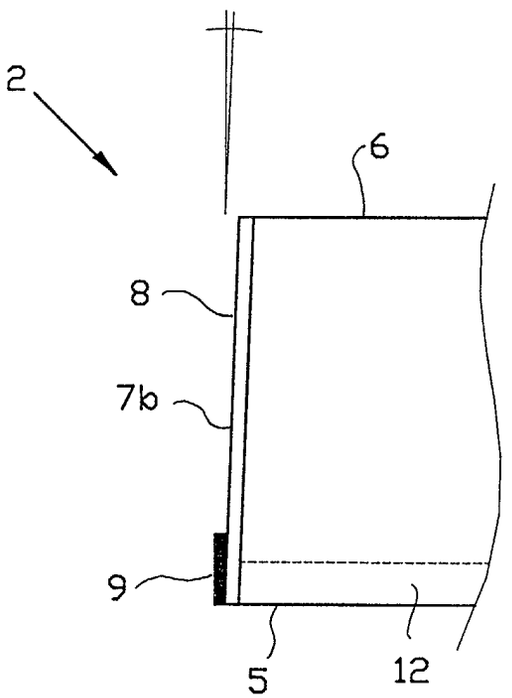

FIG. 2

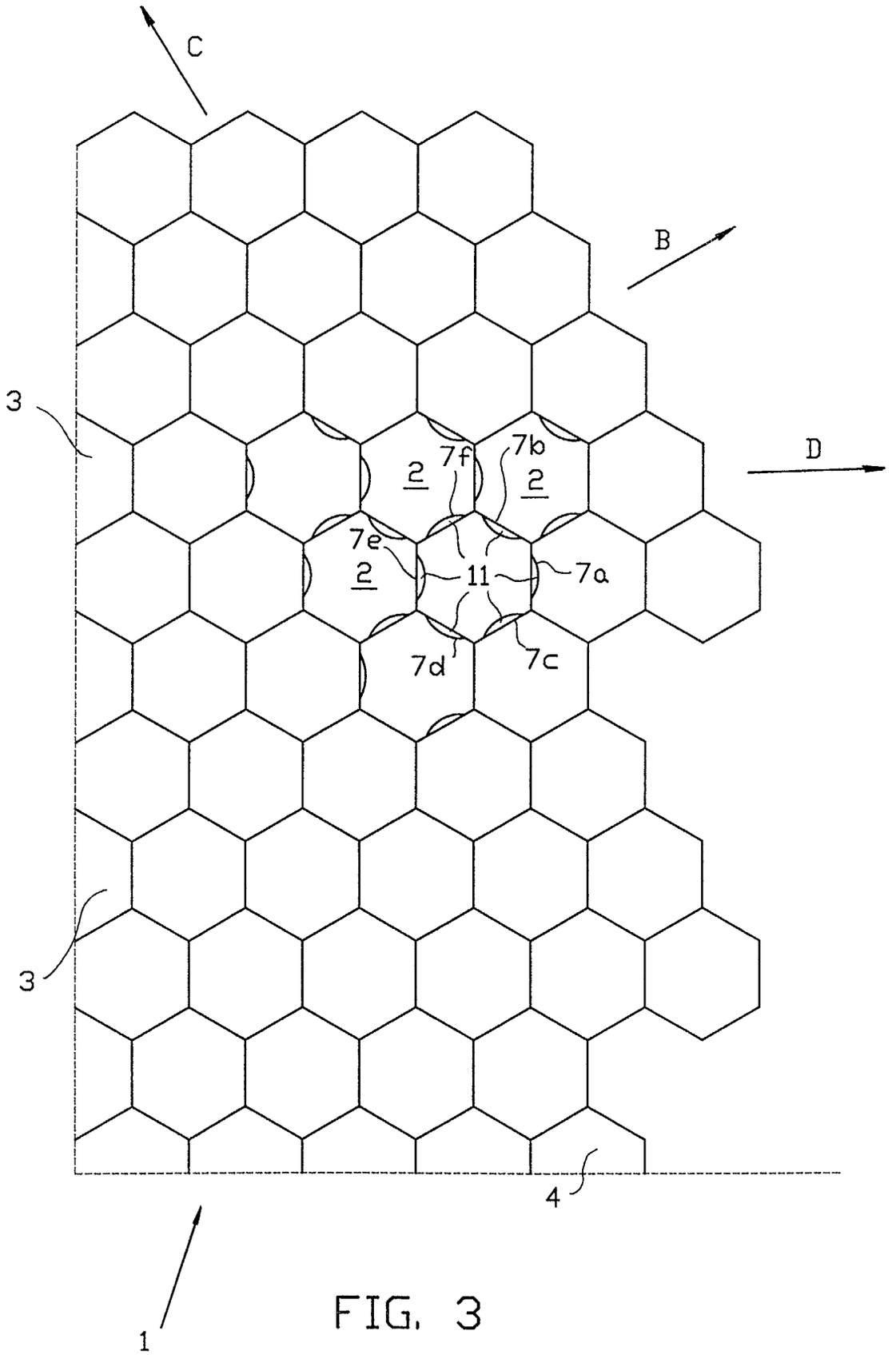

FIG. 3

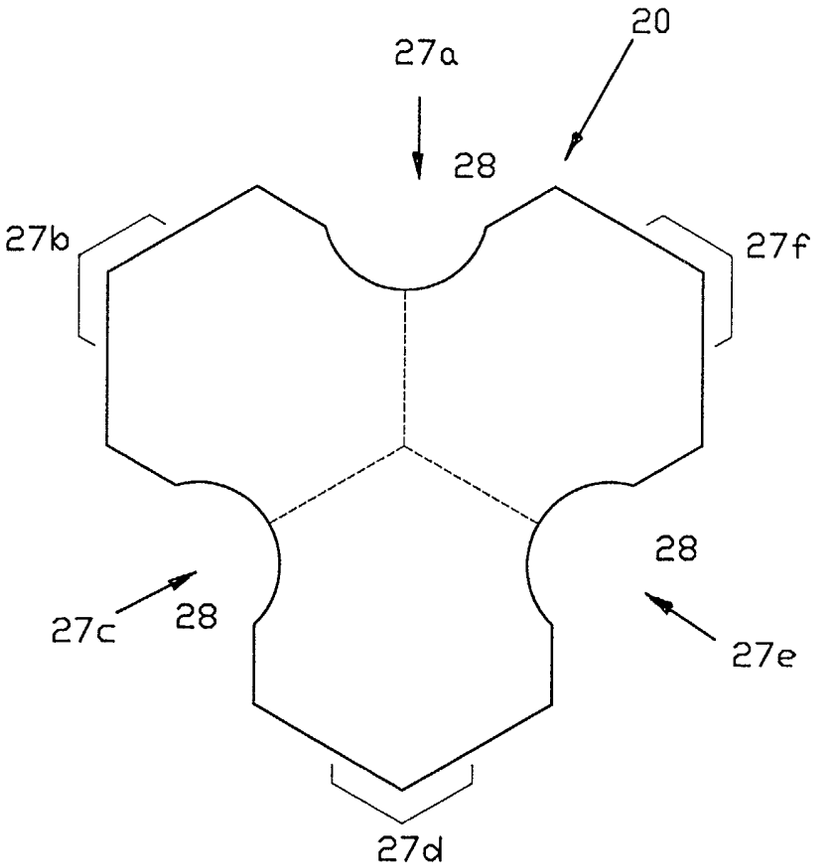

FIG. 4

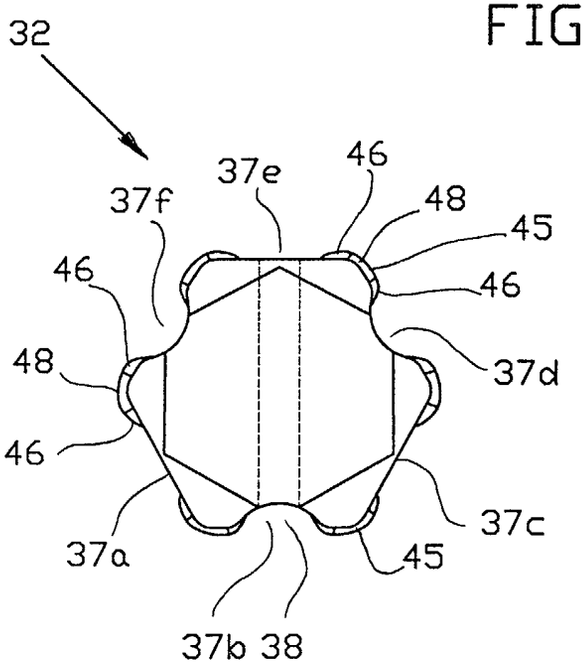

FIG. 5B

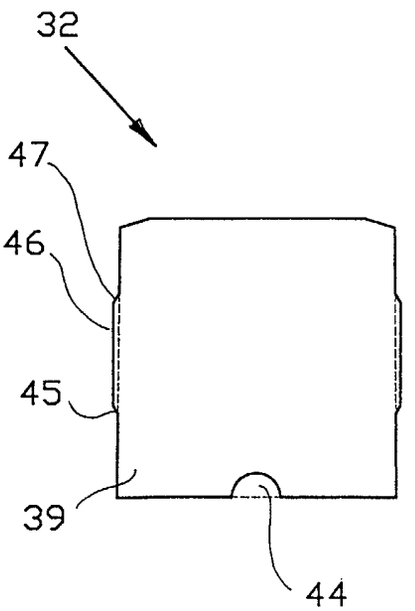

FIG. 5C

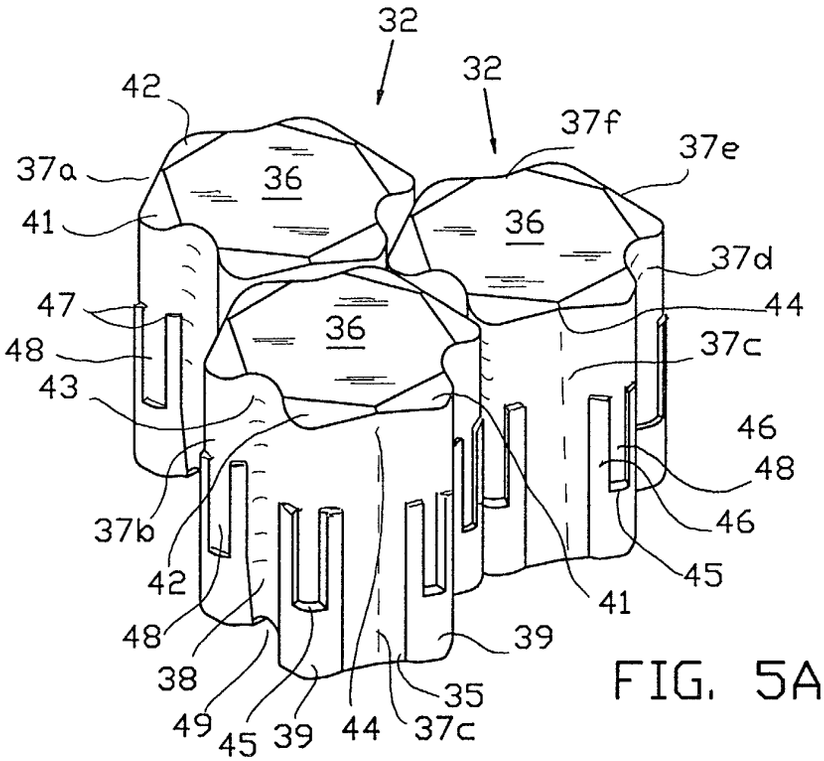
32
32
42
37f
37e
37a
36
36
41
37d
47
44
36
48
37c
43
46
48
37b
46
42
45
41
48
39
38
35
49
45
39
44
37c

FIG. 5A

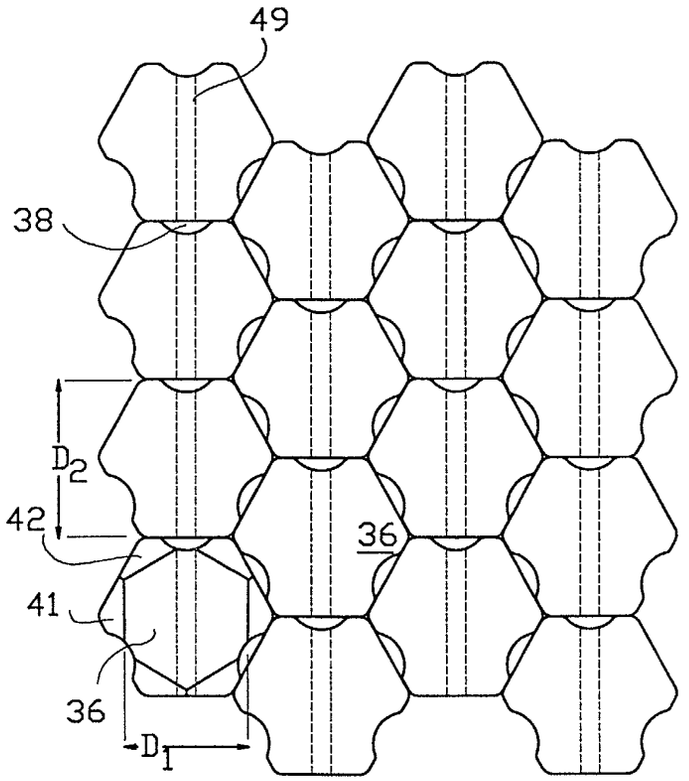
49
38
D2
42
36
41
36
D1

FIG. 6

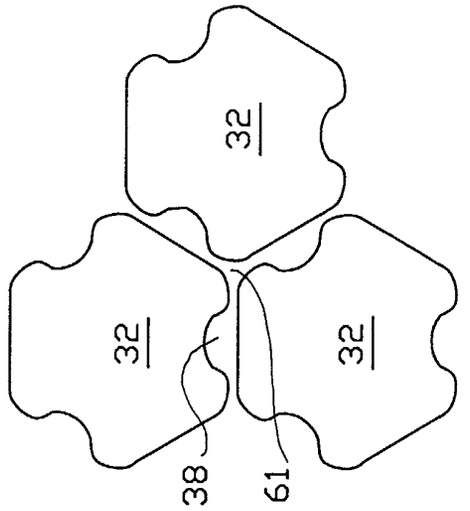

FIG. 7C

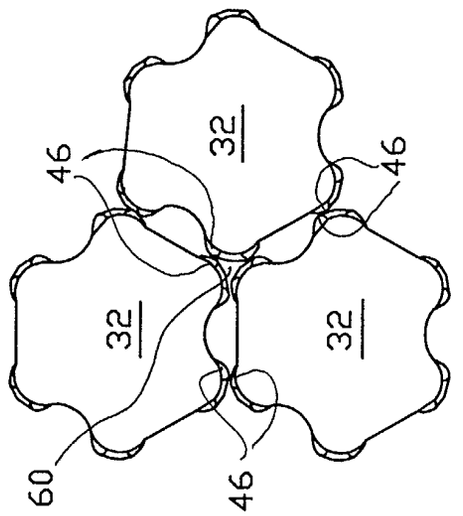

FIG. 7B

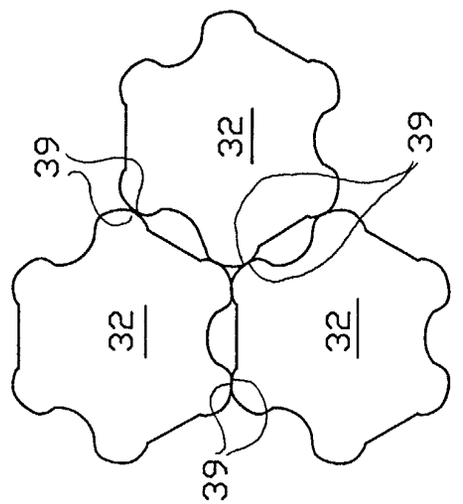

FIG. 7A

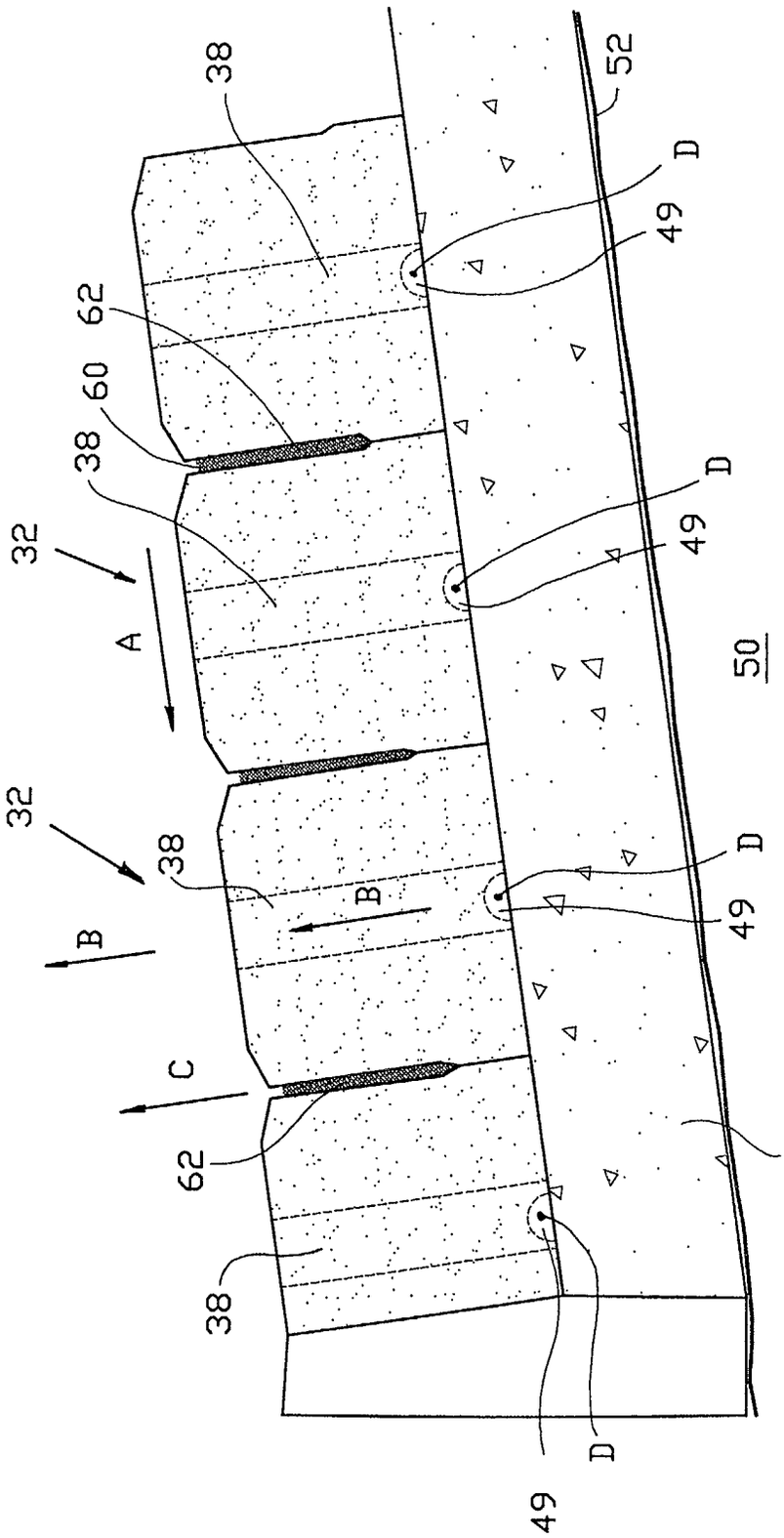

FIG. 8