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(54) ASSEMBLY OF REVETMENT STONES

(57) Assembly of revetment stones, comprising
- a number of revetment stones
- wherein the revetment stones each have a lower side,
an upper side and a circumferential perimeter,
- wherein each revetment stone of the first pair of revet-
ment stones is provided with passages extending be-

tween the lower side and the upper side, and
- wherein the assembly has a rectangular outer perime-
ter,
- wherein the revetment stones have been placed against
each other and at that location define one or more con-
necting seams that are undulating or zigzag-shaped.

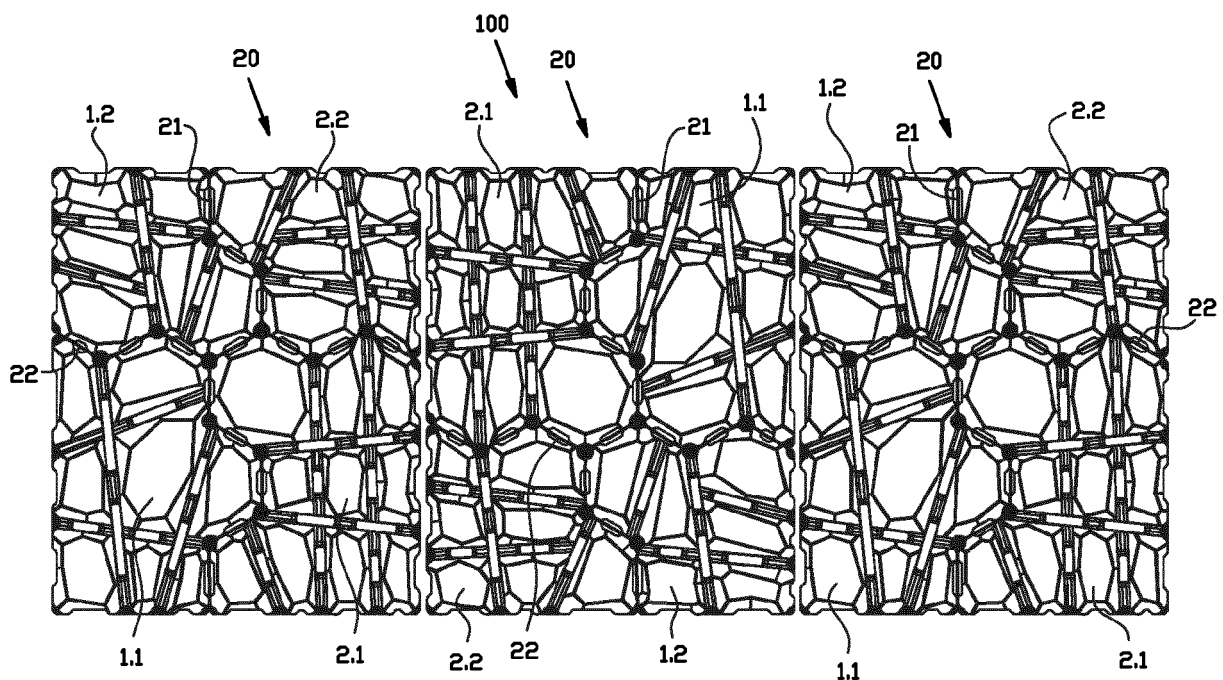


FIG. 6A

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Description

BACKGROUND OF THE INVENTION

[0001] The invention relates to an assembly of revetment stones, as well as to a covering formed with such assemblies, covering for instance a bottom, a bank or a dike. The invention further relates to a method for laying such a covering.

[0002] It is known to cover a bank, in particular a dike slope, with revetment stones. An example from 1981 is the revetment stone by the name of Basalton®, which was developed as a concrete alternative to basalt pillars. A covering is then built from alike packages consisting of a number of polygonal concrete pillars having flat circumferential surfaces and various diameters. Another example, from 1997, is the Hydroblock®, which has convex and concave circumferential surfaces and forms a covering with identical concrete blocks. The RONA®ton, which is of a more recent date, has a substantially hexagonal cross-section and can be placed in a honeycomb-shaped bond, inter alia see EP 1.275.784. The blocks positioned against each other form accommodation spaces for grit to increase the mutual clamping forces and define passages for confined water escaping from underneath the covering. A number of identical blocks can be joined together into identical packages using fitting blocks, see EP 2.531.656.

SUMMARY OF THE INVENTION

[0003] It is an object of the invention to provide a revetment stone assembly with which a revetment stone covering of high stability can be achieved.

[0004] It is an object of the invention to provide an assembly of concrete blocks with which a to large extent a natural look for a revetment stone covering can be obtained.

[0005] According to one aspect the invention provides an assembly of revetment stones, comprising

- a first pair of revetment stones consisting of a first revetment stone and a second revetment stone,
- wherein the revetment stones each have a lower side, an upper side and a circumferential perimeter,
- wherein each revetment stone of the first pair of revetment stones is provided with passages extending between the lower side and the upper side, and
- wherein the circumferential perimeter of each revetment stone comprises a first straight side and a second straight side that connect to each other at a right angle,
- wherein the circumferential perimeter of the first revetment stone comprises a third side and a fourth side and the circumferential perimeter of the second revetment stone comprises a third side and a fourth side,
- wherein the fourth side of the first revetment stone

and the third side of the second revetment stone are formed complementary to one another and seen in top view have an undulating or zigzag shape,

- wherein the second and third sides of the second revetment stone connect to each other and the first and fourth sides of the first revetment stone connect to each other, and
- wherein in a condition in which the fourth side of the first revetment stone and the third side of the second revetment stone are placed against each other so as to complement one another, the first straight side of the first revetment stone and the second straight side of the second revetment stone are aligned with each other.

[0006] That way, a revetment stone assembly is provided having three straight sides and an undulating/zigzag-shaped joint.

[0007] It is noted that undulating means a bent/curved sine-shaped course as well as an angular sine-shaped course, such as in U- or Z- sheet-pile walls.

[0008] In a further development, the assembly further comprises

- a second pair consisting of a first revetment stone and a second revetment stone,
- wherein the revetment stones each have a lower side, an upper side and a circumferential perimeter,
- wherein each revetment stone of the second pair of revetment stones is provided with passages extending between the lower side and the upper side, and
- wherein in the second pair of revetment stones, the circumferential perimeter of each revetment stone comprises a first straight side and a second straight side that connect to each other at a right angle,
- wherein in said second pair of revetment stones, the circumferential perimeter of the first revetment stone comprises a third side and a fourth side and the circumferential perimeter of the second revetment stone comprises a third side and a fourth side,
- wherein in said second pair of revetment stones, the third side of the first revetment stone and the fourth side of the second revetment stone are formed complementary to one another and seen in top view have an undulating or zigzag shape,
- wherein in said second pair of revetment stones, the second and third sides of the first revetment stone connect to each other and the first and fourth sides of the second revetment stone connect to each other, and
- wherein in said second pair of revetment stones, in a condition in which the third side of the first revetment stone and the fourth side of the second revetment stone are placed against each other so as to complement one another, the second straight side of the first revetment stone and the first straight side of the second revetment stone are aligned with each other.

[0009] In a first further development of the assembly according to the invention, the third side and the fourth side of the first and the second revetment stones, respectively, of the first pair of revetment stones are straight and aligned with each other. This may also apply to the second pair of revetment stones, wherein the fourth side and the third side of the first and the second revetment stones, respectively, of the second pair of revetment stones are straight and aligned with each other. A covering may then for instance have been constructed of strips of first pairs of revetment stones and/or second pairs of revetment stones that are placed next to one another in series.

[0010] In a second, alternative further development, the third side of the first revetment stone of the first pair of revetment stones and the fourth side of the first revetment stone of the second pair of revetment stones are formed complementary to one another and seen in top view have an undulating or zigzag shape, and the third side of the first revetment stone of the first pair of revetment stones in a corner connects to the second side of the first revetment stone of the first pair of revetment stones and the fourth side of the first revetment stone of the second pair of revetment stones in a corner connects to the first side of the first revetment stone of the second pair of revetment stones. That way a bond is also formed between both pairs of revetment stones.

[0011] Similarly, the fourth side of the second revetment stone of the first pair of revetment stones and the third side of the second revetment stone of the second pair of revetment stones can be formed complementary to one another and seen in top view have an undulating or zigzag shape, and the fourth side of the second revetment stone of the first pair of revetment stones in a corner connects to the first side of the second revetment stone of the first pair of revetment stones and the third side of the second revetment stone of the second pair of revetment stones in a corner connects to the second side of the second revetment stone of the second pair of revetment stones. That way a bond is also formed between both pairs of revetment stones.

[0012] In a further development, the first pair of revetment stones and the second pair of revetment stones have been designed to be joined together into a condition,

- in which the second straight side of the first revetment stone of the first pair of revetment stones and the first straight side of the first revetment stone of the second pair of revetment stones are aligned with each other; and
- in which the first straight side of the second revetment stone of the first pair of revetment stones and the second straight side of the second revetment stone of the second pair of revetment stones are aligned with each other.

[0013] That way a package of four revetment stones is obtained having four straight sides and internal undu-

lating or zigzag-shaped joints.

[0014] In a further embodiment, wherein the first straight side of the first revetment stone of the first pair of revetment stones and the second straight side of the second revetment stone of the first pair of revetment stones together define a first assembly length, and

- the second side of the first stone of the first pair of revetment stones and the first side of the first revetment stone of the second pair of revetment stones together define a second assembly length,

the first assembly length is larger than the second assembly length.

[0015] In one embodiment the first pair of revetment stones and the second pair of revetment stones are designed to be joined together into a condition,

- in which the complementary fourth and third sides of the first and second revetment stones, respectively, of the first pair of revetment stones and the complementary third and fourth sides of the first and second revetment stones, respectively, of the second pair of revetment stones form a first continuous undulating or zigzag-shaped connecting seam.

[0016] In one embodiment, the first pair of revetment stones and the second pair of revetment stones are designed to be joined together into a condition,

- in which the complementary third and fourth sides of the first revetment stones of the first pair and the second pair of revetment stones, respectively, and the complementary fourth and third sides of the second revetment stones of the first pair and second pair of revetment stones, respectively, form a second continuous undulating or zigzag-shaped connecting seam.

[0017] The first connecting seam and the second connecting seam may be substantially transverse to each other.

[0018] The second connecting seam may have the shape of an undulating sheet-pile wall, according to a regular honeycomb course with side portions of equal length that are consecutive at angles of 60 degrees, and the first connecting seam can be zigzag-shaped, having side portions of equal length that are consecutive at angles of 30 degrees.

[0019] In one embodiment, the third side of the first revetment stone of the first pair of revetment stones and the fourth side of the first revetment stone of the second pair of revetment stones form a tongue-and-groove connection.

[0020] The sides may be designed to have a few functional details. For instance, at the location where the complementary sides meet, the sides in question may be formed with pairs of contacting cams for in between them

forming vertical passages between said sides.

[0021] Furthermore, at the location where the complementary sides meet, the sides in question may have been formed mutually adapted to one another in order to form a gutter-shaped recess extending in downward direction and a bottom for said recess, for realising a vertical accommodation space for grit between both sides. Grit may be arranged in them for increasing the connection, comparable to the above-mentioned RONA[®]ton. The bottoms of the accommodation spaces for grit may be situated between the pairs of contacting cams. The formed accommodation spaces for grit preferably taper slightly in downward direction, with a tapering of one or several degrees.

[0022] The revetment stones may have been formed with grooves, preferably straight grooves, in their upper sides, said grooves extending between the first and third sides and/or second and fourth sides and/or between adjacent sides. Said grooves can debouch in the sides in question. The grooves may increase the resistance to water flowing across the upper side of the assembly and may have a function in spreading the water. They may have different lengths. They may be positioned higgledy-piggledy with respect to each other. They may provide the upper side of the assembly with an irregular, random look.

[0023] At the location where the groove debouches, the side in question can be formed with a gutter-shaped recess extending in downward direction terminating at a distance above the bottom, wherein at the location of said gutter between the sides of the revetment stones placed against each other, a vertical accommodation space for grit provided with an accommodation space bottom has been formed. Grit can be arranged in the accommodation space. These formed accommodation spaces for grit also preferably taper slightly in downward direction, with a tapering of one or several degrees.

[0024] The above-mentioned passages, through which water is able to flow vertically through the revetment stone, may extend downward from the bottom of the grooves. The vertical passages then connect to the horizontal grooves which then form a kind of guide for the water exiting the passages or flowing towards the passages.

[0025] The passages may have a flat cross-section, wherein the largest (longitudinal) dimension of said cross-section is parallel to the groove in question, wherein, preferably, the width of the passages is 3 cm or smaller. In that way the erosion of the granular material located underneath the revetment stones is counteracted.

[0026] In the above-mentioned case of a rectangular assembly, the first assembly length may be 110 cm and the second assembly length 90 cm.

[0027] If connection to a covering substantially consisting of regular hexagonal revetment stones is wanted, the first connecting seam and the second connecting seam may advantageously be geared to said hexagons, so that each revetment stone of the assembly with its third or

the fourth side is able to connect to the covering of substantially regular hexagonal revetment stones. It will also be possible then to use a revetment stone for filling an end strip between a rectangular revetment stone assembly placed as the last in a series and a linear (transverse) end edge of for instance an engineering structure. The revetment stone is then placed with its straight edge against said last revetment stone assembly, after which hexagonal revetment stones and halves of such revetment stones are placed between the zigzag edge or undulating edge of said revetment stone and the linear end edge of the engineering structure.

[0028] In one embodiment, the length of the first side of the first revetment stone of the first pair of revetment stones is larger than the length of the second side of the second revetment stone of the first pair of revetment stones. In one embodiment, the length of the second side of the first revetment stone of the second pair of revetment stones is larger than the length of the first side of the second revetment stone of the second pair of revetment stones. In one embodiment, the length of the second side of the first revetment stone of the first pair of revetment stones is smaller than the length of the first side of the first revetment stone of the second pair of revetment stones, and the length of the first side of the second revetment stone of the first pair of revetment stones is smaller than the length of the second side of the second revetment stone of the second pair of revetment stones.

[0029] The first revetment stones of the first pair and/or the second pair of revetment stones will then extend further in the direction of the first assembly length, they are longer in that direction than the second revetment stones of the pair in question are. In a series of revetment stone assemblies in which the assemblies have been placed on a slope with the second assembly length in horizontal direction and the first assembly length in ascending slope direction, if the one assembly is turned 180 degrees relative to both assemblies that connect in horizontal direction, it can be achieved in that way that the joint line between both pairs of the consecutive assemblies always staggers and that there is no horizontal strip in that series in which the longer revetment stones are lacking.

[0030] In the case of an assembly consisting of a first pair of revetment stones and a second pair of revetment stones, the lengths of the first side of the first revetment stone of the first pair and the second side of the first revetment stone of the second pair may correspond. In that way the second connecting seam may be transverse to those sides.

[0031] It is also possible that in case of an assembly consisting of a first pair of revetment stones and a second pair of revetment stones, the lengths of the first side of the first revetment stone of the first pair and the first side of the second revetment stone of the second pair correspond. To put it more generally, the length of the second side of the first revetment stone of the second pair of revetment stones will then be smaller than the length of

the first side of the second revetment stone of the second pair of revetment stones. The second connecting seam will then stagger. In that case, the aforementioned placement in series will not require placing consecutive assemblies turned 180 degrees relative to each other.

[0032] It is noted that the lengths of the revetment stones in the first longitudinal direction do not need to correspond with each other as long as within a pair the one revetment stone has a larger length than the other revetment stone.

[0033] In one embodiment, the straight first and second sides are formed with pairs of contacting cams for in between them forming vertical continuous recesses in a condition in which several assemblies have been placed against each other in series.

[0034] In one embodiment, the third and fourth sides of each revetment stone connect to each other, in particular overlapping each other in the corner area.

[0035] In one embodiment, the third and fourth sides follow a pattern corresponding to a honeycomb pattern.

[0036] In the case of an assembly of the aforementioned first and second pair of revetment stones, the second revetment stone of the first pair of revetment stones and the first revetment stone of the second pair of revetment stones may abut each other, - wherein the first revetment stone of the first pair of revetment stones and the second revetment stone of the second pair of revetment stones are spaced apart from each other.

[0037] The above-mentioned first and second connecting seams may partially coincide. That may be so in connection with the said honeycomb pattern.

[0038] According to a further aspect, the invention provides an assembly of revetment stones comprising

- a number of revetment stones,
- wherein the revetment stones each have a lower side, an upper side and a circumferential perimeter,
- wherein each revetment stone of the first pair of revetment stones is provided with passages extending between the lower side and the upper side,
- wherein the assembly has a rectangular outer perimeter and,
- wherein the revetment stones have been placed against each other and at that location define one or more connecting seams that are undulating or zig-zag-shaped.

[0039] The assembly may comprise two revetment stones, in particular two revetment stones of different sizes.

[0040] Alternatively, the assembly may comprise at least three revetment stones, in particular revetment stones of different shapes and/or sizes. In one embodiment thereof, the assembly comprises four revetment stones, wherein each revetment stone has one right angle located at the perimeter of the assembly. Two connecting seams may be defined between the revetment stones, which connecting seams are transverse to each

other, in particular parallel to the cathetuses.

[0041] The one or more connecting seams follow a pattern corresponding to a honeycomb pattern. The pattern of hexagonal RONA[®]ton revetment stones particularly comes to mind.

[0042] According to further aspect, the invention provides a method for placing the aforementioned revetment stone assemblies, - wherein the revetment stone assemblies have been formed by joining a first pair of revetment stones and the second pair of revetment stones together into a rectangle, and

the revetment stone assemblies are placed on a slope in longitudinal series, which longitudinal series connect to each other in the direction of the incline.

[0043] If rectangular revetment stone assemblies are used that have a first assembly length that is larger than the second assembly length, the revetment stone assemblies can be placed with the first assembly length parallel to the direction of incline.

[0044] As described above, the revetment stone assemblies can then be placed with the orientation of each revetment stone assembly in a direction of incline that is the opposite of the one of the adjacent revetment stone assemblies.

[0045] According to a further aspect, the invention provides a bank protection comprising a number of revetment stone assemblies according to the invention.

[0046] According to a further aspect, the invention provides a bottom protection comprising a number of revetment stone assemblies according to the invention.

[0047] According to a further aspect, the invention provides a dike covering comprising a number of revetment stone assemblies according to the invention.

[0048] The aspects and measures described in this description and the claims of the application and/or shown in the drawings of this application may where possible also be used individually. Said individual aspects may be the subject of divisional patent applications relating thereto. This particularly applies to the measures and aspects that are described per se in the sub claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0049] The invention will be elucidated on the basis of a number of exemplary embodiments shown in the attached drawings, in which:

Figures 1A-C, 2A-C, 3A-C and 4A-C show an isometric view, a top view and a bottom view, respectively, of a first, second, third and fourth revetment stone, respectively, of a first example of a revetment stone assembly according to the invention; Figures 5A and 5B show the revetment stones of figures 1 - 4 in a condition in which they lie apart and in a joined condition, respectively; Figure 6A shows a top view of a slope covering consisting of assemblies according to figure 5B; Figures 6B and 6C show two details of a connection

of revetment stones according to the invention on an existing covering consisting of hexagonal revetment stones;

Figure 7 shows a second example of a revetment stone assembly according to the invention; and

Figure 8 shows a third example of a revetment stone assembly according to the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0050] In figures 1A-C, a first revetment stone 1.1, made of concrete, of a first pair of revetment stones is depicted, which revetment stone 1.1 has a perimeter 5a, an upper side 6a and a lower side 7a. The perimeter 5a is defined by a first side 1a and a second side 2a, each defining a cathetus. The second side 2a connects to the third side 3a, and the first side 1a connects to the fourth side 4a. The third and fourth sides 3a, 4a substantially follow a pattern of a bond of regular hexagons (honeycombs), wherein the third side 3a has a sheet-pile wall profile-like look and the fourth side 4a is zigzag-shaped.

[0051] In figures 2A-C, a second revetment stone 1.2, made of concrete, of the first pair of revetment stones is depicted, which revetment stone 1.2 has a perimeter 5b, an upper side 6b and a lower side 7b. The perimeter 5b is defined by a first side 1b and a second side 2b, each defining a cathetus. The second side 2b connects to the third side 3b, and the first side 1b connects to the fourth side 4b. The third and fourth sides 3b, 4b substantially follow a pattern of a bond of regular hexagons (honeycombs), wherein the fourth side 4b has a sheet-pile wall profile-like look and the third side 3b is zigzag-shaped.

[0052] In figures 3A-C, a first revetment stone 2.1, made of concrete, of a second pair of revetment stones is depicted, which revetment stone 2.1 has a perimeter 5c, an upper side 6c and a lower side 7c. The perimeter 5c is defined by a first side 1c and a second side 2c, each defining a cathetus. The second side 2c connects to the third side 3c, and the first side 1c connects to the fourth side 4c. The third and fourth sides 3c, 4c substantially follow a pattern of a bond of regular hexagons (honeycombs), wherein the fourth side 4c has a sheet-pile wall profile-like look and the third side 3c is zigzag-shaped.

[0053] In figures 4A-C, a second revetment stone 2.2, made of concrete, of the second pair of revetment stones is depicted, which revetment stone 2.2 has a perimeter 5d, an upper side 6d and a lower side 7d. The perimeter 5d is defined by a first side 1d and a second side 2d, each defining a cathetus. The second side 2d connects to the third side 3d, and the first side 1d connects to the fourth side 4d. The third and fourth sides 3d, 4d substantially follow a pattern of a bond of regular hexagons (honeycombs), in particular that of the commercially available revetment stone RONA[®]ton, wherein the third side 3d has a sheet-pile wall profile-like look and the fourth side 4d is zigzag-shaped.

[0054] All four revetment stones 1.1, 1.2, 2.1, 2.2 have been provided with continuous vertical passages 8a-8d,

extending from the lower side 7a-d to the upper side 6a-d. The passages 8a-d have a cross-section having the shape of an elongated hole, with a width not exceeding 3 cm. The passages 8a-d debouch in straight grooves 9 formed in the upper side, which grooves have a width corresponding to that of the passages 8a-d and a depth of comparable dimensions. The grooves 9 extend between two sides, in most cases between two opposite sides, such as sides 1 and 3 and sides 2 and 4, sometimes between adjacent sides, such as between sides 2a and 3a of revetment stone 1.1. Due to the grooves 9, each revetment stone acquires an irregular surface having scattered pentagons, hexagons, heptagons. In the example, the revetment stone shows eight polygons in its upper side, revetment stone 1.2 shows six polygons, revetment stone 2.1 shows ten polygons and revetment stone 2.2 shows seven polygons. As can be seen in the assembly of figure 5B, a random look is thus acquired, which may provide a covering with a rough and natural look and which can boost a random distribution of vegetation, such as grasses.

[0055] The grooves 9 debouch in the perimeter 5 at the location of vertical recesses 10 formed in the perimeter, which recesses have a bottom 11 that is located at a distance above the lower side 7 of the revetment stone in question. The vertical recesses 10 are designed to form accommodation spaces for grit 30 (figure 5B) in the sides of adjacent revetment stones together with recesses 12 that have been provided with bottoms 13.

[0056] In their perimeters, the revetment stones 1.1, 1.2, 2.1, 2.2 have furthermore been provided with pairs of vertically extending cams 14, which in between them define a vertical recess 15, which in cooperation with pairs of cams of adjacent revetment stones, also define vertical passages.

[0057] As can be seen in figures 5A and 5B, the third and fourth sides 3a-4c and 4b-3d are formed so as to be complementary to one another. It can also be seen that the third and fourth sides 4a-3b and 4d-3c have been formed so as to be complementary to one another. As a result, as can be seen in figure 5B, the four revetment stones 1.1, 1.2, 2.1, 2.2 are capable of being fitted into/against each other such that a revetment stone assembly 20 is obtained having a rectangular perimeter 25.

[0058] The revetment stone assembly 20 has a length L_s and a width B_s of, in this example, 110 cm x 90 cm (approximately). The revetment stones 1.1 and 2.1 have lengths L_a and L_b that are mutually almost equal and are each larger than the lengths L_c and L_d of revetment stones 1.2 and 2.2. By fitting the revetment stones into each other, the assembly length and assembly width exceeds the sum of the largest lengths/widths of the revetment stones.

[0059] In the assembly 20, the abutting third and fourth sides of the four revetment stones form two connecting seams 21 and 22 that are transverse to each other. Due to the honeycomb shape the connecting seams 21 and 22 overlap each other at the location of partial surfaces

34' and 34", see figure 5A. The connecting seam 21 follows a sheet-pile wall profile course, and the connecting seam 22 follows a zigzag course.

[0060] The assembly 20 has been provided with grooves 9a-d scattered across its surface for spreading water across the surface and with passages 8a-d and passages 23 scattered across its surface, which have been formed by the recesses 15. As a result, confined water is able to escape upwards from underneath the assembly and lifting forces exerted on the revetment stones of the assembly are limited, in particular in the narrow zone just below the location where a wave hits the covering.

[0061] Due to their oblong shape, the passages 8 in each revetment stone and the passages 23 between the revetment stones, with the limited width, counteract upward escape of granular material from underneath the revetment stones. The passages are scattered across the revetment stone and across the assembly, as well as in case of several assemblies placed against each other across the covering. The percentage of hollow space in the bottom surface of the covering may amount to approximately 10% to 11%.

[0062] When placed as a covering 100 on a slope, the assemblies 20 can be placed in horizontal series with the long sides against each other, and then alternating, as shown in figure 6A. As a result, the zigzag seam 22 staggers, wherein in a situation in which a wave-induced hydraulic load is exerted on a covering, distributed across the length, the larger and more heavyweight revetment stones 1.1 and 2.1 are always loaded as well, so not just the smaller, more lightweight revetment stones 1.2 and 2.2. As a result the design can be more lightweight.

[0063] Once the covering has been installed, grit can be washed in so the accommodation spaces for grit 30 that slightly taper in downward direction and have been formed by the recesses 10 and 12 between the revetment stones within an assembly and the accommodation spaces for grit between the assemblies are filled with grit. Filling the downwardly slightly tapering recesses with grit ensures that relative to each other, the revetment stones placed against each other show limited vertical upward movement.

[0064] By constructing the covering from assemblies of revetment stones instead of covering plates of similar dimensions, a warning function is obtained, as the vertical subsiding of one revetment stone will make clear that the substrate has been washed out.

[0065] The covering 100 of figure 6A may in various ways connect to a covering of substantially regular hexagonal revetment stones, like the above-mentioned RONATON revetment stones.

[0066] Two examples thereof have been depicted in figures 6B and 6C. In figure 6B, the edge of a covering or addition 200 of a pattern of substantially hexagonal revetment stones 201 is depicted, which forms an edge 203 and an edge 204, which are shaped like a sheet-pile wall or are zigzag-shaped, respectively. The dimensions

of the revetment stone 2.1 is geared such to the dimensions of the hexagonal revetment stones 201, that the sides 4c and 3c and the edges 203 and 204 are complementary to one another, so that a perfect connection is obtained.

[0067] In figure 6C the covering or addition of the hexagonal revetment stones 201 having the edge 203, connects to the sides 4c and 4b of the revetment stones 2.1 and 1.2, respectively.

[0068] Said addition can be or have been placed between a rectangular revetment stone assembly placed last and a linear end edge of for instance an engineering structure.

[0069] Figure 7 depicts the possibility of an alternative joining with the revetment stones 1.1, 1.2, 2.1 and 2.2 discussed above, wherein the longer revetment stones 1.1 and 2.1 are situated in diametrically opposing corners. As a result, in the assembly 20' shown, the connecting seam 21' continues in the shape of a sheet-pile wall, but there is a staggering in the connecting seam 22'. Similar to the staggering in the covering of figure 6A. To achieve the same effect as in figure 6A, the assemblies 20' can be placed in the same orientation in a covering.

[0070] In figure 8 a further alternative is depicted, in which the assembly 20" has dimensions comparable to those of the assemblies 20 and 20', but wherein the assembly 20" has been constructed from only two revetment stones 1 and 2, wherein the integrally formed revetment stone 1 has the shape and dimensions of the revetment stones 1.1 and 2.1 joined together, and the integrally formed revetment stone 2 has the shape and dimensions of the revetment stones 1.2 and 2.2. In that case there will be one connecting seam 21" within the assembly 20". The alternative similar to figure 7 is also possible here, wherein the one revetment stone has the shape and dimensions of the revetment stones 1.1 and 2.2 and the other revetment stone has the shape and dimensions of the revetment stones 1.2 and 2.1. Other combinations are possible.

[0071] Alternatively, it is possible that the revetment stones have a comparable length in the longitudinal direction of the assembly. It is also possible to construct an assembly from two identical revetment stones, such as two revetment stones 1 (each a unity of revetment stones 1.1 and 2.1), or from two identical stones 2 (each a unity of revetment stones 1.2 and 2.2).

[0072] The invention is/inventions are not at all limited to the embodiments discussed in the description and shown in the drawings. The above description has been included to illustrate the operation of preferred embodiments of the invention and not to limit the scope of the invention.

[0073] Starting from the above explanation many variations that fall within the spirit and scope of the present invention will be evident to a skilled person. Variations of the parts described in the description and shown in the drawings are possible. They can be used individually

in other embodiments of the invention(s). Parts of the various examples given can be combined together.

Claims

1. Assembly of revetment stones, comprising

- a first pair of revetment stones consisting of a first revetment stone and a second revetment stone, 10
- wherein the revetment stones each have a lower side, an upper side and a circumferential perimeter,
- wherein each revetment stone of the first pair of revetment stones is provided with passages extending between the lower side and the upper side, and 15
- wherein the circumferential perimeter of each revetment stone comprises a first straight side and a second straight side that connect to each other at a right angle, 20
- wherein the circumferential perimeter of the first revetment stone comprises a third side and a fourth side and the circumferential perimeter of the second revetment stone comprises a third side and a fourth side, 25
- wherein the fourth side of the first revetment stone and the third side of the second revetment stone are formed complementary to one another and seen in top view have an undulating or zigzag shape, 30
- wherein the second and third sides of the second revetment stone connect to each other and the first and fourth sides of the first revetment stone connect to each other, and 35
- wherein in a condition in which the fourth side of the first revetment stone and the third side of the second revetment stone are placed against each other so as to complement one another, the first straight side of the first revetment stone and the second straight side of the second revetment stone are aligned with each other. 40

2. Assembly according to claim 1, furthermore comprising 45

- a second pair consisting of a first revetment stone and a second revetment stone, 50
- wherein the revetment stones each have a lower side, an upper side and a circumferential perimeter,
- wherein each revetment stone of the second pair of revetment stones is provided with passages extending between the lower side and the upper side, and 55
- wherein in the second pair of revetment stones, the circumferential perimeter of each revetment

stone comprises a first straight side and a second straight side that connect to each other at a right angle,

- wherein in the second pair of revetment stones, the circumferential perimeter of the first revetment stone comprises a third side and a fourth side and the circumferential perimeter of the second revetment stone comprises a third side and a fourth side,

- wherein in the second pair of revetment stones, the third side of the first revetment stone and the fourth side of the second revetment stone are formed complementary to one another and seen in top view have an undulating or zigzag shape,

- wherein in the second pair of revetment stones, the second and third sides of the first revetment stone connect to each other and the first and fourth sides of the second revetment stone connect to each other, and

- wherein in the second pair of revetment stones, in a condition in which the third side of the first revetment stone and the fourth side of the second revetment stone are placed against each other so as to complement one another, the second straight side of the first revetment stone and the first straight side of the second revetment stone are aligned with each other.

3. Assembly according to claims 1 or 2,

- wherein the third side and the fourth side of the first and the second revetment stones, respectively, of the first pair of revetment stones are straight and aligned with each other, and/or

- wherein the fourth side and the third side of the first and the second revetment stones, respectively, of the second pair of revetment stones are straight and aligned with each other.

4. Assembly according to claim 2,

- wherein the third side of the first revetment stone of the first pair of revetment stones and the fourth side of the first revetment stone of the second pair of revetment stones are formed complementary to one another and seen in top view have an undulating or zigzag shape,

- and the third side of the first revetment stone of the first pair of revetment stones in a corner connects to the second side of the first revetment stone of the first pair of revetment stones and the fourth side of the first revetment stone of the second pair of revetment stones in a corner connects to the first side of the first revetment stone of the second pair of revetment stones, and/or

- wherein the fourth side of the second revetment stone of the first pair of revetment stones and

the third side of the second revetment stone of the second pair of revetment stones are formed complementary to one another and seen in top view have an undulating or zigzag shape,

- and the fourth side of the second revetment stone of the first pair of revetment stones in a corner connects to the first side of the second revetment stone of the first pair of revetment stones and the third side of the second revetment stone of the second pair of revetment stones in a corner connects to the second side of the second revetment stone of the second pair of revetment stones.

5. Assembly according to claims 2, 3 or 4,

- wherein the first pair of revetment stones and the second pair of revetment stones are designed to be joined together into a condition,

- in which the second straight side of the first revetment stone of the first pair of revetment stones and the first straight side of the first revetment stone of the second pair of revetment stones are aligned with each other; and

- in which the first straight side of the second revetment stone of the first pair of revetment stones and the second straight side of the second revetment stone of the second pair of revetment stones are aligned with each other, wherein, preferably,

- the first straight side of the first revetment stone of the first pair of revetment stones and the second straight side of the second revetment stone of the first pair of revetment stones together define a first assembly length, and

- the second side of the first revetment stone of the first pair of revetment stones and the first side of the first revetment stone of the second pair of revetment stones together define a second assembly length,

- wherein the first assembly length is larger than the second assembly length.

6. Assembly according to claims 3, 4 or 5,

wherein the first pair of revetment stones and the second pair of revetment stones are designed to be joined together into a condition:

- in which the complementary fourth and third sides of the first and second revetment stones, respectively, of the first pair of revetment stones and the complementary third and fourth sides of the first and second revetment stones, respectively, of the second pair of revetment stones form a first continuous undulating or zigzag-shaped connecting seam,

and/or

wherein the first pair of revetment stones and the second pair of revetment stones are designed to be joined together into a condition:

- in which the complementary third and fourth sides of the first revetment stones of the first pair and the second pair of revetment stones, respectively, and the complementary fourth and third sides of the second revetment stones of the first pair and second pair of revetment stones, respectively, form a second continuous undulating or zigzag-shaped connecting seam,

wherein, preferably, the first connecting seam and the second connecting seam are substantially transverse to each other, wherein, preferably, the second connecting seam has the shape of an undulating sheet-pile wall, according to a honeycomb course with side portions of equal length that are consecutive at angles of 60 degrees, wherein the first connecting seam can be zigzag-shaped, having side portions of equal length that are consecutive at angles of 30 degrees.

7. Assembly according to any one of the preceding claims, wherein at the location where the complementary sides meet, the sides in question:

- have been formed with pairs of contacting cams for in between them forming vertical passages between the said sides and/or

- have been formed in mutual coordination in order to form a gutter-shaped recess extending in downward direction and a bottom for said recess, for realising a vertical accommodation space for grit between both sides, wherein, preferably, the bottoms of the accommodation spaces for grit are situated between the pairs of contacting cams.

8. Assembly according to any one of the preceding claims, wherein the revetment stones have been formed with grooves, preferably straight grooves, in their upper sides, said grooves extending between the first and third sides and/or second and fourth sides and/or between adjacent sides,

wherein, preferably, the grooves debouch in the sides in question, and/or

the grooves divide the upper side of the revetment stones into an irregular pattern of polygons of various dimensions and shapes and/or

wherein the passages extend in downward direction from the bottom of the grooves and/or

have a flat cross-section, wherein the largest (longitudinal) dimension of said cross-section is parallel to the groove in question, wherein, preferably, the width of the passages is 3 cm or smaller.

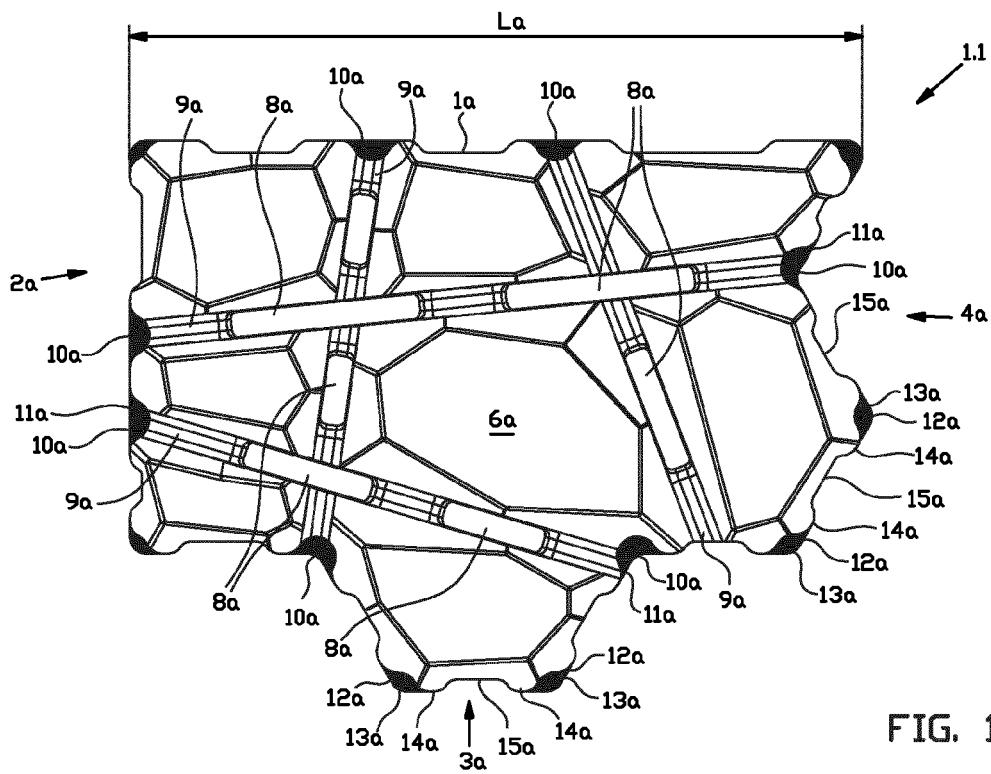
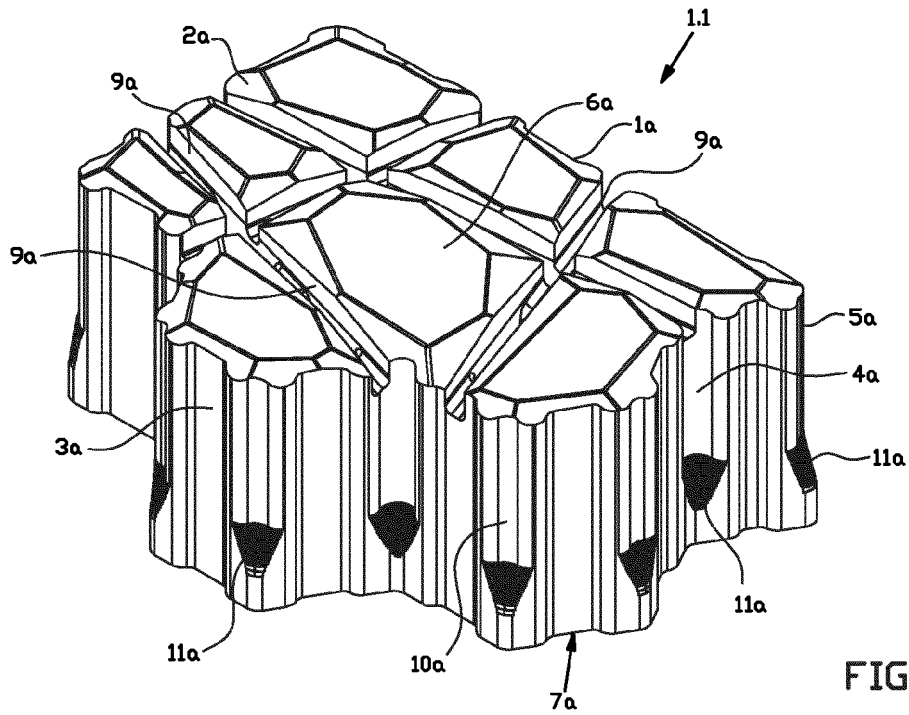
9. Assembly according to claim 8, wherein at the location where the groove debouches, the side in question has been formed with a gutter extending in downward direction terminating at a distance above the bottom, wherein at the location of said gutter between the sides of the revetment stones placed against each other, a vertical accommodation space provided with an accommodation space bottom has been formed which tapers slightly in downward direction.
10. Assembly according to any one of the preceding claims, when depending on claim 2,
- wherein the length of the first side of the first revetment stone of the first pair of revetment stones is larger than the length of the second side of the second revetment stone of the first pair of revetment stones,
 - and the length of the second side of the first revetment stone of the second pair of revetment stones is larger than the length of the first side of the second revetment stone of the second pair of revetment stones, and/or
 - wherein the length of the second side of the first revetment stone of the first pair of revetment stones is smaller than the length of the first side of the first revetment stone of the second pair of revetment stones, and the length of the first side of the second revetment stone of the first pair of revetment stones is smaller than the length of the second side of the second revetment stone of the second pair of revetment stones.
11. Assembly according to any one of the preceding claims, when depending on claim 5,
- wherein the second revetment stone of the first pair of revetment stones and the first revetment stone of the second pair of revetment stones abut each other and
 - wherein the first revetment stone of the first pair of revetment stones and the second revetment stone of the second pair of revetment stones are spaced apart from each other.
12. Assembly according to any one of the preceding claims, when depending on claim 6, wherein the first and second connecting seams partially coincide.
13. Method for placing revetment stone assemblies according to any one of the preceding claims, when

depending on claim 2, on an elongated slope,

- wherein the revetment stone assemblies have been formed by joining a first pair of revetment stones and the second pair of revetment stones together into a rectangle, and

the revetment stone assemblies are placed on the slope in longitudinal series, which longitudinal series connect to each other in the direction of the incline.

14. Method according to claim 13, wherein use is made of revetment stone assemblies according to claim 5, wherein the first assembly length is parallel to the direction of the incline.
15. Bank protection, dike covering or bottom protection, comprising a number of revetment stone assemblies according to any one of the claims 1 - 12.



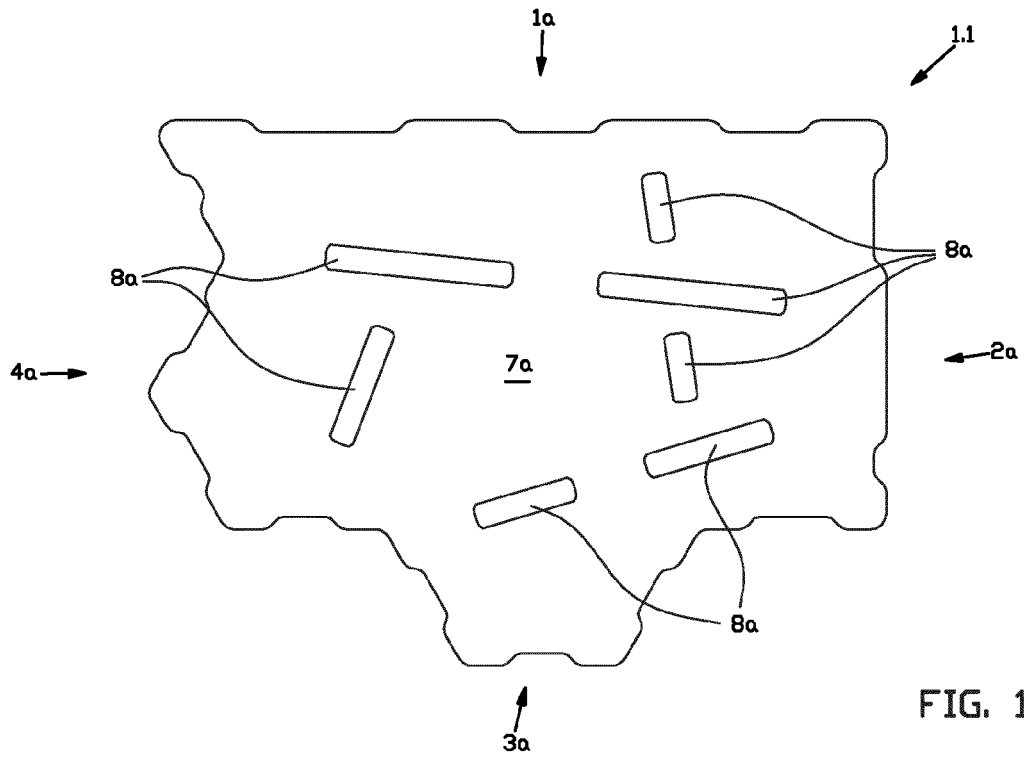


FIG. 1C

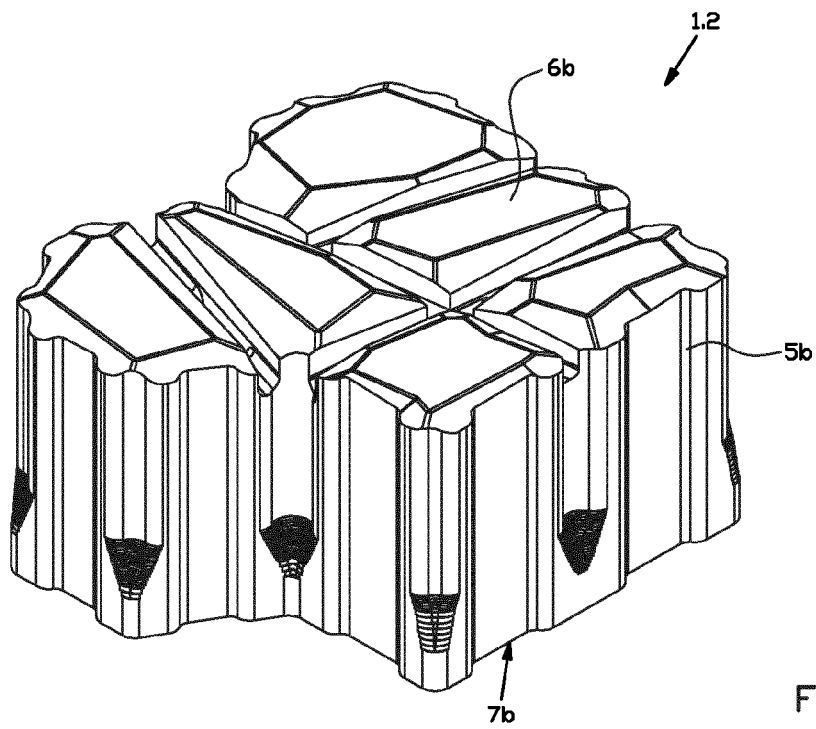


FIG. 2A

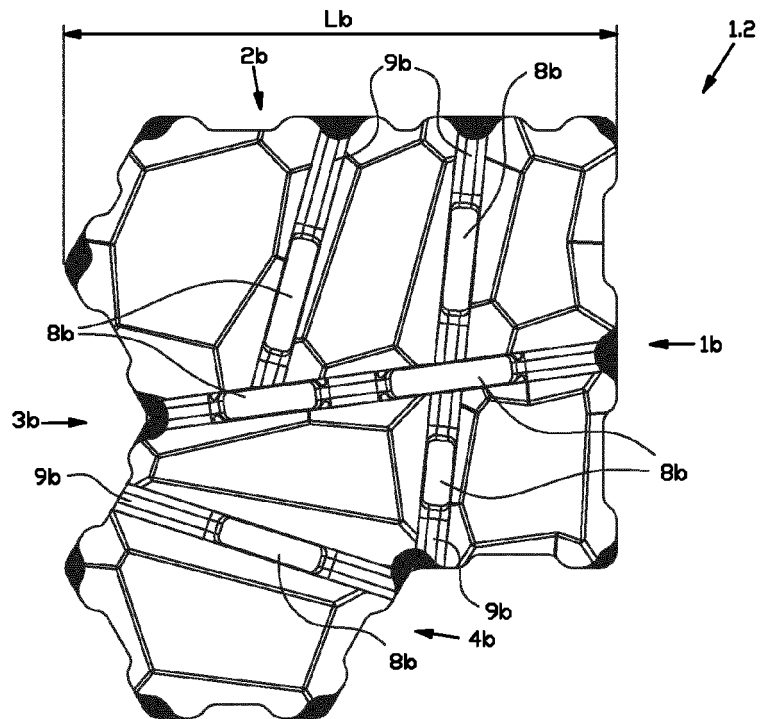


FIG. 2B

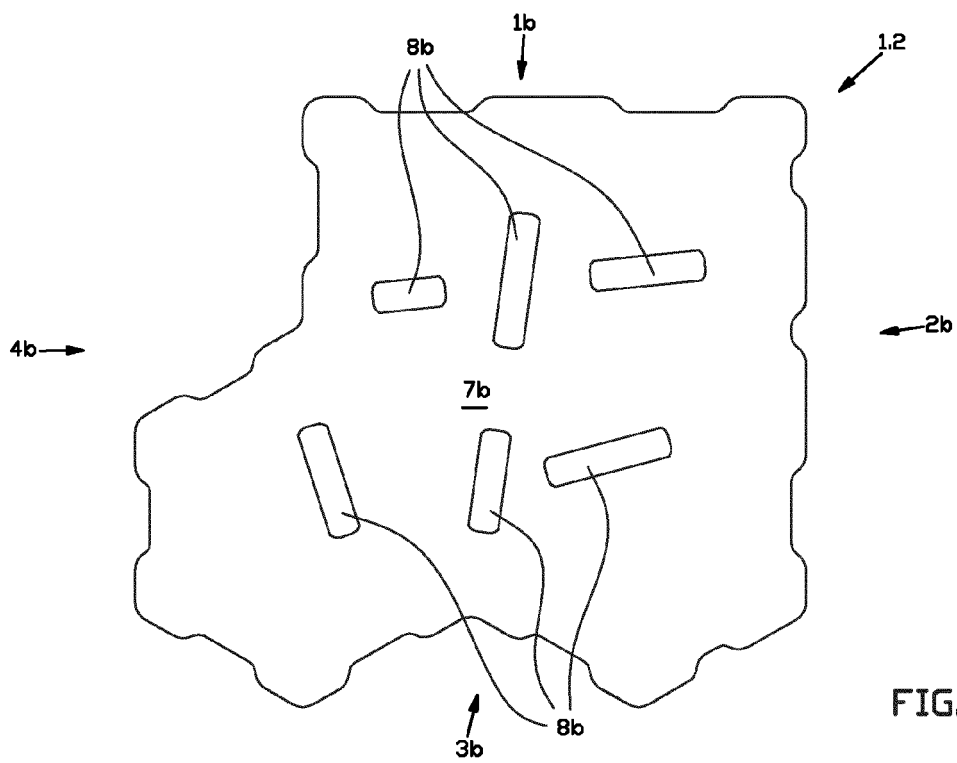


FIG. 2C

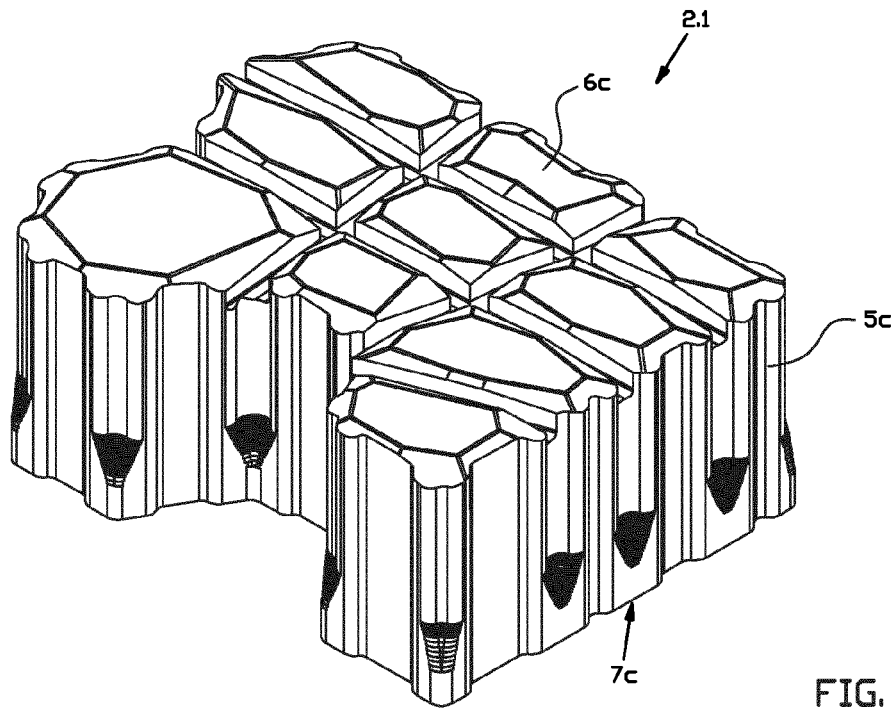


FIG. 3A

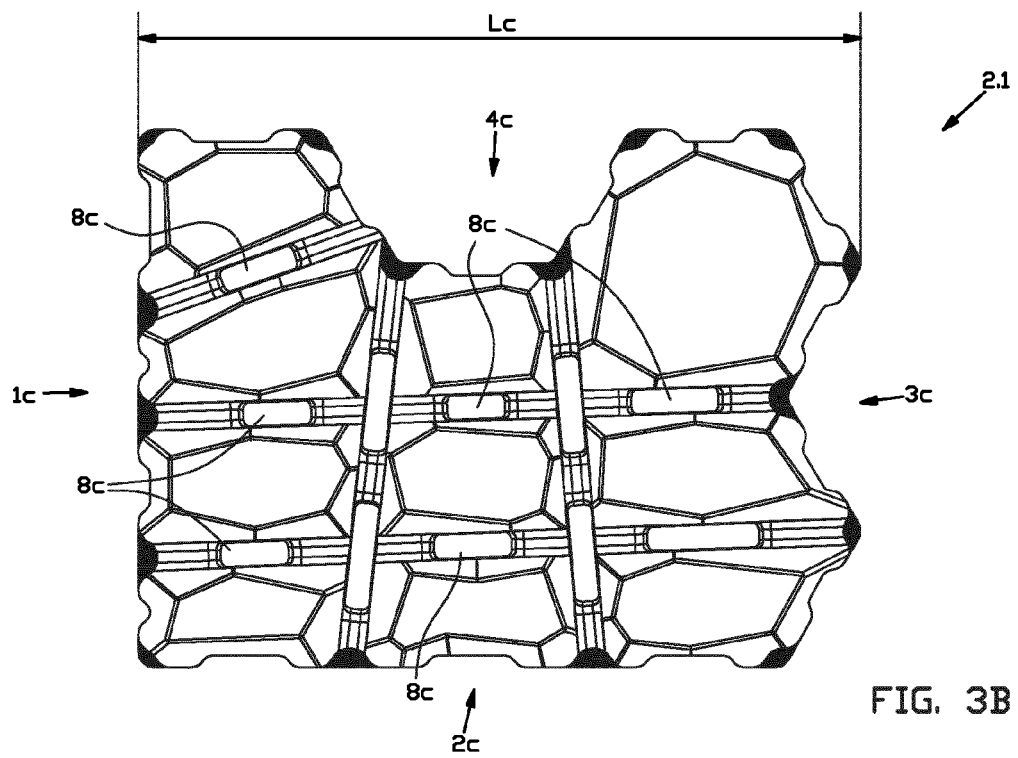


FIG. 3B

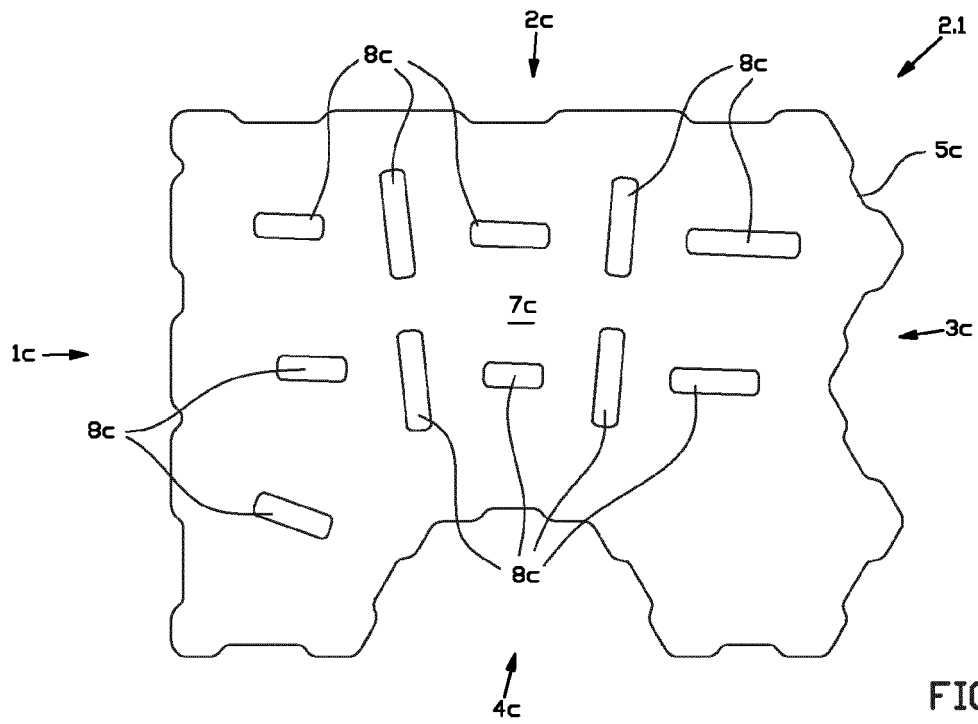


FIG. 3C

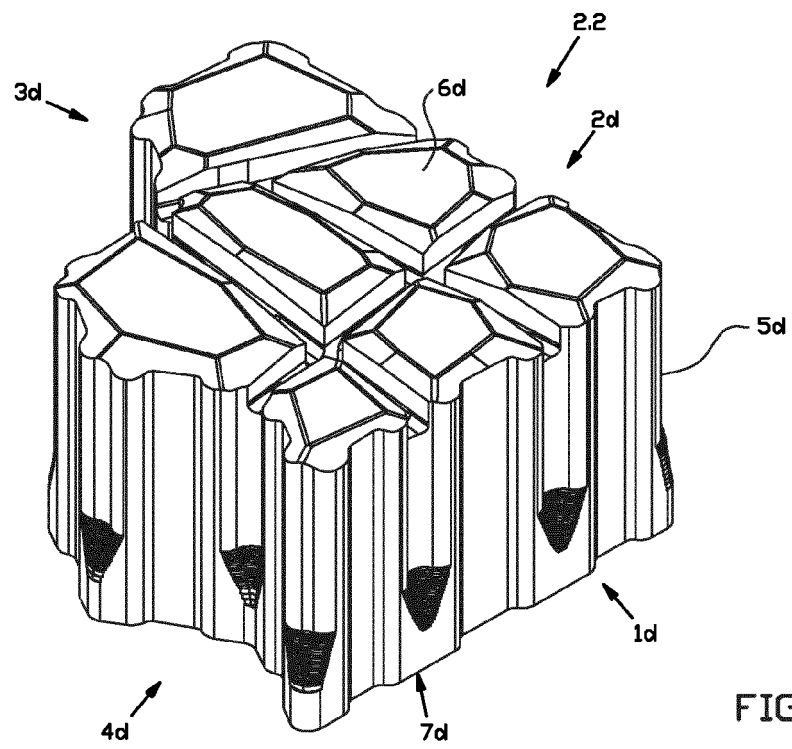
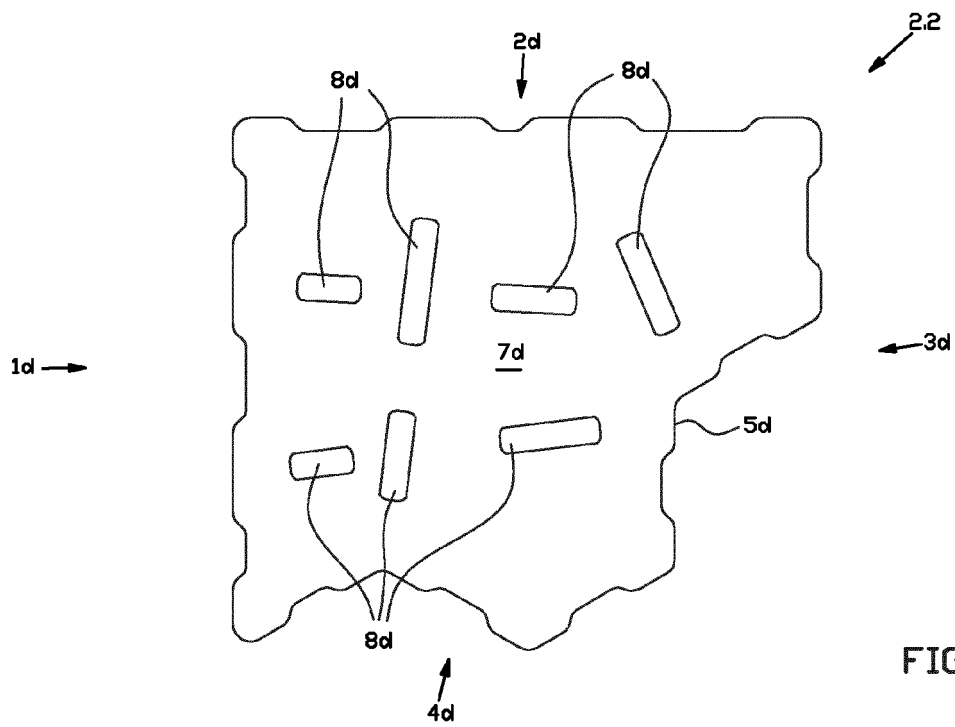
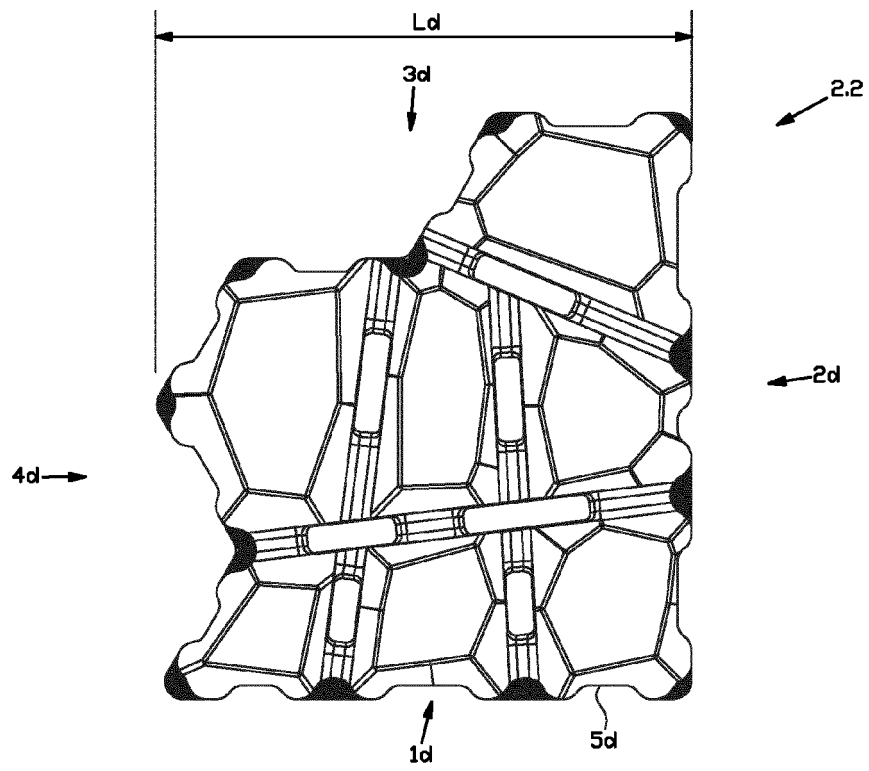


FIG. 4A



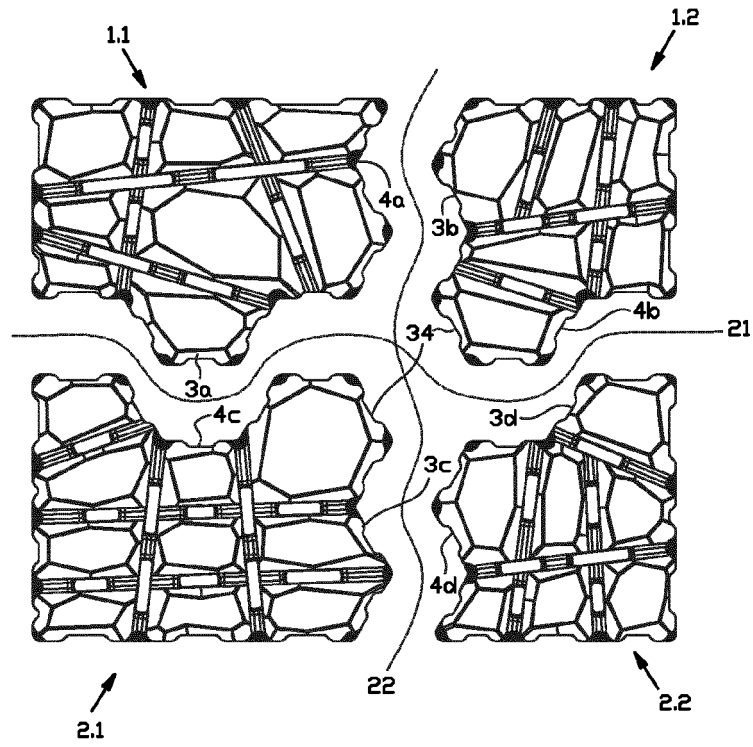


FIG. 5A

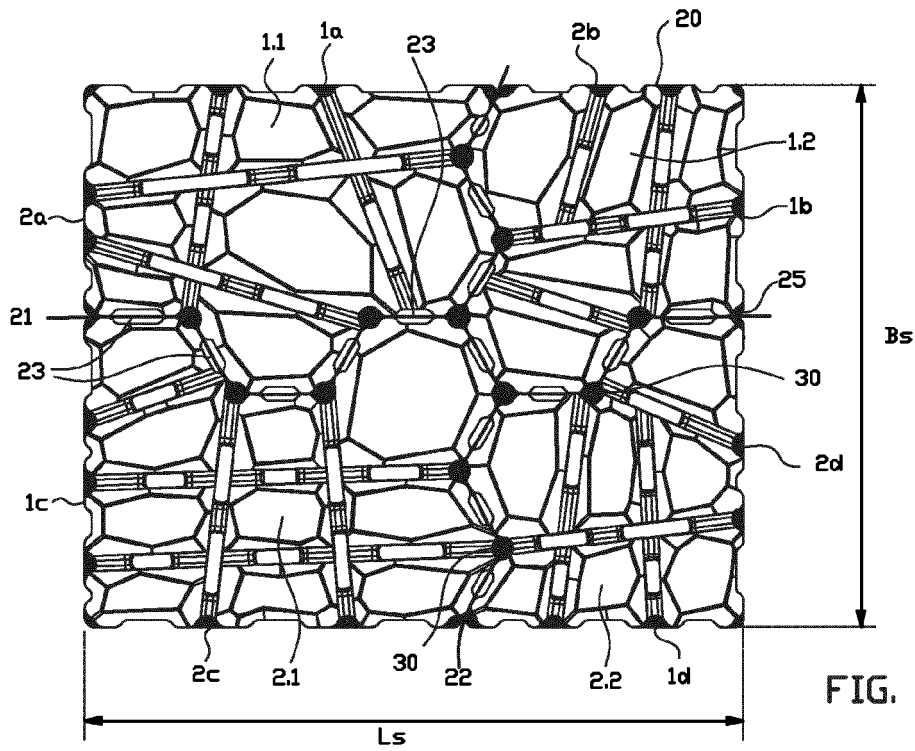


FIG. 5B

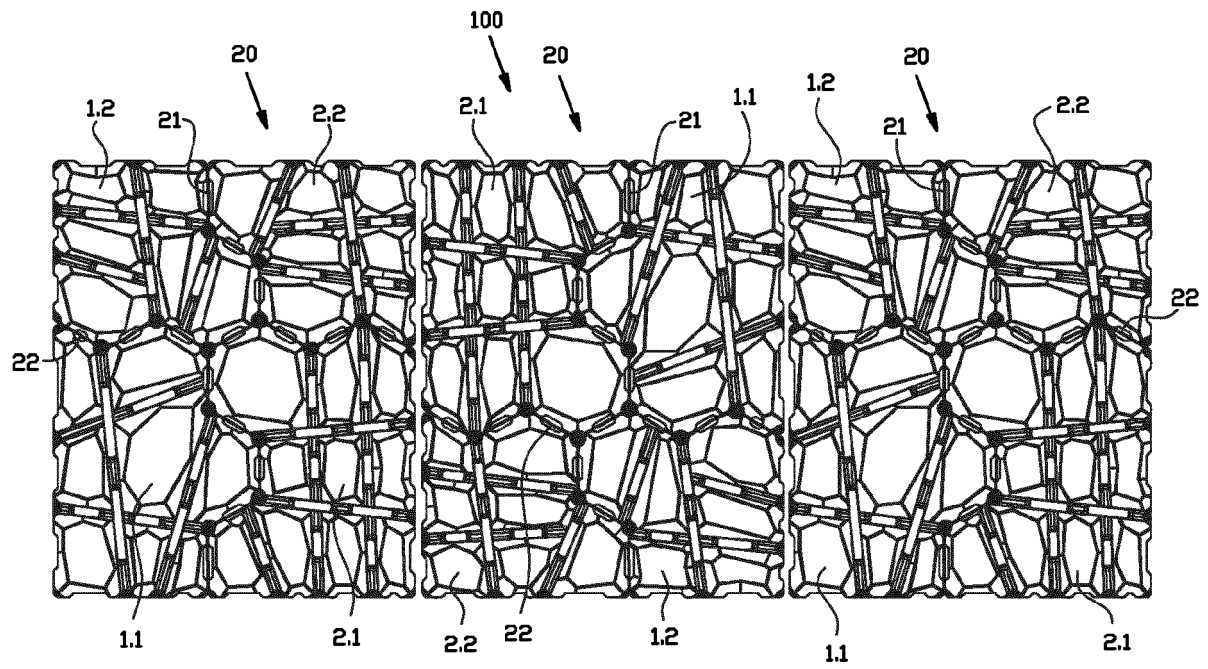


FIG. 6A

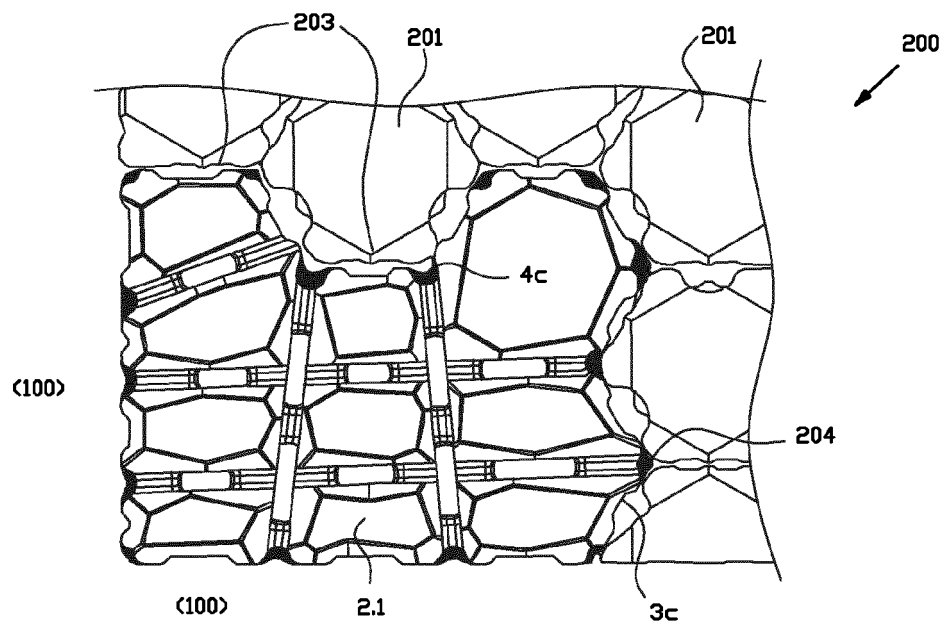


FIG. 6B

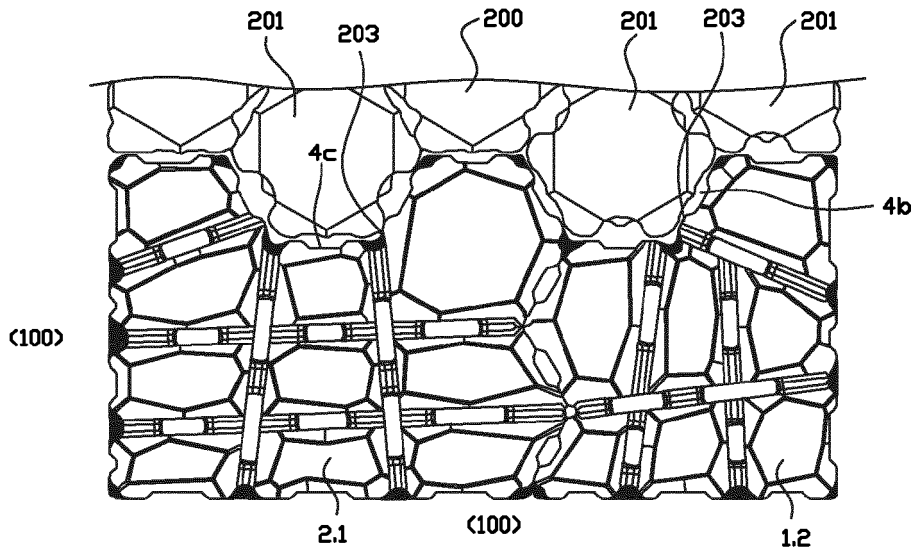


FIG. 6C

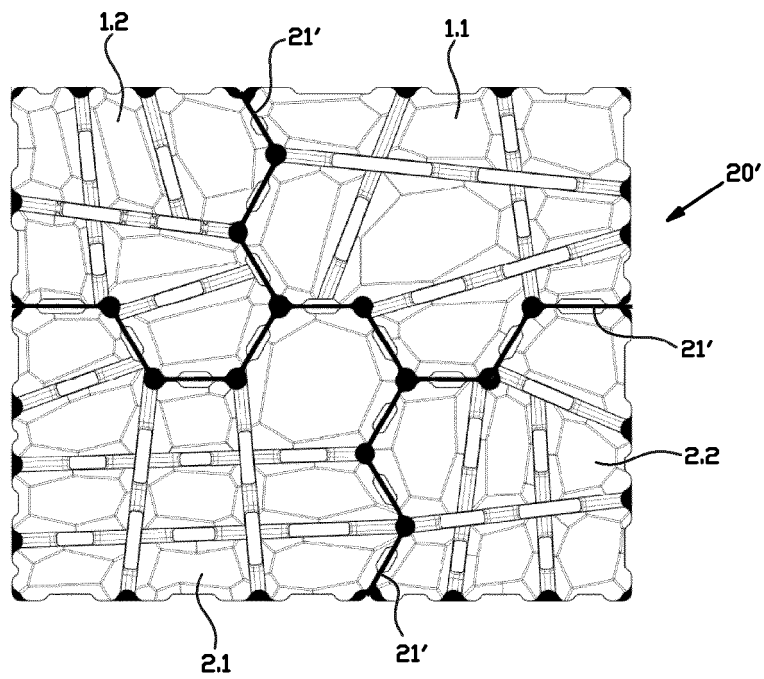


FIG. 7

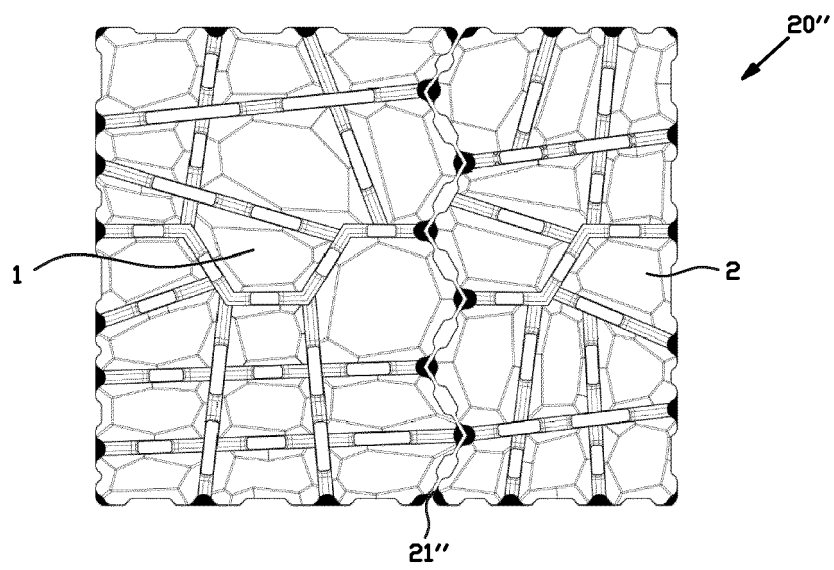


FIG. 8



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Place of search The Hague		Date of completion of the search 26 January 2023	Examiner Fordham, Alan
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