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(54) **REVETMENT FOR AN EMBANKMENT, AS WELL AS REVETMENT ELEMENT THEREFORE**

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Description

[0001] The invention is related to a revetment for an embankment, bank and the like, according to the preamble of claim 1.

[0002] A revetment of this type is disclosed in WO-A-97/43487. Said prior art revetment has revetment elements the line of symmetry of which is generally oriented in the longitudinal direction of the rows. The convexly respectively concavely shaped ends of said revetment elements offer the possibility to arrange the revetment elements according to curved patterns. Thereby, the contour of specific forms, such as of dikes, banks and the like can be followed. The openings which are left free make the revetment less vulnerable with respect to water pressure from the backside of the revetment. According to said prior art document, the revetment elements are all oriented similarly in the longitudinal direction, which offers only limited possibilities for arranging the revetment elements.

[0003] A further revetment of this type is disclosed in FR-A-2.657.638. Said prior art revetment comprises modular construction elements or revetment elements the circumference of which is formed by circular forms. One end of each revetment element has a convex circular shape, whereas the opposite end has a concave circular shape. The sides of the elements have mixed concave/convex circular shapes. This specific layout with circular shapes provides the possibility to arrange the elements next to each other, whereby a completely closed covering can be obtained. Such revetment is less fit for protecting dikes, banks and the like, as the water pressure at the back of the revetment cannot escape and thus poses the risk of destroying the revetment.

[0004] The object of the invention is therefore to provide an improved revetment which can be applied in a more flexible way and which is suitable for applications wherein an embankment is saturated with water. This object is achieved by the revetment having the features of claim 1.

[0005] In the revetment according to the invention, the longitudinal direction or direction of the line of symmetry of the revetment elements is not coincident with the longitudinal direction of the row in question, but transverse with respect to said longitudinal row direction. This offers specific advantages, which make it possible to adapt the revetment better to the form of the dike, bank or the like to be covered. For instance, the revetment elements may all be arranged in the same way with respect to their longitudinal direction or line of symmetry, according to which they are pointing in the same direction with their asymmetric part.

[0006] However, preference is given to the layout according to which the orientation of revetment elements of a row with respect to their respective line of asymmetry is opposite the orientation of revetment elements of a neighbouring row with respect to their respective line of asymmetry. Thus, the revetment elements of neighbour-

ing rows are pointing in opposite directions, that is towards each other or away from each other, with their asymmetric part.

[0007] The asymmetric form of the revetment elements can be obtained in many different ways. According to one of the possible embodiments, the revetment elements may have a generally triangular shape. Alternatively or additionally, the revetment elements may have a general T-shape.

[0008] The revetment elements have a longitudinal section and a lateral section. According to a preferred embodiment, said lateral section is positioned symmetric with respect to the line of symmetry of the revetment elements. It is then quite well possible to obtain orderly rows with oppositely oriented revetment elements in neighbouring rows. In particular, the lateral sections of neighbouring rows may protrude between each other in case the rows are shifted in longitudinal direction with respect to each other over half the longitudinal length of the revetment element.

[0009] Conversely, the longitudinal section has a longitudinal side located opposite the lateral section, said longitudinal sides of the revetment elements of neighbouring series facing each other and/or contacting each other. In this connection, a further refinement can be obtained in case the lateral section is symmetric with respect to the line of symmetry of the revetment elements.

[0010] For the purpose of obtaining open spaces, and also for allowing the revetment elements to be laid according to slight curves, the longitudinal section may have opposite ends in longitudinal direction which are convexly shaped. Additionally, the longitudinal section may have a concavely shaped longitudinal side located opposite the lateral section. The lateral section has a convexly shaped lateral end. The lateral section has opposite sides, when seen in longitudinal direction, which are concavely shaped.

[0011] These convex and concave shapes provide the revetment with openings which are desirable for preventing the build up of water pressure behind the revetment. In this connection, preferably the concavely shaped opposite sides of the lateral section have a radius of curvature which is smaller than the radius of curvature of the concavely shaped longitudinal side of the longitudinal section. Furthermore, each convexly shaped end of the longitudinal section may merge into a concavely shaped side of the lateral section.

[0012] As a result of the general T-shape of the revetment elements described before, the rows may be arranged with respect to each other in such a way that the lateral end of a revetment element of a series abuts the longitudinal sections of adjoining revetment elements of a neighbouring series.

[0013] As already mentioned before, the rows which form the rows may be laid according to several forms. According to a first possibility, the rows are rectilinear. Alternatively or additionally, the rows are curved according to a part of a circle.

[0014] The invention will now be described further with reference to examples of the revetment and of the revetment element used for the revetment as shown in the drawings.

Figure 1 shows a top view of the revetment consisting of rectilinear rows of revetment elements.

Figure 2 shows a top view of the revetment consisting of slightly curved rows of revetment elements.

Figure 3 shows a view in perspective of the revetment element used for the revetment used for the revetment according to the invention.

[0015] The revetment shown in figure 1 consists of revetment elements 1 which are arranged according to rows 2 and rows 3. It will be noted that the revetment elements 1 of the rows 2 are oriented all in the same direction, whereas the revetment elements 1 of the other rows 3 are all oriented in the opposite direction with respect to the orientation of the revetment elements 1 in rows 2. As shown in figure 3, each revetment element 1 comprises a top face 4, a bottom face 5 and a circumference 6 which stretches all around the revetment element 1 and which extends between the top face 4 and the bottom face 5. Generally speaking, said top face 4 and said the bottom face 5 are oriented parallel. The revetment elements 1 comprise a longitudinally extending section 7 as well as a transversely extending section 8. Both said longitudinally extending section 7 and said transversely extending section 8 are symmetrical with respect to the line of symmetry 9 as shown in figure 3. Furthermore, the revetment element 1 has a line of asymmetry 10 which line is shown in figure 1 as well.

[0016] The revetment element 1 in question has a general T-shape which is formed by said longitudinal section 7 and the transverse section 8. Said longitudinal section 7 has opposite ends 11, 12 in longitudinal direction which are convexly shaped. Furthermore, the longitudinal section 7 has a longitudinal side 13 opposite the lateral section 8, which longitudinal side 13 has a concave shape. Conversely, the lateral section 8 has a convexly shaped lateral end 14. Moreover, the lateral section 8 has sides 15, 16 which are located opposite each other when seen in longitudinal direction, which sides have a concave shape. The convexly shaped end 14 of the lateral section 8 merges smoothly into said concavely shaped sides 15, 16. Furthermore, said concavely shaped sides 15, 16 merge into the corresponding convexly shaped ends 11, 12 via the respective transitions 17, 18.

[0017] Now turning to the rectilinear embodiment as shown in figure 1, it is clear that the neighbouring rows 2 respectively 3 are shifted with respect to each other in the longitudinal direction, over a distance which is about equal to half the longitudinal dimension of the longitudinal section 7. Furthermore, the convexly shaped ends 11, 12 of the longitudinal sections 7 abut each other. Also, the convexly shaped ends 14 of the lateral sections 8 abut onto the longitudinal sections 7 of the revetment

elements of a neighbouring row, about at the location of the transitions 17, 18 of the concavely shaped sides 15, 16 and the convexly shaped ends 11, 12 of the neighbouring revetment elements of a neighbouring row.

[0018] As a result of the convex and concave shapes of the revetment elements 1, open spaces 19, 20 are formed between said revetment elements 1 which are beneficial for allowing water to pass through for the purposes of preventing the development of water pressure behind the revetment in question.

[0019] In the embodiment of figure 1, according to which the rows 2 are arranged rectilinearly, all elements of neighbouring rows are shifted with respect to each other over about half the length of the longitudinal section 7. This is different in the embodiment shown in figure 2, according to which embodiment the rows 2, 3 are arranged according to a circle with large radius of curvature, e.g. of 100 metres. Here, the pairs of neighbouring rows 2, 3 which are characterised by the longitudinal sections 8 thereof which are pointing towards each other, are indeed arranged in such a way that the revetment elements thereof are shifted over half the length of the longitudinal section 7. However, pairs of neighbouring rows 2, 3 which are characterised by their longitudinal sides 13 lying against each other, have revetment elements 1 which are shifted with respect to each other over a distance which is different from half the length of the longitudinal section 7. This difference is caused by the curvature of the rows.

[0020] Nevertheless, also in this arrangement open spaces 19, 20 are formed, and also open spaces 21 between pairs of abutting longitudinal sides 13.

35 Claims

1. Revetment for an embankment, bank and the like, comprising revetment elements (1) which have parallel bottom (5) and top (4) surfaces and which are arranged according to rows (2, 3) which are positioned next to each other in transverse direction, said rows (2, 3) each extending in longitudinal direction, each revetment (1) element being symmetric with respect to a line of symmetry (9) and asymmetric with respect to a line of asymmetry (10) which is perpendicular with respect to the line of symmetry (9), open spaces (19-21) being enclosed between subsequent revetment elements (1) of a row (2, 3) and between revetment elements (1) of neighbouring rows (2, 3) the lines of symmetry (9) of the revetment elements (1) are oriented in the transverse direction, and the revetment elements (1) which are arranged according to a single row (2, 3) have the same orientations with respect to their respective line of asymmetry (10), **characterised in that** the revetment elements (1) have a longitudinal section (7) and a lateral section (8), and **in that** the lateral section (8) has sides (15, 16) located opposite each other

er when seen in longitudinal direction, which sides (15, 16) are concavely shaped, and **in that** the longitudinal sections (7) have convexly shaped opposite ends (11, 12) which abut an opposite end of a neighbouring element.

2. Revetment according to claim 1, wherein the orientation of revetment elements (1) of a row (2, 3) with respect to their respective line of asymmetry (10) is opposite the orientation of revetment elements (1) of a neighbouring row (2, 3) with respect to their respective line of asymmetry (10).
3. Revetment according to claim 1 or 2, wherein the lines of symmetry (9) of the revetment elements (1) are oriented perpendicularly with respect to the longitudinal direction.
4. Revetment according to any of the preceding claims, wherein the revetment elements (1) have a generally triangular shape.
5. Revetment according to any of the preceding claims, wherein the revetment elements (1) have a general T-shape.
6. Revetment according to any of the preceding claims, wherein the lateral section (8) is positioned symmetric with respect to the line of symmetry (9) of the revetment elements (1).
7. Revetment according to any of the preceding claims, wherein the lateral section (8) is symmetric with respect to the line of symmetry (9) of the revetment elements (1).
8. Revetment according to any of the preceding claims, wherein the longitudinal section (7) has opposite ends (11, 12) in longitudinal direction which are convexly shaped.
9. Revetment according to any of the preceding claims, wherein the longitudinal section (7) has a longitudinal side (13) located opposite the lateral section (8), said longitudinal sides (13) of the revetment elements (1) of neighbouring series facing each other and/or contacting each other.
10. Revetment according to claim 9, wherein the longitudinal side (13) of the longitudinal section (7) is concavely shaped.
11. Revetment according to any of the preceding claims, wherein the lateral section (8) has a convexly shaped lateral end (14).
12. Revetment according to claims 10 or 11, wherein the concavely shaped opposite sides (15, 16) of the lat-

eral section (8) have a radius of curvature which is smaller than the radius of curvature of the concavely shaped longitudinal side (13) of the longitudinal section (7).

13. Revetment according to claims 8, wherein each convexly shaped end (11, 12) of the longitudinal section (7) merges into a concavely shaped side (15, 16) of the lateral section (8).
14. Revetment according to any of the preceding claims, wherein neighbouring rows (2, 3) are shifted with respect to each other in the longitudinal direction over a distance smaller than the longitudinal dimension of a revetment element (1).
15. Revetment according to any of the preceding claims, wherein neighbouring rows (2, 3) are shifted with respect to each other in the longitudinal direction over a distance equal to half the longitudinal dimension of a revetment element (1).
16. Revetment according to claim 14 or 15, wherein the lateral end (14) of a revetment element (1) of a series abuts the longitudinal sections (7) of adjoining revetment elements (1) of neighbouring rows.
17. Revetment according to claim 16, wherein the lateral ends (14) of the revetment elements (1) of neighbouring rows (2, 3) enclose open spaces (19).
18. Revetment according to any of the preceding claims, wherein the rows (2, 3) are rectilinear.
19. Revetment according to any of claims 1-17, wherein the rows (2, 3) are curved according to a part of a circle.

Patentansprüche

1. Befestigung für einen Damm, eine Böschung und dergleichen, umfassend Befestigungselemente (1), die parallele Boden (5)- und Oberseiten (4)-Oberflächen haben und die in Reihen (2, 3) angeordnet sind, die in Querrichtung nebeneinander positioniert sind, wobei sich die Reihen (2, 3) jeweils in Längsrichtung erstrecken, jedes Befestigungselement (1) symmetrisch bezüglich einer Symmetrielinie (9) und asymmetrisch bezüglich einer Asymmetrielinie (10), die senkrecht in Bezug auf die Symmetrielinie (9) ist, ist; offene Räume (19-21) zwischen nachfolgenden Befestigungselementen (1) einer Reihe (2, 3) und zwischen Befestigungselementen (1) benachbarter Reihen (2, 3) eingeschlossen sind; die Symmetrielinie (9) der Befestigungselemente (1) in der Querrichtung orientiert sind und die Befestigungselemente (1), die in einer einzelnen Reihe (2, 3) angeordnet

- sind, dieselben Orientierungen bezüglich ihrer entsprechenden Asymmetrielinie (10) haben, **dadurch gekennzeichnet, dass** die Befestigungselemente (1) einen Längsteil (7) und einen Seitenteil (8) haben und dass der Seitenteil (8) Seiten (15, 16) hat, die einander gegenüber angeordnet sind, wenn in Längsrichtung gesehen wird, wobei die Seiten (15, 16) konkav geformt sind, und dass die Längsteile (7) konvex geformte gegenüberliegende Enden (11, 12) haben, die an einem gegenüberliegenden Ende eines benachbarten Elements anstoßen.
2. Befestigung gemäß Anspruch 1, wobei die Orientierung von Befestigungselementen (1) einer Reihe (2, 3) bezüglich ihrer entsprechenden Asymmetrielinie (10) der Orientierung von Befestigungselementen (1) einer benachbarten Reihe (2, 3) bezüglich ihrer entsprechenden Asymmetrielinie (10) entgegengesetzt ist.
 3. Befestigung gemäß Anspruch 1 oder 2, wobei die Symmetrielinien (9) der Befestigungselemente (1) bezüglich der Längsrichtung senkrecht orientiert sind.
 4. Befestigung gemäß einem der vorangehenden Ansprüche, wobei die Befestigungselemente (1) eine im Allgemeinen dreieckige Form haben.
 5. Befestigung gemäß einem der vorangehenden Ansprüche, wobei die Befestigungselemente (1) eine allgemeine T-Form haben.
 6. Befestigung gemäß einem der vorangehenden Ansprüche, wobei der Seitenteil (8) symmetrisch bezüglich der Symmetrielinie (9) der Befestigungselemente (1) positioniert ist.
 7. Befestigung gemäß einem der vorangehenden Ansprüche, wobei der Seitenteil (8) bezüglich der Symmetrielinie (9) der Befestigungselemente (1) symmetrisch ist.
 8. Befestigung gemäß einem der vorangehenden Ansprüche, wobei der Längsteil (7) gegenüberliegende Enden (11, 12) in Längsrichtung hat, die konvex geformt sind.
 9. Befestigung gemäß einem der vorangehenden Ansprüche, wobei der Längsteil (7) eine Längsseite (13), die gegenüber dem Seitenteil (8) lokalisiert ist, hat, wobei die Längsseiten (13) der Befestigungselemente (1) benachbarter Reihen einander gegenüberliegen und/oder einander berühren.
 10. Befestigung gemäß Anspruch 9, wobei die Längsseite (13) des Längsteils (7) konkav geformt ist.
 11. Befestigung gemäß einem der vorangehenden Ansprüche, wobei der Seitenteil (8) ein konvex geformtes seitliches Ende (14) hat.
 12. Befestigung gemäß Anspruch 10 oder 11, wobei die konkav geformten gegenüberliegenden Seiten (15, 16) des Seitenteils (8) einen Krümmungsradius haben, der kleiner ist als der Krümmungsradius der konkav geformten Längsseite (13) des Längsteils (7).
 13. Befestigung gemäß Anspruch 8, bei der jedes konvex geformte Ende (11, 12) des Längsteils (7) in eine konkav geformte Seite (15, 16) des Seitenteils (8) übergeht.
 14. Befestigung gemäß einem der vorangehenden Ansprüche, wobei benachbarte Reihen (2, 3) zueinander in Längsrichtung über eine Distanz, die kleiner ist als die Längsabmessung eines Befestigungselements (1) verschoben sind.
 15. Befestigung gemäß einem der vorangehenden Ansprüche, wobei benachbarte Reihen (2, 3) zueinander in Längsrichtung über eine Distanz, die gleich der Hälfte der Längsabmessung eines Befestigungselements (1) ist, verschoben sind.
 16. Befestigung gemäß Anspruch 14 oder 15, wobei das seitliche Ende (14) eines Befestigungselements (1) einer Reihe an die Längsteile (7) von angrenzenden Befestigungselementen (1) benachbarter Reihen anstößt.
 17. Befestigung gemäß Anspruch 16, wobei die seitlichen Enden (14) der Befestigungselemente (1) benachbarter Reihen (2, 3) offene Räume (19) einschließen.
 18. Befestigung gemäß einem der vorangehenden Ansprüche, wobei die Reihen (2, 3) geradlinig sind.
 19. Befestigung gemäß einem der Ansprüche 1 bis 17, wobei die Reihen (2, 3) entsprechend einem Teil eines Kreises gebogen sind.

Revendications

1. Revêtement pour une digue, un talus et similaire, comprenant des éléments de revêtement (1) qui ont des surfaces inférieure (5) et supérieure (4) parallèles et qui sont agencés selon des rangées (2, 3) qui sont positionnées les unes à côté des autres dans la direction transversale, lesdites rangées (2, 3) s'étendant chacune dans la direction longitudinale, chaque élément de revêtement (1) étant symétrique par rapport à une ligne de symétrie (9) et asymétri-

- que par rapport à une ligne d'asymétrie (10) qui est perpendiculaire par rapport à la ligne de symétrie (9), des espaces ouverts (19-21) étant enfermés entre des éléments de revêtement (1) successifs d'une rangée (2, 3) et entre des éléments de revêtement (1) de rangées de voisines (2, 3), dans lequel les lignes de symétrie (9) des éléments de revêtement (1) sont orientées dans la direction transversale, et les éléments de revêtement (1) qui sont agencés selon une seule rangée (2, 3) ont les mêmes orientations par rapport à leur ligne d'asymétrie (10) respective, **caractérisé en ce que** les éléments de revêtement (1) ont une section longitudinale (7) et une section latérale (8), et **en ce que** la section latérale (8) a des côtés (15, 16) opposés les uns aux autres, lorsqu'ils sont observés dans la direction longitudinale, lesquels côtés (15, 16) sont formés de manière concave, et **en ce que** les sections longitudinales (7) ont des extrémités opposées (11, 12) formées de manière convexe, qui viennent en butée contre une extrémité opposée d'un élément voisin.
2. Revêtement selon la revendication 1, dans lequel l'orientation des éléments de revêtement (1) d'une rangée (2, 3) par rapport à leur ligne d'asymétrie (10) respective est opposée à l'orientation des éléments de revêtement (1) d'une rangée voisine (2, 3) par rapport à leur ligne d'asymétrie (10) respective.
 3. Revêtement selon la revendication 1 ou 2, dans lequel les lignes de symétrie (9) des éléments de revêtement (1) sont orientées de manière perpendiculaire par rapport à la direction longitudinale.
 4. Revêtement selon l'une quelconque des revendications précédentes, dans lequel les éléments de revêtement (1) ont une forme généralement triangulaire.
 5. Revêtement selon l'une quelconque des revendications précédentes, dans lequel les éléments de revêtement (1) ont une forme générale en T.
 6. Revêtement selon l'une quelconque des revendications précédentes, dans lequel la section latérale (8) est positionnée symétriquement par rapport à la ligne de symétrie (9) des éléments de revêtement (1).
 7. Revêtement selon l'une quelconque des revendications précédentes, dans lequel la section latérale (8) est symétrique par rapport à la ligne de symétrie (9) des éléments de revêtement (1).
 8. Revêtement selon l'une quelconque des revendications précédentes, dans lequel la section longitudinale (7) a des extrémités (11, 12) opposées dans la direction longitudinale qui sont formées de manière convexe.
 9. Revêtement selon l'une quelconque des revendications précédentes, dans lequel la section longitudinale (7) a un côté longitudinal (13) positionné de manière opposée à la section latérale (8), lesdits côtés longitudinaux (13) des éléments de revêtement (1) des séries voisines se faisant face et/ou étant en contact les uns par rapport aux autres.
 10. Revêtement selon la revendication 9, dans lequel le côté longitudinal (13) de la section longitudinale (7) est formé de manière concave.
 11. Revêtement selon l'une quelconque des revendications précédentes, dans lequel la section latérale (8) a une extrémité latérale (14) de forme convexe.
 12. Revêtement selon les revendications 10 ou 11, dans lequel les côtés opposés (15, 16) de forme concave de la section latérale (8) ont un rayon de courbure qui est inférieur au rayon de courbure du côté longitudinal (13) de forme concave de la section longitudinale (7).
 13. Revêtement selon la revendication 8, dans lequel chaque extrémité (11, 12) de forme convexe de la section longitudinale (7) se fond dans un côté (15, 16) de forme concave de la section latérale (8).
 14. Revêtement selon l'une quelconque des revendications précédentes, dans lequel les rangées voisines (2, 3) sont décalées les unes par rapport aux autres dans la direction longitudinale sur une distance inférieure à la dimension longitudinale d'un élément de revêtement (1).
 15. Revêtement selon l'une quelconque des revendications précédentes, dans lequel les rangées voisines (2, 3) sont décalées les unes par rapport aux autres dans la direction longitudinale sur une distance égale à la moitié de la dimension longitudinale d'un élément de revêtement (1).
 16. Revêtement selon la revendication 14 ou 15, dans lequel l'extrémité latérale (14) d'un élément de revêtement (1) d'une série vient en butée contre les sections longitudinales (7) des éléments de revêtement (1) attenants des rangées voisines.
 17. Revêtement selon la revendication 16, dans lequel les extrémités latérales (14) des éléments de revêtement (1) des rangées voisines (2, 3) enferment des espaces ouverts (19).
 18. Revêtement selon l'une quelconque des revendications précédentes, dans lequel les rangées (2, 3) sont rectilignes.
 19. Revêtement selon l'une quelconque des revendica-

tions 1 à 17, dans lequel les rangées (2, 3) sont incurvées selon une partie d'un cercle.

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Fig 1

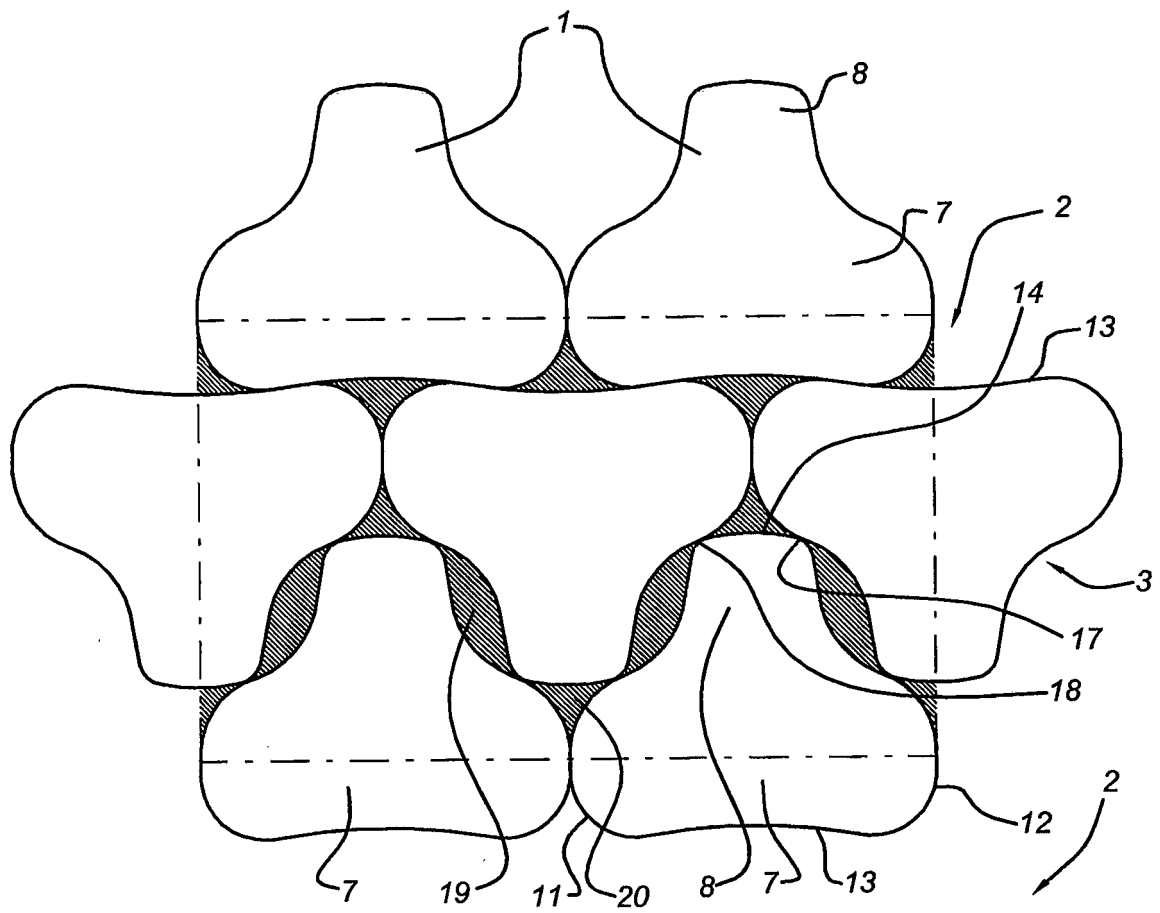


Fig 2

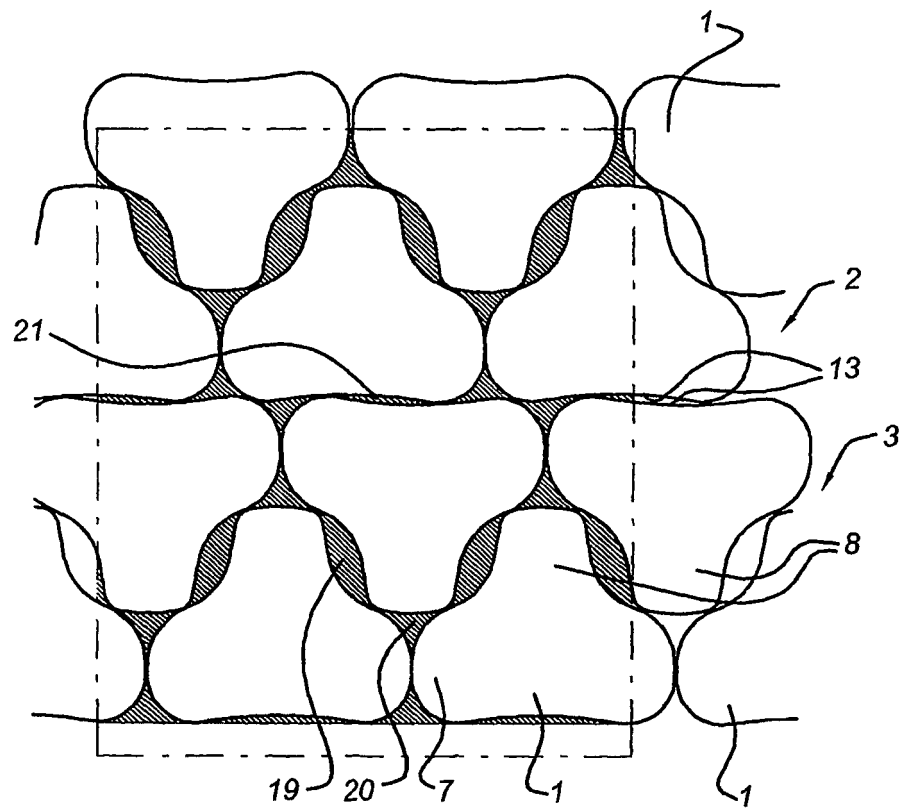
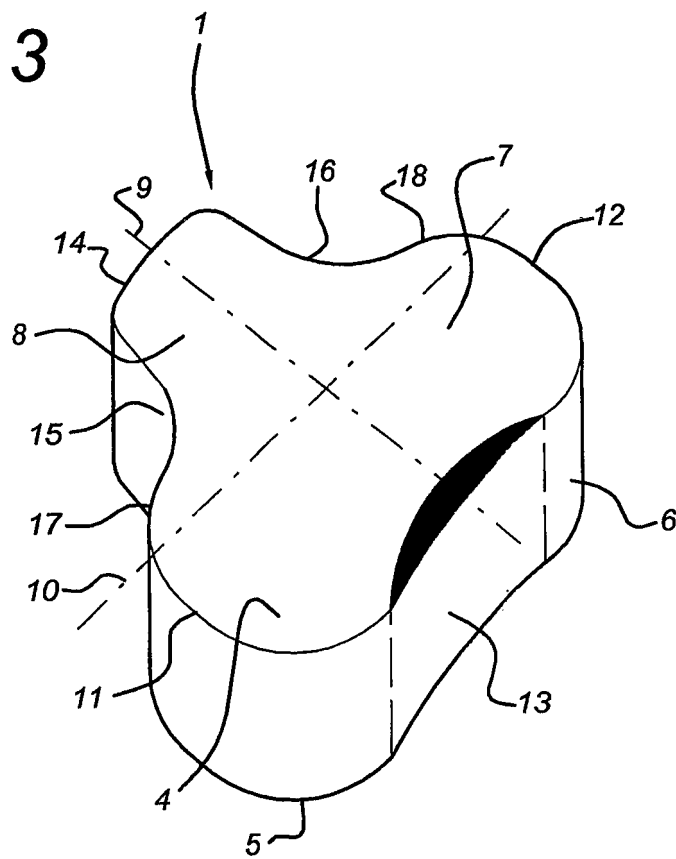


Fig 3



REFERENCES CITED IN THE DESCRIPTION

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