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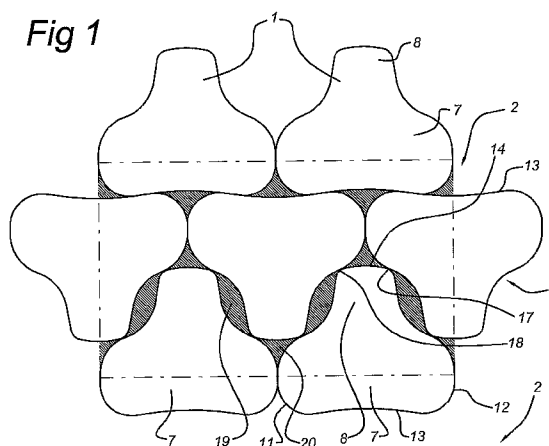
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(54) Title: REVETMENT FOR AN EMBANKMENT, AS WELL AS REVETMENT ELEMENT THEREFORE



(57) Abstract: A revetment for an embankment, bank and the like, comprises 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).

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Revetment for an embankment, as well as revetment element therefore

The invention is related to a revetment for an embankment, bank and the like, comprising revetment elements which have parallel bottom and top surfaces and which
5 are arranged according to rows which are positioned next to each other in transverse direction, said rows each extending in longitudinal direction, each revetment element being symmetric with respect to a line of symmetry and asymmetric with respect to a line of asymmetry which is perpendicular with respect to the line of symmetry, open spaces being enclosed between subsequent revetment elements of a row and between
10 revetment elements of neighbouring rows.

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
15 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
20 for arranging the revetment elements.

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
25 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
30 revetment.

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 in that the lines of

symmetry of the revetment elements are oriented in the transverse direction and in that the revetment elements which are arranged according to a single row have the same orientations with respect to their respective line of asymmetry.

In the revetment according to the invention, the longitudinal direction or direction
5 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
10 their longitudinal direction or line of symmetry, according to which they are pointing in the same direction with their asymmetric part.

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
15 their respective line of asymmetry. Thus, the revetment elements of neighbouring rows are pointing in opposite directions, that is towards each other or away from each other, with their asymmetric part.

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

In general, the revetment elements may 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
25 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.

Conversely, the longitudinal section has a longitudinal side located opposite the
30 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.

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
5 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.

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
10 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.

As a result of the general T-shape of the revetment elements described before, the
15 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.

As already mentioned before, the rows which form the rows may be laid
20 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.

The invention is furthermore related to a revetment element for a revetment according to any of the preceding claims, said revetment element being symmetric with respect to a line of symmetry and asymmetric with respect to a line of asymmetry
25 perpendicular with respect to the line of symmetry.

A revetment element of this type is also disclosed in FR-A-2.657.638. Said prior art revetment element has limitations as highlighted before with respect to the build up of water pressure behind the revetment which is obtained by means of revetment elements. According to the invention, these limitations are mitigated in that the
30 revetment element has a longitudinal section and a lateral section, said lateral section being positioned symmetric with respect to the line of symmetry of the revetment elements. Preferably, the lateral section is symmetric with respect to the line of

symmetry of the revetment elements. More preferably, the revetment element has a generally triangular shape or a general T-shape.

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

5 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.

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

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
15 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
20 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.

25 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
30 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.

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.

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 is beneficial for allowing water to pass through for the purposes of preventing the development of water pressure behind the revetment in question.

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.

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

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), characterised in that the lines of symmetry (9) of the revetment elements (1) are oriented in the transverse direction and in that 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).
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 revetment elements (1) have a longitudinal section (7) and a lateral section (8).

7. Revetment according to claim 6, wherein the lateral section (8) is positioned symmetric with respect to the line of symmetry (9) of the revetment elements (1).

8. Revetment according to claim 6 or 7, wherein the lateral section (8) is
5 symmetric with respect to the line of symmetry (9) of the revetment elements (1).

9. Revetment according to any of claims 6-8, wherein the longitudinal section (7) has opposite ends (11, 12) in longitudinal direction which are convexly shaped.

10. Revetment according to any of claims 6-9, 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.

11. Revetment according to claim 10, wherein the longitudinal side (13) of the longitudinal section (7) is concavely shaped.

12. Revetment according to any of claims 6-11, wherein the lateral section (8) has a convexly shaped lateral end (14).

20

13. Revetment according to any of claims 6-12, wherein the lateral section (8) has sides (15, 16) located opposite each other when seen in longitudinal direction, which sides (15, 16) are concavely shaped.

14. Revetment according to claims 11 and 13, wherein the concavely shaped opposite sides (15, 16) of the lateral 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).

15. Revetment according claims 9 and 13 or 9 and 14, 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).

30

16. Revetment according to any of claims 6-15, 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).

5 17. Revetment according to any of claims 7-16, 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).

10 18. Revetment according to claim 16 or 17, 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.

15 19. Revetment according to claim 18, wherein the lateral ends (14) of the revetment elements (1) of neighbouring rows (2, 3) enclose open spaces (19).

20 20. Revetment according to any of the preceding claims, wherein the rows (2, 3) are rectilinear.

25 21. Revetment according to any of claims 1-20, wherein the rows (2, 3) are curved according to a part of a circle.

30 22. Revetment element (1) for a revetment according to any of the preceding claims, said revetment element (1) being symmetric with respect to a line of symmetry (9) and asymmetric with respect to a line of asymmetry (10) perpendicular with respect to the line of symmetry (9), characterised by a longitudinal section (7) and a lateral section (8), said lateral section (8) being positioned symmetric with respect to the line of symmetry (9) of the revetment elements (1).

35 23. Revetment element (1) according to claim 22, wherein the lateral section (8) is symmetric with respect to the line of symmetry (9) of the revetment elements (1).

24. Revetment element (1) according to claim 22 or 23, wherein the revetment element has a generally triangular shape.

25. Revetment element (1) according to any of claims 23 or 24, wherein the revetment element has a general T-shape.

5 26. Revetment element (1) according to any of claims 23-25, wherein the longitudinal section (7) has opposite ends (11, 12) in longitudinal direction which are convexly shaped.

10 27. Revetment element (1) according to any of claims 22-26, 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) via a transition (17, 18).

15 28. Revetment element (1) according to any of claims 22-27, wherein the longitudinal section (7) has a concavely shaped longitudinal side (13) located opposite the lateral section (8).

Fig 1

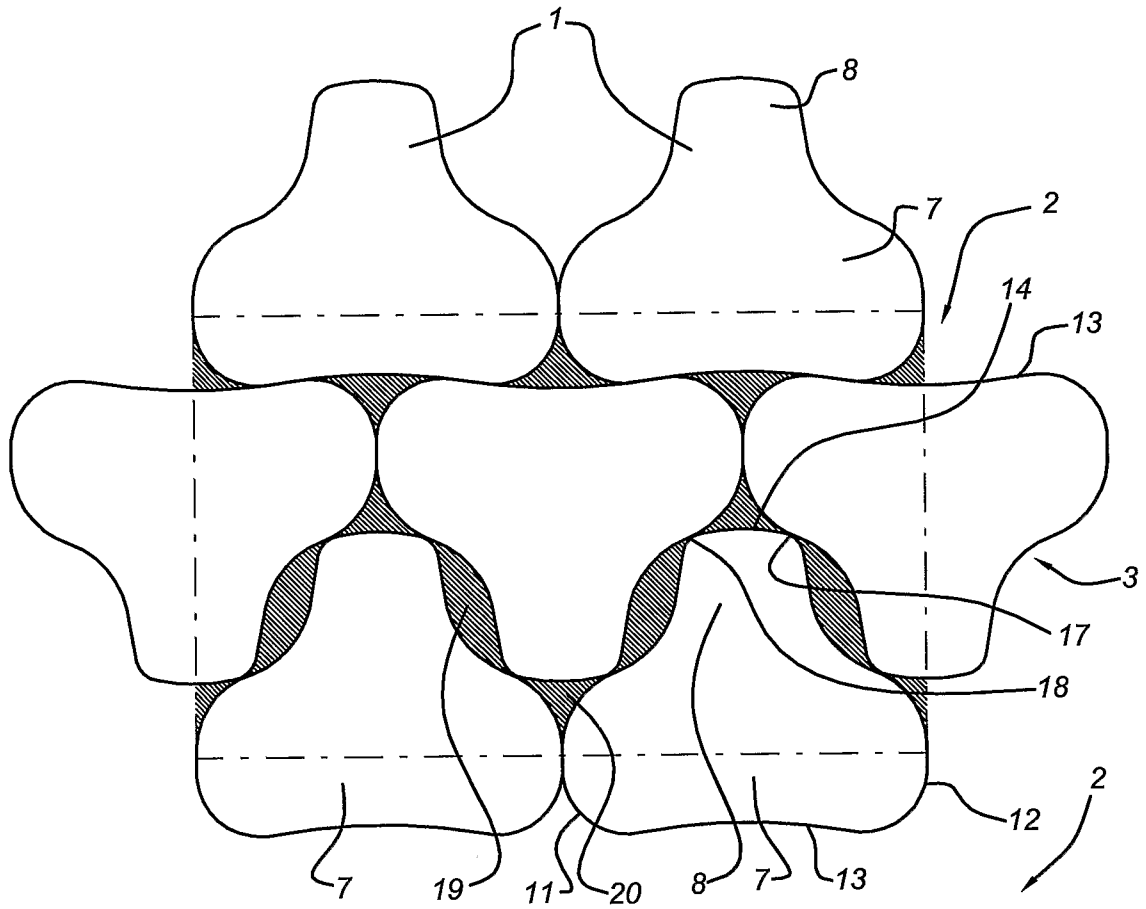


Fig 2

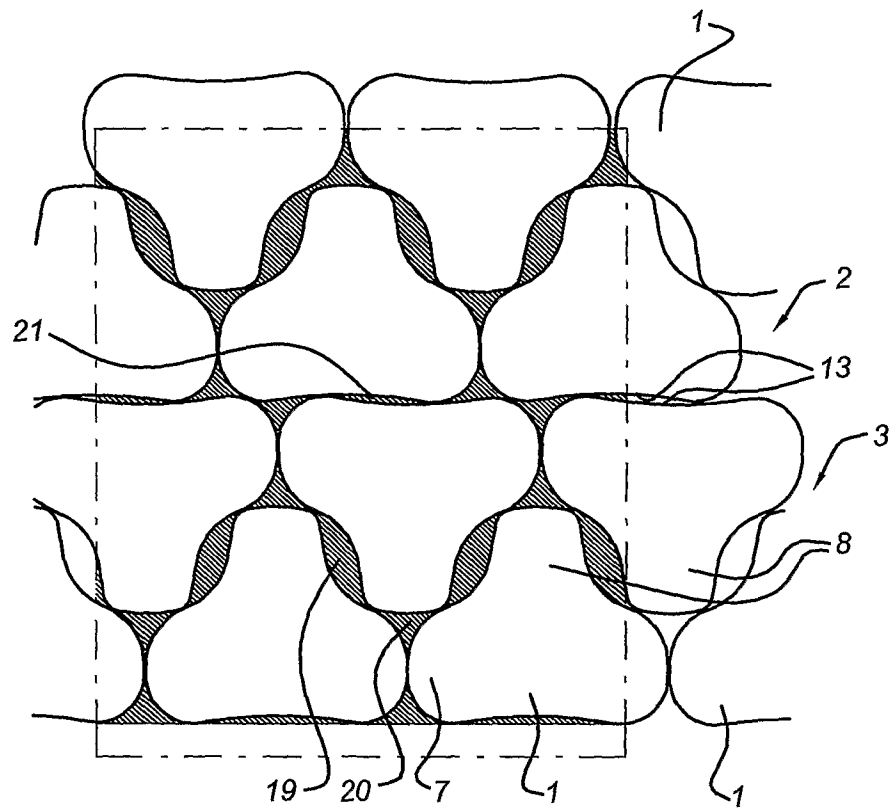
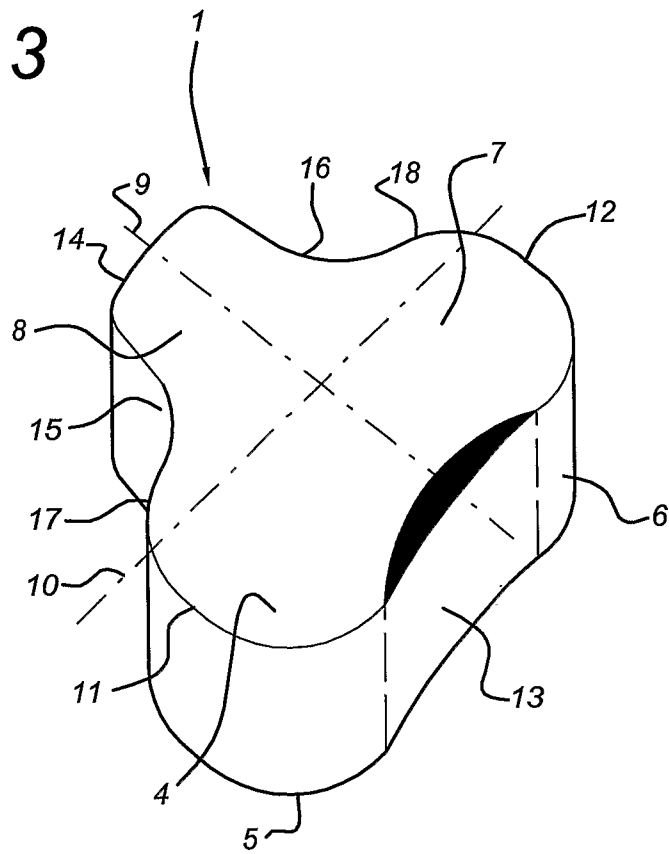


Fig 3

INTERNATIONAL SEARCH REPORT

International application No

PCT/NL2007/000216

A. CLASSIFICATION OF SUBJECT MATTER
INV. E02B3/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E02B E01C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	WO 97/43487 A (DEN BOER BETON GROOT AMMERS B [NL]; MEERKERK PLEUN [NL]) 20 November 1997 (1997-11-20) cited in the application page 3, line 3 - line 34; figures 1,2,4	1,3,6-9, 11-15, 19-23, 26-28
X	DE 80 13 431 U1 (BEHATON GMBH & CO KG, 7570 BADEN- BADEN) 19 February 1981 (1981-02-19) figure 2	1-4,6-8, 22-24
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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