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(54) Internally reinforced geotechnical structure and process for manufacturing the same.

(57) An internally reinforced geotechnical structure with an exposed surface suitable to form slopes, walls and systems for preventing erosion, comprising a plurality of layers (1) which are mutually superimposed and have their exposed surface arranged vertically or tapered from the base toward the top. Each layer (1) comprises at least one primary reinforcement and separation element (2) arranged so that a first segment (2a) lies along a horizontal plane, then folds onto itself with a folded segment (2b) and continues with a second segment (2c) along a horizontal plane which is spaced from the first segment (2a) in order to contain at least one portion (5) of material. At the folding segment (2b), externally to the primary reinforcement element (2), each layer (1) has a secondary reinforcement element, advantageously constituted by a containment frame (11), for containing a material mass (20) which covers said primary reinforcement element (2). Said secondary reinforcement element (11) has a front wall (13) substantially spaced from said primary reinforcement element (2).

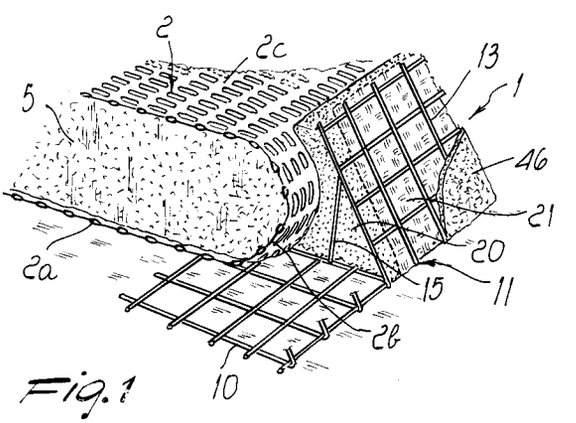


Fig. 1

EP 0 603 460 A1

The present invention relates to an internally reinforced geotechnical structure with exposed surface suitable to form slopes, walls and systems for preventing erosion, and to a process for the manufacture thereof.

As is known, the need to avoid building massive walls to provide support, anti-erosion protection or containment of sometimes large earthy or rocky masses is increasingly felt; this need is commonly dictated by reasons of practicality and economy as well as by reasons of environmental impact.

The solutions known and practiced so far entail, in various forms and manners, the use of fabrics or of nets which, by interacting with iron box-like components and similar elements which produce a load-bearing action, allow to contain and reinforce the soil to form, for example, an embankment which can subsequently be grassed.

In the systems in use, the element having the reinforcing function adheres to the front walls of the box-like component of the metallic structure also by means of a coupling provided by cramping, pressure or fastening. With this arrangement, these reinforcement elements are not protected against damage or deterioration caused by the destructive action of fire, tears, cuts or by the action of sunlight or in any case of any other factor which can modify the durable stability of the embankment.

French patent No. 2,303,121 and Swiss patent no. 680.078 propose, for example, other solutions in which the box-like component itself is the reinforcement element. This reinforcement frame has, directly on its exposed surface, inserts made of geocompatible textile material or other products having the purpose of containing the material inside the frame.

In the solutions described in these patents there is a single front reinforcement element, constituted by the metallic frame itself.

The box-like component is subject to physical deterioration, and this can be the cause of irreparable damage to the structure of the entire construction.

Patent US 4,856,939 describes a ground retention net, or containment net, which is inserted in or anchored to the box-like component or to metallic elements which are connected to a substantially vertical front wall; the ground retention net is completely exposed and can be damaged by fire or other factors, and this circumstance compromises the stability of the construction.

Furthermore, the presence of the reinforcement ground retention net in this position prevents the possible planting of the face.

Patents US 4,117,686 and EP 0,197,000 provide for the use of box-like components for containing material in order to provide geotechnical structures in which there is no internal separation and reinforcement system.

In this case, too, the only reinforcement element is exposed to the deteriorating action already described above.

Patent application GB 2,073,281 describes a structure which also has a single reinforcement structure which is external and therefore exposed to the known deterioration problems.

A principal object of the present invention is to eliminate the drawbacks described above by providing a double reinforcement and containment system in which the primary reinforcement element is internal to the secondary reinforcement element.

Another object of the invention is to provide a system of reinforced soils having a primary reinforcement element constituted by ground retention nets or geocompatible textile products, preferably made of plastic, which are appropriately arranged and do not make contact with the exposed part of the slope corresponding to the secondary reinforcement element.

Another object of the present invention is to provide a slope in which the reinforcement element performing the load-bearing action is completely protected against the dangers arising from possible fires which, by affecting the face of the embankment, seriously damage current systems, in which the containment or reinforcement elements, once burned, compromise the stability of the entire construction since they are no longer present.

Another object of the present invention is to provide systems, such as slopes or others, wherein the material of the layer contained in the reinforcement ground retention net is different from the remaining material interposed between said ground retention net and the secondary reinforcement element.

A further object of the present invention is to provide a primary reinforcement element with appropriate filtering or separating elements in order to keep the separation unchanged in time.

Another object of the present invention is to provide an erosion-preventing structure wherein the material interposed between the primary reinforcement element and the secondary reinforcement element can be constituted by stones or gravel.

Another object of the present invention is to provide a slope or a wall in which the embankment can be formed with predominantly rocky materials, but can have, on its exposed surface, a layer of loam, the thickness of which is adjustable and variable in any way, consequently allowing the grassing of the slope.

Another object of the present invention is to provide a construction requiring limited work steps and furthermore allowing to plant the exposed surface.

Another object of the present invention is to provide a construction in which the safety factors are higher, since there are two separate reinforcement systems, and in which any face repair work is facilitated as it does not affect the primary reinforcement elements of the entire structure.

With these and other objects in view, there is provided, according to the present invention, an internally reinforced geotechnical structure with an exposed surface suitable to form slopes, walls and systems for preventing erosion, comprising a plurality of layers of ground or other materials mutually superimposed and having their exposed surface arranged vertically or tapered from the base toward the top. For each one of said layers there is at least one primary reinforcement element arranged so that a first segment lies along a horizontal plane, then folds upward, so as to form a front segment, and then possibly folds, with a folded segment, so as to continue with a second segment laid along a horizontal plane and spaced from said first segment, in order to contain at least one portion of said layer. At the front segment and externally to the primary reinforcement element there is, for each one of said layers, a secondary reinforcement element for containing at least one portion of material which covers the primary reinforcement element, in which the secondary reinforcement element has a front wall substantially spaced from said primary reinforcement element.

Further characteristics, objects, and advantages of the present invention will become apparent from the following description of some preferred but not exclusive embodiments thereof, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

figure 1 is a perspective view of a layer of soil including the structure of the invention;

figure 2 is a view of the initial step of the placement of the external frame constituting the secondary reinforcement element and of the filling with a portion of covering material, constituted by earth suitable to be grassed or planted;

figure 3 illustrates the placement of the primary reinforcement element, constituted by a ground retention net;

figure 4 is a view of the step of the compaction of the layer of figure 3;

figure 5 illustrates the step of the folding of the ground retention net after the filling and compaction of the entire volume of the layer of soil;

figure 6 is a schematic view of two superimposed layers of soil, in which the ground retention net of the lower layer is folded differently;

figure 7 is a view of a plurality of superimposed layers of soil with a continuous front surface having different inclinations;

figure 8 is a schematic view of a slope with layers of predominantly rocky material contained inside the ground retention net and earth contained outside it, for grassing;

figure 9 is a perspective view of a layer of soil with a ground retention net folded so as to contain a portion of soil lower than the height of the layer, thus facilitating planting;

figure 10 is a schematic view of a slope constituted by a plurality of superimposed layers;

figure 11 is a schematic view of a layer of soil with a front containment element constituted by compacted soil;

figure 12 is a schematic view of the front containment element constituted by compacted soil and of the ground retention net, arranged in a preliminary step of the creation of the construction;

figure 13 is a view of the step of the filling of a layer of soil adjacent to a block of compacted earth;

figure 14 is a schematic view of two superimposed layers of soil;

figure 15 is a schematic view of an erosion-preventing structure;

figures 16, 17, 18 and 19 illustrate the various constructive steps of an erosion-preventing structure of the kind illustrated in figure 15;

figure 20 is a view of a further embodiment of a layer of soil, with separation between the primary reinforcement element and the secondary reinforcement element;

figure 21 is a view of a different embodiment, with separation between the primary reinforcement element and the secondary reinforcement element; and

figure 22 is a view of a further embodiment of the invention.

With reference to the above figures, and in particular to figures 1 to 8, the internally reinforced geotechnical structure with exposed surface suitable to form slopes, walls and the like which can be grassed or planted, comprises a plurality of layers of soil, generally designated by the reference numeral 1, which are superimposed so as to have an exposed surface preferably tapering from the base toward the top of the slope.

Each layer of soil comprises a primary reinforcement element advantageously formed by a reinforcement ground retention net or geocompatible textile product, generally designated by the reference numeral 2, having a first lower segment 2a which extends along a horizontal plane and is arranged above the lower segment 10 of a secondary reinforcement element advantageously constituted by a forming and containment frame, generally made of iron, designated by the reference numeral 11.

The ground retention net constituting the primary reinforcement element, is folded so as to have a front folding segment 2b which substantially affects the entire height of the layer of soil 1; the ground retention net is then folded so as to form a second upper horizontal segment 2c substantially arranged parallel to the first segment and in practice containing a portion of a layer, designated by the reference numeral 5, the final height of which is substantially equal to the height of the frame 11.

The frame 11 has, as already mentioned above, a lower segment 10, which is at least partially arranged below a segment of the ground retention net 2, and a front wall 13, advantageously inclined with a tilt corresponding to the inclination of the slope.

It is furthermore possible to provide one or more lateral reinforcement ties 15 which join the lower segment 10 to the front wall 13 in order to better contain stresses.

A mass of material is placed in the space delimited by the frame 11 and by the ground retention net 2; in the specific example, said mass, designated by the reference numeral 20, is constituted by earth or loam contained at the front wall by a covering element 21 made of a geocompatible textile product, a mat or the like, i.e. by a material which can be easily perforated by vegetation and is in any case suitable to contain the soil 20.

The mass of material 20 has the particular function of completely covering the ground retention net, which constitutes the load-bearing element of the construction, so that said ground retention net cannot be affected by the destructive action of fire and cannot be torn during normal slope maintenance operations.

In this manner there is provided an exposed surface, constituted by the front walls, which can be easily grassed by means of a grassing layer, designated by the reference numeral 46, or can be planted, and is protected by a covering layer made of geocompatible textile products or the like having the purpose of containing only a limited mass of soil, i.e. the mass of the covering material 20 arranged between the ground retention net and the frame.

The fact is significant that if, for any reason, the covering layer is damaged, it is sufficient to perform repairs affecting only and exclusively the covering layer, since the load-bearing structure, constituted by the ground retention net, is not affected.

In fact, if the covering element should give for any reason, the only part of material which can escape is the part contained between the frame 11 and the folded ground retention net 2, so that the stability of the construction is not compromised in any way.

It is equally possible to perform even local renovation work entailing a partial replacement of frame elements without thereby affecting structural elements of the construction.

The fact is furthermore significant that with this type of arrangement it is also possible to provide for two different materials, i.e. earth or loam in the region comprised between the ground retention net and the frame, even in the form of panels, whereas inside the ground retention net it is possible to provide for rocky material without thereby compromising the possibility of grassing the slope.

With reference to figures 9 and 10, a different embodiment of the construction is illustrated; it is conceptually related to the preceding solution, the only variation being that the portion of layer contained by the primary reinforcement element, constituted in the present case by a ground retention net, is lower than the total height of the layer, so that at each one of said layers there is a portion, designated by the reference numeral 30, which is contained by the ground retention net, and an overlying portion, designated by the reference numeral 31, which is preferably formed by a layer of soil, or possibly of other materials, which is practically not contained by the ground retention net but covers the primary reinforcement element.

This allows to have a mass of soil facilitating the spread of roots and also of vegetation such as trees, plants or shrubs, which consequently gives subsequent greater stability to the construction even if the external metallic frame has deteriorated due to its mechanical characteristics, for example due to corrosion.

Considering figure 8, a particular case with respect to the one shown in figures 9 and 10 is illustrated; in this case, in fact, the material contained in the primary reinforcement element is rock or stone, and the presence of the loam outside said element allows to have, as already mentioned earlier, a surface which can be planted and grassed.

In this case it is recommendable to use a filtering geocompatible textile product 45 for preventing the removal of the loam from the upper layer and its dispersion within the stone mass; on the other hand, the geocompatible textile product facilitates the drainage of the water, which can be collected with known drainage methods.

With the above described embodiments, the process entails the initial earth-moving operation, then the laying of the forming and containment frame 11, with the placement of a covering element at the front wall, and then the frame is partially filled with material which in practice constitutes the portion of covering material.

Once these preliminary steps have been carried out, the primary reinforcement element is

placed by arranging its first segment along a horizontal plane, then folding it upward so as to form a front segment and keeping the segment outward, as shown schematically in figure 3.

The volume inside the primary reinforcement element is then filled with a portion of soil or other material which may be present in such an amount as to affect, for example, two thirds of the entire height of the layer, as shown in figures 3 and 4.

Then the soil or other material is compacted and the primary reinforcement element is folded in order to obtain the construction shown in figures 9 and 10, or one or more steps of soil addition and subsequent compaction are performed until the height of the layer is reached, as shown in figure 4; once filling has been performed, the primary reinforcement element is folded over onto itself.

The layer is thus completed with a layer portion contained inside the secondary reinforcement element and a portion of covering material contained between the secondary reinforcement element and the primary reinforcement element, and is ready for the superimposition of a subsequent layer.

With reference to figures 11 to 14, an embodiment conceptually similar as regards the placement of the reinforcement element 2 is shown; the element constituting the secondary reinforcement element is instead different in its execution, since instead of the frame there is a compacted block of earth, designated by the reference numeral 40, forming the front face and acting as finishing and protection element for the layer.

In practice, the blocks 40 themselves are a mass of soil on which a rapid grassing process is possible.

This embodiment excludes the use of metallic supporting frames, thus offering a practical method for building the containment construction which is in tune with the environmental solutions typical of the types of embankments considered herein.

The block is of the grassable type, or may be already grassed with a layer, again designated by the reference numeral 46, after its installation, even by superimposing grassing mats on its face.

The construction of figure 15 illustrates an embodiment particularly suitable for the containment of erosion phenomena such as those due to river or stream currents or due to waves and tides.

In this construction, the primary reinforcement element, again constituted by the ground retention net 2, is spaced from the secondary reinforcement element, again constituted by the frame 11, by a volume preferably constituted by gravel or stones 41 which are in turn contained in the frame by a fine-mesh net or the like designated by the reference numeral 43.

The ground retention net 2 is coupled to an appropriate filtering geocompatible textile product 42 preventing the soil 5 contained inside the ground retention net from being removed by the above described phenomena, such as for example tides or currents.

A surface layer 44, constituted by a known mat, can be applied on the exposed surface of the frame; said mat can be used in order to facilitate the rooting of surface flora.

Figures 16 to 19 illustrate a system for producing the construction of figure 15.

As shown in figure 19, the filtering layers or elements 42, which may also be arranged outside the ground retention net 2, are preferably superimposed, thus ensuring perfect retention of the soil 5.

A different embodiment of the layer of reinforced structure 1 is illustrated with reference to figure 20; in this embodiment, there is a primary reinforcement element constituted by a ground retention net, again designated by the reference numeral 2, reinforcing the soil and having a portion 2a which extends along a substantially horizontal plane, continues with a front segment 2b, inclined forward according to the inclination of the covering material arranged inside the secondary reinforcement element, and continues further with an upper segment 2c substantially parallel to the segment 2a.

The secondary reinforcement element, now generally designated by the reference numeral 60, comprises a frame which forms an inclined front wall 61 and a segment portion 62 which remains substantially spaced from the ground retention net 2.

The front wall 61 is advantageously internally lined with a covering element 63 which may extend so as to also cover the horizontal segment 62.

A portion of covering material is placed in the region delimited between the ground retention net 2 and the frame 60 and acts as a protection element for the ground retention net and as stabilizer for the frame 60.

According to what is shown in figure 21, the characteristics shown in figure 20 are again provided, with the variation that the covering element 63 also has a rear segment, designated by the reference numeral 64, which in practice, in cooperation with the horizontal segment, completely closes the portion of covering material, acting as a containment element.

It is also possible to provide a system for coupling to the soil, constituted by a hook 70 for stabilizing, especially during the initial steps, the placement of the frame 60.

This connection can be provided by means of simple rods bent into a U-shape, forming a conventional forked bracket.

In the embodiment shown in figure 22, the second horizontal segment 2c of the primary reinforcement element has, for the most part of its extension, a distance from the segment 2a which is lower that the height of the layer; this embodiment is advantageous because, during the final step of the compacting of the soil, the tracks of soil-compacting machines are not in contact with the primary reinforcement element, thus eliminating any possibility of damaging it.

With the embodiment described in figures 20,21 and 22, all contact between the frame constituting the secondary reinforcement element and the ground retention net constituting the primary reinforcement element is avoided, so that the danger of damage of the part of the primary reinforcement element which reinforces the ground by the part of the secondary reinforcement element is avoided. The secondary reinforcement element can in fact often be constituted by materials such as iron, whereas the primary reinforcement element, which is constituted for example by plastic, is weaker and can consequently be damaged.

From what has been described above it can thus be seen that the invention achieves the intended objects, and in particular the fact is stressed that an internally reinforced geotechnical structure with exposed surface suitable to form slopes, walls and systems for preventing erosion is provided which allows to entrust the containment action to an element assuredly protected within the system, whereas the front wall is separate and also has the purpose of protecting the load-bearing part, constituted by the ground retention net or by equivalent elements, against the action of fire or of any other element which can damage both the ground retention net and the embankment itself, for example by removing material.

On this subject it can be noted that in order to obtain the desired results, the minimum distance of the primary reinforcement element from the front wall is a function of various parameters.

For example, to withstand the action of the heat produced by a fire, this minimum distance must be comprised between 15 and 30 cm and is in any case a function both of the type of material used, constituting the primary reinforcement element, and of the filling material used and of its insulating power.

In any case, the above mentioned distance can vary substantially according to the above mentioned parameters.

The optimum solution provides for the use of a minimum distance of no less than 30 cm, in the narrowest region, since this measurement allows both a good insulating thickness against the transmission of heat in case of fire and a sufficient thickness for planting operations.

In the case of erosion-preventing structures, a minimum distance of approximately 15 cm is preferable, so as to reduce the speed of the water practically to zero toward the inside of the structure.

In any case, different constructive parameters may recommend greater or lower thicknesses.

It is significantly important that any damage of the front wall, in the solution shown in the above description, allows the escape of material only restricted to the portion comprised between the primary reinforcement element and the secondary reinforcement element, i.e. therefore to a part which per se does not have load-bearing functions and does not compromise in any case the stability of the system; repairs of the damaged construction can thus be performed successfully.

Furthermore, with the described arrangement it is also possible to plant and grass regions where predominantly rocky material is available, since this predominantly rocky material can constitute the portion of soil contained in the ground retention net, while it is possible to apply, at the front, a layer or panel made of earth or loam of the desired thickness which consequently allows grassing.

The invention thus conceived is susceptible to numerous modifications and variations, all of which are within the scope of the inventive concept.

All the details may furthermore be replaced with technically equivalent elements.

In practice, the materials employed, as well as the contingent shapes and dimensions, may be changed in any manner according to the requirements.

Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. Internally reinforced geotechnical structure (1) with an exposed surface suitable to form slopes, walls and systems for preventing erosion, comprising a plurality of layers which are mutually superimposed and have their exposed surface arranged vertically or tapered from the base toward the top, characterized in that for each one of said layers there is at least one primary reinforcement element (2) arranged so that a first segment (2a) lies along a horizontal plane, then folds upward, so as to form a front segment (2b), and then folds, with a subsequent folded segment, so as to con-

tinue with a second horizontal segment (2c) which is spaced from said first horizontal segment, in order to contain at least one portion (5;30;45) of said layer and in that at the front segment and externally to the primary reinforcement element there is, for each one of said layers, a secondary reinforcement element (11;60) for containing at least one portion of material (20;40;41) covering the primary reinforcement element, said secondary reinforcement element having a front wall which is substantially spaced from said primary reinforcement element.

2. Geotechnical structure according to claim 1, characterized in that said primary reinforcement element is arranged so that it has a first segment (2a) laid along a horizontal plane and folded upward so as to form a front segment (2b) delimiting a portion of material (20;40;41) which covers said primary reinforcement element and is comprised between said front segment of the primary reinforcement element and the secondary reinforcement element.

3. Geotechnical structure according to the preceding claims, characterized in that said secondary reinforcement element comprises a frame (11;60) for the forming and containment of at least one portion of said covering material.

4. Geotechnical structure according to one or more of the preceding claims, characterized in that it has, inside the secondary reinforcement element, a covering element (21;43;63) possibly superimposed onto the horizontal segment of said secondary reinforcement element and to the horizontal segment of the primary reinforcement element of the upper layer and internally comprising said portion of covering material.

5. Geotechnical structure according to one or more of the preceding claims, characterized in that said front segment (2b) of the primary reinforcement element substantially affects the entire height of said layer.

6. Geotechnical structure according to one or more of the preceding claims, characterized in that said first horizontal segment (2a) of the primary reinforcement element of one layer is in contact with, and superimposed on, the second horizontal segment (2c) of the primary reinforcement element arranged in the underlying layer.

7. Geotechnical structure according to one or more of the preceding claims, characterized in that said second horizontal segment (2c) of the primary reinforcement element is spaced from said first horizontal segment (2a) of the primary reinforcement element by a distance which is lower than the total height of said layer, a portion (31) of said layer, not contained by said primary reinforcement elements, being interposed between the primary reinforcement elements of the two superimposed layers.

8. Geotechnical structure according to one or more of the preceding claims, characterized in that said portion (5) of the layer is constituted by earth and in that said covering material (20) is constituted by earth.

9. Geotechnical structure according to the preceding claims, characterized in that said covering material (20) is constituted by a panel of compacted and possibly pre-seeded loam.

10. Geotechnical structure according to one or more of the preceding claims, characterized in that said portion of the layer (45) is predominantly constituted by gravel, rock and the like, and in that said covering material is constituted by earth, a filtering geocompatible textile product (42) being furthermore provided and being associated with said primary reinforcement element at least along the entire region of contact of said primary reinforcement element with said covering material.

11. Geotechnical structure according to one or more of the preceding claims, characterized in that said covering material (41) is constituted by rock, gravel, stones or the like with an erosion-preventing function.

12. Geotechnical structure according to claim 10, wherein a filtering geocompatible textile material (42) is associated inside or outside the primary reinforcement element at least in its front part.

13. Geotechnical structure according to claim 11, wherein said filtering geocompatible textile material is externally coupled to said primary reinforcement element and sufficiently extends along the horizontal upper and lower portions of the primary reinforcement element; said filtering geocompatible textile material furthermore extending, in the lower horizontal portion, substantially beyond the secondary reinforcement element, so that superimposition and

contact occur in two superimposed layers without the presence of any separation element between at least one part of the lower horizontal portion of said filtering geocompatible textile product of the upper layer and at least one part of the upper horizontal portion of said filtering geocompatible textile product of said lower layer, obtaining a filtering barrier associated with the primary reinforcement element and continuous inside the layers of the geotechnical structure.

14. Geotechnical structure, comprising a plurality of mutually superimposed layers and with its exposed surface arranged vertically or tapered from the base toward the top, characterized in that for each one of said layers there is at least one primary reinforcement element arranged so that a first segment lies along a horizontal plane and is folded upward so as to form a front segment and is then folded on itself with a subsequent folding portion so as to continue with a second horizontal segment spaced from said first horizontal segment to contain at least one portion of said layer, compacted blocks (40) of earth or the like being provided at said front segment and outside the primary reinforcement element, said blocks forming a secondary reinforcement element forming the front wall and covering said primary reinforcement elements.

15. Geotechnical structure comprising a plurality of mutually superimposed layers with the exposed surface arranged vertically or tapered from the base toward the top, characterized in that for each one of said layers there is at least one primary reinforcement element (2) arranged so that a first segment (2a) lies along a horizontal plane and is folded upward so as to form a front segment (2b) and is then folded so as to form a second horizontal segment (2c) spaced from said first segment, a secondary reinforcement element (11;60) being furthermore provided and being constituted by a frame which forms a front wall connected to a base wall spaced from said primary reinforcement element.

16. Geotechnical structure according to claim 15, characterized in that it comprises, inside said frame, a covering element (63) affecting at least said front wall.

17. Geotechnical structure according to one or more of the preceding claims, characterized in that said covering element affects the front and horizontal internal surface of said frame.

18. Geotechnical structure according to one or more of the preceding claims, characterized in that said covering element has a rear segment (64) interposed between said primary reinforcement element and the covering material arranged inside said secondary reinforcement element.

19. Geotechnical structure, according to one or more of the preceding claims, characterized in that said second horizontal segment (2c) has, at least for a part of its extension, a distance from said first horizontal segment which is lower than the height of the layer.

20. Process for forming a steep slope, characterized in that it consists in laying a secondary reinforcement element, constituted by a forming and containment frame (11;60) is which the lower segment (10) is arranged along a horizontal plane and a front wall (13) is inclined with respect to said lower segment; in applying a covering element (21;63) to the inside of said front wall; in performing an at least partial filling of said frame with covering material (20;40;41); in applying a primary reinforcement element (2) having a first segment (2a) arranged along a horizontal plane, a segment (2b) which covers the portion of covering material, and continues with a segment (2c) folded outside the secondary reinforcement element; in laying portions (5;30;45) of said layer on said first horizontal segment of the primary reinforcement element for the preset height; in compacting said layer portions; in folding the folded segment of the primary reinforcement element onto the compacted portion of the layer, forming the second horizontal segment; in completing the filling of the portion of covering material; and in forming at least one upper layer in the same manner.

21. Process according to one or more of the preceding claims, characterized in that it consists in placing a block (40) of compacted soil in a levelled region to form the exposed face of the slope; in applying a primary reinforcement element having a first horizontal segment; in performing a fold, arranging the front segment adjacent to said block of compacted soil and a segment folded onto said block; in laying on said first segment of the primary reinforcement element a portion of soil to reach the preset level after compaction; in folding the folded segment, forming the second horizontal segment of said primary reinforcement element; and in forming further layers in succession.

22. Internally reinforced geotechnical structure having at least one layer (1) comprising a primary reinforcement element (2) with a first lower segment (2a), a folded front segment (2b), and a second upper segment (2c), a portion of material (5;30;45) being disposed inside said primary reinforcement element, the layer further comprising a frontal material mass (20;40;41) arranged frontally with respect to said front segment (2b) of the primary reinforcement element.

23. The structure of claim 22, further comprising a secondary reinforcement element (11;60) arranged outside said material mass.

24. The structure of claims 22 and 23, comprising a plurality of mutually stacked layers.

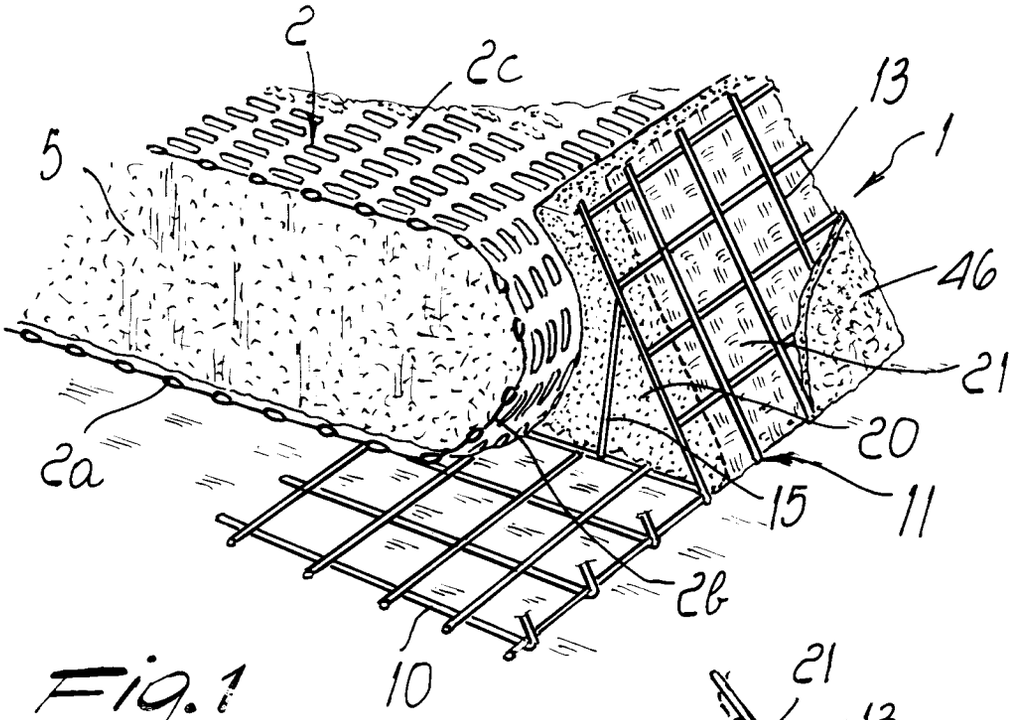


Fig. 1

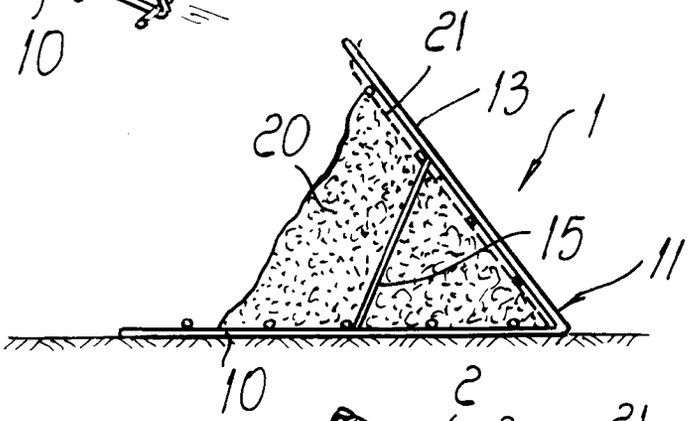


Fig. 2

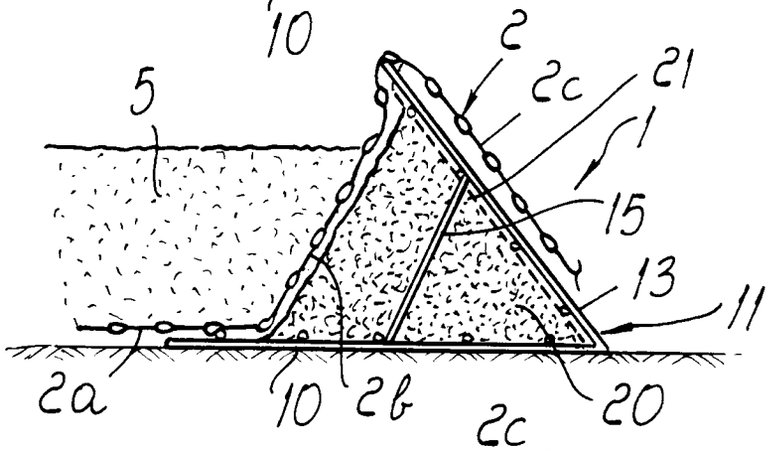
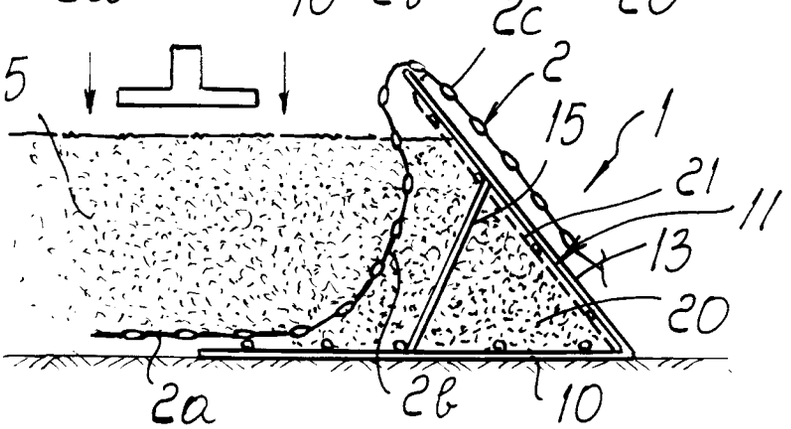


Fig. 3



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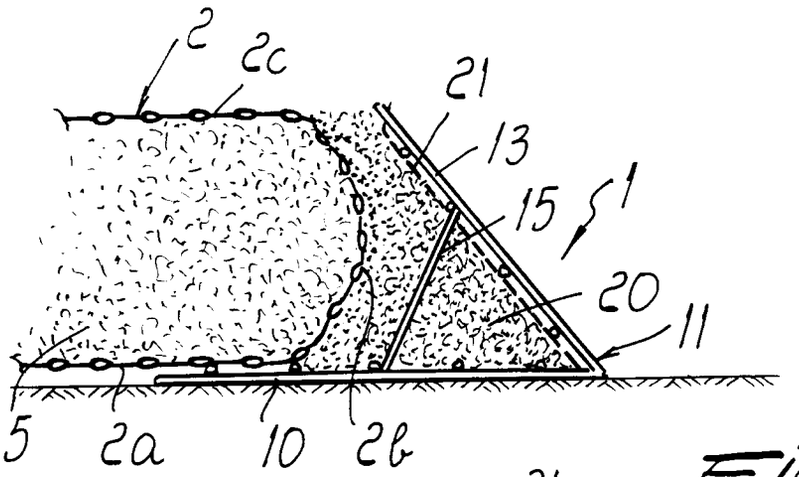


Fig. 5

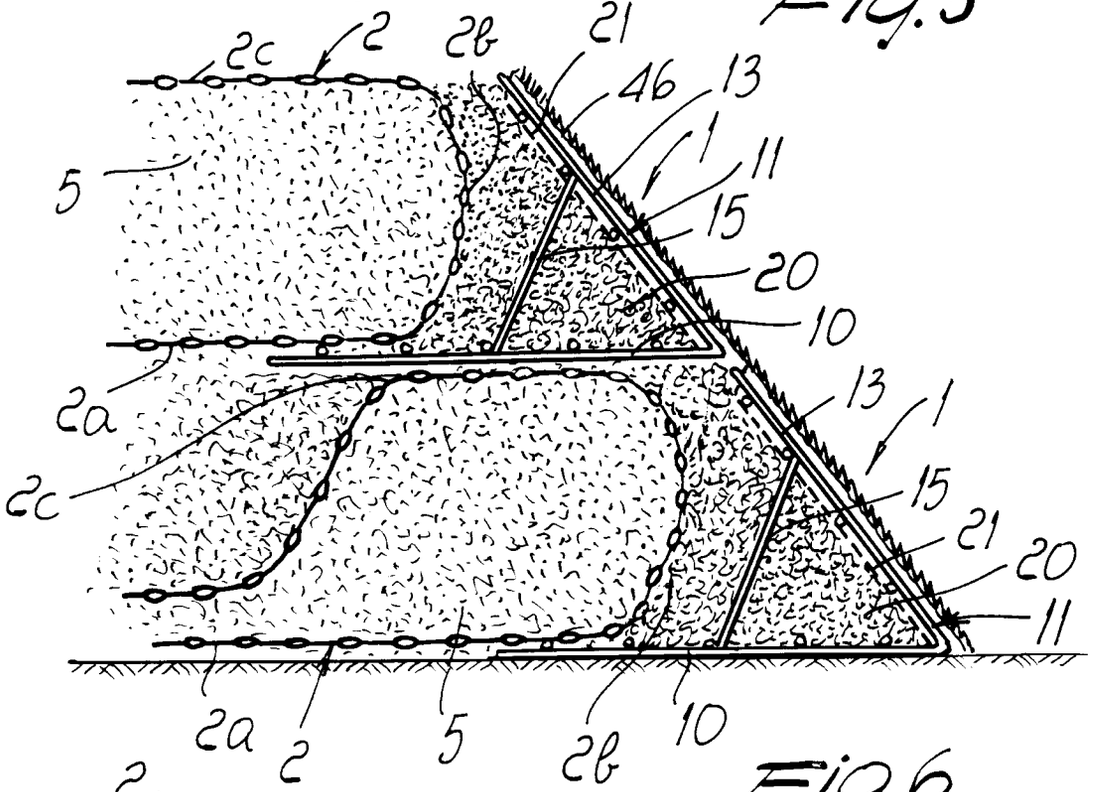
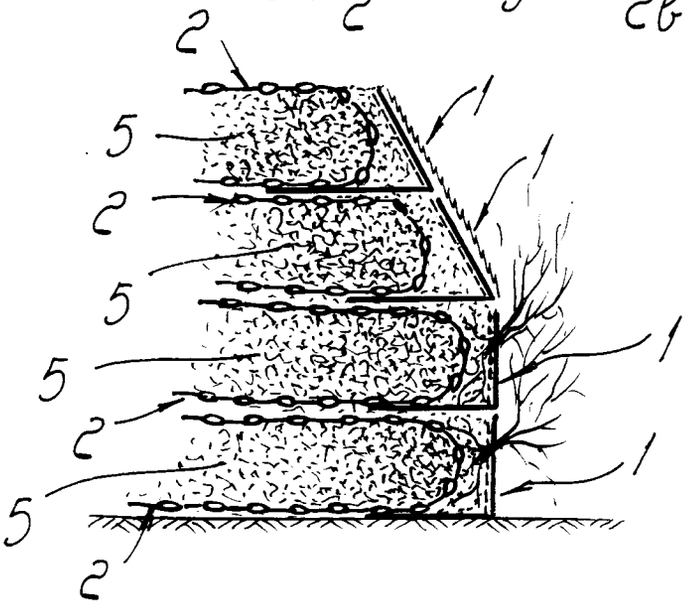


Fig. 6



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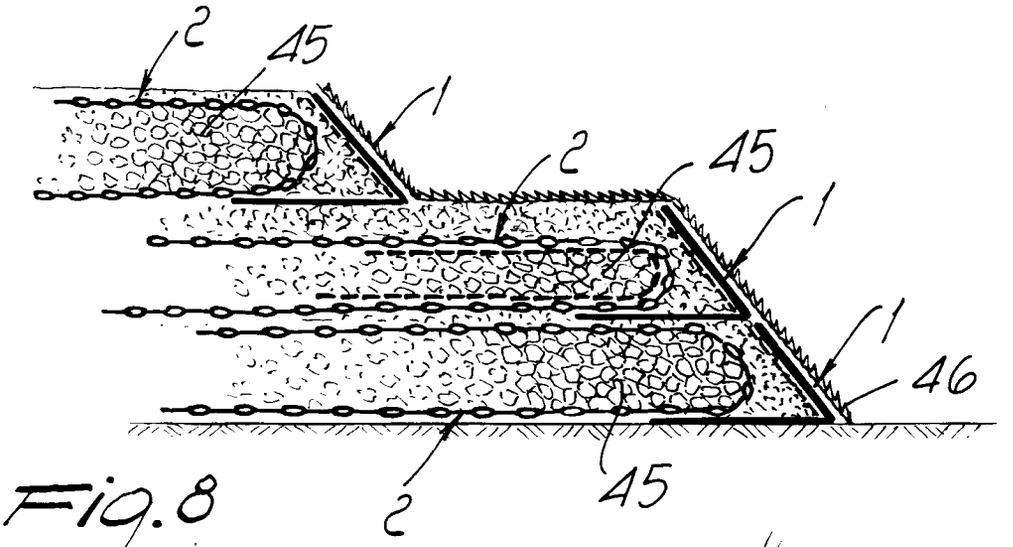
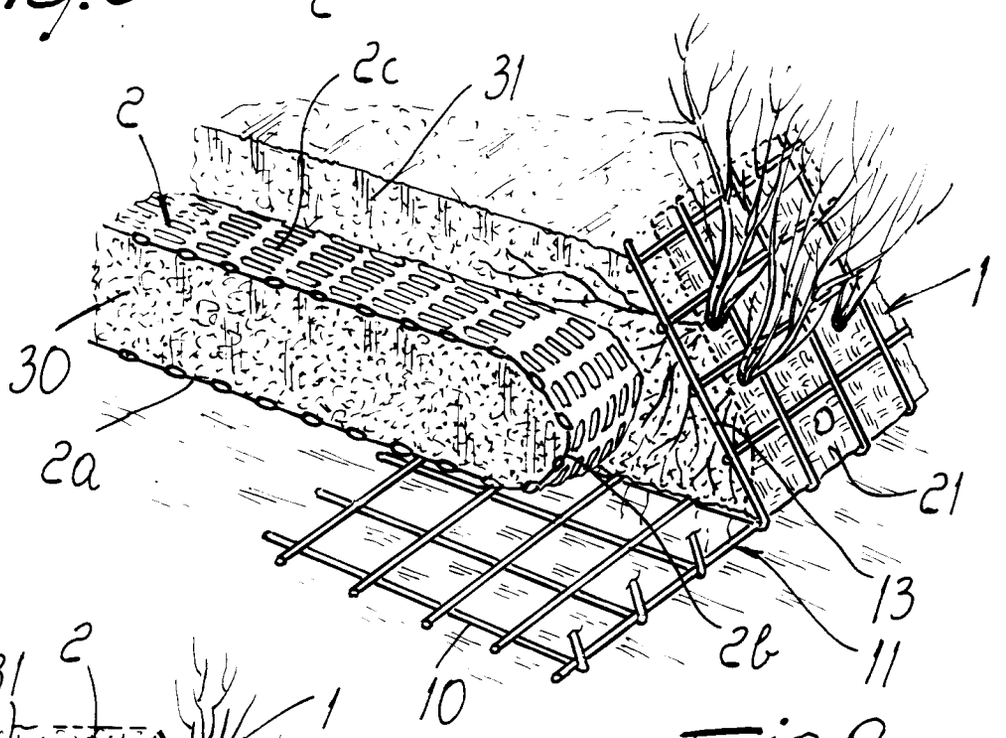


Fig. 8



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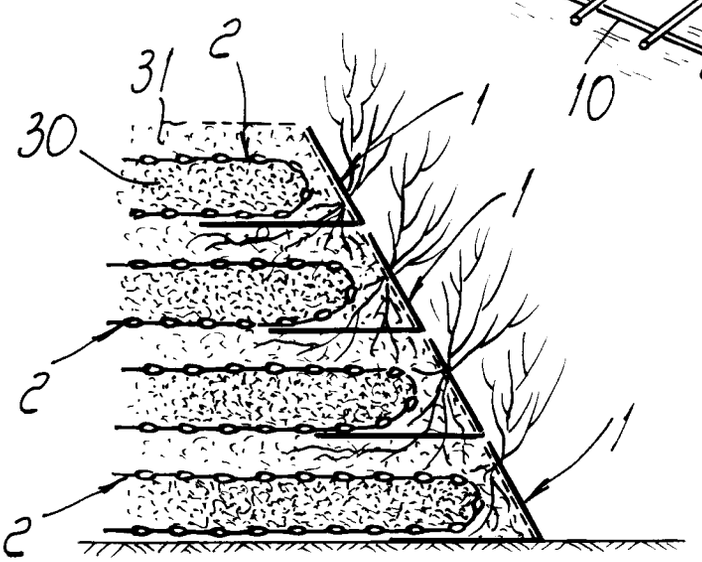
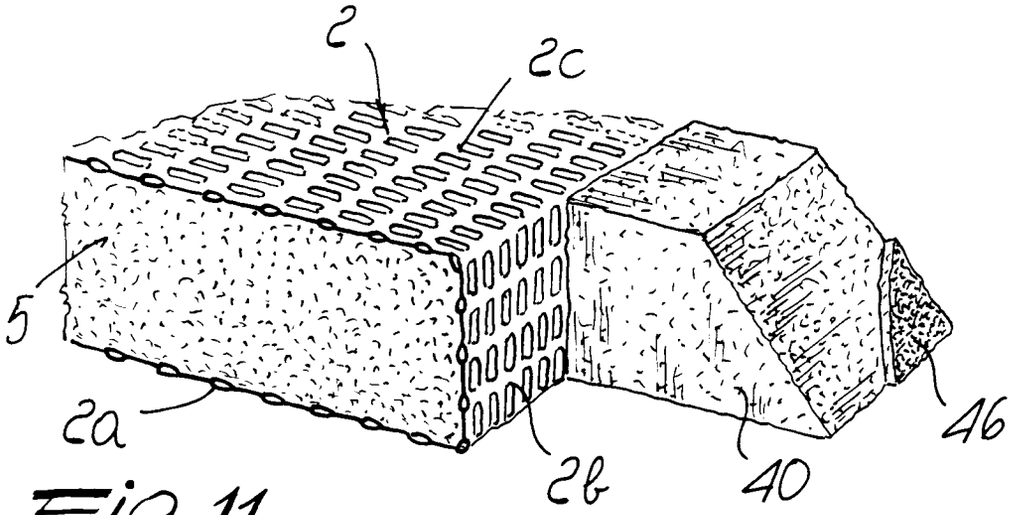


Fig. 10



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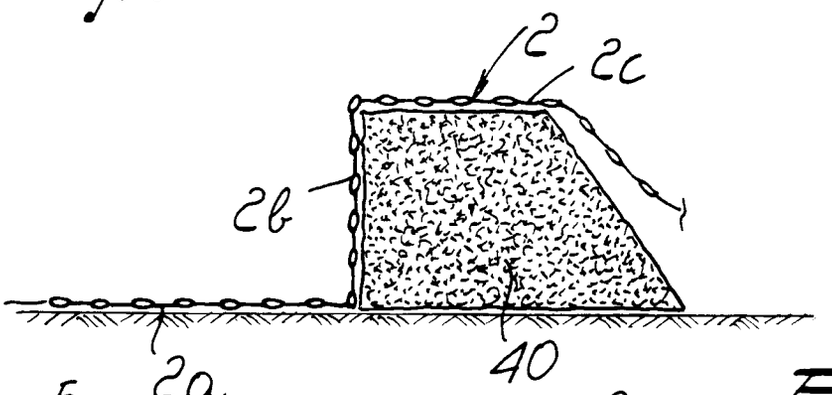
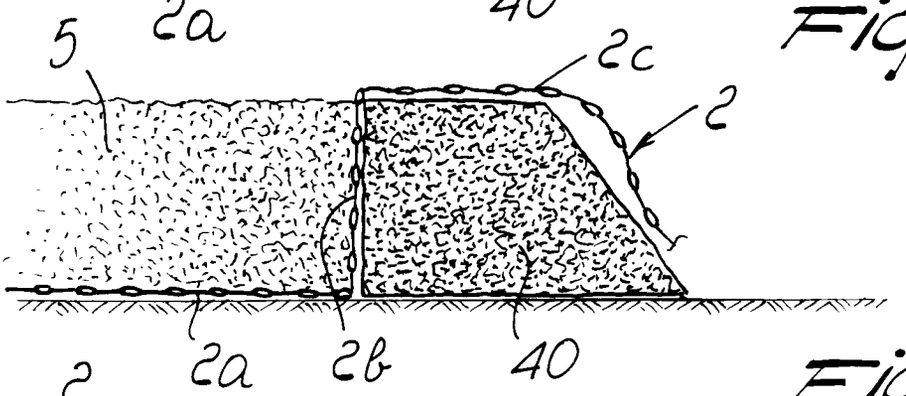


Fig. 12



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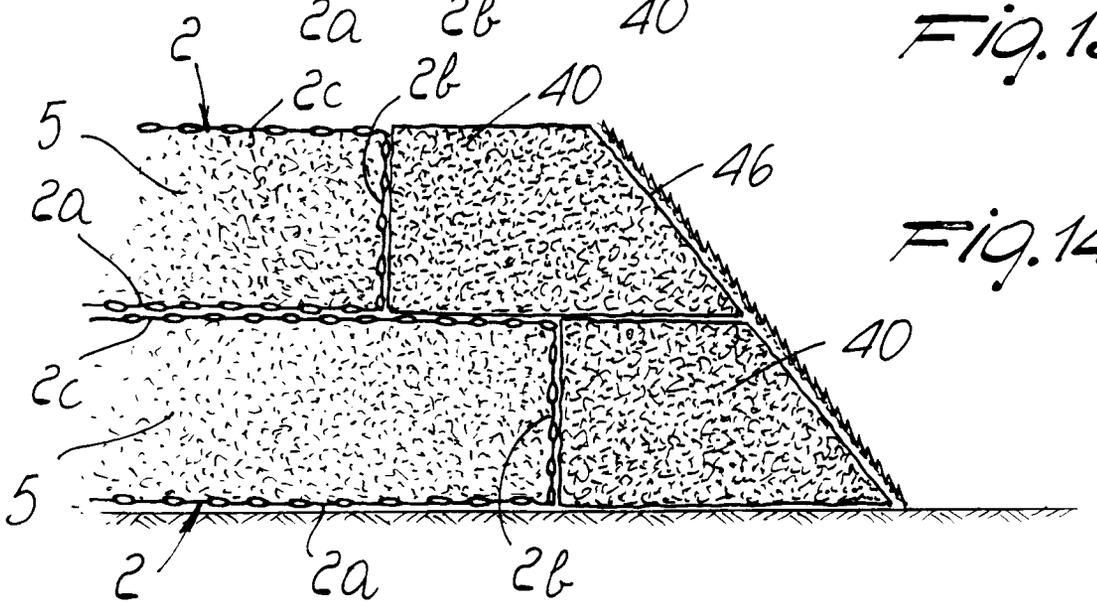
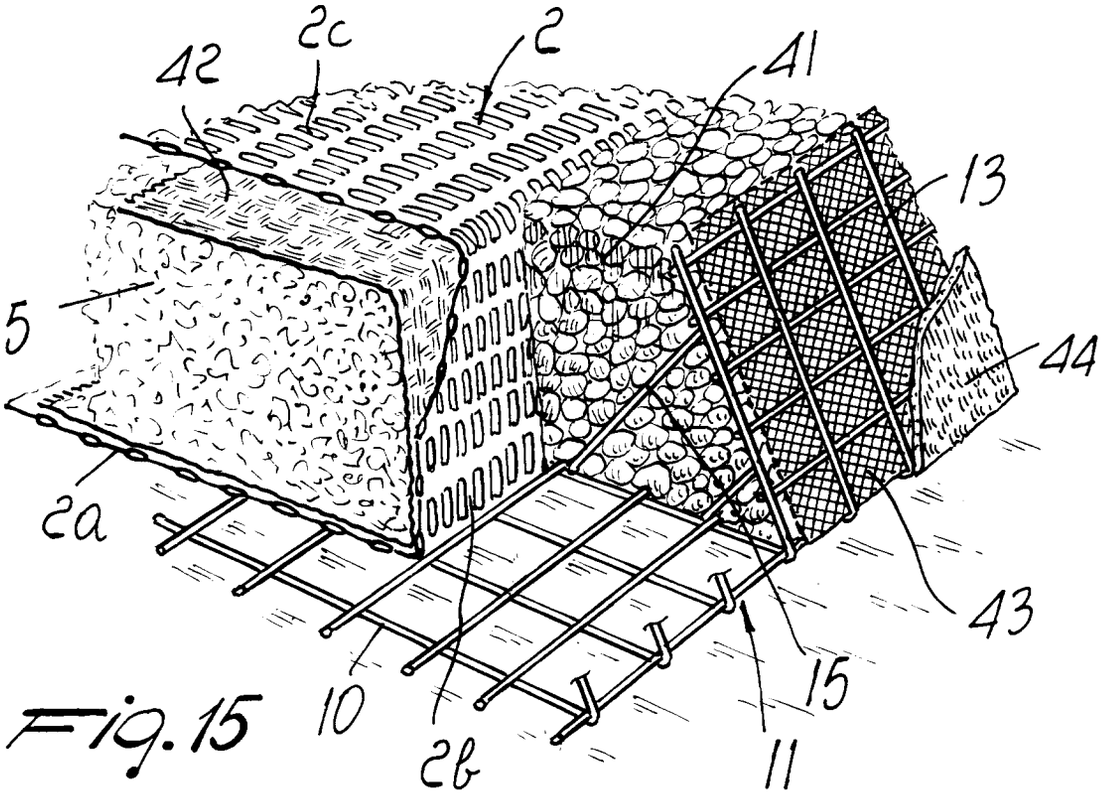


Fig. 14



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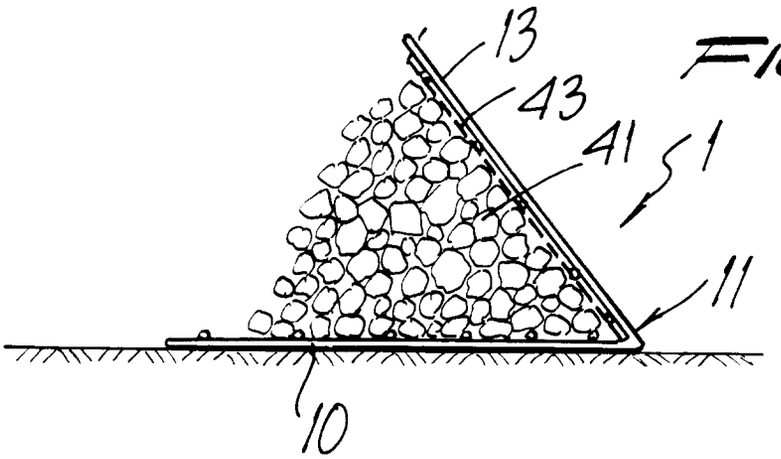
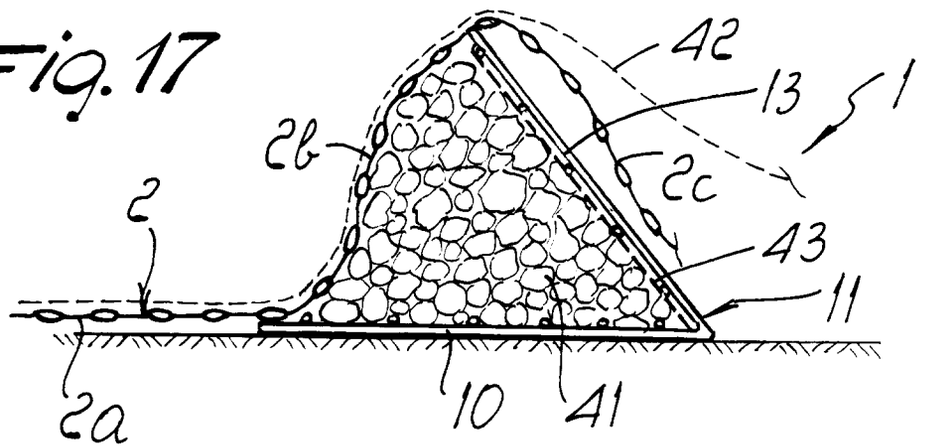


Fig. 16

Fig. 17



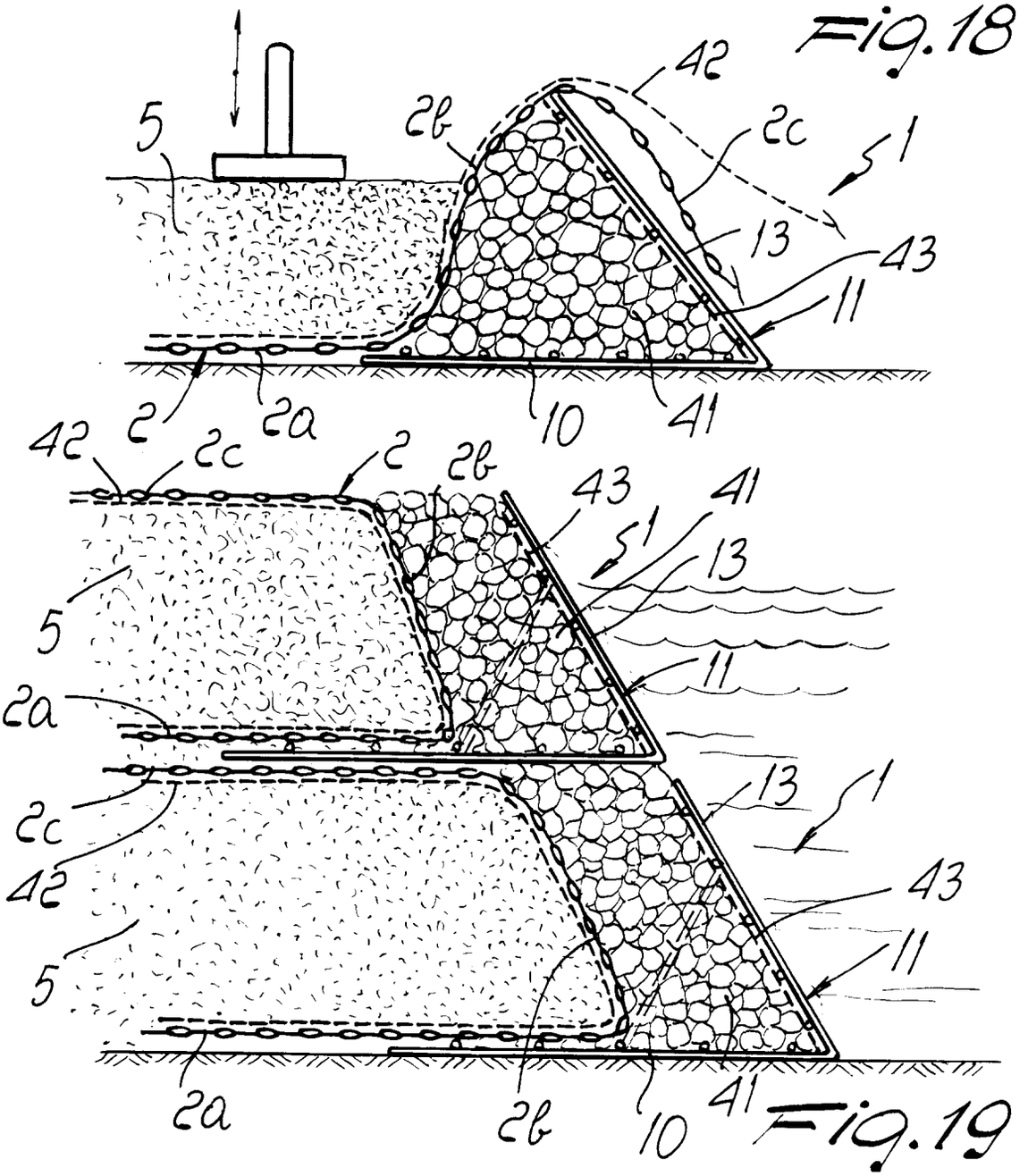

42
2b
2c
1
5
13
43
11
2
2a
10
41

Fig. 18

42
2c
2
2b
43
41
5
1
13
11
2a
2c
42
5
2a
2b
10
41

Fig. 19

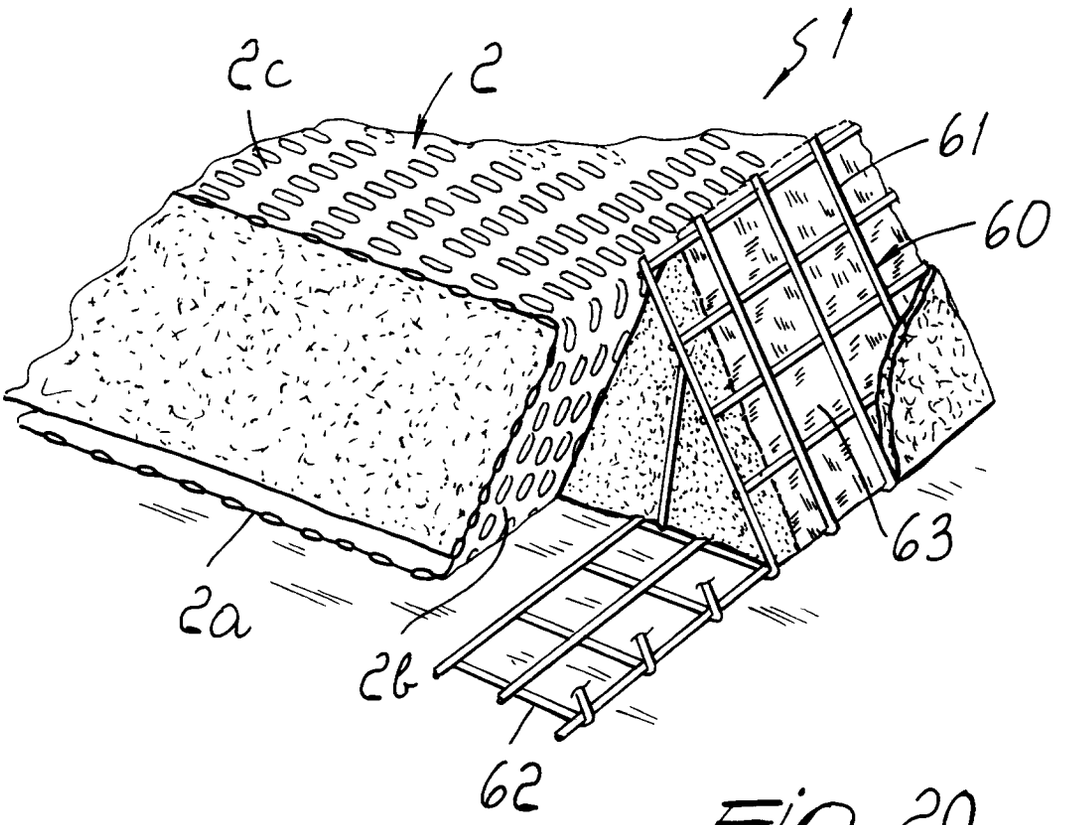


Fig. 20

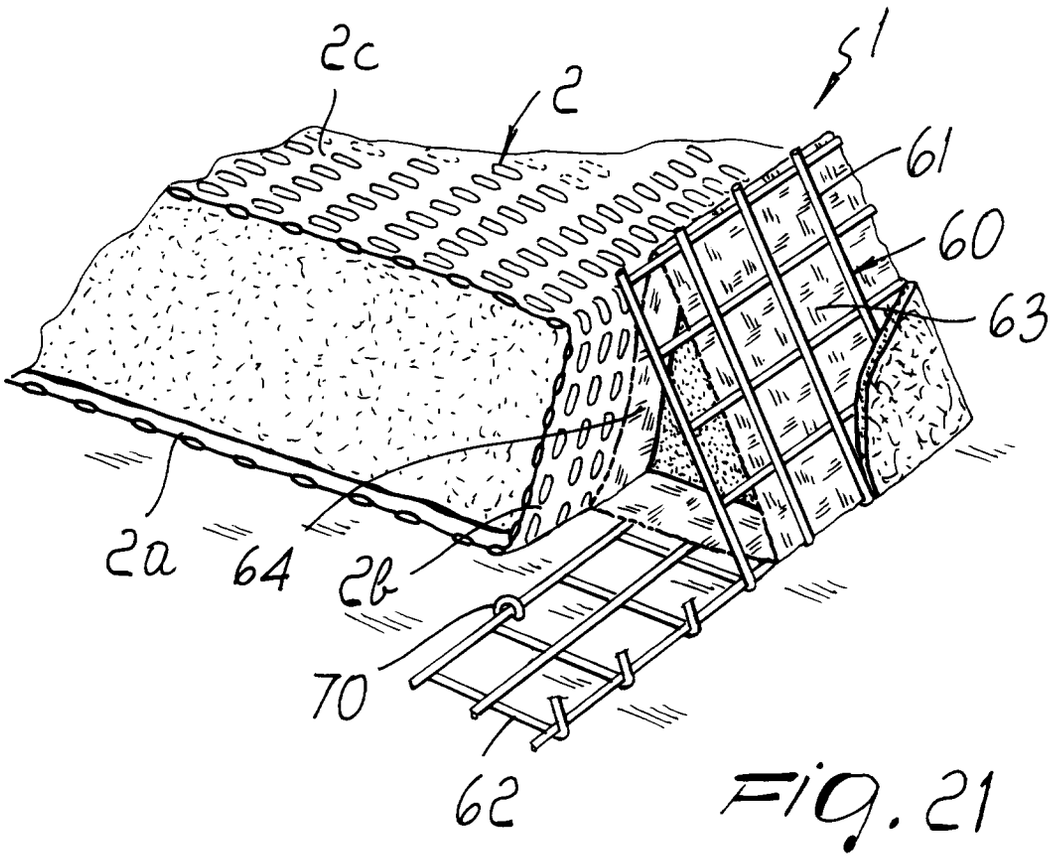


Fig. 21

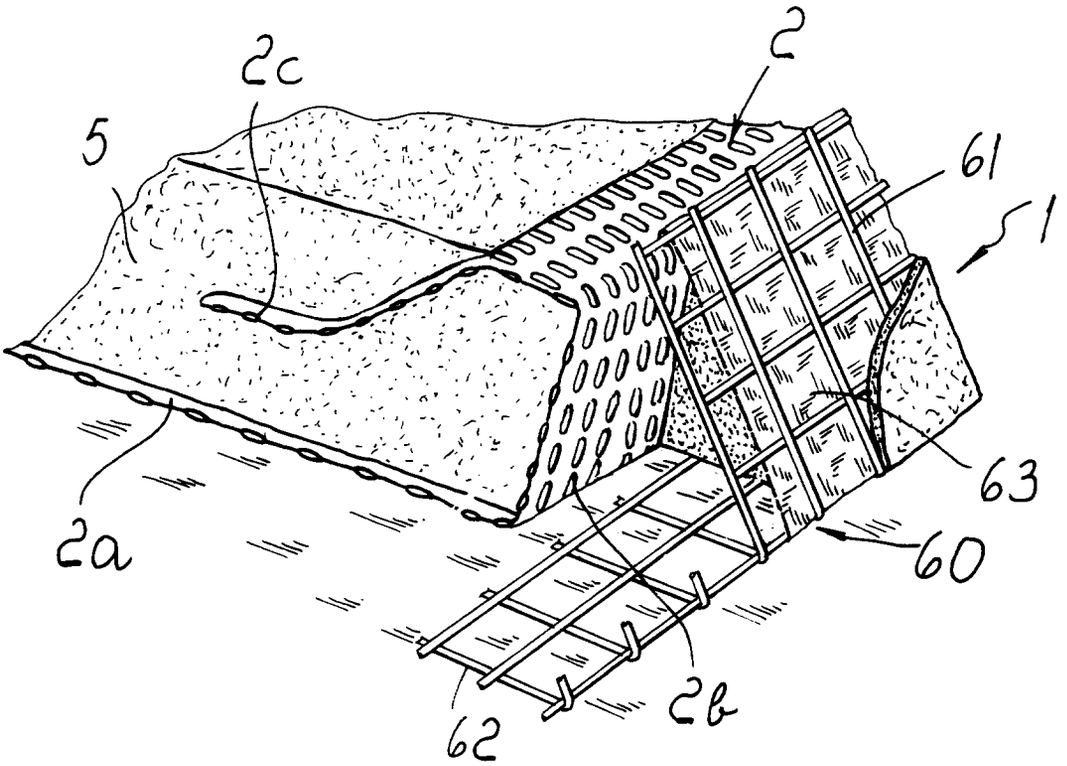


Fig. 22

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 11 1198

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X Y A	DE-A-39 12 796 (PD PHYSIK+DATENTECHNIK GMBH) * column 1, line 1 - column 2, line 36; figure 1 *	1,2,7-9, 14-17 3-5 20-24	E02D29/02
D,Y	CH-A-680 078 (BOSSARD & STÄRKLE AG) * column 1, line 45 - column 2, line 56; figures 1-4 *	3-5	
A	EP-A-0 318 243 (VIDAL) * column 4, line 50 - column 5, line 27; figures 1,2 *	6	
D,A	US-A-4 117 686 (HILFIKER) * column 2, line 30 - column 3, line 30; figure 2 *	10-13	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

E02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 April 1994	Tellefsen, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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