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(11)

EP 1 728 924 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.12.2006 Bulletin 2006/49

(51) Int Cl.:
E01F 7/04 (2006.01) **E02D 17/20** (2006.01)

(21) Application number: **06011101.0**

(22) Date of filing: **30.05.2006**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI
SK TR**
Designated Extension States:
AL BA HR MK YU

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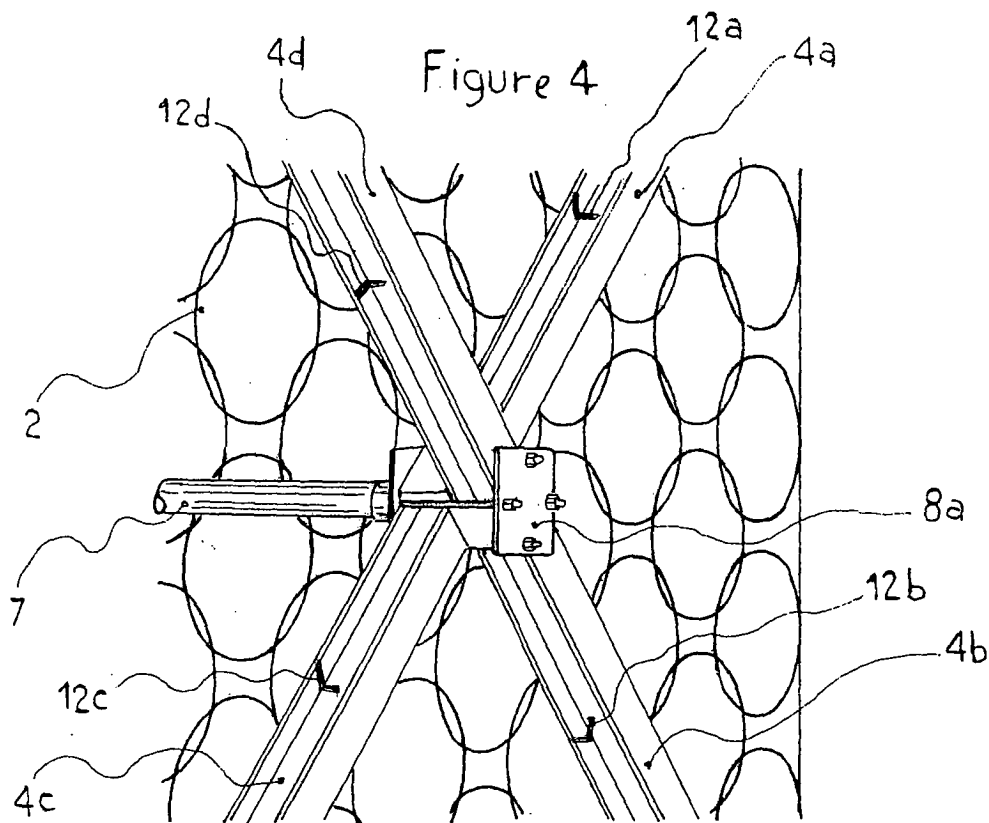
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(30) Priority: **31.05.2005** IT **mi20051020**

(54) Device for holding sliding masses or bodies

(57) A retaining device (1) for sliding bodies or masses comprising a catch netting (2), which is peripherally fastened to a framework, which is in turn provided with a plurality of bearing rod-like elements (4a, 4b, 4c, 4d) that are fastened to each other (8a, 8b, 10) at a mutual

coupling point or area, as well as means (6, 11) for anchoring this framework to the ground. At least one of the rod-like elements further comprises weakening and/or failure means (12a, 12b, 12c, 12d; 13a, 14a, 13b, 14b, 13c, 14c, 13d, 14d; 16, 18, 19a, 19b) acting on its structure.



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Description

[0001] The present invention relates to a retaining (i.e. holding) or braking device for sliding (i.e. downslope-moving) bodies or masses of/on slopes, of the type comprising a catch netting that is peripherally fastened to a support framework, which is, in turn, fixed to the ground by suitable mechanical means for anchorage to the soil.

[0002] It should be observed that by "sliding bodies or masses" is meant any assembly of entities comprising, either together or separately, rocks, soil, stones, gravel, snow, ice, etc. that break off from an inclined wall and tend to slide down under gravity. In this sense, the sliding bodies or masses can be, for example, earth-flows, landslides, ground failures, snow-slides, or even avalanches.

[0003] A known technique is to provide retaining devices for sliding bodies or masses which consist of nettings held in an extended position by a framework obtained by coupling a plurality of metallic or wooden girders or beams. This framework is then firmly anchored to the ground by means, for example, of a set of tie-rods connected to one or more posts that are deeply implanted into the soil. The function performed by the netting, which is usually made of synthetic or metallic meshes, is to cushion and/or retain the sliding masses or bodies, due to the shape and resilience thereof, without hindering the passage of the wind or other weather events, and allowing small wild animals to freely pass therethrough.

[0004] These devices are usually employed either as snow barriers, in which case they are arranged on slopes at those sites where a snow mass is likely to break off, or as soil retainers, in which case they can also be at least partially laid below ground level, and act as a static barrier for the soil, for the stabilization of slopes, river dykes and debris flows.

[0005] The Swiss Patent CH-A-674998, in the name of STREIFF, teaches to provide a retaining device for snow masses, or even avalanches, of the type in which a framework with beams rigidly fastened to each other supports a netting that is peripherally, loosely, fastened to this framework. A rigid pyramidal framework is then arranged to fix said framework to the ground by means of anchoring means comprising screws or posts embedded (i.e. implanted) in the ground. After it has been installed, the netting of the STREIFF device is arranged and shaped such as to absorb the impact and break the flow of snow and ice of possible snow-slides, snow masses or avalanches.

[0006] The European Patent EP-A-828897, in the name of LASAR, describes a device for breaking snow masses, such as avalanches and snow-slides, by means of a netting supported, along the periphery thereof, by a framework formed by beams that are crossed and fastened to each other with some clearance therebetween. A plurality of tie-rods being interposed between the ends of said beams and the one end of a strut, which is, in turn, coupled to the framework at the other end, connect said framework to a ground anchorage element.

[0007] The Spanish Utility Model ES-U-1057315, in the name of FATZER, relates to a retaining device for sliding masses of the type indicated above, in which the framework, of the type having crossed beams, lays on a plane and is pivotable on said laying plane.

[0008] These prior art retaining devices for sliding masses are quite effective in the event of impact against sliding objects, but when the kinetic energy (or linear momentum) of said masses exceeds a certain threshold, the device is no longer capable of retaining the sliding mass. Thus, if the whole device disengages from the ground, or the netting unfastens from the framework, or even breaks, the device is no longer capable of performing the expected function.

[0009] In fact, in the above-mentioned devices, the impact absorption is substantially demanded to the catch netting, essentially as a function of its elasticity, shape and arrangement on the framework. When the netting is subjected to a stress exceeding its resilience characteristics, the above conditions of abnormal or degraded operation of the device are likely to occur.

[0010] It is accordingly an object of the present invention to provide a retaining device for sliding masses or bodies of the type comprising a catch netting that is fastened to a framework anchored to the ground, which is capable of absorbing impacts of masses provided with a non-negligible linear momentum.

[0011] It is thus an object of the present invention to provide a retaining device for sliding masses or bodies which proves to be particularly effective in retaining these sliding bodies or masses, while being easy to manufacture and install.

[0012] These and other objects are achieved by the retaining device for sliding bodies according to the first independent claim and the subsequent dependent claims.

[0013] The retaining device for sliding bodies or masses according to the present invention comprises at least one catch netting, which is peripherally fastened to a framework, which is in turn provided with a plurality of bearing rod-like elements that are fastened to each other at a mutual coupling point or area, as well as means for anchoring this framework to the ground. Advantageously, at least one of said bearing rod-like elements comprises weakening or failure means acting on its structure.

[0014] The provision of weakening or failure means acting on the structure of at least one of said rod-like elements, which consist for example of notches or hinges between the portions of this bearing rod-like element, provide the framework with an increased capacity of absorbing the impact against sliding masses, due to its increased compliance.

[0015] According to a preferred aspect of the present invention, these weakening and/or failure means are arranged such as to facilitate the collapse of the rod-like element structure, on which they are provided, on the downhill side of the device, when the latter is installed.

[0016] Furthermore, according to another particular

aspect of the present invention, the bearing rod-like elements forming the framework suitable to support the catch netting are mutually rigidly fastened to each other and also to the ground by means of tie-rods, preferably made of steel rope, and by means of at least one strut that is suitable to connect the mutual coupling point or area of the rod-like elements to a suitable ground connecting member.

[0017] Several embodiments of the present invention will be now described only by way of example, with reference to the annexed figures, in which:

- Fig. 1 is an axonometric schematic view of a device according to a preferred aspect of the present invention, taken on the downhill side of the device;
- Fig. 2 is an axonometric schematic view of the device from Fig. 1 taken on the uphill side of the device;
- Fig. 3 is an axonometric detailed view of the mutual coupling area of the bearing rod-like elements of the device of Fig. 1 and 2;
- Fig. 4 is an axonometric schematic view taken on the downhill side of a particular embodiment of the weakening and/or failure means that can be provided on the device of the preceding figures;
- Fig. 5 is an axonometric schematic view, taken on the downhill side, of another specific embodiment of the weakening and/or failure means that can be provided on the device of the preceding figures; and
- Fig. 6 is a schematic top view of a bearing rod-like element of the device in Fig. 1 being provided with a further embodiment of the above-mentioned weakening and/or failure means acting on its structure.

[0018] With reference to Fig. 1 and 2, the device 1 for retaining sliding bodies, or masses along a slope 9 comprises, as is known in the art, at least one catch netting 2 that is fastened to a framework 4a, 4b, 4c, 4d, 8a, 8b, 10, and means 5a, 5b, 5c, 5d, 6, 7, 11 for anchoring the framework 4a, 4b, 4c, 4d, 8a, 8b, 10 to the ground.

[0019] More particularly, the catch netting 2, which has the purpose of braking any sliding bodies or breaking the impacting snow masses, comprises a plurality of concatenated meshes, which are made of synthetic or metal wire, contoured by a fixing cable 3 that is fastened at the ends of a plurality of bearing rod-like elements 4a, 4b, 4c, 4d, which, in turn, form the above-mentioned framework.

[0020] In the particular embodiment of the device 1 as illustrated in the figures, the netting 2 is arranged, with respect to the slope 9, uphill of these bearing rod-like elements 4a, 4b, 4c, 4d, when the device 1 is installed. As those skilled in the art will appreciate, the netting 2 may be also arranged downhill of the rod-like elements 4a, 4b, 4c, 4d, without departing from what is contemplated in the present invention. Furthermore, while the netting 2 as illustrated and described herein is of the type with annular concatenated meshes, any other type of netting, such as with rectangular or rhomboidal meshes, or

also of the type with twined or crossed ropes, can be alternatively employed in the retaining and/or braking device for sliding bodies, or masses being the object of this patent.

[0021] It should be also noted that by "bearing rod-like element" is meant any structural element which has a predominant dimension over the other two, and which, by departing from at least one area or point of mutual coupling with other bearing rod-like elements, has the function of supporting or connecting at least one portion of said catch netting 2.

[0022] In the device 1 described herein, the bearing rod-like elements 4a, 4b, 4c, 4d, that are preferably made of steel girders or beams, are mutually fastened at an individual mutual coupling area, which is substantially at the geometrical centre of the netting 2. In the particular embodiment of the device 1, furthermore, the rod-like elements 4a, 4b, 4c, 4d are radially arranged relative to this mutual coupling area and consist of two beams 4a, 4c and 4b, 4d, made of steel, which are crossed and mutually fastened at this coupling area.

[0023] In greater detail, with reference also to Fig. 3, the two beams 4a, 4c; 4b, 4d are integrally fastened to each other via to two brackets 8a, 8b that are duly shaped to hold the two beams 4a, 4c; 4b, 4d crossed at a pre-determined angle and are also fixed to each other by a plurality of bolts 10, or other equivalent threaded elements that are arranged at the clearances between the two crossed beams. The two brackets 8a, 8b and the bolts 10 provide a rigid fastening between the two beams 4a, 4c and 4b, 4d, which thus have no degree of freedom, i.e. no clearance is allowed therebetween.

[0024] As an alternative to the use of the brackets 8a, 8b and relative bolts 10, the two beams 4a, 4c; 4b, 4d, or the corresponding bearing rod-like elements can be integrally fastened to each other in a given area of mutual coupling by welding or directly bolting the rod-like elements 4a, 4b, 4c, 4d.

[0025] The rigidity of the fastening between said bearing rod-like elements 4a, 4b, 4c, 4d forming the framework, and thus the rigidity of the latter, is particularly useful in view of the static mechanical strength and accuracy upon installation, when the device 1 illustrated therein is employed as a soil retainer, and is thus at least partially laid below ground level.

[0026] The beams 4a, 4c and 4b, 4d of the framework also have, at their ends, suitably drilled and/or shaped coupling flanges to hold the peripheral fixing cable 3 for the netting 2.

[0027] It should be noted that, according to the expression "rod-like element" as used herein, any beam 4a, 4c and 4b, 4d of the device 1 illustrated herein thus defines two distinct rod-like elements 4a, 4c and 4b, 4d. Alternatively, in an embodiment (not shown) of the device 1, the rod-like elements 4a, 4b, 4c, 4d may be provided by means of four different beams, or girders, that are fastened to each other.

[0028] It should also be noted that the use of two over-

lapped beams 4a, 4c; 4b, 4d results in the relative bearing rod-like elements 4a, 4b, 4c, 4d not being co-planar to each other, without this impairing the effectiveness of the device 1.

[0029] The support framework of the netting 2, which consists, as stated above, of the rod-like elements 4a, 4b, 4c, 4d and brackets 8a, 8b held by bolts 10, is thus fastened to the ground due to a plurality of tie-rods, or stays, 5a, 5b, 5c, 5d connecting each rod-like element 4a, 4b, 4c, 4d to a ground connecting member 6, 11, which consists, in the particular device 1 as illustrated herein, of a coupling body 6 for the tie-rods 5a, 5b, 5c, 5d and a screw or post 11 being joined to the body 6, for example by means of a steel rope and intended to be deeply embedded in the ground.

[0030] According to the known technique, the tie-rods 5a, 5b, 5c, 5d can be made of steel rope and can connect the body 6 at the ends of the rod-like elements 4a, 4b, 4c, 4d.

[0031] Alternatively, the engaging points of the tie-rods 5a, 5b, 5c, 5d with the respective rod-like elements 4a, 4b, 4c, 4d can be located in any intermediate point thereof, and particularly can be arranged at, or nearness to the middle point of these rod-like elements 4a, 4b, 4c, 4d, relative to their mutual coupling area.

[0032] Interposed between the framework 4a, 4b, 4c, 4d, 8a, 8b, 10 and the body 6, there can further be a stiffening strut 7 that can be made of steel tube.

[0033] The strut 7, that may be integral with or made as one piece with the coupling body 6, can be advantageously just rested on, or however fastened, with at least one degree of freedom, to the framework 4a, 4b, 4c, 4d, 8a, 8b, 10, at the mutual coupling area of the rod-like elements 4a, 4b, 4c, 4d.

[0034] In the particular embodiment of the device 1 described herein, according to the present invention, the strut 7 is inserted in a bush 15 integral with the bracket 8b, such as to be free to move along its own axis, i.e. in a sliding manner relative to this bracket 8b. As will be apparent to those skilled in the art, this facilitates the installation of the device 1, while ensuring an optimum stability to the latter.

[0035] The strut 7, tie-rods 5a, 5b, 5c, 5d, and ground connecting member 6, 11 are a particular embodiment of said ground anchoring means of the framework 4a, 4b, 4c, 4d, 8a, 8b, 10.

[0036] It should be noted that this ground anchoring means of the framework 4a, 4b, 4c, 4d, 8a, 8b, 10 are arranged such as to allow the latter to be anchored to the slope 9 uphill of the catch netting 2. However, the framework 4a, 4b, 4c, 4d, 8a, 8b, 10 of the netting 2 can be anchored to the ground also downhill of this netting 2, along the slope 9.

[0037] According to the present invention, advantageously, at least one of the rod-like elements 4a, 4b, 4c, 4d has weakening and/or failure means acting on its structure, which are capable of allowing the same to collapse, at at least one portion thereof, when the kinetic

energy of the sliding bodies or masses impacting the same exceeds a value preset during the design step.

[0038] According to a preferred aspect of the present invention, said weakening or failure means are arranged such as to facilitate the collapse of the structure of the rod-like element to which they are associated downhill of the slope 9. Thereby, the impact of the sliding bodies or masses against the netting 2 may allow the failure of the rod-like element 4a, 4b, 4c or 4d in the forward direction of the sliding mass, thereby ensuring a further impact absorption by the whole device 1.

[0039] Advantageously, the Applicant has found that these weakening and/or failure means acting on the structure of at least one bearing rod-like element 4a, 4b, 4c, 4d can be shaped and arranged on this rod-like element such as to act at a distance that, relative to the mutual coupling point or area of the bearing rod-like elements 4a, 4b, 4c, 4d, is lower than or equal to half the length of the rod-like element. In a preferred embodiment of the present invention, as shown in Fig. 4, these weakening and/or failure means can be provided on all the rod-like elements 4a, 4b, 4c, 4d, with which the framework of the device 1 is provided, and consist of notches 12a, 12b, 12c, 12d, or linear tracts with a reduced (i.e. smaller) section that are formed along the structure of each rod-like element 4a, 4b, 4c, 4d.

[0040] Particularly, each of the two steel beams 4a, 4c and 4b, 4d of the device 1 illustrated in Fig. 4 can have a pair of notches 12a, 12c and 12b, 12d, that are arranged uphill of these beams and equally spaced relative to said mutual coupling area of the rod-like elements, i.e. equally spaced relative to the brackets 8a, 8b.

[0041] The depth of the notches 12a, 12b, 12c, 12d, their number on each rod-like element 4a, 4b, 4c, 4d, as well as their arrangement along the beams 4a, 4c and 4b, 4d, determine the resistance of the latter to the impact with the sliding bodies or masses, and thus the absorption amount of the relative collision by the device 1.

[0042] In the embodiment of Fig. 5, another embodiment of the weakening and/or failure means is represented according to a preferred aspect of the present invention.

[0043] In this embodiment, each rod-like element 4a, 4b, 4c, 4d has a through notch 13a, 13b, 13c, 13d that determines the separation of the relative rod-like element in two different segments, which are fastened to each other via a hinge 14a, 14b, 14c, 14d.

[0044] The arrangement of the notches 13a, 13b, 13c, 13d and respective hinges 14a, 14b, 14c, 14d is such to allow the failure of the structure, i.e. the relative rotation of the upper segments of each rod-like element 4a, 4b, 4c, 4d relative to the lower elements, only in a downhill direction relative to the slope 9, i.e. in accordance with the direction of the sliding masses impacting on the netting 2.

[0045] This embodiment of the weakening and/or failure means acting on the structure of the bearing rod-like elements 4a, 4b, 4c, 4d is adapted to be replicated sev-

eral times throughout each rod-like element 4a, 4b, 4c, 4d, such that the latter is composed by a plurality of segments fastened by hinges 14a, 14b, 14c, 14d allowing the same to rotate in the way defined by the impact direction of the sliding bodies or masses.

[0046] In another embodiment of the weakening and/or failure means acting on the structure of the bearing rod-like elements 4a, 4b, 4c, 4d, as shown in Fig. 6, at least one bearing element 4a is sectioned, by a through notch 16, in two segments 17a, 17b that are mutually fastened by a folding plate 18 fixed to these segments by means of bolts or other threaded fixing means 19a, 19b.

[0047] This folding plate 18 can be also welded on at least one of the segments 17a, 17b providing said bearing rod-like element 4a and be fastened to the other segment 17b, 17a by threaded means, or also be welded to both segments 17a, 17b.

[0048] The folding plate 18, for example a steel folding plate having a small thickness, can be advantageously arranged along the downhill side of the relative bearing rod-like element 4a, such as to bend and allow the relative rotation of the two segments 17a, 17b in the way as defined by the impact direction of the sliding bodies or masses.

[0049] Of course, without departing from the scope of the present invention, this embodiment of the weakening and/or failure means can be replicated two or more times throughout the extension of the bearing rod-like element 4a to which it is associated, and can also be provided on two or more of the rod-like elements 4a, 4b, 4c, 4d forming the framework of the device 1.

Claims

1. A retaining device (1) for sliding bodies or masses of the type comprising at least a catch netting (2) being peripherally fastened to a framework provided with a plurality of bearing rod-like elements (4a, 4b, 4c, 4d), and means (6, 11) for anchoring said framework to the ground, said bearing rod-like elements being mutually fastened (8a, 8b, 10) at at least one mutual coupling point, or area, said device being **characterized in that** at least one of said rod-like elements comprises weakening and/or failure means (12a, 12b, 12c, 12d; 13a, 14a, 13b, 14b, 13c, 14c, 13d, 14d; 16, 18, 19a, 19b) acting on its structure.
2. The device according to claim 1, **characterized in that** said weakening and/or failure means comprise at least one portion having a reduced thickness (12a, 12b, 12c, 12d) of said at least one rod-like element.
3. The device according to claim 1, **characterized in that** at least one of said rod-like elements comprises two or more segments joined by fracture lines (13a,

13b, 13c, 13d; 16), said fracture lines being said weakening and/or failure means.

4. The device according to claim 3, wherein said fracture lines are at least partial cuts formed in said at least one rod-like element.
5. The device according to claim 4, wherein said cuts completely section said at least one rod-like element in at least two segments (17a, 17b), which are fastened to each other by folding connecting plates (18).
6. The device according to claim 1, **characterized in that** said weakening and/or failure means comprise at least one connecting hinge (14a, 14b, 14c, 14d) between separate segments of said at least one rod-like element.
7. The device according to any preceding claim, **characterized in that** said weakening and/or failure means act on said rod-like elements nearness to said at least one mutual coupling point or area of said plurality of rod-like elements.
8. The device according to claim 7, **characterized in that** said weakening and/or failure means act at a distance equal to or lower than half the length of each rod-like element from said at least one mutual coupling point or area.
9. The device according to any preceding claim, **characterized in that** said weakening and/or failure means are arranged such as to facilitate the failure of the structure of said at least one rod-like element on the downhill side of the device, when the latter is installed.
10. The device according to any preceding claim, **characterized in that** said plurality of rod-like elements are rigidly fixed to each other.
11. The device according to any preceding claim, wherein said rod-like elements are mutually fastened at only one mutual coupling point or region, and wherein said rod-like elements are at least three and are radially arranged relative to each other and relative to said mutual coupling point or region.
12. The device according to any preceding claim, **characterized in that** said means for anchoring said framework to the ground comprise a plurality of tie-rods (5a, 5b, 5c, 5d) that are fastened, at the one end thereof, to said plurality of rod-like elements, and at the other end thereof, to a ground connecting member (6, 11).
13. The device according to claim 12, **characterized in that** said means for anchoring said framework to the

ground comprise at least one strut (7) interposed between said framework and said ground connecting member.

- 14.** The device according to claim 13, **characterized in that** said at least one strut is fastened, with at least one degree of freedom, to said framework. 5
- 15.** The device according to claim 12, 13 or 14, wherein said tie-rods are made of metallic rope. 10
- 16.** Use of the device according to any preceding claim as a snow barrier.
- 17.** Use of the device according to any claim 1 to 15 as a soil retainer. 15
- 18.** Use of the device according to claim 17, as a static barrier for the soil, for stabilization of slopes, river dykes and debris flows. 20
- 19.** Use according to claim 17 or 18, wherein said device is at least partially laid below ground level.

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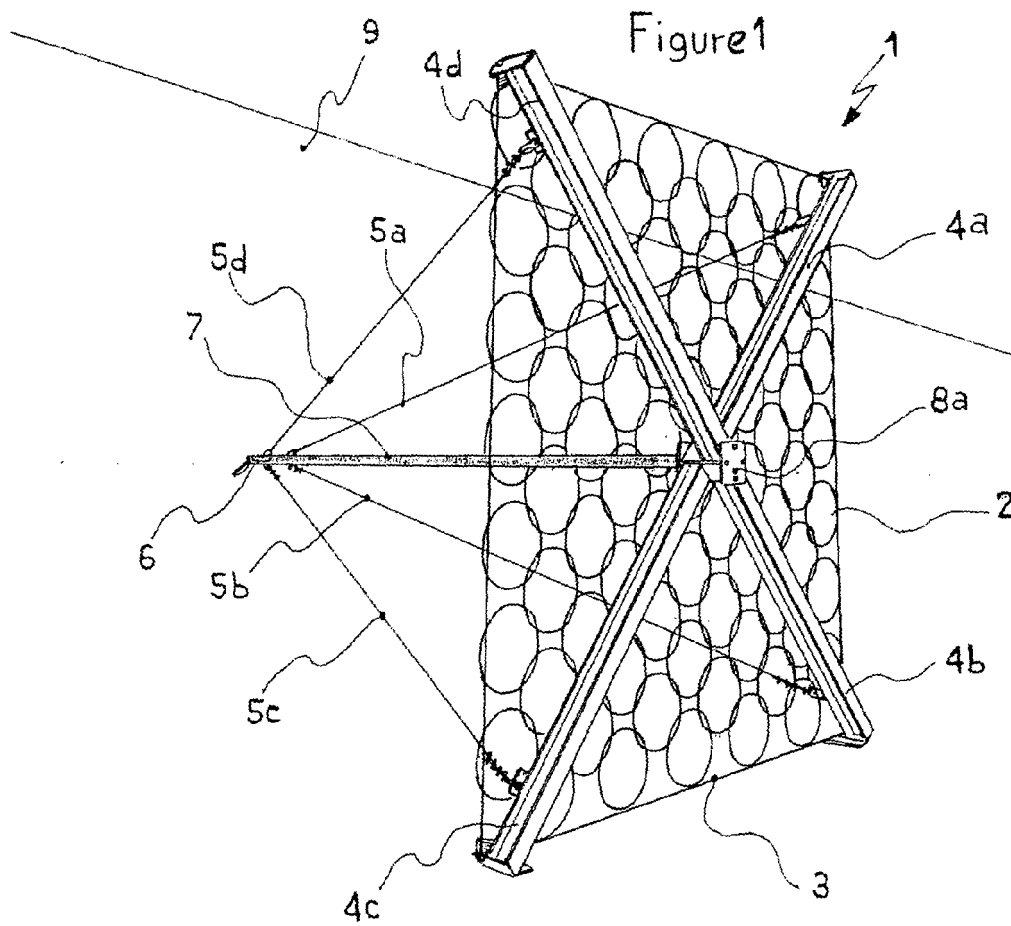
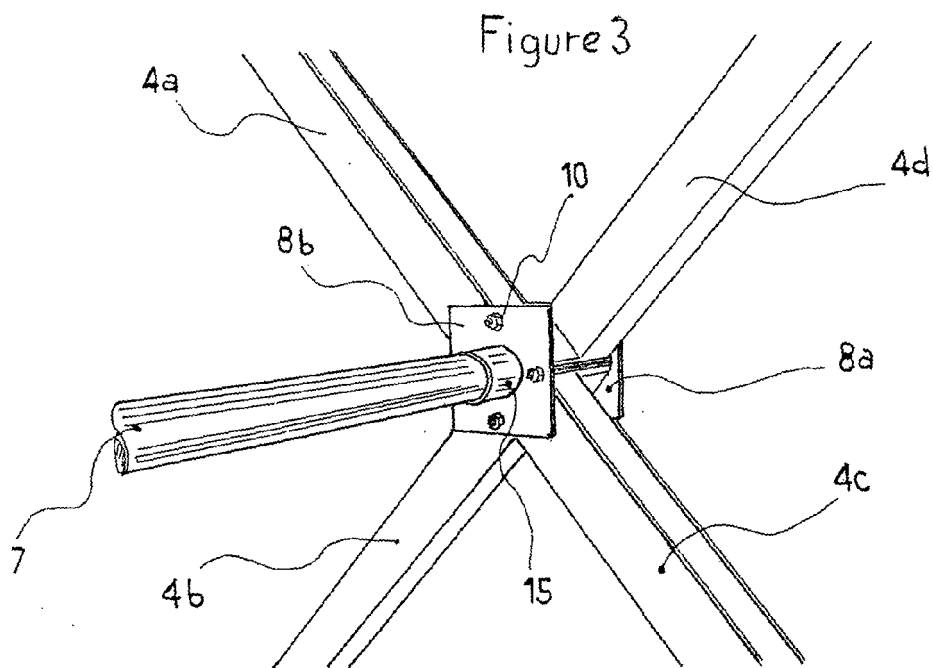
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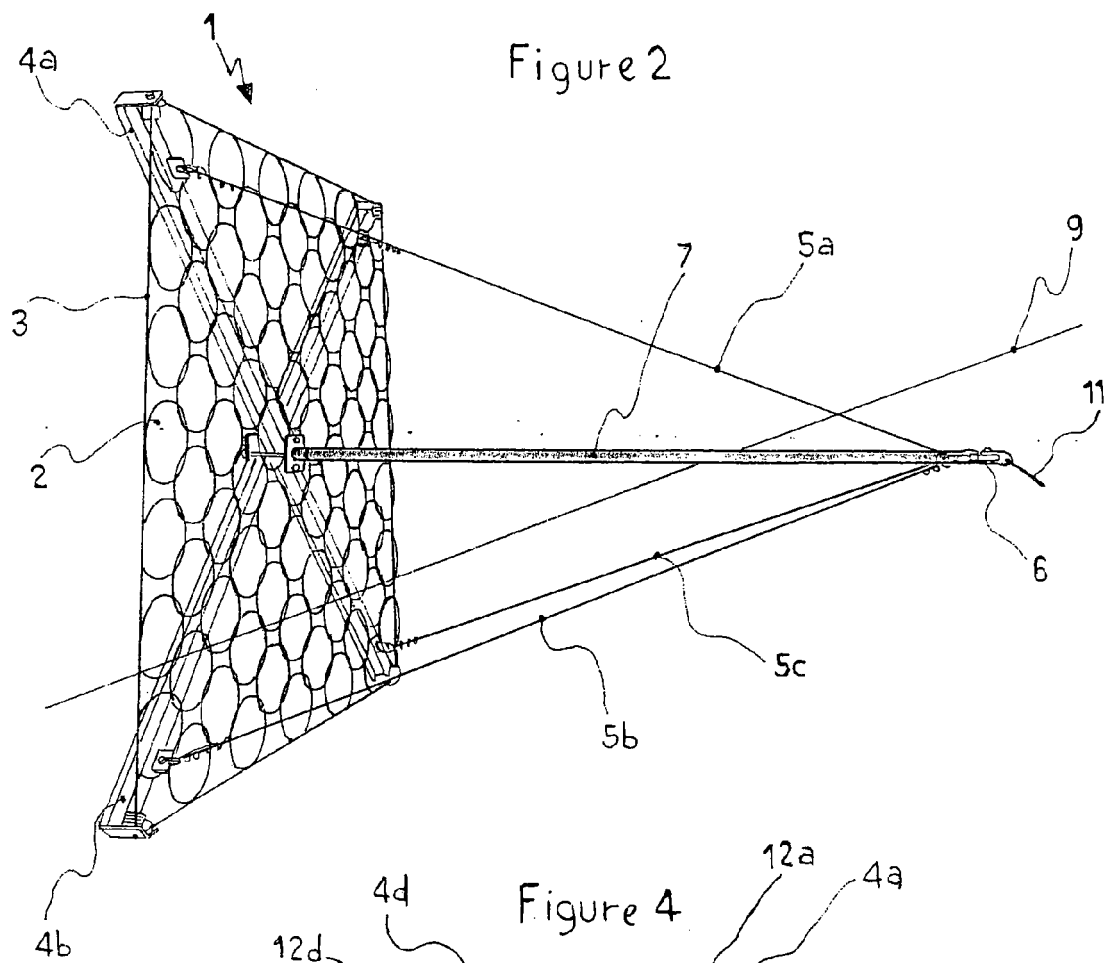
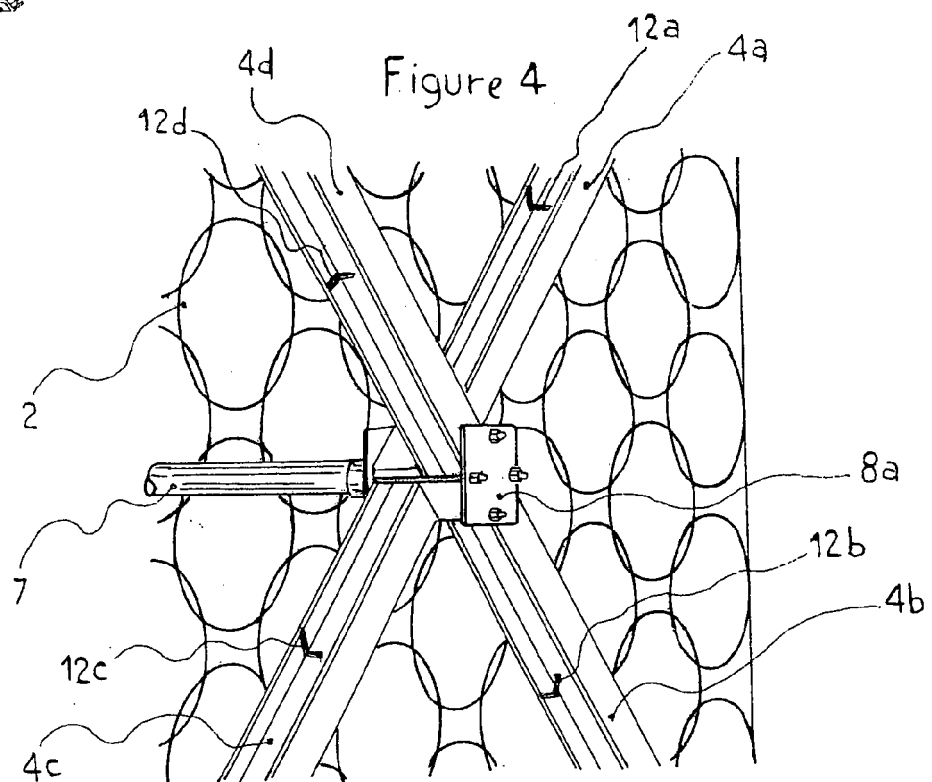


Figure 5

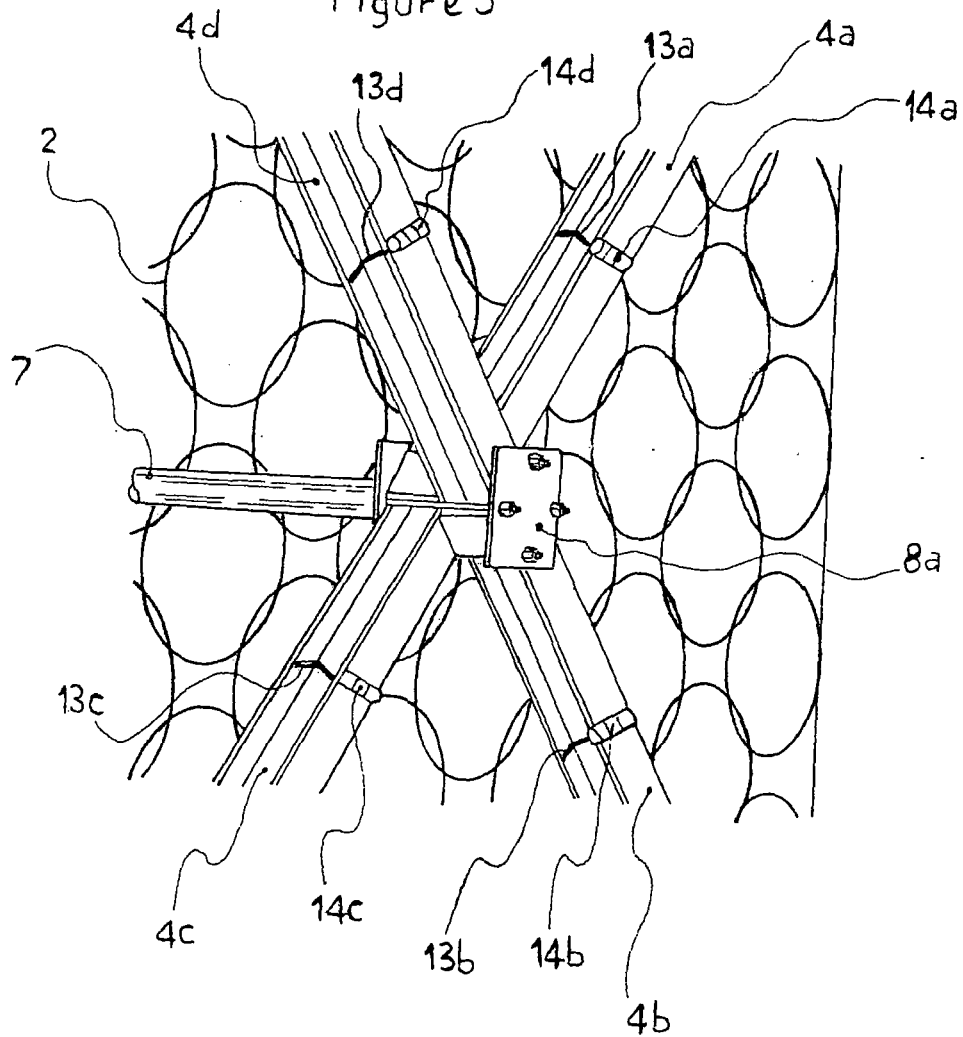
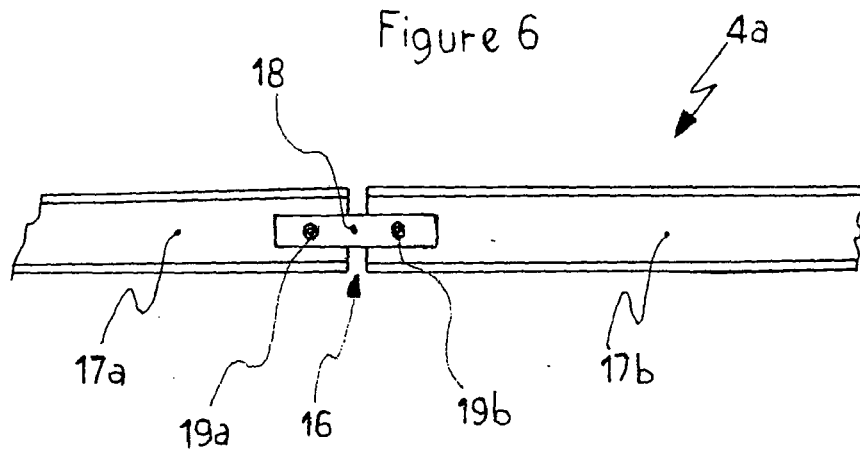


Figure 6





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 01 1101

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 27 October 2006	Examiner Tran, Kim-Lien
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 06 01 1101

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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27-10-2006

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