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(54) **PROTECTIVE NET, ESPECIALLY FOR ROCKFALL PROTECTION OR FOR VERGE SECURING**

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(57) **ABSTRACT**

A protective net, especially for rockfall protection or for verge securing, with a diagonal weave (**10**), is formed by a three-dimensional mattress-like structure. The same is woven from individual spiral-shaped bent wire strands, wire bundles, wire cables (**11, 12, 13, 14**) or suchlike, which incorporate two or more wires (**22**) or wire strands made of steel. It is of great advantage if the wire strands, wire cables, or wire bundles or suchlike are made at least in part from high tensile steel, and if the protective nets can therefore be equipped with very great strength.

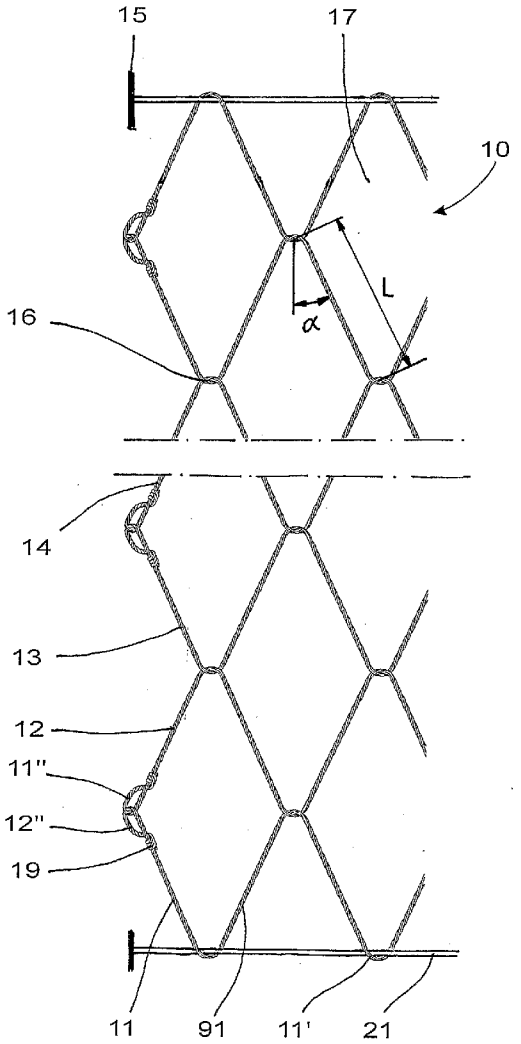


Fig.1

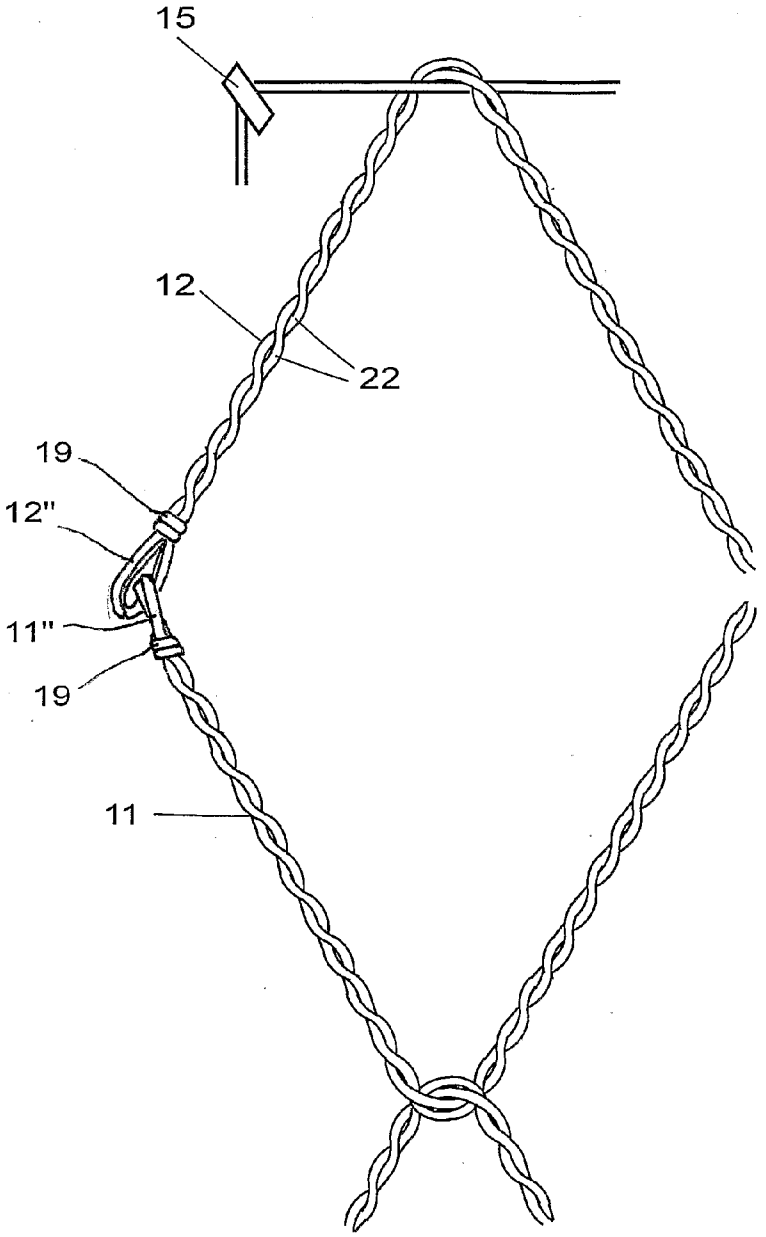


Fig.3

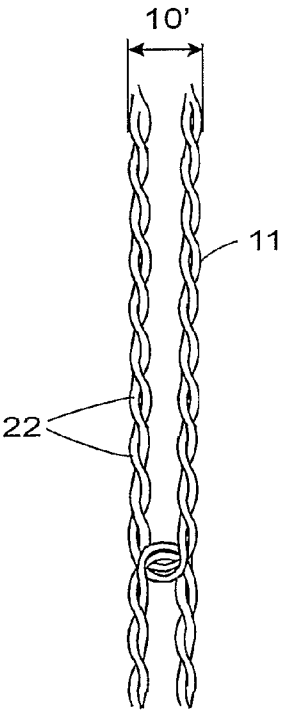
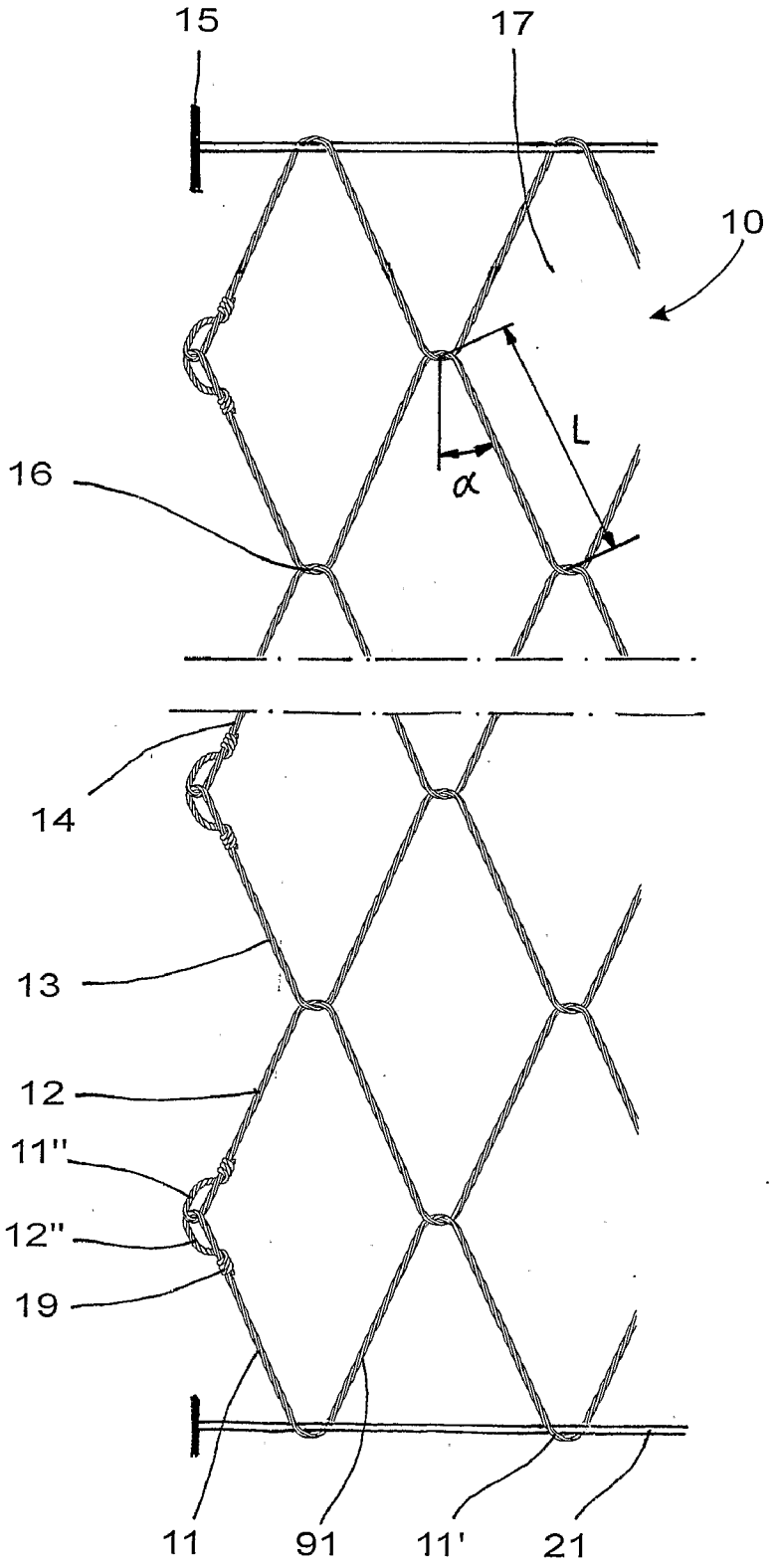


Fig.2



PROTECTIVE NET, ESPECIALLY FOR ROCKFALL PROTECTION OR FOR VERGE SECURING

[0001] The invention concerns a protective net, especially for rockfall protection or verge securing according to the main description of Claim **1**.

[0002] A protective net of this type is known from EP-B-0 979 329. The protective net is designed as a diagonal weave with rhomboid-shaped loops and a three-dimensional mattress-like structure which is woven from individual, spiral-shaped bent wires made of high tensile steel. The wires have a very high tensile strength, so that the weave will retain its three-dimensional mattress-like structure even under stretched conditions and can serve to cover an earth surface as a retainer or stabiliser of vegetation layers. The wire weave can be folded and takes up little space during storage or transport. Thanks to the high bend resistance of the wires the risk of a ladder forming when a wire breaks is reduced.

[0003] It is the purpose of this invention to provide a protective net of the type mentioned above and to further improve the same in order to substantially reduce the risk of breakage.

[0004] This task is solved in accordance with the invention by a protective net with the characteristics described in Claim **1**.

[0005] Further preferred embodiments of the protective net of this invention form the subject of the subclaims.

[0006] The fact that the protective net of this invention is woven from individual, spiral-shaped bent wire strands, wire cables, or wire bundles preferably incorporating two or more wires (or wire strands) made of high tensile steel creates a protective net of great firmness which will permit practically no deformation under load, and which does not require loop fixing elements (for example cross clamps).

[0007] The diagonal weave of this invention made of wire strands, wire cables, or wire bundles can be produced practically "infinitely" on rolls, whereby the longitudinal roll sides preferably incorporate very firm edge knots in the form of loops formed from wire strand, wire cable, or wire bundle ends.

[0008] The invention will now be described in more detail with reference to the drawings, whereby:

[0009] FIG. **1** shows an overview of a loop of a protective net of this invention;

[0010] FIG. **2** shows a partial overview of a protective net;

[0011] FIG. **3** shows a partial side view of the net according to FIG. **1**; and

[0012] FIG. **4** shows a schematic view of a protective net system forming verge securing on a slope.

[0013] FIGS. **1** and **2** show respectively a protective net for securing an earth surface layer such as for example for verge securing or securing of a rock wall along a road or suchlike, which here takes the form of a square diagonal weave **10** with four- or multi-cornered loops **17** as an example. The diagonal weave **10** is woven from a number of spiral-shaped bent wire strands, wire cables, or wire bundles **11**, **12**, **13**, **14**, which each incorporate two or more wires **22** made of a high tensile steel. These can consist of wires wound from two or more wire strands, or wires wound from two or more wire bundles, or wire strands turned into a wire cable, or a combination of these elements.

[0014] The wires have a nominal strength of between 100 and 2200 N/mm^2 according to DIN Standard 2078, for example one of 1770 N/mm^2. It is however also possible to use spring wire steel according to DIN Standard 17223. The thickness of the wire will depend on the necessary tensile strength and can for example be 3 mm.

[0015] These wires **22** are normally galvanised and equipped with a coating of zinc/aluminium and/or a plastic coating or a chrome alloy in order to provide the required corrosion resistance. For this a zinc coating with an area weight of between 100 and 250 g/m^2 can for example be envisaged.

[0016] On the side ends of the weave **10** the wire strands, i.e. wire cables, i.e. wire bundles **11**, **12**, **13**, **14** are flexibly connected with one another in pairs via loops **11"**, **12"**, whereby these loops **11"**, **12"** are formed by the wire strands, i.e. wire cables, i.e. wire bundles **11**, **12**, **13**, **14** themselves that are bent at their ends. The wire strands, i.e. wire cables, i.e. wire bundles **11**, **12**, **13**, **14** are preferably additionally equipped with several loops **19** wound around their own circumference after having been bent to form loops, which will guarantee sufficient security against an opening up of the same due to the tensile load applied to these loops in a stretched condition.

[0017] The diagonal weave **10** is held on the earth surface at a defined tension by fitting elements **15** sunk into the earth. Preferably one wire or rope **21** each of the spiral-shaped bent edge wire cable, i.e. edge wire strand, i.e. edge wire bundle **11** located at the upper and lower ends of the weave **10** is inserted back into the same, the same being tensioned by the fitting elements **15** against the floor or suchlike. In principle it is also possible that the fitting elements **15** hold the loops **11'** directly.

[0018] The individual spiral-shaped bent wire strands, wire cables, or wire bundles **11**, **12**, **13**, **14** incorporate an angle of incline α as well as a length L between two bends which determine the form and size of the loops **17** of the diagonal weave **10**. It is of advantage for the angle of inclination α if an angle value of approximately 20 to 35° can be selected. The individual loops **17** each form a rhomboid, whereby the loop width can be 77×143 mm for example. This offers the advantage that the weave **10** will not stretch significantly when the same is laid out on the earth surface and tensioned by means of the ropes **21** in a longitudinal direction. In addition the individual loops **17** form a rhomboid with an elongated opening in this way. This has the advantage of a reduced permeability to earth material.

[0019] The individual wire strands, wire cables, or wire bundles **11**, **12**, **13**, **14** are flexibly held in their woven condition with the result that the diagonal weave **10** can be folded like a mat, i.e. rolled up. Accordingly very little space is required for storage and transport of such weaves.

[0020] According to FIG. **3** the weave **10** incorporates a three-dimensional mattress-like structure which is made possible by the use of the high tensile steel wire. The individual wire strands, wire cables, or wire bundles **11**, **12**, **13**, **14** are spiral-shaped and bent for this purpose, and then

interwoven with one another, so that the weave **10** resulting from this forms an almost rectangular circumference when viewed in cross-section. The wire strands, wire cables, or wire bundles therefore consist of bent sections **11'** and straight sections **91**. This elongated rectangle has a thickness **10'** of several wire cable, i.e. wire strand thicknesses. This means that this wire weave **10** is three-dimensional even in a pre-tensioned condition. This results in an increased springiness of the weave for one, as the wire strands, wire cables, or wire bundles can be stretched in a longitudinal direction with increasing tension and will give this mesh weave an increased elasticity. On the other hand this three-dimensional design provides additional support or stability of the vegetation layers covered by this weave or after coating of earth surfaces, for example verges.

[**0021**] The fact that the protective net of this invention is woven from individual spiral-shaped bent wire strands, wire cables, or wire bundles incorporating two or more wires made from high tensile steel turned to form a wire strand or a wire bundle, or two or more wire strands made from high tensile steel turned to form a wire cable, means that a very firm protective net is created which permits practically no deformation under load, and which does not require loop fixing elements (for example cross clamps).

[**0022**] The diagonal weave of this invention made from wire strands, wire cables, or wire bundles can be produced practically "infinitely" on rolls, whereby the longitudinal roll sides preferably incorporate very firm edge knots in the form of loops formed from wire strand, wire cable, or wire bundle ends.

[**0023**] Basically the protective nets can however also consist of wire strands, wire bundles, spiral cables with thinner or thicker wires that are not, or only partly made from high tensile steel.

[**0024**] FIG. **4** shows a protective net system **10** according to this invention, which is here used for verge securing **40**, for example of a verge **45** located on a steep slope which forms the earth surface layer that is to be secured.

[**0025**] This verge securing **40** consists of the wire weave **10** laid out across a desired verge area and the fitting elements **15** sunk into the ground with which the weave **10** is secured on the earth surface, i.e. claw plates or suchlike. For the fitting elements **15** known ground or rock nails are required, which are preferably affixed at regular intervals into the verge **45**. At the upper and lower end of the weave **10** a rope **21** is envisaged with which the weave **10** can be stretched and tensioned.

[**0026**] With such a protective net system it is possible to optimally secure a slope. It is also possible with the net design of this invention to absorb large advancing forces caused by stones or rocks falling into the verge without problem.

[**0027**] With a method according to this invention for producing a protective net **10** a wire strand, a wire bundle, a wire cable **11**, **12**, **13**, **14** or suchlike is introduced at a defined angle of inclination α during a first step at least as far as a spike of a means not illustrated in detail here and bent around the spike in a defined length L by approximately 180°. During further steps the wire strand, the wire bundle, the wire cable **11**, **12**, **13**, **14** or suchlike is advanced by the defined length L several times around its longitudinal axis in relation to the spike **66** and bent around the spike by 180° each time until this wire strand, wire bundle, wire cable **11**, **12**, **13**, **14** or suchlike has taken on a spiral-shaped form. Once these spiral-shaped bent wire strands, wire bundles, wire cables **11**, **12**, **13**, **14** or suchlike have been created the same are woven together with a second spiral-shaped bent wire strand, wire bundle, wire cable or suchlike, then the second with a third, and repeated until the wire weave has reached the desired size.

[**0028**] It is preferred that high tensile wires are used at least in part for these wire strands, wire bundles, or wire cables. It is however also possible to use wires with less firmness. The fact that thicker wire bundles can be used as opposed to individual wires results in an increased overall firmness.

1. Protective net, especially for rockfall protection or for verge securing, which is formed by means of a diagonal weave (**10**) produced from wires (**22**) and forming a three-dimensional, mattress-like structure, characterised in that the diagonal weave (**10**) is woven from wire strands, from wire bundles, from wire cables (**11**, **12**, **13**, **14**) or suchlike, incorporating two or more wires (**22**) or wire strands made of steel.

2. Protective net according to claim 1, characterised in that the wire strands, wire cables, or wire bundles (**11**, **12**, **13**, **14**) or suchlike are made at least in part from high tensile steel.

3. Protective net according to claim 1, characterised in that the wire strands, wire cables, or wire bundles (**11**, **12**, **13**, **14**) are flexibly connected with one another at their ends in pairs via loops (**11"**, **12"**).

4. Protective net according to claim 3, characterised in that the wire strands, wire cables, or wire bundles (**11**, **12**, **13**, **14**) are additionally equipped with at least one loop (**19**) wound around their own circumference following their bending into loops (**11"**, **12"**).

5. Protective net according to claim 1, characterised in that the wires (**22**) forming the wire strands, wire cables, or wire bundles (**11**, **12**, **13**, **14**) are corrosion resistant.

6. Protective net according to claim 1, characterised in that the wires (**22**) forming the wire strands, wire cables, or wire bundles (**11**, **12**, **13**, **14**) have a nominal strength within a range of 1000 to 2200 N/mm^2.

7. Protective net according to claim 1, characterised in that the spiral-shaped, bent wire strands, wire cables, or wire bundles (**11**, **12**, **13**, **14**) forming the diagonal weave (**10**) have an angle of inclination (α) of preferably between 25° to 35°.

8. Protective net according to claim 1, characterised in that a verge securing (**40**) incorporates the wire weave (**10**), fitting elements (**15**) that can be sunk into the ground with claw plates or suchlike holding the weave to the earth surface, and at least one rope (**21**) on the surface, holding and stretching the weave.

9. Method for producing a protective net according to claim 1, characterised in that a wire strand, a wire bundle, a wire cable (**11**, **12**, **13**, **14**) or suchlike is introduced at a defined angle of inclination (α) at least up to a spike of a means and bent around said spike in a defined length (L) by approximately 180°, and in that the wire strand, the wire bundle, the wire cable (**11**, **12**, **13**, **14**) or suchlike is advanced by the defined length L several times around its longitudinal axis in relation to the spike (**66**) and bent around

the spike by 180° each time until this wire strand, wire bundle, wire cable (**11**, **12**, **13**, **14**) or suchlike has taken on a spiral-shaped form.

10. Method according to claim 9, characterised in that a spiral-shaped bent wire strand, a wire bundle, a wire cable (**11**, **12**, **13**, **14**) or suchlike is woven together with a second spiral-shaped bent wire strand, a wire bundle, a wire cable (**11**, **12**, **13**, **14**) or suchlike, the second with a third, and repeated until the wire weave has reached the desired size.

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