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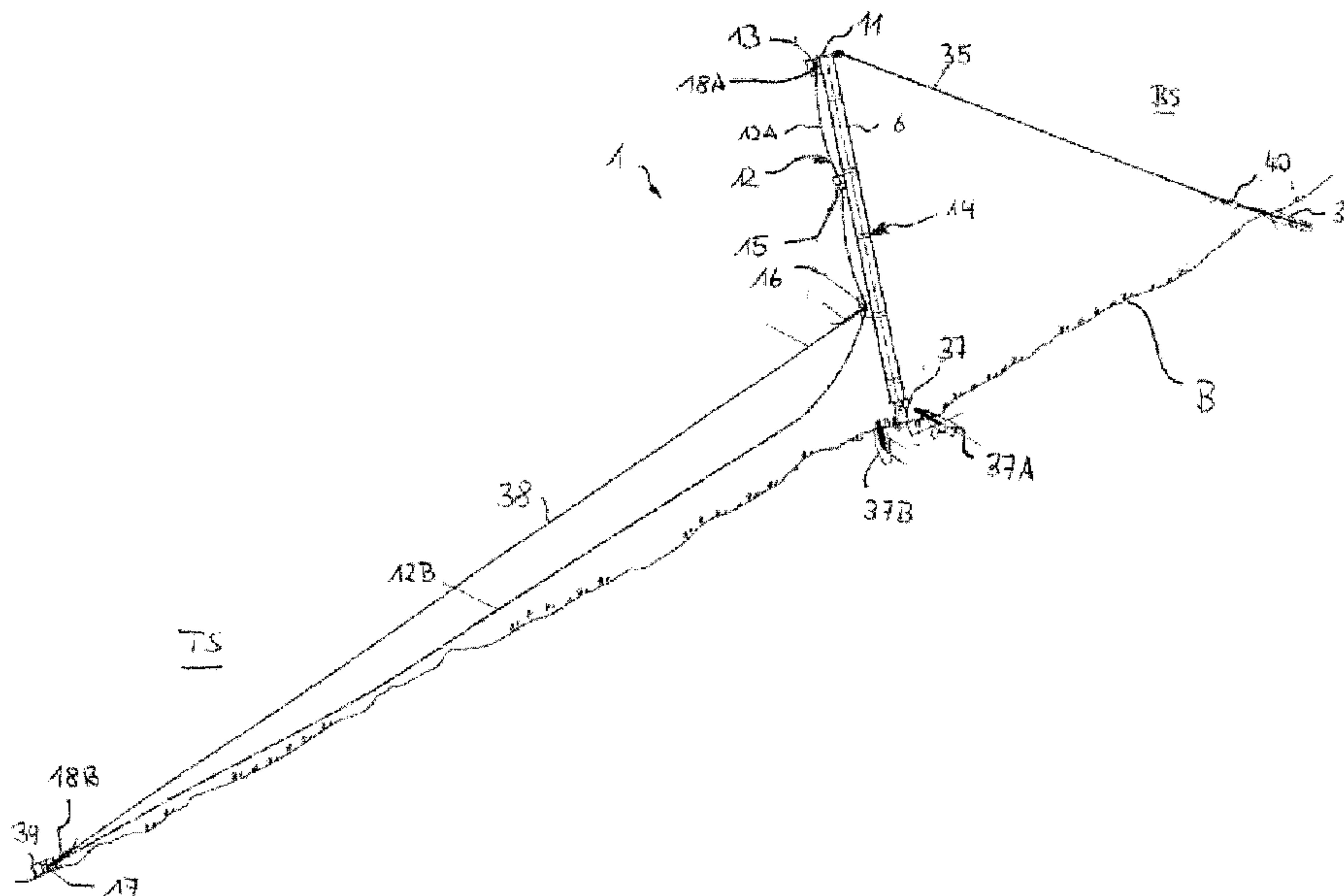
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(54) Title: ROCKFALL PROTECTION SYSTEM



(57) Abrégé/Abstract:

A rockfall protection system (1) is provided between an uphill side (BS) and a downhill side (TS) of a mountain slope (B), having a plurality of upright and spaced supports (2 to 6), each featuring a support head (7 to 11), a catch net (12), an upper support cable (13) guiding an upper edge (18A) of the catch net (12) at the support heads (7 to 11) of the supports (2 to 6), an upper central cable (15) and a lower central cable (16) guiding the catch net (12) in a central support area (14) of the supports (2 to 6), a lower support cable (17) guiding a lower edge (18B) of the catch net (12). The lower support cable (17) is guided on the mountain slope (B) together with the lower edge (18B) of the catch net (12) on the downhill side of the supports (2 to 6) and separated from said supports (2 to 6). The lower central cable (16) is tensioned on the mountain slope (B) using side anchors (20) provided with braking elements (19), with the braking element (19) being connected at one of its ends (19A) to the side anchor (20) and at its other end (19B) to the central cable (16) by a cable loop (21). The side anchor (20) is connected to the central cable (16) via a predetermined breaking point (22).

Abstract

A rockfall protection system (1) is provided between an uphill side (BS) and a downhill side (TS) of a mountain slope (B), having a plurality of upright and spaced supports (2 to 6), each featuring a support head (7 to 11), a catch net (12), an upper support cable (13) guiding an upper edge (18A) of the catch net (12) at the support heads (7 to 11) of the supports (2 to 6), an upper central cable (15) and a lower central cable (16) guiding the catch net (12) in a central support area (14) of the supports (2 to 6), a lower support cable (17) guiding a lower edge (18B) of the catch net (12). The lower support cable (17) is guided on the mountain slope (B) together with the lower edge (18B) of the catch net (12) on the downhill side of the supports (2 to 6) and separated from said supports (2 to 6). The lower central cable (16) is tensioned on the mountain slope (B) using side anchors (20) provided with braking elements (19), with the braking element (19) being connected at one of its ends (19A) to the side anchor (20) and at its other end (19B) to the central cable (16) by a cable loop (21). The side anchor (20) is connected to the central cable (16) via a predetermined breaking point (22).

ROCKFALL PROTECTION SYSTEM

FIELD OF INVENTION

The invention relates to a rockfall protection system.

BACKGROUND OF INVENTION

A rockfall protection system is known from EP 1 911 884 A1. Although it is possible with a rockfall protection system of this type to safely catch material falling from a mountain slope, in particular boulders and/or tree trunks, there is a problem to the extent that rockfall protection systems must be positioned relatively high up on mountain slopes to catch falling material as early as possible, which however increases the effort required to remove the accumulated material due to poor accessibility.

SUMMARY OF INVENTION

One aspect of this invention provides a rockfall protection system for use between an uphill side and a downhill side of a mountain slope, having:

- a plurality of upright and spaced supports, each featuring a support head,
- a catch net,
- an upper support cable guiding an upper edge of the catch net at the support heads of the supports,
- an upper central cable and a lower central cable guiding the catch net in a central support area of the supports, and
- a lower support cable guiding a lower edge of the catch net;

wherein:

- the lower support cable is to be guided on the mountain slope together with the lower edge of the catch net on the downhill side of the supports and separated from said supports,

- the lower central cable is to be tensioned on the mountain slope using side anchors provided with braking elements,
- the braking element is to be connected at one of its ends to the side anchor and at its other end to the central cable by a cable loop, and
- the side anchor is for connecting to the central cable via a predetermined breaking point.

Another aspect of the invention provides a rockfall protection system between an uphill side and a downhill side of a mountain slope, having:

- a plurality of upright and spaced supports, each featuring a support head,
- a catch net,
- an upper support cable guiding an upper edge of the catch net at the support heads of the supports,
- an upper central cable and a lower central cable guiding the catch net in a central support area of the supports, and
- a lower support cable guiding a lower edge of the catch net;

wherein:

- the lower support cable is guided on the mountain slope together with the lower edge of the catch net on the downhill side of the supports and separated from said supports,
- the lower central cable is tensioned on the mountain slope using side anchors provided with braking elements,
- the braking element is connected at one of its ends to the side anchor and at its other end to the central cable by a cable loop, and
- the side anchor is connected to the central cable via a predetermined breaking point.

In accordance with an aspect of the invention, the lower edge of the catch net is fixed and guided, together with the lower supporting cable guiding said lower edge, away from the supports on the downhill side of the mountain slope. To permit controlled removal of

the material accumulated by the catch net, the lower central cable is furthermore in accordance with the invention tensioned using braking elements at the side anchors on the mountain slope. The braking elements are here fastened at one of their ends to the respective side anchor, and with their other ends using a cable loop to the central cable. Finally, the side anchor is connected via a predetermined breaking point to the central cable. If material rolling down a mountain slope is caught by the catch net, the result is first that a force acts on the predetermined breaking point of the side anchor and causes this predetermined breaking point to fail. This in turn tensions the cable loop connected to the central cable and to the braking element, which on the one hand has the effect that the associated braking element can come into action and hence the central cables can absorb the energy from the forces generated by the falling material, and on the other hand causes the catch net to give way in its lower area. This giving way in turn prevents the material caught by the catch net from entangling in the net. Instead, it is possible with this method for the material caught by the central area of the catch net to be deliberately bounced back to the mountain slope, so that it can then be removed safely below that area of the catch net laid towards the downhill side of the mountain slope as far as the lower edge of said net. The lower edge and the lower support cable are here preferably laid at places enabling easy removal of the material accumulated by the net.

Although it is known *per se*, to fix the lower area of the catch net downhill of the mountain slope away from the supports, studies conducted in connection with this invention have shown that with a design of this type, without the provision of central cables in accordance with the invention and without their tensioning as previously set forth using braking elements and predetermined breaking points, the accumulated material is not caught in an area close to the supports, but there is a high risk that the energy of the falling material is too high in the area of the lower support cable, hence resulting in a failure of the structure.

Various embodiments of the present invention may be used to provide a rockfall protection system which on the one hand permits the absorption of high energies in a

net and on the other hand allows accumulated material to be transported out of a support area into areas of easier accessibility below the supports.

The present specification discloses and claims a rock fall obstruction between an uphill side and a downhill side of a mountain slope, comprising: a plurality of upright and spaced supports, each having a support head, a catch net, an upper support cable guiding an upper edge of the catch net at the support heads of the supports, an upper central cable and a lower central cable guiding the catch net in a central support area of the supports, a lower support cable for guiding a lower edge of the catch net, characterized in that the lower support cable is guided on the mountain slope together with the lower edge of the catch net on the downhill side of the supports and separated from said supports, and that the lower central cable is tensioned using side anchors provided with braking elements on the mountain slope, wherein the braking element is connected at its one end to the side anchor and at its other end to the central cable via a cable loop, and wherein the side anchor is connected to the central cable via a predetermined breaking point.

Further details, features and advantages of the present invention as defined by the appended claims can be inferred from the following description of embodiments of the invention in accordance with the accompanying drawings. Advantageous developments of the invention also become apparent from the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

- Fig. 1 shows in slightly simplified form a schematic side view of a rockfall protection system in accordance with the present invention,
- Fig. 2 is a top view of the rockfall protection system in accordance with Fig. 1, and
- Fig. 3 is a side view of an anchor plate in accordance with the present invention.

DETAILED DESCRIPTION

Fig. 1 shows in schematically simplified form a rockfall protection system 1 fixed on a mountain slope B between an uphill side BS and a downhill side TS to safeguard said mountain slope.

Viewing the Figures 1 and 2 together shows that the rockfall protection system 1 has a catch net 12 (omega net) which is divided into two catch net areas 12A and 12B. The catch net area 12A is here guided by a plurality of upright and spaced supports 2 to 6 in a central support area 14.

Figure 1 shows a side view of the support 6 as being representative of all identically designed supports 2 to 6. The support 6 guides at its head 11 an upper support cable 13

of the catch net area 12A and also an upper central cable 15 and a lower central cable 16. Thanks to this arrangement, an upper edge 18A of the catch net area 12A is guided by the support cable 13 at the support head 11, while the upper central cable 15 and the lower central cable 16 guide the catch net area 12A in the central support area 14 of the supports 2 to 6.

The catch net area 12B laid over the downhill side TS of the mountain slope B is guided by means of a lower support cable 17 using a plurality of anchor plates fixed on the mountain slope B. As shown in the example in Fig. 2, five such anchor plates are provided, of which one is identified by the reference numeral 39 in the side view of Figure 1.

The lower support cable 17 is here fixed on both sides using side anchors 31 and 34 on the mountain slope B, said anchors being provided with a braking element 32 and 33 respectively, with reference being made here to Figure 2.

As is shown in Figure 1, above the catch net area 12B a downhill bracing system 38 is arranged, which according to Fig. 2 in this preferred embodiment is formed by five bracing cables. The bracing system 38 is intended for limiting net deformation in the catch net area 12B.

As can be seen by viewing Figures 1 and 2 together, the supports 2 to 6 are each guided at their respective support heads 7 to 11 by two uphill retaining cables from uphill anchors. In Fig. 2, the retaining cables 27 and 28 of support 2 are identified here with their respective reference numerals representatively for all uphill retaining cables and anchors. The uphill anchors are identified by the reference numerals 29 and 30.

The side view of Figure 1 illustrates the uphill retaining cable 35 with its associated uphill anchor 36 and a braking element 40. Since in the example five supports 2 to 6 are provided, the result is a total number of ten such uphill retaining cables with associated uphill anchors, as can be seen in detail in Fig. 2.

In a further embodiment, these uphill retaining cables can be omitted, so that the arrangement of the supports and base plates is only a rigid connection.

To complete the description of the support arrangement, it must be pointed out that the supports 2 to 6 are each mounted at their support base using a base plate 37 on the mountain slope and fixed using respective associated tension anchors 37A and compression anchors 37B. In this connection, reference is made to Figure 1, reference numerals 37 (base plate), 37A (tension anchor) and 37B (compression anchor).

It can also be seen from Figure 2 that the lower central cable 16 is guided at its two ends by an identically structured arrangement of side anchors, cable loops and braking elements. The same applies for the upper central cable 15, so that the embodiments described in the following and provided on the right-hand side of Figure 2 with the corresponding reference numerals are representative of these arrangements.

In this embodiment, two central cables 15, 16 are arranged, however it is also possible to provide four or six or any number of central cables. In addition, the design can also feature central cables that have dual guidance.

Accordingly, on the mountain slope B the lower central cable 16 is tensioned using side anchors 20 provided with braking elements 19. The braking element 19 is here fixed at one of its ends 19A to the side anchor 20. At its other end 19B, the braking element 19 is connected by a cable loop 21 to the central cable 16. Figure 2 furthermore illustrates that the side anchors 20 are each connected via a predetermined breaking point 22 to the central cable 16.

The upper central cable 15 is fixed using a lateral brace 26 and a braking element 24 on a side anchor 23, which in turn is fastened to the mountain slope B.

Due to this arrangement, it is possible to safely slow down and catch material to be retained, such as boulders coming away from the mountain slope B on the uphill side BS, using the catch net area 12A guided in the central support area 14. To ensure the accumulated material does not remain entangled in the catch net area 12A, the force exerted when the net catches it results in a failure of the predetermined breaking point 22, which tensions the cable loop 21. As a result, the braking element 19 can come into effect and the accumulated material can bounce back onto the mountain slope B due to the catch net area 12A giving way in its lower part. Then the slowed down material can be removed on the downhill side TS below the catch net area 12B as far as its lower edge 18B. In the area of the lower edge 18B, the accumulated material is finally halted and can be removed substantially more easily from the catch net 12 in this area than if the accumulated material were to become entangled in the catch net area 12A of the catch net 12.

The anchor 39 shown in detail in Figure 3 is representative for the plurality of anchors visible in Figure 2. The anchor 39 has an anchor plate 43 on which is arranged a cable guide unit 46 of cylindrical design, i.e. with rounded guide surfaces. The cable guide unit 46 limits with a pile guide 47 a recess 48 through which the lower downhill support cable 17 and the lower bracing system 38 are passed.

A micro-pile 42 is passed through the pile guide 47 and engages on the uphill side in an anchor grout 41 inserted into the mountain slope B. A shim 44 is arranged on the pile guide 47 and the micro-pile 42 is fixed by means of a screw union 45.

In addition to the written disclosure above, explicit reference is made here to its drawn representation in Figures 1 to 3.

It must be added that all braking elements are provided with predetermined breaking points permitting a deformation of said braking elements only after a specified load level has been exceeded. This makes replacement of deformed braking elements necessary

only in the case of rockfall events with higher energies, and hence saves maintenance costs over the duration of use.

List of reference numerals

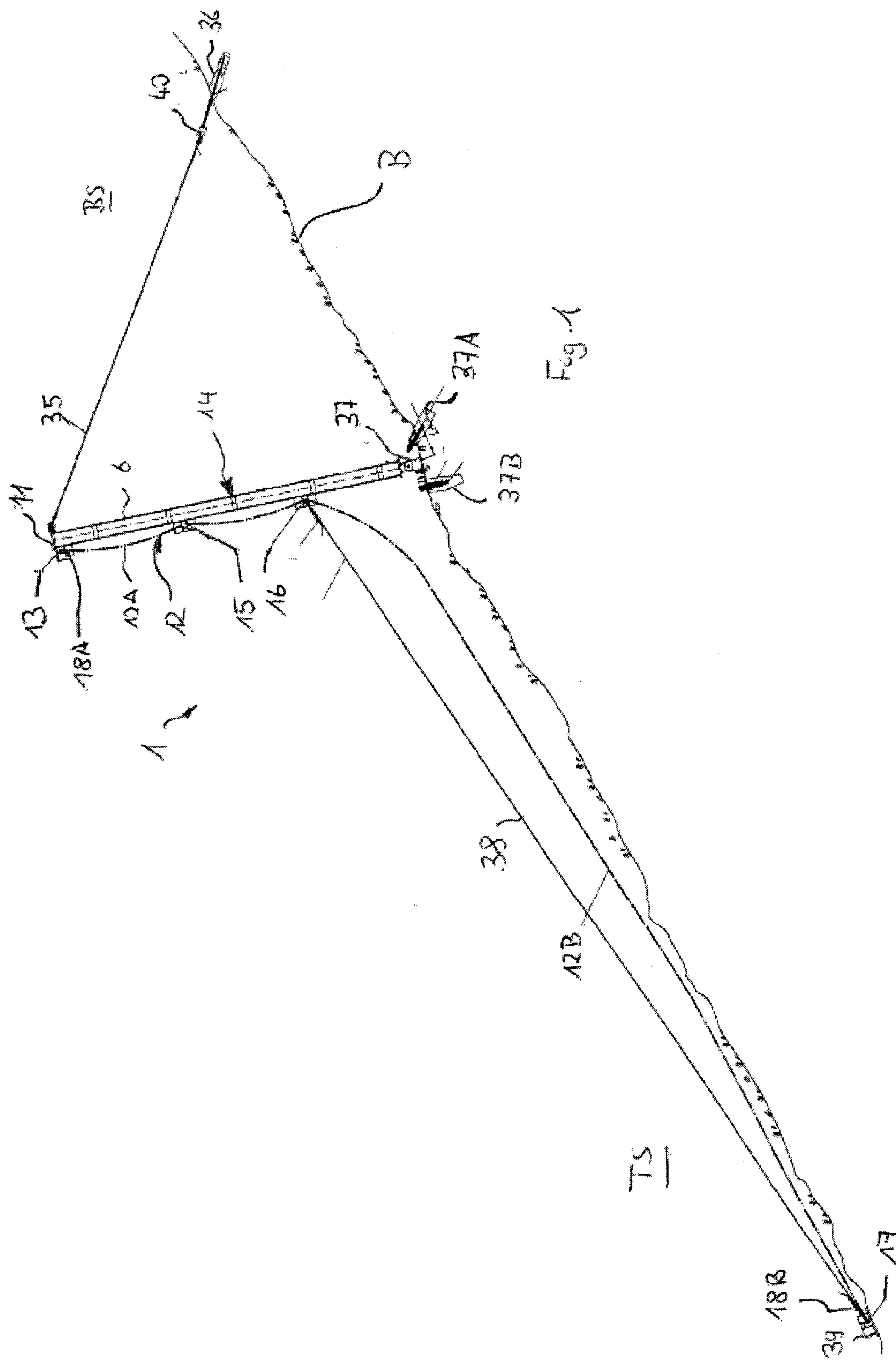
1	Rockfall protection system
2 to 6	Upright supports
7 to 11	Support head
12	Catch net (omega net)
12A, 12B	Catch net areas
13	Upper support cable
14	Central support area
15	Upper central cable
16	Lower central cable
17	Lower downhill support cable
18A	Upper edge of catch net
18B	Lower edge of catch net
19	Braking element, lower central cable
19A, 19B	End of braking element
20	Side anchor
21	Cable loop
22	Predetermined breaking point
23	Side anchor, upper support cable, upper central cable and lateral brace
24	Braking element, upper central cable
25	Braking element, upper support cable
26	Lateral brace
27, 28	Uphill retaining cables of support head
29, 30	Uphill anchor
31, 34	Side anchor, lower support cable
32, 33	Braking element, support cable
35	Uphill retaining cable

36	Uphill anchor
37	Base plate
37A	Tension anchor
37B	Compression anchor
38	Downhill bracing system
39	Downhill anchor
40	Braking element
41	Anchor grout
42	Micro-pile
43	Anchor plate
44	Shim
45	Screw union
46	Cable guide unit
47	Pile guide
48	Recess
B	Mountain slope
BS	Uphill side
TS	Downhill side

What is claimed is:

1. A rock fall obstruction between an uphill side and a downhill side of a mountain slope, comprising:
 - a plurality of upright and spaced supports, each having a support head,
 - a catch net,
 - an upper support cable guiding an upper edge of the catch net at the support heads of the supports,
 - an upper central cable and a lower central cable guiding the catch net in a central support area of the supports,
 - a lower support cable for guiding a lower edge of the catch net,characterized in
 - that the lower support cable is guided on the mountain slope together with the lower edge of the catch net on the downhill side of the supports and separated from said supports, and
 - that the lower central cable is tensioned using side anchors provided with braking elements on the mountain slope,
 - wherein the braking element is connected at its one end to the side anchor and at its other end to the central cable via a cable loop, and
 - wherein the side anchor is connected to the central cable via a predetermined breaking point.
2. The rock fall obstruction according to claim 1, characterized in that the predetermined breaking point is configured as a cable loop or cable.
3. The rock fall obstruction according to claim 1 or 2, characterized by a downhill bracing system.
4. The rock fall obstruction according to claim 1, 2 or 3, characterized in that a downhill anchor is provided with a rounded cable guide unit.

5. The rock fall obstruction according to claim 4, characterized in that the cable guide unit is configured as a cylindrical tube fixed onto an anchor plate.
6. The rock fall obstruction according to claim 4 or 5, characterized in that the anchor also includes a pile guide.



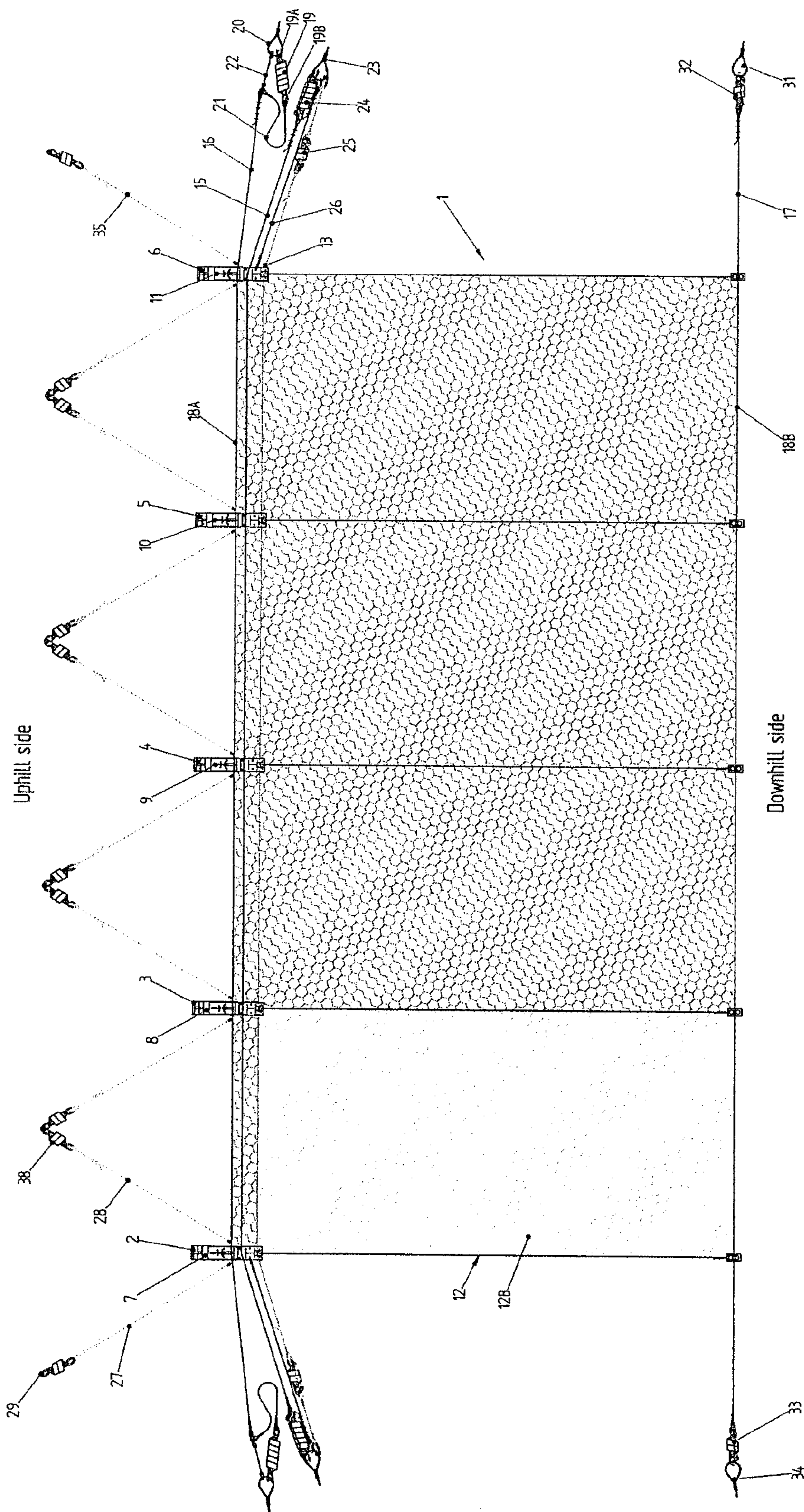


Fig. 2

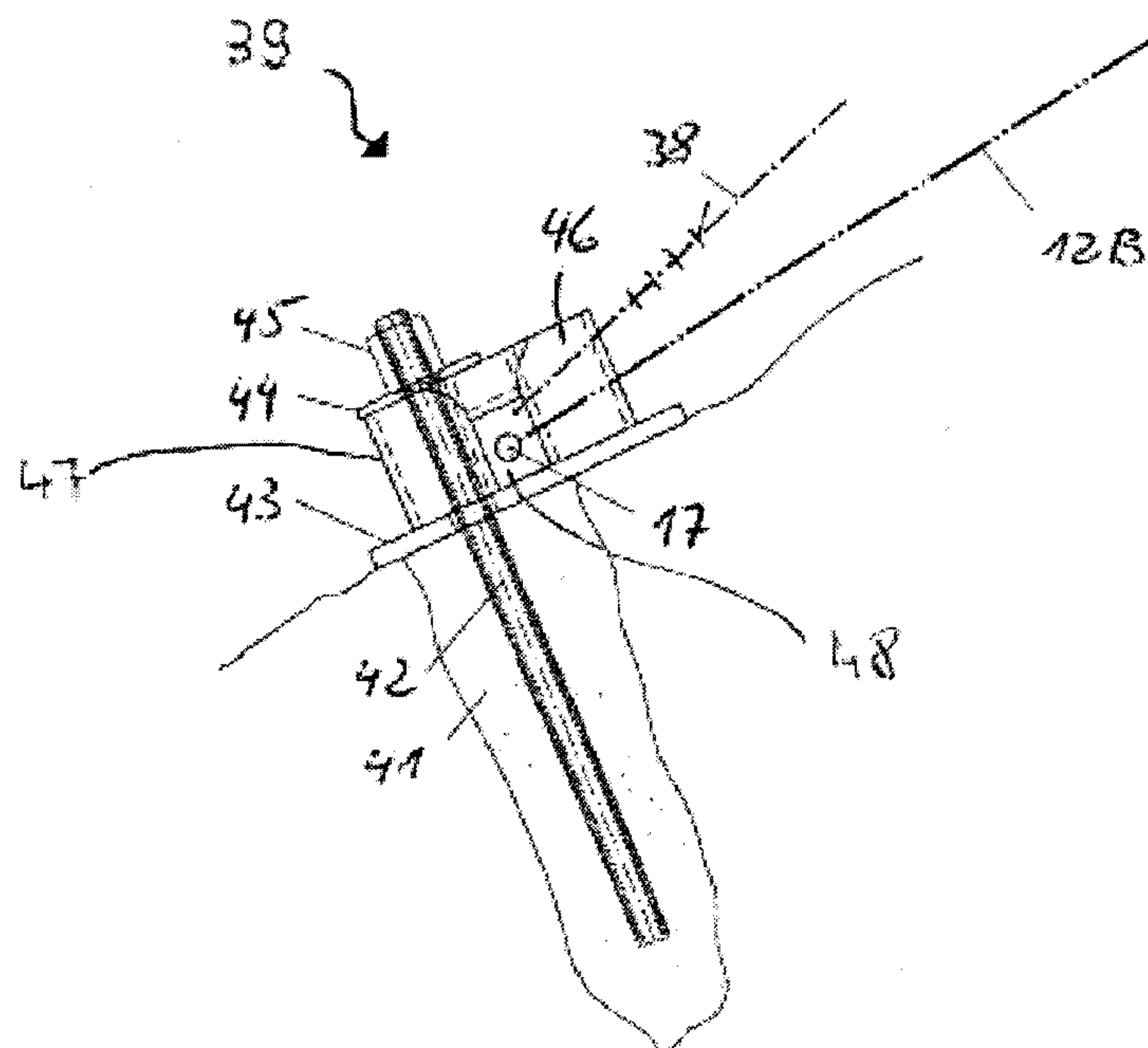


Fig. 3

