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(54) **GROUND SUPPORT**

BODENVERSTÄRKUNG

DISPOSITIF DE RENFORCEMENT DE SOL

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Description

[0001] The invention relates to ground supports of the kind generally known as soil nails. Soil nails are inserted into unstable ground, for example at the side of a steep cutting in order to provide stability for the ground. Use of soil nails allows steeper cuttings than can be employed with unsupported soil, thus allowing roads and other works to be accommodated on smaller sites than would otherwise be possible. Temporary soil nails can also be used to provide stability for deep excavations with steep walls, for example in foundations for buildings.

[0002] A typical soil nail comprises a steel bar which is inserted into an hole bored in the ground, a space within the bore around the bar being filled with grout or a similar filler. At its outer end, the soil nail is normally connected to a surface support such as a ground plate or to steel mesh embedded in a layer of concrete.

[0003] A soil nail is not normally tensioned during or immediately after installation. However as the ground being supported yields, normally with a tendency to induce an axial tensile force into the soil nail, load builds up in the soil nail and it becomes effective as a support for the ground against further movement. Soil nails are typically about 3 metres to 10 metres in length.

[0004] An important criterion for a permanent soil nail is resistance to corrosion. For this reason, conventional steel soil nails are usually provided with corrosion protection, typically in the form of a thermoplastic sleeve surrounding the steel bar with grout between the bar and the sleeve and also surrounding the sleeve. In some installations, double protection is required; this is normally provided by use of two separate thermoplastic shields, both embedded in grout and surrounding the steel bar.

[0005] An object of the present invention is to provide a ground support of the kind known as a soil nail which is effective against corrosion but does not require the conventional protective sleeve.

[0006] In accordance with the invention there is provided a ground support for stabilising ground by installation thereof in a bore in the ground characterised by a head member at the inner end of the support, at least one elongated flexible polymeric tendon extending longitudinally within the bore from the head member to the outer end of the bore, the tendon being embedded in a matrix of filler material and means for anchoring the end or ends of the tendon externally of the bore. Preferably the tendon is in the form of a belt or strip of webbing.

[0007] The head member provides an anchorage for the inner end of the tendon and the tendon increases the capacity of the soil body to resist tensile forces. The filler material fills the void in the bore provided during the installation and permits forces to be transmitted between the tendon and the soil body both directly and via the head member.

[0008] Preferably a double tendon is formed by attaching the material thereof remote from its ends to the head member to provide two tendon sections, each of which extends along the bore. The filler can then help to maintain the tendon sections in desired positions in the bore. Preferably the tendon is attached to the head member by passing it around the head member.

[0009] Preferably two double tendons are employed to provide four tendon sections extending along the bore.

[0010] The outer end or ends of the tendon or tendons may be attached to a surface support adjacent the entry to the bore and means such as a turn buckle may be provided for taking up slack in the tendon.

[0011] The filler may be a conventional grout, as used in ground anchoring, or it may be a sand and cement mix or hydraulically placed sand or a synthetic resin or pulverised fuel ash and cement mix or some other suitable material.

[0012] An embodiment of the invention will now be described by way of example only with reference to the accompanying drawings in which:-

Figure 1 illustrates a typical application for soil nails;

Figure 2 is a longitudinal section of a ground support or soil nail according to the invention after installation;

Figure 3 is a section on line A-A of Figure 2.

Figure 4 corresponds generally to Figure 2 showing a modification; and

Figure 5 is an illustration of a complete ground support installation incorporating a series of ground supports conforming generally to Figure 4.

[0013] Figure 1 is a cross-section through a civil engineering site such as a road widening scheme at a position where the road is below ground level. Soil from region A has been excavated to provide new road surface B in place of the original ground surface C. The excavation leaves a near vertical bank D which if unsupported would be unstable and would cause soil to collapse on to the road surface. The soil in region E is supported by soil nails F.

[0014] As excavation takes place from above, bores are drilled in the soil to receive the soil nails. Each nail is then inserted in position and the bore grouted or otherwise filled. At its outer surface, the soil nail is connected into a surface support G which in this case is material known as shotcrete. The shotcrete is concrete which is sprayed on to the surface and is supported by steel mesh extending over the surface.

[0015] There is a tendency for the soil to slip diagonally along a shear plane such as H. A small amount of movement is allowed to occur. This builds up tension in the soil nails which thus stabilise the soil and resist further slippage.

[0016] Figures 2 and 3 show a soil nail in accordance with the invention which may be employed for example in a civil engineering site as shown in Figure 1. The soil nail is assembled into the condition shown in Figures 2 and 3 within a bore drilled or otherwise formed in the soil to be stabilised. The soil nail will be described in this installed condition.

[0017] The main basis of tensile strength for the soil nail is two doubled over flexible polymeric tendons 11 and 12. Each tendon is in the form of a belt or strip of webbing produced from structural fibres such as polyester or polyaramid. One suitable polyaramid material is known by the trade name Kevlar. Suitable webbing is known by the trade name Paraweb. Each doubled over tendon extends throughout the length of a bore 13. In particular, it extends from outside the bore, round a head member constituted by a nose cone 14 at the inner end of the bore and again emerges at the outer end. The individual tendons are spaced at 90° to each other as best seen in Figure 3. Ties and/or spacers such as 15 are provided at intervals to retain the tendons generally near the outer periphery of the bore 13. More than two doubled tendons may be employed if required and instead of or in addition to double tendons one or more single tendons may be secured to the nose cone.

[0018] The structure of the nose cone 14 is not critical. It may be a plastics moulding. Alternatively it could be formed of metal or concrete or other stable material. The nose cone serves as an aid to insertion of the tendons in the bore and helps to ensure that the tendons extend along the full length of the bore.

[0019] At their outer ends, the tendons are typically engaged with a surface support for the soil. In Figure 2 steel mesh 16 represented in the drawing by four transverse rods is provided at the surface of the soil and the tendons are wrapped round the reinforcement rods and united by a clip 17.

[0020] During further construction of the soil nail after the nose cone and tendons have been placed in position, the bore 13 is filled with a matrix 18 of grout or of a sand and cement composition or other suitable filler to embed the tendon in the filler. It is not necessary for the filler to be rigid, for example it could be constituted by sand which may be hydraulically placed to ensure effective compaction. This matrix surrounds the tendons so that they are intimately embedded in the surrounding soil body. In the completed soil nail, the nose cone embedded within the matrix acts as an anchor for the inner ends of the tendons so that tensile loads developed in the tendons by soil movements at one location are transferred into the soil elsewhere along the length of the soil nail both by friction between the tendons and the matrix and by compression in the matrix at the location of the end anchorage. These loads are transferred in turn into the soil by friction between the matrix and the surrounding soil.

[0021] To complete the outer end of the structure in this example, the outer surface of the soil including the reinforcement 16 and the outer ends of the tendons is embedded in material 19 known as shotcrete, that is sprayed on concrete.

[0022] A typical soil nail of this kind is from 3-10 metres in length in a bore of about 75mm diameter. Each tendon typically has a tensile strength of about 50kN, providing a tensile strength of about 200kN for a soil nail with two doubled over tendons.

[0023] In use as described more generally above in relation to Figure 1, tension tends to develop in the soil nail as the soil within which it is installed begins to yield due to release of the horizontal confining pressure previously provided by soil A. The tensions in the tendons within the soil nails support the soil in region E to prevent collapse of the soil behind the bank D.

[0024] In an alternative construction, instead of filling the bore, the soil may be allowed to collapse around the tendon or tendons such that the soil comes into intimate direct contact with the tendons to embed tendons in the soil and tensile load develops in the tendons due to shear effect between the soil and the tendons.

[0025] In a further alternative, instead of a pre-formed bore, the tendons may be driven into the ground by a rod which forms the bore at the same time as inserting the tendons.

[0026] The ground support shown in Figure 4 incorporates tendons 11 in a bore 13 and corresponds generally to the arrangement of Figure 2. Any variations, other than those specifically described, are self evident and coincidental.

[0027] In Figure 4 the shotcrete is applied in two separate layers 31 and 32. After application of the first layer 31, a load transfer assembly 33 is applied against the face of the shotcrete at the entry to the bore 13. The load transfer assembly incorporates a plate 34 which engages against the face of the shotcrete and through which the tendons 11 pass. The load transfer assembly also incorporates turn buckles 35 supported in seats 36. End portions of the tendons 11 are passed through the turn buckles 35 which are arranged such that slack can be taken up in the tendon by rotating the turn buckle, for example by means of a tommy bar. When all slack has been taken up in the tendon and the tendon is under light tension, the turn buckle is locked off, for example by means of a pin passing through the turn buckle and the seat 36. The second layer 32 of shotcrete is then applied.

[0028] This application of tension to the tendons as opposed to taking up slack is effected after the grout has cured. A complete support system may be made up of several support installations as shown in Figure 4, arranged at suitable spacing.

[0029] Figure 5 shows diagrammatically a support system with an alternative tensioning means. A grid of soil nails 41 conforms generally to Figure 2. A netting of structural plastics material or a grid of steel reinforcement rods may be applied to the exposed surface of the area being stabilised as illustrated at 42. The preliminary

layer of shotcrete 31 as shown in Figure 4 may also be applied or reliance may be placed on the grid 42 itself at this stage.

[0030] For taking up slack in the tendons 11, instead of relying on the turn buckle arrangement as shown in Figure 4, adjacent tendons are connected together through adjustable connectors 43 for taking up slack. The outer parts of the tendons thus form a support for the surface of the area being stabilised. The tendons 11 are both connected to the connectors 43 and are then tightened and locked in the tightened condition by operation of the connector. The tendons are prevented from pulling sideways out of the borehole by means of a retaining ring device 44 at the head of each nail. Any suitable form of connector may be employed, possibly employing a turn buckle as illustrated in Figure 4 or possibly being constituted by some other kind of tensioning and locking device. At the edges of the grid, where there is no adjacent tendon for connecting to an edge tendon, the tendon may be terminated as shown in Figure 4 or by connecting it to a grid or by pinning the connecting turn buckle device to the ground surface by using a driven steel pin, or in any suitable way. This technique is suitable for environmental designs, where vegetation can be encouraged to grow through the retaining grids and meshes, so that the supported slope rapidly takes on a natural appearance. If required, however, shotcrete, possibly incorporating some further stabilising mesh can also be applied to the surface, to protect the tendons and prevent erosion.

[0031] By avoiding any slack in the terminations of the tendons at the outer ends of the soil nails, tension builds up immediately on occurrence of any slip in the soil being stabilised whereas without some pre-tension, significant movement may occur at or near the surface before tension builds up.

Claims

1. A ground support for stabilising ground by installation thereof in a bore (13) in the ground characterised by a head member (14) at the inner end of the support, at least one elongated flexible polymeric tendon (11,12) extending longitudinally within the bore (13) from the head member (14) to the outer end of the bore (13), the tendon (11,12) being embedded in a matrix (18) of filler material and means (17;35;43) for anchoring the end or ends of the tendon (11,12) externally of the bore (13).

2. A ground support as claimed in claim 1 characterised in that the flexible polymeric tendon (11,12) is in the form of a belt or strip of webbing.

3. A ground support as claimed in claim 1 or claim 2 characterised in that the support includes a double tendon (11,12) formed by attaching the material thereof remote from its ends to the head member (14) to provide two tendon sections (11,12), each of which extends along the bore (13).

4. A ground support as claimed in claim 3 characterised in that the tendon (11,12) is attached to the head member (14) by passing it around the head member(14).

5. A ground support as claimed in claim 4 characterised in that at least two double tendons (11,12) are employed to provide at least four tendon sections extending along the bore (13).

6. A ground support as claimed in any one of the preceding claims characterised in that the filler is constituted by grout or by a sand and cement mix or by compacted sand or by a synthetic resin or by pulverised fuel ash and cement mix.

7. A ground support as claimed in any one of the preceding claims characterised in that the outer end or ends of the tendon or tendons (11,12) are anchored externally of the bore (13) by attachment to a surface support (16,19;34) adjacent the entry to the bore (13).

8. A ground support as claimed in claim 7 characterised in that said surface support (34) includes means (35) for taking up slack in the tendon (11,12).

9. A ground support as claimed in claim 8 characterised in that the means (35) for taking up slack is a turn buckle.

10. A ground support as claimed in claim 9 characterised in that the turn buckle (35) is mounted on the surface support (34).

11. A ground support installation incorporating ground supports as claimed in any one of claims 1 to 6 characterised in that the tendons (11,12) of adjacent ground supports are anchored by interconnection of the outer ends of the tendons (11,12) of one ground support, to the outer ends of tendons (11,12) of adjacent ground supports such as to form a support for the surface of the area being stabilised.

12. A ground support installation as claimed in claim 11 characterised in that adjustable connectors (43) are provided for taking up slack.

Patentansprüche

1. Bodenstütze zum Stabilisieren des Bodens durch ihren Einbau in eine Bohrung (13) im Boden, gekennzeichnet durch ein Kopfteil (14) am inneren

Ende der Stütze, mindestens eine längliche flexible polymere Sehne (11, 12), die sich in der Bohrung (13) von dem Kopfteil (14) zum äußeren Ende der Bohrung (13) in Längsrichtung erstreckt, wobei die Sehne (11, 12) in eine Matrix (18) aus Füllmaterial eingebettet ist, und eine Einrichtung (17; 35; 43) zum Verankern des Endes oder der Enden der Sehne (11, 12) außerhalb der Bohrung (13).

2. Bodenstütze nach Anspruch 1, dadurch gekennzeichnet, daß die flexible polymere Sehne (11, 12) in Form eines Gewebegurts oder -bands ist.

3. Bodenstütze nach Anspruch 1 oder Anspruch 2, dadurch gekennzeichnet, daß die Stütze eine doppelte Sehne (11, 12) aufweist, die durch Befestigen ihres Materials fern von ihren Enden an dem Kopfteil (14) gebildet ist, um zwei Sehnenabschnitte (11, 12) zu schaffen, von denen sich jeder längs der Bohrung (13) erstreckt.

4. Bodenstütze nach Anspruch 3, dadurch gekennzeichnet, daß die Sehne (11, 12) an dem Kopfteil (14) durch Herumführen um das Kopfteil (14) befestigt ist.

5. Bodenstütze nach Anspruch 4, dadurch gekennzeichnet, daß mindestens zwei doppelte Sehnen (11, 12) verwendet werden, um mindestens vier Sehnenabschnitte zu schaffen, die sich längs der Bohrung (13) erstrecken.

6. Bodenstütze nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Füllstoff aus Mörtel oder durch eine Sand- und Zementmischung oder durch verdichteten Sand oder durch ein Kunstharz oder durch eine pulverisierte Brennstoffasche- und Zementmischung gebildet ist.

7. Bodenstütze nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das äußere Ende oder die äußeren Enden der Sehne oder Sehnen (11, 12) außerhalb der Bohrung (13) durch Befestigung an einer Oberflächenabstützung (16, 19; 34) angrenzend an den Eingang zu der Bohrung (13) verankert sind.

8. Bodenstütze nach Anspruch 7, dadurch gekennzeichnet, daß die Oberflächenabstützung (34) eine Einrichtung (35) zum Spannen der Sehne (11, 12) enthält.

9. Bodenstütze nach Anspruch 8, dadurch gekennzeichnet, daß die Einrichtung (35) zum Spannen ein Spannschloß ist.

10. Bodenstütze nach Anspruch 9, dadurch gekennzeichnet, daß das Spannschloß (35) auf der Bodenabstützung (34) angebracht ist.

11. Bodenstützeneinbau mit Bodenstützen gemäß irgend einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß die Sehnen (11, 12) von benachbarten Bodenstützen durch Untereinanderverbinden der äußeren Enden der Sehnen (11, 12) von einer Bodenstütze mit den äußeren Enden der Sehnen (11, 12) von angrenzenden Bodenstützen verankert sind, um eine Abstützung für die Oberfläche des zu stabilisierenden Bereichs zu bilden.

12. Bodenstützeneinbau nach Anspruch 11, dadurch gekennzeichnet, daß einstellbare Verbinder (43) zum Spannen vorgesehen sind.

Revendications

1. Dispositif de renforcement de sol destiné à stabiliser le sol en installant celui-ci dans un alésage (13) dans le sol, caractérisé par un élément de tête (14) à l'extrémité interne du dispositif de renforcement, au moins un élément de précontrainte polymère flexible allongé (11, 12) s'étendant de manière longitudinale à l'intérieur de l'alésage (13) depuis l'élément de tête (14) vers l'extrémité externe de l'alésage (13), l'élément de précontrainte (11, 12) étant encastré dans une matrice (18) de matière de remplissage et des moyens (17 ; 35 ; 43) destinés à ancrer la ou les extrémité(s) de l'élément de précontrainte (11, 12) à l'extérieur de l'alésage ou forage (13).

2. Dispositif de renforcement de sol selon la revendication 1, caractérisé en ce que l'élément de précontrainte polymère flexible allongé (II, 12) a la forme d'une ceinture ou d'une bande de sangle.

3. Dispositif de renforcement de sol selon la revendication 1 ou 2, caractérisé en ce que le dispositif de renforcement inclut un double élément de précontrainte (11, 12) formé en fixant la matière de celui-ci à distance de ses extrémités à l'élément de tête (14) pour fournir deux sections d'élément de précontrainte (11, 12) dont chacune s'étend le long de l'alésage (13).

4. Dispositif de renforcement de sol selon la revendication 3, caractérisé en ce que l'élément de précontrainte (11, 12) est fixé à l'élément de tête (14) en le passant autour de l'élément de tête (14).

5. Dispositif de renforcement de sol selon la revendication 4, caractérisé en ce qu'au moins deux doubles éléments de précontrainte (11, 12) sont employés pour fournir au moins quatre sections d'élément de précontrainte s'étendant le long de l'alésa-

ge (13).

6. Dispositif de renforcement de sol selon l'une des revendications précédentes, caractérisé en ce que la matière de remplissage est constituée de mortier, d'un mélange de sable et de ciment, d'un sable compacté, d'une résine synthétique ou d'un mélange de cendres de combustibles pulvérisées et de ciment.

7. Dispositif de renforcement de sol selon l'une des revendications précédentes, caractérisé en ce que la ou les extrémité(s) externe(s) du ou des éléments de précontrainte (11, 12) sont ancrées à l'extérieur de l'alésage (13) en étant fixées à un support de surface (16, 19 ; 34) adjacent à l'entrée de l'alésage (13).

8. Dispositif de renforcement de sol selon la revendication 7, caractérisé en ce que ledit support de surface (34) inclut des moyens (35) pour éliminer le relâchement dans l'élément de précontrainte (11, 12).

9. Dispositif de renforcement de sol selon la revendication 8, caractérisé en ce que les moyens (35) pour éliminer le relâchement sont un manchon de serrage.

10. Dispositif de renforcement de sol selon la revendication 9, caractérisé en ce que le manchon de serrage (35) est monté sur le support de surface (34).

11. Installation de dispositif de renforcement de sol incorporant des dispositifs de renforcement de sol selon l'une des revendications 1 à 6, caractérisée en ce que les éléments de précontrainte (11, 12) des dispositifs de renforcement de sol adjacents sont ancrés par interconnexion des extrémités externes des éléments de précontrainte (11, 12) d'un dispositif de renforcement de sol aux extrémités externes des éléments de précontrainte (11, 12) des dispositifs de renforcement de sol adjacents de manière à former un support pour la surface de la zone devant être stabilisée.

12. Installation de dispositif de renforcement de sol selon la revendication 11, caractérisée en ce que les connecteurs (43) ajustables sont fournis pour éliminer le relâchement.

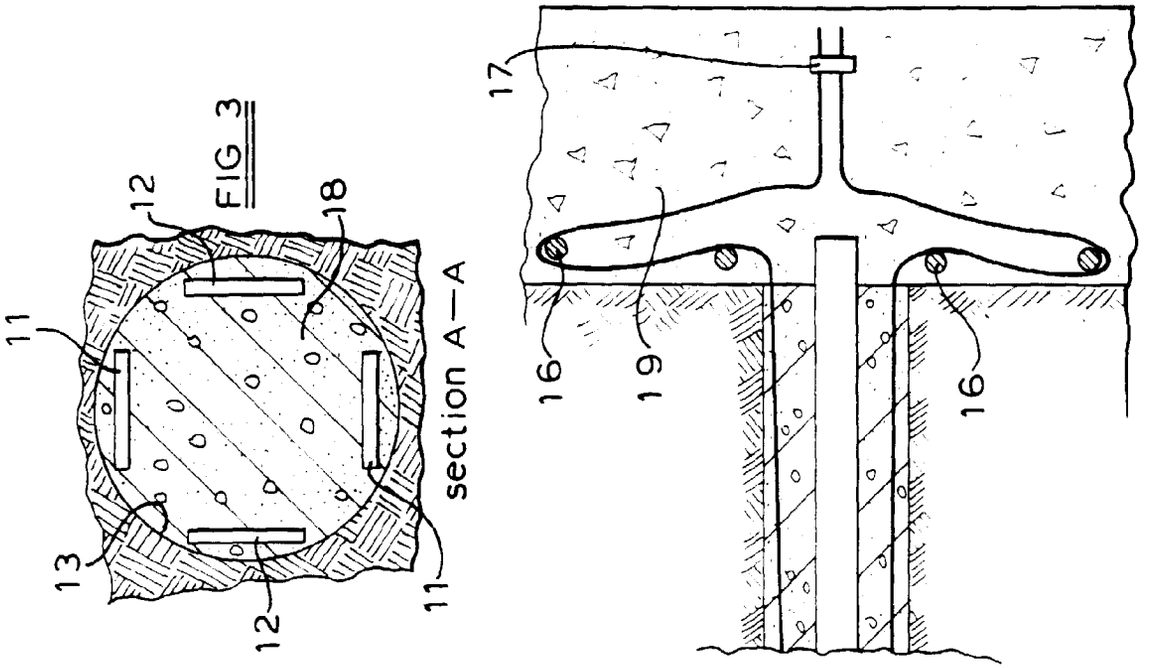

FIG 3

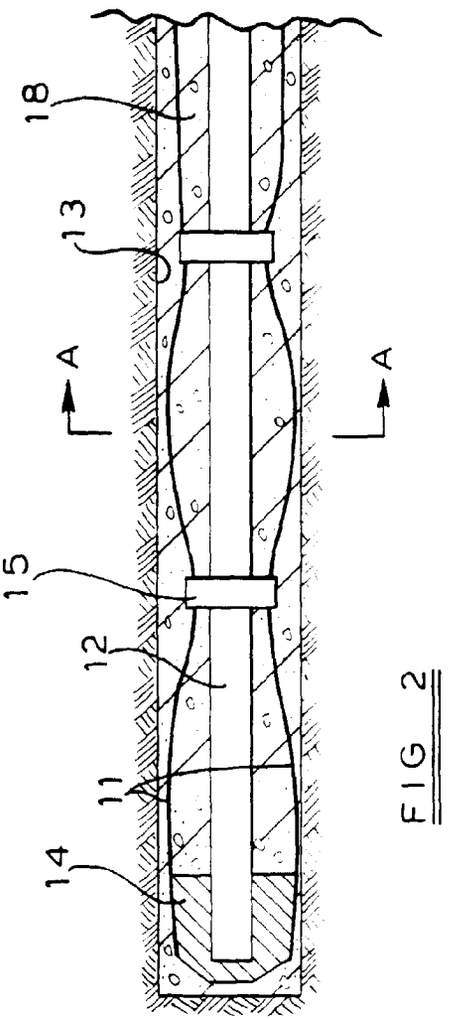

FIG 2

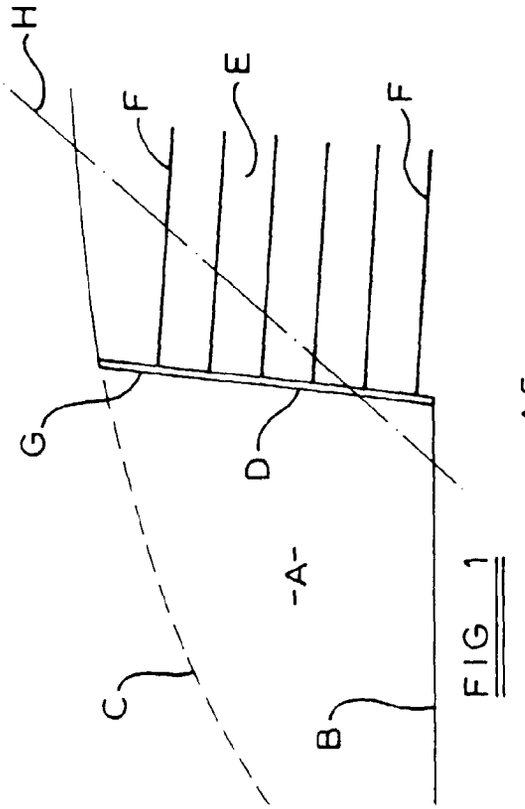

FIG 1

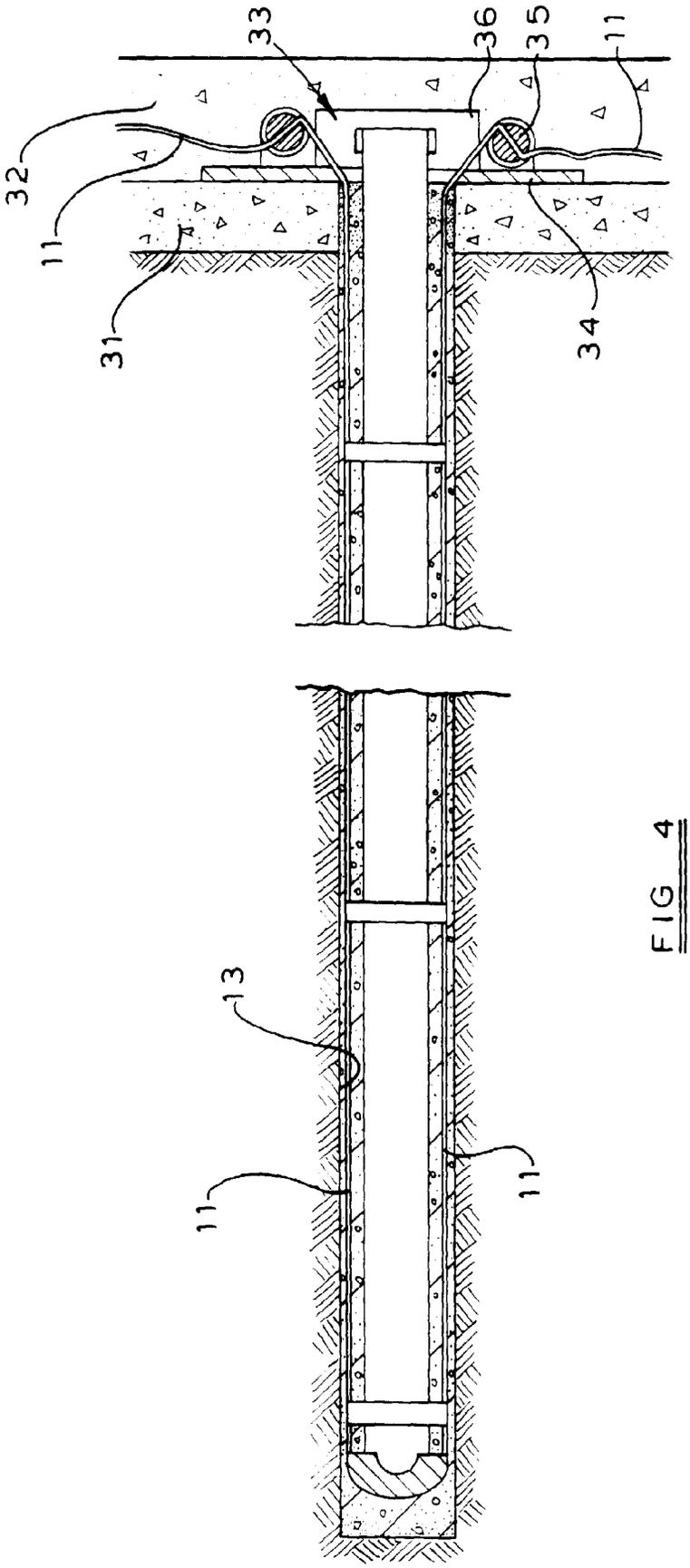

FIG 4

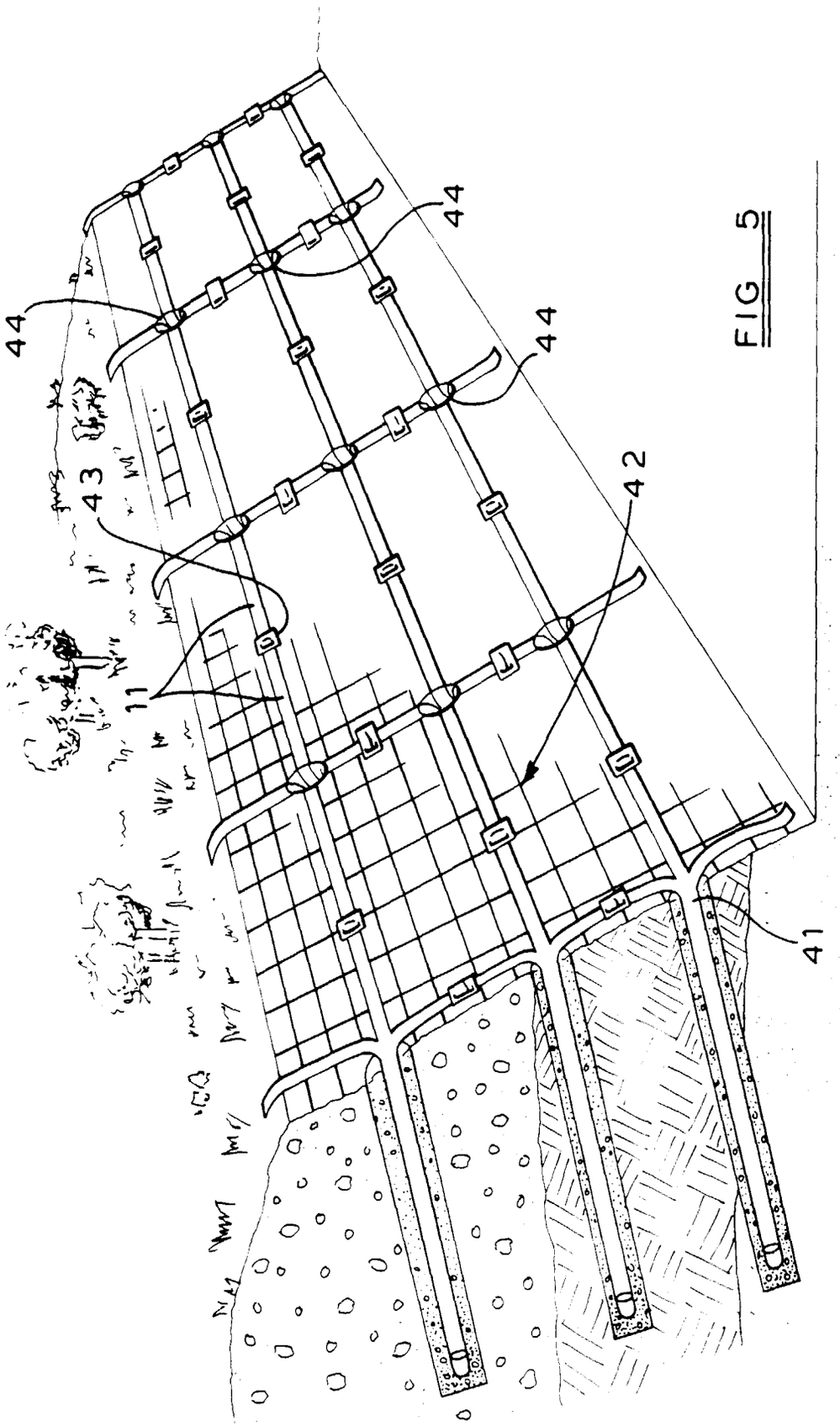

FIG 5