(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 726 383 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
14.08.1996 Bulletin 1996/33

(51) Int. Cl.[6]: **E21D 20/02**, E21D 9/00, E02D 5/80

(21) Application number: **96101053.5**

(22) Date of filing: **25.01.1996**

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **09.02.1995 IT MI950235**

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(54) Injection anchor for tunnels and trenches

(57) A device is described for reinforcement, consolidation and stabilization of the ground, particularly for preventing landslides or deformation of the working face in tunnels or trenches, comprising an injection tube (5), advantageously with valves, to be inserted in a respective borehole (20) in the ground (3), around which tube (5) are arranged a plurality of strong reinforcing elements (7, 7'), mounted by means of centering spacers (6) and held together by external retaining elements.

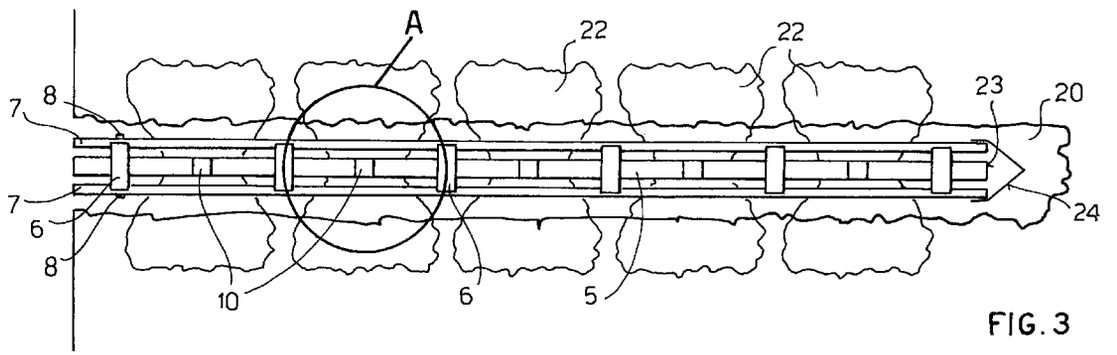

FIG. 3

EP 0 726 383 A1

Description

The present invention relates to a device for consolidating and stabilizing ground, to preventing collapse or deformation of the ground during excavation of tunnels or trenches.

Excavation in tunnels and the like, especially in clay formations, often involves serious problems relating to the stability of the working face (breast) which, due to removal of the ground, loses some of its ability to withstand the stresses caused by advancement of the excavation.

As is known, in order to stabilize the ground during these excavations, boreholes are made on the face, in which tubes, normally of synthetic material, are inserted as reinforcement.

The boreholes are then filled with cement mortar, which acts as a binding and retaining element.

This procedure, though widely used, has not always proved effective, since it does not always permit a good uniform distribution of the cement mortar and it does not allow localized high-pressure injections to be carried out, which would allow consolidation and recompacting of the ground.

Furthermore, the small area of contact between the tube and the cement mortar and the low adhesion coefficient of the tube surface do not allow the resistance of the reinforcement to be transmitted completely to the ground, thus leaving it partly unused.

When working in restricted spaces or with boreholes whose length exceeds that of the tubular reinforcements that can be transported to the site, it is necessary to make joins in the reinforcement, by gluing for example, which is unlikely to allow the strength of the tube to be kept constant along the entire borehole.

The aim of the present invention is to overcome all the disadvantages listed above, providing a device for stabilizing the excavation or working face and preventing landslides or deformation of the ground in tunnels or trenches, which ensures that the reinforcement is highly resistant.

Another aim of the invention is to allow the high tensile strength of the reinforcement to be transmitted to the injection mixture even over very short lengths.

Yet another aim of the invention is to guarantee complete and uniform distribution of the cement mixture inside the borehole by means of a plastic tube, advantageously with valves.

Yet another aim of the invention is to guarantee the possibility of inserting reinforcements of any length, even in very small spaces and without transport problems, with no breaks or falls in the strength of the reinforcements along the entire borehole.

The device according to the invention presents the characteristics listed in the attached claims.

It comprises a plurality of strong elements, made from glass fibres impregnated with synthetic resins (fibreglass-reinforced plastic) mounted by means of centering spacers around a plastic injection tube, preferably a valved tube.

With such a device it is possible to exploit the known method of localized repeated injection of consolidating chemical or cement mixtures, by means of tubes with valves which, with pressures even higher than 100 bar, allow consolidation of the rock and also recompression of materials with low permeability using the claquage method.

The device is kept perfectly centered in the injection mixture by means of centering spacers; in this way the surfaces of the reinforcement, advantageously consisting of fiberglass-reinforced plastic straps, are completely surrounded by the cement, and a possible surface treatment of the straps with quartz sand allows a complete bond between reinforcement and injected mixture, thus allowing the reinforcement's strengthening capacity to be completely transmitted to the ground.

Lastly the strengthening elements of the device, that is the straps, can be rolled for transport, and the device itself can be assembled directly near the borehole, allowing continuous reinforcements to be made, without any break in strength, with a length of the order of a hundred metres.

Further characteristics of the invention will be made clearer by the detailed description that follows, referring to a purely exemplary, and therefore non-limiting, embodiment thereof, illustrated in the attached drawings, in which:

Figure 1 is an axonometric partially exploded view of a device according to the invention;

Figure 2 is a cross section taken along the line II-II of Figure 1;

Figure 3 is a longitudinal section diagrammatically illustrating how the device works inside a borehole, during injection;

Figure 4 is an enlargement of the detail indicated by A in Figure 3;

Figure 5 is a diagrammatic cross section showing a typical example of use of the device according to the invention for excavation of tunnels;

Figure 6 is a view in cross section, like that in Figure 2, illustrating a different configuration of the device.

In Figure 5 an excavation front or working face 1 of a tunnel 2 being dug in ground 3 of any type is illustrated.

Structural elements 4 are inserted in the ground 3 and in the front 1, in order to consolidate the ground.

In particular the structural elements inserted in the excavation front 1 serve as reinforcements for consolidation and stabilization of the ground, so as to prevent

landslides or deformation of the ground during excavation of the tunnel.

According to the invention, the structural elements 4 for consolidation of the front 1 consist of a device comprising a tube 5 which in the figures is shown as a tube with valves around which a plurality of fiberglass straps 7 (three in the example) are positioned by means of centering spacers 6.

The centering spacers 6 are put on the tube 5, whilst the strong fiberglass straps 7 are fitted outside them and fixed to them by means of fastening elements 8 consisting, for example, of a metal band or a binding of fiberglass reinforced adhesive tape.

In the example shown, which is the preferred embodiment of the device, the tube 5 is provided with "manchette" valves 10 (i.e. valves comprising an elastic annular band around a perforated portion of the tube) which, as is known, when subjected to pressure within the tube 5, allow the injection mixture to escape through the holes 11 (see Figure 4), completely surrounding the straps 7 and completely filling the borehole 20 in which the device is inserted.

It will later be possible to return inside of the tube 5 with a packer 21 (Figure 4) to carry out localized injections 22, locally injecting the individual valves 10, thus eliminating any injection defects and, if necessary, consolidating the surrounding ground.

In the case of a tube without valves, a single uniform injection of cement mortar will be made, filling the borehole 20 and coming out of the open front end 23 of the tube 5. The cone-shaped cap 24 disposed at the front end of the tube 5 serves only as guide to facilitate insertion of the device 4 into the borehole 20, without obstructing the outlet end 23 of the tube.

The fiberglass straps 7, thanks to their shape, ensure a greater area of contact with the injection mixture 22 than would a tubular cross section with the same resistance section.

Furthermore, during construction a quartz sand coating is advantageously applied to the surface of said straps, making it possible to obtain a very high friction coefficient and a good chemical compatibility with the injection mixtures.

It is thus possible to transmit all the strength of the reinforcement to the ground, preventing landslides or ground settling, even with very limited anchoring lengths.

The device according to the invention also has the peculiarity of being able to be assembled easily near the borehole.

In this case, the fiberglass straps 7 can be rolled in the desired length with an external diameter of less than 2.30 metres, whilst the tubes 5, manufactured in the desired lengths, have threaded ends 30 and are complete with coupling sleeves 31, threaded on the inside.

Hence all the material can be easily transported near the borehole, though creating structural elements with lengths of the order of a hundred metres which do not have any decrease in strength along the entire borehole since a continuous reinforcement (created by the straps 7) can be used without additions or breaks.

The cross section in Figure 6 shows a possible variant embodiment in which the straps 7 are replaced by round bars 7', which may be held together by outer bands 8.

Obviously the invention is not limited to the particular embodiment described above and illustrated in the attached drawings, but a number of changes can be made to the details, without departing from the scope of the invention itself which is defined by the claims that follow.

Claims

1. A device for reinforcement, consolidation and stabilization of the ground, particularly to prevent landslides or deformations of the excavation front in tunnels or trenches, comprising an injection tube (5) for injecting cement mortar, said tube to be inserted in a respective borehole (20) in the ground (3), characterized in that it has a plurality of reinforcing elements (7, 7') mounted by means of centering spacers (6) around said tube (5) and possibly held together by external fastening elements (8).

2. A device according to claim 1, characterized in that said reinforcing elements (7, 7') are made of fiberglass.

3. A device according to claim 1 or 2, characterized in that said reinforcing elements (7, 7') have their outer surface treated with a coating of quartz sand.

4. A device according to any one of the preceding claims, characterized in that said reinforcing elements (7, 7') are made of aramidic fibre, carbon fibre, polyvinyl alcohol fibre and the like.

5. A device according to any one of the preceding claims, characterized in that said tube (5) has an open front end (23) where a cone-shaped guide cap (24) is provided.

6. A device according to any one of the previous claims, characterized in that said tube is a valved tube (5), provided with manchette valves for localized injections.

7. A device according to any one of the preceding claims characterized in that said reinforcing elements (7) are continuous straps.

8. A device according to any one of claims 1 to 6, characterized in that said reinforcing elements (7') are continuous round bars.

9. A device according to any one of the preceding claims, characterized in that said tube (5) is manu-

factured in elements that can be joined together by means of coupling sleeves (31) that can be screwed on terminal threads (30) of said tube elements.

10. A device according to any one of the preceding claims characterized in that said retaining elements (8) holding the reinforcing elements (7, 7') consist of metal bands, binding with fiberglass reinforced adhesive tape and the like.

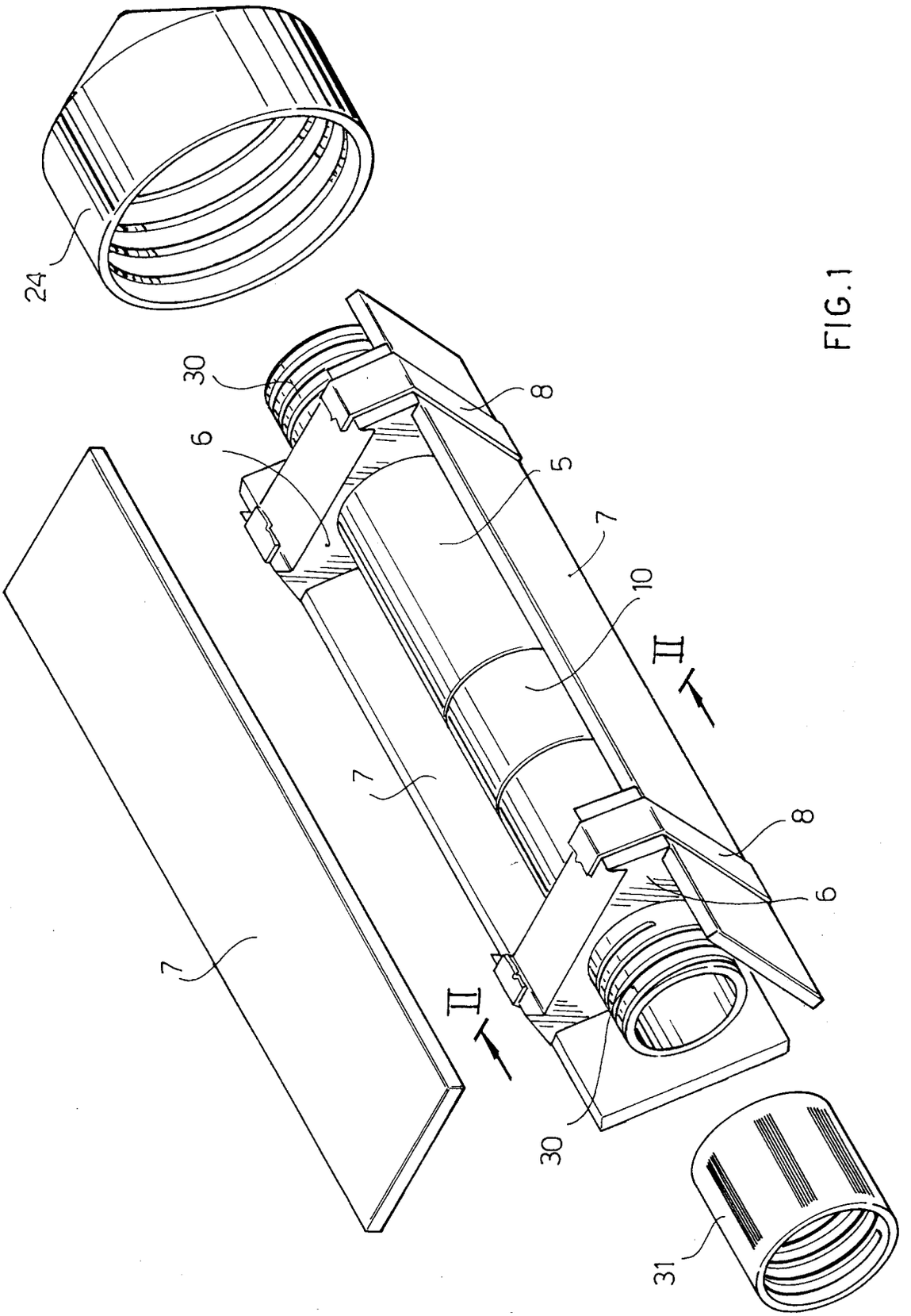

FIG.1

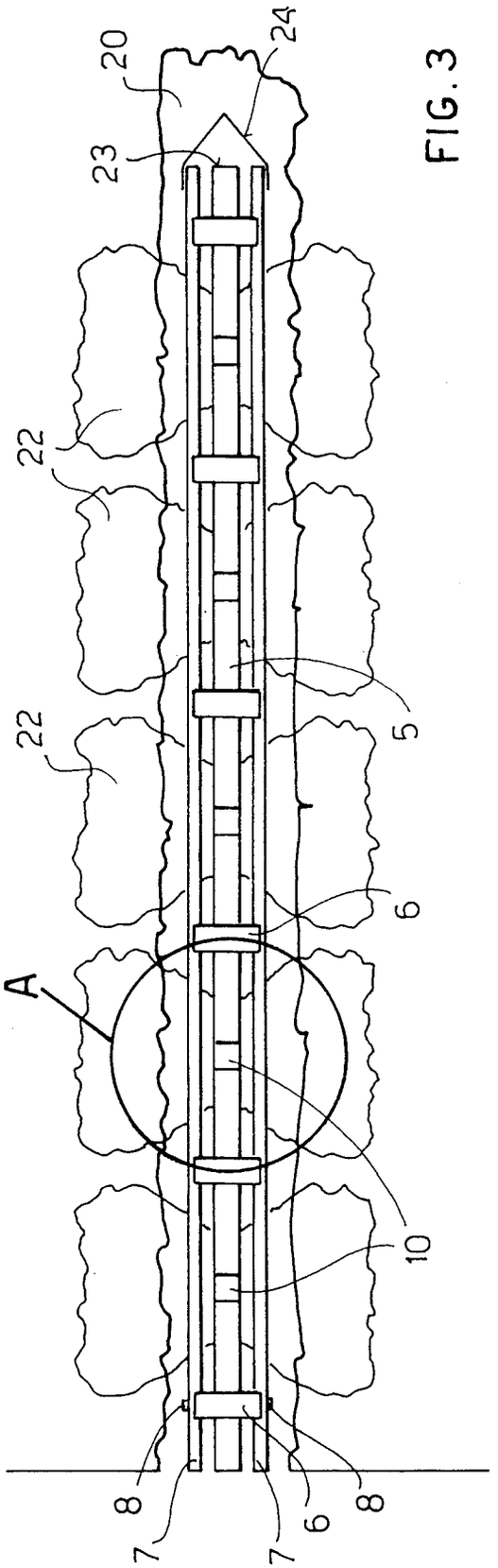

FIG. 3

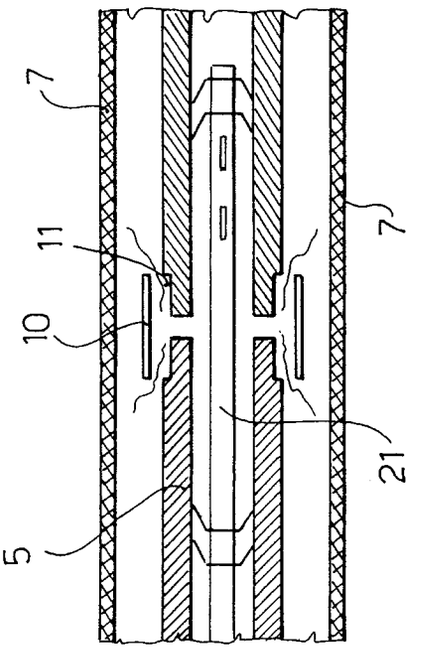

FIG.4

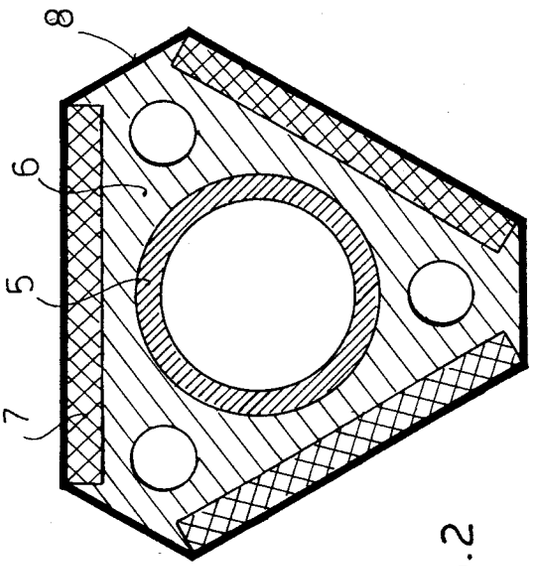

FIG.2

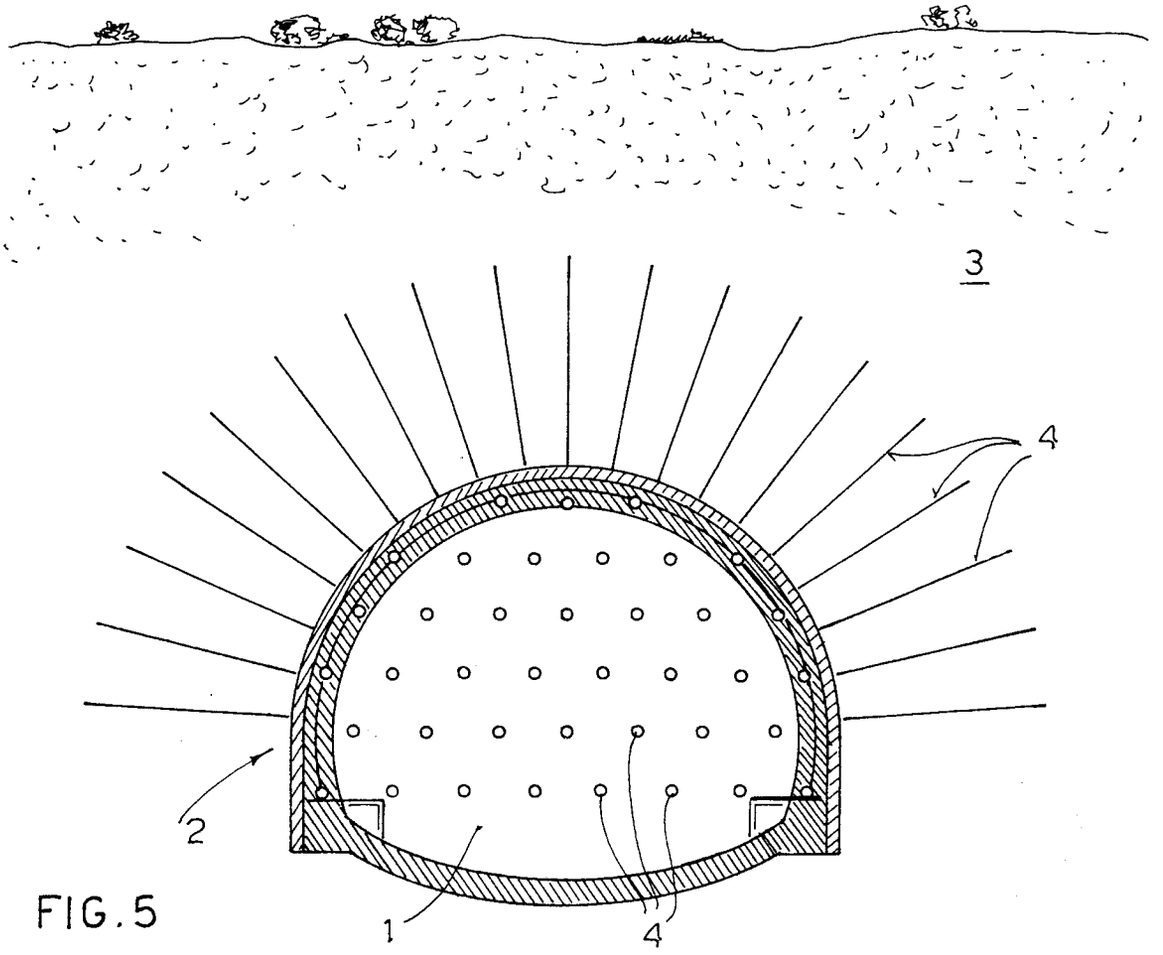

FIG.5

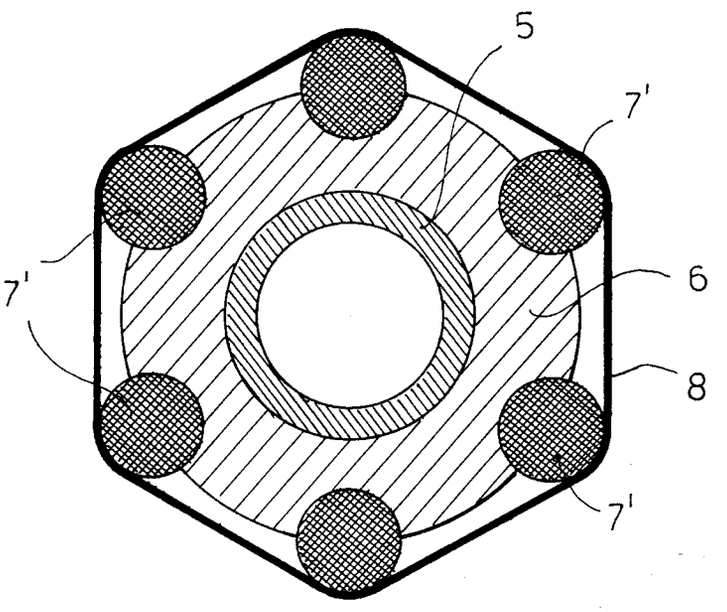

FIG.6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 10 1053

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.6)
A	DE-C-35 36 998 (BERGWERKSVERBAND GMBH) * the whole document * ---	1,5,6	E21D20/02 E21D9/00 E02D5/80
A	AT-B-392 501 (ING. MAYREDER) * the whole document * ---	1,5	
A	DE-U-90 04 177 (BERWERKSVERBAND GMBH) * the whole document * ---	1,6	
A	FR-A-2 101 916 (DYCKERHOFF) * figures * ---	1,5,10	
A	FR-A-2 643 096 (SOLETANCHE) * the whole document * ---	1,5,8,9	
A	EP-A-0 196 451 (DYCKERHOFF) * figure 6 * ---	1,8	
A	FR-A-2 467 532 (TOKIO CHIKA) ---		
A	GB-A-2 018 855 (SONDAGES INJECTIONS) -----		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
E21D E02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	7 May 1996	Fonseca Fernandez, H

CATEGORY OF CITED DOCUMENTS

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