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(54) Fixation device for tension elements and anchor formed therewith

(57) The invention relates to a device for fixing a tension element (5) in the ground (4), with at least two force transmitting members (13,14) connected close to an outer end to the tension element (5) and for embedding in a first plug of anchoring material (3), which members are mutually displaceable and staggered in longitudinal direction. The force transmitting members (13,14) can herein have different lengths. One of the force transmitting members can be tubular, wherein the force transmitting members then run concentrically.

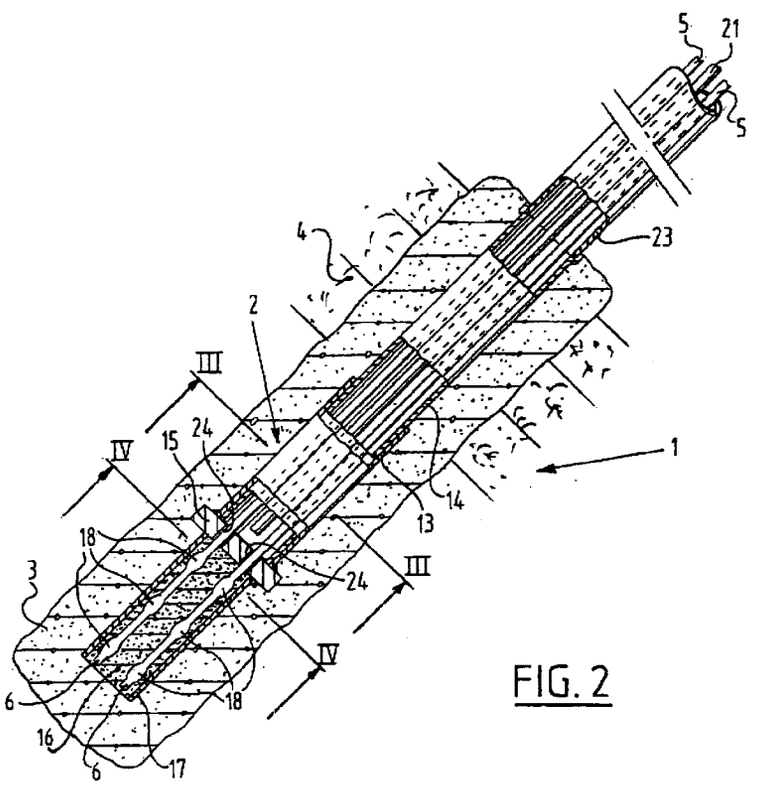

FIG. 2

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Description

[0001] The invention relates to a device for fixing at least one tension element in the ground, comprising at least one force transmitting member connected close to an outer end to the tension element and for embedding in a first plug of anchoring material. Such a fixation device is known from the European patent specification 0 356 215 and in combination with the tension element is generally designated an anchor.

[0002] Such an anchor is used to anchor a tension element, thus a tension rod or cable, in the ground. This is important for instance for supporting all kinds of constructions such as sheet pilings round a pit excavation or high, moored structures such as transmitter masts and the like.

[0003] A temporary auxiliary tube is herein first placed in the ground. This is carried sufficiently far into a load-bearing layer. The auxiliary tube is filled with a setting filler or anchoring mass, generally designated as cement grout, whereafter the anchor is lowered into this auxiliary tube. The auxiliary tube is then pulled stepwise out of the ground and the grout is simultaneously pressed under pressure to the outside through the open end of the auxiliary tube. A grout plug is hereby formed in which the anchor is wholly embedded so that a good adhesion with the surrounding earth is obtained. After setting of the grout plug the fixation device and the tension cable or rod fastened thereto are then fixed in the ground. The other free end of the tension cable or rod can then be connected to the construction for supporting.

[0004] In the fixation device known from the stated European patent use is made of a number of tension elements in the form of multi-strand cables which are anchored in the ground by arranging the outer end of each cable in a ribbed tube filled with an anchoring material such as cement grout or resin, and embedding the thus pre-anchored outer ends in a relatively long plug of anchoring material. The tubes with the outer ends of the different cables therein are herein arranged in staggered positions in lengthwise direction of the plug, so that the tensile force exerted by the cables is distributed evenly along the length of the grout plug. This tensile force is then transferred through the grout plug, also distributed over its whole length, into the ground. Owing to this uniform force transfer this known anchor can ultimately exert a greater tensile force on the ground than conventional anchors, wherein the outer ends of the tension cables are all connected to the grout plug at the same point. The tensile force of the anchor is herein effectively transferred into the ground along only a small part of its length as a consequence of a phenomenon known as "progressive debonding".

[0005] The known fixation device requires very careful mounting however, because the length of the individual tension elements must be accurately chosen such that the different anchoring tubes with the ends of the tension cables therein are arranged in precise succession in the grout plug and no overlap occurs. In addition, a uniform force transfer is not obtained with the known anchoring system when only a single tension element is used, since there can then be no staggered fixing of the tension element to the grout plug.

[0006] The invention therefore has for its object to provide an improved fixation device of the above described type. This is achieved according to the invention in that at least two mutually displaceable force transmitting members staggered in longitudinal direction are connected to the or each tension element. By making use of a plurality of force transmitting members per tension element, a uniform distribution of the force over the grout plug can still be obtained even when only a single tension element is applied. In addition, because tension elements of different length do not have to be used, the mounting of the fixation device according to the present invention is simple. The construction of the fixation device can in fact be chosen here irrespective of the number of tension elements used.

[0007] Preferred embodiments of the fixation device according to the invention are described in the dependent claims.

[0008] The invention also relates to the anchor formed by the combination of one or more tension elements and a fixation device as described above, and to the anchoring obtained by lowering this anchor into a bore hole and embedding it in a plug of anchoring material.

[0009] The invention will now be elucidated on the basis of two embodiments wherein reference is made to the annexed drawing, in which:

fig. 1 is a schematic cross-section through the ground having therein an anchor according to a first embodiment of the invention;
fig. 2 shows a partly broken-away longitudinal section through the anchor of fig. 1;
fig. 3 and 4 show cross-sections along the respective lines III-III, IV-IV in fig. 2;
fig. 5 is a side view of a part of a tension element of the anchor according to the invention;
fig. 6 is a schematic cross-section through an anchor according to a second embodiment of the invention; and
fig. 7 shows a schematic longitudinal section through a third embodiment of the anchor according to the invention with the associated distribution of forces.

[0010] An anchor 1 according to the invention, which is used for supporting a construction in the ground 4, is formed by a bundle of elements 5 under strain of tension, a metal fixation device or anchor construction 2 connected thereto and a plug of anchoring material 3 arranged therearound (fig. 1). Anchor 1 is herein arranged in a relatively firm layer of the ground 4 which has sufficient gripping force to fix a structural element,

in the shown embodiment a sheet pile 9 bounding a pit excavation 10. The free outer end 7 of each tension element 5 is herein connected to sheet pile 9 by means of a nut 8 (or in the case of a tension cable by means of securing wedges). Due to the presence of tension elements 5 fixed in the ground 4 the sheet pile 9 is thus held in place and crumbling or even collapse of the earth 12 in the proximity of pit excavation 10, whereby damage could be caused to buildings 11 in the vicinity thereof, is prevented.

[0011] Fixation device 2 consists of a connecting element 15, in the shown embodiment in the form of a disc with a number of openings 24, on which are mounted two force transmitting members 13, 14 (fig. 2). The force transmitting members, which extend in the direction of the free ends 7 of tension elements 5, are formed by concentric tubes 13, 14 of different length which are freely displaceable relative to each other. Each of the force transmitting members 13, 14 is connected via its outer wall to a part of grout plug 3 such that the tensile force from tension elements 5, which is transferred as pressure force via connecting disc 16 to force transmitting tubes 13, 14, is transmitted into grout plug 3 distributed uniformly in length direction. Force transmitting members 13, 14 can herein follow the deformation of the associated part of grout plug 3 since they are after all freely movable relative to each other. The force is thus ultimately also transferred in uniformly distributed manner from grout plug 3 to the surrounding earth 4, whereby the phenomenon of so-called "progressive debonding" will not occur, or hardly so, and the total force generated by anchor 1 is greater than would be possible with a conventional anchor construction.

[0012] The force transmitting members can also be connected via another force transmitting member to tension element 5 while retaining the mutual displaceability. For this purpose a third force transmitting member 26 can for instance be fixed with an outer end 27 to the inner force transmitting member 14 at a distance from connecting element 15 (fig. 7). Because members 14 and 26 are mutually connected at only one point, they can still stretch independently of each other from this connecting point and thus follow the deformation of the associated part of grout prop 3. In this manner an even more uniform distribution of the force F is achieved along the length l of fixation device 2.

[0013] The part of fixation device 2 above the connecting element 15 described up to this point functions as a so-called duplex anchor.

[0014] In order to transfer the tensile force of tension elements 5 to connecting element 15, the outer ends 6 of tension elements 5, which are placed through openings 24 in connecting disc 15, are per se anchored in a separate, second plug 16 of an anchoring material such as cement grout or the like. This second grout plug 16, which is received in a sleeve 17, presses against the underside of connecting element 15. In order to anchor outer ends 6 very firmly in second grout plug 16, these ends can be provided locally with thickened portions 18. This is not essential however for all applications. These thickened portions 18 can be formed for instance by untwisting the strands 19 of each intertwined tension element 5 over a determined distance from the outer end 6, placing a spacer ring 20 between the thus parted strands 19, which ring can be pushed for instance onto the middle strand 25, and subsequently rewinding strands 19 (fig. 5).

[0015] Because sleeve 17 with the second grout plug 16 therein is also embedded into the first grout plug 3, this part of fixation device 2 likewise contributes toward transfer of the tensile force from tension elements 5 to grout plug 3, and essentially functions herein as a so-called mono-anchor. The total fixation device 2 thus forms as it were a combination of a mono-anchor and a duplex anchor and can therefore transfer a very great force to the ground.

[0016] In order to also ensure a uniform force transmission in the part of grout plug 3 located under connecting element 15, sleeve 17 can likewise be formed by a number of concentric parts of different length, which must then again be freely displaceable relative to each other.

[0017] The part of tension elements 5 located above grout plug 3 is received in the shown embodiment in a tube 23, which can be manufactured from a suitable plastic such as PE or PVC. Also arranged in this tube 23 is a filler hose 21 through which tube 23 can for instance be filled with water or with a grout so as to prevent compression of tube 23. This is particularly important when tension elements 5 have to be removed again after use of anchor 1. If tube 23 were to be compressed under the influence of the pressure of the surrounding earth 4, a very great resistance would occur during withdrawal of elements 5 from the ground, whereby tension elements 5 could even unintentionally fail whereby a part would thus still be left behind. In the case of removable tension elements 5 the filler hose 21 can also be used to carry an explosive charge or for instance an oxygen lance to grout plug 3 in order to release tension elements 5 therefrom.

[0018] Although the invention is described above on the basis of a bundle of parallel tension elements 5 and a duplex anchor, it may also be applied with only a single tension element 5, for instance in combination with a mono-anchor. Connecting element 15 can herein then be embodied as the bottom of a tube which functions as outermost, short force transmitting member 13 and the diameter of which is scarcely larger than that of tension element 5, which can take the form of for instance a tension rod. This tension rod 5 can herein be placed through an opening 24 in connecting element 15 and be fixed therein in any manner (fig. 6). The outer end of the tension rod placed through connecting element 15 herein protrudes outside tube 13 and thus functions directly as the inner, longer force transmitting member 14.

[0019] The force transmitting members could also be

embodied as non-concentric elements placed for instance mutually adjacently. It is then important here that the part of the longer force transmitting member overlapping the shorter member is not attached to the grout plug. This part can be coated for this purpose with for instance a non-adhesive coating. More than two force transmitting members could also be used. For transmission of greater forces over longer grout plugs, three or more concentric tubes could perhaps be used.

[0020] The scope of the invention is therefore defined solely by the appended claims.

Claims

1. Device for fixing at least one tension element in the ground, comprising at least one force transmitting member connected close to an outer end to the tension element and for embedding in a first plug of anchoring material, **characterized in that** at least two mutually displaceable force transmitting members staggered in longitudinal direction are connected to the or each tension element.

2. Fixation device as claimed in claim 1, **characterized in that** the force transmitting members have different lengths.

3. Fixation device as claimed in claim 1 or 2, **characterized in that** at least one of the force transmitting members is tubular and the force transmitting members run concentrically.

4. Fixation device as claimed in any of the foregoing claims, **characterized in that** at least one of the force transmitting members is connected with an outer end to one of the other force transmitting members.

5. Fixation device as claimed in any of the foregoing claims, **characterized by** a connecting element carrying the force transmitting members which is connected close to the outer end to the or each tension element and which extends substantially transversely thereof.

6. Fixation device as claimed in claim 5, **characterized in that** the force transmitting members extend from the connecting element in the direction of the free outer end of the or each tension element.

7. Fixation device as claimed in claim 5 or 6, **characterized by** a second plug of anchoring material arranged on the side of the connecting element remote from the free outer end of the or each tension element and receiving the outer end of the or each tension element.

8. Fixation device as claimed in claim 7, **characterized in that** the second plug of anchoring material is received in a sleeve for embedding in the first plug.

9. Fixation device as claimed in claim 8, **characterized in that** the sleeve comprises a number of concentric parts of different length.

10. Fixation device as claimed in any of the foregoing claims, **characterized by** a number of parallel tension elements connected to a common set of force transmitting members.

11. Anchor comprising one or more tension elements and a fixation device as claimed in any of the foregoing claims connected thereto.

12. Anchoring, comprising a bore hole in the ground, an anchor as claimed in claim 11 lowered therein and a plug of anchoring material surrounding the anchor.

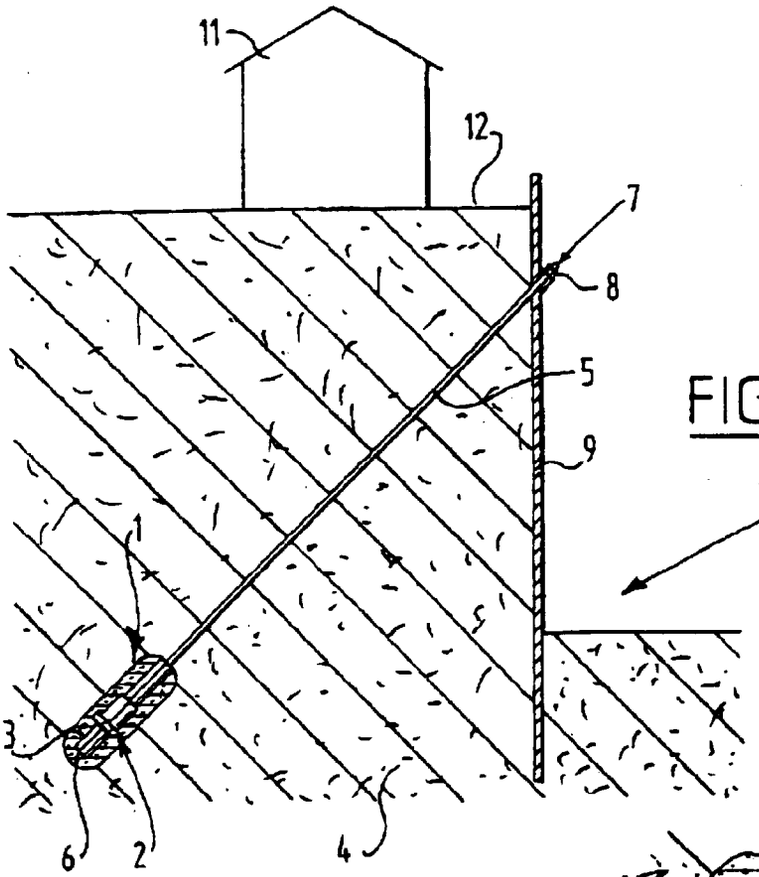
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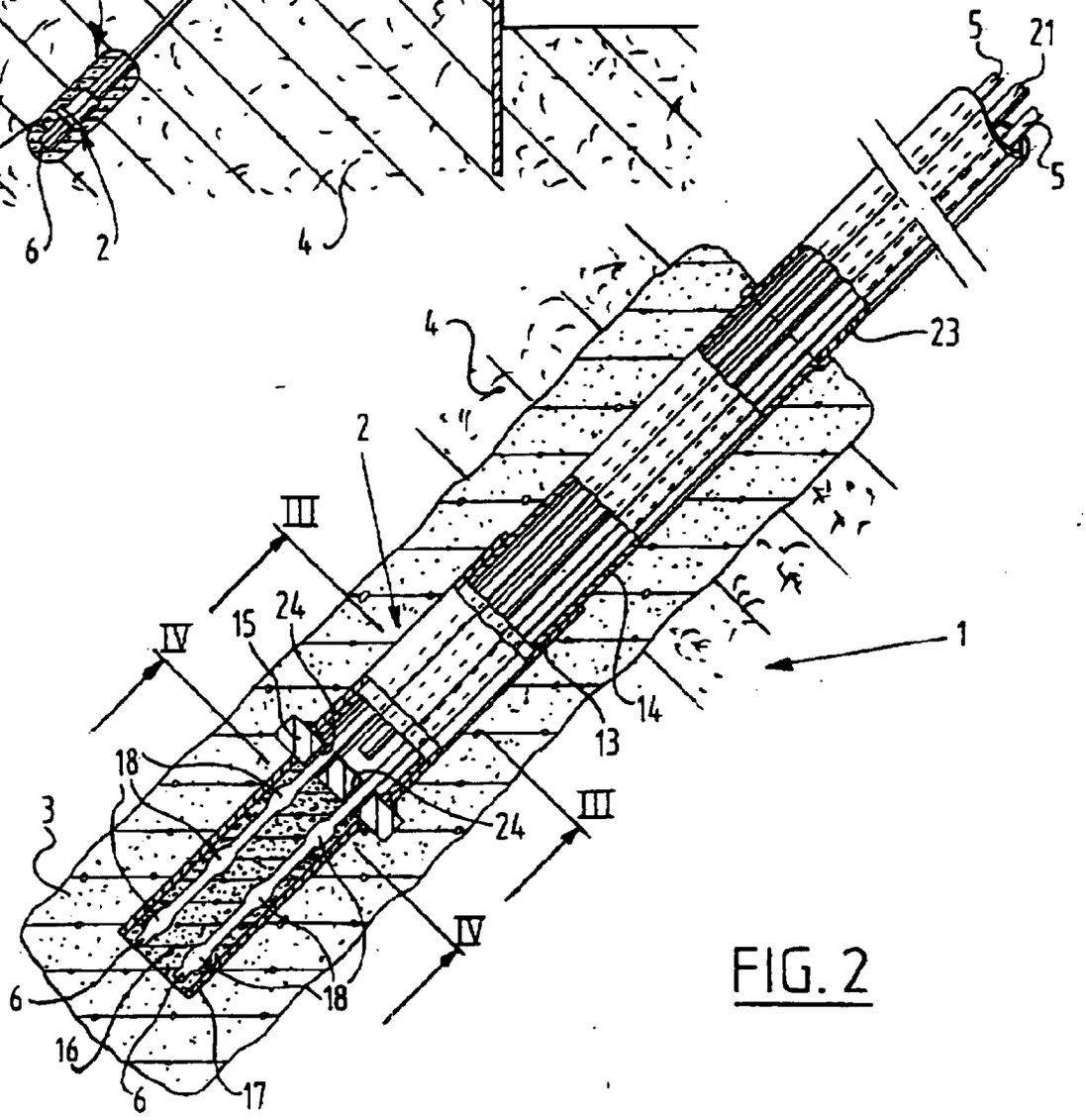
FIG. 1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23
4
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III
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FIG. 2

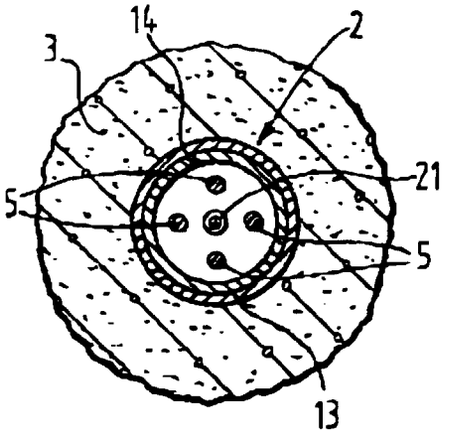

FIG. 3

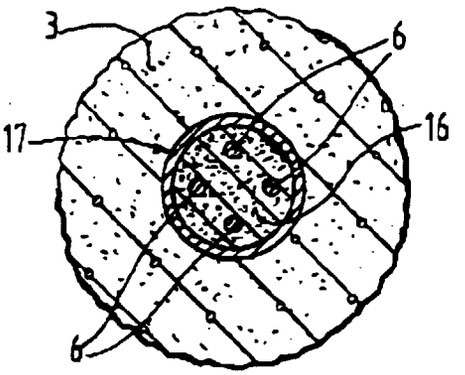

FIG. 4

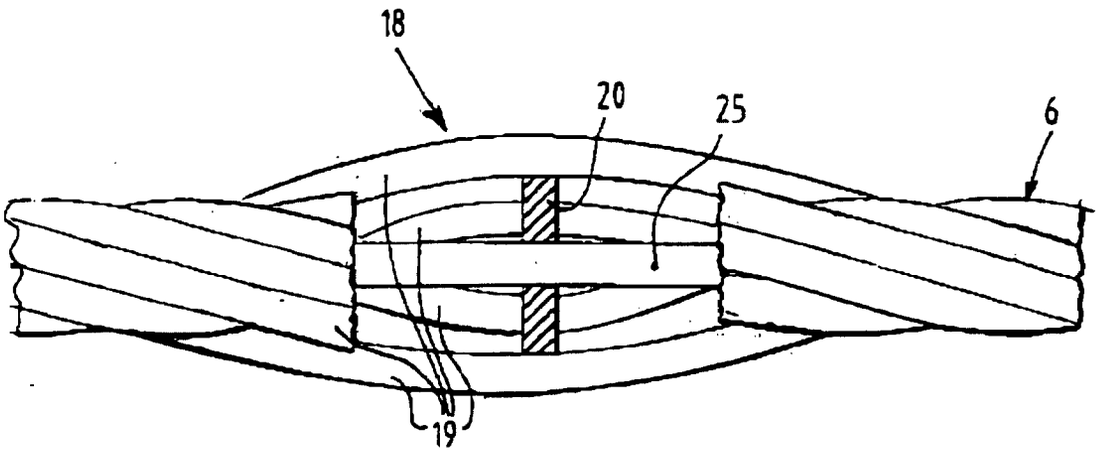

FIG. 5

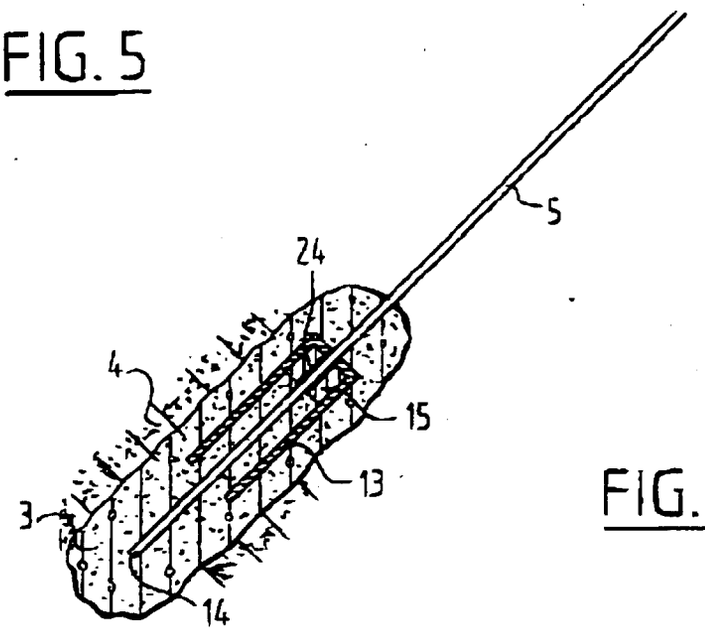

FIG. 6

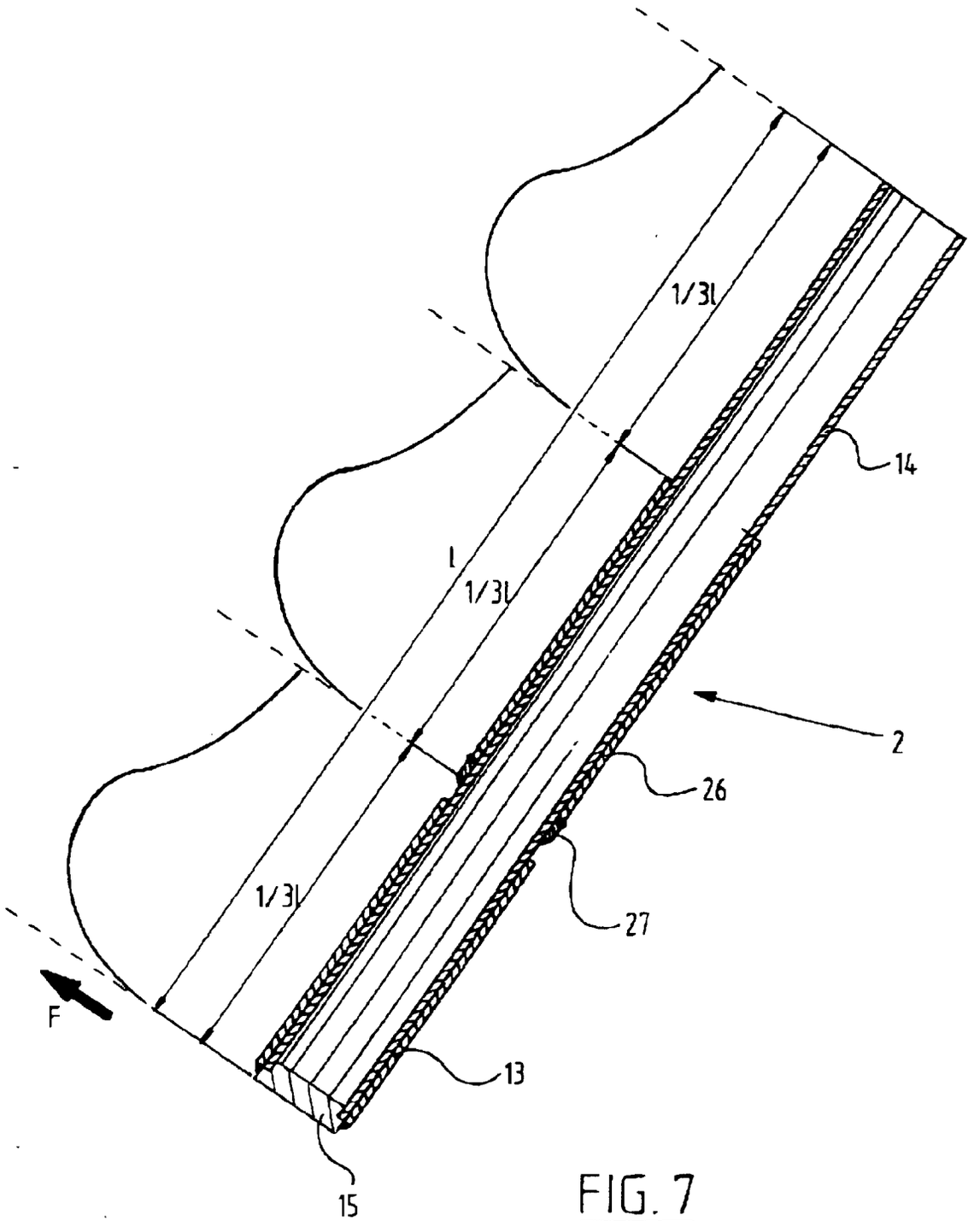

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 99 20 0278

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)
X A	DE 19 04 371 A (STUMP BOHR G.M.B.H.) 30 July 1970 * the whole document * ---	1-3,10, 11 5,6,10	E02D5/80
A	DE 42 16 196 C (KUPFER HERBERT PROF DR ING ;KUPFER HELMUT DR ING (DE); LINSE DIETH) 2 December 1993 * the whole document * ---	1-5, 10-12	
A	DE 20 41 249 A (STUMP BOHR G.M.B.H.) 24 February 1972 * page 4, line 6 - page 6, line 30; figures * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) E02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 March 1999	Blommaert, S

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 20 0278

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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17-03-1999

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82