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(72) Inventor: **Merridew, Chris**
92000 Nanterre (FR)

(74) Representative: **Dronne, Guy**
Cabinet Beau de Loménie,
158, rue de l'Université
75340 Paris Cedex 07 (FR)

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(71) Applicant: **COMPAGNIE DU SOL**
92000 Nanterre (FR)

(54) **A method and equipment for strengthening a piles wall**

(57) A method for strengthening a wall comprising a plurality of piles (10,12) made of concrete and separated by intervals consisting of less hard material said method comprising the steps of:

- drilling anchoring holes into the material forming said intervals;

- fixing anchoring members (24) within said anchoring holes, said anchoring members having heads which project out of said material;
- fixing a strengthening structure (32) to the heads of said anchoring members, said strengthening structure facing at least said intervals between said piles.

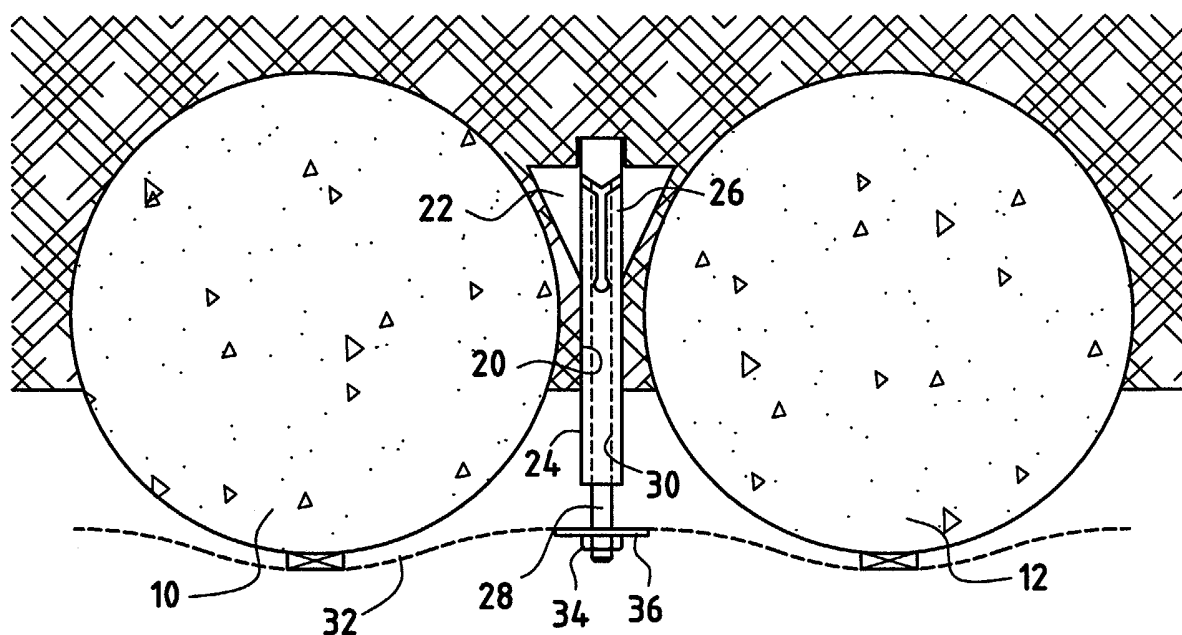


FIG.3

Description

[0001] The present invention relates to a method for strengthening a piles wall and an equipment to implement the method.

[0002] More precisely, the invention relates to the building of a strengthening structure such as a lining wall over a "wall" comprising a plurality of concrete piles separated by intervals. The interval between two piles can consist of the remaining ground within which the piles have been made. The interval can also consist of intermediate piles disposed between two main piles made of reinforced concrete. The intermediate piles are made of a grout which is less hard than the reinforced concrete.

[0003] Enclosed figure 1 illustrates a piles wall provided with a lining wall. Figure 1 shows the alignments A, B and C of concrete piles D. The piles are obtained by drilling vertical boreholes within the ground, filling up the boreholes with concrete and disposing a reinforcement structure into the boreholes. Then the ground within the volume limited by the alignments of piles A, B, C and D is excavated. As a result, the intervals between the piles consist of the remaining soil or ground. Such a piles wall is generally called a "contiguous bored piles wall" (C.B.P.W.).

[0004] Another type of piles wall called "secant piles wall" (S.P.W.) consists of an alternation of primary piles made of harder concrete and secondary piles made of softer material such as grout, the secondary piles being located between two primary piles.

[0005] To improve the sealing and/or the mechanical strength of the piles wall, a vertical lining wall LW is built over the pile wall. The lining wall should be anchored within the pile wall. In some other cases, a lining wall is not necessary. It is sufficient to anchor strengthening sections such as a steel section between the piles. To achieve this anchoring, holes are drilled in the piles and anchoring members are inserted and fixed within these holes.

[0006] This way of anchoring the strengthening structure such as the lining wall on the piles wall has many drawbacks. Since the holes must be drilled in a hard material with a percussive drilling tool, this operation is time-consuming. Generally, the piles are reinforced so there is a risk of hitting the reinforcement.

[0007] Finally, this drilling technique creates problems of "health and safety" (dust and "white hand, etc.).

[0008] A first object of the present invention is to provide a method for strengthening a piles wall (C.B.P.W. or S.P.W.) which does not present the above-mentioned drawbacks.

[0009] To achieve this object, according to the invention, the method for strengthening a wall comprising a plurality of piles made of concrete and separated by intervals consisting of less hard material said method comprises the steps of:

- drilling anchoring holes into the material forming said intervals;
- fixing anchoring members within said anchoring holes, said anchoring members having heads which project out of said material;
- fixing a strengthening structure to the heads of said anchoring members, said strengthening structure facing at least said intervals between said piles.

[0010] It will be understood that, because the holes are to be drilled in a softer material, it is not necessary to implement the percussive-drilling techniques and the risks of hitting the reinforcement of the piles are avoided.

[0011] Preferably, said anchoring holes have a first portion opening into the outside surface of said intervals and an inner second portion having an enlarged size and said anchoring members are bolts having a head and an expandable end and being provided with means to expand said end.

[0012] Thanks to the particular shape of the holes and the type of bolts which are used, the anchoring members are firmly secured even though the material which forms the intervals between the piles is softer.

[0013] A second object of the present invention is to provide an equipment to implement the method of strengthening the piles walls (C.B.P.W. or S.P.W.).

[0014] To achieve this object, according to the invention, the equipment for strengthening a wall comprising a plurality of piles made of concrete separated by intervals consisting of less hard material, the equipment comprises:

- a tool for drilling anchoring holes into the material forming said intervals,
- a plurality of anchoring members having a head, said member being adapted for fixing within said anchoring holes; and
- a strengthening structure adapted for fixing to the head of said anchoring members.

[0015] Other features and advantages of the invention will appear clearer on reading the following description of various preferred embodiments of the invention given as non-limiting examples. The description refers to the accompanying figures in which :

- Figure 1, described above, shows a piles wall provided with a lining wall according to the prior art;
- Figure 2 illustrates the first step of the strengthening method according to the invention in the case of a lining wall;
- Figure 3 illustrates the second step of the building method;
- Figure 4 illustrates the third step of the building method;
- Figure 5 shows an example of a reaming tool for implementing the strengthening method; and
- Figure 6 shows an example of a Jeffer bolt adapted

for use as an anchoring member.

[0016] Referring now to figures 2 to 4, the method of the invention applied to the building of a lining wall will be described in detail.

[0017] Figure 2 shows two contiguous bored piles 10 and 12 and the interval 14, consisting of remaining soil, between the two piles. For example, the piles are made of reinforced concrete and their diameter is from 300 to 2100 mm. The length L of the interval 14 is from 50 to 300 mm, typically 150 mm.

[0018] In a first step, a plurality of anchoring holes such as 16 are drilled into the interval 14 by means of a drilling tool 18 which will be described in more detail hereinafter. At present, it is sufficient to underline that, because the interval 14 is softer than the piles, it is not necessary to use a percussive tool. Preferably the hole 16 comprises a first outer portion 20 having a substantially constant diameter and a second inner portion 22 which is enlarged.

[0019] In a second step illustrated by figure 3, anchoring members are inserted into the holes 16 and fixed within them. Preferably, the anchoring members consist of expansible bolts such as bolt 24. These bolts are generally called "Jeffer bolts".

[0020] The bolt 24 comprises an expansible end 26 and a threaded head 28. The threaded head 28 is the end of a stem 30 which is used to expand the bolt. The threaded head 28 of the bolt is also used to fix an anchoring structure such as a mesh 32. The portion of the mesh 32 surrounding the head 28 is secured to the bolt 24 by means of a nut 34 and a washer 36.

[0021] In the third step illustrated in figure 4, the end 26 of the bolt 24 is expanded in the enlarged portion 22 of the hole 16. So, the bolt 24 is firmly anchored in the material forming the interval 14 between the two piles 10 and 12 and the mesh 32 is fixed to the bolts 24.

[0022] When the mesh is fixed over the whole surface of the piles wall, the lining wall 38 can be built with any convenient material (please give examples of material). The mesh 32 has a double function. Firstly, the mesh serves as an anchoring structure for anchoring the lining wall over the piles wall. Secondly, the mesh serves as a reinforcement for the lining wall itself.

[0023] According to an improved implementation of the method the stem of the bolts 24 can be hollow. Thus, a grout can be injected into the enlarged portion 22 of the hole 16 to fill it up. The injected grout both improves the anchoring of the bolt and protects the bolt against corrosion.

[0024] The same building method can be implemented in the case of a secant piles wall.

[0025] As already explained, the invention is also applicable to the making of a strengthening structure different from a lining wall in the case of both C.B.P. W. or S.P.W.

[0026] In such a case, the method for fixing the anchoring members (e.g. Jeffer bolts) is not changed. The

difference consists in the fact that the reinforcing structure such as a mesh is replaced by steel sections or similar structures which are fixed or tied by means of the anchoring members.

[0027] The tool sections can extend over the whole piles wall or only over the intervals between the piles.

[0028] The drilling tool 18 is schematically shown in figure 5. The tool comprises a stem 50 and a drilling head 52. Preferably, the stem 50 is provided with a flight 54 to remove the spoil.

[0029] Close to the drilling head 52, the tool is provided with a pivoting blade 56. The blade 56 has a first end 56a which is pivotally mounted on the stem and an intermediate portion 56b which is connected to a control arm 58. The second end of the arm 58 is connected to an inner or outer control sleeve not shown in figure 5. By moving the sleeve, the arm 58 is moved and the blade 56 is pivoted about its end 56a. The pivoting of the blade 56 allows the performance of the enlarged portion 22 of the anchoring holes 16.

[0030] Figure 6 shows a Jeffer bolt 24 which can be used as an anchoring member to implement the building method. These bolts are well known so it is not necessary to describe them in detail. The bolt comprises a cylindrical body 60, the distal end 62 thereof being split to define two expansible wings 64 and 66. A central stem 68 is slidably mounted within the body 60. The stem 68 is provided with an expansion head 70 and a threaded end 72. When the stem is moved with respect to the body 60; by means of the nut 34 and the washer 36, the control head 70 produces the expansion of the wings 64 and 66.

[0031] The bolt 24 can be made of steel, stainless steel, coated steel (to improve durability), glass reinforced plastic, carbon fibres reinforced plastic, etc.

[0032] It is apparent from the above description that the method and the equipment for building the lining wall has many advantages compared to the prior art techniques. The building of the lining wall is easier and the lining wall has a higher mechanical strength. This is very important when the purpose of the lining wall is to resist the bending force developed by the soil between the piles and the pressure of the water contained in the soil.

[0033] As previously explained, the stem 68 of the bolt can be hollow to allow the injection of grout or similar material into the anchoring hole.

Claims

1. A method for strengthening a wall comprising a plurality of piles made of concrete and separated by intervals consisting of less hard material said method comprising the steps of:

- drilling anchoring holes into the material forming said intervals;
- fixing anchoring members within said anchor-

- ing holes, said anchoring members having heads which project out of said material;
- fixing a strengthening structure to the heads of said anchoring members, said strengthening structure facing at least said intervals between said piles.
2. A method according to claim 1, wherein said step of fixing strengthening structure consists in fixing strengthening sections to the head of said anchoring members between said piles.
3. A method according to claim 2, wherein said strengthening sections are steel sections.
4. A method according to claim 1, wherein said step of fixing strengthening structure consists in:
- fixing an anchoring structure to the heads of said anchoring members, said anchoring structure facing said piles wall; and
 - building said lining wall over said anchoring structure, said anchoring structure forming a reinforcement for said lining wall.
5. A method according to anyone of claims 1 to 4, wherein said anchoring holes have a first portion opening into the outside surface of said intervals and an inner second portion having an enlarged size and said anchoring members are bolts having a head and an expansible end and being provided with means to expand said end.
6. A method according to claim 5, wherein said bolts have a hollow stem and grout is injected into said anchoring holes through the hollow stem of said bolts to fill up said second portion of the holes.
7. A method according to claim 4, wherein said anchoring structure is a mesh.
8. A method according to claim 7, wherein said intervals are formed by the ground wherein the piles are made.
9. A method according to claim 7, wherein said intervals include piles made of a grout which is less hard than the concrete piles.
10. An equipment for strengthening a wall comprising a plurality of piles made of concrete separated by intervals consisting of less hard material, the equipment comprising:
- a tool for drilling anchoring holes into the material forming said intervals,
 - a plurality of anchoring members having a head, said member being adapted for fixing
- within said anchoring holes; and
- a strengthening structure adapted for fixing to the head of said anchoring members.
11. An equipment according to claim 10, wherein said tool includes means for drilling a hole into said intervals and means for enlarging the inner portion of said holes.
12. An equipment according to claim 11, wherein said anchoring members are bolts provided with an expansible end.
13. An equipment according to claim 10, wherein said strengthening structure includes a plurality of steel section.
14. An equipment according to claim 10, wherein said strengthening structure includes an anchoring structure.
15. An equipment according to claim 14, wherein said anchoring section is a mesh.

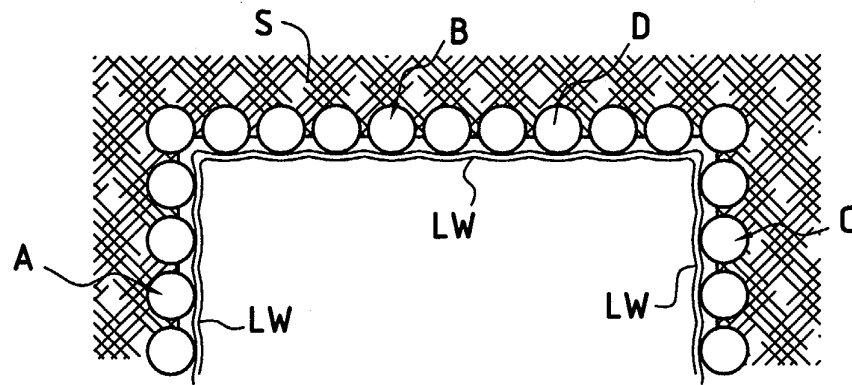


FIG. 1

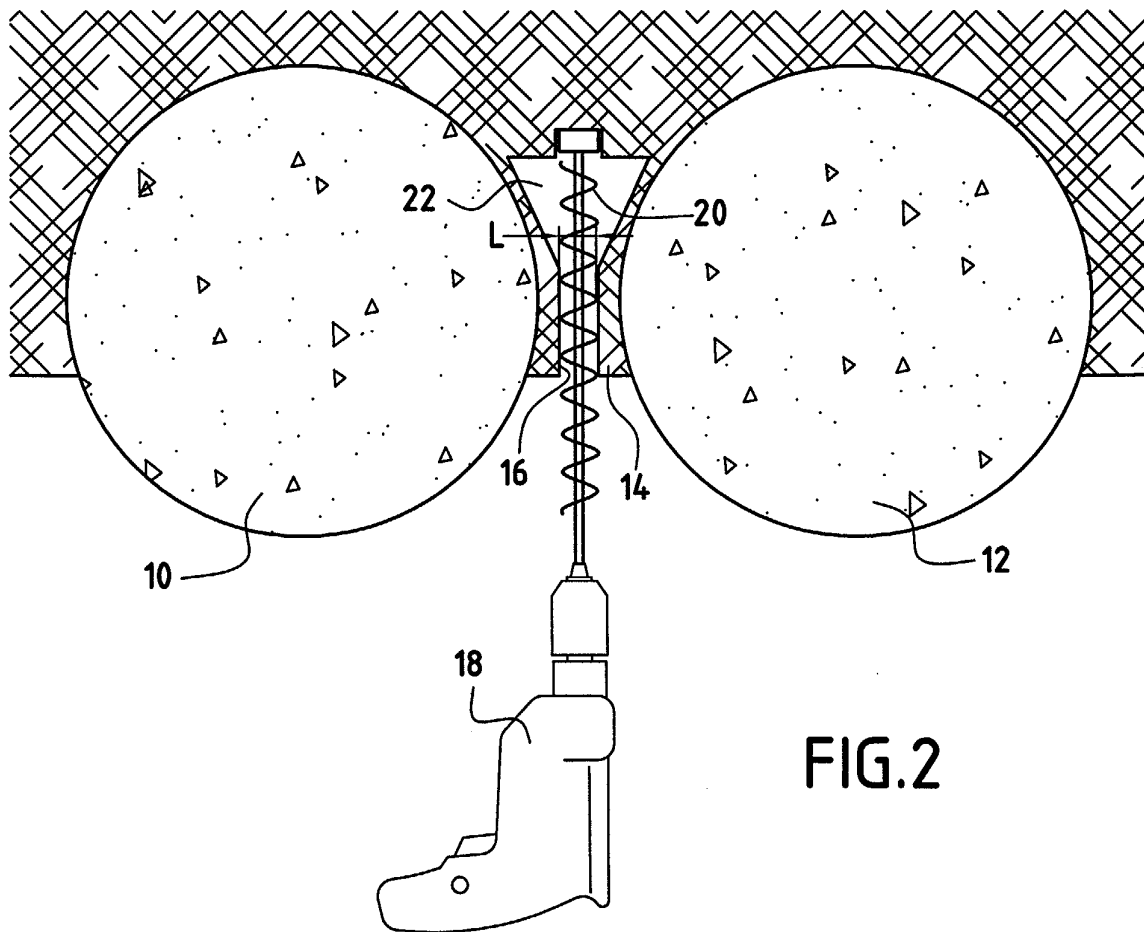


FIG. 2

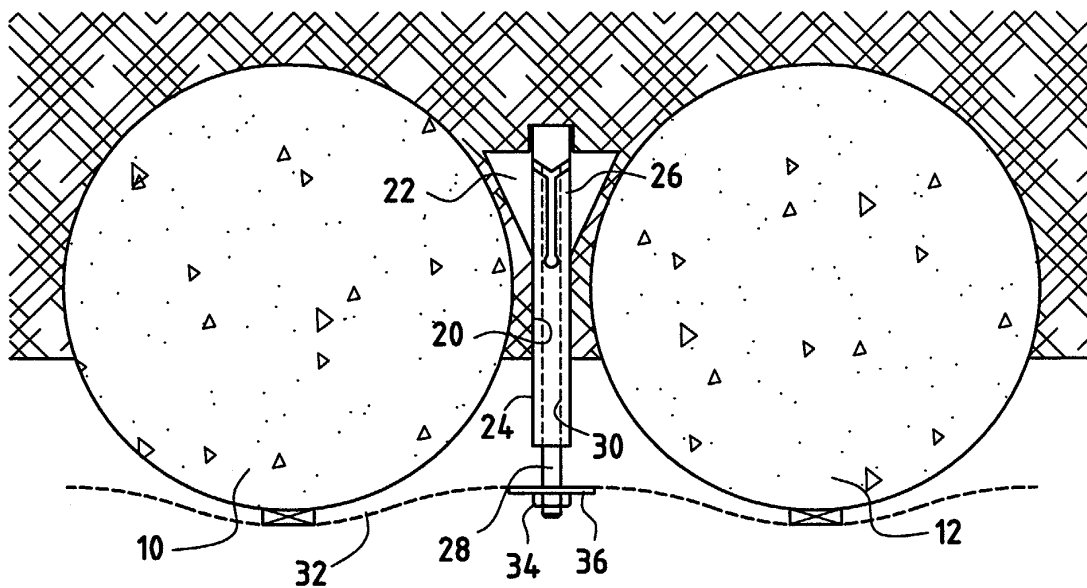


FIG. 3

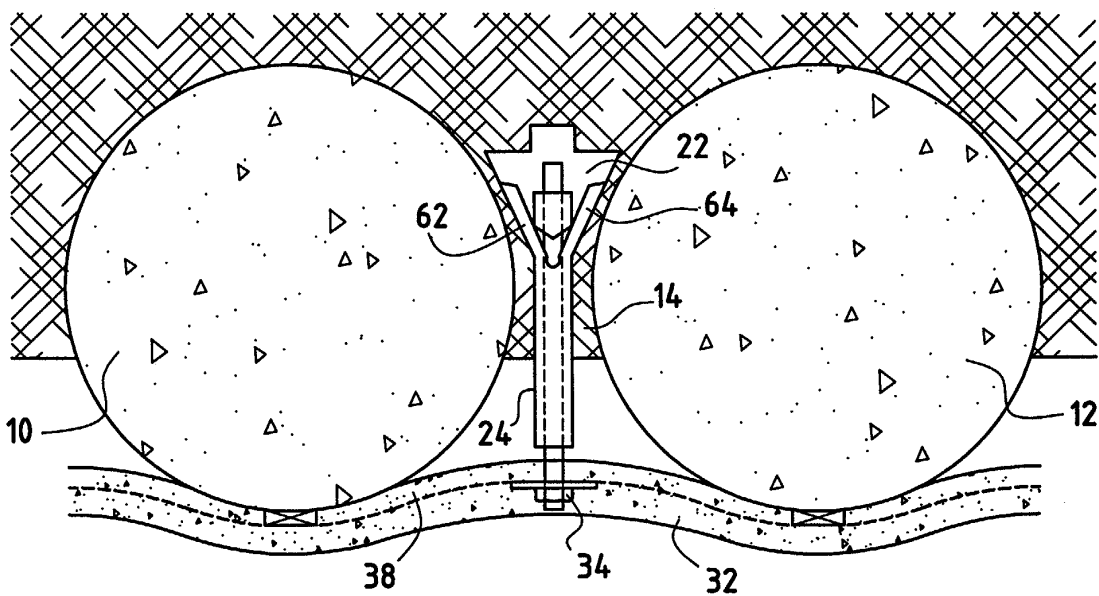


FIG. 4

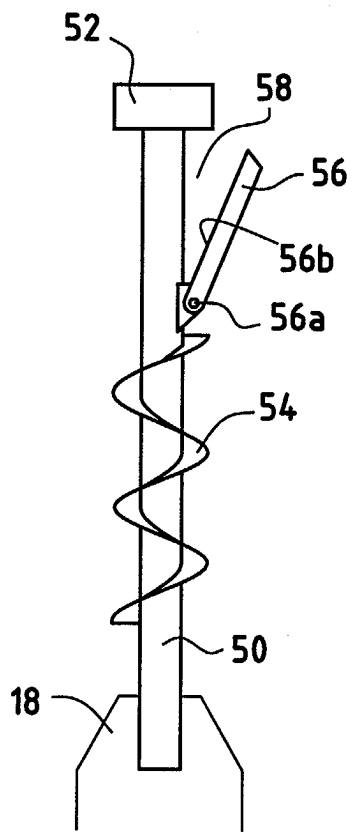


FIG. 5

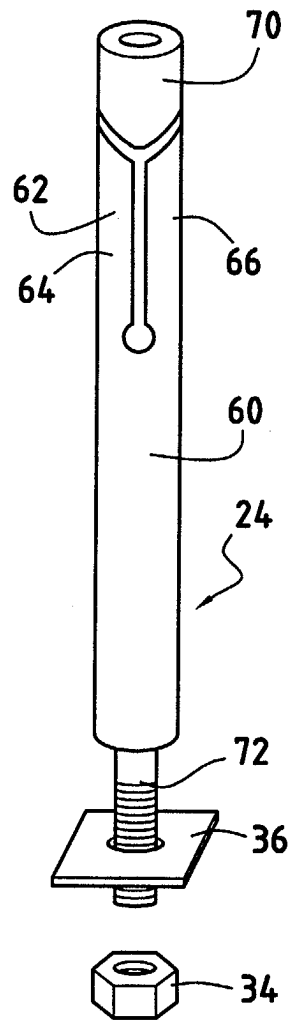


FIG. 6



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 04 29 1663

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 6 299 386 B1 (WOLSCHLAG CHRIS J ET AL) 9 October 2001 (2001-10-09)	1-3,10, 13	E02D5/74 E02D5/18
Y	* column 4, line 12 - column 6, line 47; figures 1-10 *	5,6,11, 12	
X	US 4 911 583 A (CAREY CHARLES) 27 March 1990 (1990-03-27)	1,4,7,8, 14,15	
	* column 3, line 4 - column 4, line 3; figures 1-6 *		
Y	US 4 362 440 A (GLAESMANN OTTO-ERNST ET AL) 7 December 1982 (1982-12-07)	5,6	
	* column 1, line 63 - column 2, line 17; figure *		
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	* figures 7,10 *		
A	US 4 402 639 A (KESSLER JUERGEN) 6 September 1983 (1983-09-06)	5	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
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A	PATENT ABSTRACTS OF JAPAN vol. 0172, no. 82 (M-1420), 31 May 1993 (1993-05-31) & JP 5 009928 A (RAILWAY TECHNICAL RES INST), 19 January 1993 (1993-01-19) * abstract *		
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 5 August 2004	Examiner Kergueno, J
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 04 29 1663

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