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(54) Lock monitoring device

(57) The invention relates to a method for monitoring the interlocking engagement of sheet piles (1,2) driven into the ground, which slidably engage each other with their profiled longitudinal edges (1b,2a). The invention furthermore relates to a device for monitoring the interlocking engagement of sheet piles driven into the ground, which slidably engage each other with profiled longitudinal edges, according to the method according to the invention.

A contact element (4) comprising an upwardly extending conductor (9) is fitted in the profile of a sheet pile to be installed, near the lower transverse edge thereof, wherein, after the sheet pile has been installed, the conductor is connected, via a power source, to a next sheet pile joining the sheet pile already installed, and if the profiled longitudinal edges of the two sheet piles interlock along the entire length of the sheet piles, the lower transverse edge of the next sheet pile will be brought into electric contact with said contact element.

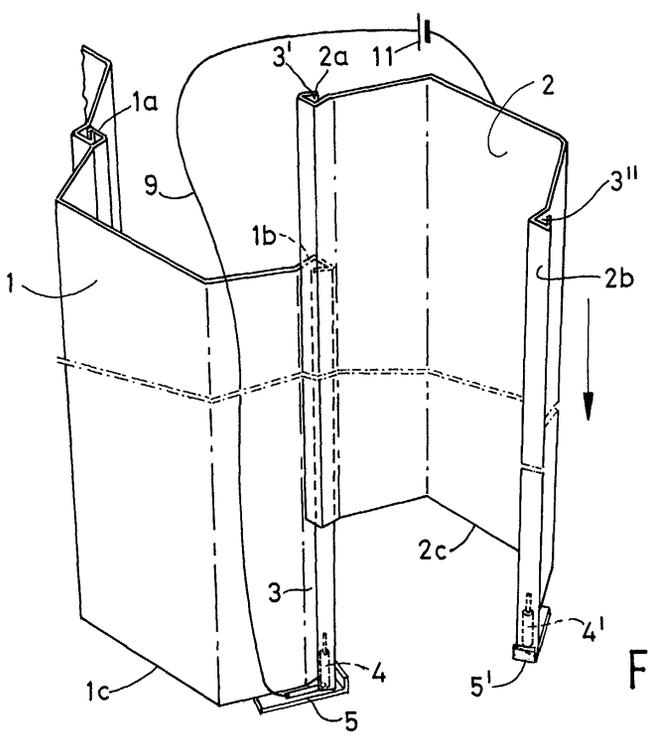

FIG. 2

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Description

[0001] The invention relates to a method for monitoring the interlocking engagement of sheet piles driven into the ground, which slidably engage each other with their profiled longitudinal edges.

[0002] The invention furthermore relates to a device for monitoring the interlocking engagement of sheet piles driven into the ground, which slidably engage each other with profiled longitudinal edges, according to the method according to the invention.

[0003] The installation of sheet pile walls, in which successive sheet piles engaging each other with their profiled longitudinal edges are driven or vibrated into the ground, is generally known and used, for example, for constructing campsheds along waterways so as to make the campshed watertight. Sheet pile walls are also installed for the purpose of isolating polluted soil and ground water, the latter in the case of groundwork, for example, such as the construction of sewers or tunnels, when ground water must not interfere with the work and hinder the workers.

[0004] The metal sheet piles, which are provided with profiled longitudinal edges, are usually driven into the ground one by one by means of a crane and a vibrating or pile driving device, in which the profiled longitudinal edges of a sheet pile to be installed and a sheet pile already installed interlock.

[0005] When the abutting sheet piles properly mate, i.e. when the profiled longitudinal edges interlock along the entire length, a sheet pile wall thus obtained will generally exhibit the desired degree of watertightness. In practice, however, situations frequently occur in which the engagement between a sheet pile which is being driven into the ground and the adjacent sheet pile, which is already present in the ground, is lost near the lower transverse edge thereof. Experts call this a sheet pile "moving out of its lock".

[0006] The known proposals for monitoring the proper interlocking engagement of sheet piles along their entire length can be divided into mechanical and electronic monitoring systems. An example of a mechanical monitoring system comprises a detection wire, which is connected to a pin that is passed through the profile near the lower transverse edge. The pin and the detection wire are driven into the ground together with the sheet pile in question, after which the pin and/or the detection wire are severed or otherwise destroyed by the next sheet pile in the situation in which the sheet piles interlock along their entire length. The rupture of the detection wire can be detected in various ways, for example by pulling up the wire. Such rupture detection is for example demonstrated in NL-93/01636.

[0007] Another mechanical monitoring system, which employs a detection wire, is demonstrated in NL-94/02032. In this system, the detection wire is carried along by the lower transverse edge of the next sheet pile and tensioned by said edge.

[0008] Such monitoring systems employing a detection wire are not 100% accurate, however, since the rupture of the detection wire may also be caused by other factors, for example by obstacles that are present in the ground when the sheet pile is being driven into the ground. In such a situation it is impossible to establish with certainty whether the sheet piles actually interlock along their entire length.

[0009] One application of an electronic monitoring system employs electromagnetic sensors, which detected a change in an applied magnetic field caused by the passage of the lower transverse edge of the next sheet pile. Another electronic monitoring system is based on the interruption of a circuit caused by the rupture of an electrical conductor by the lower transverse edge of the next sheet pile.

[0010] Whereas the use of sensors makes the monitoring system costly and complicated, whilst in addition regular calibration is required (in connection with the composition of the soil), the latest electronic application has this drawback that - analogously to the mechanical detection wire - the rupture of the electrical conductor may be caused by factors other than the sheet pile to be installed.

[0011] Consequently it is the object of the invention to provide a monitoring system which, in contrast to the known monitoring systems, make's it possible to monitor the full interlocking engagement of sheet piles in the ground with a significantly greater degree of accuracy. In order to accomplish that objective, the method is according to the invention characterized in that a contact element comprising an upwardly extending conductor is fitted in the profile of a sheet pile to be installed, near the lower transverse edge thereof, wherein, after the sheet pile has been installed, the conductor is connected, via a power source, to a next sheet pile joining the sheet pile already installed, and if the profiled longitudinal edges of the two sheet piles interlock along the entire length of the sheet piles, the lower transverse edge of the next sheet pile will be brought into electric contact with said contact element.

[0012] The monitoring system according to the invention is based on the closing of a circuit by the next sheet pile to be installed, which closing can be detected in various ways. In contrast to the current monitoring systems, the failure of said circuit to close is a direct indication that the two sheet piles in the ground do not fully interlock. Such a system rules out the possibility of all kinds of incorrect conclusions being drawn, therefore, for example in the situation as described above when the rupture of the detection wire is caused by a different factor.

[0013] One embodiment of a monitoring device for carrying out the method according to the invention is characterized in that the device comprises a metal pin extending into the profile of a sheet pile already installed, in which the pin can be connected, via an electrical, upwardly extending conductor and a power source, to a next sheet pile to be connected to the sheet

pile that is are ready present, in such a manner that the lower transverse edge of said next sheet pile can be brought into electric contact with said pin in the case of a full interlocking engagement between the sheet piles.

[0014] In order to obtain a more accurate operation of the device according to the invention, at least one covering consisting of an electrically insulating material surrounds the metal pin. The pin provided with a covering may be accommodated in a length of pipe extending into the profile.

[0015] Preferably, said covering is a length of hose made of silicone rubber, which can be fitted round the pin; more in particular, said covering consists of two lengths of hose made of different materials, which are slid into each other.

[0016] In a very functional embodiment of the device according to the invention, the length of pipe is arranged on a flange which can be fixed to the lower transverse edge of the sheet pile. As a result, a more robust construction is obtained, so that the device will be affected less by the vibrations and the shocks to which it is exposed when the pile is being driven into the ground, which has a positive effect on the functionality of the device and consequently reduces the risk of damage and failure. In addition, the flange screens the profile of the longitudinal edge accommodating the contact pin, so that there will be no risk of soil accumulating in the profile upon installation of the pile and damage being caused to the contact pin.

[0017] Additional protection, as well as a possibility of fixing the flange to the lower transverse edge of the sheet pile, for example by welding, is obtained in that, in accordance with the invention, the flange comprises an upwardly bent portion extending beyond the longitudinal edge of the sheet pile. Said flange may be provided with a pull relief device for the electrical conductor on its upwardly facing side,

[0018] According to the invention, in order to prevent damage to the current-carrying conductor, and in particular in order to prevent rupture of the conductor and consequent failure of the device, the current-carrying conductor is passed through a pipe fixed to the sheet pile.

[0019] The invention also relates to a sheet pile fitted with the device according to the invention.

[0020] The invention will now be explained in more detail with reference to the drawing, which drawing successively shows in:

Figure 1 side elevation of a sheet pile wall built up from sheet piles;

Figure 2 view of a sheet pile, near the lower transverse edge thereof, which sheet pile is fitted with an embodiment of the device according to the invention; and in

Figures 3A and 3B are views of the device as shown in Figure 2.

[0021] Figure 1 shows a sheet pile wall built up from sheet piles 1 and 2, respectively, in which the sheet piles are installed in the ground with their profiled longitudinal edges 1b and 2a, respectively, interlocking. The sheet pile 2 has not been driven into the ground completely yet, for example by means of a crane (not shown) and a pile driving and/or vibrating device. The interlocking of adjacent sheet piles takes place by means of the profiled longitudinal edges 1a, 1b, 2a and 2b that are shown in Figure 2. The sheet piles 1 and 2, which preferably have a specific shape (a U-shape in this situation), have complementary longitudinal edges which, when slid into each other, are capable of forming a watertight sheet pile wall.

[0022] Figure 2 shows an embodiment of a monitoring system according to the invention, which functions to signal the interlocking engagement along their entire length of the two profiled longitudinal edges 1b and 2a, respectively. The device according to the invention for monitoring the interlocking engagement of said two profiled longitudinal edges comprises a contact pin 4, which can extend into the lock 3 formed by the profile 1b. The device furthermore comprises a flange 5, which can be fixed to the lower transverse edge 1c of the sheet pile 1, for example by welding.

[0023] Referring to Figures 3A and 3B, the contact pin 4 is accommodated in a length of pipe 8, which is welded to the flange 5 at A. The contact pin 4 is provided with an electrical conductor 9, which is passed to the upper side via a pull relief device 10, at which upper side it can be connected to the next sheet pile 2 (see Figure 2) via a power source 11. When the next sheet pile 2 is being driven of vibrated into the ground, with the profiled longitudinal edge 2a slidably engaging the profiled longitudinal edge 1b of the sheet pile 1 already installed, the lower transverse edge 2c will make contact with the contact pin 4 that is accommodated in the lock 3 of the profiled longitudinal edge 1b, thus closing the circuit being formed, if the two profiled longitudinal edges 1b and 2a remain in interlocking engagement along their entire length. Said closing of the circuit can be established in a suitable manner, for example by means of a signalling element incorporated in the circuit, for example a lamp or a loudspeaker (not shown).

[0024] In order to prevent the contact pin 4 making electric contact with the profiled longitudinal edge 1b of the sheet pile 1, said contact pin is according to the invention surrounded by a covering 7a (see Figures 3A and 3B), which covering is preferably made of an electrically insulating material, more in particular silicone rubber. Thus, the circuit can only be closed as a result of the lower transverse edge 2c of the sheet pile 2 coming into contact with the contact pin 4.

[0025] With a view to obtaining a somewhat robust construction, and also with a view to fitting the contact pin 4 in the lock 3 of the profile 1b in a simpler manner, the contact pin 4 provided with the covering 7a is accommodated in a length of pipe 8 which is fixed to the flange 5. The length of pipe 8 is provided with an opening

at the location indicated at 8a and the flange 5, at which opening the current-carrying conductor 9 provided with a covering 7b is connected to the contact pin 4. Because the length of pipe 8, in which the contact pin 4 provided with a covering 7a and the current-carrying conductor 9 are accommodated, are according to the invention fixed to the flange 5 at A, preferably by welding, the covering 7b must not only be flexible but also heat-resistant. Said flexible, heat-resistant covering 7b may cover the entire contact pin 4, but it is also possible for the covering 7b to blend into another type of covering 7a in the direction of the free end of the contact pin 4, which covering 7a will be arranged round the covering 7b in that case.

[0026] The essence of the invention is comprised in the fact that when the sheet pile 2 is being driven into the ground, the lower end edge 2c will come into contact with the covered contact pin 4 if the two profiled longitudinal edges 1b and 2a interlock along their entire length, and damage the covering 7a to such an extent that an electric circuit will be closed. The closing of the circuit can be detected by suitable means, for example a lamp or a loudspeaker. When such signalling fails to occur, this is a direct indication that the circuit is not closed and that consequently the profiled longitudinal edge 2a of the sheet pile 2 does not interlock along the entire length with the profiled longitudinal edge 1b of the sheet pile 1 already installed. In other words, it can be concluded therefrom that a watertight connection between the two successive sheet piles has not been obtained. The sheet pile 2 will have to be pulled out of the ground, therefore, and a new sheet pile 2 will have to be installed.

[0027] With this monitoring device according to the invention, the interlocking engagement of the two sheet piles can be monitored with greater accuracy than is possible with the applications that have been known so far.

[0028] Preferably, the flange 5 as shown in Figure 2 is fixed to the lower transverse edge 2c and the profile 1b of the sheet pile 1, more in particular by welding. The flange 5 protects the current-carrying conductor 9 as well as the contact pin 4 extending into the lock 3 of the profiled longitudinal edge 1b, in particular while the sheet pile 1 is being driven into the ground. Thus it is possible to prevent damage being caused to the current-carrying conductor and to the contact pin 4 upon driving the sheet pile 1 into the ground, which might result in an inaccurate operation of the monitoring system.

[0029] More in particular, the current carrying conductor is passed to the upper side through a pipe which is welded to the sheet pile 1. In particular, this latter measure prevents unhoped-for damage to or rupture of the electrical conductor 10, which would inevitably cause the monitoring system not to function any more. In addition to the length of pipe 8, the bent part 6 of the flange 5 functions as an additional means of protection for the contact pin 4. Said bent part 6 extends beyond the profiled longitudinal edge 1a of the sheet pile 1, as is shown in Figure 3B. The bent part 6 can be fixed to the sheet pile 1 by welding, thus providing additional strength and protection when the sheet pile 1 is being driven into the ground.

[0030] As is shown in Figure 2, the sheet pile 2 is fitted with a corresponding version of the monitoring device according to the invention near the transverse edge 2c and the profiled longitudinal edge 2b. The contact pin 4' is accommodated in the lock 3" of the profiled longitudinal edge 2b. A corresponding flange 5' is welded to the lower side of the transverse edge 2c.

[0031] The device for monitoring the interlocking engagement of two sheet piles can be constructed in a very simple manner and comprises a minimum number of parts. In addition to that, the device is of a very robust construction, which further guarantees the proper functioning thereof, even under the most severe conditions to which it is exposed when the sheet pile is being driven into the ground.

Claims

1. A method for monitoring the interlocking engagement of sheet piles driven into the ground, which slidably engage each other with their profiled longitudinal edges, **characterized in that** a contact element comprising an upwardly extending conductor is fitted in the profile of a sheet pile to be installed, near the lower transverse edge thereof, wherein, after the sheet pile has been installed, the conductor is connected, via a power source, to a next sheet pile joining the sheet pile already installed, and if the profiled longitudinal edges of the two sheet piles interlock along the entire length of the sheet piles, the lower transverse edge of the next sheet pile will be brought into electric contact with said contact element.

2. A device for monitoring the interlocking engagement of sheet piles driven into the ground, which slidably engage each other with profiled longitudinal edges, according to the method according to the invention, **characterized in that** the device comprises a metal pin extending into the profile of a sheet pile already installed, in which the pin can be connected, via an electrical, upwardly extending conductor and a power source, to a next sheet pile to be connected to the sheet pile that is are ready present, in such a manner that the lower transverse edge of said next sheet pile can be brought into electric contact with said pin in the case of a full interlocking engagement between the sheet piles.

3. A device according to claim 2, **characterized in that** at least one covering consisting of an electrically insulating material surrounds the metal pin.

4. A device according to claim 3, **characterized in that** the pin provided with a covering is accommodated in a length of pipe extending into the profile.

5. A device according to claim 3 or 4, **characterized in that** said covering is a length of hose made of silicone rubber, which can be fitted round the pin.

6. A device according to claim 5, **characterized in that** said covering consists of two lengths of hose made of different materials, which are slid into each other.

7. A device according to any one or more of the claims 4 - 6, **characterized in that** the length of pipe is arranged on a flange which can be fixed to the lower transverse edge of the sheet pile.

8. A device according to claim 7, **characterized in that** the flange comprises an upwardly bent portion extending beyond the longitudinal edge of the sheet pile.

9. A device according to claim 7 or 8, **characterized in that** said flange is provided with a pull relief device for the electrical conductor on its upwardly facing side.

10. A device according to claim 2, **characterized in that** the current-carrying conductor is passed through a pipe fixed to the sheet pile.

11. A sheet pile fitted with the device according to any one or more of the claims 2 - 10.

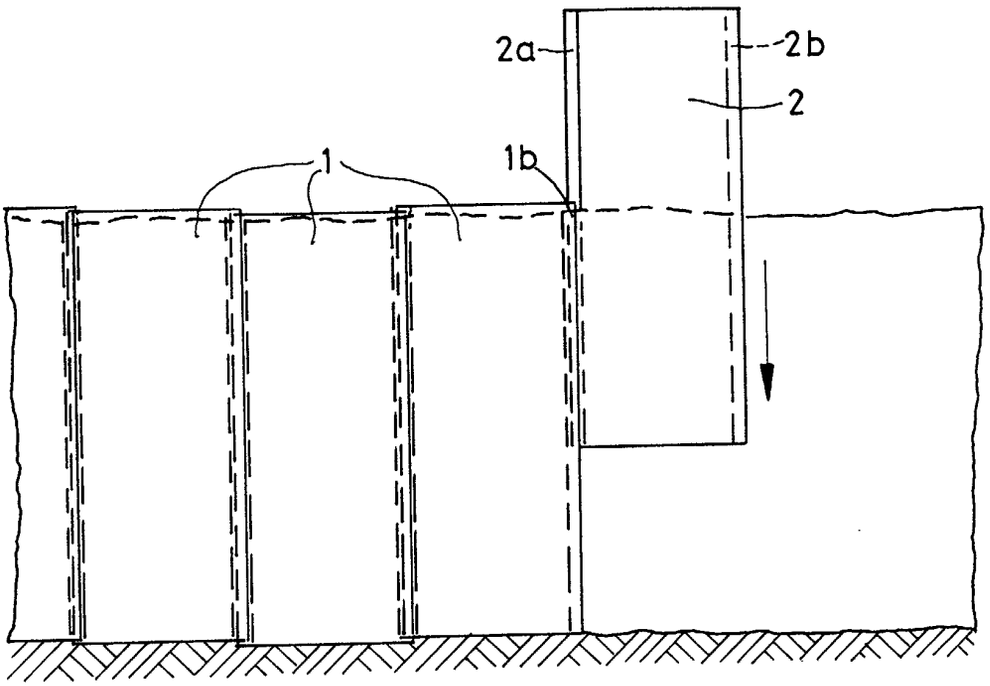

FIG. 1

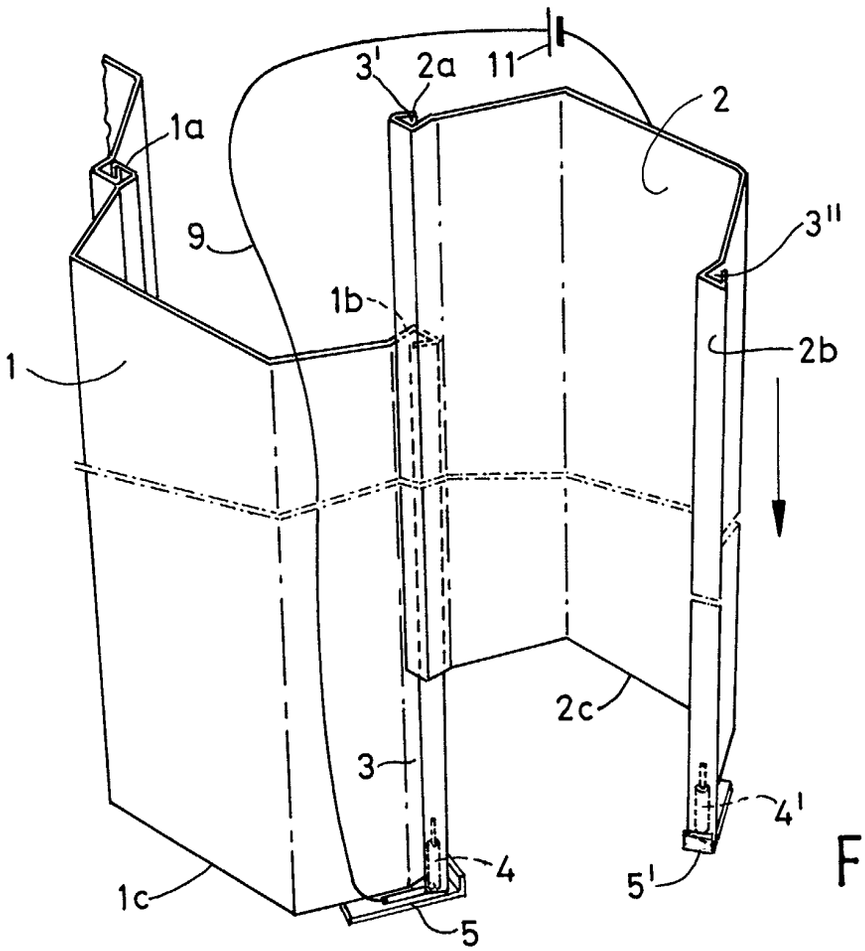

FIG. 2

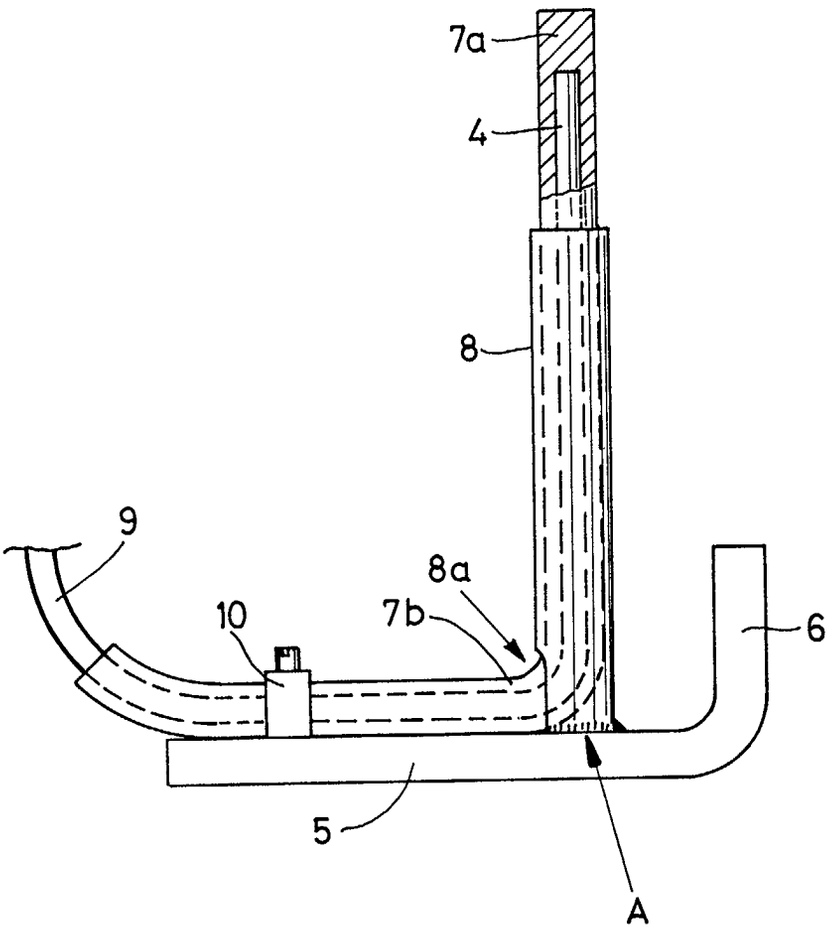

FIG. 3A

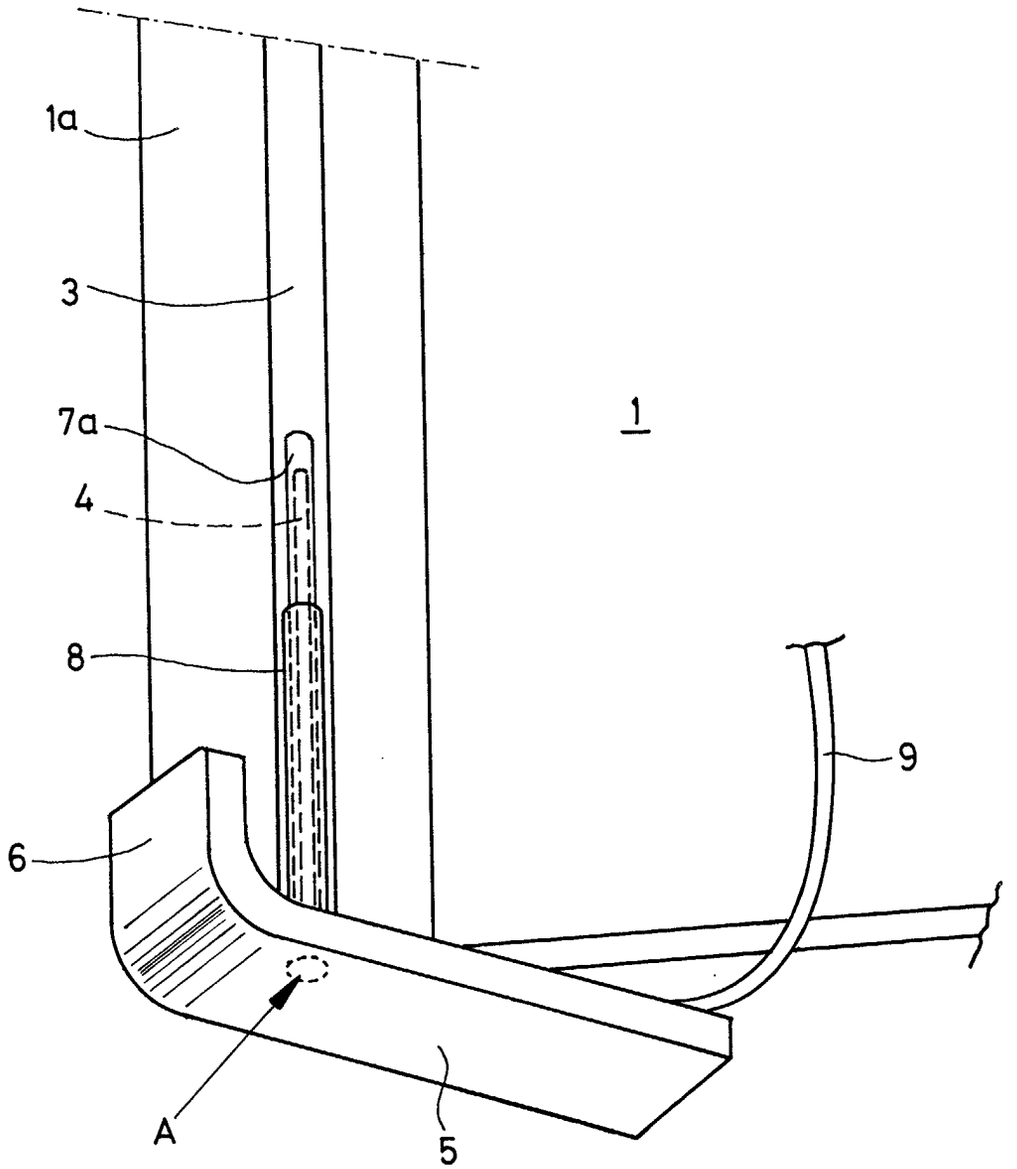

FIG. 3B

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 07 7738

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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)
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			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			E02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	4 November 2002	De Neef, K

CATEGORY OF CITED DOCUMENTS

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