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(54) **A METHOD AND A TOOL FOR REMOVING GROUT OF A TOP END OF A GROUT ANCHOR UNDER WATER**

(57) A method for removing grout of a top end of a grout anchor under water;

wherein a wet diving bell type tool is used, comprising: a cylindrical wall (101) having a top end and a bottom end, and a top wall (102) at the top end for closing the opening of the cylindrical wall; and a plurality of high pressure water nozzles (106) mounted to the cylindrical wall near the bottom end thereof, which plurality of nozzles is distributed along the circumference of the cylindrical wall and the openings of the nozzles are directed towards the axis of the cylindrical wall; wherein the inner diameter of the cylindrical wall and the diameter of a circle through the openings of the plurality of nozzles is larger than the diameter of the grout anchors; wherein for each top end of the grout anchors that has to be removed, the method comprises the following steps: lowering the wet diving bell in the water over the top end of a respective grout anchor such that the nozzles are directed at a part of the grout of the grout anchor to be removed; ensuring that the lower part of the diving bell up to and including the plurality of nozzles is filled with a gas; pumping a fluid under high pressure through the plurality of nozzles against the grout in order to break the grout in pieces.

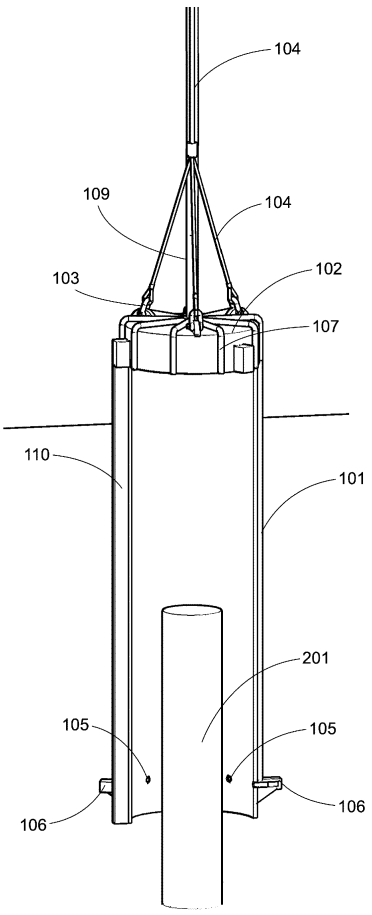

Fig. 2

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Description

[0001] The present invention relates to a method for removing grout of a top end of a grout anchor under water.

[0002] Grout anchors are anchoring elements for construction pit walls and floors, quay structures. These tension elements consist of a steel tube, rod or strand (a so-called GEWI anchor), embedded in grout that is injected into the ground. The rod is embedded in a cylinder of grout over a length of for instance 4 to 6 m. The grout cylinders typically have a diameter of 300 - 400 mm. The tensile force is derived from the shear stress between the grout body and the surrounding soil. A hollow drill tube is inserted into the ground and acts as a casing. When the desired depth is reached, the anchor rod is slid into the tube. Then grout, a mixture of cement and water, is injected between the anchor rod and the casing. The casing is gradually withdrawn, filling the space that is released with the injected grout. This creates the grout body, which can absorb the tensile forces. Once the grout body has cured sufficiently the anchor can be tensioned on an anchor plate and/or a purlin.

[0003] When a concrete floor is constructed under water, for instance for a car parking, a plurality of grout anchors for anchoring the floor in the underwater bottom ground are produced in the above mentioned manner. It is ensured that the top ends of the grout anchors are well in or above the level of concrete floor that will be cast, and after the curing of the grout and removing the casing it may appear that each grout anchor has a different height. The excess length of grout at the top end of each grout anchor, which may be a length of about 1 meter or more, has to be removed. This is usually done under water by professional divers with pneumatic or hydraulic tools, which is a costly and difficult task.

[0004] The invention aims at providing an easier, faster and/or cheaper method for removing the top ends of grout anchors under water.

[0005] To this end, a method according to the preamble is characterized in that a wet diving bell type tool is used, comprising:

> a cylindrical wall having a top end and a bottom end, and a top wall at the top end for closing the opening of the cylindrical wall; and
> a plurality of high pressure water nozzles mounted to the cylindrical wall near the bottom end thereof, which plurality of nozzles is distributed along the circumference of the cylindrical wall and the openings of the nozzles are directed towards the axis of the cylindrical wall;
> wherein the inner diameter of the cylindrical wall and the diameter of a circle through the openings of the plurality of nozzles is larger than the diameter of the grout anchors;

wherein for each top end of the grout anchors that has to be removed, the method comprises the following steps:

> lowering the tool in the water over the top end of a respective grout anchor such that the nozzles are directed at a part of the grout of the grout anchor to be removed;
> ensuring that at least the lower part of the tool up to and including the plurality of nozzles is filled with a gas;
> pumping a fluid under high pressure through the plurality of nozzles against the grout in order to break the grout in pieces;
> if necessary, moving the tool up or down to remaining parts of the grout of the grout anchor to be removed.

[0006] By creating a water free gas environment around the grout to be removed and aiming the high pressure water jets from the nozzles at the grout, the grout is efficiently broken into pieces for removal.

[0007] Preferably, the fluid is water and/or the gas is air.

[0008] Preferably, during the pumping of fluid through the plurality of nozzles the gas, such as air, is pumped into the interior of the tool to ensure that the lower part of the tool up to and including the plurality of nozzles remains filled with a gas.

[0009] Preferably, the pressure of the pumped fluid is at least 200 bar, more preferably at least 600 bar, most preferably at least 1200 bar.

[0010] Preferably, the amount of fluid flow from each nozzle is at least 7 l/min, more preferably at least 15 l/min, most preferably at least 25 l/min.

[0011] Preferably, the inner diameter of the cylindrical wall is between 350 mm and 1.000 mm.

[0012] Preferably, the inner height of the cylindrical wall is between 2 and 5 meter, preferably between 2.5 and 3.5 m.

[0013] According to a favourable embodiment, the nozzles are mounted against the outer surface of the cylindrical wall.

[0014] Thereby they do not form obstacles inside the cylindrical wall when lowering the tool over the grout anchor.

[0015] Preferably, the tool is provided with ballast elements having a weight chosen so as to ensure that the tool will sink when it is at least partially or fully filled with gas.

[0016] Preferably, the tool is provided with fluid conduits between each of the nozzles and a central fluid conduit coupler located near the top end of the cylindrical wall or on the top wall.

[0017] Preferably, The tool is provided with a camera near the top end of the cylindrical wall and under the top wall, for inspecting the progress of removal of the grout.

[0018] The present invention also relates to a wet diving bell type tool, comprising:
a cylindrical wall having a top end and a bottom end, and a top wall at the top end for closing the opening of the cylindrical wall;

wherein the tool further comprises:
a plurality of high pressure water nozzles mounted to the cylindrical wall near the bottom end thereof, which plurality of nozzles is distributed along the circumference of the cylindrical wall and the openings of the nozzles are directed towards the axis of the cylindrical wall.

[0019] Finally, the present invention relates to use of a wet diving bell type tool in accordance with the previous claim, wherein the tool is used for removing grout of a top end of a grout anchor under water.

[0020] The present invention will now be illustrated with reference to the drawing where

Fig. 1 shows a perspective view of a wet diving bell type tool for removing grout of a top end of a grout anchor;
Fig. 2 shows a partially open perspective view of the tool of figure before removing the grout of the grout anchor; and
Fig. 3 shows a partially open perspective view of the tool of figure after removing the top end of grout of the grout anchor.

[0021] According to the figures, an embodiment of a tool for removing grout of the top end of a grout anchor comprises a wet diving bell type body comprising a cylindrical wall 101 and a top wall 102 that closes the top opening of the cylindrical wall 101. The height of the cylindrical wall 101 is for instance 3 meter and the inner diameter is for instance 500 mm, but this may be adapted in accordance with the excess height of the grout anchors, and the diameter thereof.

[0022] The top wall 102 is provided with (for instance three) hoisting eyes 103, to which hoist cables 104 may be attached.

[0023] Near the bottom circumference of the cylindrical wall 101 a multitude (for instance 10) of holes 105 are provided in the cylindrical wall 101, distributed about the circumference of the cylindrical wall. At each hole 105 a nozzle 106 is mounted against the outer surface of the cylindrical wall 101 such that the outlet openings of the nozzles 106 are directed through the holes 105 to the axis of the cylindrical wall 101.

[0024] Fluid conduits 107 are mounted to the outer surface of the cylindrical wall 101 and the top wall 102, which each connect a nozzle 106 with a central fluid conduit coupler 108 on the top wall 102. A high pressure fluid hose 109 is (preferably detachably) coupled to the coupler 108.

[0025] The outer surface of the cylindrical wall 101 is provided with vertical beams or ballast elements 110 which add sufficient weight to the tool so that it will sink sufficiently deep into the water if the wet diving bell tool is filled with air.

[0026] As shown in figure 2 the tool is sunk into the water by means of a crane over the top end of a grout anchor 201. It is ensured that air the interior of the tool, or at least the lower part thereof is filled with air. If the tool is not provided with an air inlet/outlet opening the interior will stay filled with air when lowering the tool in the water. However, to ensure that the nozzles stay free from the water level, an air inlet/outlet opening (not shown) is provided in the top part of the tool, for instance in the top end wall, to which hole a hose and an air pump may be connected. Once placed over the anchor, the diving bell is filled with air to repress the water from it. An abundance of pressurized air is constantly added to keep the diving bell free from water. Water is then pumped through the hose 109, the conduits 107 and the nozzles 106, under high pressure of for instance between 1.000 and 1.550 bar at 28 liter per minute for each nozzle, against the grout anchor 201. This will break the grout and the grout pieces will fall off and/or may be removed easily later.

[0027] This is continued while moving the tool up and/or down until all the grout is removed from the top end of the GEWI anchor rod 301 as shown in figure 3. This process may be monitored by operators by means of one or more cameras which may be mounted inside the tool, for instance against the top wall.

[0028] The invention has thus been described by means of a preferred embodiment. It is to be understood, however, that this disclosure is merely illustrative. Various details of the structure and function were presented, but changes made therein, to the full extent extended by the general meaning of the terms in which the appended claims are expressed, are understood to be within the principle of the present invention. The description and drawings shall be used to interpret the claims. The claims should not be interpreted as meaning that the extent of the protection sought is to be understood as that defined by the strict, literal meaning of the wording used in the claims, the description and drawings being employed only for the purpose of resolving an ambiguity found in the claims. For the purpose of determining the extent of protection sought by the claims, due account shall be taken of any element which is equivalent to an element specified therein. An element is to be considered equivalent to an element specified in the claims at least if said element performs substantially the same function in substantially the same way to yield substantially the same result as the element specified in the claims.

Claims

1. A method for removing grout of a top end of a grout anchor under water;

   wherein a wet diving bell type tool is used, comprising:

   a cylindrical wall having a top end and a bottom end, and a top wall at the top end for closing the opening of the cylindrical wall; and

a plurality of high pressure water nozzles mounted to the cylindrical wall near the bottom end thereof, which plurality of nozzles is distributed along the circumference of the cylindrical wall and the openings of the nozzles are directed towards the axis of the cylindrical wall;
wherein the inner diameter of the cylindrical wall and the diameter of a circle through the openings of the plurality of nozzles is larger than the diameter of the grout anchors;

wherein for each top end of the grout anchors that has to be removed, the method comprises the following steps:

lowering the tool in the water over the top end of a respective grout anchor such that the nozzles are directed at a part of the grout of the grout anchor to be removed;
ensuring that at least the lower part of the tool up to and including the plurality of nozzles is filled with a gas;
pumping a fluid under high pressure through the plurality of nozzles against the grout in order to break the grout in pieces;
if necessary, moving the tool up or down to remaining parts of the grout of the grout anchor to be removed.

2. The method according to claim 1, wherein the fluid is water and/or the gas is air.

3. The method according to claim 1 or 2, wherein during the pumping of fluid through the plurality of nozzles the gas, such as air, is pumped into the interior of the tool to ensure that the lower part of the tool up to and including the plurality of nozzles remains filled with a gas.

4. The method according to any of the preceding claims, wherein the pressure of the pumped fluid is at least 200 bar, more preferably at least 600 bar, most preferably at least 1200 bar.

5. The method according to any of the preceding claims, wherein the amount of fluid flow from each nozzle is at least 7 l/min, more preferably at least 15 l/min, most preferably at least 25 l/min.

6. The method according to any of the preceding claims, wherein the inner diameter of the cylindrical wall is between 350 mm and 1.000 mm.

7. The method according to any of the preceding claims, wherein the inner height of the cylindrical wall is between 2 and 5 meter, preferably between 2.5 and 3.5 m.

8. The method according to any of the preceding claims, wherein the nozzles are mounted against the outer surface of the cylindrical wall.

9. The method according to any of the preceding claims, wherein the tool is provided with ballast elements having a weight chosen so as to ensure that the tool will sink when it is at least partially or fully filled with gas.

10. The method according to any of the preceding claims, wherein the tool is provided with fluid conduits between each of the nozzles and a central fluid conduit coupler located near the top end of the cylindrical wall or on the top wall.

11. The method according to any of the preceding claims, wherein The tool is provided with a camera near the top end of the cylindrical wall and under the top wall, for inspecting the progress of removal of the grout.

12. A wet diving bell type tool, comprising:
a cylindrical wall having a top end and a bottom end, and a top wall at the top end for closing the opening of the cylindrical wall;
wherein the tool further comprises:
a plurality of high pressure water nozzles mounted to the cylindrical wall near the bottom end thereof, which plurality of nozzles is distributed along the circumference of the cylindrical wall and the openings of the nozzles are directed towards the axis of the cylindrical wall.

13. Use of a wet diving bell type tool in accordance with the previous claim, wherein the tool is used for removing grout of a top end of a grout anchor under water.

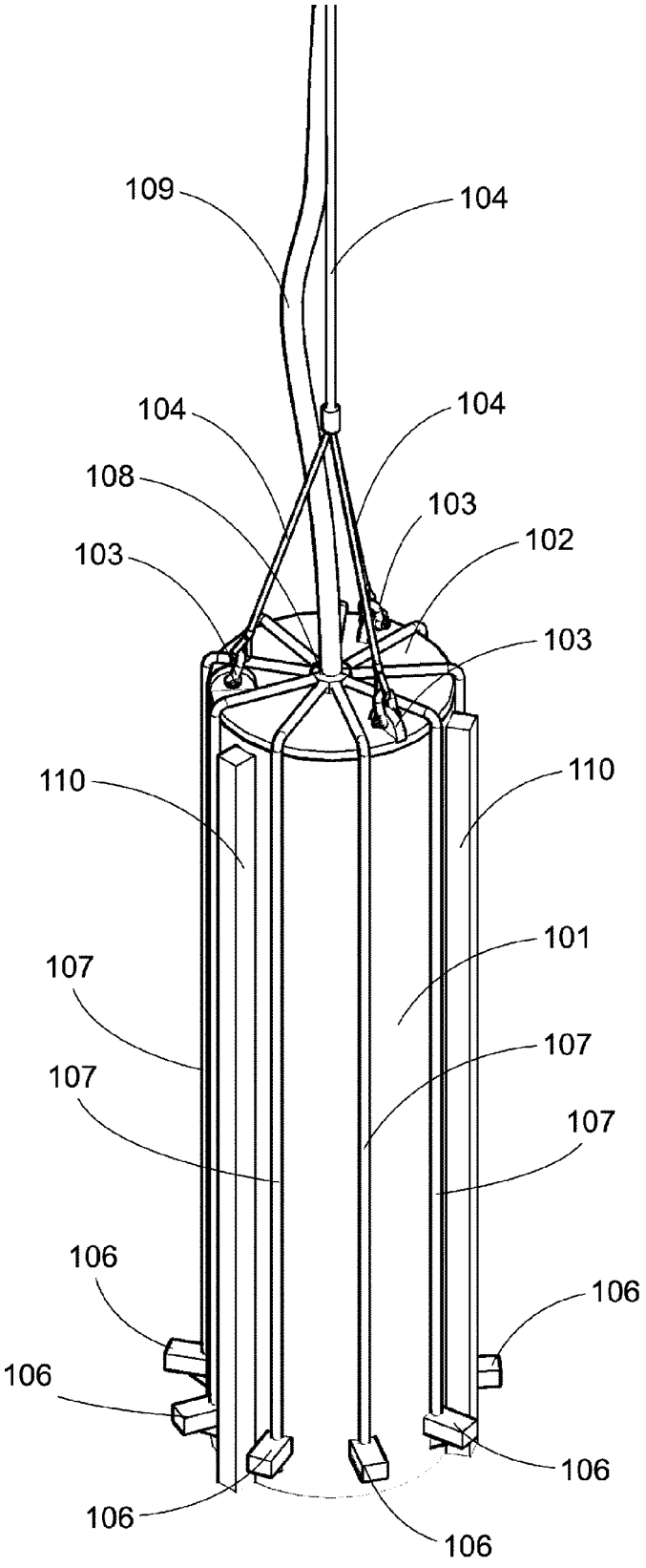
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Fig. 1

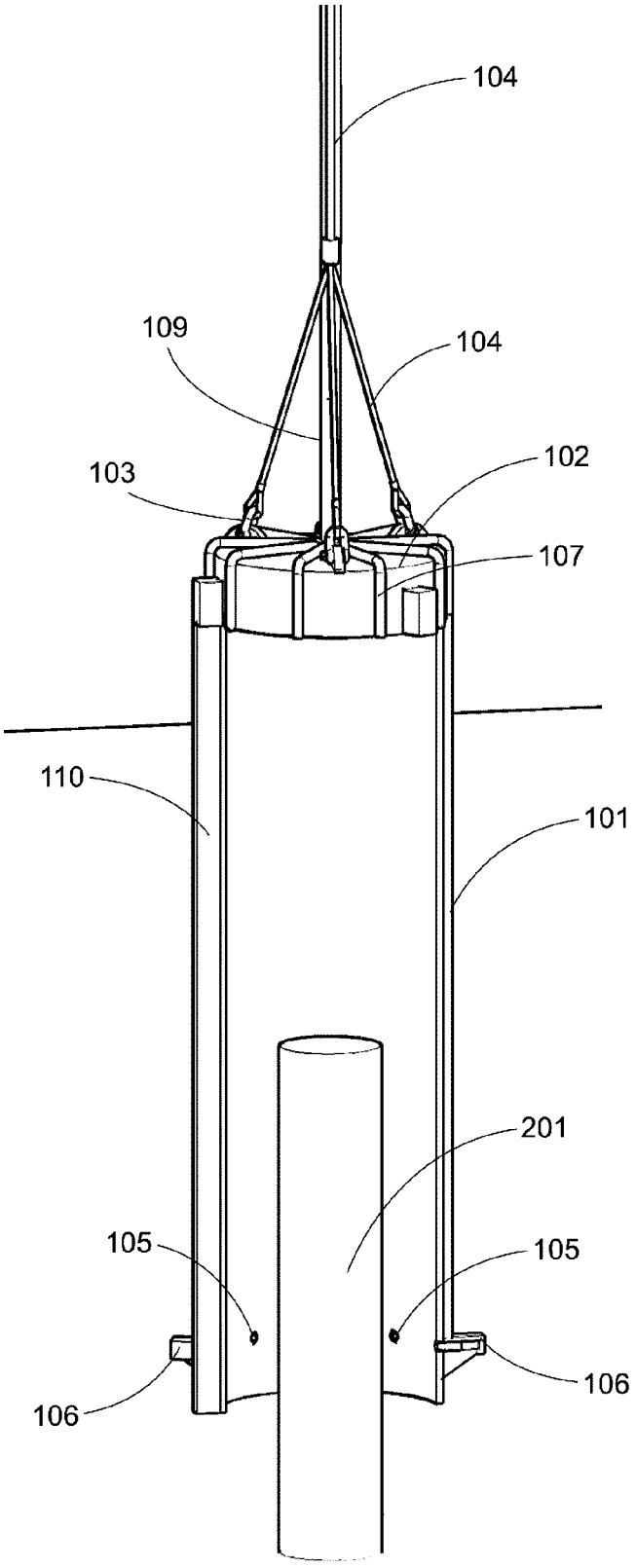

Fig. 2

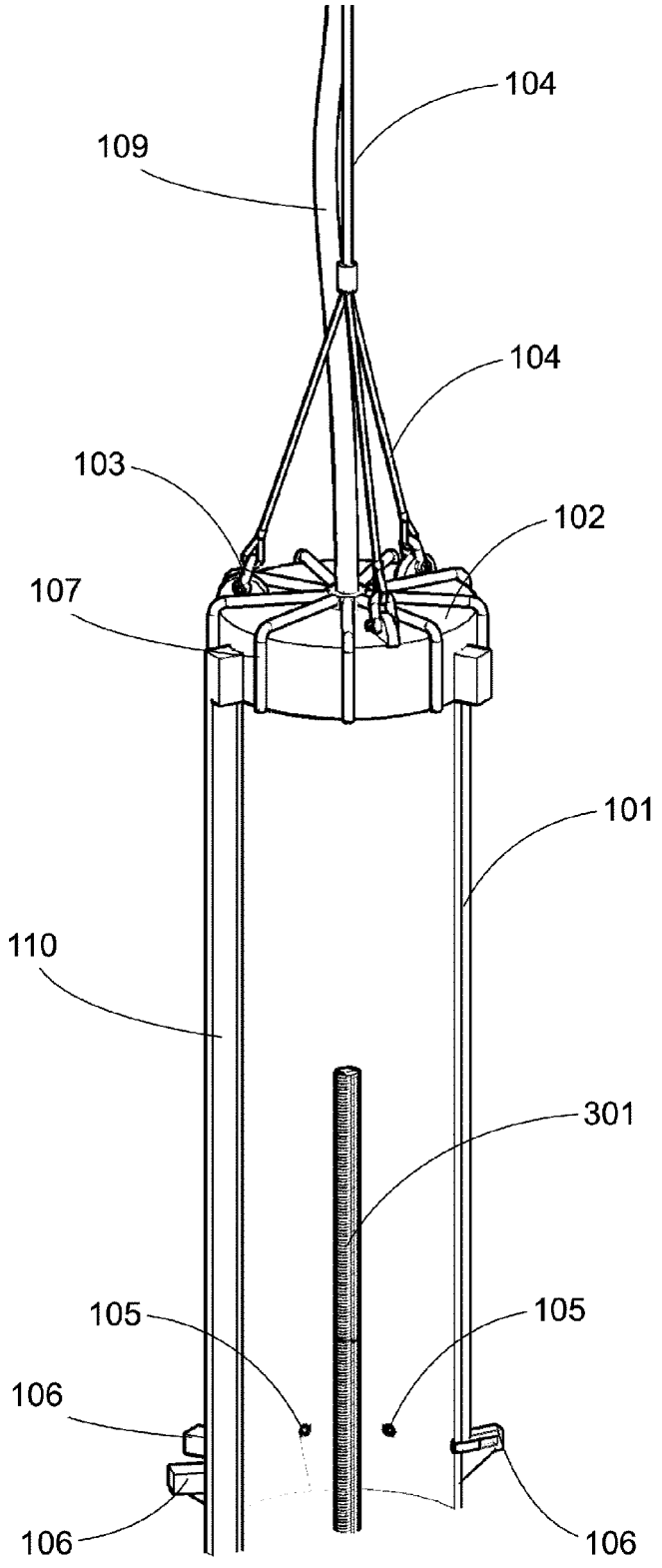

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 6777

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 0 319 204 A1 (SEISAN GIJUTSU CENTER KK [JP]; NIPPON KAGAKU SANGYO KK [JP]) 7 June 1989 (1989-06-07) * col.5, lines 20-57; col. 6, lines 37-45; figures 1-6, 18 *	1-13	INV. E02D27/24 E02D5/80 E02D27/50 E02D27/42 E02D27/52
A	US 4 180 047 A (BERTELSON GEORGE H [US]) 25 December 1979 (1979-12-25) * the whole document *	1-13	E02D5/22 E02D9/00 E02D9/04
A	US 1 644 560 A (EDWARD BIGNELL) 4 October 1927 (1927-10-04) * the whole document *	1-13	
A	US 2009/266552 A1 (BARRA MARC T [US] ET AL) 29 October 2009 (2009-10-29) * the whole document *	1-13	
A	WO 2017/007946 A1 (MIMOUNI NABIL [US]; WILLS RONNIE WAYNE II [US]) 12 January 2017 (2017-01-12) * the whole document *	1-13	
			TECHNICAL FIELDS SEARCHED (IPC)
			E02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	1 August 2023	Patrascu, Bogdan

CATEGORY OF CITED DOCUMENTS

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0319204 A1	07-06-1989	AU 2642388 A	01-06-1989
		CA 1298274 C	31-03-1992
		DE 3874695 T2	29-04-1993
		EP 0319204 A1	07-06-1989
		KR 890010391 A	08-08-1989
		US 4900198 A	13-02-1990
US 4180047 A	25-12-1979	NONE	
US 1644560 A	04-10-1927	NONE	
US 2009266552 A1	29-10-2009	NONE	
WO 2017007946 A1	12-01-2017	CA 2995076 A1	12-01-2017
		EP 3320173 A1	16-05-2018
		US 2018195247 A1	12-07-2018
		US 2019382978 A1	19-12-2019
		WO 2017007946 A1	12-01-2017

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