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(54) Apparatus and Method for the lifting of building foundations

(57) The present invention refers to an apparatus for the operations of preloading and/or lifting of foundations. In particular, said apparatus consists in piles or micro-piles P of metal, each of which is anchored to the structure S through a counterpipe C, external to P, provided with a specific adjustment and locking system R. Moreover, also disclosed in the present description is a method for the lifting of foundations which utilizes said apparatus.

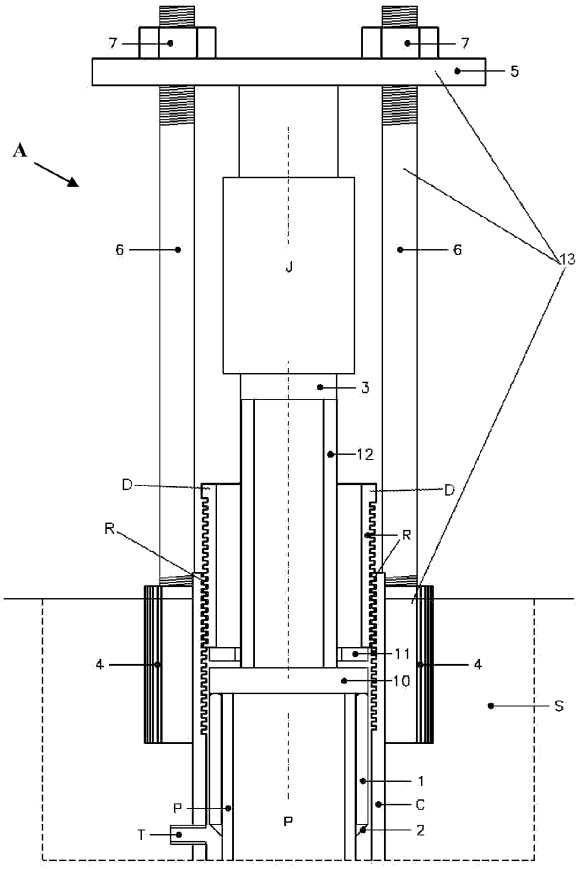

FIG. 5

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Description

FIELD OF THE INVENTION

[0001] The present invention refers to an apparatus and a method for the operations of preloading and/or lifting of structures. In particular, the apparatus comprises at least one pile made integral to the structure through a counterpipe and an adjustment and/or locking system. Moreover, in the present description it is also described a method for operations of preloading and/or lifting of a structure.

STATE OF THE PRIOR ART

[0002] Various systems for the lifting of foundations are described in the state of the art. Basically, they can be told apart by the foundation/subfoundation typologies (direct, deep, rammed piles, bored piles), the technical modes for carrying them out, the costs, the extent of the loads and/or of the attainable lifting, etc.

[0003] U.S. Pat. N. 6,347,489 describes a column for supporting structures, like e.g. houses, comprising lateral adhesion members. Two or more of these columns can be comprised in systems suitable for the lifting of foundations of the building of interest.

[0004] The use of currently available systems, though advantageous, is characterized by a series of operative problems, linked above all to the necessity of being unable to operate in total safety the desired lifting of the structure in plural subsequent steps, even after time has passed. In other words, with the current systems, during a lifting it is not possible to stop operations in order to assess, e.g., the correctness of work done, concomitantly maintaining the result achieved.

[0005] Hence, object of the present invention is to solve the above-mentioned problems, by advancing an apparatus for the operations of preloading and/or lifting of structures as defined in claim 1.

[0006] Preferred features of the present invention are set forth in the respective dependent claims.

[0007] The present invention entails several evident advantages that will be highlighted in the following description.

[0008] In particular, the present invention comprises an adjustment system for adjusting the foundation/subfoundation structure. Such adjustment system allows to easily modulate the preloading and/or lifting into plural steps, according to operative needs. A further advantage consists in the option of carrying out over time new height adjustments, therefore carrying out, when needed, new operations of preloading and/or lifting of foundations, and this also thanks to the reduced external encumbrance of the individual components of the apparatus.

[0009] Other advantages, as well as the features and the operation steps of the present invention will be made apparent in the following detailed description of preferred embodiments thereof, given by way of example and not for limitative purposes. Reference will be made to the figures of the annexed drawings, wherein:

Figure 1A shows a first embodiment of the present invention;
Figures 1B and 1C respectively show a bottom and a top view of a third plate comprised in an embodiment of the apparatus according to the present invention;
Figure 2 illustrates an embodiment in accordance with the apparatus described herein;
Figure 3 illustrates a further embodiment in accordance with the apparatus described herein;
Figures 4A and 4B show shimming rings according to the present invention; and
Figure 5 illustrates a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0010] The present invention generally relates to an apparatus A related to the making of a subfoundation structure onto which an opposing action is to be exerted in order to apply a system of forces needed for the preloading and/or lifting of the structure itself to the desired configuration. Preloading, e.g., may be required to reduce or avoid settlings of foundations, or of the subfoundation, over time, and to cause the latter to react, right from the initial stages of its making.

[0011] To describe the present invention, hereinafter reference will be made to the above-indicated figures.

[0012] The present invention describes an apparatus A for operations of preloading and/or lifting of a structure S. In particular, by the term "structure S" in the present description architectural and/or engineering structures are meant. In other words, the term "structure S" comprises foundations of buildings and of artefacts in general, with reference to both new constructions and already existing constructions affected by settling. Typically, yet without limitation, the structure S is comprised of an element of reinforced concrete which is effectively connected to the main structure to be supported and/or lifted.

[0013] Therefore, the apparatus A is useful, e.g., for the positioning and/or repositioning of the ground height.

[0014] The apparatus A comprises at least one pile P, at least one hollow counterpipe C and at least one actuator J. In particular, the pile P is preferably a structurally solid pile P which is apt to be inserted into the ground where the structure S is present.

[0015] The hollow counterpipe C is made integral to the structure S and positioned externally and coaxially to the pile P. The actuator J is suitable for guaranteeing the applying of a force on said pile P in order to allow the preloading and/or lifting of the structure S. For this purpose, the actuator J is made integral to the structure S.

[0016] The apparatus A of the present invention comprises an adjustment and/or locking device R. In particular, the device R comprises at least one opposing sur-

face 1 integral to the pile P and a thread (internal thread), present internally to the counterpipe C. Moreover, the device R comprises a hollow tubular member D having an external thread.

[0017] The thread internal to the counterpipe C and the thread external to the hollow tubular member D are apt to cooperate therebetween, to thereby allow inserting and adjustment (in height) of the tubular member D onto the counterpipe C, when required. This cooperation, as is evident, makes the hollow tubular member D integral to the counterpipe C. Moreover, the function of the device R being that of stably setting the preloading and/or the lifting of the structure S obtained by applying a force on pile P by means of the actuator J, the tubular member D is positionable, upon ending the preloading and/or lifting operation, into contact with the opposing surface 1.

[0018] Then, the pile P inserted into the ground is anchored to the structure S through the counterpipe C, external to P. The adjustment and/or locking device R is utilized to keep in preloading or lifting position the structure S following the applying of force.

[0019] After the operations of drilling or of driving into the ground, the pile P is stressed by using a thrust system self-opposed with the same counterpipe C, or with the structure S, so as to cause the preloading of P and also attaining an upward reaction that can be enhanced up to the desired lifting of the structure S itself.

[0020] As is evident to a technician in the field, the individual components comprised in the apparatus A may be of any material deemed suitable by the same technician. In a preferred embodiment, said material is metal. Even more preferably, said material is steel. Moreover, on the basis of the knowledge and teachings present in the state of the art, the technician in the field will be able to define, without any effort of inventive activity, the actual dimensions of the individual components according to the extent of loads to be borne in the specific applications. Thus, e.g., the pile P may have any diameter suitable for the implementation of the present invention.

[0021] In a first embodiment of the invention, illustrated in Figure 1A, the pile P is of the driven or drilled type, made (cast) in advance in the construction ground. Pile reinforcement is preferably metallic and, without limitation, comprised of a steel post of diameter and thickness suitable for the loads to be borne, filled or not filled thereinside by a mixture, or a cement mortar, or other suitable material.

[0022] An opposing surface 1, preferably of steel and of adequate thickness, is firmly secured to the pile P, e.g. by means of weldings 2. Moreover, the pile P is inserted into a counterpipe C which, besides being hollow, is made integral to the structure S by means of suitable load-transferring devices (e.g., lands, brackets, etc.). The counterpipe C has, in accordance with the present invention, an internal thread. In a preferred embodiment, such thread may be limited to the upper portion of the counterpipe C. The hollow tubular member D, integral to the pile P, is provided with an external thread, on all or part of its length, and is apt to be screwed/unscrewed inside the threaded portion of the counterpipe C allowing to vary its distance from the opposing surface 1, positioned on the shaft of the pile P.

[0023] In a further embodiment, the apparatus A comprises at least one first plate 3, positionable between the pile P and the actuator J. Preferably, said first plate 3 is of steel and secured (e.g. by welding) to the head of the pile P. Therefore, the arrangement is such as to allow the loading of the pile itself through the applying of an axial force on the first plate 3. In other words, the actuator J applies to the plate 3 a compression urging the pile P bottomward; the pile P, by reaction, causes an upward stressing on the structure S, causing the preloading and/or lifting of the structure S that, according to the present invention, is integral to the apparatus A.

[0024] The tubular member D is hollow thereinside to allow passage of pile P and applying of the preloading and/or lifting force on the first plate 3 by means of the actuator J. Then, upon reaching the desired configuration in terms of force and/or displacement, or in any one intermediate position, the tubular member D of the apparatus A is screwed into the counterpipe C until obtaining contact with the opposing surface 1. This situation is graphically described in Figure 2. Thus, the reaction of pile P is transferred directly to counterpipe C and therefore to structure S. The actuator J may be unloaded for any recovery of the stroke for continuing the operations, or definitively at completion of the works.

[0025] The apparatus A further comprises at least one second plate 10 positionable between said pile P and said actuator J. Moreover, the apparatus A may comprise a solid tubular member 12 positionable between the first plate 3 and the second plate 10. In an embodiment, the opposing surface 1 is integral to the second plate 10. As illustrated in Figure 5, load transfer from J to P may occur by means of a tubular member 12, even having a solid section, contacting the opposing surface 1 by means of a second plate 10, preferably of steel. In this case it might be expedient to provide the adjustment and/or locking device R with a partitioning ring 11.

[0026] In an embodiment, the apparatus A further comprises at least one shimming ring 9 apt to be interposed between the opposing surface 1 and the hollow tubular member D.

[0027] In a specific design mode, yet without being limited thereto, the shimming ring 9 comprises at least two portions apt to be connected therebetween, e.g. by welding.

[0028] As reported in Figure 3, the apparatus A according to the invention may have, should marked lowering of the pile P under load be manifest and/or high extents of lifting be required, one or more shimming rings 9. Therefore, in order to reduce the length of the internal threaded section of the counterpipe C and the overall length of the device R, it is possible to carry out the above-described preloading and/or lifting operations in more stages, making use of shimming rings 9. In this case, the

unthreaded length of the counterpipe C should be adequate to the needs of the technician in the field who, with no need of further technical details being provided herein, will rapidly be able to determine the thickness of the rings 9.

[0029] The shimming rings 9 are depicted in detail in Figures 4A and 4B. Preferably, they are rings 9 of steel, each consisting of two or more parts to allow their insertion into the system when the actuator is active; the individual parts constituting the shimming ring 9 are joined in place by, e.g., welding or other suitable system, like screws, pins, etc., apt to guarantee their stable connection.

[0030] In a preferred embodiment of the present invention, the apparatus A further comprises a system 13 for opposing the force imposed on the pile P by means of the actuator J. Such opposing system 13 comprises at least one third plate 5, at least two bars 6 connectible to the third plate 5, first means for connecting the bars 6 to the third plate 5 and second means for connecting the bars 6 to the counterpipe C.

[0031] In particular, the first connecting means present on the bars 6 preferably comprises a first threaded end portion and corresponding nuts 7 for the securing to the plate 5; whereas the second connecting means comprises at least one sleeve 4 per each bar 6. The sleeve is made integral to the counterpipe C and comprises an internal thread apt to cooperate with a second threaded end portion of the bar 6.

[0032] As shown in Figures 1A and 5, the actuator J is preferably comprised of an oil hydraulic cylinder, opposing on the third plate 5 held by the bars 6 through the bolts 7. The bars 6, arranged as can be intuitively deduced by the technician in the field, adequate in section and number to the specific needs, are secured to the counterpipe C by means of threaded sleeves 4. The opposing system 13 comprised of plate 5, bars 6 and bolts 7 is generally provisional and can also be of a different type, as long as it is suitable to oppose the action which, through the actuator J, has to be applied to the pile P. The connection of the bars 6 to the counterpipe C is of removable type, for easily allowing subsequent installations of the opposing system 13 for any subsequent need, as well as for recovering the components used once operations have ended.

[0033] Once the preloading and/or lifting operations have ended, in case no recalibration is envisaged for the forces and/or heights of the structure S, the opposing system 13, and therefore the individual components 5, 6 and 7 can be removed, mutually constraining the pile P and the counterpipe C in a definitive manner by welding 8.

[0034] Due to encumbrance needs, in case of any reduced thickness available for screeds, etc., the external parts of the apparatus A exceeding the counterpipe C may be cut off, optionally even flush with the head of the counterpipe C itself (see

[0035] Figures 2 and 3).

[0036] To complete the operations, it is advisable to fill the void between the counterpipe C and the pile P. For this reason, in an embodiment, the counterpipe C comprises at least one port T for the inletting of sealing material into the space between the pile P and the counterpipe C. In particular, yet without being limited thereto, the material to be inlet may be, e.g., cement grout or resin.

[0037] All of the configurations described may be employed also to impart tractive forces to the pile P, if so required by specific needs.

[0038] Object of the present description is also a method for operations of preloading and/or lifting of a structure S. The technician in the field is well aware of the required steps to be carried out in order to prearrange an apparatus for the lifting and/or preloading of a general structure of interest. For this reason, in the present description it is left out of consideration any propaedeutical operation such as demolition of non-structural parts, excavations, safety proppings, finishing works, etc., which, obviously, will be suitably evaluated case-wise.

[0039] In currently utilized methods, a detailed geometric and structural survey of the structure is performed in order to allow an accurate evaluation of actions on the foundation, as well as the extent of the lifting and/or preloading needed to bring the structure to the desired position and configuration. In particular, by way of example, hereinafter there are reported the operating steps to be carried out in case the piles P have been included in the ground during the designing of structure S. In case the piles have not been included in the ground, the technician in the field, without any effort of inventive activity, will be able to adapt to his/her specific needs what is reported herebelow.

[0040] Upon making the piles P, which should be designed with features, number and position such as to safely support the loads transmitted by the structure, operations of local excavation are carried out; the piles are stripped and their ends cut to size, applying the opposing surfaces 1, or the plates 10, the tubular members 12 and the plates 3. The counterpipes C are inserted, provided with the adjustment and/or locking devices R which have to be suitably adjusted; then, reinforced concrete works are carried out for connecting the counterpipes C to the existing structure, generally to its foundations, prearranging also all opposing systems 13, when external.

[0041] Upon waiting the curing times of the castings, the opposing systems are locally or globally completed by introducing the plates 5, the bars 6 and the bolts 7, prearranging all required instrumentations apt to monitor the structure in the preloading and/or lifting stages. Then the actuators J, preferably yet without limitation of oil hydraulic type, are installed, preferably constituting groups to be actuated synchronically or asynchronically, and anyhow with studied sequences and stages. I n each stage the groups of actuators J are progressively actuated, providing at the end of each sequence to progressively adjust the locking and/or adjustment devices R so as to carry out all operations in total safety, all according to what has been described in the foregoing for the individ-

ual apparatus of preloading and/or lifting of which at the present invention.

[0042] Upon ending the preloading and/or lifting stages the actuators J are removed and, in case no subsequent height recalibration is envisaged, the plates 5, the bars 6 and the bolts 7 are removed.

[0043] Finally, the tubular members are definitively locked by means of welding and injection of grout and/or resins for sealing the interspace between pile P and counterpipe C, as well as any empty space between foundation/subfoundation and ground.

[0044] Therefore, the method described herein schematically comprises the steps of

- prearranging at least one pile P into the ground, in correspondence of a structure S;
- prearranging at least one hollow counterpipe C integral to the structure S, externally and coaxially to the pile P;
- applying a force on the pile P, for the preloading and/or lifting of the structure S; and
- locking the structure S in a preloading and/or lifting position.

[0045] In a preferred embodiment, the method for operations of preloading and/or lifting of a structure S is characterized in that it utilizes an apparatus A in accordance with what has been described in the foregoing.

[0046] The present invention has been hereto described according to preferred embodiments thereof, given by way of example and not for limitative purposes.

[0047] It is understood that other embodiments might exist, all to be deemed as falling within the protective scope thereof, as defined by the annexed claims.

Claims

1. An apparatus (A) for operations of preloading and/or lifting of a structure (S) comprising:

- at least one pile (P) apt to be inserted into the ground;
- at least one hollow counterpipe (C) integral to said structure (S), external and coaxial to said pile (P);
- at least one actuator (J) made integral to the structure (S) and suitable for applying a force on said pile (P), for the preloading and/or lifting of said structure (S);

characterised in that it comprises an adjustment and/or locking device (R) comprising:

• at least one opposing surface (1) integral to said pile (P);
• a thread internal to said counterpipe (C), and
• a hollow tubular member (D) having an external thread apt to cooperate with said internal thread, making said tubular member integral to the counterpipe (C),

wherein said hollow tubular member (D) is positionable into contact with said opposing surface (1).

2. The apparatus (A) according to claim 1, further comprising at least one first plate (3) positionable between said pile (P) and said actuator (J).

3. The apparatus (A) according to claim 1 or 2, further comprising at least one second plate (10) positionable between said pile (P) and said actuator (J).

4. The apparatus (A) according to claim 3, further comprising a solid tubular member (12) positionable between said first plate (3) and said second plate (10).

5. The apparatus (A) according to claim 3 or 4, wherein said at least one opposing surface (1) is integral to said second plate (10).

6. The apparatus (A) according to any one of the claims 1 to 5, further comprising at least one shimming ring (9) apt to be interposed between said opposing surface (1) and said hollow tubular member (D).

7. The apparatus (A) according to claim 6, wherein said at least one shimming ring (9) comprises at least two portions apt to be connected therebetween.

8. The apparatus (A) according to any one of the claims 1 to 7, wherein said counterpipe (C) comprises at least one port (T) for the inletting of sealing material into a space between said pile (P) and said counterpipe (C).

9. The apparatus (A) according to any one of the claims 1 to 8, further comprising a system (13) for opposing said force, comprising:

- at least one third plate (5);
- at least two bars (6) connectible to said at least one third plate (5);
- first means for connecting said bars (6) to said third plate (5); and
- second means for connecting said bars (6) to said counterpipe (C).

10. The apparatus (A) according to claim 9, wherein said first connecting means comprises a first threaded portion on said bars (6) and corresponding nuts (7).

11. The apparatus (A) according to claim 9 or 10, wherein said second connecting means comprises at least one sleeve (4) per each bar (6), integral to said coun-

terpipe (S), said sleeve (4) comprising an internal thread apt to cooperate with a second threaded portion of said bar (6).

12. A method for operations of preloading and/or lifting of a structure (S) comprising the steps of:

- prearranging at least one pile (P) into the ground in correspondence of said structure (S);
- prearranging at least one hollow counterpipe (C) integral to said structure (S), externally and coaxially to said pile (P);
- applying a force on said pile (P), for the preloading and/or lifting of said structure (S); and
- locking said structure (S) in a preloading and/or lifting position.

13. The method for operations of preloading and/or lifting of a structure (S) according to claim 12, **characterised in that** it utilizes an apparatus (A) according to any one of the claims 1 to 11.

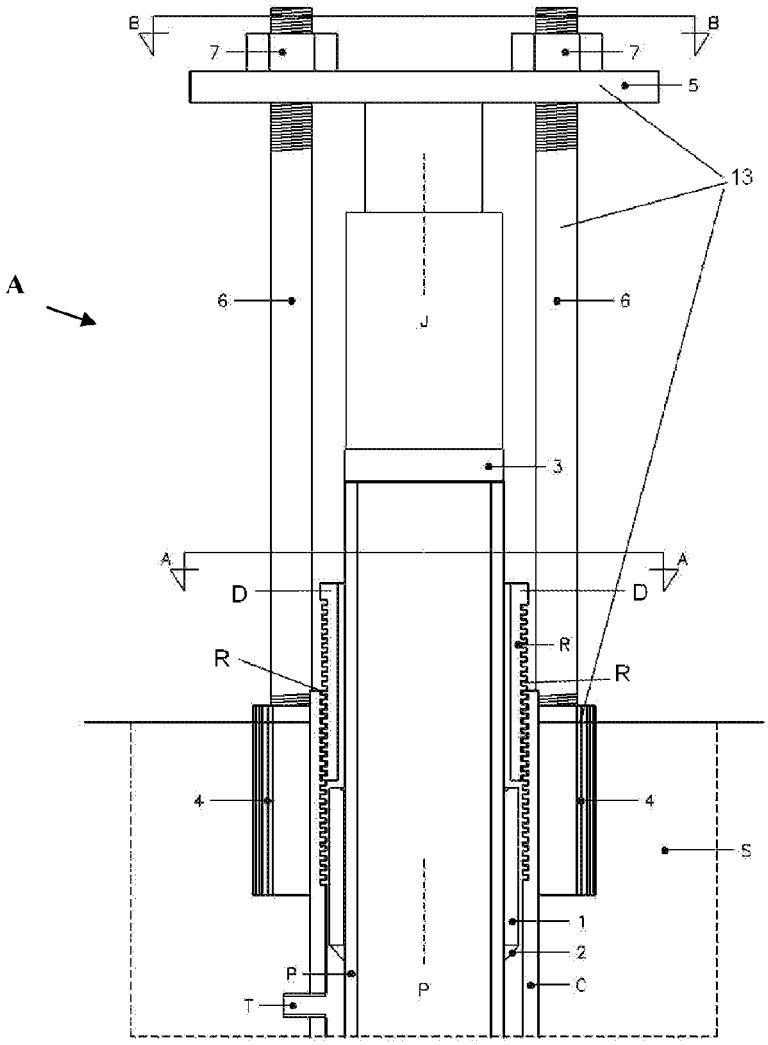

FIG. 1A

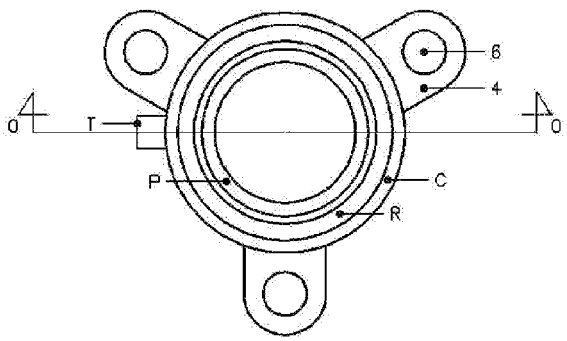

FIG. 1B

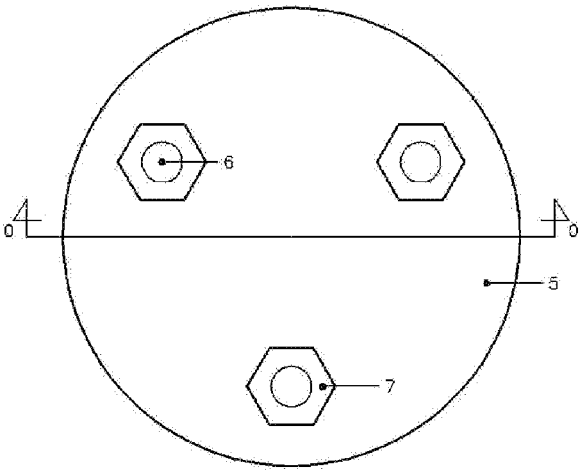

FIG. 1C

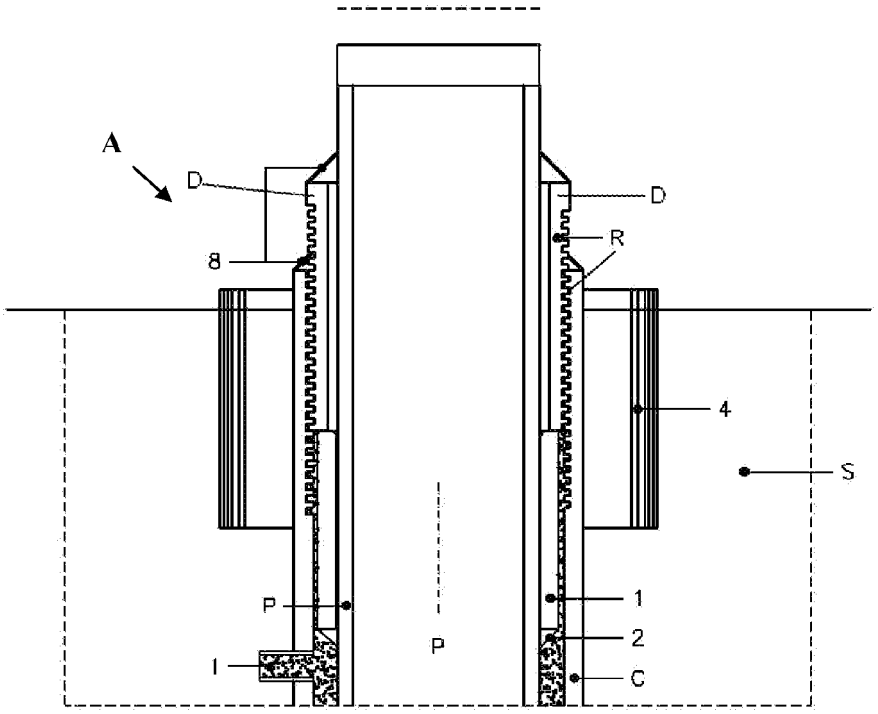

FIG. 2

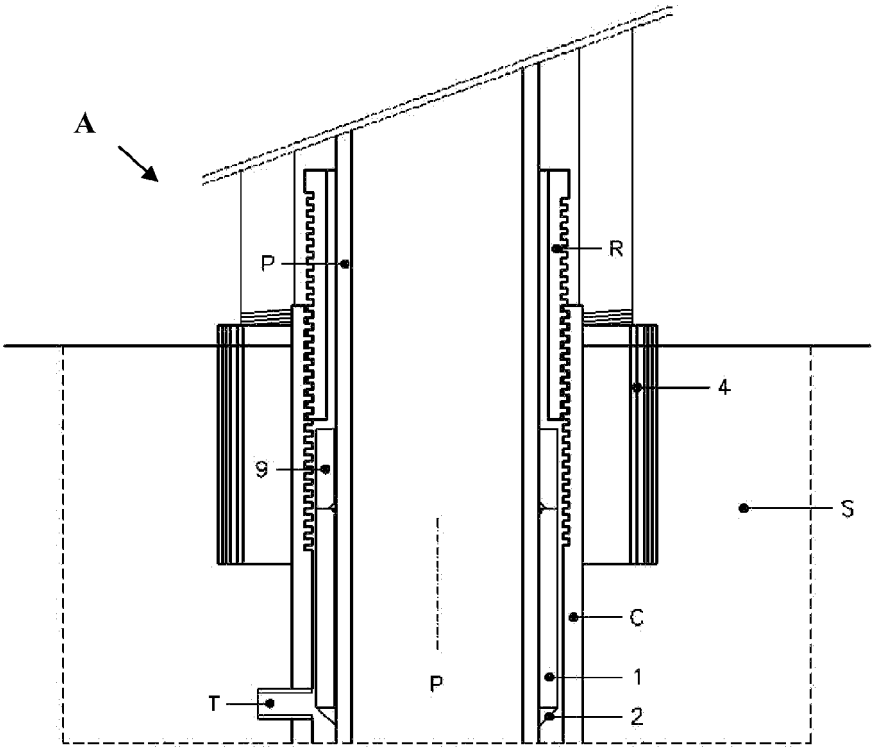

FIG. 3

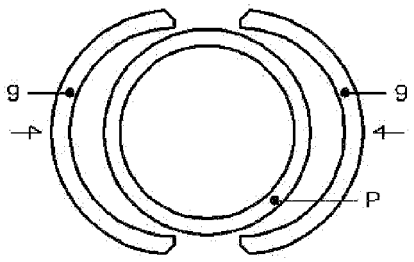

FIG. 4A

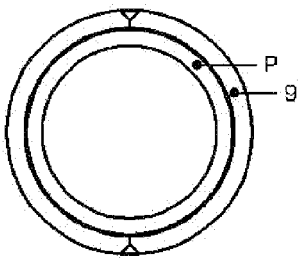

FIG. 4B

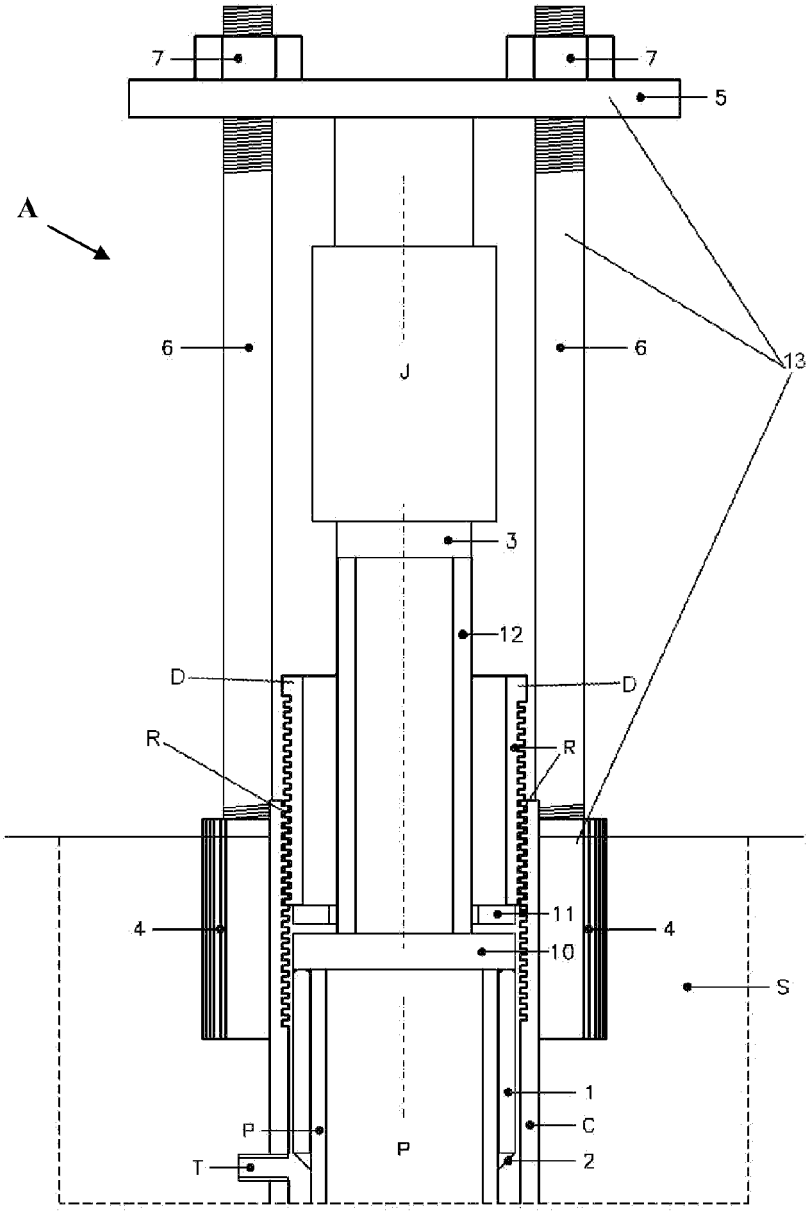

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 10 19 3150

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 6 347 489 B1 (MARSHALL JR CHESTER R [US] ET AL) 19 February 2002 (2002-02-19) * the whole document *	1-13	INV. E02D35/00
X	US 5 176 472 A (KINDER WILLIAM D [US]) 5 January 1993 (1993-01-05) * column 3, line 51 - column 12, line 63; figures 11,12 *	12,13	
A	US 5 862 635 A (LINSE ROBERT P [US] ET AL) 26 January 1999 (1999-01-26) * the whole document *	1-13	
A	US 6 659 692 B1 (MAY DONALD [US]) 9 December 2003 (2003-12-09) * 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	12 May 2011	Geiger, Harald

CATEGORY OF CITED DOCUMENTS

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1 EPO FORM 1503 03.82 (P04C01)

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12-05-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6347489 B1	19-02-2002	NONE	
US 5176472 A	05-01-1993	NONE	
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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