



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
26.09.2012 Bulletin 2012/39

(51) Int Cl.:
E21B 3/04 (2006.01) E21B 7/02 (2006.01)
E21B 19/16 (2006.01)

(21) Application number: **12159469.1**

(22) Date of filing: **14.03.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(30) Priority: **22.03.2011 IT TO20110248**

(54) **Locking device for tubular elements**

(57) A device for locking tubular elements to a drilling machine

adapted to drive said tubular elements or casing pipes into the ground. Said drilling machine comprises a guiding mast and a rotary tool head (1) for handling drill strings which are slideable along the mast and are operated by a mechanism that causes axial movement.

Said rotary head comprises a fixed part slideable along the guides of said mast or tower (2) and a rotary part connected to the first casing pipe piece, allowing rotation thereof about an axis of rotation (4).

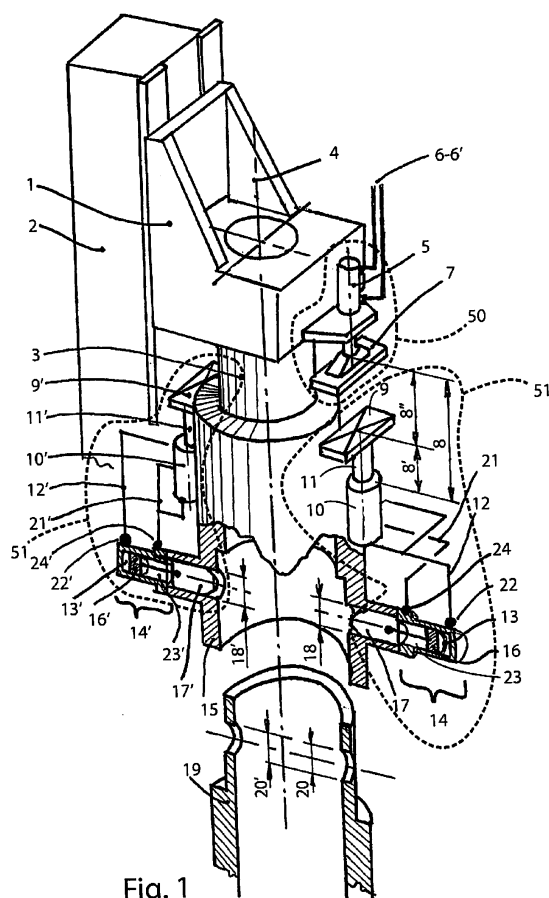


Fig. 1

Description

[0001] The present invention relates to a locking device for tubular elements. In particular, the present invention relates to a locking device for tubular elements, such as, for example, casing pipes to be driven into bores drilled in the ground for the installation of foundation piles.

[0002] Said casing pipes are used for consolidating the bore walls and prevent them from collapsing, and are coupled to one another in pieces several metres long. Within these casing pipes, the drill string excavates the hole during the pipe driving steps and also during the next steps, even when the pipe has already reached its required drive height, because the pile generally goes in deeper.

[0003] The pipes are driven one by one into the ground by a drilling machine that comprises at least one guiding mast (or tower), which is substantially vertical, and at least one tool head for handling both the drill string and the surrounding casing pipes, which are slideable along the mast and are operated by a mechanism exerting a pull and a thrust.

[0004] At the end of said tool head, a rotary table is connected internally to the drill string and externally to the first casing pipe piece, thus allowing rotation thereof. The casing pipe performs the main function of stabilizing the bore walls and to allow drilling even in particularly hard ground or through water-bearing strata. The casing pipe is also fitted with excavating teeth at its edge, in order to bit the ground at the annular portion. It is also characterized by a diameter as large as several metres.

[0005] The excavation equipment further comprises a control cabin for an operator, which cabin contains all the manipulators necessary for operating the machine.

[0006] The connections between the various pieces can be effected by welding, if the casing must not be recovered, or through joints of various types, if the casing must be recovered prior to installation of the foundation pile. The male and female joints are characterized by being fitted one into the other with relative ease, while being able to transmit torque and axial movement, i.e. to exert a pull and, if necessary, also a thrust onto the whole string, of which they are essential components. They are provided with devices that allow transmission of torque and axial thrust between one piece and the other: in this particular case, between the pipe piece connected to the rotary table and the string driven into the ground.

[0007] Radial locking is normally ensured by interpenetrating fretted profiles, keys, bayonet-style joints or the like, capable of transmitting rotational torque. Axial locking is ensured by screws or pins going through the thickness of both joints and capable of transmitting pull or thrust. Screws and pins are normally driven or screwed in manually. When the casing pipe has been fully driven into the ground, the coupling with the next pipe can be easily accomplished by hand, in that this operation can be carried out at ground level. On the contrary, the connection between the top of the casing pipe still to be driven

into ground and the rotary table of the machine must be made several metres above ground. The personnel entrusted with this task must therefore work in uncomfortable positions at a height of several metres from ground level. This height corresponds to the length of the pipe piece to be coupled (or decoupled) to (from) the casing string driven into the ground. In order to facilitate and make safer the work of the people who must install and remove the accessories used for joining two contiguous pieces of casing pipe, mechanical, hydraulic or pneumatic mechanisms have been developed which replace, whether totally or partially, the work of man. In the prior art, such locking devices comprise so-called "bolts", which are driven linearly by electric, hydraulic or pneumatic power sources.

[0008] More specifically, patent DE 19621849 and patent DE 3721448 describe hydraulic bolts in which the fluid that causes the linear movement of the bolts is moved from the generating source, which is located on a static part of the machine, to the bolt region, which is located on a rotary part. There is only one power fluid supply system, continuous from the fixed part to the rotary part, which uses hydraulic or pneumatic joints or sliding electric contacts.

[0009] The Applicant has observed that in such systems the fixed part, i.e. the one associated with the frame of the rotary table, is totally constrained to the rotary part. If, for any reasons, the two parts should be set apart axially from each other, the power fluid flow would be interrupted and the system would no longer be able to ensure that the bolts can be driven into their seats and held in position or removed therefrom. Power transmissions using fluids flowing into rotary joints are expensive and difficult to implement in equipment requiring a large-diameter gap around the axis of rotation.

[0010] Furthermore, patent publication DE 10 2006 022613 A1 describes a system for engaging and disengaging drill pipes, consisting of a fixed portion, connected to the fixed part of the rotary head, and a rotary portion, connected to the rotary part of the rotary head. The system is held in the engaged position by springs arranged on the rotary part, the action of which is countered by actuators mounted on the fixed portion of the system. Therefore, these springs cause the system to have a monostable behavior, i.e. it tends to remain in only one stable condition of engagement because of the elastic action exerted by the springs, from which position it can be temporarily moved in an "unstable" manner only as long as the actuators stay activated in an extended position, thus exerting a countering thrust. In fact, as soon as the actuators are deactivated, the springs will automatically pull the system back into the engaged position. In addition, in the extended configuration the fixed actuators are permanently in contact with the rotary part, so that in this condition rotation is prevented or wear is generated between the contacting and relatively moving parts, which may then fail over time.

[0011] It is the object of the present invention to provide

a locking device for rotary tubular elements, wherein bolts are driven in to securely and stably constrain together two half-joints belonging to two contiguous tubular element pieces by means of a linear movement generated by a pressurized fluid or through magnetic or electric means, wherein the connection between the fixed part of the device and the movable part is accomplished exclusively by means of mechanical thrust between linear actuators, generated by physical contact between the two parts.

[0012] The manoeuvre requires no human intervention in the bolt area.

[0013] Each one of these movable and fixed parts is sealed, autonomous and independent of the other, and communicates therewith via an interface of planes which are abutted, pushed or pulled relative to each other.

[0014] The two parts of the device can be moved apart with no consequences other than that of "freezing" the state of the bolts in the position they are in when disconnection occurs, i.e. they remain stable. The manoeuvres of the "bolts" are therefore of the stable and held type, i.e. fully open or fully closed. The fixed part of the device, i.e. the one mounted on the fixed part of the rotary head (frame), may be hydraulic, pneumatic or electric. The second part, mounted on the rotary members, requires, in order to operate, the displacement of a fluid contained therein in an idle state, which is pressurized by the thrust exerted by members of the device arranged on the fixed part, which come in contact with members of the movable part. For the above reasons, the second part must necessarily be hydraulic or pneumatic. Therefore, in the light of the above, the second part or movable portion of the device operates in a bistable manner, controlled by the first part or fixed portion of the device. More in detail, the movable portion can selectively and alternately switch between a stable locked condition and a stable unlocked condition every time the fixed portion of the device exerts a thrust on a fluid contained in the movable portion, in accordance with predefined operating modalities (e.g. as a function of the relative angular positions taken by the fixed portion and by the movable portion). The movable portion can thus remain in said stable locked condition or in said stable unlocked condition until the fixed portion of the device exerts again a thrust on a fluid contained in the movable portion in accordance with said predefined operating modalities. In the stable locked condition, said movable portion moves and holds the bolts in the locked configuration, wherein they are adapted to lock a tubular element or casing pipe to the rotary part of the rotary head. Conversely, in the stable unlocked condition said movable portion moves and holds the bolts in the unlocked configuration, wherein they are adapted to release a tubular element or casing pipe from the rotary part of the rotary head. This allows the actuating elements to not stay in contact during the rotations.

[0015] One aspect of the present invention relates to a device having the features set out in the appended claim 1.

[0016] One exemplary but non-limiting embodiment of the present invention will now be described with reference to the annexed drawings, wherein:

- 5 • Figure 1 is a perspective view of that portion of a drilling machine where the connection is made between the rotary table and a tubular element in accordance with a first embodiment of the locking device of the present invention;
- 10 • Figure 2 shows the hydraulic circuit of the device of Fig. 1;
- Figures 3a-3e diagrammatically show the connection between the rotary table and a tubular element in accordance with a second embodiment of the locking device of the present invention;
- 15 • Figure 4 is a perspective view of that portion of a drilling machine where the connection is made between the rotary table and a tubular element in accordance with a variant of the present invention.

[0017] With reference to the above-mentioned drawings, the portion of the drilling machine illustrated therein shows a rotary table 1, slideable along the guides of a guiding mast (tower) 2, which supports the mechanical members that rotate the rotary part or tubular elements 3 connected to the drill strings (not shown) and to rotary part 15 of the locking device, which is directly connected to pipe pieces 19, about the axis of rotation 4.

[0018] With particular reference to Fig. 1, the locking device according to the present invention is arranged on said rotary table 1 and comprises a fixed portion, indicated by the closed dashed line 50, associated with the fixed part of the rotary table, and a movable portion, indicated by the closed dashed lines 51, associated with rotary part 3 of table 1.

[0019] For the purposes of the present invention, the fixed part of rotary table 1 (frame) is meant to be that non-rotating part which can move axially along the axis of rotation 4 through the guides of tower 2.

[0020] For the purposes of the present invention, the rotary part of rotary table 1 is meant to be that part which includes the mechanical members that comprise and rotate said tubular elements 3.

[0021] Fixed portion 50 of the device comprises at least one drive actuator 5, preferably a linear one, e.g. of the electric, hydraulic or pneumatic type, the axis of which is preferably parallel to the axis of rotation 4, which is adapted to handle a thrust member 11-11', preferably a linear actuator, through contact with movable portion 51 of the device. Said movable portion 51 comprises at least one handling member 16-16' acting upon at least one bolt 17 - 17', which receives the thrust from said thrust member 11-11' when the latter is in contact with actuator 5, and which is adapted to insert or extract, in a stable and held manner, said at least one bolt into/from at least one coupling sleeve defined between the rotary part of the table and the tubular element, fitted or joined one over the other.

[0022] Said actuator 5 is preferably powered by power hoses or cables 6, 6' connected to a power assembly of the drilling machine; said thrust member comprises a thrust plate 7, which is driven by the actuator for a stroke 8 along the axis of rotation.

[0023] Preferably, the handling member comprises at least one locking counterplate 9 and at least one unlocking counterplate 9', adapted to receive the thrust from the thrust plate, e.g. when they are near the same vertical axis, in such a way as to insert or extract said at least one bolt in order to lock or unlock the tubular element to/from the rotary part of the table.

[0024] Furthermore, the handling member is preferably of the hydraulic type, e.g. a hydraulic linear actuator, and comprises at least one first fluid-containing locking chamber 10 that is pressurized by the downward movement of locking plate 9, through at least one first locking piston 11. At least one pair of locking ducts 12 and 12' carry the fluid from the locking chamber to at least one pair of opposite second locking chambers 13 and 13' of respective cylinders 14 and 14'. The pressure of the fluid in said second chambers pushes pairs of second pistons 16 and 16', which in turn push bolts 17 and 17' along channels 18 and 18', until they enter into holes 20 and 20' of casing pipe 19, thus constraining rotary portion 15 connected to rotary part 3 of table 1 to the same casing pipe 19. In this respect, matching the holes may be facilitated by radial striker elements ensuring coaxiality of the holes.

[0025] At least one pair of safety valves 22 or 22' are mounted in line on the pair of locking ducts 12 or 12' to ensure a positive and constant locking of the bolts.

[0026] The handling member comprises at least one first unlocking chamber 10', which is pressurized by the downward movement of the unlocking plate 9', through at least one first unlocking piston 11'.

[0027] Within each cylinder 14 or 14' there is a second unlocking chamber 23 or 23', located on the opposite side of piston 16 or 16' with respect to the second locking chamber 13 or 13'. At least one pair of unlocking ducts 21 and 21' carry the fluid from the first unlocking chamber to the pair of opposite unlocking chambers 23 and 23'.

[0028] The pressure against unlocking counterplate 9', exerted by thrust plate 7, is then transmitted to piston 11', which causes fluid to move from the first unlocking chamber 10' to the second unlocking chambers 23 and 23'. This moves the second pistons 16 and 16' in the direction opposite to that which allows locking the bolts. In this manner, the bolts are moved backwards in channels 18 and 18', until they release rotary portion 15 connected to rotary part 3 of table 1 on adjacent casing pipe 19.

[0029] Additional safety valves 24 and 24' mounted in line on ducts 21 and 21' ensure a positive and constant unlocking of the bolts, which have now fully returned into the respective ducts, after having released positively and definitively, i.e. in a stable and held manner, casing pipe 19 from rotary portion 15 connected to rotary part 3 of

rotary table 1.

[0030] The hydraulic diagram of Fig. 2 is recommended for the case wherein the power transmission fluid selected for use in the "movable" handling member of rotary part 51 is hydraulic oil. In the solution shown, both the first locking chamber 10 and the first unlocking chamber 10' have a dual-piston configuration with return springs 25. There are also a volume compensation tank 26 and at least one pressure accumulator 27. Pressure accumulator 27 ensures pressurization of the system when the bolts are closed and preservation of the energy received via the thrust of actuator 5.

[0031] Volume compensation tank 26 thus allows reducing the quantity of working fluid in rotary part 51 and handling the differential volumes which are created while the bolts are being actuated.

[0032] Once the bolts have been locked inside holes 20, thrust plate 7 is withdrawn along its stroke 8, ensuring that, when in operation, there is always a safety distance 8" between plate 7 and counterplate 9 or 9'. From this moment onwards, the casing pipe pieces can be rotated and pushed or pulled while the bolts remain firmly in position.

[0033] When an additional casing pipe piece must be coupled onto casing pipe piece 19, it will be sufficient to stop the rotation and place unlocking counterplate 9', i.e. the one for releasing bolts 17 and 17', instead of counterplate 9, under thrust plate 7. During its stroke 8, thrust plate 7 will sink by unlocking quantity 8'. This time, the system will provide for pressurizing unlocking chambers 23 and 23' which, by displacing pistons 16 and 16' in cylinders 14 and 14', will disengage the bolts in a stable and held manner.

[0034] In the embodiment shown in all of the annexed drawings there are two bolts. In particular, in the embodiment shown in Fig. 1 they are arranged radially relative to the cross-section of the tubular element, whereas in the embodiment shown in Figs. 3a-3e they are tangential to the circumference of the cross-section of the coupling sleeve.

[0035] Of course, within the scope of the present invention, the number of bolts may be increased; likewise, components 9, 10, 11 (9', 10', 11') of the "movable" secondary part are at least two, but there may be more of them as well. In particular, the bolts (two of which are shown herein because this is the minimum number of components in opposing balance) may even be three (arranged at 120°) or more, or anyway in a number sufficient to transmit the required pull and thrust. If the number of bolts increases, they can carry lighter forces and their dimensions can be decreased, resulting in increased radial compactness, reduced dimensions of the fittings to be provided on the casing pipes, and reduced minimum thickness of the bolts themselves.

[0036] Also the number of drive actuators 11-11' on the rotary part 51 may be reduced to at least one. In such a case, a remotely controlled selector valve may divert the flow from a first system, including devices 14-17

adapted to control the locking of bolts, to a second system, including devices 14'-17' adapted to control the unlocking of bolts. In this simplified variant, the other system elements present in rotary part 51 will be common to both locking and unlocking systems, exactly as shown in Fig. 2.

[0037] Therefore, the simplest embodiment includes at least one linear actuator 5 integral with fixed part 50, which drives at least one linear actuator 11 integral with rotary part 51 via (direct or indirect) mechanical contact that generates the insertion or extraction movement of at least one bolt 17, which thus remains inserted in or extracted from seats 18, 20 of tubular elements 15 and 19 in a stable and held manner. Bolts 17 and 17' have preferably a conical shape in the portion thereof penetrating into holes 20, 20' of casing pipes 19. The same holes 20, 20' may thus have a conical seat, the conicity of which may be equal to or greater than that of bolts 17, in order to facilitate the extraction of the latter.

[0038] As an alternative to this solution, at least one of the two holes, e.g. 20 and 20', may be elliptic in shape, the hole elongating in the horizontal direction. This particular shape will aid the insertion of the bolt into the seat and will allow for less accuracy of the holes themselves (diameter and angular pitch). Bolts 17 and 17' may therefore have a cylindrical shape, with the advantage of a much larger area of contact with the thickness of pipe 19.

[0039] The residual play between elliptic hole 20, 20' and the dimensions of bolts 17, 17' will be completely eliminated by the first setting rotation occurring as the casing pipe starts operating.

[0040] Cylinders 14 and 14' are preferably but not necessarily arranged radially relative to axis 4, and may also be connected indirectly via suitable links.

[0041] In the embodiment shown in Figs. 3a-3e, cylinders 14 and 14' are mounted tangentially to the circumference of the coupling sleeve between the casing pipe and the rotary part of the table.

[0042] A toroidal chamber 29 is obtained partially (e.g. for one half) in rotary part 15 connected to rotary part 3 of table 1 and partially in casing pipe 19. Said chamber may be of the full-circumference or sector type, as shown in the drawing. As it travels in cylinder 14 or 14', piston 16 or 16' pushes into toroidal chamber 29 a bolt consisting of a flexible element 28, e.g. a "chain" made out of rollers (or a rope, or a spring...), said rollers being connected together, the first one of which being connected at one end to the stem of piston 16 or 16'. Said rollers have, preferably but not necessarily, an axis parallel to the axis of rotation 4.

[0043] The stroke of pistons 16 and 16' in toroidal chamber 29 causes "chain" 28 to follow a path identified in the drawing by angle α . The heads of the rollers that make up chain 28, which are in contact with the horizontal walls of toroidal chamber 29, prevent any axial sliding, de facto making said rollers axially constrained to each other with absolute certainty.

[0044] Fig. 4 shows an alternative embodiment of the

present invention, wherein actuator 5 mounted on the fixed part, preferably of the linear type, does not carry the typical thrust plate 7, but an abutment surface 30, represented without limitation herein as a roller.

[0045] Locking chamber 10 and unlocking chamber 10', unlike those shown in Fig. 1, are mounted horizontally and tangentially with respect to axis 4. Pressurization of the fluid contained in said chambers still occurs through the sliding motion of the first linear actuator or locking piston 11 and unlocking piston 11', which are secured to counterplates 9 and 9', the surface of which abutting against the sliding part of actuator 5 being now vertical.

[0046] The sliding of roller 30 in direction K, which is substantially parallel to the direction of axis 4, and the rotation of the rotary part of the table in direction R about axis 4, bring components 30 and 9 or 9' in contact with each other.

[0047] A further rotation R about axis 4 generates a thrust from counterplate 9 or 9' against roller 30 in direction C-C. This thrust displaces piston 11 or 11' in the fluid chamber 10 or 10', thus locking or unlocking the bolts, as shown in Fig. 1. Yet another variant concerns the shape of plates 7, 9 and 9'. One of them, e.g. thrust plate 7, may be implemented by means of an idle wheel supported by the actuator. The contact between the plates will be in this case a rolling contact (as opposed to the sliding contact of the previous solution), and this may promote relative radial movements which could be necessary to aid the insertion of bolts 17 and 17', also when the surfaces are in contact with each other.

[0048] As the bolt is being inserted (i.e. when plate 7 comes in contact with counterplate 9), the system is pressurized by an in-line valve, which is needed to increase the pressure upstream of the cylinders, and which also allows charging accumulator 27. In this manner, the energy produced is released all of a sudden, thereby having an impulsive effect upon the bolts, which can thus enter into the respective seats more rapidly.

[0049] Bolt 17 and 17', normally cylindrical in shape, may be modified to become an actuating cylinder. At the outermost part in the radial direction, there may be an increased diameter allowing insertion and extraction movements. This will result in the elimination of cylinders 16 and 16'.

[0050] The shape of bolts 17 and 17' may also be prismatic and elongated, so as to transmit also the transversal loads generated by torque transmission, thereby avoiding the need for radial strikers mounted on the casing pipes specifically for this purpose.

[0051] The first locking and unlocking cylinders 10, 10' may be single, as shown in Fig. 1, or double (or more), as shown in the diagram of Fig. 2; they may also be arranged horizontally, tangential to the rotary part of the table. In this manner, plate 7 may no longer be horizontal, but substantially vertical, and the same layout should also be applied to counterplates 9 and 9'. In particular, at least one of them (7 or 9 and 9') may be shaped like a plate

positioned parallel to a radial axis, and the countering plate should also be shaped like a plate or, as aforesaid, like a wheel in order to exploit the rolling effect.

[0052] The present invention achieves the following advantages: its application allows casing pipes to be mounted automatically under the rotary table, without human intervention except for the operator at the controls.

[0053] "Fixed" primary power system 50 on board the machine, i.e. on the frame of rotary table 1, requires no invasive modifications. A single piston, representing linear actuator 5, is sufficient to make any excavation equipment suitable for supporting the device of the present invention.

[0054] "Movable" secondary system part 51, as shown in Fig. 2, is completely separated from the machine, in that it is autonomous, sealed and independent. All components (tank, cylinders, valves, accumulator) are mounted on the rotary part of the string and require no power connection to the remaining part of the equipment. The fluid that powers the secondary system may be different from the one that powers the primary system.

[0055] Contact between fixed and rotary parts only occurs as the bolts are being locked/unlocked, and for a very short time compared to the duration of the operation for inserting the casing pipes, because the drives are of the stable and held type. The stresses generated by mutual contact between the two parts are also limited to the same short time. Advantageously, the application of the invention to the "movable" secondary system may be hydraulic, thus avoiding those problems which are typical of the sliding contacts employed in prior-art solutions, which are not compatible with the working environment of the present machinery, i.e. drilling machines.

Claims

1. A device for locking tubular elements to a drilling machine adapted to drive said tubular elements or casing pipes into the ground, said drilling machine essentially comprising at least one guiding mast and at least one rotary tool head (1) for handling drill strings which are slideable along the mast and are operated by a mechanism that causes axial movement, said rotary head comprising at least one fixed part slideable along the guides of said mast or tower (2) and one rotary part connected to the first casing pipe piece, allowing rotation thereof about an axis of rotation (4), **characterized in that** said locking device is arranged on said rotary table and comprises a fixed portion associated with a fixed part of the table and a movable portion associated with a rotary part of the table, said parts being provided with separate power systems independent of each other.
2. Device according to claim 1, wherein said fixed portion of the device comprises at least one drive actu-

ator (5) adapted to handle a thrust member in contact with the movable portion of the device, wherein said movable portion comprises at least one handling member which receives the thrust from said thrust member when they are in contact, and which is adapted to insert or extract at least one bolt (17, 17') into/from at least one coupling sleeve, defined between the rotary part of the table and the tubular element, fitted or inserted one over the other.

3. Device according to claim 2, wherein said actuator (5) is powered by a power assembly of the drilling machine.
4. Device according to claim 2, wherein the handling member comprises at least one locking counterplate (9) and at least one unlocking counterplate (9'), which are adapted to receive the thrust from the thrust member in such a way as to insert or extract said at least one bolt in order to lock or unlock the tubular element of the rotary part of the table.
5. Device according to claim 2, wherein said at least one bolt (17, 17') has a conical shape and is inserted into at least one hole (20, 20') of said casing pipe (19).
6. Device according to claim 2, wherein said at least one bolt (17, 17') has a prismatic shape and is inserted into at least one hole (20, 20') of said casing pipe (19).
7. Device according to claim 2, wherein said at least one bolt (17, 17') has a cylindrical shape and is inserted into at least one hole (20, 20') of said casing pipe (19).
8. Device according to claim 2, wherein said at least one bolt consists of a flexible element (28) which is inserted into a toroidal chamber (29) obtained partially in the rotary part (15) of the table (1) and partially in the casing pipe (19).
9. Device according to claim 4, wherein said locking (9) and unlocking (9') counterplates receive the thrust from said thrust member in a direction parallel to the axis of rotation (4).
10. Device according to claim 4, wherein said locking (9) and unlocking (9') counterplates receive the thrust from said thrust member in a horizontal direction through the rotation of the rotary part of the table.
11. Device according to claim 2, wherein said bolts are inserted radially into the coupling sleeve.
12. Device according to claim 2, wherein said bolts are inserted into the coupling sleeve in a direction tangential to the circumference thereof.

13. Device according to claim 1, wherein the system of the rotary part is constituted by at least one volume compensation tank (26) and at least one pressure accumulator (27), which ensure pressurization of the system when the bolts are closed and preservation of the energy received through the thrust exerted by the actuator (5).

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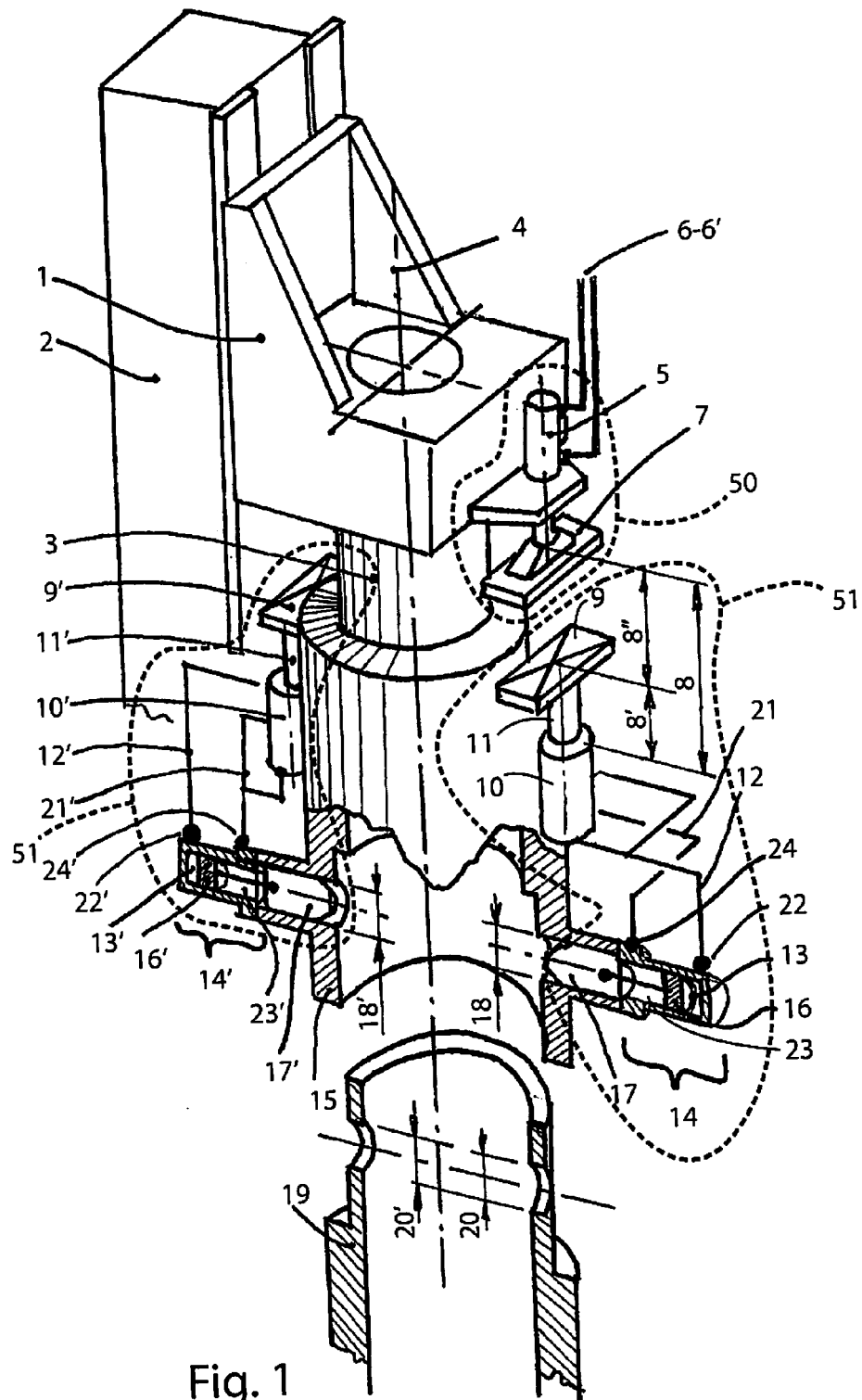
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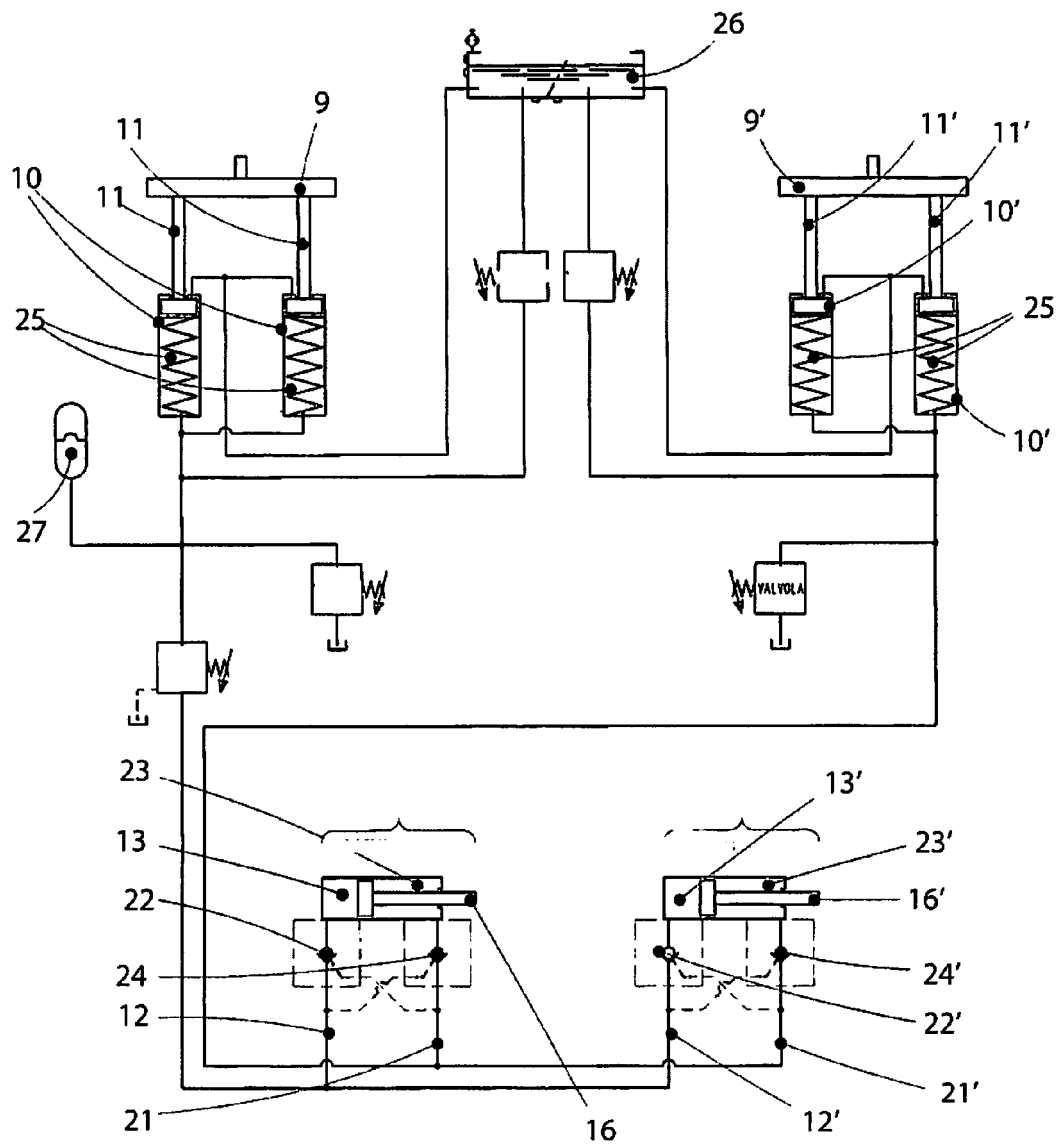
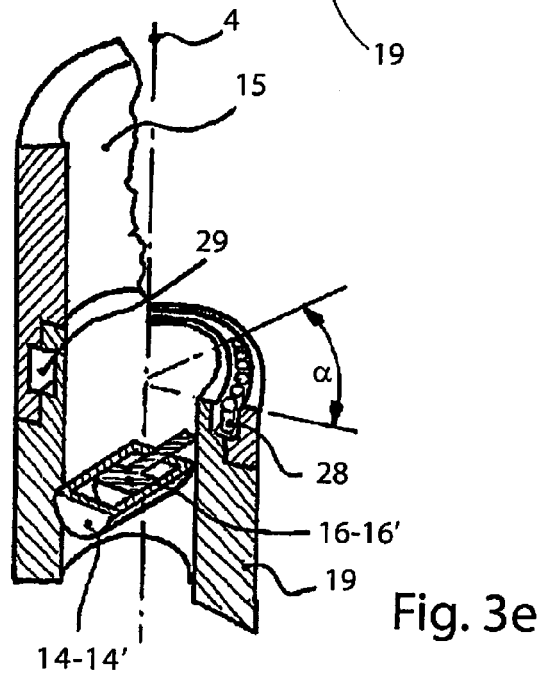
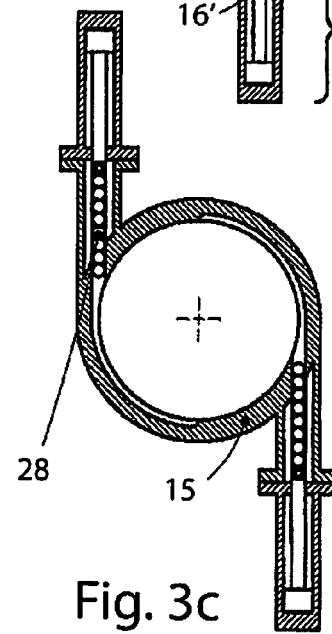
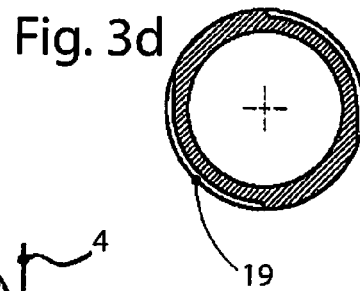
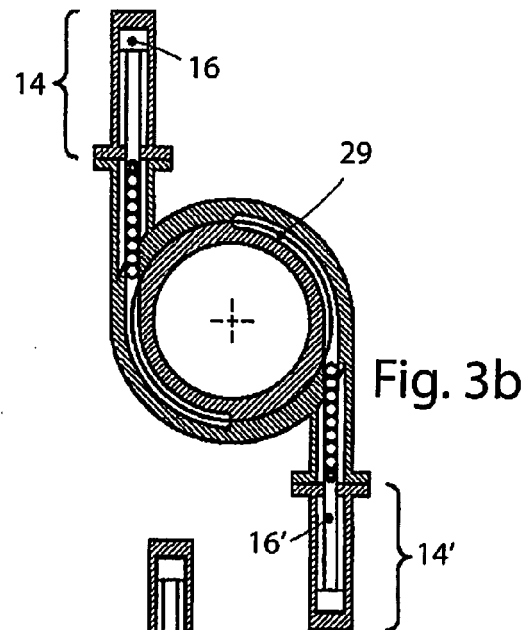
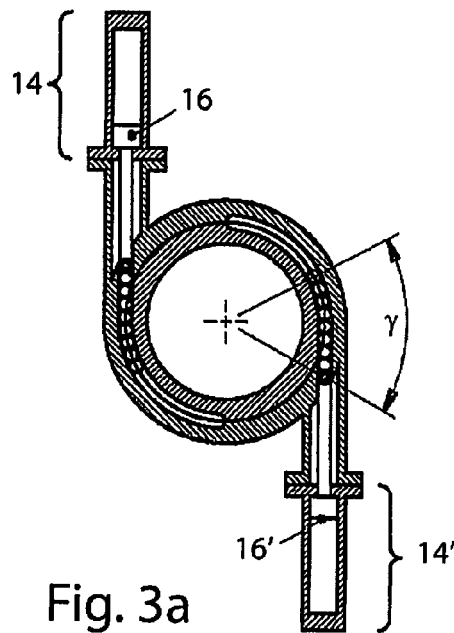


Fig. 2



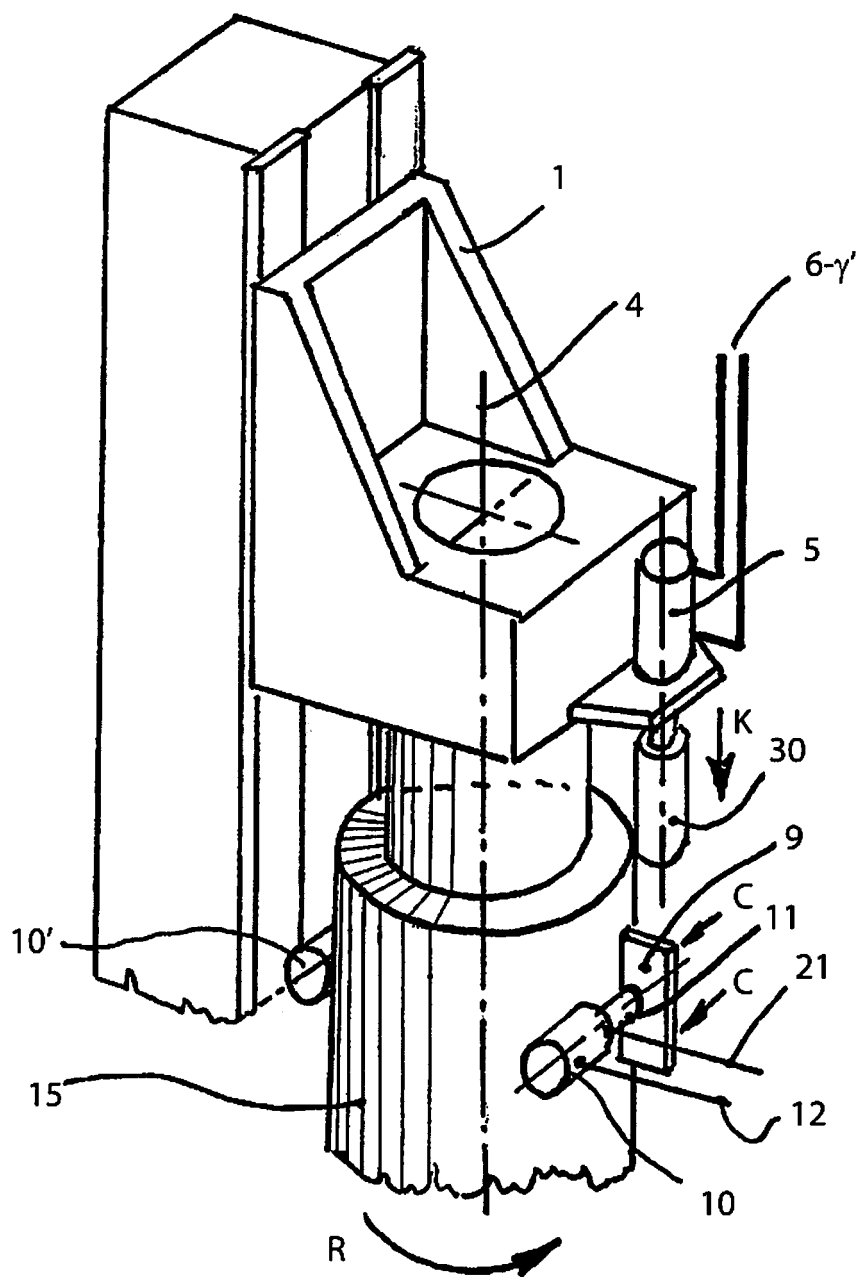


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 12 15 9469

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	DE 10 2006 022613 A1 (KLEMM BOHRTECHNIK ZWEIGNIEDERL [DE]) 22 November 2007 (2007-11-22)	1-3,5-8, 11,12	INV. E21B3/04 E21B7/02 E21B19/16	
Y	* page 6, paragraph 51 - paragraph 54;	13		
A	figures 1-3 *	4,9,10		
Y	DE 196 21 849 A1 (BILFINGER BERGER BAU [DE]) 6 March 1997 (1997-03-06) * column 5, line 39 - line 51; figure 2 *	13		
A	DE 100 23 467 C1 (BAUER SPEZIALTIEFBAU [DE]) 27 September 2001 (2001-09-27) * the whole document *	1-13		
A	DE 37 21 448 A1 (BILFINGER BERGER BAU [DE]) 19 January 1989 (1989-01-19) * the whole document *	1-13		
A	DE 36 42 387 A1 (DELMAG MASCHINENFABRIK [DE]) 30 June 1988 (1988-06-30) * the whole document *	1-13		
A	EP 1 860 275 A1 (BAUER MASCHINEN GMBH [DE]) 28 November 2007 (2007-11-28) * the whole document *	1-13		TECHNICAL FIELDS SEARCHED (IPC)
A	EP 1 624 151 A2 (ABF BOHRTECHNIK GMBH & CO KG [DE]) 8 February 2006 (2006-02-08) * the whole document *	1-13		E21B
A	US 6 488 094 B1 (MCDOWELL BOBBY DEWAIN [US]) 3 December 2002 (2002-12-03) * the whole document *	1-13		
A	US 1 812 721 A (WALDO SHELDON) 30 June 1931 (1931-06-30) * the whole document *	1-13		
The present search report has been drawn up for all claims				
Place of search Munich		Date of completion of the search 29 May 2012	Examiner Morrish, Susan	
CATEGORY OF CITED DOCUMENTS 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		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		

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EPO FORM 1503 03.82 (P04C01)

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

EP 12 15 9469

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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29-05-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102006022613 A1	22-11-2007	NONE	
DE 19621849 A1	06-03-1997	NONE	
DE 10023467 C1	27-09-2001	DE 10023467 C1 IT MI20010953 A1	27-09-2001 11-11-2002
DE 3721448 A1	19-01-1989	NONE	
DE 3642387 A1	30-06-1988	CH 675747 A5 DE 3642387 A1	31-10-1990 30-06-1988
EP 1860275 A1	28-11-2007	AT 398227 T CA 2582125 A1 CN 101063403 A EP 1860275 A1 ES 2307248 T3 JP 4657241 B2 JP 2007291848 A PT 1860275 E RU 2370618 C2 SG 136880 A1 US 2007277988 A1	15-07-2008 26-10-2007 31-10-2007 28-11-2007 16-11-2008 23-03-2011 08-11-2007 09-09-2008 20-10-2009 29-11-2007 06-12-2007
EP 1624151 A2	08-02-2006	AT 370308 T DE 102004034703 A1 DK 1624151 T3 EP 1624151 A2 ES 2293425 T3	15-09-2007 16-02-2006 27-12-2007 08-02-2006 16-03-2008
US 6488094 B1	03-12-2002	NONE	
US 1812721 A	30-06-1931	NONE	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- DE 19621849 [0008]
- DE 3721448 [0008]
- DE 102006022613 A1 [0010]