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(54) Pile driving installation and vibration device for such installation

(57) A pile driving installation comprises a mast (2) for supporting a pile (30) as well as a vibration device (1), which vibration device (1) comprises vibrators (3), a frame (4) which is slidable along the mast, as well as clamping means (5) comprising at least one set of clamping jaws (7). The clamping jaws are pivotable with respect to each other and at one end are connected to each other through an actuator (17) for transferring the clamping jaws between an open position for allowing the vibration device and the pile to slide along each other, and a closed position for clamping the vibration device onto the pile. The vibrators are rigidly connected to the clamping jaws and the clamping jaws are resiliently supported with respect to the frame.

Fig 1

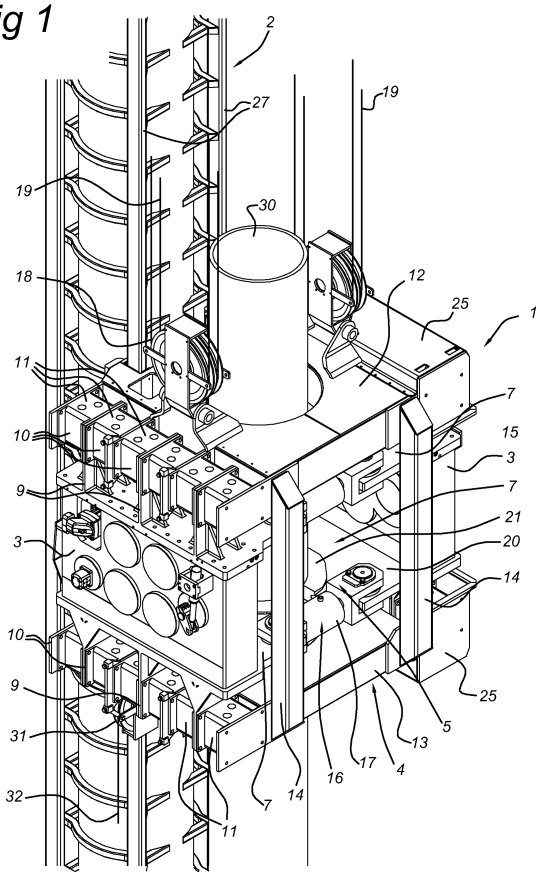

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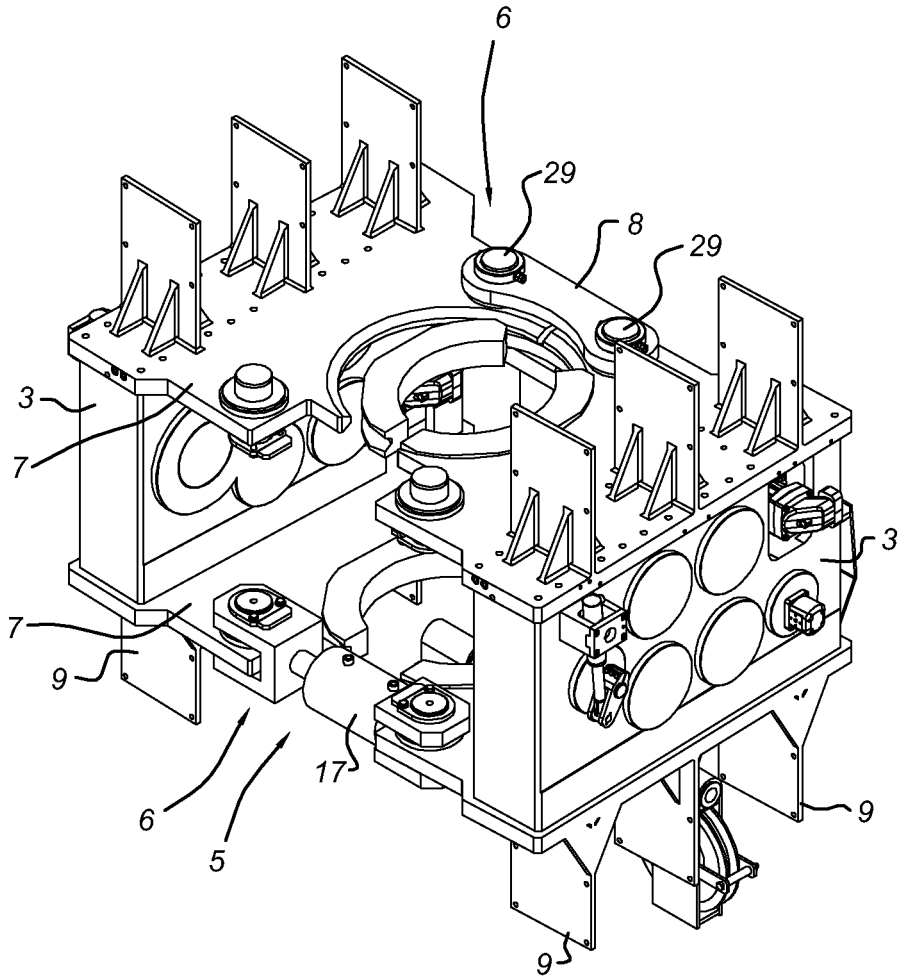
Fig 3



Description

[0001] The invention is related to a pile driving installation, comprising a mast for supporting a pile as well as a vibration device. Said vibration device comprises vibrators, a frame which is slidable along the mast, as well as clamping means comprising at least one set of clamping jaws. The clamping jaws are pivotable with respect to each other and at one end are connected to each other through an actuator for transferring the clamping jaws between an open position for allowing the vibration device and the pile to slide along each other, and a closed position for clamping the vibration device onto the pile.

[0002] Such a pile driving installation is known, and can be used for driving several types of elongate members into a body of earth material. These members include concrete piles, planks as well as hollow or massive steel piles. Such hollow steel piles can be applied in the process of forming concrete piles in situ. To that end, the steel pile is provided with a cap at its lower end. After the steel pile with cap has been driven into the ground, a reinforcement is placed and concrete material is poured into the pile which is gradually removed by the installation. The cap is left behind on the bottom of the hole filled with concrete. The elongate members may also comprise other materials, such as plastics, non-ferro metals, and the like.

[0003] The prior art pile driving installation has a vibration device the clamping jaws of which are pivotably connected to the frame. In turn, the vibrators are rigidly connected to said frame. This design has the disadvantage that the vibrations generated by the vibrators are to be transmitted to the clamping jaws via the hinge connections between the frame and the clamping jaws. These connections are therefore subjected to intense vibrations and high loads, which is not favourable for an acceptable useful life thereof. Moreover, these hinge connections may exhibit some play or flexibility which influences the vibration behaviour of the vibration device in an uncontrollable and thus undesirable way.

[0004] The purpose of the invention is therefore to provide a pile drive installation of the type described before which is of a more robust character, and by means of which a predictable vibration behaviour can be assured. Said object is achieved in that the vibrators are rigidly connected to the clamping jaws, and in that the clamping jaws are resiliently supported with respect to the frame. According to the invention, the vibrations generated by the vibrators are directly transferred to the clamping jaws. Thereby, a predictable vibration behaviour can be obtained, having regard to the fact that the connections between the vibrators and the clamping jaws are well defined and resistant against fatigue and high loads.

[0005] The connection between the clamping jaws and the frame can be obtained by means of resilient suspension members. These suspension members provide a clamping of the vibrations with respect to the frame and thus with respect to the mast which guides the frame. Furthermore, these suspension members should be strong and stiff enough to transfer pulling forces onto the clamping jaws. Such combined pulling and vibration can be exerted on the pile in case additional driving power is required.

[0006] Preferably, a series of jaw connecting plates is connected to each clamping jaw, said series of jaw supporting plates being generally oriented according to the longitudinal direction of the pile, each resilient suspension member being connected to a jaw supporting plate. Similarly, the frame can be provided with frame supporting plates which are generally oriented according to the longitudinal direction of the pile, each resilient suspension member being connected to a frame supporting plate.

[0007] A compact and strong connection is obtained in case the jaw supporting plates of a jaw and the corresponding frame supporting plates overlap each other, a resilient suspension member being connected each time to a pair of a jaw supporting plate and a frame supporting plate. Additionally, the supporting plates of each jaw, the corresponding frame supporting plates and intermediate resilient suspension members can be aligned according to a direction transverse to the longitudinal direction of the pile.

[0008] As mentioned before, it may be necessary to exert pulling forces onto the vibration device. To that end, the top side of the frame may be provided with pulling means for pulling the vibration device in upward direction. Also, the bottom side of the frame may be provided with pulling means for pulling the vibration device in downward direction. These pulling means may be carried out as cable sheaves over which the cable of a cable drive associated with the mast is slung.

[0009] The installation according to the invention can be used for driving piles of different shapes and dimensions. It is thus necessary to adapt the clamping jaws, and for this purpose each clamping jaw may comprise a clamping body and a clamping shell the internal surface of which is a clamping surface to be clamped onto a pile. The clamping shells may be carried out in various shapes and dimensions for accomodating the piles to be treated. Of course the connection between the clamping body and the clamping shell should be strong and stiff enough to transfer the vibrating loads, whilst furthermore the exchange of clamping shells should be uncomplicated. This can be achieved by means of an embodiment wherein each clamping shell comprises an external groove facing away from the clamping surface, said external groove fitting on a correspondingly shaped ridge of the corresponding clamping body. Preferably, the external groove and ridge have corresponding tapering shapes, in a cross section according to a longitudinal radially oriented plane of the pile. Said tapering shapes may for example have a top angle of about 30 degrees. The tapering shapes provide a perfect fit without play between the clamping shells and the vibration system. Other shapes are possible as well, including other non-rectangulare shapes.

[0010] The clamping action between the vibration device and the pile can further be improved in an embodiment comprising two sets of clamping jaws which are at a distance from each other in the longitudinal direction of the pile. In case two vibrators are provided, each clamping jaw of a set can be rigidly connected to a corresponding vibrator. A compact, reliable lay out can be obtained in case one set of clamping jaws is connected to the top side of the two vibrators, and the other set of clamping jaws is connected to the bottom side of the two vibrators.

[0011] Usually, the vibrators are of a mechanical type provided with rotating members having an imbalance, said rotating members of the vibrators being interconnected through a torsion shaft. By means of this mechanical interconnection of the vibrators, it can be ensured that they behave in unison for obtaining an optimal driving result. Preferably, the torsion shaft is provided with a universal joint for accomodating mutual pivoting movements of the vibrators upon opening and closing of the clamping jaws.

[0012] The invention is furthermore related to a vibration device for an installation, as described before, for driving a pile into an earth body, comprising vibrators, a frame as well as clamping means comprising at least one set of clamping jaws, said clamping jaws being pivotably connected to each other at one end and at the other end being connected to each other through an actuator for transferring the jaws between an open position for allowing the vibration device and a pile to slide along each other, and a closed position for clamping the vibration device onto the pile.

[0013] According to the invention, the vibrators are rigidly connected to the clamping jaws and the clamping jaws are resiliently supported with respect to the frame.

[0014] Reference is made to the pile driving installation as disclosed in NL-C-1.028.140. Said prior art pile driving installation comprises a vibration device having a rigid frame onto which the vibrators are directly connected. The pile in question is clamped in the frame by means of a chain, which is actuated by a hydraulic cylinder. The vibration device as applied in this pile drive installation is of a different type, having regard to the fact that clamping jaws are lacking.

[0015] The device according to the invention can be used for vertical or horizontal pile driving, including under an oblique angle. Furthermore said device can be used under water.

[0016] The invention will now be described further with reference to an embodiment shown in the drawings.

[0017] Figure 1 shows a view in perspective of the pile drive installation according to the invention.

[0018] Figure 2 shows another view in perspective of the vibration device according to the invention.

[0019] Figure 3 shows a disassembled vibration device without frame.

[0020] Figure 4 shows the disassembled frame of the vibration device.

[0021] Figure 5 shows a detail of a clamping jaw.

[0022] Figure 6 shows a view of the resilient blocks in a deformed state.

[0023] The vibration installation as shown in figure 1 exists of a vibration device 1 and a mast 2 along which the vibration device is guided. Said vibration device 1 comprises vibrators 3, a frame 4 and clamping means 5. Said clamping means consist of the two sets 15, 16 of clamping jaws 7. As shown in figure 3, the clamping jaws 7 of each set are interconnected by pivots 29 through a jaw link 8. A clamping jaw 7 of each set 15, 16 is connected to a vibrator 3, one to the top side thereof and the other to the bottom side thereof. Furthermore, jaw supporting plates 9 are connected to the top side and the bottom side of a vibrator 3, as well as to the corresponding top set 15 and bottom set 16 of clamping jaws 7. Similarly, frame supporting plates 10 are connected to the top ring 12 and the bottom ring 13 of the frame 4. Said top ring 12 and bottom ring 13 are interconnected through columns 14. Between each pair of a jaw supporting plate 9 and a frame supporting plate 10, a resilient block 11 is connected, e.g. a block of an elastomer material such as rubber.

[0024] The clamping jaws 7 of each set 15, 16, at their end opposite the pivots 9, are connected to each other by means of an actuator carried out as a hydraulic piston/cylinder device 17, although other actuator types are feasible as well such as electro/mechanical actuators, screw spindles and the like. Elongation of the actuator 17 makes the clamping jaws 7 pivot away from each other, thus giving an opening which is wide enough to accommodate and slide a pile. Once the vibration device 1 has reached the desired location, the actuator is made to retract so as to clamp the clamping means 5 onto the pile 30.

[0025] This pivotal movement of the clamping jaws 7 with respect to the rigid frame 4 is made possible by the flexibility of the resilient blocks 9, which deform in this process according to the shapes as shown in figure 6.

[0026] The top ring 12 of the frame 4 carries cable sheaves 18 over which a cable 19 of a hoisting device (not shown) is slung which belongs to the installation (not shown) supporting the mast 1. By pulling the cable 19, the vibration device 1 experiences an upward force which together with the vibrations generated by the vibration device 1 will pull the pile 30 out of the ground. In this process, the resilient blocks 11 transfer the pulling force exerted by the cable 19 onto the clamping means 5. Similarly, the bottom ring 13 of the frame comprise cable sheaves 31 with cable 32 as well for pulling the vibration device in downward direction so as to aid the pile driving into the ground in combination with the vibrations exerted by said vibration device 1.

[0027] Said clamping means 5 comprise clamping jaws 7 which consist of a clamping plate 20 and of a shell 21, as shown in figure 5. The clamping plates 20 have a tapered ridge 22, which matches with a correspondingly tapered groove 23 of the clamping shell 21. The inner surface 24 of the clamping shell 21 can be clamped onto

the outer pile surface. The clamping means 5 can now be adjusted to piles of different shapes and diameters by selecting the proper clamping shells 21.

[0028] A cap 25 can be provided for protecting and supporting the resilient blocks 11. Two of these caps 25 are shown in figure 1; for reasons of clarity these caps have been omitted in the left hand side of the vibrating device 1 in figure 1 and in figure 2. The frame 4 has a guide portion 26 for guiding the vibration device 1 with respect to the guide rails 27 mounted on the mast 2.

[0029] Although in the foregoing description, tapered shapes for the clamping plates 20 and ridge 22 have been mentioned, other shapes are possible as well, such as concave/convex, partly concave/convex and partly flat or tapered, flat and tapered etc.

Claims

1. Pile driving installation, comprising a mast (2) for supporting a pile (30) as well as a vibration device (1), said vibration device (1) comprising vibrators (3), a frame (4) which is slidable along the mast (2), as well as clamping means (5) comprising at least one set (15, 16) of clamping jaws (7), said clamping jaws (7) being pivotable with respect to each other and at one end being connected to each other through an actuator (17) for transferring the clamping jaws (7) between an open position for allowing the vibration device (1) and the pile (30) to slide along each other, and a closed position for clamping the vibration device (2) onto the pile (30), **characterised in that** the vibrators (3) are rigidly connected to the clamping jaws (7), and **in that** the clamping jaws (7) are resiliently supported with respect to the frame (4).

2. Installation according to claim 1, wherein the clamping jaws (7) are supported with respect to the frame (4) by means of resilient suspension members (11).

3. Installation according to claim 2, wherein a series of jaw supporting plates (9) is connected to each clamping jaw (7), said series of jaw supporting plates (9) being generally oriented according to the longitudinal direction of the pile (30), each resilient suspension member (11) being connected to a jaw supporting plate (9).

4. Installation according to claim 2 or 3, wherein the frame (4) is provided with frame supporting plates (10) which are generally oriented according to the longitudinal direction of the pile (30), each resilient suspension member (11) being connected to a frame supporting plate (10).

5. Installation according to claim 3 and 4, wherein the jaw supporting plates (9) and the corresponding frame supporting plates (10) overlap each other, a resilient suspension member (11) being connected each time to a pair of a jaw supporting plate (9) and a frame supporting plate (10).

6. Installation according to claim 5, wherein each clamping jaw (7) is supported with respect to the frame (4) by means of n jaw supporting plates (9), n+1 frame supporting plates (10) as well as 2n resilient suspension members (11).

7. Installation according to claims 5 or 6, wherein the jaw supporting plates (9) of each clamping jaw (7), the corresponding frame supporting plates (10) and intermediate resilient suspension members (11) are aligned according to a direction transverse to the longitudinal direction of the pile (30).

8. Installation according to any of claims 5-7, wherein the jaw supporting plates (9) and the frame supporting plates (10) are parallel to each other.

9. Installation according to any of claims 5-8, wherein the jaw supporting plates (9), frame supporting plates (10) and intermediate resilient support members (11) of each jaw (7) are covered by a cap (25).

10. Installation according to any of the preceding claims, wherein the frame (4) comprises a top ring (12) and a bottom ring (13) which are at a distance from each other in the longitudinal direction of the pile.

11. Installation according to any of the preceding claims, wherein two sets (15, 16) of clamping jaws (7) are provided which are at a distance from each other in the longitudinal direction of the pile.

12. Installation according to any of the preceding claims, wherein two vibrators (3) are provided and each clamping jaw (7) of a set (15, 16) is rigidly connected to a corresponding vibrator (3).

13. Installation according to claim 11 and 12, wherein the top set (15) of clamping jaws (7) is connected to the top side of the two vibrators (3), and the bottom set (16) of clamping jaws (7) is connected to the bottom side of the two vibrators (3).

14. Installation according to any of claims 11-13 when dependant on claim 10, wherein the top set (15) of clamping jaws (7) is resiliently supported with respect to the top ring (12) of the frame (4), and the bottom set (16) of clamping jaws (7) is resiliently supported with respect to the bottom ring (13) of the frame (4).

15. Installation according to any of the preceding claims, wherein the top side of the frame (4) is provided with pulling means (18) for pulling the vibration device (1)

in upward direction.

16. Installation according to any of the preceding claims, wherein the bottom side of the frame (4) is provided with pulling means (31) for pulling the vibration device (1) in downward direction.

17. Installation according to any of the preceding claims, wherein each clamping jaw (7) comprises a clamping body (20) and a clamping shell (21) the internal surface (24) of which forms a clamping surface to be clamped onto a pile.

18. Installation according to claim 17, wherein each clamping shell (21) comprises an external groove (23) facing away from the clamping surface (24), said external groove (23) fitting on a correspondingly shaped ridge (22) of the corresponding clamping body (20).

19. Installation according to claim 18, wherein the external groove (23) and ridge (22) have corresponding tapering shapes, in a cross section according to a longitudinal radially oriented plane of the pile (30).

20. Installation according to any of the preceding claims, wherein the frame (4) and the mast (1) comprise guide means (26, 27) for guiding said frame (4) and mast (1) along each other.

21. Installation according to any of the preceding claims, wherein the resilient suspension members comprise elastomer blocks (11).

22. Installation according to any of the preceding claims, wherein each clamping jaw (7) extends over a curve of about 180°.

23. Installation according to any of the preceding claims, wherein each clamping jaw (7) has a further end opposite its end which is connected to the actuator (17), said further ends of the jaws of each set (15, 16) of jaws (7) being pivotably connected to a link member (8).

24. Vibration device (1) for an installation according to any of the preceding claims for driving a pile (30) into an earth body, comprising vibrators (3), a frame (4) as well as clamping means (5) comprising at least one set (15, 16) of clamping jaws (7), said clamping jaws (7) being pivotably connected to each other at one end and at the other end being connected to each other through an actuator (17) for transferring the clamping jaws (7) between an open position for allowing the vibration device (2) and a pile (30) to slide along each other, and a closed position for clamping the vibration device (2) onto the pile (30), **characterised in that** the vibrators (3) are rigidly connected to the clamping jaws (7), and **in that** the clamping jaws (7) are resiliently supported with respect to the frame (4).

Fig 1

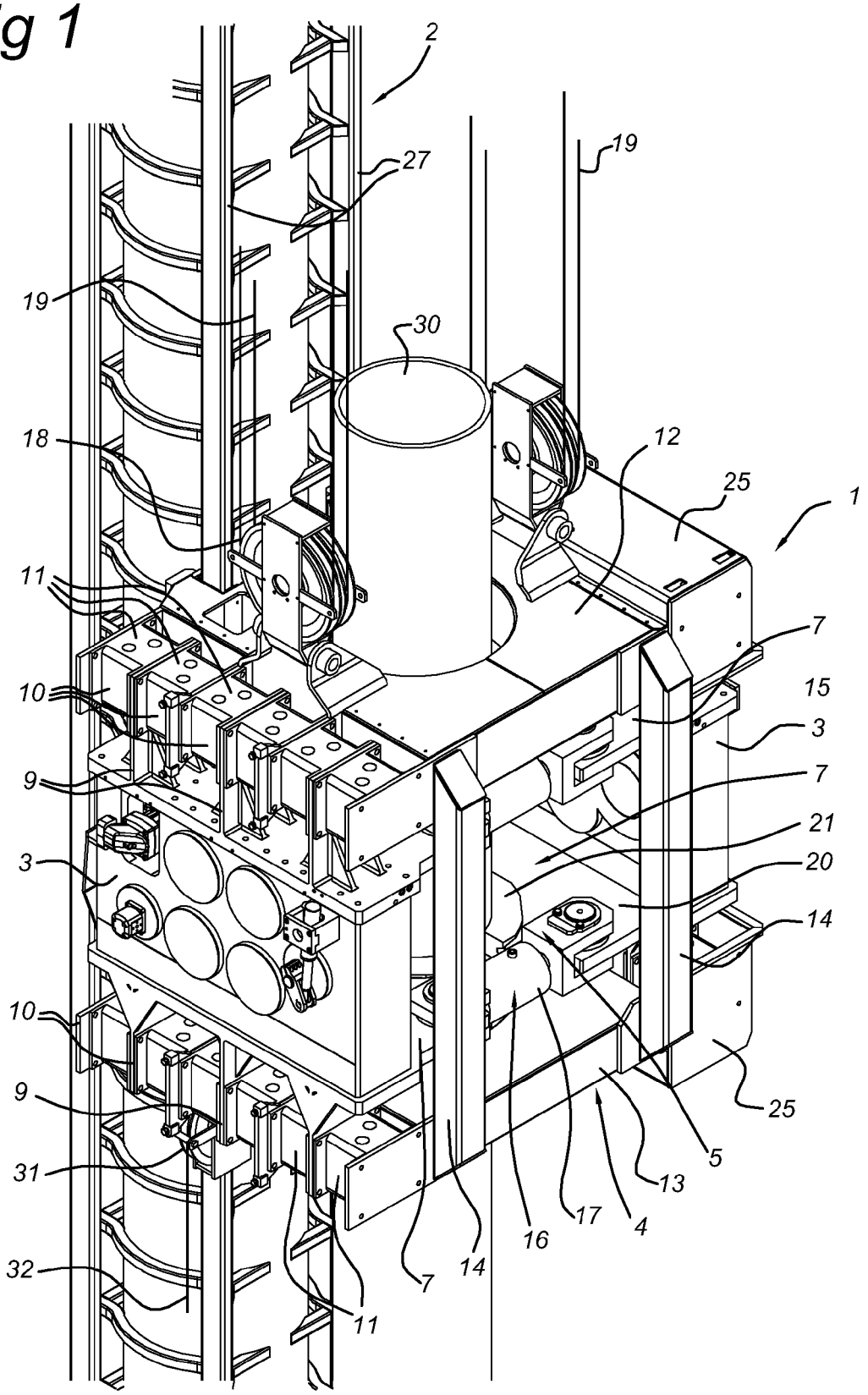

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Fig 2

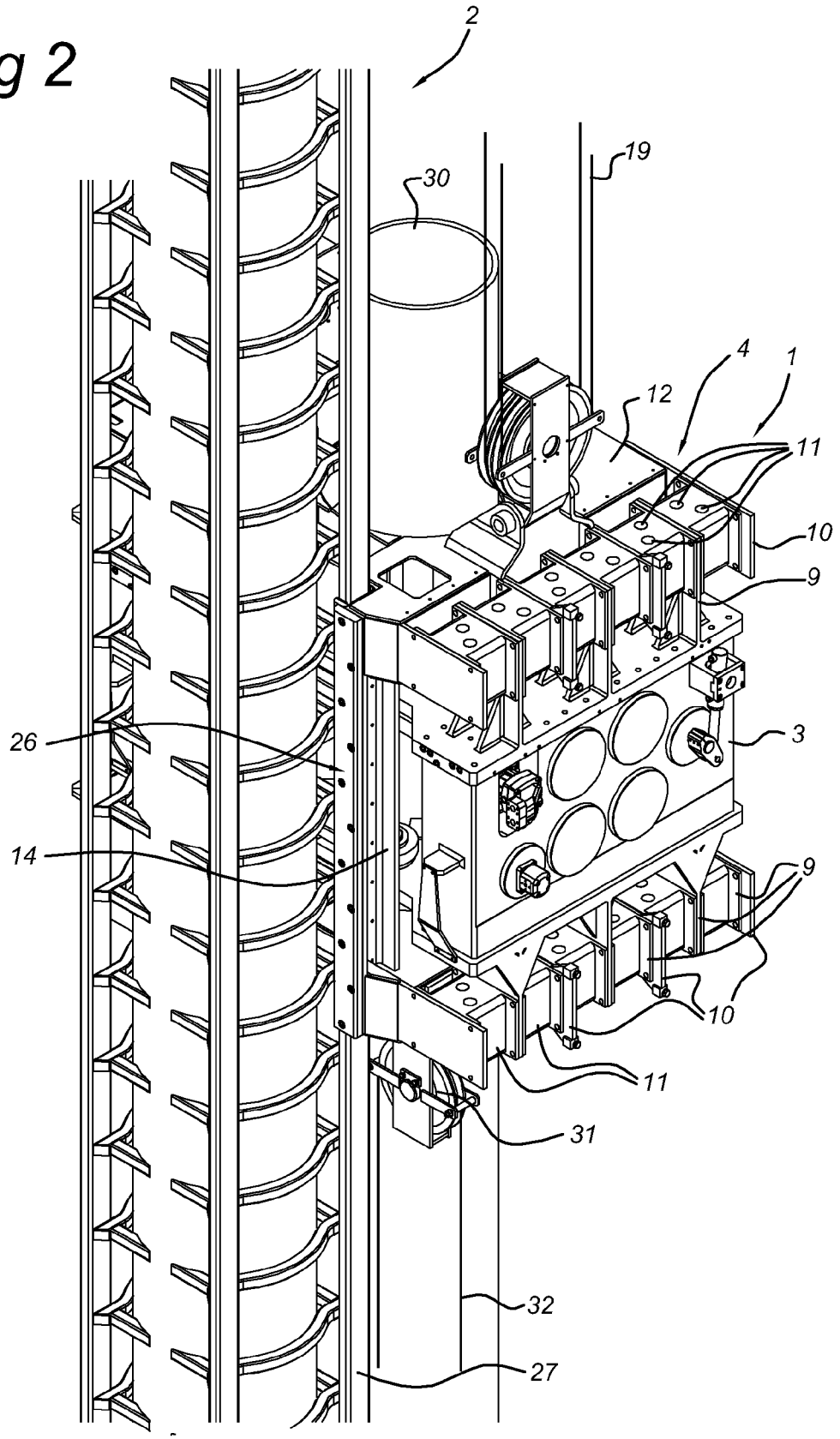


Fig 3

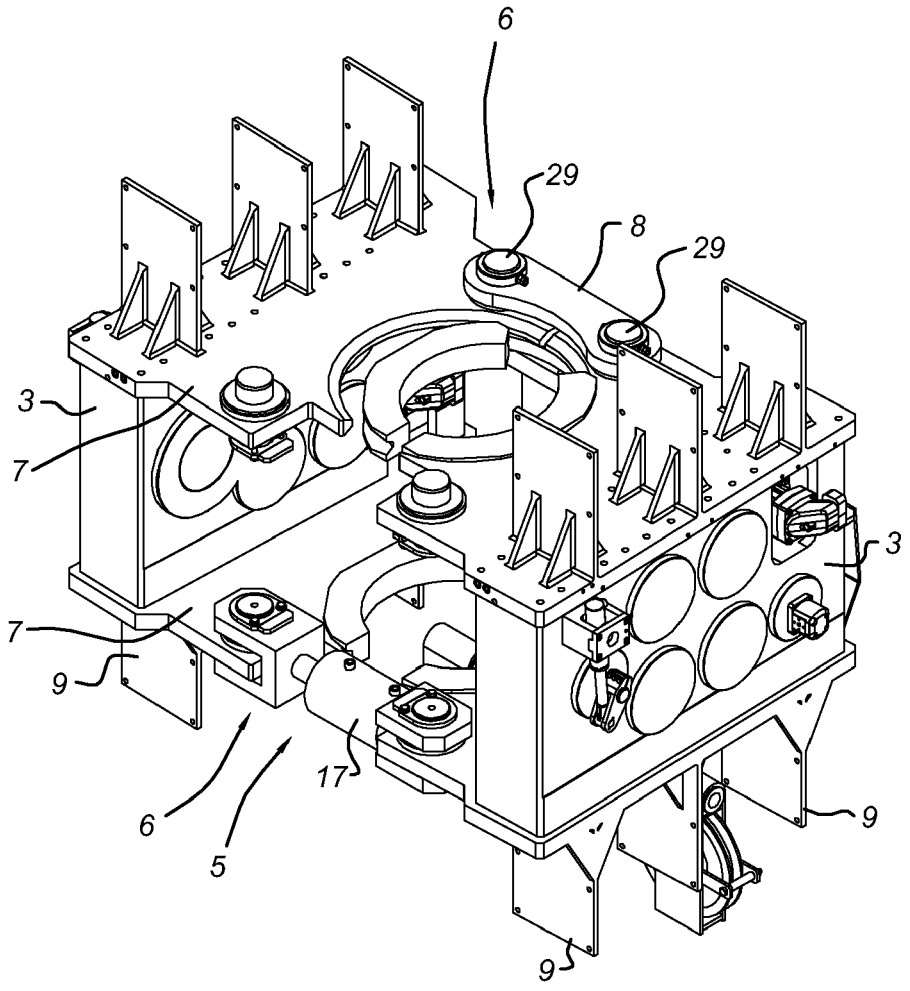


Fig 4

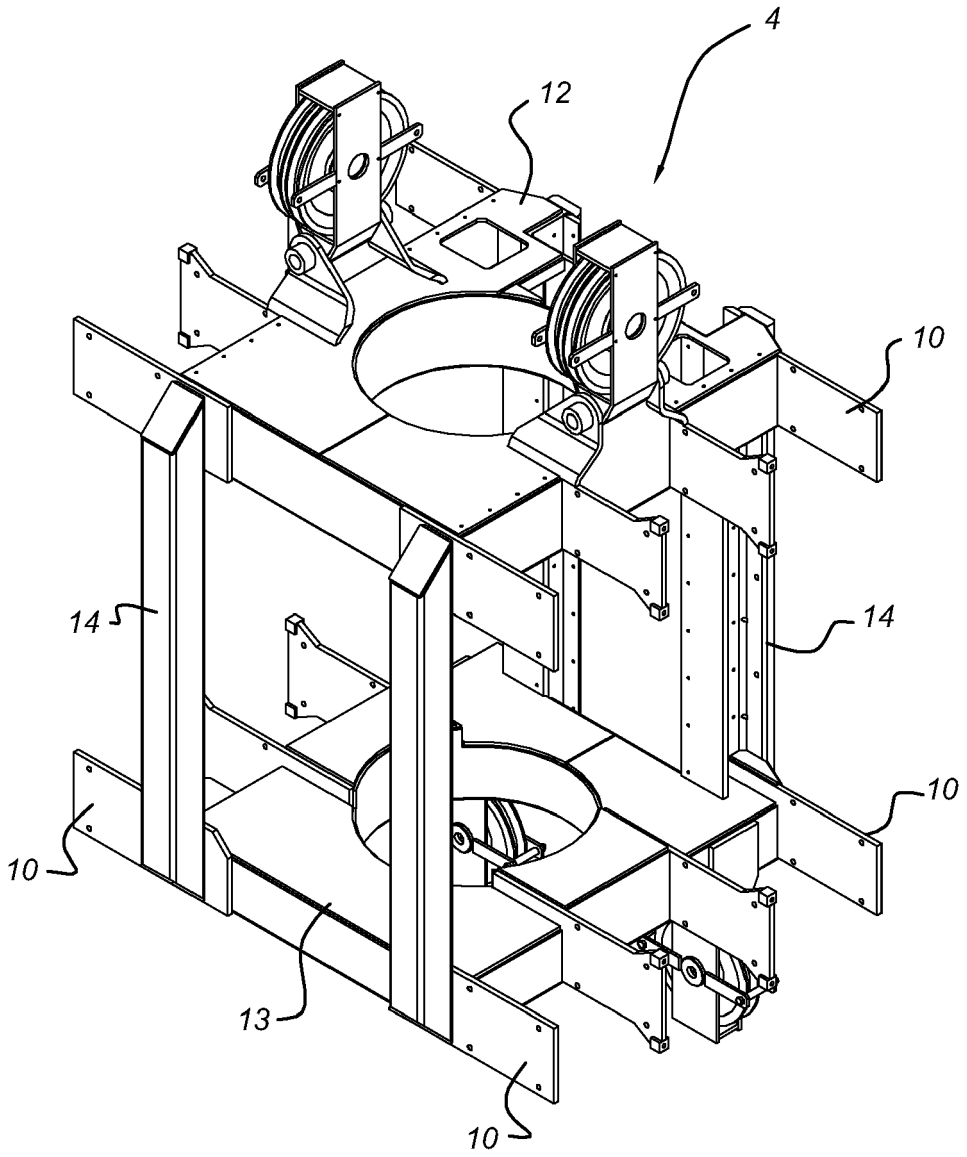


Fig 5

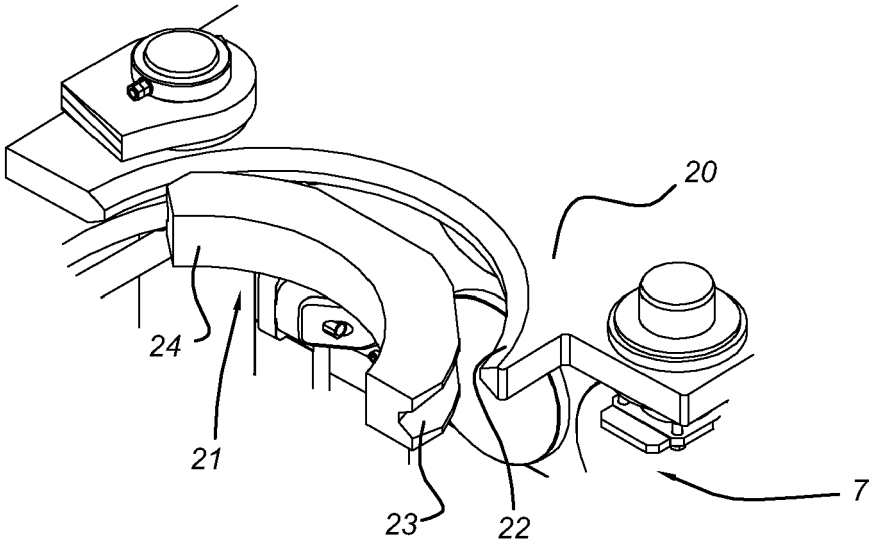
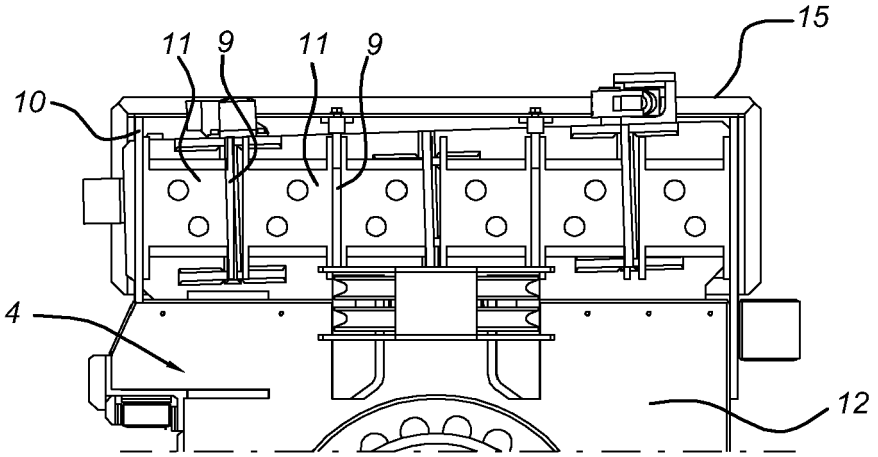


Fig 6



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EUROPEAN SEARCH REPORT

Application Number
EP 07 10 6237

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	EP 1 134 319 A2 (BVV SPEZIALTIEFAUFBAUTECHNIK V [DE] BVV SPEZIALTIEFBAUTECHNIK VERT [DE]) 19 September 2001 (2001-09-19) * paragraph [0012] - paragraph [0018]; figures 1-5 *	1-24	INV. E02D5/66
A	US 5 794 716 A (WHITE JOHN L [US]) 18 August 1998 (1998-08-18) * column 3, line 20 - column 7, line 25; figure 1 *	1-24	
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A	US 6 672 805 B1 (WHITE JOHN L [US]) 6 January 2004 (2004-01-06) * column 1, line 67 - column 3, line 33; figures 1,2 *	1-24	TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 September 2007	Geiger, Harald

CATEGORY OF CITED DOCUMENTS

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