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(54) **Excavation device**

(57) An excavation device (10) comprises a pair of milling wheels (13) with a substantially horizontal axis of rotation (X), each equipped peripherally with excavation means (26), in order to define an excavation front (24) substantially parallel to the axis (X), chain-type transmission means (25) to draw in rotation the milling wheels (13), in which the transmission means (25) is driven by drive means (20) and is also provided, on the side that is external during use, with excavation means (26). The excavation means (26) comprises a plurality of excavation teeth (126) disposed on the external side of the chain-type transmission means (25) and disposed offset, with respect to each other, in a direction transverse to the longitudinal development of the transmission means (25), so that the excavation front (24) is substantially continuous and uniform.

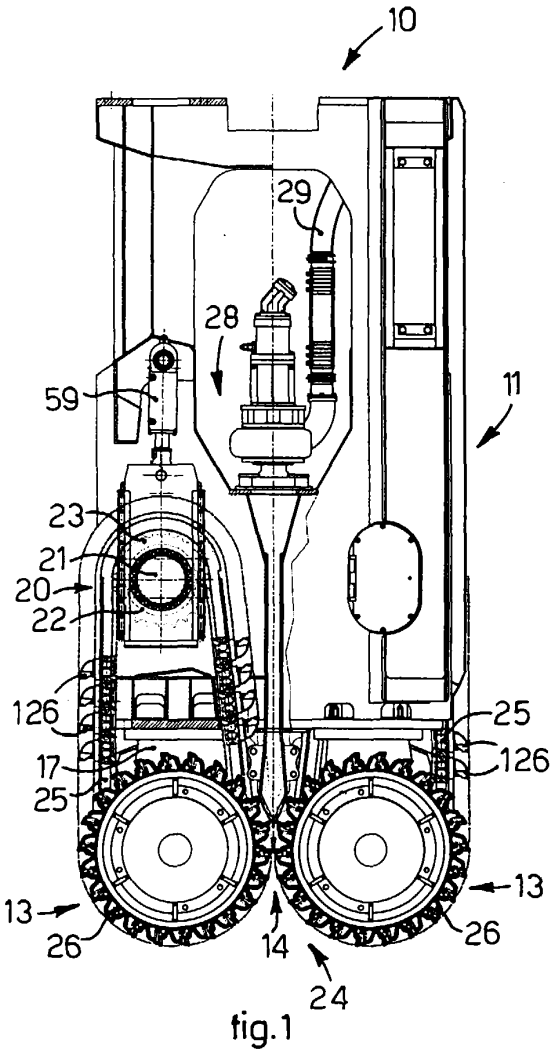

fig.1

EP 1 847 652 A1

Description

FIELD OF THE INVENTION

[0001] The present invention concerns an excavation device with milling wheels with a horizontal axis.

[0002] In particular, the present invention concerns an excavation device with milling wheels with a horizontal axis and additional excavation means, cooperating and associated with said milling wheels, which allow to obtain a continuous and uniform excavation front.

BACKGROUND OF THE INVENTION

[0003] It is known to excavate ditches, trenches, wells, diaphragms or other by means of excavation devices with two pairs of milling wheels with horizontal shafts and substantially parallel, during use, to the excavation surface, which are driven by drive means. Motion is usually transferred to the shaft of the milling wheels by chain-type transmission means.

[0004] The above known excavation devices, however, have disadvantages concerning the achievement of a continuous and uniform excavation front. This happens because, both in the zones of ground located between the milling wheels belonging to the same pair, and also in the zones between one pair of milling wheels and the other, the excavation capacity is not guaranteed because the milling utensil is missing.

[0005] Furthermore, known excavation devices have the disadvantage that they do not have a uniform distribution on the excavation means of the stresses deriving from the excavation.

[0006] One purpose of the present invention is to achieve an excavation device that achieves a continuous and uniform excavation front, without dead spaces, even between the milling wheels, and between adjacent pairs of milling wheels.

[0007] A further purpose of the present invention is to achieve an excavation device that distributes the stresses and the strains on the excavation means in a uniform manner.

[0008] The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

SUMMARY OF THE INVENTION

[0009] The present invention is set forth and characterized in the main claims, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

[0010] In accordance with the above purposes, an excavation device according to the present invention comprises at least a pair of milling wheels with a substantially horizontal axis of rotation, each equipped peripherally with excavation means able to define an excavation front substantially parallel to said axis of rotation.

[0011] The excavation device also comprises chain-type transmission means, which are able to draw in rotation said milling wheels.

[0012] The transmission means is driven by drive means and is also provided externally, that is, on the side which is external during use, with excavation means, so that the intermediate space between the two milling wheels of each pair is also affected by the excavation action.

[0013] In accordance with a characteristic feature of the present invention, the excavation means comprises a plurality of excavation teeth disposed on the external side of said chain-type transmission means and disposed offset, with respect to each other, in a direction transverse to the longitudinal development of said transmission means, so that said excavation front is substantially continuous and uniform.

[0014] More precisely, each excavation tooth is, at least slightly, laterally offset with respect to the excavation tooth immediately adjacent, so as to generate, during use, a continuous progress of the excavation action, which affects in a uniform manner the entire width of the excavation front, also allowing a regular and efficient removal of the material.

[0015] In a preferential form of embodiment, the excavation teeth are disposed with a constant pitch along the length of the chain-type transmission means.

[0016] Said disposition of the excavation teeth guarantees, at the same time, the same excavation strain for each excavation tooth, preventing preferential overloads on certain teeth only.

[0017] In another preferential form of embodiment, when the excavation tooth is at a lateral end of the relative chain-type transmission means, another excavation tooth is also provided in correspondence with the other end of the chain-type transmission means, so as not to generate tilting forces on the chain means, maintaining the chain as much as possible on its ideal resting plane.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] These and other characteristics of the present invention will become apparent from the following description of a preferential form of embodiment, given as a non-restrictive example with reference to the attached drawings wherein:

- fig. 1 is a front view, partially sectioned, of an excavation device according to the present invention;
- fig. 2a is a lateral view of the excavation device in fig. 1;
- fig. 2b is a lateral view, partially sectioned, of the excavation device in fig. 1;
- fig. 3 shows the disposition of the excavation teeth of the excavation device in fig. 1;
- fig. 4 is an enlarged view of fig. 3;
- fig. 5 is a schematic view of the disposition in fig. 3;

- fig. 6 is a schematic view of a variant of the disposition of the excavation teeth of the excavation device in fig. 1;
- fig. 7 shows a further variant of the disposition of the excavation teeth of the excavation device in fig. 1;
- fig. 8 shows another variant of the disposition of the excavation teeth of the excavation device in fig. 1;
- fig. 9 is an enlarged view of a part of the variant of fig. 8;
- fig. 10 is a schematic view of the variant in fig. 8;
- fig. 11 is a schematic view of another variant of the disposition of the excavation teeth of the excavation device in fig. 1;
- fig. 12 is a three-dimensional view of a part of the excavation device in fig. 1;
- fig. 13 is a sectional view of a part of the excavation device in fig. 1; and
- fig. 14 is a lateral view of the excavation device in fig. 1 attached to a tracked crane.

DETAILED DESCRIPTION OF A PREFERENTIAL FORM OF EMBODIMENT

[0019] In accordance with the present invention, in fig. 1 an excavation device 10 is shown, suitable to operate in any type of ground and able to excavate ditches, trenches, wells, panels, diaphragms with a structural function, such as the perimeter walls of an underground car park, or with the function of foundations, such as for a building, or again with a waterproofing function, usually used in dams or in general for zones to be waterproofed.

[0020] The excavation device 10 comprises an excavation head 11 (figs. 1, 2a and 2b), with a substantially box-like external shape and possibly connected in the upper part to a guide 111, carried by a self-propelled means 55 (fig. 14).

[0021] From the lower part of the excavation head 11 two pairs of milling wheels 13 extend with a substantially horizontal axis of rotation X (figs. 1, 2a and 2b).

[0022] The milling wheels 13 define, during use, an excavation front 24, substantially parallel to the axis of rotation X (figs. 1, 2a and 2b).

[0023] Advantageously, each milling wheel 13 comprises a first internal toothed wheel 15 disposed between two external wheels 16, coaxial and solid with the first internal wheel 15 (fig. 2b).

[0024] Each pair of milling wheels 13 is drawn in rotation by a transmission chain 25 (fig. 1).

[0025] Each chain 25 is driven by a hydraulic motor 20, by means of cooperation with a toothed crown 23, in this specific case disposed at the upper part with respect to the milling wheels 13 (figs. 1 and 2b), and is maintained in a condition of operative tension by means of a tensioning unit 59 (figs. 1, 2a and 2b).

[0026] The hydraulic motor 20 has a fixed drive shaft 21 (fig. 1) and a rotary casing 22 (fig. 2b); the toothed crown 23 is on the periphery of the rotary casing 23 (fig. 1). The toothed crown 23 is coupled with the chain 25 and, as mentioned, draws the latter in rotation.

[0027] In this way, advantageously, we obtain a reduced axial bulk of the hydraulic motor 20 - toothed crown 23 group and, consequently, a reduced thickness of the excavation head 11. Furthermore, in this way, the number of mobile parts is reduced and an overall very strong excavation device is achieved.

[0028] In this specific case, the chain 25 draws in rotation the first wheel 15 and therefore the external wheels 16, solid with the latter.

[0029] The first internal wheel 15 is supported by a fork 17 (figs. 1, 2b, 12 and 13), which, according to a characteristic feature of the present invention, is made in a single piece, for example by welding elements or other construction methods, such as casting.

[0030] In this specific case, the fork 17 comprises a platelet 40 (figs. 12 and 13) to attach it to said excavation head 11, for example by means of pins and bolts.

[0031] Advantageously, the fixing points of the platelet 40 are offset by a certain amount with respect to the longitudinal axis of the fork 17, so that, by means of a 180° rotation of the fixing position of the platelet 40 to the excavation head 11, it is possible to vary the width of the excavation front 24, for example from 2800 mm to 3000 mm or from 3000 mm to 3200 mm.

[0032] From said platelet 40 two support blades 41 develop parallel to each other, for example connected by welding or also generally obtained with cast parts or other construction methods, like casting, in a direction substantially perpendicular to said axis X (figs. 12 and 13), connected by a connection element 42, welded to said support blades 41. The support blades 41 each have a flange 47 (fig. 12), also advantageously connected by welding, so as to define overall a housing seating 43 in which a shaft 44 is able to be rotatably housed, rotating around said axis X (fig. 12). Advantageously, therefore, a stronger structure is obtained that allows a larger support surface for the rotary shaft 44 and for the bearings that support the shaft 44.

[0033] The shaft 44 is solidly connected with the internal wheel 15, and is therefore driven by said chain 25; it is also solidly connected with said external wheels 16.

[0034] To this purpose, the support blades 41 are each associated with a wheel-bearing hub 45 (fig. 13), which acts as a support for a respective external wheel 16 and is, therefore, solidly connected with both said shaft 44, and the respective external wheel 16.

[0035] In accordance with the present invention, each hub 45 is maintained in position in said housing seating 43 by means of a corresponding threaded pin 48 and a hydraulic tightening nut 46, coaxial to said shaft 44 (fig. 13), advantageously allowing a rapid dismantling of the hubs and therefore of the whole group of milling wheels 13.

[0036] Each milling wheel 13 is equipped peripherally with excavation means 26, which defines said excavation front 24 (figs. 1, 2a and 2b).

[0037] Each chain 25 is also provided with excavation

means 26 (figs. 1, 2a and 2b), which develops along the side of the chain 25 that is external during use, that is, the side able to face the ground to be excavated.

[0038] In accordance with a further characteristic feature of the present invention, said excavation means 26 comprises, on the external side, a plurality of excavation teeth 126 (figs. 1, 2 and 2b), which are disposed offset with respect to each other, advantageously in a progressive manner between one excavation tooth and the one immediately adjacent, in a direction transverse to the longitudinal development of said chain 25 (figs. 3 - 11).

[0039] In a preferential form of embodiment, said excavation teeth 126 are disposed with a constant pitch along the length of said chain 25 (figs. 3, 4, 7 - 9).

[0040] In this way, a progressiveness in the excavation action is created which allows to obtain a continuous, uniform and homogeneous excavation action.

[0041] Said excavation front 24 is thus continuous and uniform, with no dead spaces and has a section substantially coinciding with the larger section of the excavation head 11 (fig. 1).

[0042] The excavation teeth 126 can consist of wide platelets or teeth of the pointed type

[0043] The cutting width for excavation teeth 126 with platelets is usually wider than that of pointed teeth and usually the number of passages of the teeth through the same excavation position is higher for the former for one travel of the chain.

[0044] In accordance with an alternative form of embodiment of the present invention, the excavation teeth 126 carried by the chain 25 extend radially for a length shorter than the respective excavation teeth 126 carried by the milling wheels 13, with reference to the common excavation front 24 (fig. 1). This allows to perform works that have defined and reliable reciprocal joints between excavated diaphragms, or panels, disposed in succession.

[0045] In particular, the chain 25, in substance, is formed by a plurality of tooth-bearing platelets 12, 112 (figs. 3, 4, 7 - 9), each, on the external side of the chain 25, equipped with at least one of said excavation teeth 126 that extends radially towards the outside, with respect to said milling wheels 13. In accordance with a variant of the present invention, not shown, the tooth-bearing platelets that carry the excavation teeth are alternated with tooth-bearing platelets that do not carry any excavation teeth.

[0046] Each tooth-bearing platelet 12, 112 is equipped with apertures, which promote the discharge of the material from inside the chain and contribute to lighten the structure, while maintaining its strength.

[0047] According to one form of embodiment of the present invention, the tooth-bearing platelets comprise first excavation platelets 12 comprising a single excavation tooth 126 and second tooth-bearing platelets 112 comprising two excavation teeth 126 (figs. 3, 4 and 7).

[0048] The succession and the order of the first 12 and second 112 tooth-bearing platelets along a chain 25 depend on the type of ground to be excavated.

[0049] Advantageously, the second platelets 112 have two opposite sides 212 (figs. 3, 4 and 7), in a direction substantially parallel to said axis X, in proximity of each of which the excavation teeth 126 are disposed, that is, they are symmetrical with respect to the center line M of the chain 25. This double disposition of the teeth allows to balance the strains on the excavation teeth 126, if the geometry according to which they are disposed provides, in itself, a single tooth in a peripheral position, at one lateral end of the excavation platelet 12.

[0050] When the chain 25 is completely unwound, that is, extended on the plane as can be seen for example in fig. 4, where the continuity in the representation of the chain 25 is indicated by a connecting line between the two portions of chain shown, the excavation platelets 12 , 112 define a surface 50 from which said excavation teeth 126 project, which are positioned of said surface 50 along at least two trajectories P, T substantially rectilinear and which reciprocally intersect, substantially in correspondence with the center line M of said surface 50 (figs. 3 - 6).

[0051] According to a form of embodiment of the present invention, the excavation teeth 126 are oriented on said surface 50 defining a substantially X-shaped (fig. 6) or double-X-shaped (figs. 3, 4 and 5) development, or with higher multiples, for example with six X-shaped modules (fig. 7). This disposition is advantageously very balanced for the forces and stresses that act upon the chain 25, during excavation. In fact, in this case the excavation teeth 126 are positioned double, that is, symmetrical with respect to the center line M, in the zones in proximity with the sides 212, while they are single in the substantially central zones of the excavation platelets 112 (figs. 3, 4 and 7).

[0052] Alternatively, said excavation teeth 126 are positioned on said surface 50 along a second trajectory S or broken line (figs. 8 - 11), comprising at least two segments Q, R substantially rectilinear and concurrent in correspondence with the external perimeter 51 of said surface 50. In this case, for example said excavation teeth 126 are oriented on said surface 50 defining a substantially S-shaped or partly S-shaped (figs. 8, 9 and 10), or double S-shaped (fig. 11) development, that is, a coiled or sinusoidal, or multiple S-shaped development. The S-shaped disposition is advantageous, mostly for soft grounds, as it allows to apply a smaller number of excavation teeth and enables an effortless release of the crushed material, as it prevents debris from accumulating between the excavation teeth 126.

[0053] The milling wheels 13 are advantageously counterrotating, so as to convey and draw the debris and crushed materials produced by the excavation towards a central suction area 14, located between the milling wheels 13 (fig. 1). A crushing means 27, for example of the type with blade or scalpel, is positioned between the milling wheels 13 (fig. 1), which in this specific case contributes to further crushing the debris.

[0054] In the central suction area 14 the debris is suc-

tioned by suitable discharge means 28, which comprises a discharge pipe 29 (fig. 1).

[0055] It is clear that modifications and/or additions of parts may be made to the excavation device as described heretofore, without departing from the field and scope of the present invention.

[0056] For example, it comes within the field and scope of the present invention to provide that each hydraulic motor directly drives the pairs of milling wheels 13.

[0057] Furthermore, motion can also reach the milling wheels 13 by means of suitable transmission means, for example chains, gears or other. The milling wheels 13 act, in substance, as pinions and cooperate with a guide wheel, positioned at the upper part in the excavation head 11, in order to drive the chain 25, which is, advantageously, maintained in a condition of operative tension by means of the tensioning unit 59.

[0058] Furthermore, it comes within the field and scope of the present invention to orient the excavation teeth 126 along the chain 25 so as to achieve a generic broken line, curved or other trajectory.

Claims

1. Excavation device comprising:

- at least a pair of milling wheels (13) with a substantially horizontal axis of rotation (X), each equipped peripherally with excavation means (26), able to define an excavation front (24) substantially parallel to said axis (X);
- chain-type transmission means (25) able to draw in rotation said milling wheels (13), said transmission means (25) being driven by drive means (20) and being also provided, on the side which is external during use, with excavation means (26), **characterized in that** said excavation means (26) comprises a plurality of excavation teeth (126) disposed on the eternal side of said chain-type transmission means (25) and disposed offset, with respect to each other, in a direction transverse to the longitudinal development of said transmission means (25), so that said excavation front (24) is substantially continuous and uniform.

2. Device as in claim 1, **characterized in that** each excavation tooth (126) is at least slightly offset laterally with respect to the excavation tooth (126) immediately adjacent.

3. Device as in claim 1 or 2, **characterized in that** said excavation teeth (126) are disposed with a constant pitch on the length of said chain-type transmission means (25).

4. Device as in any claim hereinbefore, **characterized in that** said transmission means (25) comprises a plurality of platelets (12, 112), equipped with at least one of said excavation teeth (126) that develops radially towards the outside, with respect to said milling wheels (13).

5. Device as in claim 4, **characterized in that** said platelets comprise first platelets (12) comprising a single excavation tooth (126) and second platelets (112) comprising two excavation teeth (126).

6. Device as in claim 5, **characterized in that** said second platelets (112) have two opposite sides (212), in a direction substantially parallel to said axis (X), on each of which said excavation teeth (126) are disposed.

7. Device as in claim 5 or 6, **characterized in that** said platelets (12, 112) define a surface (50) from which said excavation teeth (126) project, which are positioned on said surface (50) along at least two trajectories (P, T) substantially rectilinear and that reciprocally intersect substantially in correspondence with the center line (M) of said surface (50).

8. Device as in claim 7, **characterized in that** said excavation teeth (126) are oriented on said surface (50) defining a substantially X-shaped development.

9. Device as in claim 7, **characterized in that** said excavation teeth (126) are positioned on said surface (50) defining a substantially multiple X-shaped development.

10. Device as in claim 5 or 6, **characterized in that** said platelets (12, 112) define a surface (50) from which said excavation teeth (126) project, which are positioned on said surface (50) along a second trajectory (S) comprising at least two segments (Q, R) substantially straight and concurrent in correspondence with the external perimeter (51) of said surface (50).

11. Device as in claim 10, **characterized in that** said excavation teeth (126) are oriented on said surface (50) defining a substantially S-shaped development.

12. Device as in claim 10, **characterized in that** said excavation teeth (126) are oriented on said surface (50) defining a substantially multiple S-shaped development.

13. Device as in any claim hereinbefore, **characterized in that** it comprises at least a pair of milling wheels (13), facing each other and connected to an excavation head (11) by means of a fork support (17) made in a single piece.

14. Device as in claim 13, **characterized in that** said

fork support (17) comprises an attachment platelet (40) to said excavation head (11), from said platelet (40) two support surfaces (41) extending parallel to each other, in a direction substantially perpendicular to said axis (X), said support surfaces (41) each comprising a flange (47), so as to define overall a housing seating (43) in which a shaft (44) is able to be rotatably housed, rotating around said axis (X), said shaft (44) being able to be driven by said transmission means (25) and being solidly connected with said milling wheels (13).

15. Device as in claim 14, **characterized in that** said support surfaces (41) are each associated with a support hub (45) which is solidly connected both with said shaft (44), and also with a respective milling wheel (13).

16. Device as in claim 15, **characterized in that** each hub (45) is maintained in said housing seating (43) by means of a corresponding threaded pin (48) and hydraulic tightening nut (46), coaxial to said shaft (44).

17. Device as in any claim from 14 to 16, **characterized in that** it comprises a toothed wheel (15) interposed between said support surfaces (41), said toothed wheel (15) being parallel and made solid with respect to said milling wheels (13) by means of said shaft (44), said toothed wheel (15) cooperating with said transmission means (25), in order to draw in rotation said milling wheels (13).

18. Device as in any claim hereinbefore, **characterized in that** it comprises debris discharge means (28).

19. Excavation device comprising:

- at least a pair of milling wheels (13) with a substantially horizontal axis of rotation (X), each one equipped peripherally with excavation means (26), able to define an excavation front (24) substantially parallel to said axis (X);
- chain-type transmission means (25) able to draw in rotation said milling wheel (13), said transmission means (25) being driven by drive means (20) and also being provided, on the side that is external during use, with excavation means (26), **characterized in that** said pair of milling wheels (13) is connected to an excavation head (11) by means of a fork support (17) made in a single piece.

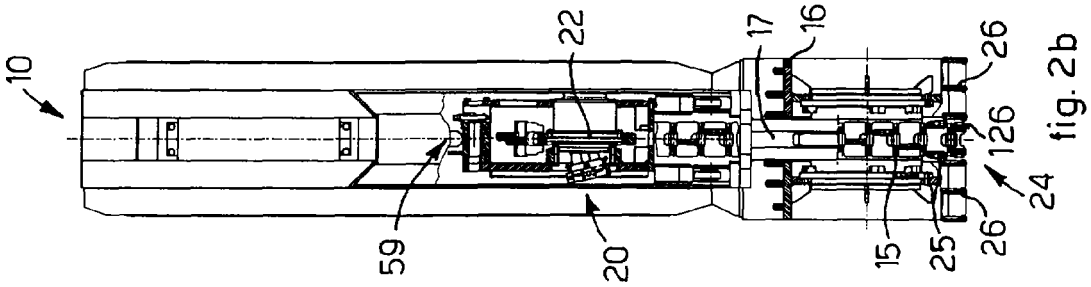

fig. 2b

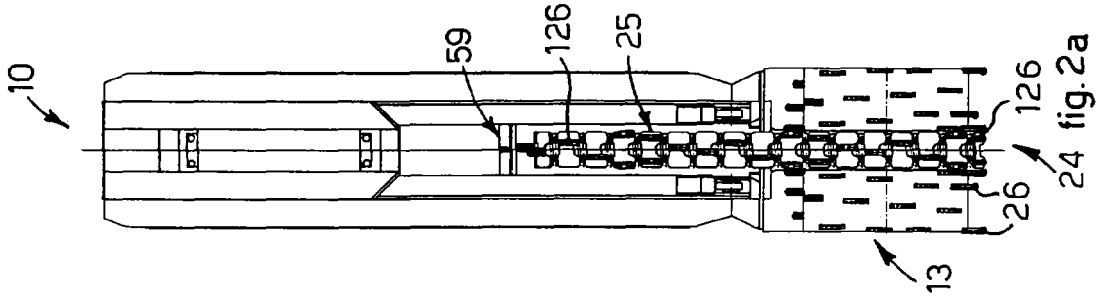

fig.2a

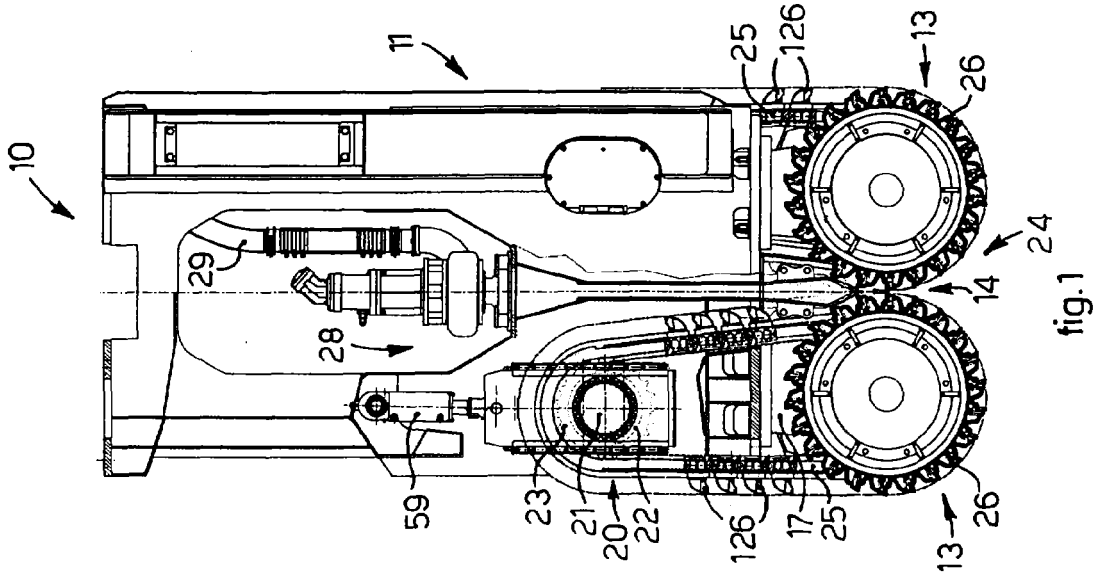

fig.1

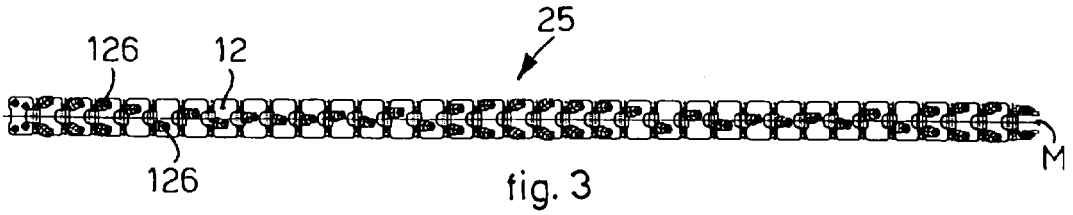

fig. 3

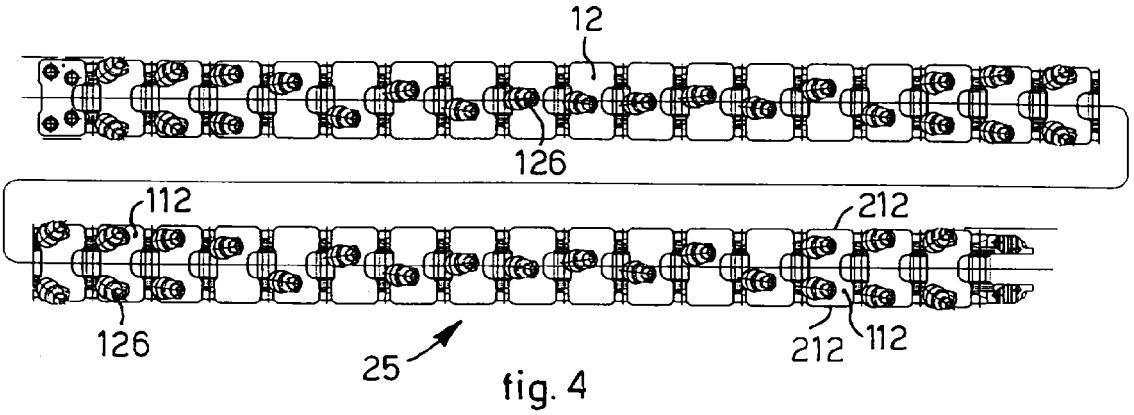

fig. 4

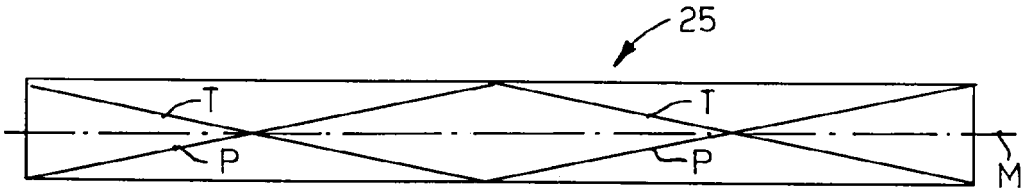

fig. 5

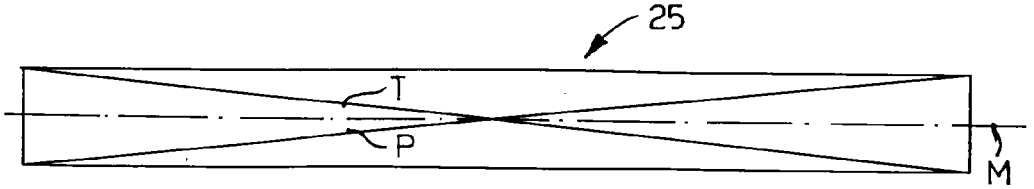

fig. 6

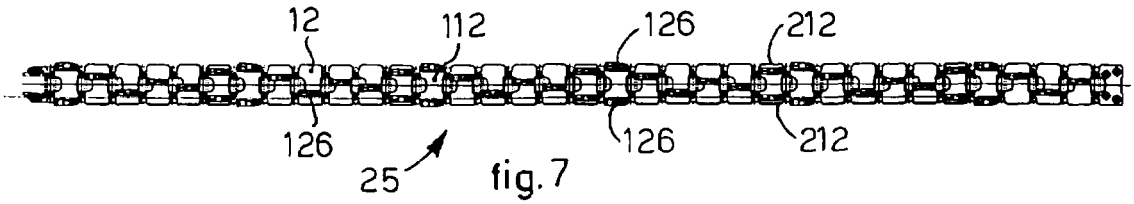

fig. 7

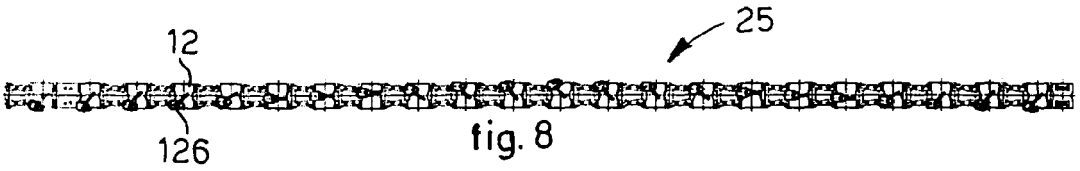

fig. 8

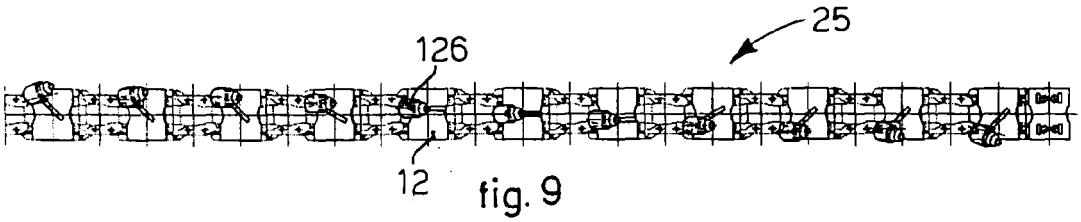

fig. 9

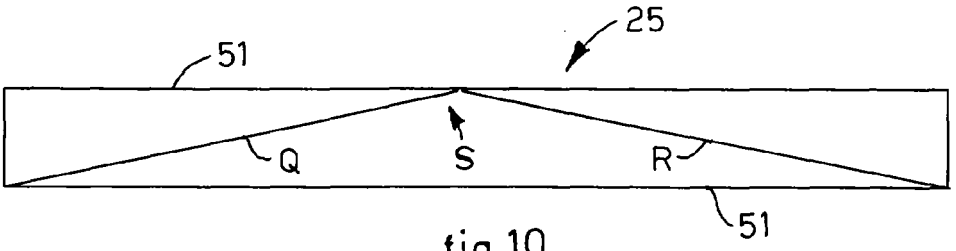

fig. 10

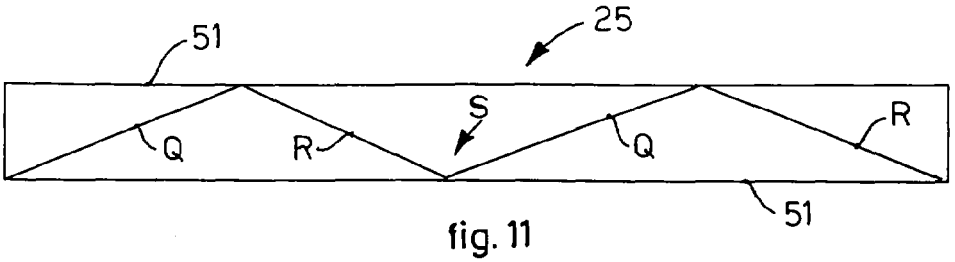

fig. 11

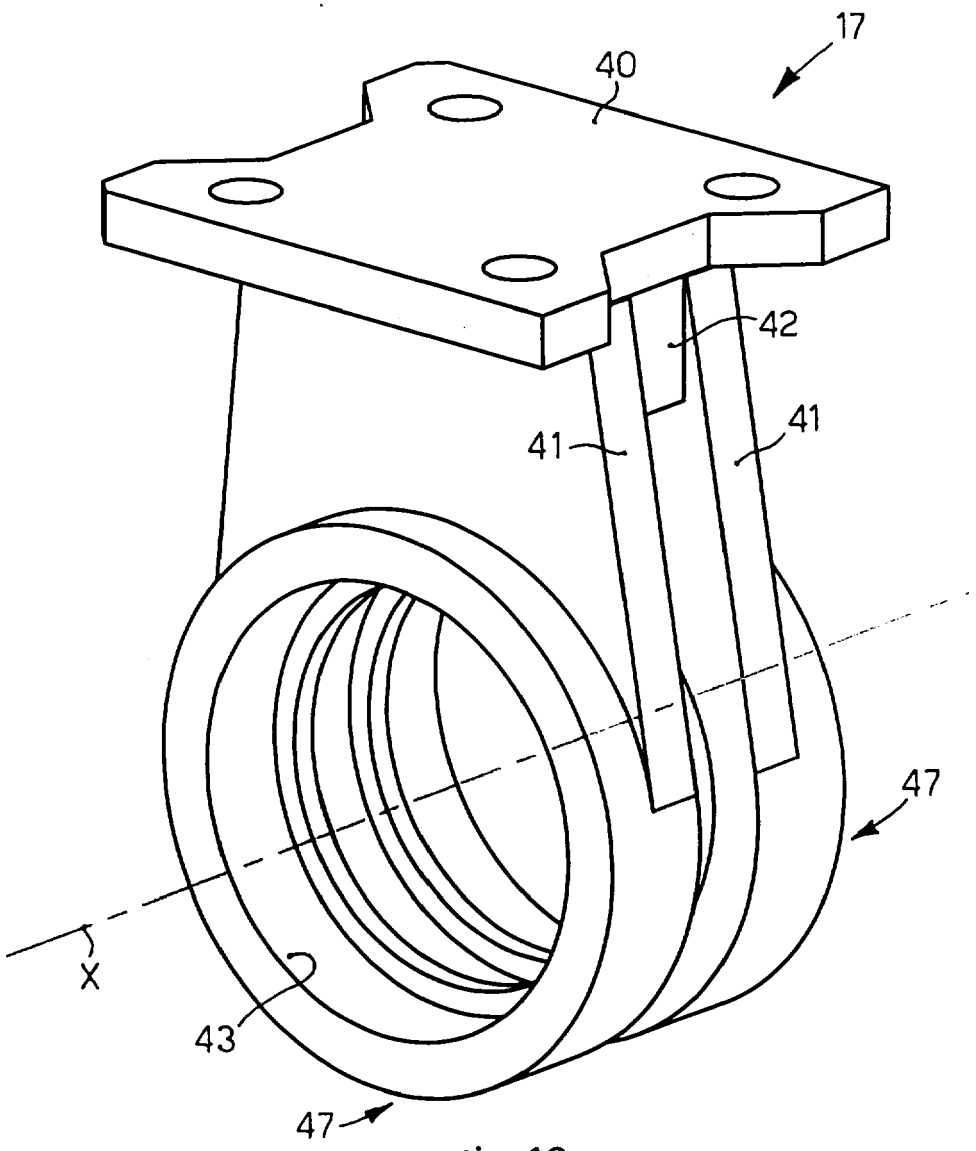

fig. 12

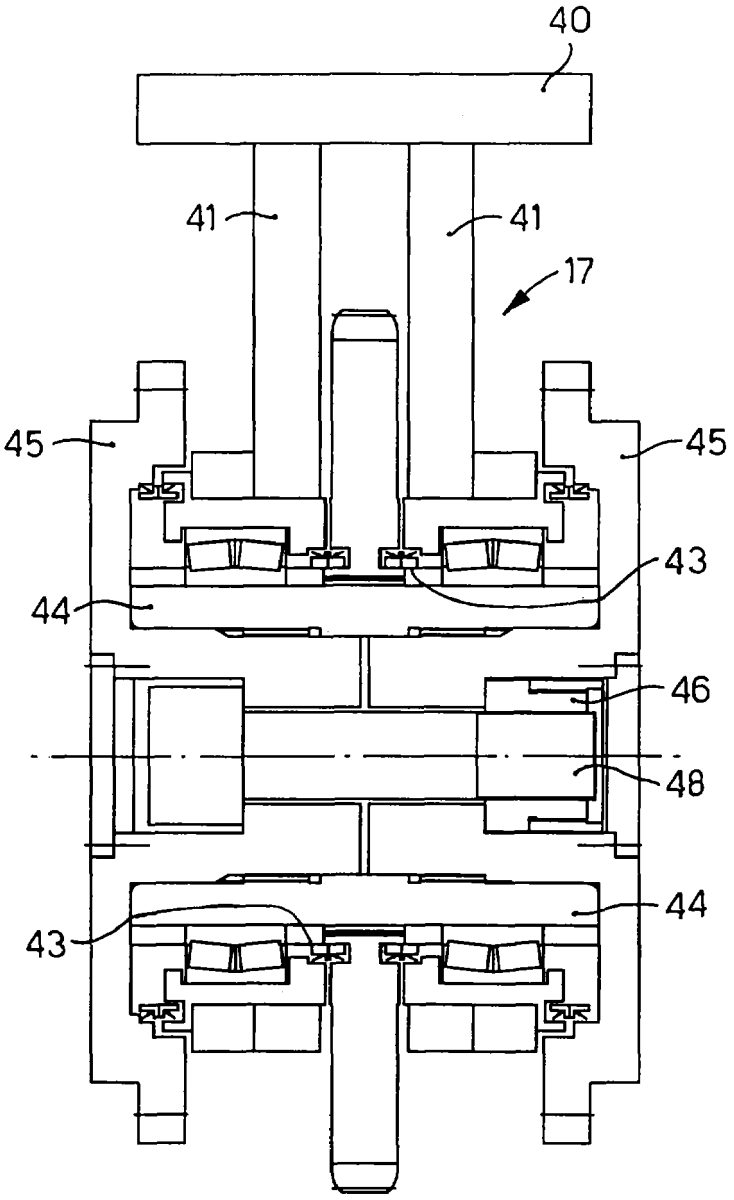

fig. 13

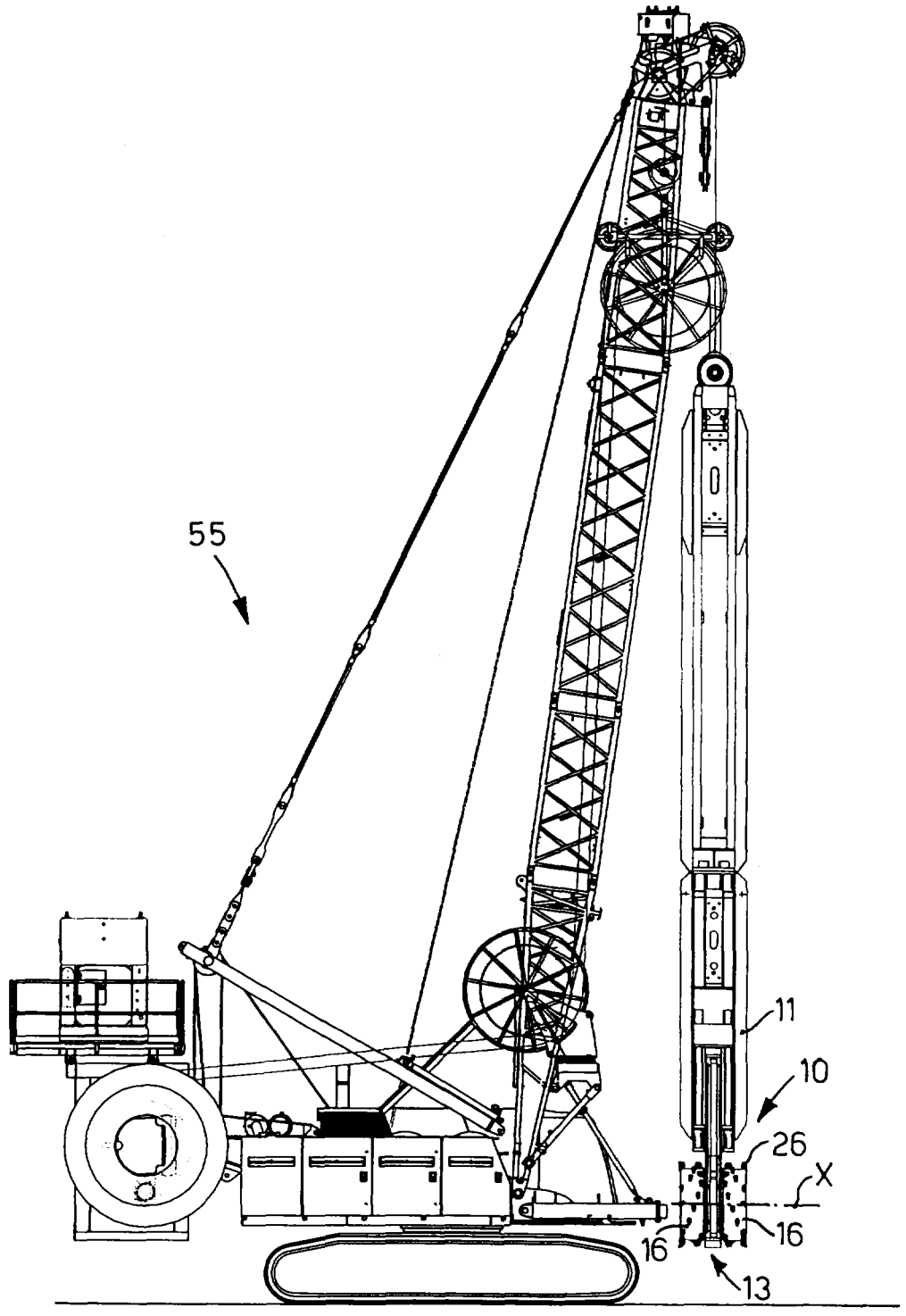

fig. 14

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 10 6366

DOCUMENTS CONSIDERED TO BE RELEVANT

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E02D
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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	1 August 2007	Geiger, Harald

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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