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(54) **Trench cutting apparatus**

(57) A trench cutting apparatus (2) for cutting a trench in the sea bed supporting a pipe is disclosed. The apparatus comprises a tractor (8) and tracks (14) for engaging the sea bed and supporting the tractor. A first chain cutter (18) for cutting a first trench portion in the sea bed on a first side of the pipe cooperates with a second chain cutter (20) for cutting a second trench portion on a second side

of the pipe and the first and second chain cutters are spaced from each other in a direction of travel of the apparatus, such that the first and second chain cutters cooperate with each other to form a trench (28) below the pipe while leaving uncut sea bed material 34 between the pipe and the trench.

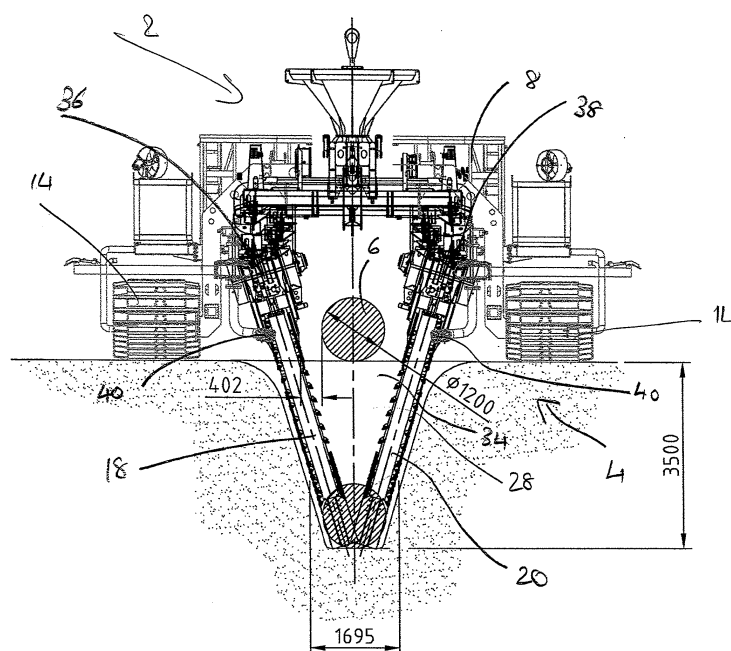


FIG 5

Description

[0001] The present invention relates to a trench cutting apparatus for cutting a trench through a floor of a body of water supporting an elongate object, and relates particularly, but not exclusively, to a trench cutting apparatus for cutting a trench on the sea bed supporting a pipe or cable.

[0002] IT1228784 discloses a trench cutting apparatus for cutting a trench below a pipe in which inclined chain cutters are angled towards each other to cut a V-shaped trench. This arrangement suffers from the drawback that it is of complicated construction, and it is not possible to easily adjust the depth of trench cut by the apparatus. Furthermore, this apparatus suffers from the drawback that there is a risk that the cutters may come into contact with and cause damage to the pipe underneath which a trench is being cut.

[0003] EP1985766 discloses a trench cutter in which a pipe is lifted from the sea floor while three inclined chain cutters cut a trench into which the pipe is subsequently placed. This arrangement suffers from the drawback that lifting the pipe away from the cutters increases the risk of damage to the pipe, but there is a risk of damage to the pipe by the cutters if the pipe is not lifted.

[0004] Preferred embodiments of the present invention seek to overcome one or more of the above disadvantages of the prior art.

[0005] According to the present invention, there is provided a trench cutting apparatus for cutting a trench in a floor of a body of water supporting an elongate object, the apparatus comprising:

- (i) a body portion;
- (ii) floor engaging means for engaging a floor of a body of water and for supporting the body portion;
- (iii) first trench cutting means for cutting a first trench portion in the floor on a first side of an elongate object; and
- (iv) second trench cutting means for cutting a second trench portion in the floor on a second side of the elongate object;

wherein said apparatus is adapted to move relative to said elongate object and at least part of said first trench cutting means is spaced from at least part of said second trench cutting means in a direction of travel of said apparatus in use, such that said first trench cutting means and said second trench cutting means co-operate with each other to at least partially form a trench below the elongate object while leaving uncut material of said floor between the object and the trench.

[0006] By providing at least part of a first trench cutting means spaced from at least part of a second trench cutting means in a direction of travel of the apparatus in use, such that the first trench cutting means and the second trench cutting means co-operate with each other to at least partially form a trench below the elongate object

while leaving uncut material of the floor between the object and the trench, this provides the advantage that in certain circumstances less energy is consumed in cutting the trench, since the uncut floor material between the object and the trench can at least partially break up under its own weight when under tension, while also enabling the region of uncut floor material left by the first and second trench cutting means to be sufficiently large to prevent the elongate object from coming into contact with the first and second trench cutting means. The advantage is also provided that the apparatus can be constructed more compactly and with less weight. By providing at least part of the first and second trench cutting means spaced from each other in a direction of travel of the apparatus, this also provides the advantage that the trench portions cut as the apparatus moves forward relative to the object can be made to intersect each other, which, by suitable pivoting of parts of the first and second trench cutting means relative to the body portion, can enable trenches of adjustable depth to be cut.

[0007] The first trench cutting means and second trench cutting means may be adapted to co-operate with each other to form trenches of adjustable depth.

[0008] At least part of said first trench cutting means may be pivotable relative to said body portion about a first axis, and at least part of said second trench cutting means may be pivotable relative to said body portion about a second axis.

[0009] This provides the advantage of enabling trenches of adjustable depths to be cut in a convenient manner.

[0010] At least part of said first trench cutting means and at least part of said second trench cutting means may be pivotable relative to said body portion to avoid contact with said elongate object.

[0011] This provides the advantage of avoiding damage to the elongate object if, for example, soft floor material should be encountered through which the elongate object can sink under its own weight.

[0012] The apparatus may further comprise detecting means for detecting the elongate object.

[0013] The detecting means may be adapted to detect the elongate object in front of and/or behind said first and said second trench cutting means.

[0014] The apparatus may further comprise support means for supporting said elongate object behind said first and second trench cutting means.

[0015] This provides the advantage of minimising the risk of damage to the elongate objects as it moves into the newly formed trench behind the apparatus.

[0016] The detecting means and/or the support means may comprise at least one roller for engaging the elongate object.

[0017] The apparatus may be adapted to engage the elongate object substantially without lifting the elongate object relative to the floor of the body of water.

[0018] This provides the advantage of minimising the risk of damage to the object.

[0019] The apparatus may further comprise material

cutting means for at least partially cutting said uncut material of said floor between the trench and the elongate object.

[0020] The material cutting means may comprise jetting means for directing at least one fluid jet at said uncut material of said floor.

[0021] The apparatus may further comprise material removal means for removing cut floor material from the trench.

[0022] The apparatus may further comprise material moving means for moving material in the trench towards said first and/or second trench cutting means.

[0023] This provides the advantage of increasing the likelihood of material being removed from the trench as a result of engagement with the first and/or second trench cutting means.

[0024] The apparatus may further comprise protection means for preventing the elongate object from coming into contact with at least part of said first and/or second trench cutting means.

[0025] The protection means may be adapted to support at least part of said uncut of said floor material.

[0026] A preferred embodiment of the invention will now be described, by way of example only and not in any limitative sense, with reference to the accompanying drawings, in which:-

Figure 1 is a side view of a trench cutting apparatus embodying the present invention in a stowed condition;

Figure 2 is a side view of the apparatus of Figure 1 in a deployed condition;

Figure 3 is a plan view of the apparatus of Figure 2;

Figure 4 is a front view of the apparatus of Figure 1;

Figure 5 is a front view of the apparatus of Figure 2;

Figure 6 is a front view of the apparatus of Figure 2 with chain cutters thereof in an emergency release condition; and

Figures 7 to 14 show a sequence of inserting a pipe into a trench by means of the apparatus of Figures 1 to 6.

[0027] Referring to Figures 1 to 6, a trenching apparatus 2 for forming a trench in the sea bed 4 for receiving an elongate pipe 6 supported on the sea bed 4 comprises a body portion comprising a tractor 8 having a cable attachment point 10 for enabling the apparatus 2 to be lowered from a vessel (not shown) to the sea bed 4 by means of a cable 12, and ground engaging means is provided in the form of a pair of tracks 14 mounted on each side of the tractor 8. A set of forward rollers 16 for engaging the pipe 6 are pivotably mounted between a stowed po-

sition, shown in Figure 1, and a deployed position, shown in Figure 2, for enabling the position of the apparatus 2 relative to the pipe 6 to be controlled. First trench cutting means in the form of a first chain cutter 18 and second trench cutting means in the form of a second chain cutter 20 are pivotably mounted relative to the tractor 8 about respective first pivot axes 22, 24, the first pivot axes 22, 24 being generally transverse to a central longitudinal axis 26 (Figure 3) of the apparatus 2 and spaced apart in a direction of travel of the apparatus 2, i.e. generally parallel to the longitudinal axis 26. The first 18 and second 20 chain cutters are arranged on opposite sides of the central axis 26 of the apparatus 2 as shown in Figure 5, and are pivotable about the respective first pivot axes 22, 24 between the stowed position shown in Figures 1 and 4 and a deployed position shown in Figures 2 and 5 to cut a generally V-shaped trench 28 (Figure 5) below the pipe 6 supported on the sea bed 4, leaving uncut sea bed material 34 between the pipe 6 and the trench 28.

[0028] The first 18 and second 20 chain cutters comprise respective chain-driven tungsten carbide cutting teeth 30, and are provided with jet outlets 32 for enabling liquid jets to be directed at the uncut sea bed material 34 located between the pipe 6 and trench 28. The first 18 and second 20 chain cutters are also pivotable about respective second pivot axes 36, 38 (Figure 5) arranged generally parallel to the longitudinal axis 26 of the apparatus 2 and are pivotable between the trenching position shown in Figure 5, and an emergency release position shown in Figure 6, in which the pipe 6 can sink into soft sea bed material without coming into contact with the first 18 or second 20 chain cutter.

[0029] Material removal means, in the form of forward dredge pumps 40 (Figures 4 and 5) arranged adjacent respective upper portions of the first 18 and second 20 chain cutters, enables cut sea bed material raised to an upper part of the trench 28 by the action of the first 18 and second cutters to be removed from the V-shaped trench 28 such that the first 18 and second 20 cutters form V-shaped trench 28 leaving the uncut sea bed material 34 between the pipe 6 and the trench 28. This action is assisted by material moving means in the form of a respective rear scraper 42 mounted to the booms of the first 18 and second 20 chain cutter. The scrapers 42 urge sea bed material cut by the chain cutters 18, 20 to the bottom of the newly cut trench 28 towards the lower part of the chain cutters 18, 20, thereby enabling the first 18 and second 20 chain cutters to transport some of the cut sea bed material towards the forward dredge pumps 40 for removal from the trench 28.

[0030] Further material removal means, in the form of a rear dredge pump 44 pivotable between a stowed position shown in Figure 1 and a deployed position shown in Figure 2, enables sea bed material falling into the trench 28 rearwardly of the apparatus, for example as a result of collapse of the walls of the trench 28 or cut sea bed material which has passed over the scrapers 42, to be removed from the trench 28. A rear pair of rollers 46

for engaging the pipe 6 enables the position of the apparatus 2 relative to the pipe 6 to be controlled, and may also assist in supporting the pipe 6 rearward of the tractor 8, although it will be appreciated that the rollers 46 may also engage the pipe 6 without supporting it.

[0031] The operation of the apparatus 2 shown in Figures 1 to 6 will now be described with reference to Figures 7 to 14.

[0032] In an initial condition, the rear dredge pump 44, first 18 and second 20 chain cutters, and front 16 and rear 46 rollers of the apparatus 2 are in the stowed condition shown in Figure 1, and the apparatus 2 is lowered from a vessel (not shown) by means of a cable 12 attached to the attachment point 10 so that the tractor 8 is located with its longitudinal axis 26 generally above and parallel to that of the pipe 6, with one of its tracks 14 resting on the sea bed 4 on each side of the pipe 6, as shown in Figures 4 and 7.

[0033] The front 16 and rear 46 rollers are then pivoted about their respective pivot axes into engagement with opposite sides of the pipe 6 forwardly and rearwardly of the tractor 8, as shown in Figure 8. The first 18 and second 20 chain cutters are then pivoted about their respective first pivot axes 22, 24 relative to the tractor 8 to form a shallow inclined trench on each side of the pipe 6 as shown in Figure 9 as the apparatus 2 is driven in the direction of arrow A. As the apparatus 2 is moved further forwards in the direction of arrow A in Figure 9, the rear rollers 46 are lowered further and inclined relative to the pipe 6 to engage respective lower side surfaces of the pipe 6 as shown in Figures 10. The rear dredge pump 44 is then lowered relative to the tractor 8 to remove cut sea bed material from the bottom of the trench 28 as shown in Figure 11, and at the same time, the first 18 and second 20 chain cutters are pivoted further about their respective pivot axes 22, 24 to increase the depth of the trench 28 as the apparatus 2 moves forwards.

[0034] As the apparatus 2 moves further forwards, the first 18 and second 20 chain cutters are further pivoted about their respective pivot axes 22, 24 to the full depth of the trench 28, thereby forming a V-shaped trench 28 below the pipe 6, leaving a region of uncut sea bed material 34 between the pipe 6 and the trench 28, as shown in Figures 5 and 12. This prevents the pipe 6 from coming into contact with the first 18 and second 20 chain cutters, thereby avoiding damage to the pipe 6. At the same time, protection means in the form of wear plates (not shown) arranged between the pipe and the first 18 and second 20 chain cutters prevents the pipe 6 from coming into contact with the chain cutters 18, 20 in the event of unexpected movement of the pipe 6 (for example as a result of encountering soft sea bed material), and the wear plates also serve to support uncut sea bed material below the pipe 6.

[0035] Forward jetting pumps (not shown) emit jets of liquid through jetting outlets 32 arranged in the first 18 and second 20 chain cutters, which serve to break up the uncut sea bed material 34 located between the pipe

6 and the V-shaped trench 28, thereby assisting break-up of the uncut material under its own weight under tension. In the arrangement shown in Figure 14, the apparatus 2 is shown cutting the trench 28 at its full intended depth, and the pipe 6 is supported by the sea bed 4 at a location 48 in front of the trench 28 and by the bottom of the trench at a location (not shown) rearward of the apparatus 2. In the event of suddenly encountering soft sea bed material through which the pipe 6 can sink, the first 18 and second 20 chain cutters can be pivoted about their respective second pivot axes 36, 38 into a generally vertical arrangement as shown in Figure 6, thereby allowing the pipe 6 to sink without the pipe 6 coming into contact with the first 18 or second 20 chain cutter.

[0036] It will be appreciated by persons skilled in the art that the above embodiment has been described by way of example only and not in any limitative sense, and that various alterations and modifications are possible without departure from the scope of the invention as defined by the appended claims.

Claims

1. A trench cutting apparatus for cutting a trench in a floor of a body of water supporting an elongate object, the apparatus comprising:

- (i) a body portion;
- (ii) floor engaging means for engaging a floor of a body of water and for supporting the body portion;
- (iii) first trench cutting means for cutting a first trench portion in the floor on a first side of an elongate object; and
- (iv) second trench cutting means for cutting a second trench portion in the floor on a second side of the elongate object;

wherein said apparatus is adapted to move relative to said elongate object and at least part of said first trench cutting means is spaced from at least part of said second trench cutting means in a direction of travel of said apparatus in use, such that said first trench cutting means and said second trench cutting means co-operate with each other to at least partially form a trench below the elongate object while leaving uncut material of said floor between the object and the trench.

2. An apparatus according to claim 1, wherein the first trench cutting means and second trench cutting means are adapted to co-operate with each other to form trenches of adjustable depth.

3. An apparatus according to any one of the preceding claims, wherein at least part of said first trench cutting means is pivotable relative to said body portion about

a first axis, and at least part of said second trench cutting means is pivotable relative to said body portion about a second axis.

4. An apparatus according to any one of the preceding claims, wherein at least part of said first trench cutting means and at least part of said second trench cutting means are pivotable relative to said body portion to avoid contact with said elongate object. 5
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5. An apparatus according to any one of the preceding claims, further comprising detecting means for detecting the elongate object.
6. An apparatus according to claim 5, wherein the detecting means is adapted to detect the elongate object in front of and/or behind said first and said second trench cutting means. 15
7. An apparatus according to any one of the preceding claims, further comprising support means for supporting said elongate object behind said first and second trench cutting means. 20
8. An apparatus according to claim 5, 6 or 7, there the detecting means and/or the support means comprises at least one roller for engaging the elongate object. 25
9. An apparatus according to any one of the preceding claims, wherein the apparatus is adapted to engage the elongate object substantially without lifting the elongate object relative to the floor of the body of water. 30
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10. An apparatus according to any one of the preceding claims, further comprising material cutting means for at least partially cutting said uncut material of said floor between the trench and the elongate object. 40
11. An apparatus according to claim 11, wherein the material cutting means comprises jetting means for directing at least one fluid jet at said uncut material of said floor. 45
12. An apparatus according to any one of the preceding claims, further comprising material removal means for removing cut floor material from the trench.
13. An apparatus according to any one of the preceding claims, further comprising material moving means for moving material in the trench towards said first and/or second trench cutting means. 50
14. An apparatus according to any one of the preceding claims, further comprising protection means for preventing the elongate object from coming into contact with at least part of said first and/or second trench

cutting means.

15. An apparatus according to claim 14, wherein the protection means is adapted to support at least part of said uncut of said floor material.

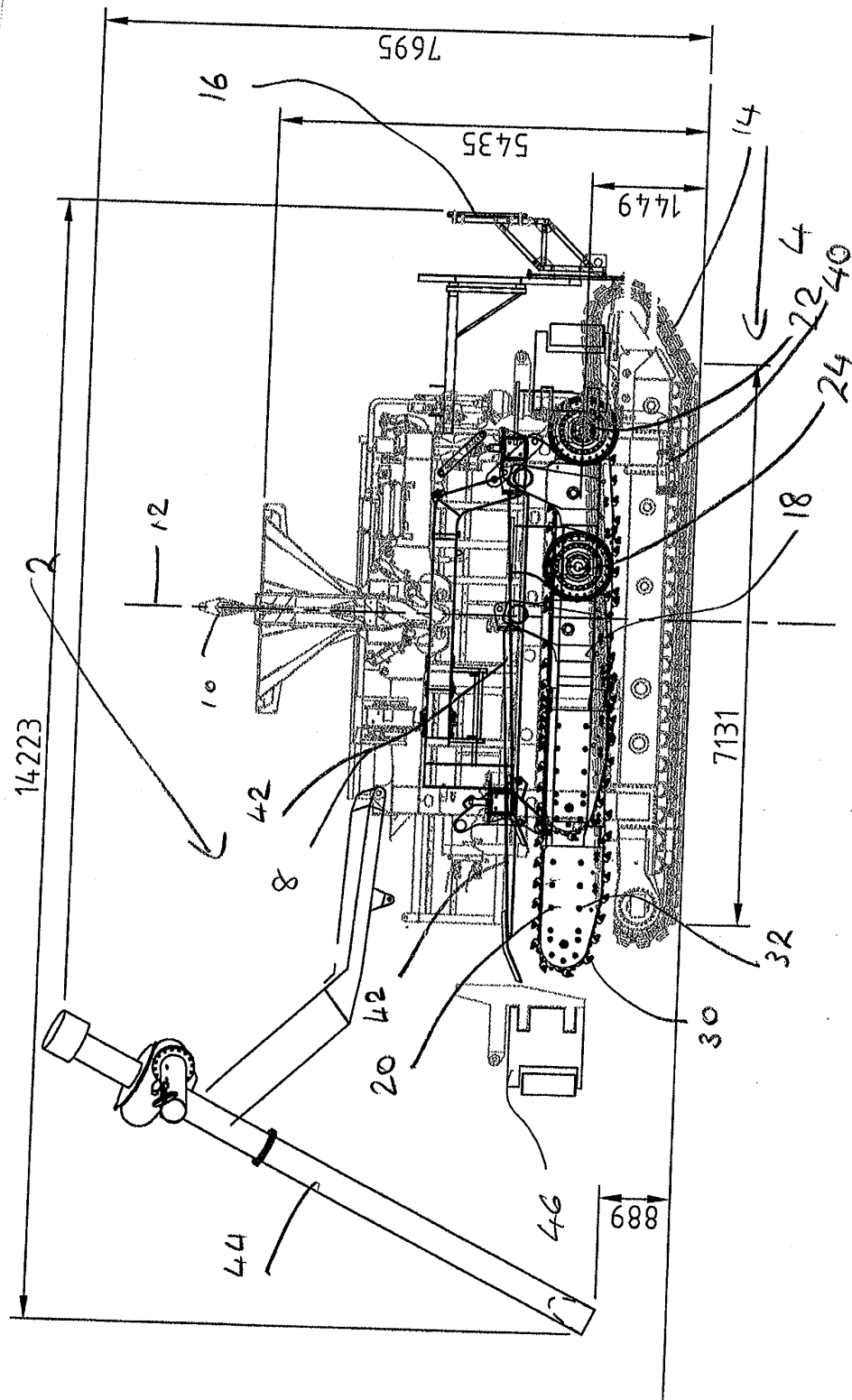


FIG 1

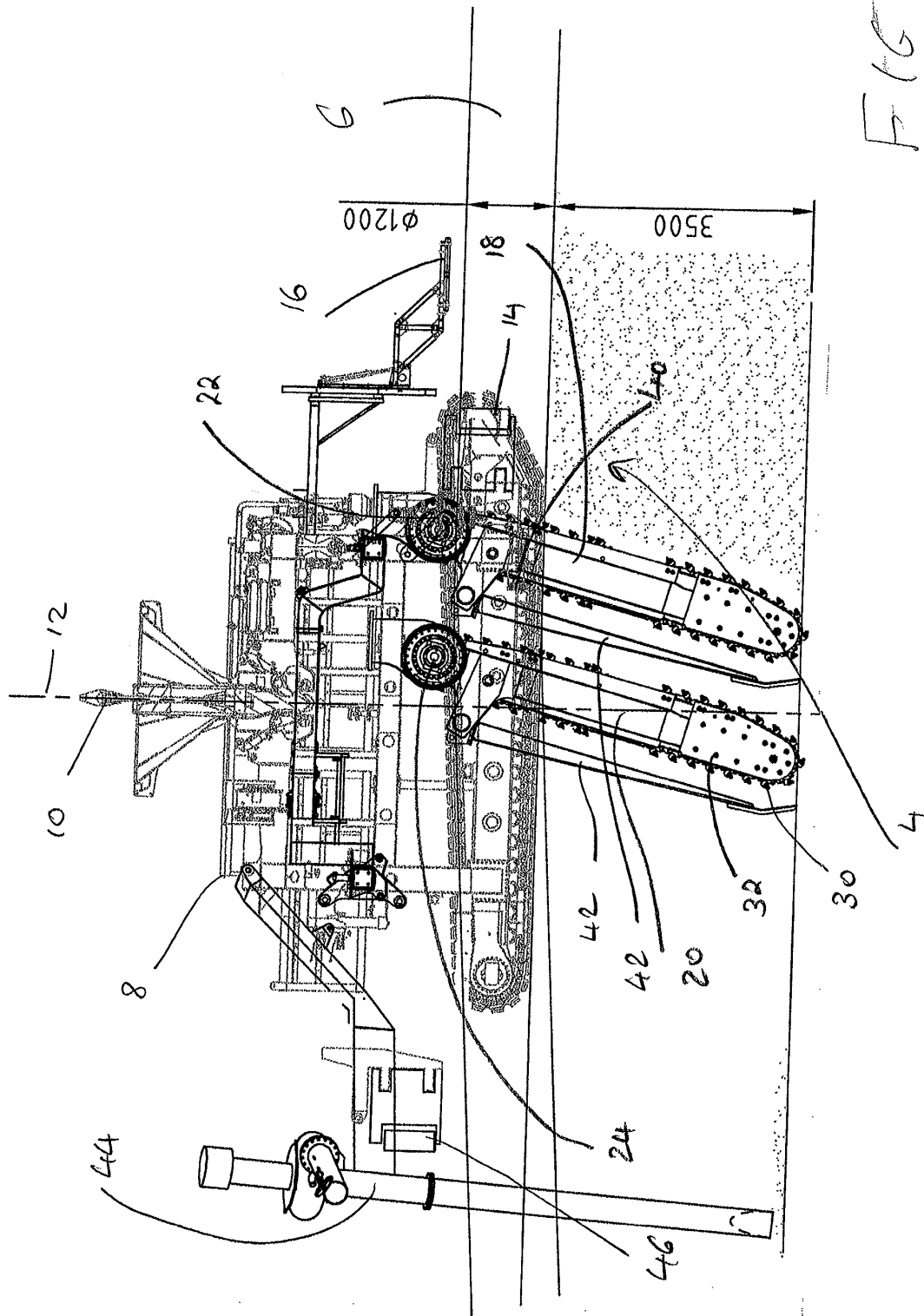


FIG 2

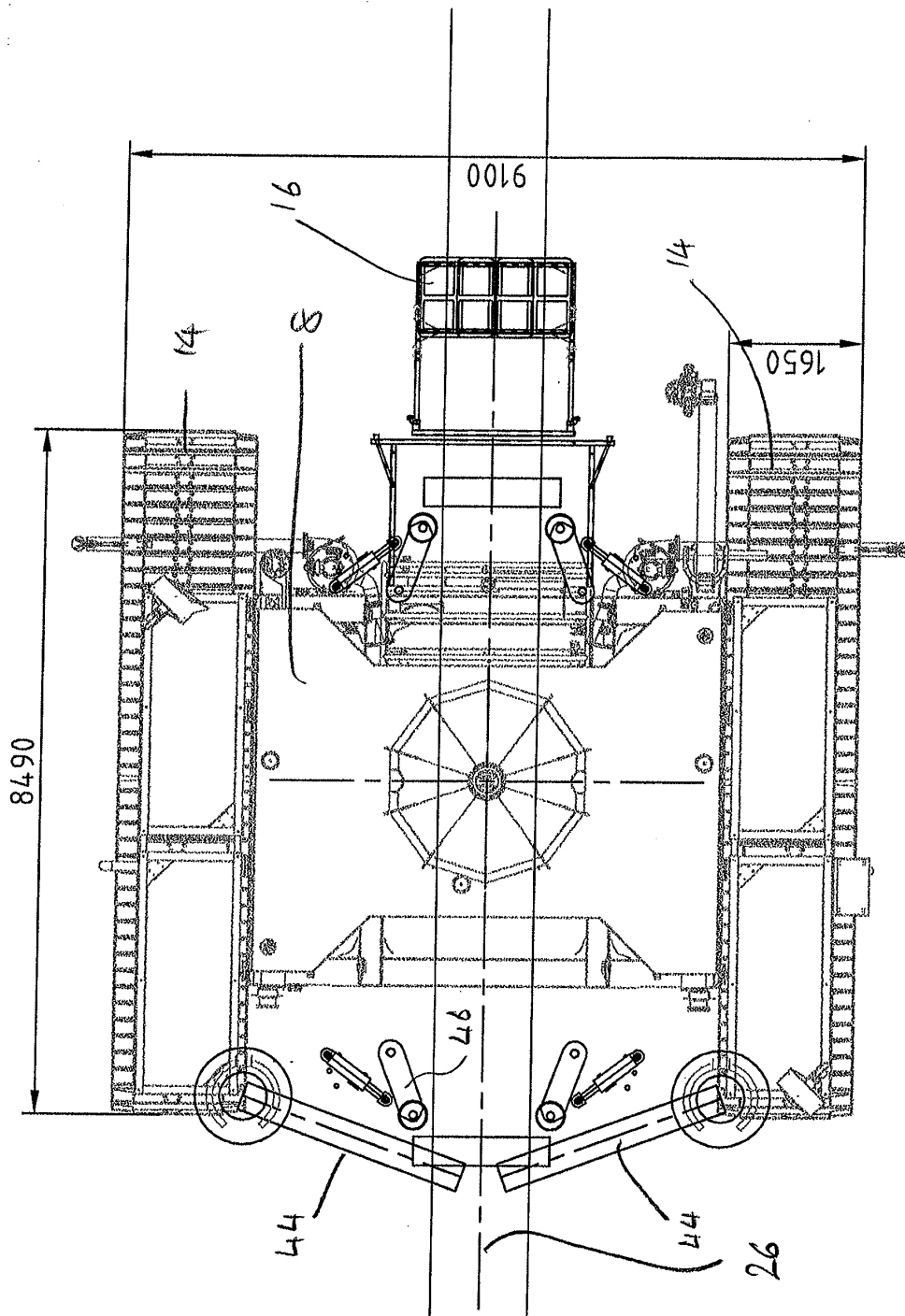


FIG 3

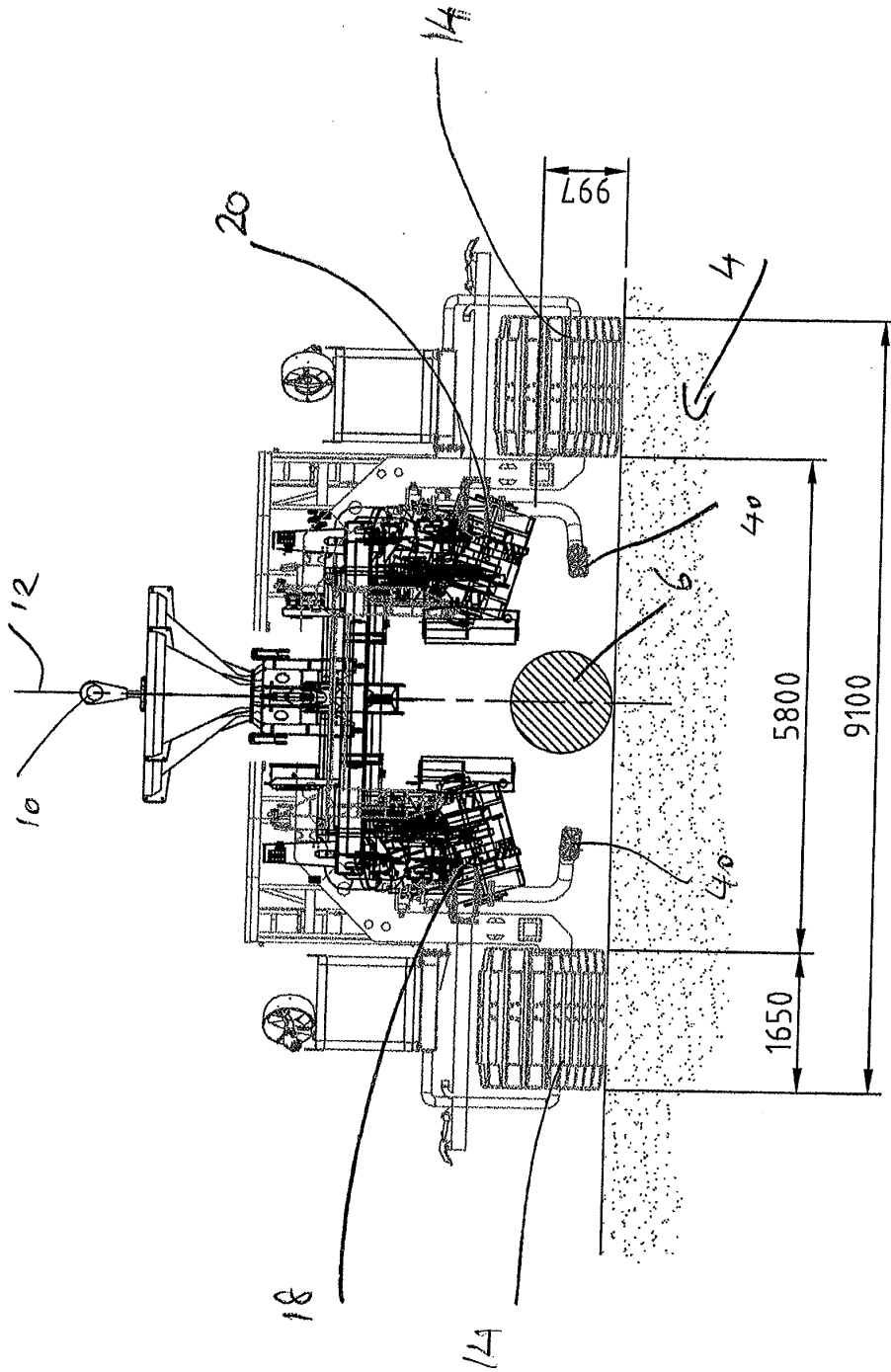
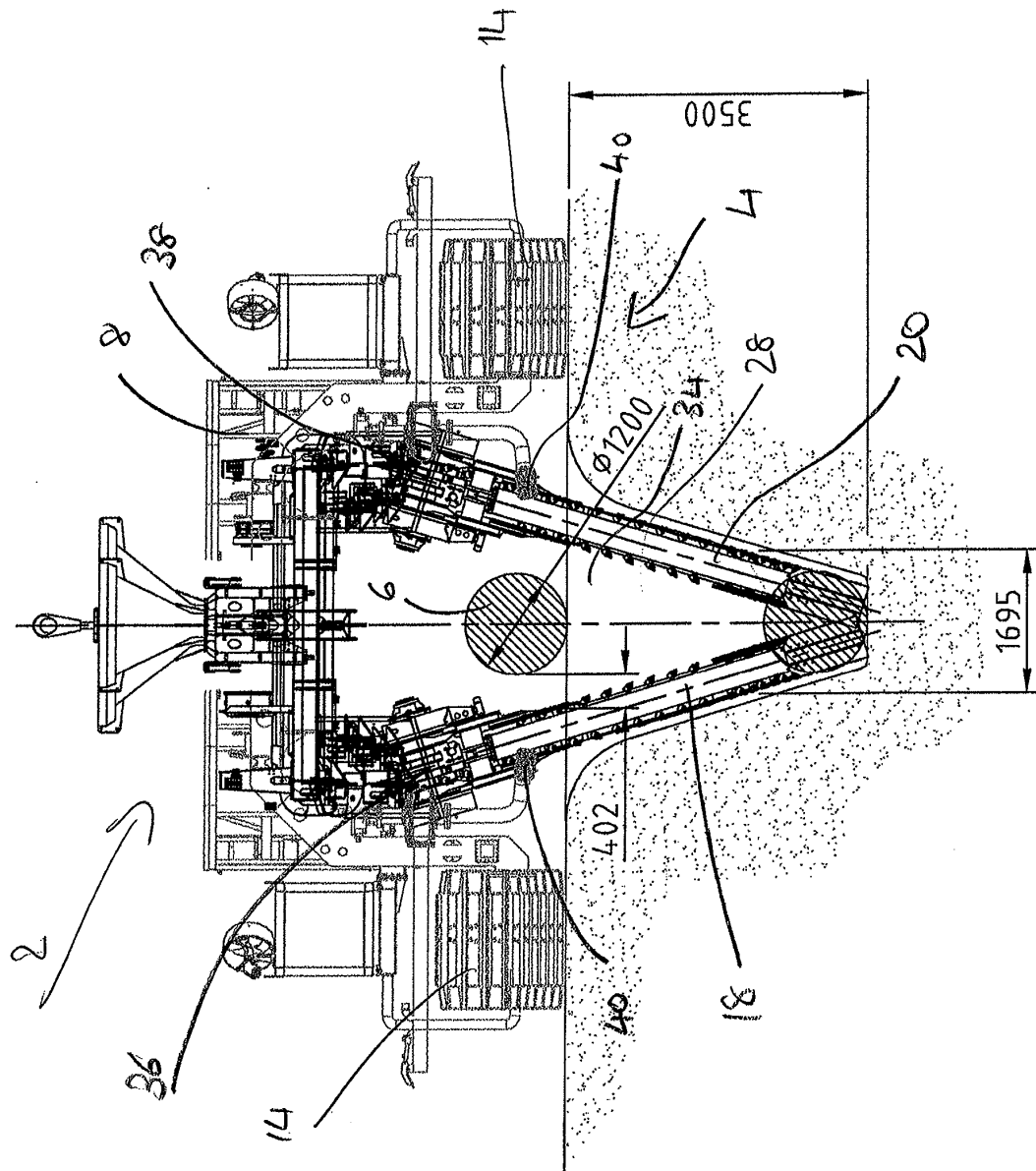
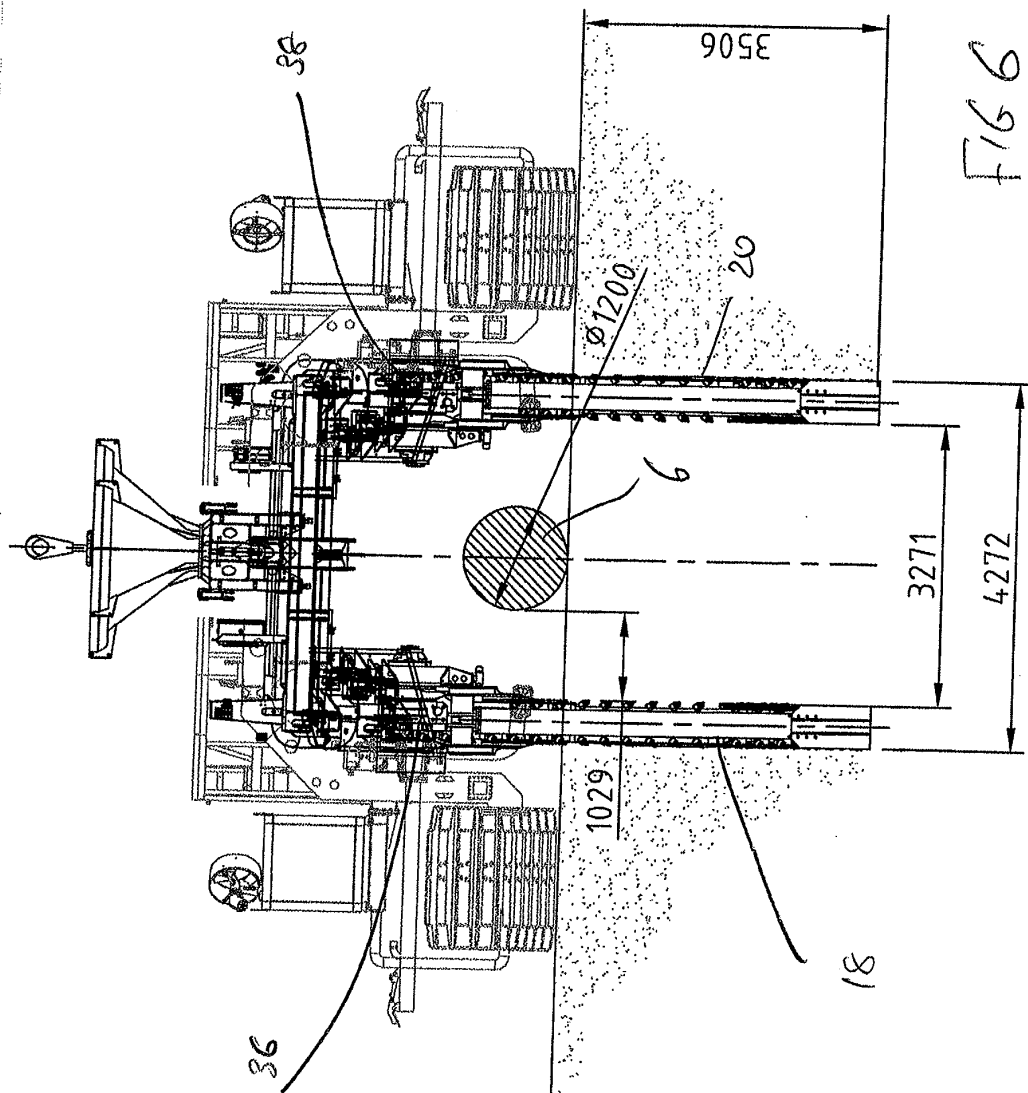


FIG 4



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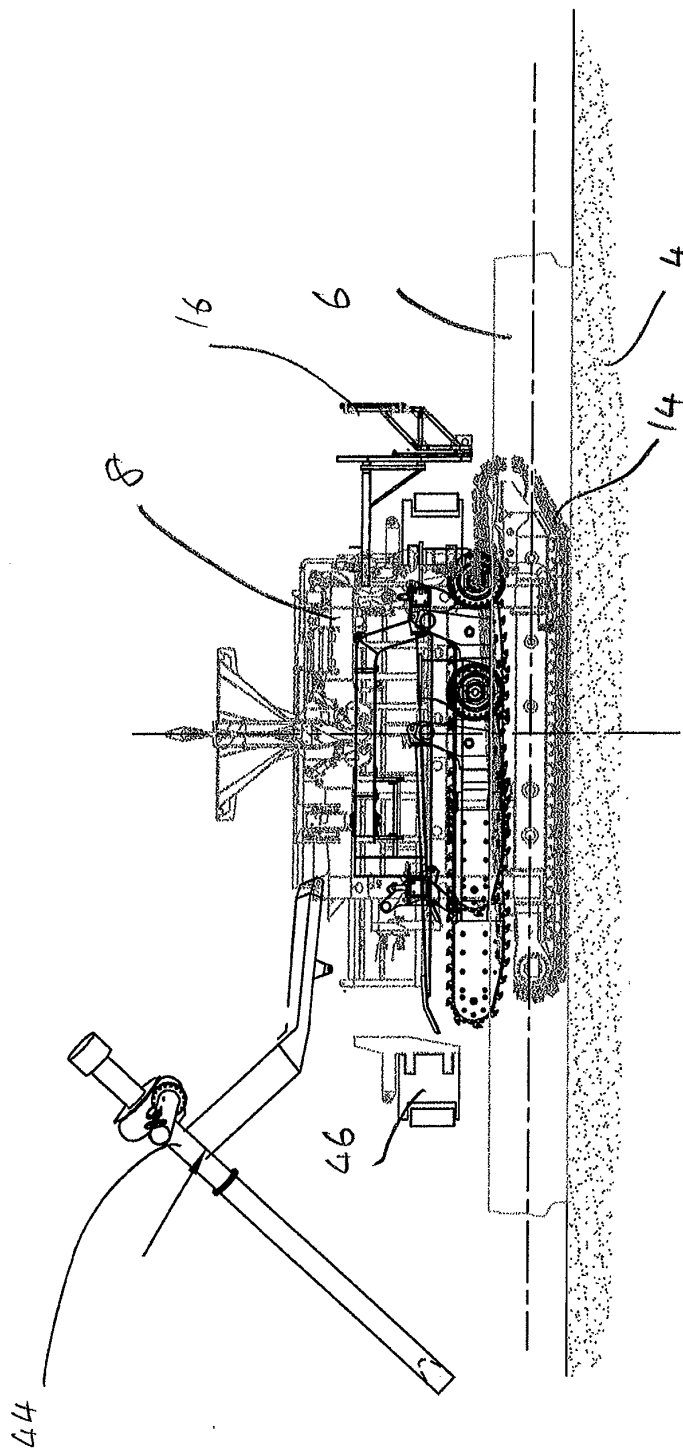


FIG 7

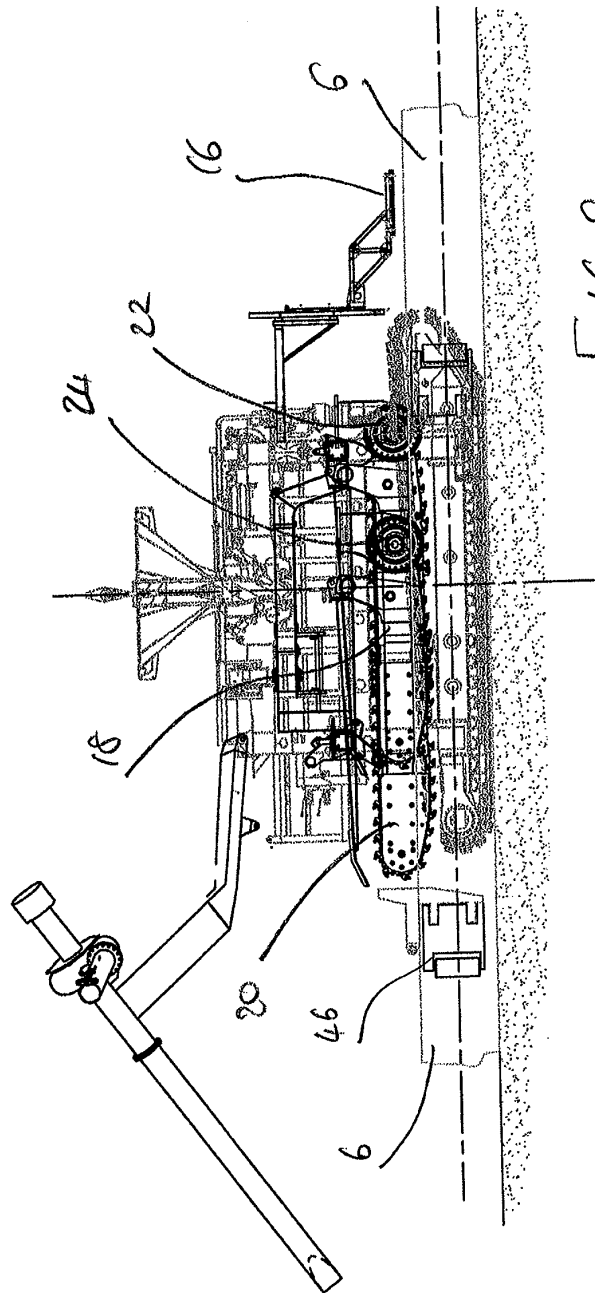
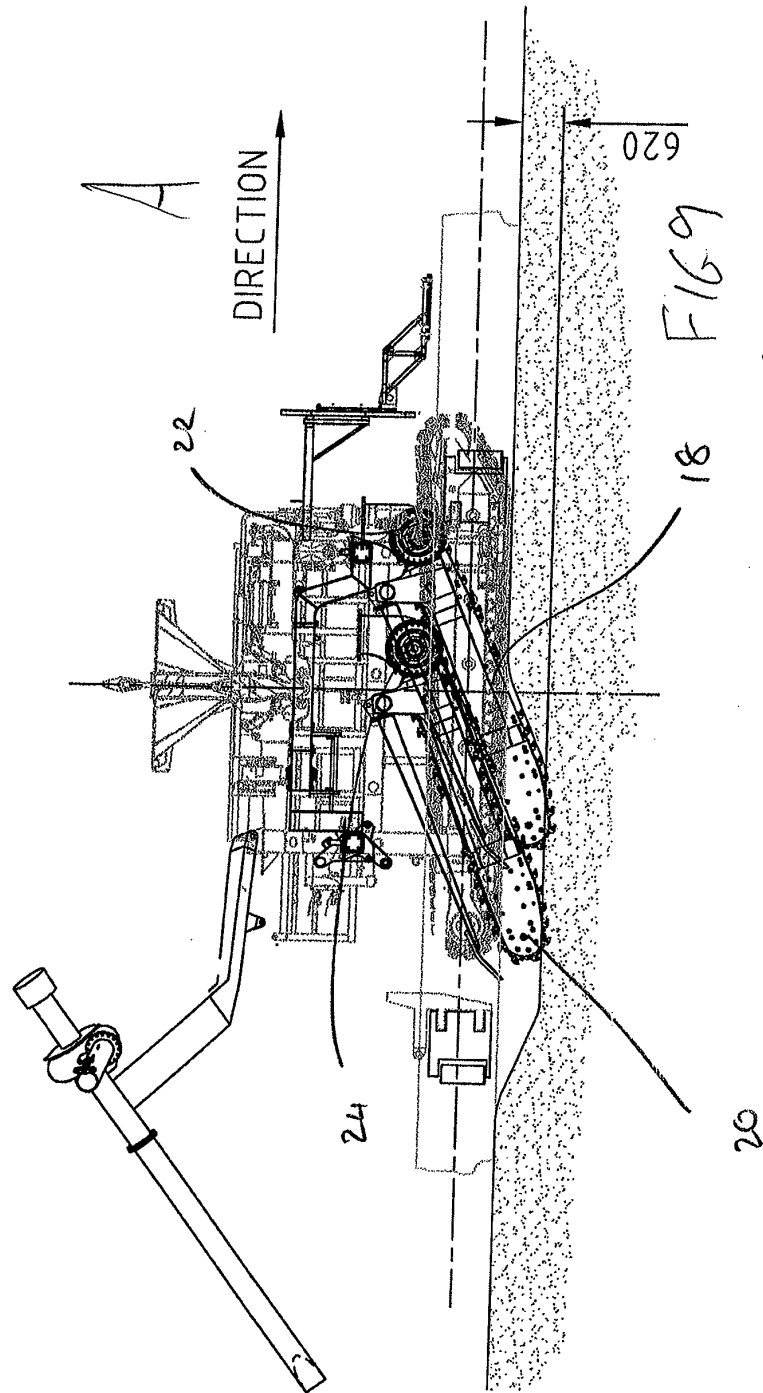
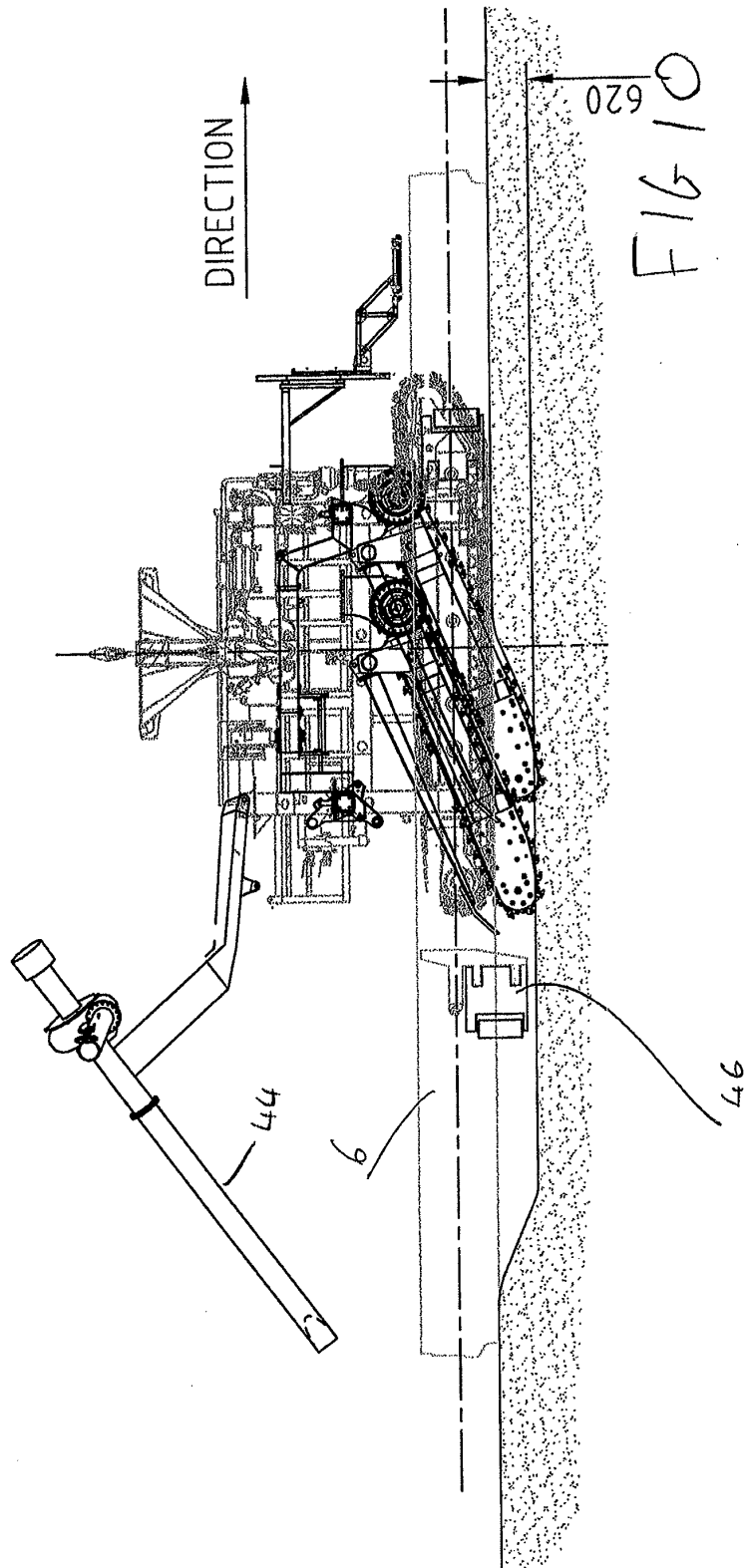
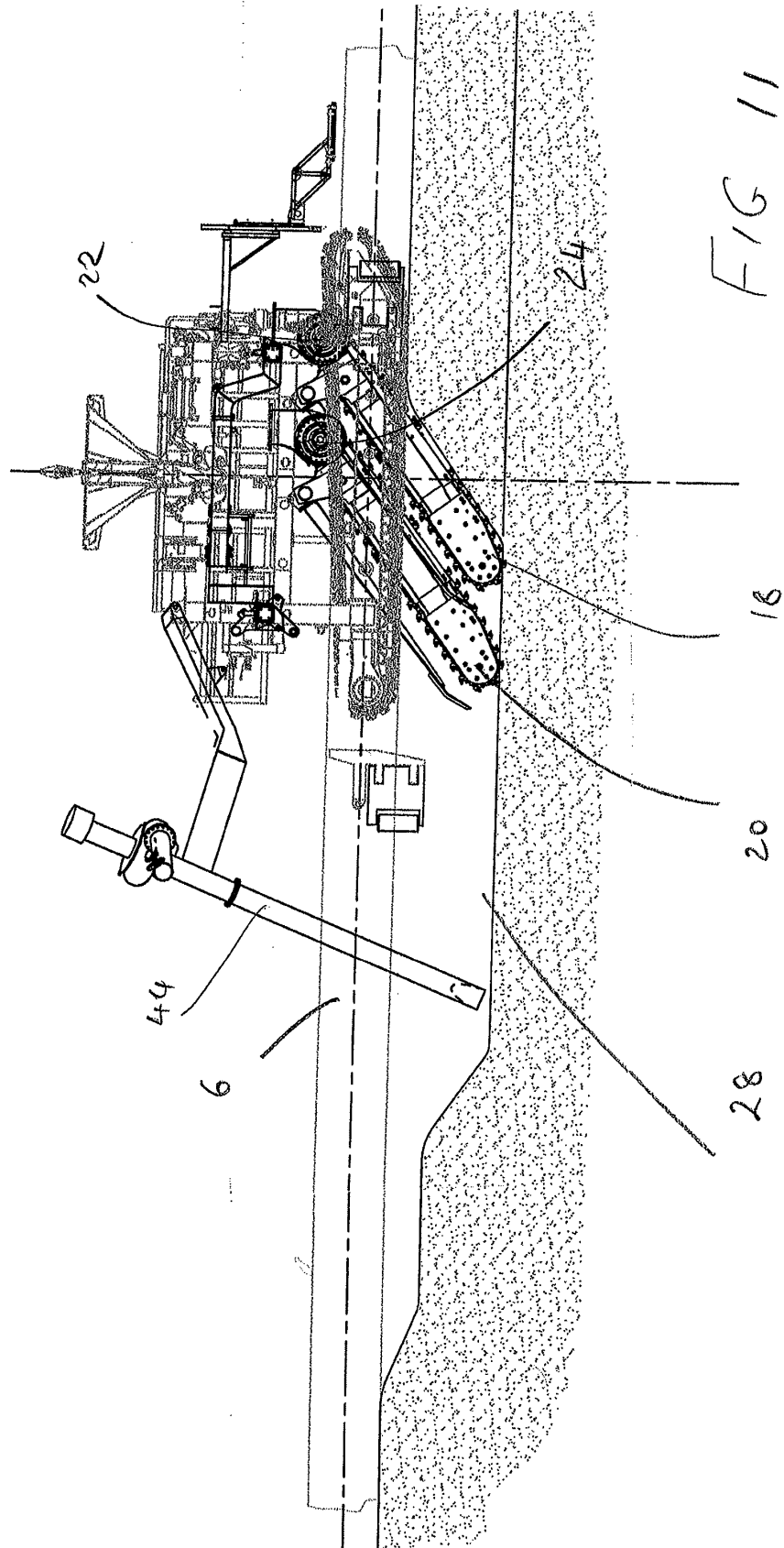
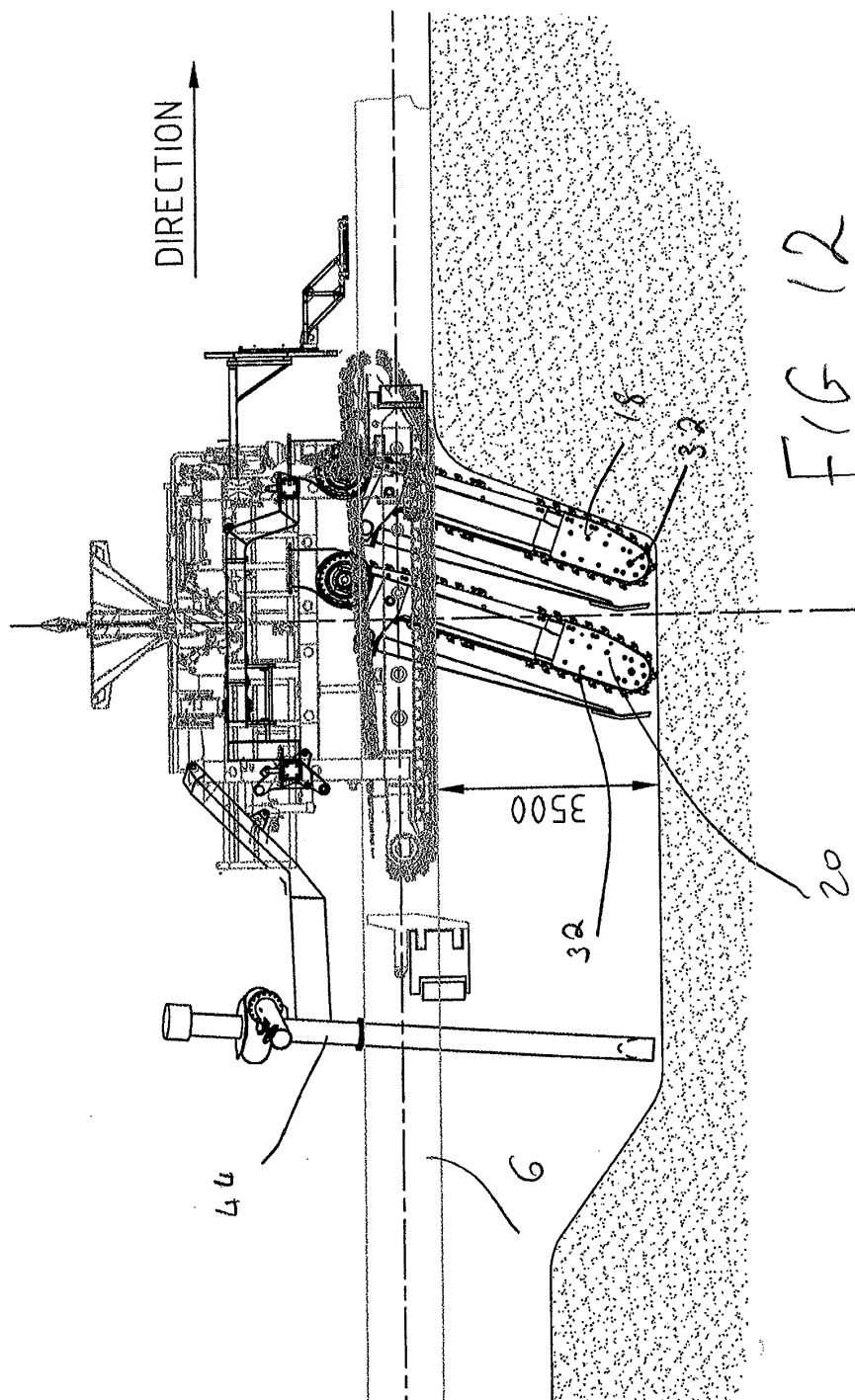


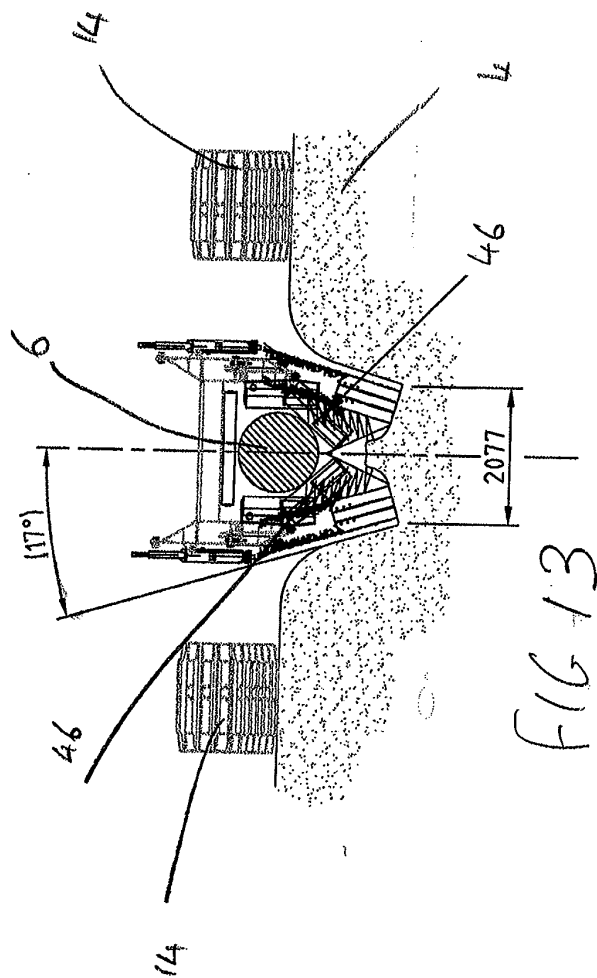
FIG 8

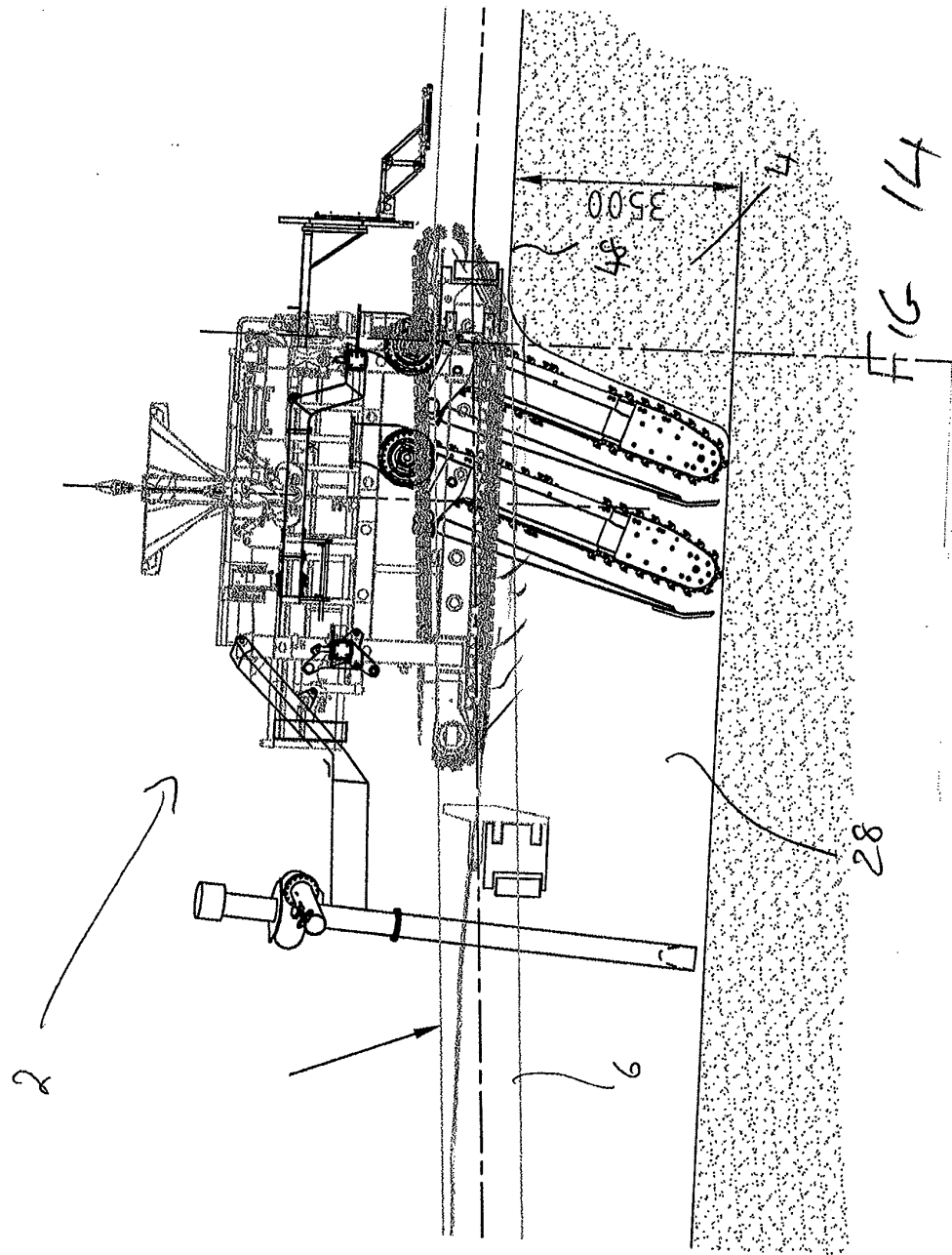














EUROPEAN SEARCH REPORT

Application Number
EP 13 16 2482

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 20 September 2013	Examiner Clarke, Alister
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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