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(54) **Drilling machine to prepare excavations for tunnels**

(57) Drilling machine (10) to prepare excavations for tunnels by making a plurality of holes and inserting mating treatment means inside, said machine (10) comprising at least a drilling assembly (20) able to make said holes on the area to be drilled and two introduction as-

semblies (30a, 30b) provided with independent movement means and arranged on opposite sides of said drilling assembly (20), each of said introduction assemblies (30a, 30b) being able to operate on a defined portion of said area to be drilled.

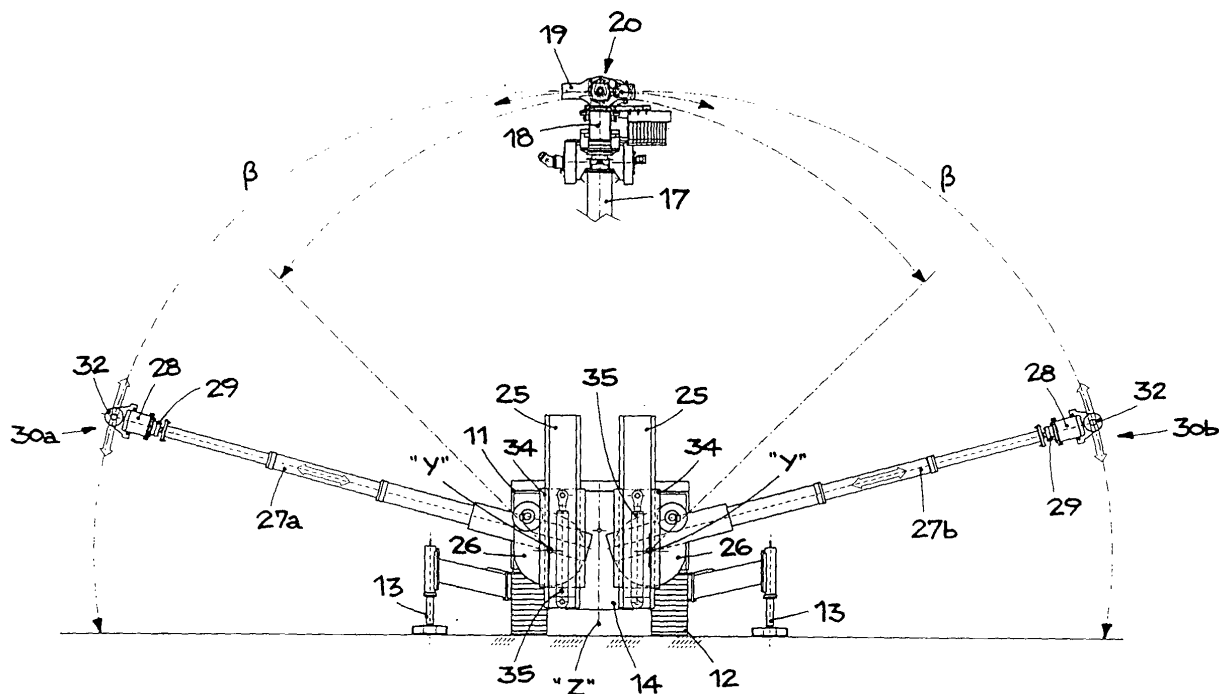


Fig. 3

Description

FIELD OF THE INVENTION

[0001] The invention concerns a drilling machine employed to prepare the excavations to make a tunnel.

[0002] The machine according to the invention is used particularly to make consolidation work in excavating tunnels by means of different techniques including those using micro-piles, anchorages, injections, jet-grouting or otherwise.

BACKGROUND OF THE INVENTION

[0003] The state of the art includes drilling machines used to prepare excavations for tunnels and able to make substantially horizontal holes in the wall which has to be excavated, and to introduce means, whether they be elements and/or substances, for consolidation work in said holes.

[0004] Such drilling machines are provided with one or two drilling assemblies, each comprising a mast, or guide beam, on which one or more rotary heads are mounted sliding longitudinally; by means of said heads the drilling instrument, generally consisting of rod elements, is made to rotate to penetrate into the ground.

[0005] Each mast is also provided with guide elements suitable to keep the drill tool on its axis, and vice means able to allow the tool to be assembled and disassembled.

[0006] The masts are mounted by means of articulated joints provided for this purpose on telescopic columns attached to rotary plates and therefore able to assume a different extension and a different inclination according to the position where the holes have to be made.

[0007] The treatment means are inserted into the ready prepared holes by means of introduction assemblies with which the drilling machines are provided and which in general are mounted on the masts supporting the rotary head of the drilling tools.

[0008] The masts are therefore extremely heavy and cumbersome, with considerable limits in terms of movement and functionality.

[0009] Moreover, when the machine is working, when the treatment means are picked up, positioned and inserted, the drilling of the holes must be interrupted, because it is impossible to use the mast simultaneously for drilling and treatment operations.

[0010] This entails a longer time to complete the working cycle and the productivity of the drilling machine is reduced.

[0011] The present Applicant has devised and embodied this invention to overcome these shortcomings and to obtain other advantages.

SUMMARY OF THE INVENTION

[0012] The invention is set forth and characterized in

the main claim, while the dependent claims describe other characteristics of the invention.

[0013] The purpose of the invention is to achieve a drilling machine to prepare excavations for tunnels which is practical and efficient and allows to optimize working times.

[0014] Another purpose of the invention is to achieve a high-productivity drilling machine which can operate continuously, simultaneously making and treating the holes over the entire drilling area.

[0015] The drilling machine according to the invention comprises a drilling assembly able to make the holes over the entire area to be drilled and two independent introduction assemblies, arranged in a counter-opposed position at the sides of the drilling assembly, able to pick up and insert the treatment means into the ready made holes.

[0016] In a preferential embodiment, the introduction assemblies are arranged symmetrical with respect to the longitudinal median plane of the drilling machine and each of them is able to operate on at least half of the area to be drilled.

[0017] According to a variant, each of the introduction assemblies is able to operate on an area greater than half of the drilling area.

[0018] The drilling assembly is supported by a pair of telescopic column elements able to rotate with respect to a horizontal axis and comprises a guide beam, or mast, for the drilling tools.

[0019] The two introduction assemblies are mounted on relative shaft supports with a variable extension; these are also able to rotate with respect to a substantially horizontal axis so as to be able to be selectively arranged between a first position in proximity with the ground and a second position wherein they are beyond the longitudinal median plane of the drilling machine.

[0020] The shaft-type supports are arranged inside the space defined between the two column elements of the drilling assembly, so as not to interfere with them.

[0021] In a preferential embodiment, each introduction assembly comprises a relative guide beam element, or mast, for the treatment means.

[0022] In one embodiment, the masts of the introduction assemblies are of the folding type and, in their condition of minimum extension, their bulk is contained in the space defined between the column elements of the drilling assembly.

[0023] According to a variant, the masts of the introduction assemblies are of the telescopic type.

[0024] The drilling assembly and the introduction assemblies are therefore provided with independent support and movement means and are therefore able to be displaced and to operate autonomously inside the drilling area without interfering with each other.

[0025] In this way it is possible to perform the drilling and the treatment of the ready made holes simultaneously and continuously, with a considerable reduction in the work times, thus increasing the productivity of the

drilling machine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] These and other characteristics of the invention will become clear from the following description of two preferential forms of embodiment given as a non-restrictive example with reference to the attached drawings wherein:

- Fig. 1 is a side view of a drilling machine according to the invention in a first embodiment;
- Fig. 2 is a schematic front view of the drilling machine in Fig. 1;
- Fig. 3 is a schematic view of a transverse section of the drilling machine in Fig. 1 in a first working position;
- Fig. 4 shows the machine in Fig. 3 in a second working position;
- Fig. 5 is a side view of a drilling machine according to the invention in a second embodiment;
- Fig. 6 is a schematic front view of the drilling machine in Fig. 5;
- Fig. 7 is a schematic view of a transverse section of the drilling machine in Fig. 5.

DETAILED DESCRIPTION OF TWO PREFERENTIAL EMBODIMENTS

[0027] With reference to the attached Figures, a drilling machine 10 according to the invention, shown in two different embodiments respectively in Figs. 1-4, and 5-7, is able to be used to prepare excavations to make tunnels.

[0028] It comprises a frame 11 mounted on a truck 12 with tracks and provided with four, hydraulically driven stabilizer rods 13 able to rest on the ground to prevent the truck 12 from moving when the drilling machine 10 is operating.

[0029] On the front and on the rear side the frame 11 extends in two extensions 14, each of which is provided with a relative support 15.

[0030] On the two supports 15 respective rotary plates 16 are mounted, with a horizontal axis of rotation "x" substantially aligned and lying on the longitudinal median plane "Z" of the drilling machine 10.

[0031] Two relative columns 17, of the telescopic type and independently driven, are associated with the two rotary plates 16. They are able to perform angular excursions α , in the two directions of rotation, of about 120° with respect to the longitudinal median plane "Z" and in any case such as to cover the whole area to be drilled.

[0032] The columns 17 support a drilling assembly 20 comprising a central mast, or guide beam, 18 along which a rotary head 19 is mounted sliding on a trolley 21 and able to make the tools or drilling rods 33 rotate.

[0033] The central mast 18 is associated with the rel-

ative columns 17 by means of articulated joints 22 which allow it to be possibly inclined in order to achieve non-horizontal holes.

[0034] On the two articulated joints 22 are mounted mating guide elements, respectively front 40 and rear 41, on which the central mast 18 is able to slide axially by adjusting two cylinders 42 and 43 associated therewith.

[0035] To be more exact, a first cylinder 42 of the differential type is associated at one end to the front guide element 40 and at the other end to the central mast 18.

[0036] The second cylinder 43, of the constant areas type, is associated at one end to the rear guide element 41 and at the other end to the central mast 18.

[0037] The central mast 18 is axially displaced, for example when it is necessary to move the drilling assembly 20 nearer to or farther from the drilling face, by activating the first cylinder 42 and by-passing, that is excluding, the second cylinder 43; in this way, while the first cylinder 42 acts in push-pull fashion on the central mast 18, moving it axially, the second cylinder 43 follows the movements of the central mast 18 with a contrasting and balancing function.

[0038] The system defined by the two cylinders 42 and 43 and the guide elements 40 and 41 therefore allows a uniform distribution of the stresses of the drilling assembly 20 on the two columns 17; it also allows to compensate the size of the drilling assembly 20 which allows to vary the inclination of the central mast 18 and the amplitude of the angles between the columns 17 when such conditions become necessary to make the holes, without danger of breakages and/or damage to the drilling assembly 20.

[0039] The second cylinder 43 is by-passed, both due to the inclination of the central mast 18 and also due to the varied amplitude of the angle of the columns 17.

[0040] A centering trolley 23, able to keep the drill rods 33 in position, is also mounted on the central mast 18, and also two vices 24 which permit to mount and remove the drill rods 33 during the working cycle.

[0041] In the embodiment shown in Figs. 1-4, on each extension 14 a pair of vertical guide stanchions 25 are also installed, arranged in a position inside the columns 17 and symmetrical with respect to the longitudinal median plane "Z" of the drilling machine 10.

[0042] A relative slider 34 is associated with every guide stanchion 25, and is able to slide vertically, driven by an actuator 35.

[0043] Each slider 34 supports a relative motorized rotary plate 26 with a horizontal axis of rotation "y" parallel to the axis "x".

[0044] On each rotary plate 26 a telescopic shaft 27 is mounted, so that there are two pairs of shafts 27a and 27b arranged symmetrical with respect to the longitudinal median plane "Z" of the drilling machine 10.

[0045] According to the rotation of the respective rotary plate 26, each pair of shafts 27a, 27b is able to make angular excursions β so as to cover more than half of

the area to be drilled, in this case of an amplitude of about 150° (Fig. 3).

[0046] The two pairs of shafts 27a and 27b support respective introduction assemblies 30a and 30b, used to insert the treatment means into the holes prepared by the drilling assembly 20.

[0047] The two introduction assemblies 30a, 30b are thus able to be arranged selectively, and independently from each other, between a first position near the ground and a second position where they lie beyond said longitudinal median plane "Z" with respect to the axis of rotation "y" of the relative rotary plates 26.

[0048] According to specific needs, this allows to operate either with the two introduction assemblies 30a, 30b arranged on opposite sides with respect to the longitudinal median plane "Z" (Fig. 3) or with the introduction assemblies arranged on the same side of the drilling machine 10.

[0049] The drilling machine 10 shown in Figs. 5-7 has a different system to move the pairs of shafts 27a, 27b and hence the relative introduction assemblies 30a, 30b.

[0050] In this embodiment, on each extension 14 there is a pair of supports 36 on which respective base profiles 37 are pinned, with axes of rotation "w" parallel to the axis "x" and symmetrical with respect to the longitudinal median plane "Z".

[0051] Each of the base profiles 37 supports a relative shaft 27 and is associated with a pair of actuators 38 which, when the actuators are activated, enable the shaft to be made to rotate around the axis "w".

[0052] To be more exact, in the retracted condition of the actuators 38, the base profiles 37 are arranged facing downwards and take the pairs of shafts 27a, 27b and the relative introduction assemblies 30a, 30b near the ground, as shown by the line of dashes in Fig. 7.

[0053] In the condition of maximum extension of the actuators 38, the base profiles 37 and the respective pairs of shafts 27a, 27b face upwards and are slightly inclined beyond the vertical, so that the introduction assemblies 30a, 30b are in any case arranged beyond the longitudinal median plane "Z".

[0054] In this case, the angular excursion β of each pair of shafts 27a, 27b is less (about 110°) than that of the embodiment shown in Figs. 1-4, but in any case it allows the introduction assemblies 30a, 30b to cover more than half of the area to be drilled.

[0055] Each introduction assembly 30a, 30b comprises a lateral mast 28 of the folding type which in its condition of minimum extension is arranged in the space defined between the two columns 17.

[0056] The lateral mast 28 is connected to the shafts 27 by means of articulated joints 29 which allow it to incline; it is provided with centering elements 31 able to keep the treatment means on axis, in this case consisting of reinforcement rods 39 and a mandrel 32 able to make said reinforcement rods 39 rotate to facilitate their insertion into the holes.

[0057] The working cycle of the drilling machine 10 according to the invention provides that the drilling assembly 20 is first of all loaded with the rods 33 and then made to rotate to progressively make all the holes covering the entire drilling area.

[0058] Simultaneously, the introduction assemblies 30a and 30b are displaced, each one inside its own field of action, into correspondence with the ready made holes inside which they insert the reinforcement rods 39 which are prepared thereon in turn.

[0059] In this way the drilling assembly 20 can work continuously without needing interruptions to insert the treatment means, since this function is performed by the two introduction assemblies 30a and 30b which are operationally independent as well as faster and more specialized.

[0060] This entails a considerable reduction in the work times and hence an increase in the productivity of the drilling machine 10.

[0061] During the working cycle, the columns 17 and the shafts 27 are adjusted in length according to the position of the holes and are made to rotate in such a manner that the central mast 18 never interferes with the lateral masts 28.

[0062] In the event that the drilling assembly 20 has to be taken to an extreme position in correspondence with the ground, the lateral mast 28 of the introduction assembly 30a or 30b arranged on that side is temporarily folded to allow the columns 17 to rotate completely and pass.

[0063] Then the lateral mast 28 can be extended immediately to allow the introduction assembly 30a or 30b to continue working.

[0064] It is obvious however that modifications and/or additions can be made to the drilling machine 10 as described heretofore, but these shall remain within the field and scope of this invention.

[0065] For example, the frame 11 can be mounted sliding on fixed guides, of the rail type or similar, instead of being associated with the truck 12.

[0066] Or the field of action of the introduction assemblies 30a, 30b can be wider than the one shown here.

[0067] Furthermore, the lateral masts 28 of the introduction assemblies 30a, 30b can be telescopic or retractable, instead of a folding type, so that in any case in their condition of minimum extension they are arranged in the space defined between the two columns 17.

[0068] It is also obvious that, although the description refers to specific examples, a person of skill shall certainly be able to achieve many equivalent forms of drilling machine, all of which shall come within the field and scope of the invention.

Claims

1. Drilling machine to prepare excavations for tunnels

by making a plurality of holes and inserting mating treatment means inside, said machine comprising at least a drilling assembly (20) able to make said holes on the area to be drilled and at least an introduction assembly able to insert said treatment means inside said holes, the machine being **characterized in that** it comprises at least a second introduction assembly and **in that** said introduction assemblies (30a, 30b) are provided with independent movement means and are arranged on opposite sides with respect to said drilling assembly (20) so that each introduction assembly (30a, 30b) is able to operate on a defined portion of said area to be drilled.

2. Drilling machine as in Claim 1, **characterized in that** said introduction assemblies (30a, 30b) are arranged symmetrical with respect to the longitudinal median plane ("Z") of said drilling machine (10).
3. Drilling machine as in Claim 1 or 2, **characterized in that** each of said introduction assemblies (30a, 30b) is able to operate on a surface substantially equivalent to half said area to be drilled.
4. Drilling machine as in Claim 1 or 2, **characterized in that** each of said introduction assemblies (30a, 30b) is able to operate on a wider surface than half said area to be drilled.
5. Drilling machine as in any claim hereinbefore, **characterized in that** said introduction assemblies (30a, 30b) are mounted on relative shaft-type supports (27), with a variable extension, able to rotate with respect to a substantially horizontal axis ("y", "w").
6. Drilling machine as in Claim 5, **characterized in that** said shaft-type supports (27) are of the telescopic type.
7. Drilling machine as in Claim 5 or 6, **characterized in that** the shaft-type supports (27a, 27b) of the respective introduction assemblies (30a, 30b) have their axes of rotation ("y", "w") symmetrical to the longitudinal median plane ("Z") of said drilling machine (10).
8. Drilling machine as in any claim from 5 to 7 inclusive, **characterized in that** said introduction assemblies (30a, 30b) are able to be selectively arranged between a first extreme position near the ground and a second extreme position wherein they are beyond said longitudinal median plane ("Z") with respect to the axis of rotation ("y", "w") of the relative shaft elements (27).
9. Drilling machine as in any claim from 5 to 8 inclu-

sive, **characterized in that** said shaft elements (27) are able to make an angular excursion (β) of at least 110° .

- 5 10. Drilling machine as in any claim from 5 to 9 inclusive, **characterized in that** said shaft elements (27) are mounted on respective motorized rotary plates (26) able to rotate with respect to said axis ("y").
- 10 11. Drilling machine as in Claim 10, **characterized in that** each of said rotary plates (26) is mounted on a relative slider element (34) able to slide on a mating, substantially vertical, guide stanchion (25).
- 15 12. Drilling machine as in any claim from 5 to 9 inclusive, **characterized in that** said shaft elements (27) are mounted on respective base profiles (37) associated with actuator means (38) able to make them rotate with respect to said axis ("w").
- 20 13. Drilling machine as in any claim hereinbefore, **characterized in that** each of said introduction assemblies (30a, 30b) comprises at least a relative lateral guide beam element, or mast, (28) for said treatment means (39) to be inserted into said holes.
- 25 14. Drilling machine as in Claim 13, **characterized in that** centering means (31) are mounted on said lateral masts (28) to keep said treatment means (39) in position.
- 30 15. Drilling machine as in Claim 13 or 14, **characterized in that** mandrel means (32) are mounted on said lateral masts (28) to rotate said treatment means (39).
- 35 16. Drilling machine as in any claim from 13 to 15 inclusive, **characterized in that** said lateral masts (28) are associated with shaft elements (27) which can be individually activated by means of articulated joints (29) able to allow them to be arranged according to an inclination which varies according to the extension of said shaft elements (27).
- 40 17. Drilling machine as in any claim from 13 to 16 inclusive, **characterized in that** said lateral masts (28) can be extended longitudinally in variable fashion.
- 45 18. Drilling machine as in Claim 17, **characterized in that** said lateral masts (28) are of the folding type.
- 50 19. Drilling machine as in Claim 17, **characterized in that** said lateral masts (28) are of the telescopic type.
- 55 20. Drilling machine as in any claim from 5 to 19 inclusive, wherein said drilling assembly is supported by at least two column elements (17) of the telescopic

type, **characterized in that** said shaft elements (27) are arranged in the space between said two column elements (17).

21. Drilling machine as in Claims 17 and 20, **characterized in that** said lateral masts (28), in their condition of minimum extension, are arranged in the space between said two column elements (17). 5
22. Drilling machine as in claim 20 or 21, **characterized in that** said column elements (17) are able to rotate with respect to a substantially horizontal axis ("x") performing, in both directions of rotation, angular excursions (α) of at least 120°. 10
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23. Drilling machine as in any claim from 20 to 22 inclusive, **characterized in that** said column elements (17) support a central guide beam element, or mast, (18) for the drilling tools (33). 20
24. Drilling machine as in Claim 23, **characterized in that** said central mast (18) is mounted on guide elements (40, 41) with respect to which it is able to slide axially on the activation of actuators (42, 43). 25
25. Drilling machine as in Claim 24, **characterized in that** said actuators (42, 43) are connected at one end to said central mast (18) and at the other end to one of said guide elements (40, 41). 30
26. Drilling machine as in Claim 24 or 25, **characterized in that** said guide elements (40, 41) are associated with articulated joints (22) mounted on said columns (17) and able to vary at least the amplitude of the angle between the latter and the inclination of said central mast (18). 35
27. Drilling machine as in Claim 26, **characterized in that** said actuators (42, 43) and said guide elements (40, 41) define means to distribute the stresses of said drilling assembly (20) uniformly on said columns (17) and to compensate the size of said drilling assembly (20), to allow to vary the inclination of said central mast (18) and/or the amplitude of the angle between said columns (17). 40
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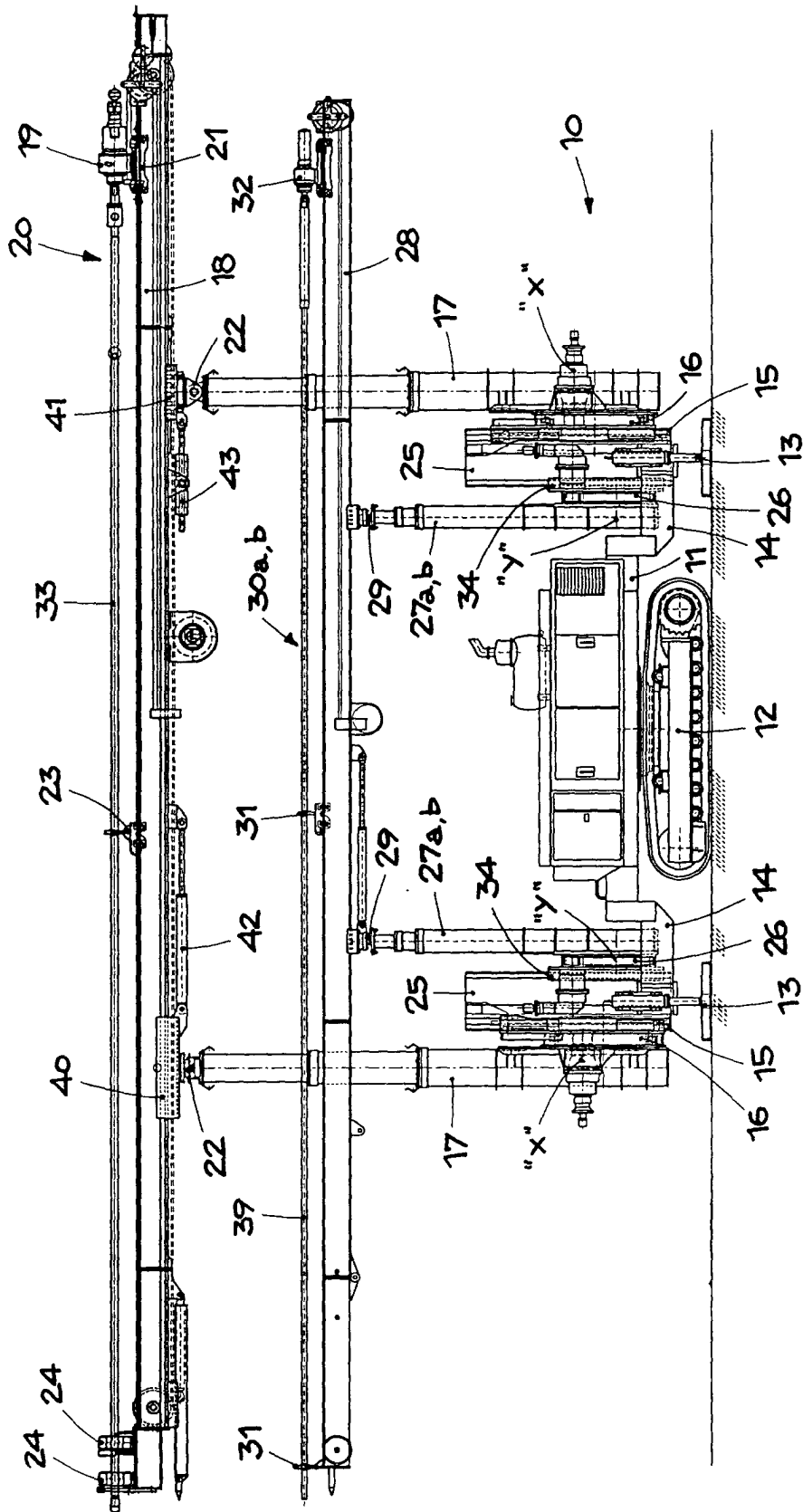


fig.1

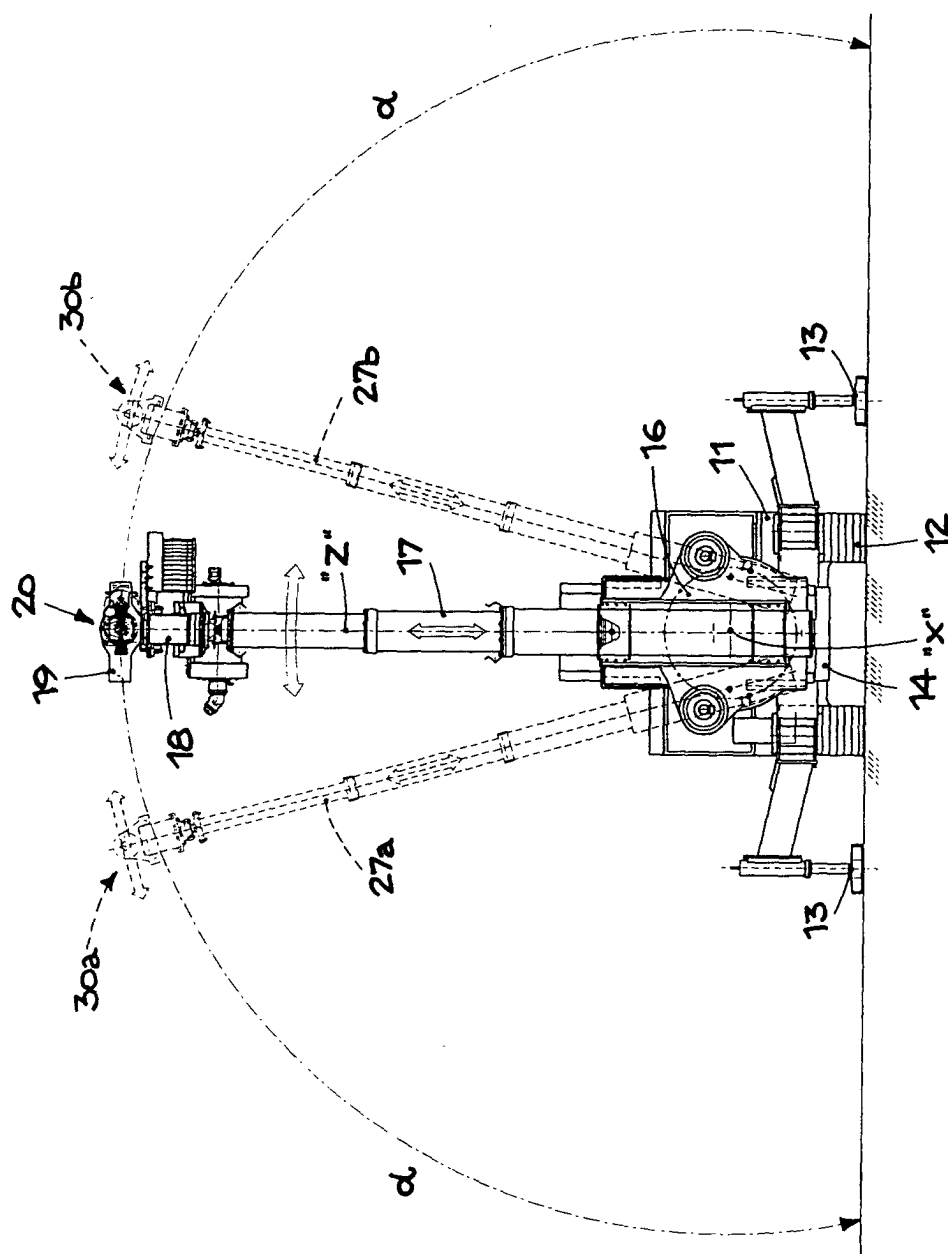


Fig. 2

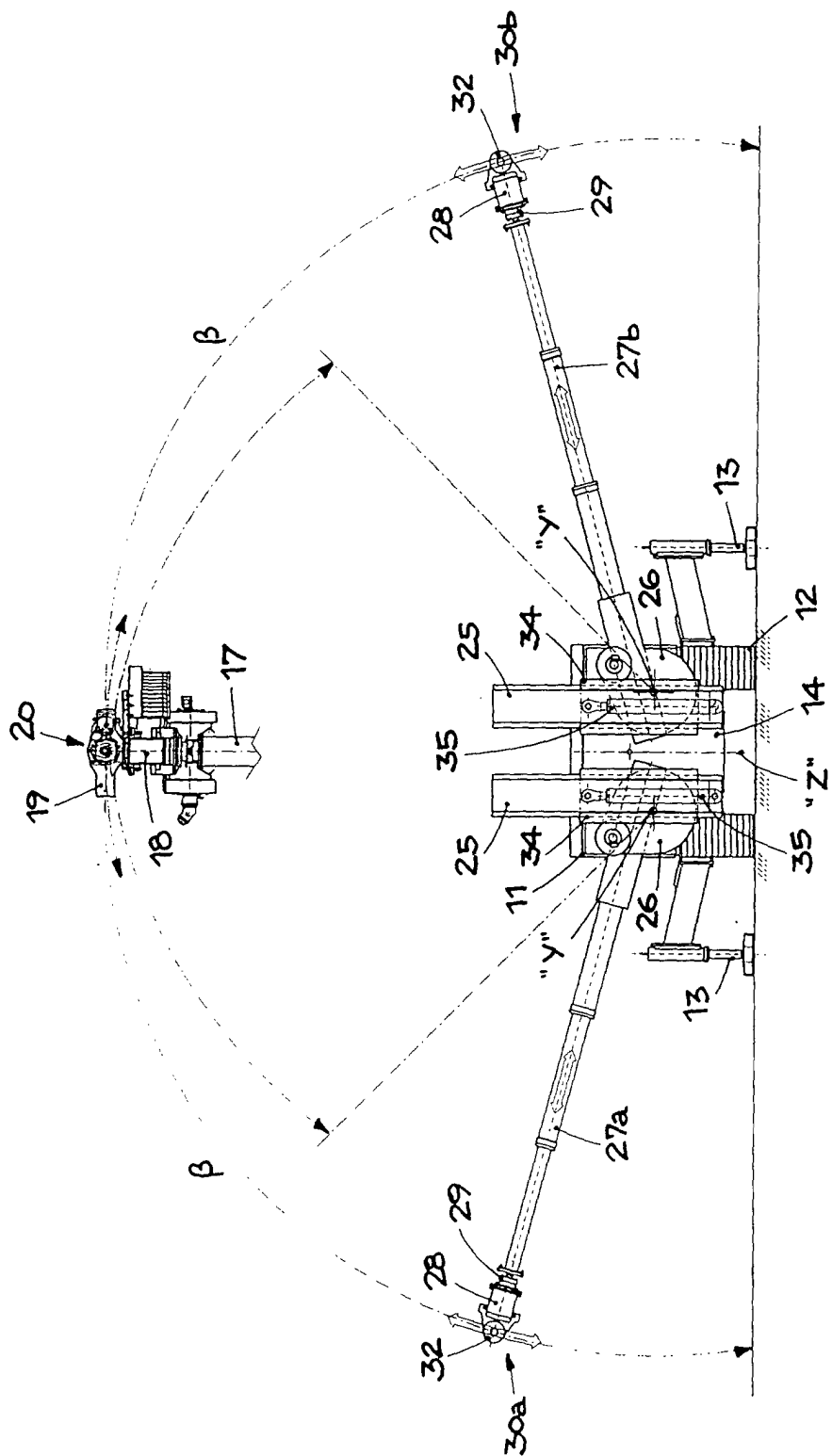


fig.3

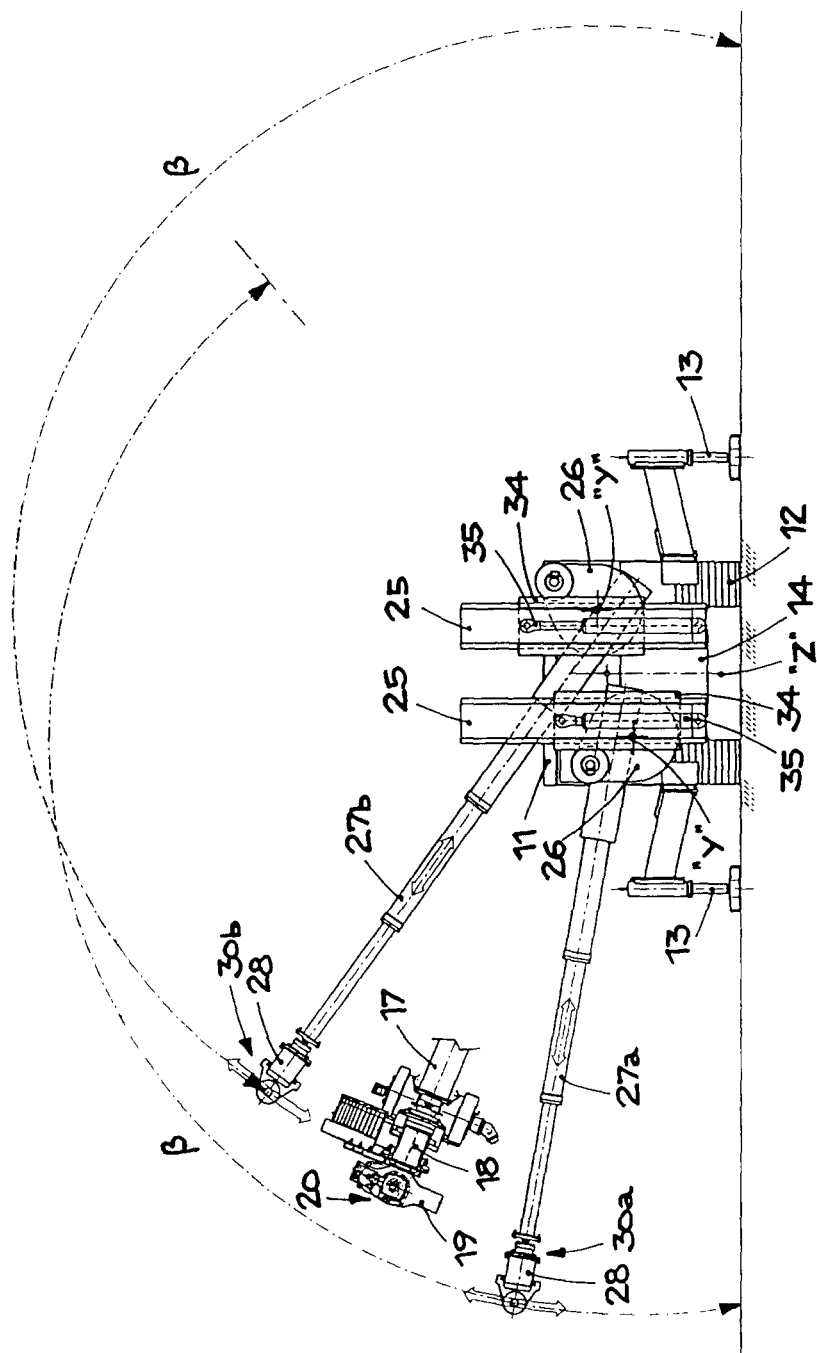


fig.4

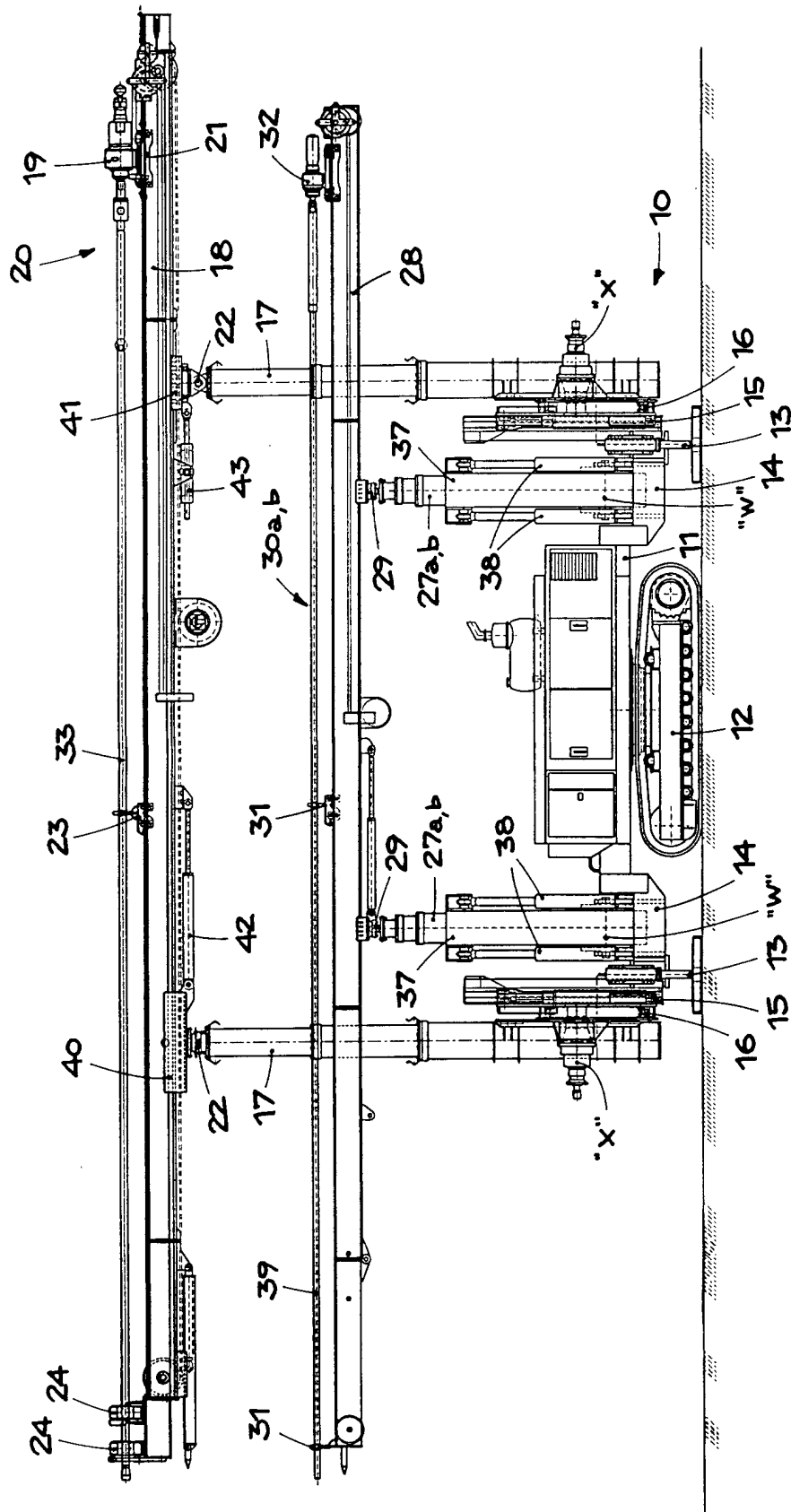
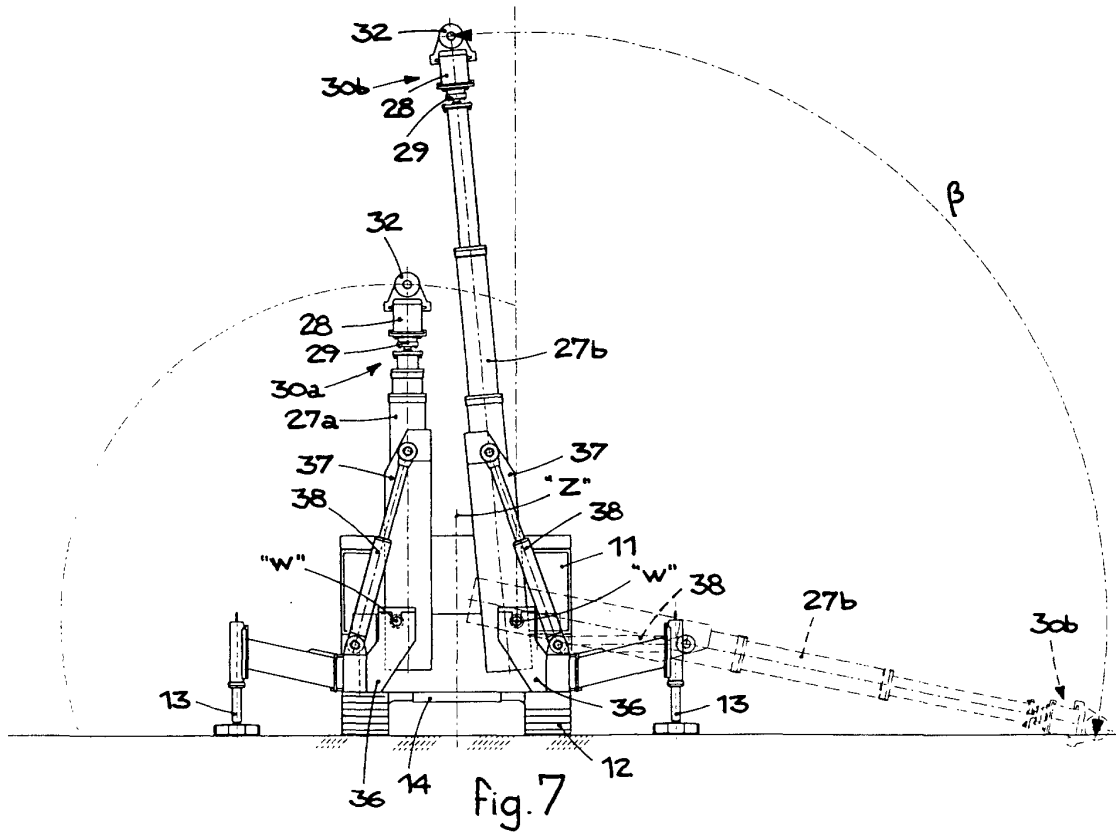
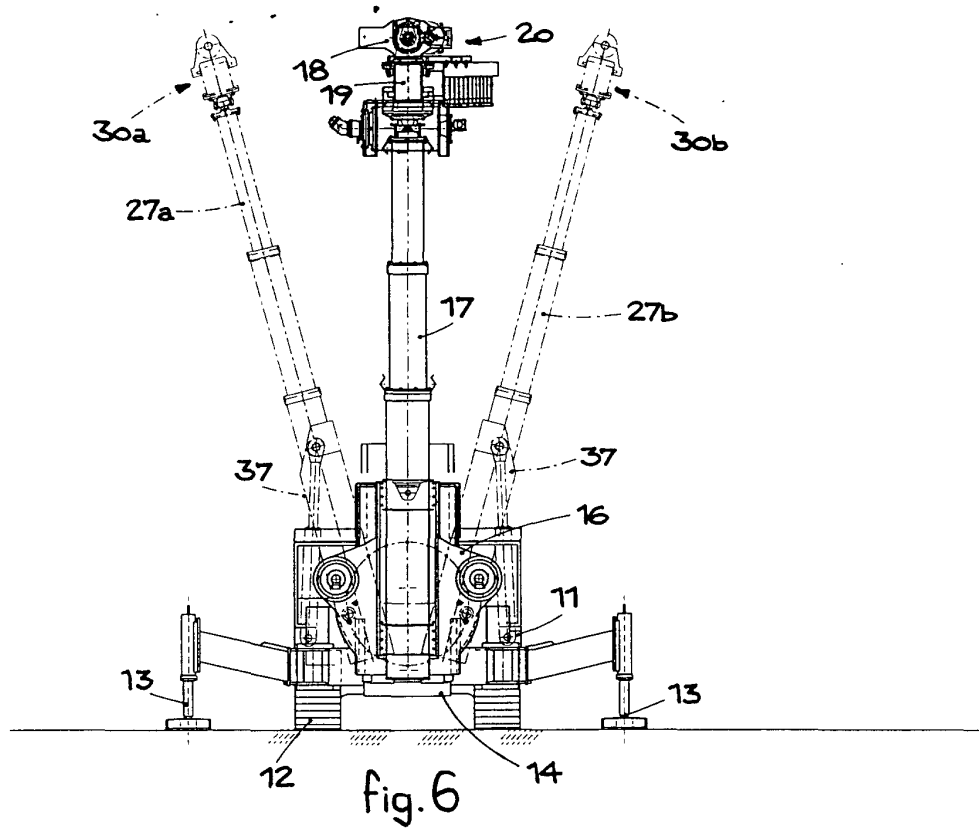


fig. 5





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 11 4557

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	EP 0 424 733 A (CASAGRANDE SPA) 2 May 1991 (1991-05-02) * page W *	1	E21B15/04 E21B7/02 E21D20/00 E21B19/00 E21D9/10
A	EP 0 424 768 A (CASAGRANDE SPA) 2 May 1991 (1991-05-02) * the whole document *	1	
A	EP 0 424 779 A (CASAGRANDE SPA) 2 May 1991 (1991-05-02) * figures *	1	
A	EP 0 394 806 A (TREVI SPA) 31 October 1990 (1990-10-31)		
A	DE 28 36 659 A (EBELING WOLFGANG DIPL ING) 6 March 1980 (1980-03-06)		
A	EP 0 215 998 A (LUEN LAM MING) 1 April 1987 (1987-04-01)		
A	US 3 708 021 A (BODINE A) 2 January 1973 (1973-01-02)		
A	EP 0 538 718 A (TREVI SPA) 28 April 1993 (1993-04-28)		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.7) E21B E21D E21C
Place of search THE HAGUE		Date of completion of the search 4 October 2001	Examiner Fonseca Fernandez, H
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 01 11 4557

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04-10-2001

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
EP 0424733	A	02-05-1991	IT	1236446 B	09-03-1993
			EP	0424733 A1	02-05-1991
			JP	3158592 A	08-07-1991
			US	5116164 A	26-05-1992
EP 0424768	A	02-05-1991	IT	1236445 B	09-03-1993
			EP	0424768 A1	02-05-1991
			JP	3158591 A	08-07-1991
			US	5129764 A	14-07-1992
EP 0424779	A	02-05-1991	IT	1236444 B	09-03-1993
			EP	0424779 A1	02-05-1991
			JP	3158593 A	08-07-1991
EP 0394806	A	31-10-1990	IT	1234069 B	29-04-1992
			AT	107737 T	15-07-1994
			DE	69010067 D1	28-07-1994
			DE	69010067 T2	13-10-1994
			EP	0394806 A1	31-10-1990
			ES	2057243 T3	16-10-1994
			JP	2050829 C	10-05-1996
			JP	3063399 A	19-03-1991
			JP	7062430 B	05-07-1995
			US	5104260 A	14-04-1992
DE 2836659	A	06-03-1980	DE	2836659 A1	06-03-1980
EP 0215998	A	01-04-1987	CN	85108187 A ,B	10-04-1986
			EP	0215998 A2	01-04-1987
			US	4785892 A	22-11-1988
US 3708021	A	02-01-1973	NONE		
EP 0538718	A	28-04-1993	IT	1257701 B	01-02-1996
			AT	147131 T	15-01-1997
			DE	69216358 D1	13-02-1997
			DE	69216358 T2	03-07-1997
			EP	0538718 A1	28-04-1993
			ES	2097254 T3	01-04-1997
			JP	2594006 B2	26-03-1997
			JP	5302489 A	16-11-1993
			US	5290125 A	01-03-1994

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82