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(54) Device and method for making trenches

(57) Trencher, comprising a frame provided with propelling means, a tool arm attached to the frame and provided with a circulating driven endless tool carrier, which supports an earth moving tool, and a drive for circulating the tool carrier according to an elongated circulation path substantially in a vertical plane, wherein the tool is designed as a brush having elastically bendable bristle pins

and the endless tool carrier circulates about two circulation axes that are spaced apart in the vertical plane, wherein the circulation path between the two circulation axes comprises an upwardly inclined excavation path for the bristle pins and wherein the brush is designed as a number of brush units that are attached in series to the tool carrier in sense of circulation, and keep spaces open in between them in sense of circulation.

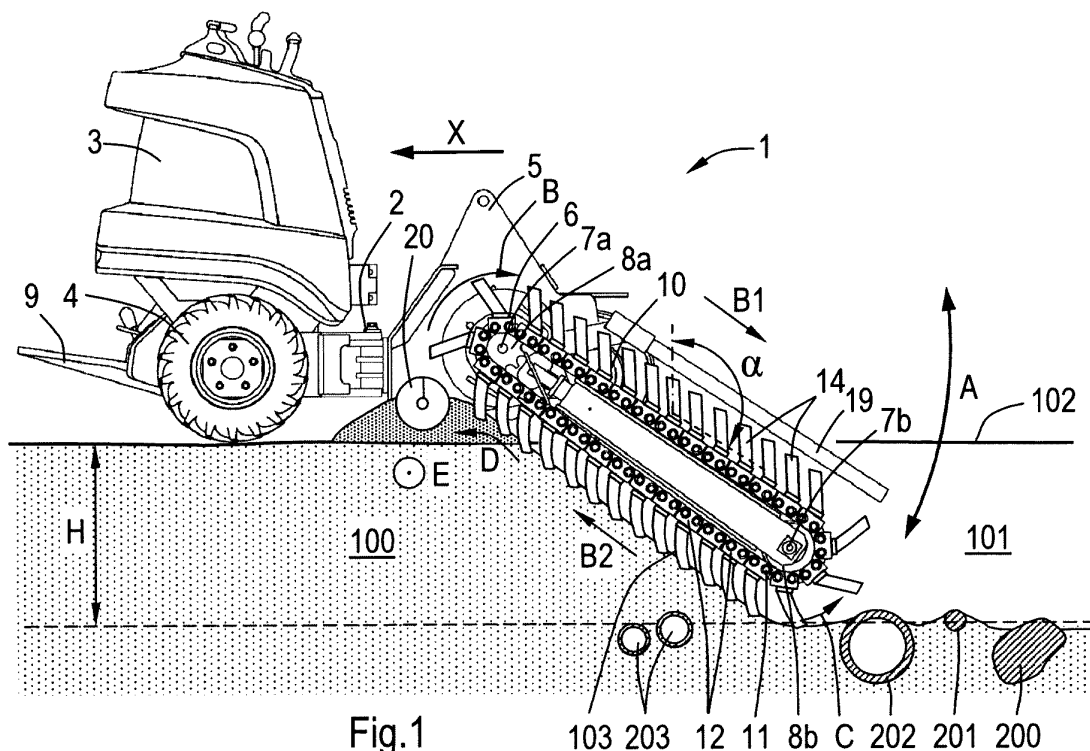


Fig.1

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Description

BACKGROUND OF THE INVENTION

[0001] The invention relates to a device and method for making trenches, in particular for laying or replacing cables and conduits underneath pavements.

[0002] Previously such trenches were made using a trench cutter provided with an arm that could be swung up and down and around which a circulating chain having excavation teeth circulated. The arm was taken to the desired depth while excavating, after which the trench cutter was moved rearward, with a breach running accordingly in the same direction, wherein the excavation teeth excavated the earth from the bottom up along the breach, and at surface level took the excavated earth within the operational range of a transversely positioned worm. The worm ensured displacement of the excavated earth to a location at some distance from the trench made.

[0003] It often happened that the excavation teeth moving in the breach pulled up and/or tore apart the cables and conduits. The work had to be stopped then - in some cases for quite a while -. Damage as a result of broken cables and conduits could be considerable.

[0004] In order to prevent this, trenches were then made using a mini excavator. The arm of a mini excavator moves an excavator bucket filled with earth sideward until amply adjacent to the trench, after which the arm is swung back again for a next excavation motion. The swinging of the arm is a safety hazard to people, often requiring measures such as an extra working man for supervision. Apart from that the discontinuous excavation process requires quite a lot of time.

SUMMARY OF THE INVENTION

[0005] It is an object of the invention to provide a device and method for making trenches for laying cables and conduits, wherein while maintaining efficiency there is less risk of broken cables/conduits and undesirable stops of the activities.

[0006] It is an object of the invention to provide a device and method for making trenches for laying cables and conduits with which a relatively high working speed can be achieved.

[0007] According to one aspect the invention for that purpose provides a device for making trenches in a ground of soil material, comprising a frame provided with propelling means, a tool arm attached to the frame and provided with a circulating driven endless tool carrier, which carries an earth moving tool, and a drive for circulating the tool carrier according to a circulation path substantially in a vertical plane, wherein the tool is designed as a brush having elastically bendable bristle pins and the endless tool carrier circulates about at least two circulation axes that are spaced apart in the vertical plane, wherein between the two circulation axes the circulation

path comprises an upwardly inclined, preferably stretched, excavation path for the bristle pins. The bristle pins form a resilient tool for dislodging and taking along the earth upwards along the breach. The earth will be able to leave the ground with a considerable horizontal directional component, as a result of which the controllability (limitation of spilling, more secure discharge) is enhanced. In case a relatively hard object is hit, the bristle pins are able to bend out of their initial path in order to pass by the object. On the one hand the object is thus spared, on the other hand the tool itself is spared. The event can be noticed by the operator of the device, after which the breach can be inspected and if necessary the earth around the object can be removed on site using a spade, in case it is a cable or conduit, or the object itself can be removed, in case it is a stone. The earth can be discharged by the brush to a soil discharge, in particular a worm, preferably present at the device, which worm is situated in operational direction in front of the brush and moves the earth, laterally in particular, transverse to the operational direction. In the process the bristle pins push the earth to the soil discharge.

[0008] In one embodiment the excavation path runs according to a straight line. Alternatively the stretched excavation path may run according to a slightly convex curve, wherein the curvature centre is situated above the tool carrier, for instance at a distance in the order of the length of the tool carrier or more.

[0009] The brush can be designed as a number of brush units composed of one or several brush parts, which units are attached in series to the tool carrier in sense of circulation, and keep spaces open in between them in sense of circulation. In that way the bristle pins are given room to bend away, without being impeded by the bristle pins of the trailing brush unit. Furthermore room is provided to soil material in front of the bristle pins of a brush unit.

[0010] Of at least some of the brush units, preferably of all brush units, the bristle pins can be at a pin angle to the local tangent to the circulation path of the tool carrier at the brush unit in question, which angle deviates from 90 degrees. Formulated in a different way, if the brush unit, in particular the brush part, comprises a base on which the bristle pins are attached, and the base has a basic plane, the bristle pins may extend from the base at a pin angle to the basic plane that deviates from 90 degrees. The pin angle, opening forward in circulating drive direction, will then preferably be obtuse exceeding 90 degrees, preferably in the range of approximately 100 - approximately 140 degrees, preferably approximately 120 degrees. Due to rearward inclination of the bristle pins, when considered in direction of circulation, the resilience of the bristle pins at interaction with an object is enhanced and jamming is further prevented. Furthermore accumulation of soil material between the bristle pins is counteracted, as a result of which the brush might otherwise get clogged and the elasticity of the bristle pins be reduced.

[0011] In a further development the bristle pins of a brush unit have pin ends, wherein the pin ends of the leading bristle pins in a brush unit extend beyond the pin ends of the trailing bristle pins. The pins situated more to the rear are then slightly receded with their pin ends. In particular the leading bristle pins may have a larger length than the trailing bristle pins. The pin ends of the bristle pins in a brush unit can then be situated in a plane forming a rearward opening acute angle to said tangent or said basic plane. In that way wear of the (trailing) pins can be limited.

[0012] In one embodiment the bristle pins in the brush units are divided into a number of groups situated adjacent in a direction transverse to the plane of the circulation path, which groups leave slit-shaped passages open in between them. In this way it is also counteracted that soil material gets in between the bristle pins and gets stuck there.

[0013] It is possible that the bristle pins in a brush unit occupy at least almost the full operational width of the brush. Alternatively it is also possible to have the bristle pins occupy only a part of said operational width, wherein, in order to nonetheless make a trench of the desired width, of a pair of brush units that are consecutive in circulation path, the bristle pins of the one, first brush unit of said pair are situated offset in widthwise direction, transverse to the circulation path with respect to the other, second brush unit of said pair. When used in argillaceous (sandy) soils or other at least slightly cohesive soils, excavated earth that would otherwise result in clogging up of the space between the bristle pins, can be given room to escape. In that case the bristle pins of the first brush unit may form one or several groups of bristle pins that are situated near the centre of the brush unit and the bristle pins of the second brush unit form groups of bristle pins that are situated in the marginal areas of the brush unit. The bristle pins of the first brush unit may in that case have a joint width that approximately corresponds with the distance in latitudinal direction between the groups of bristle pins of the second brush unit.

[0014] The series of brush units can in that case be composed of consecutive pairs of consecutive first and second brush units.

[0015] The groups of bristle pins can form individual brush parts.

[0016] Replacing the brush units, in particular brush parts, having bases on which the bristle pins are attached, is enhanced when the tool carrier is provided with holders for the brush units, and wherein the holders are provided with one or more accommodation spaces for fitting accommodation of the bases of the brush units, in particular brush parts, wherein the accommodation spaces have an access opening for the base in question that opens in circulation direction and is provided with a stop for the base, which stop faces circulation direction, wherein preferably the holders are provided with several accommodation spaces, wherein preferably the device is furthermore provided with one or more filling pieces

for filling the accommodation spaces that have not been provided with brush parts, so that soil cannot accumulate in the empty accommodation spaces.

[0017] In a further development of the device according to the invention, a first one of the circulation axes is situated at the proximal end of the tool arm and a second circulation axis is situated at the distal end of the tool arm. The first circulation axis can be driven by the drive, such as a hydraulic motor. The hydraulic motor can be kept just above surface level, wherein the second circulation axis extends into the trench.

[0018] In a simple embodiment thereof there are only two circulation axes for the tool carrier. The circulation path preferably is elongated, with stretched tracks in between the two circulation axes.

[0019] According to a further aspect the invention provides a method for making trenches from surface level in a ground of soil material, in particular for laying cables and/or conduits, wherein a brush provided with elastically bendable bristle pins is rotated according to an unround circulation path deviating from a circular path, which path is situated substantially in a vertical plane, and is elongated in particular, wherein the brush is moved according to the operational direction that is desired for the trench, wherein soil is dislodged and passed upwards by the bristle pins according to an inclined, in particular at least substantially stretched excavation path and is discharged to a laterally operational soil discharger, wherein preferably the excavation path is at an angle to the horizontal of 20-50 degrees, wherein preferably the soil on surface level is discharged by the brush in a direction having a horizontal directional component in operational direction that exceeds the vertical directional component. The method is particularly carried out using a device according to the invention.

[0020] The aspects and measures described in this description and the claims of the application and/or shown in the drawings of this application may where possible also be used individually. Said individual aspects may be the subject of divisional patent applications relating thereto. This particularly applies to the measures and aspects that are described per se in the sub claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The invention will be elucidated on the basis of an exemplary embodiment shown in the attached drawings, in which:

Figure 1 shows a side view of an exemplary embodiment according to the invention, in side view, during making a trench;

Figure 2 shows a rear view of the device of figure 1;

Figures 3A and 3B show a rear view and a side view, respectively, of a brush unit for a device according to the invention;

Figures 4A-4E show two schematic representations of placing brush units of figures 3A, B, a side view of a placed brush unit and two rear views of placed brush units;

Figure 5 shows a rear view of another brush unit for a device according to the invention; and

Figures 6A and 6B show a schematic bottom view and a schematic side view, respectively, of a series of brush units in a device according to the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0022] The automotive device 1, provided with a drive, of figures 1 and 2 comprises a frame 2 carried by wheels 4 and 10 which frame has a tractor part 3 having platform 9 for an operator. The rear part 5 is connected with the tractor 3 so as to hinge about a vertical centre line, and comprises a tool arm or ladder 6 on which a chain-shaped tool carrier 11 is supported. The chain 11 circulates about sprocket wheels 8a and 8b attached to a first axis 7a and a second axis 7b, respectively. The first axis 7a and therefore sprocket wheel 8a are directly driven by a hydraulic motor, not shown, for instance at an rpm of the chain of 200/min. The chain 11 thus circulates in direction B, having a downwards path B1 and an upward path B2. The tool arm 6 can be adjusted (direction A) as regards angle in the vertical plane about a centre line coinciding with the first axis 7a, between a selected excavation angle and a horizontal transport position. The excavation angle may for instance be 30 degrees to the horizontal. The ladder 6 may have a length of for instance 0.7 m between both rotation axes 7a,b.

[0023] A screen 19 and a laterally (direction E) discharging worm 20 are furthermore attached to the rear part 5.

[0024] A series of holders 12 (schematically shown, for instance more than 20) are attached to the chain 11, to which holders brush units 14 are detachably attached, keeping spaces open in between them - considered in circulation direction -. The brush units 14, also see figures 3A, B, 4A-E and 5, are made of a suitable synthetic material, such as polyamide, and comprise a brush base 15 and thereon integrally formed therewith, for instance by means of injection moulding, elastically bendable bristle pins 16. The bristle pins 16 can alternatively be made of steel. The brush units with bristle pins 16 have been selected with a bending stiffness and wear-resistance in accordance with the type of soil to be moved. For sandy soil the brush units may for instance be made of polypropylene, for instance having a largest pin length of 12 cm and a pin thickness of 0.32 cm.

[0025] The bristle pins 16 are at an obtuse angle α to the circulation direction B. Said angle can generally also be considered the angle between the tangent of the circulation path formed by the chain (which tangent is parallel to the basic plane 15a of the base 15-which basic

plane in this case is parallel to the circulation direction B -, as can be seen in figure 3A, and has a constant orientation in a straight excavation path as depicted in figure 1). In this example the said angle is 120 degrees.

[0026] The pin ends 16a of the bristle pins 16 are in a plane that is at an acute angle β of 10-20 degrees to the basic plane 15a, see figure 3A. The leading pins are thus longer than the trailing pins. In that way wear can be limited.

[0027] In the embodiment of figures 3A, B, in widthwise direction of the tool (in figure 3B from left to right or vice versa) the base 15 including a group of bristle pins 16 forms a short brush part 14a, for instance approximately a quarter of the width of the tool. This provides opportunities for adjusting the device to the soil properties. A brush unit 14 may comprise one or more of such brush parts, placed on the same holder 12 attached to the chain. Considered in transverse direction, the location of the brush units can then also be varied with. Figure 4C shows a holder 12a provided with two mutually identical brush parts 14b,c placed adjacently, almost directly on either side of a centre plane M of the tool, which plane M is parallel to the plane of circulation of the chain 11. A slit 17 has been left open between the groups of pins 16 of the brush parts. Figure 4D shows a holder 12b provided with two brush parts 14a,d, that are identical to each other and to brush parts 14b,c, which brush parts 14a,d are situated on either side of a centre plane M, yet at greater distance therefrom, so that, considered in a plane of projection P, transverse to the local direction of movement (see figure 4B), they end up adjacent the brush parts 14b,c. As a result the brush parts 14a-d together form a brush assembly operational over at least substantially the entire width of the tool, albeit in two steps. The holders 12a and 12b can be attached to the chain 11 alternately one behind the other, also see figure 6A, in which the offset position of the brush parts over the width of a brush part can be seen.

[0028] It is noted that instead of the shown positioning of brush parts another positioning can also be chosen, depending on the conditions (such as soil properties), for instance the holder 12a with two brush parts on the one side of the centre plane and the consecutive holder with two brush parts on the other side of the centre plane. It is also possible to choose holders having a continuous series of brush parts in transverse direction, in this example having four brush parts 14a-d on the same holder 12, having spaces in between the brush parts that are consecutive in transverse direction. The holder will then have four accommodation spaces. Such holders can also be used for the alternating positioning mentioned earlier, wherein the unoccupied accommodation spaces can be closed off by filling pieces having the shape of the base 15, so that no earth accumulates in the accommodation spaces that are not used.

[0029] The attachment of the brush parts 14a-d can be easily effected, see figures 3A, B, in combination with figures 4A and 4D. The brush base 15 is provided with

ribs 21 on two opposite edges. The holders 12a,b are provided with accommodation spaces 13a-d, which each have two opposite edges with slots 22a-d and a forward stop edge 23a-d oriented in circulation direction and which are open to the fore (in circulation direction) and downward and are upwardly bounded by a wall of the holder 12a,b. As suggested in figures 4A and 4D a brush part 14 (a-d) can be inserted with its base in rearward direction into an accommodation space 12 (a-d), wherein the ribs 21 are snugly accommodated in the slots 22 (a-d), until the base 15 abuts the stop edge 23 (a-d). The base 15 will then be confined in all directions, except in a direction opposite the direction of insertion. The bristle pins 16 extend downward through the opening in the holder 12a,b, see figure 4B. This way of placing the brush parts in the holders is simple so that the brush parts can be replaced quickly and standstill of the device according to the invention can remain within limits. The forces exerted during use by the soil on the bristle pins moving past it urges the base 15 against the stop edge of the accommodation space.

[0030] In an alternative embodiment the brush part is wider (considered in a direction transverse to the centre plane), for instance at least nearly as wide as the brush tool, see figure 5, brush part 14'. Considered in transverse direction, four groups of bristle pins 16 with spaces 17 in between them, extend from a common base 15. The base 15 may be 30 cm wide and 5.5 cm wide. Such a brush unit is also deployed in road sweepers. The base 15 can be attached in manner comparable to the one discussed above, or by confinement/clamping in a holder of which one permanent plate is attached to the chain and the other plate can be attached by means of a detachable bolt connection to the permanent plate while clamping the base of the brush unit. However, this requires more labour when replacing.

[0031] In operation the device 1 is first activated on site with the brush pins in the lowermost excavation path, engaging surface level 102 stripped of paving. The chain 6 is driven in direction B, as a result of which the brush units 14 in excavation path B2 excavate the earth and pass it along to the area of influence of the worm 20. The ladder 6 is then tilted about first axis 7a, until the desired excavation depth is reached and the ladder 6 is for instance at an excavation angle of approximately 30 degrees. The device 1 is then moved in direction X, the wheels 4 and 10 passing over tiles that are not shown, situated on the surface level 102 of the ground 100. The speed of movement among others depends on the properties of the ground, and could be more than 50 meters per hour, even 75 meters per hour is possible. In an upwardly inclined excavation path B2, the bristle pins then sweep along a breach 103 progressing in direction X, dislodge soil material from the breach 103 and take it along in the direction D, in order to discharge the soil material at surface level, inclined forward and slightly upward, while urging the earth to the area of influence of the leading worm 20, which moves the soil material lat-

erally. Thus a trench 101 of a depth (H) of for instance 30 cm is formed in direction X, for instance for a fibre optics cable.

[0032] At unknown locations cobble 200, cable 201 and conduits 202, 203 are situated in the ground 100. As the bristle pins 16 incline rearward and moreover when abutting such an object yield in rearward direction C, the cable and conduits are not damaged and the chain 11 is not jammed at an object in the ground.

[0033] In soil that is non-cohesive to a large extent, such as nearly pure sand, a brush can be used of which the brush units occupy at least nearly the entire width on a holder, in the example this means each time all brush parts 14a-d on one holder or with the brush unit shown in figure 5. In case of argillaceous sandy soil it may occur however that - despite the presence of the open spaces 17 in between - soil material clogs together to a great extent between the brush units that are closely consecutive to each other in circulation direction, and during the movement along the breach is pressed in between the pins and at the upper turning point of the chain 11 remains stuck there. In that condition the brush units are passed down and then arrive at the lower end of the breach in a condition in which they are already filled with earth, from which location another process of clogging together takes place again. As a result the bristle pins are hampered in their movement/deformation, In order to counteract this, the mutually offset positioning of the groups of bristle pins with partial bristle pin occupation of the holders (as can be seen in figure 6A) is useful, as a result of which sufficient room - and thus freedom - is provided for moving earth, that is pushed along in front of the bristle pins along the breach, to the side and fall past the bristle pins, and then end up in the area of influence of the next brush units. The process can be repeated there - if necessary -.

[0034] The above description is included to illustrate the operation of preferred embodiments of the invention and not to limit the scope of the invention. Starting from the above explanation many variations that fall within the spirit and scope of the present invention will be evident to an expert.

Claims

1. Device for making trenches in a ground of soil material, comprising a frame provided with propelling means, a tool arm attached to the frame and provided with a circulating driven endless tool carrier, which carries an earth moving tool, and a drive for circulating the tool carrier according to a preferably elongated circulation path substantially in a vertical plane, wherein the tool is designed as a brush having elastically bendable bristle pins and the endless tool carrier circulates about at least two circulation axes that are spaced apart in the vertical plane, wherein between the two circulation axes the circulation path

comprises an upwardly inclined excavation path for the bristle pins.

2. Device according to claim 1, wherein the excavation path is substantially stretched, preferably runs according to a straight line. 5
3. Device according to claim 1 or 2, wherein the brush is designed as a number of brush units composed of one or several brush parts, which units are attached in series to the tool carrier in sense of circulation, and preferably keep spaces open in between them in sense of circulation. 10
4. Device according to claim 3, wherein of at least some of the brush units, preferably of all brush units, the bristle pins are at a pin angle to the local tangent to the circulation path of the tool carrier at the brush unit in question, which angle deviates from 90 degrees, wherein preferably, the pin angle, opening forward in circulating drive direction, exceeds 90 degrees, preferably in the range of approximately 100 - approximately 140 degrees, preferably approximately 120 degrees. 20
5. Device according to claim 3, wherein the brush unit, in particular the brush part, comprises a base on which the bristle pins are attached, wherein the base has a basic plane and the bristle pins extend from the base at a pin angle to the basic plane, which angle deviates from 90 degrees, wherein preferably the pin angle, opening forward in circulating drive direction, exceeds 90 degrees, preferably in the range of approximately 100 - approximately 140 degrees, preferably approximately 120 degrees. 25 30 35
6. Device according to claim 3, 4 or 5, wherein the bristle pins of a brush unit have pin ends, wherein the pin ends of the leading bristle pins in a brush unit extend beyond the pin ends of the trailing bristle pins, wherein preferably the leading bristle pins have a larger length than the trailing bristle pins, and/or wherein preferably, the pin ends of the bristle pins in a brush unit are situated in a plane forming a rearward opening acute angle to said tangent or said basic plane. 40 45
7. Device according to any one of the claims 3-6, wherein the bristle pins in the brush units are divided into a number of groups situated adjacent in a direction transverse to the plane of the circulation path, which groups leave slit-shaped passages open in between them. 50
8. Device according to any one of the claims 3-7, wherein of a pair of brush units that are consecutive in circulation path, the bristle pins of the one, first brush unit of said pair are situated offset in widthwise 55

direction, transverse to the circulation path with respect to the other, second brush unit of said pair, wherein preferably, the bristle pins of the first brush unit form one or several groups of bristle pins that are situated near the centre of the brush unit and the bristle pins of the second brush unit form groups of bristle pins that are situated in the marginal areas of the brush unit, wherein preferably, the bristle pins of the first brush unit have a joint width that approximately corresponds with the distance in latitudinal direction between the groups of bristle pins of the second brush unit.

9. Device according to claim 8, wherein the series of brush units has been built up from consecutive pairs of consecutive first and second brush units.
10. Device according to claim 8 or 9, wherein the groups of bristle pins form individual brush parts.
11. Device according to any one of the preceding claims, wherein the brush unit, in particular the brush part, comprises a base on which the bristle pins are attached, wherein the tool carrier is provided with holders for the brush units, and wherein the holders are provided with one or more accommodation spaces for fitting accommodation of the bases of the brush units, in particular brush parts, wherein the accommodation spaces have an access opening for the base in question that opens in circulation direction and is provided with a stop for the base, which stop faces circulation direction, wherein preferably, the holders are provided with several accommodation spaces, wherein preferably, the device is furthermore provided with one or more filling pieces for filling accommodation spaces that have not been provided with brush parts.
12. Device according to any one of the preceding claims, wherein of the circulation axes, of which there are preferably only two, a first circulation axis is situated at the proximal end of the tool arm and a second circulation axis is situated at the distal end of the tool arm, wherein preferably, the drive is operative at the first circulation axis and preferably is a hydraulic motor engaging onto the first circulation axis.
13. Device according to any one of the preceding claims, provided with a soil discharge, in particular a worm, which in operational direction is situated in front of the brush and displaces the soil, laterally in particular, transverse to the operational direction.
14. Method for making trenches from surface level in a ground of soil material, in particular for laying cables and/or conduits, wherein a brush provided with elastically bendable bristle pins is rotated according to an unround circulation path deviating from a circular

path, which path is situated substantially in a vertical plane, and is elongated in particular, wherein the brush is moved according to the operational direction that is desired for the trench, wherein soil is dislodged and passed upwards by the bristle pins according to an inclined, in particular at least substantially stretched excavation path and is discharged to a laterally operational soil discharger, wherein preferably, the excavation path is at an angle to the horizontal of 20-50 degrees, wherein preferably, the soil at surface level is discharged by the brush in a direction having a horizontal directional component in operational direction that exceeds the vertical directional component.

15. Method according to claim 14, wherein use is made of a device according to any one of the claims 1-13.

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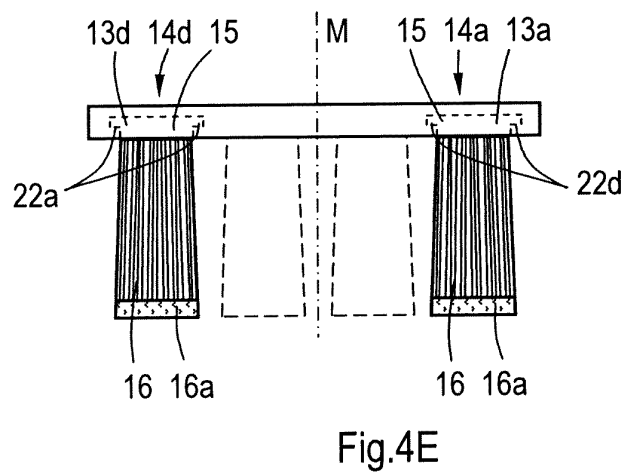
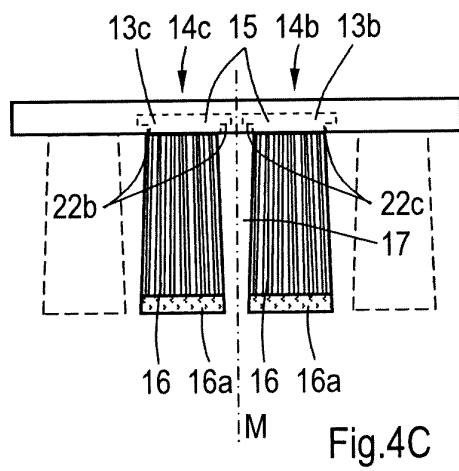
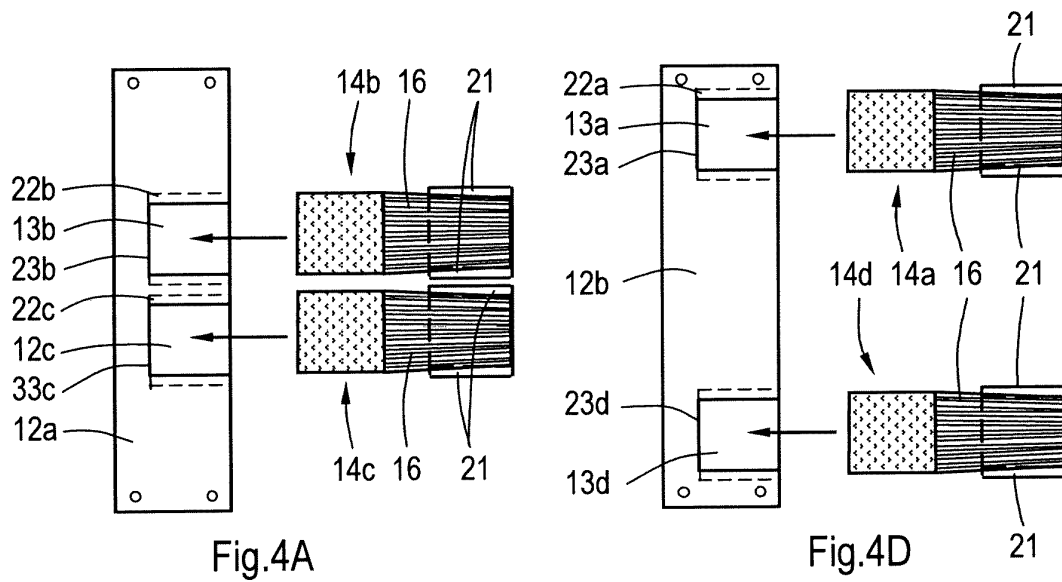
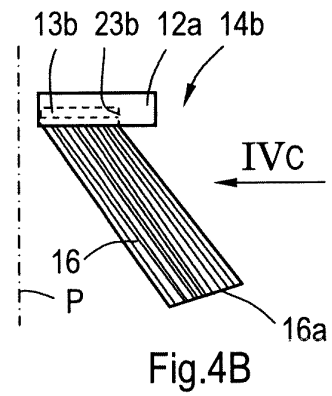
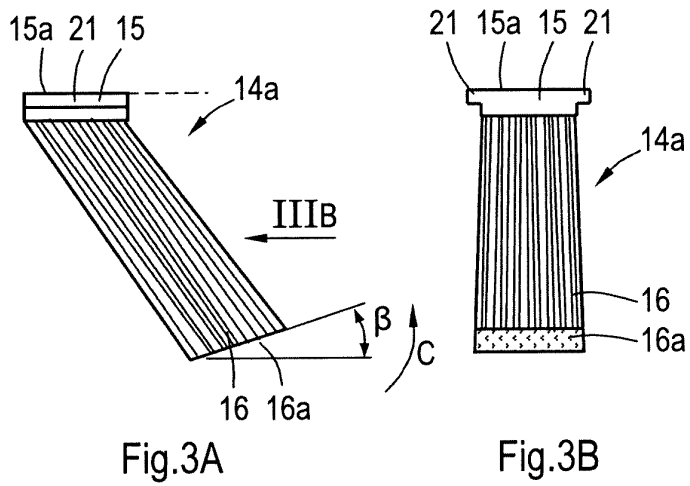
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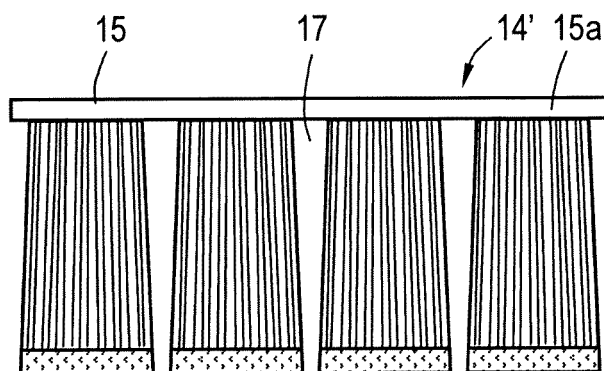


Fig.5

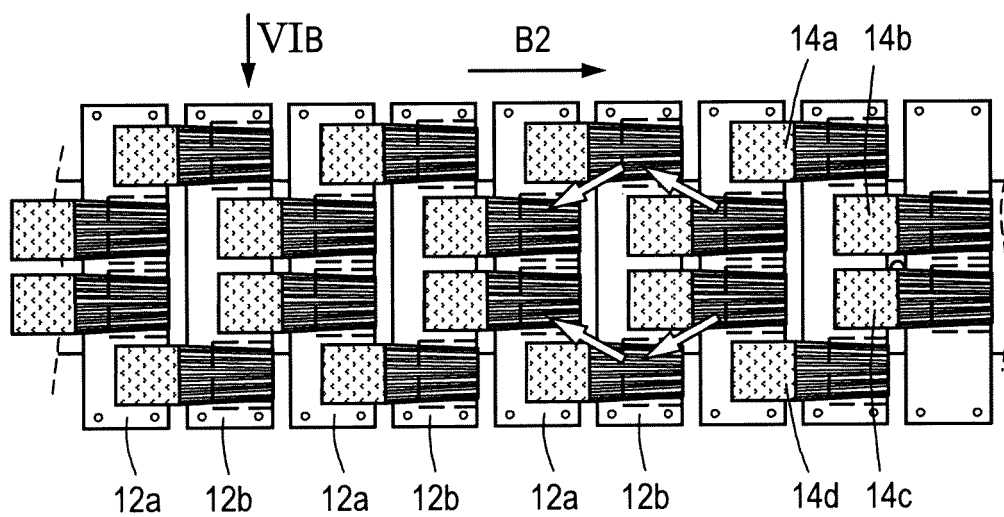


Fig.6A

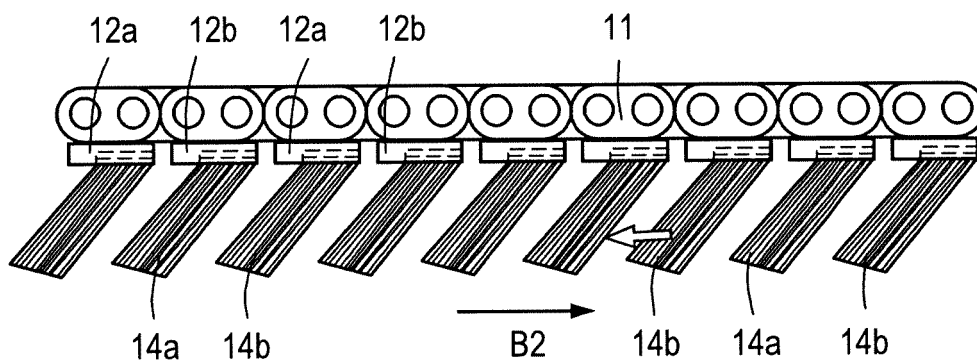


Fig.6B



EUROPEAN SEARCH REPORT

Application Number
EP 13 00 4631

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	US 2007/220783 A1 (HAMBURGER JACOB A [US] ET AL) 27 September 2007 (2007-09-27) * the whole document *	1-15	INV. E02D17/06 E02F5/06
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			TECHNICAL FIELDS SEARCHED (IPC)
			E02D E02F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 November 2013	Examiner Geiger, Harald
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 00 4631

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18-11-2013

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