

English Translation of

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METHOD AND TRENCH CUTTING DEVICE FOR PRODUCING A CUT TRENCH IN THE GROUND

The invention relates to a method for producing a cut trench in the ground by means of a trench cutting device having a trench cutter and a supporting means which is designed for lifting and lowering the trench cutter, wherein the trench cutter is connected at its upper end to the supporting means and at its lower end has at least one cutting wheel which is rotatably supported and can be driven in a rotating manner via a rotary drive in order to remove ground material, wherein a target value for an advancing speed of the trench cutter during removal of ground material can be preset in a control unit, through which a lowering of the trench cutter by the supporting means into the ground is controlled, in accordance with the preamble of claim 1.

The invention further relates to a trench cutting device having a trench cutter and a supporting means which is designed for lifting and lowering the trench cutter into the ground, wherein the trench cutter is connected at its upper end to a supporting means and at its lower end has at least one cutting wheel which is rotatably supported and driven in a rotating manner via a rotary drive in order to remove ground material, wherein a control unit is furthermore provided, through which a lowering of the trench cutter by the supporting means into the ground can be controlled, wherein a target value for an advancing speed of the trench cutter during removal of ground material can be entered into the control unit, in accordance with the preamble of claim 10.

A generic method can be taken from EP 0 790 356 B1. In this known trench cutting device a trench cutter is lowered with a target advancing speed into the ground. The target advancing speed is entered into a control means. In this process, a load of the trench cutter is detected by the control means. If a load of the trench cutter and therefore a specific pressing force onto the cutting wheels is exceeded, the advancing

speed of the trench cutter is reduced. This serves to avoid overloading of the cutting wheels in cutting operation.

The detection of a load on a trench cutter during cutting is relatively laborious and is also accompanied by inaccuracy. Due to the relatively high weight of a trench cutter it is necessary that during lowering into the ground and during removal of ground material the trench cutter is to be constantly subjected to a certain pull force, with which the cutting wheels are relieved of a part of the applied weight force of the trench cutter.

To determine the load it is therefore common practice to detect a force on the cutter winch or a supporting rope of the trench cutter. However, on this force value further factors, such as the friction of the cutter on the trench walls and the type of filling of the trench with a stabilizing liquid, have a not insignificant influence. To avoid overloading of the cutting wheels that can lead to increased wear or destruction of the cutting teeth a corresponding safety factor has to be taken into account in the measured load value. This makes it more difficult to operate the trench cutting device at an upper power limit, at which a high cutting progress concurrent with low wear is ensured.

The invention is based on the **o b j e c t** to provide a method and a trench cutting device for producing a cut trench in the ground, with which a trench cutting device can be operated in a particularly efficient manner.

The object is achieved on the one hand by a method having the features of claim 1 and on the other hand by a trench cutting device having the features of claim 10. Preferred embodiments are stated in the respective dependent claims.

The method according to the invention is characterized in that the advancing speed is controlled by means of the control unit depending on a rotational speed and/or a torque of the at least one cutting wheel, wherein on reaching a preset limit value for the rotational speed and/or for the torque the advancing speed of the trench cutter is changed, in particular reduced, with respect to the target value for the advancing speed.

The invention is based on the finding that for the control or regulation of the advancing speed the rotational movement of the at least one cutting wheel can be used. The rotational movement of the cutting wheel can in particular be considered as the rotational speed and/or the torque of the cutting wheel. If the advancing speed is too

high for an in-situ ground layer, the rotational speed of the cutting wheel decreases and a torque present at the cutting wheel increases. If the rotational speed drops, favorable cutting conditions for a high removal rate no longer prevail. In addition, with an increase of the torque a load of the cutting wheel transmission and of the removal teeth rises and there is the risk of tooth breakage. Therefore, the rotational movement allows a very good conclusion as to whether a preselected target advancing speed is too high or, as the case may be, even too low for an in-situ ground layer. In addition to a reduction of the advancing speed an increase can be provided too. Within the meaning of the invention a limit value can be understood not only as a specific single value but also as a limit range with a value range.

The invention is furthermore based on the finding that a rotational movement and in particular a rotational speed and/or a torque of the at least one cutting wheel can be detected relatively easily and precisely as compared to a load. This permits a very precise and also quick control or regulation of a trench cutter during removal of ground material. Thus, the invention makes it possible for even an inexperienced device operator to work close to the power limit of a trench cutter so that an efficient cutting with a high daily rate can be achieved.

Within the meaning of the invention a limit value does not have to be a fixed value. This can also be a dynamic limit value that depends on other factors and/or parameters, e.g. on ground parameters etc., and can change. The limit values can in particular be limit value characteristics that are stored in the control as characteristic curves or tables.

A preferred embodiment of the invention resides in the fact that on reaching the limit value for the rotational speed or the torque the advancing speed of the trench cutter is reduced until the rotational speed is again above a preset rotational speed limit value or the torque is below a preset torque limit value. The trench cutter can thus be operated with a relatively high target advancing speed and with a relatively high load. If the rotational speed falls below a preset limit value or if the torque rises above a preset limit value, the control unit is designed such that the advancing speed is changed, in particular reduced until the rotational speed is again above a preset rotational speed limit value or the torque is below a preset torque limit value. A reduction of the advancing speed usually also brings about a reduction of the load on

the trench cutter. In this way, the at least one cutting wheel can be relieved, thus resulting in an increase in rotational speed or a reduced torque requirement.

It is especially preferred that the advancing speed of the trench cutter is increased up to the target value for the advancing speed if the rotational speed is above the rotational speed limit value or the torque is below the torque limit value. In this way, a regulation of the advancing speed can be effected as a function of the measured rotational speed or the measured torque. The limit value, on reaching of which the advancing speed is reduced, can be equal to the rotational speed limit value or the torque limit value, at which the advancing speed is increased again. By preference, however, these limit values can also be different and constitute a limit range. This counteracts the risk of the regulation of the system giving rise to oscillations.

Moreover, for an efficient cutting operation it can be expedient that the advancing speed is furthermore controlled depending on a load of the trench cutter. The load can be detected as an additional measured value, in which case a limit value for an upper load and a lower load, at which the advancing speed is reduced or increased, can also be entered into the control unit.

According to a further development of the invention particularly good control or regulation of the trench cutter is achieved in that the rotational speed or the torque is detected in a direct manner and a related measured value is forwarded to the control unit.

In conjunction with this, it is particularly preferred that the rotational speed is detected by means of a rotational speed pickup or the torque is detected by means of a torque pickup. Rotational speed pickups are sufficiently known and can detect a rotational speed e.g. on a drive shaft in particular in a contactless manner. Detection can take place optically, inductively, magnetically or in another known way. Correspondingly, known torque pickups can be provided on a drive shaft of the cutting wheel for example. Known torque pickups can operate e.g. electronically with one or several strain gauges positioned on a shaft.

Alternatively or additionally, according to a further development of the method pursuant to the invention provision can be made for the rotational speed and/or the torque to be

detected in an indirect manner. As a result, in particular measuring means located directly on the cutting wheel or the cutting wheel transmission can be avoided.

It is particularly preferred that in order to detect the rotational speed and/or the torque a power consumption of the rotary drive is measured. For example if, at a preset advancing speed, the cutting wheel makes contact with a ground layer of greater compactness this can be detected due to an increase in the power consumption of the rotary drive. This is generally possible with all drive types, for example also with an electric rotary drive.

A preferred embodiment variant of the invention resides in the fact that the rotary drive is operated hydraulically with a hydraulic circuit, wherein a pressure or a pressure change is detected in the hydraulic circuit. In trench cutters with hydraulic drive the pressure present at hydraulic pumps of the hydraulic circuit can be used to control or regulate the advancing speed. For example if the torque rises above a defined limit value and therefore the pressure present at the hydraulic pumps, the advancing speed can be reduced. Here, a limit value can preferably lie approximately 10 % below the pressure for a maximum rotational speed or a maximum torque in order to retain sufficient reserve during operation of the cutting wheels.

Moreover, the control unit can be designed such that in the case of complete blockage of the at least one cutting wheel the trench cutter is slightly raised through the control unit by means of the supporting means. This reduces the contact force and therefore the required torque. The cutting wheels can thus start to rotate again.

With regard to the trench cutting device the invention is characterized in that the control unit is designed for controlling the advancing speed depending on a rotational speed and/or a torque of the at least one cutting wheel and for presetting a limit value for the rotational speed and/or the torque, wherein on reaching the preset limit value for the rotational speed or for the torque the advancing speed of the trench cutter can be reduced with respect to the target value for the advancing speed. Within the meaning of the invention the term control is to be understood in a broad sense and can also comprise a regulation.

With the trench cutter according to the invention the previously described method can be carried out in particular. The advantages described beforehand can be achieved thereby.

A preferred embodiment of the trench cutting device according to the invention can be seen in the fact that the supporting means is a carrier implement with a supporting rope or a supporting rod, wherein the trench cutter is suspended in a vertically adjustable manner on the supporting rope or the supporting rod. The supporting rope or the supporting rod forms a supporting element, with which the trench cutter can be sunk vertically into the ground. For this purpose, the supporting means can have a winch for the supporting rope or a linear drive, more particularly a hydraulic cylinder means, for the supporting rod. A load can in this case be detected by a force pickup on the winch or a pressure sensor in the hydraulic system of the hydraulic cylinder.

Basically, the trench cutting device can be designed with only one cutting wheel or with a pair of two cutting wheels. A purposeful operation of the trench cutting device is achieved by the fact that a total of four cutting wheels are provided which are arranged in pairs next to each other. The axis of the at least one cutting wheel is directed transversely to the direction of advance, in particular being directed horizontally. In the case of two cutting wheel pairs each the two cutting wheels of a cutting wheel pair rotate about the same cutting wheel axis. The cutting wheel axes of the two cutting wheel pairs are arranged in parallel and spaced apart from each other.

The invention is described in greater detail hereinafter by way of a preferred embodiment illustrated schematically in the accompanying Figure. The single accompanying Figure shows a perspective view of a trench cutting device 10 according to the invention.

The trench cutting device 10 according to the Figure has a supporting means 20 with a carrier implement 22 that is provided with a crawler-track running gear. On the carrier implement 22 a mast 24 is supported in an approximately vertically directed manner, over the mast head of which a supporting rope 26 is guided.

At the free end of the supporting rope 26 a generally known trench cutter 30 with a scaffold-like cutter frame 32 is suspended. The supporting rope 26 is connected to the trench cutter 30 at an upper end thereof. The other end of the supporting rope 26 is

guided to a winch 28, indicated only, on the carrier implement 22. By means of the winch 28 the trench cutter 30 can be lifted and lowered vertically.

At a lower end of the cutter frame 32 of the trench cutter 30 a total of four cutting wheels 34 are each arranged in pairs, as illustrated schematically only in the Figure. By way of a rotary drive 36 on the cutter frame 32, which is indicated schematically in the Figure and driven hydraulically, the cutting wheels 34 can be set into rotating motion. When lowering the trench cutter 30 into the ground, ground material can be removed by the rotating cutting wheels 34.

An advancing speed of the trench cutter 30 can, for example, be determined on the winch 28 by measuring the winch rotation over time. In a control unit on the carrier implement 22 a target value for the advancing speed can be entered, whereby e.g. the winch 28 is actuated accordingly.

Furthermore, by the control unit a rotational speed and/or a torque of the cutting wheels 34 can be detected directly or indirectly through the pressure prevailing at the hydraulic units that are also arranged on the carrier implement 22. If, at a preset advancing speed of the trench cutter 30, the rotational speed at the cutting wheels 34 falls below a preset limit value, a drive of the winch 28 can be actuated by the control unit in order to reduce the advancing speed of the trench cutter 30. This reduction of the advancing speed of the trench cutter 30 takes place until the rotational speed of the cutting wheels 34 is again above a rotational speed limit value. Afterwards, through corresponding actuation of the winch 28, the advancing speed of the trench cutter 30 can be increased again by the control unit until the preset advancing speed of the trench cutter 30 is reached. Alternatively or additionally, a control or regulation can also take place by taking into account the torque on the cutting wheels 34.

CLAIMS

1. Method for producing a cut trench in the ground by means of a trench cutting device (10) having a trench cutter (30) and a supporting means (20) which is designed for lifting and lowering the trench cutter (30),
wherein the trench cutter (30) is connected at its upper end to the supporting means (20) and at its lower end has at least one cutting wheel (34) which is rotatably supported and can be driven in a rotating manner via a rotary drive (36) in order to remove ground material,
wherein a target value for an advancing speed of the trench cutter (30) during removal of the ground material can be preset in a control unit, through which a lowering of the trench cutter (30) by the supporting means (20) into the ground is controlled,
characterized in that
the advancing speed is controlled by means of the control unit depending on a rotational speed and/or a torque of the at least one cutting wheel (34), wherein on reaching a preset limit value for the rotational speed and/or for the torque, the advancing speed of the trench cutter (30) is changed, in particular reduced, with respect to the target value for the advancing speed.
2. The method according to claim 1,
characterized in that
on reaching the limit value for the rotational speed or the torque, the advancing speed of the trench cutter (30) is reduced until the rotational speed is again above a preset rotational speed limit value or the torque is below a preset torque limit value.
3. The method according to claim 2,
characterized in that
the advancing speed of the trench cutter (30) is increased up to the target value for the advancing speed if the rotational speed is above the rotational speed limit value or the torque is below the torque limit value.

4. The method according to any one of claims 1 to 3, characterized in that the advancing speed is furthermore controlled depending on a load of the trench cutter (30).
5. The method according to any one of claims 1 to 4, characterized in that the rotational speed or the torque is detected in a direct manner and a related measured value is forwarded to the control unit.
6. The method according to claim 5, characterized in that the rotational speed is detected by means of a rotational speed pickup or the torque is detected by means of a torque pickup.
7. The method according to any one of claims 1 to 6, characterized in that the rotational speed and/or the torque are detected in an indirect manner.
8. The method according to claim 7, characterized in that to detect the rotational speed and/or the torque a power consumption of the rotary drive (36) is measured.
9. The method according to claim 8, characterized in that the rotary drive (36) is operated hydraulically with a hydraulic circuit, wherein a pressure or a pressure change is detected in the hydraulic circuit.
10. Trench cutting device, for producing a cut trench in the ground, having a trench cutter (30), a supporting means (20) which is designed for lifting and lowering the trench cutter (30), and a control unit, wherein the trench cutter (30) is connected at its upper end to the supporting means (20) and at its lower end has at least one cutting wheel (34) which is rotatably supported and can be driven in a rotating manner via a rotary drive (36) in order to remove ground material,

wherein a target value for an advancing speed of the trench cutter (30) during removal of ground material can be preset into the control unit, through which a lowering of the trench cutter (30) by the supporting means (20) into the ground is controlled,

characterized in that

the advancing speed is controlled by means of the control unit depending on a rotational speed and/or a torque of the at least one cutting wheel (34), wherein on reaching a preset limit value for the rotational speed and/or for the torque, the advancing speed of the trench cutter (30) is changed, in particular reduced with respect to the target value for the advancing speed.

11. The trench cutting device according to claim 10,
characterized in that
the supporting means (20) is a carrier implement (22) with a supporting rope (26) or a supporting rod, wherein the trench cutter (30) is suspended in a vertically adjustable manner on the supporting rope (26) or the supporting rod.
12. The trench cutting device according to claim 10 or 11,
characterized in that
a total of four cutting wheels (34) are provided which are arranged in pairs next to each other.