
Vibrator arrangement for improving building soil

Description

The invention relates to a vibrator arrangement for building soil improvement, comprising a sluice with a silo tube and with a sluice drive for moving the sluice, wherein the
5 sluice is adapted to receive and guide a bulk material into the silo tube, a feed container for feeding the bulk material to the sluice, wherein a feed container drive is provided for moving the feed container between a waiting position and an abutment position at the sluice. The invention further relates to a method of transferring bulk material from a feed container into a sluice having a silo tube at a vibrator device, wherein the sluice
10 is moved by a sluice drive, wherein the feed container is filled with the bulk material and wherein the feed container is moved by a feed container drive between a waiting position and a abutment position at the sluice.

Vibrator arrangements are used in methods of building soil improvement, which differ
15 with regard to the mode of action and load transfer. With the vibro-compaction method, for example, coarse-grained soils are compacted in themselves, while with the vibro-replacement method, load-bearing columns of gravel or crushed stone are produced in mixed and fine-grained soils that are not capable of compaction. Furthermore, pile-like foundation elements can be produced, through which relatively high loads can be
20 transferred, if a permanent load-bearing connection with replacement columns is not guaranteed.

Publication EP 2 241 677 A1 discloses a device for feeding inert materials to vibrating soil compaction systems on a compaction device having a tower or arm for supporting
25 a drill battery. The inert material is fed to the drill battery from a sluice. The funnel-shaped feeder device is moved between a first lower level near the ground and a second level at which the sluice is located. The feeder device is provided with an openable outlet flap to transfer the inert material from the feeder device to the sluice. The outlet flap is opened by mechanical means on the device and the sluice.

For example, in the vibro-replacement method, work is carried out in alternating steps. Gravel or crushed stone that emerges during the vibrator stroke is compacted during pressing and displaced laterally into the ground. The coarse-grained addition material
5 is discharged at the tip of the vibrator with the aid of compressed air. For this purpose, the system is supplied with compressed air, which supports the transport of the bulk material within the system. A disadvantage of the prior art system is that the feed device can only be docked to the sluice when the sluice is not in an upward or downward motion. If there is a collision between the sluice and the feeder device, this can cause
10 the rope to break, causing the feeder device to fall. In addition, the entire system must be vented before the sluice can be opened. This leads to considerable downtimes. The process can only be continued when the bulk material has been transferred into the sluice and the working air pressure has been reached again after closing the sluice.

15 It is an object of the invention to propose a vibrator arrangement and a method for building soil improvement, which make it possible to reduce the downtime.

The task is solved by the objects of the independent claims. In the subclaims, preferred embodiments and advantageous further embodiments are indicated.

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A vibrator arrangement for building soil improvement according to the invention has a sluice with a silo tube and with a sluice drive for moving the sluice, wherein the sluice is arranged to receive a bulk material and to guide it into the silo tube. Further, a feed container is provided to feed the bulk material to the sluice, wherein a feed container
25 drive is provided to move the feed container between a waiting position and an abutment position at a stop formed on the sluice.

The sluice and the feed container are each guided, for example, on a lead or via a rope on a boom. The sluice drive is independent of the feed container drive. Corresponding
30 guides and drives of the sluice and the feed container are known to the skilled person, as well as vibrators for generating a vibration of the vibrator arrangement, which is preferably arranged with such a vibrator as a deep vibrator or as a top vibrator.

According to the invention, a controller of the feed container drive is adapted to reduce a force of the feed container drive towards the stop from a first value to a second value when in the abutment position, the second value having a smaller absolute value than a force of the sluice drive.

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An advantage of the vibrator arrangement according to the invention is that the first value of the force of the feed container drive is suitable to move the feed container from the waiting position to the abutment position at the stop formed at the sluice, while the force of the feed container drive reduced to the second value couples the feed container to the sluice by holding the feed container in the abutment position at the stop by the force of the feed container drive reduced to the second value. Particularly advantageously, this coupling of the feed container with the sluice works independently of a movement of the sluice, since the force of the feed container drive reduced to the second value has a smaller absolute value than a force of the sluice drive.

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For the purposes of the invention, sluice drive force means a drive force of the sluice drive acting on the sluice. Other forces acting on the sluice do not count towards the force of the sluice drive. For the purposes of the invention, feed container drive force means a drive force of the feed container drive acting on the feed container. Other forces acting on the feed container do not count towards the force of the feed container drive. Other forces may include, for example, the driving force of the other drive or weight forces acting on the feed container or silo.

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During operation of the vibrator arrangement, for example during the vibro-replacement method, the sluice with the silo tube is pulled out of a borehole against the direction of gravity during the vibrator stroke and is retracted into the borehole in the direction of gravity during pressing. The vibrator arrangement according to the invention advantageously allows the coupling described above both during the vibrator stroke and during the retraction of the sluice. This reduces the downtime of the vibrator arrangement, as the sluice does not have to be stopped for the coupling process.

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According to a preferred embodiment, the feed container drive controller is further configured to maintain the force of the feed container drive acting in the direction of the

stop after reaching the abutment position during a transfer of bulk material from the feed container into the sluice. The bulk material is thus advantageously taken over during the vibrator stroke or during the retraction of the vibrator arrangement.

- 5 During the vibrator stroke, the force of the sluice drive moves the sluice upwards, against the direction of gravity. The force of the feed container drive, reduced to the second value, is also upwardly directed and, in the case, is sufficient to move the feed container upwardly, at a speed at least equal to the speed of the sluice, so that the sluice and the feed container remain coupled. Preferably, the movement of the feed
10 container is decelerated by the sluice so that part of the force of the feed container drive acts on the sluice via the stop.

- During retraction, the force of the sluice drive moves the sluice downwards, in the direction of gravity. The force of the feed container drive, reduced to the second value,
15 is still directed upwards, against the force of the sluice drive. Since this force is smaller than the force of the sluice drive, the feed container is pressed downwards by the sluice.

- Likewise, the takeover process can take place during a transition from pulling out the
20 sluice to retracting the sluice or vice versa. The direction of the force of the sluice drive is thereby reversed, whereby the force of the feed container drive reduced to the second value after reversal of the direction of the force of the sluice drive again has a smaller absolute value than the force of the sluice drive. The skilled person will recognize that in the transition phase, the force of the feed container drive reduced to the
25 second value will be temporarily greater in absolute value than the force of the sluice drive, thereby not disengaging the coupling of the feed container to the sluice.

- Preferably, the feed container drive controller is further configured to move the feed container from the abutment position upon completion of the transfer of bulk material.
30 The coupling is thus advantageously released again and the feed container returns to the waiting position by means of the feed container drive until bulk material is to be transferred to the sluice again.

The waiting position in the sense of the invention is a position of the feed container which is located away from the sluice. In particular, the waiting position is arranged such that the sluice does not reach this position during regular operation, so that the movement of the sluice is not hindered by the feed container being in the waiting position. The waiting position is not necessarily an unchangeable position. The waiting position is preferably variable in location. For example, the waiting position is defined at a fixed distance from the sluice so that the waiting position also moves when the sluice moves. The waiting position is preferably the position in which the feed container is filled with the bulk material. The abutment position in the sense of the invention is defined by the stop on the sluice and thus moves with the sluice.

According to a preferred embodiment, it is provided that at least two different sensors are connected to the controller system for determining a position of the feed container relative to the sluice. In particular, a sensor is provided to detect an approach of the feed container to the abutment position, for example to reduce a travel speed of the feed container. A further sensor is designed to detect when the abutment position is reached and to send a signal to the controller system accordingly.

According to another preferred embodiment, it is provided that the feed container drive comprises a hydraulic motor, wherein a bypass is provided in parallel with the hydraulic motor, the bypass comprising a bypass valve to open and close the bypass. In particular, the force of the feed container drive is advantageously reduced from the first value to the second value when the bypass is open. For this purpose, the bypass has, for example, an adjustable pressure relief valve.

According to another preferred embodiment, it is provided that the sluice comprises a closable outlet, wherein the outlet is opened to direct the bulk material from the sluice into the silo tube. Further preferably, the sluice comprises a closable inlet, wherein the inlet is opened to receive the bulk material from the feed container. The embodiment is particularly advantageous because the silo tube is preferably pressure-ventilated. The two closable openings of the sluice, the inlet and the outlet, allow the bulk material to be transferred from the feed container into the sluice without having to vent the pressure-ventilated silo tube. Preferably, it is further provided that the sluice is supplied

with compressed air independently of the silo tube. If the sluice is vented to transfer the bulk material while the silo tube, separated from the sluice by the closed outlet, remains pressurized, it is advantageously possible to pressurize the sluice after completion of the takeover with the inlet and outlet closed to establish pressure balancing
5 between the sluice and the silo tube before the outlet is opened.

When driving the vibrator arrangement into the ground, it may be advantageous, depending on the ground conditions, either to initially drive the silo tube in without bulk material, or to fill it completely or partially with bulk material. The correct decision, usually based on experience, allows, for example, to avoid jammers in the soil or to make
10 it easier to retract the vibrator assembly. The empty silo tube is preferably supplied with compressed air when the outlet is closed. The sluice preferably remains depressurized, especially preferably with the inlet open. When bulk material is then fed in, there is a time saving advantage as the feed container can transfer the bulk material
15 without delay to the sluice with the inlet already open. In addition, the filling of the sluice with compressed air and the venting are economized. This is made possible by the outlet, which separates the sluice from the silo tube.

Before a complete pull out of the vibrator assembly from the soil, it is advantageous to
20 vent the sluice and the silo tube via two valves without opening the inlet or the outlet of the sluice. This avoids in particular that in the last section, before the vibrator arrangement is driven out of the ground, a blow-out of the compressed air occurs, which would mean a risk of injury by stones flying around. Furthermore, the sluice and the silo tube can be opened and filled more quickly.

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A further object of the invention relates to a method of transferring bulk material from a feed container to a sluice comprising a silo tube in a vibrator arrangement, the vibrator arrangement preferably corresponding to the vibrator arrangement according to the invention described above. All features of the vibrator arrangement can be applied
30 mutatis mutandis to the process and vice versa.

In the method according to the invention, the sluice is moved by a sluice drive, the feed container is filled with the bulk material and the feed container is moved by a feed

container drive between a waiting position and an abutment position at a stop formed on the sluice. In the abutment position, a force of the feed container drive towards the stop is reduced from a first value to a second value, wherein the second value has a smaller absolute value than a drive force of the sluice drive.

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An advantage of the method is that the first value of the force of the feed container drive is adapted to move the feed container from the waiting position to the abutment position against the stop formed on the sluice, while the force of the feed container drive reduced to the second value couples the feed container to the sluice by holding
10 the feed container in the abutment position against the stop by the force of the feed container drive reduced to the second value. Particularly advantageously, this coupling of the feed container to the sluice is performed independently of a movement of the sluice, since the force of the feed container drive reduced to the second value has a smaller magnitude than a force of the sluice drive.

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Preferably, the feed container is held in the abutment position by the force reduced to the second value when the sluice is moved. In particular, the feed container is held in the abutment position when the sluice is moved in a first direction towards the waiting position by moving the feed container together with the sluice in the first direction,
20 wherein a driving force of the sluice drive acts on the feed container via the stop and overcomes the force of the feed container drive reduced to the second value. In particular, the feed container is held in the abutment position when the sluice is moved in a second direction opposite to the first direction by the feed container following the stop in the second direction by the force of the feed container drive reduced to the second
25 value.

Preferably, it is provided that at least a portion of the bulk material is transferred from the feed container into the sluice while the feed container is held in the abutment position. Particularly preferably, after reaching the abutment position, a closable outlet between the pressure-ventilated silo tube and the sluice is closed, the sluice being subsequently vented separately via a valve before a closable inlet of the sluice is opened.
30 It is further preferred that the bulk material is transferred through the inlet from the feed container into the sluice, wherein the feed container is moved synchronously with the

sluice during the transfer operation. After taking over the bulk material, the inlet is preferably closed first and then the outlet is opened. In a particularly preferred embodiment, the sluice is pressurized independently of the silo tube while the inlet and outlet are closed to balance pressure between the sluice and the silo tube before the outlet is
5 opened.

After the bulk material has been taken over, the feed container is preferably moved into the waiting position. The feed container preferably remains in the waiting position until the sluice is to be filled with bulk material again. Particularly preferably, the feed
10 container is filled with the bulk material in the waiting position.

Hereinafter, the invention will be explained in more detail with reference to the accompanying drawings by way of an example of an embodiment. The explanations refer to the vibrator arrangement according to the invention as well as to the method according
15 to the invention. The embodiments are merely exemplary and do not limit the general idea of the invention.

Figure 1 shows an embodiment of a vibrator arrangement according to the invention with a feed container in an abutment position on a sluice in a schematic sectional view;
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Figure 2 shows the embodiment according to Figure 1 with an open inlet of the sluice in a schematic sectional view;

Figure 3 shows a schematic sectional view of the embodiment according to Figure 1 after a transfer of bulk material;
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Figure 4 shows the embodiment according to Figure 1 with the feed container in a waiting position in a schematic sectional view;

30 Figure 5 shows the embodiment according to Figure 1 with an open outlet of the sluice in a schematic sectional view;

Figure 6 a detail of the embodiment according to Figure 1 in a schematic sectional view

without the sluice;

Figure 7 is a schematic representation of a controller system for the feed container drive of the embodiment according to Figure 1.

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Figures 1 to 5 show an embodiment of a vibrator arrangement according to the invention with a feed container 1 and a sluice 2 in a schematic sectional view in various positions respectively in various working steps. With reference to the embodiments, it will be explained how a transfer of bulk material 3 from the feed container 1 into the
10 sluice 2 takes place in the vibrator arrangement according to the invention, or according to the inventive method.

The sluice 2 has a sluice drive 4 with which the sluice 2 is moved. As part of the sluice drive 4, a guide carriage 41 of the sluice 2 is shown in Figure 1, which is guided in a
15 known manner on a lead not shown. The sluice drive 4 transmits a driving force to the guide carriage 41 of the sluice 2, which is connected to the guide carriage 41 via a mounting 42. The feed container is moved by a feed container drive 5 between a waiting position, as shown in figures 4 and 5, and an abutment position, as shown in figures 1 to 3. In the abutment position, the feed container 1 is located at a stop 6 formed at
20 the sluice 2. In the illustrated embodiment, the stop 6 is formed on the guide carriage 41 of the sluice 2. Upon reaching the abutment position, a force of the feed container drive 5 towards the stop 6 is reduced from a first value to a second value, the second value having a smaller absolute value than a driving force of the sluice drive 4. With reference to Figure 7, a controller 8 of the feed container drive 5 will be explained in
25 more detail at a later stage. Of the feed container drive 5, a guide carriage 51 of the feed container 1 is shown in Figure 1, which is also guided in a known manner on a lead which is not shown. The feed container drive 5 transmits a driving force to the guide carriage 51 of the feed container 1, which is connected to the guide carriage 51 via a mounting 52. In the following description of figures 1 to 6, the guide carriage 41
30 is also referred to as the sluice drive 4 by way of representation and the guide carriage 52 is also referred to as the feed container drive 5, since the respective drive forces are transmitted to the corresponding guide carriage 41, 51.

The sluice 2 has a closable outlet 10 and an inlet 11 which is also closable, wherein in Figure 1 both the outlet 10 and the inlet 11 are closed. The outlet 10 is formed as a conical closure at a lower end of the sluice 2, to which an upper end of the silo tube 7 is flanged, so that the outlet 10 can uncover and close an opening between the sluice 2 and the silo tube 7. For this purpose, a seat for the conical closure 10 is formed at the opening, which is generally provided with a rubber sealing to ensure a substantially gas-tight closure even if small amounts of the bulk material remain between the closure 10 and the seal. The closure 10, as well as its seat, can be cleaned with supplied cleaning fluid via a nozzle 26 in the silo tube 7, also referred to as a cleaning element 26. An actuating linkage 12 is connected to the outlet 10, which is preferably hydraulically actuated. The silo tube 7 is preferably pressurized to assist an outlet of coarse bulk material at a lower end of the silo tube 7, which is not shown, by means of compressed air. Advantageously, the closable outlet 10 allows the inlet 11 of the sluice to be opened in the closed position without venting the silo tube 7.

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With reference to Figure 2, inlet 11 is explained in more detail below. The inlet 11 is designed as a pivotable flap in an upper region of a wall of the sluice 2, which in the abutment position according to Figure 1 is aligned with respect to an outlet opening 14 of the feed container 1 in such a way that the transfer of the bulk material 3 from the feed container 1 into the sluice 2 is possible. The inlet 11 is pivotable by means of a pivot mechanism 15 for opening and closing, preferably by hydraulic actuation. In Figure 2, the inlet 11 is shown open, with the outlet 14 of the feed container 1 still closed. Since the outlet 10 of the sluice 2 is closed, the silo tube 7 remains pressurized while the sluice 2 is ready to receive the bulk material 3. The sluice 2 according to the invention forms an additional reservoir with a double opening mechanism, comprising the inlet 11 and the outlet 10. Thus, the sluice 2 forms a pressure container which, on the one hand, can receive the bulk material 3 and, on the other hand, can be separately aerated and deaerated.

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Figure 3 shows the vibrator arrangement according to the invention chronologically after the situation shown in Figure 2. The feed container 1 is further in the abutment position against the stop 6 formed at the sluice 2, by the force of the feed container drive 5 which operates against the stop 6. The outlet opening 14 of the feed container

1 is now open, and the bulk material 3 has been transferred from the feed container 1 to the sluice 2 via a bulk chute 16 through the open outlet opening 14 and the open inlet 11. The outlet 10 of the sluice 1 is still closed, so that the pressure ventilation of the silo tube 7 is maintained.

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Figure 4 shows the vibrator arrangement according to the invention chronologically after the situation shown in Figure 3. After the bulk material 3 has been transferred from the feed container 1 to the sluice 2, the feed container 1 has left the abutment position at the stop 6. The feed container drive 5 has moved the feed container 1 to a waiting position. The waiting position is characterized in that the feed container 1 is arranged remote from the sluice 2, in this case along the not shown lead at a distance below the sluice 2. The sluice 2 can be moved independently of the feed container 1 as long as the latter is arranged in the waiting position. The feed container 1 can, for example, be refilled with bulk material in the waiting position. At sluice 2, inlet 11 is closed again. The outlet 10 is provided to direct the bulk material 3 from the sluice 2 into the silo tube 7. However, the outlet 10 is still closed. The sluice 2 can now preferably be pressure-ventilated separately before the outlet 10 is opened, in order to adapt the pressure conditions of the sluice 2 to the silo tube 7 again.

Figure 5 shows the vibrator arrangement according to the invention chronologically after the situation shown in Figure 4. The outlet 10 has been opened so that the bulk material 3 has passed from the sluice 2 into the silo tube 7. The feed container 1 remains unchanged in its waiting position. Subsequently, the outlet 10 is closed again to allow separate venting of the sluice 2 for a subsequent transfer of bulk material. The feed container 1, which has been filled again or continues to be filled with bulk material 3, moves back into the abutment position as shown in Figure 1 if required. The sequence shown in Figures 1 to 5 is repeated several times and thus advantageously permits continuous operation of the vibrator arrangement according to the invention.

With reference to Figure 6, a detail of the feed container 1 is explained. The mounting 52 of the feed container 1, which is not fully visible in figures 1 to 5, connects the latter to the guide carriage 51 of the feed container 1. Only the guide carriage 41 of the sluice 2 is shown with the stop 6, wherein the guide carriage 51 of the feed container 1 moves

against the stop 6. The abutment position is then reached, in which the force of the feed container drive 5, reduced to the second value, holds the feed container 1. A sensor 9 is provided as a proximity sensor 9 to detect an approach of the guide carriage 51 of the feed container 1 to the guide carriage 41 respectively the stop 6 of the sluice 2. Furthermore, Figure 6 shows the force ratios of the driving forces acting between the guide carriage 51 of the feed container 1 and the guide carriage 41 of the sluice 2, which are transmitted via the stop 6. In the abutment position, the force of the feed container drive 5 in the direction of the stop 6 is reduced from the first force value F_1 to the second force value F_2 , which is why the first force value F_1 is represented by a dashed arrow and the second force value F_2 is represented by a full line arrow. The force F_1 of the feed container drive 5 engages the guide carriage 51 of the feed container 1 and is transmitted to the guide carriage 41 of the sluice 2 via the stop. The force F_S of the sluice drive 4 engages the guide carriage 41 of the sluice 2 and is opposed to the force F_1 of the feed container drive 5. The vibrator assembly is driven into the ground because the force F_S of the sluice drive 4 is of a greater absolute value than the reduced force F_1 of the feed container drive 5. The resulting force F_R is shown accordingly by an arrow on the stop 6. The feed container 1 and the sluice 2 are coupled by the acting forces and are moved together.

In the following, the controller system 8 of the feed container drive 5 set up for this purpose is explained in more detail with reference to Figure 7. The vibrator arrangement according to the invention allows the feed container 1 to be held in the abutment position with the sluice 2, while the sluice 2 is moving. The realization of this synchronization between the feed container 1 and the sluice 2, which allows the transfer of the bulk material 3 previously described with reference to figures 1 to 5, while the vibrator arrangement continues to operate continuously, advantageously avoids downtimes. The synchronization between the feed container 1 and the sluice 2 is necessary because during the transfer of the bulk material the chute 16 enters the sluice 2 through the open inlet 11 (cf. Figure 3) so that a safe transfer of the bulk material 3 can take place. Otherwise, the chute 16 could be damaged and the bulk material 3 could fall onto a construction area below, causing property damage and/or personal injury. The controller 8 of the feed container drive 5 enables the synchronous movement between the feed container 1 and the sluice 2 to be maintained at the operating speed of the

vibrator arrangement during a pull and compaction operation, that is, an upward and downward movement of the vibrator arrangement. For example, the feed container drive 5 and the sluice drive 4 each have a separate hydraulic winch, with only the hydraulic winch 53 of the feed container drive 5 shown in Figure 7.

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For coupling between the feed container 1 and the sluice 2, the guide carriage 51 of the feed container 1 is first moved from the waiting position according to Figure 5 in the direction of the stop 6 on the guide carriage 41 of the sluice 2. This is preferably done initially in a rapid movement until the proximity sensor 9 (cf. Figure 6) signals the controller 8 to move the guide carriage 51 in a creep feed movement against the stop 6.

The method according to the invention subsequently provides that a force of the feed container drive 5 in the direction of the stop 6 is reduced from a first value to a second value in the abutment position, the second value having a smaller absolute value than a drive force of the sluice drive 4, which is realized in the embodiment by the controller 8 according to Figure 7. The guide carriage 51 of the feed container 1 remains actively controlled upwardly via a proportional valve 17 throughout the above described transfer procedure according to Figures 1 to 3. Accordingly, the proportional valve 17 is shown in a switching position for movement of the feed container 1 upwards, in the direction of the stop 6. Oil is supplied to a hydraulic motor 55 of the feed container drive 5 via the actively controlled proportional valve 17 through a hydraulic line 21. A return flow of oil on a low-pressure side of the hydraulic motor 55 occurs through the hydraulic line 22. A flow direction of the oil in the illustrated switching position of the proportional valve 17 is shown by directional arrows of the hydraulic lines 21, 22. Switching the proportional valve 17 would cause a downward movement of the feed container 1, for example from the abutment position to the waiting position, which is not shown here. Double-arrow P represents opposite directions of movements upward and downward.

The hydraulic motor 55 of the feed container drive 5 is connected via a shaft to a winch 53, through which a cable 54 connected to the guide carriage 51 of the feed container 1 moves the feed container 1 upwards or downwards. A bypass 23 is provided in parallel with the hydraulic motor 55, the bypass including a bypass valve 19 to open and

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close the bypass 23. An adjustable pressure relief valve 20 is further arranged in the bypass 23, so that when the bypass 23 is open, the force of the feed container drive 5 is reduced from the first value to the second value defined by the pressure relief valve 20.

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After reaching the abutment position, the guide carriage 41 of the sluice 2 determines the movement of the guide carriage 51 of the feed container 1 as it continues to press upwardly against the stop 6 on the guide carriage 41 of the sluice 2. Reaching the abutment position is detected by another sensor 18, in this case a pressure sensor 18, causing the bypass valve 19 to open the bypass 23. For this purpose, in the embodiment the bypass valve is designed as a 2/2 directional controller valve 19. A contact pressure is maintained via the pressure relief valve 20, which is set to a fixed pressure value, to generate the force of the feed container drive 5 reduced to the second value. The force reduced to the second value is generated under the contact pressure by the hydraulic motor 55 and transmitted via the winch 53 to the traction cable 54 connected to the guide carriage 51. A torque arrow denoted by M represents a torque of the feed container drive 5.

In case of an upward movement of the sluice 2 with the feed container 1 in the abutment position, for example when the vibrator arrangement is pulled out, the feed container 1 follows the sluice 2 as a result of the contact pressure defined by the pressure relief valve 20 according to the working speed of the sluice 2. Oil continues to be supplied to the hydraulic motor 55 of the feed container drive 5 via the actively controlled proportional valve 17 through the hydraulic line 21. A flow direction of the oil during the upward movement of the sluice 2 corresponds to the previously described flow direction and is additionally represented by a first arrow $P1$. However, due to the open bypass 23, the pressure at the hydraulic motor 55 is reduced to the contact pressure in order to generate the force of the feed container drive 5 reduced to the second value. The contact pressure is set by means of the pressure relief valve 20, in particular at least to such a level that the force of the feed container drive 5 generated by the hydraulic motor 55 and reduced to the second value compensates for a weight force of the masses of the feed container 1 and the bulk material 3, and moreover generates the drive force required for the feed container 1 to follow the sluice 2 without delay.

The direction of the weight force is indicated by an arrow marked G.

In case of a downward movement of the sluice 2 with the feed container 1 in the abutment position, for example during retraction, impact and vibrating movements, the guide carriage 41 of the sluice 2 presses with a greater force against the guide carriage of the feed container 1. The hydraulic motor 55 of the feed container drive 5 is thus moved against its actual direction of rotation due to the force acting via the winch 53. Since the hydraulic pressure via the proportional valve 17 is greater than the contact pressure defined by the pressure relief valve 20, the oil flows via the open bypass 23, i.e. via the open bypass valve 19, the pressure relief valve 20 and a check valve 24 to the low-pressure side of the hydraulic motor 55, which draws it in to prevent cavitation. A direction of flow of the oil through the hydraulic motor 55 and the bypass 23 during the downward movement of the sluice 2 is shown by a second arrow P2.

Upon completion of the bulk transfer procedure, the proportional valve 17 is switched (not shown), reversing the direction of force of the feed container drive 5 and causing the feed container 1 to leave the abutment position. The pressure sensor 18 is relieved and closes the bypass valve 19 of the bypass 23. The feed container 1 moves from the abutment position to the waiting position until the next loading process, which is initiated by switching the proportional valve 17 again to the position shown in Figure 7. The mass of the feed container 1 pulling in the direction of the weight force G is lowered in a controlled manner by a lowering brake holding valve 25. A safety valve 26, here designed as a pressure relief valve, prevents overloading of the wire rope 54.

List of reference signs

1	Feed container
2	Sluice
3	Bulk material
4	Sluice drive
41	Guide carriage of the sluice
42	Mounting of the sluice
5	Feed container drive
51	Guide carriage of the feed container
52	Mounting of the feed container
53	Winch of the feed container drive
54	Cable, wire rope, traction rope of the feed container drive
55	Hydraulic motor of the feed container drive
6	Stop
7	silo tube
8	controller of the feed container drive
9	Sensor, proximity sensor
10	Outlet, conical closure
11	Inlet, flap
12	Actuating linkage
14	Outlet opening
15	Pivot mechanism
16	Chute
17	Proportional valve
18	Sensor, pressure sensor
19	Bypass valve
20	Pressure relief valve
21	Hydraulic line

22	Hydraulic line
23	Bypass
24	Check valve
25	Lowering brake holding valve
26	Cleaning element, nozzle
P	Double arrow
P1	First arrow, first flow direction
P2	Second arrow, second flow direction
M	Torque arrow
G	Weight force direction
F1	Force arrow, first force value of the feed container drive
F2	Force arrow, second force value of the feed container drive
FS	Force arrow, force value of the sluice drive
FR	Resulting force

Claims

1. Vibrator arrangement for improving building soil, comprising
a sluice (2) with a silo tube (7) and with a sluice drive (4) for moving the sluice,
the sluice being arranged to receive a bulk material (3) and to guide it into the
silo tube,
a feed container (1) to feed the bulk material (3) to the sluice,
wherein a feed container drive (5) is provided to move the feed container be-
tween a waiting position and an abutment position against a stop (6) formed on
the sluice (2), and
wherein a controller (8) of the feed container drive (5) is arranged to reduce a
force of the feed container drive in the direction of the stop (6) while in the
abutment position from a first value to a second value, wherein the second
value has a smaller absolute value than a force of the sluice drive (4).
2. Vibrator arrangement according to any one of the preceding claims, character-
ized in that the controller (8) of the feed container drive (5) is further arranged
to maintain the force of the feed container drive acting in the direction of the
stop (6) after reaching the abutment position during feeding of bulk material (3)
from the feed container (1) into the sluice (2).
3. Vibrator arrangement according to any one of the preceding claims, character-
ized in that at least two different sensors (9, 18) are connected to the controller
(8) for determining a position of the feed container (1) relative to the sluice (2).
4. Vibrator arrangement according to claim 3, characterized in that at least one of
the sensors (18) emits a signal as soon as the feed container (1) reaches the
abutment position.
5. Vibrator arrangement according to any one of the preceding claims, character-
ized in that the feed container drive (5) comprises a hydraulic motor (55),
wherein a bypass (23) is provided in parallel with the hydraulic motor, the by-
pass comprising a bypass valve (19) to open and close the bypass.

6. Vibrator arrangement according to claim 5, characterized in that the force of the feed container drive (5) is reduced from the first value to the second value when the bypass (23) is open.
7. Vibrator arrangement of any one of claims 5 or 6, characterized in that the bypass (23) comprises an adjustable pressure relief valve (20).
8. Vibrator arrangement according to any one of the preceding claims, characterized in that the sluice (2) comprises a closable outlet (10), wherein the outlet is opened to direct the bulk material (3) from the sluice into the silo tube (7).
9. Vibrator arrangement according to any one of the preceding claims, characterized in that the sluice (2) comprises a closable inlet (11), wherein the inlet is opened for taking over the bulk material (3) from the feed container (1).
10. Method for transferring bulk material (3) from a feed container (1) into a sluice (2) with a silo tube (7) in a vibrator device,
wherein the sluice is moved by a sluice drive (4),
wherein the feed container is filled with the bulk material,
wherein the feed container is moved by a feed container drive (5) between a waiting position and an abutment position against a stop (6) formed on the sluice,
wherein, in the abutment position, a force of the feed container drive (5) in the direction of the abutment is reduced from a first value to a second value,
wherein the second value has a smaller absolute value than a driving force of the sluice drive (4).
11. Method according to claim 10, characterized in that the feed container (1) is held in the abutment position by the force reduced to the second value when the sluice (2) is moved.
12. Method according to any one of claims 10 or 11, characterized in that at least part of the bulk material (3) is transferred from the feed container (1) into the sluice (2) while the feed container is kept in the abutment position.

13. A method according to any one of claims 10 to 12, characterized in that the feed container (1) is held in the abutment position when the sluice (2) is moved in a first direction towards the waiting position by moving the feed container (1) together with the sluice (2) in the first direction, wherein a driving force of the sluice drive (4) acts on the feed container via the stop (6) and overcomes the force of the feed container drive (5) reduced to the second value.
14. The method according to claim 13, characterized in that the feed container (1) is held in the abutment position when the sluice (2) is moved in a second direction opposite to the first direction, by the feed container following the stop (6) in the second direction by the force of the feed container drive (5) reduced to the second value.
15. Method according to any one of claims 10 to 14, characterized in that, after reaching the abutment position, a closable outlet (10) between the pressure-ventilated silo tube (7) and the sluice (2) is closed, the sluice being separately vented before a closable inlet (11) of the sluice is opened.