(19) DANMARK

Patent- og
Varemærkestyrelsen

(10) **DK/EP 3581867 T3**

(12) Oversættelse af
europæisk patentskrift

(51) Int.Cl.: ***F 27 B 7/38 (2006.01)*** ***B 65 G 25/06 (2006.01)*** ***C 04 B 7/47 (2006.01)***
F 27 D 15/02 (2006.01)

(45) Oversættelsen bekendtgjort den: **2021-01-04**

(80) Dato for Den Europæiske Patentmyndigheds
bekendtgørelse om meddelelse af patentet: **2020-10-07**

(86) Europæisk ansøgning nr.: **18177718.6**

(86) Europæisk indleveringsdag: **2018-06-14**

(87) Den europæiske ansøgnings publiceringsdag: **2019-12-18**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

(73) Patenthaver: **Alite GmbH, Brauerhof 1, 31535 Neustadt, Tyskland**

(72) Opfinder: **Hammerich, Jörg, Stockhausenstraße 5, 31535 Neustadt, Tyskland**

(74) Fuldmægtig i Danmark: **Budde Schou A/S, Dronningens Tværgade 30, 1302 København K, Danmark**

(54) Benævnelse: **Klinkerkøler og fremgangsmåde til drift af en klinkerkøler**

(56) Fremdragne publikationer:
DE-A1-102010 060 759

DESCRIPTION

Field of the invention

[0001] The invention relates to a conveyor for conveying and preferably as well for cooling bulk material, like e.g. cement clinker and to a method for operating a corresponding conveyor.

Description of the related art

[0002] Clinker manufacturing comprises calcination and sintering of raw meal to cement clinker, hereinafter "clinker" for short. Sintering takes place at about 1450°C, depending on the raw meal composition. The hot clinker is subsequently discharged to a clinker cooler. The clinker cooler receives the hot clinker and while conveying it to the next processing step, the clinker is cooled down. The clinker cooler has a conveyor floor on which the clinker forms a so called clinker bed with a height of typically 0.5m to 0.7m. The construction of the grate floor is essential as on the one hand cooling air has to be inserted into the clinker bed via the grate floor and on the other hand clinker drop through the grate floor has to be avoided. In addition the clinker has to be transported and the grate floor must withstand the high clinker temperatures and the abrasion caused by moving the clinker over the grate floor.

[0003] Presently, most clinker coolers are grate coolers enabling to inject a cooling gas from below the conveyor floor into a clinker bed residing on the conveyor floor, this being the grate floor. The cooling gas cools the clinker down and in turn is heated up. The heat being transferred to the cooling gas can be used as process heat.

[0004] For conveying the clinker a number of systems have been suggested, for example drag chain conveyors, i.e. systems based on conveying means that are moved forward above the grate surface and moved back to the kiln facing side of the grate below the grate. These systems mostly comprise chains to which the conveying means are attached (cf. EP 07 185 78 A2, Fig. 3). Belt or chain conveyors have been suggested as well (c.f. DE23 46 795 or DE1 985 673). Modern clinker coolers however use reciprocating conveying means. This group of grate coolers can be separated in essentially two groups:

[0005] The first group comprises stepped grate coolers having rows of box like grate elements being mounted one besides of the other on cross beams. Some of the cross beams reciprocate to thereby convey the clinker bed towards the cooler outlet. This type of clinker cooler has been discussed in a number of publications, e.g. in EP0167658A and is characterized in that the grate elements of each row reciprocate in phase. Mostly all movable rows are in phase, as well. Grate coolers of the second group have planks that extend in the conveying direction and which are arranged one besides of the other (with moving gaps in between). At least a number of planks are pushed forward simultaneously. Subsequently, the movable planks are retracted one after the other. This type is as well referred to as walking floor conveyor. To reduce costs it has been suggested to group the planks. In this case the planks of all movable groups are advanced simultaneously and the groups are subsequently retracted one group after the other. A similar transport mechanism is as well used with other conveying means being arranged on or above a conveyor floor. Like the planks, these conveying means are arranged one besides of the other and they are advanced at the same time and retracted one after the other or in groups. The second group of conveyors includes both the typical walking floor conveyors and conveyors having reciprocating conveying means that are advanced and retracted in essentially the same sequence like the planks of a walking floor conveyor. Walking floor clinker coolers are discussed, e.g. in EP1475594, EP1992897A or DK1999 014 03, to name only a few.

[0006] DE 10 2010 060 759 A1 suggests a drive for a conveyor floor of trucks supporting unloading of transported goods. The drive converts a rotational movement of a motor driven shaft into a reciprocating movement of conveying means: The shaft is coupled to a number of discs each having a ring shaped slit, wherein the distance of the slit to the rotational axis varies as a function of the angular position. Into the slit of each disk engages a pin being attached to a drive lever. The lower end of the drive lever is pivotably supported and the upper end of the drive lever is attached to a pusher being movably supported on a guide rail. Thus, a rotation of the discs is converted into a translation of the respective pushers, to which the conveying means may be attached.

Summary of the invention

[0007] The invention is based on the observation that in present walking floor coolers each movable plank or each group of movable planks is driven by a separate hydraulic drive. These hydraulic drives each require hydraulic lines, at least one control valve and actuators for controlling these valves. Installation, operating and maintenance costs are thus high.

[0008] The problem to be solved by the invention is to reduce the installation and maintenance costs for walking floor type coolers and other clinker coolers with reciprocating conveying means.

[0009] Solutions to the problem are described in the independent claims. The dependent claims relate to further improvements of the invention.

[0010] The conveyor grate enables to convey bulk material, like e.g. cement clinker in a conveying direction. In case the conveyor grate is a conveyor grate of a clinker cooler the conveying direction is defined by a vector pointing away from the clinker inlet, usually to the clinker outlet of the clinker cooler (assuming the clinker cooler to be single grate clinker cooler, not necessarily being the case). The conveyor has at least two conveying means. These conveying means can be movable planks of the conveyor grate or groups of movable planks, wherein the planks of a group move synchronous. Static planks may exist as well. The static planks may be considered to form a separate group of planks. In some cases, the conveying means are positioned one besides of the other and supported by a linear-motion bearing enabling the conveying means to move relative to a basis parallel to the conveying direction which is parallel to the conveyor grate's longitudinal direction. This movement is referred to as reciprocating movement. In other words, the conveying means oscillate between an advanced and a retracted position.

[0011] There may be gaps in between of at least some of the conveying means e.g. to enable a coolant flow from below the grate floor into the bulk material on top of the conveyor grate. In case of a walking floor conveyor, the conveying means are not necessarily directly one besides of the other, there may be other components in between of two conveying means. Similarly, the conveying means of other conveyor types may as well be spaced from each other e.g. to thereby enable a coolant flow through the conveyor grate and/or to provide moving gaps in between of neighbored grate elements.

[0012] The conveying means may as well comprise or consist of cross bars or other pushing means being movably supported on or above a conveyor grate and driven to be advanced in the conveying direction and retracted, subsequently. In this case the conveying means are as well arranged one besides of each other and are preferably configured to be advanced in the conveying direction at the same time and may be configured to be retracted by a movement opposite to the conveying direction. At least in case of walking floor conveyors, the at least two conveying means are preferably retracted at different times, preferably sequentially or in other words one after the other. Although, the retraction time intervals may overlap, this is not preferred, as it reduces conveying efficiency. By the movement sequence, bulk material can be transported in the conveying direction.

[0013] Thus, advancing a conveying means can be expressed in other words as moving the conveying means in the conveying direction towards its front end positon. Retracting a conveying means can thus be considered as moving the conveying means in the direction opposite to the conveying direction towards its rear end position. Thus, the conveying means can be considered to reciprocate for example one besides of the other between front and rear end positions.

[0014] In short, the conveyor grate has at least two conveying means that may be arranged one besides of the other. For example, as set out above, the at least two conveying means may be planks, being arranged one besides of the other and forming at least a portion of the conveyor grate. In addition, the conveyor has at least one motor for advancing the at least two conveying means preferably at least essentially at the same time in the conveying direction and for retracting the at least two conveying means for example separately. Thus, the conveying means reciprocate. In other words the conveying means are shifted forth and back and in this sense oscillate between their advanced position and their retracted position.

[0015] The motor is preferably an electric motor. Preferably, a first of the at least two conveying means is selectively coupled via at least one first clutch to the motor and/or a second of the at least two conveying means is selectively coupled via at least one second clutch to the same motor. Thus, a single motor is sufficient to drive the conveying means. By operating (i.e. opening or closing) the clutches the two conveying means can be coupled independently from each other to the same motor. "Coupled" means herein to establish a power transmitting coupling. In this particular example the coupling enables to transmit a torque (and a rotation) from the motor via a closed clutch to the respective conveying means. In case of a linear motor, a force is transmitted by the closed clutch. "Selectively coupled" expresses that the coupling can be established by closing the respective clutch and as well that the coupling can be released by opening the respective clutch. Changing the clutch state from open to close and vice versa is preferably controlled by a controller.

[0016] For short, we will hereinafter refer to the first clutch and to the second clutch without intending to express that there is exactly one of said clutches. The term should be understood as "at least one first clutch" and "at least one second clutch", respectively. The clutches enable to couple the conveying means independently to the motor. Thus, e.g. by closing the first and the second clutch, the two conveying means can be moved e.g. advanced simultaneously. By closing only a single clutch, only the respective conveying means is driven to be advanced or retracted. The clutches thus enable to jointly drive the conveying means when advancing the conveying means and subsequently to retract them one after the other (or in groups) by closing the respective clutches. Thus only a single motor is required instead of a motor for each conveying means.

[0017] In an example, the conveyor has at least two motors being coupled to jointly drive the conveying means to thereby provide redundancy for driving the conveying means.

[0018] For example, the conveyor may comprise a main shaft. The main shaft is preferably coupled to the motor, e.g. via a reduction gear or some other transmission. The main shaft may be the rotor of the motor or alternatively a separate shaft. The main shaft may thus be driven by the (at least one) motor. The first conveying means may be coupled to a first linear drive for driving the first conveying means in the conveying direction and for retracting it, wherein the first linear drive has a first input shaft being selectively coupled to the rotor and/or a main shaft via the first clutch. Similarly, the second conveying means may be selectively coupled to a second linear drive for driving the second conveying means in the conveying direction and for retracting it, wherein the second linear drive has a second input shaft being selectively coupled to the rotor and/or a separate main shaft via the second clutch. For example, the at least one of the linear drives may comprise a crank or a crank shaft being selectively coupled via the first clutch to the rotor and/or the separate main shaft. The crank may be coupled via a connecting rod to the respective conveying means. This construction is cost efficient, durable and enables to drive each conveying means independently from the other conveying means. An alternative cost efficient linear drive may comprise a worm onto which a nut slides forth and back depending on the rotational direction of the worm relative to the nut.

[0019] Preferably, the main shaft extends below the conveyor grate and is rotatably supported relative to a basis, e.g. (via) a conveyor housing. This enables an inexpensive and at the same time reliable conveyor. The motor preferably has a stator, which may be attached to the basis as well, e.g. as well via the housing. The motor's rotor and the main shaft are preferably coupled by a reduction gear. In a preferred embodiment, the main shaft is coupled at each end to a reduction gear being attached to a basis, e.g. (via) the conveyor housing.

[0020] At least one of the input shafts of the clutches is oriented at least essentially parallel, i.e. within ±10° (preferably within ±5°, particularly preferred within ±1°) or less, parallel to the main shaft, thereby simplifying the transmission from the motor to the respective conveying means.

[0021] At least one of the clutches' input and/or output shafts may be supported via at least one bearing by the conveyor housing being a mounting basis or at least be firmly mounted to a mounting basis. This eases construction and maintenance and thus cuts costs down.

[0022] The conveyor may preferably comprise at least one of a first position sensor for detecting a position of the first conveying means and a second position sensor for detecting a position of the second conveying means. If there are further conveying means there is preferably at least one position sensor for at least one, preferably for all further conveying means. In short, it preferably comprises a position sensor for each of the conveying means. In a preferred embodiment, the rotational position of the input shaft of at least one of the linear drives is measured by an angle sensor, enabling to determine the position of the respective conveying means and the direction of the movement. Thus, the angle sensor is in this context a particularly preferred embodiment of a position sensor.

[0023] The conveyor may comprise a controller. The controller is preferably connected via at least one clutch control line to at least the first and second clutches for controlling engaging and disengaging the first and second clutches and thus operation of the conveying means. The controller may further be connected via at least one motor control line with the at least one motor for controlling the movement being provided by the motor. For example, the controller may control the rotational speed and/or direction of the motor via the control line. This enables to enhance conveying efficiency. For example, the controller may increase the speed of the motor and thus of the conveying means to a first speed when retracting the conveying means and decrease the speed to a second speed, when advancing the conveying means. In other words, the conveying means are advanced slower than they are retraced. Thereby conveying efficiency can be increased.

[0024] The speed of rotary motors is usually measured in "rpm", but linear motors may be used as well. In the latter case, the speed is the linear velocity of the motor's movable portion.

[0025] The invention may as well be implemented by a method for conveying material like cement clinker on a conveyor grate with at least a first conveying means and a second conveying means, wherein the first and the second conveying means are e.g. arranged one besides of the other. The method may in particular be used to operate a conveyor as explained above. The method comprises advancing the first and the second conveying means simultaneously and retracting the first and the second conveying means asynchronously. Simultaneously means at the same time, but not necessarily in phase and/or with the same speed and/or amplitude. For example, the second conveying means may be advanced after advancing of the first conveying means already started. In other words, there may be a preferably small time delay τ between starting to advance the first and the second conveying means. Preferably, the time delay τ is small relative to the inverse of the frequency f (v=1/f) of reciprocation. For example, $0 < \tau < \alpha \cdot v$, wherein α is smaller 1 ($0<\alpha<1$), preferably $0<\alpha\leq 0.1$, particularly preferred $0<\alpha\leq 1/36$ or even more preferred $0<\alpha\leq 1/72$ or $1/360\leq\alpha\leq 1/72$. For example, if $\alpha=1/360$, the time delay τ causes an incoherency of the reciprocating movement (assuming the reciprocating movements to have the same amplitude) corresponding to a 1°rotation of a crank shaft (a 1°phase shift). Thus, the conveying means reciprocate almost in phase, but the breakaway torques do not accumulate, reducing construction, operating and maintenance costs.

[0026] The two conveying means do not necessarily need to reach their front end position at the same time, i.e. advancing of them may end at different times. Asynchronous means that there is at least a time interval in which only one of conveying means is retracted. Preferably, only a single conveying means (e.g. a group of planks) is retracted at the same time. Preferably, the other conveying means is/are retracted, once retraction of the initial single conveying means is finished. The retraction times may overlap, but this is preferably avoided.

[0027] Advancing and retracting the conveying means is preferably controlled by operating a first clutch to thereby engage or disengage the first conveying means with at least one motor and by operating a second clutch, to thereby engage or disengage the second conveying means with the at least one motor. Thus, by closing both (at least one) clutches at the same time the conveying means can be advanced simultaneously. Once the two conveying means reach their front end position one clutch may remain closed while the other(s) are opened. Now, only a single conveying means is retracted. Preferably, when it reaches its rear end position, said one clutch is opened, i.e. the clutch is disengaged and the conveying means stops moving. A further clutch may be closed to thereby retract a further conveying means. Once it reaches its rear end position the further clutch may be disengaged. In this way all conveying means may be retracted one after the other by subsequently closing (and opening) one clutch after the other. Preferably, if all conveying means are at their rear end position, the cycle starts again by advancing preferably all (at least a majority) of the conveying means by closing the respective clutches. Preferably, the motor is controlled accordingly as explained below.

[0028] In a preferred embodiment the speed of the motor is controlled to provide a first speed and/or torque while the clutches are open and/or closed and to provide a second speed and/or torque while at least one of the clutches is operated to change from an open to closed state or from a closed to an open state, wherein the second speed is slower that the first speed. This reduces wear of the clutches and they can thus be dimensioned accordingly smaller. Reducing the speed and/or torque of the motor during operation of the clutches thus contributes to reducing installation and operating costs at the same time. In a particularly preferred embodiment the motor is stopped for the time at least one clutch is closed and/or opened (i.e. operated) and is restarted after the new clutch state is established. This enables to further cut down installation and operating costs. In this case the clutch can be a non-frictional clutch, e.g. a clutch having (at least) two parts that can be engaged into each other to provide a positive locking to engage the clutch and to disengage the two parts thereby releasing the positive locking. As apparent, above, the motor does not need to be stopped completely, but the torque being provided to the operated clutch should be reduced to 25% or less (preferably 15% or less, more preferred 10% or less, even more preferred 5% or less, particularly preferred 1% or less) of the maximum continuous torque of the clutch. Thereby, wear of the clutch can be reduced.

[0029] Above, we assumed that all conveying means are retracted one after the other and are advanced at the same time. But this assumption was made only to simplify presentation of the invention. What is relevant is that (assuming equally effective conveying means) more conveying elements are advanced (or not moved at all) than retracted at the same time.

[0030] Only to avoid misunderstandings and ambiguities, we recall that a clutch is a mechanical device which engages and disengages power transmission especially from a driving shaft to a driven shaft. The driving shaft is the input shaft of the clutch and the driven shaft is the output shaft of the clutch.

[0031] Above, the invention is described with respect to a walking floor conveyor. However, the invention can be applied to other conveying types as well, in particular to stepped grate coolers having reciprocating cross beams as conveying means. In this case, at least one of the cross beams is coupled to the at least one motor by at least one clutch. The remaining cross beams may be coupled to the motor by a clutch as well or without a clutch. By operating the clutch(es), the conveying speed can be adjusted for the respective section of the conveyor grate. The term "respective section" refers to the section of the conveyor grate, where conveying takes place by reciprocating at least one cross beam being coupled to the (at least one motor) by the respectively operated clutch(es).

[0032] Selectively coupling and decoupling at least one cross beam from the motor by closing or opening the clutch, respectively, can be used to homogenize the bulk material height on the conveyor grate, for example a clinker bed height: Discontinuous bulk material supply to the conveyor (for example by a kiln) can be compensated at least partially by selectively operating (at least) the at least one clutch. Thereby, the respective cross beam(s) is(are) decoupled from the motor and the conveying speed in the respective section of the conveyor is reduced.

[0033] For example (preferably intermittently) opening the at least one clutch connecting at least one cross beam of the receiving section of the conveyor grate enables to reduce the conveying speed in the receiving section of the conveyor, and thus to compensate for a reduction in the bulk material delivery rate to the conveyor. Similarly, compensation for an enhanced bulk material delivery rate can be obtained by maintaining the at least one clutch connecting at least one cross beam of the receiving section of the conveyor grate closed and opening at least one clutch connecting at least one cross beam of a subsequent section of the conveyor grate.

[0034] By operating the clutch, not only the frequency of the reciprocating movement can be adjusted, but as well the stroke (i.e. the amplitude) of the respective conveying means. Thus, the amplitude of the conveying means can be reduced and/or the respective conveying means can be shut off while other conveying means continue to reciprocate. For example the particular cross beam (or a set of cross beams) may be coupled to the motor by the clutch for every n^{th} stroke only, wherein n can be any integer or a fraction. If n is an integer bigger than 1 ($n>1$), conveying is slowed down (or even shut off) in the respective section. If n equals one ($n=1$), the respective cross beams reciprocates like the other cross beams (assuming the remaining clutches are closed, as well). If n is smaller than 1 ($n<1$), clutches connecting the remaining cross beams with the motor are opened, accordingly the conveying in the remaining section(s) of the conveyor grate is reduced. This example can be read more generally by replacing the term cross beam by plank or any other type of reciprocating conveying means.

[0035] The invention has been explained with respect to various types of conveyor grates for clinker cooling. However, the invention is not limited to clinker cooling. The grate openings may as well be used for aeration, fluid removal, injecting of process gas, heating or other treatments of the material to be conveyed. Thus, the term clinker can be replaced by bulk material or even by material. If no grate openings are required, they can of course be omitted and the conveyor grate becomes a conveyor floor. Thus, the term "grate" can be replaced by "floor".

Description of Drawings

[0036] In the following the invention will be described by way of example, without limitation of the general inventive concept, on examples of embodiment with reference to the drawings.

Figure 1 shows a schematic sketch of a clinker cooler.

Figure 2 shows a simplified cross section of the clinker cooler.

Figure 3 shows a method for operating the conveyor.

[0037] Figure 1 shows a preferred embodiment of a conveyor floor. In particular, figure 1 shows a clinker cooler with an example conveyor floor. The side walls of the housing 30 have been omitted for simplicity and the coupling of a transmission 130 and the input shafts of clutches 115, 125 is simplified. For a more accurate depiction see Fig. 2.

[0038] The example conveyor has a conveyor floor 10, being in this example a conveyor grate 10 comprising planks 11, 12, 13 (see as well Fig. 2) and may comprise a housing 30. The conveyor grate 10 receives clinker from a kiln 1 as indicated by the dashed arrow in Fig. 1. The clinker may be distributed by an optional clinker inlet distribution system, e.g. by the system being suggested in EP 3 112 786 B to provide a clinker bed on the planks 11, 12, 13 forming the conveyor grate 10. In Fig. 1, the optional clinker distribution system is depicted as a chute. The conveyor conveys the clinker or any other bulk material in the conveying direction 2 towards a clinker outlet, being symbolized by an optional crusher 8. The longitudinal directions of the planks 11, 12, 13 extend parallel to the conveying direction 2. The planks 11, 12, 13 are depicted as single piece items, but of course they can be segmented to ease manufacturing, transport, mounting and repair.

[0039] A gaseous coolant can be injected via the conveyor grate into the bulk material. The coolant in turn heats up and the heat can be used as process heat. For example, a portion of the heated coolant may enter the kiln (as indicated by an arrow pointing into the kiln 1), another portion may enter a tertiary air duct 3. Other portions may be withdrawn via at least one coolant release 4 from the cooler housing 30.

[0040] As explained above, the conveyor has a number of planks 11, 12, 13 as can be seen best in Fig. 2. Between the planks 11, 12, 13 are moving gaps that may as well be used as grate openings for injecting a fluid, e.g. said coolant, from below the grate into the bulk material on top of the grate. Other suggestions for grate openings have been made in the above cited prior art. Some of the planks may be static. In this example, the static planks are labeled by reference numeral 13. Only for simplicity, only two static planks 13 are indicated, but of course there may be more. For example, every fourth, third or even every second plank could be static. The other planks 11 and 12 are movably supported e.g. by plain bearings, rollers, a pendulum suspension and/or a hydrostatic bearing or the like. The movable support has been omitted to focus on the relevant portion of the application. The movable support enables the movable planks to reciprocate, i.e. to be pushed forward parallel to their longitudinal direction and to be retracted afterwards. To convey the bulk material, at least the majority of the movable planks can be advanced at the same time. Subsequently, a smaller amount of planks is retracted at the same time until at least a majority of the movable planks can be advanced again. We referred to the number of planks for simplicity only, assuming that all planks essentially have the same surface (±25%, preferably ± 15%, even more preferred ±10%, or better ±5% or less) for supporting the bulk material. However, it should be noted that the friction between the conveyor grate and the bulk material is the relevant magnitude: When pushing the bulk material forward, the friction between the bed of the bulk material residing on the grate and the non-advancing portions of the grate (including potentially not advancing conveying means) while advancing at least some of the conveying means must be smaller than the force the advancing conveying means exert on the bed of bulk material. The bed thus moves in the conveying direction 2 (i.e. forward). When retracting conveying means, the frictional force required for slipping the retracting conveying means backward should be lower than the (static) friction between the bed of the bulk material and the non-retracting portions of the conveyor grate. Thus the bed of bulk material -essentially- does not move backwards. This is of course still a simplified picture, but it provides an idea of the fundamental concept.

[0041] The conveyor of Fig. 2 has as an example only two groups of movable planks: A first group of planks labeled by reference numeral 11 and a second group which is labeled by reference numeral 12. There could be as well further groups of movable planks, which could be driven in the same way as the first and the second group of planks 11, 12. Each plank 11, 12 of a group is advanced and/or retracted synchronously with the other planks 11, 12 of its group, but it may be advanced or retracted independently from the planks of the respective other group(s). Thus, more generally, each group of planks 11, 12 provides a (group of) conveying means.

[0042] The conveying means 11 of the first group (for short: first planks 11) are coupled to a first linear drive. As depicted, the first linear drive may comprise a first crank shaft 114. In Fig. 2 the first crank shaft is partially hidden by a second crank shaft 124 and a main shaft 6, but in Fig. 1 their relative positions are indicated. As can be seen best in Fig. 2, the first crank shaft 114 has first crank arms 113, to which first connecting rods 111 are movably attached, e.g. each by a rotary bearing. The other end of the connecting rods 111 is coupled, e.g. via another rotary bearing to first attachment means 110 of the planks 11. In short, a rotation of the first crank shaft 114 results into a synchronous reciprocating movement of the first planks 11 parallel to their longitudinal and thus the conveyor grate's longitudinal axis.

[0043] Similarly, the conveying means 12 of the second group (for short second planks 12) are coupled to a second linear drive. As depicted in Fig. 2, the second linear drive may comprise the second crank shaft 124. The second crank shaft 124 has second crank arms 123, to which second connecting rods 121 may be attached, again preferably by rotary bearings. The other end of the second connecting rods 121 may each be coupled, e.g. via another rotary bearings, to second attachment means 120 of the second planks 12. Thus, a rotation of the second crank shaft 124 results into a synchronous reciprocating movement of the second planks 12 parallel to the longitudinal axis of the conveyor grate.

[0044] Any number of further groups of conveying means, for example a further group of movable planks (for short further planks), could be coupled to further linear drives. Like the above example of first and second linear drives, the further linear drives may each comprise at last one further crankshaft being coupled via at least one further connecting rod to a corresponding further attachment means of the respective further plank(s).

[0045] The first, second and any optional further linear drive may be selectively coupled via at least one first clutch 115, at least one second clutch 125 and optionally by at least one optional further clutch to the same motor M. The motor M can be seen in Fig. 1, only. As apparent from Fig. 2, the crank shafts 114, 124 may preferably be rotatably supported by sidewalls of the conveyor housing 30. The output shafts of the second clutches 125 are attached to the second crank shaft 124, the latter is thus the driven shaft. Attaching the output shaft of a single clutch to any portion of the second crank shaft 124 would be sufficient. But two clutches can be configured to provide redundancy. Alternatively, the two second clutches 125 and the crank shaft 124 may be dimensioned smaller to thereby reduce the costs. The input shaft 126 of each second clutch 125 is coupled via a transmission 129, 130 to the motor M. The first crank shaft 114 and any optional further crank shaft may be selectively coupled in essentially the same way to the motor M. Only to avoid any misunderstanding, the output shaft of the first clutches 115 may be attached to both ends of the first crank shaft 114 and again, attaching the output shaft of a single clutch to any portion of the first crank shaft 114 would be sufficient. Again, two clutches 114 can be configured to provide redundancy. Alternatively, the two first clutches 115 and the first crank shaft 114 may be dimensioned smaller to thereby reduce the costs. The input shaft of each first clutch 115 is coupled via a transmission 119, 130 to the motor M.

[0046] There may be two or more motors M. But each group of conveying means is driven via its linear drive by at least one motor M that drives as well another group of conveying means, assuming the respective clutches to be closed.

[0047] In a preferred embodiment, the conveyor comprises at least one position sensor 127. Depicted is only a single (second) position sensor 127 for monitoring the angular position of the second crank shaft 124 or more generally of the position of the second conveying means. In the example the position sensor 127 is positioned outside of the conveyor housing 30 and monitors the angular position of the output shaft of the clutch and thus indirectly the positon of the second crank shaft 124. Particularly preferred, there is a position sensor for at least any group of conveying means, i.e. a position sensor 117 for the first group and a position sensor 1x7 for any further group (wherein x>2, e.g. 3, 4, ...). The at least one position sensor is connected to a control unit 5, thereby enabling the controller 5 to obtain position sensor signals from the position sensor 127. The controller 5 preferably controls operation of the first and second clutches 115, 125 (and optionally of any further clutch being indicated by a link to 1x5 in Fig. 1 and Fig. 2) via corresponding control lines.

[0048] In the Figures 1 and 2, each conveying means is driven only via a single linear drive. However, this is only an example. There may be more first, second or optional further linear drives for selectively transmitting the motor's power to the first, second or optional further conveying means, respectively. This is particularly helpful when long conveying means need to be driven, to thereby reduce bending moments on the conveying means. In Fig. 2 a further conveying means 1x is depicted, in Fig. 1 it has been omitted.

[0049] A method for operating the conveyor is depicted in Fig. 3: Initially the motor M is shut off and all clutches are open (i.e. disengaged). The controller sends a control signal to close the at least one first clutch 115. Subsequently, the controller 5 controls the motor's rotor to rotate while monitoring the sensor signals of the first position sensor 117. Once the position sensor's signal indicates that the first conveying means 11 has reached its rear end position, as well referred to as retracted position, i.e. the position where it is the closest to the conveyor inlet, the first clutch 115 may be opened by the controller 5. Preferably, the motor M is stopped while operating the clutch 115. The initializing step is repeated for the second and optional further groups of conveying means. In other words the controller sends a control signal to close the at least one second (or further) clutch 125, (or 1x5). Subsequently, the controller 5 controls the motor's rotor to rotate while monitoring the sensor signals of the second (or further) position sensor 127 (or 1x7). Once the position sensor signal indicates that the respective conveying means has reached its retracted position, i.e. the position where it is the closest to the conveyor inlet the second (or further) clutch 125 (or 1x5) is opened by the controller 5. This sequence is referred to as initializing step 81.

[0050] Now, preferably all conveying means are in their retracted position. By closing the clutches 115, 125, 1x5 of the retracted conveying means 11, 12, 1x and controlling the motor's rotor to rotate, the respective conveying means 11, 12, 1x can be advanced at the same time, and preferably in phase, i.e. preferably synchronous (step 82). In an embodiment, the first, second and optional further clutches are closed, preferably one after the other, while the motor is powered during operation of at least the second and the optional further clutches, to thereby reduce the required torque (or in case of a linear motor, the force), i.e. to avoid that the initial breakaway torques (or forces) sum up. The first clutch may be opened when starting the motor as well, to enhance engine run up, but to avoid accumulation of breakaway torques this is not necessary. More generally speaking the operation of closing at least two of the clutches preferably takes place with a time delay, to thereby reduce breakaway torques (and/or forces). This measure enables to dimension the motor and the transmission smaller and thus to reduce manufacturing, maintenance and operating costs.

[0051] The time delay τ can be small relative to the inverse of the frequency f ($v=1/f$) of reciprocation. For example, $0 < \tau < \alpha \cdot v$, wherein α is smaller 1 ($\alpha<1$), preferably $\alpha<0.1$, particularly preferred $\alpha<1/36$ or even more preferred $\alpha<1/72$. For example, if $\alpha=1/360$, the time delay causes an incoherency of the reciprocating movement corresponding to a 1°rotation of a crank shaft. Thus, the conveying means are advanced almost in phase, but the breakaway torques do not accumulate, reducing construction and maintenance costs.

[0052] While advancing the conveying means, the controller 5 may monitor the position sensors 117, 127, 1x7 and open for example at least half of the clutches once the conveying means 11, 12, 1x reach their front end position.

[0053] Subsequently, in step 83, the conveying means are retracted. Retraction preferably takes place groupwise, i.e. one group after the other. Staying with the above example, the first clutch may remain closed (alternatively the first clutch may be opened at the end of step 83 and subsequently be closed again) and the rotor rotates while the controller monitors at least the position of the first group of conveying means (by evaluating the position data of the first position sensor 117). Once the first conveying means 11 reaches its retracted position, the first clutches 115 are opened and the second clutches 125 are closed. During operation of the clutches, the rotor is preferably stopped, but continues to rotate once the new clutch states are established. The second clutches 125 are preferably opened if a further group of conveying means needs to be retracted, once the second group of conveying means as well reaches its retracted position. If a further group of conveying means needs to be retracted, the respective further clutches are closed and the motor is powered to drive the group of further conveying means. During operation of the clutches, the rotor is preferably stopped (or at least the torque provided by the rotor is reduced). But the rotor continues to rotate once the new clutch state(s) is(are) established. Preferably, after all conveying means have been retracted, the method continues with step 82, i.e. at least a portion of the conveying means is advanced at the same time, again.

[0054] As mentioned above, when closing a clutch the motor is preferably stopped until the clutch is engaged to thereby reduce wear and allow for use of simpler (and thus cheaper) clutches. If non-friction clutches are used it might be necessary to rotate the motor to positon the input shaft and the output shaft relative to each other but while closing the clutches essentially no torque (e.g. less than 25% of the max. continuous operating torque) should be transmitted by the clutches until they are fully engaged. Similarly, the torque of the motor is preferably as well reduced to essentially no torque while opening a clutch. As apparent from the above, opening and closing of a clutch is herein referred to as operating the clutch. In other words, if a clutch is operated, it changes its state from open to closed or vice versa.

List of reference numerals

[0055]

1
: kiln

2
: conveying direction, parallel to the longitudinal direction of the conveyor

3
: tertiary air duct (optional)

4
: coolant release opening

5
: controlling unit /controller

6
: main shaft

8
: conveyor exit symbolized by a crusher

10
: conveyor floor, e.g. a cooling grate of a clinker cooler

11
: conveying means of the first group, e.g. plank of the first group of conveying means

12
: conveying means of the second group, e.g. plank of the second group of conveying means

13
: static plank

30
: housing

81
initializing step
82
advancing step
83
retraction step
110
first attachment means
111
first connecting rods
113
first crank arm
114
first crank shaft
115
first clutch
117
position sensor of the first group of conveying means
120
second attachment means
121
second connecting rods
123
second crank arm
124
second crank shaft
125
second clutch
126
input shaft of the second clutch
127
position sensor of the second group of conveying means
129
part of transmission e.g. pulley
1x
further conveying means (Fig. 2 only)
1x0
further attachment means (Fig. 2 only)
1x1
further connecting rod (Fig. 2 only)
1x3
further crank arm (Fig. 2 only)
1x5
further clutch

1x7
further sensor
130
part of transmission, e.g. a belt or a chain
M
Motor
R
Rotor

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- EP0718578A2 [0004]
- DE2346795 [0004]
- DE1985673 [0004]
- EP0167658A [0005]
- EP1475594A [0005]
- EP1992897A [0005]
- DK199901403 [0005]
- DE102010060759A1 [0006]
- EP3112786A [0038]

PATENTKRAV

1. Transportrist (10) til transport af massegodsmateriale, såsom cementklinker, i en transportretning (2), hvor transportristen (10) har

- i det mindste to transportorganer (11, 12),
- i det mindste én motor (M) til at fremføre de i det mindste to transportorganer (11, 12) samtidigt i transportretningen (2) og til at tilbagetrække de i det mindste to transportorganer,

kendetegnet ved, at
et første af de i det mindste to transportorganer (11, 12) er selektivt koblet, via en første kobling (115), til motoren (M) og et andet af de i det mindste to transportorganer (11, 12) er selektivt koblet, via en anden kobling (125), til den samme motor (M), hvor selektivt koblet udtrykker, at koblingen kan etableres ved at slutte den respektive kobling og ligeledes at koblingen kan løsnes ved at åbne den respektive kobling.

2. Transportrist (10) ifølge krav 1,
kendetegnet ved, at

- motoren (M) omfatter en rotor (R),
- det første transportorgan (11) er koblet til et første lineært drev til at drive det første transportorgan (11) i transportretningen (2) og til at tilbagetrække dette, hvor det første lineære drev har en første indgangsaksel (114), som er selektivt koblet til rotoren (R) via den første kobling (115), og at
- det andet transportorgan (12) er koblet til et andet lineært drev til at drive det andet transportorgan (12) i transportretningen (2), og til at tilbagetrække dette, hvor det andet lineære drev har en anden indgangsaksel (124), som er selektivt koblet til rotoren (R) via den anden kobling (125).

3. Transportrist (10) ifølge krav 2,
kendetegnet ved, at en hovedaksel (6)

- strækker sig under transportristen (10),
- er roterbart understøttet i forhold til et transportørhus,
- er drevet af motoren (M), og

- er selektivt koblet, via den første kobling (115), til det første transportorgan (11) og, via den anden kobling (125), til det andet transportorgan.

4. Transportrist (10) ifølge krav 2 eller 3,
kendetegnet ved, at i det mindste én af indgangsakslerne (114, 124) er orienteret i det mindste i det væsentlige parallelt, dvs. indenfor ± 10° eller mindre, med hovedakslen (6) og/eller rotoren (R).

5. Transportrist (10) ifølge ethvert af kravene 2 til 4,
kendetegnet ved, at i det mindste én af indgangsakslerne (114, 124) er understøttet, via i det mindste ét leje, af transportørhuset.

6. Transportrist (10) ifølge ethvert af kravene 2 til 5,
kendetegnet ved, at i det mindste én af indgangsakslerne (114, 124) er en krumtapaksel, som er koblet, via i det mindste én forbindelsesstang (111, 121), med i det mindste ét af de respektive transportorganer (11, 12).

7. Transportrist (10) ifølge ethvert af de foregående krav,
kendetegnet ved, at
transportristen har en første positionsføler (117) til at detektere en position for det første transportorgan (11) og/eller en anden positionsføler (127) til at detektere en position for det andet transportorgan (12).

8. Transportrist (10) ifølge ethvert af de foregående krav,
kendetegnet ved, at

- en styring (5) er forbundet, via i det mindste én koblingsstyreledning, med i det mindste den første og anden kobling (115, 125), til at styre forbindelse og adskillelse af det første og andet transportorgan (11, 12) med motoren (M), ved at aktivere den første og anden kobling (115, 125) og
- styringen (5) er yderligere forbundet, via i det mindste én motorstyreledning, med den i det mindste ene motor (M), til at styre bevægelsen, som tilvejebringes af motoren (M).

9. Transportrist (10) ifølge ethvert af kravene 1 til 11,

kendetegnet ved, at motoren (M) har en stator, hvor statoren er understøttet af et transportørhus (30).

10. Fremgangsmåde til transport af materiale med en transportrist (10) med i det mindste et første transportorgan (11) og i det mindste ét andet transportorgan (12), omfattende i det mindste:

(i) fremføring af det første og andet transportorgan (11, 12) samtidigt og
(ii) tilbagetrækning af det første og det andet transportorgan (11, 12) asynkront,
kendetegnet ved, at den yderligere omfatter i det mindste
(iii) drift af en første kobling (115) for derved at forbinde og afbryde det første transportorgan (11) med i det mindste én motor (M) og/eller
(iv) drift af en anden kobling (125), for derved at forbinde eller afbryde det andet transportorgan (12) med den i det mindste ene motor (M).

11. Fremgangsmåde ifølge krav 10, **kendetegnet ved, at**
motoren (M) styres til at tilvejebringe en første hastighed og/eller et første moment, når koblingerne (115, 125) er åbne og/eller lukkede og til at tilvejebringe en anden hastighed medens i det mindste én af den første og anden kobling (115, 125) aktiveres til at ændres fra lukket til åben og/eller fra åben til lukket, hvor den anden hastighed er langsommere end den første hastighed.

DRAWINGS

Fig. 1

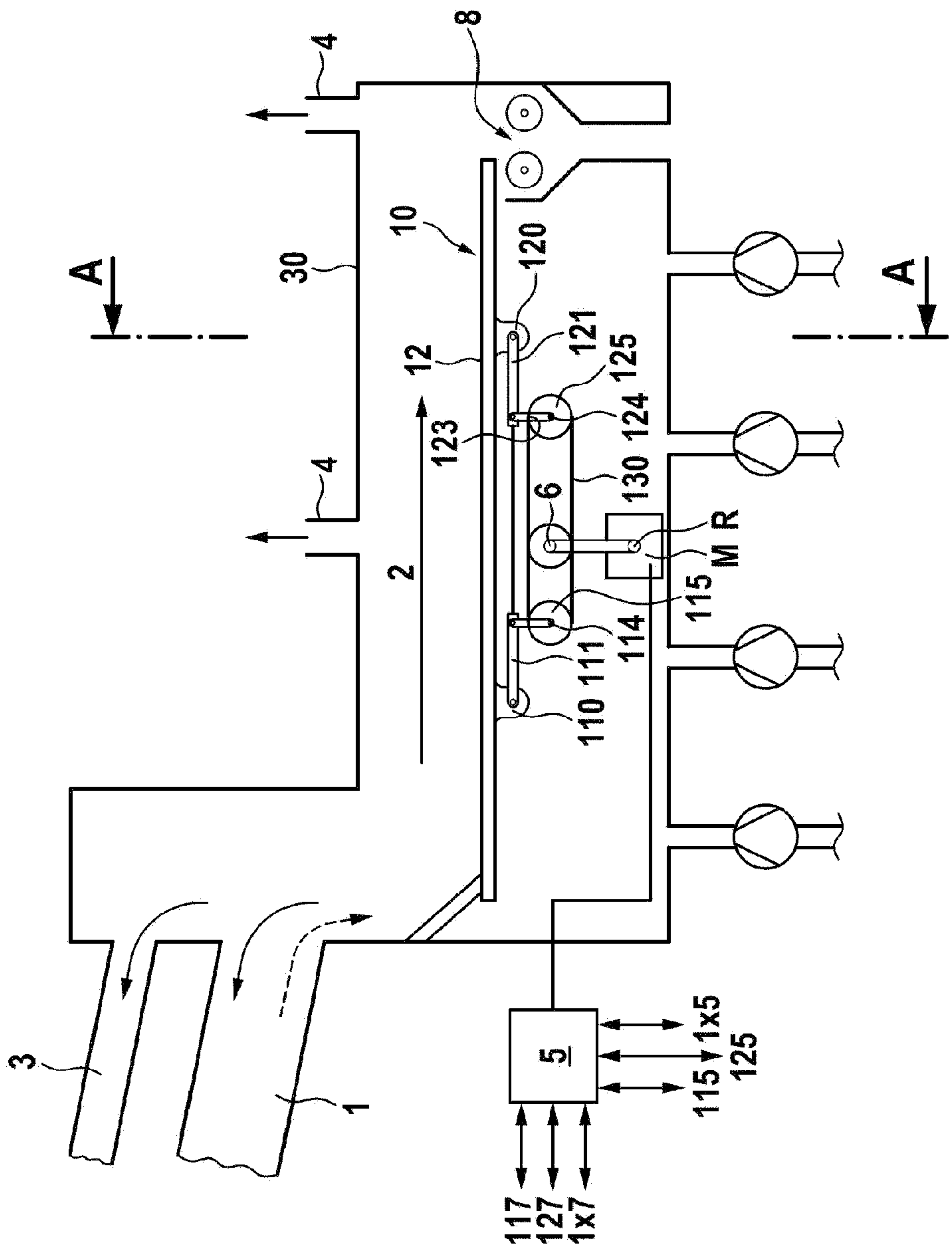
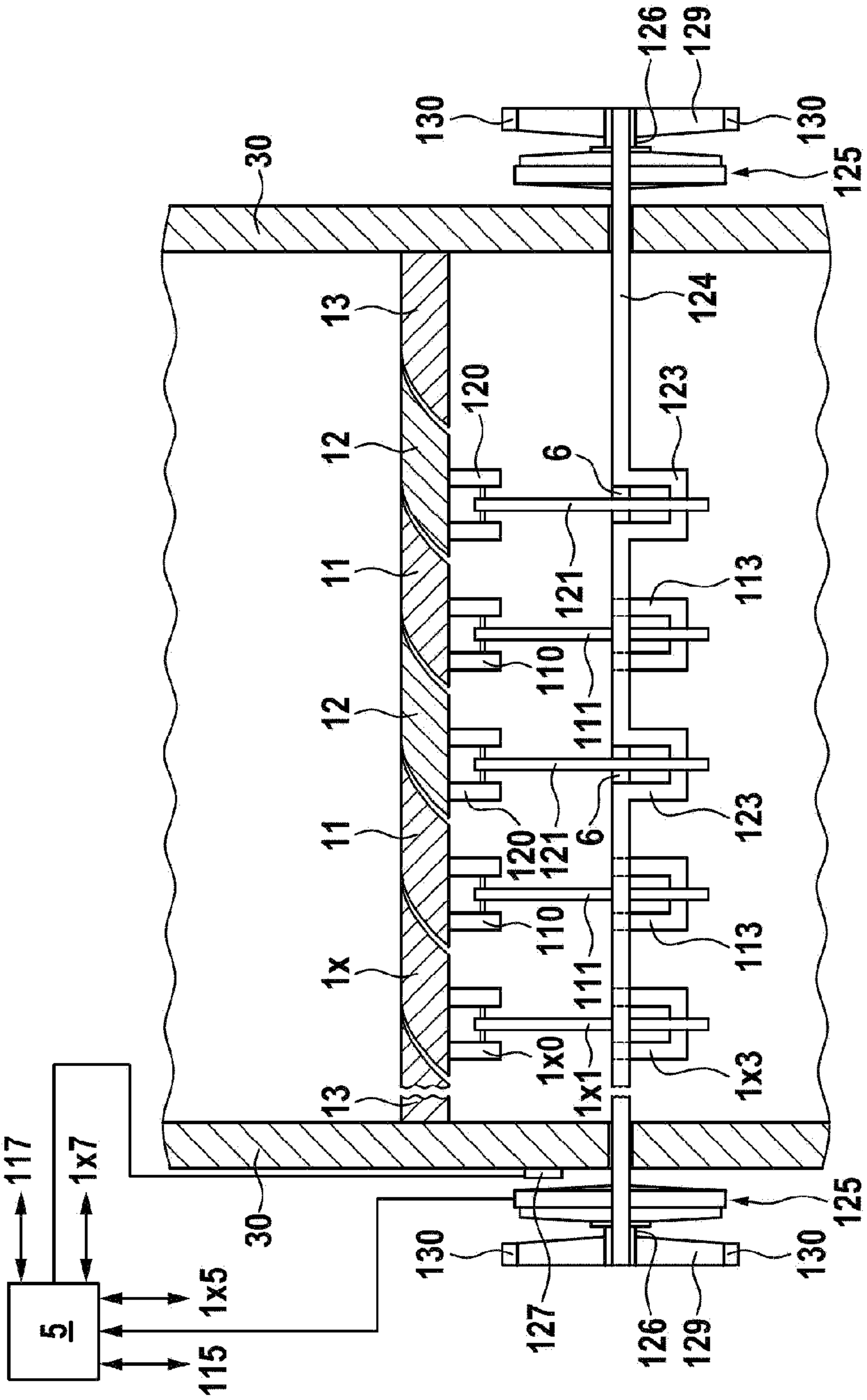


Fig. 2



30
130
126
129
130
125
13
124
120
12
123
6
11
121
113
110
111
12
120
121
6
123
11
110
113
1x
111
1x0
1x1
1x3
13
117
1x7
30
125
130
127
126
129
130
5
1x5
115

Fig. 3