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Description

Technical field

The present invention relates to a coating device, in particular a coating device having a throw-off and/or distribution function for ridding parts at least partially wetted with excess liquid, a drivetrain for such a coating device and a coating method, in particular a method for ridding parts wetted with coating material. The present invention further relates to a coating installation having such a coating device.

Prior art

A large number of parts or components are typically provided with a surface coating. In particular in the case of small parts, for example screws or nuts, this surface coating often takes place by means of immersion in a liquid coating agent or a coating agent dissolved in liquid, in the following referred to simply as 'coating liquid', but which does not take place individually for each individual small part (parts or components). Instead, the small parts are typically poured in the manner of bulk material into a container having perforated container walls, for example a basket, which is then immersed in the liquid. Circulating the small parts ensures that no untreated contact surfaces remain on the small parts. Excess coating liquid is then thrown off the small parts outside the coating liquid. Examples of coating methods and devices as well as their implementation are known, for example, from DE 199 31 663 C1 or EP 2 913 284 A1.

DE 196 47 921 A1 discloses a method and a device for coating industrial parts. A coating drum is first immersed in a container with coating agent, which is then raised by a lifting table into the highest position. In order to uniformly distribute the coating agent, the drum is brought into an inclined position about a pivot axis located outside the drum and driven by means of thread-on sprockets.

Subsequently, the coating container is lowered and the excess coating agent is thrown off by rotating the coating drum about its own axis at a high speed.

DE 196 13 927 C1 discloses a coating frame and a corresponding device for coating small parts. According to this document, the coating takes place by immersing a coating drum in a bath with coating agent, wherein a plurality of helical coating drums are mounted on an adjusting wheel. The drums can in each case be rotated about an axis and the axis of rotation of the adjusting wheel, wherein said axes are parallel to one another. The excess coating agent is thrown off in centrifugal drums. According to this document, the coated small parts are conveyed via a chute out of the coating drums and into the centrifugal drums.

JP 2002/210 404 A discloses a coating method and a coating centrifuge for small parts, for example screws. According to this document, two coating containers are located on a rotatable shaft. The coating containers consist of a steel mesh. The coating of the screws located in the two coating containers takes place by immersing the coating containers in coating baths. Due to the fast rotation of the shaft, the excess coating material is then thrown off.

In many cases, the small parts to be coated have recesses, for example threads. It has been shown that, in these cases, the known coating methods, which work according to the above-described principle, result in an undesirably high proportion of waste, in particular because coating agent is not sufficiently removed from recesses of the small parts during the conventional throw-off procedure and/or because the formation of air pockets results in the liquid used for the coating not being able to spread to all locations on the small part, and therefore the small parts remain uncoated in places.

Other techniques used are: in KR 2016-0069654 A, which is directed to a coating device with higher coating efficiency due to a multi-axial rotary movement; in the

case of the coating device described here, a turntable rotates about a main shaft such that a basket fastened thereon can circulate about the main shaft. At the same time, the basket rotates about a rotary shaft and the position of an object to be coated changes in the basket, which ensures a uniform coating process; furthermore, the efficiency of the described coating device can be increased by installing two or more baskets on the turntable; in EP 3 696 121 A1, which describes a machine 10 for handling baskets for receiving objects, comprising: a transport carriage for a horizontal movement, a container holding group comprising a central body that is connected to the transport carriage, wherein the central body is configured to carry at least two gripper groups for blocking corresponding object holding containers, a first movement apparatus which is configured to move the transport carriage relative to a carrying structure, a second movement apparatus which is configured to raise and lower the container holding group relative to the transport carriage, first rotation means which are configured to rotate the container holding group about a first axis of rotation relative to the support carriage, second rotation means which are configured to rotate each gripper group about a corresponding second dedicated axis of rotation, third rotation means which are configured to adjust the inclination of the second axes of rotation of the gripper groups relative to a corresponding third axis of rotation; in JP H05-337401 A, which is directed to a centrifuge which comprises a variable motor that serves to drive a rotor, wherein compressed-air motors are provided for rotatably driving the inner housings fastened to the rotor; in CN 109 759 273 A, which also describes a device for throwing off a liquid; and in ES 2 204 214 A1, which describes an automatic device for applying centrifuge paint.

Presentation of the invention

Against the background of the above-described need, an object of the present invention is to provide a coating device, a drivetrain, a coating method and a coating installation which are capable, on the one hand, of improving the reliability and

efficiency during the removal (throwing-off) of excess liquid, in particular excess coating material, on wetted parts and, on the other hand, of ensuring that the coated parts are completely coated. Furthermore, the mass flow rate at parts to be coated should be optimised by means of the proposed devices and methods. Moreover, the required electrical power should be drastically reduced by means of the proposed devices and methods.

The above-mentioned objects are solved by means of a coating device as defined by the appended claim 1, a drivetrain as defined by the appended claim 9, a coating method as defined by the appended claim 10 and a coating installation as defined by the appended claim 13.

Preferred developments of the invention are specified in the dependent claims, wherein the subject matter of the claims relating to the coating device, drivetrain and coating installation can be applied within the scope of the coating method and vice versa. Equally, the subject matter of the claims relating to the drivetrain can be applied within the scope of the coating device and coating installation and vice versa.

Here, the basic concept of the present invention is to provide a coating device in which at least two holders are provided which are fastened to a rotor and which are each designed to receive a container to be filled with parts to be coated, wherein a first drive is provided for rotatably driving the rotor by means of a first rotary shaft that can be driven about a rotor axis of rotation. Furthermore, a second drive is provided for rotatably driving the two holders fastened to the rotor, in each case about a holder axis of rotation, wherein the two holder axes of rotation do not coincide with the rotor axis of rotation and the second drive comprises a primary part that is rigidly connected to the first rotary shaft or to the rotor. In other words, the second drive rotates together with the at least two holder axes of rotation about the rotor axis of rotation.

In this way, a coating device can be provided which can, firstly, provide the two rotary movements, required for the coating method according to the invention, of the holders and thus of the containers to be filled with parts to be coated and received by means of the holders and, secondly, by designing the second drive as a drive that rotates with the two holder axes of rotation about the rotor axis of rotation, in other words has a primary part that is rigidly connected to the first rotary shaft or to the rotor, makes it possible to increase the available drive forces/torques for the rotary movement of the containers about the holder axes of rotation as well as shorten the reaction time of the drive for the rotary movement of the containers about the holder axis of rotation, while also reducing the electrical drive power required for this.

Here, the electrical drive power can be significantly reduced by applying the required high torque at very low rotational speeds by using co-rotating drives on the rotor axis of rotation or on the rotor itself, in contrast to external drive concepts such as a belt drive from the outside via a cantilever drive shaft, in which the required high torque must additionally be provided at high rotational speeds.

According to one aspect of the present invention, a coating device, in particular a coating device having a throw-off and/or distribution function for ridding parts at least partially wetted with excess liquid, in particular excess coating material, comprises: at least two holders which are fastened to a rotor and which are each designed to receive, preferably in a suspended manner, a container to be filled with parts to be coated, wherein the containers preferably comprise a container wall that is at least partially permeable to liquid, a first drive which has a first rotary shaft that can be driven about a rotor axis of rotation for rotatably driving the rotor, a second drive which is provided for rotatably driving the two holders fastened to the rotor, in each case about a preferably dedicated holder axis of rotation, wherein the rotor axis of rotation and the two holder axes of rotation are preferably oriented

approximately parallel to one another, and a preferably active primary part of the second drive is rigidly connected to the first rotary shaft, wherein the primary part is fastened to the first rotary shaft and a preferably passive secondary part of the second drive is rotatably mounted on the first rotary shaft, wherein the axis of rotation of the second drive is collinear with the rotor axis of rotation of the first rotary shaft.

Here, it is advantageous if the primary part is fastened to the first rotary shaft and a preferably passive secondary part of the second drive is rotatably mounted on the first rotary shaft, wherein the axis of rotation of the second drive is preferably designed or arranged so as to be collinear with the rotor axis of rotation of the first rotary shaft.

In the context of the present invention, the term 'parts' covers a large number of different components that are typically provided with a surface coating, for example screws or nuts, or bearing bolts or the like.

Furthermore, in the context of the present invention, the term 'liquid', in particular 'coating material', includes all liquids that can be used for coating the above-mentioned parts, wherein the parts or small parts are not individually coated as detailed above, but rather are received in the manner of bulk material in a container and immersed in the coating liquid.

Here, it is also advantageous that the primary part of the second drive is directly or indirectly rigidly connected to the first rotary shaft or to the rotor. By rigidly connecting the primary part of the second drive to the rotary shaft or to the rotor, the primary part of the second drive follows the rotary movement of the rotary shaft and/or rotor. In other words, when the rotor is set into a rotary movement about the rotor axis of rotation by means of the first drive, the primary part of the second drive follows this rotary movement.

Furthermore, it is preferable for the second drive to be designed as a direct drive, in particular a torque motor, a compressed-air motor, a hydraulic motor or an electric motor with a transmission. Here, any type of drive (hydraulic, compressed air or a mechanical reduction gear with electric motor) can be flanged directly coaxially to the planetary shaft as long as the required torque can be applied therewith.

According to one embodiment of the present invention, the second drive is designed as a torque motor having a holding torque of more than 1000 Nm, in particular more than 4000 Nm.

According to another embodiment of the present invention, it can be advantageous if the two holder axes of rotation are arranged at the rotor such that the rotor axis of rotation is a central axis of the rotor that is at the same distance from both holder axes of rotation. In other words, the two holder axes of rotation are arranged at the rotor symmetrically with respect to the rotor axis of rotation, wherein the two holder axes of rotation are preferably arranged such that the axes of rotation lie within the received containers, wherein said axes of rotation in particular form the central axis of the respective containers.

Furthermore, it is advantageous if the second drive comprises at least two drive units which are each assigned to a holder axis of rotation and which preferably directly drive the relevant holder axis of rotation. In other words, the number of drive units corresponds to the number of holders, such that each holder can be driven directly by a dedicated co-rotating drive.

Moreover, the coating device may comprise a support structure, in particular a holding frame having a central beam, on which support structure the first rotary shaft, which defines the rotor axis of rotation of the rotor, is rotatably mounted, on the end of which first rotary shaft facing away from the support structure the rotor

is fastened, in particular releasably fastened.

According to another embodiment of the present invention, the coating device may further comprise two second rotary shafts which define the holder axes of rotation and which are rotatably mounted on the rotor, wherein the two second rotary shafts can be driven preferably via drive wheels fastened to the rotary shafts.

Here, it is also conceivable that the primary part of the second drive, in particular the stator of the torque motor is fastened preferably releasably, in particular by means of a tensioning element, to the first rotary shaft, and a preferably passive secondary part, in particular the rotor of the torque motor, of the second drive is rotatably mounted on the first rotary shaft, in particular by means of a bearing element, more preferably by means of a bearing arrangement, wherein the rotor of the torque motor is preferably designed as an outrunner.

Within the context of the present invention, the term 'active primary part', with regard to the second drive, defines a structural unit of the drive which provides the drive energy or drive force. In the torque motor, the primary part constitutes, for example, the stator provided with electric coils and which drives the passive secondary part (rotor with passive magnets). Accordingly, in this case only the primary part must be supplied with electrical power.

Moreover, it is advantageous if the coating device comprises a drive pinion which is rotatably mounted on the first rotary shaft. Here, it is in particular advantageous if the drive pinion is mounted by means of a bearing element, in particular by means of the bearing arrangement of the rotor of the torque motor.

It is further preferable for the drive pinion to be connected in a force-transmitting and/or torque-transmitting manner to the primary part of the second drive, in particular the rotor of the torque motor, and for the drive pinion to be preferably

engaged with the drive wheels. Alternatively, the drive pinion may be connected in a force-transmitting and/or torque-transmitting manner to the drive wheels via a transmission member, for example a toothed belt or a chain.

According to another embodiment, the coating device comprises a sensor system, in particular an encoder, which is designed to detect the rotational speed of the second drive or drive pinion and/or to detect a rotary relative movement between the primary and secondary part of the second drive.

Moreover, it is preferable for the rotor to be designed as a double-bladed rotor in which two rotor blades are arranged at a distance from one another in the longitudinal direction of the first rotary shaft (in the direction of the rotor axis of rotation), wherein the two rotor blades are interconnected via two connection elements, in particular connection flanges.

Furthermore, it is advantageous if the rotor is rotatably arranged or mounted on a support structure, in particular a holding frame having a central beam, which support structure can be pivoted about a pivot axis that extends in parallel with the ground.

According to another embodiment of the present invention, the coating device comprises a reservoir which is at least partially filled with coating material, in particular coating liquid, and in which the containers to be filled with parts to be coated can be immersed and removed. Here, it is further advantageous if the reservoir is movably arranged on the coating device, in particular the reservoir is designed to be height-adjustable relative to the ground, in order to immerse and/or remove the containers in/from the reservoir. In other words, it is designed such that it can be raised and lowered by means of a lifting device.

Moreover, the coating device may comprise a clamping mechanism for clamping the

containers on the holders of the rotor, wherein the clamping mechanism can preferably be actuated by means of a drive, in particular a pneumatic drive. Here, the drive is preferably designed such that it can actuate or drive the clamping mechanism into an open position, in which the containers can be removed, and a closed position, in which the containers are securely received in the holders.

According to another embodiment of the present invention, the coating device comprises a ventilation device which is designed to supply the second drive with purge air, by means of which an overpressure can be applied to an encapsulated receiving region (or motor space) of the second drive.

A further aspect of the present invention is directed to a drivetrain for a coating device, in particular for the above-described coating device, wherein the drivetrain comprises: at least two holders which are fastened to a rotor and which are each designed to receive, preferably in a suspended manner, a container to be filled with parts to be coated, a first drive which has a first rotary shaft that can be driven about a rotor axis of rotation in order to rotatably drive the rotor, a second drive which is provided for rotatably driving the two holders fastened to the rotor in each case about a holder axis of rotation, wherein the rotor axis of rotation and the two holder axes of rotation are preferably oriented approximately parallel to one another, and a preferably active primary part of the second drive is preferably directly or indirectly rigidly connected to the first rotary shaft, wherein the second drive is preferably designed as a torque motor, wherein the primary part is fastened to the first rotary shaft and a preferably passive secondary part of the second drive is rotatably mounted on the first rotary shaft, wherein the axis of rotation of the second drive is collinear with the rotor axis of rotation of the first rotary shaft.

Here, it is advantageous if the primary part is fastened to the first rotary shaft and a preferably passive secondary part of the second drive is rotatably mounted on the first rotary shaft, wherein the axis of rotation of the second drive is preferably

designed or arranged so as to be collinear with the rotor axis of rotation of the first rotary shaft.

A further aspect of the present invention is directed to a coating method, in particular for coating parts, wherein the method according to the invention is carried out using the above-described coating device. The coating method comprises the steps of:

- immersing, preferably at least two, containers which are filled with parts to be coated and which preferably have a container wall that is at least partially permeable to liquid, in particular perforated, in a portion of a reservoir that is filled with a coating liquid,

- removing the containers filled with the parts to be coated from the coating liquid,

- throwing off and/or distributing excess coating liquid remaining on the parts to be coated after same have been lifted out,

wherein, when excess coating liquid remaining on the parts to be coated after same have been removed is thrown off and/or distributed, the preferably at least two containers filled with the parts to be coated are rotated at least twice about a holder axis of rotation which lies within the containers and/or at least twice about a rotor axis of rotation which lies outside the containers and which preferably extends parallel to the holder axes of rotation lying within the containers,

wherein the rotation of the containers about the holder axes of rotation lying within the containers takes place independently of the rotation of the containers about the rotor axis of rotation lying outside the containers by means of a co-rotating (second) drive, in particular a torque motor, wherein the second drive, in particular a primary part of the second drive, rotates with the holder axes of rotation about the rotor axis of rotation (during the throw-off and/or distribution process), wherein the primary part of the co-rotating drive is fastened to the first rotary shaft and a preferably passive secondary part of the co-rotating (second) drive is rotatably mounted on the first rotary shaft, wherein the axis of rotation of the co-rotating

(second) drive is collinear with the rotor axis of rotation of the first rotary shaft.

Here, it is advantageous if the primary part is fastened to the first rotary shaft and a preferably passive secondary part of the second drive is rotatably mounted on the first rotary shaft, wherein the axis of rotation of the second drive is preferably designed or arranged so as to be collinear with the rotor axis of rotation of the first rotary shaft.

According to another embodiment, the direction and speed of the rotation of the containers filled with the parts to be coated about the holder axes of rotation lying within the containers and the direction and speed of the rotation about the rotor axis of rotation lying outside the containers are controlled independently of one another.

Furthermore, it is preferable, while the containers filled with the parts to be coated are immersed in the coating liquid, for the containers to be rotated at least temporarily about the holder axes of rotation lying within the containers and/or at least temporarily about the rotor axis of rotation which lie outside the containers and which extends parallel to the holder axes of rotation lying within the containers.

Moreover, it is advantageous here if the immersion and/or removal of the containers filled with the parts to be coated in/from a portion of the reservoir that is filled with the coating liquid takes place by means of a lifting movement of the reservoir.

A further aspect of the present invention is directed to a coating installation which comprises at least one coating device of the like described above.

According to another embodiment, the coating installation may further comprise: a filling device for filling containers to be filled with parts to be coated and/or an

emptying device for emptying containers filled with the then coated parts and/or a drying device in which the parts can dry and evaporate after the coating process.

Furthermore, it is preferable if the coating installation additionally has a container handling system for transporting the containers between and to transfer the containers to the devices belonging to the coating installation.

Here, it is advantageous if the devices belonging to the coating installation are arranged in a circle around the container handling system.

It should be emphasised that, although automated process control with a high throughput and optimised efficiency is possible with such a coating installation, the coating may, of course, also be carried out with only a coating device, with the container filling and emptying being carried out manually.

Brief description of the drawings

Further features and advantages of a device, use and/or method will become apparent from the following description of embodiments with reference to the appended figures, in which:

Fig. 1 schematically shows a spatial sectional representation of an embodiment of a coating device according to the invention,

Fig. 2 schematically shows a spatial detail representation of the support device with a drivetrain of the coating device represented in Fig. 1,

Fig. 3 schematically shows a spatial sectional representation of the support device with a drivetrain shown in Fig. 2,

Fig. 4 schematically shows a spatial detail representation of the drivetrain shown in Fig. 2 and 3,

Fig. 5 schematically shows a detail sectional view of the drivetrain of the

embodiment shown in Fig. 1,

Fig. 6 schematically shows a spatial representation of an embodiment of a coating installation according to the invention, and

Fig. 7 shows a schematic plan view of the embodiment, represented in Fig. 6, of a coating installation according to the invention.

Description of embodiments

The same reference signs given in various figures denote identical, mutually corresponding or functionally similar elements.

Fig. 1 schematically shows a spatial sectional representation of an embodiment of a coating device 200 according to the invention. The coating device 200 shown comprises a rack 250 as a carrying structure for a holding frame 220 (support structure) having two side parts 220a, 220b, which are perpendicular to a central beam 221 connecting them, which, in the represented embodiment, is pivotable about an axis of rotation A4 that extends horizontally with respect to the ground. The holding frame 220 is therefore mounted in the rack 250 so as to be pivotable about the axis of rotation A4, wherein a motor 251 for performing the pivoting movement can be seen in the representation of Fig. 1. Here, the pivot angle relative to the upright position of the holding frame 202, in which the two side parts 220a, 220b extend approximately vertically proceeding from the central beam 221 towards the ground, is preferably +/- 50°.

As can also be seen from Fig. 1, a first rotary shaft 204, which defines a rotor axis of rotation A1 of a rotor 201, is rotatably mounted on the central beam 221. The first rotary shaft 204 is fastened to the central beam 221 by means of a bearing flange 225, which comprises a bearing arrangement for rotatably mounting the first rotary shaft 204, and extends parallel to the side parts 220a, 220b of the holding frame 220. The rotor 201 is releasably fastened to the side or end of the first rotary shaft

204 that faces away from the support structure (holding frame 220). In other words, in Fig. 1, the rotor 201 is arranged at the end of the first rotary shaft 204 that faces the ground.

It can also be seen in Fig. 1 that the first rotary shaft 204 extends through the bearing flange 225 and a first drive 202, which is designed to rotatably drive the rotor about the rotor axis of rotation A1 defined by the first rotary shaft 204, is arranged at the second end of the first rotary shaft 204. The first drive 202 is designed as a hollow shaft drive.

In the embodiment represented in Fig. 1, two holders 210A, 210B are provided on the rotor 201, which holders are each designed to receive one container 10A, 10B in a suspended manner, wherein the containers 10A, 10B are intended to be filled with parts to be coated. In order to enable the coating process and a downstream throw-off and/or distribution process for the coating liquid, in the embodiment shown the containers 10A, 10B are each designed with container walls or side walls which are permeable to liquid.

It can also be seen in Fig. 1 that the coating device 200 has a second drive 203, which is designed to rotatably drive the two holders 210A, 210B arranged or fastened on the rotor 201 in each case about a holder axis of rotation A2, A3, which, in the embodiment shown, extend through the centre of the holders 210A, 210B and through the centre of the two received containers 10A, 10B. Here, the two holder axes of rotation A2, A3 and the rotor axis of rotation A1 are oriented in parallel with one another. The second drive 203 is designed according to the invention as a torque motor.

Fig. 2 shows a schematic spatial detail representation of the support device 220 with a drivetrain 100 of the embodiment of a coating device 100 according to the invention represented in Fig. 1. The two containers 10A, 10B for receiving the parts

to be coated as well as the support device 220 can be seen particularly well in Fig. 2. In the representation shown, the components of the rotor 201 are protected by a rotor hood. Furthermore, the first drive 202 is also protected by a motor hood. The two protective hoods additionally serve as personal protection.

Fig. 3 schematically shows a spatial sectional representation of the support device 220 with a drivetrain 100 shown in Fig. 2. As can be seen in Fig. 3, the two holder axes of rotation A2, A3 are arranged on the rotor 201 such that the rotor axis of rotation A1 forms a central axis of the rotor 201 that is equidistant from the two holder axes of rotation. The two holder axes of rotation A2, A3 are defined by two rotary shafts 205A, 205B, which are rotatably mounted on the rotor 201.

Fig. 4 schematically shows a spatial detail representation of the sectional representation in Fig. 3 in order to illustrate the drivetrain 100 shown in Fig. 2 and 3 more clearly. It can be seen particularly well in Fig. 4 that the rotor 201 is designed as a so-called 'double-blade rotor', in which two rotor blades 209 are arranged at a distance from one another in the longitudinal direction of the first rotary shaft 204, in other words in the direction of the rotor axis of rotation A1. As shown in Fig. 4, the two rotor blades 209 are interconnected via two connection elements 211. The two connection elements 211 are preferably designed as hollow connection flanges in the through-hole of which a bearing arrangement is arranged for rotatably mounting the two second rotary shafts 205A, 205B.

Fig. 4 also shows that the torque motor 203 comprises a stator 221 and a rotor 223, wherein the stator 221 (primary part of the second drive) is releasably fastened, in particularly rigidly fastened, via a tensioning element 222 to the first rotary shaft 204 and thus follows the rotary movement of the first rotary shaft 204. The rotor 223 (secondary part of the second drive) of the torque motor, which is designed as an outrunner, is rotatably mounted on the first rotary shaft 204, in particular by means of a bearing arrangement 224. The drivetrain 100 further comprises a drive

pinion 207, which is also rotatably arranged on the first rotary shaft 204, in particular by means of two bearings that belong to the bearing arrangement 224 of the rotor 223. As can also be seen in Fig. 4, the drive pinion 207 is connected in a force-transmitting and torque-transmitting manner to the rotor 223 (primary part of the second drive) of the torque motor 203 via a connection element, in particular screws.

The drive pinion 207 serves to drive two drive wheels 206A, 206B, which are each fastened to the end of one of the two rotary shafts 205A, 205B that faces the support structure 220, and thus makes it possible to rotatably drive the two second rotary shafts 205A, 205B. Rotatably driving the two second rotary shafts 205A, 205B makes it possible to drive the two holders 10A, 10B and thus the containers 10A, 10B fastened in a suspended manner to the holders 10A, 10B in an additional rotary movement about the holder axes of rotation A2, A3.

Since the torque motor 203 is directly connected to the drive pinion 207, it is also referred to as a direct drive, which does not require a transmission. As can further be seen in Fig. 4, the drive pinion 207 meshes directly with the two drive wheels 206A, 206B in the embodiment represented. In other words, the drive pinion 207 is engaged with the two drive wheels 206A, 206B. Alternatively, it would also be conceivable to provide a transmission member such as toothed belt or a chain between the drive pinion 207 and the two drive wheels 206A, 206B, i.e. to prevent the gear wheels from engaging directly. However, due to the high torques of the torque motor, direct engagement is the preferred embodiment. Furthermore, it is also possible to not provide a central torque motor that drives both holders, but rather to provide a separate drive or torque motor for both holders. In other [*words – missing text?*], to provide two torque motors that directly rest on the two holder axes of rotation A2, A3.

Fig. 5 schematically shows a detail sectional view of the drivetrain 100 of the

embodiment of the coating device 200 according to the invention shown in Fig. 1. As can be seen in Fig. 5, the coating device 200, in particular the drivetrain 100, further comprises a clamping mechanism 240 for clamping the containers 10A, 10B on the holders 210A, 210B. The single clamping mechanism 240 is actuated by means of a pneumatic drive 241, which is arranged on the support device 220, in particular the central beam 221. Accordingly, the two clamping mechanisms 240 can only be actuated in a particular position, the so-called 'zero position' of the rotor 201. By means of the two drives 241, the clamping mechanism can be brought via an actuation element 242 into an open position, in which the containers 10A, 10B can be removed, and into a closed position, in which the containers 10A, 10B are securely received in a suspended manner in the holder.

It can also be seen in Fig. 5 that the two clamping mechanisms 240 each comprise a transmission element 243, which transmission elements each respectively pass through the two second rotary shafts 205A, 205B, which are designed as hollow shafts. In order to actuate the clamping mechanisms, the rotor 201 is brought into the zero position and the relevant actuation element 224 is moved downwards towards the transmission element 243 by means of the pneumatic drives 241, as a result of which the transmission element 243 is also pushed downwards, in particular counter to the spring force of a compression spring 244, when the relevant actuation element makes contact with the transmission element, as a result of which hook-shaped elements 245 are brought into a release position, in which the containers 10A, 10B can be removed from the holders 210A, 210B and introduced therein again. After the containers 10A, 10B have been changed, the actuation elements 224 are drawn back into their starting position by means of the two drives 241, as a result of which the two transmission elements 243 are released and moved back into their starting position by means of the spring force of the two compression springs 244, as a result of which the hook-shaped elements 245 are moved back into the locked position or closed position.

Fig. 6 schematically shows a spatial representation of an embodiment of a coating installation 300 according to the invention. The coating installation 300 shown comprises:

- a filling device 310 for filling containers 10 to be filled with parts to be coated,
- a coating device 200 for coating the parts to be coated by immersing the containers 10 filled with parts to be coated in a coating liquid and throwing off excess coating liquid,
- a drying device 330 for drying and evaporating coated parts,
- an emptying device 320 for emptying containers 10 filled with the then coated parts, and
- a container handling system 340 for transporting the containers between and to transfer the containers to the devices belonging to the coating installation 300.

The individual devices and their functions are explained in more detail further below. However, it should be noted that the entire coating installation shown is designed for processing two containers with parts to be coated at the same time, which makes the use of said coating installation particularly efficient.

Fig. 7 shows a schematic plan view of the embodiment, represented in Fig. 6, of a coating installation 300 according to the invention in order to illustrate further details.

The filling device 310, coating device 200, drying device 330 and emptying device 400 or more precisely the containers or container receiving positions of these devices indicated by means of circles are arranged approximately in a circle around the container handling system 340 for transporting the containers between and to transfer the containers to the devices belonging to the coating installation 300. The

circular arrangement of the components around the central container handling system 340 allows for a flexible layout and flexible method control.

For example, a transfer from the coating device 200 to the emptying device 320 can take place without necessarily having to pass through the drying device 330 for fast-drying coatings for which further drying or a temperature increase for drying is not necessary.

However, a multiple coating can also be easily realised by inserting the containers with parts that have already received a first coating back into the container holding position of the coating device 200 by means of the container handling system 340 after they have passed through the drying device 330.

It should further be noted that it also provides the possibility of removing the parts from the containers 10 prior to the drying, as will be explained in more detail below as a variant. In particular in the case of such an installation concept, the emptying device 320 can be arranged upstream of the drying device 330 and/or supply same with the parts emptied out of the containers 10.

The filling device 310 comprises a bunker 311 (only part of which is shown) having a store for parts to be coated that is, for example, designed as a vibration bunker, having an outlet pipe 312, which can optionally be pivoted together with the bunker or separately from the bunker and out of which the parts slide when the bunker 311 is opened.

In order to position the containers 10 designed here as baskets and with a perforated container wall relative to the outlet pipe 312 – if necessary using an optional hopper (not represented here) arranged between the outlet pipe 112 and the container 10 – such that they can be filled by means of said outlet pipe, the filling device 310 comprises a, for example, E-shaped container receiving position 313, in

which two containers 10 having a perforated container wall are placed one next to the other on the cross-beams of the E-shaped container receiving position 313 (i.e. on the crossbars of the letter E).

The container receiving position 313 is arranged on a plate 314, which is connected to a carrying column that is preferably driven by a motor and that is mounted in a base so as to rotate through an angle of at least 180° about an axis of rotation, such that each of the two containers 10 can be arranged for filling purposes below the outlet pipe 312 or hopper by rotating the E-shaped container receptacle 313 by 180°.

In addition, the use of a lift-tilt device (not shown) is preferably also possible, which facilitates the introduction of the parts to be coated into the outlet pipe 112 or hopper by moving the bunker.

A result of arranging the containers 10 on the legs of an E-shaped container receiving position 313 is that there are underrun openings between the underside of the containers 10 and the plate 114 which simplify transportation of the containers 10 by means of the container handling system 340, as will be described in more detail below.

The opening of the bunker 311 is preferably controlled by a weighing apparatus (not pictured) with residual quantity optimisation.

Accordingly, when the coating method according to the invention is carried out, in the case where the coating installation 300 described here is used, a step of automatically loading the containers with parts to be coated is performed, wherein the parts to be coated are treated in the manner of bulk material.

Next, the containers 10 filled with parts to be coated must then be transported to

the coating device 200. This takes place in the same way as the other transport steps described below by means of the container handling system 340, which will be described next in particular with reference to Fig. 6 and 7.

The container handling system 340 comprises a frame 342, which is preferably driven by a motor and mounted on a stand 341 so as to rotate about an axis of rotation A10 that extends vertically to the ground. A bearing 343 for two container carriers 344 that is preferably driven by a motor and is height-adjustable is arranged between said frame.

The container carriers 344 can be moved into or onto said bearing 343, preferably in a manner driven by a motor, in a direction parallel to the ground. They are therefore designed such that their extent in the plane lying parallel to the ground is smaller in the direction perpendicular to the travel direction of the container carriers 344 than the distance between the cross-beams of the E-shaped container receiving position 101 and they have a surface that extends parallel to the ground and that is wide enough such that a container 10 can stand comfortably thereon.

This design of the container handling system 340 makes it possible to use the container carriers 344 in a similar manner to the tines of a forklift truck for transportation, in that the container carriers 344 are introduced into the underrun openings and then raised in order to receive the containers 10, to move said container carriers to another device of the coating installation 300 and to transfer them there to a corresponding container receiving position of the relevant device.

While the degrees of freedom of movement described so far are sufficient in the case of a circular arrangement of the devices belonging to the coating installation 300, if another arrangement of these devices is desired in the installation, this can also be implemented if the stand 341 is movable, for example, on a rail system 345.

Optionally, the possibility of moving the distance of the two container carriers 344 relative to one another may also be provided. This allows for greater flexibility in the design of the container receiving positions of the respective devices.

Typically, the containers 10 filled with parts to be coated are then transferred to the coating device 200 already described above with reference to Fig. 1 to 5.

After the coating has been applied to the parts to be coated by means of the coating device 200, said parts can optionally be dried and evaporated by means of a drying device 330. An example of such a drying device 330 will be described below based on Fig. 6 and 7.

The drying device 330 comprises a large number of trays 331, which may also be divided into two halves in each case as an alternative to the form represented here. The containers 10A, 10B may, for example, be emptied with an emptying device 320, as described below or in another manner, after they have been transferred by the container handling system 340 to the drying device 330, specifically either, as represented, to wire mesh conveyor belts 332, which then convey the parts to the trays 331, or directly to the trays 331.

The trays 331 are then initially transported through an evaporation zone 333 and then through a drying and/or baking zone 335 directly heated by means of a heater 334, wherein the speed is adapted to the respective requirements of the coating, and then transferred to a cooling zone 336, in which they cool down. The evaporation zone 333 is preferably heated merely indirectly by means of the heater 334.

In the case of the drying device 330 shown, the drying and/or baking zone 335 and the unheated cooling zone 336 are located on a plane next to one another and are separated from one another by means of a preferably heat-insulating wall. A tray

transport device 337 is provided for transferring the trays from the drying and baking zone 335 to the unheated cooling zone 336.

Then trays are then tipped out, which can optionally also be done into containers 10A, 10B if further processing is to take place. The containers 10A, 10B used there may also be fresh containers which were not in the coating device 200 and/or which are transferred into another coating device.

Since the drying device 330, as can be surmised from Fig. 7, is often the largest of the devices belonging to the coating installation 300 in terms of space requirement, the geometry thereof can in particular be varied in order to adapt the coating installation 300 to the available space conditions and ambient conditions.

For example, at the end of the drying and/or baking zone 335, the trays 331 may be transferred, for example by means of a lift system, into a plane which lies below the plane of the evaporation zone 333 and drying and/or baking zone 335 and in which lies the cooling zone 336, in which the trays are cooled while being transported back.

Alternatively, it may also be provided that the optionally divided trays 331 do not move in a linear manner but rather in a circle, which can also be achieved with a turntable other than with a conveyor belt. As in the case of the drying device 330, a drying and/or baking zone and a cooling zone are provided. Said zones may also be arranged in two different planes, in particular above or below one another, between which planes the trays can be moved by means of a lift.

A feature common to all drying devices discussed above is that the drying device is loaded and unloaded on the same side, which has the advantage that the same container handling system 340 can be used for the loading and unloading process and the containers 10 can be supplied back to the coating device 200 very efficiently and over short distances in cases in which a multi-layered coating is desired.

In principle, it is of course also possible, instead of emptying the containers 10 onto the trays 331 as described, to provide the trays 331 with container receiving positions into which the container handling system 340 places the containers 10, such that the parts to be coated are dried in the container 10.

Finally, the functioning of a possible, preferred emptying device 320 will be explained below with reference to Fig. 6 and 7. As these figures show, the emptying device 320 comprises an L-shaped carrying arm 322, which is preferably driven by a motor and which is mounted at the end of the short limb of the L so as to be rotatable about an axis A11 that extends horizontally with respect to the ground and substantially parallel to the long limb of the L. In this way, an eccentric pivot axis is provided, which reduces the fall height of the coated parts from the containers 10 during emptying thereof and thus prevents any damage to the coating during the emptying process.

Two carrier plates 323A, 232B are arranged preferably so as to be rotatably mounted on the long limb of the L, which carrier plates can, for example, be made to rotate about the axes A12, A13 via a toothed belt and driven by a motor arranged on the short limb of the L, wherein a counter-rotation can optionally be ensured by providing a transmission.

The container receiving position 321 is designed as follows: Support elements 327 are arranged respectively on the carrier plates 323A, 323B such that containers 10 can be placed on the planar upper sides of said support elements facing away from the carrier plates 323A, 323B and optionally secured, for example by means of clamping or by means of holding clamps, while the space between the carrier plate 323A, 323B and the bottom sides of the containers 10 form underrun openings 328, into which the container carriers 345 of the container handling system 340 can be inserted in order to be able to place containers 10 at the container receiving position

321, more precisely on the support elements 327 thereof, and to be able to pick them up therefrom.

For the emptying, the L-shaped carrying arm 322 is pivoted about the axis A11, while the containers 10 are optionally additionally made to rotate about the axes A12, A13, if applicable in the opposite direction, in order to facilitate emptying of the containers 10, for example onto a conveyor belt 329.

List of reference signs

10A, 10B	Containers
200	Coating device
201	Rotor
202	First drive
203	Second drive (torque motor)
204	First rotary shaft (rotor rotary shaft)
205A, 205B	Second rotary shaft(s) (holder rotary shafts)
206A, 206B	Drive wheels
207	Drive pinion
208	Rotary encoder
209	Rotor blade
210A, 210B	Holders
211	Connection element
220	Holding frame
220A, 220B	Side parts
221	Stator
222	Tensioning element
223	Rotor (of torque motor) / outrunner
224	Bearing arrangement
230	Reservoir

240	Clamping mechanism
241	Drive (clamping mechanism)
242	Actuation element
243	Transmission element
244	Spring
245	Hook-shaped element
250	Rack
251	Motor (pivot drive)
300	Coating installation
310	Filling device
311	Bunker
312	Outlet pipe
313	Container receiving position
314	Plate
320	Emptying device
321	Container receiving position
322	Carrier arm
323A, 323B	Carrier plates
327	Support elements
328	Underrun opening
330	Drying device
331	Tray
332	Wire mesh conveyor belt
333	Evaporation zone
334	Heating zone
335	Drying and/or baking zone

336	Cooling zone
337	Tray transport device
340	Container handling system
341	Stand
342	Frame/column
343	Bearing
344	Container carrier
345	Rail system
A1	Rotor axis of rotation
A2, A3	Holder axes of rotation
A4	Pivot axis
A10-A13	Axes of rotation

Patentkrav

1. Belægningsapparat (200), især belægningsapparat (200) med centrifugerings- og/eller fordelerfunktion til befrielse af i det mindste delvis med overskydende væske, især overskydende belægningsmateriale, befugtede dele, omfattende:

mindst to til en rotor (201) fastgjorte holdere (210A, 210B), der hver især er indrettet til fortrinsvis hængende at optage en beholder (10A, 10B), der skal fyldes med dele, der skal belægges, idet beholderne (10A, 10B) fortrinsvis har en i det mindste delvis væskepermeabel beholdervæg,

et første drev (202), der har en første roterende aksel (204), der kan drives om en rotor-omdrejningsakse (A1) til at drive rotoren (201) roterende,

et andet drev (203), der er bestemt til roterende at drive de to på rotoren fastgjorte holdere (210A, 210B) om hver især en holder-omdrejningsakse (A2, A3),

idet rotor-omdrejningsaksen (A1) og de to holder-omdrejningsakser (A2, A3) fortrinsvis er orienteret omtrent indbyrdes parallelt, og

en primær del af det andet drev (203) er stift forbundet med den første roterende aksel (204),

idet den primære del er fastgjort til den første roterende aksel (204), og en sekundær del af det andet drev (203) er monteret drejeligt på den første roterende aksel (204), idet det andet drevs (203) omdrejningsakse er udformet kollineært med den første roterende aksels (204) rotor-omdrejningsakse (A1).

2. Belægningsapparat (200) ifølge krav 1, hvori det andet drev (203) er udformet som et direkte drev, især en torquemotor, en trykluftmotor, en hydraulikmotor eller en elektromotor med transmission.

3. Belægningsapparat (200) ifølge krav 1 eller 2, hvori det andet drev (203) er udformet som en torquemotor med et holdemoment på mere end 1000 Nm, især på mere end 4000 Nm.

4. Belægningsapparat (200) ifølge et af de foregående krav 1 til 3, som endvidere omfatter to andre roterende aksler (205A, 205B), som definerer holder-

omdrejningsakserne (A2, A3) og er monteret drejeligt på rotoren (201), idet de to andre roterende aksler (205A, 205B) fortrinsvis kan drives over på de roterende aksler (205A, 205B) fastgjorte drivhjul (206A, 206B).

5. Belægningsapparat (200) ifølge et af de foregående krav 1 til 4, som endvidere omfatter et drivtandhjul (207), der er monteret drejeligt på den første roterende aksel (204), især ved hjælp af et monteringselement (224B), mere foretrukket ved hjælp af monteringsanordningen (224), idet drivtandhjulet (207) fortrinsvis er forbundet kraftoverførende og/eller drejningsmomentoverførende med en rotor (223) i torquemotoren (203), og drivtandhjulet (207) fortrinsvis står i indgreb med drivhjulene (206A, 206B).

6. Belægningsapparat (200) ifølge et af de foregående krav 1 til 5, hvori rotoren (201) er udformet som en dobbeltvinget rotor, i hvilken to rotorvinger (209) er anbragt i afstand fra hinanden i den første roterende aksels (204) længderetning, idet de to rotorvinger (209) er forbundet med hinanden over to forbindelseselementer (211), især forbindelsesflanger.

7. Belægningsapparat (200) ifølge et af de foregående krav 1 til 6, som endvidere omfatter en i det mindste delvis med belægningsmateriale, især belægningsvæske, fyldt forrådsbeholder (230), som de beholdere (10A, 10B), der skal fyldes med dele, der skal belægges, kan nedsænkes i og udtages fra, idet forrådsbeholderen (230) til nedsænkning og/eller udtagning af beholderne (10A, 10B) i/fra forrådsbeholderen (230) er anbragt bevægeligt på belægningsapparatet (200), især at forrådsbeholderen (230) er udformet transportabel i højden i forhold til jordbunden.

8. Belægningsapparat (200) ifølge et af de foregående krav 1 til 7, som endvidere omfatter et ventilationsapparat, der er indrettet til at forsyne det andet drev (203) med en skylleluft, med hvilken et indkapslet optageområde i det andet drev (203) fortrinsvis kan sættes under overtryk.

9. Drivkraftlinie (100) til et belægningsapparat (200), især belægningsapparatet (200) ifølge et af de foregående krav 1 til 8, omfattende:

mindst to på en rotor (201) fastgjorte holdere (210A, 210B), der hver især er indrettet til fortrinsvis hængende at optage en beholder (10A, 10B), der skal fyldes med dele, der skal belægges,
et første drev (202), der til at drive rotoren (201) roterende har en første roterende aksel (204), der kan drives om en rotor-omdrejningsakse (A1),
et andet drev (203), der er bestemt til roterende at drive de to på rotoren fastgjorte holdere (210A, 210B) om hver især en holder-omdrejningsakse (A2, A3),
idet rotor-omdrejningsaksen (A1) og de to holder-omdrejningsakser (A2, A3) fortrinsvis er orienteret omtrent indbyrdes parallelt, og
en primær del af det andet drev (203) er stift forbundet med den første roterende aksel (204),
idet den primære del er fastgjort på den første roterende aksel (204), og
en sekundær del af det andet drev (203) er monteret drejeligt på den første roterende aksel (204), idet det andet drevs (203) omdrejningsakse er udformet kollineært med den første roterende aksels (204) rotor-omdrejningsakse (A1).

10. Belægningsfremgangsmåde, især til belægning af dele, under anvendelse af belægningsapparatet ifølge et af de foregående krav 1 til 8, omfattende følgende trin:

- nedsænkning af med de dele, der skal belægges, fyldte beholdere (10A, 10B), der fortrinsvis har en i det mindste delvis væskepermeabel, især perforeret, beholdervæg, i et med en belægningsvæske (231) fyldt afsnit af en forrådsbeholder (230),
- udtagning af de med de dele, der skal belægges, fyldte beholdere (10A, 10B) af belægningsvæsken,
- centrifugering og/eller fordeling af på de dele, der skal belægges, efter at de er løftet op, resterende overskydende belægningsvæske,

idet de med de dele, der skal belægges, fyldte beholdere (10A, 10B) ved centrifugeringen og/eller fordelingen af på de dele, der skal belægges, efter udtagningen resterende overskydende belægningsvæske i det mindste på et eller andet tidspunkt roteres om en inde i beholderne (10A, 10B) liggende holder-omdrejningsakse (A2, A3) og/eller i det mindste på et eller andet tidspunkt roteres om en uden for beholderne (10A, 10B) liggende

rotor-omdrejningsakse (A1), der forløber parallelt med de inde i beholderne (10A, 10B) liggende holder-omdrejningsakser (A2, A3),
idet rotationen af beholderne (10A, 10B) om de inde i beholderne (10A, 10B) liggende holder-omdrejningsakser (A2, A3) foregår uafhængigt af beholdernes (10A, 10B) rotation om den uden for beholderne (10A, 10B) liggende rotor-omdrejningsakse (A1) ved et medroterende drev (203), der roterer med holder-omdrejningsakserne (A2, A3) om rotor-omdrejningsaksen (A1), idet den primære del af det medroterende drev (203) er fastgjort på den første roterende aksel (204), og en sekundær del af det medroterende drev (203) er monteret drejeligt på den første roterende aksel (204), idet det medroterende drevs (203) omdrejningsakse er udformet kollineært med den første roterende aksels (204) rotor-omdrejningsakse (A1).

11. Belægningsfremgangsmåde ifølge krav 10, ved hvilken de med de dele, der skal belægges, fyldte beholdere (10A, 10B), medens beholderne (10A, 10B) er nedsænket i belægningsvæsken (231), i det mindste midlertidigt roteres om de inde i beholderne (10A, 10B) liggende holder-omdrejningsakser (A2, A3) og/eller i det mindste midlertidigt om den uden for beholderne (10A, 10B) liggende rotor-omdrejningsakse (A1), der forløber parallelt med de inde i beholderne (10A, 10B) liggende holder-omdrejningsakser (A2, A3).

12. Belægningsfremgangsmåde ifølge et af de foregående krav 10 til 11, ved hvilken nedsænkningen og/eller udtagningen af de med den dele, der skal belægges, fyldte beholdere (10A, 10B) i/fra et med belægningsvæsken (231) fyldt afsnit af forrådsbeholderen (230) foregår ved en løftebevægelse af forrådsbeholderen (Y).

13. Belægningsanlæg (300) omfattende et belægningsapparat (200) ifølge et af kravene 1 til 8.

14. Belægningsanlæg (300) ifølge krav 13, som endvidere omfatter: et påfyldningsapparat (310) til påfyldning af beholdere (10A, 10B), der skal fyldes med dele, der skal belægges, og/eller et udtømningsapparat (320) til tømning af med de da belagte dele fyldte beholdere (10A, 10B) og/eller et tørreapparat

(330).

15. Belægningsanlæg (300) ifølge krav 13 eller 14, hvilket belægningsanlæg (300) endvidere har et beholderhåndteringssystem (340) til transport af beholderne (10A, 10B) mellem og til overlevering af beholderne (10A, 10B) til de til belægningsanlægget hørende apparater, idet de til belægningsanlægget (300) hørende apparater (310, 320, 330) fortrinsvis er anbragt cirkulært omkring beholderhåndteringssystemet (340).

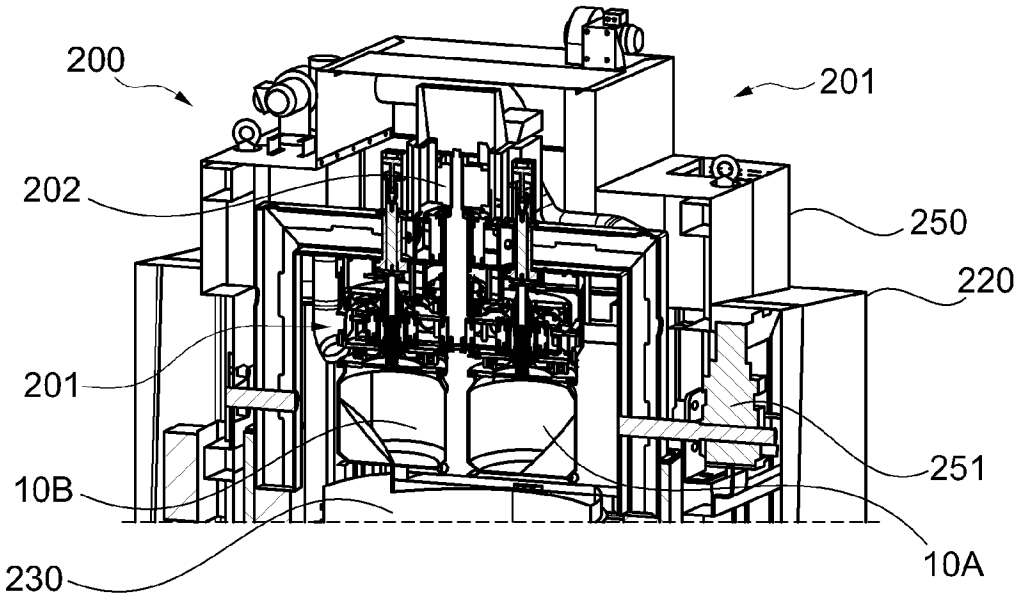
200
201
202
250
220
201
251
10B
10A
230

Fig. 1

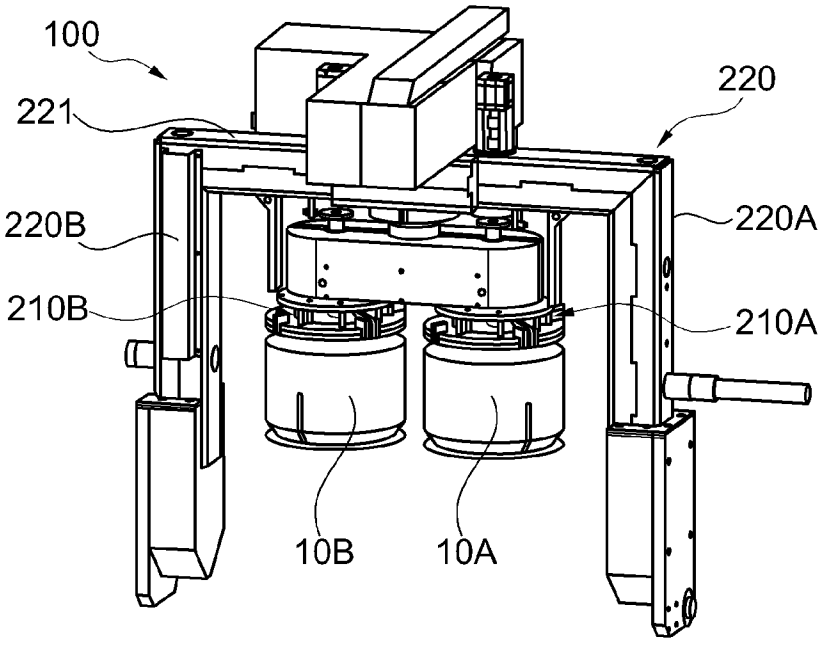
100
220
221
220A
220B
210A
210B
10B
10A

Fig. 2

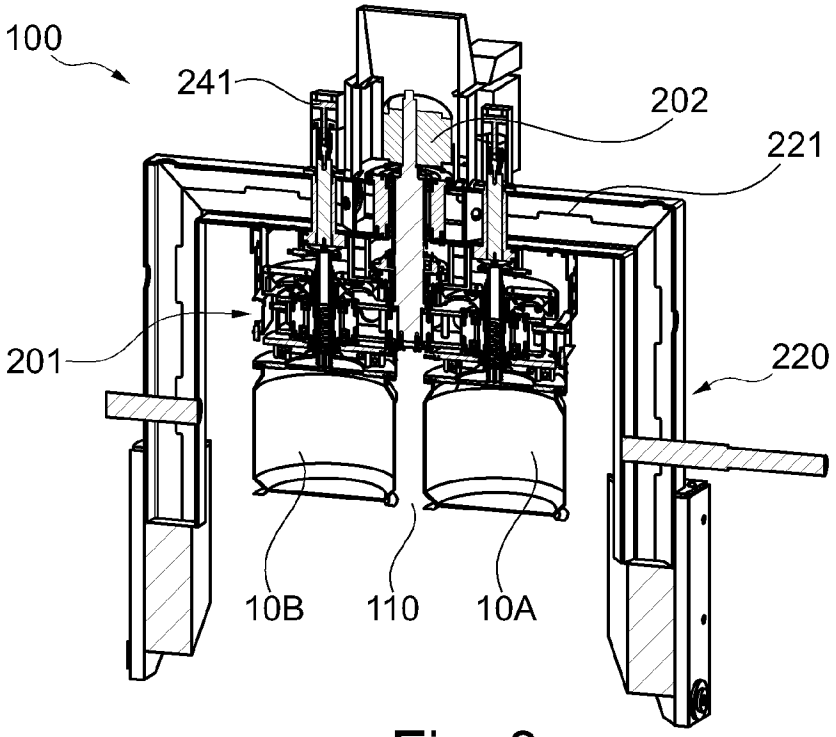
100
241
202
221
201
220
10B
110
10A

Fig. 3

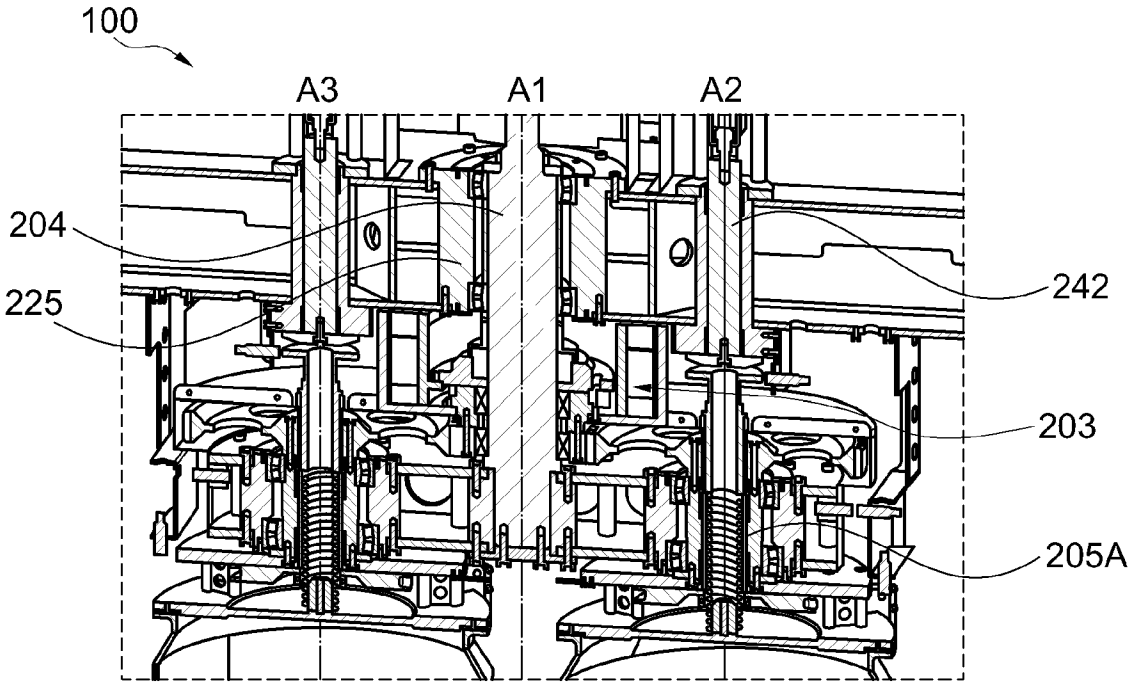
100
A3
A1
A2
204
225
242
203
205A

Fig. 4

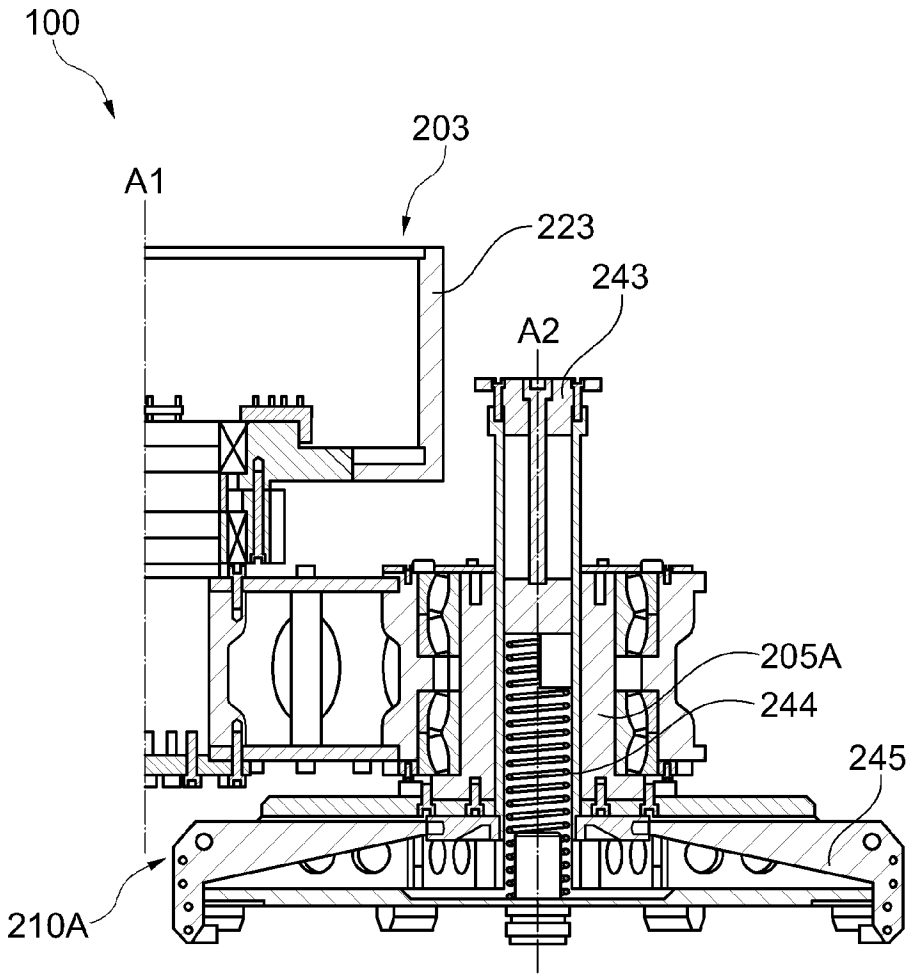

Fig. 5

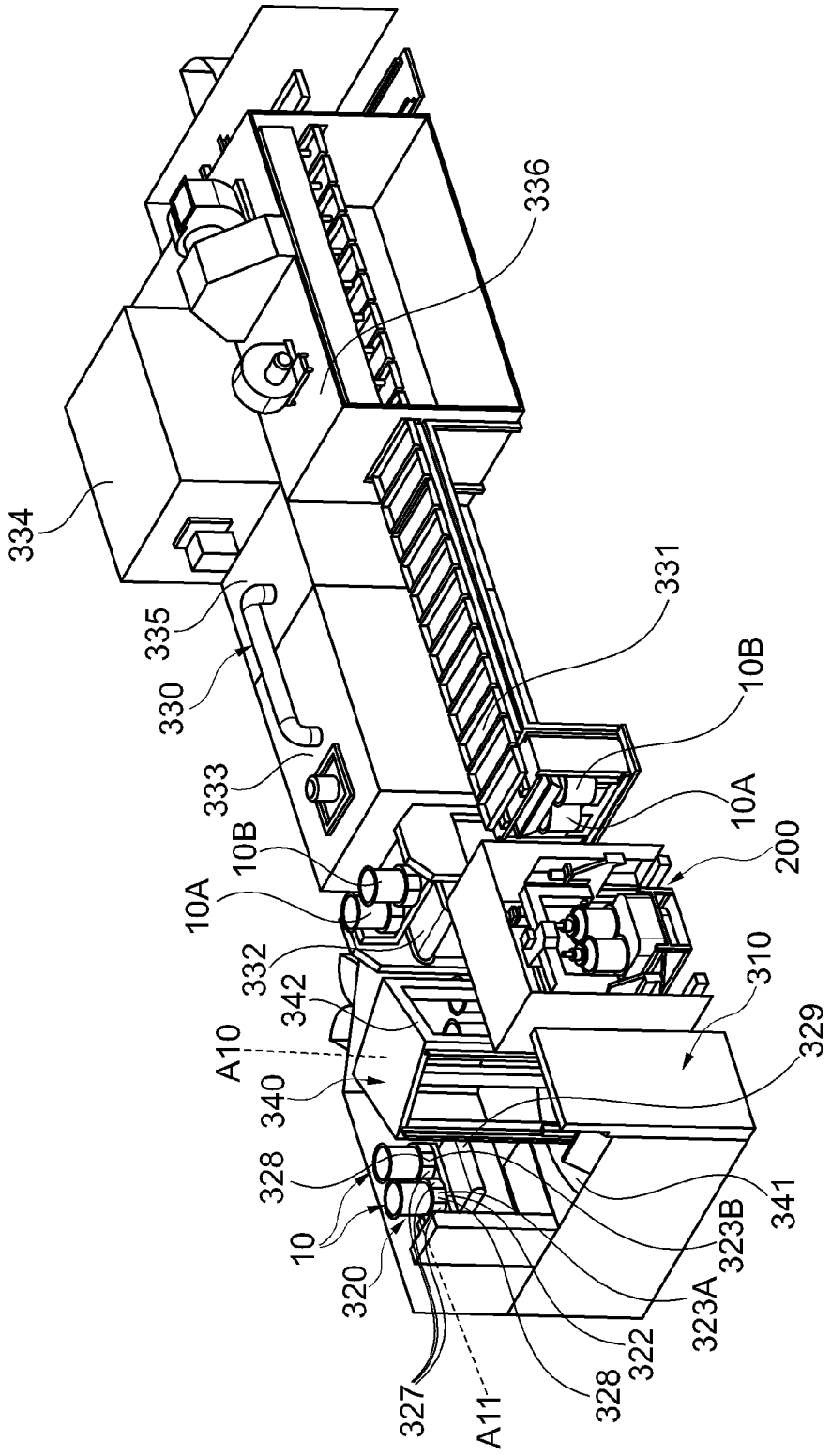
334
336
335
330
331
333
10B
10A
200
332
342
310
A10
340
329
328
10
320
341
323B
323A
322
327
A11

Fig. 6

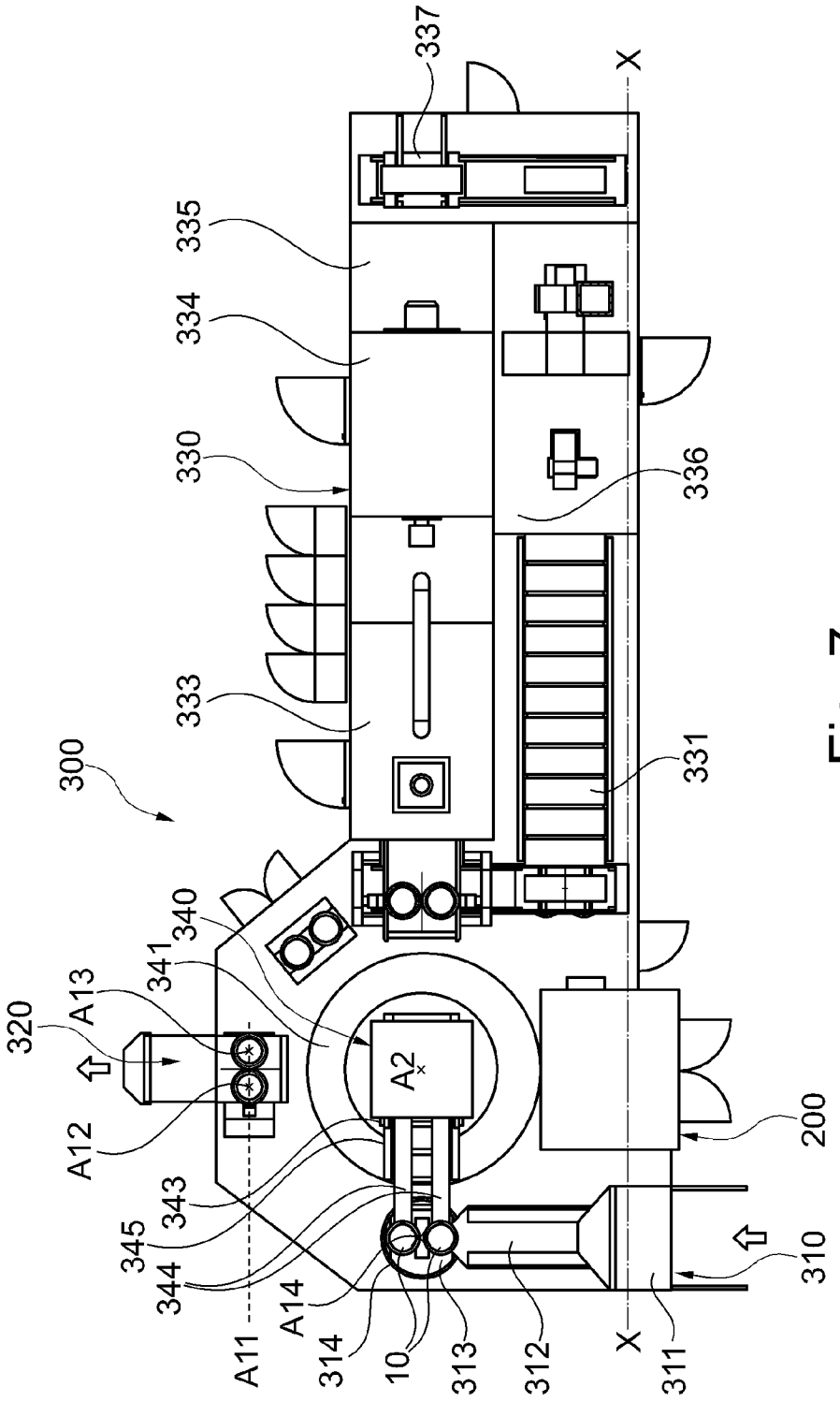
337
X
335
334
330
336
333
331
300
340
341
320
A13
A12
A2x
200
343
345
344
A14
A11
314
10
313
312
311
310

Fig. 7