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(54) MACHINE FOR FILLING CAPSULES AND RELATED METHOD

(57) A capsule (100) filling machine (1) comprising a transfer turret (2) arranged to transfer the capsules (100) through successive operating stations, including at least one dosing station (3) arranged to fill capsule bodies (101) of the capsules (100) with a product (P) and comprising a dosing turret (5) and a first dosing unit (10) mounted on the dosing turret (5); the first dosing unit (10) comprises a dosing cylinder (12) and a piston (13) movable within the dosing cylinder (12) at least between a first internal position (D), wherein it forms within the dosing cylinder (12), a dosing chamber (15) for holding a product dose (P1), and an ejection position (E) to push the product dose (P1) out of the dosing cylinder (12) to a respective capsule body (101); the machine (1) includes a first electrical linear actuator (6) associated with the dosing turret (5) and suitable for moving the piston (13) of the first dosing unit (10) between said first internal position (D) and said ejection position (E).

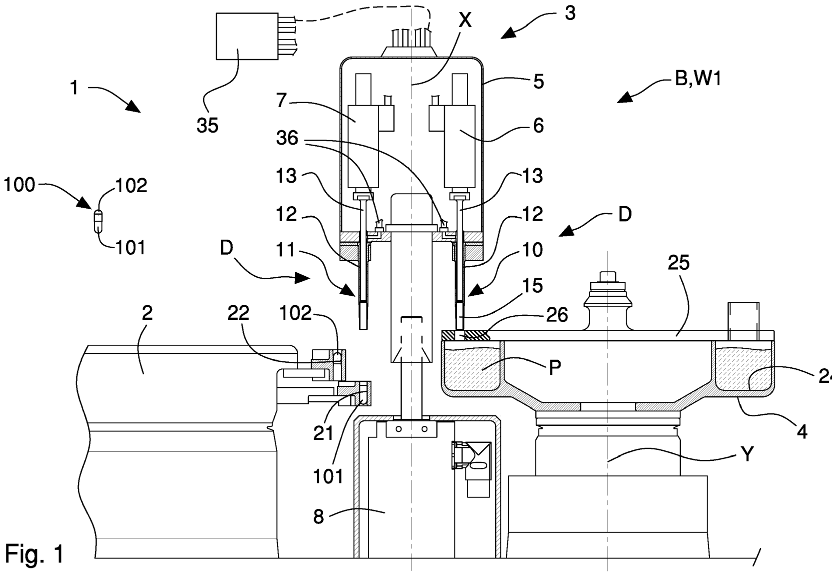

Fig. 1

EP 3 295 920 A1

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Description

[0001] This invention relates to automatic machines for the manufacture of pharmaceuticals and/or foodstuffs. In particular, the invention relates to a machine and a method for filling capsules, caps or similar elements with a pharmaceutical or food product.

[0002] Various types of filling machines are known to fill capsules, in particular body-cap type capsules made of hard gelatin, containing liquid or pharmaceuticals or foodstuffs, powder, granules, tablets, micro-tablets, delayed-action drugs, etc.

[0003] Some known filling machines include a transfer turret, or wheel, which rotates around a vertical axis and is provided with housings or seats for holding the capsules, and a plurality of operating stations disposed around said transfer turret. During its rotation, the transfer turret moves the capsules, typically intermittently or stepwise, through the various operating stations including a capsule feed station, one or more dosing stations, and one capsule closure station.

[0004] The capsule feed station is provided with a feeding unit that draws the capsules out from a warehouse and, after correctly orienting and aligning them, inserts the capsules into the transfer turret seats. Specific means open the capsules by separating the cap from the body.

[0005] In the dosage station, the product is dispensed in a controlled manner into the capsule bodies.

[0006] At the closing station, the cap are placed again on the respective capsule bodies so as to close and recap the capsules filled with the product coming from the filling machine.

[0007] Filling machine of prior art are discloses in EP2090279 and WO0032151.

[0008] Machines for filling the capsules with powdered products, granules, similar delayed-action drugs, where the dosing station comprises a dosage turret or wheel rotating around a respective vertical axis and are typically provided with two sets of volumetric dispensers, between them angularly spaced at 180° with respect to the vertical axis and able to extract certain quantities or doses, of a product from a reservoir at a withdrawal position, transferring and then releasing the dosage into the capsule bodies in a release position.

[0009] The volumetric dispensers of each group are angularly spaced apart and arranged so as to interact with a corresponding number of capsules housed in the transfer turret seats.

[0010] Each volumetric dispenser includes a hollow pipe or cylinder, arranged parallel to the vertical axis of the dosing turret and provided with a lower opening, and a respective sliding piston within the hollow cylinder. The piston forms within the hollow cylinder a dosing chamber openly spaced so as to receive and retain the product when the cylinder is inserted and immersed in a layer of product contained in a reservoir. The dosing turret is in fact moving linearly along the vertical axis between a lowered position and a raised position.

[0011] In the lowered position of the dosing turret, while the cylinders of a dosage unit are immersed in the product within the reservoir, so as to load and withdraw relevant product doses, the other cylinders of the dosage unit are superimposed and substantially in contact with the relevant capsules to be filled, so that the doses of the product are transferred to these.

[0012] When the dispenser is inserted and immersed at a predefined speed in the product layer contained in the reservoir, the product is inserted and compacted inside the hollow cylinder into the dosing chamber, forming a sort of "carrot" of the product that constitutes the dose.

[0013] An air intake system is generally associated with the dispensers to assist in retaining the product within the dosing chambers, particularly while the dispensers are being rotated with the dosing turret from the collection position to the release position.

[0014] The pistons are mounted so that they slide inside the respective cylinders and expel the doses of the product. Specifically, each piston moves between an upper inner position, in which with its own lower terminal part forms with the respective hollow cylinder the dosing chamber, and a lower outer position where said lower end part faces the lower open terminal part of the cylinder so as to empty the dosage chamber and transfer the product to the underlying capsule.

[0015] Pusher pins are mounted above the dosing turret and are arranged to contact and move, from the internal position to the external position in order to expel product doses, dosing pistons when the dosing turret moves from the raised position to the position lowered. During the dose ejection, the intake of air (if present) inside the dispenser device is interrupted.

[0016] An elastic element, typically a helical spring, is mounted inside the hollow cylinder of the dispenser device to bring the piston back to its internal position when the dosing turret moves from the lowered position to the raised position by disengaging the respective pusher pin.

[0017] The inner top position of the piston is defined by a transverse pin fixed to one upper end of the piston opposite to the lower operating slider and sliding inside a slot formed in the cylinder wall, which works together with a control plate mounted on the dosing turret. In essence, once the transverse pin, pushed by the elastic element, reaches the adjustment plate, the inner top position of the piston is defined. The vertical position of the adjustment plate can be modified to change the inner top position of the piston. The transverse pin engaged in the cylinder slot also prevents the piston from coming out of the cylinder, defining the lower outer position of the cylinder.

[0018] A volumetric dispenser of the type just described appears in EP 1052961.

[0019] One known disadvantage of filling machines is that they are not flexible and difficult to adjust because the volume of the dosing chamber can only be modified mechanically and with a stationary machine, changing the position of the adjusting plate that determines the upper position of the dispenser pistons.

[0020] It is also a known fact that filling machines have the disadvantage of not accurately measuring products that are not easily compacted and/or compressible within the cylinders, such as granules, micro-tablets, delayed-action drugs, and the like. During rotation of the transfer turret, especially if carried out at high speed, the product at the lower opening of the hollow cylinder, as it is not sufficiently compacted, tends to detach itself, thereby causing a change in the amount of product actually released within the capsule. The above-mentioned dosage variations, especially of pharmaceutical products, are not generally acceptable.

[0021] In the known filling machines, in order to optimise performance and simplify drive mechanisms and kinematics, the dosing turret rotates intermittently in a single rotation direction (clockwise or anti-clockwise), requiring the use of suitable manifolds, or rotary electric distributors, and electric motors for the pneumatic and/or electrical supply of the devices and/or sensors mounted on said dosing turret. The above rotating manifolds and electric motors with sliding contacts, besides being expensive, are complex and require periodic maintenance to ensure their proper functioning.

[0022] An aim of this invention is to improve the machines and methods known for filling capsules, caps or similar elements produced in powder, granules, micro-tablets, delayed-action drugs or the like, particularly for pharmaceutical or food products.

[0023] Another aim is to provide a filling machine and a filling method to reliably, accurately and repeatedly fill capsules, caps or similar elements even with products which are difficult to compact and/or compress such as granules, micro-tablets or delayed-action drugs.

[0024] An additional aim is to provide a high-performance filling machine with a simple, robust structure that offers a reliable and safe operation.

[0025] Firstly the invention is conceived as a filling machine according to claim 1.

[0026] Secondly, the invention provides for a method for filling capsules with a product according to claim 10.

[0027] The invention can be better understood and implemented with reference to the accompanying drawings which explain by way of example and not limited, a performance where:

- figure 1 is a schematic, partially sectional view of a capsule filling machine according to the invention, in association with a capsule to be filled and in which a dosing turret is in a first working position and in a raised position;
- figure 2 is a partial and enlarged view of the machine of figure 1 with the dosing turret in a lowered position to allow a first dosing unit to draw a product dose from a reservoir;
- figure 3 is a partial and enlarged view of the machine of figure 1 with the dosing turret in a raised position and the first dosing unit provided with a product dose;
- figure 4 shows an enlarged view of the dosing unit of figure 3 with the piston in a first internal position and a second internal position respectively;
- figure 5 is a partial and enlarged view of the machine of figure 1 with the dosing turret rotated in a second working position and in the raised position with the first dosing unit provided with the product dose overlapped and aligned to a capsule body to be filled;
- figure 6 is a partial and enlarged view of the machine of figure 5 with the dosing turret in the lowered position, the first dosing unit adjacent to the capsule body and a second dosing unit inserted into the reservoir to draw a product dose;
- figure 7 is a view similar to that of figure 6, wherein the product dose is ejected from the first dosage unit and released into the capsule body;
- figure 8 is a schematic and simplified plan view from above of the machine according to the invention.

[0028] Referring to figure 8, a filling machine 1 according to the invention is shown, the filling machine is suitable for filling capsules 100, hard gelatin capsules or similar containers with powder, granules, micro-tablets, delayed-action drugs or the like, and in particular with a pharmaceutical or food product.

[0029] The filling machine 1 comprises a transfer turret 2 and a plurality of operating stations, arranged stationary around the transfer turret 2 itself. More particularly, the filling machine 1 comprises an inlet station 51 in which 100 empty capsules enter the filling machine 1, an opening and control station 52 where the capsules 100 are opened and controlled, a dosing station 3 where bodies 101 of capsules 100 are filled with a product dose PI, a closure station 54 where the capsules 100 are closed and an exit station 55 where the filled capsules 100 are discharged from the filling machine 1.

[0030] Advantageously, the filling machine 1 also includes a waste removal station 53, for example located upstream of the closing station 54 with respect to the rotation direction of the transfer turret 2, where non-compliant capsules 100 are discarded. Also, advantageously, the filling machine 1 comprises a cleaning station downstream of the output station 55 and upstream of the capsule input station 51 with respect to the direction of rotation of the transfer turret 2, where first seats 21 and/or second transfer turret seats 22 are cleaned prior to housing subsequent capsules 100.

[0031] Referring to figures 1 and 7, the transfer turret 2 can be rotated around a respective axis, in particular vertical, and is provided with first seats 21 and second seats 22 to respectively accommodate the bodies 101 and the caps 102 of the capsules 100; the latter being previously opened in the opening and control station 52, which is located upstream of the dosing station 3, with reference to the rotational direction of said transfer turret 2.

[0032] The dosing station 3 is arranged to fill the bodies of the capsules 100 with a predetermined dose PI of the above-mentioned product P taken from a reservoir 4 and comprises a dosing turret 5 rotating around a rotation axis X, which in particular is vertical, between a first working position W1 and a second working position W2. Additionally, dosing turret 3 is linearly movable along the X rotation axis between a lowered position A and a raised position B.

[0033] The dosing station 3 includes at least a first dosing unit 10 mounted on said dosing turret 5 and comprising a first hallow dosing cylinder 12 having an opening 12a at one lower end and a respective piston 13 sliding within the dosing cylinder 12. The piston 13 is in particular, movable at least between a first internal position D where it forms within the dosing cylinder 12 a dosing chamber 15 suitable for collecting and retaining a product dose PI from the reservoir 4, and an ejection position E in which the piston 13, more precisely a working end of the piston 13, substantially faces a lower opening 12a of the dosing cylinder 12 to push the product dose PI out of the dosing cylinder 12 and release it into the body 101 of a capsule 100.

[0034] The dosing cylinder 12 and the piston 13 of the first dosing unit 10 are mounted on the dosing turret 5 substantially parallel to the axis of rotation X.

[0035] A first electrical linear actuator 6 is provided and associated with the dosing turret 5 connected to the first dosing unit 10 to move the respective piston 13 into the dosing cylinder 12 along a direction parallel to the axis of rotation X between the first internal position D and the ejection position E.

[0036] This first electrical linear actuator 6 comprises a movable slider directly connected to the piston 13.

[0037] The first electrical linear actuator 6 also allows to adjust the first internal position D of the piston 13 with respect to the lower opening 12a of the dosing cylinder 12 so as to modify a volume of the dosing chamber 15 and then the volume of the dose PI of product P to be dosed.

[0038] The reservoir 4 includes, for example, a container provided with an annular housing 24 disposed to hold the product P and closed at the top by a cover 25 provided with a hole 26 for the introduction of the dosing cylinder 12 of the first dosing unit 10. The reservoir 4 can rotate around a vertical axis Y so as to present to the first dosing unit 10 a product layer P within the annular chamber 24 of constant height and suitable for a correct filling of the dosing cylinder 12.

[0039] The dosing station 3 is arranged so as to comprise at least one second dosing unit and at least one second electrical linear actuator. For example, in the embodiment illustrated in the figures, the dosing station 3 includes a second dosing unit 11 mounted on the dosing turret 5, identical to the first dosing unit 10 and angularly spaced from the latter by the rotation axis X, in particular spaced by 180°, i.e. substantially opposite to said rotation axis X. A second electrical linear actuator 7, identical to the first electrical linear actuator 6, is mounted on the dosing turret 5 and connected to the second dosing unit 11 so as to move the piston 13 of the latter into the respective dosing cylinder 12.

[0040] The second electrical linear actuator 7 also allows to adjust the first internal position D of the piston 13 with respect to the lower opening 12a of the dosing cylinder 12 so as to modify a volume of the dosing chamber 15 and then the volume of the PI product dose to be dosed.

[0041] The dosing cylinder 12 and the piston 13 of the second dosing unit 11 are mounted on the dosing turret 5 substantially parallel to the axis of rotation X.

[0042] The two electrical linear actuators 6, 7 comprise a respective linear electric motor, for example of the brushless type with a sliding magnetic slider inside a linear stator, or a respective actuator equipped with a rotating electric motor coupled to a screw-nut drive system, by interposing a motor reducer.

[0043] Preferably, the magnetic electric motor slider slides along an axis parallel to the piston axis 13.

[0044] In a different embodiment of the filling machine 1 not shown in the figures, the dosing turret 5 includes a plurality of first dosing units 10 parallel to each other and angularly and regularly spaced with respect to the rotation axis X so as to form a first group of (first) dosing units 10 and a plurality of second dosing units 11 parallel to each other and angularly and regularly spaced with respect to the rotation axis X to form a second group of (second) dosing units 11 opposed, i.e. rotated at 180°, with respect to said first group of (first) dosing units. The number of the first dosing units 10 is equal to the number of dosing units 11 and equal to the number of capsule bodies 101 housed in the first seats 21 of the transfer turret 2 to be filled in a single operation or phase. The angular pitch or angular distance between two adjacent dosing units 10, 11 (in both groups) is equal to the pitch or angular distance between the two first adjacent seats 21 adjacent to the transfer turret 2.

[0045] In this embodiment of the machine, the first electrical linear actuator 6 and the second electrical linear actuator 7 are respectively connected to the plurality of the dosing units 10 and to the plurality of second dosing units 11 so as to move their respective pistons 13. In particular, the pistons 13 of the first dosing units 10 are connected to each other and to the first electrical linear actuator 6 by a first connecting element so as to move together. Similarly, the pistons 13 of the second dosing units 11 are connected to each other and to the second electrical linear actuator 7 by a second connection element so as to move together.

[0046] In a different embodiment, the pistons 13 of the first dosing units 10 and the second dosing units 11 are mutually disconnected and each piston 13 is coupled to and moved by a respective first or second electrical linear actuator 6, 7. In this variant, each piston 13 can be independently controlled.

[0047] In another embodiment of the filling machine 1 not shown in the figures, the dosing turret 5 includes only a plurality of first dosing units 10 which are angularly and regularly spaced about the rotation axis X, the first electrical linear actuator 6 being connected to the said first dosing units 10 so as to move their respective pistons 13. Also in this embodiment, the number of the first dosing units 10 is equal to the number of bodies 101 of the capsules 100 housed in the first seats 21 of the transfer turret 2 and to be filled in a single operation or phase. The pitch or angular distance between the first two adjacent dosing units is equal to the pitch or angular distance between the two first adjacent seats 21 adjacent to the transfer turret 2.

[0048] The filling machine 1 further comprises air suction means 35 connected to the dosing units 10 by respective ducts 36 in order to suck air from the inside of the dosing cylinders 12 and cooperate in order to draw the dose PI during the drawing of the product P from the reservoir 4 and to hold it inside the dosing chambers 15, particularly during the rotation of the dosing turret 5, as best explained in the following description.

[0049] The piston 13 of the dosing units 10, 11 may also be movable by means of the respective electrical linear actuators 6, 7 from the first internal position D to a second internal position F (furthest from the lower opening 12a with respect to the first internal position D) a volume of the dosing chamber 15 formed by the piston 13 with its relative hollow dosing cylinder 12 is incrementally increased to move more within the dosing cylinder 12 the product dose PI drawn from the reservoir 4. In practice, the dose PI of the product P moves away from the lower opening 12a. The displacement of the piston 13 inside the dosing cylinder 11 substantially causes an "intake effect" and dragging of the product dose PI within the dosing chamber 15 which allows to move a peripheral portion of said dose away from the lower opening 12a of the dosing cylinder 12. In this manner, as best described in the following description, during the rotation of the dosing turret 5 for aligning the dosing unit 10 with the body 101 of the capsule to be filled, the peripheral portion of the dose PI, as it is completely contained within the cylinder 12 and adheres to the inner walls of the latter, can hardly detach and fall from the dosing cylinder 12 due to air flows and/or vibrations generated by the rotation of the dosing turret 5.

[0050] According to a particularly advantageous aspect of the invention, during the withdrawal of product P from the reservoir 4, the electrical linear actuators 6, 7 control respective pistons 13 so that the operating end of said respective pistons 13 is substantially flush with the lower opening 12a of the respective dosing cylinder 12 (ejection position E) when the operating end contacts the product P in the reservoir 4, when the dosing turret 3 moves from the raised position B to the lowered position A. Further, the electrical linear actuators 6, 7 control the respective pistons 13 to move from the ejecting position E to the first internal position D while the dosing turret 3 moves towards the lowered position A. In particular, the electrical linear actuators 6, 7 control the respective pistons 13 so that they move with a rise rate of substantially the same form, but towards the opposite, in respect of a lowering speed of the dosing turret 3 from the raised position B to the lowered position A.

[0051] According to this particularly advantageous aspect of the invention, the presence of air inside the dosing chamber 15 is considerably reduced before the collection of the product, so as to reduce, if not eliminate, dust problems during the dosage of the dose P1.

[0052] An electric actuator 8 is provided for moving the dosing turret 5 along the axis of rotation X and to rotate the dosing turret 5 around the rotation axis X between the first working position W1, wherein the first dosing unit 10 is capable of collecting a product dose PI from the reservoir 4 and the second working position W2, wherein the first dosing unit 10 is capable of transferring and releasing the product dose PI into the cap 101 of a capsule 100.

[0053] During the running of the filling machine 1 of this invention, in the first working position W1 of the dosing turret, the second dosing unit 11 (as opposed to the first dosing unit 10) is capable of transferring and releasing a respective product dose PI into a body 101 of a capsule 100, while in the second working position W2, the second dosing unit 11 is able to draw a product dose PI from the reservoir 4.

[0054] The electric actuator 8, which includes, for example, an electrically rotolinear brushless motor, is arranged to move the dosing turret 5 along the axis X and rotate the dosing turret 5 between the two working positions W1, W2 of an angle of about 180°, with an intermittent rotating motion in the opposite directions of rotation. In other words, the dosing turret 5 is rotated alternately 180° clockwise and then counter-clockwise (for example, it is rotated clockwise from the first working position W1 to the second working position W2 and counter-clockwise from the second working position W2 to the first working position W1). Thus, in the absence of progressive rotation in a single direction of rotation, such as in intermittent mechanical drives, no collector or distributor rotation is required to provide the pneumatic and / or electrical supply for devices and / or sensors mounted on said dosing turret, thereby allowing to simplify the structure and operation of the filling machine 1.

[0055] In a different embodiment of the filling machine 1 of the invention not shown in the figures, mechanical levelling screeds (blade) or pneumatic (air blowing) are arranged to remove excess product at the lower opening 12a of the dosing cylinder 12 and detach the material in excess of the dose PI when the dosing unit 10, 11 is extracted and raised from the reservoir 4 in the raised position B of the dosing turret with the piston 13 arranged in the first internal position D. When the excess product is removed, the piston 13 is moved in the second internal position F so as to bring the product dose PI completely into the dosing cylinder 12.

[0056] The operation of the filling machine 1 of the invention and in particular of the dosing station 3 comprises a first step (Figure 1) in which the dosing turret 5 is in the raised position B and rotated in the first working position W1, in which the first dosing unit 10 is above the product P in the reservoir 4.

[0057] Firstly, the electrical linear actuators 6, 7 are actuated to adjust the first internal position D of the pistons 13 of the dosing units 10, 11 with respect to the lower openings 12a of the corresponding dosing cylinders 12, forming within the latter the dosage chambers 15 having a predetermined volume equal to that of the dose PI of the product P to be dosed in the capsules 100.

[0058] According an embodiment of the invention, the electrical linear actuators 6, 7 are actuated so as to displace the respective pistons 13 in the ejection position E.

[0059] In a second step (Figure 2), the dosing turret 5 is moved linearly along the axis of rotation X from the raised position B to the lowered position A so that the first dosing unit 10 can be inserted or "dipped" inside of the reservoir 4, passing through the hole 26 of the cover 25, in the product P layer contained in the annular housing 24. As is known, by inserting the dosing cylinder 12 into the product layer, part of the latter penetrates and compresses, more or less strongly, depending on the kind of product P within the dosing chamber 15.

[0060] According to an embodiment of the invention above given, during the second step in which the dosing turret 5 is moved linearly along the axis of rotation X from the raised position B to the lowered position A, the electrical linear actuators 6, 7 are actuated in such a way to move the respective pistons 13 from the ejection position E to the first internal position D, with module speed substantially equal but opposite to a lowering speed of the dosing turret 5 from the raised position B to the lowered position A.

[0061] The product PI dose is withdrawn from the reservoir 4, then introduced and retained in the dosing chamber 15 also by means of the air suction carried out within the dosing cylinder 12 by the air suction means 35 connected to the first dosing unit 10 through a respective duct 36.

[0062] In this second step, the second dosing unit 11 is superimposed and aligned with a first seat 21 of the transfer turret 2, but is free of the product dose P1.

[0063] In a third stage (Figure 3), the dosing turret 5 is moved from the lowered position A to the raised position B to disengage the first dosing unit 10 from the product P and from the reservoir 4.

[0064] At the same time as the lifting motion of the dosing turret 5, or on completing the latter, the piston 13 of the first dosing unit 10 is moved by the first electrical linear actuator 6 to the second internal position F, so as to increase the volume of the dosing chamber 15 and move the dose PI of product PI drawn from the reservoir 4 more within the inside of dosing cylinder 12.

[0065] The displacement of piston 13 inside the dosing cylinder 11 causes the suction of the product dose PI within the dosing chamber 15, thereby allowing the peripheral portion of the dose to be moved away from the lower opening 12a of the dosing cylinder 12 (Figure 4).

[0066] In essence, the first electrical linear actuator 6 is programmed to allow the relevant piston 13 to be positioned in at least two (different) internal positions, one defining the volume of the dosing chamber 15, and one which defines a safe transport condition of the dose PI, from the first working position W1 to the second working position W2.

[0067] It should be noted that the first electrical linear actuator 6 can be programmed to move piston 13 from the first internal position D to the second internal position F regardless of the movement of the dosing turret 5 from the lowered position A to the raised position B. Advantageously, the first electrical linear actuator 6 can be programmed to move the piston 13 from the first internal position D to the second internal position F only once the excess product has been removed.

[0068] Further, according to a preferred embodiment, the dosing station 3 comprises a motorisation (e.g., a brushless motor) for moving the dosing turret 5 from the lowered position A to the raised position B according to a motion law comprising a concurrent stop step when the excess product is removed.

[0069] In a subsequent fourth step (Figure 5), the dosing turret 5 in the raised position B is rotated in the second working position W2 wherein the first dosing unit 10 is aligned and superimposed on a first seat 21 of the transfer turret 2, containing the body 101 of a capsule 100, while the second dosing unit 11 is above the reservoir 4, aligned with the hole 26 of the cap 25.

[0070] The displacement of the piston 13 inside the dosing cylinder 11 from the first internal position D to the second internal position F allows the peripheral portion of dose PI to be fully contained within dosing cylinder 12 during the rotation of the dosing turret 5 (fourth phase), preventing product detachments and losses due to airflows and/or vibrations generated by the dosing turret 5 movement.

[0071] The dosing turret 5 is rotated from the first working position W1 to the second working position W2 for example clockwise rotation with reference to a plan view from the top of the filling machine 1 of the invention.

[0072] In a fifth step (Figure 6), the dosing turret 5 is moved in the lowered position A so that the first dosing unit 10 can be positioned with the lower opening 12a of the dosing cylinder 12 aligned and substantially facing the capsule body 101 to be filled with the product dose PI. At the same time, the second dosing unit 11 is inserted inside the reservoir 4 in order to draw or load a respective product dose PI.

[0073] In a subsequent sixth step (Figure 7), the piston 13 of the first dosing unit 10 is moved by the first electrical linear actuator 6 from the second internal position F to the ejection position E in order to eject the product dose PI from the dosing chamber 15 and transfer it to the body 101 of the capsule 100. Air suction (if present) inside the dosing cylinder 12 at this stage is deactivated to allow the ejection of the dose P1. It must be noted that during the ejection of the product dose PI it is not necessary to stop the piston 13 in the first internal position D and advantageously, it is possible to move the piston 13 of the first dosing unit 10 by means of the first electrical linear actuator 6 in a non-stop stroke between the second internal position F and the ejection position E. Note that through the first electrical linear actuator 6 it is possible to precisely, accurately and repeatedly check the movement of the piston 13, particularly downstream from the second internal position F to the ejection position E. More in detail, acting on the first electrical linear actuator 6, it is possible to control the motion (speed, acceleration) of the piston 13 which can be selected and set in function not only of the amount of product to be dosed (volume of dose P1) but also of the type of product to be dosed, e.g. more or less compacted powder, granules, micro-tablets, delayed-action drugs etc.

[0074] In a subsequent seventh step, not shown in the figures, the dosing turret 5 is moved to the raised position B so as to move away the first dosing unit 10 from the capsule body 101 filled with the product dose PI and at the same time disengage the second dosing unit 11 from the product P and the reservoir 4. At the same time as the lifting motion of the dosing turret 5, or on completing this, the piston 13 of the first dosing unit 11 is moved by the first electrical linear actuator 7 to the second internal position F, so as to increase the volume of the dosing chamber 15 and move the product dose PI drawn from the reservoir 4 more within the inside of dosing cylinder 12.

[0075] In essence, as described with reference to the first electrical linear actuator 6, the second electrical linear actuator 7 can also be programmed to allow the respective piston 13 to be positioned in at least two (different) internal positions, one defining the dosing chamber 15, and one that defines a safe transport condition of the dose PI, from the second working position W2 to the first working position W1.

[0076] It must also be noted that the first electrical linear actuator 6 and the second electrical linear actuator 7 can be actuated independently of each other so that optimum motion laws can be chosen to eject the product dose PI towards the respective capsule body 101 and simultaneously to draw and keep the product within the dosing chamber 15 without the motion law of the first electrical linear actuator 6 adversely affecting the motion law of the second electrical linear actuator 7. Advantageously, an optimal motion law can be adopted to let the piston 13 occupy the second internal position F independently of the motion law adopted to eject the product dose PI.

[0077] In a subsequent eighth phase not shown in the figures, the dosing turret 5 is returned from the second working position W2 to the first working position W1 with a rotation of 180° counter-clockwise, referring to a plan view from above of filling machine1.

[0078] In a ninth phase, the dosing turret 5 is moved from the raised position B to the lowered position A so that the first dosing unit 10 can be inserted inside the reservoir 4 to draw or load a respective dose PI of the product and the second dosing unit 11 is positioned with the lower opening 12a of the dosing cylinder 12 aligned and substantially facing the capsule body 101 to be filled with the product dose PI.

[0079] In a subsequent tenth phase, the piston 13 is movable at a second electrical electric actuator 7 from the second internal position F to the ejection position E, advantageously according to a stroke without intermediate stops, to expel the dose PI released to the respective underlying capsule body 11.

[0080] The next step coincides with the third step previously described.

[0081] In the normal operation of the filling machine the steps from the third to the tenth are repeated cyclically.

[0082] Once the body101 of a capsule 100 has been filled with the product dose PI, the transfer turret 2 is rotated with a defined angle or pitch so as to position a subsequent capsule body 101 to be filled.

[0083] It must be noted that the description of the operation of the filling machine 1 is also the same in the case of a plurality of first dosing units 10 and a plurality of second dosing units 11 arranged to fill at the same time a plurality of capsule bodies 101 (in number equal to that of dosing units 10, 11) with respective doses PI of the product so as to increase the productivity of the filling machine 1 of the invention.

[0084] The method according to the invention for filling capsules 100 or similar containers with a product P in powder, granules, mini-tablets, delayed-action drugs or the like comprises:

- withdrawing a product dose PI from a reservoir 4 by means of a dosing unit 10, 11 comprising a respective hallow dosing cylinder 12, with an opening 12a at one end, and a respective piston 13 movable inside the dosing cylinder 12 and placed in a first internal position D wherein it forms within the dosing cylinder 12 a dosing chamber 15 adapted to receive and retain the product dose PI;
- moving the dosing unit 10, 11 in line with the body 101 of a capsule 100 to eject the product dose PI out of the dosing cylinder 12 and release it into the capsule body 101 by moving the piston 13 inside the dosing cylinder 12 to an ejection position E;
- before moving the dosing unit 10, 11, moving the piston 13 from its first internal position D to a second internal position F (further away from the lower opening 12a than the first internal position D), where a volume of the dosing chamber 15 is displaced from the lower end 12a, moving the dose PI of the product withdrawn from the reservoir 4 into the inside of the dosing cylinder 12, thereby preventing detachments of product from the dose PI during said moving of the dosing unit 10, 11.

[0085] Withdrawing the product dose PI comprises inserting or "diving" the dosing unit 10, 11 into a product layer P contained in the reservoir 4 such that a portion of said product P penetrates and is compressed within the dosage chamber 15 formed by the piston 13 in the hallow dosing cylinder 12, thus achieving the dose PI of product.

[0086] Moving the dosing unit 10, 11 comprises rotating about a rotation axis X, in particular almost vertical, a dosing turret 5 on which said dosing unit 10, 11 is mounted.

[0087] Advantageously, the method further comprises moving the piston 13 of the dosing unit 10, 11, in particular from the internal position D, to the second internal position F and the ejection position E by means of an electrical linear actuator 6, 7 mounted on the dosing turret 5.

[0088] It is also possible adjust said first internal position D of the piston 13 in the respective dosing cylinder 12 via the electrical linear actuator 6, 7 so as to modify a volume of said dosing chamber 15 and therefore of said product dose PI drawn from the dosing unit 10, 11.

[0089] The method further comprises air suction within the dosing cylinder 12 of the dosing unit 10, 11 to help draw said product dose PI from the reservoir 4 and to retain inside the dosing chamber 15 said dose PI while the dosing unit 10, 11 is moved, in particular during the rotation of the dosing turret 5 and therefore, of dosing unit 10, 11 from the reservoir 4 to the first seat 21 of the transfer turret 2.

[0090] Advantageously, according to a preferred embodiment, the method of the invention comprises, during the step of drawing the dose PI in which the dosing unit 10, 11 is inserted into a product layer P contained in the reservoir 4, moving the piston 13 from the ejection position E to the first internal position D. According to such a preferred embodiment, it is foreseen that the piston 13 moves from the ejecting position E to the first internal position D with a module speed substantially equal but in the opposite direction at a lowering speed of the dosing turret 5 from a raised position B to a lowered position A.

[0091] In an embodiment of the filling method of the invention, after drawing the product dose PI and before moving the piston 13 into the second internal position F, it is possible to remove excess product from the lower opening 12a of the dosing cylinder 12 of the dosing unit 10, 11 to detach excess product P from dose PI.

[0092] Removing excess product from the lower opening 12a of the dosing cylinder 12 of the dosing unit 10, 11 is useful and entails blowing air at and transversely to, this lower opening 12a. Alternatively, removing excess product from the lower opening 12a of the dosing cylinder 12 of the dosing unit 10, 11 entails providing and moving a plate alternately and transversely to the dosing cylinder 12 at the lower opening 12a between a non-interference position with the said lower opening 12a and a closure position with the lower opening 12a. In essence, in the passage between the non-interference position and the closure position, the removal of excess product from the lower opening 12a is carried out.

[0093] The machine and the method of the invention allow to reliably, accurately, and repeatedly fill capsules, caps or similar elements even with products which are difficult to compact and/or compress such as granules, micro-tablets or delayed-action drugs.

[0094] Due to the electrical linear actuators 6, 7 mounted on the dosing turret 4, it is possible to move the piston 13 of each dosing unit 10, 11 regardless of the movement of the dosing turret 5 around and along the rotation axis X.

[0095] The piston 13 can be moved, particularly in the ejection stroke of dose PI from the dosing cylinder 10, 11 into the capsule body 101 with extreme precision, for example controlling the law of motion (speed, acceleration) which can be selected and set in operation, not only for the quantity of product to be dosed (volume of dose P1), but also for the type of product to be dosed, e.g. more or less compacted powder, granules, micro-tablets, delayed-action drugs, etc.

[0096] In addition, the electrical linear actuator 6 allows to rapidly and accurately vary, for example by software, the first internal position D of the piston 13 with respect to the lower opening 12a of the dosing cylinder 12 so as to modify a volume of the dosing chamber 15 and then a volume or amount of the dose PI of the product to be dosed.

[0097] Advantageously, the electrical linear actuator 6 allows to adjust, for example by software, rapidly and accurately, the second internal position F of the piston 13 with respect to the lower opening 12a of the dosing cylinder 12.

[0098] Finally, the electrical linear actuator 6 allows to move, separately and independently of the aforesaid filling machines, piston 13 of the dosing units 10, 11 from the first internal position D to the second internal position F, so as to increase the volume of the dosing chamber 15 and move the product dose PI drawn from the reservoir 4 more within the dosing cylinder 12.

[0099] As previously pointed out, the piston retraction movement 13 inside the dosing cylinder 12 causes drainage by "suction" of the product dose PI within the dosing chamber 15, which allows to move away the peripheral portion of the dose PI from the lower opening 12a of the dosing cylinder 12. In this way, during the rotation of the dosing turret 5 (to align the dosing unit 10, 11 to a first seat 21 of the transfer turret 2), the peripheral portion of the dose PI is completely contained within the dosing cylinder 12 and, adhering to the inner walls of the latter, it can hardly detach itself due to airflows and/or vibrations generated by the movement of the dosing turret 5.

[0100] The above solution is particularly advantageous in the case of products P in the form of granules, micro-tablets, delayed-action drugs which are more difficult to compress within the dosing cylinder 12 and therefore more likely to escape during the displacement of the dosing unit 10, 11 particularly during rotation of the dosing turret 5.

[0101] Due to the use of electrical linear actuators for the pistons 13 of the dosing units 10, 11 and the rotary electric motor 8 for the shift and rotation of the dosing turret 5, the filling machine 1 of the invention, in addition to offering a high performance, has a particularly simple, economical and robust structure and versatile, reliable and safe operation. In particular, the use of the rotary electric motor 8 allows the turret to be moved along its axis of rotation and to rotate the dosing turret 5 between the two operating positions W1, W2 at an angle of about 180°, with an intermittent rotating motion in the opposite directions of rotation, i.e. the dosing turret can be rotated alternately by 180° clockwise and then counter-clockwise. In this way, in the absence of a progressive rotation in a single direction of rotation, there is no need for collectors, or distributors, rotators and / or electric motors with sliding contacts to carry out the pneumatic and / or electrical supply of the devices and / or sensors mounted on the aforementioned dosing turret, thereby simplifying the structure and operation of the filling machine as well as increasing its reliability.

Claims

1. A machine (1) for filling capsules (100) or similar containers with a product comprising a rotating transfer turret (2) arranged to transfer said capsules (100) through adjacent operating stations and provided with seats (21, 22) for housing capsule bodies (101) and capsule caps (102) of said capsules (100), and at least one dosing station (3) arranged to fill said capsule bodies (101) with a product (P) drawn from a reservoir (4) and comprising of a dosing turret (5) rotating around a rotation axis (X) and moving along said axis (X) between a lowered position (A) and a raised position (B), at least one first dosing unit (10) associated with said dosing turret (5), said dosing unit comprising an hallow dosing cylinder (12) having an opening (12a) at a lower end and a piston (13) movable within the dosing cylinder (12) at least between a first internal position (D), in which the piston (13) forms inside said dosing cylinder (12) a dosing chamber (15), between the piston (13) and said opening (12a), for drawing a dose (P1) of product (P) from said reservoir (4) and retaining it, and an ejection position (E) for ejecting said dose (P1) of product (P) out of said dosing cylinder (12) and releasing it into the body (101) of the capsule (100), **characterised by** including a first electrical linear actuator (6) associated to said turret (5) and connected to said first dosing unit (10) and configured to move the piston (13) between said first internal position (D) and said ejection position (E).

2. Machine according to Claim 1, comprising at least one second dosing unit (11) mounted on the dosing turret (5), identical to said first dosing unit (10) and angularly spaced from the axis of rotation (X), in particular distanced by 180°, and at least a second electrical linear actuator (7) connected to said second dosing unit (11) for moving the piston (13) between said first internal position (D) and said ejection position (E).

3. Machine according to any one of the preceding claims, wherein the dosing turret (5) includes a plurality of first dosing units (10) angularly spaced around the axis of rotation (X), the first electrical linear actuator (6) being connected to said plurality of first dosing units (10) and arranged to move the respective pistons (13) of said plurality of first dosing units (10).

4. Machine according to any one of the preceding claims, wherein the first electrical linear actuator (6) comprises a linear electric motor.

5. Machine according to any one of the preceding claims, wherein the first electrical linear actuator (6) comprises a rotary electric motor coupled to a screw-nut drive system.

6. The machine according to any of the preceding claims, wherein said piston (13) is movable from the first electrical linear actuator (6) from the first internal position (D) to a second internal position (F) further away from said opening (12a), said dosage chamber (15) increasing so that the product (P) dose (P) drawn from said reservoir (4) is moved away from the opening (12a).

7. Machine according to any of the preceding claims, comprising an electric actuator (8) preferably a rotary engine for moving the dosing turret (5) along the axis of rotation (X) and rotating the dosing turret (5) around the axis (X), in particular with intermittent rotating motion in the two opposite directions of rotation, between a first operating position (W1), wherein the first dosing unit (10) is suitable for drawing a dose (P1) of product (P) from said reservoir (4), and a second operative position (W2), wherein said first dosing unit (10) is suitable for transferring and releasing said product dose (P1) of product (P) into a capsule body (101) of a capsule (100).

8. Machine according to any one of the preceding claims, comprising air suction means (35) connected to the first dosing unit (10) by means of a duct (36) for sucking air from the inside of the dosing cylinder (12) and for cooperating for drawing and retaining the dose (P1) of product (P) within said dosing chamber (15).

9. Machine according to any one of the preceding claims, wherein said first electrical linear actuator (6) comprises a movable slider directly connected to the first piston (13).

10. Method for filling capsules (100) or similar containers with a powder (P) product, granules, micro-tablets, delayed-action drugs or the like, comprising:

- withdrawing a product (P) dose (P1) from a reservoir (4) by means of a dosing unit (10, 11) comprising ah hallow dosing cylinder (12) with an opening (12a) at one end and a piston (13) movable within the dosing cylinder (12), said piston (13) being arranged in a first internal position (D) to form within said dosing cylinder (12) between the piston (13) and said opening 12 a dosing chamber (15) adapted to receive and retain said product (P) dose (P1);
- moving said dosing unit (10, 11) to a body (101) of a capsule (100) and eject said product dose (P1) out of said dosing cylinder (12) to release said product dose (P1) into said body (101) by moving said piston (13) inside said dosing cylinder (12) to an ejection position (E),

characterised by the fact that the movement of the piston (13) from said first internal position (D) to said ejection position (E) is carried out by means of an electrical linear actuator (6, 7) connected to said dosing unit (10, 11).

11. Method according to claim 10, wherein the piston movement (13) between said first internal position (D) and said ejection position (E) is performed by means of an electric linear motor (6, 7).

12. Method according to claim 10 or 11, wherein after withdrawing the product (P) dose (P1) from the reservoir (4), said piston (13) is further moved from said first internal position (D) to a second internal position (F) farther away from said opening (12a), wherein a volume of said dosage chamber (15) is increased to allow said product dose (P) withdrawn from said reservoir (4) to move away from said opening (12a).

13. Method according to Claim 12, wherein the piston movement (13) between said first internal position (D) and said second internal position (F) is carried out by means of a linear electric motor (6, 7).

14. Method according to any one of claims 10 to 13, comprising sucking air from the inside of the dosing cylinder (12) of the dosing unit (10, 11) to help the withdrawal of said product dose (P1) from the reservoir (4) and to retain within said dosing chamber (15) said product dose (P1) during said moving of the dosing unit (10, 11).

15. Method according to any one of claims 10 to 14, comprising, when drawing a product dose (P1) from a reservoir (4), moving the piston (13) from the ejection position (E) to the first internal position (D).

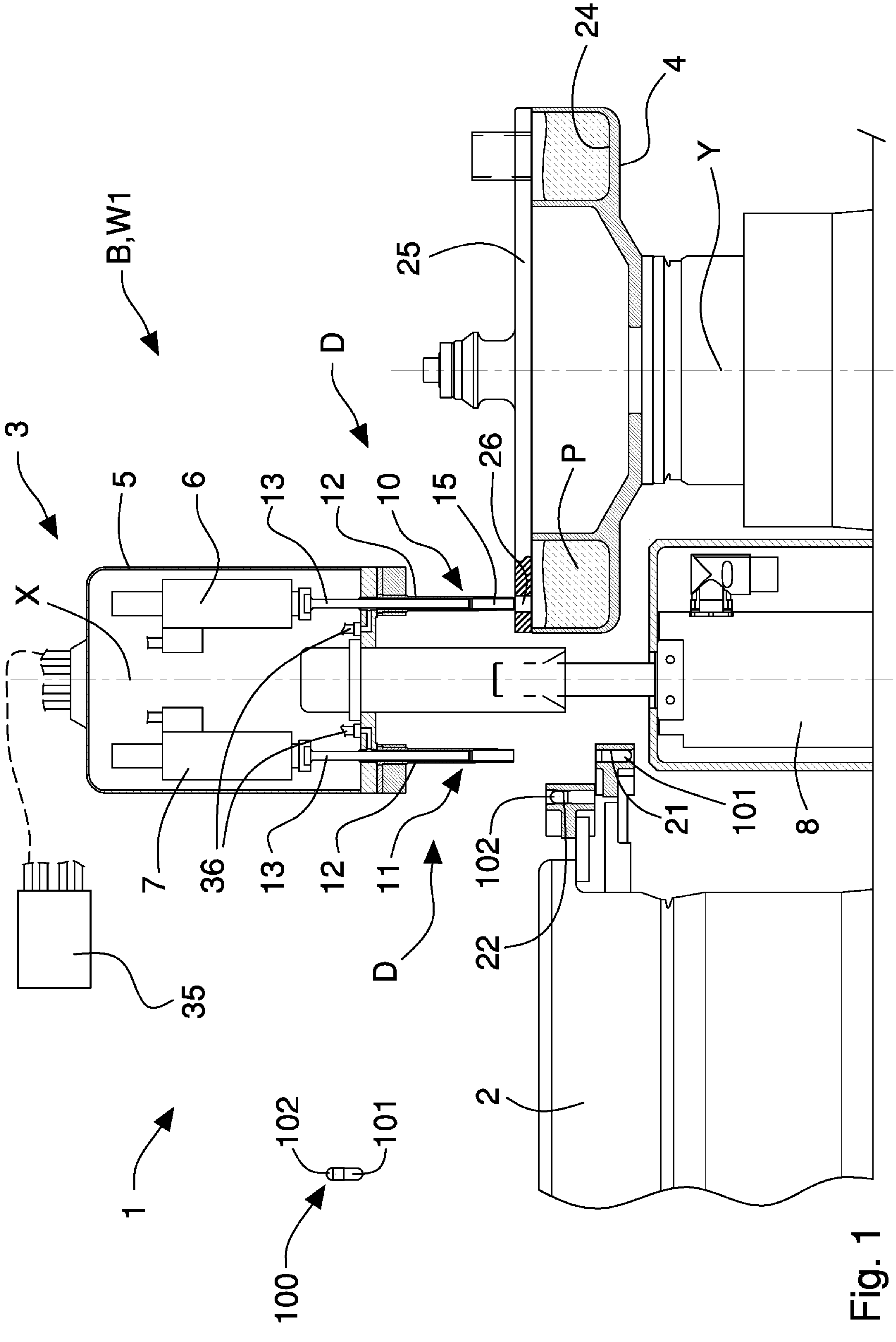


Fig. 1

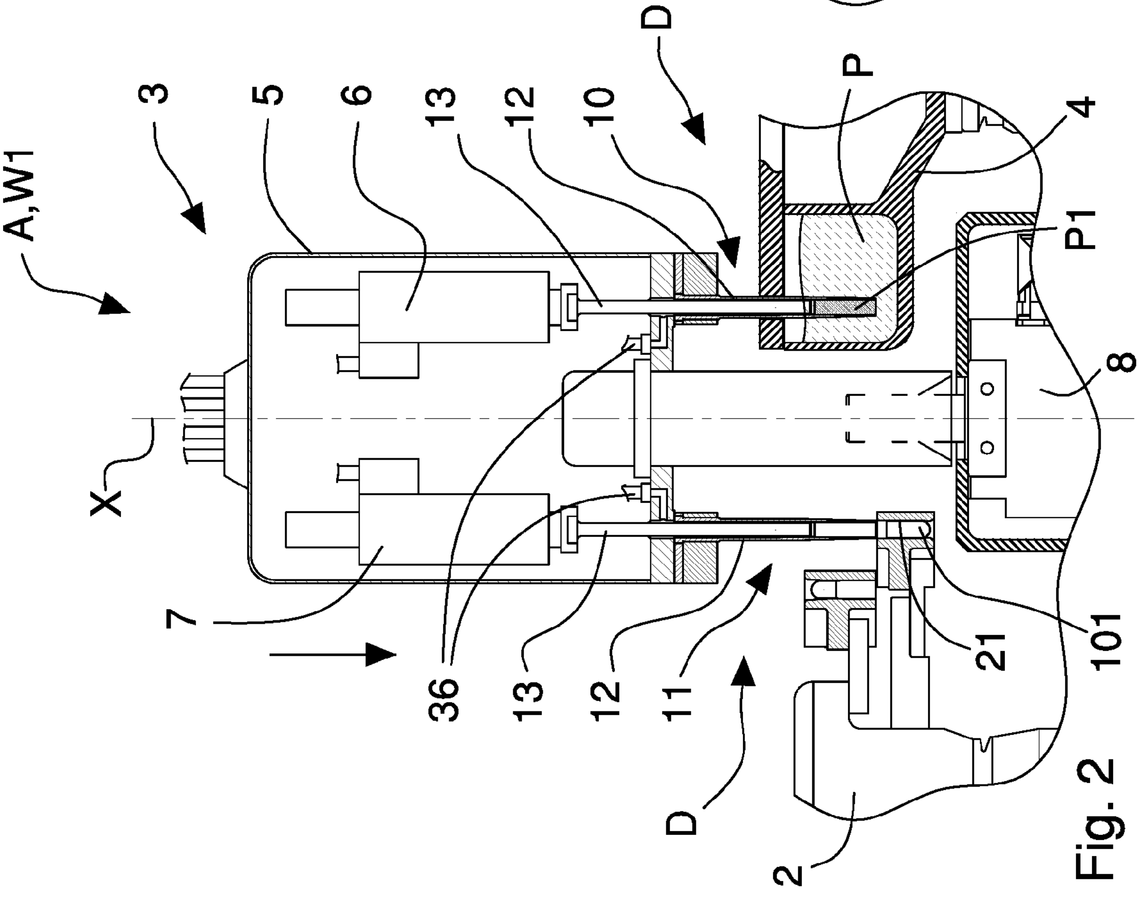
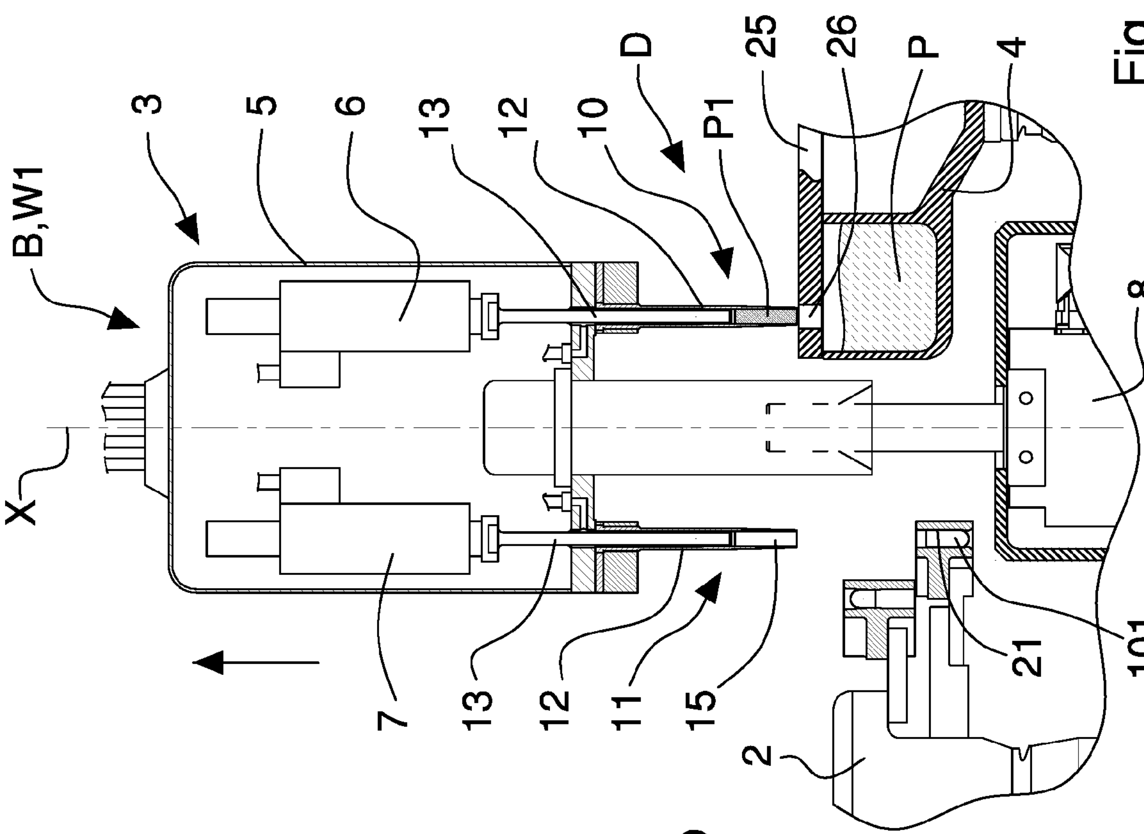

A,W1
X
3
5
6
13
12
10
D
P
4
P1
8
101
21
11
12
13
36
7
D
2

Fig. 2


B,W1
X
3
5
6
13
12
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D
P1
25
26
P
4
8
101
21
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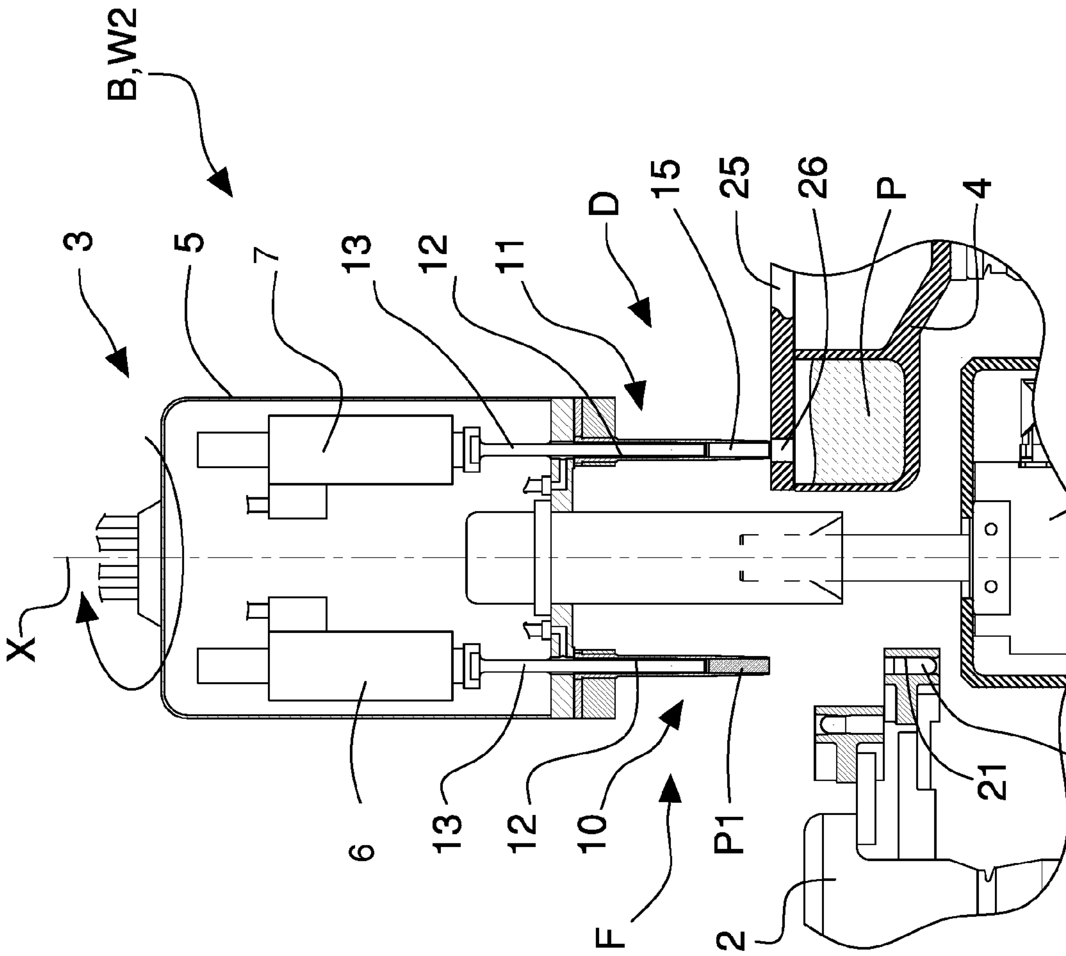
11
12
13
7
2

Fig. 3


B,W2
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7
13
12
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D
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P
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X
8
6
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12
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P1
F
2
21
101

Fig. 5

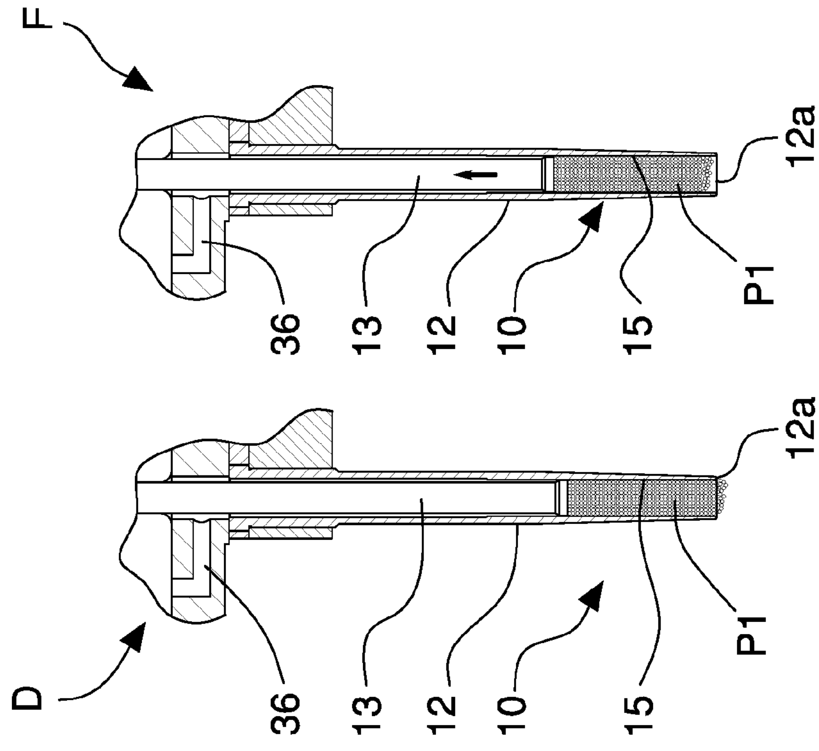
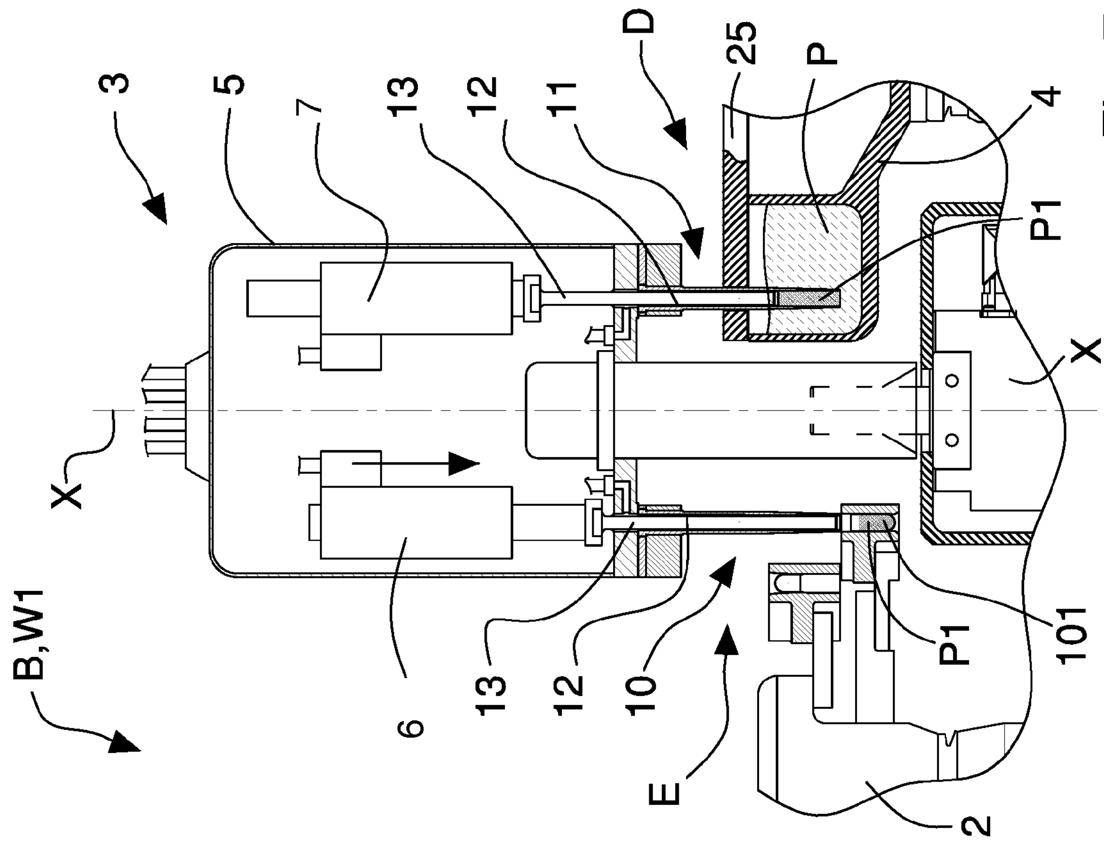

F
36
13
12
10
15
P1
12a
D
36
13
12
10
15
P1
12a

Fig. 4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D
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P
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P1
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B,W1
6
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12
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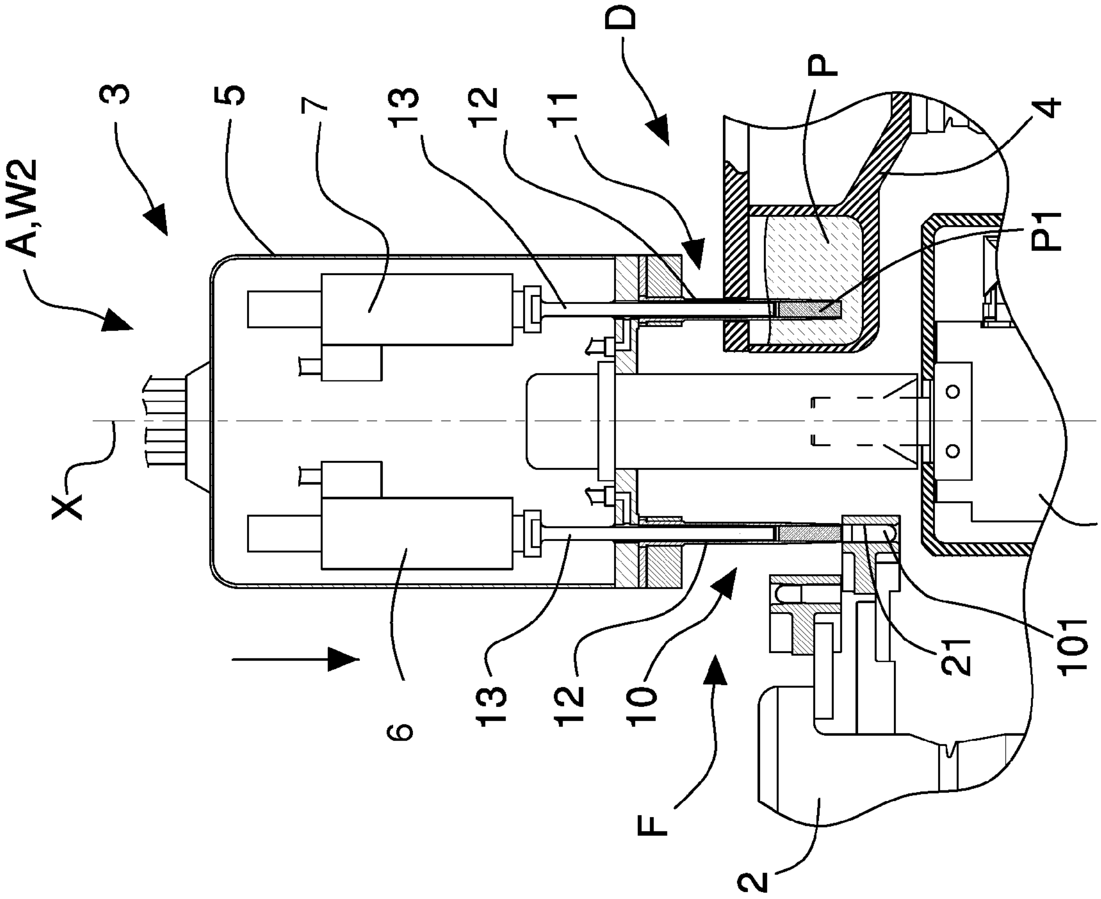
E
2
P1
101

Fig. 7


A,W2
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7
13
12
11
D
P
4
P1
X
8
6
13
12
10
F
2
21
101

Fig. 6

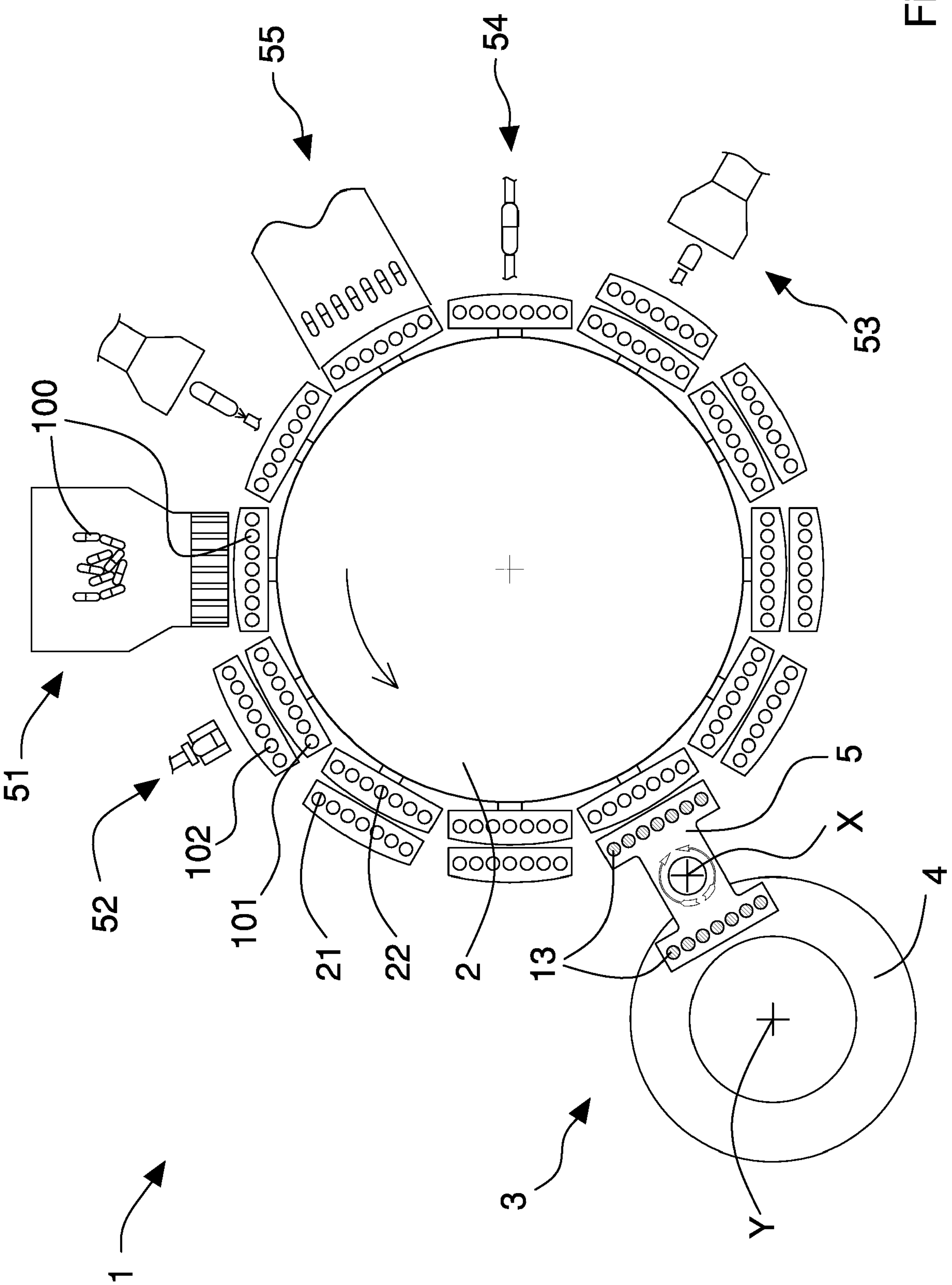

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 17 19 0027

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A61J

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	21 December 2017	Schiffmann, Rudolf

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X : particularly relevant if taken alone
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