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(54) **Multi-layer tablet compressing machine**

(57) The tablet compressing machine compacts one pharmaceutical product (2) at a time in various stages in order to obtain one layer for each product (2) and thereby to produce a multi-layer tablet (3).

The machine comprises:

an annular body (6) with a vertical axis of rotation (Y) and provided with drive means;

hollow bodies (7) carried by the annular body (6) and with their own horizontal and radial longitudinal axis (X) with respect to the axis of rotation (Y);

feed units, one for each product (2), each of which has a container (8) and a hopper (11) for feeding the product (2) to the corresponding container (8), and

two pistons (12 and 13) for each of the hollow bodies (7), adapted to slide into the hollow body (7) by means of drive means in order to form a chamber (34) immediately below the container (8) for each of the feed units, to compact the product (2) in order to obtain one layer for each product (2) and to produce the multi-layer tablet (3) in correspondence with the last of the feed units and then to eject the multi-layer tablet (3) from the hollow body (7).

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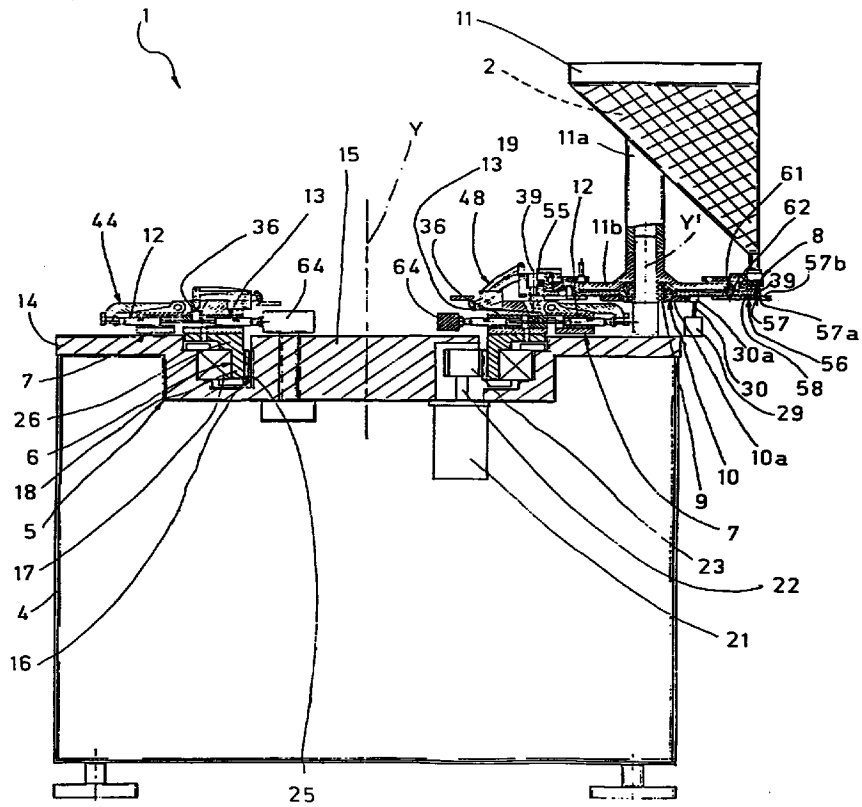


Fig.1

Description

This invention relates to a tablet compressing machine for the production of multi-layer pharmaceutical tablets.

As is known, tablet compressing machines comprise:

a container for a normally pulverulent pharmaceutical product;
a hopper for feeding the pharmaceutical product to the container;
a plurality of hollow bodies with a vertical axis and communicating with the container, and
two vertical pistons movable along respective hollow bodies.

The abovementioned pistons inside the corresponding hollow bodies move in a predetermined sequence firstly in order to create between them a chamber supplied with the pharmaceutical product and then to compact the product in order to obtain a tablet which, once formed, is ejected from the hollow body.

The tablet compressing machine described hereinabove has a few disadvantages.

In particular, a tablet made up of several layers where each layer can relate to a different pharmaceutical product cannot be obtained with this tablet compressing machine. Moreover, the pharmaceutical product passes between the container and the interior of the hollow body by means of a conduit with a substantially horizontal axis and therefore there is no guarantee of continuous and homogeneous feeding. Depending on the properties of the pharmaceutical product, there may be deposits of the product along the internal walls of this conduit, obstructing the passage of the said product. Consequently, given that the dimensions of the chamber determine the quantity of product that is to be compacted, there is no guarantee that this chamber will be completely filled with the product and the actual quantity channelled into this chamber is therefore indeterminate. In the case of a pharmaceutical product, this indeterminateness with respect to the quantity of product making up the tablet is an extremely significant disadvantage. Moreover, the vertical position of the two pistons results in structural complexity of the mechanisms controlling the movement of the said pistons and limits the number of possible layers per tablet.

The aim of this invention is to produce a multi-layer tablet compressing machine which does not have the aforesaid disadvantages and which therefore allows for the production of multi-layer tablets and also allows for correct and efficient channelling of the pharmaceutical product towards the compaction zone so as to determine with high precision the quantity of product to make up the layer of the tablet.

According to this invention, a multi-layer tablet compressing machine of the type adapted to compact one

pharmaceutical product at a time in various stages in order to obtain one layer for each product and thereby to produce a multi-layer tablet is characterised in that it comprises:

an annular body with a vertical axis of rotation;
drive means for the said annular body;
a plurality of hollow bodies carried by the said annular body and having their own horizontal and radial longitudinal axis with respect to the said axis of rotation;
a plurality of feed units, one for each pharmaceutical product, each of which has a container and a corresponding hopper for feeding the said product to the corresponding said container, and
two respective external and internal pistons for each of the said hollow bodies, coaxial with one another and with the said longitudinal axis of the corresponding said hollow body, the said pistons being adapted to slide into the corresponding said hollow body by means of corresponding first and second drive means in order to form a chamber immediately below the said container for each of the said feed units, to compact the said product in order to obtain one layer for each product and to produce the said multi-layer tablet in correspondence with the last of the said feed units and then to eject the said multi-layer tablet from the said hollow body.

The invention will now be described with reference to the accompanying drawings given purely by way of non-limiting examples and in which:

Figure 1 is a part side view and part sectional view of a first embodiment of a tablet compressing machine;

Figure 2 is a plan view of the machine of Figure 1, with parts broken away for the sake of clarity;

Figure 3 is a plan view of a component of the machine of Figure 1;

Figures 4 to 7 show one operating cycle of elements of the machine of Figure 1;

Figure 8 is a perspective view of a tablet;

Figure 9 is a part side view and part sectional view of a second embodiment of a tablet compressing machine;

Figure 10 is a plan view of the machine of Figure 9, with parts broken away for the sake of clarity, and Figures 11 to 14 show one operating cycle of elements of the machine of Figure 9.

In Figures 1 and 2, the reference numeral 1 designates in its entirety a tablet compressing machine which compacts various pharmaceutical products 2 in order to obtain multi-layer tablets 3 (Figure 8) in which each layer relates to one of the said pharmaceutical products 2.

The machine 1 comprises:

a fixed frame 4 resting on a floor;
 a fixed disc 5 defined on a horizontal plane and integral with the frame 4;
 an annular body 6 rotating in the direction of the arrow R about a vertical axis Y passing through the centre of the fixed disc 5;
 drive means for the annular body 6;
 a plurality of hollow bodies 7 carried by the annular body 6 and having their own horizontal and radial longitudinal axis X with respect to the axis Y;
 a plurality of feed units each of which is provided with an annular container 8 rotating in the direction of the arrow R' about a respective vertical axis Y' and a fixed hopper 11 adapted to feed the product 2 to a corresponding container 8, and
 two respective external and internal pistons 12 and 13 for each hollow body 7, coaxial with one another and with the axis X of the corresponding hollow body 7.

The machine 1 moreover comprises a plurality of first cams acting on the external piston 12 for the movement of the latter and a plurality of second cams acting on the internal piston 13 for the movement of the latter, the first cams being supported by an external ring gear 14 of the disc 5 and the second cams being supported by an internal ring gear 15 of the disc 5.

Referring to Figure 1, the disc 5 between the ring gears 14 and 15 is provided on its upper surface with an annular recess 16 inside which a lower portion 18 of the annular body 6 is housed by means of a bearing 17. The said drive means comprise an electric motor 21 the casing of which is supported by the lower surface of the disc 5 inside the frame 4. A drive shaft 23 with a vertical axis extends from the motor 21 into the recess 16 via a hole 22 formed in the disc 5, a gear wheel 24 being connected to the said drive shaft. Toothing 25 meshing with the gear wheel 24 is formed on the internal surface of the portion 18 of the body 6. The annular body 6 has an upper annular portion 26 which extends towards the top outside the recess 16 and supports the said hollow bodies 7 with uniform distribution.

Referring to Figures 4 to 7, each hollow body 7 has a through hole 31 with an axis X inside which a cylinder 32 is housed in a substantially central position. Coaxially with the axis X, the cylinder 32 has a through hole 33 in the interior of which the phase for preparing a chamber 34 (Figure 4), the phase for feeding the pharmaceutical product 2 into the chamber 34 and the phase for compacting this product 2 in order to obtain one layer of the tablet 3 are carried out in succession for each feed unit, as will be seen more clearly hereinafter.

Referring to Figures 1 and 2, each hopper 11 is supported by a fixed column 11a coaxial with the corresponding axis Y'. The column 11a is provided with an annular flange 11b which supports the corresponding

container 8 rotating about the said axis Y'. At a lower level than that of the flange 11b, the column 11a supports a disc 10 rotating about the axis Y' by means of the bearings 9. This disc 10 has a plurality of vertical through holes 19 along its external ring gear.

The machine 1 is provided with drive means for the disc 10 comprising an electric motor 29 to the drive shaft 30 of which a gear wheel 30a meshing with a toothed portion 10a of the disc 10 is connected.

Referring to Figures 1, 2 and 3, the container 8 is defined by two annular walls and by a bottom wall from which the feeding elements extend towards the bottom, each of which is defined by a conduit 39 meshing with a corresponding hole 19 in the disc 10. As a result of this meshing of the conduits 39 in the holes 19, the rotation of the disc 10 therefore involves equal rotation of the container 8. The circumference defined by all of the longitudinal axes of the holes 19 is tangential to the circumference defined by all of the longitudinal axes of a plurality of openings 36 each of which is formed in the upper part of each hollow body 7.

During the rotation of the container 8, each conduit 39 communicates for a certain period of time with the chamber 34 of a hollow body 7 situated substantially therebelow via the said opening 36 and via a hole 37 formed in each cylinder 32. An opening 38 is moreover formed in each hollow body 7 beside the cylinder 32, via which the tablet 3 drops towards the bottom (Figure 7).

Referring to Figures 4 to 7, the pistons 12 and 13 have respective heads 41, central portions 42 and end portions 43 with a smaller diameter than that of the portions 42. The end portions 43 of the two pistons 12 and 13 are adapted to slide relative to one another along the hole 33 in the cylinder 32. The heads 41 of the pistons 12 and 13 are on opposite sides outside the hole 31 of the hollow body 7. Each hollow body 7 supports an inverted L-shaped lever 44 on its upper surface in correspondence with the zone for housing the piston 13. In particular, the lever 44 comprises a substantially horizontal portion 45 the free end of which is hinged on to a rib 46 extending towards the top from the hollow body 7 and a substantially vertical portion 47 extending towards the bottom.

Referring to Figures 4 to 7, each hollow body 7 supports a lever mechanism 48 of the type with an articulated quadrilateral acting on the opposite side to the lever 44. The lever mechanism 48 comprises a fixed block 49 integral with the hollow body 7, a first lever 50 hinged via a first longitudinal end on to an upper section of a pin 52 and via a second longitudinal end on to the block 49, and a second lever 51 substantially parallel to the lever 50 hinged via a first longitudinal end on to the upper section of the pin 52 and via a central section on to the block 49, the said second lever 51 having a second longitudinal end which supports a roller 53. The pin 52 is adapted to be outside the opening 36 during the feeding phase and during the phase for ejecting the multi-layer tablet 3 and is adapted to enter the opening

36 at a predetermined moment in time in order to help the product 2 fed in to drop towards the bottom via the opening 36. In the compaction phase, the pin 52 then enters the interior of the hole 37 via the opening 36 in order to form a wall part of the chamber 34 via its shaped point 52a. A series of cams 54 move the pin 52 as just described by means of contact with the roller 53.

Referring to Figures 1, 3 and 4, the flange 11b supports a fixed wall 55 which extends from the top to the bottom inside the container 8. This fixed wall 55 delimits an area of the container 8 in which there is no product 2 except in the conduit 39. In principle, during the rotation of the container 8, the product 2 is diverted, thereby leaving a zone of the container 8 below the wall 55 free of product 2.

Referring to Figure 1, the disc 10 for each hole 19 comprises a device 56 installed below the disc 10 and adapted to open or close the corresponding hole 19. The device 56 comprises a block 57 having a flat part 57a and beside it a vertical through hole 57b. The device 56 moreover comprises a horizontal pin 58 which supports the block 57 and which is movable by means of its vertical appendix 61 along a track 62 formed on the lower surface of the flange 11b from a position in which the flat part 57a closes the hole 19 and a position in which the hole 57b is coaxial with the hole 19 for a predetermined period of time.

During use, the cycle for the production of the tablet 3 (Figure 8) by the pair of pistons 12 and 13 of each hollow body 7 consists of:

- a phase for dropping a first product 2 into the chamber 34;
- a phase for the initial compaction of the first product 2 present in the chamber 34;
- a main compaction phase in order to obtain one layer of the said first product 2;
- a phase for dropping a second product 2 into the chamber 34;
- a phase for the initial compaction of the second product 2 present in the chamber 34 against the layer already formed;
- a main compaction phase in order to obtain one layer of the said second product 34, joining this layer to the layer already formed, and
- once all of the layers have been formed and therefore the tablet 3 has been defined, a phase for ejecting the tablet 3 from the hollow body 7 via the opening 38.

The initial compaction and main compaction phases and therefore the phases for forming the layers are carried out in the section of the hole 33 situated between the chamber 34 and the opening 38. In the phase for dropping the product 2 into the chamber 34, the conduit 39 from which the product 2 is supposed to drop is situated in the space below the fixed wall 55 and therefore contains none of the product 2, the internal

dimensions of the conduit 39 thereby defining the quantity of product 2 fed in. During the dropping phase, and exclusively during this phase, the hole 57b is coaxial with the conduit 39 and the opening 36 so that the product 2 drops directly into the chamber 34. Immediately after the phase for dropping the product 2, the lever mechanism 48 comes into action, first performing the function of helping the product 2 to slide towards the chamber 34 by means of the pin 52 and then the function of delimiting the chamber 34 from above. Once the chamber 34 has been closed from above, while the piston 12 remains idle with the free end of the portion 43 inside the said section of the hole 33, the piston 13 is moved towards the piston 12 before a reduced stroke in order to carry out the precompaction phase which allows the particles of the pharmaceutical product 2 present in the chamber 34 to be forced together and then a subsequent stroke in order to carry out the main compaction phase which determines the formation of the layer.

While the piston 13 is being retracted from the chamber 34 and the lever mechanism 48 carries the pin 52 above the hollow body 7, this hollow body 7 rotating about the axis Y is then brought below a second feed unit in correspondence with which a second layer of a different product 2 is formed. Once the tablet 3 has been formed, the piston 12 is displaced via the free end of its portion 43 towards the opening 38 and the piston 13 is advanced towards the opening 38 so that the tablet 3 drops towards the bottom via this opening 38.

Several portions of pharmaceutical products 2 are fed in for each complete revolution (360°) of the annular body 6 (five portions in the machine 1 shown) so as to define a tablet 3 with several layers and to eject the tablet 3. A first group of cams 64 controlling the movement of the piston 13 and a second group of cams 54 controlling the movement of the lever mechanism 48 are associated with each feed unit to this end. In the phases for dropping the product 2 into the chamber 34 and in the initial compaction and main compaction phases, the lever 44 is disposed with the portion 47 as shown in Figures 4, 5 and 6, where the portion 47 bears against the head 41 of the piston 12. The phase for ejecting the tablet 3 takes place between the last and the first feed unit and, to this end, in this zone, the external ring gear 14 of the disc 5 supports a cam 65 which performs the function of raising the portion 47 of the lever 44 and moving the piston 12 towards the exterior and, in particular, bringing the free end of the portion 43 into correspondence with the opening 38.

Referring to Figures 9 and 10, the reference numeral 101 designates in its entirety a tablet compressing machine which differs from the machine 1 by only a few features, as a result of which those parts of the machine 101 also found in the machine 1 are designated by the same reference numerals. In particular, the machine 101 is provided with feed units differing from those installed in the machine 1, for which reason the

machine 101 does not have any lever mechanisms 48. The feed unit of the machine 101 comprises a fixed hopper 102 and an annular container 103 rotating in the direction of the arrow R' about a vertical axis Y', the hopper 102 feeding the product 2 to the container 103 situated therebelow. The feed unit of the machine 101 moreover comprises a plurality of feeding elements 104 each of which is carried by a corresponding hollow body 7. Each feeding element 104 comprises a sleeve 105 with a vertical axis and a coaxial piston 106 installed within the sleeve 105. Each hollow body 7 supports a block 108 by means of a vertical pin 107 with a longitudinal axis Y'', the said block carrying the upper end of the sleeve 105 and being movable along the axis Y''. In this manner, the sleeve 105 is movable along its longitudinal axis. The block 108 in turn supports a second block 112 by means of a sprung vertical pin 111, the said block carrying the upper end of the piston 106 and being movable along the longitudinal axis of the pin 111. In this manner, the piston 106 is movable along its longitudinal axis independently of the sleeve 105. The movement of the blocks 108 and 112 is controlled by two fixed cams 113. During use during the rotation of the container 103, while one hollow body 7 moves towards this container 103, the entire feeding element 104 (sleeve 105 and piston 106) is raised to a level higher than that of the upper edge of the container 103. As soon as the said hollow body 7 is below the area of the container 103 described, the entire feeding element is lowered within the container 103 in order to remove a predetermined quantity of product 2 and immediately after this removal, it is raised so that the hollow body 7 can be discharged freely from the area of the container 103 described. During the course from one container 103 to the next inside the hollow body 7, the phases for forming the layer are carried out in the same manner as that described for the machine 1, as illustrated in Figures 11 to 14. The product 2 is removed from the container 103 by displacing the piston 106 towards the bottom to a predetermined level and by displacing the sleeve 105 towards the bottom to a level lower than that of the lower end of the piston 106 so as to create a chamber filled with product 2 inside the sleeve 105. The piston 106 is then displaced towards the bottom over a reduced stroke so as to carry out reduced compaction of the product 2 inside the sleeve 105 in order to prevent the product 2 from being discharged from the sleeve 105 during the ascent of the feeding element 104.

In an analogous manner to the machine 1, in order to carry out the phase for dropping the product 2 into the chamber 34, in the machine 101, the feeding element 104 is first displaced towards the bottom coaxially with the opening 36 and then only the piston 106 is displaced towards the bottom so as to discharge the product 2 from the sleeve 105 and press it towards the chamber 34. The piston 106 is then displaced towards the bottom again in order to delimit the chamber 34 from above.

It will be clear that the hollow bodies 7 can be

grouped together in several sectors in order to facilitate assembly and disassembly thereof. In principle, sectors can be produced in which several hollow bodies 7 are formed, wherein these sectors can be removed in a simple manner for correct and rapid maintenance of the machine 1, 101.

The advantages obtained as a result of this invention will be clear from the above description.

In particular, in the machine 1, 101, multi-layer tablets are produced using one pharmaceutical product for each layer. The chambers 34 are moreover fed with a vertical stroke of reduced length, thereby resulting in correct and efficient feeding without the risk of deposits of the product 2 along the walls delimiting the said stroke. In principle, the machine 1, 101 gives a better guarantee that the chamber 34 will be completely filled with the product 2 and that there will therefore be greater precision in the quantity of product 2 fed in from layer to layer. The horizontal arrangement of the pistons 12 and 13 therefore allows for simplification of the construction and assembly of the cams controlling the stroke of the said pistons 12 and 13 and also makes it possible to produce tablets with a large number of layers.

Claims

1. Multi-layer tablet compressing machine of the type adapted to compact one pharmaceutical product (2) at a time in various stages in order to obtain one layer for each product (2) and thereby to produce a multi-layer tablet (3), characterized in that it comprises:

an annular body (6) with a vertical axis of rotation (Y);
 drive means for the said annular body (6);
 a plurality of hollow bodies (7) carried by the said annular body (6) and having their own horizontal and radial longitudinal axis (X) with respect to the said axis of rotation (Y);
 a plurality of feed units, one for each pharmaceutical product (2), each of which has a container (8, 103) and a corresponding hopper (11, 102) for feeding the said product (2) to the corresponding said container (8, 103), and two respective external and internal pistons (12 and 13) for each of the said hollow bodies (7), coaxial with one another and with the said longitudinal axis (X) of the corresponding said hollow body (7), the said pistons (12 and 13) being adapted to slide into the corresponding said hollow body (7) by means of corresponding first and second drive means in order to form a chamber (34) immediately below the said container (8, 103) for each of the said feed units, to compact the said product (2) in order to obtain one layer for each product (2) and to produce

the said multi-layer tablet (3) in correspondence with the last of the said feed units and then to eject the said multi-layer tablet (3) from the said hollow body (7).

2. Machine according to claim 1, characterised in that it comprises a fixed disc (5) having an external ring gear (14) supporting the said drive means responsible for the axial movement of the said external piston (12) and an internal ring gear (15) supporting the said second drive means responsible for the axial movement of the said internal piston (13).

3. Machine according to claim 2, characterised in that the said fixed disc (5) is provided on its upper surface with an annular recess (16) for housing a lower annular portion (18) of the said annular body (6).

4. Machine according to claim 3, characterised in that the said drive means comprise an electric motor (21) the casing of which is supported by the lower surface of the said disc (5) and from which a drive shaft (23) having a vertical axis extends inside the said recess (16), a gear wheel (24) meshing with a toothed face (25) of the said lower portion (18) of the said annular body (6) being connected to the said drive shaft.

5. Machine according to claim 3, characterised in that the said annular body (6) has an upper annular portion (26) which extends towards the top outside the said recess (16) and supports the said hollow bodies (7) with uniform distribution.

6. Machine according to at least one of the preceding claims, characterised in that each of the said hollow bodies (7) has:

a first through hole (31) coaxial with the said longitudinal axis (X) for housing a cylinder (32) having a second through hole (33) in the interior of which the said chamber (34) is prepared, the said pharmaceutical product (2) is fed into the said chamber (34) and the said product (2) is compacted;

a first opening (36) communicating towards the top with the said container (8, 103) situated thereabove and towards the bottom with the said second hole (33) via a third hole (37) formed in the said cylinder (32), and

a second opening (38) formed beside the said cylinder (32) and via which the said multi-layer tablet (3) is ejected towards the bottom.

7. Machine according to claim 6, characterised in that the said pistons (12 and 13) have respective heads (41), central portions (42) and end portions (43), the said end portions (43) of the two pistons (12

and 13) being adapted to slide relative to one another along the said second hole (33) in the said cylinder (32) and the said heads (41) of the said pistons (12 and 13) being situated on opposite sides outside the said first hole (31) in the said hollow body (7).

8. Machine according to claim 6, characterised in that the said container (8, 103) rotates about a second axis of rotation (Y').

9. Machine according to claim 8, characterised in that each of the said feed units comprises a feeding element (39, 104) adapted to remove a predetermined quantity of the said product (2) from the said container (8, 103) and to feed the said quantity into the said chamber (34).

10. Machine according to claim 9, characterised in the said feeding element comprises a conduit (39) originating from a bottom wall of the said container (8) and filled with the said predetermined quantity of the said product (2), the said conduit (39) communicating with the said chamber (34) situated therebelow for a predetermined period of time.

11. Machine according to claim 10, characterised in that the said hollow body (7) comprises a lever mechanism (48) having a pin (52) which presses the said product (2) fed in towards the said chamber (34) and delimits the said chamber (34) from above.

12. Machine according to claim 9, characterised in that one said feeding element (104) is associated with each of the said hollow bodies (7), comprising:

a vertical sleeve (105) axially movable to enter into and exit from the said container (103);

a vertical piston (106) movable axially within the said sleeve (105);

drive means for the said sleeve (105), and drive means for the said vertical piston (106), the said product (2) being removed from the said container (103) by means of displacement of the said vertical piston (106) towards the bottom to a predetermined level and by means of displacement of the said sleeve (105) towards the bottom to a level lower than that of the lower end of the said vertical piston (106) so as to create a space in the interior of the said sleeve (105) which is filled with product (2),

the said product (2) being fed into the said chamber (34) by first bringing the said feeding element (104) back up out of the said container (103) and then displacing the said feeding element (104) towards the said chamber (34) together with the said vertical piston (106) which executes a longer stroke in order to dis-

charge the product (2) from the said sleeve (105) and to delimit the said chamber (34) from above.

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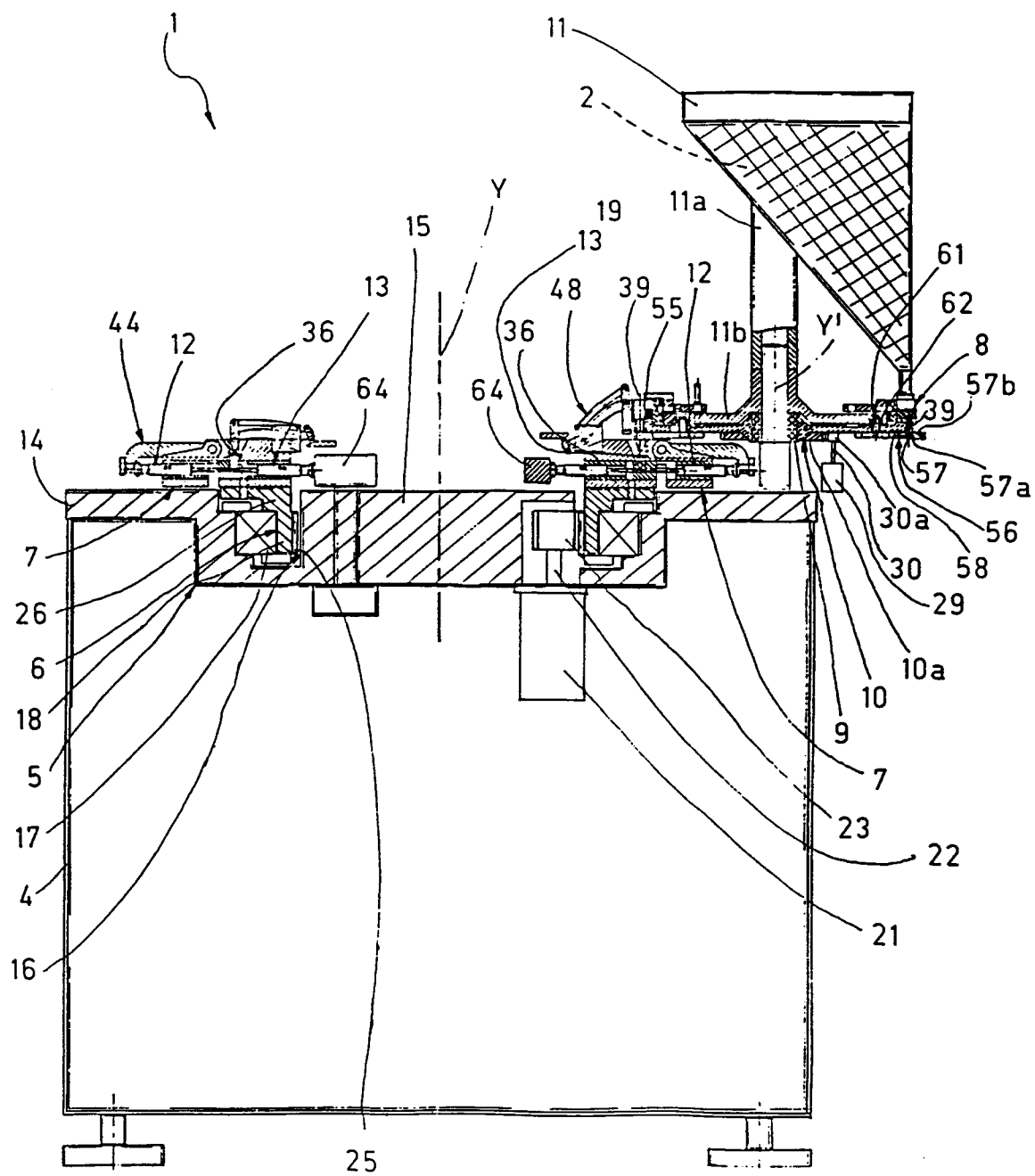


Fig.1

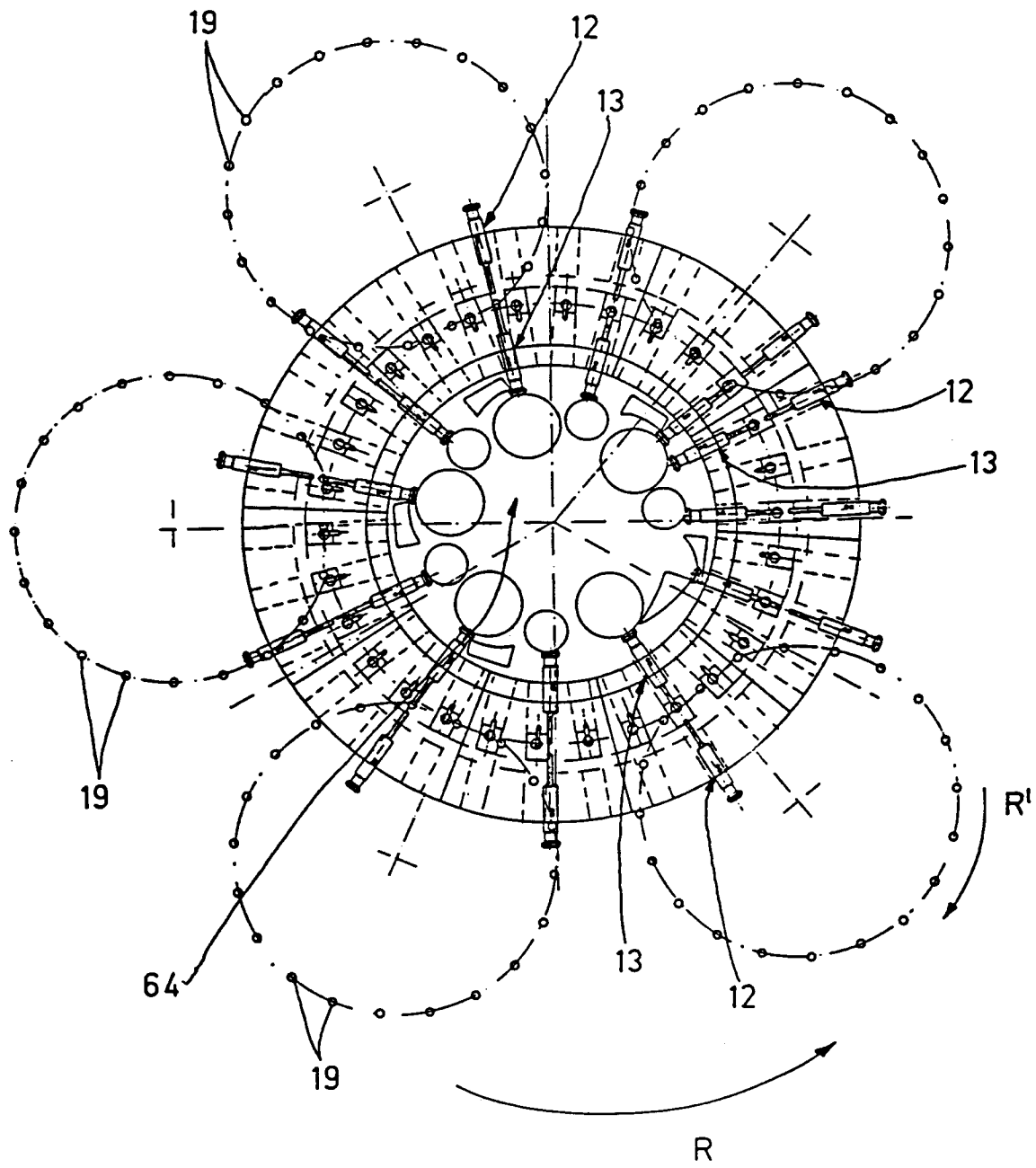


Fig.2

Fig. 3

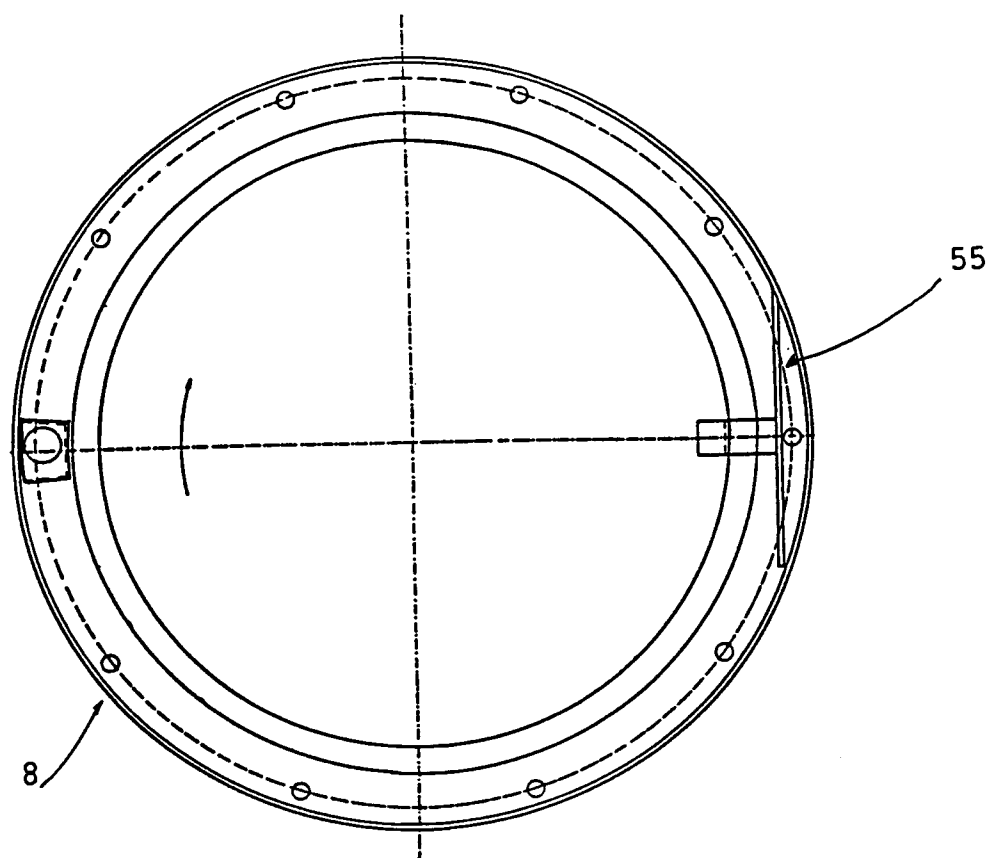
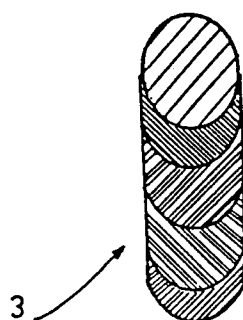
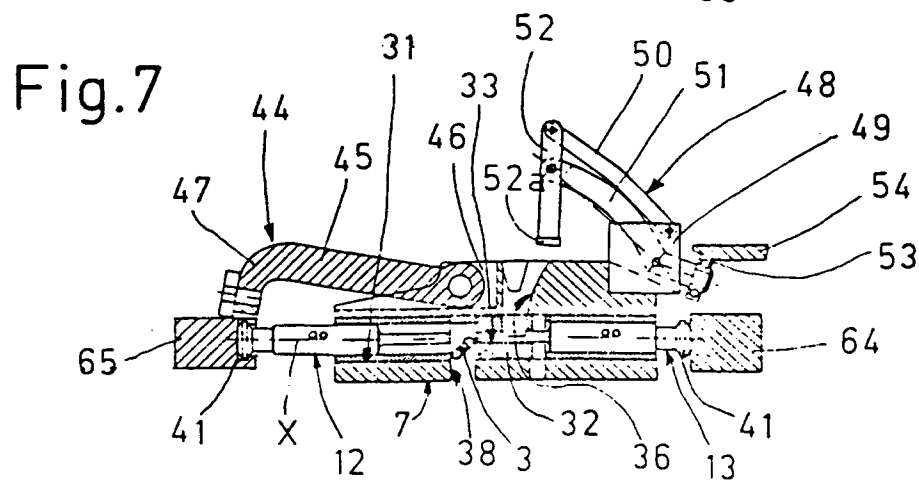
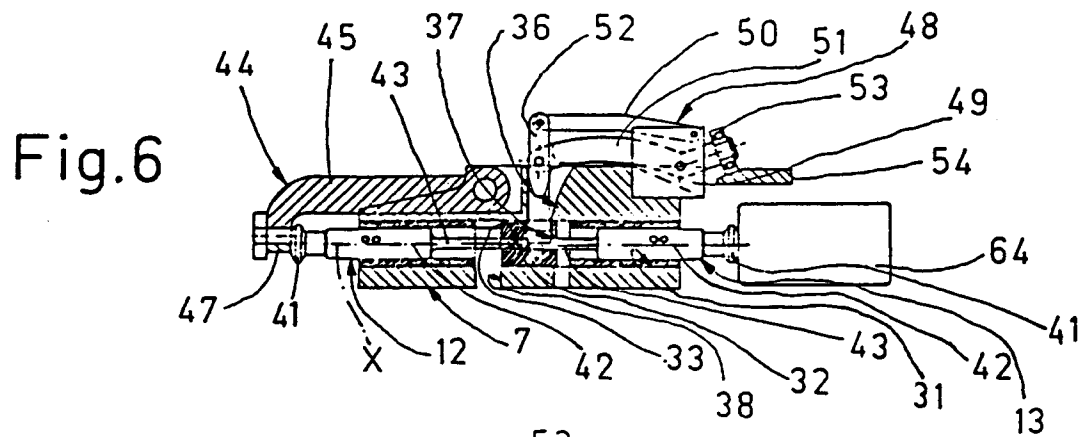
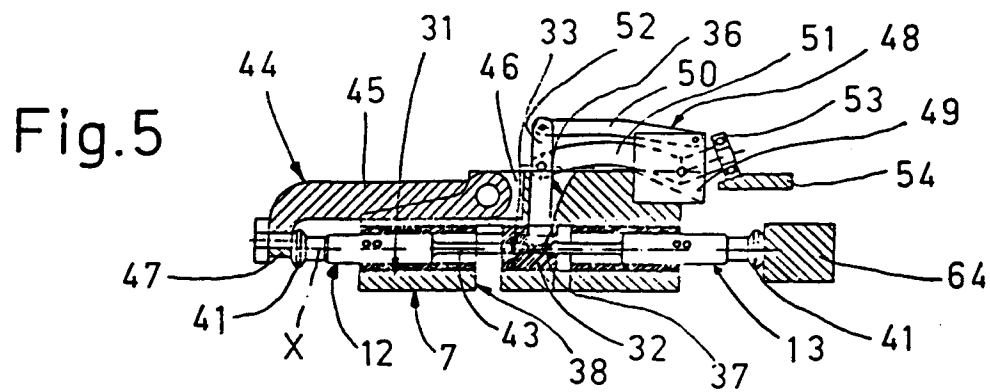
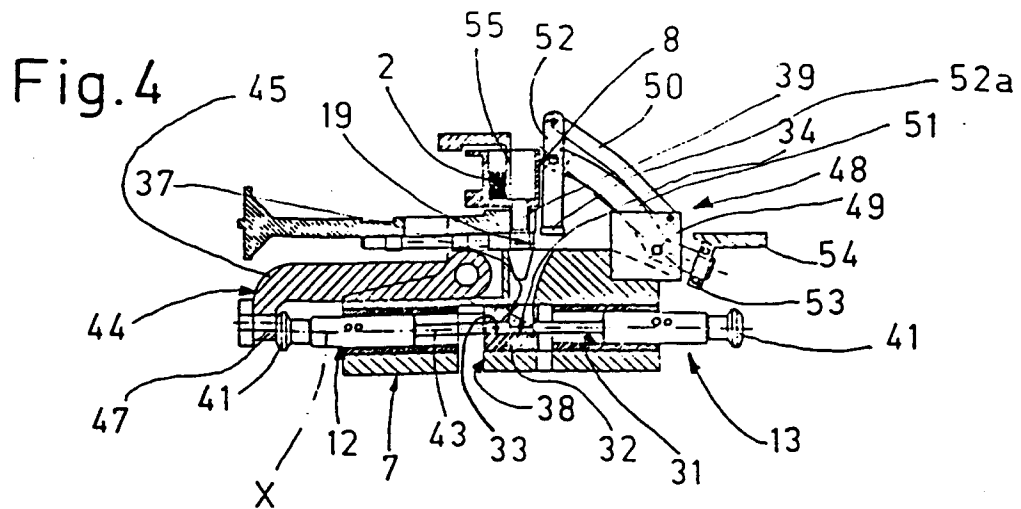


Fig. 8





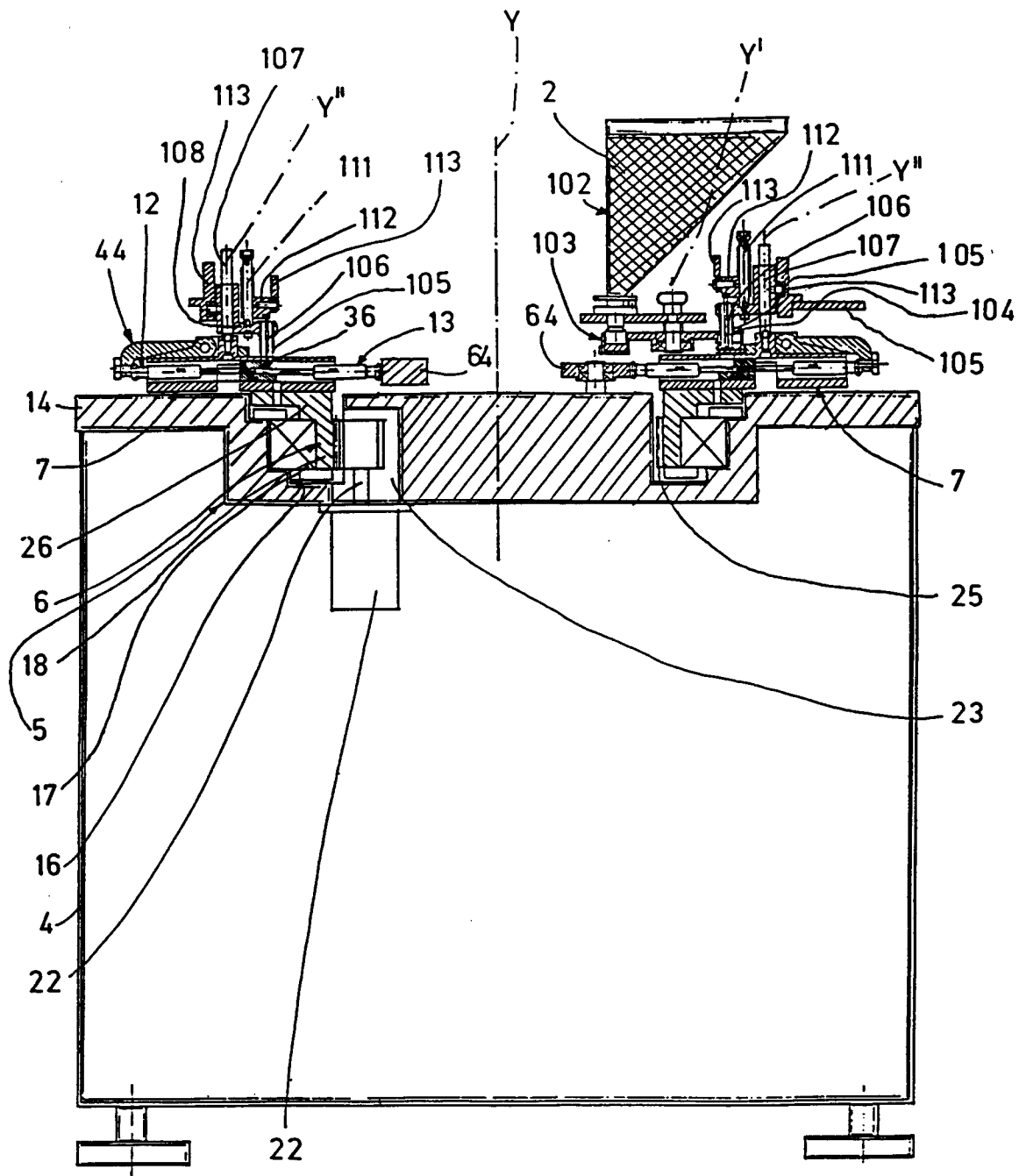


Fig.9

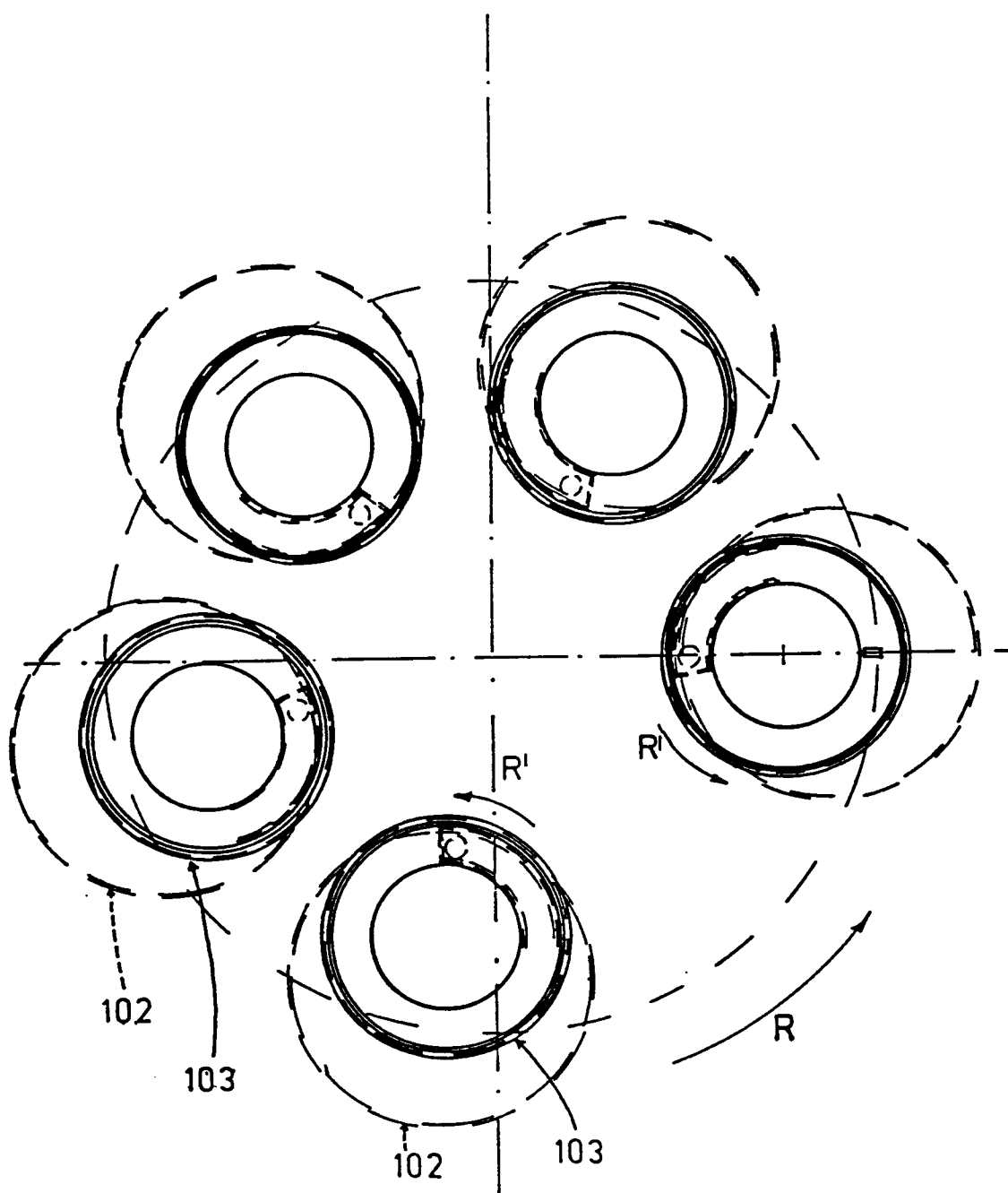


Fig.10

Fig.11

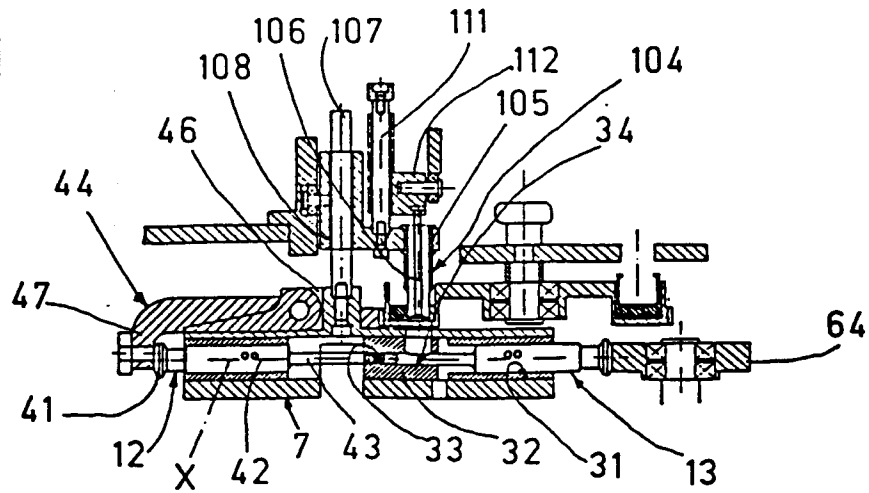


Fig.12

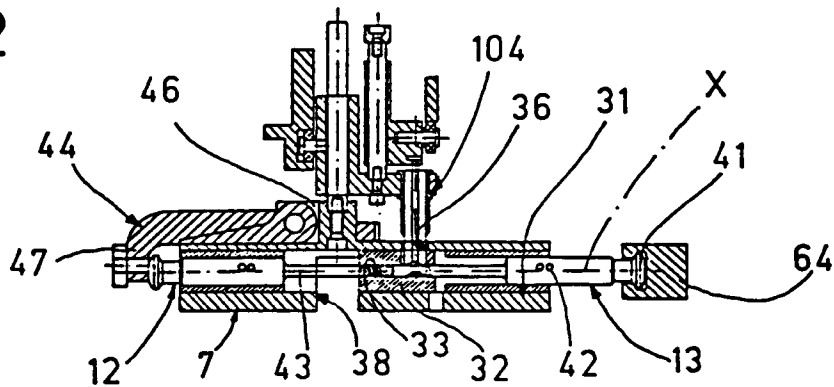


Fig.13

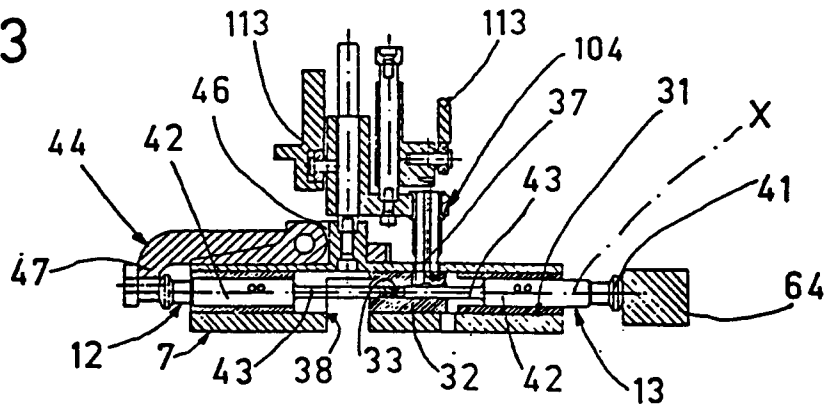
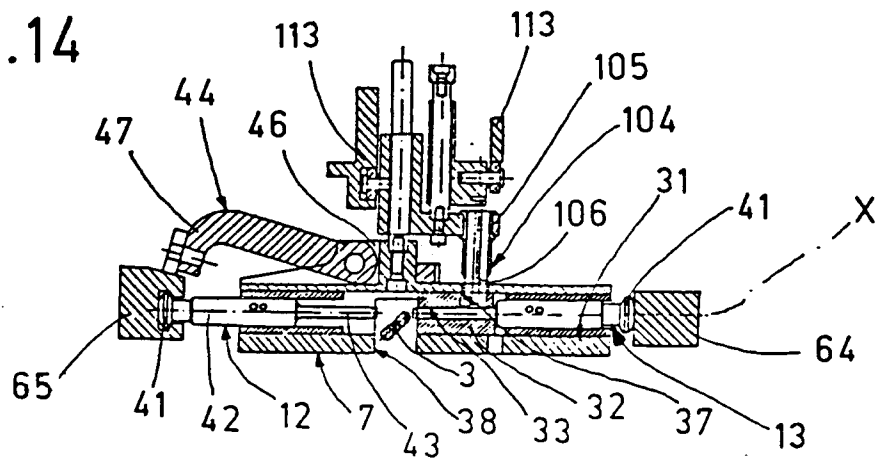


Fig.14





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 10 6369

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	DE 295 20 473 U (KOCH RUDOLF) 28 March 1996 * claims; figures * ---	1-12	B30B11/12 B30B15/30
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A	WO 96 35566 A (FUISZ TECHNOLOGIES LTD) 14 November 1996 * abstract; figures * -----	1,12	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 13 July 1998	Examiner Belibel, C
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

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