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(54) **APPARATUS FOR FILLING CONTAINERS WITH A POWDERED MATERIAL**

VORRICHTUNG ZUM FÜLLEN VON BEHÄLTERN MIT EINEM PULVERFÖRMIGEN MATERIAL

APPAREIL DE REMPLISSAGE DE CONTENANTS AVEC UN MATÉRIAU PULVÉRULENT

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## Description

### Technical field

**[0001]** The present invention relates to an apparatus for filling containers with a powdered material.

### Prior art

**[0002]** The need to fill and close containers, such as bottles, vials, syringes, etc., with measured quantities of a filling material has long been known.

**[0003]** In the event that the containers are intended for use in technical sectors such as, for example, the chemical, pharmaceutical or biotechnology sector, high precision requirements relating to the volume of material to be inserted in each container is often required. In addition, it is often necessary to ensure the maintenance of predetermined conditions of working environment in order to avoid any contamination of the filling material and also to ensure the safety of operators.

**[0004]** Therefore, apparatuses have been developed that allow the filling of containers with measured quantities of a material and the closure of these containers in a controlled work environment.

**[0005]** A known type of apparatuses comprises a collecting station at which the containers to be filled are transported and a filling station comprising dispensing means. A capping station, is arranged downstream of the filling station, provided with a device for capping the containers, and a possible crimp capping station following the capping station.

**[0006]** Patent EP 1 390 261 describes an apparatus for filling and closing containers with a powdered material comprising means of transport, which define a path for the containers extending on a substantially horizontal plane, and a series of operating stations arranged along the way. The operating stations comprise a first weighing station, a pair of consecutive filling stations and a following second weighing station. Downstream of said station, a pair of capping stations are provided. Each filling station consists of a dosing disk, connected to a hopper for feeding the powdered material by means of a feeding device. Each dosing disc is arranged in a position overlying the path and is rotated in an intermittent manner by actuator means. The dosing disc comprises a plurality of radial channels within which relative pistons are arranged. A dosing chamber is defined in each channel to receive the powdered material to be inserted into a container. EP 3295920 A1 also discloses an apparatus according to preamble of claim 1.

**[0007]** A widespread problem in the sector relating to the container filling phase is the fact that, at the end of each filling cycle, which generally coincides with the depletion of the material contained in a batch, a residual quantity of powdered material remains in the container which feeds the material to the measuring member. The use of the powdered material is therefore not optimized

and this affects production costs especially in the case where high cost powder products are processed.

**[0008]** The need is therefore felt to devise an apparatus that solves the aforementioned problem.

### Disclosure

**[0009]** The aim of the present invention is that of solving the aforementioned problems, devising an apparatus which allows the maximization of the consumption of the powdered material.

**[0010]** Within this aim, a further object of the present invention is to provide an apparatus for filling the containers with a powdered material which allows the number of containers discarded to be reduced to a minimum at each production cycle.

**[0011]** Still further object of the present invention is to devise an apparatus which is versatile, configurable according to the properties of the material to be treated.

**[0012]** Another object of the invention is to provide an apparatus that is capable of handling containers in safe and reliable way.

**[0013]** Still another object is to provide an apparatus of simple constructive and functional conception, having reliable operation, versatile use, and relatively unexpensive cost.

**[0014]** The aforementioned objects are achieved, according to the present invention, by the apparatus for filling containers with a powdered material according to claim 1.

**[0015]** The apparatus for filling containers with a powdered material includes a feeding station arranged for feeding a plurality of containers; a filling station, arranged downstream of said feeding station, comprising a measuring assembly configured to fill each said container with a measured quantity of a powdered material, said measuring assembly comprising at least one pair of measuring members.

**[0016]** The apparatus comprises a feeding receptacle, arranged adjacent to said measuring assembly, said feeding receptacle comprising a containment body adapted to contain a predetermined quantity of powdered material, said containment body being rotatable around an axis of rotation substantially vertical.

**[0017]** The feeding receptacle comprises at least one collection cavity made on a wall of said containment body which functions as a collection tank for said powdered material, in a step of recovery of said powdered material.

**[0018]** Said step of recovery of said powdered material occurs when the level of said powdered material inside said containment body is lower than a predetermined value.

**[0019]** It is observed that the provision of at least one collection cavity of the powdered material has the effect of maximizing the consumption of the powdered material, with a consequent reduction of production costs. The cavity of collection of material in fact allows the recover within it of at least a part of the powdered material which

remains in the containment body of the feeding receptacle when the material of the batch runs out.

**[0020]** Each said measuring member of said measuring assembly is capable of alternatively collecting a measured quantity of said powdered material from said feeding receptacle and the expulsion of said measured quantity of said powdered material into a relative container.

**[0021]** Preferably, each said measuring member internally forms a calibration chamber.

**[0022]** Preferably, said containment body and said measuring members are movable in a relative translation motion, along a direction parallel to said axis of rotation, in said recovery step of said powdered material.

**[0023]** Even more preferably, said containment body is movable in translation, upon actuation of a motor member, along a direction parallel to said axis of rotation, in said step of recovery of said powdered material. This feature helps to maximize the amount of powdered material recovered because it facilitates the recovery of the material by the measuring members, exploiting the depth of the at least one collection cavity.

**[0024]** Preferably, said containment body comprises a bottom wall and a perimeter wall, which extends from said bottom wall, said at least one collection cavity being made on said bottom wall.

**[0025]** Preferably said bottom wall is substantially flat.

**[0026]** Preferably said collection cavity protrudes along a substantially orthogonal direction with respect to said bottom wall.

**[0027]** Preferably, said collection cavity comprises side walls which extend along a substantially orthogonal direction with respect to said bottom wall of said containment body.

**[0028]** Preferably, said at least one collection cavity has a slotted plan shape.

**[0029]** Preferably, said feeding receptacle comprises a pair of collection cavities.

**[0030]** Preferably each said collection cavity is arranged at a peripheral region of said bottom wall.

**[0031]** Preferably, said containment body is associated with a first rotation shaft, adapted to be rotated around said substantially vertical axis of rotation by a second motor member.

**[0032]** Preferably, said feeding receptacle comprises a lid arranged above said containment body, said lid having at least one opening for inserting said measuring members in said containment body.

**[0033]** Preferably, in said step of recovery of said powdered material, said lid is movable according to a translation motion, on actuation of a motor member, along a direction parallel to said substantially vertical axis of rotation, in the opposite direction with respect to the translation motion of said containment body.

**[0034]** Preferably, said lid is associated with a second rotation shaft which can be translated by said motor member.

**[0035]** Preferably, said second rotation shaft is coaxial

with said first rotation shaft.

**[0036]** Preferably, said apparatus comprises sensor means configured to detect the thickness of the layer of powdered material contained within said containment body.

**[0037]** Preferably, said sensor means comprise optical sensor means.

**[0038]** Preferably, said optical sensor means comprise at least one optical fiber.

**[0039]** Preferably, said apparatus comprises a control unit.

**[0040]** Preferably, said optical sensor means are adapted to send a signal to said control unit when the level of said detected powdered material is lower than said predetermined value.

**[0041]** Preferably, said control unit is configured to command, upon receipt of said signal by said optical sensor means, the rotation of said containment body around said axis of rotation by an angle of rotation of a value such as to align said measuring members to said at least one collection cavity.

**[0042]** Preferably, said control unit is also configured to control, upon receipt of said signal, the translation of said containment body and of said lid along said direction parallel to said rotation axis in respectively opposite directions.

**[0043]** Preferably, said feed receptacle comprises a collection member, connected to said lid, which may be activated to deaerate and compact the layer of powdered material before being removed by said measuring members.

**[0044]** Preferably, said collecting member has a helical shape.

**[0045]** Preferably a conveying element is associated with said lid.

**[0046]** Preferably, said conveying element is connected to a container for discharging the powdered material for discharging the powdered material into said containing body when it is necessary to restore the layer of the material.

**[0047]** Preferably, said apparatus comprises a pneumatic circuit which connects each said measuring member to a source of positive pressure and to a source of negative pressure respectively for introducing a flow of a fluid inside said calibration chamber and for creating a vacuum condition in said calibration chamber, each said measuring member being fed independently by means of said pneumatic circuit to regulate the pressure value independently. It is observed that the possibility of regulating the pressure independently for each measuring member allows the collection of the material and the filling of the containers in an accurate way as it is possible to regulate the pressure in each measuring member for creating a vacuum condition in the calibration chamber, during the collection step, and the pressure of the flow of fluid dispensed, during the filling step, based, for example, on the characteristics of the powdered material. Furthermore, the accurate regulation of pressure in each

measuring member allows the compensation for any tolerance errors, obtaining a uniform measuring for all the measuring members.

**[0048]** Preferably, said pneumatic circuit comprises at least one pair of diverter valves connected to relative said measuring members, each said diverter valve receiving an incoming flow of a pressurized fluid and also being connected to said source of negative pressure, each said diverter valve being controlled to selectively enable the passage of said fluid or to enable the creation of a vacuum condition in said calibration chamber of the relative measuring device.

**[0049]** Preferably, said measuring assembly comprises a support device having at least one pair of measuring members, said support device comprising a pair of arms integral with a stem, said arms each carrying at least one measuring member.

**[0050]** Preferably, said stem can be rotated around a rotation axis by a respective motor member to bring said metering members alternately in correspondence with said feeding receptacle, for collecting the powdered material, and in a position above said containers for filling said containers.

**[0051]** Preferably, said apparatus comprises a first handling assembly which can be moved to transport at least one said container from said feeding station to said filling station.

**[0052]** Preferably, said apparatus comprises a capping station, arranged downstream of said filling station.

**[0053]** Preferably, said apparatus comprises a second handling assembly which can be moved to transport at least one said container from said filling station to said capping station and to transport each said container from said capping station to a following station.

**[0054]** Preferably, said capping station comprises sensors adapted to detect the presence of a cap on each container and to send a signal to a control unit if the cap is not present on a container.

**[0055]** Preferably, said control unit is configured to command, upon receipt of said signal, the movement of the second handling assembly towards said capping station for capping the container with the missing cap.

**[0056]** Preferably, said apparatus comprises a crimp capping station arranged downstream of said capping station.

**[0057]** Preferably, said crimp capping station is separated from said capping station by a partition wall.

**[0058]** Preferably, said apparatus comprises a third handling assembly.

**[0059]** Preferably, said third handling assembly is movable for transporting at least one said container towards said crimp capping station.

**[0060]** Preferably, said crimp capping station comprises further sensors adapted to detect the presence of a crimp cap on each container and to send a signal to said control unit if the crimp cap is not present on a container.

**[0061]** Preferably, said control unit is configured to

control, upon receipt of said signal, the movement of the third handling assembly towards a device for feeding the crimp caps, arranged in said capping station, for collecting the crimp cap to be applied to the container with the missing crimp cap.

**[0062]** Preferably each said handling assembly is made by a robotic arm.

**[0063]** It is observed that the handling assembly allow the change in their trajectory according to the needs and, therefore, allow the aforementioned recovery functions. This means that it is possible to minimize the number of containers to be discarded.

**[0064]** The use of manipulators to move the containers also allows an efficient transport of the containers and maintenance of a level of cleanliness at the end of the process that is better than the use of handling systems such as, for example, belts, augers, etc.

**[0065]** Preferably, said apparatus comprises an insulator that delimits an internal region in which said feeding station, said filling station, said capping station and said crimp capping station are arranged so as to prevent mutual contamination between the external environment and said internal region.

**[0066]** Preferably, said insulator is associated with an assembly for controlling the characteristics of the internal region delimited by the insulator.

**[0067]** Preferably, said control assembly includes a series of filters, capable of filtering the air taken from the region, and a series of fans that introduce a laminar flow of filtered air into the region that allows maintenance of an environmental control necessary to carry out an aseptic process.

**[0068]** Preferably said laminar flow flows in a vertical direction.

#### Description of drawings

**[0069]** The details of the invention will become more evident from the detailed description of a preferred embodiment of the apparatus for filling containers with a powdered material according to the invention, illustrated by way of example in the accompanying drawings, wherein:

Figure 1 shows a top view of the apparatus object of the invention;

Figure 2 shows a perspective view of a detail of the apparatus object of the invention;

Figure 3 shows a front view of the detail illustrated in figure 2;

Figure 4 shows a longitudinal section view of the detail illustrated in Figure 3 along the plane of line IV-IV;

Figure 5 shows a plan view of the detail illustrated in Figures 2-4;

Figure 6 shows a perspective view of a further detail of the apparatus;

Figure 7 shows a plan view of the detail illustrated in

Figure 6;

Figure 8 shows a sectional view of the detail illustrated in Figures 6 and 7 along the plane of line VIII-VIII;

Figure 9 shows a diagram of a pneumatic circuit for pressurizing and depressurizing the seal of a robotic arm used in the apparatus;

Figure 10 shows a schematic representation of a pneumatic circuit relating to a pair of measuring members of the apparatus.

#### Best mode

**[0070]** With particular reference to these figures, the reference number 1 indicates as a whole the apparatus for filling containers with a powdered material and for closing containers according to the present invention.

**[0071]** The containers 2 can be bottles, vials and the like, intended, for example, for the pharmaceutical, biotechnological or chemical sector.

**[0072]** Preferably, the powdered material is a material having physical and chemical characteristics which make it difficult to process. More specifically, the term hardly workable powder material means a powder that has characteristics such as not to be easily manageable in order to obtain a high precision in the measuring.

**[0073]** In the pharmaceutical field, powders that are difficult to process are, for example, highly hygroscopic powders, having a melting temperature close to room temperature which generates marked adhesiveness problems if processed at environmental conditions above 15°C and/or with relative humidity higher than 25%. An example of a powdered material is the monohydrate form of Cyclophosphamide, which has a melting temperature in the range of 40-45°C, but which can already degrade at temperatures above 30°C. Chemical degradation causes a change in the physical characteristics that prejudice the workability in the measuring process.

**[0074]** The apparatus 1 includes a frame that defines the supporting structure of the apparatus. The frame 3 supports a substantially horizontal work surface 4 on which a series of operating stations are arranged, as described below.

**[0075]** Preferably the frame 3 is associated with an insulator that surrounds the work surface 4 in order to isolate the operating stations from the external environment and thus avoid contamination between the external environment and the internal region delimited by the insulator. The insulator also performs the function of ensuring the safety of operators, in particular in the event that cytotoxic powdered materials are treated.

**[0076]** More specifically, the insulator has a box-like shape and is fixed to a part of the frame 3 arranged, in a mounting configuration, at the top so as to enclose the operating stations inside. The insulator will not be further described as it is known per se.

**[0077]** The insulator is associated with a control assembly of the characteristics of the internal region de-

limited by the insulator, which is designed, in particular, to control the level of purity of the air in that region. The control assembly includes a series of filters, adapted to filter the air taken from the region, and a series of fans that introduce a laminar flow of filtered air into the region. Laminar flow flows in a vertical direction. The vertical and laminar air flow allows an environmental control that is necessary for carrying out an aseptic process.

**[0078]** In a region below the work surface 4, the frame 3 forms a base, not visible in the figures, suitable for housing the motorization systems of the apparatus. Sealing means, not shown, are arranged at a passage area between the base and the region above the work surface 4, for preventing mutual contamination between the two regions.

**[0079]** The frame 3 is preferably made of stainless steel and covered with stainless steel panels to allow easy sterilization.

**[0080]** The apparatus 1 comprises a feeding station 5 designed to receive a plurality of containers 2 and transfer them to a collecting area 6.

**[0081]** The feeding station 5 comprises a transfer member 7 which is made up of a table revolving around a substantially vertical axis of rotation. The transfer member 7 can have a discoidal shape.

**[0082]** The transfer member 7 receives the containers 2 from a transport member, such as, for example, a conveyor belt, not visible in the figures, and is rotated around the axis of rotation to lead the containers 2 towards the collection area 6. The transport member is placed inside a sterilization tunnel to ensure the sterility of the containers 2.

**[0083]** The transfer member 7 is provided with guide means 8 which convey the containers 2 towards the collection area 6. Preferably, the containers 2 arriving at the collection area 6 are arranged aligned.

**[0084]** The apparatus 1 also comprises a first handling assembly 9 adapted to move the containers 2 from the feeding station 5 to a following filling station 10, arranged downstream of the feeding station 5.

**[0085]** A capping station 11 is arranged downstream of the filling station 10. A second handling assembly 9 transports the containers 2 from the filling station 10 to the capping station 11.

**[0086]** Each handling assembly 9 is made by a robotic arm, more specifically by an anthropomorphic robot.

**[0087]** Each robotic arm 9 is isolated from the base by sealing means and comprises, in a known way, a base associated with a series of segments connected by joints.

**[0088]** Gripping means 12 are connected to an end opposite the base, which is the wrist of the robotic arm.

**[0089]** The gripping means 12 comprise at least one gripper member which is movable alternately, upon activation of an actuator, between a gripping configuration and a release configuration of a container 2. Preferably the actuator, not visible in the figures, is of the pneumatic type.

**[0090]** According to a preferred embodiment, the grip-

ping means 12 comprise a pair of gripper members which are operated by respective actuators to grasp and release the corresponding containers 2.

**[0091]** Each gripper member comprises an operating portion consisting of two clamping elements which are placed close to each other in the gripping configuration, and spaced apart in the release configuration. The operating portion, not visible in the figures, is associated with the wrist of the robotic arm 9 through a connection portion, also not visible in the figures.

**[0092]** The connection portion is coated with a covering element to prevent any contamination of the gripper member by the powdered material and also to prevent contamination of the powdered material.

**[0093]** The covering element can be made from a bellows equipped with a tightness control system.

**[0094]** Preferably, each gripper member is made of stainless steel or of an antistatic plastic material.

**[0095]** The gripping means 12 are provided with sensors, not shown, which are capable of detecting whether each gripper member has gripped a relative container.

**[0096]** A series of nozzles, not visible in the figures, which are arranged close to the gripping means 12, above the gripping means 12, are also associated with the robotic arm 9. The nozzles are connected to a supply circuit for an inert gas such as, for example, argon or nitrogen, so as to blow the gas into each container 2 before filling the container 2 with a powdered material and after filling the container 2.

**[0097]** The joints of the robotic arm 9 are equipped with pressurized seals. More specifically, the apparatus includes a pneumatic circuit 50 to pressurize and depressurize the seals of each robotic arm 9.

**[0098]** Figure 9 shows a diagram of the pneumatic circuit 50 for pressurizing and depressurizing a seal of a robotic arm 9. The circuit 50 allows setting the pressure of a fluid in the seal of the robotic arm 9 at a value within a range selected by the operator and, in general, allows checking the state of the seal.

**[0099]** The circuit 50 comprises a proportional pressure regulating valve 51 connected, through a first conduction means 52, to a respective seal of the robotic arm 9. The proportional pressure regulating valve 51 is capable of setting the pressure of a fluid entering the seal.

**[0100]** Preferably the fluid is compressed air.

**[0101]** The proportional pressure regulating valve 51 is connected to a safety valve 53. This safety valve 53 allows the inlet pressure of the valve 51 to be kept below a maximum limit value. The maximum limit value is the maximum pressure value accepted at the inlet by the proportional pressure control valve 51. When the inlet pressure of the valve 51 is less than or equal to this maximum limit value, the integrity of the mechanical components contained therein is ensured and the correct operation of the valve is therefore also ensured.

**[0102]** The safety valve 53 receives incoming compressed air at a pressure P1 and is piloted by a pressure P0.

**[0103]** P0 means the pressure of the compressed air which is conducted by a source of compressed air 54 entering the circuit 50 while P1 is the pressure outgoing a pressure regulator 55 placed upstream of the safety valve 53.

**[0104]** Preferably the pressure P0 is 6-8 bar while the pressure P1 is a value lower than P0.

**[0105]** Preferably the pressure P1 has a value lower than said maximum limit value of the incoming pressure of the proportional pressure regulating valve 51.

**[0106]** More specifically, a second conduction means 56 of compressed air, connected to the compressed air source 54, gives rise to two branches: a first branch 56a enters the pressure regulator 55 while a second branch 56b, to which corresponds the pressure P0, is a pilot signal for the safety valve 53.

**[0107]** The circuit 50 also includes a control valve 57 which has the incoming compressed air, which outgoes from the relative seal of a robotic arm 9 and is connected, when outgoing, to a pressure sensor 58 and to a silencer 59. Control valve 57 is piloted by pressure P0.

**[0108]** The pressure sensor 58 detects the pressure value in the seal and sends an alarm signal to the control unit if the measured value is outside the pressure range set by the operator.

**[0109]** In the event that it is necessary to perform maintenance on the seal, it can be depressurized by means of the control valve 57, by switching the control valve 57 and discharging all the pressurized air in the seal. In addition, any pressure loss or overpressure in the seal can be detected by reading the pressure sensor 58.

**[0110]** The containers 2 are transported by the first robotic arm 9 from the collection area 6 to the filling station 10 and are released resting on a support member of the type of a plate, not visible in the figures.

**[0111]** A weighing assembly 13 is arranged at the filling station 10, comprising at least one load cell for measuring the tare weight of a container 2, before filling it with a powdered material, and the gross weight of the container 2 once filling with a powdered material has been carried out.

**[0112]** The apparatus is equipped with a control unit capable of managing the entire process and, in particular, allowing identification of the containers 2 to be discarded based on the net weight determined starting from the acquired data of gross and tare weight.

**[0113]** Preferably, the weighing assembly 13 comprises a pair of load cells and a compensation cell designed to detect any inconvenience during the weighing step, such as vibrations, and to eliminate such disturbances.

**[0114]** The weighing assembly 13 is supported by a support 14 integral with the base of the apparatus.

**[0115]** The filling station 10 comprises a measuring assembly 15.

**[0116]** The measuring assembly 15 comprises a support device 16 bearing at least one pair of measuring members 17, wherein each measuring member 17 is

adapted to alternatively take a measured quantity of powdered material and dispense the measured quantity of powdered material in a suitable container 2.

**[0117]** Each measuring member 17 is adapted to collect a measured quantity of material from a feeding receptacle 18, arranged next to the measuring assembly 15, which is described below.

**[0118]** The support device 16 comprises a pair of arms 19 that each form at least one seat 20 for a respective measuring member 17. According to a preferred embodiment, each arm 19 supports a pair of measuring members 17 and, therefore, forms a pair of seats 20 for respective measuring members 17.

**[0119]** The arms 19 are connected integrally to a stem 21 and are mounted on the stem 21 so as to occupy positions at the opposite ends of the diameter of the stem 21.

**[0120]** The rod 21 is rotated according to a rotation axis A by a first motor member 22. More specifically, the stem 21 is rotated according to an alternating motion so as to bring the measuring members 17 of each arm 19 alternately at the feeding receptacle 18, to collect the powder material, and in an overlying position the containers 2 for filling.

**[0121]** The configuration of the support device 16 allows, upon actuation of the first motor member 22, at the same time the collection of the powdered material by means of the measuring members 17 carried by an arm 19 and the filling of the containers 2 by means of the measuring members 17 carried by the opposite arm 19.

**[0122]** Preferably the stem 21 is rotated at a predetermined angle of rotation around the axis of rotation A.

**[0123]** Preferably the rotation angle is substantially equal to 180°.

**[0124]** It is possible to provide that each arm 19 forms a series of support portions aligned along a vertical direction to keep each measuring member 17 stable during the operating steps.

**[0125]** Each measuring member 17 comprises a calibration chamber that defines the volume of the powdered material to be inserted inside each container 2.

**[0126]** Each metering member 17 comprises a casing 23 having a tubular shape and a piston, not visible in the figures, which is housed inside the casing 23. The casing has an open end and the calibration chamber is defined between an internal wall of the casing and a piston head, at said open end.

**[0127]** The piston comprises a body, internally hollow, and a head associated with a filter.

**[0128]** The filter is made from a mesh, preferably made of metal material, which is fixed to an edge of the piston head and forms a surface of the piston head. The filter is permeable to the passage of a flow of a fluid and is impermeable to the passage of powdered material.

**[0129]** The dimensions of the free spaces defined by the mesh are established on the basis of the type of powdered material treated.

**[0130]** The piston head can have a truncated cone

shape.

**[0131]** The piston can be operated in sliding, on activation of an actuator member, along a longitudinal direction to expel the powdered material contained in the calibration chamber or to modify, if necessary, the dimensions of the calibration chamber as well as to carry out the cleaning of the piston. In the latter case, the piston is operated sliding along a longitudinal direction for a stroke that extends outside the casing 23.

**[0132]** Each metering member 17 is connected, by means of a pneumatic circuit 60, to a source of positive pressure and to a source of negative pressure respectively to introduce a flow of a fluid into the calibration chamber and to create a vacuum condition in the calibration chamber.

**[0133]** The source of negative pressure can be a vacuum pump.

**[0134]** The positive pressure source can be a compressor or a source of a compressed inert gas such as, for example, nitrogen or argon. In the cleaning phase, a flow of compressed air or an inert gas is used and in the phase of expelling the material, a flow of compressed air or a flow of an inert gas can be used.

**[0135]** Each measuring member 17 is controlled, by means of the pneumatic circuit 60, independently with respect to the other measuring members 17 in order to be able to autonomously regulate the pressure in each measuring member 17. The pneumatic circuit 60 allows a precise regulation of the pressure in each measuring member 17 in order to compensate for any tolerance errors, obtaining a uniform measuring for all measuring members 17.

**[0136]** In particular, the pneumatic circuit 60 comprises, for each measuring member 17, a diverter valve 61 which receives incoming pressurized fluid at its inlet and is also connected, through connection means 62, to a vacuum pump 63. The diverter valve 61 is controlled to selectively allow the passage of a fluid under pressure or to create a vacuum condition in the calibration chamber of the relative measuring member 17 so as to suck up the powdered material.

**[0137]** Figure 10 shows a diagram of the pneumatic circuit 60 relating to a pair of measuring members 17a, 17b arranged diametrically opposite on the stem 21 or, better, measuring members 17 which operate, at an instant of time t, in different operating phases.

**[0138]** Each diverter valve 61 is connected at the outlet to a relative measuring member 17a, 17b by interposing a pair of filters 64. The redundancy of the filters 64 guarantees a condition of maximum safety for the operator in the event that it is necessary to replace or to carry out maintenance on one of the filters 64. The redundancy of the filters 64 also makes it possible to ensure a high level of sterility of the fluids entering the measuring members 17a, 17b.

**[0139]** Upstream of the diverter valves 61, the circuit 60 comprises a fluid distribution block 65 for the cleaning and expulsion phases. The distribution block 65 receives

an incoming fluid for cleaning and expelling compressed air or argon or nitrogen.

**[0140]** The compressed air is transported to the distribution block 65 through relative conduction means connected to a source of compressed air 66.

**[0141]** Argon and nitrogen are transported to the distribution block 65 respectively by relative conduction means connected respectively to a source of compressed argon 67 and to a source of compressed nitrogen 67'.

**[0142]** It is possible to expel the powdered material by selecting one of the gases transported to the distribution block 65, namely compressed air or argon or nitrogen.

**[0143]** A first conduction means 68 which conveys a flow of compressed air to a pressure regulator 69 is connected at the outlet to the distribution block 65 for each pair of measuring members 17.

**[0144]** The first conduction means 68 gives rise, downstream of the pressure regulator 69, to two branches 68a, 68b relating to the cleaning steps of respective measuring members 17a, 17b.

**[0145]** A second conduction means 70 is also connected at the outlet to the distribution block 65 which conveys a flow of compressed air or a flow of a compressed inert gas at the inlet to a further pressure regulator 69 and, downstream of the pressure regulator 69, gives rise to a pair of branches 70a, 70b relating to the ejection phases of respective measuring members 17a, 17b.

**[0146]** For each pressure regulator 69 the relative conduction means 68, 70 gives rise to two branches connected to respective measuring members 17a, 17b arranged diametrically opposite on the stem 21 or, better, measuring members 17 which operate, at an instant of time  $t$ , in different operational phases. By way of example, when the dispenser 17a is in the phase of expulsion of the powdered material, the opposite dispenser 17b is in the suction phase of material, therefore, it is connected to the vacuum pump or vice versa. The configuration of the circuit 60 is optimized by exploiting the connection of each pressure regulator 69 to the measuring members 17 which operate, at a predetermined instant  $t$ , in different operating phases.

**[0147]** The circuit 60 associates to each measuring member 17, for example for the measuring device indicated with 17a, the branch 68a of the first conduction means 68, which passes a cleaning fluid, and the branch 70a of the second conduction means 70 which passes a fluid to discharge the powdered material. The branches 68a, 70a cross and a third conduction means 71 connected to the diverter valve 61 is connected to the node of the branches.

**[0148]** Non-return valves 72 are arranged on each branch 68a, 70a to prevent the passage of fluids from one branch to the other and to prevent the creation of overpressure on the valves.

**[0149]** Similarly, for the further measuring device 17b the circuit 60 associates the branch 68b of the first con-

duction means 68, which passes a fluid for cleaning, and the branch 70b of the second conduction means 70, which passes a fluid for expelling the powdered material. The branches 68b, 70b cross and a third conduction means 73 connected to the diverter valve 61 is connected to the node of the branches. The non-return valves 72 prevent the passage of fluids from one branch to the other.

**[0150]** The pneumatic circuit 60 and the pneumatic circuit 50 for pressurizing the seals of the robotic arms 9 are controlled by means of a control panel which records the changes made, for example the adjustment operations, to be recorded, improving control over the circuits.

**[0151]** Each measuring member 17 is fed independently from the pneumatic circuit 60 described above with a flow of a fluid under pressure to expel the collected powdered material or is connected to the vacuum pump to create a vacuum condition in the calibration camera.

**[0152]** Alternatively or in combination with the expulsion of the powdered material with a pressurized fluid, each measuring member 17 can expel the powdered material by the force exerted by the piston when it is operated in translation inside the casing 23.

**[0153]** In a step of collecting the powdered material, a vacuum condition can be created in the calibration chamber of each measuring member 17 and/or the powdered material is collected by applying a compression force of the measuring device 17 on the material compacting in the calibration chamber.

**[0154]** A ring-shaped member 24 for cleaning the measuring members 17 is mounted around the stem 21.

**[0155]** The cleaning member 24 has a series of openings provided with suction means, not visible in the figures, at which each measuring member 17 can be inserted to remove the residual material that has remained adhered.

**[0156]** It is possible to provide that the cleaning member 24 is equipped with a scraper element, not shown, arranged to cooperate with the suction means in removing the material.

**[0157]** The feeding receptacle 18 is arranged adjacent to the support device 16 of the measuring members 17 and is mounted on a base 25 integral with a first shaft 26, capable of being rotated around a substantially vertical axis of rotation B by a second member motor 27.

**[0158]** The second motor member 27 transmits the rotation motion to the shaft 26 by means of transmission 28.

**[0159]** The shaft 26 is also connected to a third motor member 29 which drives it in translation along a longitudinal direction parallel to the axis of rotation B thanks to the interposition of screw means 30, for example a ball screw.

**[0160]** The feeding receptacle 18 comprises a containment body 31 adapted to contain a predetermined quantity of a powdered material. The containment body 31 is revolving around the axis of rotation B upon actuation of

the second motor member 27 and is operated in translation upon actuation of the third motor member 29.

**[0161]** The containment body 31 is rotated by an angle of rotation whose value is varied periodically to enable the measuring members 17 to collect the material from different regions of the layer of material contained within the containment body 31.

**[0162]** Above the containment body 31 there is a lid 32 which is in a fixed position with respect to the containment body 31.

**[0163]** The containment body 31 comprises a bottom wall 33 from which a perimeter wall 34 develops.

**[0164]** Preferably the containment body 31 has a cylindrical shape.

**[0165]** At least one collection cavity 35 is on the bottom wall 33, which functions as a collection tank for the powdered material when the level of the material inside the containment body 31 is lower than a predetermined reference value.

**[0166]** The collection cavity 35 is open on one side facing the inside of the containment body 31 to allow the entry of powdered material.

**[0167]** The collection cavity 35 extends along a direction orthogonal to the bottom wall 33, in the thickness of the base 25.

**[0168]** According to an embodiment, the collection cavity 35 has a slotted plan shape.

**[0169]** According to the embodiment illustrated in Figures 6-8, the feeding receptacle 18 comprises a pair of collection cavities 35.

**[0170]** Optical sensor means configured to measure the thickness of the layer of powdered material inside the containment body 31 are associated with the feeding receptacle 18. The optical sensor means may comprise an optical fiber.

**[0171]** The lid 32 forms an opening 36, for example in the shape of a slot, which allows the measuring members 17 to be inserted into the containment body 31 for collecting the powdered material.

**[0172]** Associated with the lid 32 is a conveying element 37 having a tubular shape, which is connected to a container for discharging the powdered material, not visible, for discharging the powdered material into the containment body 31 when it is necessary to restore the layer of the material. The unloading container preferably uses the force of gravity to unload the material into the conveying element 37.

**[0173]** The lid 32 is integral with a second shaft 38 which is operable in translation by a motor member. More specifically, in a phase of recovery of the powdered material, the lid 32 is driven in translation along a direction parallel to the axis of rotation B in an opposite direction with respect to the movement of the containment body 31. In this way, the lid 32 maintains a fixed position with respect to the containment body 31, allowing the phase of recovery of the material to be carried out, which is better explained below.

**[0174]** The second shaft 38 is coaxial with the first shaft

26.

**[0175]** The feeding receptacle 18 also comprises a collection member connected to the lid 32 which is activated to rake the powdered material towards the collection cavity 35, favoring the recovery of the powder material. The collection member performs the function of deaerating and compacting the layer of powdered material before the material is removed by the measuring members 17.

**[0176]** Preferably the collection member has a helical shape.

**[0177]** Once the filling of the containers 2 has been completed, the containers 2 are weighed again by the weighing assembly 13 to determine the gross weight of each container 2 and are collected by the second robotic arm 9.

**[0178]** The second robotic arm 9 transports the containers to the capping station 11 and, once arrived at this station 11, supports the containers by the gripping means 12 for a predetermined time interval necessary for the application of relative caps on the containers 2.

**[0179]** The capping station 11 comprises a first device 39 for feeding the caps, which is made from a container having a truncated cone shape. The first feeding device 39 is vibrating and forms a pair of outlet channels to release, step by step, a pair of caps to be applied on relative containers 2.

**[0180]** A first pre-feeding device 40 consisting of a hopper containing a predetermined quantity of caps can be associated with the first feeding device 39. The pre-feeding device 40 is equipped with an unloading element, for example an unloading chute, to supply the caps to the first feeding device 39.

**[0181]** The first pre-feeding device 40 is arranged near an access point of the insulator to allow easy loading of the caps.

**[0182]** The capping station 11 also comprises a capping device 41 which collects the outgoing caps from the feeding device 39 and makes them available to the containers 2, preferably one pair of caps at a time.

**[0183]** More specifically, the capping device 41 transports the caps to the containers 2 and positions them aligned with the open end of the containers 2, associating them with the containers 2. In the case of using bottles, the caps are positioned aligned with the orifice of the bottles.

**[0184]** The second robotic arm 9 can be moved in order to associate the caps with the containers 2 and to complete the capping.

**[0185]** The second robotic arm 9 carries the capped containers 2 on a release surface 42.

**[0186]** The release plane 42 is located at a partition wall 43 interposed between the capping station 11 and a following crimp capping station 44.

**[0187]** An opening is made on the partition wall 43, wherein the release plane 42 is arranged.

**[0188]** The capping station 11 comprises sensors, not shown, configured to detect the presence of the cap on

each container 2. The sensors may be optical sensors such as, for example, cameras.

**[0189]** In the event that the cap on a container 2 is not detected, due to the loss of the cap during handling or during collection, the second robotic arm 9 is moved again towards the capping station 11 to carry out the capping of the container 2 previously detected. In the time interval in which the second arm 9 brings the capped container towards the release surface 42, the handling device 41 collects and make available the missing cap. The further cap collected from the handling device 41 is expelled.

**[0190]** The crimp capping station 44 comprises a second device 45 for feeding crimp caps having a truncated cone shape. The feeding device 45 is vibrating and is equipped with an outlet guide 46 to make the crimp caps available to the containers 2.

**[0191]** A pre-feeding device 47 consisting of a hopper containing a predetermined quantity of crimp caps can be associated with the feeding device 45, as in the case of the capping station 11. The pre-feeding device 47 is equipped with an unloading element, for example an unloading chute, for supplying the crimp caps to the feeding device 45.

**[0192]** The crimp capping station 44 comprises a third robotic arm 9 for handling the containers 2.

**[0193]** The characteristics of the first and the second robotic arm 9 are also applicable to the third robotic arm 9 with the exception of the nozzles as the third arm 9 does not supply an inert gas into the containers 2.

**[0194]** The crimp capping station 44 comprises a crimp capping device 48 comprising means for supporting containers equipped with closing capsules and a series of crimp capping heads each equipped with a crimp capping blade oscillating between a disengagement position and a working position for deforming the crimp cap around the neck of the bottle.

**[0195]** The crimp capping device 48 is not further described as it is known per se.

**[0196]** The third robotic arm 9 collects the containers 2 from the release surface 42 and transports them to the crimp capping device 48 by taking the crimp caps off the feeding device 45. The third robotic arm 9, during the transport of the containers 2 towards the crimp capping station 48, let the containers 2 pass under a device for riveting the respective caps so as to avoid that the caps are positioned wrongly or came out.

**[0197]** The containers 2 outgoing from the capping device 48 are transported by the robotic arm 9 on an output plane 49, to a subsequent station if the net weight is correct, otherwise they are rejected.

**[0198]** The crimp capping station 44 comprises sensors, not shown, configured to detect the presence of the crimp cap on each container 2.

**[0199]** In the event that a crimp cap is not detected on a container 2, due to the loss of the crimp cap during handling or during collection, the third robotic arm 9 holds the container 2 equipped with the crimp cap with the

gripping means and is moved back towards the feeding device 45 for collecting the crimp cap to be applied to the container 2 with the missing crimp cap. The third robotic arm 9 is then moved towards the crimp capping device 48 for crimp capping the container 2.

**[0200]** The operation of the apparatus for filling containers with a powdered material is easy to understand from the above description.

**[0201]** The containers 2 arriving at the feeding station 5 are transferred by means of the transfer member 7 from the conveyor belt to the release surface 6 and are collected by the first robotic arm 9.

**[0202]** The first robotic arm 9 transports a pair of containers 2 from the release surface 6 to the filling station 10 and, in particular, releases them to the weighing assembly 13 to measure the tare of the containers 2.

**[0203]** After, each container 2 is filled with a measured quantity of a powdered material by means of the measuring assembly 15.

**[0204]** In particular, each measuring member 17, which is arranged above a relative container 2 from the support device 16, discharges the amount of powdered material contained in the calibration chamber inside the relative container 2. The discharge of the powdered material can take place by moving the piston of the measuring member 17 and/or by the flow of compressed air or an inert gas introduced into the calibration chamber from the pneumatic circuit 60.

**[0205]** Simultaneously with the expulsion of the powdered material into a container 2 by a measuring member 17, at least one further measuring member 17 collects a measured amount of powdered material from the feeding receptacle 18.

**[0206]** The operation of the feeding receptacle 18 is described in detail below.

**[0207]** In a phase of steady operation, the containment body 31 of the feeding receptacle 18 is rotated around the rotation axis B by a rotation angle which is periodically varied to allow the measuring members 17 to take the material from regions different from the layer of material contained in the containment body 31. The measuring members 17 carried by the relative arm 19 are inserted through the opening of the lid 32 and each collect a predetermined amount of powdered material, defined by the volume of the calibration chamber. The collection takes place through the application of a compression force by the pistons of the pair of measuring members 17 on the layer of the powdered material and/or by suction thanks to the creation of a vacuum condition in the calibration chambers.

**[0208]** The thickness of the layer of powdered material inside the containment body 31 is kept approximately constant thanks to the feeding of the material by the discharge container.

**[0209]** When the optical sensor means detects that the layer of material inside the containment body 31 is below a predetermined value, due to the exhaustion of the material in the discharge container, it sends a signal to

the control unit. The control unit commands the implementation of a recovery phase of the remaining powdered material in the containment body 31.

**[0210]** In particular, the control unit controls the rotation of the containment body 31 around the axis of rotation B by a rotation angle having a value such as to bring the measuring members 17 aligned with the collection cavity 35 along a longitudinal direction. The rotation angle is, for example, 360°.

**[0211]** The containment body 31 is also operated in translation along a direction parallel to the axis of rotation B, by the action of the third motor member 29, on command of the control unit. The lid 32 is in turn translated along the same direction in the opposite direction to that of the containment body 31.

**[0212]** In said recovery phase of the powdered material, the measuring members 17, aligned with the collection cavity 35, can collect the powdered material contained in the cavity and, thanks to the translation of the feeding receptacle 18, may recover the material by exploiting the depth of the collection cavity 35. The collecting operation, in the recovery phase, takes place in the manner described for the steady state operation phase.

**[0213]** Once the containers 2 have been filled, these containers are weighed again by the weighing unit 13 to measure the gross weight and are collected by the second robotic arm 9 to be transferred from the filling station 10 to the following capping station 11.

**[0214]** The control unit establishes, based on the net weight values of the containers, the suitability of the containers 2.

**[0215]** The first robotic arm 2, having completed the filling of the containers 2, performs a return stroke to collect a further pair of empty containers 2.

**[0216]** The second robotic arm 9 transfers the pair of containers 2 below the capping device 41 and keeps them in position, by the gripping means 12, so that respective caps are applied to the containers 2.

**[0217]** The capped containers 2 are subsequently transported by the second robotic arm 9 to the release surface 42.

**[0218]** The third robotic arm 9 collects the pair of containers 2 from the release surface 42 and transports them to the crimp capping device 48, taking a pair of crimp caps from the relative feeding device 45 during the path.

**[0219]** The crimp capping device 48 is operated to apply a capsule on each container 2 and perform the capping of each container 2.

**[0220]** The containers 2 are then transported by the third robotic arm 9 on the output plane 49, towards a subsequent station.

**[0221]** If the net weight acquired at the filling station 10 is not correct, the containers 2 are rejected. The rejection of the containers 2 takes place only at the end of the crimp capping process.

**[0222]** The apparatus according to the present invention achieves the purpose of maximizing the consumption of the powdered material thanks to the provision of a

rotating feeding receptacle equipped with at least one material collection cavity.

**[0223]** The material collection cavity in fact allows the recovery inside it at least a part of the powdered material which remains in the containment body of the feed receptacle when the material present in the discharge container ends, or when the material of the batch runs out. The fact that the measuring members collect the material from the collection cavity, in the recovery phase, has the effect of significantly reducing, for each batch of material used, the quantity of powdered material that is not used for filling the containers. Optimizing the consumption of powdered material leads to a reduction in production costs.

**[0224]** A further aspect to underline is that the use of robotic arms to move the containers allows an efficient transport of the containers and also the minimization of the number of containers discarded at each production cycle. If the sensors present in the capping and crimp capping stations do not respectively detect the presence of a cap or a crimp cap on a container, the control unit commands the movement of the robotic arms in order to recover the cap or crimp cap and apply them again on that container. The robotic arms allow the change of their trajectory according to different needs and, therefore, allow the aforementioned recovery functions. This means that it is possible to reduce the number of containers to be rejected.

**[0225]** In addition, the robotic arms make it possible to maintain a level of cleanliness at the end of the process that is better than the use of handling systems such as, for example, belts, augers, etc.

**[0226]** An advantageous aspect of the apparatus according to the present invention is that it allows effective filling of the containers with a powdered material thanks to the fact that the pressure of the fluid entering the calibration chamber of each measuring device can be adjusted and, equally, the negative pressure to create the vacuum in the chamber, independently from the other measuring members.

**[0227]** The possibility of adjusting the pressure independently for the various measuring members allows an optimal level of precision in the filling phase. For example, in the case of mechanical problems, the independent pressure regulation allows a compensation which, especially in the case of small volumes of material, is advantageous.

**[0228]** In the case of powdered materials that are difficult to process, the independent pressure regulation is useful to solve problems of incorrect measuring that can occur.

**[0229]** An advantageous aspect of the present apparatus is the fact that for each measuring member the piston can be driven in translation inside the relative casing for discharging the powdered material, in combination with the introduction of the supplied fluid into the calibration chamber, from the pneumatic circuit or as an alternative to the fluid.

[0230] Similarly, in the collection phase, the compression exerted by the measuring member on the layer of the powders material can be combined with the suction due to the vacuum condition created in the calibration chamber.

[0231] The possibility of using said technologies gives versatility to the apparatus since it easily adapts to different types of powdered material. Depending on the characteristics of the treated powdered material it may, in fact, be necessary to combine the flow of the fluid with the mechanical action of the piston or use only the fluid or only the force exerted by the piston to discharge the material.

[0232] It should be emphasized that, thanks to the pneumatic circuit connected to the measuring members, which allows the pressure in the measuring members to be regulated in a precise and independent manner, and also thanks to the fact that the aforementioned technologies for collecting and filling can be combined or used separately, the apparatus minimizes the impact that hardly workable powders can have in the phases of collecting the powdered material and filling the containers, ensuring stability to these processes.

[0233] An advantage is linked to the provision of an insulator that surrounds the operating stations, preventing contamination between the external environment and the operating region as well as the provision of a control assembly that generates a vertical laminar air flow inside the insulator. These characteristics are relevant in sectors that require precise environmental control during the process, such as, for example, the pharmaceutical sector, to preserve the sterility of containers and the product, as well as to ensure the safety of operators, especially in the case of cytotoxic products.

[0234] Finally, it should be emphasized that the configuration of the measuring assembly comprising a support device, which leads the measuring members alternatively to collect the material and to carry out the filling, and, in particular, the fact that the measuring members have a compact configuration and reduced size, minimizes the interaction with the vertical laminar air flow and, therefore, minimizes the occurrence of turbulence phenomena. In this way the measuring assembly helps to ensure that the sterility level of the process is maintained.

[0235] The apparatus described for illustrative purpose only, is subject to numerous changes and variations according to different needs.

[0236] In the practical embodiment of the invention, the materials used, as well as the shape and the dimensions, may be modified depending on requirements.

[0237] Should the technical features mentioned in any claim be followed by reference signs, such reference signs were included strictly with the aim of enhancing the understanding of the claims and hence they shall not be deemed restrictive in any manner whatsoever on the scope of each element identified for exemplifying purposes by such reference signs.

## Claims

1. An apparatus for filling containers with powdered material comprising

a feeding station (5) arranged to feed a plurality of said containers (2);  
 a filling station (10), arranged downstream of said feeding station (5), comprising a measuring assembly (15) configured to fill each said container (2) with a measured quantity of powdered material, said measuring assembly (15) comprising at least one pair of measuring members (17); a feed receptacle (18), arranged adjacent to said measuring assembly (15), said feed receptacle (18) comprising a containment body (31) capable of containing certain quantity of powdered material, said containment body (31) being rotatable about a substantially vertical axis of rotation (B), **characterized in that** said feeding receptacle (18) comprises at least one collection cavity (35) made on a wall of said containment body (31) which functions as a collection tank of said powdered material when the level of said powdered material inside said containment body (31) is lower than a predetermined value, wherein said containment body (31) is adapted to be translated, on actuation of a motor member (29), along a direction parallel to said rotation axis (B), in a step of recovery of said powdered material, said step of recovery of said powdered material occurring when the level of said powdered material inside said containment body is lower than a predetermined value;  
 wherein each of said measuring member (17) is adapted to alternatively collect a measured quantity of said powdered material from said feed receptacle (18) and discharge said measured quantity of said powdered material into a relative container (2), wherein each of said measuring member (17) internally shapes a calibration chamber.

2. An apparatus according to claim 1, **characterized in that** said containment body (31) comprises a substantially flat bottom wall (33) and a perimeter wall (34), which extends from said bottom wall (33), said at least one collection cavity (35) being made on said bottom wall (33).
3. An apparatus according to claim 2, **characterized in that** said collection cavity (35) comprises side walls which extend along a substantially orthogonal direction with respect to said bottom wall (33) of said containment body (31).
4. An apparatus according to any one of preceding

- claims, **characterized in that** said feed receptacle (18) comprises a lid (32) arranged above said containment body (31), said lid (32) having at least one opening for inserting said measuring members (17) in said containment body (31).
5. An apparatus according to claim 4, **characterized in that**, in said step of recovery of said powdered material, said lid (32) is movable according to a translational motion, on actuation of a motor member, along a direction parallel to said axis of rotation (B), in the opposite direction with respect to the translational motion of said containment body (31).
6. An apparatus according to claim 5, **characterized in that** it comprises an optical sensor means configured to detect the thickness of the layer of powdered material inside said containment body (31), said optical sensor means being able to send a signal to a control unit when the level of said detected powdered material is lower than said predetermined value.
7. An apparatus according to claim 6, **characterized in that** said control unit is configured to control the rotation of said containment body (31) around said axis of rotation (B) of a rotation angle, upon receipt of said signal by said optical sensor means, such as to align said measuring members (17) with said at least one collection cavity (35), said control unit being also configured to control translation of said containment body (31) and of said lid (32), upon receipt of said signal, along said direction parallel to said axis of rotation (B) according to respectively opposite directions.
8. An apparatus according to any one of the preceding claims, **characterized in that** it comprises a pneumatic circuit (60) which connects each said measuring member (17) to a source of positive pressure (66, 67, 67') and to a source of negative pressure (63) respectively, adapted to introduce a flow of a fluid inside said calibration chamber and to create a vacuum condition in said calibration chamber, each said measuring member (17) being fed independently by means of said pneumatic circuit (60) for regulating the pressure value independently.
9. An apparatus according to any one of the preceding claims, **characterized in that** said measuring assembly (15) comprises a support device (16) bearing said at least one pair of measuring members (17), said support device (16) comprising a pair of arms (19) integral with a stem (21), said arms (19) each having at least one measuring member (17), said stem (21) being rotated around an axis of rotation (A) by a motor member (22) so as to bring said measuring members (17) alternatively to said feed receptacle (18), to collect the powdered material, and to a position above said containers (2) to fill said containers (2).
10. An apparatus according to any one of the preceding claims, **characterized in that** it comprises a first handling assembly (9) movable to transport at least one said container (2) from said feeding station (5) to said filling station (10).
11. An apparatus according to claim 10 **characterized in that** it comprises a capping station (11) located downstream of said filling station (10); a second handling assembly (9), movable for transporting at least one said container (2) from said filling station (10) to said capping station (11) and to transport each said container (2) from said capping station (11) to a following station.
12. An apparatus according to as in claim 11, **characterized in that** it comprises a crimp capping station (44), said crimp capping station (44) being arranged downstream of said capping station (11), said capping station (11) being separate from said crimp capping station (44) by a partition wall (43); a third handling assembly (9) movable for transporting at least one said container (2) towards said crimp capping station (44).

### Patentansprüche

1. Gerät zum Befüllen von Behältern mit pulverförmigem Material, umfassend
- eine Zuführstation (5), die dazu eingerichtet ist, eine Vielzahl der Behälter (2) zuzuführen;
- eine Füllstation (10), die stromabwärts der Zuführstation (5) eingerichtet ist, die eine Messanordnung (15) umfasst, die dazu konfiguriert ist, jeden Behälter (2) mit einer gemessenen Menge an pulverförmigem Material zu füllen, wobei die Messanordnung (15) mindestens ein Paar von Messelementen (17) umfasst; einen Zuführbehälter (18), der an die Messanordnung (15) angrenzend eingerichtet ist, wobei der Zuführbehälter (18) einen Aufnahmekörper (31) umfasst, der in der Lage ist, eine bestimmte Menge an pulverförmigem Material aufzunehmen, wobei der Aufnahmekörper (31) um eine im Wesentlichen vertikale Drehachse (B) drehbar ist, **dadurch gekennzeichnet, dass** der Zuführbehälter (18) mindestens einen Sammelhohlraum (35) umfasst, der an einer Wand des Aufnahmekörpers (31) hergestellt ist, der als Sammelbehälter für das pulverförmige Material fungiert, wenn der Pegel des pulverförmigen Materials innerhalb des Aufnahmekörpers (31) niedriger als ein

- vorbestimmter Wert ist, wobei der Aufnahmekörper (31) dazu angepasst ist, bei Betätigung eines Motorelements (29) entlang einer Richtung parallel zu der Drehachse (B) in einem Rückgewinnungsschritt des pulverförmigen Materials verschoben zu werden, wobei der Rückgewinnungsschritt des pulverförmigen Materials auftritt, wenn der Pegel des pulverförmigen Materials innerhalb des Aufnahmekörpers niedriger als ein vorbestimmter Wert ist; wobei jedes der Messelemente (17) dazu angepasst ist, alternativ eine gemessene Menge des pulverförmigen Materials aus dem Zuführbehälter (18) zu sammeln und die gemessene Menge des pulverförmigen Materials in einen entsprechenden Behälter (2) abzugeben, wobei jedes Messelement (17) innen eine Kalibrierungskammer formt.
2. Gerät nach Anspruch 1, **dadurch gekennzeichnet, dass** der Aufnahmekörper (31) eine im Wesentlichen flache Bodenwand (33) und eine Umfangswand (34) umfasst, die sich von der Bodenwand (33) erstreckt, wobei der mindestens eine Sammelhohlraum (35) an der Bodenwand (33) hergestellt ist.
  3. Gerät nach Anspruch 2, **dadurch gekennzeichnet, dass** der Sammelhohlraum (35) Seitenwände umfasst, die sich entlang einer im Wesentlichen orthogonalen Richtung in Bezug auf die Bodenwand (33) des Aufnahmekörpers (31) erstrecken.
  4. Gerät nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** der Zuführbehälter (18) einen Deckel (32) umfasst, der oberhalb des Aufnahmekörpers (31) eingerichtet ist, wobei der Deckel (32) mindestens eine Öffnung zum Einführen der Messelemente (17) in den Aufnahmekörper (31) aufweist.
  5. Gerät nach Anspruch 4, **dadurch gekennzeichnet, dass** in dem Rückgewinnungsschritt des pulverförmigen Materials der Deckel (32) gemäß einer Verschiebungsbewegung bei Betätigung eines Motorelements entlang einer Richtung parallel zu der Drehachse (B) in der entgegengesetzten Richtung in Bezug auf die Verschiebungsbewegung des Aufnahmekörpers (31) bewegbar ist.
  6. Gerät nach Anspruch 5, **dadurch gekennzeichnet, dass** es ein optisches Sensormittel umfasst, das dazu konfiguriert ist, die Dicke der Schicht aus pulverförmigem Material innerhalb des Aufnahmekörpers (31) zu erfassen, wobei das optische Sensormittel in der Lage ist, ein Signal an eine Steuereinheit zu senden, wenn der Pegel des erfassten pulverförmigen Materials niedriger als der vorbestimmte Wert ist.
  7. Gerät nach Anspruch 6, **dadurch gekennzeichnet, dass** die Steuereinheit dazu konfiguriert ist, die Drehung des Aufnahmekörpers (31) um die Drehachse (B) eines Drehwinkels bei Empfang des Signals durch das optische Sensormittel zu steuern, um die Messelemente (17) mit dem mindestens einen Sammelhohlraum (35) auszurichten, wobei die Steuereinheit auch dazu konfiguriert ist, die Verschiebung des Aufnahmekörpers (31) und des Deckels (32) bei Empfang des Signals entlang der Richtung parallel zu der Drehachse (B) gemäß jeweils entgegengesetzten Richtungen zu steuern.
  8. Gerät nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** es einen pneumatischen Kreislauf (60) umfasst, der jedes Messelement (17) mit einer Überdruckquelle (66, 67, 67') bzw. mit einer Unterdruckquelle (63) verbindet, die dazu angepasst ist, einen Fluss eines Fluids in die Kalibrierungskammer einzuführen und einen Vakuumzustand in der Kalibrierungskammer zu erzeugen, wobei jedes Messelement (17) unabhängig mittels des pneumatischen Kreislaufs (60) zum unabhängigen Regeln des Druckwerts gespeist wird.
  9. Gerät nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Messanordnung (15) eine Tragvorrichtung (16) aufweist, die das mindestens eine Paar von Messelementen (17) trägt, wobei die Tragvorrichtung (16) ein Paar von Armen (19) aufweist, die einstückig mit einem Schaft (21) gebildet sind, wobei die Arme (19) jeweils mindestens ein Messelement (17) aufweisen, wobei der Schaft (21) durch ein Motorelement (22) um eine Drehachse (A) gedreht wird, um die Messelemente (17) alternativ zu dem Zuführbehälter (18) zu bringen, um das pulverförmige Material zu sammeln, und in eine Position oberhalb der Behälter (2) zu bringen, um die Behälter (2) zu füllen.
  10. Gerät nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** es eine erste Handhabungsanordnung (9) umfasst, die bewegbar ist, um mindestens einen Behälter (2) von der Zuführstation (5) zu der Füllstation (10) zu transportieren.
  11. Gerät nach Anspruch 10, **dadurch gekennzeichnet, dass** es eine Verschleißstation (10) stromabwärts der Füllstation (11) umfasst; eine zweite Handhabungsanordnung (9), die bewegbar ist, um mindestens einen Behälter (2) von der Füllstation (10) zu der Verschleißstation (11) zu transportieren und jeden Behälter (2) von der Verschleißstation (11) zu einer nachfolgenden Station zu transportieren.
  12. Gerät nach Anspruch 11, **dadurch gekennzeichnet,**

**net, dass** es eine Crimp-Verschleißstation (44) umfasst, wobei die Crimp-Verschleißstation (44) stromabwärts der Verschleißstation (11) eingerichtet ist, wobei die Verschleißstation (11) von der Crimp-Verschleißstation (44) durch eine Trennwand (43) getrennt ist;  
eine dritte Handhabungsanordnung (9), die zum Transportieren mindestens eines Behälters (2) in Richtung der Crimp-Verschleißstation (44) bewegbar ist.

## Revendications

1. Appareil de remplissage de contenants avec un matériau pulvérulent comprenant

une station d'alimentation (5) agencée pour alimenter une pluralité desdits contenants (2) ;  
une station de remplissage (10), agencée en aval de ladite station d'alimentation (5), comprenant un ensemble de mesure (15) configuré pour remplir chaque dit contenant (2) avec une quantité mesurée de matériau pulvérulent, ledit ensemble de mesure (15) comprenant au moins une paire d'éléments de mesure (17) ; un réceptacle d'alimentation (18), agencé de manière adjacente audit ensemble de mesure (15), ledit réceptacle d'alimentation (18) comprenant un corps de contenant (31) capable de contenir une certaine quantité de matériau pulvérulent, ledit corps de contenant (31) pouvant tourner autour d'un axe de rotation (B) sensiblement vertical,

**caractérisé en ce que** ledit réceptacle d'alimentation (18) comprend au moins une cavité de collecte (35) réalisée sur une paroi dudit corps de contenant (31) qui fonctionne comme un réservoir de collecte dudit matériau pulvérulent lorsque le niveau dudit matériau pulvérulent à l'intérieur dudit corps de contenant (31) est inférieur à une valeur prédéterminée, dans lequel ledit corps de contenant (31) est adapté pour être translaté, lors de l'actionnement d'un élément moteur (29), le long d'une direction parallèle audit axe de rotation (B), dans une étape de récupération dudit matériau pulvérulent, ladite étape de récupération dudit matériau pulvérulent se produisant lorsque le niveau dudit matériau pulvérulent à l'intérieur dudit corps de contenant est inférieur à une valeur prédéterminée ;

dans lequel chacun desdits éléments de mesure (17) est apte à collecter alternativement une quantité mesurée dudit matériau pulvérulent à partir dudit réceptacle d'alimentation (18) et à déverser ladite quantité mesurée dudit matériau pulvérulent dans un contenant (2) relatif, dans

lequel chacun desdits éléments de mesure (17) forme intérieurement une chambre d'étalonnage.

2. Appareil selon la revendication 1, **caractérisé en ce que** ledit corps de contenant (31) comprend une paroi de fond (33) sensiblement plate et une paroi de périmètre (34), qui s'étend à partir de ladite paroi de fond (33), ladite au moins une cavité de collecte (35) étant réalisée sur ladite paroi de fond (33).
3. Appareil selon la revendication 2, **caractérisé en ce que** ladite cavité de collecte (35) comprend des parois latérales qui s'étendent le long d'une direction sensiblement orthogonale par rapport à ladite paroi de fond (33) dudit corps de contenant (31).
4. Appareil selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit réceptacle d'alimentation (18) comprend un couvercle (32) agencé au-dessus dudit corps de contenant (31), ledit couvercle (32) ayant au moins une ouverture pour insérer lesdits éléments de mesure (17) dans ledit corps de contenant (31).
5. Appareil selon la revendication 4, **caractérisé en ce que**, dans ladite étape de récupération dudit matériau pulvérulent, ledit couvercle (32) est mobile selon un mouvement de translation, lors de l'actionnement d'un élément moteur, le long d'une direction parallèle audit axe de rotation (B), dans la direction opposée par rapport au mouvement de translation dudit corps de contenant (31).
6. Appareil selon la revendication 5, **caractérisé en ce qu'il** comprend un moyen de capteur optique configuré pour détecter l'épaisseur de la couche de matériau pulvérulent à l'intérieur dudit corps de contenant (31), ledit moyen de capteur optique étant capable d'envoyer un signal à une unité de commande lorsque le niveau dudit matériau pulvérulent détecté est inférieur à ladite valeur prédéterminée.
7. Appareil selon la revendication 6, **caractérisé en ce que** ladite unité de commande est configurée pour commander la rotation dudit corps de contenant (31) autour dudit axe de rotation (B) d'un angle de rotation, lors de la réception dudit signal par ledit moyen de capteur optique, de manière à aligner lesdits éléments de mesure (17) avec ladite au moins une cavité de collecte (35), ladite unité de commande étant également configurée pour commander la translation dudit corps de contenant (31) et dudit couvercle (32), lors de la réception dudit signal, le long de ladite direction parallèle audit axe de rotation (B) selon des directions respectivement opposées.
8. Appareil selon l'une quelconque des revendications

précédentes, **caractérisé en ce qu'il** comprend un circuit pneumatique (60) qui relie chaque dit élément de mesure (17) à une source de pression positive (66, 67, 67') et à une source de pression négative (63) respectivement, adapté pour introduire un écoulement d'un fluide à l'intérieur de ladite chambre d'étalonnage et pour créer une condition de vide dans ladite chambre d'étalonnage, chaque dit élément de mesure (17) étant alimenté indépendamment au moyen dudit circuit pneumatique (60) pour réguler la valeur de pression indépendamment.

9. Appareil selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit ensemble de mesure (15) comprend un dispositif de support (16) portant ladite au moins une paire d'éléments de mesure (17), ledit dispositif de support (16) comprenant une paire de bras (19) solidaires d'une tige (21), lesdits bras (19) ayant chacun au moins un élément de mesure (17), ladite tige (21) étant mise en rotation autour d'un axe de rotation (A) par un élément moteur (22) de manière à amener lesdits éléments de mesure (17) alternativement audit réceptacle d'alimentation (18), pour collecter le matériau pulvérulent, et à une position au-dessus desdits contenants (2) pour remplir lesdits contenants (2).
 

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10. Appareil selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'il** comprend un premier ensemble de manipulation (9) mobile pour transporter au moins un dit contenant (2) de ladite station d'alimentation (5) à ladite station de remplissage (10).
 

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11. Appareil selon la revendication 10, **caractérisé en ce qu'il** comprend une station de capsulage (11) située en aval de ladite station de remplissage (10) ; un deuxième ensemble de manipulation (9), mobile pour transporter au moins un dit contenant (2) de ladite station de remplissage (10) à ladite station de capsulage (11) et pour transporter chaque dit contenant (2) de ladite station de capsulage (11) à une station suivante.
 

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12. Appareil selon la revendication 11, **caractérisé en ce qu'il** comprend une station de capsulage par sertissage (44), ladite station de capsulage par sertissage (44) étant agencée en aval de ladite station de capsulage (11), ladite station de capsulage (11) étant séparée de ladite station de capsulage par sertissage (44) par une paroi de séparation (43) ; un troisième ensemble de manipulation (9) mobile pour transporter au moins un dit contenant (2) vers ladite station de capsulage par sertissage (44).
 

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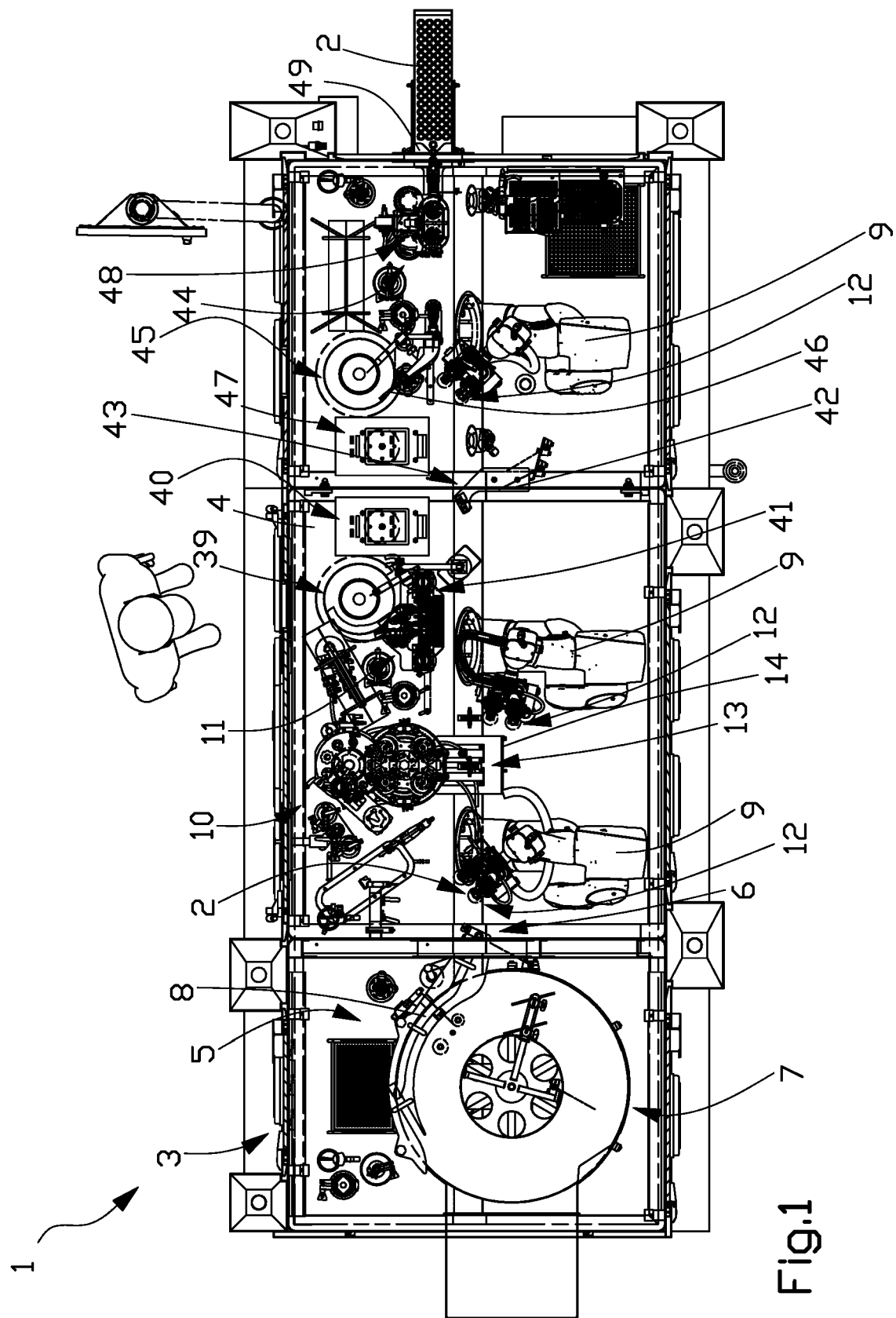
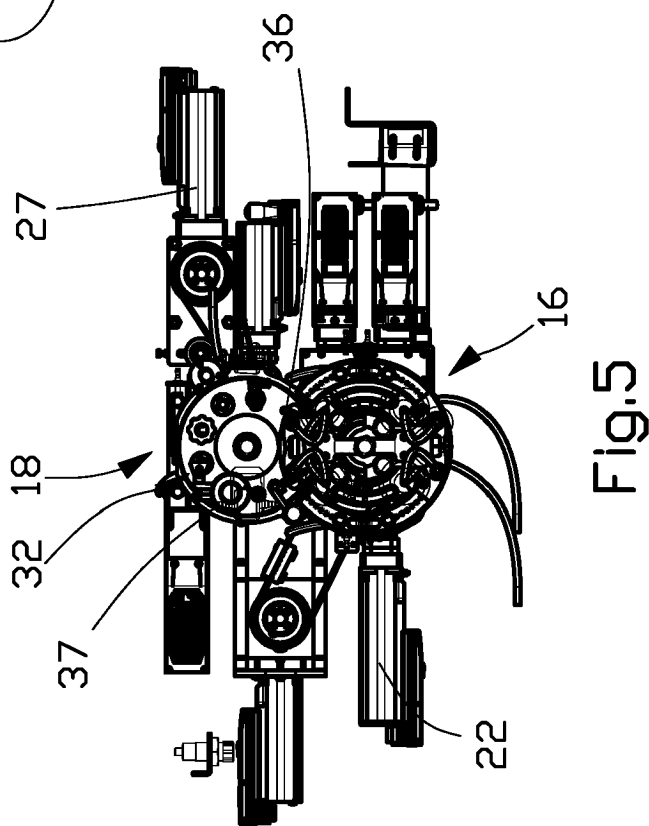
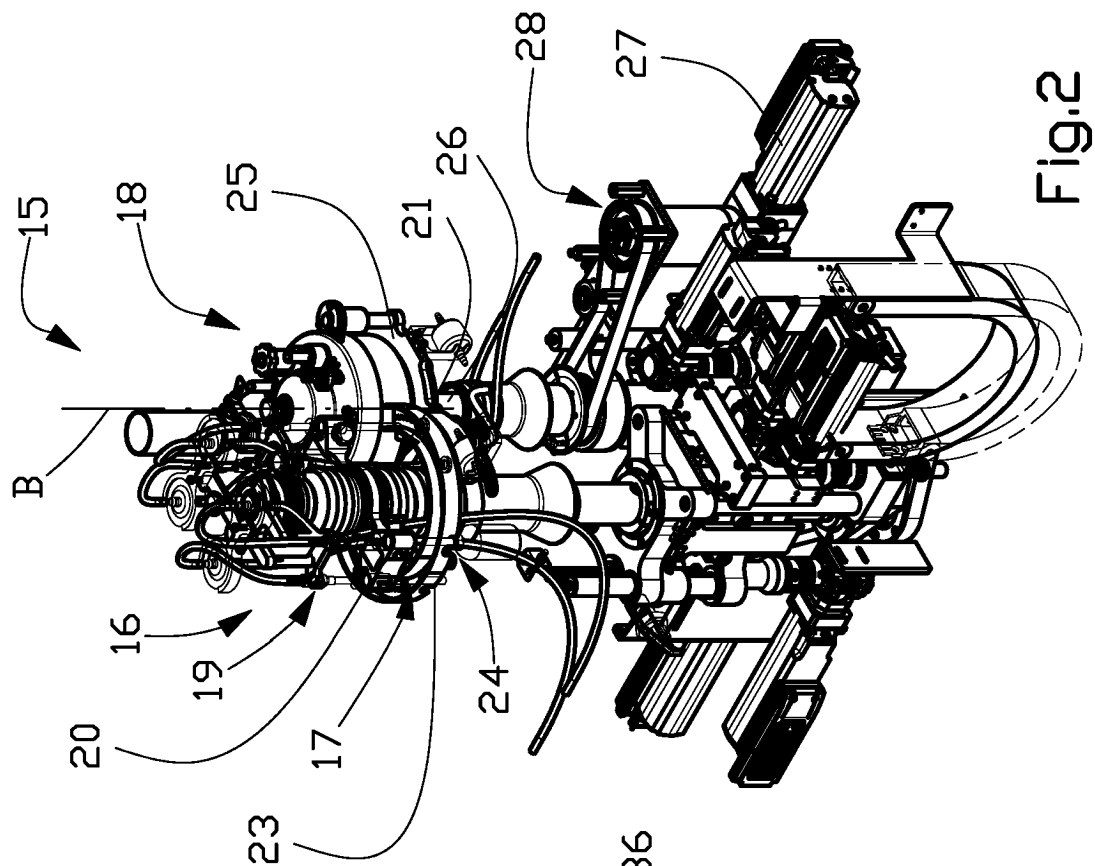
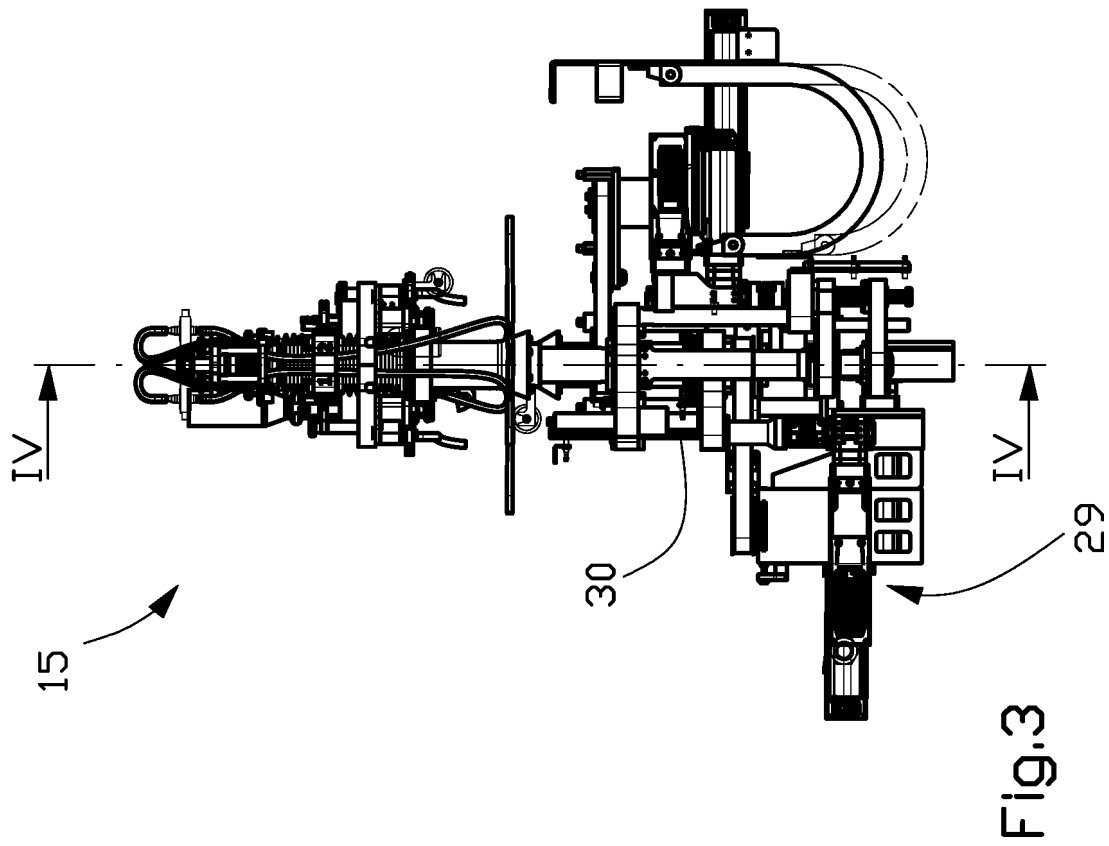
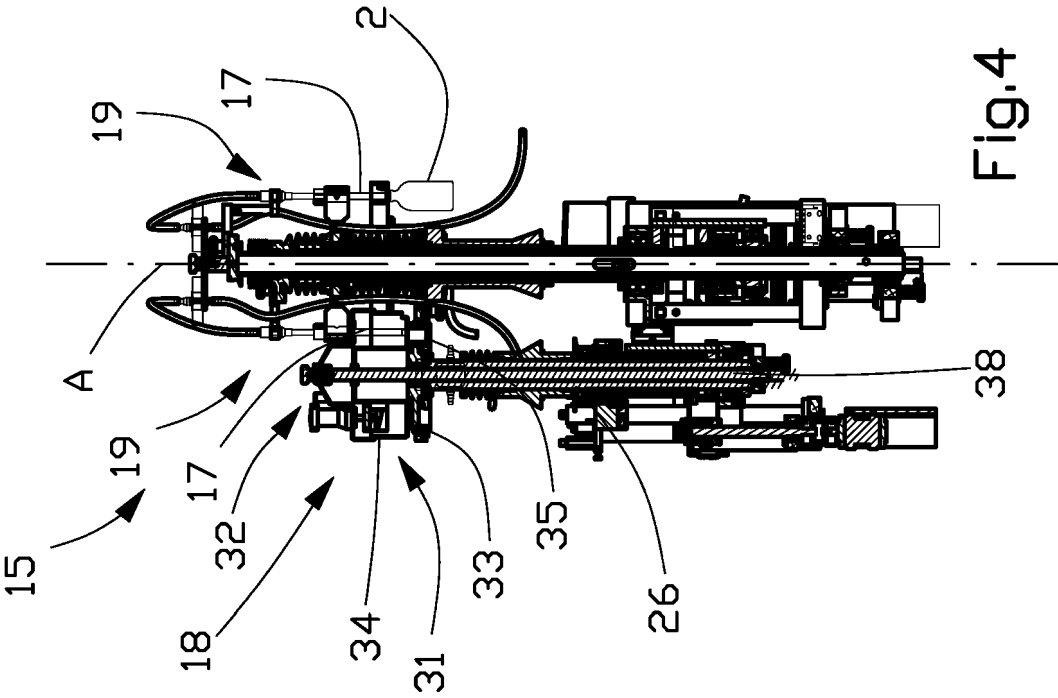
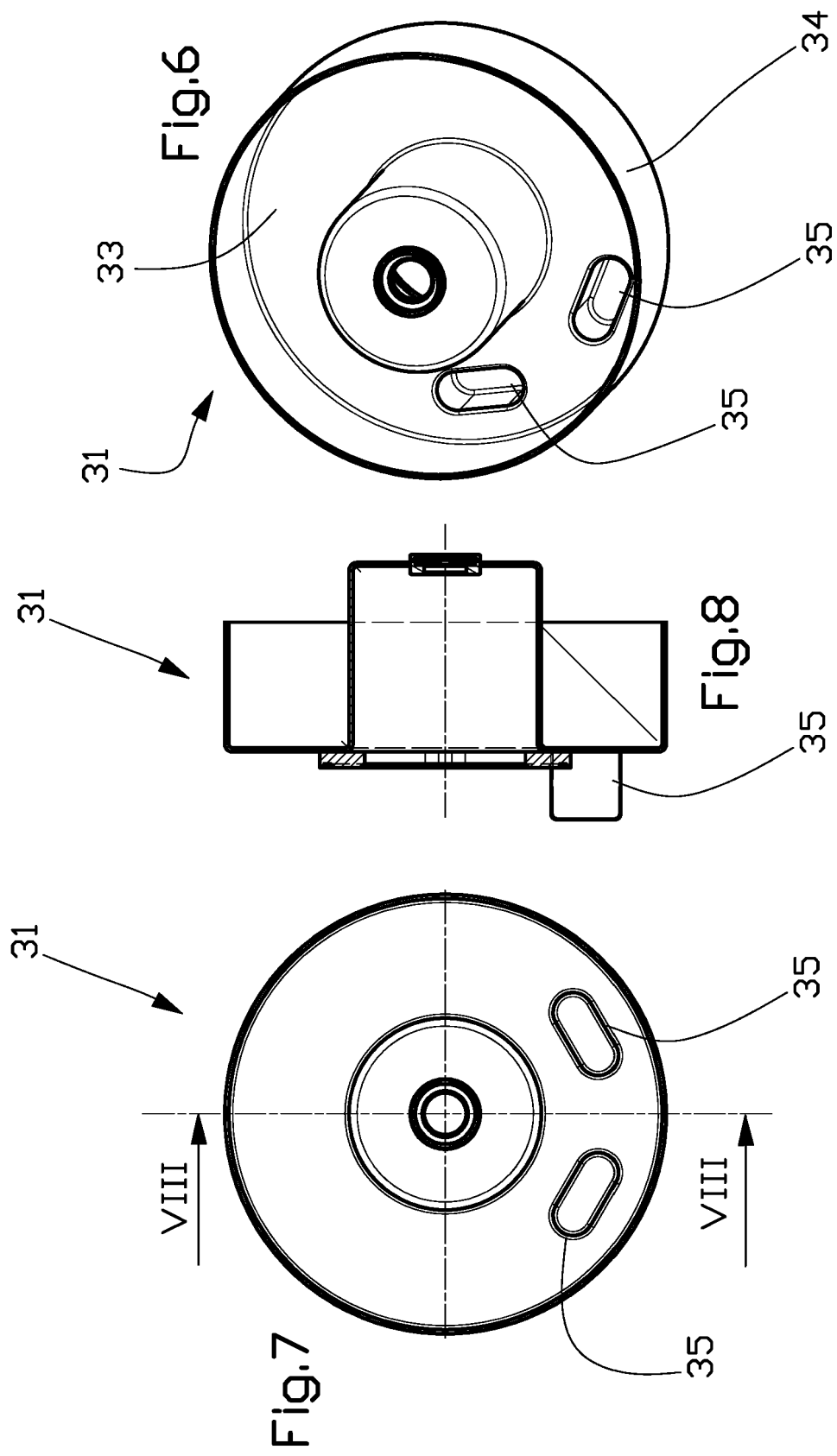


Fig.1







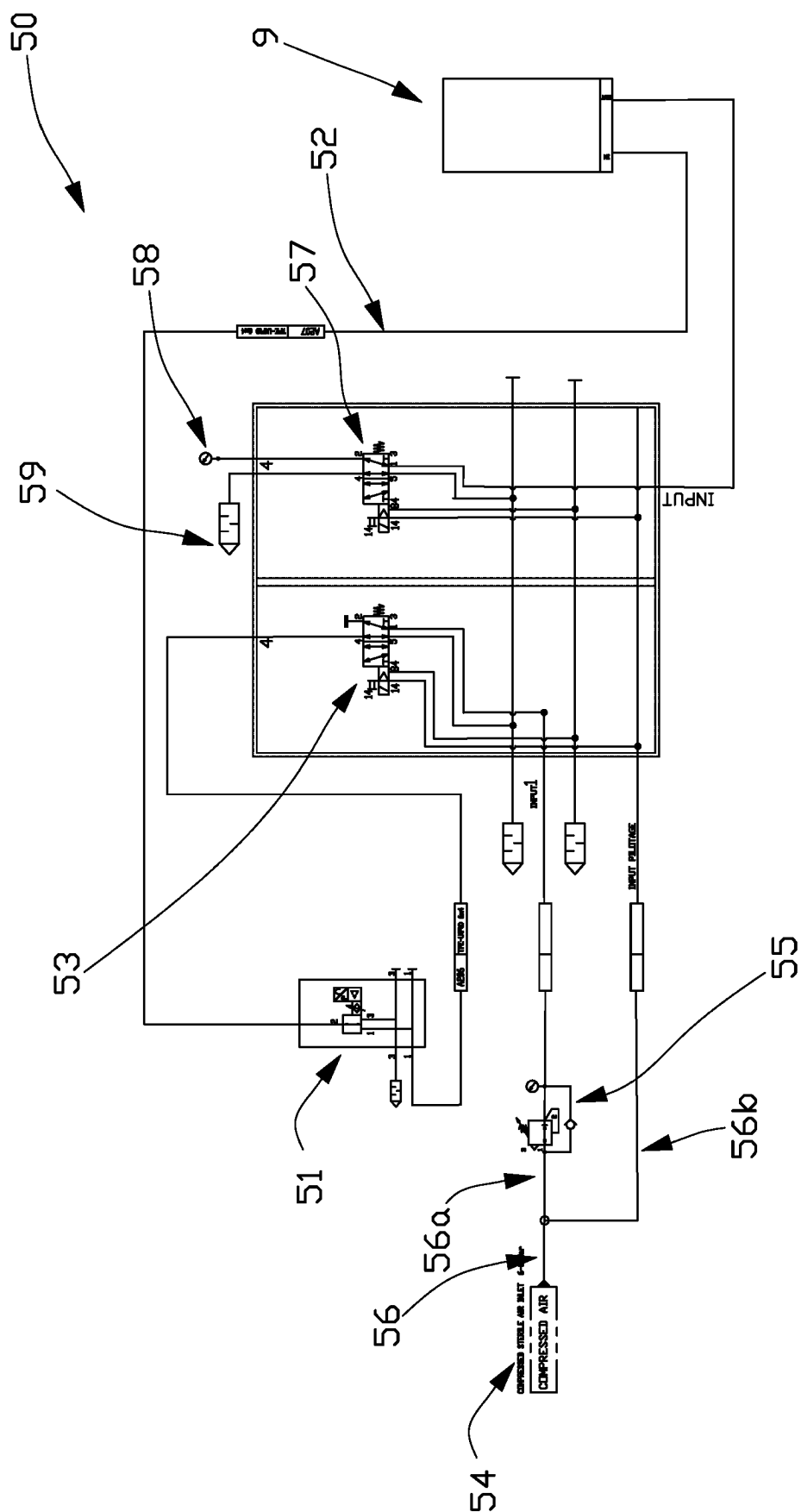


Fig. 9

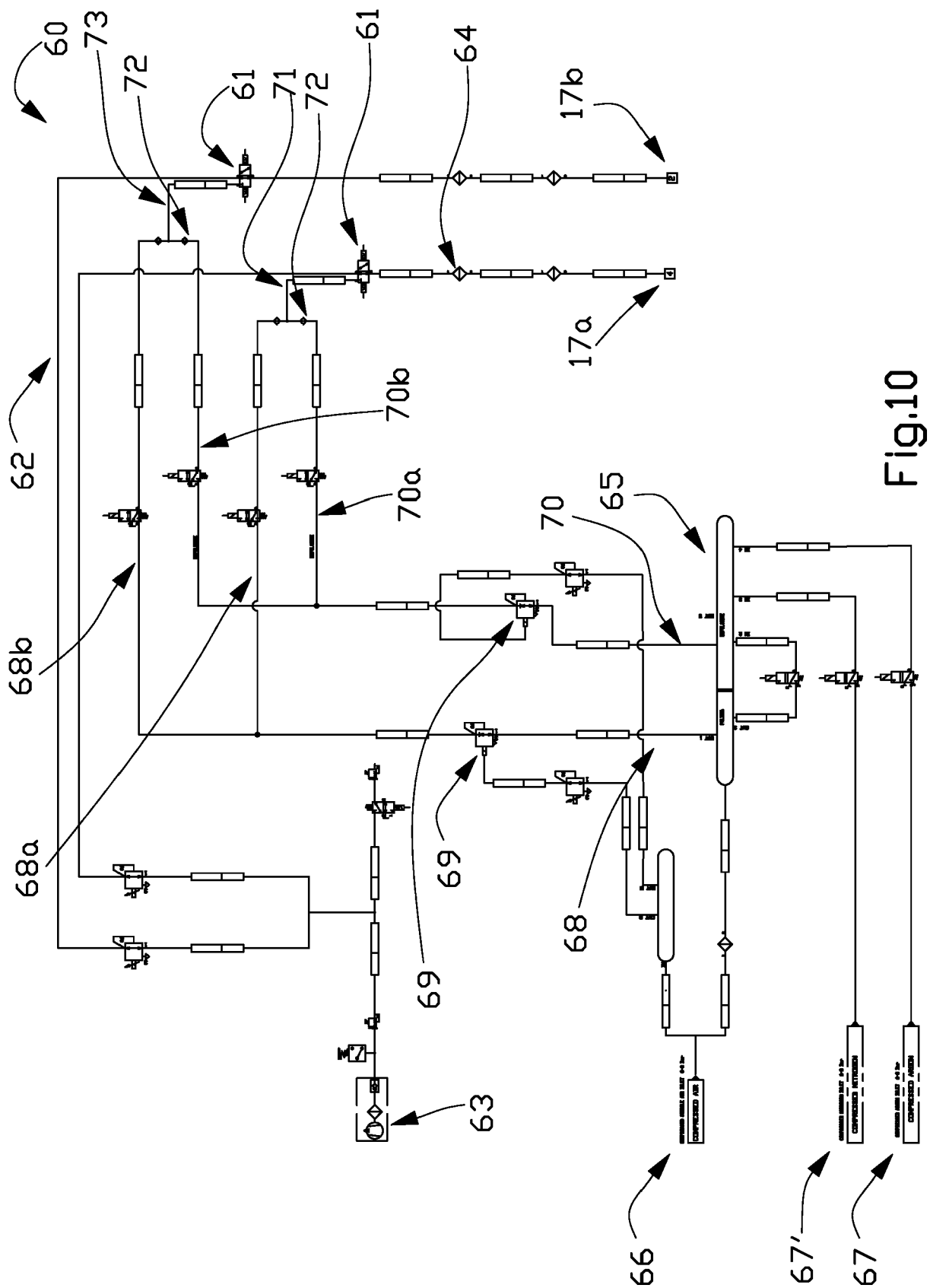


Fig.10

**REFERENCES CITED IN THE DESCRIPTION**

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