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(71) Applicant: **Eme Engel Machinefabriek en Engineering B.V.**
1508 EV Zaandam (NL)

(72) Inventors:

• **BEEK, Rombert Christiaan**
8014 GK ZWOLLE (NL)

• **DEKKERS, Ronald Petrus Gerardus**
8043 KC ZWOLLE (NL)

(74) Representative: **EP&C**

P.O. Box 3241

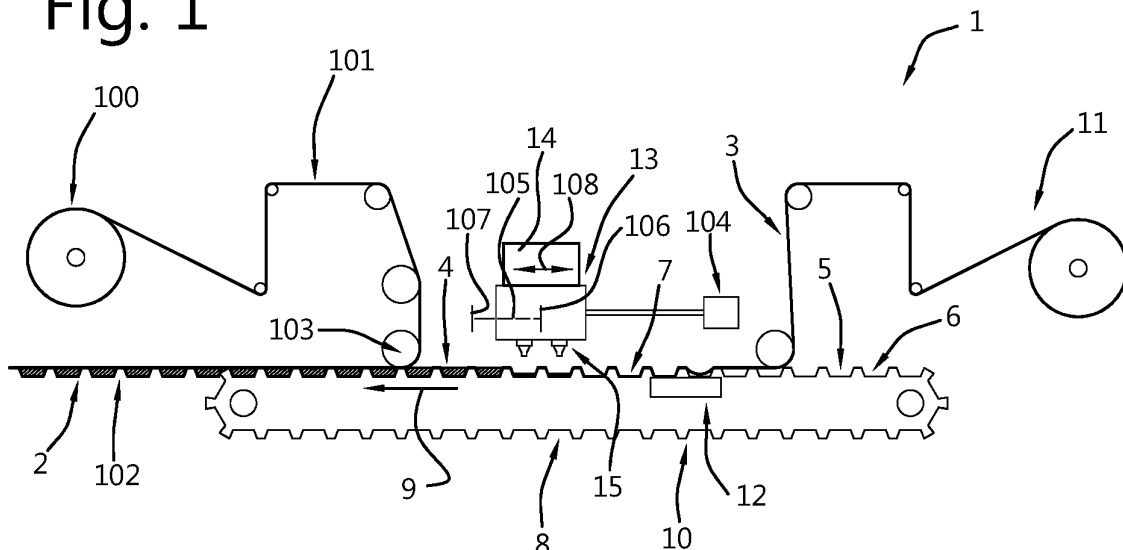
2280 GE Rijswijk (NL)

(54) **PACKAGING SYSTEM FOR PRODUCING POUCHES COMPRISING A WATER-SOLUBLE FOIL AND A FLUID**

(57) A packaging system for producing pouches comprising a water-soluble foil and a fluid, the packaging system comprising multiple moulds, each mould having a mould cavity for forming a compartment in the foil, and a mould conveyer configured to move the moulds in a conveying direction along a mould trajectory, such as an endless mould trajectory, and wherein the moulds are moved along a foil supplying device configured to position the foil on the moulds, a compartment forming device

configured to position parts of the foil in the mould cavities to form the compartments in the foil, a filling device comprising a fluid supply and multiple fluid dispensers configured to dispense the fluid in the compartments, and wherein the filling device comprises at least one reciprocating pump in fluid communication with the fluid supply and the fluid dispensers in order to pump the fluid out of the fluid dispensers.

Fig. 1



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DescriptionFIELD OF THE INVENTION

[0001] The invention relates to a packaging system for producing pouches comprising a water-soluble foil and a fluid. More specifically, the packaging system may be used for producing pouches containing a detergent fluid.

BACKGROUND OF THE INVENTION

[0002] The known packaging system has the disadvantage that a relatively high degree of maintenance is required.

[0003] The invention is based on the insight that the relatively high degree of maintenance can be caused by different factors, and may relate to characteristics of the fluid.

SUMMARY OF THE INVENTION

[0004] The invention has the objective to provide an improved, or at least alternative, packaging system and method for producing pouches comprising a water-soluble foil and a fluid.

[0005] This objective is achieved by a packaging system for producing pouches comprising a water-soluble foil and a fluid. The packaging system comprises:

- multiple moulds, each mould having a mould cavity for forming a compartment in the foil, and
- a mould conveyer configured to move the moulds in a conveying direction along a mould trajectory, such as an endless mould trajectory, and wherein the moulds are moved along:

- a foil supplying device configured to position the foil on the moulds,
- a compartment forming device configured to position parts of the foil in the mould cavities to form the compartments in the foil,
- a filling device comprising a fluid supply and multiple fluid dispensers configured to dispense the fluid in the compartments, and wherein:

- the filling device comprises at least one reciprocating pump in fluid communication with the fluid supply and the fluid dispensers in order to pump the fluid out of the fluid dispensers,

- the at least one reciprocating pump comprises a cylindrical chamber and a cylindrical plunger, which cylindrical plunger is configured to move through the cylindrical chamber in a reciprocating manner,
- the cylindrical chamber comprises an inner chamber surface,
- the cylindrical plunger comprises an out-

er plunger surface facing and in use moving along the inner chamber surface, and --- the inner chamber surface and the outer plunger surface are made of a ceramic material. Said packaging system, more specifically the filling device, requires a lower degree of maintenance.

[0006] In an embodiment of the packaging system according to the invention, the inner chamber surface of the cylindrical chamber and the outer plunger surface of the cylindrical plunger have a tolerance fit configured to prevent leakage of the fluid. This has the advantage that a robust seal between the cylindrical chamber and the cylindrical plunger is formed. Said tolerance fit may be between 1 μm and 10 μm , preferably between 2 μm and 7 μm , preferably between 2,5 μm and 5 μm . These specific tolerance fits can advantageously be used with the below mentioned fluids (and the gels) being provided with particles. These specific tolerance fits tend to provide an accurate seal combined with a relatively high wear resistance.

[0007] In an embodiment of the packaging system according to the invention, the reciprocating pump is free from any elastomeric seal. This has the advantage that the seal of the pump will not deteriorate by chemical reactions or mechanical interaction between elastomeric material and the fluid.

[0008] In an embodiment of the packaging system according to the invention, the filling device is configured to supply the fluid being provided with particles having an EQPC (diameter of a circle of equal projection area) particle size distribution of d_{10} is between 350 μm and 700 μm , preferable between 400 μm and 650 μm , preferably between 450 μm and 600 μm , with the fluid supply to the reciprocating pump in order to dispense said fluid in the compartments with the fluid dispensers. EQPC is the diameter of a circle that has the same area as the projection area of the particle.

[0009] In an embodiment of the packaging system according to the invention, the fluid supply is at least partly filled with said fluid being provided with particles having an EQPC (diameter of a circle of equal projection area) particle size distribution of d_{10} is between 350 μm and 700 μm , preferable between 400 μm and 650 μm , preferably between 450 μm and 600 μm .

[0010] In an embodiment of the packaging system according to the invention, the filling device is configured to supply the fluid being provided with particles having an EQPC (diameter of a circle of equal projection area) particle size distribution of d_{50} is between 600 μm and 950 μm , preferable between 650 μm and 900 μm , preferably between 700 μm and 850 μm , with the fluid supply to the reciprocating pump in order to dispense said fluid in the compartments with the fluid dispensers.

[0011] In an embodiment of the packaging system according to the invention, the fluid supply is at least partly filled with said fluid being provided with particles

having an EQPC (diameter of a circle of equal projection area) particle size distribution of d50 is between 600 μm and 950 μm , preferable between 650 μm and 900 μm , preferably between 700 μm and 850 μm .

[0012] In an embodiment of the packaging system according to the invention, the filling device is configured to supply the fluid being provided with particles having an EQPC (diameter of a circle of equal projection area) particle size distribution of d90 is between 800 μm and 1200 μm , preferable between 850 μm and 1200 μm , preferably between 900 μm and 1150 μm , with the fluid supply to the reciprocating pump in order to dispense said fluid in the compartments with the fluid dispensers.

[0013] In an embodiment of the packaging system according to the invention, the fluid supply is at least partly filled with said fluid being provided with particles having an EQPC (diameter of a circle of equal projection area) particle size distribution of d90 is between 800 μm and 1200 μm , preferable between 850 μm and 1200 μm , preferably between 900 μm and 1150 μm .

[0014] In an embodiment of the packaging system according to the invention, the filling device is configured to supply the fluid being provided with particles having an EQPC (diameter of a circle of equal projection area) of between 1 μm and 2000 μm , preferably between 1 μm and 1800 μm , preferably between 2 μm and 1500 μm , with the fluid supply to the reciprocating pump in order to dispense said fluid in the compartments with the fluid dispensers. EQPC is the diameter of a circle that has the same area as the projection area of the particle.

[0015] In an embodiment of the packaging system according to the invention, the fluid supply is at least partly filled with said fluid being provided with particles having an EQPC (diameter of a circle of equal projection area) of between 1 μm and 2000 μm , preferably between 1 μm and 1800 μm , preferably between 2 μm and 1500 μm .

[0016] In an embodiment of the packaging system according to the invention, wherein said particles have an aspect ratio of between 0,2 and 1, preferably between 0,3 and 0,98, preferably between 0,4 and 0,95, and preferably between 0,45 and 0,9. The aspect ratio is defined by the ratio of the minimum feret diameter to the maximum feret diameter.

[0017] In an embodiment of the packaging system according to the invention, the fluid supply is at least partly filled with the fluid having said particles having an aspect ratio of between 0,2 and 1, preferably between 0,3 and 0,98, preferably between 0,4 and 0,95, and preferably between 0,45 and 0,9.

[0018] In an embodiment of the packaging system according to the invention, the filling device is configured to supply the fluid being a gel having a viscosity of between 50 mPa.s and 1.000.000 mPa.s, preferably between 100 mPa.s and 500.000 mPa.s, preferably between 1000 mPa.s and 300.000 mPa.s, with the fluid supply to the reciprocating pump in order to dispense said gel in the compartments with the fluid dispensers. The

viscosity is determined by rheological measurements.

[0019] In an embodiment of the packaging system according to the invention, the fluid supply is at least partly filled with said gel having a viscosity of between 50 mPa.s and 1.000.000 mPa.s, preferably between 100 mPa.s and 500.000 mPa.s, preferably between 1000 mPa.s and 300.000 mPa.s.

[0020] In an embodiment of the packaging system according to the invention, said gel is a shear-thinning gel. The viscosity may apply at a shear rate between 1000 g/L and 1600 g/L, preferably between 0,001 1/s and 10000 1/s, preferably between 0,01 1/s and 1000 1/s.

[0021] In an embodiment of the packaging system according to the invention, the fluid supply is at least partly filled with said gel being a shear-thinning gel, wherein optionally the viscosity applies at a shear rate between 1000 g/L and 1600 g/L, preferably between 0,001 1/s and 10000 1/s, preferably between 0,01 1/s and 1000 1/s.

[0022] In an embodiment of the packaging system according to the invention, said gel has a density of between 1100 g/L and 1500 g/L, preferably between 1250 g/L and 1350 g/L.

[0023] In an embodiment of the packaging system according to the invention, the fluid supply is at least partly filled with said gel having a density of between 1100 g/L and 1500 g/L, preferably between 1250 g/L and 1350 g/L.

[0024] In an embodiment of the packaging system according to the invention, the filling device comprises several of the at least one reciprocating pump and said reciprocating pumps are in fluid connection with the fluid dispensers. Each of the reciprocating pumps may be in fluid connection with only one of the fluid dispensers.

[0025] In an embodiment of the packaging system according to the invention, the cylindrical plunger comprises a plunger end surface which is configured to reciprocally move in the cylindrical chamber and is made of a ceramic material. The plunger end surface and the plunger outer surface may be integrally formed.

[0026] In an embodiment of the packaging system according to the invention, the cylindrical plunger is made of the ceramic material. The complete cylindrical plunger may be made of the ceramic material.

[0027] In an embodiment of the packaging system according to the invention, the cylindrical chamber is formed by a chamber housing having the inner chamber surface and the chamber housing is made of the ceramic material. The complete chamber housing may be made of the ceramic material.

[0028] In an embodiment of the packaging system according to the invention, the cylindrical plunger comprises an internally extending plunger duct which is in fluid communication with the fluid supply, and the plunger duct comprises a duct opening at the plunger end surface to allow the fluid to enter the cylindrical chamber via the plunger duct.

[0029] In an embodiment of the packaging system

according to the invention, the cylindrical plunger extends along a longitudinal plunger axis and the duct opening surrounds the longitudinal plunger axis. The plunger end surface may extend from the duct opening to the inner chamber surface. A centre of duct opening may coincide with the longitudinal plunger axis. The complete plunger duct may extend along the longitudinal plunger axis of the cylindrical plunger. A longitudinal plunger duct axis of the plunger duct may coincide with the longitudinal plunger axis of the cylindrical plunger. The plunger duct may comprise an inner duct surface made of a ceramic material.

[0030] In an embodiment of the packaging system according to the invention, the plunger end surface radially extends transverse with respect to the longitudinal plunger axis. The plunger end surface may radially extend at an end surface angle of between 1 degrees and 25 degrees, preferably between 2 degrees and 20 degrees, preferably between 5 degrees and 15 degrees, relative to a fictive reference plane extending perpendicular to the longitudinal plunger axis. The end surface angle of the plunger end surface may vary in radial direction with respect to said fictive reference plane. The end surface angle of the plunger end surface may be constant in radial direction with respect to said fictive reference plane.

[0031] In an embodiment of the packaging system according to the invention, the plunger end surface extends beyond the duct opening in a downstream direction. The end surface may widen in a downstream direction. The plunger end surface may have a concave form or a conical form.

[0032] In an embodiment of the packaging system according to the invention, the cylindrical chamber comprises a chamber opening to discharge fluid, the reciprocating pump comprises a receiving duct downstream of the cylindrical chamber, the receiving duct comprises a receiving duct opening which is connected to the chamber opening and has the same form and size as the chamber opening, and the receiving duct has a funnel shape which narrows in a downstream direction.

[0033] In an embodiment of the packaging system according to the invention, the reciprocating pump comprises an inlet valve located upstream of the cylindrical plunger and in fluid communication with the plunger duct of the cylindrical plunger, the inlet valve comprises an inlet valve inner duct being configured to rotate from an inlet valve inactive position to block passage of the fluid into an inlet valve active position to allow passage of the fluid, and vice versa. The inlet valve inner duct may comprise an inner inlet duct surface made of a ceramic material.

[0034] In an embodiment of the packaging system according to the invention, the inlet valve comprises an inlet valve housing and a rotatable inlet valve member arranged within the inlet valve housing, the inlet valve inner duct is provided in the inlet valve member, the inlet valve member is rotatable with respect to the inlet valve housing to move the inlet valve inner duct from the inlet

valve inactive position into the inlet valve active position, and vice versa, and the inlet valve housing and/or the inlet valve member are made of a ceramic material. The complete inlet valve housing and/or the complete inlet valve member may be made of the ceramic material

In an embodiment of the packaging system according to the invention, the reciprocating pump comprises an outlet valve located downstream of the cylindrical chamber and in fluid communication with the cylindrical chamber, and the outlet valve comprises an outlet valve inner duct being configured to rotate from an outlet valve inactive position to block passage of the fluid into an outlet valve active position to allow passage of the fluid, and vice versa. The outlet valve inner duct may comprise an inner outlet duct surface made of a ceramic material.

[0035] In an embodiment of the packaging system according to the invention, the outlet valve comprises an outlet valve housing and a rotatable outlet valve member arranged within the outlet valve housing, the outlet valve inner duct is provided in the outlet valve member, and the outlet valve member is rotatable with respect to the outlet valve housing to move the outlet valve inner duct from the outlet valve inactive position into the outlet valve active position, and vice versa, and the outlet valve housing and the outlet valve member are made of a ceramic material. The complete outlet valve housing and the complete outlet valve member may be made of the ceramic material

[0036] In an embodiment of the packaging system according to the invention, the receiving duct is located between the cylindrical chamber and the outlet valve. A dispensing duct having a dispensing opening may be located downstream of the outlet valve.

[0037] In an embodiment of the packaging system according to the invention, the reciprocating pump comprises an alignment unit to allow alignment of the cylindrical plunger and the cylindrical chamber during the reciprocating movement of the cylindrical plunger, the alignment unit comprises an alignment receiving port located downstream of the inlet valve and in fluid communication with the inlet valve inner duct and an alignment discharging port connected to the cylindrical plunger and in fluid communication with the plunger duct, and a flexible alignment duct extending between the alignment receiving port and the alignment discharging port. The alignment unit can advantageously be used with the above mentioned fluids (and the gels) being provided with particles in order to achieved an increased wear resistance.

[0038] In an embodiment of the packaging system according to the invention, the alignment unit is configured to allow pivotal movement of the alignment discharging port about a first pivot axis extending perpendicular to the longitudinal plunger axis. The first pivot axis allowing pivotal movement of the alignment discharging port tends to combine a robust construction with an increased wear resistance.

[0039] In an embodiment of the packaging system

according to the invention, the alignment unit is configured to allow pivotal movement of the alignment discharging port about a second pivot axis extending perpendicular to the longitudinal plunger axis, which first pivot axis optionally extends perpendicular to the second pivot axis. The second pivot axis allowing pivotal movement of the alignment discharging port tends to increase the wear resistance further while having a relatively robust construction.

[0040] In an embodiment of the packaging system according to the invention, the inlet valve inner duct and/or alignment duct and/or the plunger duct and/or the receiving duct and/or the inlet valve inner duct located in the inlet valve active position and/or the outlet valve inner duct located in the outlet valve active position and/or the dispensing duct are aligned.

[0041] In an embodiment of the packaging system according to the invention, the ceramic material is an oxide based ceramic, such as an alumina based ceramic and/or a zirconia based ceramic. These ceramic materials can advantageously be used with the above mentioned fluids (and the gels) being provided with particles in order to achieve an increased wear resistance resulting in a low degree of maintenance. These ceramic materials allow that low friction coefficients can be achieved, such as for the inner chamber surface and the outer plunger surface.

[0042] In an embodiment of the packaging system according to the invention, the packaging system comprises a further foil supplying device configured to position a water-soluble further foil on the foil and over the fluid in the compartments in order to form a web of pouches holding the fluid between the foil and the further foil.

[0043] In an embodiment of the packaging system according to the invention, the packaging system comprises a connecting device to connect the foil and the further foil to each other.

[0044] The above defined properties of the fluid, and therefore also of the gel, and the particles are performed at an atmospheric pressure of about 1 bar and at a temperature of about 25 degrees Celsius.

[0045] It will be clear to the skilled person that the features of any combination of the above defined embodiments of the packaging system according to the invention may be combined.

[0046] The invention further relates to a method for producing pouches comprising a water-soluble foil and a fluid with a packaging system according to the invention, which method comprises moving the cylindrical plunger of the at least one reciprocating pump within the cylindrical chamber in a reciprocating manner in order to pump said fluid out of the fluid dispensers and in the compartments formed in the foil.

[0047] In an embodiment of the method according to the invention, said gel is pumped out of the fluid dispensers and in the compartments formed in the foil.

BRIEF DESCRIPTION OF THE DRAWINGS

[0048] Embodiments of the packaging system according to invention and the method according to the invention will be described by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, and in which:

Figure 1 schematically shows an overview of a first example of the packaging system according to the invention,

Figure 2 schematically shows an overview of a second example of the packaging system according to the invention,

Figure 3A schematically shows a view in perspective of an embodiment of the filling device of the packaging system of the Figures 1 and 2,

Figure 3B schematically shows the view in perspective of figure 3A in which parts are removed,

Figure 4A schematically shows another view in perspective of the filling device of Figure 3A,

Figure 4B schematically shows the view in perspective of figure 4A in which parts are removed,

Figure 5A schematically shows a side view of the filling device of Figure 3A located in the lower position,

Figure 5B schematically shows the side view of figure 5A in which parts are removed,

Figure 5C schematically shows a cross sectional view of figure 5A,

Figure 5D schematically shows the side view of the filling device of Figure 5A located in the upper position,

Figure 5E schematically shows the side view of figure 5D in which parts are removed,

Figure 5F schematically shows a cross sectional view of figure 5D,

Figure 6A schematically shows another side view of the filling device of Figure 3A located in the lower position,

Figure 6B schematically shows the side view of figure 6A in which parts are removed,

Figure 6C schematically shows a cross sectional view of figure 6A,

Figure 6D schematically shows the side view of the filling device of Figure 6A located in the upper position,

Figure 6E schematically shows the side view of figure 6D in which parts are removed,

Figure 6F schematically shows a cross sectional view of figure 6D, and

the Figures 7A-F schematically show the functioning of the reciprocating pump.

DETAILED DESCRIPTION OF THE DRAWINGS

[0049] Figure 1 shows an overview of a first example of

the packaging system 1 according to the invention. The packaging system 1 is configured produce pouches 2 comprising a water-soluble foil 3 and a fluid 4. The packaging system 1 comprises a fluid supply 14 which is at least partly filled with said fluid 4.

[0050] The packaging system 1 comprises multiple moulds 5. Each mould 5 has a mould cavity 6 for forming a compartment 7 in the foil 3.

[0051] A mould conveyor 8 moves the moulds 5 in a conveying direction 9 along a mould trajectory, more specifically an endless mould trajectory. The mould conveyor 8 is configured as a mould conveyor belt 10.

[0052] The moulds 5 are moved along a foil supplying device 11 configured to position the foil 3 on the moulds 5. Subsequently, a compartment forming device 12 positions parts of the foil 3 in the mould cavities 6 to form the compartments 7 in the foil 3. After that, a filling device 13 having a fluid supply 14 and multiple fluid dispensers 15 fills the compartments 7 with the fluid 4. A further foil supplying device 100 positions a water-soluble further foil 101 on the foil 3 and over the fluid 4 in the compartments 7 in order to form a web 102 of pouches 2 holding the fluid between the foil 3 and the further foil 101. The web 62 of pouches 2 can be cut to form individualised pouches 2. The packaging system 1 also comprises a connecting device 103 to connect the foil 4 and the further foil 101 to each other.

[0053] The mould conveyor 8 is configured to continuously move the moulds 5 in the conveying direction 10 during the filling of the compartments 7. The packaging system 1 comprises a device driver 104 configured to move the filling device 13 along a filling path 105 from a first filling position 106 into a second filling position 107, and vice versa. Said reciprocating movement of the filling device 13 is indicated by arrow 108. The device driver 104 is configured to move the filling device 13 from the first filling position 106 to the second filling position 107 during the filling of the compartments 7 and from the second filling position 107 into the first filling position 106 after the filling of the compartments 7 has been completed in order to start a new filling cycle. This allows synchronous movement of the filling device 13 with the compartments 7 to be filled as the moulds 5 are continuously moved by the mould conveyor 8. In another example, the filling device 13 may remain static during the filling of the compartments 7.

[0054] Figure 2 shows an overview of a second example of the packaging system 1 according to the invention. The main difference with respect to the packaging system 1 of figure 1 is that the mould conveyor 8 is configured as a rotary mould drum 109.

[0055] The Figures 3A-B and 4A-B show views in perspective of an embodiment of the filling device 13 of the packaging system 1 of the Figures 1 and 2. Several parts are removed in the Figures 3B and 4B to obtain a further view on the inside of the filling device 13.

[0056] The filling device 13 comprises at least one reciprocating pump 16 in fluid communication with the

fluid supply 14 and the fluid dispensers 15 in order to pump the fluid out of the fluid dispensers 15.

[0057] Figure 5A shows a side view of the filling device 13 of Figure 3A located in the lower position 81. The direction of this side view is indicated by arrow V in Figure 3A. Figure 5B shows the side view of figure 5A in which several parts are removed. Figure 5C shows a cross sectional view of figure 5A. Figure 5D shows the side view of the filling device 13 of Figure 5A located in the upper position 82. Figure 5E shows the side view of figure 5D in which parts are removed. Figure 5F shows a cross sectional view of figure 5D.

[0058] Figure 6A shows a side view of the filling device 13 of Figure 3A located in the upper position 82. The direction of this side view is indicated by arrow VI in Figure 3A. Figure 6B shows the side view of figure 6A in which several parts are removed. Figure 6C shows a cross sectional view of figure 6A. Figure 6D shows the side view of the filling device 13 of Figure 6A located in the upper position 82. Figure 6E shows the side view of figure 6D in which parts are removed. Figure 6F shows a cross sectional view of figure 6D.

[0059] The one reciprocating pump 16 is movable in a reciprocating manner from a lower position 81 shown in the Figures 5A-C and 6A-C into an upper position 82 shown in the Figures 5D-F and 6D-F, and vice versa.

[0060] The inner chamber surface 24 of the cylindrical chamber 17 and the outer plunger surface 20 of the cylindrical plunger 18 have a tolerance fit 21 configured to prevent leakage of the fluid. This has the advantage that a robust seal between the cylindrical chamber 17 and the cylindrical plunger 18 is formed. Said tolerance fit 21 may be between 1 μm and 10 μm , preferably between 2 μm and 7 μm , preferably between 2,5 μm and 5 μm .

[0061] The reciprocating pump 16 is free from any elastomeric seal. This has the advantage that the seal of the pump will not deteriorate by chemical reactions or mechanical interaction between elastomeric material and the fluid.

[0062] The at least one reciprocating pump 16 comprises a cylindrical chamber 17 and a cylindrical plunger 18. The cylindrical plunger 18 is configured to move through the cylindrical chamber 17 in a reciprocating manner. The cylindrical chamber 17 comprises an inner chamber surface 24. The cylindrical plunger 18 comprises an outer plunger surface 20 facing and in use moving along the inner chamber surface 24. The inner chamber surface 24 and the outer plunger surface 20 are made of a ceramic material. Said packaging system 1, more specifically the filling device 13, requires a lower degree of maintenance.

[0063] The filling device 13 comprises several of the at least one reciprocating pump 16 and said reciprocating pumps 16 are in fluid connection with the fluid dispensers 15. Each of the reciprocating pumps 16 is in fluid connection with only one of the fluid dispensers 15.

[0064] The cylindrical plunger 18 comprises a plunger end surface 22 (see the Figures 5C, 5F, 6C, 6F) which is

configured to reciprocally move in the cylindrical chamber 17 and is made of a ceramic material. The plunger end surface 22 and the plunger outer surface are integrally formed. The plunger end surface 22 and the plunger outer surface are made of the same ceramic material. The cylindrical plunger 18 is made of the ceramic material. The complete cylindrical plunger 18 is made of the ceramic material.

[0065] The cylindrical chamber 17 is formed by a chamber housing 23 having the inner chamber surface 24 and the chamber housing 23 is made of the ceramic material. The complete chamber housing 23 is made of the ceramic material.

[0066] The cylindrical plunger 18 comprises an internally extending plunger duct 25 (see the Figures 5C, 5F, 6C, 6F) which is in fluid communication with the fluid supply 14, and the plunger duct 25 comprises a duct opening 26 at the plunger end surface 22 to allow the fluid to enter the cylindrical chamber 17 via the plunger duct 25.

[0067] The cylindrical plunger 18 extends along a longitudinal plunger axis 27 and the duct opening 26 surrounds the longitudinal plunger axis 27. The plunger end surface 22 extends from the duct opening 26 to the inner chamber surface 24. A centre 28 of duct opening 26 coincides with the longitudinal plunger axis 27. The complete plunger duct 25 extends along the longitudinal plunger axis 27 of the cylindrical plunger 18. A longitudinal plunger duct axis 29 of the plunger duct 25 coincides with the longitudinal plunger axis 27 of the cylindrical plunger 18. The plunger duct 25 comprises an inner duct surface 30 made of the ceramic material.

[0068] The plunger end surface 22 radially extends transverse with respect to the longitudinal plunger axis 27. The arrows 32 indicate a radial direction with respect to the longitudinal plunger axis 27. The plunger end surface 22 extends radially at an end surface angle of between 1 degrees and 25 degrees, preferably between 2 degrees and 20 degrees, preferably between 5 degrees and 15 degrees, relative to a fictive reference plane 31 extending perpendicular to the longitudinal plunger axis 27. The end surface angle of the plunger end surface 22 may vary in radial direction 32 with respect to said fictive reference plane 31. The end surface angle of the plunger end surface 22 may be constant in radial direction 32 with respect to said fictive reference plane 31.

[0069] The plunger end surface 22 extends beyond the duct opening 26 in a downstream direction 33. The end surface widens in a downstream direction 33. The plunger end surface 22 may have a concave form or a conical form 36.

[0070] The cylindrical chamber 17 comprises a chamber opening 37 to discharge fluid. The reciprocating pump 16 comprises a receiving duct 38 downstream of the cylindrical chamber 17. The receiving duct 38 comprises a receiving duct opening 39 which is connected to the chamber opening 37 and has the same form and size as the chamber opening 37. The receiving duct 38 has a

funnel shape 40 which narrows in a downstream direction 33.

[0071] The reciprocating pump 16 comprises an inlet valve 41 located upstream of the cylindrical plunger 18 and in fluid communication with the plunger duct 25 of the cylindrical plunger 18. The arrow 34 indicates an upstream direction. The inlet valve 41 comprises an inlet valve inner duct 42 being configured to rotate from an inlet valve inactive position 43 to block passage of the fluid into an inlet valve active position 44 to allow passage of the fluid, and vice versa. The inlet valve inner duct 42 may comprise an inner inlet duct surface 45 made of a ceramic material.

[0072] The inlet valve 41 comprises an inlet valve housing 46 and a rotatable inlet valve member 47 arranged within the inlet valve housing 46. The inlet valve inner duct 42 is provided in the inlet valve member 47. The inlet valve member 47 is rotatable with respect to the inlet valve housing 46 about an inlet valve axis 71 to move the inlet valve inner duct 42 from the inlet valve inactive position 43 into the inlet valve active position 44, and vice versa. The inlet valve housing 46 and/or the inlet valve member 47 are made of a ceramic material. The complete inlet valve housing 46 and/or the complete inlet valve member 47 are made of the ceramic material.

[0073] The reciprocating pump 16 comprises an outlet valve 48 located downstream of the cylindrical chamber 17 and in fluid communication with the cylindrical chamber 17. The outlet valve 48 comprises an outlet valve inner duct 49 being configured to rotate from an outlet valve inactive position 50 to block passage of the fluid into an outlet valve active position 51 to allow passage of the fluid, and vice versa. The outlet valve inner duct 49 comprises an inner outlet duct surface 52 made of a ceramic material.

[0074] The outlet valve 48 comprises an outlet valve housing 53 and a rotatable outlet valve member 54 arranged within the outlet valve housing 53. The outlet valve inner duct 49 is provided in the outlet valve member 54. The outlet valve member 54 is rotatable with respect to the outlet valve housing 53 about an outlet valve axis 72 to move the outlet valve inner duct 49 from the outlet valve inactive position 50 into the outlet valve active position 51, and vice versa. The outlet valve housing 53 and the outlet valve member 54 are made of a ceramic material. The complete outlet valve housing 53 and the complete outlet valve member 54 are made of the ceramic material.

[0075] The receiving duct 38 is located between the cylindrical chamber 17 and the outlet valve 48. A dispensing duct 55 having a dispensing opening 56 is located downstream of the outlet valve 48.

[0076] The reciprocating pump 16 comprises an alignment unit 57 to allow alignment of the cylindrical plunger 18 and the cylindrical chamber 17 during the reciprocating movement of the cylindrical plunger 18. The alignment unit 57 comprises an alignment receiving port 58 located downstream of the inlet valve 41 and in fluid

communication with the inlet valve 41 inner duct 42 and an alignment discharging port 59 connected to the cylindrical plunger 18 and in fluid communication with the plunger duct 25, and a flexible alignment duct 60 extending between the alignment receiving port 58 and the alignment discharging port 59.

[0077] The alignment unit 57 is configured to allow pivotal movement of the alignment discharging port 59 via first bearings 63 about a first pivot axis 61 extending perpendicular to the longitudinal plunger axis 27 and via second bearings 64 about a second pivot axis 62 extending perpendicular to the longitudinal plunger axis 27. The first pivot axis 61 extends perpendicular to the second pivot axis 62.

[0078] The inlet valve 41 inner duct 42, the alignment duct 60, the plunger duct 25, the receiving duct 38, the inlet valve inner duct 42 located in the inlet valve active position 44, the outlet valve inner duct 49 located in the outlet valve active position 51 and the dispensing duct 55 are aligned.

[0079] The ceramic material is an oxide based ceramic, such as an alumina based ceramic and/or a zirconia based ceramic.

[0080] The filling device 13 is configured to supply the fluid being provided with particles having an EQPC (diameter of a circle of equal projection area) particle size distribution of d_{10} is between 350 μm and 700 μm , preferable between 400 μm and 650 μm , preferably between 450 μm and 600 μm , with the fluid supply 14 to the reciprocating pump 16 in order to dispense said fluid in the compartments 7 with the fluid dispensers 15. EQPC is the diameter of a circle that has the same area as the projection area of the particle.

[0081] The filling device 13 is configured to supply the fluid being provided with particles having an EQPC (diameter of a circle of equal projection area) particle size distribution of d_{50} is between 600 μm and 950 μm , preferable between 650 μm and 900 μm , preferably between 700 μm and 850 μm , with the fluid supply 14 to the reciprocating pump 16 in order to dispense said fluid in the compartments 7 with the fluid dispensers 15.

[0082] The filling device 13 is configured to supply the fluid being provided with particles having an EQPC (diameter of a circle of equal projection area) particle size distribution of d_{90} is between 800 μm and 1200 μm , preferable between 850 μm and 1200 μm , preferably between 900 μm and 1150 μm , with the fluid supply 14 to the reciprocating pump 16 in order to dispense said fluid in the compartments 7 with the fluid dispensers 15.

[0083] The filling device 13 is configured to supply the fluid being provided with particles having an EQPC (diameter of a circle of equal projection area) of between 1 μm and 2000 μm , preferably between 1 μm and 1800 μm , preferably between 2 μm and 1500 μm , with the fluid supply 14 to the reciprocating pump 16 in order to dispense said fluid in the compartment 7s with the fluid dispensers 15. EQPC is the diameter of a circle that has the same area as the projection area of the particle.

[0084] Said particles have an aspect ratio of between 0,2 and 1, preferably between 0,3 and 0,98, preferably between 0,4 and 0,95, and preferably between 0,45 and 0,9. The aspect ratio is defined by the ratio of the minimum feret diameter to the maximum feret diameter.

[0085] The filling device 13 is configured to supply the fluid being a gel having a viscosity of between 50 mPa.s and 1.000.000 mPa.s, preferably between 100 mPa.s and 500.000 mPa.s, preferably between 1000 mPa.s and 300.000 mPa.s, with the fluid supply 14 to the reciprocating pump 16 in order to dispense said gel in the compartment 7s with the fluid dispensers 15. The viscosity is determined by rheological measurements. Said gel tends amongst others to have the positive effect that it reduces segregation of the particles in the filling device.

[0086] The rheological measurements were performed on samples of the gel by using an Anton Paar MCR301 rheometer (SN80108634) equipped with a set-up with a Peltier heated cylinder geometry (P-CTD200 SN81433896) in combination with a cylinder geometry (CC27, SN37581) and solvent trap to avoid evaporation of solvent. Measurements on the samples were performed in rotation as well as in oscillation.

[0087] Said gel is a shear-thinning gel. The viscosity may apply at a shear rate between 1000 g/L and 1600 g/L, preferably between 0,001 1/s and 10000 1/s, preferably between 0,01 1/s and 10001/s.

[0088] Said gel has a density of between 1100 g/L and 1500 g/L, preferably between 1250 g/L and 1350 g/L.

[0089] The density of the gel was determined by using a digital density meter from Anton Paar (DMA500, Ser.Nr. 81069323) thermally equilibrated at 20°C and validated against air and ultrapure water (MilliQ quality, 18.2M Ω /cm). The density is an average of 5 measurements on 1mL sample volumes. The sample was taken after at least 15 minutes of rest after homogenisation.

[0090] Measurements on the fluid, and therefore also on the gel, are performed at an atmospheric pressure of 1 bar and at a temperature of 25 degrees Celsius. Before the measurements, the gel is homogenised using an overhead stirrer (IKA Eurostar20) at 1800 rpm for 10 minutes where the position of the stirrer in the gel was changed at fixed time intervals of 2 minutes to avoid significant heating of the gel during stirring.

[0091] The Figures 7A-F show the functioning of the reciprocating pump 16. In Figure 7A, the plunger 18 is located in the lower position 81, the inlet valve 41 is located in the inlet valve active position 44 and the outlet valve 48 is located in the outlet valve inactive position 50. As shown in Figure 7B, the plunger 18 is subsequently moved upwards (in upstream direction) into the upper position 82 while the inlet valve 41 is located in the inlet valve active position 44 and the outlet valve 48 is located in the outlet valve inactive position 50. The fluid flows via the plungers duct 25 into the cylindrical chamber 17.

[0092] The inlet valve 41 is subsequently placed in the inlet valve inactive position 43 (Figure 7C) and the outlet valve 48 is placed in the outlet valve active position 51

(Figure 7D).

[0093] As shown in Figure 7E, the plunger 18 is subsequently moved downwards (in downstream direction) into the lower position 81 while the inlet valve 41 is located in the inlet valve inactive position 43 and the outlet valve 48 is located in the outlet valve active position 51. The plungers 18 pushes the fluid out of the cylindrical chamber 17.

[0094] The outlet valve 48 is subsequently placed in the outlet valve inactive position 50 (Figure 7F) and the inlet valve 41 can be placed in the inlet valve active position 44 arrive at the situation of Figure 7A to start the cycle again.

[0095] The invention further relates to a method for producing pouches 2 comprising a water-soluble foil 3 and a fluid with a packaging system 1 according to the invention, which method comprises moving the cylindrical plunger 18 of the at least one reciprocating pump 16 within the cylindrical chamber 17 in a reciprocating manner in order to pump fluid out of the fluid dispensers 15 and in the compartments 7 formed in the foil 3. More specifically, said gel is pumped out of the fluid dispensers 15 and in the compartments 7 formed in the foil 3.

[0096] As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure. Further, the terms and phrases used herein are not intended to be limiting, but rather, to provide an understandable description of the invention.

[0097] The terms "a" or "an", as used herein, are defined as one or more than one. The term plurality, as used herein, is defined as two or more than two. The term another, as used herein, is defined as at least a second or more. The terms including and/or having, as used herein, are defined as comprising (i.e., open language, not excluding other elements or steps). Any reference signs in the claims should not be construed as limiting the scope of the claims or the invention.

[0098] It will be apparent to those skilled in the art that various modifications can be made to the packaging system 1 and the method without departing from the scope as defined in the claims.

Claims

1. Packaging system for producing pouches comprising a water-soluble foil and a fluid, the packaging system comprising:

- multiple moulds, each mould having a mould

cavity for forming a compartment in the foil, and
 - a mould conveyer configured to move the moulds in a conveying direction along a mould trajectory, such as an endless mould trajectory, and wherein the moulds are moved along:

- a foil supplying device configured to position the foil on the moulds,
- a compartment forming device configured to position parts of the foil in the mould cavities to form the compartments in the foil,
- a filling device comprising a fluid supply and multiple fluid dispensers configured to dispense the fluid in the compartments, and wherein:

- the filling device comprises at least one reciprocating pump in fluid communication with the fluid supply and the fluid dispensers in order to pump the fluid out of the fluid dispensers,
- the at least one reciprocating pump comprises a cylindrical chamber and a cylindrical plunger, which cylindrical plunger is configured to move through the cylindrical chamber in a reciprocating manner,
- the cylindrical chamber comprises an inner chamber surface,
- the cylindrical plunger comprises an outer plunger surface facing and in use moving along the inner chamber surface, and
- the inner chamber surface and the outer plunger surface are made of a ceramic material.

2. Packaging system according to claim 1, wherein:

- the reciprocating pump comprises an alignment unit to allow alignment of the cylindrical plunger and the cylindrical chamber during the reciprocating movement of the cylindrical plunger, and
- the alignment unit comprises an alignment receiving port located downstream of the inlet valve and in fluid communication with the inlet valve inner duct and an alignment discharging port connected to the cylindrical plunger and in fluid communication with the plunger duct, and a flexible alignment duct extending between the alignment receiving port and the alignment discharging port.

3. Packaging system according to claim 2, wherein the alignment unit is configured to allow pivotal movement of the alignment discharging port about a first pivot axis extending perpendicular to the longitudinal

plunger axis.

4. Packaging system according to claim 2 or 3, wherein the alignment unit is configured to allow pivotal movement of the alignment discharging port about a second pivot axis extending perpendicular to the longitudinal plunger axis, which first pivot axis optionally extends perpendicular to the second pivot axis.
5. Packaging system according to any one of the preceding claims, wherein the inner chamber surface of the cylindrical chamber and the outer plunger surface of the cylindrical plunger have a tolerance fit configured to prevent leakage of the fluid, wherein optionally said tolerance fit is between 1 μm and 10 μm or between 2 μm and 7 μm or between 2,5 μm and 5 μm .
6. Packaging system according to any one of the preceding claims, wherein the filling device is configured to supply the fluid being provided with particles having an EQPC particle size distribution of d_{10} is between 350 μm and 700 μm , preferable between 400 μm and 650 μm , preferably between 450 μm and 600 μm , with the fluid supply to the reciprocating pump in order to dispense said fluid in the compartments with the fluid dispensers.
7. Packaging system according to any one of the preceding claims, wherein the filling device is configured to supply the fluid being provided with particles having an EQPC particle size distribution of d_{50} is between 600 μm and 950 μm , preferable between 650 μm and 900 μm , preferably between 700 μm and 850 μm , with the fluid supply to the reciprocating pump in order to dispense said fluid in the compartments with the fluid dispensers.
8. Packaging system according to any one of the preceding claims, wherein the filling device is configured to supply the fluid being provided with particles having an EQPC particle size distribution of d_{90} is between 800 μm and 1200 μm , preferable between 850 μm and 1200 μm , preferably between 900 μm and 1150 μm , with the fluid supply to the reciprocating pump in order to dispense said fluid in the compartments with the fluid dispensers.
9. Packaging system according to any one of the preceding claims, wherein the filling device is configured to supply the fluid being provided with particles having an EQPC of between 1 μm and 2000 μm , preferably between 1 μm and 1800 μm , preferably between 2 μm and 1500 μm , with the fluid supply to the reciprocating pump in order to dispense said fluid in the compartments with the fluid dispensers.
10. Packaging system according to any one of the claims 6-9, wherein said particles have an aspect ratio of between 0,2 and 1, preferably between 0,3 and 0,98, preferably between 0,4 and 0,95, and preferably between 0,45 and 0,9.
11. Packaging system according to any one of the preceding claims, wherein the filling device is configured to supply the fluid being a gel having a viscosity of between 50 mPa.s and 1.000.000 mPa.s, preferably between 100 mPa.s and 500.000 mPa.s, preferably between 1000 mPa.s and 300.000 mPa.s, with the fluid supply to the reciprocating pump in order to dispense said gel in the compartments with the fluid dispensers.
12. Packaging system according to claim 11, wherein said gel is a shear-thinning gel, and wherein optionally the viscosity applies at a shear rate between 0,001 1/s and 10000 1/s, preferably between 0,01 1/s and 1000 1/s.
13. Packaging system according to claim 11 or 12, wherein said gel has a density of between 1000 g/L and 1600 g/L, preferably between 1100 g/L and 1500 g/L, preferably between 1250 g/L and 1350 g/L.
14. Packaging system according to any one of the preceding claims, wherein the ceramic material is an oxide based ceramic, such as an alumina based ceramic and/or a zirconia based ceramic.
15. Method for producing pouches comprising a water-soluble foil and a fluid with a packaging system according to any one of the preceding claims, comprising moving the cylindrical plunger of the at least one reciprocating pump within the cylindrical chamber in a reciprocating manner in order to pump said fluid out of the fluid dispensers and in the compartments formed in the foil.

Fig. 1

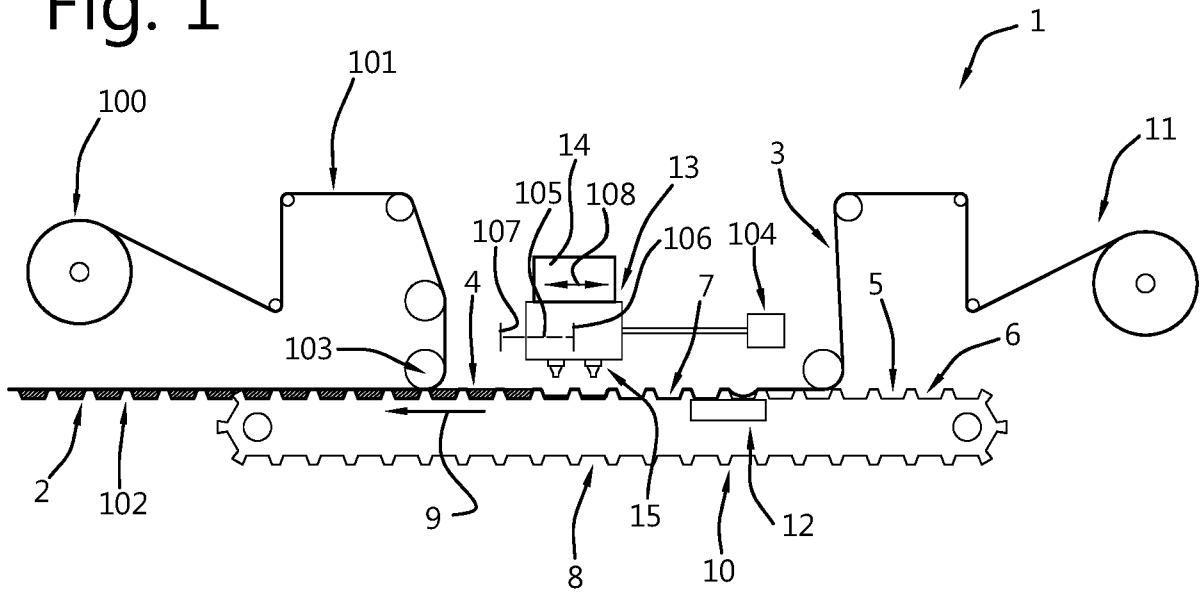


Fig. 2

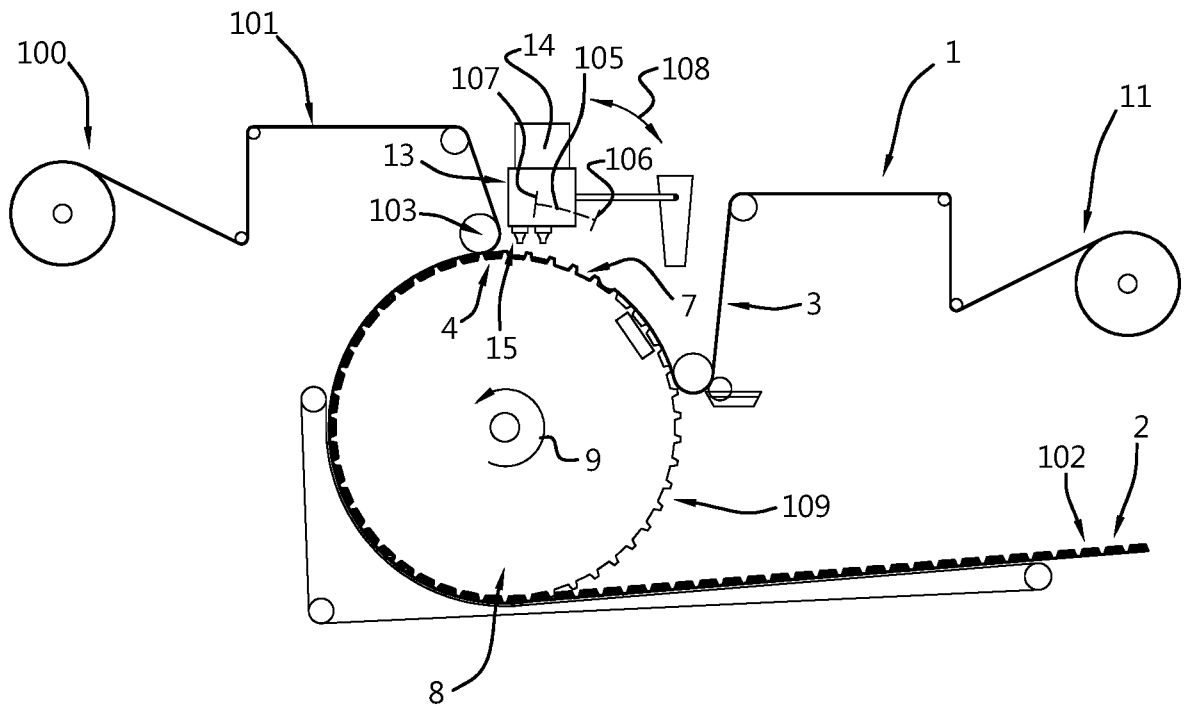


Fig. 3A

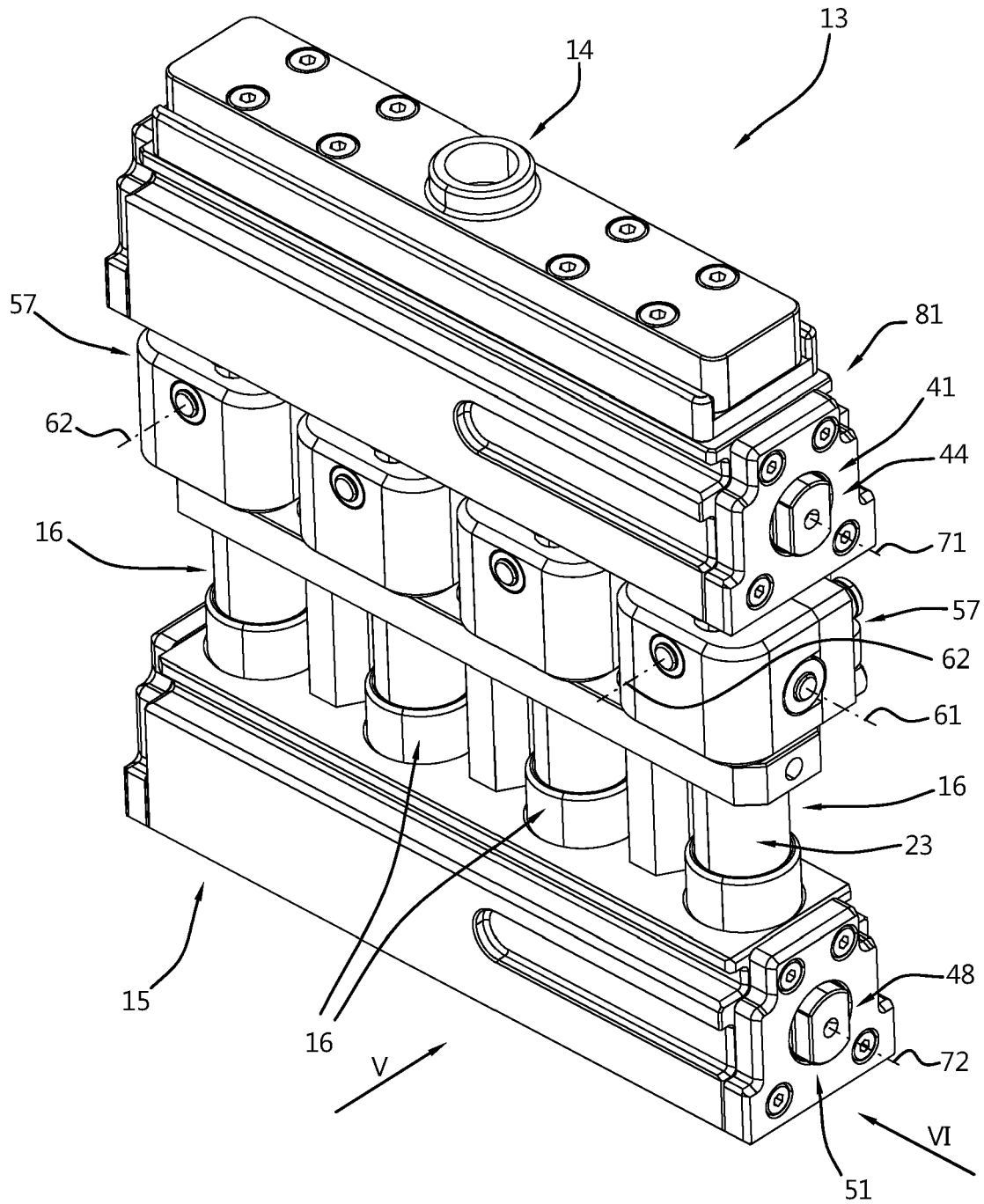


Fig. 3B

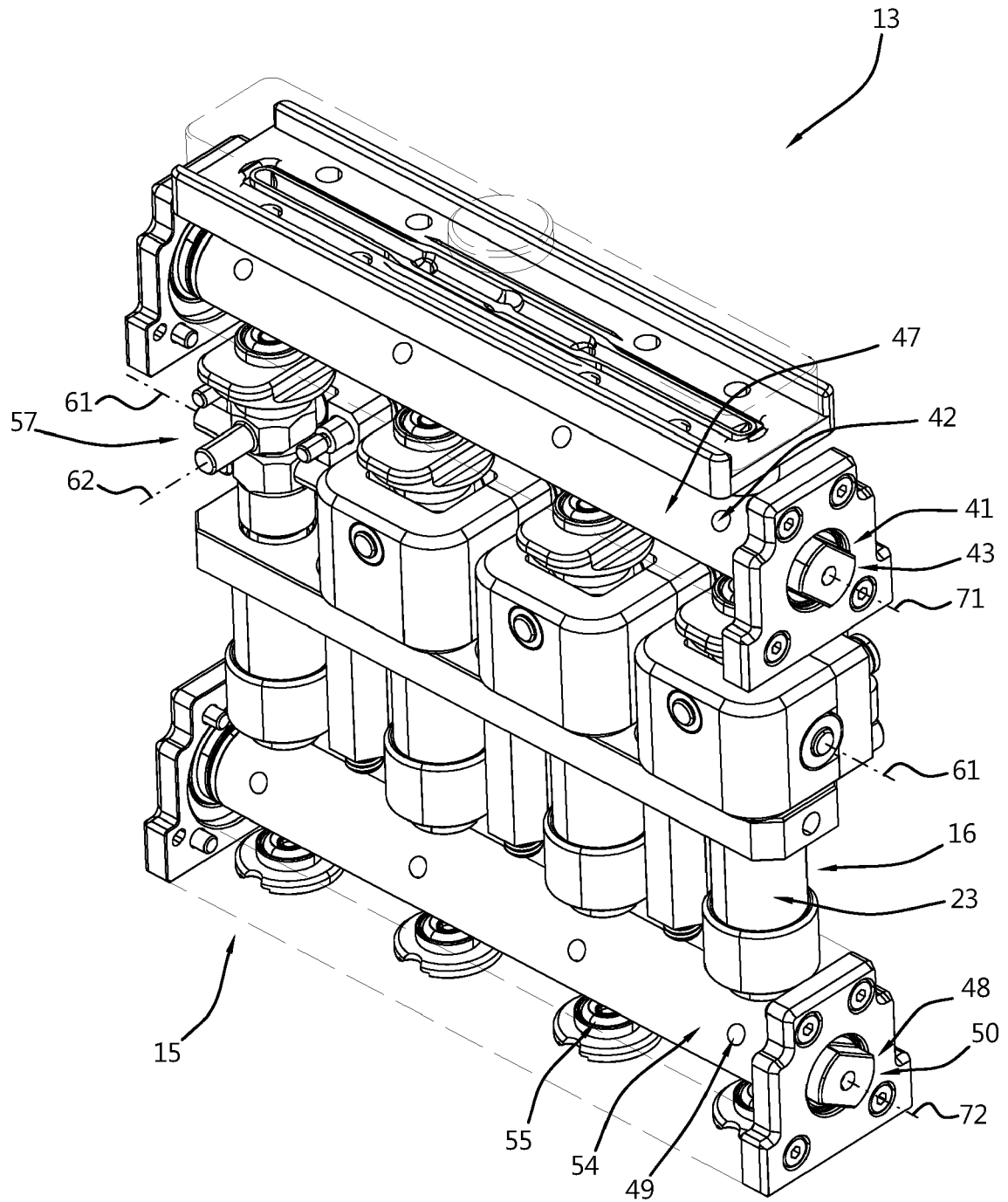


Fig. 4A

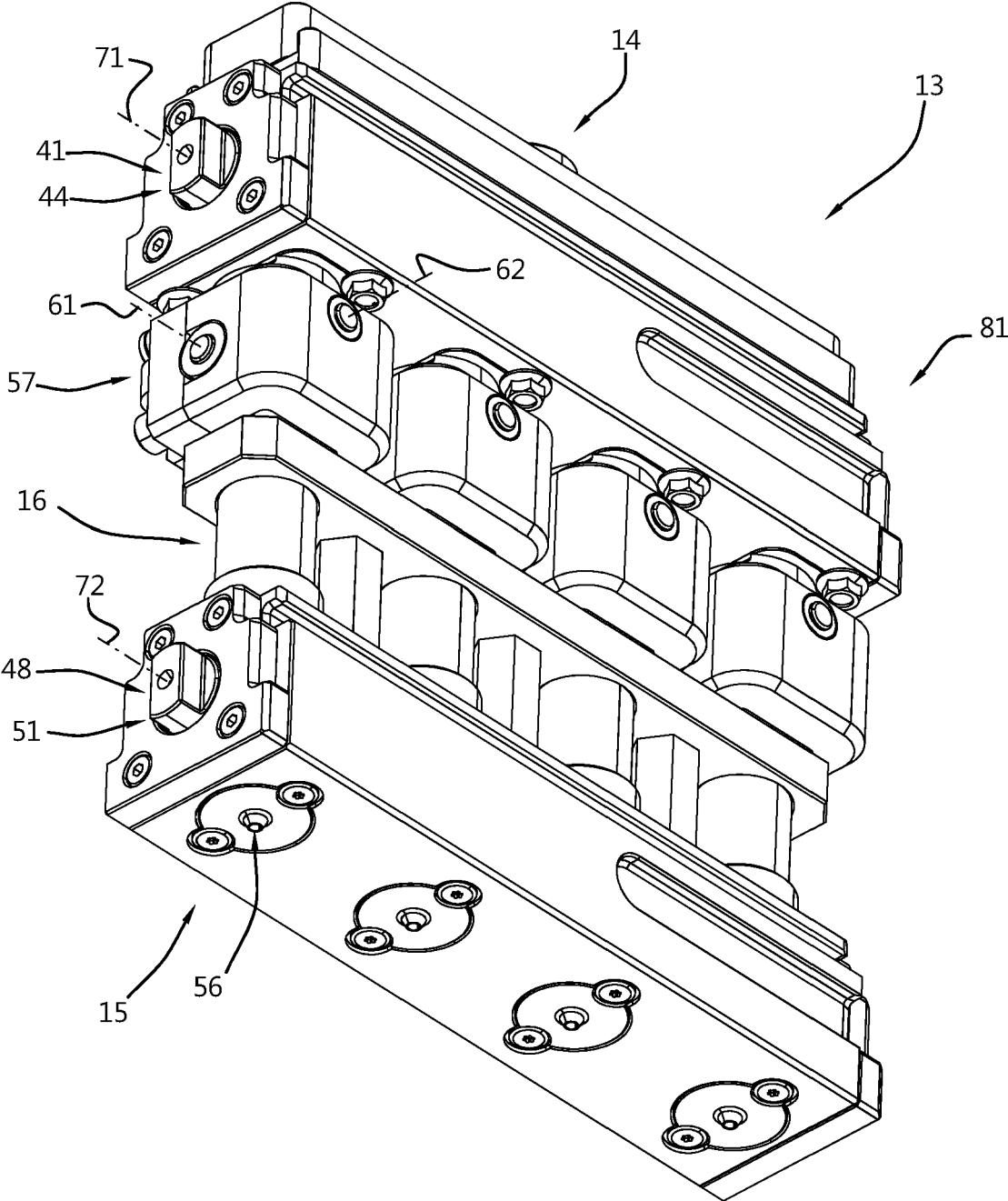


Fig. 4B

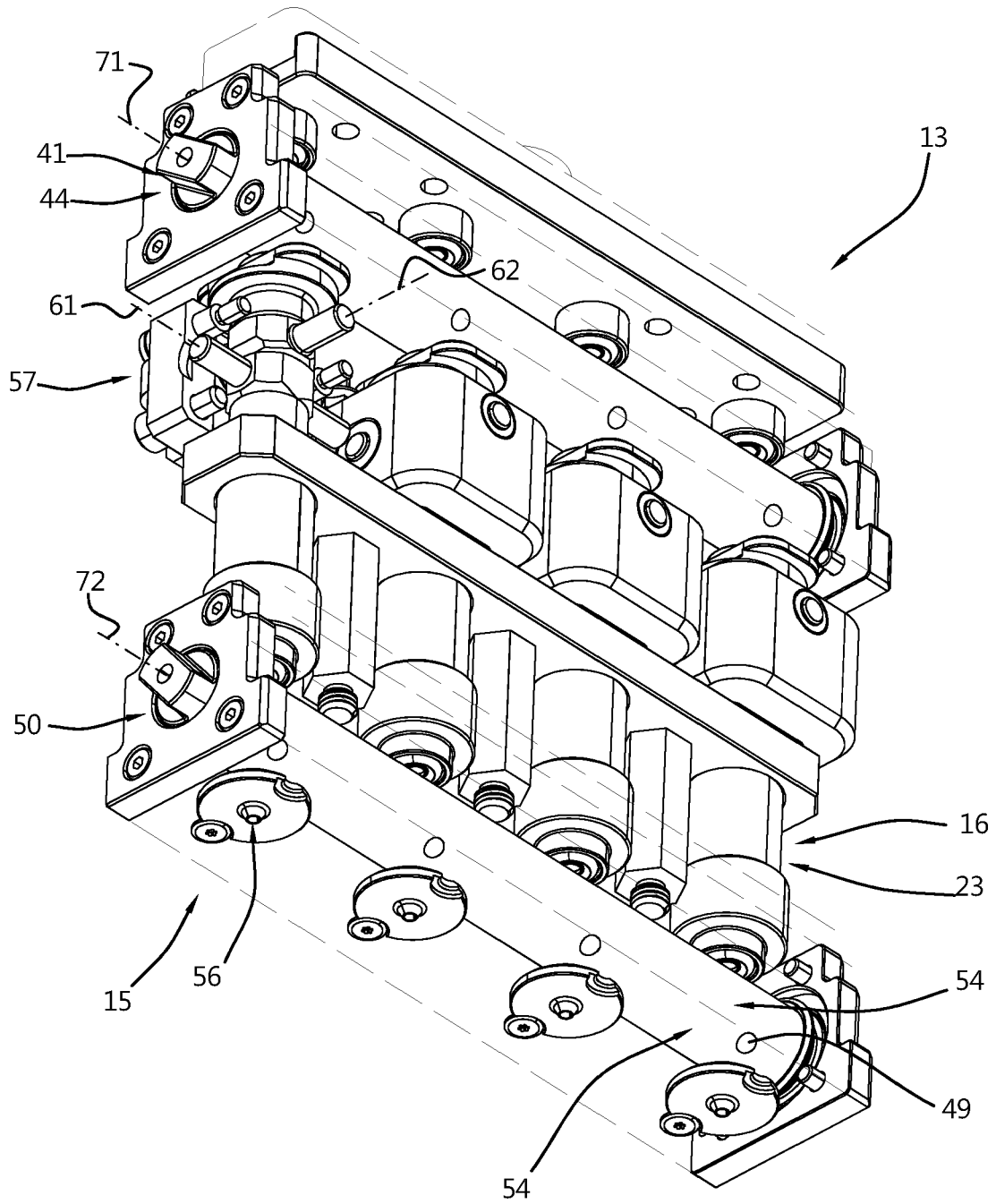


Fig. 5A

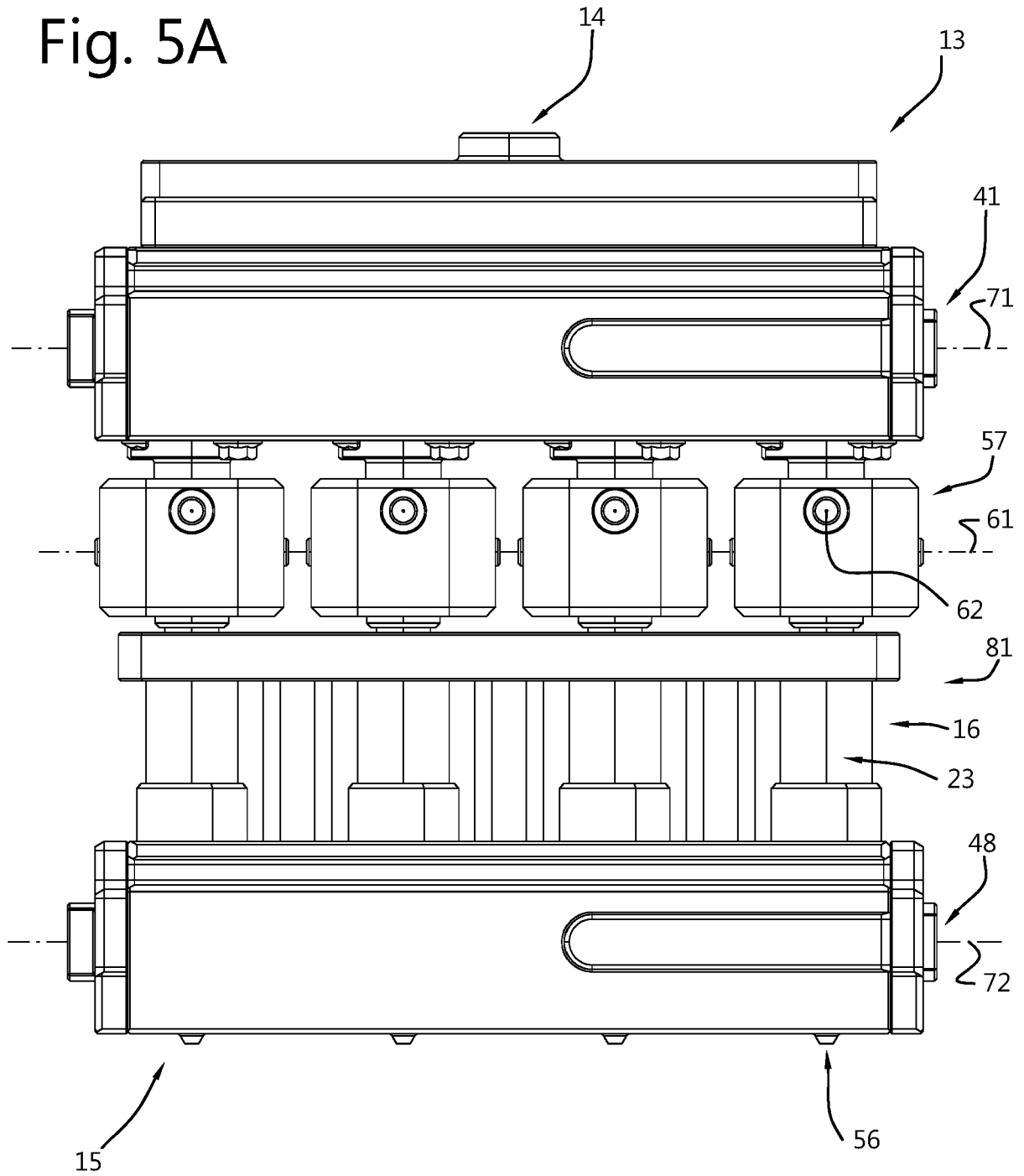


Fig. 5B

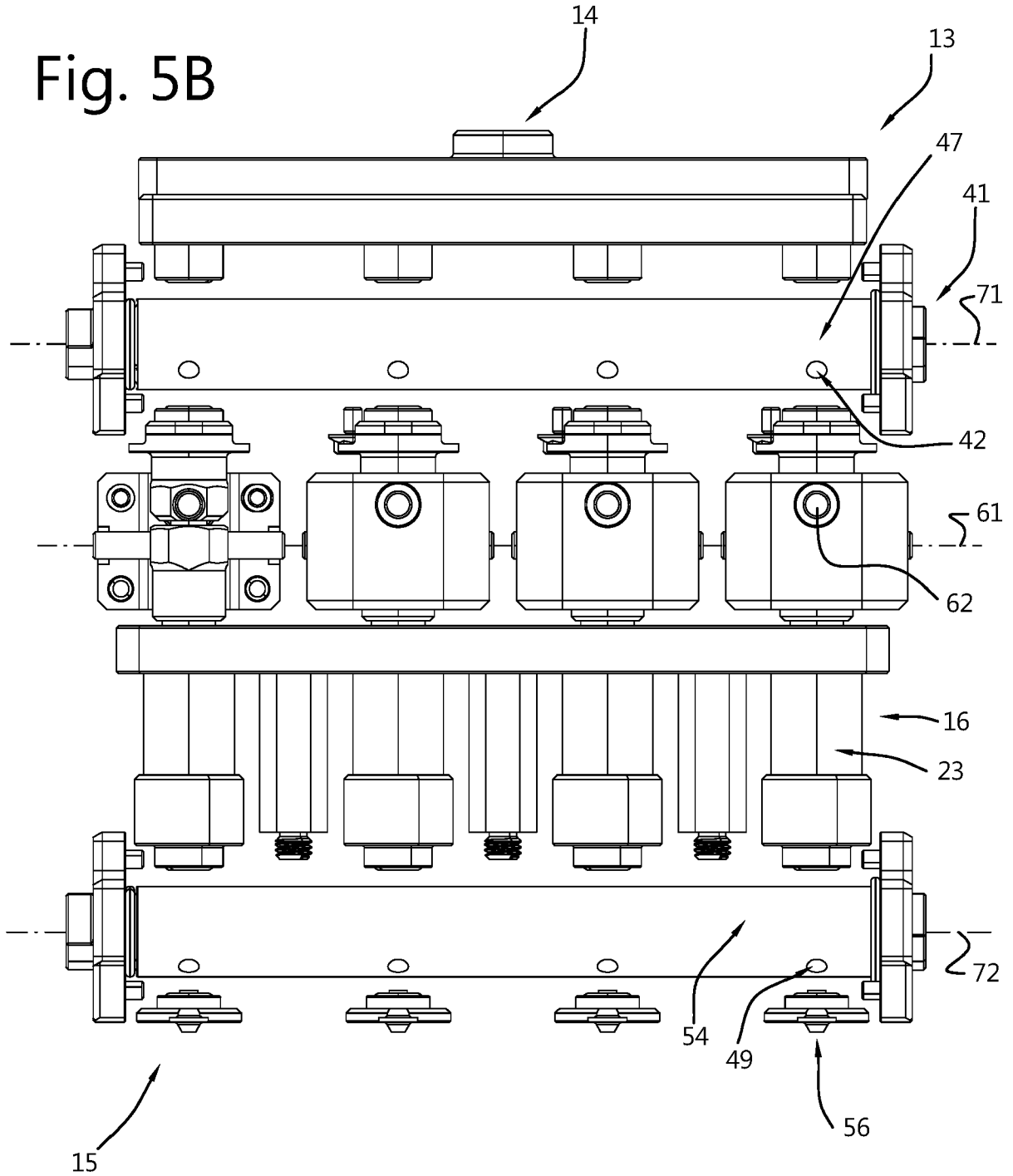


Fig. 5C

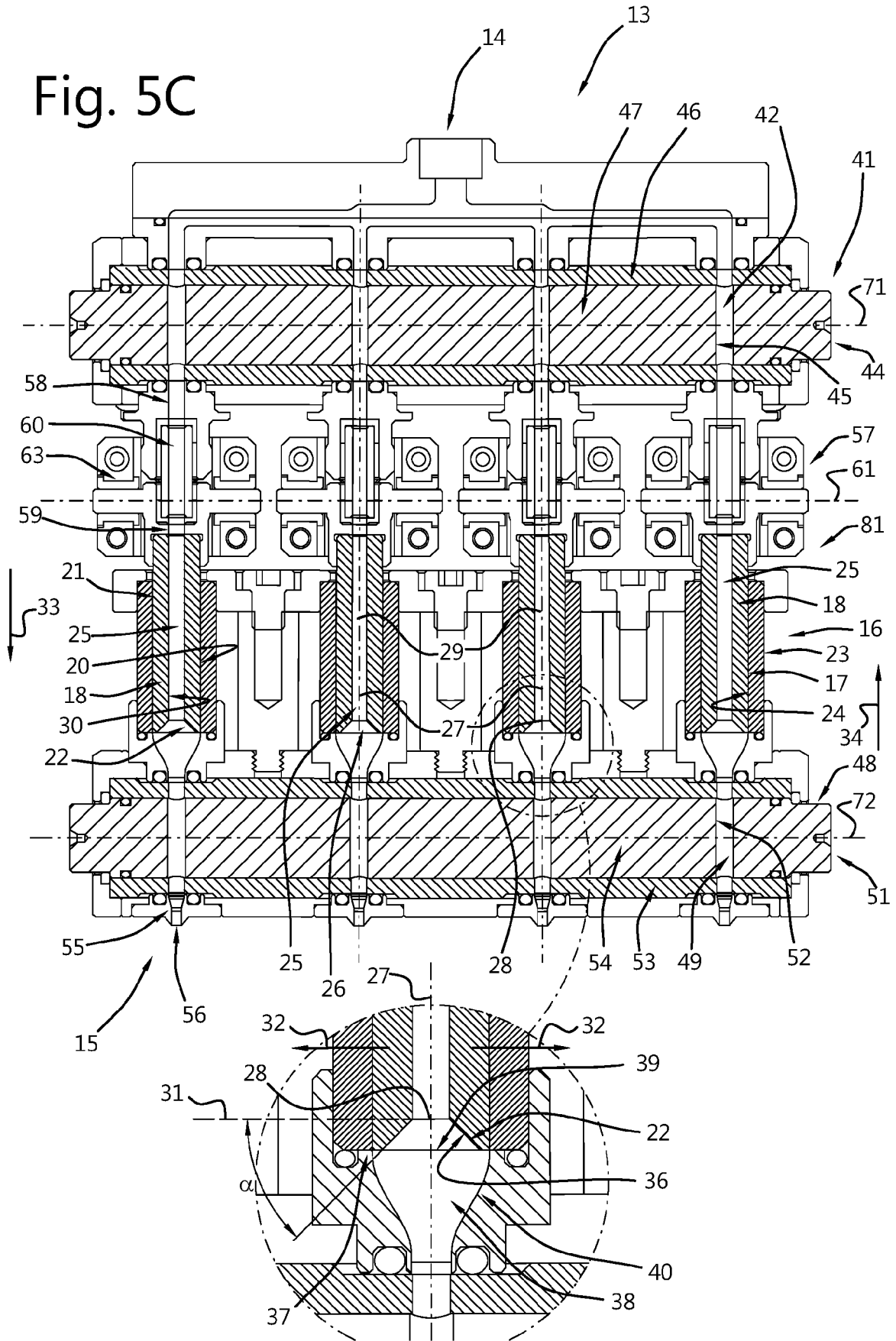


Fig. 5D

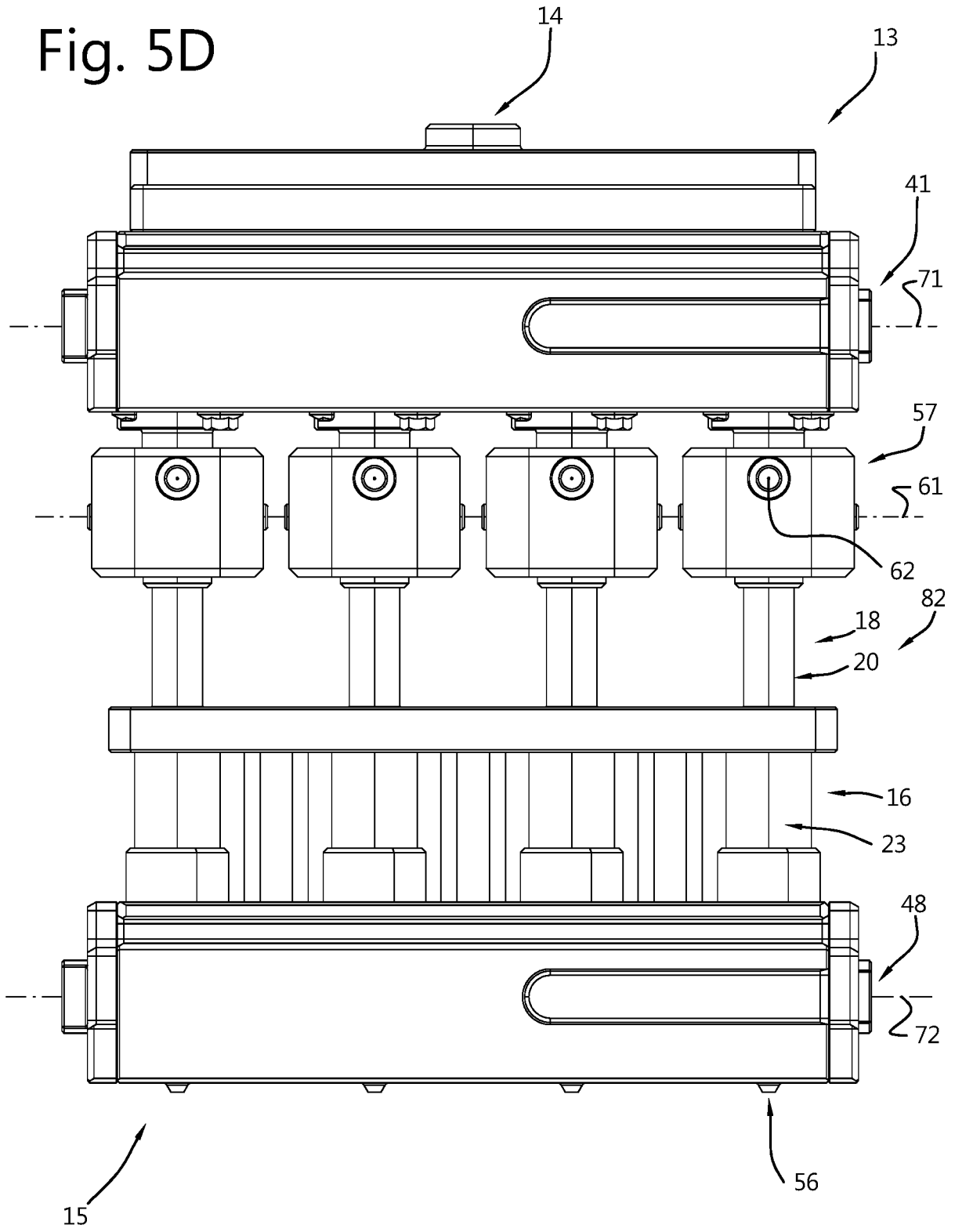


Fig. 5E

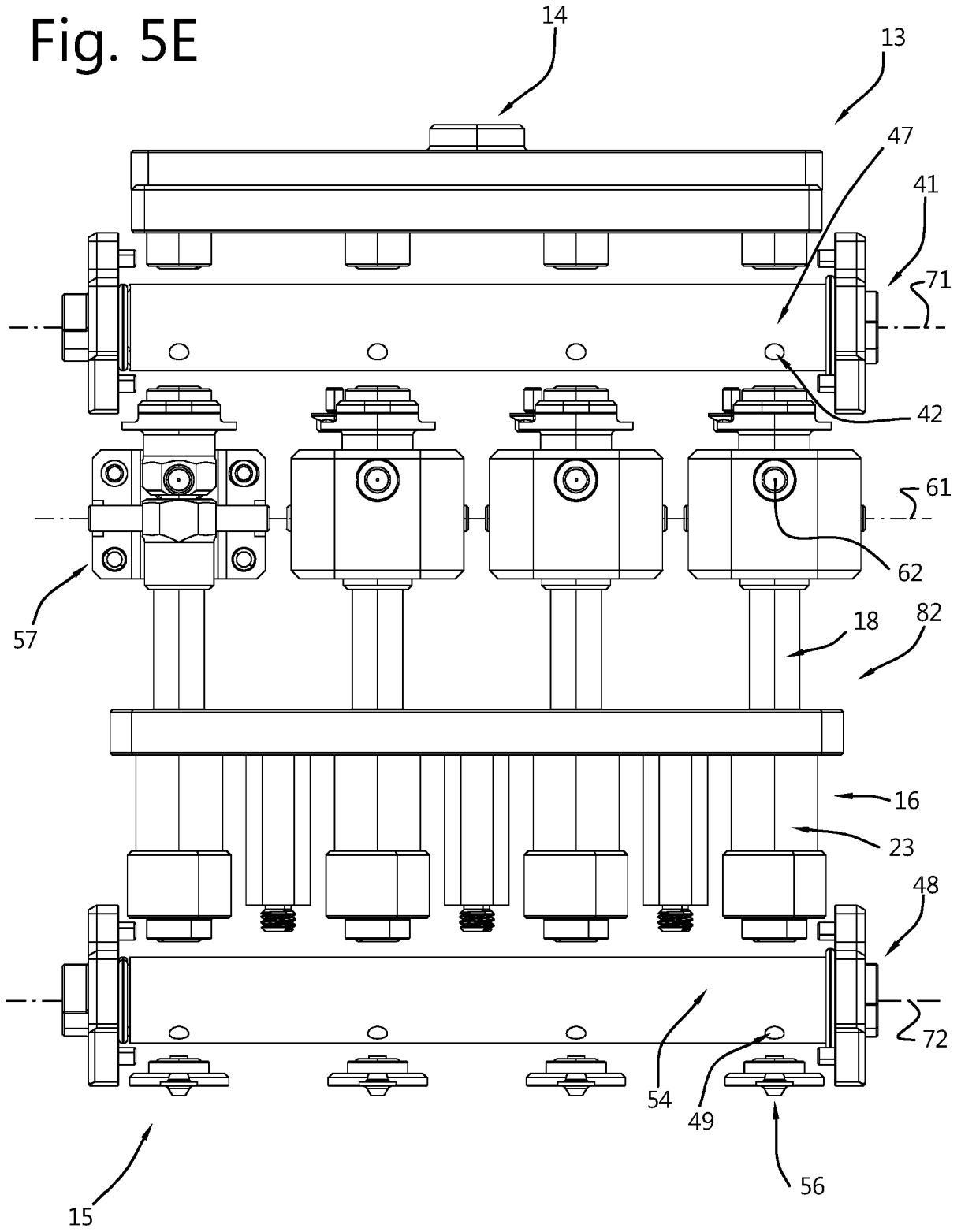


Fig. 5F

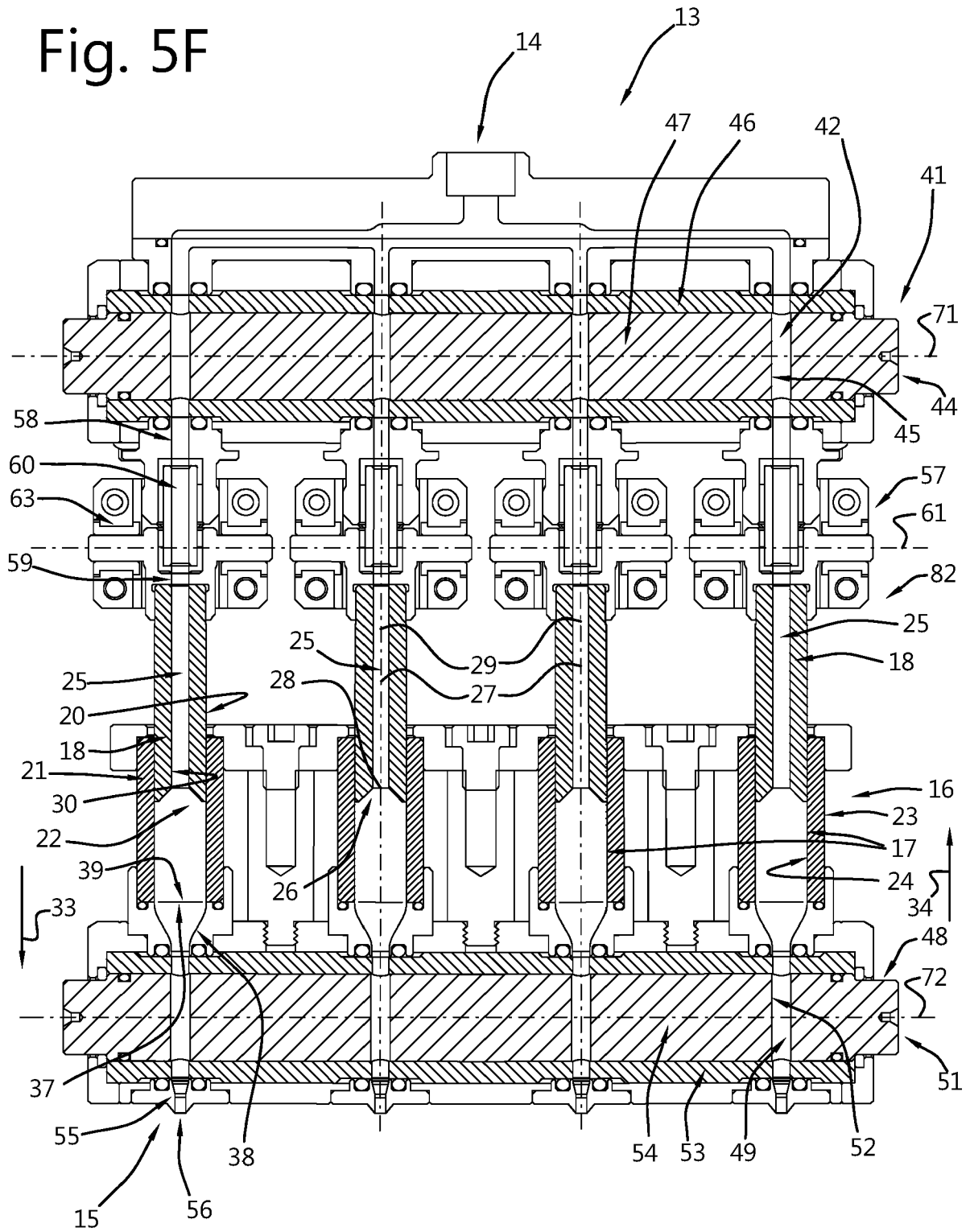


Fig. 6A

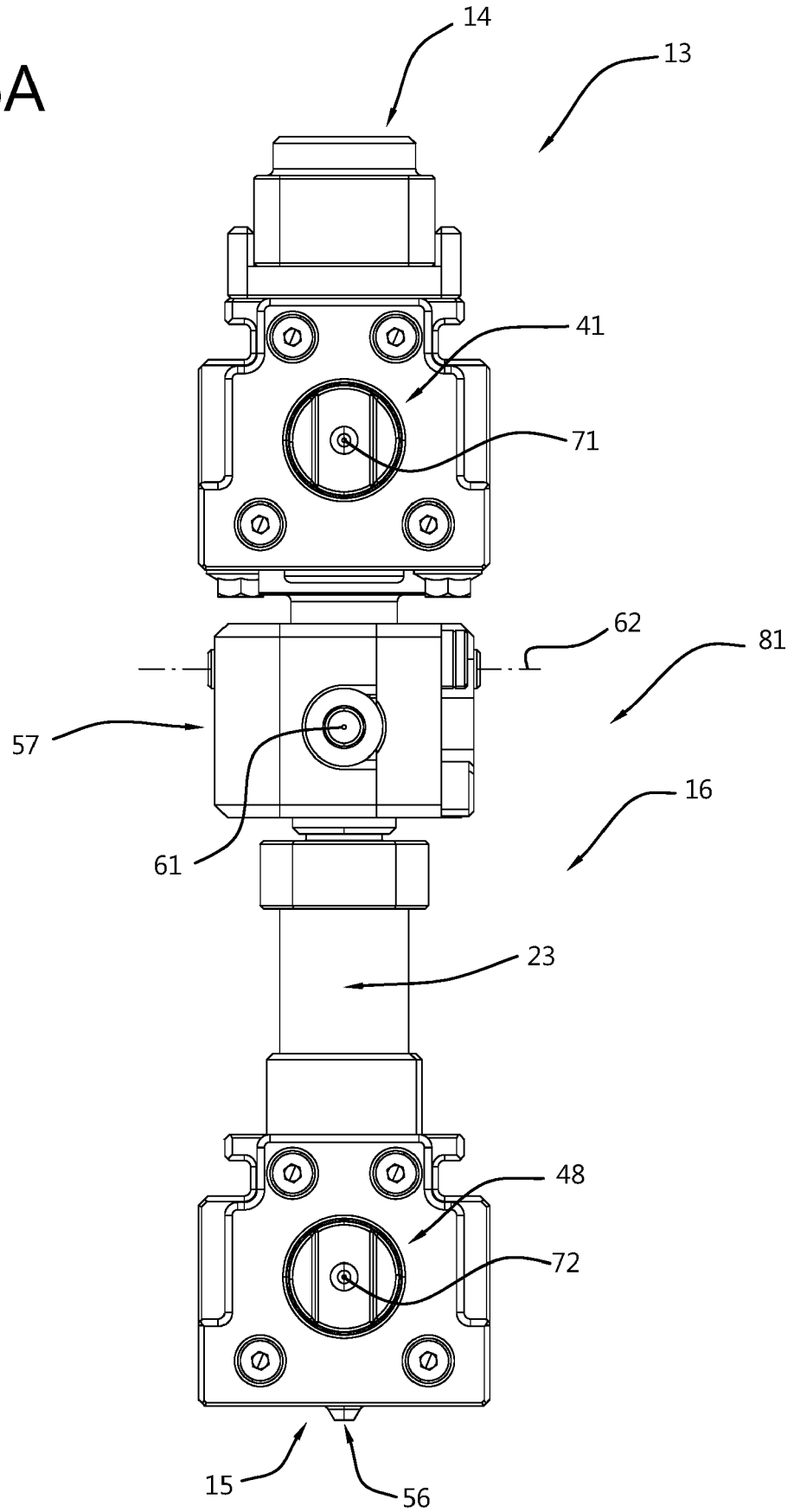


Fig. 6B

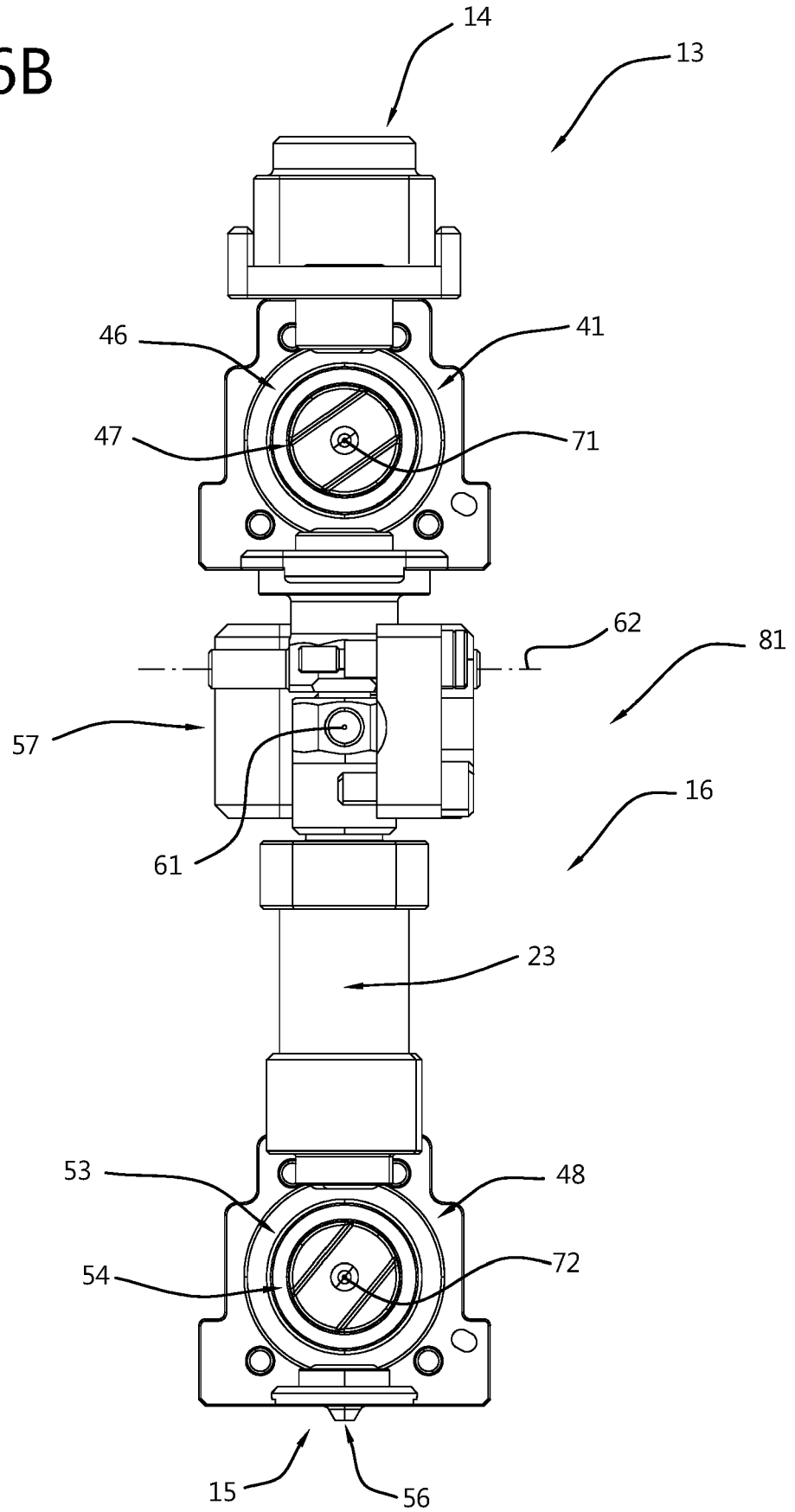


Fig. 6C

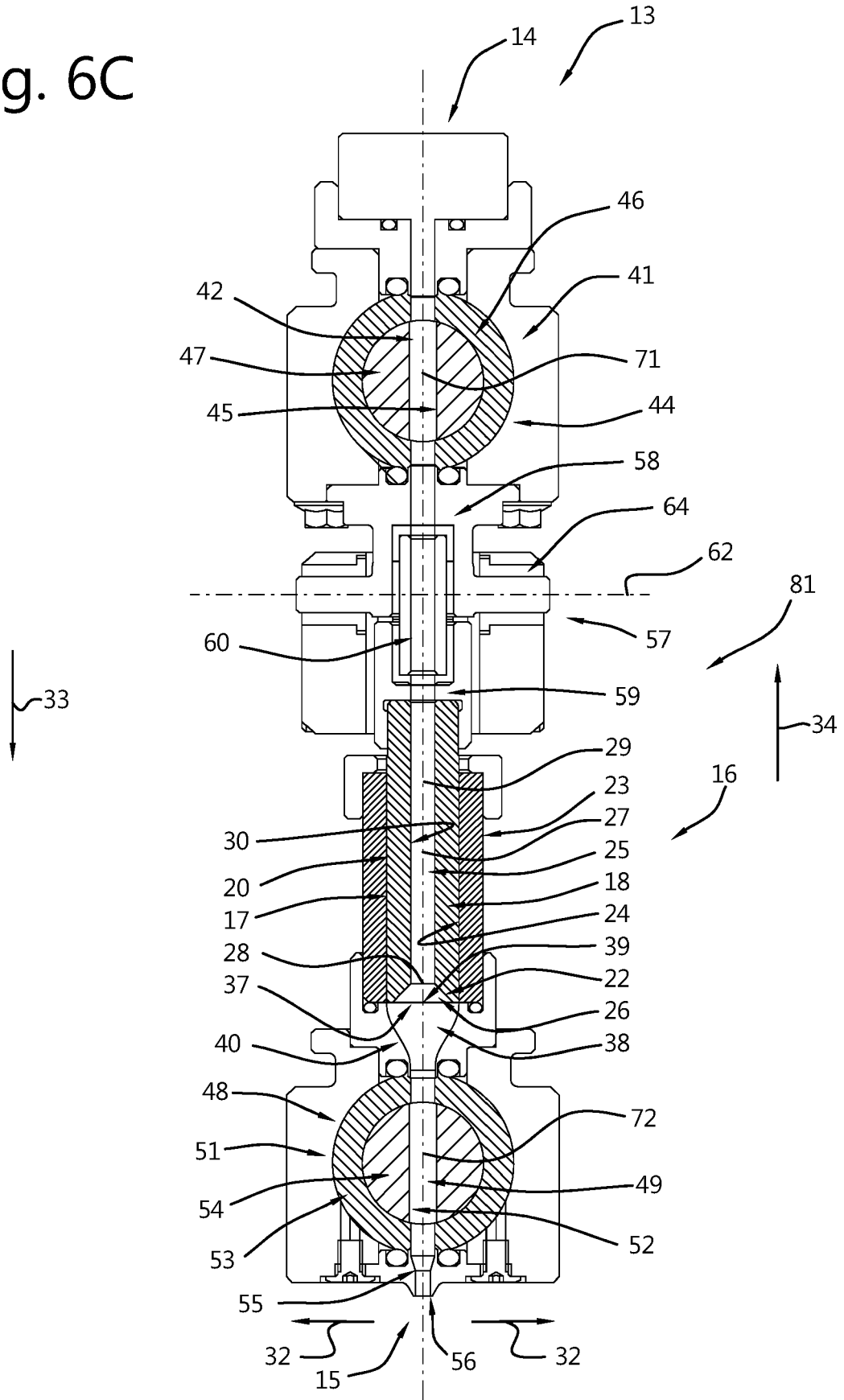


Fig. 6D

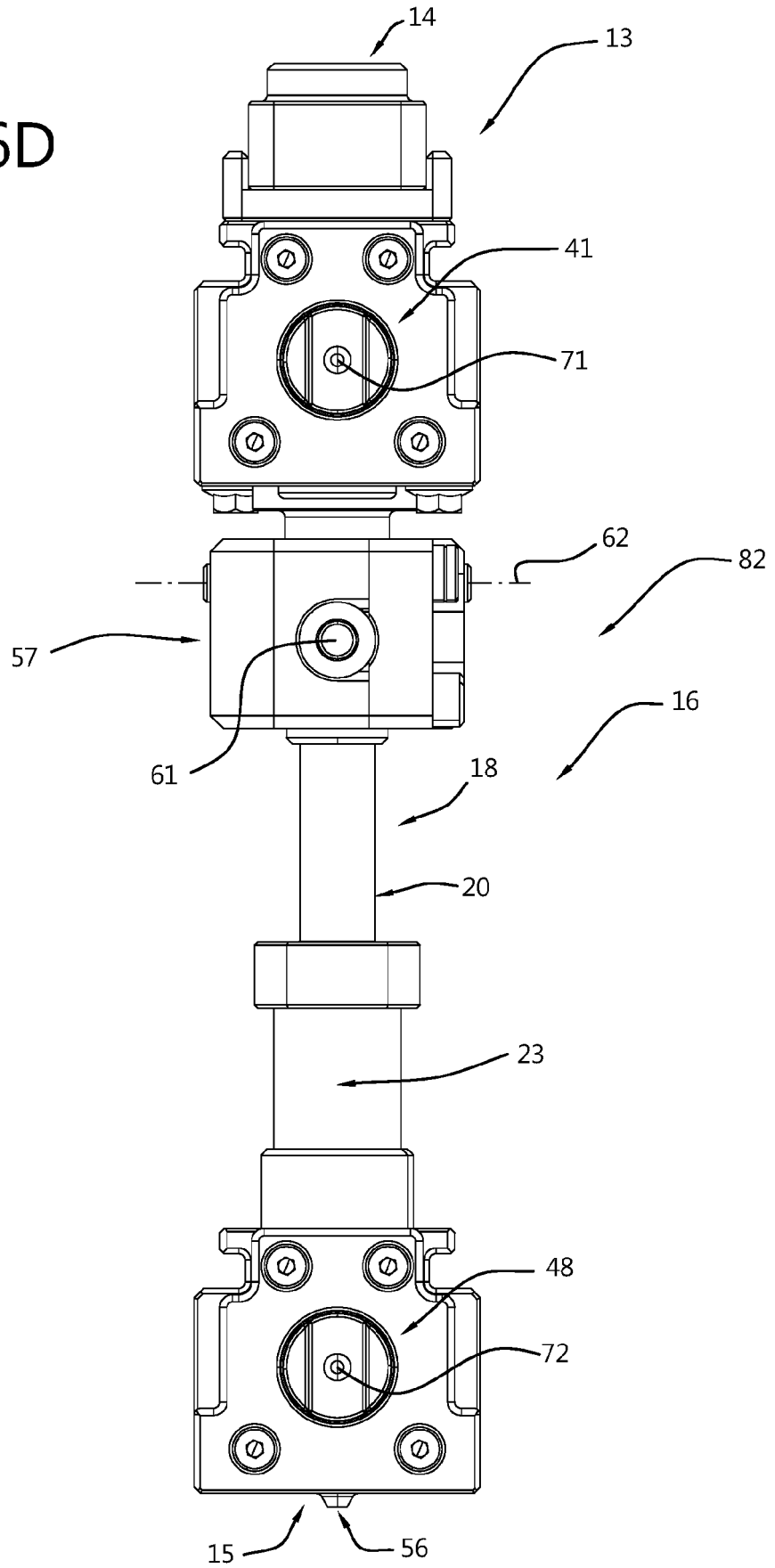


Fig. 6E

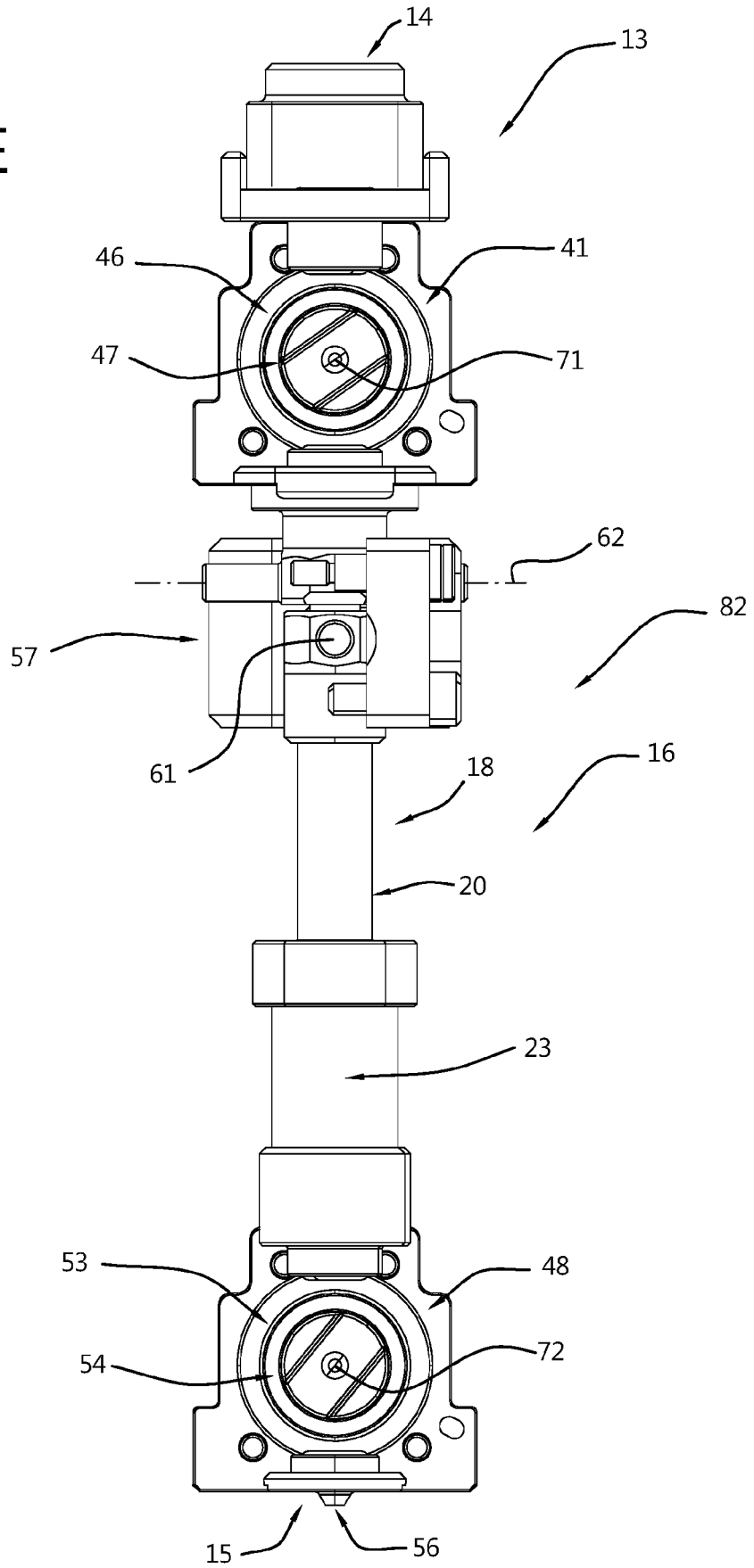
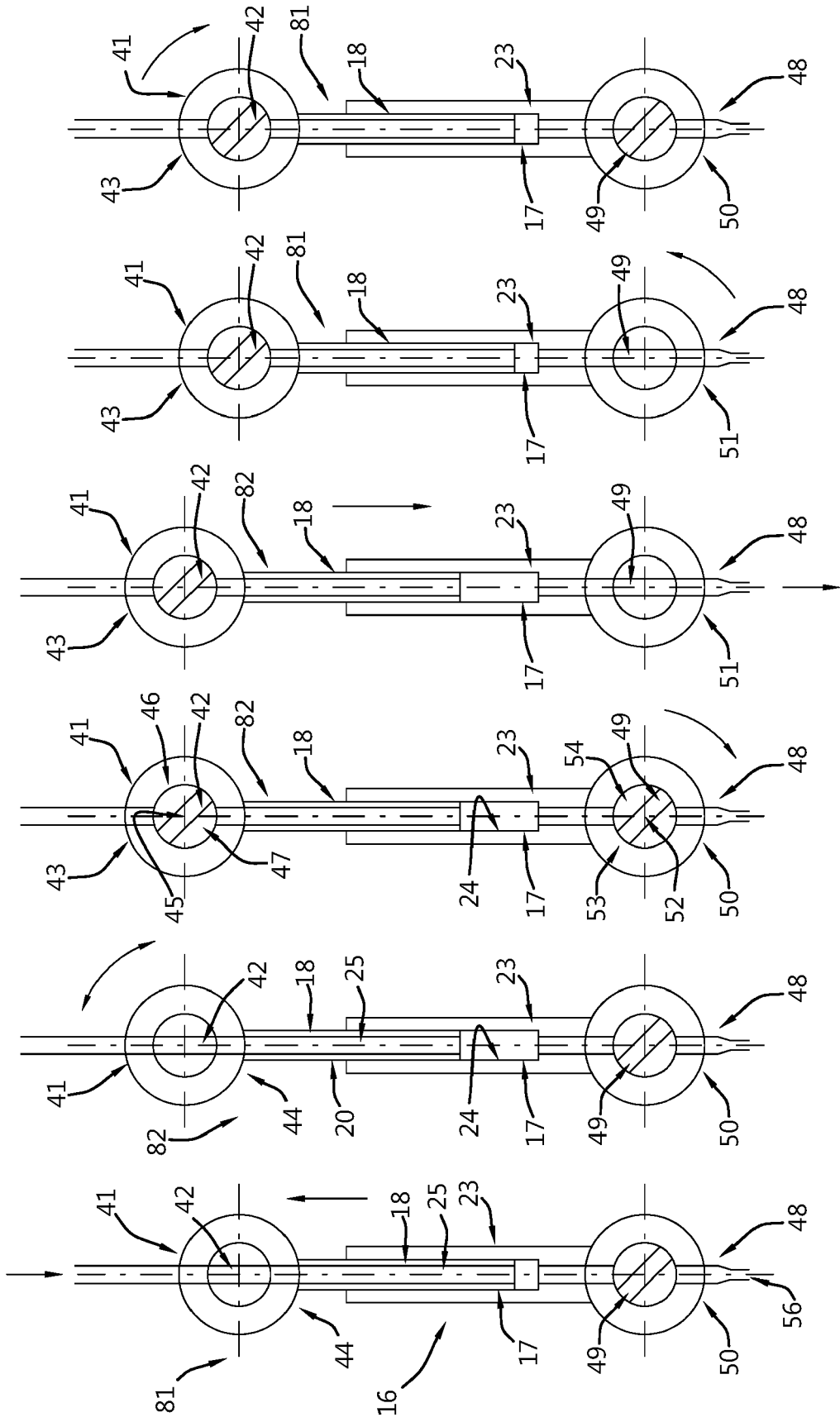


Fig. 7A Fig. 7B Fig. 7C Fig. 7D Fig. 7E Fig. 7F





EUROPEAN SEARCH REPORT

Application Number

EP 24 17 9052

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The present search report has been drawn up for all claims

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Place of search Munich	Date of completion of the search 21 November 2024	Examiner Yazici, Baris
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