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(72) Inventors:
• **BOUILLET, Adrien**
38330 Montbonnot-Saint-Martin (FR)
• **RIVOIRA, Didier**
38330 MONTBONNOT-SAINT-MARTIN (FR)
• **BEAUPOUX, Aymeric**
38330 MONTBONNOT-SAINT-MARTIN (FR)
• **BEARD, Jean-Claude**
38330 MONTBONNOT-SAINT-MARTIN (FR)

(71) Applicant: **Eveon**
38330 Montbonnot-Saint-Martin (FR)

(74) Representative: **Icosa**
83 avenue Denfert-Rochereau
75014 Paris (FR)

(54) **MIXING DEVICE AND MIXING METHOD**

(57) A mixing device (5) for mixing at least two products, at least one of said products being a liquid product, comprising:

- a supply arrangement (50) including at least two supply locations (51) each configured to receive one of the products, and at least two supply conduits (54) extending each between a connection orifice opening in one of the supply locations (51) and a supply orifice, the supply orifices being separate from each other,
- a pumping device (10) including a cylinder (11) provided with a unique cylinder orifice, and a piston (17) mounted within the cylinder (11),
- a driving system (70) configured to move the cylinder (11) between at least two supply positions, the cylinder orifice being in fluid communication with one of the supply orifices in each of the supply positions.

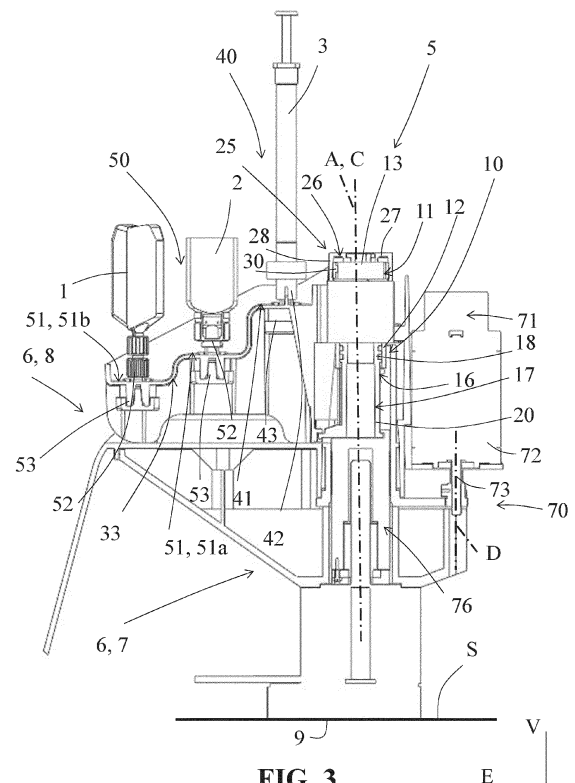


FIG. 3

Description

FIELD OF DISCLOSURE

[0001] The present disclosure relates to a mixing device and a mixing method.

[0002] In particular, the present disclosure relates to a mixing device and a mixing method for mixing at least two products, at least one of said products being a liquid product.

BACKGROUND OF INVENTION

[0003] The disclosure finds particular applications in preparation of a standardized formulation of the medical and pharmaceutical fields, such as a drug, a medicine, a medication and the like.

[0004] In such preparation, lyophilization has become an essential tool for stabilization and has gained importance. Lyophilized product is often contained in a standard primary container such as a vial or a cartridge. Reconstitution of the formulation from lyophilization of the lyophilized product is then an essential step to further use and administer the formulation to a patient. Nowadays, manual reconstitution, also called extemporaneous reconstitution, is the common method defined in instructions for marketed lyophilized drug products. Reconstitution can be either performed by a healthcare practitioner or the patient himself.

[0005] This step influences the quality of the final formulation. Developing a standardized manual protocol has become a challenge as its performance is highly dependent on human factors. Multiple factors such as chemical or biochemical properties, excipient formulation, solvent or concentration can play an important role regarding the complexity of formulation reconstitution.

[0006] A standard procedure involves the use of a syringe to transfer a solvent inside a vial and process manual mixing according a complex protocol of over 20 steps. This procedure is an open window to sterility breach, contaminations or drug exposure if not realized properly.

[0007] Depending on the drug or its indication, it is in both patient and healthcare practitioner interest to use a device aiming at standardizing reconstitution for safety as well as economical purposes such as time saving. Such device can also be a way of having homecare treatment which enables to improve patient quality of life and treatment adherence.

[0008] Same technical challenges apply for emulsion or injectable suspensions. Extemporaneous preparation remains a challenge to ensure standardization and quality of the prepared formulation prior to administration.

[0009] Same technical challenges apply also for pooling of liquid drug prior injection. In case of weight adjusted treatment, it is often required to pool multiple doses of product prior to injection as the drug is packed in a single standard container. In that case, over 20 to 100 steps might be required to prepare a full dose of product prior

to injection, considering the multiple changes of needles, sterilization of containers, etc.

[0010] It is a purpose of the present invention to address the challenges of preparation of pharmaceutical formulations in order to provide standardized preparation while saving time and preserving the healthcare practitioner and the patient from any possible risk.

[0011] EP 2 822 526 discloses a drug reconstitution device comprising a disposable liquid transfer unit and a reusable control and drive unit removably connectable to the liquid transfer unit. The liquid transfer unit includes a housing, a docking interface configured for coupling at least one of first and second constituent containers to the housing, and a pump engine and fluid flow system configured for transferring liquid from the first constituent container to the second constituent container. The control and drive unit comprises a pump drive configured to drive the pump engine during a liquid transfer action, the pump drive comprising a transmission output coupling removably engaged with a transmission input coupling of the pump engine when the liquid transfer unit and the control and drive unit are connected. Such device involves micropumps which can handle products in small quantities by definition. Preparation of large volume of drug might either take time or increase the risk for particles aggregation when it comes to biologics preparation.

[0012] EP 3 592 405 discloses a fluid transfer and mixing device that is fully disposable. The device includes an injector support surface for receiving an injection device thereon. A lyophilized drug vial, a diluent vial and a syringe are also attached to the device. The device features fluid passageways and a manual valve that may be manipulated so that the syringe may be used to transfer diluent from the diluent vial to the lyophilized drug vial, for reconstitution of the drug. The valve may also be configured so that the reconstituted drug is transferred from the lyophilized drug vial to the injection device. Such device is unsuitable when it comes to dosing quantities or involves multiple back and forth movement between containers. It is also unsuitable for preparation involving more than two containers.

[0013] EP 2 654 938 discloses a device for mixing at least two constituents. The device is designed for mixing at least two constituents originating from at least two separate reservoirs. It comprises at least two separate orifices capable of being connected to said reservoirs, a motorized pump, a fluid selector comprising at least one network of through channels capable of putting at least one of the orifices in communication with the pump. The fluid selector is arranged to be movable between several positions in order to selectively enable, using the pump, a transfer of at least one constituent from one orifice to the other orifice or to the pump, and an agitation of the resulting mixture. However, in case of multiple mixing or product pooling prior administration, the only way of performing preparation is to fully transfer the drug or solvent from one container to another one. The risk of over filling the containers and of causing a vial breakage exists,

which impacts safety the patient or the healthcare practitioner. In case of fluid recirculation, there is a risk of having foam formation altering the product.

In addition to the aforementioned limitations, the known devices implement complex supply arrangements involving valves or other moveable fluid selector with an increased number of dedicated primary containers, which cause loss of charges, enhance dead volumes and require several actuation mechanisms. Thus, the known devices are cumbersome and require a large number of components. They further do not allow an accurate control of the mixing operation whereas this mixing operation requires accurate dosing and gentle transfer with low shearing. Because of their complexity, the known devices also often lack modularity.

SUMMARY OF THE DISCLOSURE

[0014] This disclosure aims at solving the aforementioned problems.

[0015] To that end, according to a first aspect, the disclosure relates to a mixing device for mixing at least two products, at least one of said products being a liquid product, the mixing device comprising a frame, a supply arrangement mounted on the frame and a pumping device mounted on the frame,

wherein the supply arrangement includes:

- at least two supply locations each configured to receive one of the products, and
- at least two supply conducts extending each between a connection orifice opening in one of the supply locations and a supply orifice, the supply orifices being separate from each other,

wherein the pumping device includes:

- a cylinder presenting a cylinder axis and a distal portion provided with a unique cylinder orifice, and
- a piston mounted within the cylinder so as to reciprocate along the cylinder axis,

the cylinder and the piston being configured to define an inner chamber of a variable volume opening outwardly through the cylinder orifice, wherein the mixing device further comprises a driving system configured to move the cylinder with respect to the frame between at least two supply positions, the cylinder orifice being in fluid communication with one of the supply orifices in each of the supply positions.

[0016] The mixing device provides an improved solution for preparation of standardized formulation. Indeed, thanks to the aforementioned provisions, the mixing operation can be performed through actuation of the sole

pumping device. The mixing device can be simplified in structure and reduced not only in size but also in dead volumes and shearing which results in an improved control and accuracy of the mixing operation. The mixing device also enables repeated handling while avoiding alteration and foaming.

[0017] According to some provisions, the mixing device enables multiple combinations of transfer between a number of products contained in containers of different kinds which improves modularity.

[0018] According to some provisions, the mixing device prevents from over filling by using the pumping device itself as an intermediate chamber of a volume able to receive a remaining amount of mixture in excess of the volume of a filling container dedicated to receive the final formulation.

[0019] The frame may include an attaching arrangement presenting an attaching axis and configured to attach coaxially the cylinder to the frame, the attaching arrangement comprising a distribution portion configured to receive the distal portion of the cylinder and provided with the supply orifices distributed around the attaching axis, the driving system comprising a cylinder actuator configured to move the cylinder in rotation about the attaching axis with respect to the distribution portion between the supply positions.

[0020] The supply orifices may open radially with respect to the attaching axis and the cylinder orifice may open radially with respect to the cylinder axis.

[0021] Alternatively, the cylinder orifice may open axially with respect to the cylinder axis and may be centered on the cylinder axis, and the attaching arrangement may comprise a connecting portion movable in rotation about the attaching axis with respect to the distribution portion, the connecting portion being provided with a connection duct arranged to be selectively put in fluid communication with one of the supply orifices, the connecting portion being configured to connect with the distal portion of the cylinder so as to put the cylinder orifice in fluid communication with the connection duct, and to move together with the cylinder in rotation about the attaching axis upon actuation of the cylinder actuator.

[0022] Thanks to these provisions, a same syringe may be used as the pumping device for mixing the products and for administering the resulting mixture to the patient.

[0023] Alternatively, the supply orifices may open axially with respect to the attaching axis and the cylinder orifice may open axially with respect to the cylinder axis, the cylinder orifice being offset with respect to the cylinder axis.

[0024] The attaching arrangement may be configured to attach the cylinder in a removable manner.

[0025] The attaching arrangement may comprise a housing extending along the attaching axis and configured to accommodate coaxially at least the distal portion of the cylinder.

[0026] The frame may have a resting surface configured to rest on a support surface, the cylinder axis being

perpendicular to the resting surface and the distal part of the cylinder being oriented opposite the resting surface.

[0027] These provisions enable acting on air that is incompressible upon actuation of the piston which improves control of the mixing.

[0028] The cylinder orifice may be arranged at a height with respect to the resting surface that is greater than respective heights of the supply locations.

[0029] The pumping device and the supply locations may be aligned along an extension direction parallel to the resting surface, the heights of the cylinder orifice and the supply locations decreasing along the extension direction.

[0030] These provisions ease the handling of containers containing the products.

[0031] Alternatively, the frame may have a resting surface configured to rest on a support surface, the cylinder axis being perpendicular to the resting surface and the distal part of the cylinder being oriented towards the resting surface.

[0032] Alternatively, the frame may have a resting surface configured to rest on a support surface, the cylinder axis being parallel to the resting surface.

[0033] Each of the supply locations may comprise a reversible fixing member configured to reversibly fix a container filled with the product.

[0034] For containers each presenting a bottom and an opening opposite the bottom, the each of the fixing member may be configured to reversibly fix the opening of one of the containers with the bottom up.

[0035] Each of the supply locations may be equipped with a sump facing the fixing member to recover leak of products from the container.

[0036] The frame may comprise a basement and a carrier removably mounted on the basement, the carrier bearing the supply arrangement and the pumping device, the basement bearing the driving system.

[0037] These provisions enables the carrier to be used as a disposable part for single use, while the basement forms a reusable part.

[0038] The carrier may have two parallel lateral walls presenting respective internal surfaces facing each other and respective external surfaces, the supply locations being arranged between the internal surfaces and the supply conducts being arranged on at least one of the external surfaces.

[0039] These provisions enable reducing dead volumes.

[0040] The mixing device may further comprise a filling arrangement including:

- at least one filling location configured to receive a mixture of the products, and
- at least one filling conduct extending between a connection orifice opening in the filling location and a filling orifice, the filling orifice being separate from the supply orifices, wherein the driving system is fur-

ther configured to move the cylinder with respect to the frame in a filling position in which the cylinder orifice is in fluid communication with the filling orifice.

[0041] The filling location may be arranged at a height with respect to the resting surface that is lower than the height of the cylinder orifice.

[0042] The filling location may be aligned along the extension direction with the pumping device and the supply locations, possibly with the filling location interposed between the pumping device and the supply locations. The heights of the cylinder orifice, the filling location and the supply locations may decrease along the extension direction.

[0043] The driving system may be further configured to move the cylinder with respect to the frame in an inactive position in which the cylinder orifice faces an obturating wall.

[0044] The pumping device may comprise a piston actuator configured to move the piston with respect to the cylinder, the piston actuator being distinct from the cylinder actuator.

[0045] Alternatively, the pumping device may comprise a piston actuator configured to move the piston with respect to the cylinder, the piston actuator forming the cylinder actuator.

[0046] When the driving system comprises the cylinder actuator configured to move the cylinder in rotation about the attaching axis, each of the supply ducts may comprise an aspiration path and an exhaust path, the supply orifice of each of the supply ducts comprising an aspiration opening in fluid communication with the aspiration path and an exhaust opening in fluid communication with the exhaust path, and

the piston actuator may be a motor configured to impart a rotational movement, and the driving system may comprise a transmission mechanism configured to cause the piston reciprocating between top and bottom dead points from the rotational movement of the motor, and to move the cylinder in rotation about the attaching axis between the supply positions and, in each of the supply positions, to move the cylinder in rotation about the attaching axis between the aspiration opening and the exhaust opening of one of the supply ducts when the piston is moved between the top and bottom dead points.

[0047] The transmission mechanism may comprise a transmission assembly comprising:

- a translation member integral with the piston and provided with a piston slot extending perpendicular to the cylinder axis,
- a sliding member connected to the cylinder so as to move the cylinder in rotation about the attaching axis between the aspiration opening and the exhaust opening of one of the supply ducts as the sliding member is moved in translation perpendicularly to the cylinder axis, the sliding member being provided with a cylinder slot extending parallel to the cylinder

axis,

- a driving wheel rotatably mounted about a pivot axis perpendicular to the cylinder axis, the driving wheel being provided with piston and cylinder pins parallel to pivot axis and offset with respect to the pivot axis,

wherein the piston pin engages the piston slot so as reciprocate within said piston slot as the driving wheel rotates, and the piston slot is configured to reciprocate the piston between the top and bottom dead points as the piston pin reciprocates within the piston slot,

wherein the cylinder pin engages the cylinder slot so as reciprocate within said cylinder slot as the driving wheel rotates, and the cylinder slot is configured to move the sliding member in translation perpendicularly to the cylinder axis as the cylinder pin reciprocates within the cylinder slot, and

wherein the transmission mechanism is configured to impart the rotational movement to the driving wheel when the motor runs in a first direction, and to impart the rotational movement to the assembly so as to move the cylinder in rotation about the attaching axis between the supply positions when the motor runs in a second direction.

[0048] According to another aspect, the disclosure relates to a mixing method for mixing at least two products, at least one of said products being a liquid product, the mixing method implementing the mixing device as defined previously, wherein the products are received respectively in the supply location, the mixing method comprising steps consisting in:

- moving the cylinder with respect to the frame by the driving system to the supply position in which the cylinder orifice is in fluid communication with the supply orifice opening in the supply location provided with the liquid product,
- filling the inner chamber with the liquid product by actuating the piston of the pumping device,
- moving the cylinder with respect to the frame by the driving system to the other supply position in which the cylinder orifice is in fluid communication with the supply orifice opening in the supply location provided with the other product,
- discharging the liquid product to form a mixture of the products.

[0049] When the distal part of the cylinder is oriented opposite the resting surface and each of the supply locations is configured to reversibly fix the opening of one of the containers with the bottom up, the step consisting in filling the inner chamber may comprise:

- filling the inner chamber with air,
- pushing the piston towards the distal portion of the cylinder and repeatedly reciprocating the piston to

progressively fill the inner chamber with the liquid product.

[0050] More generally, independently from the aforementioned provisions, the disclosure also proposes a mixing method for mixing at least two products, at least one of said products being a liquid product, the mixing device comprising a supply arrangement mounted on the frame and a pumping device mounted on the frame,

wherein the supply arrangement includes:

- at least two supply locations each configured to receive one of the products, each of the supply locations comprising a reversible fixing member configured to reversibly fix a container filled with the product, each container presenting a bottom and an opening opposite the bottom,
- at least two supply conduits extending each between a connection orifice opening in one of the supply locations and a supply orifice, the supply orifices being separate from each other,

wherein the pumping device includes:

- a cylinder presenting a cylinder axis and a distal portion provided with a cylinder orifice, and
- a piston mounted within the cylinder so as to reciprocate along the cylinder axis,

the cylinder and the piston being configured to define an inner chamber of a variable volume opening outwardly through the cylinder orifice,

wherein the supply locations and the pumping device are configured so that the pumping device presents an orientation opposite to an orientation of the containers, the openings of the containers and the distal portion of the cylinder being oriented towards each other, wherein the mixing method comprises steps consisting in:

- filling the inner chamber with air and putting the cylinder orifice in fluid communication with the supply orifice opening in the supply location provided with the liquid product,
- orienting the pumping device with the distal portion upwards, and the containers with the bottoms up and the openings downwards,
- pushing the piston towards the distal portion of the cylinder and repeatedly reciprocating the piston to progressively fill the inner chamber with the liquid product,
- putting the cylinder orifice in fluid communication with the supply orifice opening in the supply location provided with the other product,
- discharging the liquid product to form a mixture of the products.

[0051] Such mixing method enables pushing actuation to be exerted on air that is incompressible, and replacing the whole volume of air within the inner chamber of the pumping device by the liquid product. This enables the filling of the inner chamber to be precisely controlled and the volume of liquid product to be accurately known.

BRIEF DESCRIPTION OF THE DRAWINGS

[0052] Other objects and advantages of the invention will emerge from the following of the description made in relation with the accompanying drawings in which:

- figures 1 and 2 are perspective views along two different directions of side, top and front faces of a mixing device according to a first embodiment, the mixing device comprising a frame, a supply arrangement for supplying products, a pumping device to collect and mix the products and a filling arrangement to receive a mixture of the products, the supply and filling arrangements receiving containers presenting a vertical orientation opposite a vertical orientation of the pumping device, a cylinder of the pumping device being moveable with respect to the frame between supply and filling positions through a cylinder actuator, a separate piston actuator reciprocating a piston of the pumping device in the cylinder,
- figure 3 is a view in partial section along orientation referenced III-III in figure 1 of the mixing device of figure 1,
- figure 4 is a perspective view of a carrier of the frame of the mixing device of figure 1, the carrier including the supply and filling arrangements and the pumping device,
- figure 5 is a perspective view of a basement of the frame of the mixing device of figure 1, the basement being configured to be removably support the carrier of figure 4 and including a driving system for actuating both the piston and the cylinder of the pumping device,
- figures 6 to 9 are perspective partial views of the carrier of figure 4 showing the pumping device at different steps of a mixing method,
- figure 10 is a schematic view of a first variant of the mixing device according to the first embodiment, a same syringe forming the pumping device and the filling arrangement, the syringe having with a cylinder orifice offset with respect to a cylinder axis,
- figure 11 is a schematic view of a second variant of the mixing device according to the first embodiment, a same syringe forming the pumping device and the filling arrangement, the syringe having with a cylinder orifice centred with respect to the cylinder axis,
- figure 12 is a perspective view of a second embodiment of the mixing device, the supply and filling arrangements receiving containers presenting the same vertical orientation as the vertical orientation of the pumping device,

- figures 13 and 14 are respectively a perspective view of a bottom face and a sectional view of a carrier of the mixing device of figure 12, the carrier including the supply and filling arrangements and the pumping device,
- figures 15 and 16 are views of alternative arrangements of the containers and the pumping device of the mixing device according to the second embodiment,
- figure 17 is a perspective view of a third embodiment of the mixing device, the supply and filling arrangements receiving containers presenting a vertical orientation and the pumping device presenting a horizontal orientation,
- figures 18, 19 and 20 are respectively a perspective view of a bottom face and sectional views along respective orientations XIX-XIX and XX-XX of a carrier of the mixing device of figure 17, the carrier including the supply and filling arrangements and the pumping device,
- figure 21 is a partial perspective view of the pumping device and driving system of a fourth embodiment of the mixing device, the driving system being configured so that a same actuator forms both the piston actuator and the cylinder actuator,
- figures 22 and 23 are respectively perspective and exploded views of a transmission mechanism of the driving system of figure 21,
- figures 24 to 29 are plan views in longitudinal and cross sections of the transmission mechanism at different steps of actuation of the pumping device of figure 21,
- figure 30 is a longitudinal sectional view of a gearing arrangement of the transmission mechanism enabling selective actuation of the piston and the cylinder of the pumping device.

DETAILED DESCRIPTION

[0053] Figures 1 to 5 represent a mixing device 5 for mixing two products in order to prepare a formulation of the medical or pharmaceutical field, such as a drug, a medicine, a medication and the like.

[0054] In a particular non-limitative example, the mixing device 5 can be implemented in reconstitution of a formulation based on a lyophilized product. One of the products is then a solid product, such as a lyophilized product, contained in a vial 2 and the other product is a liquid product, such as a diluent, contained in a bottle 1.

[0055] In other implementations, the products could be of any other suitable kind. In particular, both products could be liquid products. Besides, each of the products could be contained in any suitable container, such as a bottle, a vial, a cartridge or other, presenting a bottom and an opening opposite the bottom. Also, although disclosed in relation with an embodiment involving two products, the mixing device could be implemented for mixing more than two products, provided at least one of the prod-

ucts is a liquid product.

[0056] In the first embodiment, the mixing device 5 has a frame 6 comprising a basement 7 configured to form a reusable part, and a carrier 8 configured to form a disposable part that is disposed after each mixing operation. Alternatively, the basement 7 and the carrier 8 could be both reusable parts or both disposable parts. Also, the basement 7 and the carrier 8 could be integral with each other.

[0057] The carrier 8 is configured to carry a supply arrangement 50 for supplying products, a pumping device 10 to collect and mix the products and a filling arrangement 40 to receive a mixture of the products.

[0058] The pumping device 10 includes a cylinder 11 comprising a lateral wall 12 around a cylinder axis C and a transverse wall 13 extending perpendicularly to the cylindrical axis C at a distal end of the lateral wall 12. The transverse wall 13 and a portion of the lateral wall 12 close to the transverse wall 13 define a distal portion 14 of the cylinder 11 provided with a unique cylinder orifice 15. In the first embodiment represented in figures 1 to 5, the cylinder orifice 15 opens radially with respect to the cylinder axis C.

[0059] At a proximal end opposite the transverse wall 13, the lateral wall 12 of the cylinder 11 defines an opening 16 through which a piston 17 is mounted within the cylinder 11 so as to reciprocate along the cylinder axis C. The piston 17 comprises a head 18 facing the transverse wall 13 of the cylinder and in sealing contact with an inner surface of the lateral wall 12 of the cylinder 11. The cylinder 11 and the piston 17 thus define an inner chamber 19 between the transverse wall 13 and the head 18, which inner chamber 19 opens outwardly through the cylinder orifice 15. The piston 17 also comprises an actuating rod 20 that can be actuated to move the head 18 back and forth along the cylinder axis C within the cylinder 11. A volume of the inner chamber 19 can thus be varied between a minimum volume, when the head 18 of the piston 17 is at a bottom dead point, close to the transversal wall 13 of the cylinder 11, and a maximum volume when the head 18 of the piston 17 is at a top dead point, apart from to the transverse wall 13 of the cylinder 11. To enable an accurate mixing of the products, the maximum volume is precisely defined.

[0060] In figures 3 and 4, the carrier 8 has an attaching arrangement 25 presenting an attaching axis A and configured to enable attachment of the pumping device 10 upwardly, namely in a vertical orientation with the distal portion 14 up when the carrier 8 stands on a ground surface S.

[0061] In the represented embodiment, the attaching arrangement 25 comprises a housing 26 extending along the attaching axis A and configured to coaxially accommodate at least the distal portion 14 of the cylinder 11. The housing 26 has an upper transverse wall 27 arranged perpendicularly to the attaching axis A and from which a lateral wall 28 extends downwardly around the attaching axis A, towards an insertion opening 29 through which

the pumping device 10 can be inserted by its distal portion 14.

[0062] The attaching arrangement 25 has a distribution portion 35 arranged close to the transverse wall 27 of the housing 26 and configured to receive the distal portion 14 of the cylinder 11. The distribution portion 35, visible in figures 6 to 9, is provided with supply 55 and filling 45 orifices distributed around the attaching axis A and opening radially with respect to the attaching axis A.

[0063] Attachment of the pumping device 10 to the carrier 8 through the attaching arrangement 25 can be made in any suitable manner to enable the cylinder 11 to rotate about the attaching axis A to put the cylinder orifice 15 selectively in fluid communication with the aforementioned supply 55 and filling 45 orifices.

[0064] The attaching arrangement 25 also comprises a joint 30 radially interposed between the cylinder 11 and the distribution portion 35 to ensure tightness between them while enabling rotation of the cylinder 11.

[0065] The carrier 8 has two parallel lateral walls 31 extending from the housing 26 of the attaching arrangement 25 along an extension direction E, perpendicular to the attaching axis A.

[0066] The lateral walls 31 are configured to stand upwards along a vertical direction V perpendicular to the ground surface S from lower edges 32, configured to rest on the ground surface S. The attaching A and cylinder C axes are then parallel to the vertical direction V and the extension direction E is perpendicular to the vertical direction V. The insertion opening 29 of the housing 26 is further directed towards the lower edges 32 of the lateral walls 31 resulting in the aforementioned upwards vertical orientation of the distal portion 14 of the cylinder 11 when the pumping device 10 is attached to the attaching arrangement 25.

[0067] The lateral walls 31 present respective internal surfaces facing each other and spaced apart from each other along a transverse direction T perpendicular to the extension E and vertical V directions.

[0068] Between the internal surfaces of the lateral walls 31 is a stepped platform 33 presenting different support surfaces oriented opposite the insertion opening 29 of the housing 26 of the attaching arrangement 25. The support surfaces are further arranged respectively at heights with respect to the lower edges 32 of the lateral walls 31 along the vertical direction E, which heights are decreasing in the extension direction E from the attaching arrangement 25.

[0069] The support surface closest to the attaching arrangement 25 accommodates the filling arrangement 40. The filling arrangement 40 includes a filling location 41 configured to receive a mixture of the products. The filling location 41 is arranged at a lower height from the lower edges 32 than the distribution portion 35.

[0070] In the represented embodiment, the filling location 41 comprises a reversible fixing member 42 configured to reversibly fix a container to be filled with the reconstituted formulation after the products have been

mixed. Thanks to such provisions, the container can be replaced and/or used for several purposes. Advantageously, although not limited thereto, the container is a syringe 3 which, once filled with the reconstituted formulation, can be used for administration of the formulation.

[0071] In addition, as apparent from the figures, the fixing member 42 of the filling location 41 is configured to fix an opening of the container, here a distal opening of the syringe 3, with a bottom up. Thanks to such provisions and to the orientation of the support surface opposite the insertion opening 29 of the housing 26 of the attaching arrangement 25, the pumping device 10 and the syringe 3 of the filling location 41, or any other suitable container placed at the filling location 41, have opposite vertical orientations.

[0072] The filling location 41 may be equipped with a sump 43 facing the fixing member 42 to recover any possible leak of the formulation upon installation or removal of the syringe 3, upon filling or other.

[0073] The filling arrangement 40 also has a filling conduct 44 extending between a connection orifice opening in the filling location 41, especially on the fixing member 42, and the filling orifice 45 arranged, as mentioned previously, in the distribution portion 35 of the attaching arrangement 25. As can be seen in figure 4, the filling conduct 44 extends on an outer surface of one of the lateral walls 31 opposite the inner surface.

[0074] A remaining part of the platform 33 of the carrier 8 bears the supply arrangement 50. The supply arrangement 50 comprises supply locations 51 each configured to receive one of the products to be mixed, and supply conducts 54 each configured to connect one of the supply locations 51 with one of the supply orifices 55 arranged in the distribution portion 35 of the attaching arrangement 25.

[0075] More particularly, the next support surface with respect to the support surface bearing the filling arrangement 40 in the extension direction E includes a first supply location 51a configured to receive one of the products and, in the present case, the lyophilized product contained in the vial 2. The first supply location 51a is arranged at a lower height from the lower edges than the filling location 41.

[0076] As for the filling location 41, in the represented embodiment, the first supply location 51a comprises a reversible fixing member 52 configured to reversibly fix the opening of the vial 2 with the bottom up. Here again, the pumping device 10 and the vial 2 placed at the first supply location 51a have opposite vertical orientations.

[0077] The first supply location 51a may be equipped with a sump 53 facing the fixing member 52 to recover any possible leak of lyophilized product or of mixture of the lyophilized product with the diluent upon installation or removal of the vial 2, upon mixing or other.

[0078] A first supply conduct 54a extends between a connection orifice opening in the first supply location 51a, especially on the fixing member 52, and a first 55a of the aforementioned supply orifices 55 arranged in the distri-

bution portion 35 of the attaching arrangement 25. As can be seen in figure 4, the first supply conduct 54a extends on the outer surface of the lateral wall 31 of the carrier 8, next to the filling conduct 44.

[0079] The supply arrangement 50 comprises second supply location 51b and duct 54b having similar functions as the first supply location 51a and duct 54a but differing from them in their arrangement. Indeed, the second supply location 51b is arranged on the last support surface, next to the support surface bearing the first supply location 51a in the extension direction E, and at a lower height from the lower edges 32 than the first supply location 51a.

[0080] The second supply location 51b is configured to receive the other product, namely the diluent contained in the bottle 1.

[0081] A reversible fixing member 52 is then configured to reversibly fix the opening of the bottle 2 with the bottom up so that the pumping device 10 and the bottle 2 placed at the second supply location 51b have opposite vertical orientations. A sump 53 facing the fixing member 52 is provided to recover any possible leak of diluent or of mixture of diluent with the lyophilized product upon installation or removal of the bottle 2, upon mixing or other.

[0082] A second supply conduct 54b extends between a connection orifice opening in the second supply location 51b, especially on the fixing member 52, and a second 55b of the aforementioned supply orifices 55 arranged in the distribution portion 35 of the attaching arrangement 25. The second supply conduct 54b extends on the outer surface of the lateral wall 31 of the carrier 8, next to the first supply conduct 54a.

[0083] The first 55a and second 55b supply orifices and the filling orifice 45 are separate from each other and arranged in a same distribution plan perpendicular to the attaching axis A. The first 54a and second 54b supply conducts and the filling conduct 44 are formed by continuous protrusions 60 delimiting adjacent grooves on the outer surface of the lateral wall 31, the grooves being tightly closed by a sealing plate 61 fixed, especially welded, to the protrusions 60.

[0084] The basement 7 has a resting surface 9 configured to rest on the ground surface S, and is configured to support the carrier 8 so that the vertical direction V is perpendicular to the ground surface S and the lower edges 32 of the lateral walls 31 are parallel to the resting surface 9. The attaching axis A is hence perpendicular to the resting surface 9 while the extension E and transverse T directions are parallel to the resting surface 9. Besides, the cylinder orifice 15 is arranged at a height with respect to the resting surface 9 that is greater than respective heights of the supply 51 and filling 41 locations.

[0085] In order to move the cylinder 11 of the pumping device 10 with respect to the distribution portion 35 of the attaching arrangement 25 of the carrier 8, the basement 8 bears a driving system 70.

[0086] In the represented embodiment, the driving system 70 comprises a cylinder actuator 71 configured to

move the cylinder 11 in rotation about the attaching axis A with respect to the distribution portion 35 between:

- supply positions, in each of which the cylinder orifice 15 is in fluid communication with one of the first 55a and second 55b supply orifices,
- a filling position, in which the cylinder orifice 15 is in fluid communication with the filling orifice 45, and
- possibly an inactive position, in which the cylinder orifice 15 faces an obturating wall, such as a portion of the lateral wall 28 of the housing 26.

[0087] The cylinder actuator 71 comprises a motor mounted in a casing 72 of the basement 7 so as to present a driving shaft 73 rotating about a driving axis D parallel to the vertical direction V. A pinion 74 attached to the driving shaft 73 engages a toothed plate 75 fixed to the cylinder 11 so that rotation of the driving shaft 73 causes rotation of the cylinder 11 about the attaching axis A.

[0088] The driving system 70 also comprises a piston actuator 76 configured to move the piston 17 with respect to the cylinder 11 in its reciprocating movement along the cylinder axis C, in the vertical direction V. The piston actuator 76, distinct from the cylinder actuator 71, is also carried by the basement 7.

[0089] Appropriate operations of the cylinder actuator 71 and the piston actuator 76 are controlled by an electronic control unit programmable by a user.

[0090] In relation with figures 6 to 9, a mixing method implementing the mixing device 5 is disclosed.

[0091] In figure 6, the cylinder 11 is in the inactive position.

[0092] In figure 7, the cylinder actuator 71 is actuated to move the cylinder 11 with respect to the distribution portion 35 of the carrier 8 to the supply position in which the cylinder orifice 15 is in fluid communication with the second supply orifice 55b opening in the second supply location 51b. The diluent from the bottle 1 at the second supply location 51b may be collected in the inner chamber 19 of the pumping device 10 through actuation of the piston 17 of the pumping device 10 by the piston actuator 76.

[0093] In this respect, thanks to the opposite vertical orientations of the pumping device 10 and the bottle 1 containing the diluent, with the pumping device 10 standing upwards and the bottle 1 standing up-side-down, filling the inner chamber 19 of the pumping device 10 may comprise:

- filling the inner chamber 19 with air,
- pushing the piston 17 towards the distal portion 14 of the cylinder 11 and repeatedly reciprocating the piston 17 to progressively fill the inner chamber 19 with the diluent.

[0094] In doing so, operation of the piston 17 is exerted on air that is incompressible, and the whole volume of air within the inner chamber 19 can be progressively re-

placed by the diluent at balanced pressures. This enables the filling of the inner chamber 19 to be precisely controlled and the volume of diluent to be accurately known. This also avoids occurrence of stokes and the related risks of deterioration of the containers and of the products.

[0095] In figure 8, the cylinder actuator 71 is actuated to move the cylinder 11 with respect to the distribution portion 35 to the supply position in which the cylinder orifice 15 is in fluid communication with the first supply orifice 55a opening in the first supply location 51a. The diluent can then be discharged in the vial 2 of lyophilized product to reconstitute the formulation by operating the piston 17 towards the bottom dead point thanks to the piston actuator 76. To improve homogeneity of the mixture, the piston 17 can be repeatedly reciprocated.

[0096] Once mixed, the reconstituted formulation can be filled in the inner chamber 19 of the pumping device 10 by moving the piston 17 towards the top dead point. A precisely known volume of reconstituted formulation is hence contained in the inner chamber 19.

[0097] In figure 9, the cylinder actuator 71 is actuated to move the cylinder 11 with respect to the distribution portion 35 to the filling position in which the cylinder orifice 15 is in fluid communication with the filling orifice 44. The formulation can be discharged in the syringe 3 arranged at the filling location 41 by moving the piston 17 towards the bottom dead point, for subsequent administration of the formulation.

[0098] The mixing device 5 has been disclosed in relation with an embodiment having a specific arrangement of two supply locations 51 and a filling arrangement 40 to reconstitute a formulation resulting from the mixture of a lyophilized product with a diluent. The mixing device 5 is however not limited to such embodiment and such application. Depending on the application, in other embodiments, the mixing device 5 could have any other suitable arrangement of a number of supply locations 51, possibly with a filling arrangement 40 having any suitable number of filling location 41. The arrangement of the pumping device 10 could also be envisioned otherwise.

[0099] In this respect, figures 10 and 11 show first and second variants in which the pumping device 10 and the filling arrangement 40 are combined. In particular, the pumping device 10 is formed of a syringe that can be used for subsequent administration of the formulation. The attaching arrangement 25 is then configured to attach the cylinder 11 of the pumping device 10 in a removable manner. The mixing device 5 may be deprived of any further filling arrangement.

[0100] In figure 10, the cylinder orifice 15 of the syringe of the pumping device 10 opens axially with respect to the cylinder axis C while being offset with respect to the cylinder axis C. The distribution portion 35 of the attaching arrangement 25 of the carrier 8 is then modified so that the first 55a and second 55b supply orifices open axially with respect to the attaching axis A while being distributed about the attaching axis A so that rotation of

the cylinder 11 about the attaching axis A puts the cylinder orifice 15 in fluid communication selectively with one of the first 55a and second 55b supply orifices.

[0101] Alternatively, in figure 11, the cylinder orifice 15 of the syringe of the pumping device 10 opens axially with respect to the cylinder axis C and is centered on the cylinder axis C.

[0102] The attaching arrangement 25 then comprises a connecting portion 36 movable in rotation about the attaching axis A with respect to the distribution portion 35. The connecting portion 36 is provided with a connection duct 37 arranged to be selectively put in fluid communication with one of the first 55a and second 55b supply orifices. The connecting portion 36 is configured to connect with the distal portion 14 of the cylinder 11 so as to put the cylinder orifice 15 in fluid communication with the connection duct 37, and to move together with the cylinder 11 in rotation about the attaching axis A upon actuation of the cylinder actuator 71.

[0103] The other features of the first and second variants of the first embodiment are similar to those disclosed previously. Their operation is also similar except for the last step disclosed in relation with figure 9 of filling the syringe 3 after having moved the cylinder 11 to the filling position. With the first and second variants of the first embodiment, this step is directly obtained when the reconstituted formulation is filled in the inner chamber 19 of the pumping device 10 by moving the piston 17 towards the top dead point. The syringe of the pumping device 10 can be detached from the connecting portion 36 of the attaching arrangement 25 for subsequent use.

[0104] Figures 12 to 14 represent a second embodiment of the mixing device 5 that mainly differs from the first embodiment in that the attaching arrangement 25 and the supply 50 and filling 40 arrangements are configured so that the containers, especially the bottle 1, the vial 2 and the syringe 3, and the pumping device 10 have the same vertical orientation up-side-down.

[0105] In particular, the housing 26 of the attaching arrangement 25 has the inserting opening 29 directed upwards, opposite the resting surface 9 of the frame 6. Once received in the housing 26, the cylinder 11 is then arranged so that its cylinder axis A is perpendicular to the resting surface 9 and its distal part 14 is oriented towards the resting surface 9.

[0106] In this second embodiment, the carrier 8, removably attachable to the basement 7, is configured so that the first 51a and second 51b supply locations and the filling location 41 are evenly distributed around pumping device 10 on a same planar support surface of a same plate. The first 54a and second 54b supply conducts and the filling conduct 44 are arranged in a coplanar manner on a lower surface opposite the support surface, and extend radially with respect to the attaching axis A.

[0107] As can be seen in figure 14, the cylinder orifice 15 of the pumping device 10 opens axially with respect to the cylinder axis C and is offset with respect to the cylinder axis C. The first 55a and second 55b supply or-

ifices as well as the filling orifice 45 open axially with respect to the attaching axis A while being distributed about the attaching axis A so that rotation of the cylinder 11 about the attaching axis puts the cylinder orifice 15 in fluid communication selectively with one of the first 55a and second 55b supply orifices and the filling orifice 45.

[0108] In an alternative arrangement of the second embodiment shown in figure 15, the carrier 8 is configured so that the first 51a and second 51b supply locations and the filling location 41 are aligned with the pumping device 10 on a same planar support surface of a tray.

[0109] The first 54a and second 54b supply conducts and the filling conduct 44 extend parallel to each other perpendicular to the attaching axis A. The cylinder orifice 15 of the pumping device 10 opens radially with respect to the cylinder axis C and the first 55a and second 55b supply orifices as well as the filling orifice 45 open radially with respect to the attaching axis A so that rotation of the cylinder 11 about the attaching axis A puts the cylinder orifice in fluid communication selectively with one of the first 55a and second 55b supply orifices and the filling orifice 45.

[0110] In a further alternative arrangement of the second embodiment shown in figure 16, the carrier 8 is still configured as a tray but with a bottom wall having two inclined parts defining a V-shape. One of the inclined parts has a support surface receiving the filling arrangement 40 and the pumping device 10 while the other inclined part has a support surface receiving the first 51a and second 51b supply locations. The first 54a and second 54b supply conducts and the filling conduct 44 are arranged to enable fluid communication between the cylinder orifice 15 and each of the first 55a and second 55b supply orifices and the filling orifice 45 upon rotation of the cylinder 11 about the attaching axis A.

[0111] Figures 17 to 20 illustrate a third embodiment of the mixing device 5.

[0112] The mixing device 5 also has a frame 6 with a basement 7 provided with the driving system 70, and a carrier 8 provided with the supply 50 and filling 40 arrangements and the pumping device 10.

[0113] The mixing device 5 of the third embodiment mainly differs from the second embodiment in that the attaching arrangement 25 is configured so that the pumping device 10 has a horizontal orientation, with the cylinder axis C parallel to the resting surface 9 of the basement 7 when the carrier 8 is mounted on the basement 7.

[0114] In particular, the housing 26 of the attaching arrangement 25 has the attaching axis A parallel to a planar support surface of the carrier 8 receiving the first 51a and second 51b supply locations and the filling location 41.

[0115] In figures 19 and 20, the cylinder orifice 15 of the pumping device 10 opens axially with respect to the cylinder axis C and is offset with respect to the cylinder axis C. The first 55a and second 55b supply orifices and the filling orifice 45 open axially with respect to the attaching axis A, in the transverse wall 27 of the housing 26, while being distributed about the attaching axis A so

that rotation of the cylinder 11 about the attaching axis A puts the cylinder orifice 15 in fluid communication selectively with one of the first 55a and second 55b supply orifices and the filling orifice 45. The first 54a and second 54b supply conduits and the filling conduit 44 are arranged in a coplanar manner on a lower surface opposite the support surface. They converge from their respective connection orifices towards the transverse wall 27 of the housing 26 where respective extensions perpendicular to the attaching axis A reach respectively first 55a and second 55b supply orifices and the filling orifice 45.

[0116] Figures 21 to 23 represent a pumping device 10 and a driving system 70 of a mixing device 5 according to a fourth embodiment in which a same actuator forms both the piston actuator and the cylinder actuator.

[0117] In this fourth embodiment, each of the supply ducts 54 comprises an aspiration path and an exhaust path. Accordingly, the supply orifice 55 of each of the supply ducts 54 comprises an aspiration opening in fluid communication with the aspiration path and an exhaust opening in fluid communication with the exhaust path.

[0118] The actuator is a motor 80 presenting a driving shaft 81 configured to impart a rotational movement about a driving axis B parallel to the attaching axis A.

[0119] The driving system 70 comprises a transmission mechanism 82 configured to cause the piston 17 reciprocating between the top and bottom dead points from the rotational movement of the motor 80. The transmission mechanism 82 is further configured to move the cylinder 11 in rotation about the attaching axis A between the supply positions and, in each of the supply positions, to move the cylinder 11 in rotation about the attaching axis A between the aspiration opening and the exhaust opening of one of the supply ducts 54 when the piston 17 is moved between the top and bottom dead points.

[0120] The transmission mechanism 82 comprises a pinion 83 attached to the driving shaft 81 and having external teeth inclined at 45° engaging teeth inclined at 45° of a driving part 84a of a driving wheel 84 rotatably mounted about a pivot axis P perpendicular to the cylinder axis C. The driving wheel 84 also has a following part 84b coaxial to the driving part 84a and is connected to the driving part 84a by a piston pin 85 parallel to pivot axis P and offset with respect to the pivot axis P.

[0121] A translation member 86 of the transmission mechanism 82 is integral with the piston 17 and provided with a piston slot 87 extending perpendicular to the cylinder axis P.

[0122] The piston pin 85 engages the piston slot 87 so as to reciprocate within the piston slot 87 as the driving wheel 84 rotates. The piston slot 87 is configured to cause the piston 17 reciprocating between the top and bottom dead points as the piston pin 85 reciprocates within the piston slot 87.

[0123] Opposite internal surfaces facing each other, the driving 84a and following 84b parts of the driving wheel 84 have respective external surfaces each provided with a cylinder pin 88 parallel to pivot axis P and offset

with respect to the pivot axis P.

[0124] The transmission mechanism 82 comprises two sliding members 90 each connected to the cylinder 11 so as to move the cylinder 11 in rotation about the attaching axis A between the aspiration opening and the exhaust opening of one of the supply ducts 54 as the sliding member 90 is moved in translation perpendicularly to the cylinder axis C. Each of the sliding members 90 is provided with a cylinder slot 91 extending parallel to the cylinder axis C. Alternatively, the transmission mechanism 82 could comprise only one of the sliding members 90.

[0125] Each of the cylinder pins 88 engages one of the cylinder slots 91 so as to reciprocate within the cylinder slot 91 as the driving wheel 84 rotates. The cylinder slots 91 are configured to move the sliding members 90 in translation perpendicularly to the cylinder axis C as the cylinder pins 88 reciprocate within the respective cylinder slots 91. The cylinder pins 88 are arranged to move the sliding members 90 in opposite directions as they reciprocate within the cylinder slots 91.

[0126] Accordingly, as shown in figure 24, the piston 17 is at the top dead point with the piston pin 85 in a central portion of the piston slot 87 of the translation member 86, in contact with an upper surface. The sliding members 90 are aligned on either side of the driving wheel 84.

[0127] In figure 25, the driving wheel 84 is rotated causing the piston pin 85 to move along the upper surface of the piston slot 87 towards an end portion. In doing so, the piston 17 remains at the top dead point. Meanwhile, the cylinder pins 88 engaging the cylinder slots 91 cause the sliding members 90 to move in translation perpendicularly to the cylinder axis C in opposite directions, thereby causing the cylinder 11 to rotate about the attaching axis A in a first direction to put the cylinder orifice 15 in communication with the exhaust path.

[0128] In figure 26, as rotation of the driving wheel 84 continues, the piston pin 85 contacts a lower surface of the piston slot 87 causing the piston 17 to be moved to the bottom dead point. The content of the inner chamber 19 is here discharged through the exhaust path.

[0129] In figures 27 and 28, the piston pin 85 in contact with the lower surface of the piston slot 87 reaches the central portion. The piston 17 remains at the bottom dead point and the cylinder pins 88 engaging the cylinder slots 91 cause the sliding members 90 to move back in translation perpendicularly to the cylinder axis C in opposite directions. The cylinder 11 is hence caused to rotate about the attaching axis A in a second direction opposite the first direction to put the cylinder orifice 15 in communication with the aspiration path.

[0130] In figure 29, as rotation of the driving wheel 84 continues, the piston pin 85 contacts the upper surface of the piston slot 87 causing the piston 17 to be moved to the top dead point. The inner chamber 19 may be filled through the aspiration path.

[0131] In figure 30, the translation member 86, the sliding members 90 and the driving wheel 84 form a trans-

mission assembly mounted on a transmission support 95.

[0132] The transmission mechanism 82 is configured to impart the rotational movement to the driving wheel 84 when the motor 80 runs in a first direction, so as to cause the operation of the pumping device 10 as disclosed previously. Besides, the transmission mechanism 82 is configured to impart the rotational movement to the transmission support 95 of the transmission assembly so as to move the cylinder 11 in rotation about the attaching axis A between the supply positions when the motor 80 runs in a second direction.

[0133] In this respect, the transmission mechanism 82 comprises a gearing arrangement enabling selective actuation of the piston 17 and the cylinder 11 of the pumping device 10. The gearing arrangement comprises a first free wheel connecting the pinion 83 to the driving shaft 81 of the motor 80. The first free wheel causes the pinion 17 to rotate together with the driving shaft 81 only when the driving shaft 81 rotates in the first direction. The gearing arrangement comprises a second free wheel connecting the transmission support 95 to the driving shaft 81 of the motor 80. The second free wheel causes the transmission support 95 to rotate together with the driving shaft 81 only when the driving shaft 81 rotates in the second direction.

Claims

1. A mixing device (5) for mixing at least two products, at least one of said products being a liquid product, the mixing device (5) comprising a frame (6), a supply arrangement (50) mounted on the frame (6) and a pumping device (10) mounted on the frame (6),

wherein the supply arrangement (50) includes:

- at least two supply locations (51) each configured to receive one of the products, and
- at least two supply conducts (54) extending each between a connection orifice opening in one of the supply locations (51) and a supply orifice (55), the supply orifices (55) being separate from each other,

wherein the pumping device (10) includes:

- a cylinder (11) presenting a cylinder axis (C) and a distal portion (14) provided with a unique cylinder orifice (15), and
- a piston (17) mounted within the cylinder (11) so as to reciprocate along the cylinder axis (C),

the cylinder (11) and the piston (17) being configured to define an inner chamber (19) of a variable volume opening outwardly through the cyl-

inder orifice (15),

the mixing device (5) being **characterized in that** said mixing device (5) further comprises a driving system (70) configured to move the cylinder (11) with respect to the frame (6) between at least two supply positions, the cylinder orifice (15) being in fluid communication with one of the supply orifices (55) in each of the supply positions.

2. The mixing device (5) according to claim 1, wherein the frame (6) includes an attaching arrangement (25) presenting an attaching axis (A) and configured to attach coaxially the cylinder (11) to the frame (6), the attaching arrangement (25) comprising a distribution portion (35) configured to receive the distal portion (14) of the cylinder (11) and provided with the supply orifices (55) distributed around the attaching axis (A), the driving system (70) comprising a cylinder actuator (71) configured to move the cylinder (11) in rotation about the attaching axis (A) with respect to the distribution portion (35) between the supply positions.
3. The mixing device (5) according to claim 2, wherein the supply orifices (55) open radially with respect to the attaching axis (A) and the cylinder orifice (15) opens radially with respect to the cylinder axis (C).
4. The mixing device (5) according to claims 2, wherein the cylinder orifice (15) opens axially with respect to the cylinder axis (C) and is centered on the cylinder axis (C), and the attaching arrangement (25) comprises a connecting portion (36) movable in rotation about the attaching axis (A) with respect to the distribution portion (35), the connecting portion (36) being provided with a connection duct (37) arranged to be selectively put in fluid communication with one of the supply orifices (55), the connecting portion (36) being configured to connect with the distal portion (14) of the cylinder (11) so as to put the cylinder orifice (15) in fluid communication with the connection duct (37), and to move together with the cylinder (11) in rotation about the attaching axis (A) upon actuation of the cylinder actuator (71).
5. The mixing device (5) according to any of claims 2 to 4, wherein the attaching arrangement (25) is configured to attach the cylinder (10) in a removable manner.
6. The mixing device (5) according to any of claims 1 to 5, wherein the frame (6) has a resting surface (9) configured to rest on a support surface (S), the cylinder axis (C) being perpendicular to the resting surface (9) and the distal part (14) of the cylinder (11) being oriented opposite the resting surface (9).

7. The mixing device (5) according to claim 6, wherein the cylinder orifice (15) is arranged at a height with respect to the resting surface (9) that is greater than respective heights of the supply locations (51). 5
8. The mixing device (5) according to claim 7, wherein the pumping device (10) and the supply locations (51) are aligned along an extension direction (E) parallel to the resting surface (9), the heights of the cylinder orifice (15) and the supply locations (51) decreasing along the extension direction (E). 10
9. The mixing device (5) according to any of claims 1 to 8, wherein each of the supply locations (51) comprises a reversible fixing member (52) configured to reversibly fix a container filled with the product. 15
10. The mixing device (5) according to claim 9 for containers each presenting a bottom and an opening opposite the bottom, wherein each of the fixing member (52) is configured to reversibly fix the opening of one of the containers with the bottom up. 20
11. The mixing device (5) according to any of claims 1 to 10, wherein the frame (6) comprises a basement (7) and a carrier (8) removably mounted on the basement (7), the carrier (8) bearing the supply arrangement (50) and the pumping device (10), the basement (7) bearing the driving system (70). 25
12. The mixing device (5) according to claim 11, wherein the carrier (8) has two parallel lateral walls (31) presenting respective internal surfaces facing each other and respective external surfaces, the supply locations (51) being arranged between the internal surfaces and the supply conducts (54) being arranged on at least one of the external surfaces. 30
13. The mixing device (5) according to any of claims 1 to 12, further comprising a filling arrangement (40) including: 35
- at least one filling location (41) configured to receive a mixture of the products, and
 - at least one filling conduct (44) extending between a connection orifice opening in the filling location and a filling orifice (45), the filling orifice (45) being separate from the supply orifices (55), 40
- wherein the driving system (70) is further configured to move the cylinder (11) with respect to the frame (6) in a filling position in which the cylinder orifice (15) is in fluid communication with the filling orifice (45). 45
14. A mixing method for mixing at least two products, at least one of said products being a liquid product, the mixing method implementing the mixing device (5) 50

according to any of claims 1 to 13, wherein the products are received respectively in the supply location, the mixing method comprising steps consisting in:

- moving the cylinder (11) with respect to the frame (6) by the driving system (70) to the supply position in which the cylinder orifice (10) is in fluid communication with the supply orifice (55) opening in the supply location (51) provided with the liquid product,
- filling the inner chamber (19) with the liquid product by actuating the piston (17) of the pumping device (10),
- moving the cylinder (11) with respect to the frame (6) by the driving system (70) to the other supply position in which the cylinder orifice (15) is in fluid communication with the supply orifice (55) opening in the supply location (51) provided with the other product,
- discharging the liquid product to form a mixture of the products. 55

15. The mixing method according to claim 14 when dependent from claims 6, 9 and 10, wherein the step consisting in filling the inner chamber (19) comprises:

- filling the inner chamber (19) with air,
- pushing the piston (17) towards the distal portion (14) of the cylinder (11) and repeatedly reciprocating the piston (17) to progressively fill the inner chamber (19) with the liquid product. 60

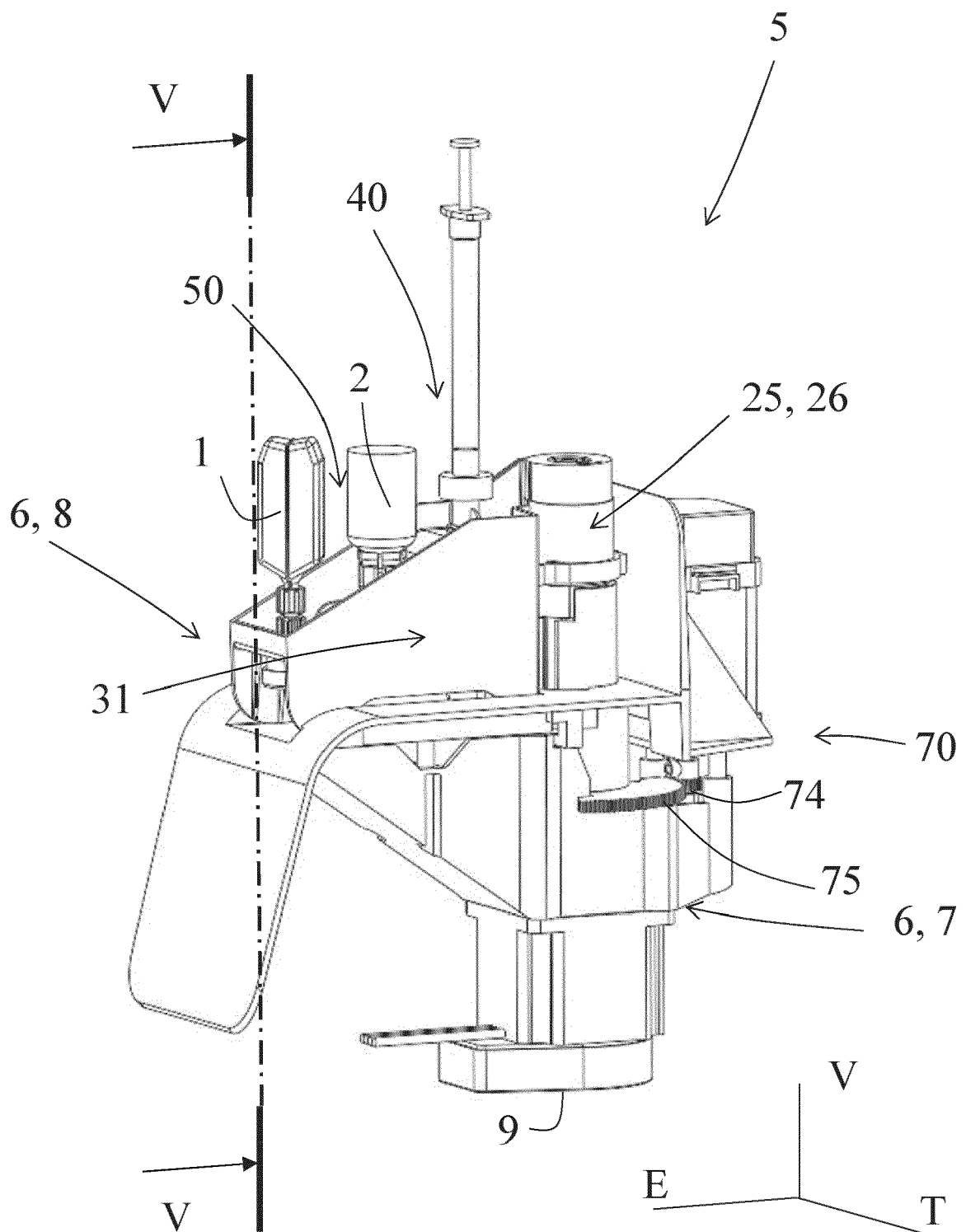


FIG. 1

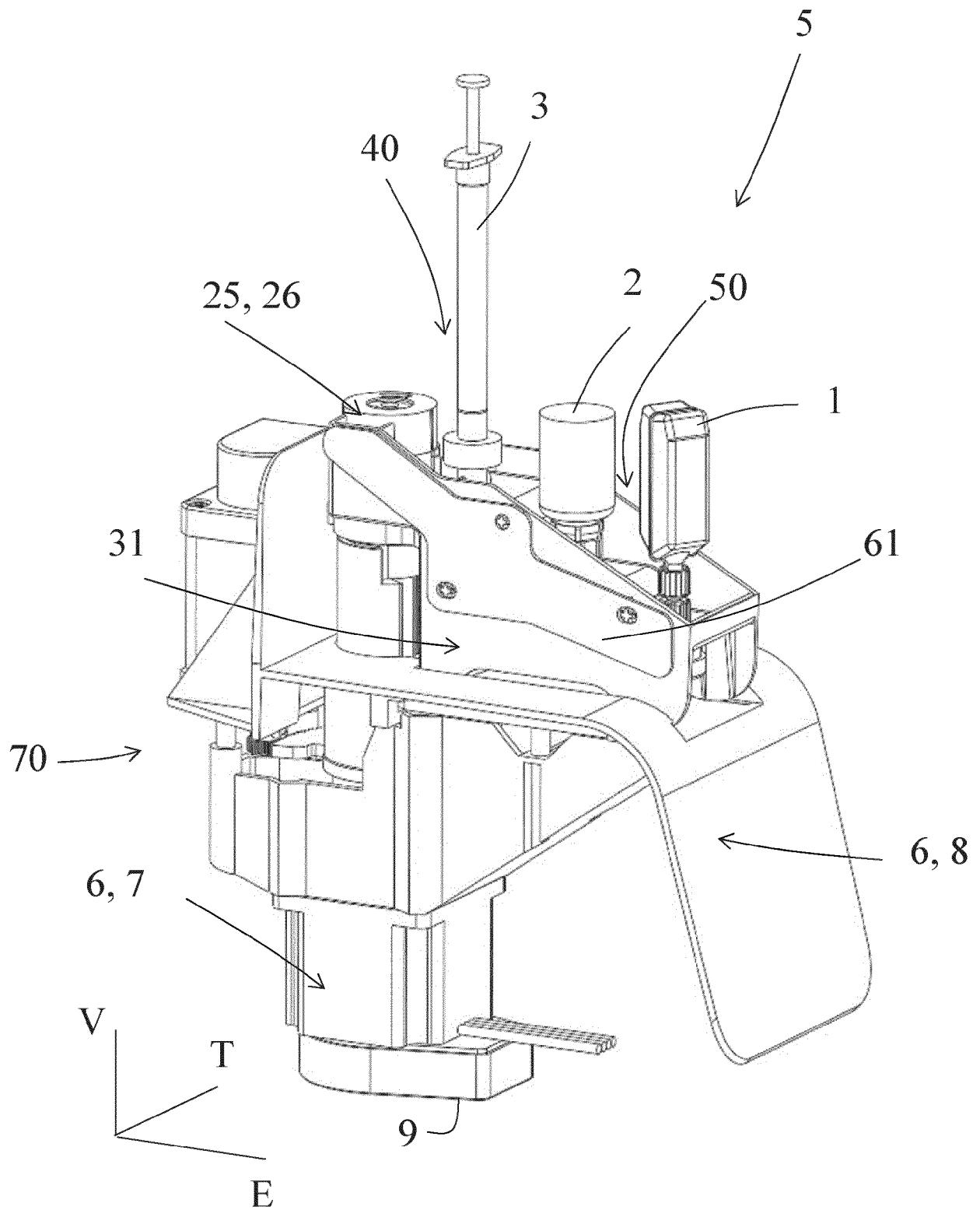
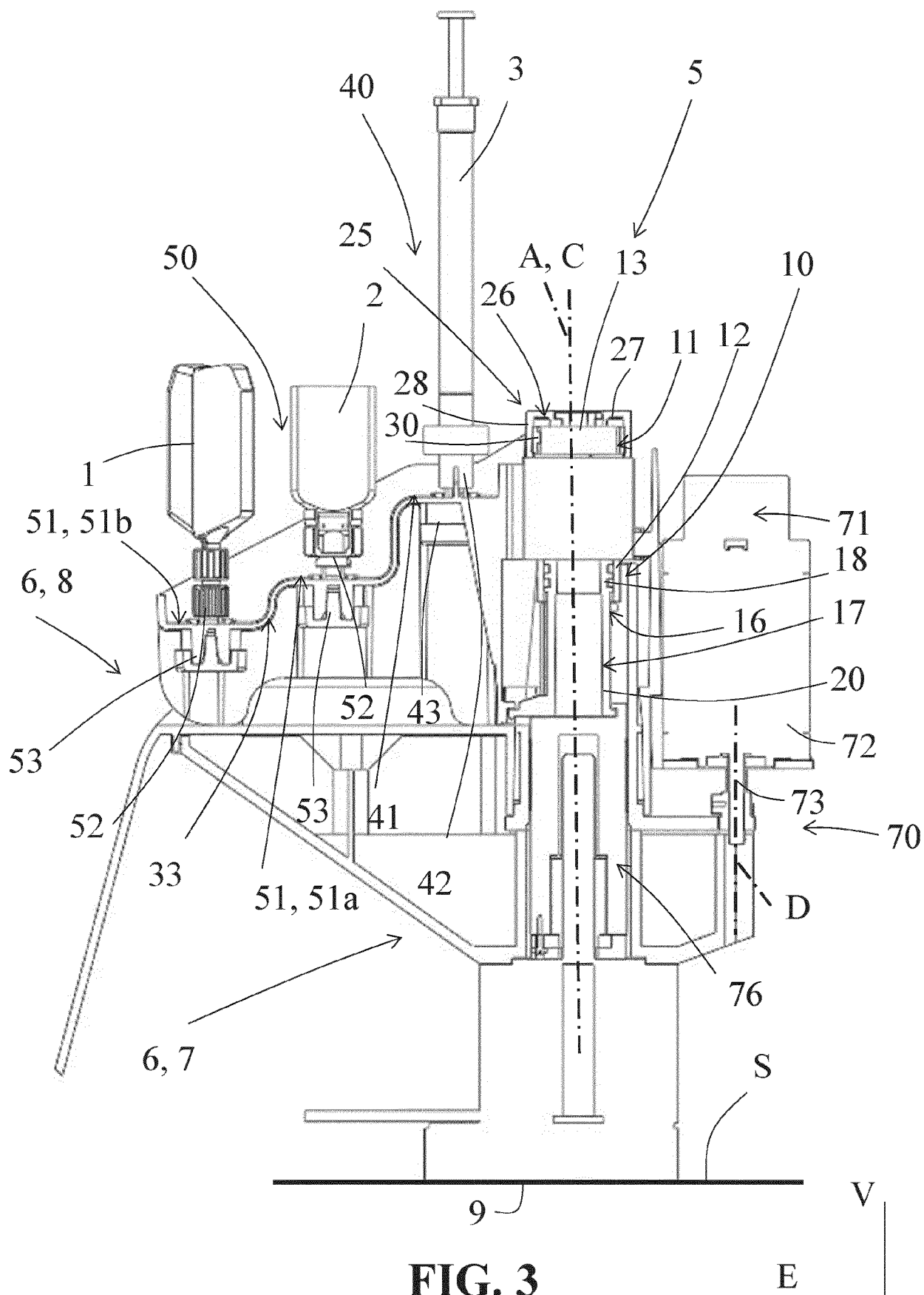


FIG. 2



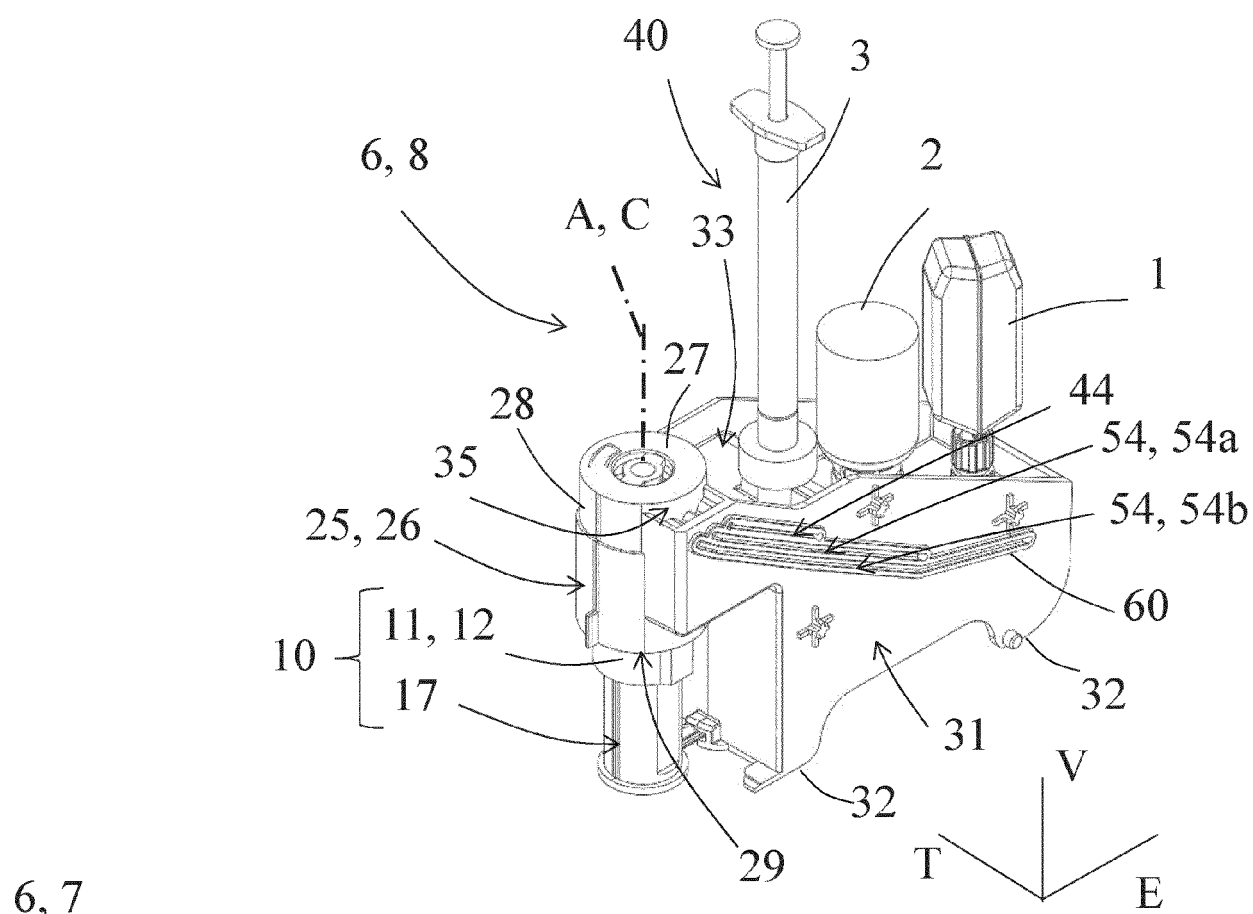


FIG. 4

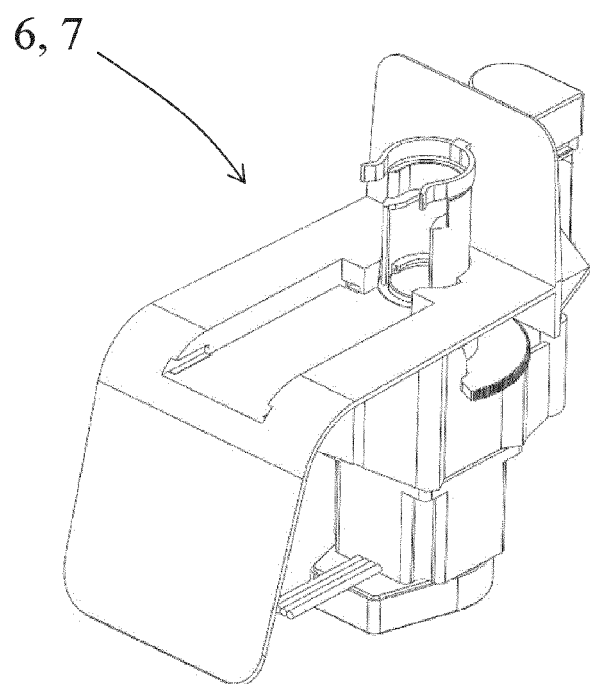


FIG. 5

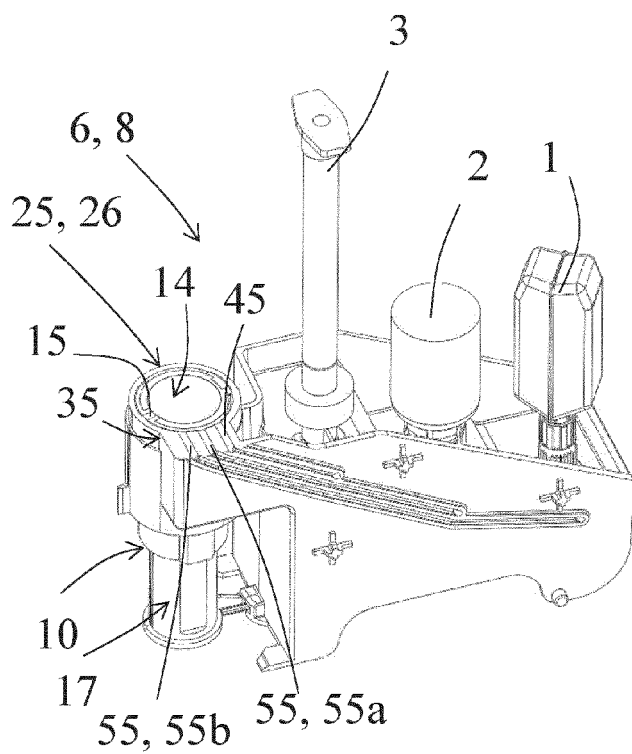


FIG. 6

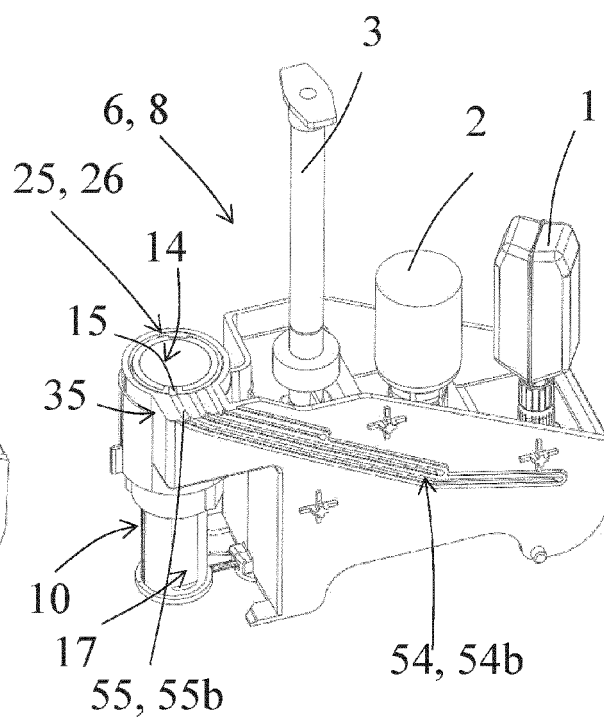


FIG. 7

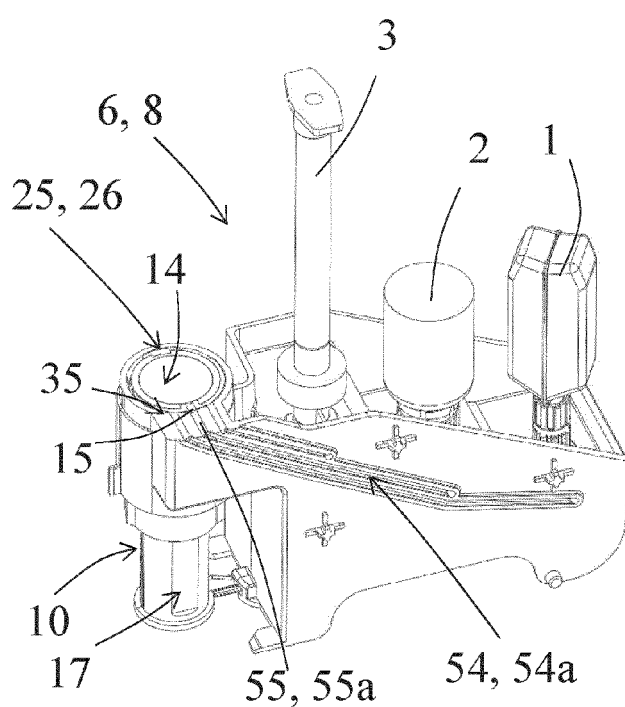


FIG. 8

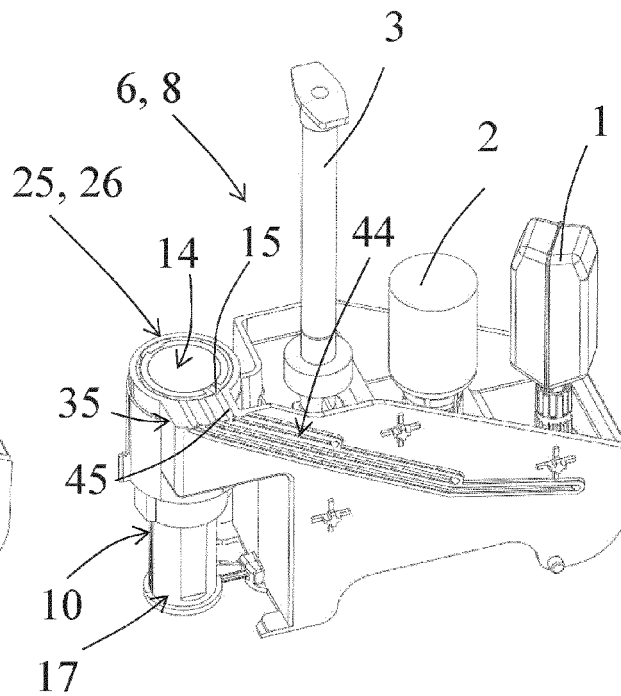


FIG. 9

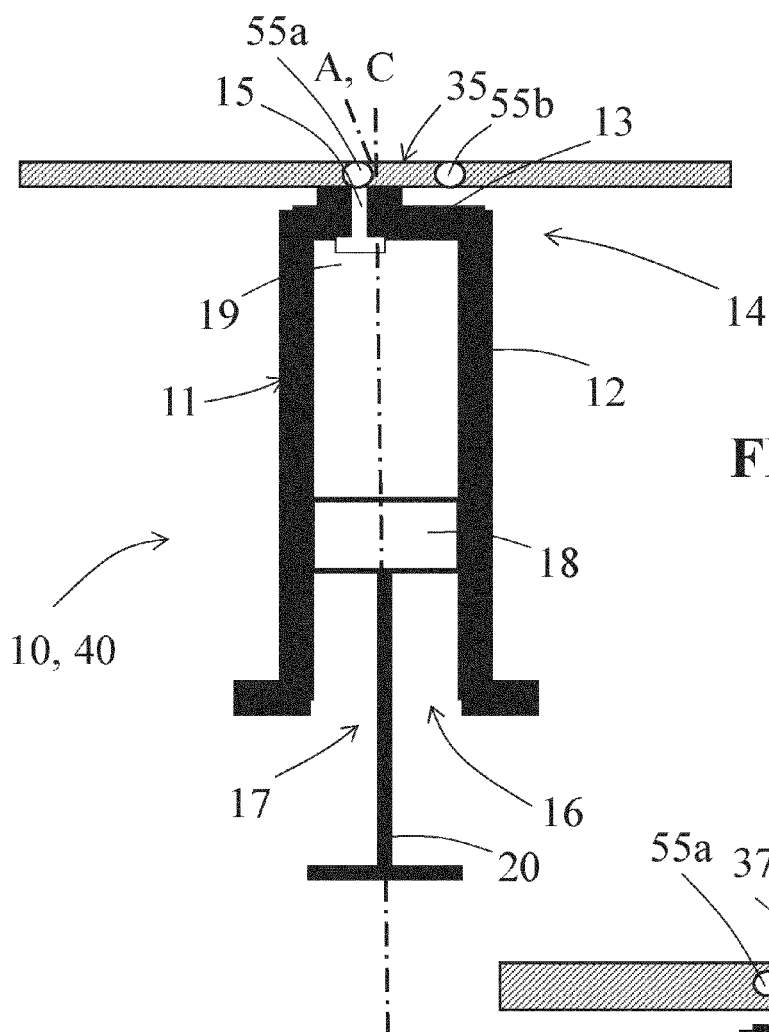
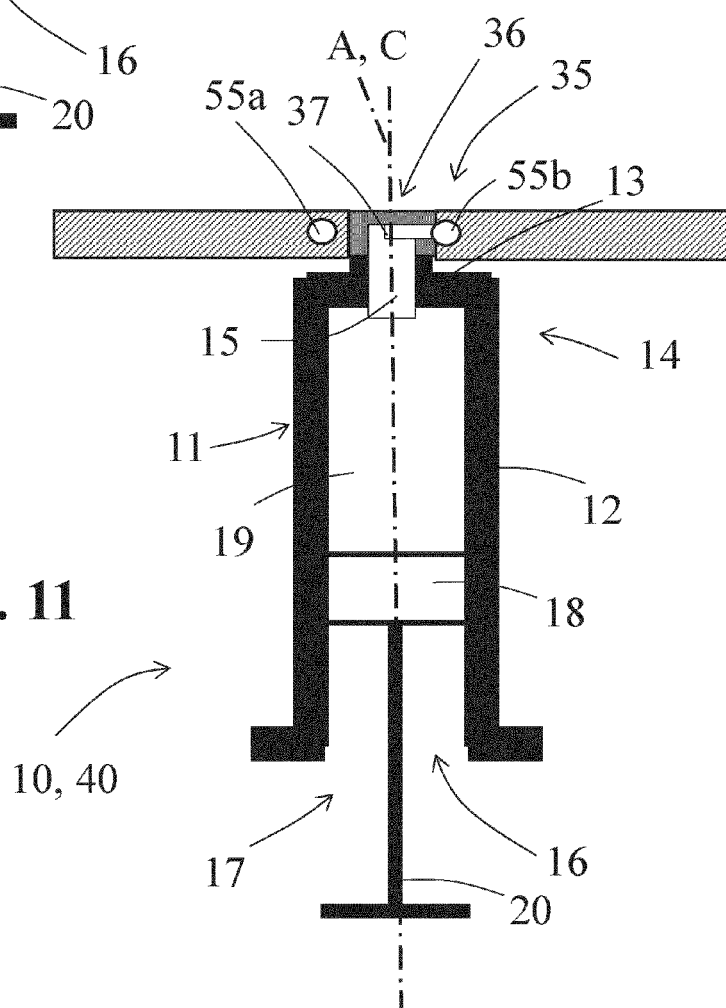


FIG. 10

FIG. 11



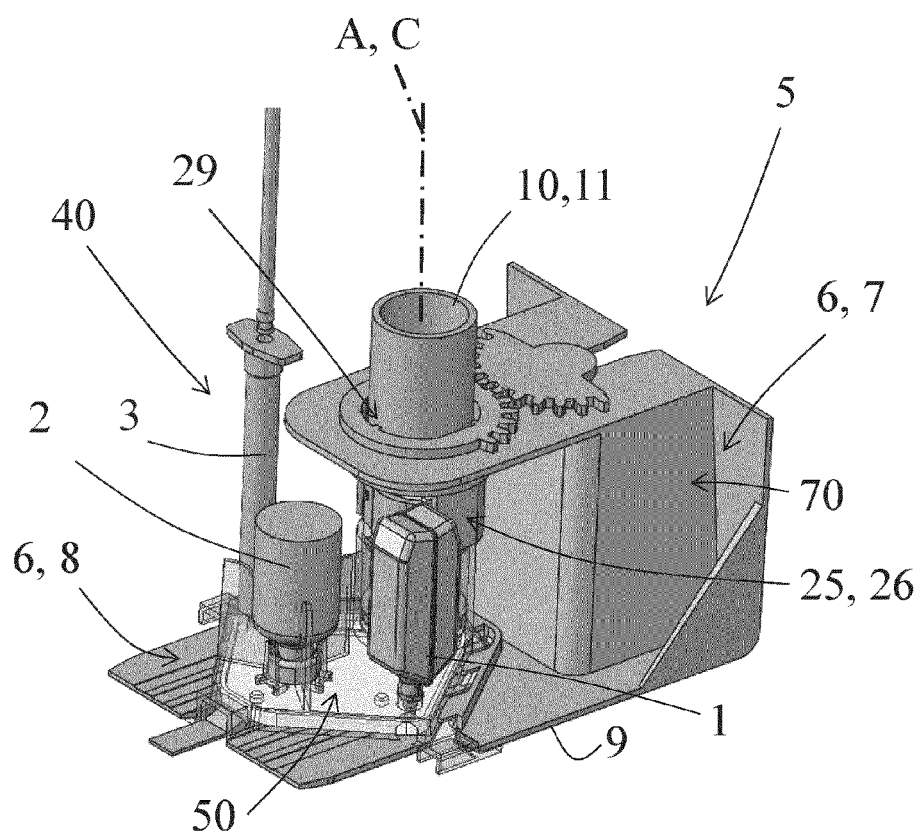


FIG. 12

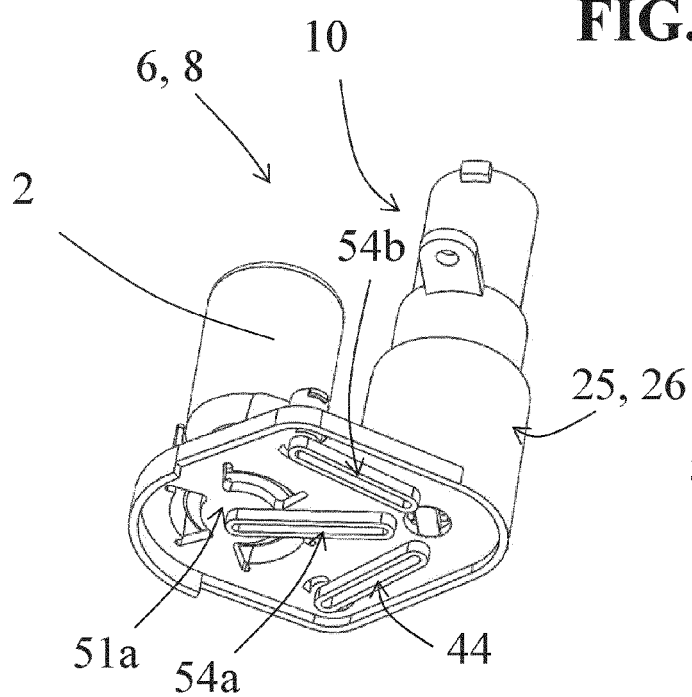


FIG. 13

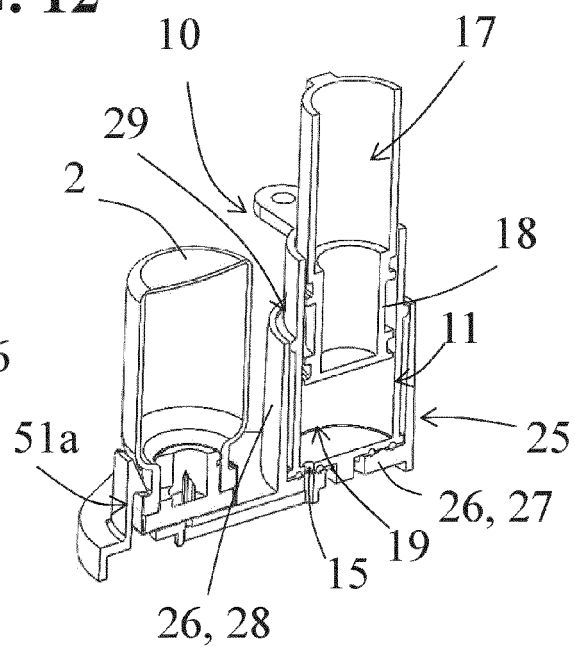


FIG. 14

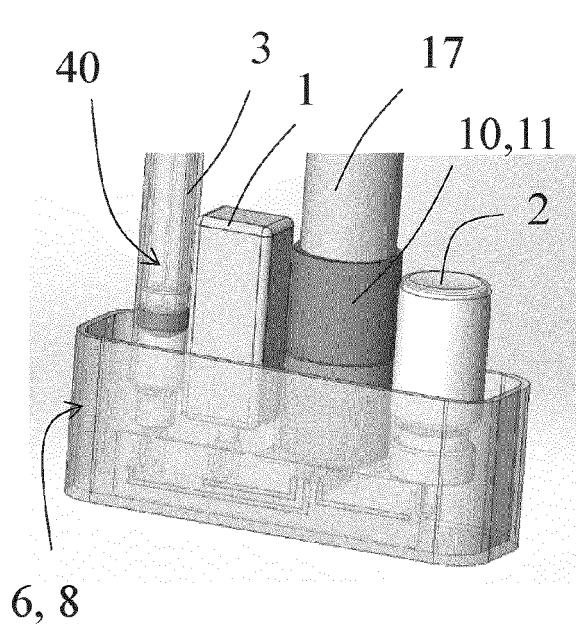


FIG. 15

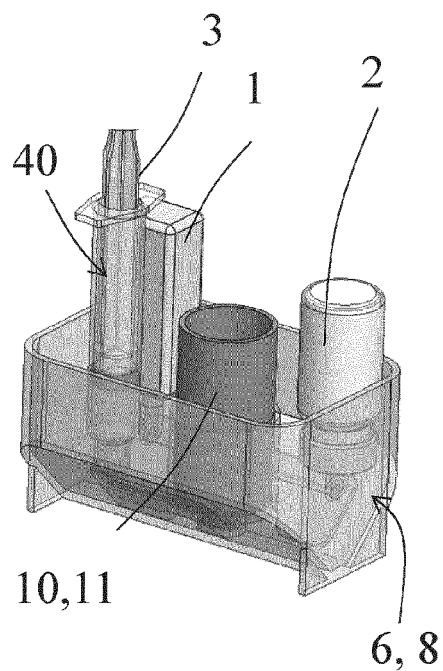


FIG. 16

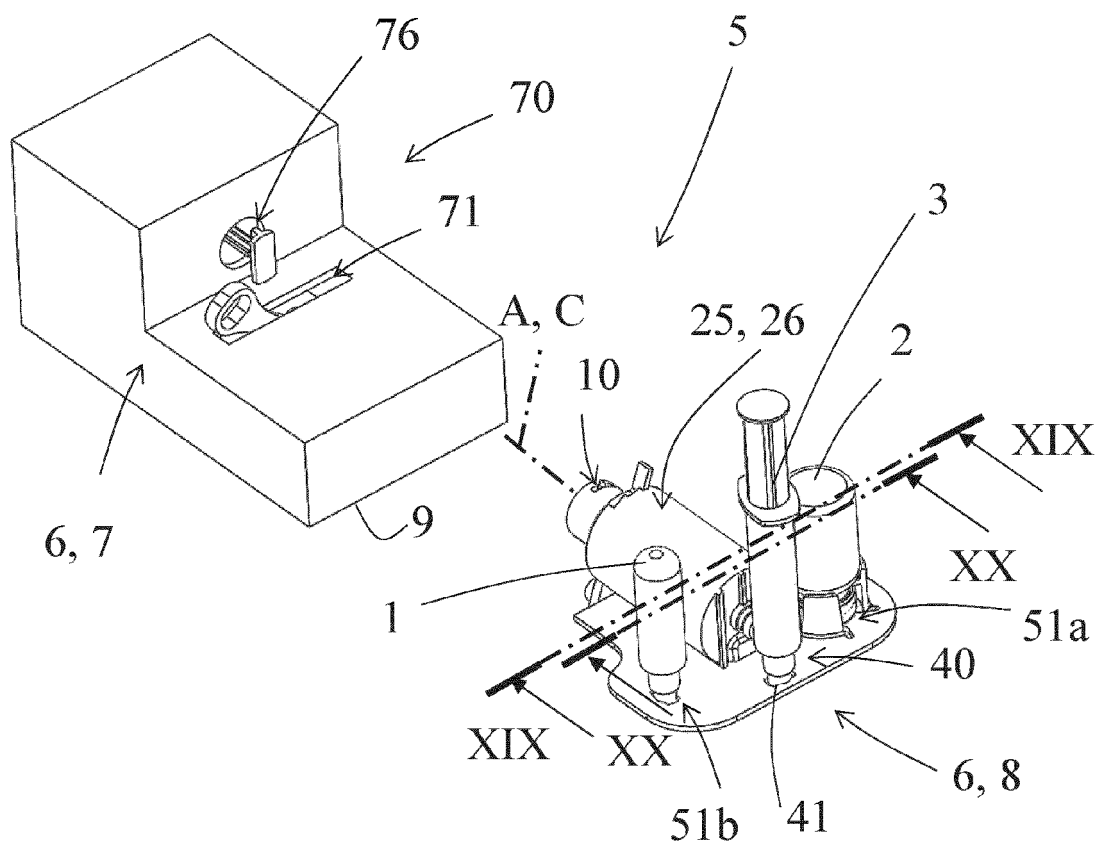


FIG. 17

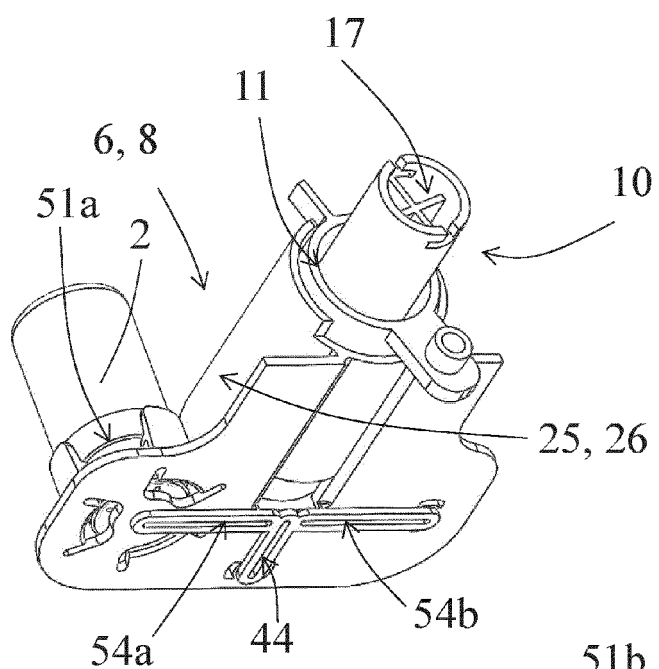


FIG. 18

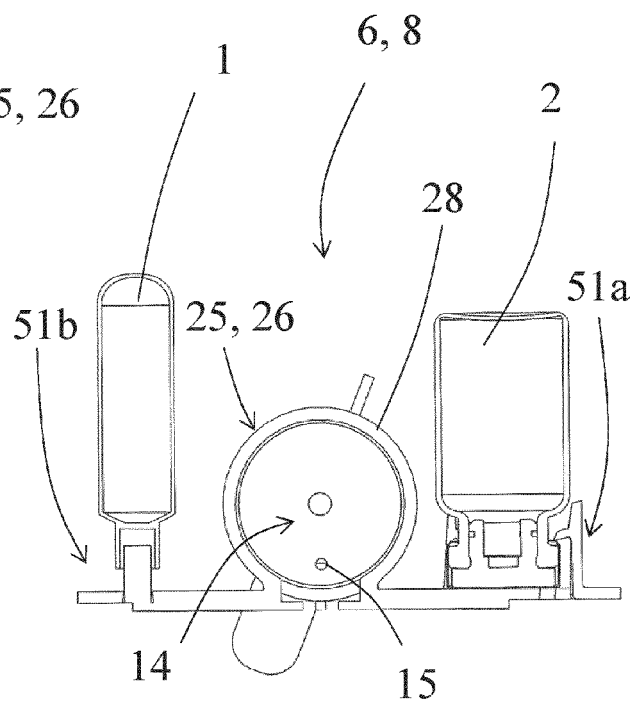


FIG. 19

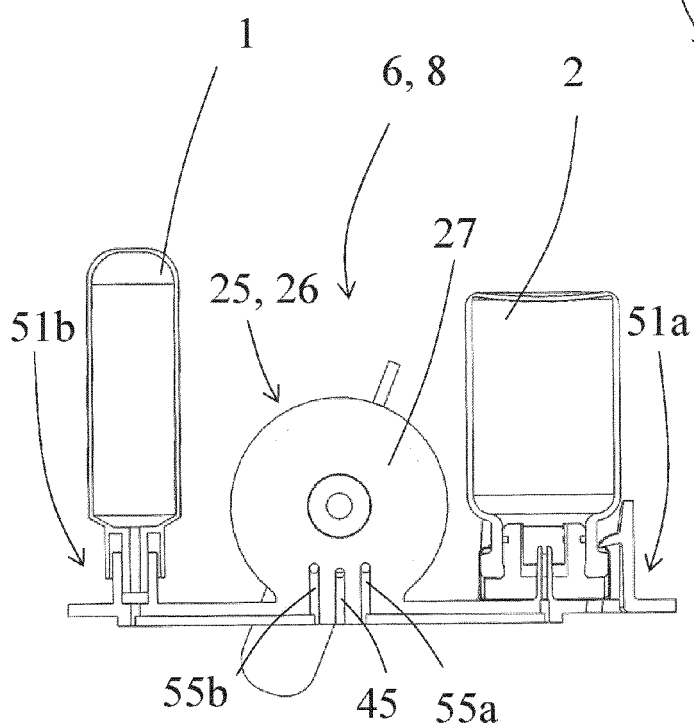


FIG. 20

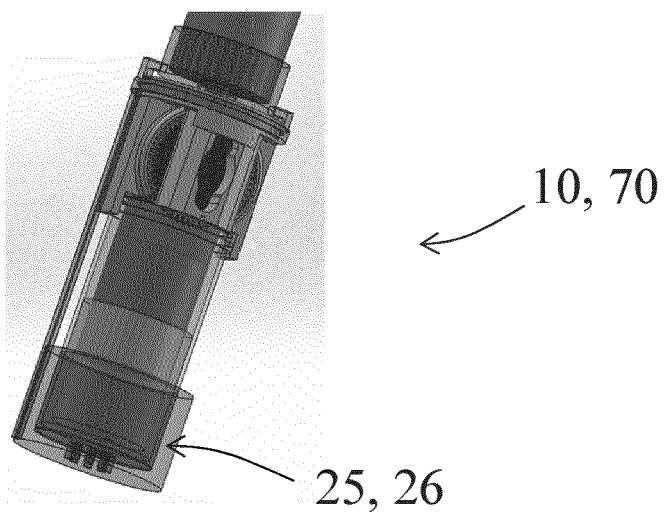


FIG. 21

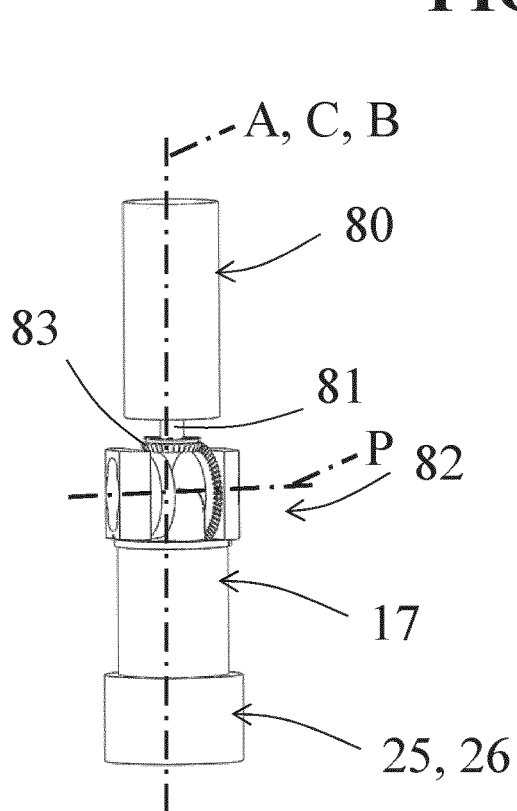


FIG. 22

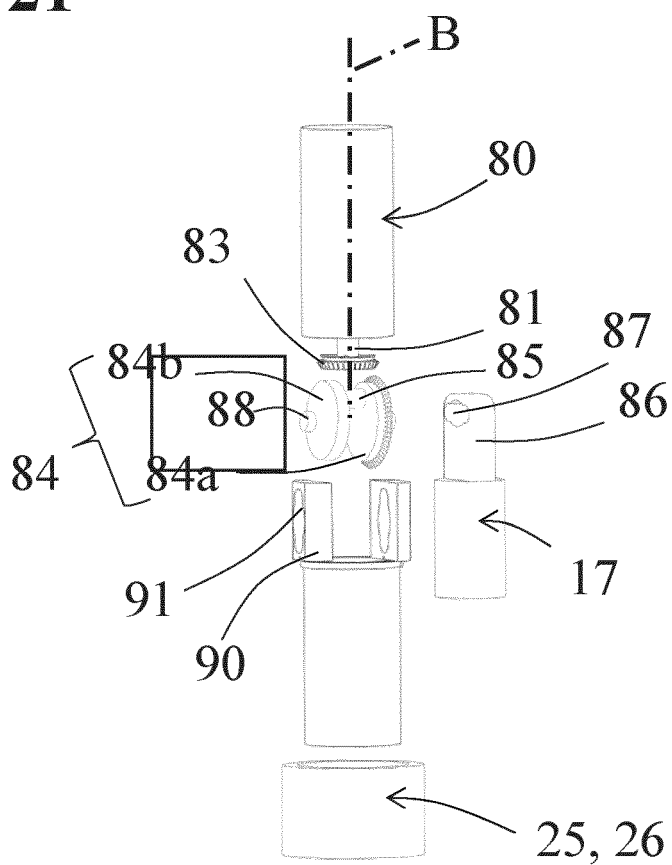
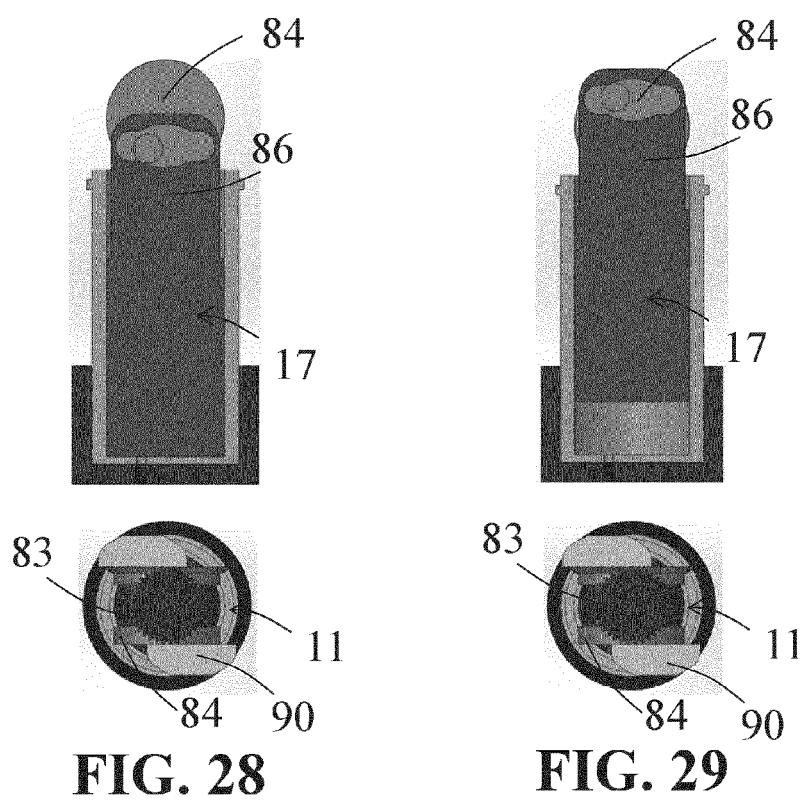
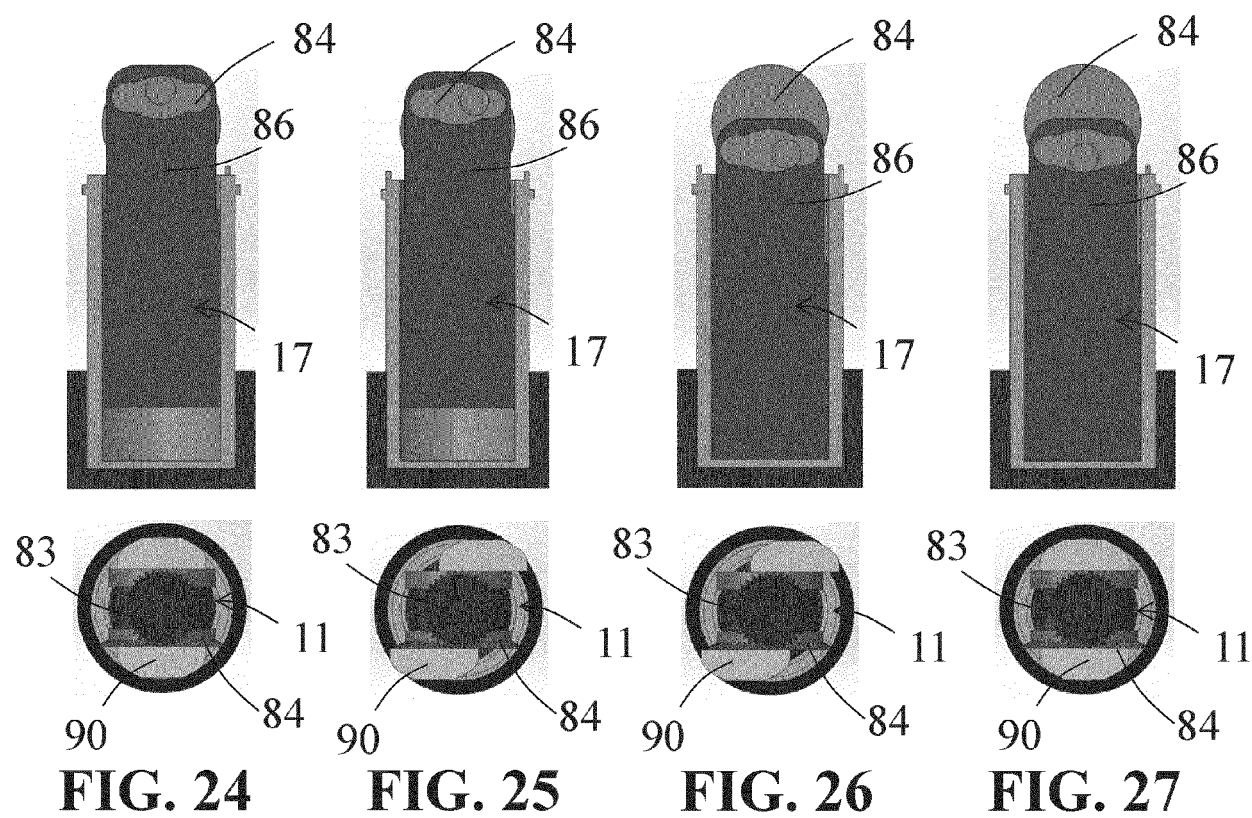


FIG. 23



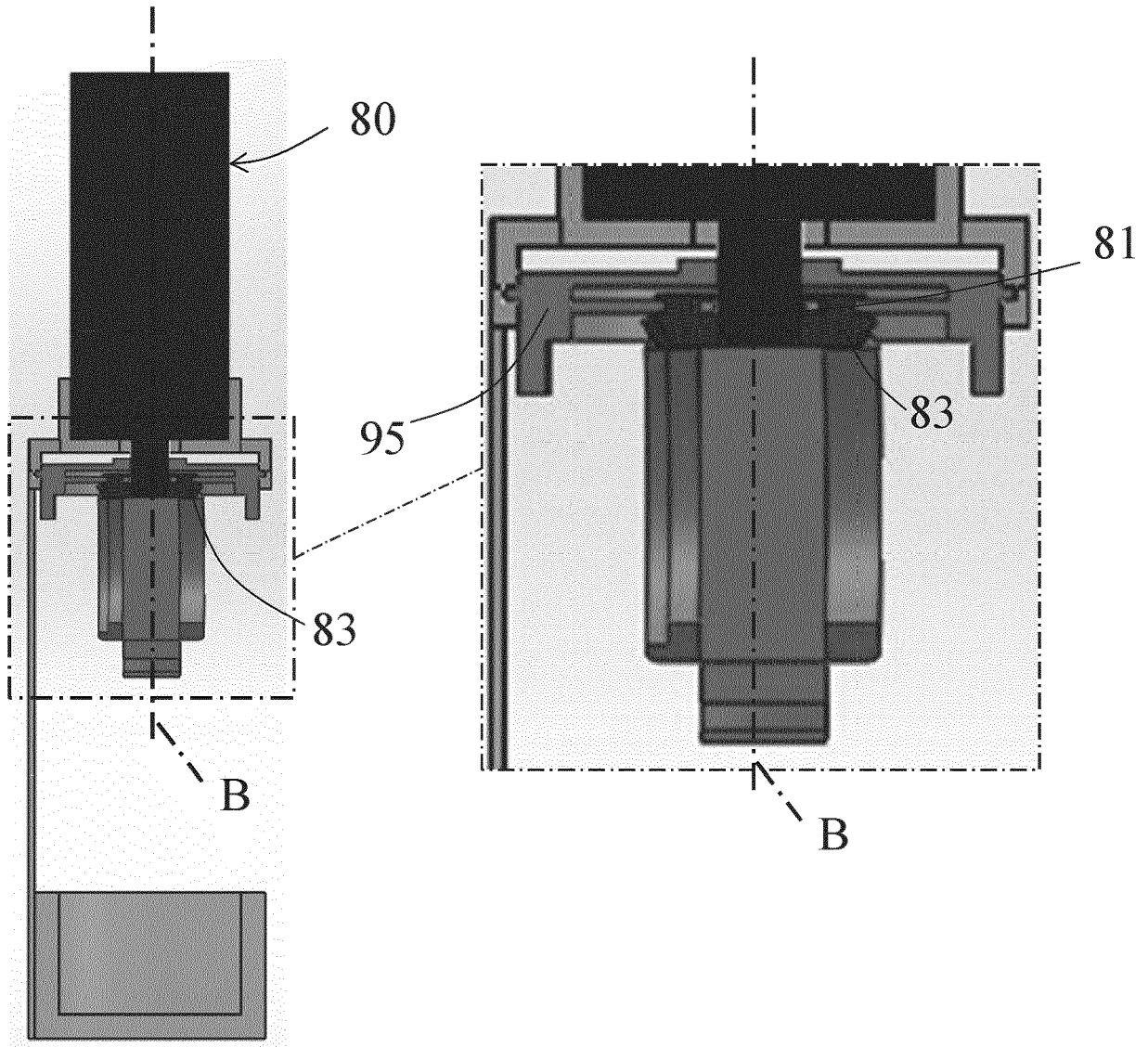


FIG. 30



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