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(54) **Reciprocating piston pump operating on pressure medium**

(57) The present invention relates to a reciprocating piston pump comprising:

- at least one cylinder with an inlet for a pressure medium;
- a piston slidable in the cylinder between a first and a second position, and forming a pressure chamber in the cylinder;
- a first valve member which is received in the piston and which in an open position mutually connects the cylinder spaces on either side of the piston;
- a second valve member which is received in the piston

and which in an open position connects a pressure medium passage formed in the piston to an outlet of the pump;

- a resilient member urging the piston in the first position;
- actuating means which are connected to the valve members and which are embodied such that in the first position the first valve member is closed and the second valve member is opened and in the second position the first valve member is opened and the second valve member is closed, wherein the piston is moved to the second position by the pressure medium.

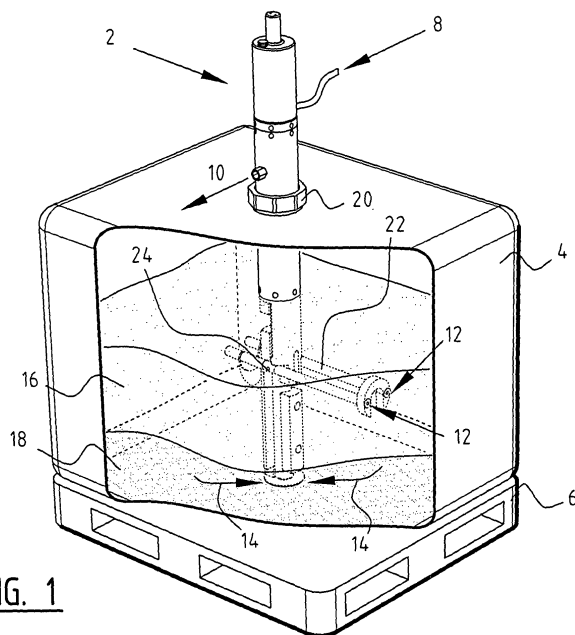


FIG. 1

Description

[0001] The invention relates to a reciprocating piston pump operating on a pressure medium.

[0002] Existing pumps are for example used to transport a medium from a pump inlet connected to a tank to a pump outlet opening. These pumps are driven by a motor that slidably moves a piston of the pump in the cylinder, thereby forming a pressure chamber in the cylinder.

[0003] Existing pumps require separate motors and connecting means, thereby increasing the number of parts, maintenance etc..

[0004] The invention now has for its object to provide a reciprocating piston pump which is more efficient and does not require separate drive means.

[0005] This objective is achieved with the reciprocating piston pump according to claim 1.

[0006] The piston of the pump will slide in the cylinder from a first to a second position by supplying the pump inlet with a pressure medium. Valve members are received or incorporated in the piston itself and are actuated by the actuating means. Therefore, the pressure medium that is brought into the cylinder during the movement of the piston from a first to a second position will be transferred to the other side of the piston during the piston's return from a second to a first position due to the valve members. In this case, during the return towards the first position, the first valve member is in an open position mutually connecting the cylinder spaces on either side of the piston. During the movement of the piston from a first to a second position, the pressure medium, that has transferred from the pump inlet to the pressure chamber, is being transported to the pump outlet. During this transport the second valve member is in an open position connecting this volume to the outlet. A pressure medium moves the piston from the first to the second position in the cylinder, and a resilient member will urge the piston from the second to the first position. This enables the piston pump to operate without requiring a separate motor for driving the pump. This results in a more efficient pumping and does not require separate drive means.

[0007] A preferred embodiment of the piston pump according to the present invention comprises a first plunger for uptake of a first medium from a second inlet to a second chamber.

[0008] The plunger moves from a first to a second position thereby creating an under pressure that will be compensated by uptake of a first medium through a second inlet of the pump. This enables transport of the first medium from e.g. a tank to an outlet. Preferably, the pump comprises sealing means for sealing the second chamber against a return flow of medium. Advantageously, the pump comprises connecting means for connecting the first plunger with the piston to simultaneously move the plunger and piston. Through this simultaneously movement both the pressure medium and the first medium are transported to the pump outlet. In other words,

the movement of the piston, either by the pressure medium or the resilient means, means transport and uptake of the first medium to the pump outlet. Preferably, the pump outlet for the first medium and the pressure medium is the same. Therefore, a mixture of the pressure medium with the first medium is provided. E.g. in case of the pressure medium being water and the first medium being a soap concentrate, such a mixture would result in a fluid soap ready for use.

[0009] In a further preferred embodiment according to the present invention the pump further comprises a second plunger for uptake of a second medium from a third inlet to a third chamber.

[0010] By moving the second plunger from a first to a second position an under pressure will be created in the third chamber. This will be compensated for by uptake of a second medium from a third inlet. This will enable transport of this second medium from e.g. a tank to an outlet. Preferably, the pump comprises second sealing means for sealing the third chamber against a return flow of medium. Further, the second pump preferably comprises second connecting means for connecting the second plunger to the piston (and preferably the first plunger) to simultaneously move the piston and second plunger (and preferably the first plunger) for transport of the pressure medium, and (first and) second medium to the pump outlet. In a preferred embodiment, the pump outlet for the pressure medium, and the first and second medium are transported to the same pump outlet. This results in a mixture of these media in the outlet flow. E.g., in case of the pressure medium being water and the first and second media being soap concentrates, the outflow of the pump will be as a fluid soap ready for use. Preferably, the third inlet is at a different position as the second inlet to enable uptake of two different media, or the same medium at different altitudes in a tank with different densities. In case of the third inlet taking media from the same tank it is possible to have a mixture at the pump outlet of the pressure medium and two different densities of the other medium thereby creating a consistent mixture.

[0011] In a further preferred embodiment according to the present invention the pump comprises floating means for connecting the third inlet to the second chamber.

[0012] By the use of floating means it is possible to keep the third inlet at the upper level of e.g. a storage tank with decreasing level as the pumping operation continues. With the floating means keeping the third inlet at a different level as compared to the second inlet during the pumping operation density differences in a storage tank are compensated. Preferably, the floating means comprise pivoting means to enable keeping the third pump inlet above the second inlet. Also preferably, the floating means comprise locking means for locking and unlocking the pivoting means. This enables the floating means to float on the top surface of the fluid in e.g. a storage tank. Therefore, the third inlet can be positioned just below this top level. As fluid is removed by the pumping operation, and the level in the tank will decrease, the

floating means will pivot around the pivoting means to remain floating on the medium and thereby keeping the third inlet just below this top level. By providing locking means it is possible to put the piston pump into a storage tank after which the locking means will be disabled and the floating means will be released. The piston pump may start operation. In case the piston pump needs to be removed from the storage tank the floating means may be retracted to their original position by enabling the locking means. This may be relevant e.g. in case a storage tank is not fully empty.

[0013] In a further preferred embodiment according to the present invention the pump further comprises at least one shock absorber with a plunger.

[0014] When the piston moves from its first to its second position, and medium is transported from the pressure chamber to the pump outlet, part of the outgoing medium is temporarily stored by the absorber. This stored volume is output during the return movement of the piston from its second to its first position due to the compressed air volume on the other side of the plunger. This smoothens the pump output.

[0015] In a further preferred embodiment according to the present invention the pump further comprises disposing means for disposing an amount of an agent medium in at least one chamber.

[0016] The disposing means will provide a certain amount of one or more agents into one of the chambers of the piston pump during a stroke of the piston and/or plungers. Such agent may include a colouring agent supplying a specific colour to the inlet space of the pressure medium, thereby colouring the outflow from the piston pump. This will be relevant e.g. in case the outflow of the piston pump has the same colour as the incoming flow. E.g. in case of the pressure medium being water and the first and/or second medium being a soap concentrate a colouring agent will enable to distinguish the ingoing water from the outgoing soap. Also other agents may be used to provide specific characteristics to the outflow of the piston pump. Preferably, the pump comprises connecting means for connecting the tank of agents medium to the pump. This enables the provision of a single piece of equipment for both the pump and the agent disposal means. Furthermore, by directly coupling the agent medium to the pump it is possible to use the movement of the piston for disposal of the agent in the main pressure chamber related to this piston.

[0017] In a further preferred embodiment according to the present invention the pressure medium is a fluid.

[0018] A fluid, like water, used for the pressure medium would allow for movement of the piston in the cylinder. Furthermore, as the piston is moved due to the resilient means, the fluid is transported to the pump outlet and preferably mixed with one or two other media like e.g. soap concentrate. Such soap concentrate may constitute of a mix of various chemicals with a rather large variation of molecular weight. This concentrate may be taken from a storage tank. Typically, after a relatively short period

of time like e.g. 5 minutes it is possible to distinguish an upper part of e.g. 60% low density concentrate and a lower part of 40% higher density concentrate. To achieve a consistent outflow of soap at the pump outlet such a mixture must reflect the differences in density of the soap concentrate. In the example mentioned here, 60% of the soap concentrate has to be taken from the upper part by the third inlet of the pump and the remaining 40% of the lower part by the second inlet of the pump. Depending on the desired characteristics of the soap product e.g. one part of soap has to be mixed with eleven parts of water. Obviously, different ratios may be achieved by changing the dimensions of the pump parts. E.g., different uptakes of volume from the storage tank by the second and/or third inlet will be possible. As a storage tank e.g. a 1000 litre IBC tank may be used. By choosing the second and third chambers of the desired dimensions it is possible to have an outflow with every desired concentrations of media. Although in our preferred embodiment the ratio of the first pressure chamber and second chamber is about 1:11, also ratios 1:10 and 1:12 are possible. However, it will be understood that also totally different ratios will be possible, like 1:1 and 1:100, depending on the density differences in the relevant media. This will include the ratios 1:23 and 1:35 that are also relevant for soap concentrates. Obviously, the volumes of the chambers related to the first and second plunger have to be chosen in correspondence with the characteristics of the soap concentrate. In the example mentioned here, this ratio would 2:3, although ratios between 1:2 and 2:1 would also be possible. However, it will be understood that ratios like 1:0,01 and 100:1 would also be possible.

[0019] The invention further relates to a method for pumping at least one medium using the reciprocating piston pump according to the invention. Using this method the advantages mentioned before will be obtained.

[0020] The invention is further illustrated in the following description with reference to the annexed figures, which show:

- Figure 1, a reciprocating piston pump according to the invention put into a storage tank;
- Figure 2, the piston pump of figure 1 extracted from the storage tank;
- Figures 3A and B, the piston pump of figure 1 with the locking means engaged and disengaged respectively;
- Figure 4, the piston pump of figure 1 with the floating means rotating;
- Figure 5A and B, the piston pump of figure 1;
- Figure 6, the valve members in the piston of the pump in figure 5;
- Figure 7, the shock absorber in the piston of the pump in figure 5;
- Figure 8, mixing chamber for the two soap concentrates;
- Figure 9, the second chamber;
- Figure 10, the pivot axis of the floating means;

- Figure 11, the second pump inlet;
- Figure 12, the third chamber; and
- Figure 13, an alternative configuration for the agent supply.

[0021] A reciprocating piston pump is located in a storage tank 4 that is put on a pallet 6 (figure 1). The piston pump 2 has an inlet 8 for supply of water as a pressure medium and an outlet 10 for the outgoing flow. The pump 2 comprises a second inlet 12 and a third inlet 14 for uptake of a relatively low density fluid 16 and a relatively high density fluid 18. The pump 2 is connected to tank 4 with connecting means 20. The pump 2 is put at the bottom of the tank 4 with inlet 14. As the volume of the fluid in tank 4 is relatively high the floating means 22 will be in approximately a horizontal position as it is rotated around pivot axis 24. To enable extraction of pump 2 from the tank 4 the floating means 22 are locked against the pump (figure 2). Also in case the pump 2 is entered into the tank 4 the locking means are engaged and will only be disengaged after pump 2 as reached its position inside tank 4 (figures 3A and 3B). After disengaging the locking means the floating means 22 will rotate around pivot axis 24 provided there is sufficient level of fluid in tank 4 (figure 4). The floating means rotate in the direction indicated by arrow A.

[0022] Pump 2 (figures 5A and 5B) comprises a housing 26 wherein a main piston 28 slides. The piston 28 is connected to a central rod 30. The pressure medium, in this case water, enters the pump 2 at the inlet body 32. As soon as the pressure medium is allowed to enter the pump 2 piston 28 will start moving downwards. Due to this downward movement the pressure chamber 34 will become smaller thereby increasing the pressure inside this chamber 34. To relieve this increased pressure, fluid in chamber 34 will be enabled to leave this room 34 and leave the pump 2 at the pump outlet 36 through the use of the valve member 38.

[0023] Valve member 38 (figure 6) comprises an upper valve part 40 and a lower valve part 42. The valve members 40 and 42 are received slidably in the piston 28. The protruding ends of the valve bodies form actuating means which can co-act respectively with stops formed in the pressure room 34 by the fluid head disk 44 and the stop at the opposite end of the cylinder formed by the inlet body 32. In the position shown in figures 5 and 6, the pressure medium flows via the inlet body 32 towards the piston 28. The pressure medium pushes the piston 28 downwards counter to the force of a spring. The fluid in room 34 will flow through the opening between the lower valve part 42 and the piston channel through the pump outlet 36. As the actuating means or valve spring 46 meets its stop at the end of the downward movements, the valve member 38 will move relative to the piston 28 and the connection between outlet 36 and room 34 will be closed. At the same time the upper valve part 40 will be opened and both rooms opposite of the piston 28 will be connected. As the spring urges the piston 28 back to

this begin position, as shown in figures 5 and 6, the fluid will be transported from above the piston 28 to the room 34 below the piston 28. At the end of this return stroke when the piston 28 returns in his begin position the valve spring 46 will move the valve member 38 relative to the piston 28 so that the next cycles may start.

[0024] Piston 28 comprises three shock absorbers 48 (figure 7). The shock absorber 48 contains a shock absorber cap 50, a shock absorber barrel 52 and a shock absorber piston 54. This will compensate for undesired pressure variations and results in a more constant outflow. Fluid enters the space between absorber piston 54 and the bottom of barrel 52. The fluid urges the piston 54 upward, by allowing fluid to enter the absorber 48 through opening 55, thereby increasing the air pressure in the space above piston 54. Fluid is collected in the space below piston 54 during the movement of the main piston 28 from its upper to its lower position. In the return movement the air pressure above piston 54 pushes piston 54 downward thereby transporting the fluid to the outlet. Piston 54 is cup-shaped to increase the volume of the shock absorber 48.

[0025] The central rod or piston rod 30 is connected to a two staged plunger. The large upper plunger is connected to the piston 28 with an area constituting a ratio between the pressure medium and the second (and further) medium of about 11:1. In the embodiment shown in the figures the lower and smaller plunger section has a surface area of 60 % of the upper plunger leaving a ring shaped area of 40 %. In the shown embodiment 60 % of the second and further medium is taken from the upper part of the storage tank volume, while the remaining 40 % are taken from the bottom of this storage tank. The piston rod 30 is connected with the piston 28 and the plungers 56,58. A downward movement of piston 28 results in a simultaneous movement of the upper plunger 56 and lower plunger 58. The circular area 60 between the lower plunger 58 and the fluid at fluid head 62 is emptied due to the downward movement of the upper plunger 20. The chamber 64 is also emptied in this same downward movement of the piston 28.

[0026] The upper outlet valve 66 (figure 8) is open during the downward movement of the piston 28 thereby allowing the medium in room 60 to be transported towards piston 28 and the pump outlet 36. An upper support ring 68 lies against fluid head disk 22 and comprises upper support ring inner seal 70, an upper outlet outer seal 72 and also an upper support ring inner seal 74. The outlet valve 66 is urged back from its second position to its first position due to the upper outlet spring 76.

[0027] The lower plunger 58 (figure 9) in his downward movement moves the lower outlet valve 78 and allows transport of the medium in room 64 towards piston 28 and pump outlet 36. The lower outlet spring 80 closes valve 78 when returning from its second position to its first position. The center rod 30 comprises a lower seal 82. The fluid head extension 84 is connected to a lower support ring 86. The support ring 86 contains inner seals

88 and lower seals 90. The fluid head extension 84 contains an upper seal 92 and lower seal 94. The valve 78 contains an outer seal 96.

[0028] The chamber 64 is supplied with medium through suction pipe 98 in the piston movement from the second position back to its first position. The medium is supplied through suction pipe 98 towards room 64 and an assembly 98 prevents a return flow of medium back into suction pipe 98 (figure 9). Assembly 100 comprises a lower inlet insert 102, a lower inlet body 104, a lower inlet gland 106 and a lower inlet poppet 108. Furthermore, the assembly 100 is provided with a lower inlet body outer seal 110, a lower inlet poppet seal 112 and two lower inlet body inlet seals 114.

[0029] The suction pipe 98 is connected to a pivotable inlet through coupling assembly 116 (figure 10). The assembly 116 pivots around a pivot axis construed by balance pivot bolt 118. The assembly 116 further comprises two balance connectors 120, two balance pivot bearings 122 and the balance pivot 124. The assembly 116 is sealed using four balance intake extension seals 126, two balance pivot seals 128 and two balance connector seals 130. The assembly 116 is connected to its inlet through a balance open union 132 and a balance float bolt 134 leading to the inlet located in the balance float 136. The inlet of floating part 136 (figure 5A) has a counter weight 138 that is connected by a horse shoe connection 140 with the counter weight extension 142. These parts are connected with four balance connectors closed unions 144.

[0030] Room 60 is supplied with medium through flexible suction pipe 146 that is connected to the corresponding inlet assembly 148 (figure 11). The assembly 148 comprises a bottom The center rod 30 comprises a lower seal 82. The fluid head extension 84 is connected to a lower support ring 86. The support ring 86 contains inner seals 88 and lower seals 90. The fluid head extension 84 contains an upper seal 92 and lower seal 94. The valve 78 contains an outer seal 96.

[0031] The chamber 64 is supplied with medium through suction pipe 98 in the piston movement from the second position back to its first position. The medium is supplied through suction pipe 98 towards room 64 and an assembly 98 prevents a return flow of medium back into suction pipe 98 (figure 9). Assembly 100 comprises a lower inlet insert 102, a lower inlet body 104, a lower inlet gland 106 and a lower inlet poppet 108. Furthermore, the assembly 100 is provided with a lower inlet body outer seal 110, a lower inlet poppet seal 112 and two lower inlet body inlet seals 114.

[0032] The suction pipe 98 is connected to a pivotable inlet through coupling assembly 116 (figure 10). The assembly 116 pivots around a pivot axis construed by balance pivot bolt 118. The assembly 116 further comprises two balance connectors 120, two balance pivot bearings 122 and the balance pivot 124. The assembly 116 is sealed using four balance intake extension seals 126, two balance pivot seals 128 and two balance connector

seals 130. The assembly 116 is connected to its inlet through a balance open union 132 and a balance float bolt 134 leading to the inlet located in the balance float 136. The inlet of floating part 136 (figure 5A) has a counter weight 138 that is connected by a horse shoe connection 140 with the counter weight extension 142. These parts are connected with four balance connectors closed unions 144.

[0033] Room 60 is supplied with medium through flexible suction pipe 146 that is connected to the corresponding inlet assembly 148 (figure 11). The assembly 148 comprises a bottom disk 150 and a bottom disk insert 152. The assembly 148 further comprises a bottom disk retaining ring 154.

[0034] The suction pipe 146 supplies the medium at the other side through an upper inlet assembly 156 (figure 12). Each of the two suction pipes 146 inputs the medium through a separate upper inlet assembly 156. Each assembly 156 comprises an upper inlet poppet 158, a lower supporting ring outer seal 160 and an upper inlet spring 162.

[0035] To enable intake of medium from the top level of a liquid in a storage tank a floating assembly is allowed to pivot around its axis, as described before. To enable removal of the pump 2 from the storage tank it is required that the floating device returns to its original position. This is achieved by a locking assembly comprising a lock spring 164, a mounting gland 166, a lock sleeve 168, a lock body 170, a large balance protector 172 and a small balance protector 174 (see also figure 4). The assembly further comprises a lock body support 176. The balance protector 174 is connected to the pivoting assembly 156 through a rod 178, washer 180 and nut 182 with bolt 184. The large protector 172 is connected through the threaded rod 186, washer 188 and nut 190. The protectors 172, 174 are connected to the pump 2 (figure 5B) and do not pivot with the floating assembly. The lock body 170 comprises a cam 171 that engages the floating means 22. By movement of the lock body 170 and cam 171, the floating means 22 are locked or unlocked for its pivotal movement. When unlocked the floating means start to pivot, depending on the level of fluid in the tank 4, and engages the lock body 170 when reaching a horizontal level.

[0036] To urge the piston 28 from its second to its first position, spring means 204 are on one end engaging spring support 206 with spring bushing 208. On its other end spring 204 lies against spring support 210 that is connected to inlet body 32. The rod 200 consists of a bottom part 212 and an upper part 214 that are connected through a union 216 comprising a seal 218. Inlet body 32 is sealed with an inlet body seal 220. The spring support 210 is sealed with seals 222, 224 and backup seal 226.

[0037] In the pump 2, agent medium is supplied from agent supply room 192 (figure 13). The agent medium is supplied using a separate plunger 228. The diameter extension 230 at the end of the rod, changing from 44 to

46 mm, drives the plunger 228. Thereby the movements of this plunger 228 are connected with piston 28. In this embodiment the displacement of the plunger 228 would be 1 mm with a diameter of 10 mm resulting in a volumetric displacement of about 79 $\mu\ell$. The inlet and outlet valves for the plunger comprise steel balls 232, 234 in a bore of about 3,2 mm with a stroke of about 0,4 mm. The balls seal in one direction. A rubber spring 236 pushes the large ball 238 and the plunger 228 against the rod. The rod extension compresses the spring 236. As a result the spring 236 increases its diameter filling the space inside the plunger and insert 240 preventing a substantial dead volume. This configuration will, in relevant cases, ensure a more constant supply of agent medium and enable a smooth start-up of the agent supply.

[0038] In an alternative configuration, agent medium is supplied from an agent supply room 192. This room 192 comprises an agent filler cap 194 for refilling and a top lid. The room 192 is sealed with a filler cap seal 198, through which the top rod 200 may be moved. This rod is supplied with a top cap. In the end of the stroke of the piston 28 moving from the first to the second position a few droplets of the agents medium are pushed out of the agent supply room 192 into the room above the piston 28. This is realised by an agent pusher that at the end of the stroke, enters into a cone of spring support 210 thereby pushing the desired droplets of agents medium by the seal into the room above the piston 28 during the movement from first to second position.

[0039] It is thus the case that after examination of the foregoing many alternative and additional embodiments can occur to the skilled person which all lie within the scope of the invention defined in the appended claims, unless there is a departure therein from the actual definitions or the spirit of the invention.

[0040] As an example the pressure medium may be water and the first and second medium may be a soap concentrate. Obviously, other media will also be possible. In addition, it will be possible to supply all inlets with different media from different storage tanks. Also, it would be possible to have a supply of agent medium already in the pressure medium instead of a separate supply room. Obviously, the configuration of the pump may be changed, for example in that room 60 is connected to the inlet of the floating assembly instead of the bottom inlet.

Claims

1. Reciprocating piston pump comprising:

- at least one cylinder with an inlet for a pressure medium;
- a piston slidable in the cylinder between a first and a second position, and forming a pressure chamber in the cylinder;
- a first valve member which is received in the piston and which in an open position mutually

connects the cylinder spaces on either side of the piston;

- a second valve member which is received in the piston and which in an open position connects a pressure medium passage formed in the piston to an outlet of the pump;

- a resilient member urging the piston in the first position;

- actuating means which are connected to the valve members and which are embodied such that in the first position the first valve member is closed and the second valve member is opened and in the second position the first valve member is opened and the second valve member is closed, wherein the piston is moved to the second position by the pressure medium.

2. Reciprocating piston pump according to claim 1, wherein the pressure medium fed at the pump inlet, in one stroke of the piston, moves the piston from a first position to a second position, wherein in said stroke the pressure medium in the pressure chamber is transported to the pump outlet.

3. Reciprocating piston pump according to claim 2, wherein the pump comprising a first plunger for uptake of a first medium from a second inlet to a second chamber.

4. Reciprocating piston pump according to claim 3, wherein the pump comprising:

- first sealing means for sealing the second chamber against a return flow of medium; and

- first connecting means for connecting the first plunger to the piston to simultaneously move the plunger and piston for transporting both the pressure medium and the first medium to the pump outlet.

5. Reciprocating piston pump according to claim 3 or 4, wherein the pump comprising a second plunger for uptake of a second medium from a third inlet to a third chamber.

6. Reciprocating piston pump according to claim 5, wherein the pump comprising:

- second sealing means for sealing the third chamber against a return flow of medium; and

- second connecting means for connecting the second plunger to the piston and to the first plunger to simultaneously move the piston, first and second plunger for transport of the pressure medium and first and second medium to the pump outlet.

7. Reciprocating piston pump according to claim 5 or

6, wherein the pump comprises floating means for connecting the third inlet to the second chamber.

8. Reciprocating piston pump according to claim 7, wherein the floating means comprising: 5

- pivoting means to keep the second pump inlet above the first inlet in the second medium; and
- locking means for locking and unlocking the pivoting means. 10

9. Reciprocating piston pump according to any of the foregoing claims, wherein the pump further comprising: 15

- at least one shock absorber located in the piston with a plunger for smoothing the outflow of the pump.

10. Reciprocating piston pump according to any of the foregoing claims, wherein the pump further comprising: 20

- disposing means for disposing an amount of an agent medium in at least one chamber. 25

11. Reciprocating piston pump according to claim 10, wherein the pump comprising agent connecting means for connecting the volume of agent medium to the pump. 30

12. Reciprocating piston pump according to any of claims 1-11, wherein the pressure medium is a fluid.

13. Reciprocating piston pump according to claim 3 or 4, wherein the ratio of the volume of the first and second chambers, or second and third chambers, is between 10 and 12. 35

14. Reciprocating piston pump according to claim 5 or 6, wherein the ratios between the volume of the second and third pressure chambers is between 0,5 and 2. 40

15. Method for pumping at least one medium using the reciprocating piston pump according to any of the foregoing claims. 45

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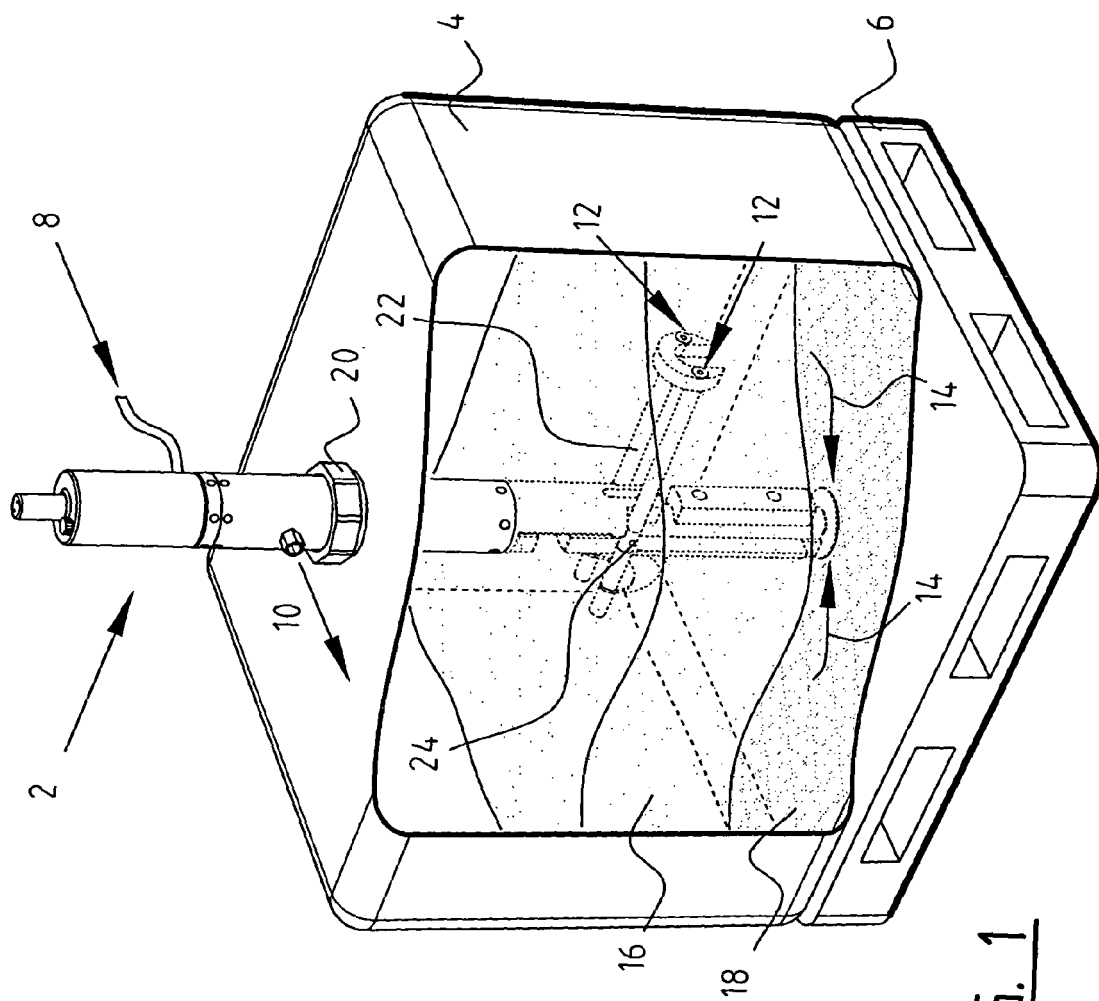
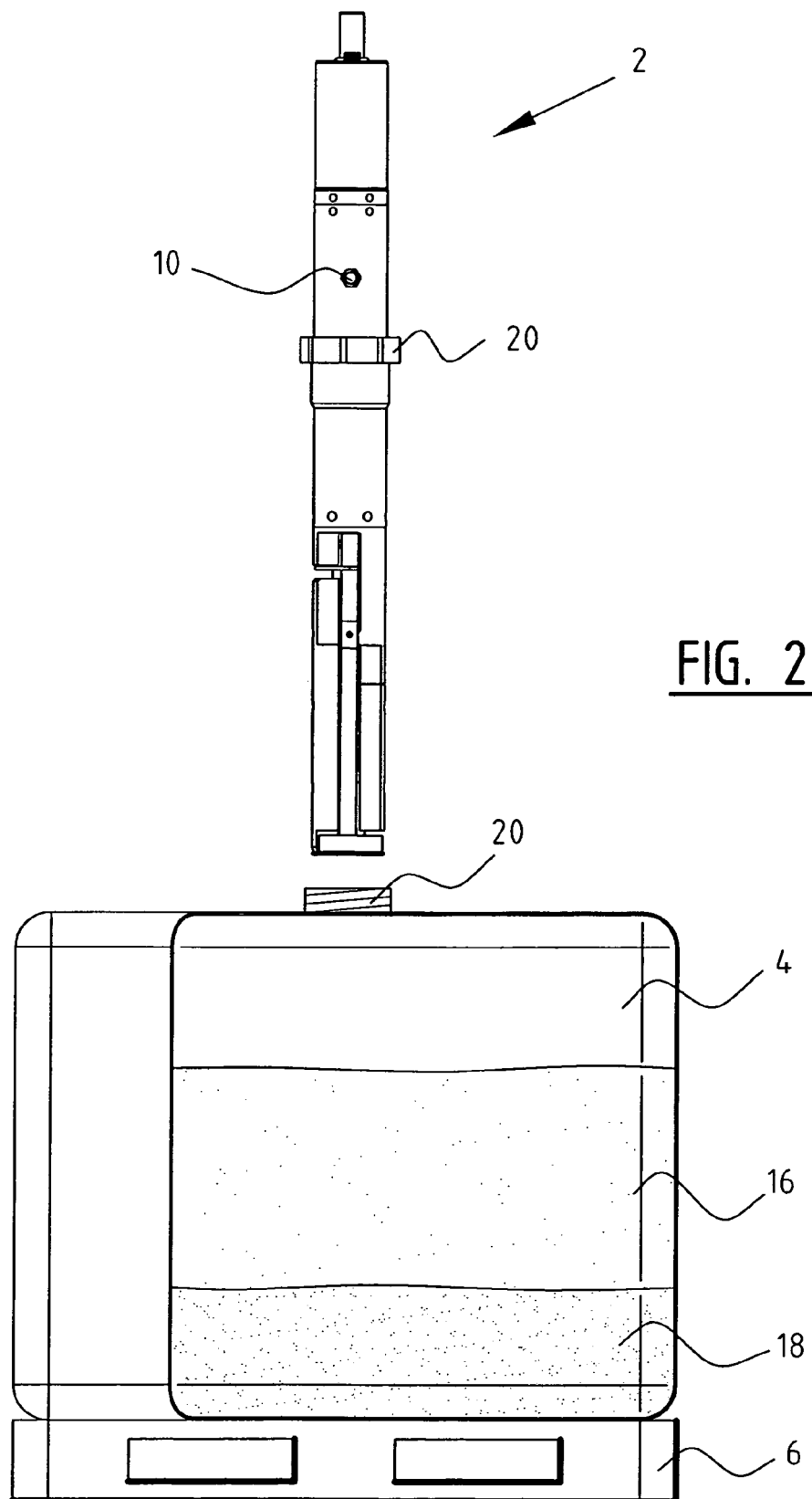
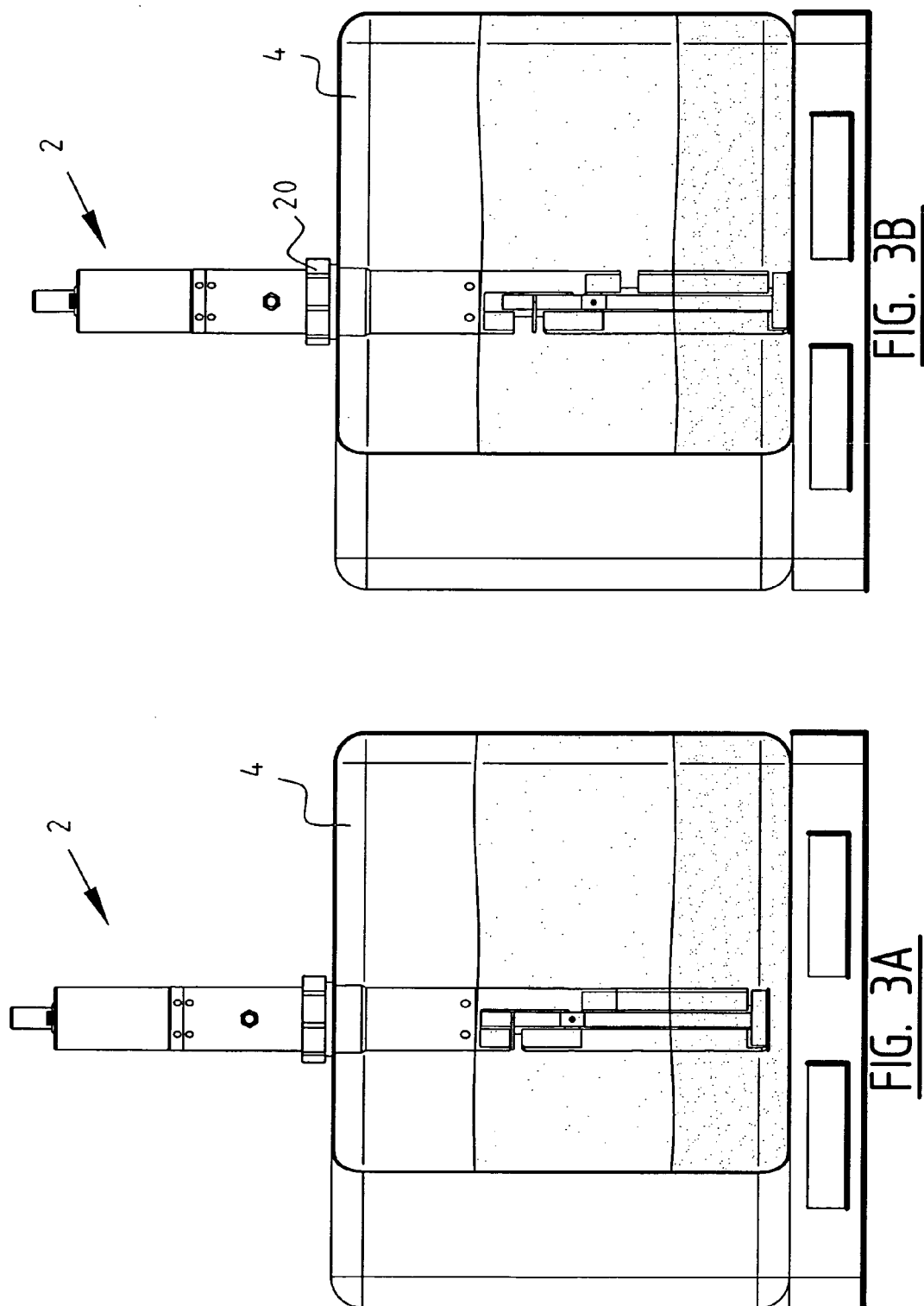


FIG. 1





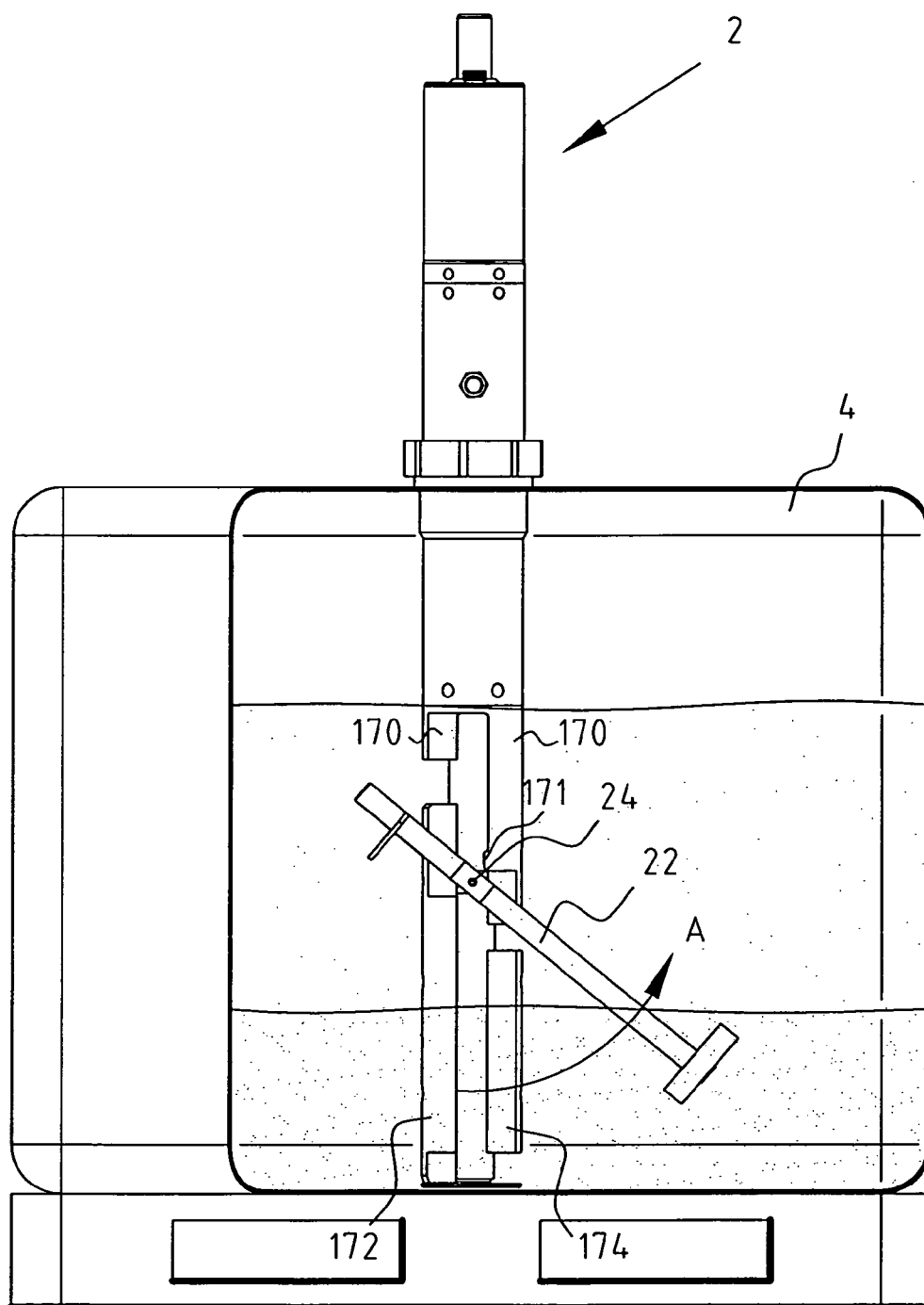


FIG. 4

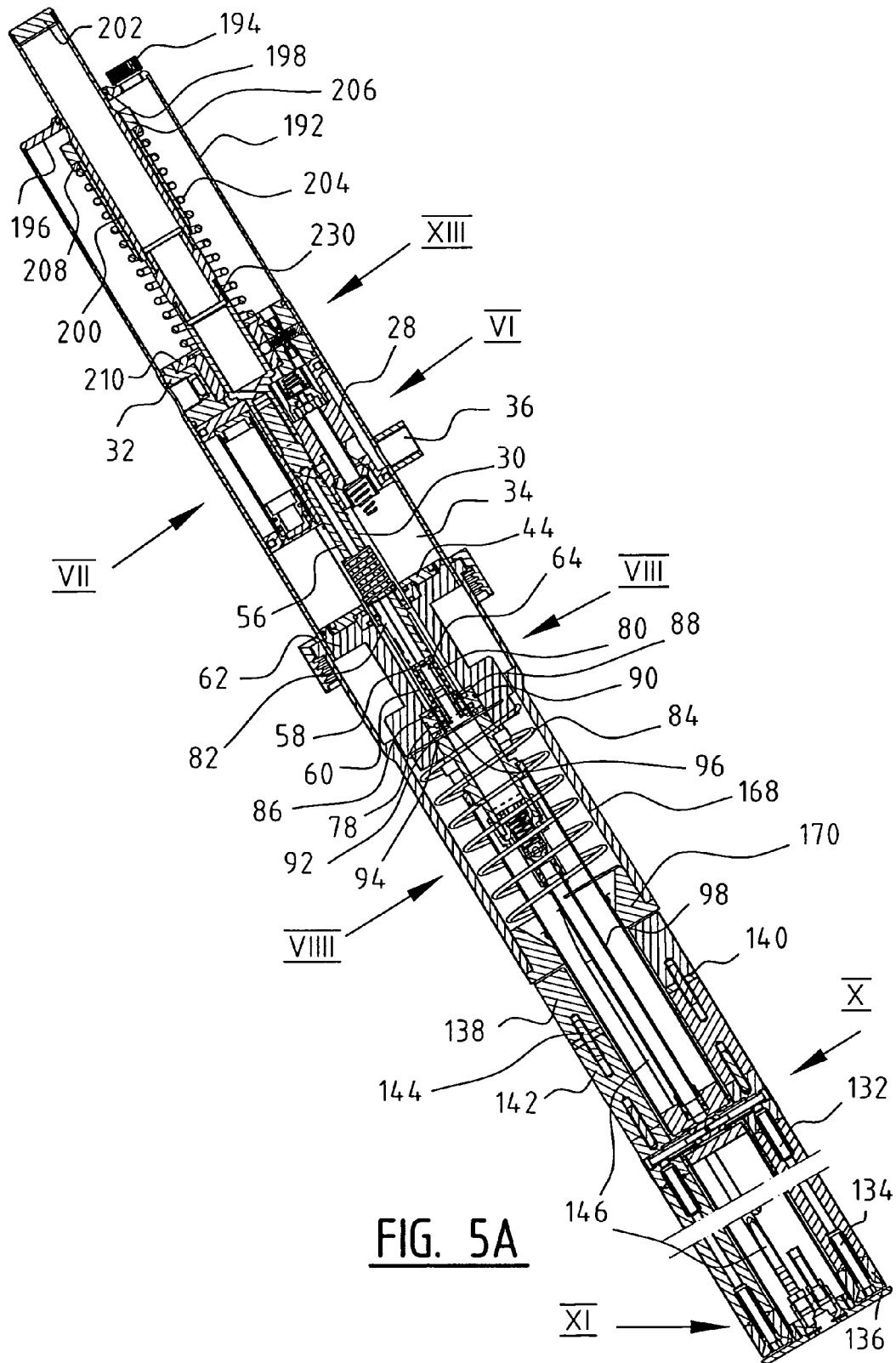


FIG. 5A

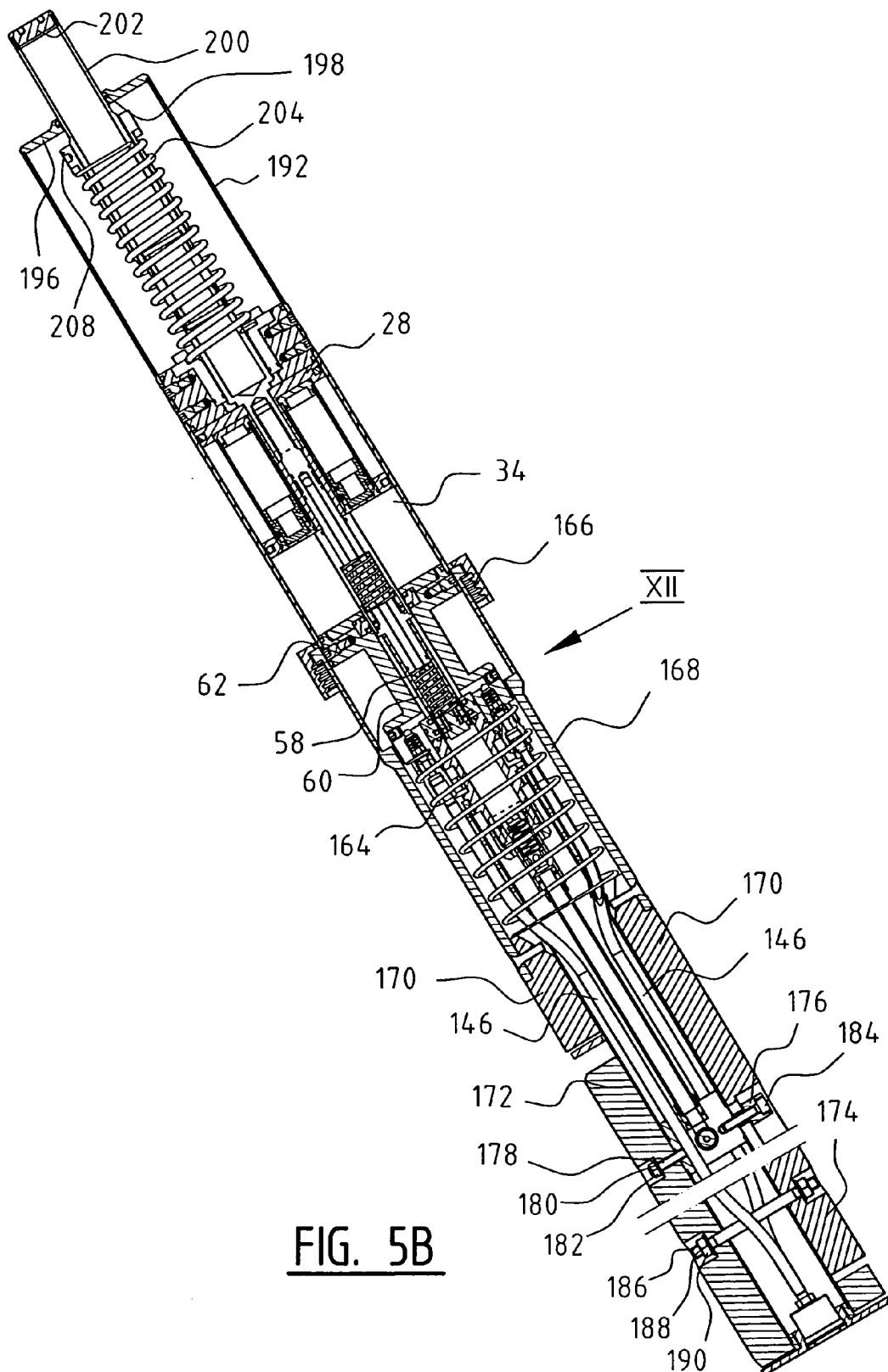


FIG. 5B

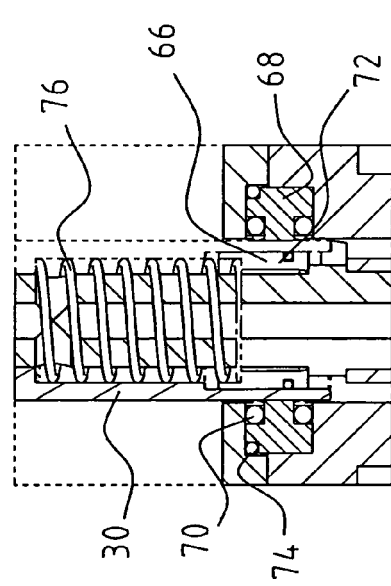


FIG. 8

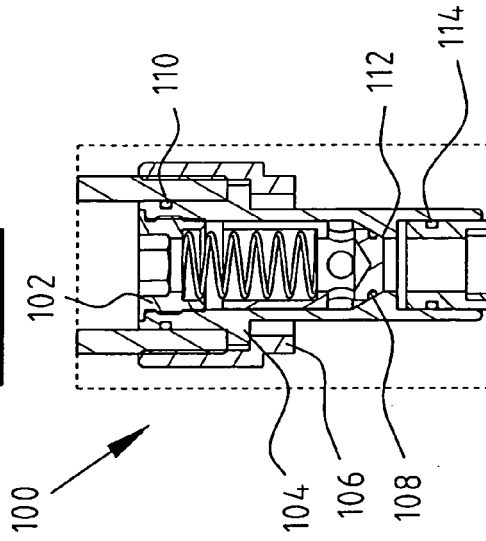


FIG. 9

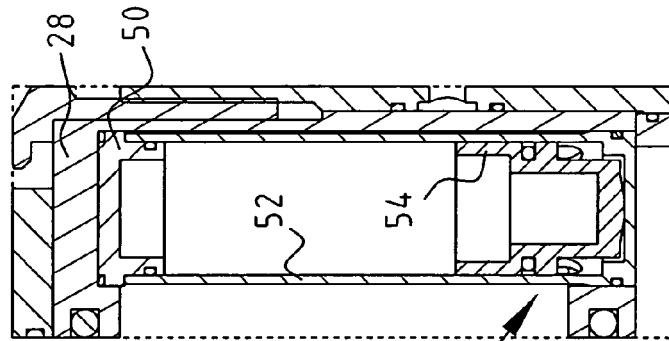


FIG. 7

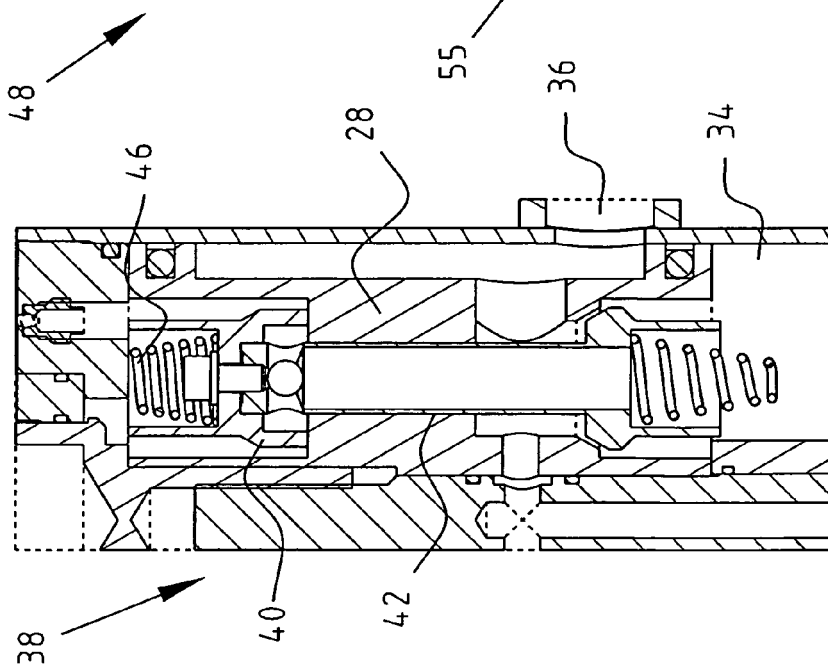
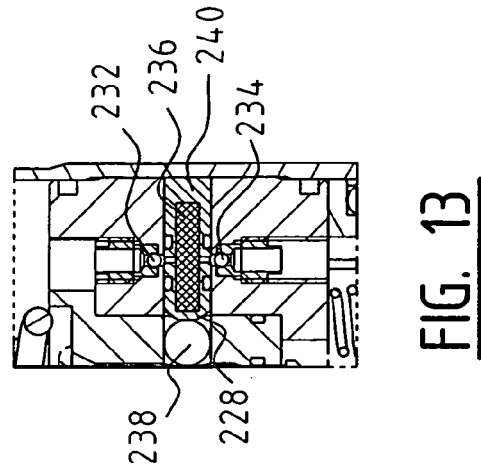
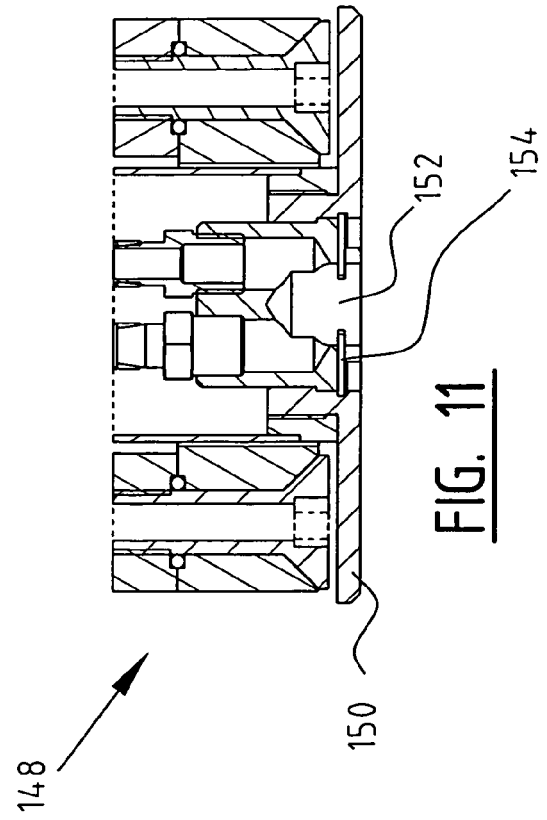
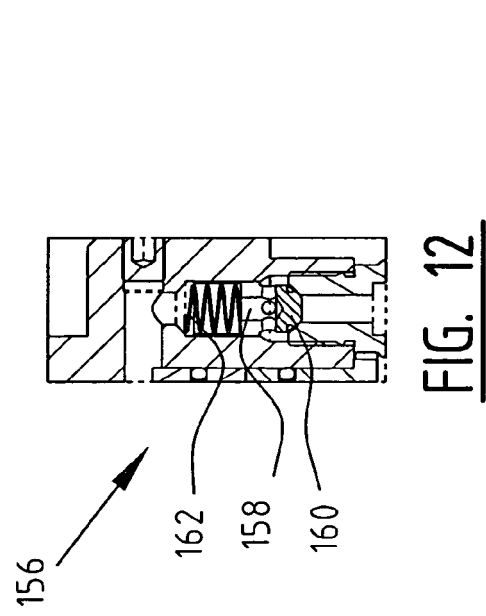
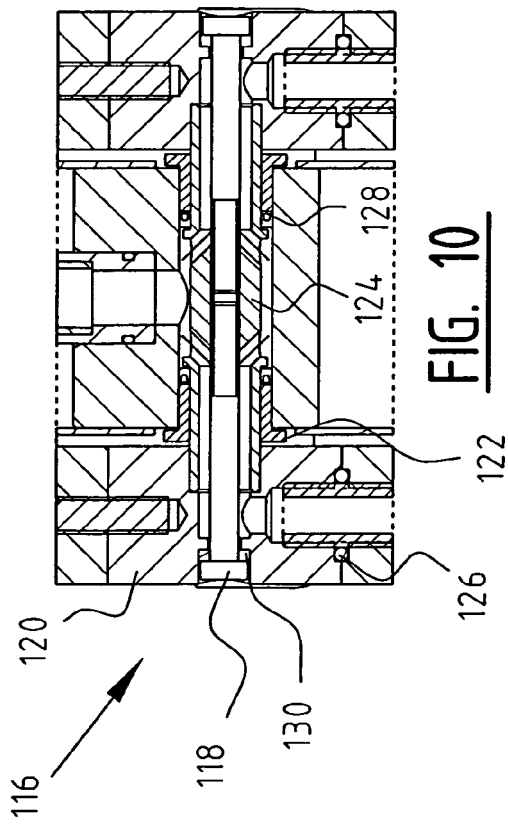


FIG. 6





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EUROPEAN SEARCH REPORT

Application Number
EP 07 07 5373

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Place of search Munich		Date of completion of the search 5 February 2008	Examiner Avramidis, Pavlos
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