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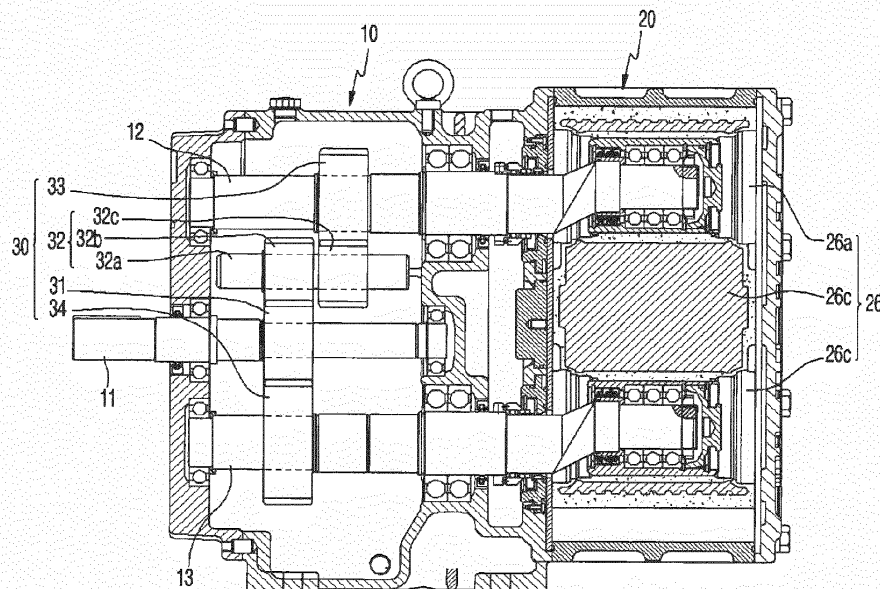
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(57) A double action rotary pump forcibly delivers fluid such as liquid or gas. A transmission unit operates at uniform or non-uniform angular speeds using driving force transmitted from a motor via a power transmission system. An operating unit is provided in series with the transmission unit. A piston of the operating unit has a pair of heads, which rotate at non-uniform angular speeds in a counteracting fashion while maintaining the

distance between shafts, and divides the spaces inside cylinders. The volumes of the divided spaces of the cylinders are repeatedly and alternately contracted and expanded in response to the rotation of the piston, so that the cylinders counteractively and continuously perform intake and exhaust operations, thereby forcibly delivering fluid. The structure of the power transmission system is improved such that the sum of flow rates that are pumped by the piston at a predetermined time point stays uniform.

FIG.1**EP 2 551 521 A2**

Description

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority from Korean Patent Application Numbers 10-2011-75023 filed on July 28, 2011 and 10-2012-26107 filed on March 14, 2012, the entire contents of which application are incorporated herein for all purposes by this reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a double action rotary pump, which is intended to forcibly deliver fluid such as liquid or gas. More particularly, the present invention relates to a pump, in which spaces of cylinders are divided by a piston that has a pair of heads, each of which is provided inside a corresponding cylinder so as to be eccentric from the center of the cylinder such that each head rotates inside the cylinder. In this pump, the volumes of the divided spaces of the cylinders are repeatedly and alternately contracted and expanded in response to the rotation of the heads so that intake and exhaust operations of the cylinders are performed counteractively and continuously, thereby forcibly delivering fluid.

Description of Related Art

[0003] Several types of double action rotary pumps for forcibly delivering fluid have been developed and used to dates. Such a pump generally includes a transmission unit and an operating unit in order to forcibly deliver fluid.

[0004] The transmission unit of the pump includes a pair of crank-type first and second shafts, which operates at uniform and non-uniform angular speeds using driving force that is transmitted from a motor via a power transmission system, which is realized by combining concentric and eccentric gears. The operating unit is provided in series with the transmission unit so as to be connected to one side of the transmission unit. The operating unit includes an intake port and an exhaust port on both sides thereof. The operating unit also includes first and second cylinders, which are arranged in upper and lower positions, are divided from each other, and are connected to each other via a through-hole. In addition, in the operating unit, a piston includes a pair of heads, each of which is provided in a corresponding one of the first and second cylinders using a corresponding one of the first and second shafts such that the each head is eccentric from the center of the corresponding cylinder. The heads rotate at non-uniform angular speeds in a counteracting fashion while maintaining a distance between the shafts. The piston also includes a connector, which extends through the through-hole and connects the heads to each other. The volumes of spaces inside the cylinders, which are divided

by the piston, are repeatedly and alternately contracted and expanded in response to the rotation of the piston, so that the cylinders counteractively and continuously perform the intake and exhaust operations, thereby forcibly delivering fluid.

[0005] According to the operating condition for the rotation of the piston, the angular speed of the heads varies depending on an angle of rotation in order to maintain the distance between the first and second shafts. That is, according to the mechanical principle, the distance between the first and second shafts essentially varies between non-uniform maximum and minimum distances when the first and second shafts operate in opposite directions. However, in the pump configured as above, variable long and short distances between the shafts are mutually corrected due to the operation at uniform and non-uniform angular speeds, so that an intended pumping operation is enabled.

[0006] However, in the operation of this type of pump, one of the first and second shafts operates at non-uniform speeds. Due to the non-uniform angular operation that is intended to correct the distance between the shafts, the flow rate of fluid that is forcibly delivered is non-uniform, which is attributable to changes in the angular speed due to the maximum and minimum diameter portions between the eccentric gears. Describing in more detail, one of the first and second shafts rotates at a uniform speed since driving force from the outside is directly delivered thereto. In addition, the other one of the first and second shafts operates at a lowest speed by gradually slowing down its rotation in the vicinity of 90° and 270° depending on the maximum and minimum diameter portions between the eccentric gears. The flow rate of fluid that is pumped varies depending on the angle of the shaft of the pump, i.e. the flow rate is the maximum at 0° and 180° and the minimum in the vicinity of 90° and 270°. In this fashion, the flow rate of one of the first and second cylinders is fixed but the flow rate of the other one of the first and second cylinders varies between the maximum and the minimum. Consequently, the sum of the instantaneous flow rates that are pumped by the pump is not uniform.

[0007] Therefore, the non-uniformity of the flow rate of fluid that is pumped is a main reason for surging that would cause a problem in the operation of the pump.

[0008] The surging of the pump causes a number of problems, which degrade the quality of the pump. Specifically, the surging creates noises and vibration, decreases the lifespan of devices, decreases the efficiency of the pump, and disables high-precision control over forced delivery, such as delivery at a fixed amount.

[0009] In addition, in the pump as described above, the power transmission system that includes the concentric or eccentric gears is composed of several stages that use at least two sets of shafts in addition to the first and second shafts. Therefore, the spatial arrangement of the power transmission system is difficult. The configuration is complicated since several types of gears having large

and small diameters are systematically and continuously associated with adjacent elements. Consequently, there are problems in that it is difficult to fabricate the pump and that the cost of manufacture of the pump increases.

[0010] Furthermore, since the power transmission system is composed of several stages, the distance of a power transmission route unnecessarily extends, thereby increasing the distance between an input and an output of driving force. In addition, mechanical friction or load between mechanical elements in respective stages increases power loss, so that power that is consumed in the operation of the pump increases, thereby decreasing the operating efficiency of the pump. Therefore, the development of a technology that can overcome such problems is required.

[0011] The information disclosed in this Background of the Invention section is only for the enhancement of understanding of the background of the invention, and should not be taken as an acknowledgment or any form of suggestion that this information forms a prior art that would already be known to a person skilled in the art.

BRIEF SUMMARY OF THE INVENTION

[0012] Various aspects of the present invention provide a pump, in which driving force is distributed using a distribution stage and a delivery stage of a power transmission system, which is realized by combining concentric and eccentric gears, so that first and second shafts operate in counteractive non-uniform angular speeds. Accordingly, the sum of flow rates that are pumped by a piston at a predetermined time point can stay uniform, thereby enabling a fixed amount of fluid to be forcibly delivered, preventing surging, and improving the performance of the pump.

[0013] Also provided is a pump, in which first and second shafts of a transmission unit operate at non-uniform angular speeds using the power transmission system, which is realized by combining a worm, which moves like a pendulum, and a pair of eccentric worm gears, which are provided on both sides of the worm such that the worm is disposed in the middle between them. Accordingly, it is possible to simplify the structure, reduce the number of parts, and simplify the parts, thereby reducing the cost of manufacture.

[0014] Also provided is a pump, in which the power transmission system is realized by combining a minimum number of mechanical elements such that the length of a route along which power is transmitted and the stages of the power transmission system are decreased, thereby reducing mechanical friction and load. Accordingly, it is possible to reduce power consumption, increase the efficiency of operation, and improve the quality of the pump.

[0015] In an aspect of the present invention, provided is a double action rotary pump, which is intended to forcibly deliver fluid such as liquid or gas. The pump includes a transmission unit and an operating unit provided in series with the transmission unit. The transmission unit op-

erates at uniform or non-uniform angular speeds using driving force that is transmitted from a motor via a power transmission system, which includes a combination of concentric and eccentric gears. In the operating unit, a piston has a pair of heads, which rotate at non-uniform angular speeds in a counteracting fashion while maintaining the distance between shafts, and divides the spaces inside cylinders. The volumes of the divided spaces of the cylinders are repeatedly and alternately contracted and expanded in response to the rotation of the piston, so that the cylinders counteractively and continuously perform intake and exhaust operations, thereby forcibly delivering fluid. The structure of the power transmission system of the transmission unit is improved such that the sum of flow rates that are pumped by the piston at a predetermined time point stays uniform. Accordingly, a fixed amount of fluid can be forcibly delivered, thereby making it possible to prevent surging. In addition, it is possible to decrease the length of the route along which power is transmitted and reduce the number of the stages of the power transmission system by simplifying the structure, thereby reducing mechanical friction or load. Accordingly, it is possible to increase the operating efficiency of the pump and improve the quality of the pump.

[0016] According to embodiments of the invention, the driving force is distributed using the distribution stage and the delivery stage of the power transmission system, which is realized by combining concentric and eccentric gears, so that the first and second shafts operate in counteractive non-uniform angular speeds. Consequently, the sum of flow rates that are pumped by the piston at a predetermined time point can stay uniform, thereby enabling a fixed amount of fluid to be forcibly delivered, preventing surging. Accordingly, it is possible to remove noises or vibration, thereby improving the endurance of devices and improving the performance of the pump.

[0017] In addition, according to embodiments of the invention, it is possible to precisely measure a flow rate and forcibly deliver a fixed amount of fluid by maintaining the amount of fluid that is pumped by the pump to be uniform, thereby enabling high-precision control over forced delivery.

[0018] Furthermore, according to embodiments of the invention, the first and second shafts of the transmission unit operate at non-uniform angular speeds using the power transmission system, which is realized by combining the worm, which moves like a pendulum, and the pair of eccentric worm gears, which are provided on both sides of the worm such that the worm is disposed in the middle between them. Accordingly, it is possible to simplify the structure, reduce the number of parts, and simplify the parts, thereby reducing the cost of manufacture.

[0019] In addition, according to embodiments of the invention, the power transmission system is realized by combining a minimum number of mechanical elements such that the length of the route along which power is transmitted and the stages of the power transmission system are decreased, thereby reducing mechanical fric-

tion and load. Accordingly, it is possible to reduce power consumption, increase the efficiency of operation, and improve the quality of the pump.

[0020] Furthermore, according to embodiments of the invention, since the amount of fluid that is pumped by the pump is maintained uniform, it is possible to precisely measure a flow rate and forcibly deliver a fixed amount of fluid, thereby enabling high-precision control over forced delivery.

[0021] The methods and apparatuses of the present invention have other features and advantages which will be apparent from, or are set forth in greater detail in the accompanying drawings, which are incorporated herein, and in the following Detailed Description of the Invention, which together serve to explain certain principles of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. 1 is a front cross-sectional view showing the structure of a pump according to one embodiment of the invention;

[0023] FIG. 2 is a side cross-sectional view showing the structure of the pump according to one embodiment of the invention;

[0024] FIG. 3A and FIG. 3B are explanatory views showing a power transmission system that is applied to the pump according to an embodiment of the invention, in which FIG. 3A is a development view of transmission shafts, and FIG. 3B is a development view of transmission gears;

[0025] FIG. 4A to FIG. 4E are explanatory views showing the operation of the pump according to one embodiment of the invention, in which FIG. 4A shows the position in which the piston is positioned at a reference point 0°, FIG. 4B is the explanatory view in which the piston is rotated to a position around 90°, FIG. 4C is the explanatory view in which the piston is rotated to a position around 180°, FIG. 4D is the explanatory view in which the piston is rotated to a position around 270°, and FIG. 4E is an explanatory view in which the piston is rotated to a position around 360°;

[0026] FIG. 5A and FIG. 5B are explanatory views showing another embodiment of the power transmission system, which is applicable to the pump of the invention, in which FIG. 5A is a development view of transmission shafts, and FIG. 5B is a development view of transmission gears;

[0027] FIG. 6A and FIG. 6B are explanatory views showing a further embodiment of the power transmission system, which is applicable to the pump of the invention, in which FIG. 6A is a development view of transmission shafts, and FIG. 6B is a development view of transmission gears;

[0028] FIG. 7 is a partially cutaway front elevation view showing a pump according to another embodiment of the invention;

[0029] FIG. 8 is a cross-sectional view taken along line

A-A in FIG. 7;

[0030] FIG. 9 is a cross-sectional view taken along line B-B in FIG. 7; and

[0031] FIG. 10A to FIG. 10D are stepwise explanatory views showing the intake and exhaust processes of the pump according to another embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0032] Reference will now be made in detail to various embodiments of the present invention, examples of which are illustrated in the accompanying drawings and described below. FIG. 1 and FIG. 2 show a pump according to an embodiment of the invention in detail. The invention provides a double action rotary pump, which is intended to forcibly deliver fluid such as liquid or gas.

[0033] The pump of this embodiment generally includes a transmission unit 10 and an operating unit 20, which are surrounded by respective casings such that they are isolated from each other.

[0034] First, the transmission unit 10 includes a main drive shaft 11 in the central portion of the body thereof, the main drive shaft 11 receiving driving force from a motor or the outside, a pair of crank-type first and second shafts 12 and 13, which are arranged in parallel in the upper and lower positions. The first and second shafts 12 and 13 are associated with the main drive shaft 11 and follow it via a power transmission system, which will be described later.

[0035] The main drive shaft 11 and the first and second shafts 12 and 13 are associated with each other by the power transmission system, which obtains a suitable transmission ratio by combining several types using large/small concentric or eccentric gears or the like. In an example, as shown in FIG. 3A and FIG. 3B, a power transmission system 30 includes a distribution stage 31, a delivery stage 32, and first and second input stages 33 and 34.

[0036] The core concept of the invention is characterized in delivering the driving force that is introduced to the main drive shaft 11 by distributing it using the distribution stage 31 and the delivery stage 32, so that respective first and second shafts 12 and 13 operate at non-uniform angular speeds in opposite directions. Due to this, the sum of flow rates that are pumped by the pump at a predetermined time point can stay uniform, so that fluid can be forcibly delivered.

[0037] Describing in more detail, the distribution stage 31, which is an eccentric gear, is provided on the main drive shaft 11, and supplies the driving force that is introduced through the main drive shaft 11 to the first and second shafts 12 and 13 by distributing the driving force. The first input stage 33, which is a concentric gear, is provided on the first shaft 12, is associated with the distribution stage 31 of the main drive shaft 11 via the delivery stage 32, and receives the distributed driving force from the main drive shaft 11. The second input stage 34, which is an eccentric gear, is provided on the second

shaft 13, is associated with the distribution stage 31 of the main drive shaft 11, and receives the distributed driving force from the main drive shaft 11. The driving force introduced through the main drive shaft 11 is distributed by the power transmission system 30, and the respective first and second shafts 12 and 13 counteractively operate at non-uniform angular speeds, thereby maintaining the distance between shaft ends according to the operating condition of the first and second shafts 12 and 13,

[0038] Here, the delivery stage 32 is a converting element for driving the first and second shafts 12 and 13 in the opposite directions by converting the delivery of power and the direction in which driving force acts. The delivery stage 32 is provided using an idle shaft 32a between the main drive shaft 11 and the first shaft 12, and includes an input section 32b and an output section 32c. The input section 32b is an eccentric gear, is associated with the distribution stage 31 of the main drive shaft 11, and receives the driving force. The output section 32c is a concentric gear, is associated with the first input stage 33, and transmits the driving force introduced through the input section 32b to the first input stage 33.

[0039] In addition, the operating unit 20 is provided in series on one side of the transmission unit 10. In the operating unit 20, first and second cylinders 21 and 22 are arranged up and down along one vertical line, and are connected to each other by a through passage 23, which extends therebetween, thereby defining one space.

[0040] In addition, an intake port 24 and an exhaust port 25 are provided on both sides between the first and second cylinders 21 and 22 of the operating unit 20, in the direction that intersects the through passage 23 of the first and second cylinders 21 and 22. In response to the intake and exhaust operations of a piston, which will be described later, fluid is taken in and exhausted through the intake port 24 and the exhaust port 25.

[0041] The piston 26, which operates using the first and second shafts 12 and 13, is provided inside the first and second cylinders 21 and 22. The piston 26 includes a pair of heads 26a and 26b, which are provided eccentrically from the centers of the first and second cylinders 21 and 22, and rotate counteractively while maintaining the distance between the shafts due to the non-uniform angular speeds of the first and second shafts 12 and 13. The heads 26a and 26b are connected to each other by a connector 26c, which passes through the through passage 23, thereby the piston 26 a unitary body. Here, the connector 26c has the function of connecting the heads 26a and 26b and the function of dividing (or partitioning) the cylinders 21 and 22.

[0042] In the piston 26, the heads 26a and 26b stay in slide contact with the inner walls of the first and second cylinders 21 and 22, and divide the first and second cylinders 21 and 22, which define one space, respectively or to the right and left sections. The volumes of the divided spaces in the respective cylinders 21 and 22 are repeatedly and alternately contracted and expanded in re-

sponse to the rotation of the piston 26, so that the both cylinders 21 and 22 can perform the intake and exhaust operations in a counteractive and continuous fashion. Consequently, fluid can be forcibly delivered by a double action mechanism.

[0043] With reference to FIG. 4A to FIG. 4E, a description will be given of the process of operating the pump according to this embodiment of the invention. FIG. 4A shows the initial state of the operation of the pump, in which the piston 26 is positioned at 0° and is reached to the top dead point. Here, the second cylinder 22 is closed and the first cylinder 21 is opened, so that fluid is started to be taken into the divided left space via the intake port 24.

[0044] FIG. 4B shows the position in which the first head 26a of the piston 26 is rotated 90° in the clockwise direction and the second head 26b of the piston 26 is rotated 90° in the counterclockwise direction. Here, the divided left space of the first cylinder 21 is expanded, thereby continuing to take in fluid.

[0045] FIG. 4C shows the position in which the piston 26 is positioned at 180°, thereby reaching the bottom dead point. The first cylinder 21 is closed while expanding to the maximum, thereby finishing the process of taking in fluid. At the same time, in contrast, the second cylinder 22 is opened, and fluid is being taken into the divided left space of the second cylinder 22.

[0046] FIG. 4D shows the position in which the first head 26a of the piston 26 is rotated further about 270° in the clockwise direction while the second head 26b of the piston 26 is rotated further about 270° in the counterclockwise direction. The divided right space of the first cylinder 21 is contracted, thereby starting to exhaust fluid that is taken in through the exhaust port 25. At the same time, in contrast, the divided left space of the second cylinder 22 is expanded, so that the process of taking in fluid is continued.

[0047] FIG. 4E shows the position in which the first head 26a of the piston 26 is rotated further 360° in the clockwise direction while the second head 26b of the piston 26 is rotated further about 360° in the counterclockwise direction, so that the piston 24 returns to the position of FIG. 4A. At this point, the space of the first cylinder 21 is in the middle between the intake operation and the exhaust operation, and the amount of exhaust is the maximum. In contrast, the space of the second cylinder 22 is expanded to the maximum, thereby finishing the process of taking in fluid. Here, no fluid is taken into or exhausted from the space of the second cylinder 22.

[0048] As the piston 26 in this state sequentially performs the pumping process, starting with the position of FIG. 4A, the first cylinder 21 starts to take in fluid while the second cylinder 22 starts to exhaust fluid in contrast. Consequently, the first and second cylinders 21 and 22 alternately perform the intake and exhaust operations, thereby enabling an intended pumping operation.

[0049] FIG. 5A and FIG. 5B show another embodiment of the power transmission system of the pump of the in-

vention. Like the foregoing embodiment, the power transmission system 130 of this embodiment connects a pair of the crank-type first and second shafts 12 and 13 to each other. The first and second shafts 12 and 13 are arranged in parallel in upper and lower positions about the main drive shaft 11, which receives driving force from a motor or the outside. The power transmission system 130 includes a distribution stage 131, a delivery stage 132 and first and second input stages 133 and 134. Here, each of the distribution stage 131 and the delivery stage 132 is configured as an eccentric gear or any eccentric member, such as a sprocket or a chain.

[0050] Describing in more detail, the distribution stage 131, which is an eccentric gear, is provided on the main drive shaft 11, and supplies driving force that is introduced through the main drive shaft 11 to the first and second shafts 12 and 13 by distributing the driving force. The first input stage 133, which is an eccentric sprocket, is provided on the first shaft 12, is associated with the distribution stage 131 via the delivery stage 132 of the chain, and receives the distributed driving force from the main drive shaft 11. The second input stage 134, which is an eccentric gear, is provided on the second shaft 13, is associated with the distribution stage 131 of the main drive shaft 11, and receives the distributed driving force from the main drive shaft 11. Accordingly, the driving force received via the main drive shaft 11 is distributed via the power transmission system 130, so that the first and second shafts 12 and 13 counteractively operate at non-uniform angular speeds in order to maintain the distance between the shafts according to the operating condition of the first and second shafts 12 and 13.

[0051] Here, the distribution stage 131 includes a first transmission element 131a, which is an eccentric gear, and a second transmission element 131b, which is an eccentric sprocket.

[0052] FIG. 6A and FIG. 6B show a further embodiment of the power transmission system of the pump of the invention. Like the foregoing embodiment, the power transmission system 230 of this embodiment connects a pair of the crank-type first and second shafts 12 and 13 to each other. The first and second shafts 12 and 13 are arranged in parallel in upper and lower positions about the main drive shaft 11, which receives driving force from a motor or the outside. The power transmission system 230 includes a distribution stage 231, a delivery stage 232 and first and second input stages 233 and 234. Here, each of the distribution stage 231 and the delivery stage 232 is configured as, for example, a concentric or eccentric gear or chain that has a large or small size.

[0053] Describing in more detail, the distribution stage 231, which is an eccentric gear, is provided on the main drive shaft 11, and supplies driving force that is introduced through the main drive shaft 11 to the first and second shafts 12 and 13 by distributing the driving force. The input stage 233, which is a concentric gear, is provided on the first shaft 12, is associated with the distribution stage 131 via the delivery stage 132 of the chain,

and receives the distributed driving force from the main drive shaft 11. The second input stage 234, which is an eccentric gear, is provided on the second shaft 13, is associated with the distribution stage 131 of the main drive shaft 11, and receives the distributed driving force from the main drive shaft 11. Accordingly, the driving force received via the main drive shaft 11 is distributed via the power transmission system 230, so that the first and second shafts 12 and 13 counteractively operate at non-uniform angular speeds in order to maintain the distance between the shafts according to the operating condition of the first and second shafts 12 and 13

[0054] Here, the distribution stage 231 includes a first transmission element 231a, which is a concentric gear, and a second transmission element 231b. The second transmission element 231b is configured by sequentially arranging an input section 231b-1, which is a small eccentric gear, a delivery section 231b-2, which is a concentric gear, and an output section 231b-3, which is a large eccentric gear.

[0055] In addition, the delivery stage 232 is a converting element for driving the first and second shafts 12 and 13 in the opposite directions by converting the delivery of power and the direction in which driving force acts. The delivery stage 232 is provided using an idle shaft 232a between the main drive shaft 11 and the first shaft 12. An eccentric idle gear 232b is associated with the delivery section 231b-2 of the distribution stage 231 of the main drive shaft 11, and receives the driving force. The delivery stage 232 is associated with the first input stage 233, and redirects the driving force that is introduced through the idle gear 232b to the first input stage 233.

[0056] In addition, the second input stage 234 includes a first input section 234a, which is a concentric gear associated with the first transmission element 231a of the distribution stage 231 of the main drive shaft 11; a delivery section 234b, which is associated with the input section 231b-1 of the second transmission element 231b of the distribution stage 231; and a second input section 234c, which is associated with the output section 231b-3 of the second transmission element 231b of the distribution stage 231.

[0057] As indicated with arrows in FIG. 6A, the power transmission system 230 is configured such that it transmits power as required by exchanging driving force between the first shaft 12 and the second shaft 13 via the main drive shaft 11 and between the main drive shaft 11 and the second shaft 13.

[0058] FIG. 7, FIG. 8 and FIG. 9 show a pump according to another embodiment of the invention. This embodiment is different from the foregoing embodiment in that the structure of the power transmission system of the transmission unit of the pump.

[0059] Like the foregoing embodiment, the pump of this embodiment includes a transmission unit 320 and an operating unit 330, which are isolated from each other on both sides inside a casing 310. The pump also has a

motor 340.

[0060] In the transmission unit 320 in the pump, which is configured as above, a pair of crank-type first and second shafts 322 and 324 are arranged in parallel, and operate at non-uniform angular speeds using the driving force that is delivered from the motor 340 via a power transmission system.

[0061] In addition, the operating unit 330 is provided in series on one side of the transmission unit 320. In the operating unit 330, first and second cylinders 336 and 337 are arranged on the same horizontal line, and are connected to each other by a through-hole 335, thereby defining one space. In addition, an intake port 332 and an exhaust port 334 are provided in the upper and lower portions.

[0062] In addition, the first and second cylinders 336 and 337 are provided with a piston 338, which includes a pair of heads 338a and 338b. The heads 338a and 338b are provided inside the first and second cylinders 336 and 337 using the first and second shafts 322 and 324, such that they are eccentric from the centers of the first and second cylinders 336 and 337. The heads 338a and 338b rotate counteractively while maintaining the distance between the shafts of eccentric portions due to non-uniform angular speeds. The piston 338 also includes a connector 338c, which extends through the through-hole 335 so as to connect the heads 338a and 338b. In the piston 338, the heads 338a and 338b stay in slide contact with the inner walls of the first and second cylinders 336 and 337, and divide the first and second cylinders 336 and 337, which define one space, respectively or to the right and left sections. The volumes of the divided spaces in the respective cylinders 336 and 337 are repeatedly and alternately contracted and expanded in response to the rotation of the piston 338, so that the both cylinders 336 and 337 can perform the intake and exhaust operations in a counteractive and continuous fashion. Consequently, fluid can be forcibly delivered by a double action mechanism. Here, the connector 338c has the function of connecting the first and second heads 338a and 338b to each other and the function of a separator sheet that divides the respective spaces of the first and second cylinders 336 and 337 from each other.

[0063] According to the core configuration that characterizes this embodiment, the number of mechanical elements of the power transmission system of the transmission unit 320 is significantly reduced, thereby simplifying the structure, decreasing the route along which power is delivered, and decreasing mechanical friction or resistance.

[0064] Describing in more detail, the power transmission system 323 of the transmission unit 320 of this embodiment includes a worm 323a and a pair of eccentric worm gears 323b and 323c. One end of the worm 323a extends further, thereby forming a rod having a predetermined length. The terminal of the rod of the worm 323a is fixed by a support piece 323a-1, which is coupled with the upper section of the casing 310, such that the driving

force from the output shaft 342 of the motor 340 is transmitted thereto. The other end of the worm 323a forms a free end. The worm 323a is interposed between the worm gears 323b and 323c, which will be describe below, and is guided by a guide rail that is provided in the lower portion of the casing 310 such that it moves like a pendulum.

[0065] In addition, the worm gears 323b and 323c are engaged with both sides of the worm 323a, such that the worm 323a is disposed in the middle between the worm gears 323b and 323c. The worm gears 323b and 323c are eccentrically provided on the first and second shafts 322 and 324, respectively.

[0066] In the power transmission system 323 configured as above, the worm 323a moves like a pendulum between the eccentric worm gears 323b and 323c while supplying driving force from the motor 340 to the worm gears 323b and 323c by distributing it.

[0067] In addition, a flexible delivery element 350 is provided between the output shaft 342 and worm 323a in order to transmit the driving force of the motor 340. Here, the delivery element 350 may be implemented as an elastic or resilient flexible material, such as a coil spring, a rubber material, or the like, which receives variation or changes between the output shaft 342 of the fixed motor 340, which is mounted on the casing 310, and the movable worm 323a, which moves like a pendulum inside the casing 310.

[0068] With reference to FIGS. 10A, 10B, 10C and 10D, a description will be given of the operation of the pump of this embodiment.

[0069] FIG. 10A shows the initial state of the operation of the pump in which the piston 338 is positioned at 0° and is reached to the top dead point. Here, the second cylinder 337 is closed and the first cylinder 336 is opened, so that fluid is started to be taken into the divided lower space of the first cylinder 336 via an intake port 332.

[0070] FIG. 10B shows the position in which the first head 338a of the piston 338 is rotated 90° in the clockwise direction and the second head 338b of the piston 338 is rotated 90° in the counterclockwise direction. Here, the divided lower space of the first cylinder 336 is expanded, thereby continuing the process of taking in fluid. At the same time, the second cylinder 337 in the closed state is opened, thereby starting to take fluid into the lower divided space.

[0071] FIG. 10C shows the position in which the piston 338 is positioned at 180°, thereby reaching the bottom dead point. The first cylinder 336 is closed while expanding to the maximum, thereby finishing the process of taking in fluid. At the same time, in contrast, fluid is being taken into the divided lower space of the second cylinder 337.

[0072] FIG. 10D shows the state in which the first head 338a of the piston 338 is rotated further about 270° in the clockwise direction while the second head 338b of the piston 338 is rotated further about 270° in the counterclockwise direction. The divided lower space of the

first cylinder 336 is contracted, thereby starting to exhaust fluid that is taken in through the exhaust port 334. At the same time, in contrast, the divided lower space of the second cylinder 337 is expanded, so that the process of taking in fluid is continued.

[0073] The first head 338a of the piston 338 is rotated further 360° in the clockwise direction while the second head 338b of the piston 338 is rotated further about 360° in the counterclockwise direction, so that the piston 338 returns to the position of FIG. 10A. At this point, the space of the first cylinder 336 is in the middle between the intake operation and the exhaust operation, and the amount of exhaust is the maximum. In contrast, the space of the second cylinder 337 is expanded to the maximum, thereby finishing the process of taking in fluid. Here, no fluid is taken into or exhausted from the space of the second cylinder 336.

[0074] As described above, the piston 338 rotates inside the cylinders 336 and 337 so that the first cylinder 336 takes in fluid while the second cylinder 337 exhausts fluid. In this fashion, the first and second cylinders 336 and 337 alternately and repeatedly perform the intake operation and the exhaust operation, so that an intended pumping operation can be performed.

[0075] The foregoing descriptions of specific exemplary embodiments of the present invention have been presented for the purposes of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teachings. The exemplary embodiments were chosen and described in order to explain certain principles of the invention and their practical application, to thereby enable others skilled in the art to make and utilize various exemplary embodiments of the present invention, as well as various alternatives and modifications thereof. It is intended that the scope of the invention be defined by the Claims appended hereto and their equivalents.

[0076] In summary an embodiment can be described as follows:

A double action rotary pump forcibly delivers fluid such as liquid or gas. A transmission unit operates at uniform or non-uniform angular speeds using driving force transmitted from a motor via a power transmission system. An operating unit is provided in series with the transmission unit. A piston of the operating unit has a pair of heads, which rotate at non-uniform angular speeds in a counteracting fashion while maintaining the distance between shafts, and divides the spaces inside cylinders. The volumes of the divided spaces of the cylinders are repeatedly and alternately contracted and expanded in response to the rotation of the piston, so that the cylinders counteractively and continuously perform intake and exhaust operations, thereby forcibly delivering fluid. The structure of the power transmission system is improved such that the sum of flow rates that are pumped by the piston at a predetermined time point stays uniform.

Claims

1. A pump comprising:

a transmission unit including a pair of crank-type first and second shafts, which operates at uniform or non-uniform angular speeds using driving force that is transmitted from a motor via a power transmission system, which includes a combination of concentric and eccentric gears; an operating unit provided in series with the transmission unit, wherein the operating unit comprises:

- an intake port and an exhaust port on both sides thereof;
- first and second cylinders in upper and lower portions thereof, wherein the first and second cylinders are divided from each other, and are connected to each other via a through-hole;
- a piston including a pair of heads, each of which is provided in a corresponding one of the first and second cylinders using a corresponding one of the first and second shafts such that the each head is eccentric from a center of the corresponding cylinder, the heads rotating at the non-uniform angular speeds in a counteracting fashion while maintaining a distance between the shafts, and a connector, which extends through the through-hole and connects the heads to each other; and
- wherein volumes of spaces inside the cylinders, which are divided by the piston, are repeatedly and alternately contracted and expanded in response to a rotation of the piston, so that the cylinders counteractively and continuously perform intake and exhaust operations, thereby forcibly delivering fluid;

a main drive shaft provided between the first and second shafts, wherein the main drive shaft is associated with each of the first and second shafts, and comprises a distribution stage, which supplies the driving force introduced from the motor to the first and second shafts by distributing the driving force;

a first input stage provided on the first shaft, the first input stage being associated with the distribution stage of the main drive shaft, and receiving the distributed driving force;

a second input stage provided on the second shaft, the second input stage being associated with the distribution stage of the main drive shaft, and receiving the distributed driving force; and a delivery stage interposed between the distri-

bution stage of the main drive shaft and the first stage on the first shaft or between the distribution stage of the main drive shaft and the second stage on the second shaft in order to cause the first and second shafts to operate in opposite directions,

wherein the driving force introduced to the main drive shaft is distributed by the distribution stage and supplied by the delivery stage, so that the first and second shafts operate at the non-uniform angular speeds so as to counteract each other.

2. The pump of claim 1, wherein the distribution stage comprises an eccentric gear, which is associated with the second input stage of the second shaft and the delivery stage, and distributes the driving force.
3. The pump of any of the preceding claims, wherein the distribution stage comprises a first transmission element associated with the second input stage of the second shaft and a second transmission element associated with the first input stage of the first shaft.
4. The pump of any of the preceding claims, wherein the distribution stage comprises a first transmission element associated with the second input stage of the second shaft and a second transmission element to and from which the driving force from the second input stage is input and output.
5. The pump of claim 4, wherein the second transmission element comprises an input section, a delivery section and an output section.
6. The pump of any of the preceding claims, wherein the delivery stage comprises an input section, which is provided on an idle shaft between the main drive shaft and the first shaft so as to be associated with the distribution stage of the main drive shaft, and an output section, which is associated with the first input stage of the first shaft.
7. The pump of any of the preceding claims, wherein the delivery stage comprises a chain, which directly connects between the distribution stage of the main drive shaft and the first input stage of the first shaft.
8. The pump of any of the preceding claims, wherein the delivery stage comprises an idle gear provided on an idle shaft between the main drive shaft and the first shaft, the idle gear being associated with the delivery section of the second transmission element of the distribution stage of the main drive shaft and the first input stage of the first shaft.
9. The pump of claim 5, wherein the delivery stage comprises an idle gear provided on an idle shaft between

the main drive shaft and the first shaft, the idle gear being associated with the delivery section of the second transmission element of the distribution stage of the main drive shaft and the first input stage of the first shaft.

10. The pump of any of the preceding claims, wherein the power transmission system comprises:

a worm having one end, which is fixed by a support piece such that the driving force from an output shaft of the motor, and the other end, which is a free end; and worm gears engaged with both sides of the worm such that the worm is disposed in a middle between the worm gears, the worm gears being eccentrically provided on the first and second shafts, respectively,

wherein the worm moves like a pendulum between the eccentric worm gears while supplying the driving force from the motor to the worm gears by distributing the driving force.

11. The pump of claim 10, further comprising a flexible delivery element interposed between the output shaft of the motor and the worm, the delivery element transmitting the driving force of the motor toward the worm.

FIG. 1

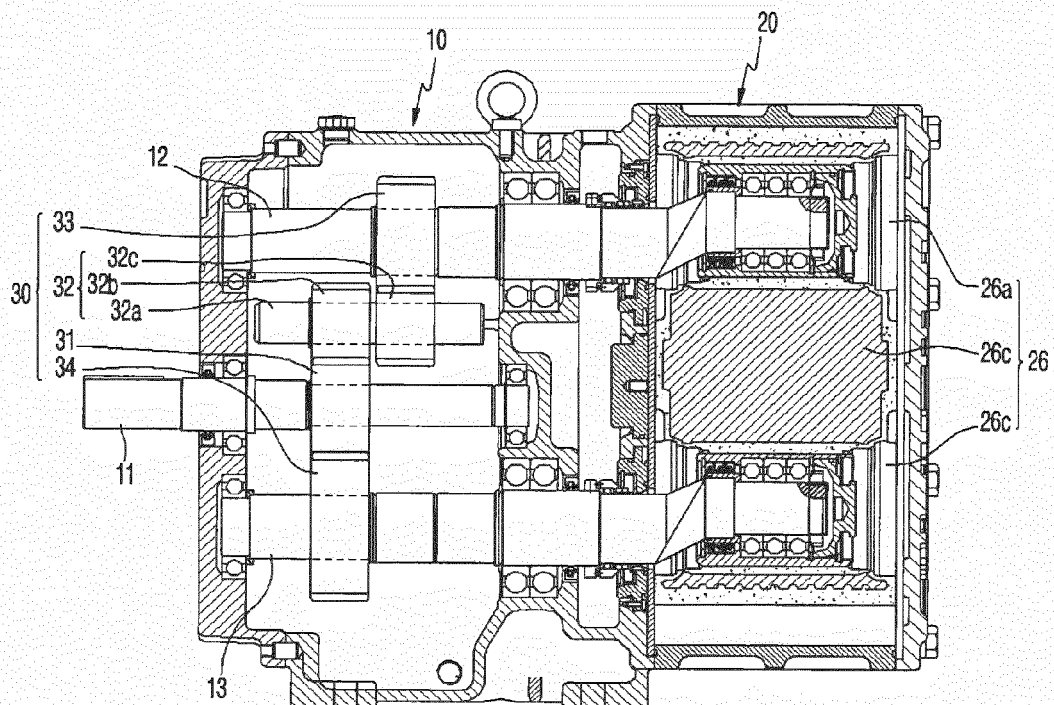


FIG.2

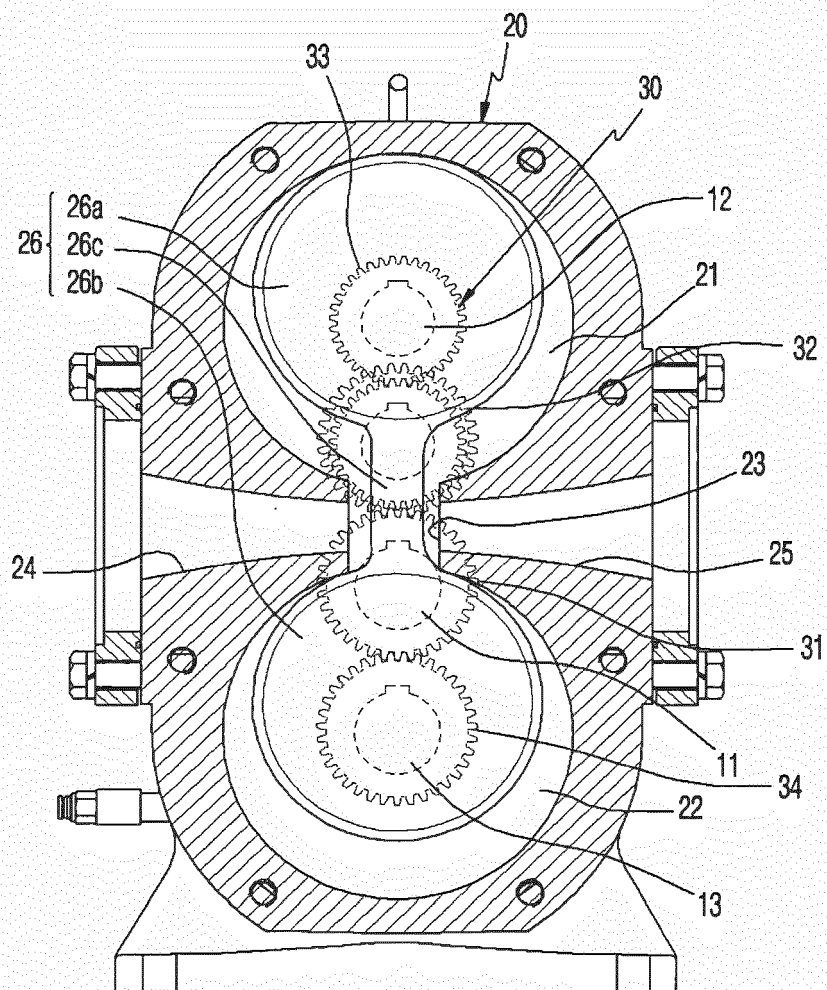


FIG. 3A

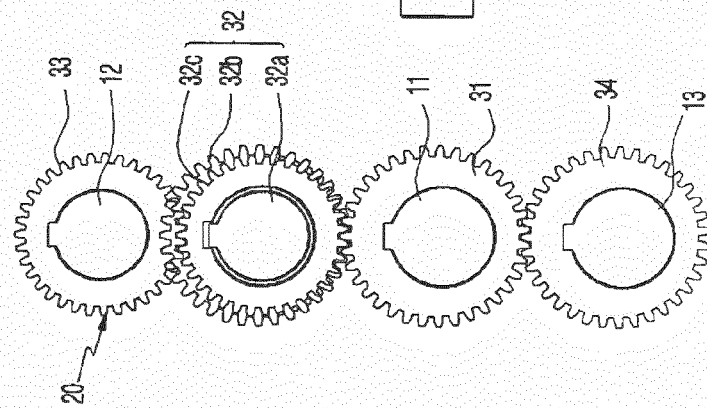
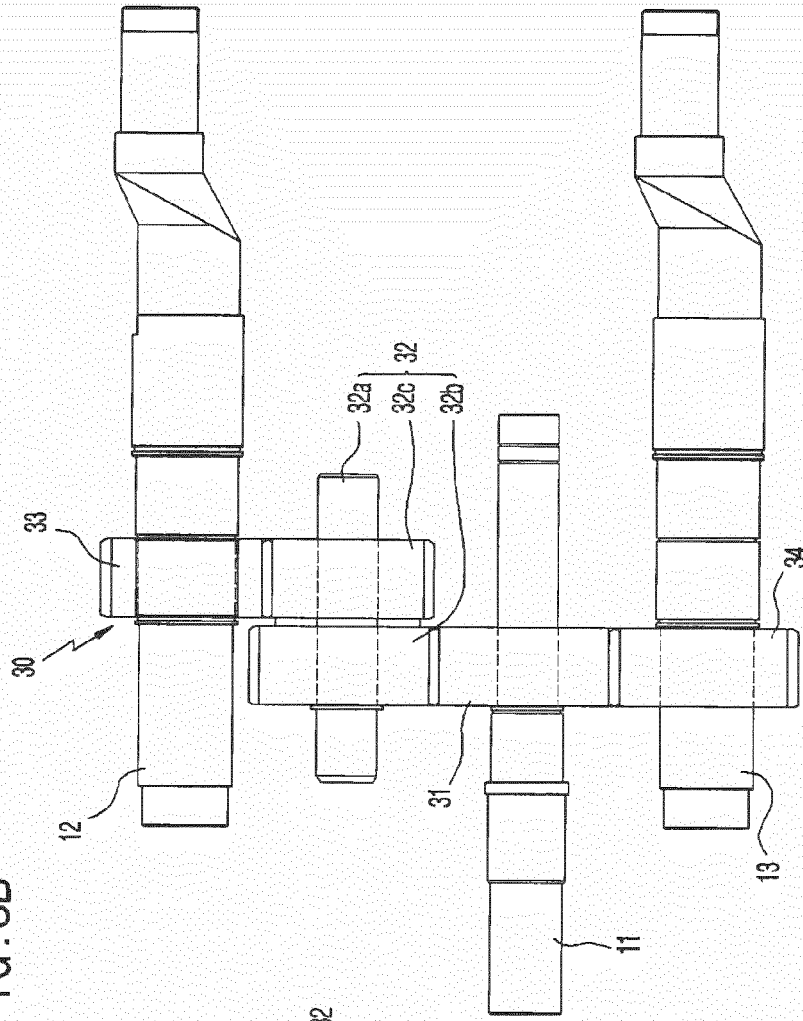


FIG. 3B



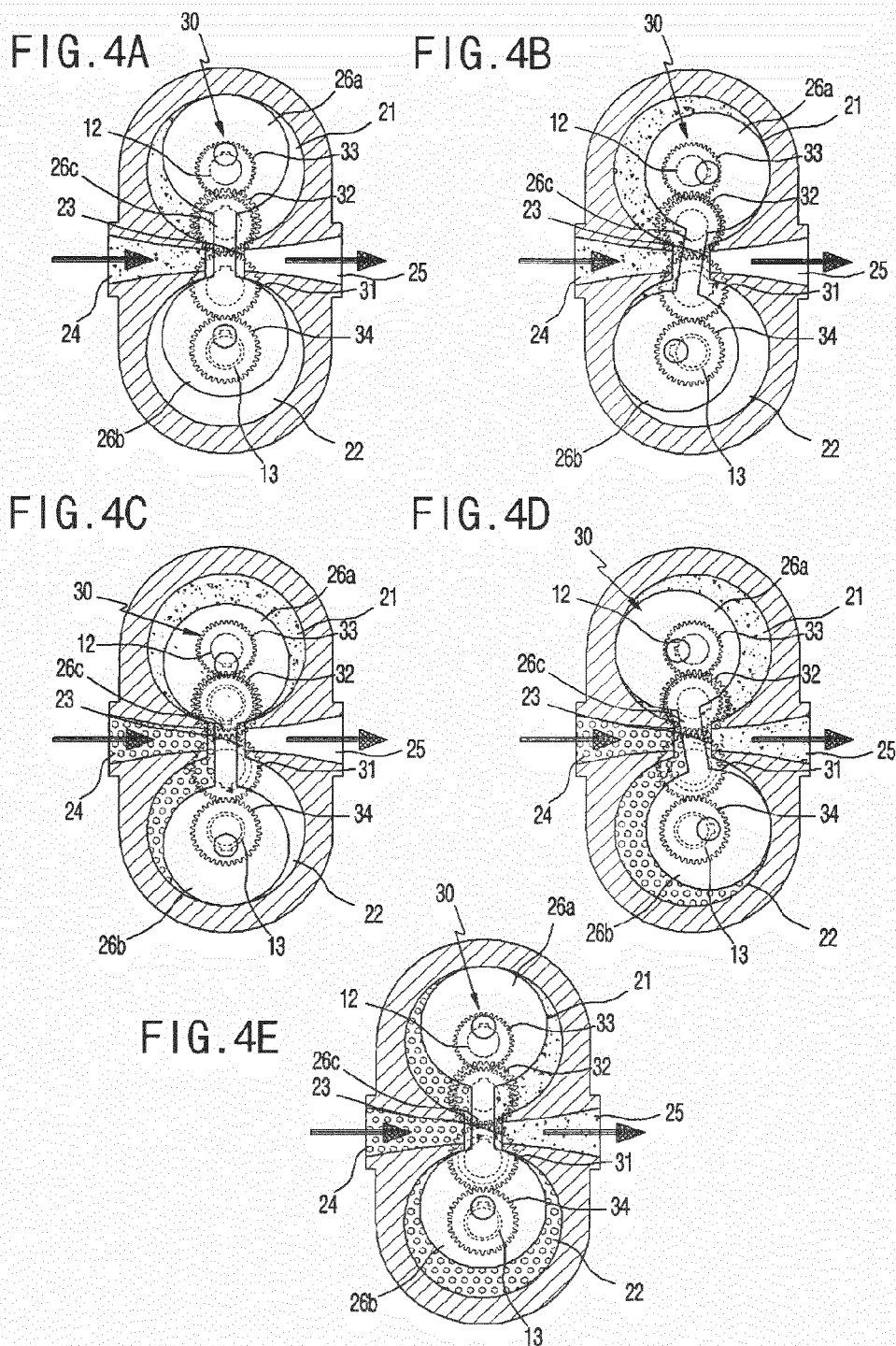


FIG. 5A

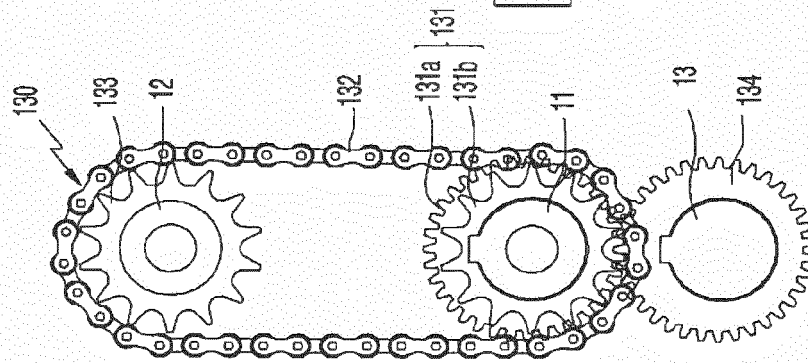
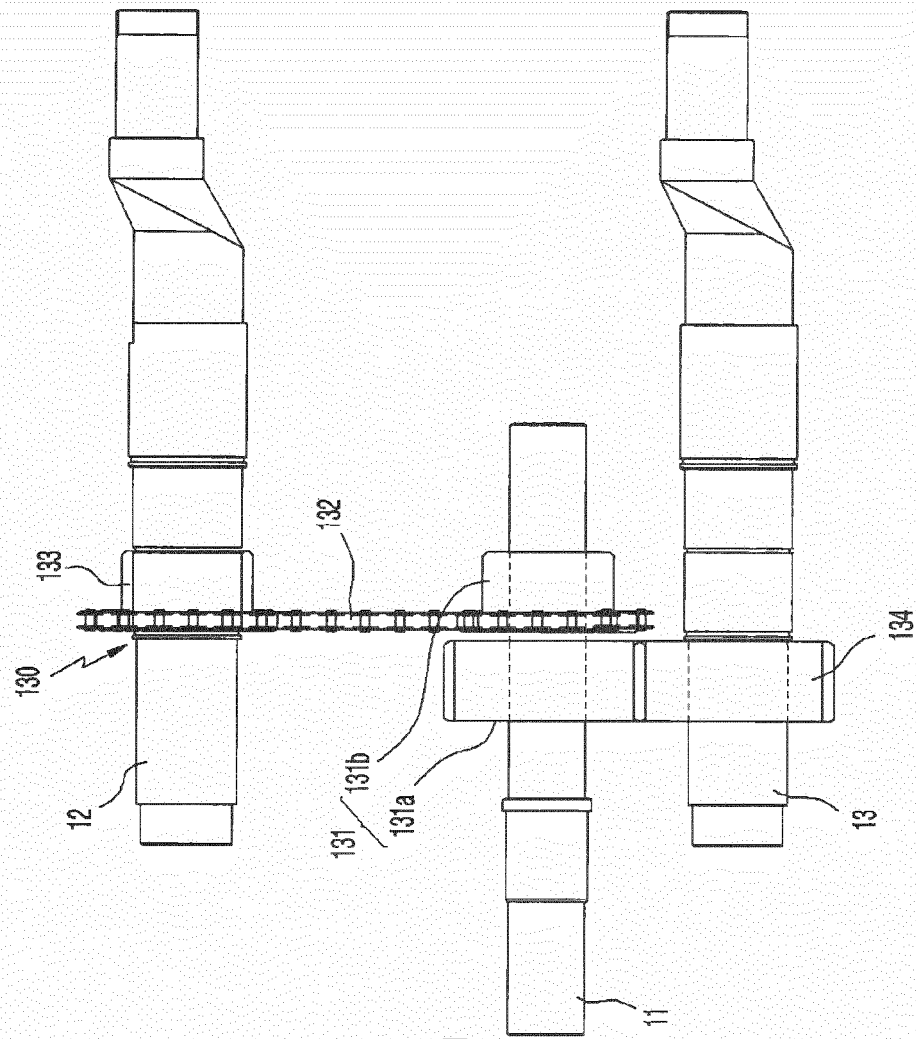


FIG. 5B



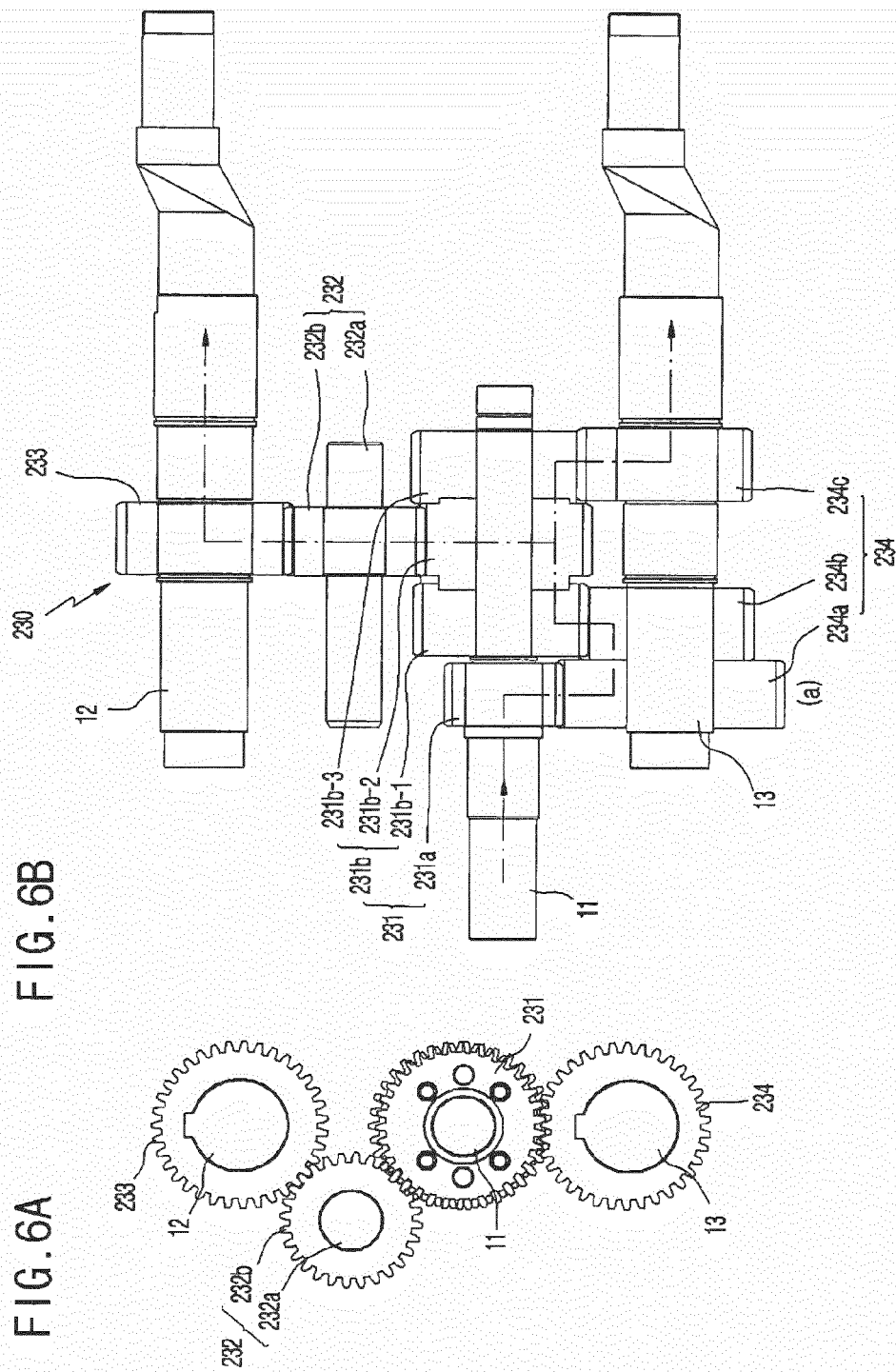


FIG. 7

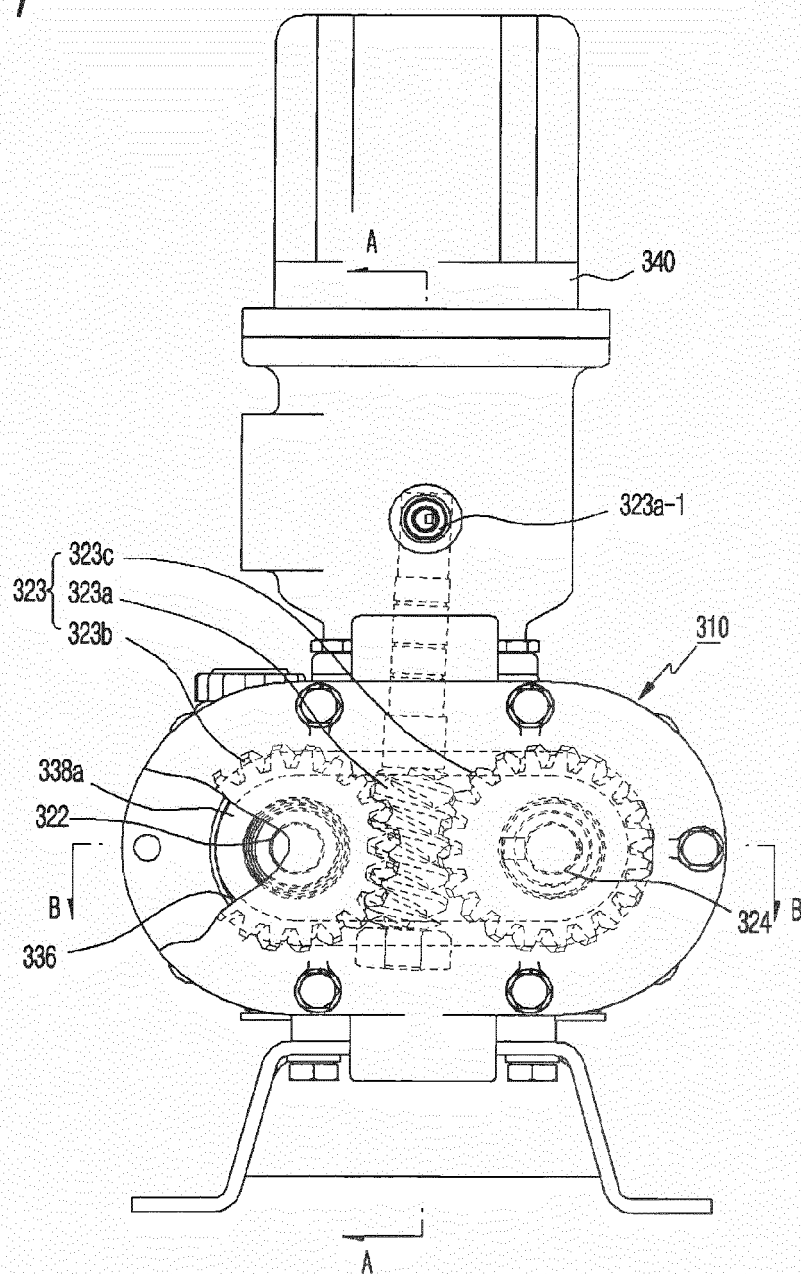


FIG. 8

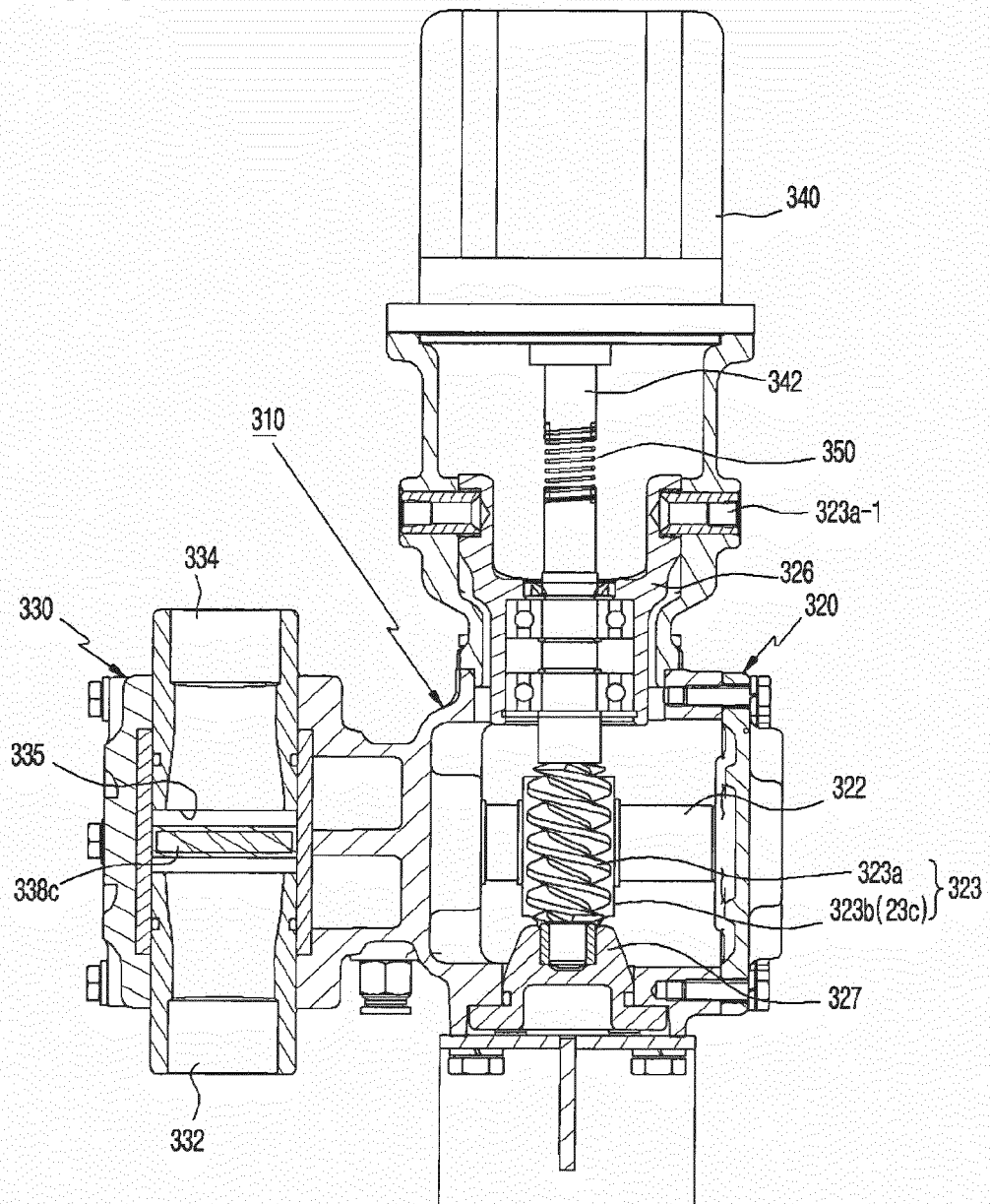


FIG. 9

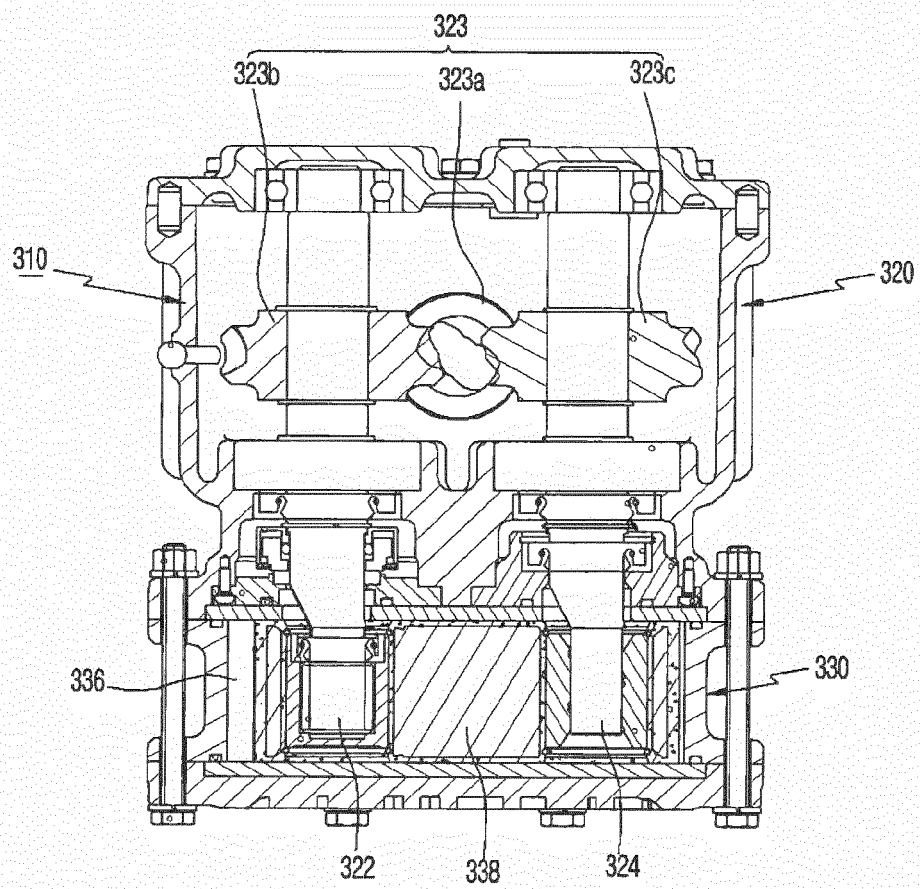


FIG. 10A

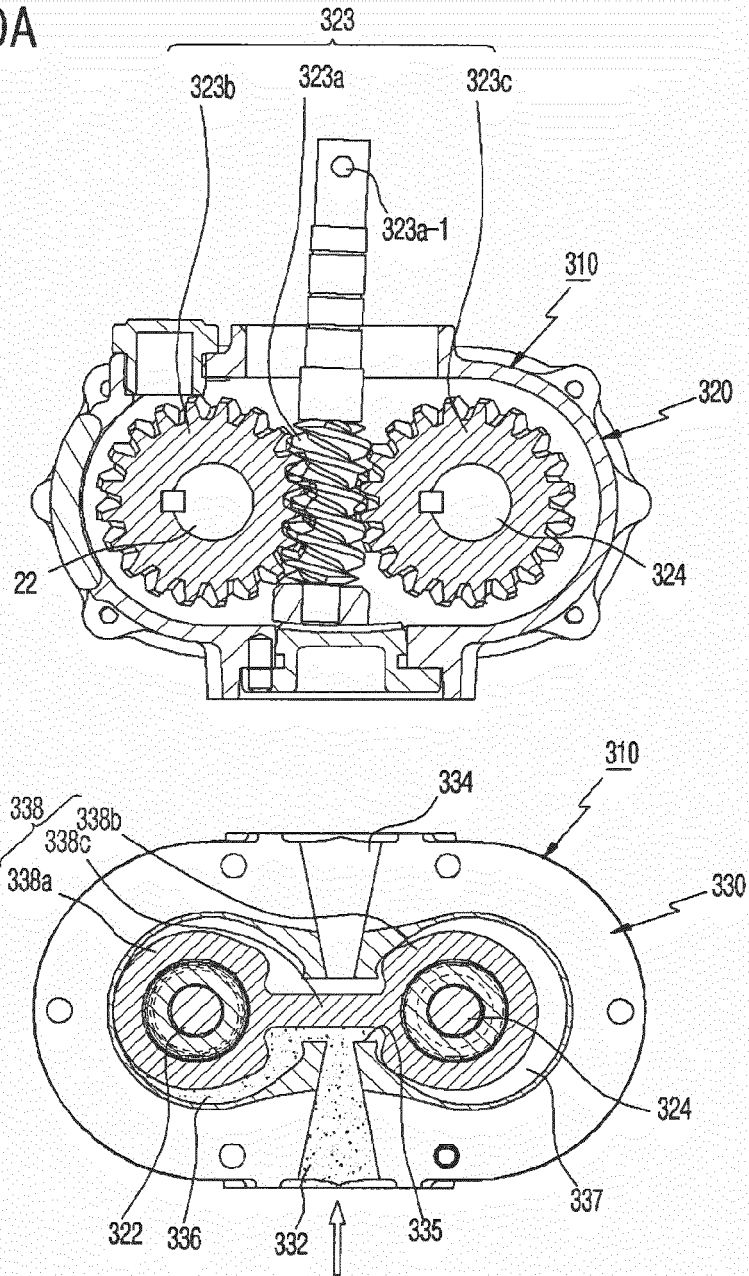


FIG. 10B

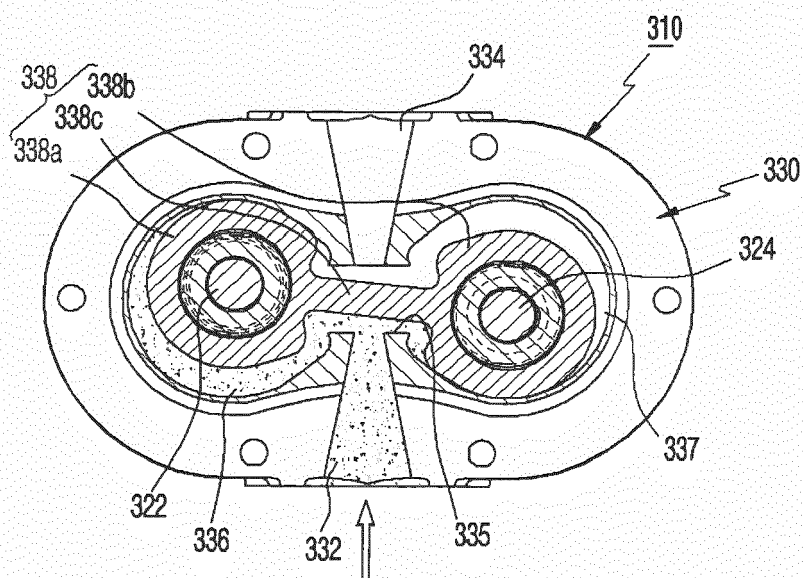
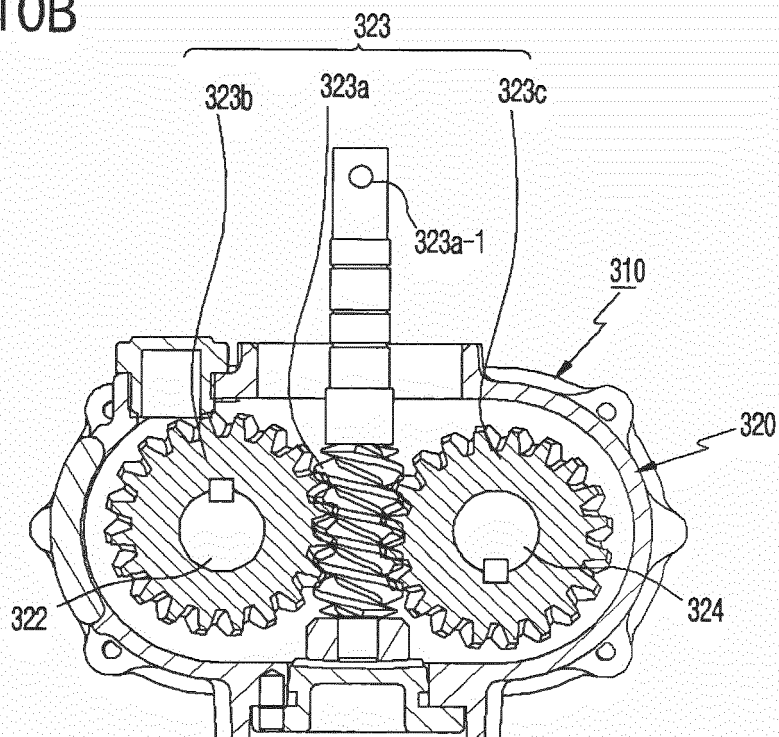


FIG. 10C

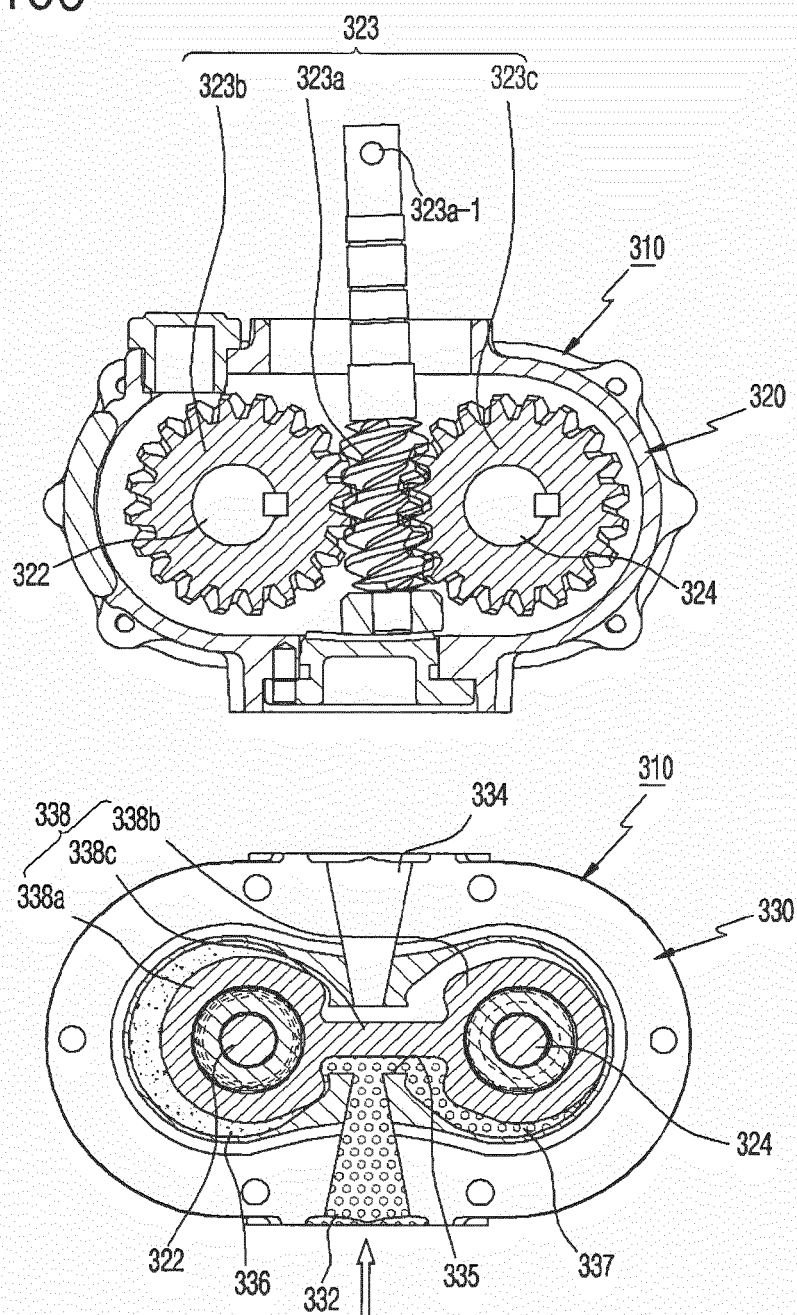
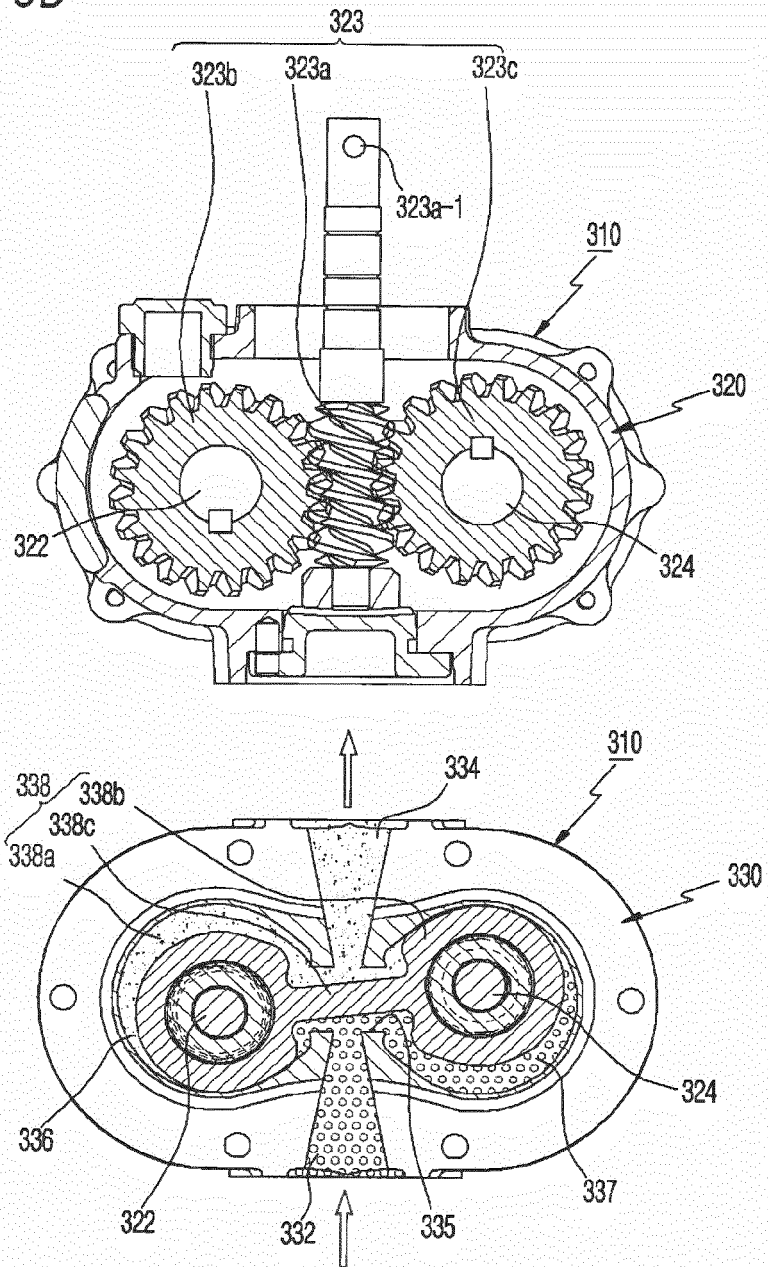


FIG. 10D



REFERENCES CITED IN THE DESCRIPTION

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