

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
10 November 2005 (10.11.2005)

PCT

(10) International Publication Number
WO 2005/106247 A2

(51) International Patent Classification⁷: **F04B 17/00**,
35/00

(21) International Application Number:
PCT/US2005/014063

(22) International Filing Date: 21 April 2005 (21.04.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/564,656 21 April 2004 (21.04.2004) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

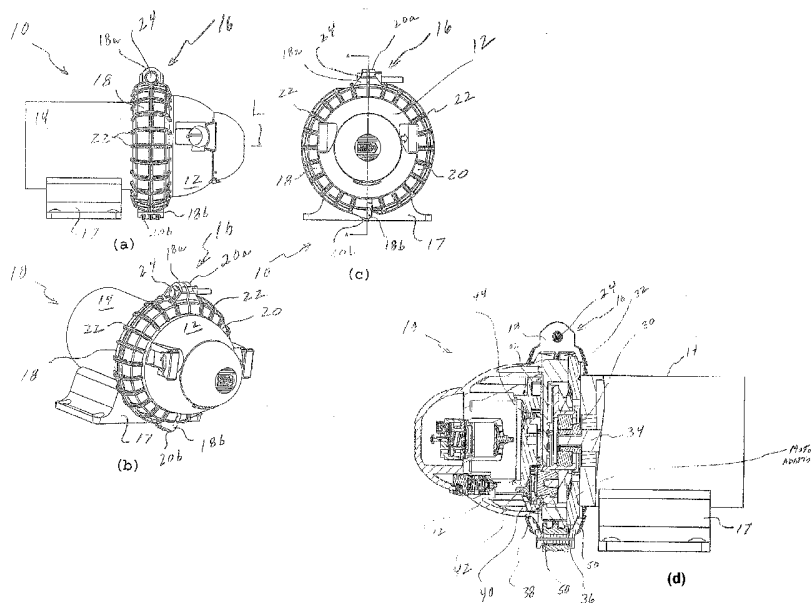
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: FIVE PISTON DIAPHRAGM PUMP



(57) Abstract: A pump having top and bottom pieces coupled together by a coupling device features a circumferential clamp that is a lightweight plastic clamp having clamping members, each with one or more strengthening members oriented along a longitudinal axis defined in relation to the top and bottom pieces. The clamping members may include two semi-circular clamping members, each with circumferentially spaced strengthening rib members oriented along the longitudinal axis of the pump housing.

FIVE PISTON DIAPHRAGM PUMP

BACKGROUND OF THE INVENTION

CROSS-REFERENCE TO RELATED APPLICATIONS

5 This application claims benefit to provisional patent application serial no. 60/564,656, filed April 21, 2004, entitled "Five Piston Diaphragm Pump," which is hereby incorporated by reference in its entirety.

10 1. Field of Invention

The present invention related to a pump; and more particularly to a pump having top and bottom pieces coupled together by a circumferential clamp.

15 2. Description of Related Art

Pumps, including diaphragm pumps, are known in the art, and typically operate by using a cam to convert rotational motion from a motor into pseudo-linear motion. The pseudo-linear motion is used to drive pistons, which first create
20 suction in their individual chambers to bring in the medium, then compress the medium until sufficient pressure is created to discharge the medium. The pumps have a series of check valves allowing the medium to only flow in a specific direction through the pump. In order to prevent internal or
25 external leakage, the seals between the piston chambers and the seals to the outside environment must remain sufficiently compressed.

The main shortcoming of the known pumps is that they use screws to retain the compression on the pump head. The use of screws provides only a localized point of force, and can only be in a limited number of locations around the pump head.

5 This allows regions of the components to flex more than others, creating potential internal and external leak paths.

Another shortcoming of the known pumps is the limited flow and pressure provided by the other five piston pumps.

Because of these shortcomings, the maximum open flow of
10 the known pumps is typically about 5.5 gallons per minute with a maximum pressure of about 65 PSI.

SUMMARY OF THE INVENTION

In its broadest sense, the present invention provides a
15 pump having top and bottom pieces coupled together by a coupling device, wherein the coupling device features a circumferential clamp made from a lightweight plastic or other suitable material having two clamping members coupled together so as to provide a substantially uniform circumferential
20 compression along a longitudinal axis of the pump defined in relation to the top and bottom pieces for clamping the top and bottom pieces together.

Each clamping member may have a V-shaped interior surface for contacting corresponding a corresponding V-shaped mating
25 surface formed by the top and bottom pieces. Each clamping member may also have one or more strengthening members oriented along a longitudinal axis defined in relation to the

top and bottom pieces.

The clamping members may include two semi-circular clamping members, each with circumferentially spaced strengthening rib members oriented along the longitudinal of the pump housing.

The lightweight plastic or other suitable material may include, by way of example, the following: 30% glass filled Polypropylene, 40% glass filled Polypropylene, Nylon, 30% glass filled Nylon, 40% glass filled Nylon.

In one embodiment, the circumferential clamp according to the present invention is used in a diaphragm pump, which is operated by using a cam to convert rotational motion from a motor into pseudo-linear motion that is used to drive one or more pistons. The two semi-circular clamping members may be coupled by a hook and pin mechanism on one side and on the other side by a nut and bolt mechanism. The two semi-circular clamping members provide uniform circumferential compression for clamping the top and bottom pieces together. The top and bottom pieces include an upper housing and a motor adapter of a pump head of the pump, and the upper housing and the motor adapter have corresponding circumferential angled surfaces for mating and coupling together.

One advantage of the present invention is that it removes the requirement of screws in a pump head assembly by using a series of semicircular clamps to provide uniform compression around the entire diameter of the pump head. The clamps are joined one end by a hook and pin mechanism and at the other

end by a nut and bolt. The clamps are assembled around the pump head components and then the bolt is tightened to bring the two halves of the clamp together, which simultaneously brings the pump head components together.

5 According to the present invention, the maximum open flow capacity of the pump is greater than 7.0 gallons per minute, while the maximum running pressure of the pump is greater than 80 PSI.

10 The present invention has applications in many different types of pumps in many different types of equipment, including RV's, boats, agricultural sprayers, water carbonation machines, busses, road roller machines, street sweeper machines, drink vending machines, etc.

BRIEF DESCRIPTION OF THE DRAWING

The drawing includes the following Figures, which are not necessarily drawn to scale:

Figure 1 includes Figures 1(a) to 1(d), wherein Figure 1(a) is a perspective view of a five piston diaphragm pump that is the subject of the invention; Figure 1(b) is a side view of the pump shown in Figure 1(a); Figure 1(c) is a front view of the pump shown in Figure 1(a); and Figure 1(d) is a cross-sectional view along section lines A-A of the pump shown in Figure 1(c).

Figure 2 includes Figures 2(a) to 2(e), wherein Figure 2(a) is a view of one clamp for the pump shown in Figure 1(a); Figure 2(b) is a cross-sectional view along section lines A-A of the clamp shown in Figure 2(a); Figure 2(c) is a side view of the clamp shown in Figure 2(a); Figure 2(d) is a cross-sectional view along section lines X-X of the clamp shown in Figure 2(c); and Figure 2(e) is a back view of the clamp for the pump shown in Figure 2(a).

Figure 3 includes Figures 3(a) to 3(d), wherein Figure 3(a) is a view of the other clamp for the pump shown in Figure 1(a); Figure 3(b) is a cross-sectional view along section lines A-A of the clamp shown in Figure 3(a); Figure 3(c) is a side view of the clamp shown in Figure 3(a); and Figure 3(d) is a cross-sectional view along section lines B-B of the clamp shown in Figure 3(c).

Figure 4 includes Figures 4(a) and 4(b), wherein Figure 4(a) is a view of an upper housing sub-assembly of the pump

shown in Figure 1(a); and Figure 4(b) is a cross-sectional view along section lines A-A of the upper housing sub-assembly shown in Figure 4(a).

Figure 5 includes Figures 5(a) and 5(b), wherein Figure 5(a) is a view of a valve chamber sub-assembly of the pump shown in Figure 1(a); and Figure 5(b) is a cross-sectional view along section lines A-A of the valve chamber sub-assembly shown in Figure 5(a).

Figure 6 includes Figures 6(a) and 6(b), wherein Figure 6(a) is a view of a lower housing sub-assembly of the pump shown in Figure 1(a); and Figure 6(b) is a cross-sectional view along section lines A-A of the lower housing sub-assembly shown in Figure 6(a).

BEST MODE OF THE INVENTION

Figure 1: The Pump

Figure 1 shows a pump generally indicated as 10 according to the present invention, having top and bottom pieces 12 and 14 coupled together by a coupling device generally indicated as 16 and resting on a mounting device 17. The pump 10 is shown, by way of example, as a five piston diaphragm pump, although the scope of the invention is not intended to be limited to any particular type or kind of pump 10. The coupling device 16 features a circumferential clamp 16 made from a lightweight plastic or other suitable material and including clamping members 18, 20, each having one or more strengthening members 22 oriented along a longitudinal axis

generally indicated as "L" defined in relation to the top and bottom pieces 12 and 14. The circumferential clamp provides a substantially uniform circumferential compression along the longitudinal axis L of the pump 10. As shown, the top piece
5 12 includes an upper housing of the five piston diaphragm pump, while the bottom piece includes a motor 14.

The lightweight plastic or other suitable material may include, by way of example, the following: 30% glass filled Polypropylene, 40% glass filled Polypropylene, Nylon, 30%
10 glass filled Nylon, 40% glass filled Nylon, well as other lightweight plastic or other suitable materials now known or later developed in the future. The scope of the invention is not intended to be limited to any particular type or kind of lightweight plastic or material used to make the clamp 16.

15

The Basic Operation

In operation, the five piston pump 10 uses the motor 14 to provide rotational motion. The pump 10 uses a cam 30 attached to a piston plate 32 to convert the rotational motion
20 into a nearly linear motion parallel to the axis of a motor shaft 34. A pump piston 36 and diaphragm 38 are integrated into a single piece, which is attached to the piston plate 32 and nearly linear motion of the piston plate 32 is transferred directly to the diaphragm piston 36. The diaphragm piston 36
25 is enclosed in a piston chamber 40 that contains inlet and outlet openings (not labelled), which are controlled and sealed by check valves 42, 44. When the pump piston 36 is

pulled down it creates a vacuum in the piston chamber 40, which pulls open the suction valve 42 and brings the medium into the piston chamber 40. When the pump piston 36 is pushed up, it compresses the medium and builds pressure until the
5 discharge valve 44 opens and the medium is pushed out to the discharge chamber and out of the pump.

In order to maximize the life of the diaphragm 38 and minimize the diameter of the pump head, the diaphragm convolution design contains a variable cross section around
10 the circumference of the pump piston 36. The diaphragm 38 and diaphragm piston 36 are manufactured in a single piece using two different shore hardnesses of a single material. The inner piston is molded using a harder shore Santoprene, and then insert molded into the diaphragm 38.

15 In order to minimize the amount of dead space in the piston chamber and therefore maximize the suction created on the down stroke, the top surface of the diaphragm piston 36 is shaped to match the inside surface of the piston chamber 40.

The clamp design 16 is integrated into the pump head by
20 incorporating specific features into the top piece 12 (upper housing) and bottom piece 14 (motor adapter) of the pump head. The upper housing 12 and motor adapter 14 have angled surfaces 50 identical to the angled inner surface of the clamp 16. When the clamp 16 is initially assembled to the pump head, it
25 contacts the outer edge of the upper housing 12 and motor adapter's angled surfaces 50, as shown. As the two halves 18, 20 of the clamp 16 are brought together by tightening the bolt

24, the clamp 16 moves up along the angled circumferential surfaces 50 which also brings the two pieces 12, 14 closer together providing the compression required for the pump 10 to operate properly.

5

Figure 2: One Clamp

Figure 2 shows, by way of example, one clamp 18 having the one or more strengthening ribs 22, one of which is labeled. The clamp 18 includes an upper coupling portion 18a and a lower coupling portion 18b. As shown, the upper
10 coupling portion 18a includes an opening 19 for receiving a bolt 24 (Figure 1). The lower coupling portion 18b includes left and right supports 18b' and 18b'' and a rod 18c extending across the same, as best shown in Figure 2(e). The clamp 18
15 also includes an interior and exterior strengthening ridges 18d (Figure 18(d)) and 18e. The clamp 18 also has interior angled surfaces 18f, 18g that correspond to the angled surfaces 50 in Figure 1(d) for tightly coupling the clamps 18, 20 to the mid-section of the pump 10.

20

Figure 3: The Second Clamp

Figure 3 shows, by way of example, the other clamp 20 having the one or more strengthening ribs 22, one of which is labeled. The clamp 20 includes an upper coupling portion 20a and a lower coupling portion 20b. As shown, the upper
25 coupling portion 20a includes an opening 21 for receiving a bolt 24 (Figure 1). The lower coupling portion 20b includes

one or more hooking members 20b', 20b'' and 20b''', as best shown in Figure 2(e). The clamp 20 also includes an interior and exterior strengthening ridges 20d (Figure 20(d)) and 20e. The clamp 20 also has interior angled surfaces 20f, 20g that
5 correspond to the angled surfaces 50 in Figure 1(d) for tightly coupling the clamps 18, 20 to the mid-section of the pump 10 and providing the substantially uniform circumferential compression between the top and bottom pieces 12 and 14. The scope of the invention is not intended to be
10 limited to any particular angle for the surfaces 18f, 18g, 20f, 20g and 50. Embodiments are envisioned using surfaces having many different angles within the scope and spirit of the invention.

In operation, the clamps 18 and 20 are arranged in
15 relation to the upper and lower pieces 12 and 14 in Figure 1, the one or more strengthening ribs 20b', 20b'' and 20b''' are coupled to the rod 18c in Figure 2(e) so as to form a hook and pin arrangement, the clamp is closed about the midsection of the pump 10, and the bolt 24 is passed (or threaded) through
20 openings 19 and 21 of the upper coupling portions 18a and 20a and fastened thereto, fastened by a nut (not shown), or some combination thereof, so as to form a bolting mechanism.

The coupling arrangement of clamps 18 and 20 in Figures 1-3 is shown by way of example for the purpose of describing
25 the invention herein. However, other embodiments are envisioned within the spirit of the invention for coupling the two clamps 18 and 20 together. For example, the scope of the

invention is not intended to be limited to only the bolting arrangement for coupling the respective upper portions 18a, 20a or the hook and pin arrangement for coupling the lower portions 18b, 20b shown and described herein, since

5 embodiments are envisioned using other coupling hardware either know known or later developed in the future for coupling the two clamps 18 and 20 together, including, but not limited to, a hinge in place of the respective lower coupling portions 18b, 20b, and/or a latching arrangement in place of

10 the bolting arrangement.

Moreover, the scope of the invention is not intended to be limited to the type, kind or number of strengthening ribs, or their displacement on the clamps 18 and 20. By way of example, the strengthening ribs 22 are shown evenly spaced

15 around the clamp 16.

Figure 4: The Upper Housing Sub-Assembly

Figure 4 shows the upper housing assembly generally indicated as 60, including an upper housing 62, a backflow

20 valve 64, a discharge insert 66, an O-ring 68, a switch diaphragm 70, a pressure switch 72, a bypass poppet 74, a bypass housing 76, one or more O-rings 78, a bypass spring 80 and screws 82. These elements of the pump 10 form part of the five piston diaphragm pump 10 shown in Figure 1, are shown by

25 way of example, and do not form parts of the overall invention.

Figure 5: The Valve Chamber Sub-Assembly

Figure 5 shows the valve chamber sub-assembly generally indicated as 90, including a valve chamber 92 and one or more check valves indicated as 94. These elements of the pump 10 form part of the five piston diaphragm pump 10 shown in Figure 1, are shown by way of example, and do not form parts of the overall invention.

Figure 6: The Lower Housing Sub-Assembly

Figure 6 shows the lower housing sub-assembly generally indicated as 100, including a lower housing 102, a diaphragm 104, an outer piston plate 106 and a cam 108. These elements of the pump 10 form part of the five piston diaphragm pump 10 shown in Figure 1, are shown by way of example, and do not form parts of the overall invention.

Possible Applications

Possible applications of the invention include: RV's, boats, agricultural sprayers, water carbonation machines, busses, road roller machines, street sweeper machines, drink vending machines. The scope of the invention is not intended to be limited to any particular type or kind of application.

Scope of the Invention

Accordingly, the invention comprises the features of construction, combination of elements, and arrangement of parts which will be exemplified in the construction

hereinafter set forth.

It will thus be seen that the objects set forth above,
and those made apparent from the preceding description, are
efficiently attained and, since certain changes may be made in
5 the above construction without departing from the scope of the
invention, it is intended that all matter contained in the
above description or shown in the accompanying drawing shall
be interpreted as illustrative and not in a limiting sense.

WHAT I CLAIM IS:

1. A pump having top and bottom pieces coupled together by a coupling device, characterized in that

the coupling device includes a circumferential clamp made
5 from a lightweight plastic or other suitable material having two clamping members for coupling together so as to provide a substantially uniform circumferential compression along a longitudinal axis of the pump defined in relation to the top and bottom pieces for clamping the same together.

10

2. A diaphragm pump according to claim 1, wherein each clamping member has circumferentially spaced strengthening rib members oriented along the longitudinal axis.

15

3. A diaphragm pump according to claim 1, wherein the two clamping members are semi-circular and joined together on one side by a hook and pin mechanism and on the other side by a bolting mechanism, including a fastening bolt used alone or in combination with a fastening nut.

20

4. A diaphragm pump according to claim 1, wherein the circumferential clamp is made from a lightweight plastic or other suitable material, including 30% glass filled Polypropylene, 40% glass filled Polypropylene, Nylon, 30%
25 glass filled Nylon, 40% glass filled Nylon.

5. A diaphragm pump according to claim 1, wherein the

clamping members have inner surfaces with V-shaped or other suitably shaped grooves for mating with corresponding V-shaped or other suitably shaped surfaces of the top and bottom pieces.

5

6. A diaphragm pump according to claim 1, wherein the top and bottom pieces include an upper housing and a motor adapter of a pump head of the pump.

10

7. A diaphragm pump according to claim 6, wherein the upper housing and the motor adapter have corresponding circumferential surfaces for mating and coupling together.

15

8. A diaphragm pump according to claim 1, wherein the diaphragm pump operates by using a cam to convert rotational motion from a motor into pseudo-linear motion that is used to drive one or more pistons for pumping a medium.

20

9. A pump having top and bottom pieces coupled together by a coupling device, characterized in that

25

the coupling device comprises a circumferential clamp made from a lightweight plastic material and having semi-circular clamping members, each having one or more strengthening members oriented along a longitudinal axis defined in relation to the top and bottom pieces.

10. A pump according to claim 9, wherein the each semi-

circular clamping member has a plurality of circumferentially spaced strengthening rib members oriented along the longitudinal axis.

5 11. A pump according to claim 9, wherein the semi-circular clamping members are joined together on one side by a hook and pin mechanism and on the other side by a bolting mechanism, including a fastening bolt used alone or in combination with a fastening nut.

10

12. A pump according to claim 9, wherein the circumferential clamp provides uniform circumferential compression along the longitudinal axis for clamping the top and bottom pieces together.

15

13. A pump according to claim 9, wherein the lightweight plastic material includes 30% glass filled Polypropylene, 40% glass filled Polypropylene, Nylon, 30% glass filled Nylon, 40% glass filled Nylon.

20

14. A pump according to claim 9, wherein the top and bottom pieces include an upper housing and a motor adapter of a pump head of the pump.

25 15. A pump according to claim 14, wherein the upper housing and the motor adapter have corresponding circumferential angled surfaces for mating and coupling

together, including V-shaped angled surfaces.

16. A pump according to claim 9, wherein the diaphragm
pump operates by using a cam to convert rotational motion from
5 a motor into pseudo-linear motion that is used to drive one or
more pistons for pumping a medium.

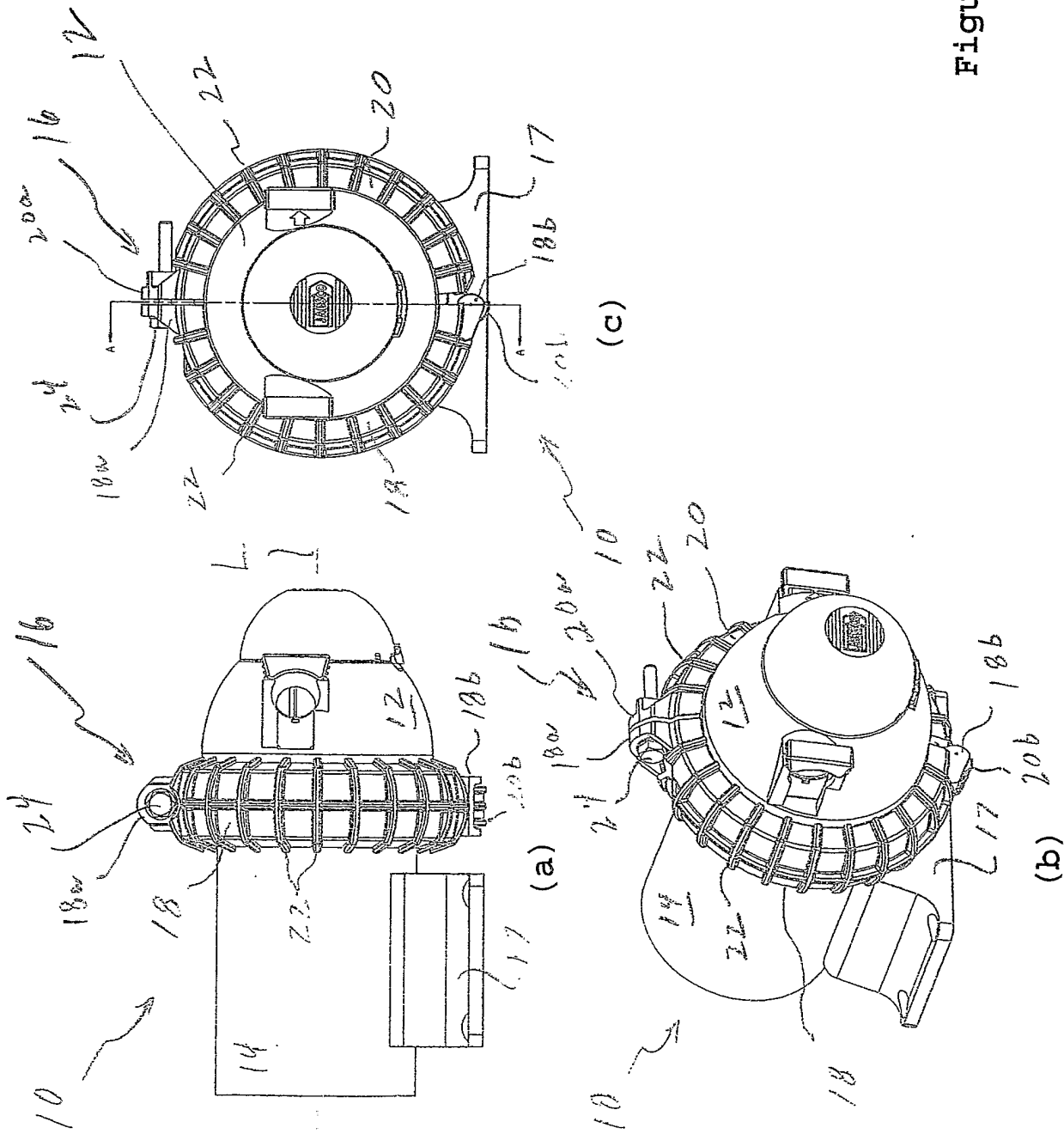
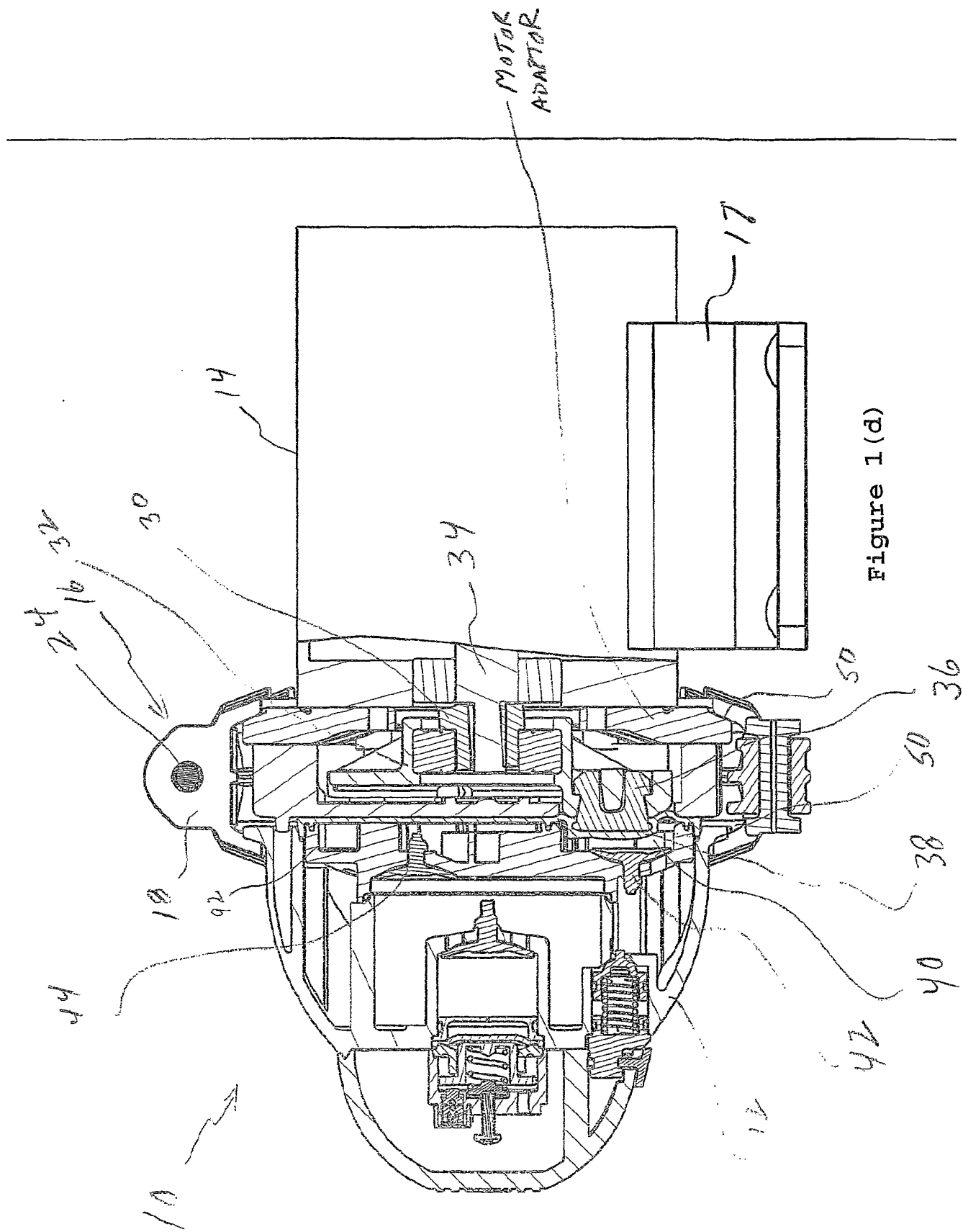


Figure 1: The Pump



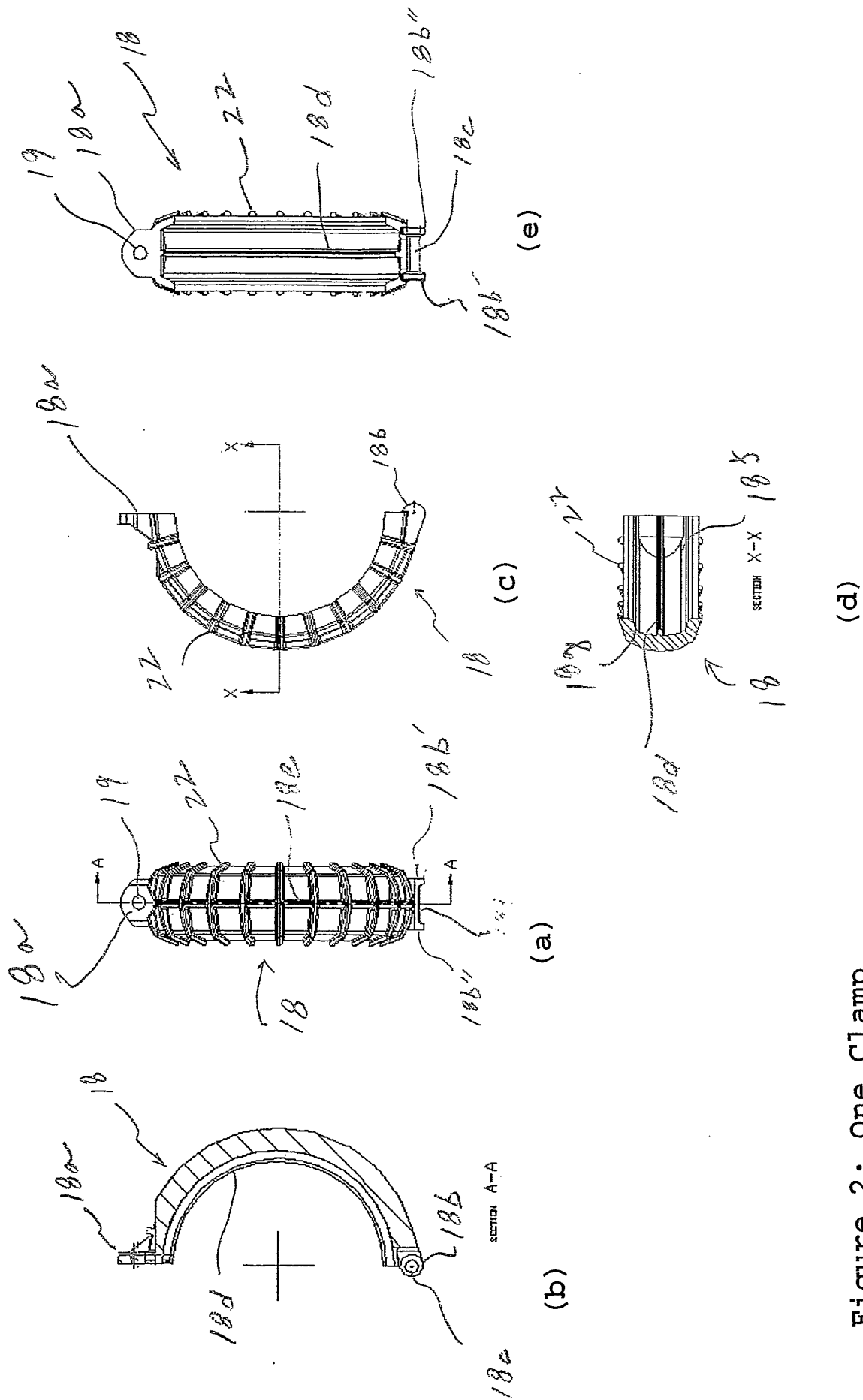
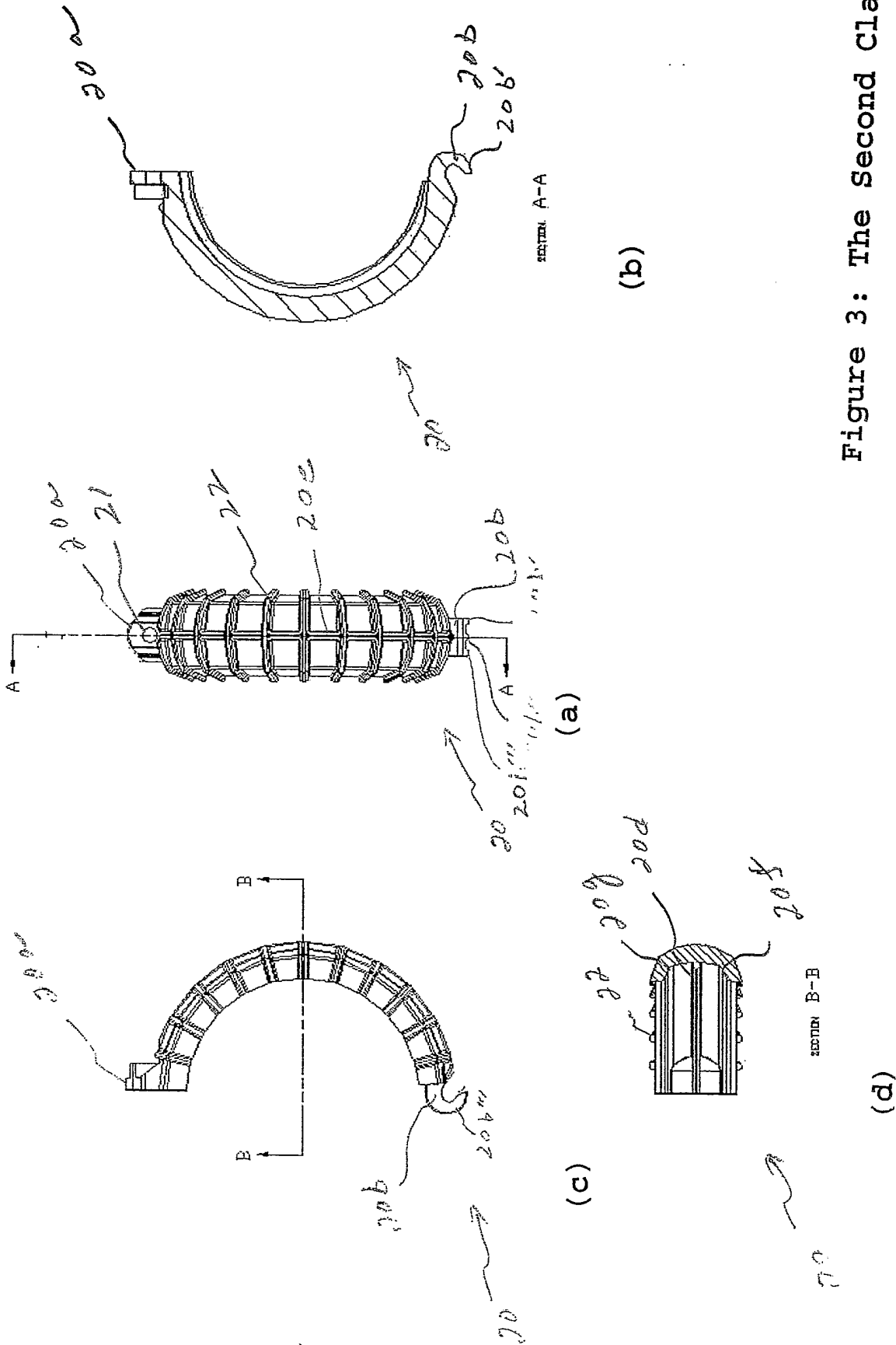


Figure 2: One Clamp



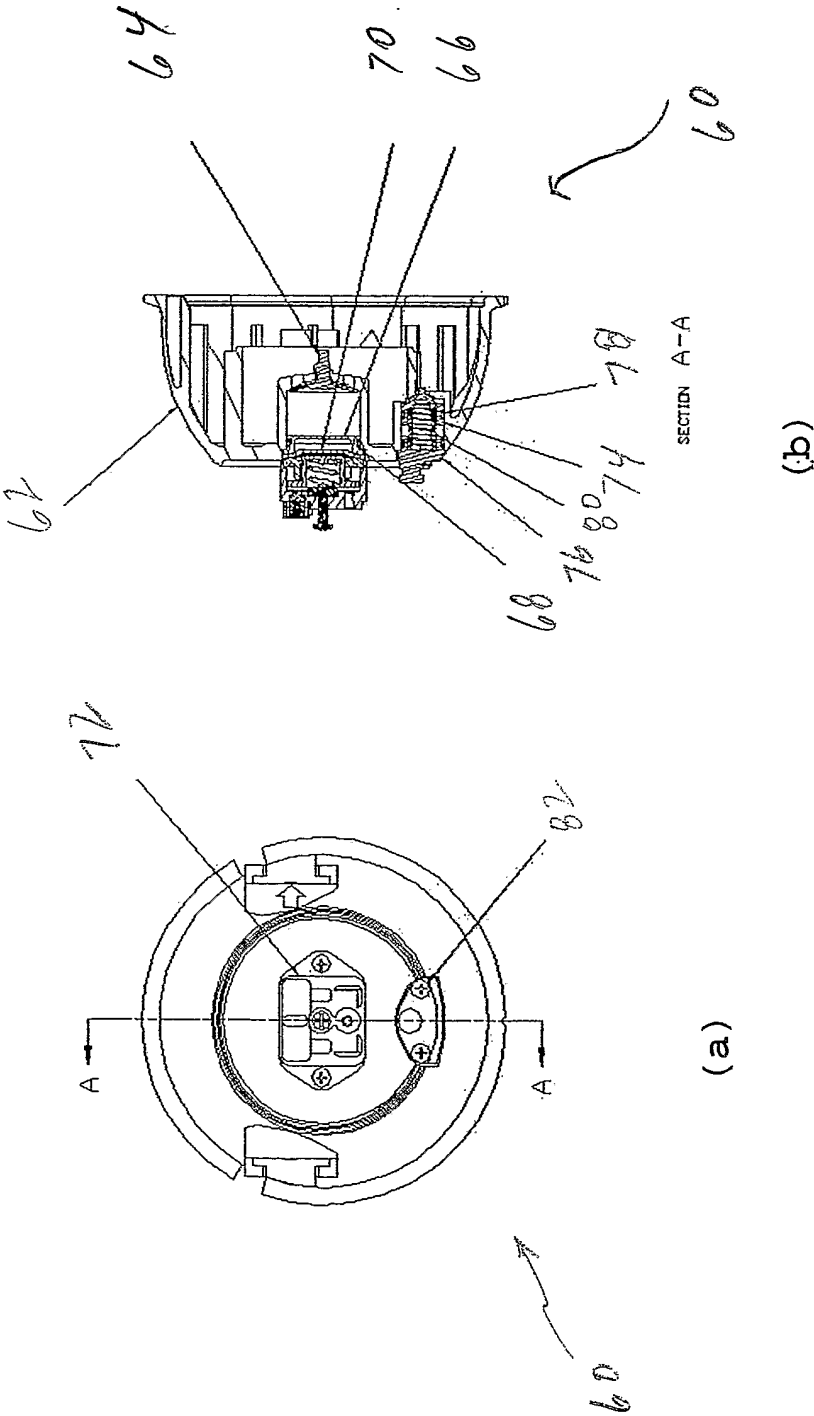


Figure 4: The Upper Housing Sub-Assembly

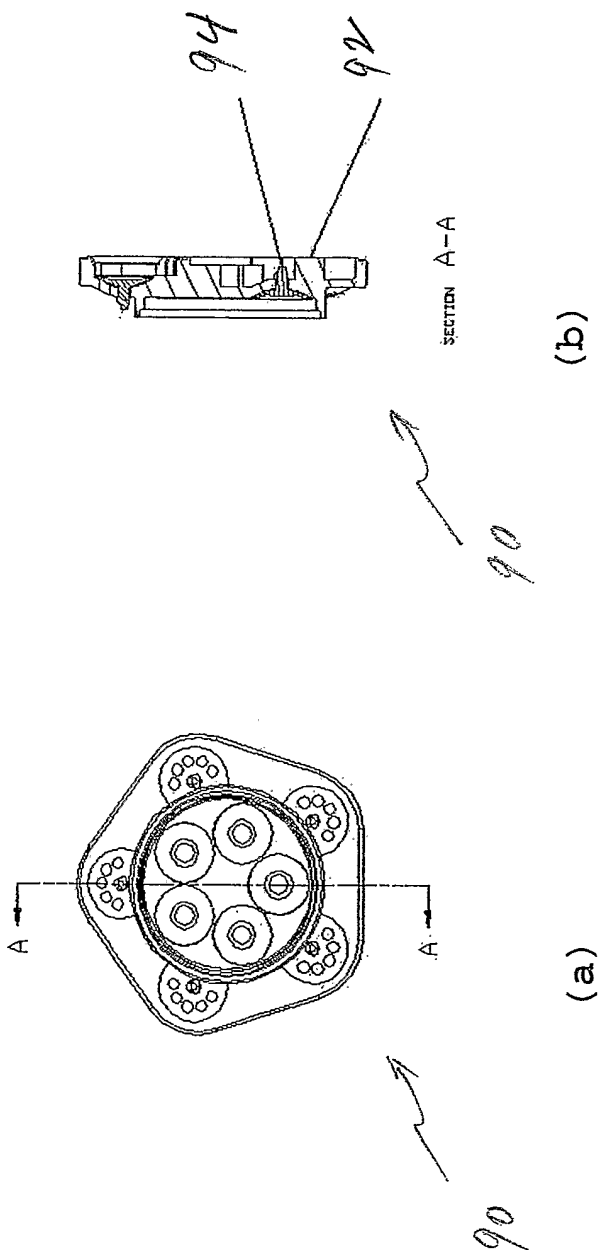


Figure 5: The Valve Chamber

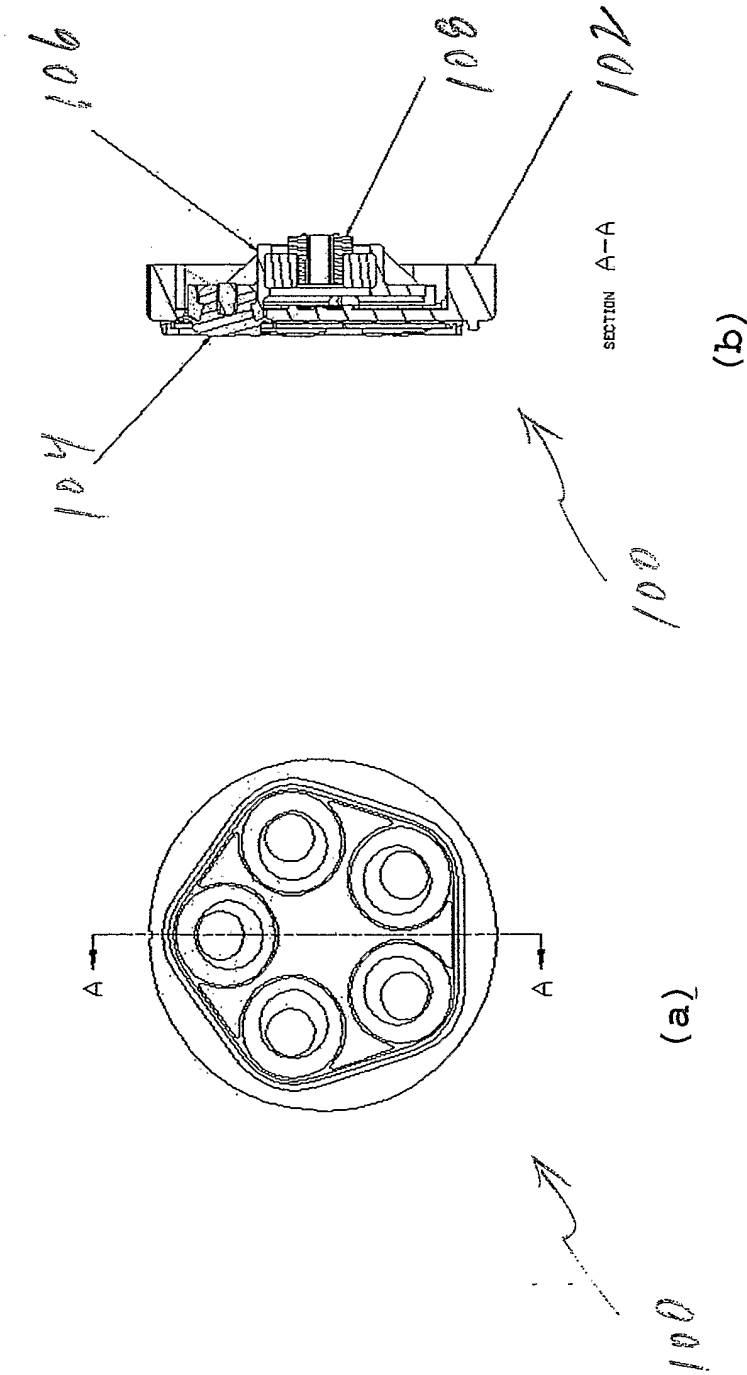


Figure 6: The Lower Housing Sub-Assembly