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(54) **PUMP ASSEMBLY**

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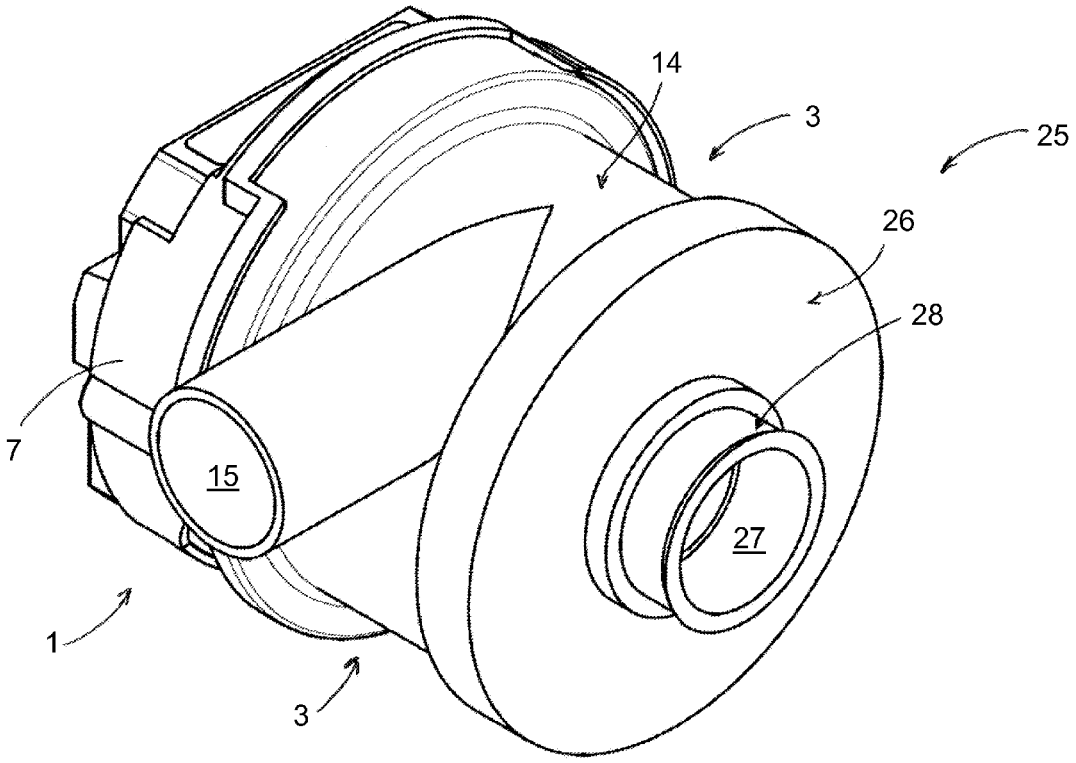
(57) **ABSTRACT**

A pump assembly having a drive module with a stator, a rotor held on a shaft so as to be rotatable relative to the stator, and a housing that circumferentially encloses a portion of the stator. An impeller is held on the shaft, and a hydraulic unit has an intake port through which liquid can be delivered to the impeller. An adapter is connected to the drive module on one side and to the hydraulic unit on the other side. A can body extends between the rotor and the stator of the drive module and encloses the rotor on an end face facing away from the impeller. A can flange adjoins the can body on a side facing the impeller and projects radially outward from the can body. A tubular section circumferentially encloses the impeller at least in part and delimits a pump chamber containing the impeller.



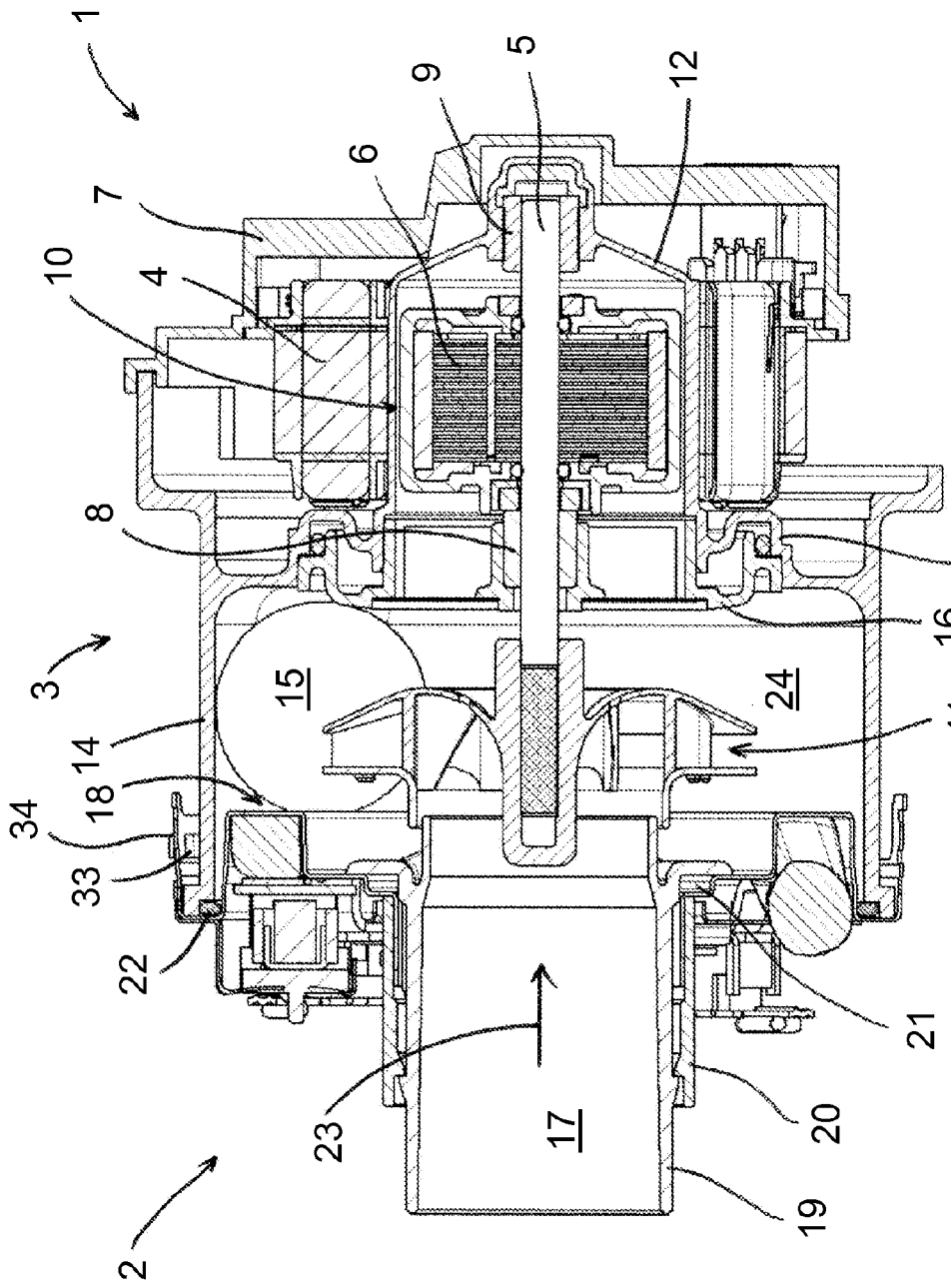


Fig. 1

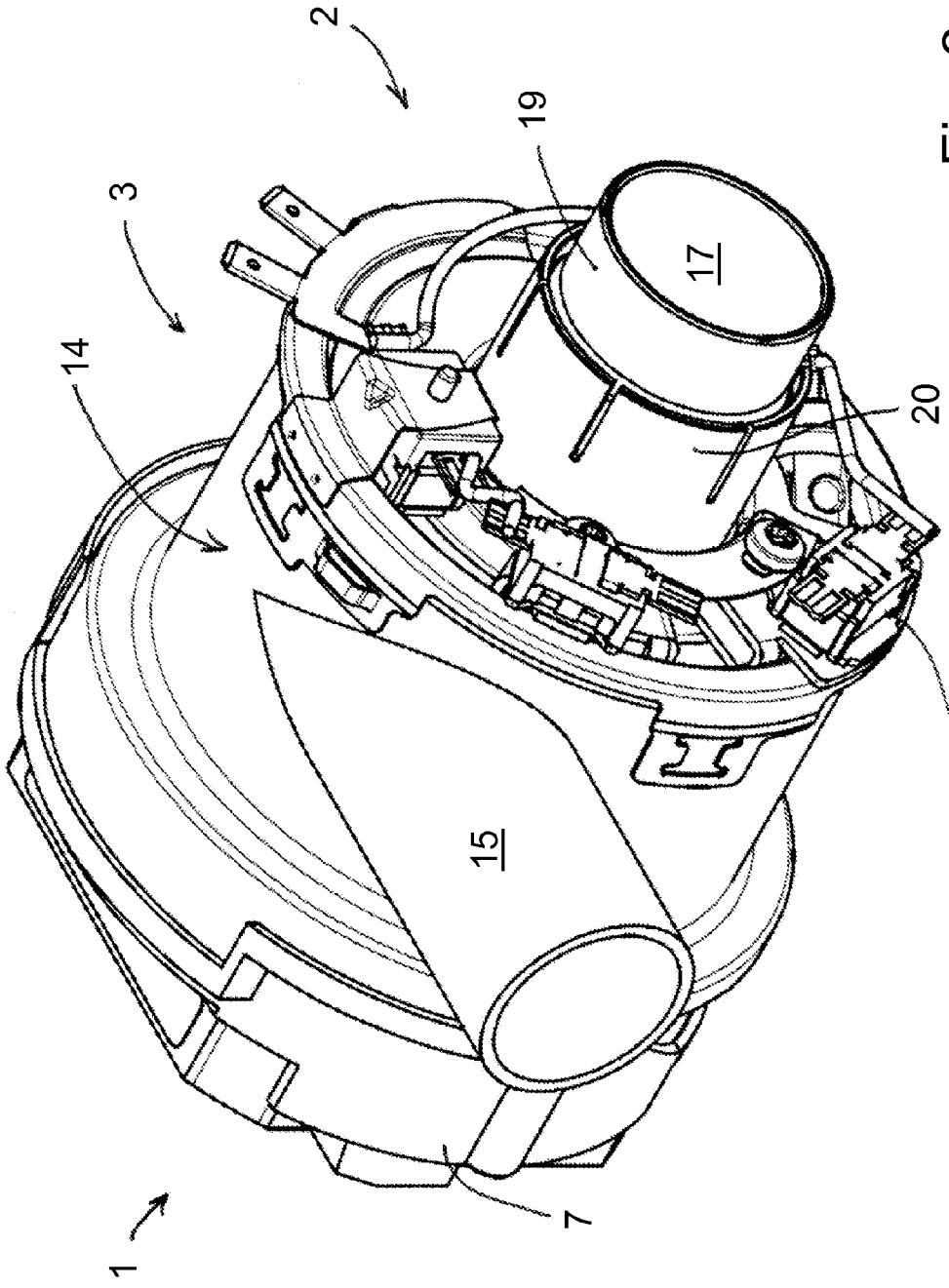


Fig. 2

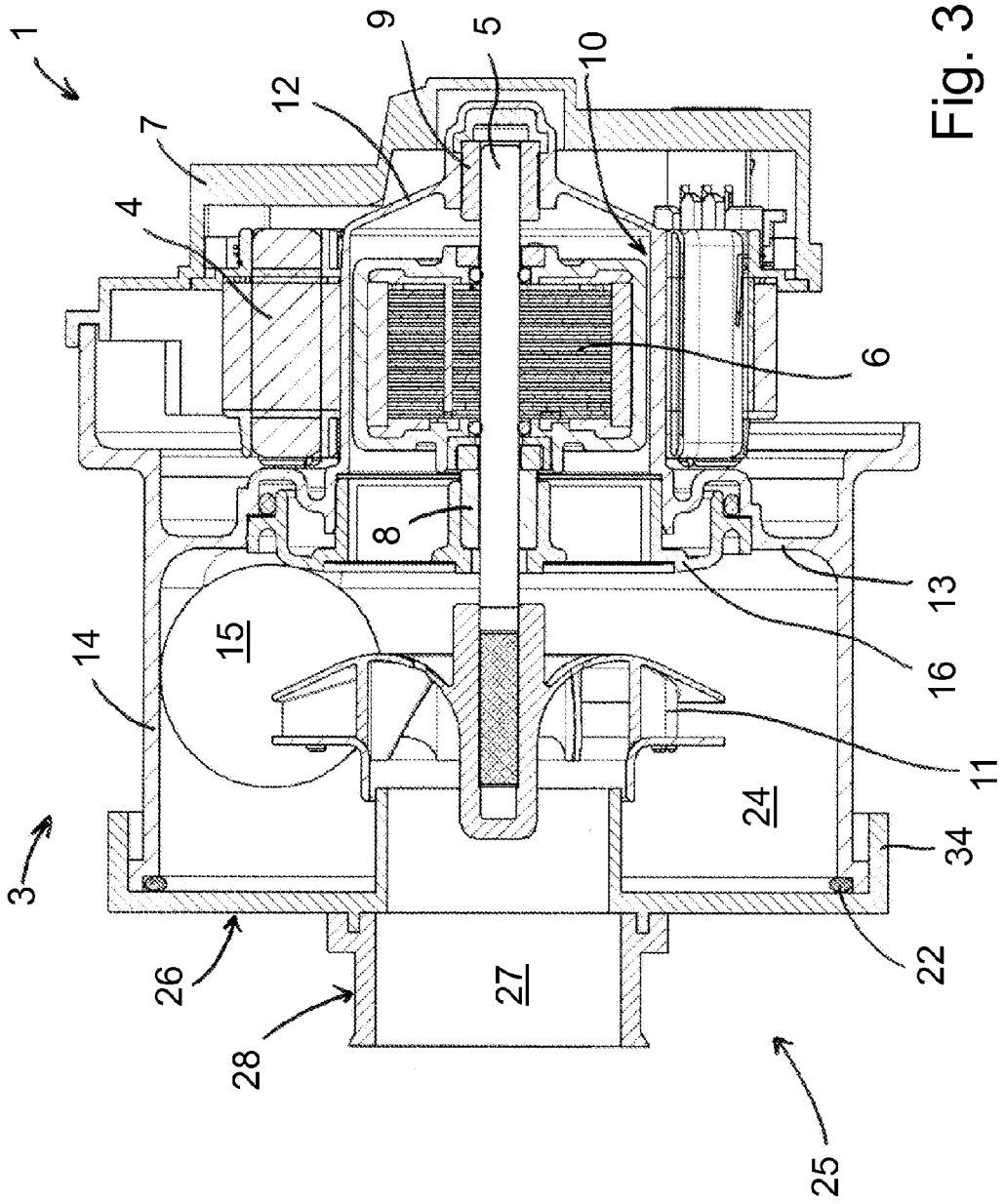


Fig. 3

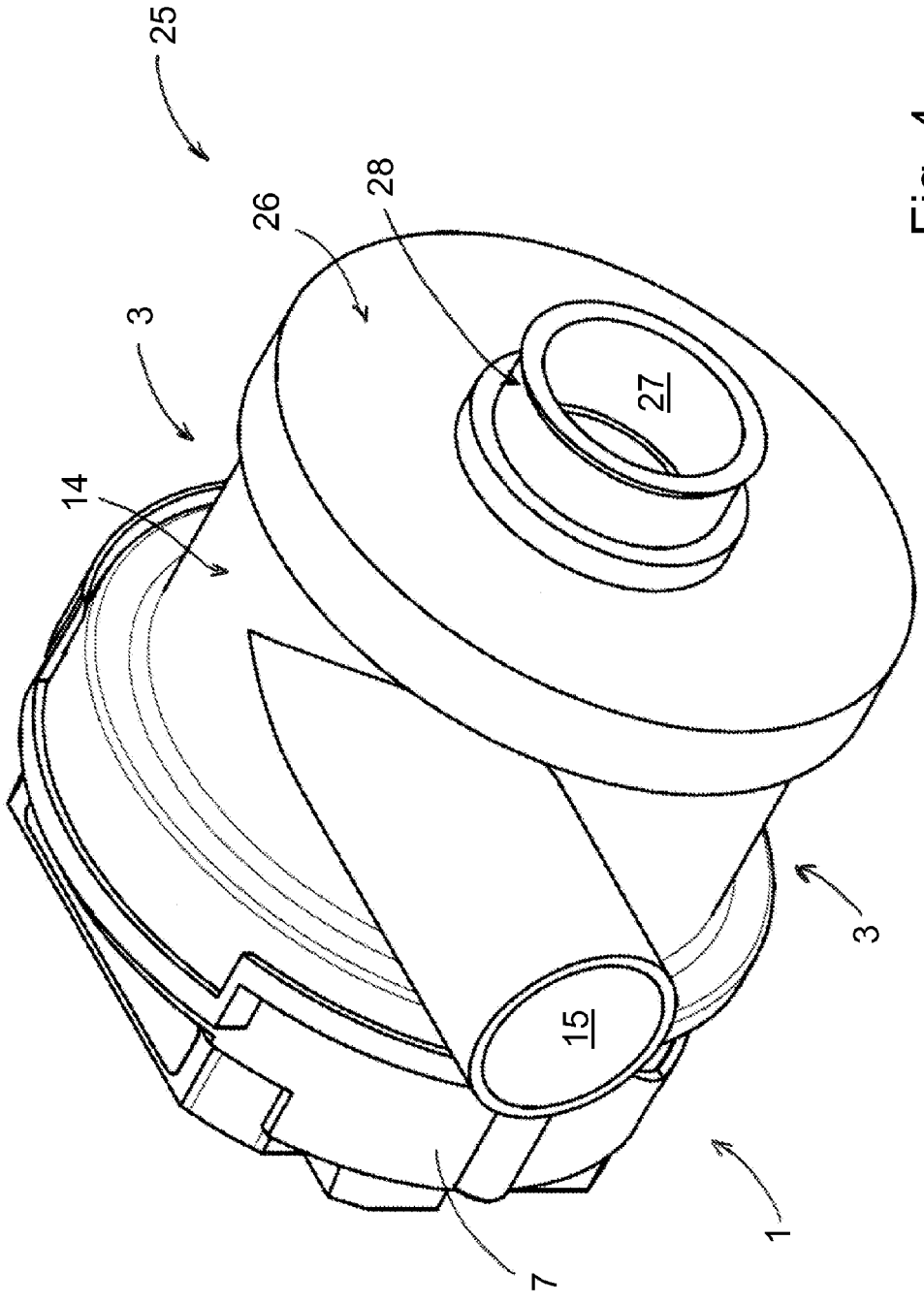


Fig. 4

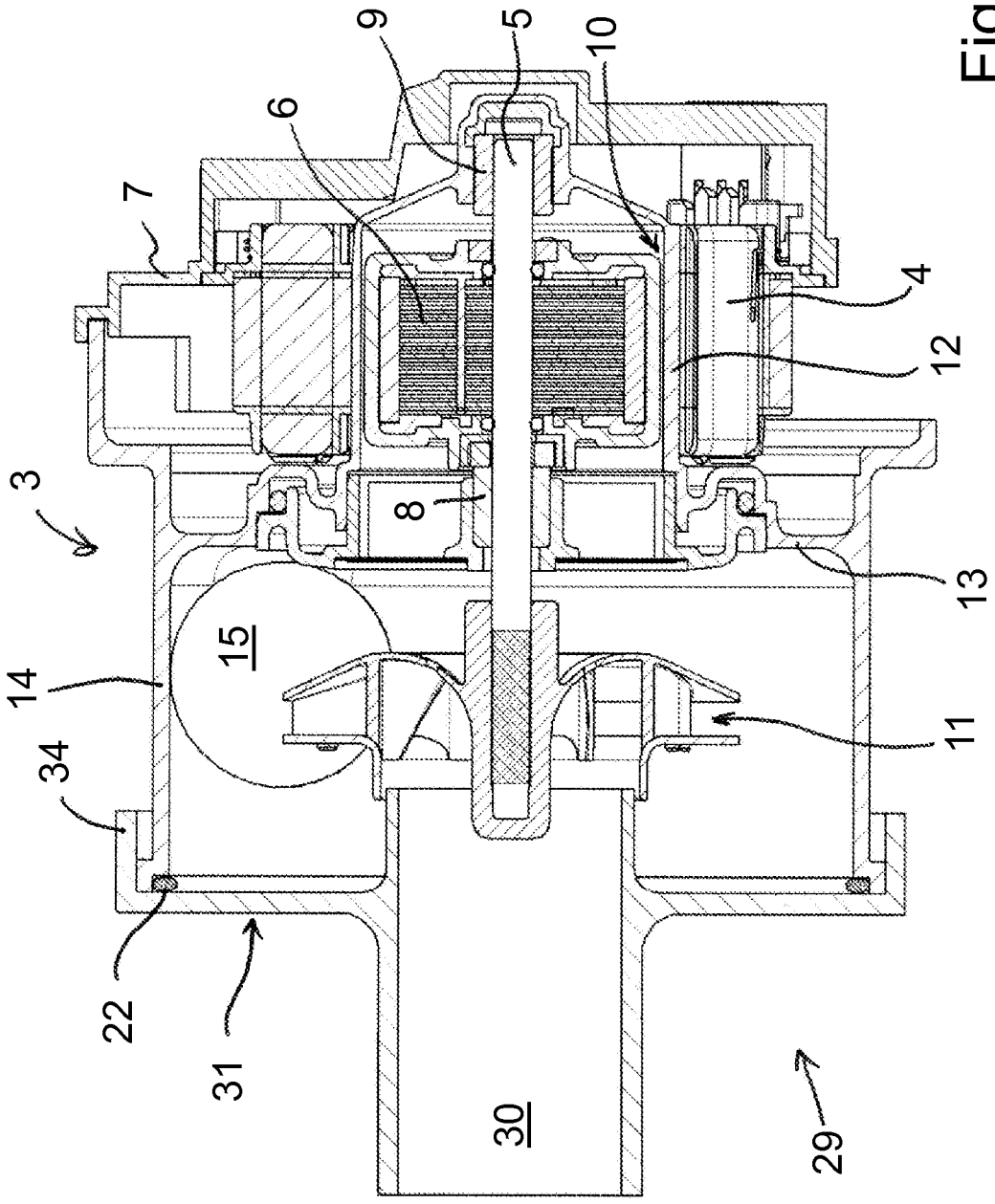


Fig. 5

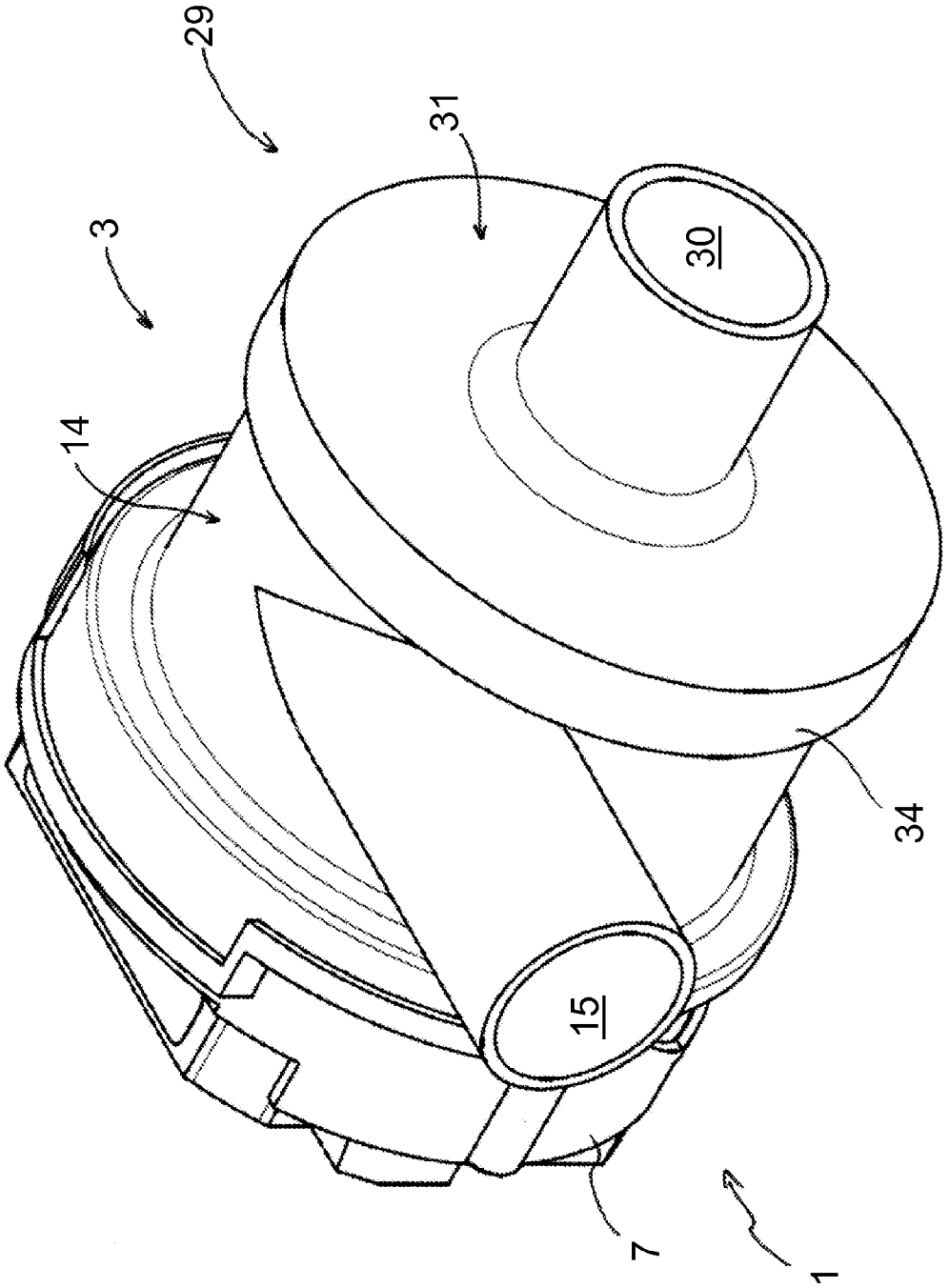


Fig. 6

PUMP ASSEMBLY

[0001] This nonprovisional application claims priority under 35 U.S.C. §119(a) to German Patent Application No. 10 2014 109 625.8, which was filed in Germany on Jul. 9, 2014, and which is herein incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a pump assembly, particularly for water-carrying cleaning appliances, comprising a drive module with a stator, with a rotor held on a shaft of the drive module so as to be rotatable relative to the stator, and with a housing that circumferentially encloses at least sections of the stator, comprising an impeller for pumping liquid that is held on the shaft and comprising a hydraulic unit with an intake port through which the liquid can be delivered to the impeller.

[0004] 2. Description of the Background Art

[0005] In water-carrying cleaning appliances such as dishwashers and washing machines, pump assemblies are provided in order to circulate water to which detergent has been added. The cleaning effect is based on the circumstance that the material to be cleaned, such as laundry or dishes, is wetted with the water and the detergent therein, and is cleansed by the action of the detergent. In addition, dirt and impurities can be mechanically removed by the pressurized liquid formed of water and detergent. Furthermore, the liquid is heated to improve the cleaning effect. Heaters, which usually are electrically operated, are provided in the cleaning appliances for this purpose.

[0006] It is known in this context to implement the circulation pump independently of the heater and to provide it separately in the cleaning appliance. It is likewise known to integrate the heater and the pump assembly. The heater in this case is provided in a pump housing and accordingly is a component of a flow-forming, hydraulic part of the pump. An impeller driven by an electric motor establishes the hydraulic pressure necessary for pumping the liquid. The liquid flows past a surface that works together with the heater, and is heated. Comparatively good heat transfer is achieved in this design, particularly by reason of relatively high turbulence in the liquid. In view of this, when the heater is integrated into the pump assembly, the heater can be small in size and the heat-transmitting surface can be compact. In addition, good energy values are achieved for the heater integrated into the pump assembly.

[0007] At the same time, due to increasing demands for energy efficiency of cleaning appliances, modern pump assemblies are driven by synchronous motors. The asynchronous motors that previously were employed only inadequately fulfill the energy requirements due to their sometimes limited efficiency. An additional advantage of synchronous motors is that a magnetic air gap between a stator of the synchronous motor and a rotor that is mounted on a shaft so as to be rotatable with respect thereto can be made comparatively large. Consequently, it is possible to provide a can between the stator and the rotor. The rotor is located in a can body, and is surrounded by the liquid. It is advantageous here that there is no longer any need for a dynamic seal between the drive module on the one side and the hydraulic unit on the other side. The hydraulic unit can be prefabricated as a subassembly and installed as a whole or connected to the drive module.

[0008] Known from DE 10 2004 011 365 A1, which corresponds to U.S. Pat. No. 7,293,958, is a hydraulic unit for a pump assembly in which the heater is provided at one end of an essentially cylindrical pump chamber adjacent to an intake port through which the liquid enters the pump chamber and is delivered to the impeller. The walls of the pump chamber are made of a thermoplastic material as part of the hydraulic unit. The heater has a stainless steel sheet formed into a saucer shape in which is embedded an electrically operated heating element. The walls of the hydraulic unit additionally include a spiral baffle for the liquid. The spiral baffle is shaped such that a flow cross-section increases toward a discharge port of the hydraulic unit provided for discharging the liquid. In this regard, the pump housing and the heater constitute a fluidic unit that is functionally and spatially integrated to a great degree.

[0009] Known from EP 2 384 685 A1, which corresponds to U.S. Pat. No. 8,245,718, is a pump assembly with an integrated heater, in which the heater is essentially cylindrical or tubular in design and circumferentially surrounds the impeller provided in the pump chamber. A synchronous motor is provided to operate the impeller. A can is provided between the stator and the rotor of the synchronous motor for hermetic separation. The heater that circumferentially surrounds the impeller is connected to a can flange in a sealed manner. The pump chamber is closed at the end face by a pump cover made of a thermoplastic material. The intake port and the discharge port of the hydraulic unit are integral components of the cover in this design. As a result of the orientation of the ports, however, a redirection of the liquid by 180° is required, with the consequence that the hydraulic efficiency of the pump assembly is relatively low.

SUMMARY OF THE INVENTION

[0010] It is therefore an object of the present invention to provide a pump assembly such that a heater can be integrated into the pump assembly in a simple, flexible, and needs-based manner, and at the same time such that high fluidic quality and good efficiency are achieved for the pump assembly.

[0011] In an embodiment, between a drive module and a hydraulic unit, an adapter, which is connected to the drive module on one side and to the hydraulic unit on the other side, which has a can body that can extend between the rotor and the stator of the drive module and encloses the rotor on an end face facing away from the impeller, which has a can flange adjoining the can body on a side facing the impeller, wherein the can flange projects radially outward from the can body at least in sections, which has a tubular section that circumferentially encloses the impeller at least in part and that delimits a pump chamber containing the impeller, and which has a discharge port formed on the tubular section for discharging the liquid from the pump chamber.

[0012] An advantage of the invention is that the provision of the adapter between the hydraulic unit and the drive module separates the fluidic unit previously implemented in accordance with the prior art. In particular, the intake port can be implemented as part of the hydraulic unit, while the discharge port can be formed on the adapter. At the same time, the division results in a spatial separation that benefits the flexible integration of the heater in the pump assembly. In particular, a variety of options for integrating the heater are created, so that a suitable heating concept can be chosen in

accordance with needs, and the heater can be designed with the appropriate output and can be placed in an application-specific position.

[0013] According to an embodiment of the invention, the pump assembly is modular in design. In this regard, provision is made that a choice of a first hydraulic unit or at least one additional hydraulic unit of the pump assembly can be attached to the adapter. At least the first hydraulic unit or the at least one additional hydraulic unit has a heater for heating the liquid. The modular design of the pump assembly results in additional options for geometric and functional variations that benefit the integration of the same pump assembly in different water-carrying cleaning appliances. In this regard, providing a modular system for the pump assembly can foster the use of common parts, and the production rate can be increased with the manufacture of the common parts. As a result of the increase in the production rate, the cost-effectiveness of the pump assembly according to the invention is improved significantly as compared to current-day concepts. At the same time, the opportunity is afforded of responding flexibly to application-specific features or customer-specific desires and specifications simply by exchanging the hydraulic unit.

[0014] At least one, or two or more hydraulic units, have the heater for heating the liquid. The heater can be associated circumferentially with the intake port, for example, and heat the liquid as it flows into the pump chamber holding the impeller. For example, the heater can be provided between a housing component of the hydraulic unit facing the impeller at the end face and the adapter, and can enclose the impeller circumferentially. For specific applications, moreover, a hydraulic unit with no heater can be attached to the adapter. The pump assembly nevertheless then provides the same drive module and the same adapter. The adapter and the drive module define common parts of the modular pump assembly in this regard, whereas different hydraulic units are used and attached to the adapter for application-specific or customer-specific designs.

[0015] According to an embodiment of the invention, the intake port can be provided on the first hydraulic unit and on the at least one additional hydraulic unit coaxially to the shaft. The identical relative positioning of the intake port on the different hydraulic units advantageously results in a substantially identical or similar flow situation for the pump assembly as a whole, regardless of which hydraulic unit is attached to the adapter. In this regard, the pump assembly can be fluidically optimized with the knowledge that the position of the intake port always remains the same. Thus, favorable flow and good hydraulic efficiency are achieved for the pump assembly despite the use of different hydraulic units.

[0016] According to an embodiment of the invention, the discharge port can project radially or tangentially in the region of the tubular section. In this way, the hydraulic efficiency is advantageously further improved when the liquid is deflected by only 90° on account of the relative arrangement of the discharge and intake ports.

[0017] According to an embodiment of the invention, a spiral baffle for the liquid can be formed in the region of the can flange. Provision can likewise be made for the adapter to be designed with a spiral shape in the region of the tubular section. In either case, the geometry improves the hydraulic efficiency of the pump assembly. Since the design measures are provided in the region of the adapter, a favorable fluidic design and high hydraulic efficiency are the result regardless of the hydraulic unit used. In contrast to the practice that was customary heretofore, the design measures that affect the shape of the flow are not provided as part of the uniform hydraulic unit for installation, but instead are implemented as part of the newly provided adapter.

[0018] According to an embodiment of the invention, the heater for the liquid can be integrated in the end wall of the hydraulic unit. An advantageous result of integrating the heater in the end wall is good efficiency in heat transfer. A large contact area and high turbulence of the flow in the pump chamber benefit the heat transfer in this design. At the same time, it has become apparent that the installation space situation in many different applications allows for integration of the heater in the end wall.

[0019] According to an embodiment of the invention, a fastenor can be provided on the adapter. Also, a mating fastenor can be provided on the first hydraulic unit and on the at least one additional hydraulic unit that are designed such that they can be placed on the fastenor of the adapter to connect the components detachably or non-detachably. In this regard, either the first hydraulic unit or the second hydraulic unit can be placed on the adapter. The fastenor of the adapter and the mating fastenor that is provided on the hydraulic units thus can be a standardized geometric interface. No adjustments to the design of the adapter are required for exchanging the hydraulic unit, and design adjustments in the region of the adapter can be avoided.

[0020] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus, are not limitive of the present invention, and wherein:

[0022] FIG. **1** is a cross-sectional representation of a pump assembly according to the invention comprising a drive module, and a first hydraulic unit, and an adapter that is provided between the drive module and the first hydraulic unit,

[0023] FIG. **2** is a perspective view of the pump assembly from FIG. **1**,

[0024] FIG. **3** illustrates the pump assembly according to an embodiment of the invention with a second hydraulic unit secured to the adapter,

[0025] FIG. **4** is a perspective view of the pump assembly from FIG. **3**,

[0026] FIG. **5** illustrates the pump assembly according to an embodiment of the invention with a third hydraulic unit secured to the adapter, and

[0027] FIG. **6** is a perspective view of the pump assembly from FIG. **5**.

DETAILED DESCRIPTION

[0028] A pump assembly according to the invention for water-carrying cleaning appliances as in FIGS. **1** and **2** com-

prises a drive module **1**, a first hydraulic unit **2**, and an adapter **3**, which is provided between the drive module **1** and the first hydraulic unit **2** and is connected to both of them. The pump assembly according to an exemplary embodiment of the invention is designed as, for example, a circulation pump for a washing machine or a dishwasher, and can be used in a commercial or home environment.

[0029] The drive module **1** provides a stator **4**, a rotor **6** held on a shaft **5** of the drive module **1** such that it can rotate relative to the stator **4**, and a housing **7** that circumferentially encloses sections of the stator **4**. Two plain bearings **8**, **9** are provided to support the shaft **5**. The drive module **1** functions in the manner of a synchronous motor, in particular. Accordingly, an air gap **10** between the stator **4** and the rotor **6** can be relatively large in design.

[0030] The drive module **1** is connected to the adapter **3**. The adapter **3** has a can body **12** that encloses the rotor **6** circumferentially in the region of the air gap **10** and on an end face facing away from the impeller **11**, a can flange **13** adjoining the can body **12** on a side facing the impeller **11**, and a tubular section **14** that extends essentially cylindrically. The tubular section **14** encloses the impeller **11** circumferentially. Radially projecting from the tubular section **14** is a discharge port **15**, which is provided for discharging the liquid circulated by the pump assembly **1**. Plain water or water with added detergent is usually provided as the liquid.

[0031] The adapter **3** is designed as a single piece. The can body **12**, the can flange **13**, the tubular section **14**, and the discharge port **15** are produced in the present case as one common plastic component. The shaft **5** is supported on the can body **12** by the plain bearing **9** on a side facing away from the impeller **11**. The second plain bearing **8** is supported on the can flange **13** by a bearing carrier **16**. The rotor **6** of the drive module **1** is implemented in this regard as a wet rotor. Accordingly, the liquid that is pumped by the pump assembly fills the can body **12** of the adapter **3**. As a result of the hermetic seal produced via the can body **12** and the can flange **13**, it is possible to dispense with a dynamic seal or separation between components of the pump assembly that move relative to one another.

[0032] The first hydraulic unit **2** connected to the adapter **3** provides an intake port **17** arranged coaxially to the shaft **5** and an end wall **18** extending radially thereto. The intake port **17** is two-piece in design. It comprises a first tubular part **19** and a second tubular part **20**. The tubular parts **19**, **20** of the intake port **17** are placed one on the other and connected together in an interlocking manner. An axially preloaded seal **21** is provided between the intake port **17** and the end face **18**. Integrated into the end wall **18** is an electrically operated heater **32**, which serves to heat the liquid pumped by the pump assembly. The heater **32** is essentially saucer-like in design.

[0033] In order to connect the first hydraulic unit **2** to the adapter **3**, a fastenor **33** is provided on the adapter **3**. The first hydraulic unit **2** correspondingly provides a mating fastenor **34**, which can be placed on the fastenor **33**. In the present case, the connection is implemented, for example, through a snap closure. It is optionally possible to implement, for example, a bayonet mount or the like. A seal **22** is provided between the hydraulic unit **2** and the adapter **3** in order to seal the pump assembly.

[0034] In operation, the liquid is delivered in a pumping direction **23** through the intake port **17** to a pump chamber **24** accommodating the impeller **11**. The pump chamber **24** is delimited circumferentially by the tubular section **14** of the adapter **3** and at one end by the end wall **18** of the first hydraulic unit **2** and at the other end by the can body **12** and the can flange **13** of the adapter **3**. After pressurization, the liquid is discharged through the discharge port **15**, which is implemented as an integral component of the adapter **3**.

[0035] The pump assembly according to the invention is implemented in the manner of a modular pump assembly. FIGS. **3** and **4** show the pump assembly according to the invention with the drive module **1** and the adapter **3**. In keeping with the modular concept, a second hydraulic unit **25** is now connected to the adapter **3** instead of the first hydraulic unit **2**. The second hydraulic unit **25** dispenses with an integrated heater. Provision is made for a flat end wall **26** that extends essentially radially, and an intake port **27** that is molded thereon. The intake port **27** is formed in the region of an outer circumferential surface **28** for installation of a tubular heater that is not shown, via which the liquid delivered through the intake port **27** is heated before entering the pump chamber **24** of the pump assembly. As usual, the adapter **3** and the second hydraulic unit **25** are detachably connected to one another by the fastenor **33** and the mating fastenor **34**. The seal **22** is provided between the adapter **3** and the second hydraulic unit **25** as before.

[0036] A third configuration of the pump assembly according to the invention, as shown in FIGS. **5** and **6**, provides a third hydraulic unit **29** connected to the adapter **3**. The third hydraulic unit **29** is implemented without a heater. An intake port **30** and an end wall **31** radially projecting outward therefrom are made as a single piece with the mating fastenor **34**. Otherwise, the adapter **3** employed and the drive module **1** are identical to the previously shown configurations of the pump assembly according to the invention.

[0037] The provision of a single drive module **1** and an adapter **3** that is always identical and the plurality of the hydraulic units **2**, **25**, **29** makes it possible to customize the pump assembly according to the invention in a very specific and needs-based way for different applications or customer-specific desires and specifications. The always identically constructed drive module **1** and the always identically constructed adapter **3** can be mass-produced. An application-specific adaptation is then carried out in the region of the hydraulic unit **2**, **25**, **29**. The modifications in the region of the hydraulic unit **2**, **25**, **29** make it possible to adapt the pump assembly to specific spatial conditions. Because important fluidic components of the hydraulic unit **2**, **25**, **29**, such as the position and arrangement of the discharge port **15**, are implemented separately in the region of the adapter **3**, extensive hydraulic dimensioning, analysis, and testing of the application-specific hydraulic units **2**, **25**, **29** are largely eliminated. The fluidic properties of the pump assembly are accordingly defined substantially by the geometry of the adapter **3** and are largely independent of the structural design of the hydraulic units **2**, **25**, **29**.

[0038] In order to optimize hydraulic efficiency, a spiral baffle for the liquid can be implemented on the adapter **3** in the region of the can flange **13**. Also, the adapter **3** can be designed with a spiral shape in the region of the tubular section **14**, with a flow cross-section increasing toward the discharge port **15**.

[0039] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be

obvious to one skilled in the art are to be included within the scope of the following claims.

What is claimed is:

1. A pump assembly for water-carrying cleaning appliances, the pump assembly comprising:

a drive module with a stator, a rotor held on a shaft of the drive module so as to be rotatable relative to the stator, and a housing that circumferentially encloses at least sections of the stator;

an impeller for pumping liquid that is held on the shaft;

a hydraulic unit with an intake port through which the liquid is adapted to be delivered to the impeller; and

an adapted arranged between the drive module and the hydraulic unit, the adapter being connected on one side to the drive module and on the other side to the hydraulic unit, the adapter comprising:

a can body that extends between the rotor and the stator of the drive module, and encloses the rotor on an end face facing away from the impeller;

a can flange adjoining the can body on a side facing the impeller, the can flange projecting radially outward from the can body at least in sections;

a tubular section that circumferentially encloses the impeller at least in part and that delimits a pump chamber containing the impeller; and

a discharge port formed on the tubular section for discharging the liquid from the pump chamber.

2. The pump assembly according to claim **1**, wherein the pump assembly is a modular pump assembly and has a first hydraulic unit and at least one additional hydraulic unit, wherein a choice of the first hydraulic unit or the at least one additional hydraulic unit is attached to the adapter on a side opposite the drive module, and wherein at least the first hydraulic unit or the at least one additional hydraulic unit has a heater for heating the liquid.

3. The pump assembly according to claim **1**, wherein the intake port on the first hydraulic unit and the intake port on the at least one additional hydraulic unit are provided coaxially to the shaft.

4. The pump assembly according to claim **1**, wherein the hydraulic unit provides an end wall that radially encloses the intake port, and wherein, together with the tubular section of the adapter, the can body and the can flange delimits the pump chamber.

5. The pump assembly according to claim **1**, wherein a spiral baffle for the liquid is arranged in the region of the can flange.

6. The pump assembly according to claim **1**, wherein the intake port is multipart in design, wherein a first tubular part of the intake port and a second tubular part of the intake port are placed one inside the other and snapped together, and wherein a preloaded axial seal is provided between the two tubular parts and/or between one tubular part and the end wall of the hydraulic unit.

7. The pump assembly according to claim **1**, wherein the heater for the liquid is integrated in the end wall of the hydraulic unit.

8. The pump assembly according to claim **1**, wherein the heater is a tubular heater, and wherein the tubular heater is provided between an end wall of a hydraulic unit and the tubular section of the adapter or in a region of the intake port upstream of the hydraulic unit or in the pump chamber adjacent to an inner circumferential surface of the tubular section between the can flange of the adapter and the end wall of the hydraulic unit.

9. The pump assembly according to claim **1**, wherein the discharge port projects radially and/or tangentially from the tubular section.

10. The pump assembly according to claim **1**, wherein the adapter has a spiral shape in a region of the tubular section.

11. The pump assembly according to claim **1**, wherein, in order to detachably connect the adapter to any desired hydraulic unit, a fastenor is provided on the adapter, and wherein a mating fastenor is provided on the first hydraulic unit and on the at least one additional hydraulic unit such that the mating fastenor of the first hydraulic unit and the mating fastenor of the at least one additional hydraulic unit are placed on the fastenor of the adapter.

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