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(54) **CONDENSATE DRAIN PUMP WITH REDUCED NOISE**

(57) Condensate drain pump (1) with reduced noise comprising: a permanent-magnet synchronous motor (13) provided with a rotor (7) rotating with respect to a rotation axis (x); an impeller (3) coaxially rotating with

respect to the rotor (7) and coupled thereto by an eccentric-teeth coupling device (8); elastic means (5) arranged to keep the impeller assembly in a sliding position against a matching element.

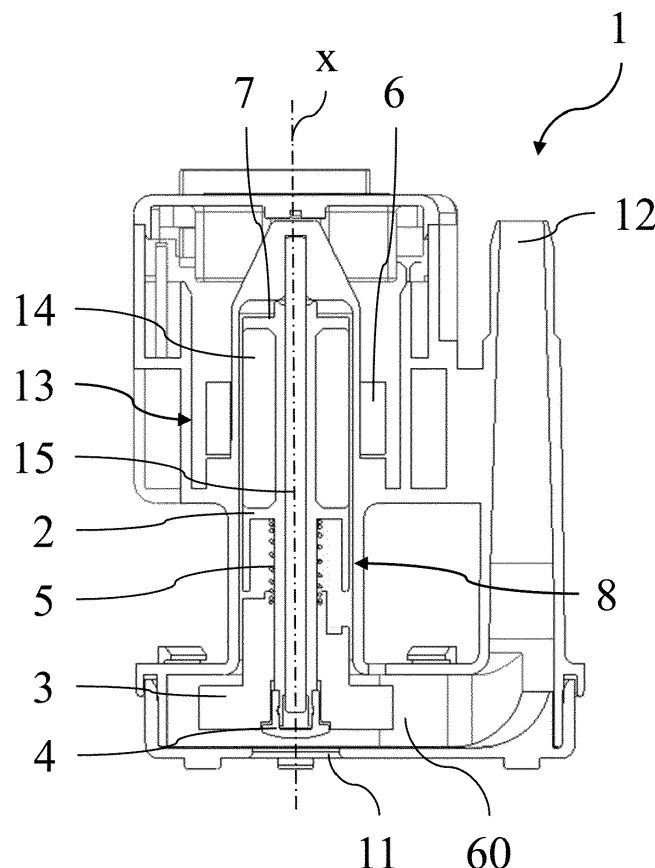


Fig. 2

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Description

Field of application

[0001] The present invention relates, in its more general aspect, to a drain pump for fluids. The pump finds a preferred application as a condensate drain pump inside household appliances.

[0002] The invention finds therefore a useful application in the field of household appliances, particularly as a component for large household appliances which need to drain the condensate such as dryers and washer-dryers.

Prior art

[0003] As hinted above, in the field of household appliances drain and/or recirculation motor-driven pumps for fluids, particularly water, are traditionally used. The electric motor is coupled, usually directly, to the impeller which is arranged to send the fluid towards a delivery.

[0004] In the pumps of the above type permanent-magnet synchronous electric motors are mostly used. The motors comprise a stator, with laminationstack electro-magnet and associated windings, and a rotor provided with one or more permanent magnets arranged between at least two pole pieces defined by the stator; the rotor is axially crossed by a driving shaft, which is integral therewith, rotatingly connected to the pump casing.

[0005] It is also known that the starting of a synchronous motor has some critical issues, which can be overcome either by a sophisticated electronic driving or, more economically, by disengaging the rotor from the load in the starting transient, allowing the motor to reach the synchronous speed before recoupling the load.

[0006] In the second case, the engagement between the rotor and the impeller occurs by means of mechanic coupling devices, such as for example toothed joints comprising a driving tooth, which is eccentric with respect to the rotation axis and integral with the rotor, and a driven tooth which is also eccentric and integral with the impeller. Upon starting, the driving tooth is thus allowed to freely travel before impacting the driven tooth. During this free travel, the load is decoupled. After the impact, if the motor has managed to reach the synchronous speed the kinematic direct connection is created between the impeller and the rotor which are, in the steady operation, substantially integral with each other. If on the contrary the synchronous speed is not reached, after the pitch loss the rotor restarts and accelerates the driving tooth once again, until the synchronous state is reached.

[0007] The eccentric-teeth coupling device, described above in the simplest embodiment thereof, can have several variants comprising for example intermediate teeth or interposed cushioning elements.

[0008] Although advantageous from different points of view, the synchronous motor pumps provided with eccentric-teeth coupling devices have however known draw-

backs.

[0009] In particular, one of the best-known drawbacks is the low level of acoustic efficiency, i.e. a high noise, both when starting the motor and during the steady operation thereof in air/water and full-load conditions.

[0010] The technical problem underlying the present invention is therefore to provide a condensate drain pump which allows, in a simple and economical way, the noise of current synchronous pumps for household appliances to be reduced both upon starting and during the working cycle, in both full-load conditions and air/water conditions.

Summary of the invention

[0011] The above technical problem was solved by the Applicant after identifying the phenomena adversely affecting the noise of a mechanically-started synchronous drain pump.

[0012] The Applicant has identified in the coupling device used in the above motor one of the main causes of noise, both during starting and in the following operation.

[0013] Upon starting, the noise is obviously linked to the continuous impacts between the eccentric teeth during the repeated attempts to reach synchronism.

[0014] The Applicant has however noticed that the eccentric-teeth coupling device can also generate some noise during the steady operation, particularly due to the discontinuous contact between the driving tooth and the impeller.

[0015] In view of these remarks, the idea underlying the present invention is to insert an elastic element axially pressing the impeller assembly against a matching surface, generating a friction which, properly calculated, decreases the relative speed of the teeth during the free travel generating a smaller impact and thus reducing the noise. This friction also avoids that, in operation, the impeller detaches from the driving tooth, also avoiding noise from being generated in the steady state.

[0016] The above-defined technical problem is therefore solved by a pump for a household appliance comprising: a synchronous motor comprising a stator and a rotor rotating with respect to said stator about a rotation axis; an impeller which is coaxial to the rotor and also pivoting about the rotation axis; an eccentric-teeth coupling device arranged to couple in rotation said impeller to said rotor allowing the rotor to freely travel upon starting; said pump further comprising elastic means acting on said impeller in the direction of the rotation axis so as to define a rubbing friction between a contact surface which is integral with the impeller and a matching surface which is not integral with the impeller.

[0017] The above rubbing defines a friction which reduces the speed of the impeller in the free motion step thereof, i.e. when the motor has not reached the synchronous state yet and the impeller is decoupled from the rotor, resulting in a reduction of the impact force between the eccentric teeth of the coupling device.

[0018] Moreover, the same friction further ensures a continuous contact between the motion transmission elements of the coupling device, reducing in view of the above the pump noise even in the full-load steady operation and in air/water conditions.

[0019] Finally, the elastic means keep the impeller in an axially fixed position, also preventing possible axial vibrations and the noise in the respective contact points.

[0020] Preferably, said matching surface is integral with the rotor at least in the axial direction: for example it can be defined by a matching element coupled to the end of a shaft which is integral with the rotor. It can be noticed anyway that the matching surface could also not be constrained by any means to the rotor, being it for example a surface of the pump casing.

[0021] Preferably, the elastic means act in the direction of the impeller away from the rotor; thereby the elastic means can be easily interposed between the rotor and the impeller, arranging them at the coupling device, resulting in simple construction and reduction of overall dimensions.

[0022] The pump according to the invention can comprise at least one shaft which is coaxial to the rotation axis and integral with one of the rotor or impeller, wherein a stop is provided which is integral to the shaft with respect to translation along the axis to prevent the extraction of the other of the rotor and impeller, wherein said contact surface or said matching surface is defined by the stop.

[0023] In a preferred embodiment, the shaft is integral with the rotor, and it is composed of a stem covered by an overmolding of plastic material in which the one or more permanent magnets of the rotor are embedded.

[0024] Preferably, the stop is formed by an end cap coupled to one of the ends of the shaft and provided with a retaining flange which defines the contact surface or the matching surface.

[0025] The end cap can be coupled to the shaft, for example, by snap coupling: for example it can be provided with an internally-grooved bush intended to lock onto an end of the shaft equipped with an annular thickening. The coupling of the end cap can be performed for example by an adhesive or ultrasonic welding.

[0026] Preferably, the eccentric-teeth coupling device comprises at least one eccentric driving tooth which is integral with the rotor and at least one eccentric driven tooth which is integral with the impeller, the at least one driving tooth being driven by the rotor along a free revolution path until the impact with the at least one driven tooth.

[0027] On the other hand, the use of eccentric-teeth coupling devices of a more sophisticated type, for example comprising intermediate teeth or cushioning elements between the teeth, is not excluded.

[0028] Preferably, the free revolution path of the driving tooth covers a maximum angle comprised between 180° and 270°, specifically arranged to maximise the chances of an effective starting.

[0029] Preferably, the at least one driving tooth is made in one piece with an overmolding of the rotor, while the at least one driven tooth is made in one piece with the rotor.

5 **[0030]** Preferably, the at least one of the driving tooth and driven tooth comprises two teeth which are separated from each other by an external cavity crossed by an intermediate rib. An overall structure with a significant angular extent can thus be formed whilst making the single tooth thinwalled, improving the elastic absorption of the collision and thus reducing noise and damage risks.

10 **[0031]** Preferably, said elastic means are positioned at the height of the coupling device, internally with respect to the at least one driving tooth and to the at least one driven tooth.

15 **[0032]** Preferably, the elastic means are composed of a helical spring; all alternative embodiments which are known to the skilled person in the art are obviously possible, comprising springs of a different kind or the interposition of elastic elements other than springs.

20 **[0033]** Preferably, said helical spring is arranged around a shaft which is coaxial to the rotation axis.

25 **[0034]** As hinted above, in a preferred embodiment the pump is specifically arranged to drain the condensate inside a household appliance.

30 **[0035]** In this embodiment, the pump preferably comprises a suction opening aligned with the rotation axis, a volute chamber in which the impeller rotates and a radial delivery in communication with a drain pipe which is parallel to the rotation axis.

35 **[0036]** Preferably, the rotor comprises at least one permanent magnet.

[0037] Further features and advantages of the present invention will be more apparent from the following description of an embodiment thereof, made with reference to the attached drawings, given by way of non-limiting examples.

Brief description of the drawings

[0038]

Figure 1 shows a perspective view of a condensate drain pump according to the present invention;

figure 2 shows a lateral sectional view of the condensate drain pump of figure 1;

figure 3 shows a perspective view of a rotor-impeller assembly of the condensate drain pump of figures 1 and 2;

figure 4 shows an exploded perspective view of the assembly of figure 3;

figure 5 shows a longitudinal sectional view of the assembly of figure 3;

figure 6 shows a sectional view along the transverse plane A-A indicated in figure 5, of the rotor-impeller assembly.

Detailed description

[0039] According to the present invention, with reference to figures 1 and 2 a condensate drain pump is described, globally indicated with 1, while with reference to figures 3 to 6 a rotor-impeller assembly of the same pump is described, globally indicated with 10.

[0040] The condensate drain pump 1 comprises a housing 16 having a lower suction opening 11 and a lateral delivery which connects to a vertical condensate drain pipe 12.

[0041] Inside the housing an electric synchronous motor 13 is present, provided with an external stator 6 which is integral with the housing 16 and with an internal rotor 7 rotating along a rotation axis x, which is coupled to the impeller 3.

[0042] The rotor 7 comprises an annular permanent magnet 14 which is embedded in a plastic overmolding 2, made around a preferably metal shaft 15.

[0043] The overmolding 2 has two washers for laterally retaining the permanent magnet 14, whose surface is on the contrary left free where it faces the air gap. One of the washers, turned towards the impeller 3, has an external surface 22 from which the shaft 15, covered by a coating portion 21 of the overmolding 2, and a cylindrical external jacket 25 coaxially extend.

[0044] The external jacket 25 stops at a distance from the impeller 3, but it has a driving tooth 24 formed in one piece. The coating portion 21 ends at a greater distance, and the impeller 3 is put thereon. The free end of the coating portion has a leading portion 23, provided with an annular thickening, for the coupling of a cap-shaped stop 4 arranged to retain the impeller 3 on the shaft 15.

[0045] Said stop 4 or cap comprises a bush 43, internally provided with a coupling groove, which couples on the leading portion 23 of the coating portion 21 of the shaft, and a retaining flange 42.

[0046] The impeller 3 comprises a blading 34, particularly with straight blades, projecting from a central hub.

[0047] A first sleeve 35, which extends in a second sleeve 32 of a lower diameter extended towards the rotor 7, is also formed in one piece with the impeller 3. A projecting portion 33, on which two driven teeth 33a, 33c are formed, radially branches off with respect to the second sleeve, up to reach the diameter of the first sleeve 35. The above projecting portion 33 has a wedge-like section, laterally restricted by two driven teeth 33a, 33c formed by radial ribs having a reduced thickness. A cavity 33d stiffened by an intermediate rib 33b, which is also radial, opens outwards between the two driven teeth 33a, 33c.

[0048] When the condensate drain pump 1 is in use, the driving tooth 24 which is integral with the overmolding

2, which is integral with the rotor 7, after a free revolution path, impacts against one of the two driven teeth 33a, 33c which are integral with the impeller 3, so as to make a kinematic transmission between the two members.

[0049] The driving tooth 24 and the driven teeth 33a, 33c thus form an eccentric-teeth coupling device 8 which, as discussed in detail above, is the main cause of noise in prior art condensate drain pumps.

[0050] The pump 1 according to the present invention further comprises elastic means 5, particularly defined by a helical spring interposed between the rotor 7 and the impeller 3 and arranged around the coating portion 21 of the shaft 15, in the gap left between the latter and the external jacket 25.

[0051] The helical spring is arranged to press the impeller 3 against the stop 4 which is integral with the shaft 15. A friction is thus created between a contact surface 31 of the impeller 3 and a matching surface 41 of the retaining flange 42.

[0052] The friction decreases the speed of the impeller 3 in the free motion step, i.e. when the impeller is decoupled from the rotor, and it leads to a reduction of the impact force between the eccentric teeth of the coupling device 8, thereby reducing the noise of the motor.

[0053] Moreover, as already discussed above, the friction also avoids the decoupling between the moving parts also reducing the noise in the steady operation.

[0054] The above-described invention, particularly the addition of friction means 5 to the assembly of the rotor housing 2 and the impeller 3, solves the above-identified technical problem allowing the noise of the condensate drain pump to be reduced.

[0055] Moreover, it has the advantage of being simple, economical and easily adjustable to the different possible applications of use of the condensate drain pump.

[0056] Obviously, in order to meet contingent and specific requirements, a person skilled in the art will be allowed to bring several modifications and variations to the above-described condensate drain pump, all however falling within the scope of protection of the invention as defined by the following claims.

Claims

1. Pump (1) for a household appliance comprising: a synchronous motor (13) comprising a stator (6) and a rotor (7) rotating with respect to said stator (6) about a rotation axis (x); an impeller (3) which is coaxial to the rotor (7) and also rotating about the rotation axis (x); an eccentric-teeth coupling device (8) arranged to couple in rotation said impeller (3) to said rotor (7) allowing the rotor (7) to freely travel upon starting; **characterized in that** it comprises elastic means (5) acting on said impeller (3) in the direction of the rotation axis (x) so as to define a friction between a contact surface (31) which is integral with the impeller (3) and a matching surface (41) which is not in-

- tegral with the impeller (3).
2. Pump (1) according to claim 1, wherein said matching surface (41) is integral to the rotor (7) with respect to translation along the rotation axis (x).
 3. Pump (1) according to one of the previous claims, wherein said elastic means act in the direction of the impeller (3) away from the rotor (7).
 4. Pump (1) according to claim 3, comprising at least one shaft (15) which is coaxial to the rotation axis (x) and integral with one of the rotor (7) or impeller (3), wherein a stop (4) is provided which is integral to the shaft (15) with respect to translation along the axis (x) to prevent the extraction of the other of the rotor (7) and impeller (3), wherein said contact surface (31) or said matching surface (41) is defined by the stop (4).
 5. Pump (1) according to claim 4, wherein the stop (4) is formed by an end cap coupled to one of the ends of the shaft and provided with a retaining flange (42) which defines the contact surface (31) or the matching surface (41).
 6. Pump (1) according to one of the previous claims, wherein the eccentric-teeth coupling device (8) comprises at least one eccentric driving tooth (24) which is integral with the rotor (7) and at least one eccentric driven tooth (33a, 33c) which is integral with the impeller (3), the at least one driving tooth (24) being driven by the rotor (7) along a free revolution path until the impact with the at least one driven tooth (33a, 33c).
 7. Pump (1) according to claim 6, wherein the free revolution path of the driving tooth (24) covers a maximum angle comprised between 180° and 270°.
 8. Pump (1) according to claim 6 or 7, wherein the at least one driving tooth (24) is made in one piece with an overmolding (2) of the rotor (7), while the at least one driven tooth (33a, 33c) is made in one piece with the rotor (7).
 9. Pump (1) according to one of claims 6-8, wherein at least one of the driving tooth (24) and driven tooth (33a, 33c) comprises two teeth (33a, 33c) which are separated from each other by an external cavity (33d) crossed by an intermediate rib (33b).
 10. Pump (1) according to one of claims 6-9, wherein said elastic means are positioned at the height of the coupling device (8), internally with respect to the at least one driving tooth (24) and the at least one driven tooth (33a, 33c).
 11. Pump (1) according to one of the previous claims, wherein said elastic means (5) are composed of a helical spring.
 12. Pump (1) according to claim 11, wherein said helical spring is arranged around a shaft (15) which is coaxial to the rotation axis (x).
 13. Pump (1) according to one of the previous claims, wherein said pump is specifically arranged to discharge the condensate inside a household appliance.
 14. Pump (1) according to claim 1, comprising a suction opening (11) aligned with the rotation axis (x), a volute chamber (60) in which the impeller (3) rotates and a radial delivery in communication with a drain pipe (12) which is parallel to the rotation axis (x).
 15. Pump (1) according to one of the previous claims, wherein said rotor (7) comprises at least one permanent magnet (14).

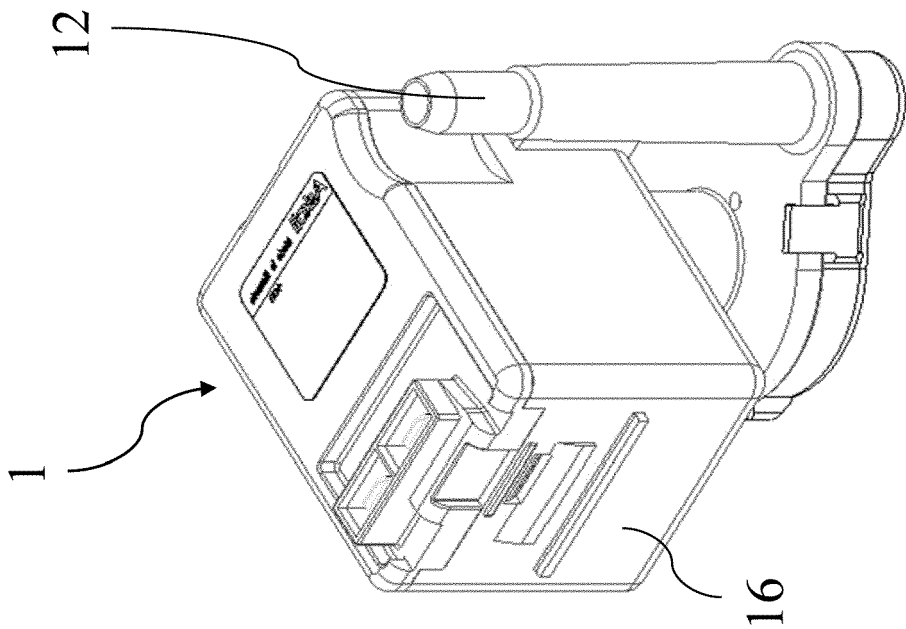


Fig. 1

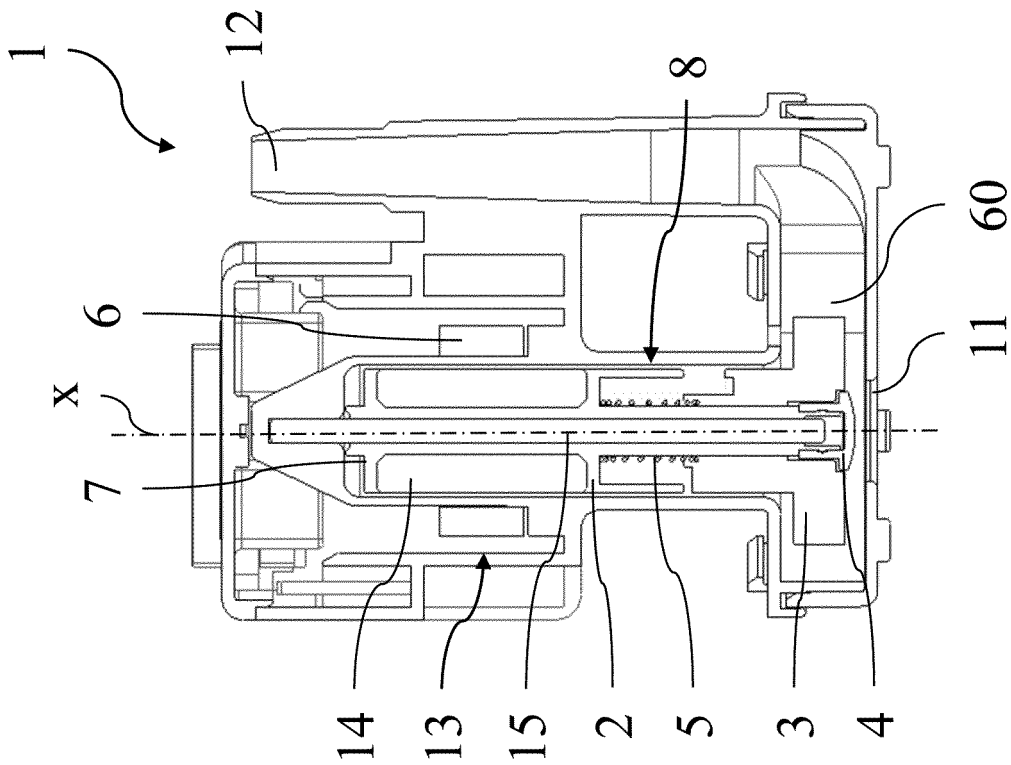


Fig. 2

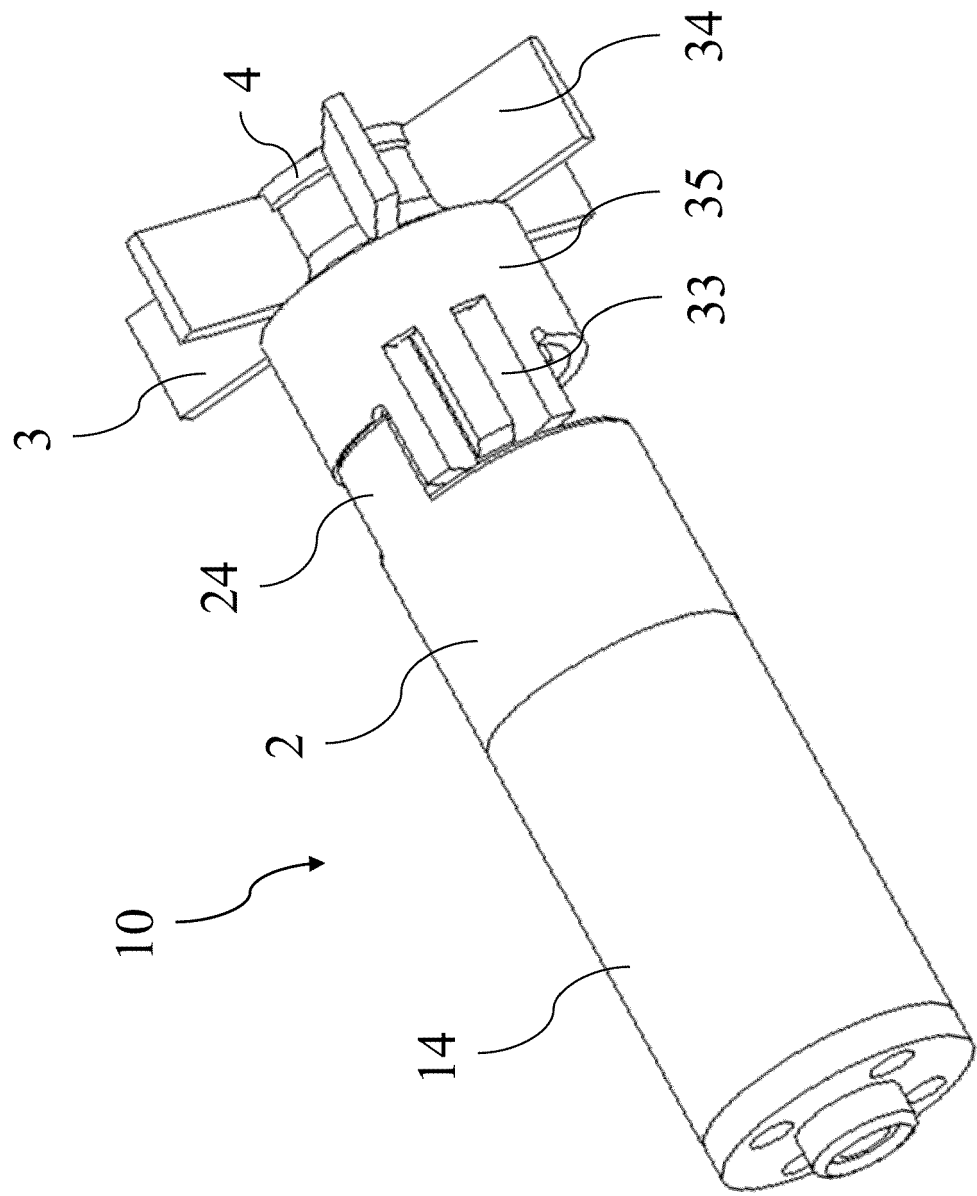


Fig. 3

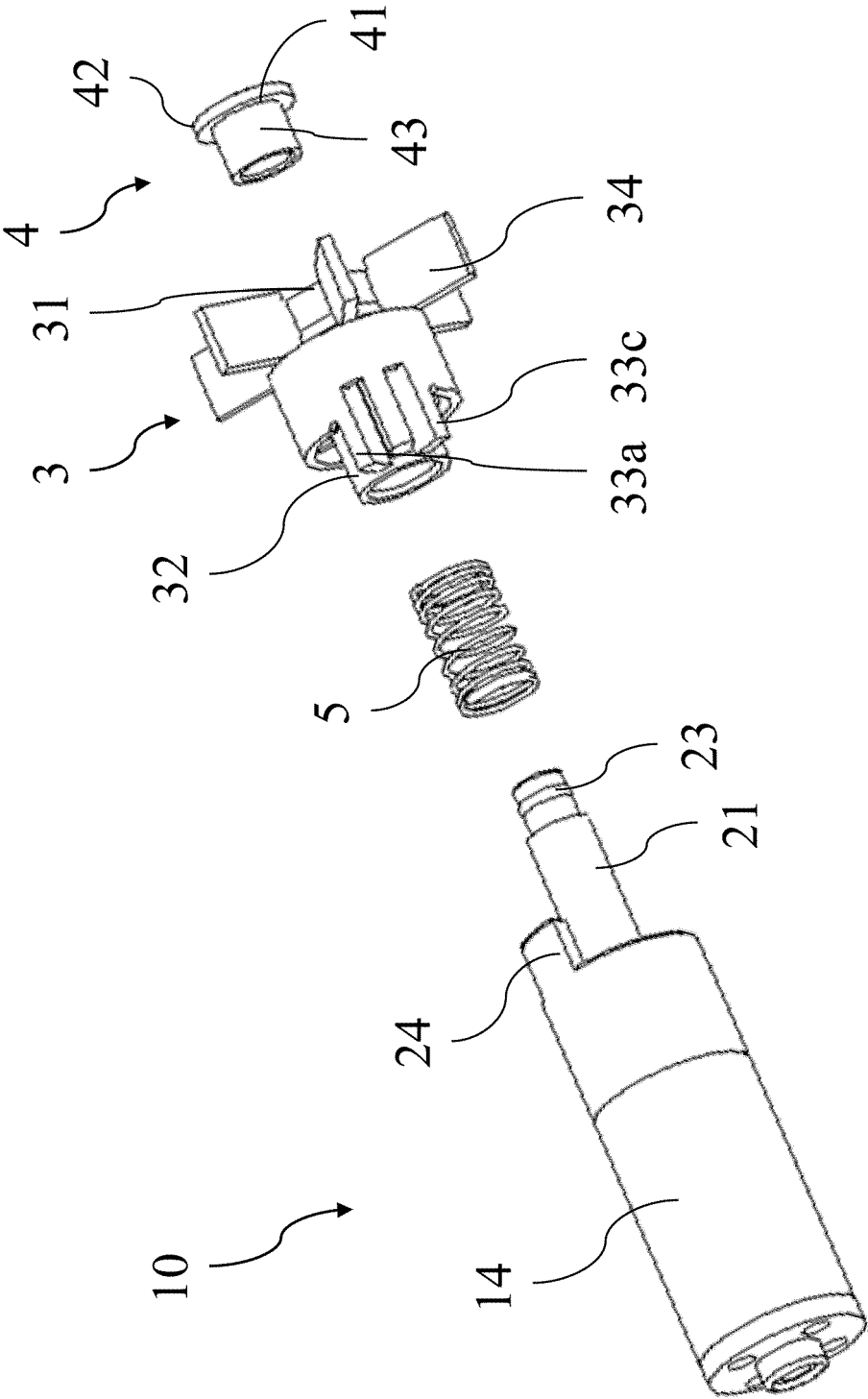


Fig. 4

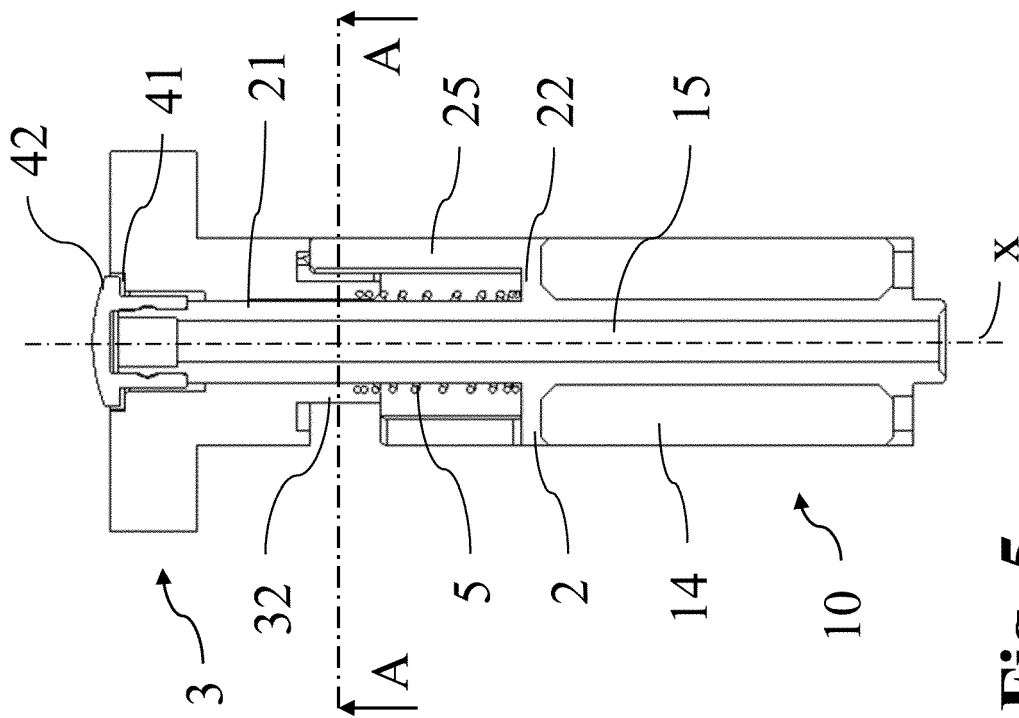


Fig. 5

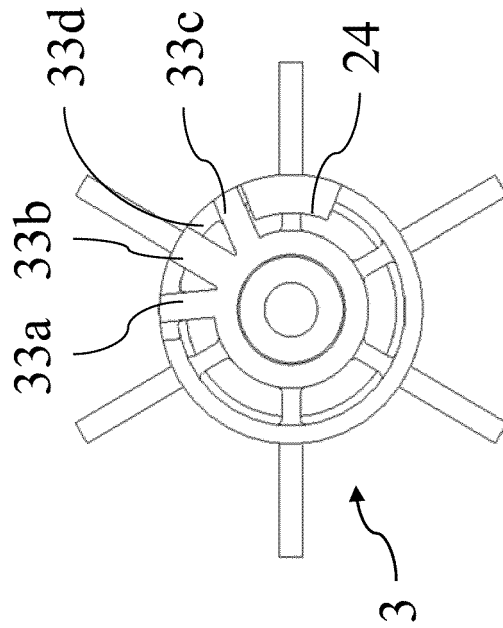


Fig. 6



EUROPEAN SEARCH REPORT

Application Number

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
			F04D
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 4 October 2022	Examiner Morales Gonzalez, M
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 22 17 0086

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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