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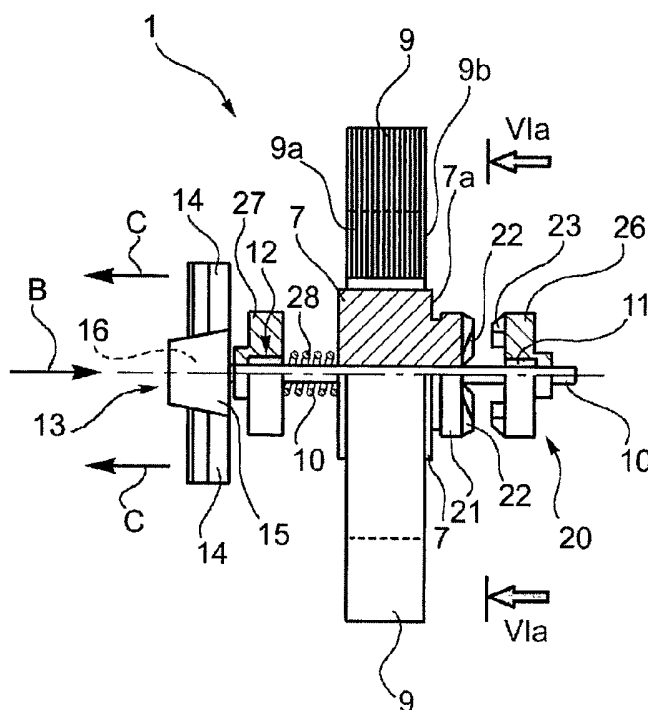
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- (74) Agents: **QUINTERNO, Giuseppe** et al.; Corso Emilia 8, I-10152 Torino (IT).
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- (71) Applicant (for all designated States except US): **EMERSON APPLIANCE MOTORS EUROPE S.r.L.** [IT/IT]; Regione Vado', Via Vittime del Vajont 44/46, I-10024 Moncalieri (IT).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **PERI, Giorgio** [IT/IT]; Via Cattanea 1, I-24060 Brusaporto (Bergamo) (IT).
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[Continued on next page]

(54) Title: AN ELECTRIC SYNCHRONOUS PUMP WITH A VOLUTE HAVING A TANGENTIAL OUTLET



(57) Abstract: The pump (1) comprises : a supporting enclosure (2-4) incorporating a shaped body (3) to which there is connected a volute (4) having an axial inlet (5) and a tangential peripheral outlet (6) for the fluid being pumped, a single phase synchronous electric motor (7, 9) including a rotor (7) with permanent magnets which is rotatably mounted and can move axially and laterally in a chamber (8) formed within body (3) adjacent to the polar extremities (9a) of a stator (9) connected to the body, and a blade-bearing impeller (13) which is coupled in rotation to rotor (7) through a coupling (16) through which the rotor (7) can rotate under no load when the rotor (7, 9) starts up before the rotor drives the impeller (13) in rotation. Between rotor (7) and supporting enclosure (2-4) there is provided a ratchet coupling device (20) and a return member (28) which tends to press rotor (7) towards a coupled axial position in which ratchet device (20) is active and causes the rotation of rotor (7) to start up in a predetermined direction is associated therewith. The impeller (13) has blades (14) which are at least partly arched or inclined relative to the axial direction of the impeller (13) in such a

way that as a result of interaction with the fluid rotation of the impeller (13) at a speed above a predetermined value is likely to cause axial lateral movement of the impeller (13) and rotor (7) relative to the body (3) against the force of the said return means (28).

**Declarations under Rule 4.17:**

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations 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, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (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 patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations
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An electric synchronous pump with a volute having a tangential outlet

This invention relates to synchronous electrical pumps, in particular for domestic electrical appliances.

More specifically the invention relates to a synchronous electrical pump of the type defined in the precharacterising clause of appended claim 1.

A synchronous electrical pump of this type constructed in accordance with the prior art is illustrated by way of example in Figures 1, 1a, 1b and 2, 2a of the appended drawings. In these figures synchronous electrical pump 1 illustrated therein comprises a supporting enclosure 2 incorporating a shaped body 3 to which there is connected a volute 4 which has an axial inlet 5 and a radial peripheral outlet 6 for the fluid being pumped. Pump 1 has a synchronous electric motor incorporating a permanent magnet rotor 7 rotatably mounted in a chamber 8 formed in body 3, between the polar extremities 9a (Figures 1a and 1b) of a stator 9 constructed of a stack of plates and connected to enclosure 2. In a manner which is in itself known and not illustrated, at least one exciter winding, in general single phase, is associated with stator 9, which in operation excites the poles of the stator simultaneously, conferring north polarity and south polarity magnetisation upon them alternately in time and space. In the embodiment illustrated by way of example, rotor 7 is within stator 9, but the arrangement of these parts may be reversed.

Rotor 7 is borne upon a shaft 10 which is rotatably mounted within body 3 through end bearings 11 and 12 (Figure 1a).

Electrical pump 1 also comprises a rotor 13 which has a plurality of straight blades 14 which extend radially from a hollow hub 15. In a way which is in itself known impeller 13 is connected rotatably to shaft 10 of rotor 7 through a coupling, indicated as a whole by 16 in Figures 2 and 2a, through which rotor 7 may be started up under no load before the latter drives the impeller in rotation. In the embodiment illustrated this coupling comprises a radial projection 17 from the rotor shaft and a projection in the form of an angular sector 18 which projects within the cavity of hub 15 of the impeller.

The synchronous electric motor of a pump of the type described above produces a negligible torque on starting and also does not have a predetermined direction of rotation, being able to rotate in one direction or the other indifferently depending upon random starting conditions.

The indeterminacy in the direction of rotation of the rotor makes it necessary to use a volute with a radial outlet which has a lesser fluid efficiency than a volute with a tangential output, and also requires a greater head of liquid at the inlet, with consequent problems with priming of the pump.

One object of this invention is to provide a synchronous electrical pump of the type initially described which makes it possible to overcome the abovementioned disadvantages of pumps according to the prior art without making it necessary to adopt special complex and costly electronic control devices.

This and other objects will be accomplished according to the invention through a synchronous electrical pump whose principal characteristics are defined in appended claim 1.

Other advantages and characteristics of the present invention will become clear from the following detailed description which is given with reference to the appended drawings which are provided purely by way of non-limiting example and in which:

Figure 1, already described, is a plan view of a synchronous electrical pump according to the prior art,

Figure 1a is a view in cross-section along the line Ia-Ia in Figure 1,

Figure 1b is a partial view along the arrow Ib in Figure 1a,

Figure 2, like that described, is a view in partial axial cross-section of a synchronous electrical pump according to the prior art,

Figure 2a is a partial view in cross-section along the line IIa-IIa in Figure 2,

Figure 3 is a side view of a known ratchet coupling device which may be used in a synchronous electrical pump according to the invention,

Figure 3a shows the device in Figure 3 in an uncoupled condition,

Figure 3b is a view along arrow IIIb in Figure 3,

Figure 4 is a side view of another ratchet coupling device of a type which is in itself known which may be used in a synchronous electrical pump according to the invention,

Figure 4a is a view along the arrows IVa in Figure 4,

Figure 5 is a side view of a variant embodiment of a ratchet coupling device of a type which is in itself known which may be used in a synchronous electrical pump according to the invention,

Figure 5a is a view along the arrows Va-Va in Figure 5,

Figure 6 is a partial view in partial axial cross-section of a synchronous electrical pump according to this invention,

Figure 6a is a view along the arrows VIa-VIa in Figure 6,

Figure 7 and Figure 7a are two side views of a first impeller with mounted blades which may be used in a synchronous electrical pump according to the invention,

Figures 8 and 8a are side views of a variant embodiment of an impeller with mounted blades which may be used in a synchronous electrical pump according to the invention, and

Figures 9 and 9a are a plan view and a side view respectively of a tangential outlet volute which may be used in a synchronous electrical pump according to the invention.

As will become more apparent below, in a synchronous electrical pump according to the invention the rotor is mounted so that it can move axially with respect to the

supporting enclosure and a ratchet coupling device of a type which is in itself known is provided between the said rotor and the said supporting enclosure. Return means tending to push it towards an axial coupled position in which the ratchet device is in operation and causes rotation of the rotor to take place in one predetermined direction only when running are associated with the rotor.

Various ratchet coupling devices which are suitable for use in a pump according to the invention are in themselves known. Some of these have already been briefly described with reference to Figures 3 - 5a of the appended drawings.

With reference to Figures 3, 3a and 3b, a ratchet coupling device 20 comprises a toothed wheel 21 which can rotate about a fixed axis 21a and is provided with a crown of saw teeth 22 and a pawl or ratchet 23 which can rotate about an axis 23a substantially parallel to axis 21a and acting together with a spring 24 (Figure 3b). The arrangement is such that pawl 23 allows toothed wheel 21 to rotate only in a predetermined direction. Rotation in the opposite direction is prevented. In Figure 3a the ratchet device is illustrated in the non-operating condition, in which pawl 23 is disengaged from teeth 22. Activation of the ratchet device is obtained through an axial displacement of either pawl or ratchet 23 or toothed wheel 21 so as to bring pawl 23 into the condition illustrated in Figure 3 in which it is engaged between two adjacent teeth of wheel 21.

Figures 3 and 5 and associated Figures 4a and 5a illustrate two different embodiments of ratchet devices 20 with a coupling of the frontal type. In these variant embodiments toothed wheel 21 has a plurality of frontal saw teeth 22 with

which at least one pawl 23, preferably of resilient material, for example an elastomer, projecting from a frontal surface of a member 26 which is coaxial with wheel 21 can act. The coupling between this member 26 and toothed wheel 21 also in this case takes place through a relative axial movement between them.

A synchronous electrical pump according to the invention has a volute 4 with a substantially tangential outlet 6, as for example illustrated in Figures 9 and 9a. Correspondingly the unit of the pump motor mounted with blades and the synchronous electric motor has the characteristics defined in appended claim 1, and will now be described in greater detail with reference to Figures 6 to 8a. In these figures parts and components which are essentially identical or equivalent to elements already described will be again allocated the same reference numbers as used previously.

With reference to Figure 6, in a synchronous electrical pump 1 according to the invention impeller 13 has blades 14 which are at least partly arcuate and are inclined relative to the axial direction of the impeller, for example as in the embodiments illustrated by way of example in Figures 7, 7a and 8, 8a.

Rotor 7 with its corresponding shaft 10 is mounted with axial movement with respect to supporting enclosure 2 for the pump. In Figure 6, shaft 10 of the rotor is mounted so that it can rotate and move axially in two end bearings 11 and 12 borne by corresponding supports 26 and 27 forming an integral part of supporting enclosure 2 (not illustrated in Figure 6). End support 26 has a frontal pawl or ratchet 23 which is able to

act together with frontal saw teeth 22 of a member 21 forming an integral part of rotor 7.

In the embodiment according to Figures 6 and 6a a helical spring 28 is inserted between stationary support 27 and rotor 7, and tends to push the latter towards an axial coupled position (not illustrated) in which ratchet device 20 comprising toothed formation 21 and pawl or ratchet 23 is active and ensures that rotor 7 only rotates in a predetermined direction under operating conditions.

The profiling or at least partial inclination of blades 14 of impeller 13 is such that, as a result of their interaction with the fluid, rotation of impeller 13 at a speed higher than a predetermined value is likely to bring about lateral axial movement of said impeller 13 and rotor 7 relative to supporting enclosure 2 of the pump, against the force of spring 28, so that rotor 7 takes up the axial position illustrated in Figure 6 in which toothed formation 21 is disengaged from ratchet or pawl 23, and ratchet device 20 is deactivated, while nevertheless allowing rotor 7 to continue to rotate in the aforesaid predetermined direction.

Still with reference to Figures 6 and 6a, impeller 13 is coupled to shaft 10 of the rotor by means of a delay coupling 16, of a type which is in itself known and already described previously.

It is now assumed that the reaction exerted by the pumped fluid on blades 14 of impeller 13 is in the direction of arrows C in Figure 6, while the liquid is drawn in the direction of arrow B and the rotor rotates in the direction of arrow D in Figure 6a: when rotor 7 starts to rotate, as in

practice insufficient liquid is drawn up, there is virtually no reaction on blades 14 and in this situation spring 28 pushes the rotor and toothed formation 21 so that it engages ratchet 23 (suitably of elastomer material). Revolution of rotor 7 in a direction contrary to that of arrow D in Figure 6a is then prevented.

When power is then supplied to the electric motor of pump 1, rotor 7 and impeller 13 can only rotate in the direction of arrow D. During the start-up stage, as soon as the speed of impeller 13 exceeds a predetermined value, the interaction between the fluid and blade 14 causes impeller 13 and rotor 7 to move laterally in the direction of arrows C, disengaging toothed formation 21 from ratchet or pawl 23. As long as the pump operates at a rotation speed above that value ratchet device 20 comprising toothed formation 21 and pawl 23 is inactive. As there is no interference between this toothed formation 21 and ratchet 23, there is no wear on ratchet device 20, neither is there any operating noise due to that device.

Obviously spring 28 will be dimensioned in such a way that it can apply a force to the rotor/impeller complex which is greater than the force due to friction between shaft 10 and bearings 11 and 12, but still less than the reaction force exerted by the fluid on impeller 13 when this rotates at a speed higher than the aforesaid predetermined value.

A similar *modus operandi* is also achieved without the use of spring 28 by replacing the returning mechanical action of the same with a magnetic force attracting rotor 7 towards the terminal surface 9b of the poles 9a of the stator (Figure 6). This magnetic force can be produced by constructing the

synchronous electric motor driving the pump in such a way that the frontal surface of the posterior extremity 7a of the rotor (Figure 6) is suitably displaced in the direction of arrows C in relation to the terminal surface 9b of poles 9a of the stator.

With reference to Figure 6a and the embodiment illustrated therein, toothed formation 21 has two frontal saw teeth 22 which are angularly equally spaced apart. As a consequence, when at rest, ratchet 23 is positioned between these teeth, with some angular play with respect to them. This feature, which is not strictly necessary but is advantageous to ensure start-up of the motor in any condition and to reduce noise on start-up, allows rotor 7 and shaft 10 to rotate through a restricted angle on start-up even in a direction opposite to that of the predetermined direction D for the rotation of blade-bearing impeller 13 when under intended operating conditions.

In variant embodiments which are not illustrated, ratchet coupling device 20 may be provided between rotor 7 and support 27.

In other variants the ratchet may be carried on the rotor, to act together with teeth 22 of wheels or stationary toothed formations.

Naturally, the principle of the invention remaining the same, the forms of embodiment and details of construction may be varied widely with respect to those described and illustrated, which have been given purely by way of example, without thereby departing from the scope of the invention.

CLAIMS

1. A synchronous electrical pump (1) comprising
- a supporting enclosure (2-4) including a shaped body (3) to which there is coupled a volute (4) having an axial inlet (5) and a peripheral outlet (6) for the fluid being pumped,
 - a single phase synchronous electric motor (7, 9) including a permanent magnet rotor (7) rotatably mounted in a chamber (8) formed in the said body (3), adjacent to the polar extremities (9a) of a stator (9) connected to the body; and
 - a blade-bearing impeller (13) coupled in rotation to the rotor (7) through a coupling (16) through which the rotor (7) can rotate without load when the rotor (7, 9) is started up before the latter causes the impeller (13) to be driven,
- the pump (1) being characterised in that
- the outlet (6) from the volute (4) is substantially tangential,
 - the rotor (7) is mounted in such a way that it is movable laterally and axially with respect to the body (3); a ratchet coupling device (20) being provided between the rotor (7) and the supporting enclosure (2-4); return means (28) being associated with the rotor, tending to press the rotor (7) towards an axial coupled position in which the said ratchet device (20) is active and makes it possible for rotation of the rotor (7) to start up in a predetermined direction,
 - the impeller (13) has blades (14) which are at least partly arcuate or inclined relative to the axial direction of the rotor (13) in such a way that, as a result of interaction with the fluid, rotation of the impeller (13) at a speed higher than a predetermined value is capable of causing lateral axial movement of the impeller (13) and the rotor (7) relative to the said body (3), against the force of the said return means (28), in such a way that the rotor (7) adopts an

axial disengaged position in which the ratchet device (20) is deactivated and the rotor continues to rotate in the said predetermined direction.

2. A synchronous electrical pump according to claim 1, in which the said return means comprise resilient means (28) acting mechanically upon the rotor (7).

3. A synchronous electrical pump according to claim 1, in which the rotor (7) and the stator (9) are constructed in such a way that when the said electric motor (7, 9) is activated the stator (9) is capable of magnetically attracting the rotor (7) in such a way as to cause it to move axially so that the ratchet device (20) passes from the active condition to the deactivated condition.

4. A synchronous electrical pump according to any of the preceding claims, in which the ratchet coupling device (20) comprises at least one ratchet (23), preferably of elastic material, capable of acting together with the teeth (22) of a formation (21) which can move relative to the said ratchet in a predetermined direction.

5. A synchronous electrical pump according to claim 4, in which the said at least one ratchet is mounted on a part (26) which is stationary relative to the supporting enclosure (2-4) of the pump and the said toothed formation (21) of the ratchet device (20) forms an integral part of the rotor (7) of the motor (7, 9).

6. A synchronous electrical pump according to claim 4, in which the ratchet coupling device (20) comprises a ratchet (23) integral with the rotor (7) of the electric motor (7, 9)

and a toothed formation (21) which is operatively stationary with respect to the supporting enclosure (2-4) of the pump.

7. A synchronous electrical pump according to claim 5, in which the ratchet (23) can move with angular play between consecutive teeth (22) of the toothed formation (21) in such a way that when the electric motor (7, 9) is activated the rotor (7) can rotate through a restricted angle in the contrary direction to the predetermined direction (D) for rotation under operating conditions.

Fig. 1
(PRIOR ART)

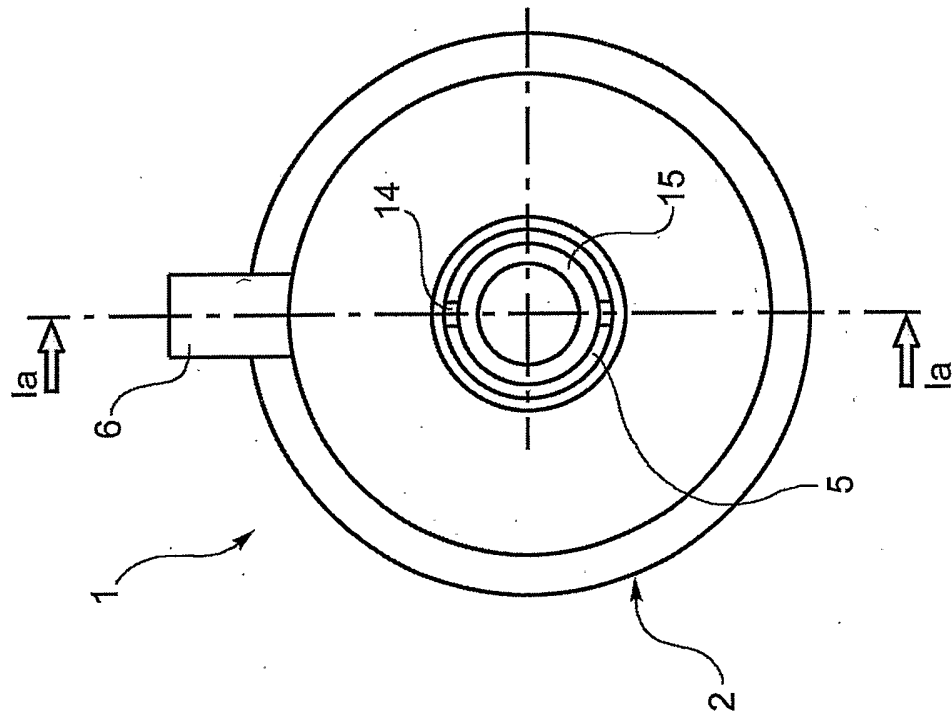


Fig. 1a

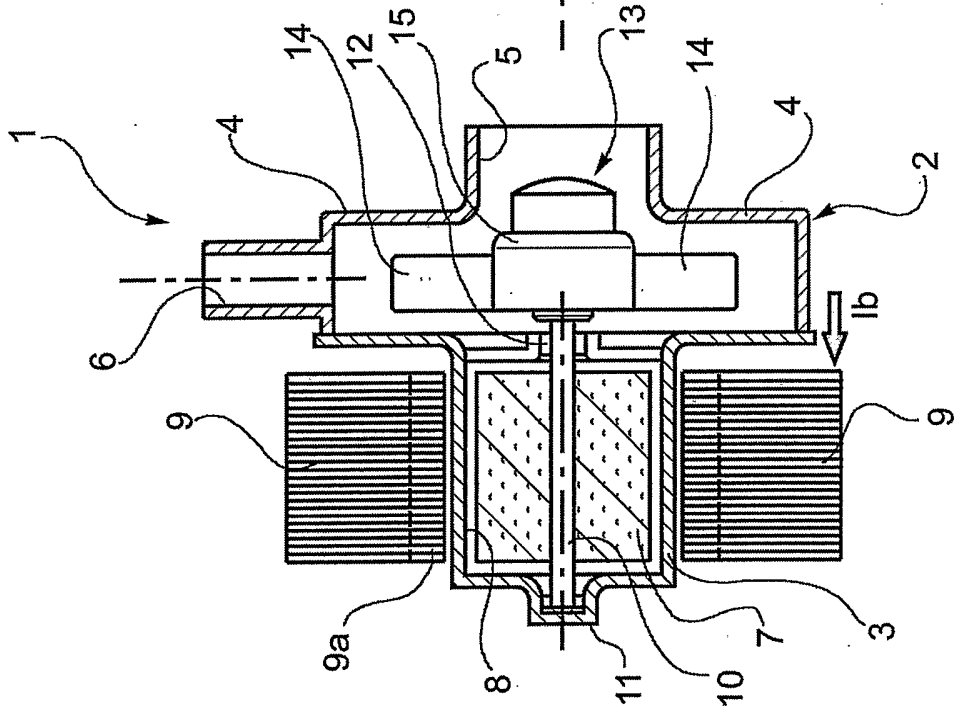


Fig. 1b

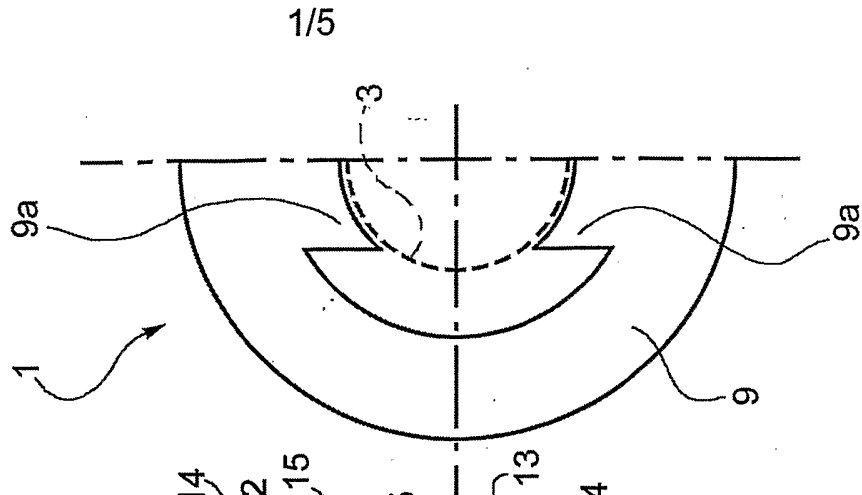


Fig. 2a

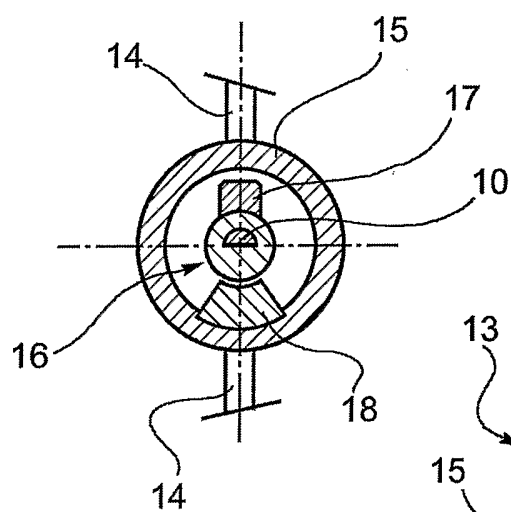
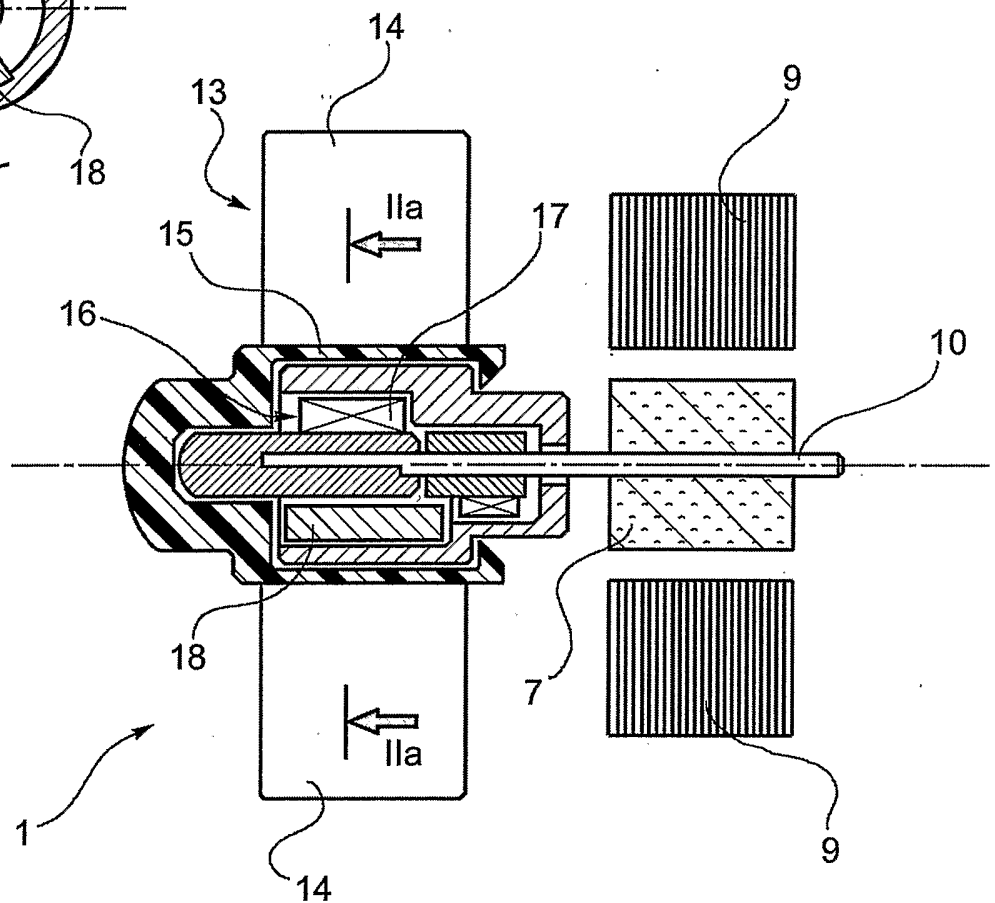


Fig. 2
(PRIOR ART)



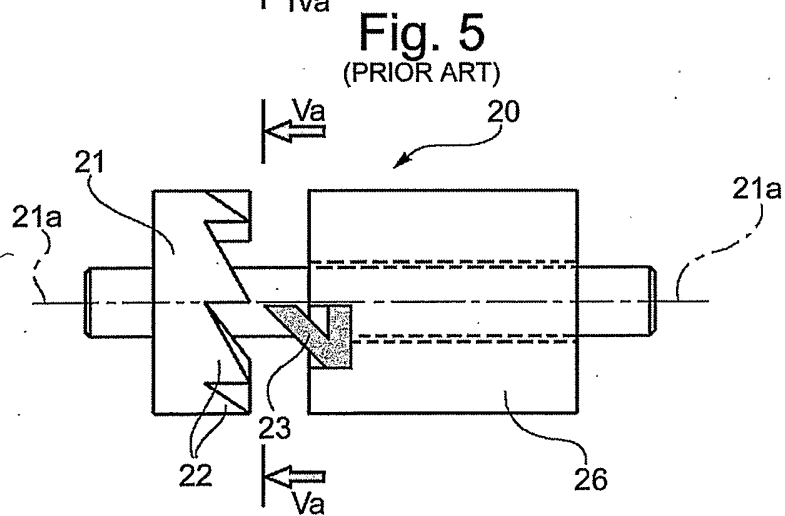
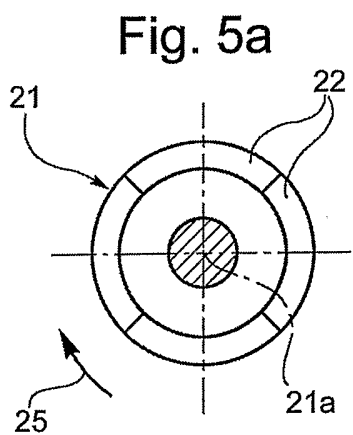
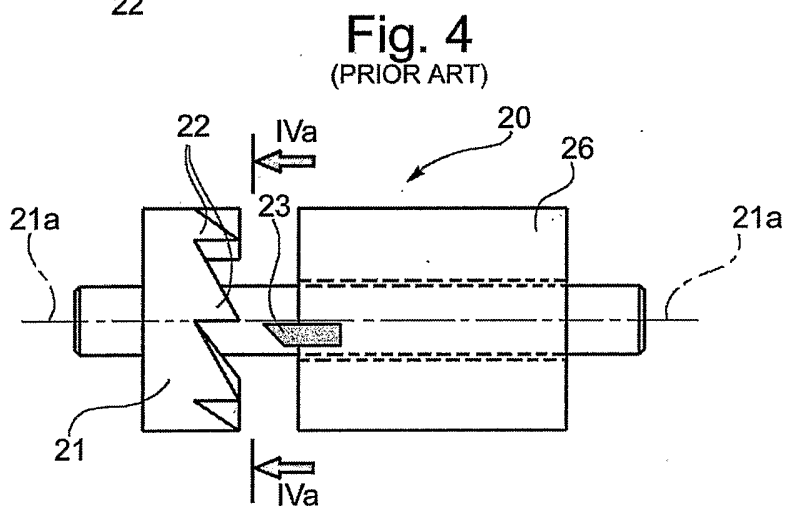
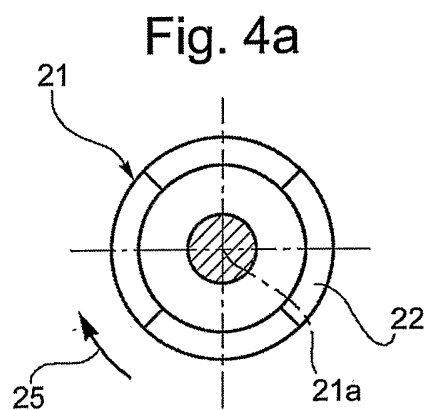
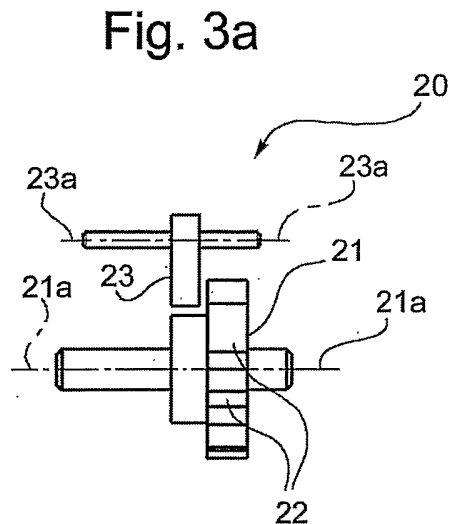
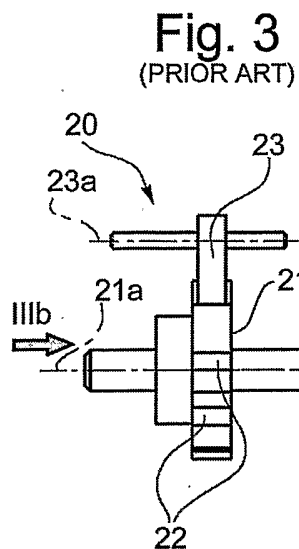
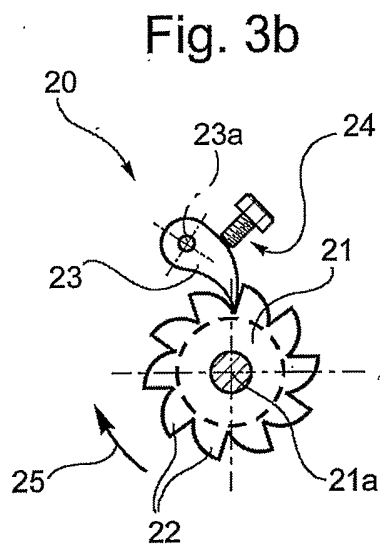


Fig. 6

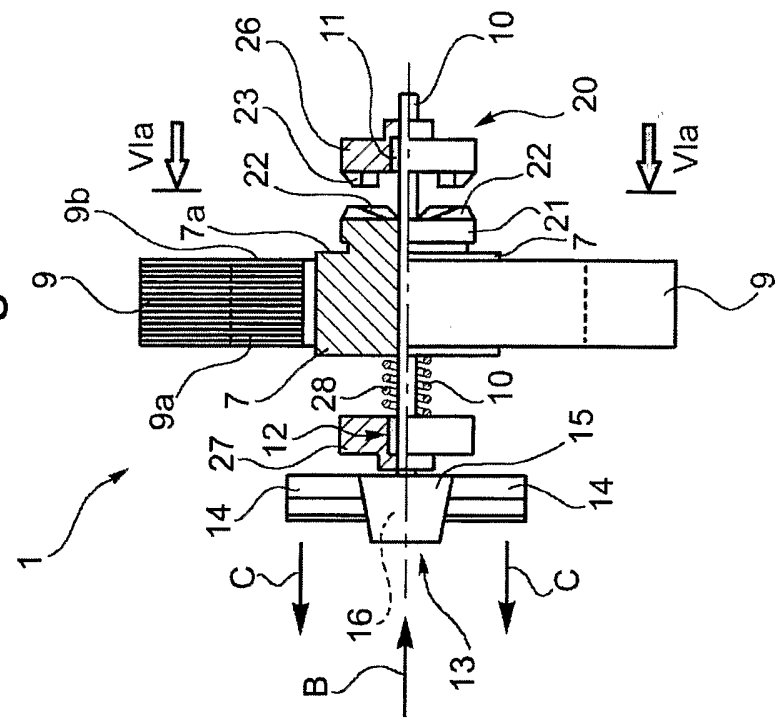
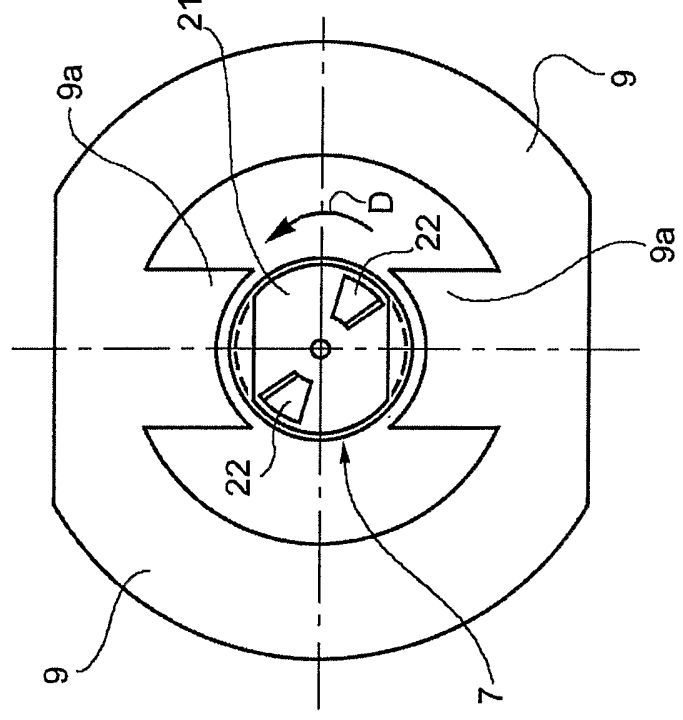


Fig. 6a



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Fig. 7

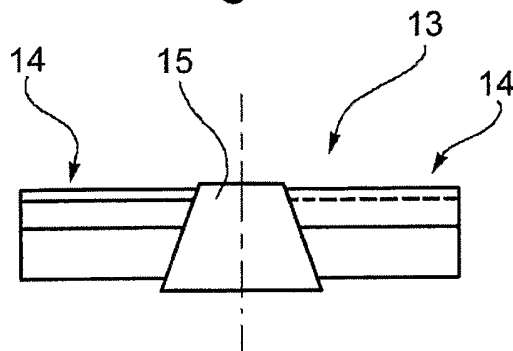


Fig. 7a

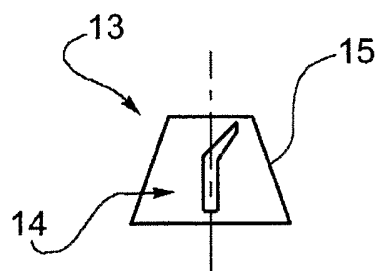


Fig. 9

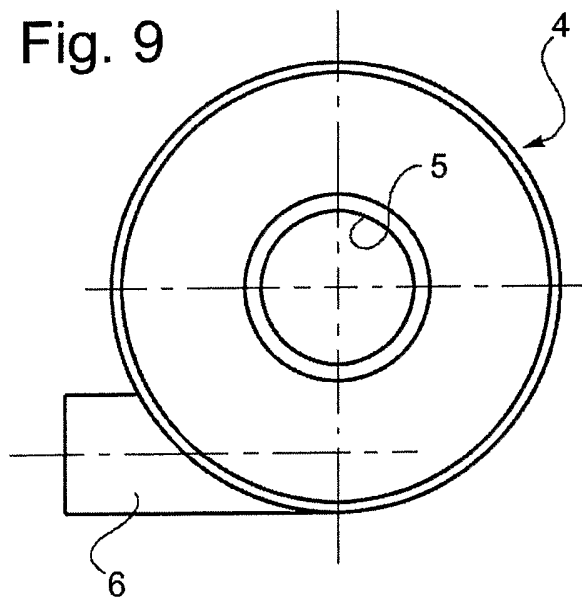


Fig. 9a

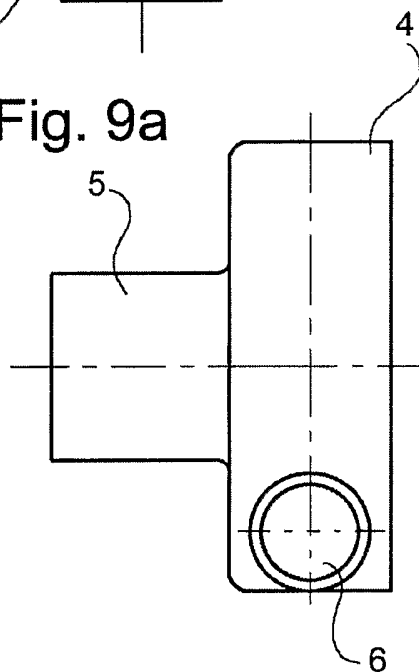


Fig. 8

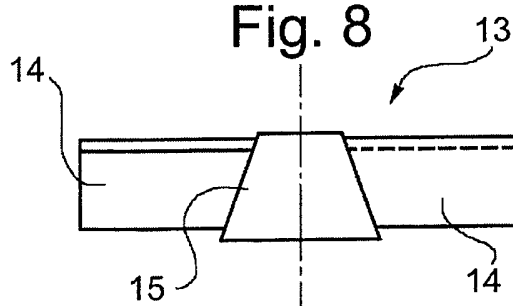
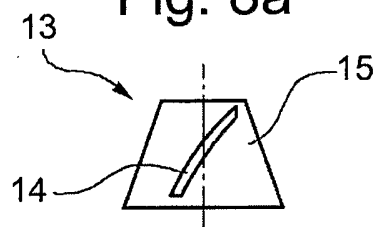


Fig. 8a



INTERNATIONAL SEARCH REPORT

PCT/IB2005/051470

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F04D13/02 F04D13/06 F04D15/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F04D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 039 286 A (POINT ET AL) 13 August 1991 (1991-08-13) the whole document	1-7
Y	EP 0 723 329 A (ASKOLL S.P.A) 24 July 1996 (1996-07-24) the whole document	1-7
A	US 1 663 226 A (WINTROATH JOHN A) 20 March 1928 (1928-03-20) the whole document	1-7

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

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