

Electric fluid pump device

5 The invention is directed to an electric fluid pump device, in particular to an electric liquid pump device for a vehicle.

Such an electric fluid pump device is typically driven by an electronically commutated electric drive motor with a static motor stator and a rotatable
10 motor rotor, wherein the outer motor stator circumferentially surrounds the inner motor rotor. The motor stator and the motor rotor are fluidically separated by a separating means defining a wet rotor chamber and a dry stator chamber. The wet rotor chamber is fluidically connected to a pumping chamber by a hollow driveshaft so that the rotor chamber is
15 flooded with the pumped fluid to cool the power electronic components of the electric drive motor. The electric fluid pump device comprises a sensor magnet body being co-rotatably connected to the driveshaft and a hall sensor for detecting the magnetic field of the sensor magnet body to determine the rotational position of the motor rotor for an exactly timed
20 commutation of the electric drive motor.

It is an object of the present invention to provide an electric fluid pump device with a simple and cost-efficient sensor magnet arrangement that allows a direct and efficient fluid flow between the pumping chamber and
25 the rotor chamber via the hollow driveshaft.

This object is achieved by an electric fluid pump device according to the invention with the features of main claim 1.

30 An electric fluid pump device according to the invention comprises a static pump housing defining a pumping chamber in which a fluid, in particular a

liquid is pumped from a pump inlet to a pump outlet. The electric fluid pump device further comprises an electronically commutated electric drive motor with a static motor stator and a rotatable motor rotor, the outer motor stator circumferentially surrounding the inner motor rotor. A so-called air gap is defined between the motor stator and the motor rotor so that the motor stator and the motor rotor are not contacting each other.

The electric fluid pump device comprises a separating means being arranged radially between the motor stator and the motor rotor within the air gap, thereby fluidically separating the motor stator and the motor rotor by defining a wet rotor chamber and a dry stator chamber. The wet rotor chamber is fluidically connected to the pumping chamber and is thereby flooded with the pumped fluid, preferably oil or water, for cooling power electronic components being preferably arranged referring to the pumping chamber at an opposite axial end of the rotor chamber. The stator chamber is fluidically separated from the rotor chamber and is also fluidically separated from the pumping chamber so that the motor stator does not come in contact with the pumped fluid. The separating means is preferably defined by a pot-shaped separating can or a separating tube.

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The electric fluid pump device further comprises a hollow driveshaft guiding fluid from the wet rotor chamber to the pumping chamber or from the pumping chamber to the wet rotor chamber, wherein the driveshaft is co-rotatably connected to the motor rotor. The driveshaft is preferably provided with a flow guiding channel extending completely through the driveshaft from one axial end surface to the other axial end surface, thereby fluidically connecting the pumping chamber at one axial end of the driveshaft with the rotor chamber at an opposite axial end of the driveshaft.

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The electric fluid pump device comprises an impeller wheel being co-rotatably connected to the driveshaft. The impeller wheel is arranged within the pumping chamber and is driven by the motor rotor of the electric drive motor via the driveshaft to provide a pumping of the fluid in the pumping chamber. The impeller wheel can be of the positive-displacement type or of the flow type so that the electric fluid pump device can be a positive-displacement pump or a flow pump, depending on the pumped fluid, which is preferably oil or water.

10 The electric fluid pump device further comprises a sensor magnet arrangement with a sensor magnet holder and a permanent magnetic sensor magnet body. The sensor magnet arrangement is co-rotatably connected to the hollow driveshaft via the sensor magnet holder, wherein the sensor magnet body is mounted within the sensor magnet holder and
15 is arranged axially adjacent to the driveshaft in a rotationally-defined position with respect to the (electro)magnetic poles of the motor rotor of the electric drive motor. By determining the rotational position of the magnetic poles of the sensor magnet body, the exact rotational position of the (electro)magnetic poles of the motor rotor can be determined to allow
20 an exact timing of the electronic commutation of the electric drive motor.

The sensor magnet holder and the sensor magnet body are provided with an annular shape. The sensor magnet body is therefore preferably defined by a ring magnet, wherein the magnetic poles are arranged diametrically
25 opposite to each other. The sensor magnet arrangement is preferably arranged at an axial end of the driveshaft. Due to the annular shape of the sensor magnet holder and the sensor magnet body, the fluid flowing through the hollow driveshaft also can flow freely and unhindered through both the annular sensor magnet body and the annular sensor magnet
30 holder so that the sensor magnet arrangement does not relevantly affect the fluid transfer between the pumping chamber and the rotor chamber.

As a result, an effective cooling of the electronic components of the electric fluid pump device is guaranteed.

In a particularly preferred embodiment of the present invention, the sensor magnet body is arranged coaxially to the driveshaft. Thereby, the central opening of the annular sensor magnet body is arranged concentrically to the flow guiding channel of the driveshaft which in combination with the axially adjacent arrangement of the sensor magnet body and of the driveshaft allows a non-redirected flow between the pumping chamber and the rotor chamber.

In another particularly preferred embodiment of the present invention, the sensor magnet holder is defined by a sensor magnet holding sleeve into which the sensor magnet body is inserted. The sensor magnet holding sleeve is preferably a deep-drawn and tube-shaped sheet metal component made of a non-ferromagnetic metal, for example a non-ferromagnetic steel to guarantee a sufficient rigidity for safely holding the sensor magnet body in position. Alternatively, the sensor magnet holding sleeve can be made of a high-strength plastic material or any other suitable non-ferromagnetic material.

In another preferred embodiment of the present invention, the sensor magnet holding sleeve is plugged on an axial end of the driveshaft opposite to the pumping chamber. Alternatively, the sensor magnet holding sleeve can be plugged in the central flow guiding channel of the hollow driveshaft. There, an electronics chamber is arranged which is fluidically separated from the rotor chamber by a separating wall being part of the pump housing or the separating means. The electronics chamber houses the electronic components, in particular the power electronic components for driving the electric drive motor. The electronic components generate a large amount of heat which is dissipated by the pumped fluid being guided

to the separating wall via the hollow driveshaft. The separating wall is usually made of a non-ferromagnetic material with relatively good heat transfer characteristics so that an effective heat transfer between the power electronic components and the pumped fluid via the separating wall is provided. By using an annular sensor magnet holder and an annular sensor magnet body an efficient flow of the pumped medium through the rotor chamber is provided so that an effective cooling of the separating wall and the electronic components can be guaranteed. Furthermore, the non-ferromagnetic separating wall material allows a precise detection of the magnetic field of the sensor magnet body through the separating wall.

In another particularly preferred embodiment, the sensor magnet holding sleeve comprises a plug-on section being pressed on the driveshaft and a sensor magnet supporting section for supporting the sensor magnet body, the sensor magnet supporting section being arranged axially adjacent to the driveshaft. The plug-on section is preferably a tube-shaped and hollow-cylindrical section which is mounted onto the driveshaft so that the plug-on section circumferentially surrounds the driveshaft at one axial end. The plug-on section is preferably pressed on the driveshaft via a press-fitted connection so that no additional fixing means is required. Alternatively, the sensor magnet holding sleeve comprises a plug-in section being pressed in the flow guiding channel of the driveshaft. The plug-in section is preferably a tube-shaped and hollow-cylindrical section which is mounted into the driveshaft so that the driveshaft circumferentially surrounds the plug-in section at one axial end. The sensor magnet body is supported within the sensor magnet supporting section so that the sensor magnet body is arranged axially adjacent to the axial end of the driveshaft. As a result, the annular sensor magnet body allows an efficient cooling flow via the hollow driveshaft and guarantees a precise determination of the rotational position of the (electro)magnetic poles of the motor rotor of the electric fluid pump device.

The outer sensor magnet supporting section is preferably provided with a larger diameter than the plug on section. A larger diameter of the sensor magnet supporting section allows to install a relatively large sensor magnet body with a relatively strong magnetic field which guarantees a relatively high resolution with respect to the detection of the magnetic field of the sensor magnet body, in particular if the magnetic field is detected through the separating wall. The larger diameter of the outer sensor magnet supporting section further provides additional radial space for a fixing means, for example an adhesive, which fixes the magnet sensor body within the sensor magnet supporting section. Moreover, with the larger diameter of the sensor magnet supporting section, an axial stop surface is defined for exactly positioning the sensor magnet body within the sensor magnet supporting section.

In a preferred embodiment of the invention, the sensor magnet body is connected to the sensor magnet supporting section by an adhesive bond. The adhesive is preferably provided within the sensor magnet supporting section radially between the sensor magnet body and the sensor magnet supporting section over the complete circumference of the sensor magnet body. The plug on section is preferably plugged on the driveshaft, for example by a press-fitted connection, so that the plug on section diameter is manufactured relatively precisely. The use of an adhesive for fixing the sensor magnet body allows to manufacture the sensor magnet supporting section with less precision compared to the plug on section and therefore results in relatively low manufacturing costs.

In another preferred embodiment of the invention, an axial end of the sensor magnet holding sleeve opposite to the plug-on section is provided with a circumferential reinforcement collar. The reinforcement collar is preferably defined by a L-shaped bended section comprising a radially

extending section extending radially outwards with respect to the sensor magnet holding sleeve. At the radial outer end of the radially extending section, an axial extending section extends axially towards the plug-on section. The reinforcement collar thereby reinforces the axial end of the
5 sensor magnet supporting section. Additionally, the radial extending section defines a type of flow guiding surface to achieve a large-area flow of the pumped medium at the separating wall for an effective cooling of the power electronics.

- 10 In another preferred embodiment of the invention, the sensor magnet holding sleeve is made of a metal sheet, in particular of a non-ferromagnetic metal sheet. For example, the sensor magnet holding sleeve is manufactured by a deep-drawing process. The sensor magnet holding sleeve is therefore relatively cost-efficient and easy to manufacture.

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- In another particularly preferred embodiment, the electric fluid pump device comprises a hall sensor to detect the magnetic field of the sensor magnet body. The hall sensor detects the magnetic field of the magnetic poles of the sensor magnet body so that the exact rotational position of
20 the sensor magnet body can be determined. As a result of the co-rotatable connection between the sensor magnet body and the driveshaft, which is also co-rotatably connected to the motor rotor, the exact rotational position of the motor rotor can be determined. The hall sensor is preferably arranged axially adjacent to the sensor magnet body at the opposite side
25 of the separating wall within the electronics chamber, for example at a printed circuit board. Since the separating wall is preferably made of a non-ferromagnetic material, the hall sensor can detect the magnetic field of the sensor magnet body through the separating wall so that the hall sensor is protected from the pumped medium within the rotor chamber.

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An embodiment of the invention is described with reference to the enclosed drawings, wherein

figure 1 shows an embodiment of an electric fluid pump device according
5 to the invention in a schematic cross-sectional view, and

figure 2 shows an enlarged section of the sensor magnet arrangement of
the electric fluid pump device of figure 1 in a schematic cross-sectional
view.

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Figure 1 shows an electric fluid pump device 10 according to the invention,
in particular an electric water pump for a vehicle. Alternatively, the electric
fluid pump device 10 could be an electric oil pump for a vehicle, wherein
the electric fluid pump device 10 is provided with, for example, a side
15 channel pump stage instead of a centrifugal pump stage. The electric fluid
pump device 10 comprises a static multipart pump housing 12 comprising
a pump cover 121, a motor housing 122, an intermediate flange 123, an
electronics housing 124 and an electronics cover 125. The pump cover 121
and the intermediate flange 123 define a pumping chamber 14 within the
20 static pump housing 12.

The electric fluid pump device 10 further comprises an electronically
commutated electric drive motor 20 with a static motor stator 21 being
arranged within an outer dry stator chamber 18 and a rotatable motor rotor
25 for 23 being arranged within an inner wet rotor chamber 16. The outer
motor stator 21 circumferentially surrounds the inner motor stator 23. The
electric fluid pump device 10 further comprises a separating means 30
being defined by a separating tube 31 extending axially between the
intermediate flange 123 and the electronics housing 124. The separating
30 tube 31 is connected to both the intermediate flange 123 and the

electronics housing 124 by a sealed connection so that the wet rotor chamber 16 is completely sealed against the dry stator chamber 18.

The electric fluid pump device 10 further comprises a hollow driveshaft 15 being co-rotatably connected to the motor rotor 23. The hollow driveshaft 15 extends axially through the rotor chamber 16 and extends further through the intermediate flange 123 into the pumping chamber 14. The hollow driveshaft 15 is provided with a flow guiding channel 155 extending axially through the complete driveshaft 15. Thereby, the through-hole 151 fluidically connects a low-pressure zone of the pumping chamber 14 and the rotor chamber 16. The electric fluid pump device 10 further comprises an impeller wheel 17 being arranged within the pumping chamber 14 and being co-rotatably connected to the driveshaft 15 such that the through-hole 155 of the driveshaft 15 is not covered by the impeller wheel 17.

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The electric fluid pump device 10 comprises a sensor magnet arrangement 40 with an annular sensor magnet holder 42 and a separate annular sensor magnet body 48. Figure 2 shows the sensor magnet arrangement 40 in detail. The sensor magnet holder 42 is defined by a tube-shaped sensor magnet holding sleeve 44 which is made of a non-ferromagnetic metal sheet by a deep drawing process. The sensor magnet holding sleeve 44 comprises a plug on section 441 which is plugged on an axial end 151 of the driveshaft 15 opposite to the pumping chamber 14 so that the plug-on section 441 circumferentially surrounds the driveshaft 15. The plug-on section 441 is fixed to the driveshaft 15 by a press-fitted connection. The sensor magnet holding sleeve 44 further comprises an annular sensor magnet supporting section 442 which extends from the plug-on section 441 axially away from the driveshaft 15 towards a separating wall 128.

The separating wall 128 is part of the electronics housing 124 and separates the rotor chamber 16 from an electronics chamber 19 being

arranged axially adjacent to the rotor chamber 16 at that axial end of the driveshaft 15 being remote to the pumping chamber 14. The electronics chamber 19 houses a plurality of power electronic components 55 for driving the electric motor 20.

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The sensor magnet supporting section 442 is provided with a larger diameter than the plug-on section 441. The sensor magnet body 48 is mounted within the sensor magnet supporting section 442 by an adhesive bond 45, wherein the adhesive circumferentially surrounds the sensor magnet body 48, the adhesive being provided radially between the sensor magnet body 48 and the sensor magnet supporting section 442. Because of the larger diameter of the sensor magnet supporting section 442, an axial stop surface is provided that axially positions the sensor magnet body 48 within the sensor magnet holding sleeve 44. The sensor magnet body 48 is further positioned coaxially to the driveshaft 15 so that the through-hole 155 of the driveshaft 15 and a central sensor magnet body opening 481 are arranged concentrically to each other.

The sensor magnet holding sleeve 442 is provided with a circumferential L-shaped reinforcement collar 443 comprising a radial section 4431 and an axial section 4432. The radial section 4431 extends radially outwards with respect to the distal axial end of the sensor magnet supporting section 442. The axial section 4432 extends axially from the radial outer end of the radial section 4431 towards the pumping chamber 14.

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The electric fluid pump device 10 further comprises a hall sensor 50 being arranged within the electronics chamber 19 at a printed circuit board 52 being in a direct contact with the separating wall 128. The hall sensor 50 is axially aligned to the sensor magnet body 48 at the opposite side of the separating wall 128. The hall sensor 50 thereby detects the magnetic field of the sensor magnet body 48 through the non-ferromagnetic separating

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wall 128 and the non-ferromagnetic printed circuit board 52. Alternatively, the hall sensor 50 can be arranged at the other side of the printed circuit board 52 so that only the separating wall is arranged between the hall sensor and the sensor magnet body 48. With the hall sensor 50, the rotational position of the sensor magnet body 48 can be exactly determined. As a result of the co-rotational connection between the sensor magnet body 48 and the driveshaft 15 via the sensor magnet holder 42 and as a result of the co-rotational connection between the driveshaft 15 and the motor rotor 23, the determination of the rotational position of the sensor magnet body 48 can be used to determine the exact rotational position of the motor rotor 23 which is necessary for a precise electronic commutation of the electric drive motor 20.

In addition to the fluidic connection via the through hole 155 of the driveshaft 15, the rotor chamber 16 is fluidically connected to a high-pressure zone of the pumping chamber 14 via a connection channel 126 within the intermediate flange 123 at a first axial end of the separating tube 31. Result of the pressure difference between the high-pressure zone of the pumping chamber 14 and the low-pressure zone of the pumping chamber 14, a partial volume flow of the total volume flow within the pumping chamber 14 flows into the rotor chamber 16 and flows axially to the other axial end of the rotor chamber 16 until the fluid contacts the separating wall 128. The fluid flows around the reinforcement collar 143, wherein the radial section 4431 additionally guides the fluid along the separating wall 128 until the fluid enters the sensor magnet body opening 481. Then, the fluid flows through the through-hole 155 within the driveshaft 15 back to the low-pressure zone of the pumping chamber 14. The fluid thereby dissipates the heat being generated by the power electronic components 55 within the electronics chamber 19 by transferring the heat via the separating wall 128 to the pumped fluid within the rotor chamber 16. Depending on the pump type, the through-hole 155

can alternatively be fluidically connected to the high-pressure zone of a pumping chamber, whereas the connection channel 126 can be connected to a low-pressure zone of a pumping chamber so that the fluid enters the rotor chamber 16 through the through-hole 155 and flows in opposite
5 direction through the rotor chamber 16.

C L A I M S

- 5 1. Electric fluid pump device (10) comprising:
- a static pump housing (12) defining a pumping chamber (14),
 - an electronically commutated electric drive motor (20) with a static motor stator (21) and a rotatable motor rotor (23), the motor stator (21) circumferentially surrounding the motor rotor (23),
 - 10 - a separating means (30) being arranged radially between the motor stator (21) and the motor rotor (23), the separating means (30) fluidically separating the motor stator (21) and the motor rotor (23) by defining a wet rotor chamber (16) and a dry stator chamber (18),
 - 15 - a hollow driveshaft (15) guiding fluid from the wet rotor chamber (16) to the pumping chamber (14) or vice versa, the driveshaft (15) being co-rotatably connected to the motor rotor (23),
 - an impeller wheel (17) being co-rotatably connected to the driveshaft (15), and
 - 20 - a sensor magnet arrangement (40) with a sensor magnet holder (42) and a separate sensor magnet body (48), the sensor magnet arrangement (40) being co-rotatably connected to the driveshaft (15), wherein
 - 25 the sensor magnet holder (42) and the sensor magnet body (48) are provided with an annular shape.
2. Electric fluid pump device (10) according to claim 1 or 2, wherein the sensor magnet body (48) is arranged coaxially to the driveshaft (15).
- 30 3. Electric fluid pump device (10) according to one of the preceding claims, wherein the sensor magnet holder (42) is defined by a sensor

magnet holding sleeve (44) into which the sensor magnet body (48) is inserted.

4. Electric fluid pump device (10) according to claim 3, wherein the
5 sensor magnet holding sleeve (44) is plugged on an axial end (151) of the driveshaft (15) opposite to the pumping chamber (14).
5. Electric fluid pump device (10) according to claim 3 or 4, wherein the
10 sensor magnet holding sleeve (44) comprises a plug-on section (441) being pressed on the driveshaft (15) and a sensor magnet supporting section (442) for supporting the sensor magnet body (48), the sensor magnet supporting section (442) being arranged axially adjacent to the driveshaft (15).
- 15 6. Electric fluid pump device (10) according to claim 5, wherein the outer sensor magnet supporting section (442) is provided with a larger diameter than the plug-on section (441).
7. Electric fluid pump device (10) according to claim 5 or 6, wherein the
20 sensor magnet body (48) is connected to the sensor magnet supporting section (442) by an adhesive bond (45).
8. Electric fluid pump device (10) according to one of the claims 5-7,
25 wherein an axial end (4421) of the sensor magnet holding sleeve (442) opposite to the plug-on section (441) is provided with a circumferential reinforcement collar (443).
9. Electric fluid pump device (10) according to one of the claims 3-8,
30 wherein the sensor magnet holding sleeve (442) is made of a metal sheet.
10. Electric fluid pump device (10) according to one of the preceding claims, wherein the electric fluid pump device (10) comprises a hall

sensor (50) to detect the magnetic field of the sensor magnet body (48).

-1/2-

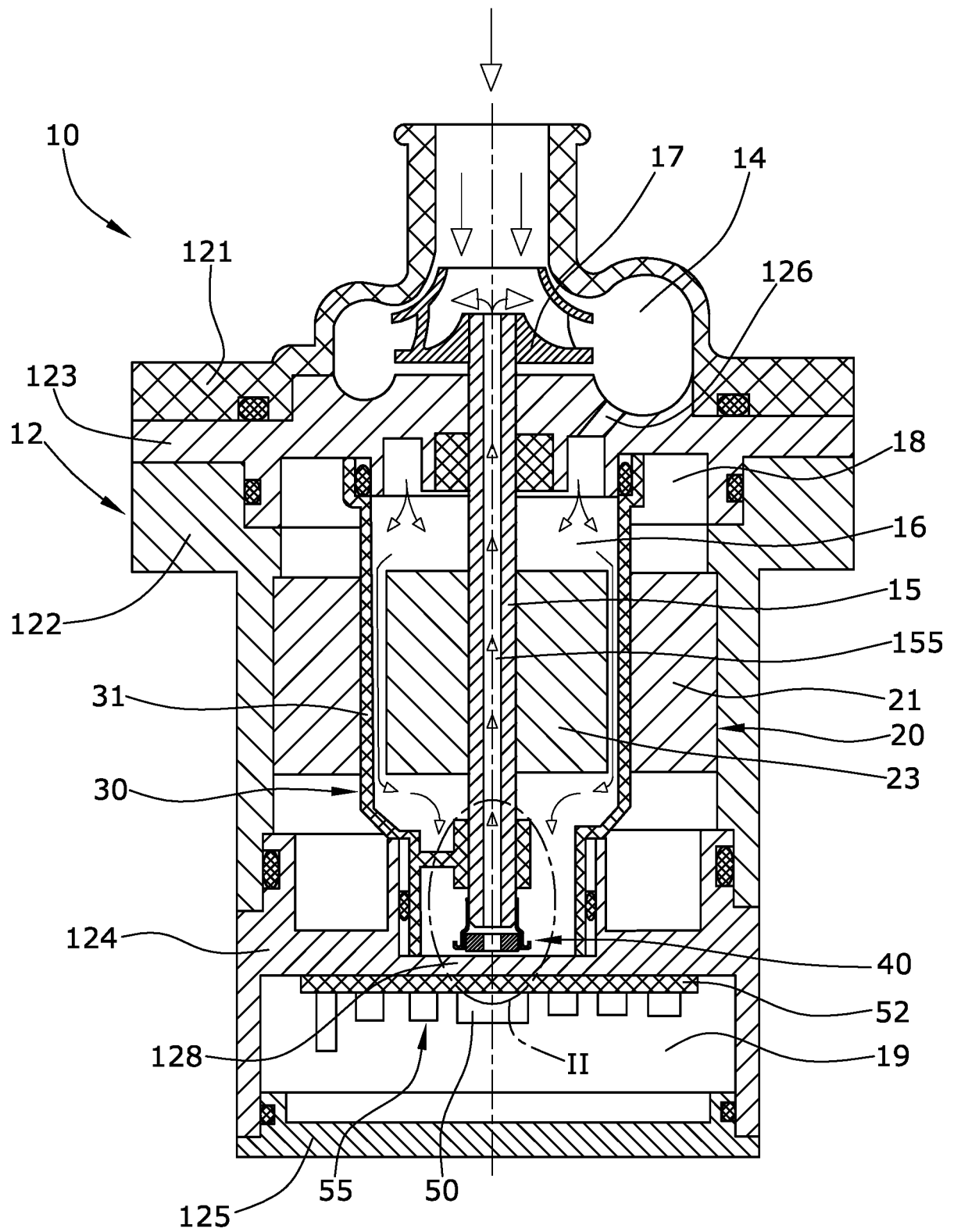


Fig.1

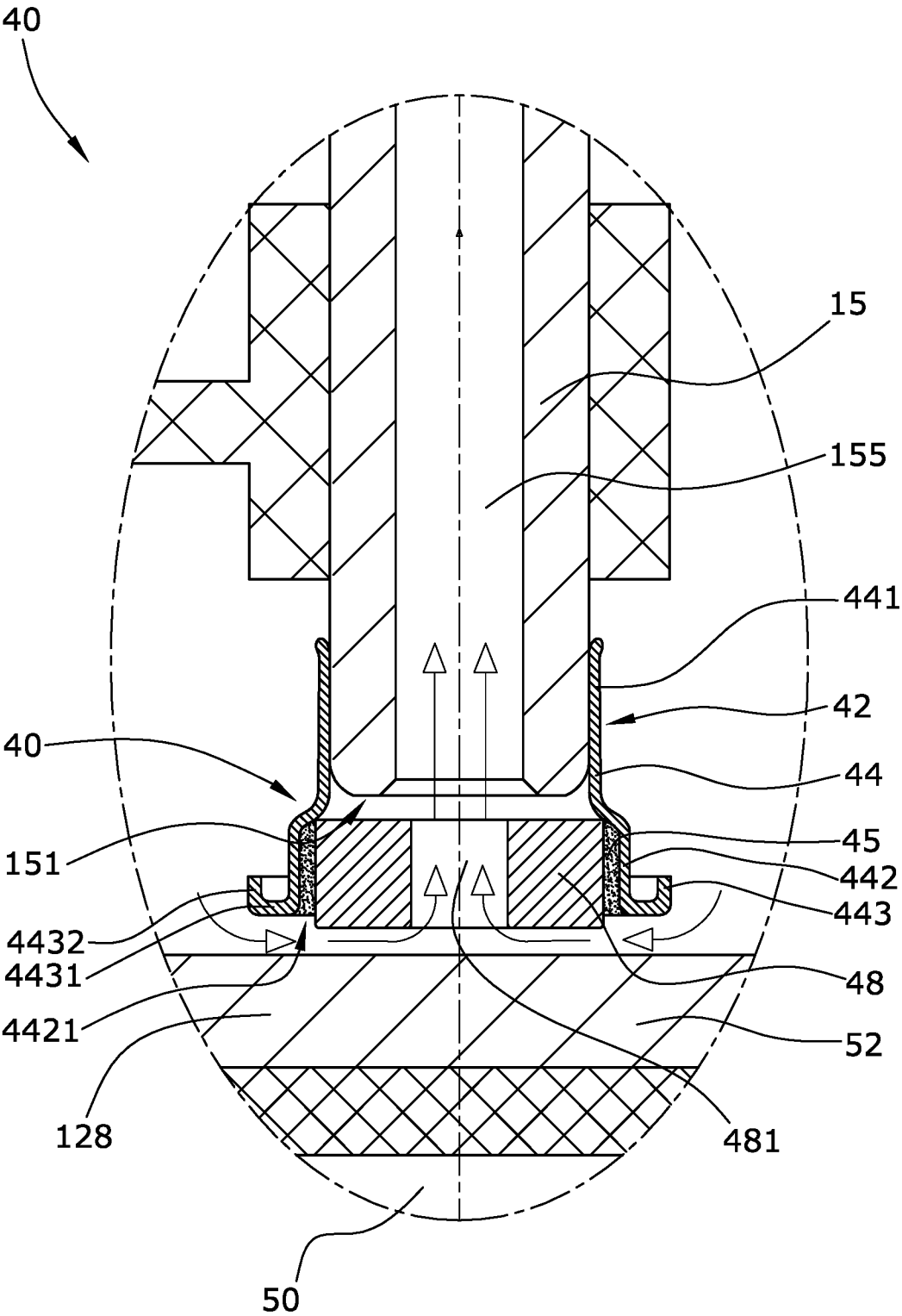


Fig.2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/068333

A. CLASSIFICATION OF SUBJECT MATTER INV. F04D13/06 F04D15/00 F04D29/58 ADD.		
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) 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 practicable, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 113 250 971 A (KUNSHAN LONGZHONG MAXGREEN AUTO PARTS CO LTD) 13 August 2021 (2021-08-13)	1-5, 7, 8, 10
Y	paragraph [0001] paragraph [0026] paragraph [0027] claims 5, 6 figures 1, 6	6, 9
X	CN 113 217 405 A (KUNSHAN LONGZHONG MAXGREEN AUTO PARTS CO LTD) 6 August 2021 (2021-08-06)	1-5, 7, 8, 10
Y	paragraph [0001] paragraph [0025] claim 8 figure 1	6, 9
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 15 January 2024		Date of mailing of the international search report 26/01/2024
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Kolby, Lars

INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 110 486 290 A (JINCHENG NANJING ELECTROMECHANICAL HYDRAULIC PRESSURE ENG RES CT AVIAT) 22 November 2019 (2019-11-22)	1, 2, 10
Y	paragraph [0021] - paragraph [0024]	6, 9
A	paragraph [0031] figure 1	3-5, 7, 8

Y	WO 2022/085457 A1 (NTN TOYO BEARING CO LTD [JP]) 28 April 2022 (2022-04-28)	6, 9
A	abstract paragraph [0045] paragraph [0086] figures 1, 8	1-5, 7, 8, 10

Y	DE 10 2021 210043 A1 (VITESCO TECHNOLOGIES GERMANY GMBH [DE]) 16 March 2023 (2023-03-16)	6, 9
A	abstract paragraph [0017] - paragraph [0018] paragraph [0025] - paragraph [0028] claims 7, 8, 12 figures 1, 2	1-5, 7, 8, 10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2023/068333

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
CN 113250971	A	13-08-2021	NONE	
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WO 2022085457	A1	28-04-2022	EP 4230869 A1 US 2023374993 A1 WO 2022085457 A1	23-08-2023 23-11-2023 28-04-2022
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