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(54) **Water pump having a reservoir**

(57) In a water pump for the cooling system of an IC-engine, a small amount of fluid leaking through a seal is drained into a weep reservoir. The latter is heated by the engine heat and/or by friction heat, which allows the leakage fluid to evaporate. According to prior art, the reservoir is usually formed integrally in the pump housing. Here, the reservoir is made of two parts: The first part is integrally formed in the pump housing (as usual) and the second part is separate. The second part is located below the first part, so the liquid falls mainly into the second part. This construction allows to design the second part with a lower heat capacity than the pump housing, e.g. by making it out of plastic or sheet metal. The main advantage is that the liquid will be heated more quickly, which improves the evaporation process. A second advantage is the modularity: The size of the second part may be easily adapted to any evaporation capacity requirement.

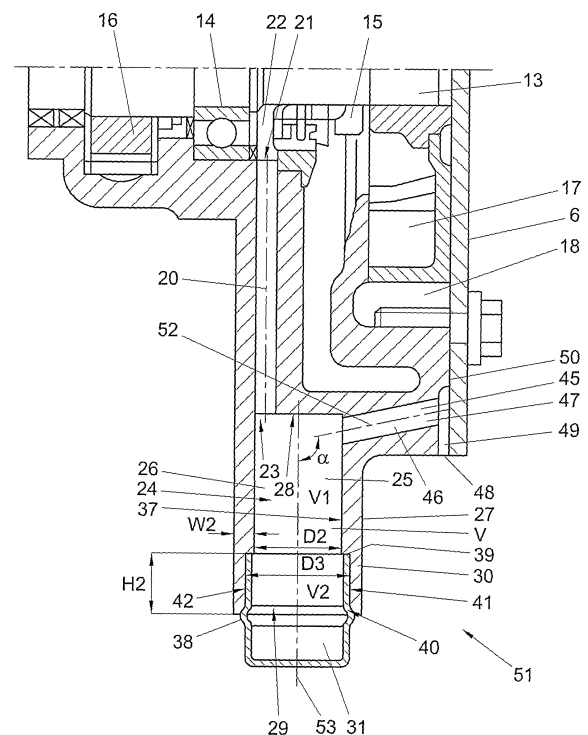


FIG. 3

Description

Technical Field

[0001] The present disclosure relates generally to a water pump and, more specifically, to a water pump comprising a reservoir.

Background

[0002] Engines such as internal combustion engines comprise an engine block and a cooling circuit for cooling the engine block and the various parts included therein such as pistons and drive shafts. A water pump will be included in the cooling circuit for circulating a coolant through the cooling circuit.

[0003] A water pump will comprise a drive shaft extending through a pump housing, which shaft is born by a bearing and sealed against the housing by a seal. At a side internal to the housing an impeller will be connected to the shaft, whereas to the opposite side of the shaft a pulley or drive wheel will be connected for driving the impeller. When the engine is driven the shaft will be rotated by the pulley, forcing the coolant through the cooling circuit by the impeller. A small amount of the coolant will be forced from the cooling circuit past the seal, lubricating the seal, bearing and shaft. To prevent the coolant from being spilled over the engine a weep reservoir may be provided, collecting the coolant passing the seal. An evaporation hole may be provided, connecting the weep reservoir with the environment. Since the water pump will be provided at a relatively hot side of the engine, the coolant will evaporate from the weep reservoir through the evaporation hole.

[0004] In European Patent Application 1 748 193 (the "193 application) a water pump is described having such configuration. In this known water pump the weep reservoir is formed in a frontal part of the water pump housing. It has a cylindrical shape and has an open front end, closed off by a plug. A channel extends from the area around the shaft and seal into the reservoir for draining coolant passing the seal into the reservoir. An evaporation opening is provided above the plug, connecting the reservoir with the environment, shielded by the pulley.

[0005] Although the reservoir of the "193 application can collect coolant to be evaporated, the volume of the reservoir is limited by the depth and cross section of the reservoir defined by the cast part. Coolant collected in the reservoir may spill through the evaporation hole in the liquid phase, for example when the engine is moved in any direction, when the engine is tilted or when the engine is not heated properly to a temperature sufficient for evaporating the coolant at a sufficient rate. This means that coolant may leak from the reservoir in liquid form and spill onto the engine or any surrounding surface. This can lead to corrosion and pollution or give the false impression that the water pump or cooling circuit is not operating properly. Furthermore, in order to provide for

a reservoir large enough, the casting may be complicated and require a relatively large amount of metal, leading to undesirable manufacturing costs and weight and a large overall size of the pump housing. Moreover, for different engines a different size of weep reservoir may be required, leading to a number of pump housings, identical except for the size of the weep reservoir.

[0006] The disclosed water pump is directed to address at least one of the problems set forth above.

Summary of the Invention

[0007] In one aspect, the disclosure is directed to a water pump. The water pump includes a pump housing and a reservoir. A first portion of the reservoir can be provided in the pump housing. A second portion of the reservoir is made as a separate part. The second portion has an internal volume that is in fluid communication with the first portion.

[0008] In another aspect, the present disclosure is directed to a set of a pump housing and a reservoir part. The pump housing comprises a first portion of a reservoir. The reservoir part forms a second portion of the reservoir and is made as a separate part from the pump housing and has an internal volume.

[0009] In still another aspect, the present disclosure is directed to a method of pumping fluid. The method includes drawing a fluid into a pump housing and pressurizing the fluid in the housing. At least part of the fluid is directed to a seal and bearing, whereby at least part of the fluid is forced past the seal. At least part of that fluid is collected in part of a reservoir coupled to the pump housing. At least the part of the reservoir in which the fluid is collected is heated and the fluid collected therein is evaporated.

[0010] Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Brief Description of the Drawings

[0011] Fig. 1 is a frontal elevation view of a water pump;

[0012] Fig. 2 is a cross sectional view of the water pump of fig. 1 taken along the line A - A;

[0013] Fig. 3 is a cross sectional view of the water pump of fig. 1 taken along the line B - B; and

[0014] Fig. 4 is a side view, partially in cross section, of a part of a water pump weep reservoir that can be used in a water pump of fig. 1.

Detailed Description

[0015] Referring to Fig. 1 and 2, an exemplary embodiment of the current disclosure shows a water pump 1 attached to the frontal side 2 of an engine block 3, only part of which is shown. The engine block can be of an engine of any type, such as an internal combustion engine running on for example gas, diesel, natural gas, ker-

osene or bio fuel. In this disclosure reference will be made to a water pump 1 although other liquids and mixtures than water can and normally may be pumped with the water pump, such as but not limited to glycol and glycol solutions and other commonly available coolant fluids. The water pump 1 has a pump housing 4 which can be cast from metal such as iron, aluminum, magnesium or steel or alloys thereof. The pump housing 4 is provided with a number of openings 5 through which it can be bolted to the engine block 3. A cover 6 is provided on the pump housing 4, closing an open side 7 of the pump housing 4. At least one opening 8 is provided in the pump housing 4 allowing fluid communication between part of a coolant circuit 9 in the engine block 3 and an inner volume 10 of the pump housing 4.

[0016] At a side 11 of the pump housing 4 a bearing housing 12 is provided. A shaft 13 extends through the bearing housing 12 and is born in the bearing housing 12 by a bearing assembly 14. A primary seal assembly or seal 15 is provided in the pump housing 4, sealing at one side against the shaft 13 and at the opposite side against the pump housing 4. The seal 15 is provided between the inner volume 10 and the bearing assembly 14. At the side of the bearing assembly 14 facing away from the seal 15 a toothed wheel 16 is provided on the shaft 13. The toothed wheel 16 is or can be brought into engagement with a drive mechanism (not shown) for rotating the shaft 13. In an embodiment the drive mechanism can comprise a shaft such as but not limited by a cam shaft, crank shaft or an auxiliary shaft, having a toothed wheel engaging the toothed wheel 16. In another embodiment a drive wheel such as a pulley can be attached to the shaft 13 at an end facing away from the engine block 3, outside the pump housing 4, for driving the pump 1 for example by a belt which belt can in an embodiment be driven by a pulley attached to a shaft such as a crank shaft of the engine 3. In an embodiment such belt can also drive a dynamo. Within the inner volume 10 of the pump housing 4 an impeller 17 is mounted to the shaft 13. The impeller 17 is enclosed in a pump chamber 18 in the pump housing 4. An inlet 19 is provided in the pump housing 4, in fluid communication with the pump chamber 18. The opening 8 opens into the pump chamber 18.

[0017] Fig. 3 shows a cross sectional view taken along the line B - B in Fig. 1. Fig. 3 shows a channel 20 extending through the pump housing 4, between an inlet end 21 communicating with a space 22 between the bearing assembly 14 and the seal 15 and an outlet end 23 in fluid communication with a reservoir, generally indicated with reference sign 24. The reservoir has a first portion 25 incorporated in the pump housing 4. The first portion 25 may be integrally cast with the pump housing 4. Alternatively at least part of the first portion 25 can be drilled or otherwise machined into the pump housing 4. The first portion 25 may have an internal volume V1. In the embodiment shown in Fig. 2 and 3 the first portion 25 includes a substantially cylindrical bore 26 having a side wall 27 and a top face 28. The outlet end 22 of the channel

20 is positioned in the top face 28. At the side opposite the top face 28 the first portion 25 has an opening 29 and has a rim portion 30, widened relative to the further part of the bore. A second portion 31 of the reservoir 24 is connected to the pump housing 4, in fluid communication with the first portion 25. In the embodiment shown the second portion can be press fit into the rim portion 30, or it can be otherwise fixed to the pump housing 4, for example by glue, sealant, screw thread, bayonet means or any other suitable coupling. The second portion 31 has an internal volume V2.

[0018] The second portion 31 is a part made separate from the pump housing 4. The second portion may for example be made at least partly of sheet metal or plastic, using any appropriate technique, such as but not limited to forging, milling, molding, casting or pressing. In fig. 4 an exemplary embodiment of a second portion 31 is shown, in an enlarged scale, partly broken away. The second portion 31 is in this embodiment substantially cup shaped and can have a substantially cylindrical wall 32, closed off at one end 33 by an end wall 34 and open at the opposite end 35. The second portion can have an inner diameter D1 similar or about equal to an inner diameter D2 of the first portion 25 above the rim portion 30. The wall 32 can have a relatively small thickness W1, for example compared to the average thickness W2 of the wall 27 of the first portion 25 in the pump housing 4. The rim portion 31 can have an inner diameter D3 which is comparable to the outer diameter D4 of the second portion, at least near the open end 35, such that the inner surface 36 of the second portion can be substantially flush with the inner surface 37 of the first portion 25 between the rim portion 31 and the top face 28. The second portion 31 has an inner length L1 between the open end 35 and the end wall 34. At a distance H1 from the open end 35 an outward extending rim 38 is provided on the second portion 31, in the embodiment shown this rim can be formed by a deformation of the wall 27 outward. The rim portion 30 has a height H2 similar to and preferably equal to the height H1, such that when the second portion 31 is inserted into the rim portion 30 the open end 35 abuts a shoulder 39 formed at the end of the rim portion 30 and the rim 38 abuts the edge 40 of the rim portion 30 at the open side of the first portion. In the embodiment shown a sealant such as a glue can be provided between the inner side wall 41 of the rim portion 30 and the outside of the wall 27 between the open end 35 and the rim 38. In such embodiment the rim portion 30 can form a first coupling 42 and the wall part 43 of the second portion 31 between the rim 38 and the open end 35 can form a second coupling 44.

[0019] A channel 45 extends between an inlet end 46 at the reservoir 24 and an outlet end 47 in a surface of the pump housing 4. The outlet end 47 can form or be in communication with an evaporation opening 48. In the detail shown in Fig. 3 the outlet end 47 is positioned in a recess 49 in the face 50 of the pump housing 4 behind the cover 6. The recess 49 opens to a side 51 of the

pump housing 4 and defines the evaporation opening 48. The channel 45 can have a longitudinal axis 52 extending at an angle α relative to a longitudinal axis 53 of the first portion 25. The angle α is preferably such that the channel 45 runs slightly upward in the direction of the outlet end 47 and can for example be between about 90 and 110 degrees. The inlet end 46 of the channel 45 can be close to or even directly adjacent to the top face 28. Alternatively the inlet opening 46 can be in the top face 28. In general the inlet opening can be above the lower most part of the reservoir 24, preferably above the end wall 35 of the second portion 31 and more preferably above the second portion 31.

[0020] As is shown in Fig. 2 a ventilation channel 54 can be provided at an upper part of the pump housing 4, connecting the space 22 with the environment 55 of the pump housing. Ventilation channel 54 can extend substantially vertically from the space 22 to a top 56 of the pump housing 4 and can extend as a tangent of the space 22.

[0021] The inner volume V1 of the first portion 25 can for example be between about 0 and 12 cubic centimeter (cc), preferably between about 0 and 6 cc. In a preferred embodiment the first volume V1 can be between about 2 and 5 cc. The second volume V2 can for example be between about 1 and 12 cc, preferably between about 1 and 10 cc, more preferably between about 1 and 8 cc. In a preferred embodiment the second volume V2 can be between about 2 and 5 cc. The total volume V of the reservoir 24 can for example be between about 5 and 20 cc, preferably between about 6 and 15 cc. In a preferred embodiment the volume V can be between about 7 and 14 cc. The internal volume V1 of the first portion can be defined by the volume enclosed within the part of the wall 27 extending between the top face 28 and the shoulder 39. The internal volume V2 of the second portion 25 can then be defined by the volume enclosed within the outer wall thereof. In this disclosure the word about has to be understood as meaning that at least a deviation of 10% of any given value is also disclosed, unless specifically indicated otherwise.

[0022] With a pump housing 4 of a given configuration, for example as shown in fig. 1 - 3, different second portions 31 can be used, as long as they have a second coupling 44 that can be coupled with the first coupling 43 of the first portion 25. This means that different second portions 25 having different internal volumes V2 can be used with the pump housing 4 for providing reservoirs 24 having different volumes V, shapes and/or dimensions. Furthermore, second portions 25 made of different materials and/or using different techniques can be used. Any one of the second portions 25 and a pump housing 4 can form a set 57 allowing the formation of a reservoir with a specific size and configuration, suitable to for example a specific engine or use.

[0023] In an embodiment the volume V of the reservoir can be almost entirely formed by the volume V2 of the second portion 25. The rim portion 30 will then be directly

adjacent the top face 28.

[0024] In a further embodiment the reservoir may have a longitudinal axis 34 extending substantially parallel to the shaft 13, providing for easy casting. In an embodiment the first and/or second portion can be non symmetrical or non cylindrical, or can for example be somewhat bottle shaped, having a neck portion formed by the second coupling 44 and a wider body, formed by the portion between the coupling 44 and the end wall 34, which can provide for a larger volume V with a shorter overall length L1.

Industrial Applicability

[0025] During operation of the water pump 1 the shaft 13 is driven rotating within the bearing 15. This may be effected by a gearing between a rotating shaft (not shown) of the engine 3 and the toothed wheel 16. The shaft 13 rotates the impeller 17 in the pump chamber 18, which is at least partly filled with coolant. By the rotation of the impeller 17 coolant is drawn into the pump chamber 18 from the coolant circuit 9, through the inlet 19, and is pressurized in the chamber 18. Most of the pressurized coolant may then be forced out of the chamber 18 by the impeller 17. Part of the coolant is forced past the seal 15 into the space 22 between the bearing assembly 14 and the seal 15, lubricating the seal 15, the bearing assembly 14 and the shaft 13 at least to some extent. The coolant that has passed the seal 15 and entered the space 22 can be drained from the space 22 through the channel 20 and be collected in the reservoir 24. This prevents the coolant to be spilled directly on the engine or into the environment, preventing corrosion or pollution and preventing an unfounded belief that the engine, especially the water pump 1 would be leaking. This could stop for example unnecessary stopping of the engine and thus loss of operation time, undue repair or replacement of the water pump and general annoyance for the users. Moreover, if coolant were spilled in liquid form it could also lead to interference with for example engine management, which could also lead to for example loss of operation time and avoidable repairs and costs.

[0026] In an exemplary embodiment as shown in the drawings, coolant that has passed the seal 15 and is collected in the reservoir 24 will for the most part be collected in the lower part of the reservoir, which is formed by the second portion 31. Since the reservoir 24 can be mainly positioned near a front end of the engine or at least near the engine at a relatively hot position when the engine is running, heat from the engine 3 will heat up the reservoir 24 and the coolant collected therein.

This coolant can therefore evaporate and escape from the reservoir in gaseous phase, through the channel 45 and the evaporation opening 48, passing the recess 48.

[0027] In an embodiment the second portion 31 can have a heat capacity substantially lower than the first portion 25. This can lead to the effect that even at relatively low engine temperatures the second portion 31 can be heated enough to make the coolant collected therein

evaporate.

[0028] A water pump 1 according to this disclosure can be used with any type of engine and in any type of vehicle or machine. It has been recognized that some engines, vehicles or machines desire a larger reservoir than other engines, vehicles or machines. For example, when a machine or vehicle is used on terrain leading to large elevations or on rough surfaces or even at accelerations of decelerations of the engine, a smaller reservoir of the prior art may lead to spilling of liquid coolant through an evaporation opening. Even if the volume of this prior art reservoir would be sufficient to hold all coolant collected therein when the engine would be stationary. Increasing the overall size and volume of such known reservoir integrated in the pump housing might solve such problem to some limited extent, but would lead to an unnecessarily large, expensive and heavy water pump, which would be hard to manufacture, if at all possible.

[0029] Embodiments of a water pump 1 according to this disclosure can be manufactured by any method of manufacturing, for example casting a pump housing 4 which includes the first portion 25 of the reservoir 24 as an integral part. The first portion 25 can be relatively shallow, which enables easy and secure, exact manufacturing. The first portion 25 can moreover be relatively small in diameter, allowing positioning thereof in a part of the pump housing 4 being relatively narrow in width. Nevertheless the overall volume V of the reservoir can be made relatively large, using a second portion 31. Furthermore, a set 57 of a pump housing 4 and a second portion 31 can be chosen on the basis of for example the intended use of the water pump and of the vehicle or machine in which an engine 3 has to be used bearing the water pump 1. For example when it is expected that the engine or a vehicle or machine equipped therewith will be used on rough terrain or at steep elevations a second portion 31 can be chosen having a relatively large volume V₂, resulting in a large overall volume. If the same or another type of engine, machine or vehicle will normally be used on a smooth surface or stationary, without any significant elevation, a smaller second portion 31 may be sufficient, reducing the overall volume, weight and cost of such water pump 1.

[0030] Although the preferred embodiments of this invention have been described herein, improvements and modifications may be incorporated without departing from the scope of the following claims.

Claims

1. A water pump, comprising:

a pump housing; and
a reservoir having first and second portions, the first portion of the reservoir being provided in the pump housing and the second portion of the reservoir being a separate part having an internal

volume in fluid communication with the first portion.

2. The water pump of claim 1, wherein the first portion is cast with the pump housing.
3. The water pump of claim 1 or 2, wherein the second portion is made of at least one of sheet metal and plastic.
4. The water pump as in any one of claims 1 - 3, wherein the first portion includes an opening and a first coupling and the second portion is provided with a second coupling that cooperates with the first coupling and that retains the second portion in position at the opening.
5. The water pump as in any one of claims 1 - 4, wherein the first and second couplings are designed for at least one of a press fit connection and a sealant connection.
6. The water pump as in any one of claims 1 - 5, wherein the second portion is manufactured by forging.
7. The water pump as in any one of claims 1 - 5, wherein the second portion is manufactured by molding.
8. The water pump as in any one of claims 1 - 7, wherein the first portion has a first volume and the second portion has a second volume.
9. The water pump as in any one of claims 1 - 8, further including an evaporation opening provided at a level above a lower end of the second portion, preferably above the second portion.
10. The water pump as in any one of claims 1 - 9, wherein the first portion has an internal volume between about 0 and 12 cc, preferably between about 0 and 6 cc and more preferably between 2 and 5 cc.
11. The water pump of claim 10, wherein the internal volume of the reservoir is between about 5 and 20 cc, preferably between about 6 and 15 cc and more preferably between 7 and 14 cc.
12. The water pump of any one of claims 1 - 11, wherein the second portion has a lower heat capacity than the pump housing.
13. A set of a water pump housing comprising a first portion of a water pump reservoir and at least one second portion of the water pump reservoir made as a separate part.
14. The set of claim 13, wherein the pump housing is a cast housing and the second portion is made of at

least one of sheet metal and plastic.

- 15.** The set of claim 13 or 14, wherein a number of second portions is provided, the second portions having different internal volumes. 5
- 16.** A method of pumping fluid, comprising:
- drawing in fluid into a pump housing;
 - pressurizing the fluid; 10
 - directing at least part of the fluid past a seal;
 - collecting at least part of the fluid passing the seal in a part of a reservoir coupled to the pump housing;
 - heating the part of the reservoir and evaporating the collected fluid. 15
- 17.** The method of claim 16, wherein the collected fluid is heated in the part of the reservoir made of at least one of sheet metal and plastic having a heat capacity lower than the pump housing. 20
- 18.** Engine, comprising; a coolant circuit; a water pump included in the coolant circuit, wherein the water pump comprises: 25
- a pump housing; and
 - a reservoir;
- wherein the reservoir comprises a part separate from the pump housing and in fluid communication with the housing; the separate part having an internal volume in fluid communication with the pump housing; and the pump housing having at least one evaporation opening in fluid communication with the reservoir. 30 35
- 19.** The engine of claim 18, wherein the at least one evaporation opening is provided at a side of the pump housing facing away from the coolant circuit. 40

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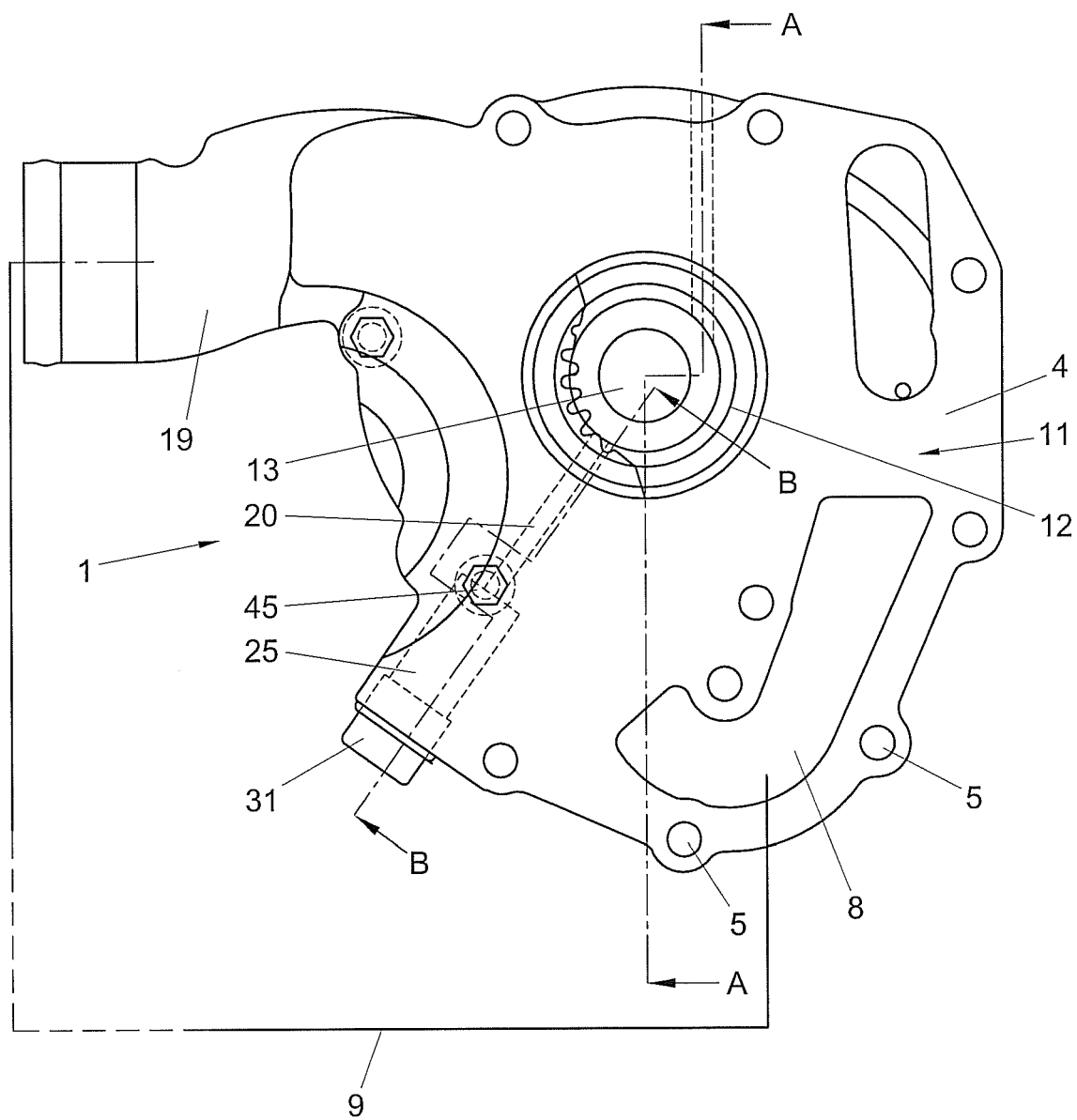


FIG. 1

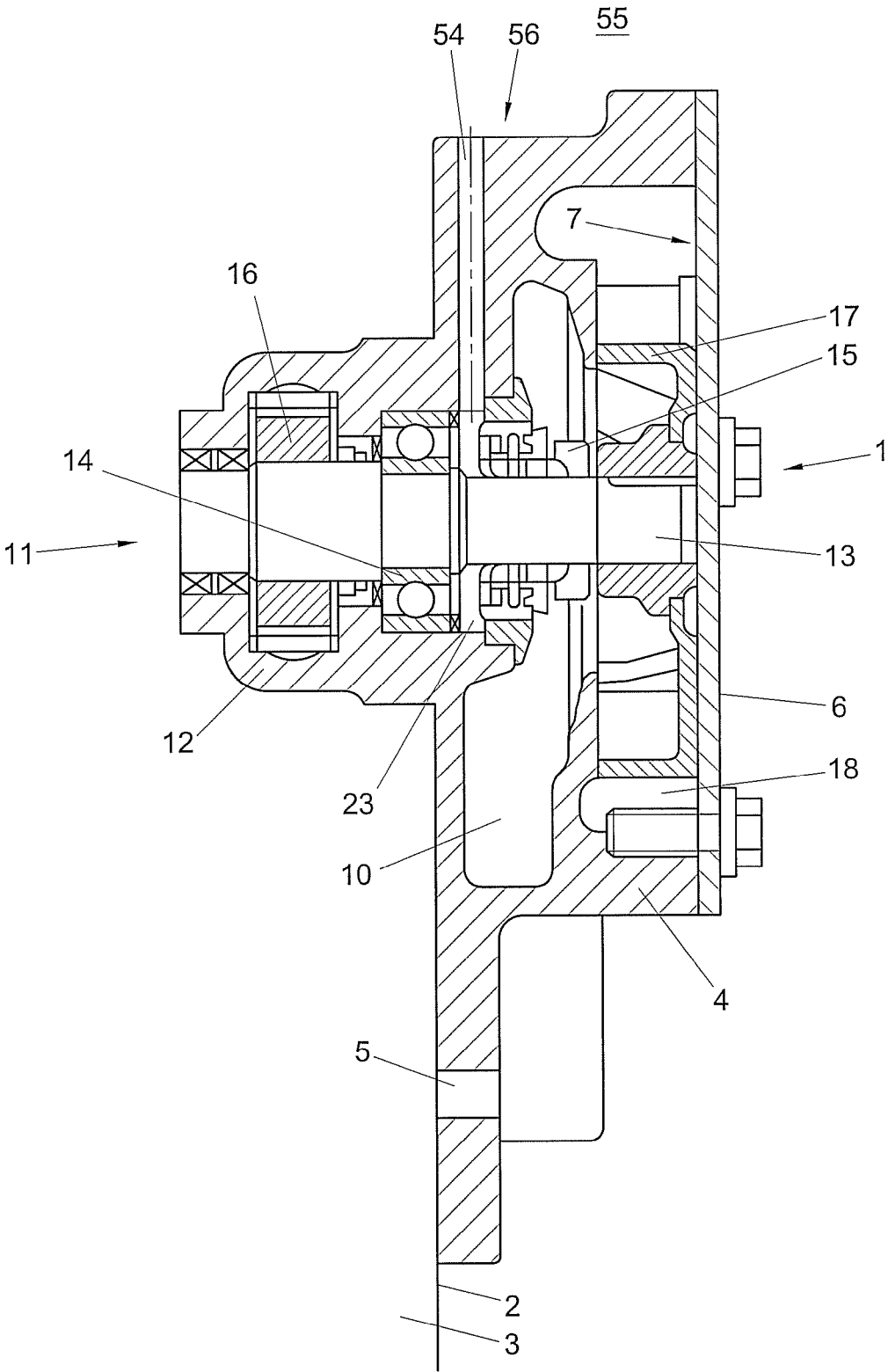


FIG. 2

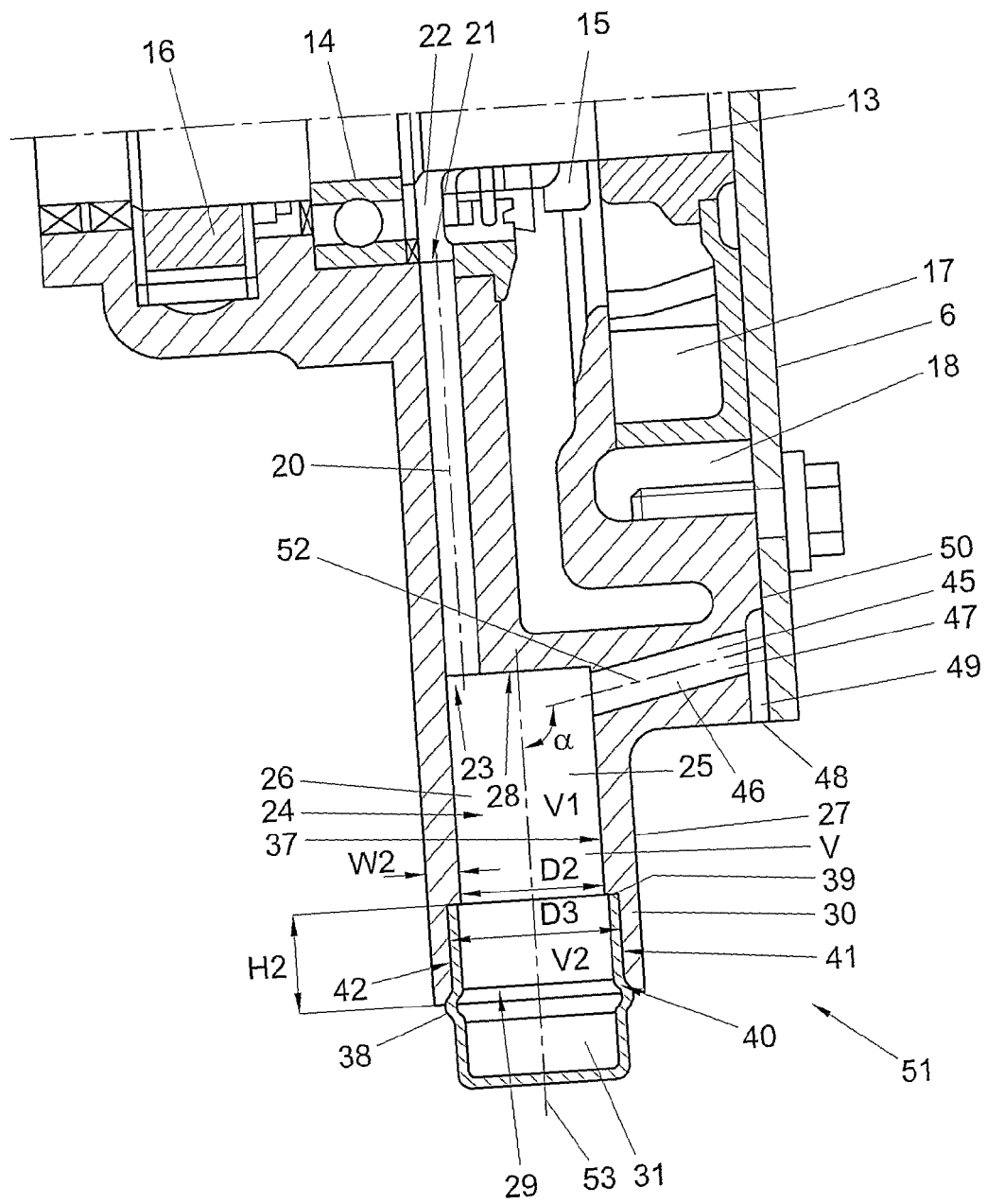


FIG. 3

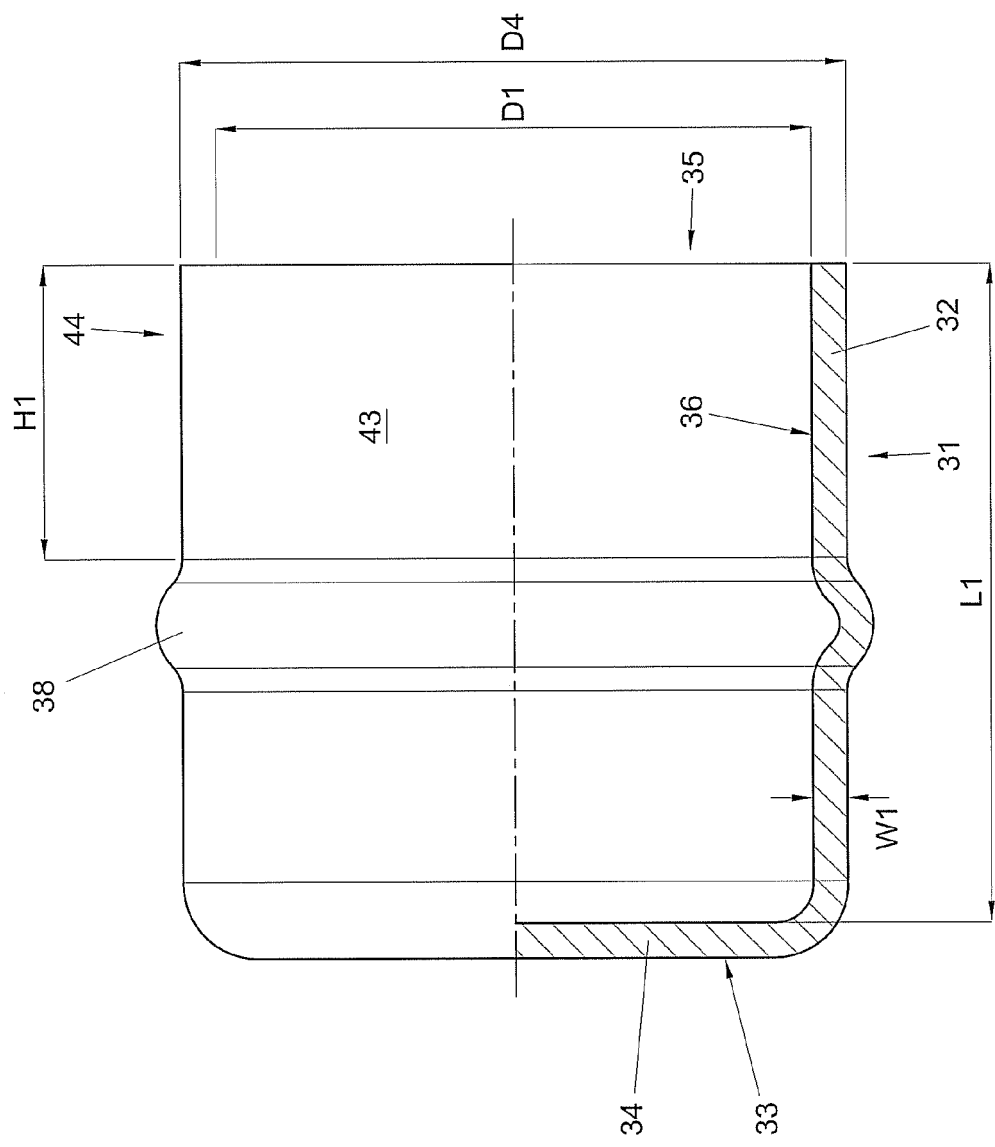


FIG. 4



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EUROPEAN SEARCH REPORT

Application Number
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Place of search The Hague		Date of completion of the search 7 April 2008	Examiner Brouillet, Bernard
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EPO FORM 1503 03.82 (P04C01)



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**ANNEX TO THE EUROPEAN SEARCH REPORT
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