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(54) Title: ELECTRIC DRIVE FOR A MOTOR VEHICLE

(57) Abstract: Electric drive for a motor vehicle, comprising a housing assembly with an inner casing portion and an outer casing portion forming a casing cooling structure through which a water based coolant is made to flow; an electric machine with a stator connected to the inner casing portion of the housing assembly and a rotor with a rotor shaft rotatably supported in the housing assembly; a transmission to transmit a rotary movement from the rotor shaft to drive a driveline of the motor vehicle; and an oil sump with an oil provided to cool and lubricate the rotor and transmission.

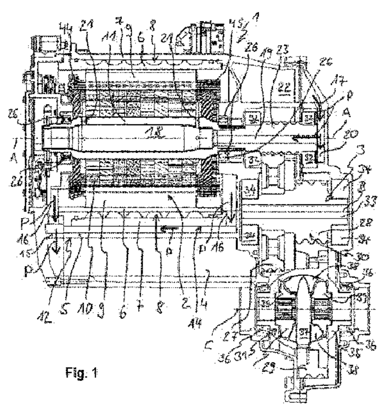

Fig. 1

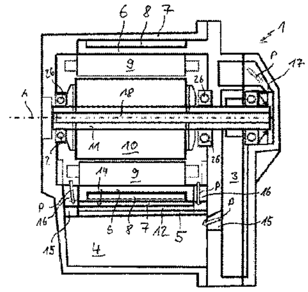

Fig. 2

WO 2023/006217 A1

Electric drive for a motor vehicle

Description

The invention relates to an electric drive for driving a motor vehicle. An electric drive can serve as the sole drive for the motor vehicle or can be provided in addition to an internal combustion engine, whereby the electric drive and the internal combustion engine can each drive the motor vehicle separately or jointly superimposed.

US 10 272 767 B1 discloses an electric drivetrain system, comprising an electric drivetrain of an electric vehicle, comprising an inverter component, a gearbox component and a motor component. A first cooling system uses ethylene glycol and water based coolant (EGW). The first cooling system comprises an EGW coolant loop to distribute the coolant through at least one of the inverter component, a housing of the gearbox component, and a housing of the motor component to remove heat from the inverter component, the housing of the gearbox component, and the housing of the motor component. A second cooling system uses oil based coolant. The second cooling system comprises an oil coolant loop to distribute the oil based coolant through at least one of internal components of the gearbox component and internal components of the motor component to remove heat from at least the internal components of the gearbox component, and from at least the internal components of the motor component. An oil coolant pump controls a flow of the oil based coolant through the oil coolant loop and a heat exchanger transfers heat from the oil coolant loop to the EGW coolant loop, away from the electric drivetrain, to a vehicle cooling system having a radiator.

EP 3 517 335 A1 discloses an electric vehicle including a power control unit, a driving motor, a first cooling channel fitted with a first pump that causes a first cooling liquid cooled in a first heat exchanger to flow through the power control unit and a second heat exchanger in this order and return to the first heat exchanger, and a second cooling channel fitted with a second pump that causes a second cooling liquid cooled by the first cooling liquid in the second heat exchanger to flow through the driving motor and return to the second heat exchanger. The second pump starts or stops circulation of the second cooling liquid, or increases or reduces a circulation volume of the second cooling liquid, based on one or both of the temperature of the power control unit and the temperature of the first cooling liquid.

From WO 2020/069744 A1 an electric drive for driving a motor vehicle is known with a housing arrangement, an electric machine, a planetary unit and a power transmission unit. The housing arrangement has a first housing part on the motor side, a second housing part on the transmission side, and an intermediate housing part which separates a motor space and a transmission space from each other. The intermediate housing member has a motor-side casing portion extending axially into the outer casing portion of the first housing member, and a transmission-side casing portion extending axially into the second housing member. A sealed cavity for a coolant to flow through is formed between the outer surface of the motor-side casing portion and the inner surface of the first housing part.

Document WO 2015/058788 A1 discloses a drive assembly for a motor vehicle with a first gear and a second gear, wherein the first gear and the second gear are drivingly connected to one another, and a lubricant filling which, in a static built-in condition of the drive assembly, defines a lubricant level. A first reservoir is arranged above the lubricant level which can be filled with lubricant as a result of the rotation of the first gear. A second reservoir is arranged above the lubricant level which can be filled with lubricant as a result of the rotation of the second gear. The first reservoir serves to lubricate a first bearing region, whereas the second reservoir serves to lubricate a second bearing region of the drive assembly.

A key issue in connection with electric drives is thermal behavior. Both the electric machine and the transmission generate heat that must be dissipated to avoid impermissibly high temperatures and thus ensure a long service life.

It is an object to propose an electric drive with electric machine and transmission, which ensures reliable cooling and lubrication of rotating drive parts and thus has a long service life.

The object is met by an electric drive according to claim 1. Embodiments are described in the dependent claims.

According to an aspect of the disclosure the electric drive for a motor vehicle comprises

- a housing assembly with an inner casing portion and an outer casing portion forming a casing cooling structure through which a water based coolant is made to flow;
- an electric machine with a stator connected to the inner casing portion of the housing assembly and a rotor with a rotor shaft rotatably supported in the housing assembly;
- a transmission to transmit a rotary movement from the rotor shaft to drive a driveline of the motor vehicle;
- an oil sump with an oil provided to cool and lubricate the rotor and transmission; and
- a housing shield arranged radially outside of the outer casing portion and at least partially below the rotary axis of the rotor, thereby forming a shield cooling structure through which oil can flow towards the oil sump, wherein the casing cooling structure including the coolant is hydraulically separated from the shield cooling structure for the oil, thereby forming a heat exchanger.

The shield cooling structure arranged radially outside from the casing cooling structure, and at least partially encasing it, advantageously allows a heat exchange between the water based coolant flowing through the casing cooling structure and the oil flowing through the shield cooling structure. A separate heat exchanger for cooling the oil can thus be omitted, resulting in a more simple and lightweight electric machine. The shield cooling structure being arranged below the rotary axis of the rotor allows to gather the oil used for cooling the rotor with winding heads which significantly improves the performance of the electric machine. The expression below is to be understood with reference to the direction of gravity force with the electrical drive being in ready-to-operate installation. Accordingly the housing shield can be arranged radially between the outer casing portion and the oil sump. The housing shield covers, for example a sector of at least 45° in circumferential direction of the rotary axis of the rotor.

According to an embodiment, the housing shield overlaps with the outer casing portion in axial direction along at least one half of an axial length of the outer casing portion. The farther the housing shield overlaps with the outer casing portion, the more effective the formed heat-exchanger works. For example, the housing shield overlaps with the outer casing portion along the full axial length of the outer casing portion. To further enhance the heat exchange, the shield cooling structure can comprise channels running generally in parallel in axial direction. The channels advantageously provide a greater surface and thus improved heat transfer from the oil to the shield cooling structure. Further, channels allow to use both axial flow directions. Generally, the shield cooling structure may have a downward slope to provide an oil flow due to gravity force, the oil flowing for example towards an outlet passage from the shield cooling structure into the oil sump. Each channel may as well have the downward slope. Further, one or more first channels can have the downward slope to provide an oil flow towards a first axial end of the shield cooling structure with a first outlet passage from the shield cooling structure into the oil sump, and one or more second channels can have the downward slope to provide an oil flow towards a second axial end of the shield cooling structure with a second outlet passage from the shield cooling structure into the oil sump.

According to a further embodiment, the shield cooling structure comprises fins connected to the outer cooling casing and/or the housing shield. The fins also provide a greater surface and thus improved heat transfer from the oil to the shield cooling structure.

According to a further embodiment, the shield cooling structure comprises an inlet passage to receive oil from the rotor inside the inner casing portion, wherein the outlet passage and the inlet passage are arranged in axial direction at opposite ends of the shield cooling structure. Alternatively, the shield cooling structure may comprise two or more such inlet passages, for example one at each end of the shield cooling structure.

According to a further embodiment, the rotor shaft is hollow and an oil supply duct is connected to an inner diameter of the rotor shaft. The oil supply duct may comprise at least two oil flow paths, a first flow path to the inner diameter of the rotor shaft and a second flow path to rotating parts, bearing members and/or sealing members of the transmission. The rotor shaft can comprise radial bores to convey oil from the inner diameter of the rotor shaft to the rotor and or to the stator. The oil can be centrifuged along the rotor toward end-windings of the stator, which are advantageously cooled by the oil. The end-windings may also be referred to as winding heads. At least a portion of the radial bores can be arranged at axial positions along the rotor shaft, which correspond to axial positions of the end-windings of the stator.

According to a further embodiment, the oil supply duct is connected to an oil reservoir arranged radially above the rotor shaft, the oil reservoir gathering oil conveyed from the oil sump upwards by rotation of gears of the transmission. The embodiment is advantageously simple in construction as no active pump is necessary for the circulation of the oil.

According to an alternative embodiment, a pump is provided for conveying oil from the oil sump to the oil supply duct, which advantageously provides enhanced control of the oil circulation. A filter can be provided in oil flow direction before the pump.

Exemplary embodiments and further advantages of the electric drive for a motor vehicle will be illustrated as follows with reference to the accompanying drawings, wherein

Figure 1 shows a longitudinal section of a first exemplary embodiment of the electric drive;

Figure 2 shows a schematic representation of the longitudinal section of the embodiment of Figure 1;

Figure 3 shows a schematic representation of a cross section of the embodiment of Figure 1; and

Figure 4 shows a longitudinal section of a second exemplary embodiment of the electric drive in a schematic representation.

In Figure 1, an electric drive for a motor vehicle with a housing assembly 1, an electric machine 2, a transmission 3, an oil sump 4 and a housing shield 5 is depicted in a longitudinal cut along a rotary axis A of a rotor 10 of the electric machine 2. Figure 2 shows the same section as a schematic representation and in Figure 3, a further schematic representation is depicted illustrating the housing assembly 1 and the housing shield 5 in a cross section rectangular to the rotary axis A. A first exemplary embodiment will be described with regard to Figures 1, 2 and 3 jointly.

The housing assembly 1 comprises an inner casing portion 6 and an outer casing portion 7 forming a casing cooling structure 8 through which a water based coolant is made to flow. The casing cooling structure 8 forms a cooling jacket around the electric machine 2. The water based coolant can be made to flow in a coolant circuit by a coolant pump (not depicted). The electric machine 2 comprises a stator 9 connected to the inner casing portion 6 of the housing assembly 1. A rotor 10 of the electric machine 2 with a hollow rotor shaft 11 is rotatably supported in the housing assembly 1 by bearing means 26.

The transmission 3 is provided to transmit a rotary movement from the rotor shaft 11 to drive a driveline of the motor vehicle comprising, for example, a reduction gear 30, a differential drive 31 and a coupling, wherein the coupling may be arranged at any suitable position of the transmission 3. The reduction gear 30 comprises a first pair of gears with a first gear 23 meshing with a second gear 27, a second pair of gears being formed by a third gear 28 meshing with a fourth gear 29, so that a rotational movement introduced by the rotor shaft 11 is translated from a high speed to a low speed. The driving first gear 23 is connected coaxially to the rotor shaft 11 in a rotationally fixed way and can be supported in the housing assembly 1 by bearing means 32. The reduction gear 30 can comprise an intermediate shaft 33, which is rotatably supported via bearing means 34, rotating around an axis B extending parallel to the rotational axis A of the rotor 10. The second gear 27 can be connected to the intermediate shaft 33 in a rotationally fixed way. Further, the intermediate shaft 33 comprises the third gear 28 formed as a pinion, which is integrally connected with the intermediate shaft 33. The third gear engages the fourth gear 29, which drives the differential drive 31 around a differential axis C. The driving first gear 23 comprises a smaller diameter and a smaller number of teeth than the diameter and, respectively, the number of teeth of the second gear 27. Also, the third gear 28 comprises a smaller diameter and a smaller number of teeth than the fourth gear 29, thus a reduction towards a lower rotational speed is achieved. The fourth gear 29 is fixedly connected to differential housing 35 of the differential drive 31. The differential housing 35 is rotatably supported in the housing assembly 1 around the differential axis C by bearing means 36. The differential housing 35 comprises a radial bore into which a journal 37 is inserted. Two differential gears 38 are rotatably supported on the journal 37 around a journal axis. The two differential gears 38 engage two sideshaft gears 39, which are arranged coaxially relative to the differential axis C. The two sideshaft gears 39 each comprise means to achieve a rotationally fixed connection with associated sideshafts (not depicted), for example splines, so that torque can be transmitted to the vehicle wheels. The two sideshaft gears 39 are axially supported relative to the differential housing 35 by friction reducing sliding discs.

The oil sump 4 forms a lower closure of the housing assembly 1 for collecting oil dripping downwards through gravitational force from the electrical machine 2 and the transmission 3. The oil flow from the transmission 3 to the oil sump 4 is illustrated by an arrow P. The oil level in the oil sump 4 can be identical with the oil level in the transmission 3 through communicating chambers. The oil is provided to cool and lubricate the rotor 10 and the transmission 3. The housing shield 5 is arranged radially outside of the outer casing portion 7 and at least partially below the rotary axis A of the rotor 10, thereby forming a shield cooling structure 12 through which oil can flow towards the oil sump 4, wherein the casing cooling structure 8 including the coolant is hydraulically separated from the shield cooling structure 12 for the oil, thereby forming a heat exchanger 14. The housing shield 5 is arranged below the electric machine 2 to collect oil dripping off the stator 9 and the rotor 10 and flowing downwards inside the inner casing portion 6 through gravitational force. Accordingly, inlet channels 16 connecting an inner space of the inner casing portion 6 with the shield cooling structure 12 are provided, the oil flow through the inlet channels 16 being illustrated by arrows P. The shield cooling structure is formed by the space between the outer casing portion 7 and the housing shield 5, which is arranged radially between the outer casing portion 7 and the oil sump 4. The housing shield 5 can overlap with the outer casing portion 7 in axial direction along at least one half of an axial length of the outer casing portion 7 to provide sufficient heat exchange between the water based coolant flowing through casing cooling structure 8 and the oil in the shield cooling structure 12. In the depicted embodiment, the housing shield 5 overlaps with the outer casing portion 7 in axial direction along essentially the full axial length of the outer casing portion 7. The housing shield 5 may cover a sector of at least 45° in circumferential direction of the rotary axis A of the rotor 10, thus providing sufficient space inside the integrated heat exchanger 14 to effectively cool the oil by the water based coolant. The oil flow through the shield cooling structure 12 is illustrated by an arrow P. The water based coolant in the casing cooling structure 8 may flow through circumferential channels formed in the inner casing portion 6, thus forming a cross-flow heat exchanger 14.

The shield cooling structure 12 can comprise first and second channels 40, 41 (Figure 3) running generally in parallel in axial direction. The first channel 40 can be separated from the second channel 41 by a wall 42, so that the oil can flow in the first channel 40 in opposite axial direction compared to the oil flow in the second channel 41. Further, the shield cooling structure 12 comprises fins 43 connected to the outer casing portion 7, which can be connected to the housing shield 5 as well or instead. The shield cooling structure 12 has a downward slope to provide an oil flow towards an outlet passage 15 to the oil sump 4. The oil flow into the oil sump 4 through the outlet passage 15 is illustrated by an arrow P. The shield cooling structure 12 further comprises at least one of the inlet passages 16 to receive oil from the rotor 10 inside the inner casing portion 6, wherein the outlet passage 15 and the inlet passage 16 are arranged in axial direction at opposite ends of the shield cooling structure 12. There can be two inlet passages 16 arranged at opposite ends of the shield cooling structure 12, the oil flowing either through the first or the second channel 40, 41. Alternatively, the oil may flow from a first end of the shield cooling structure 12 to a second end through the first channel 40 and back through the second channel 41 to the first end, which advantageously provides a longer retention time for the oil in the heat exchanger 14.

The rotor shaft 11 of the electric machine 2 is hollow and an oil supply duct 17 is connected to an inner diameter 18 of the rotor shaft 11, to supply oil as coolant and lubricant through the rotor shaft 11. Further, the rotor shaft 11 comprises radial bores 21 to convey oil from the inner diameter 18 of the rotor shaft 11 to the rotor 10 of the electric machine 2 for cooling purposes. The electric machine 2 comprises the stator 9 and the rotor 10 that is rotatable relative to the stator 9 and that drives the rotor shaft 11 connected thereto when the electric machine 2 is energized. The rotor 10 may be configured, for example, as a stack of rotor laminations mounted on the rotor shaft 11. The electric machine 2 can be configured as a synchronous or asynchronous machine. The sleeve-like casing cooling structure 8 is connected to the stator 9. The electric machine 2 may serve as a drive source for a driveline of a motor vehicle, and may be controlled by means of power electronics, such as a pulse inverter with an integrated electronic control unit (ECU, not depicted). The electric machine 2 can be supplied from a current controlling source (not depicted) and can operate in a motor mode, wherein electrical energy is converted into mechanical energy to drive the rotor shaft 11 and the components drivingly connected thereto, or in a generator mode, wherein, conversely, mechanical energy is converted into electrical energy, which can then be stored in a battery. In the present disclosure the electric machine is also referred to as electric motor. The stator 9 includes an electrical winding forming a first end-winding 44 at a first side of the stator 9 and a second end-winding 45 at the opposite second side of the stator 9. The oil leaking from the rotor shaft 11 through the radial bores 21 is centrifuged further along the rotor 10 towards the stator windings, in particular the first and second end-windings 44, 45. The radial bores 21 may be arranged at axial positions corresponding to the axial positions of the first and second end-windings 44, 45.

The oil supply duct 17 comprises two oil flow paths, a first flow path 19 to the inner diameter 18 of the rotor shaft 11 and a second flow path 20 to rotating parts, including the gears and shafts of the reduction gear 30 and the differential drive 31, to bearing members 32, 34 36 and to sealing members of the transmission 3. The oil flow through the oil supply duct 17 and branching into the first and second flow paths 19, 20 is illustrated by arrow P. The bearing means 26 are lubricated via the first flow path through the rotor shaft 11. The depicted embodiment comprises an oil reservoir 22 arranged radially above the rotor shaft 11, the oil supply duct 17 being connected to said oil reservoir 22, which is adapted to gather oil conveyed upwards from the oil sump 4 by rotation of the gears 23, 27, 28, 29 of the transmission 3. It is an advantage that the oil flow via the first and second flow paths 19, 20 can be provided from the reservoir 22 through gravity force, which renders any active circulation pump obsolete for the oil cooling and lubricating circuit in this embodiment. Further, as a fraction of the oil is retained in the reservoir 22, the lower oil level in the oil sump 4 can advantageously keep churning losses in the transmission 3 low.

A second exemplary embodiment is described with regard to Figure 4, wherein the electric drive for a motor vehicle is depicted schematically in a longitudinal cut along the rotary axis A of the rotor 10 of the electric machine 2. This second embodiment largely corresponds to the first embodiment shown in Figures 1 to 3, thus reference is made to the above description. Identical or corresponding details have been denoted with identical reference signs as in Figures 1 to 3 above.

A special feature of the embodiment according to Figure 10 is that the oil circuit comprises a pump 24 for conveying oil from the oil sump 4 to the oil supply duct 17. The oil is conveyed from the oil sump 4 to the pump 24 via a suction duct 47. The pump 24 can be driven by a supporting electric motor 46. The pump 24 allows a more purposeful distribution of the oil for the internal cooling of the electric machine 2. The oil supply duct 17 branches into the first flow path 19 to the inner diameter 18 of the rotor shaft 11 and into the second flow path 20 to the transmission 3. An oil reservoir above the rotor shaft 11 can be omitted in this embodiment. A filter 25 can be provided in oil flow direction before the pump 2, i.e. between the oil sump 4 and the pump 24.

Reference numerals

1	Housing assembly
2	Electric machine
3	Transmission
4	Oil sump
5	Housing shield
6	Inner casing portion
7	Outer casing portion
8	Casing cooling structure
9	Stator
10	Rotor
11	Rotor shaft
12	Shield cooling structure
14	Heat exchanger
15	Outlet passage
16	Inlet passage
17	Oil supply duct
18	Inner diameter oft he rotor shaft
19	First flow path
20	Second flow path
21	Radial bore
22	Reservoir
23	First gear
24	Pump
25	Filter
26	Bearing means
27	Second gear
28	Third gear
29	Fourth gear

30	Reduction gear
31	Differential drive
32	Bearing means
33	Intermediate shaft
34	Bearing means
35	Differential housing
36	Bearing means
37	Journal
38	Differential gears
39	Sideshaft gears
40	First channel
41	Second channel
42	Wall
43	Fins
44	First end-windings
45	Second end-windings
46	Supporting electric motor
47	Suction duct

A	Rotary axis
B	Intermediate shaft axis
C	Differential axis
P	Arrow

Claims

1. Electric drive for a motor vehicle, comprising:

a housing assembly (1) with an inner casing portion (6) and an outer casing portion (7) forming a casing cooling structure (8) through which a water based coolant is made to flow,

an electric machine (2) with a stator (9) connected to the inner casing portion (6) of the housing assembly (1) and a rotor (10) with a rotor shaft (11) rotatably supported in the housing assembly (1);

a transmission (3) to transmit a rotary movement from the rotor shaft (11) to drive a driveline of the motor vehicle,

an oil sump (4) with an oil provided to cool and lubricate the rotor (10) and transmission (3);

a housing shield (5) arranged radially outside of the outer casing portion (7) and at least partially below a rotary axis (A) of the rotor (10), thereby forming a shield cooling structure (12) through which oil can flow towards the oil sump (4), wherein the casing cooling structure (8) including the coolant is hydraulically separated from the shield cooling structure (12) for the oil, thereby forming a heat exchanger (14).

2. Electric drive according to claim 1, characterized in that the housing shield (5) is arranged radially between the outer casing portion (7) and the oil sump (4).

3. Electric drive according to any one of claims 1 or 2, characterized in that the housing shield (5) overlaps with the outer casing portion (7) in axial direction along at least one half of an axial length of the outer casing portion (7).

4. Electric drive according to any one of claims 1 to 3, characterized in that the shield cooling structure (12) comprises channels (40, 41) running generally in parallel in axial direction.

5. Electric drive according to any one of claims 1 to 4, characterized in that the shield cooling structure (12) comprises fins (43) connected to the outer casing portion (7) and/or the housing shield (5).

6. Electric drive according to any one of claims 1 to 5, characterized in that the shield cooling structure (12) has a downward slope to provide an oil flow towards an outlet passage (15) to the oil sump (4).

7. Electric drive according to claim 6, characterized in that the shield cooling structure (12) comprises an inlet passage (16) to receive oil from the rotor (10) inside the inner casing portion (6), wherein the outlet passage (15) and the inlet passage (16) are arranged in axial direction at opposite ends of the shield cooling structure (12).

8. Electric drive according to any one of claims 1 to 7, characterized in that the housing shield (5) covers a sector of at least 45° in circumferential direction of the rotary axis (A) of the rotor (10).

9. Electric drive according to any one of claims 1 to 8, characterized in that the rotor shaft (11) is hollow and an oil supply duct (17) is connected to an inner diameter (18) of the rotor shaft (11).

10. Electric drive according to claim 9, characterized in that the oil supply duct (17) comprises two oil flow paths, a first flow path (19) to the inner diameter (18) of

the rotor shaft (11) and a second flow path (20) to rotating parts, bearing members and sealing members of the transmission (3).

11. Electric drive according to any one of claims 9 or 10, characterized in that the rotor shaft (11) comprises radial bores (21) to convey oil from the inner diameter (18) of the rotor shaft (11) to the rotor (10) and/or the stator (9).

12. Electric drive according to any one of claims 9 to 11, characterized in that at least a portion of the radial bores (21) are arranged at axial positions along the rotor shaft (11), which correspond to axial positions of end-windings (44, 45) of the stator (9).

13. Electric drive according to any one of claims 9 to 12, characterized in that the oil supply duct (17) is connected to an oil reservoir (22) arranged radially above the rotor shaft (11), the oil reservoir (22) gathering oil conveyed from the oil sump (4) upwards by rotation of gears (23, 27, 28, 29) of the transmission (3).

14. Electric drive according to any one of claims 9 to 13, characterized in that a pump (24) is provided for conveying oil from the oil sump (4) to the oil supply duct (17).

15. Electric drive according to claim 14, characterized in that a filter (25) is provided in oil flow direction before the pump (2).

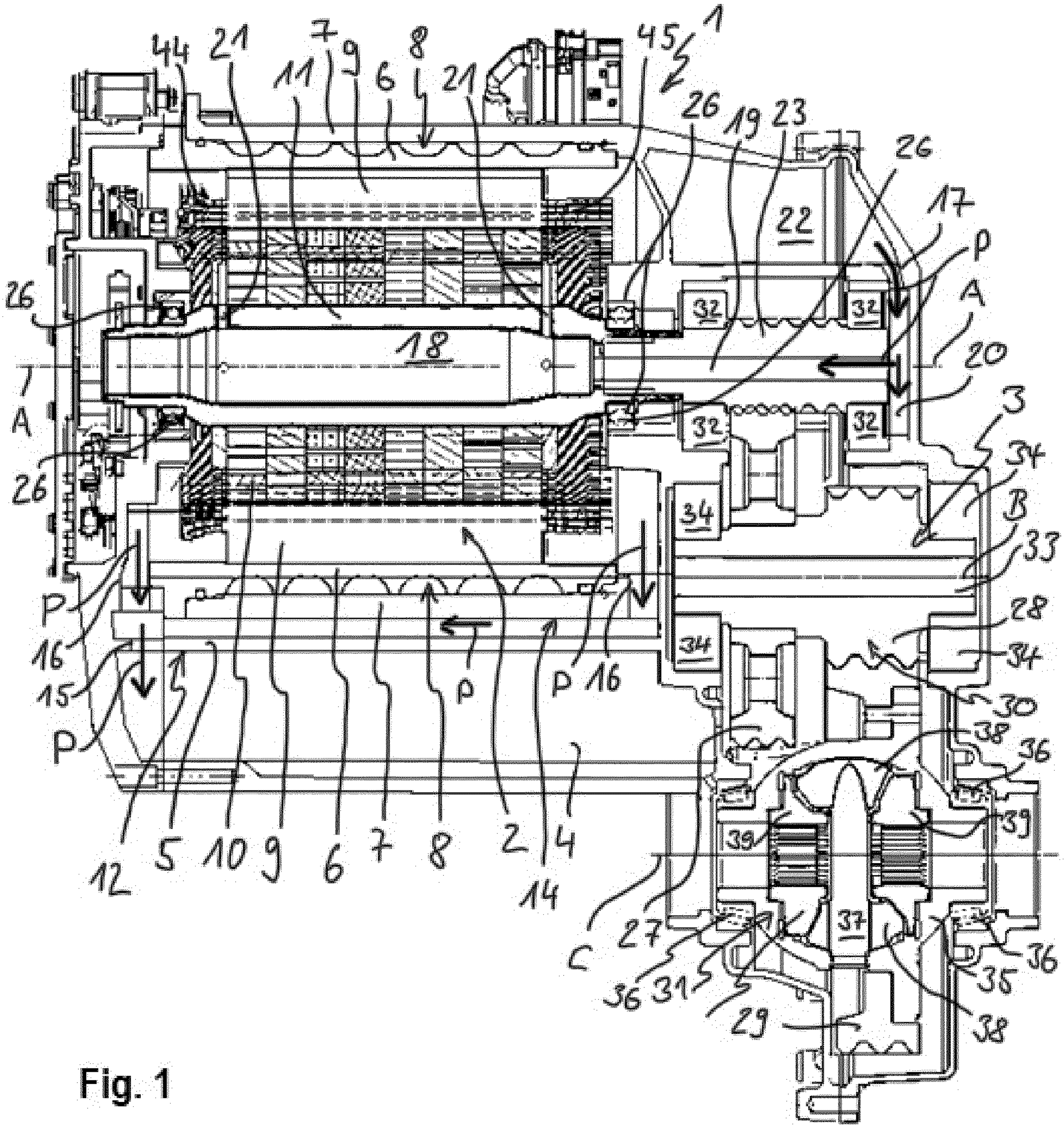
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Fig. 1

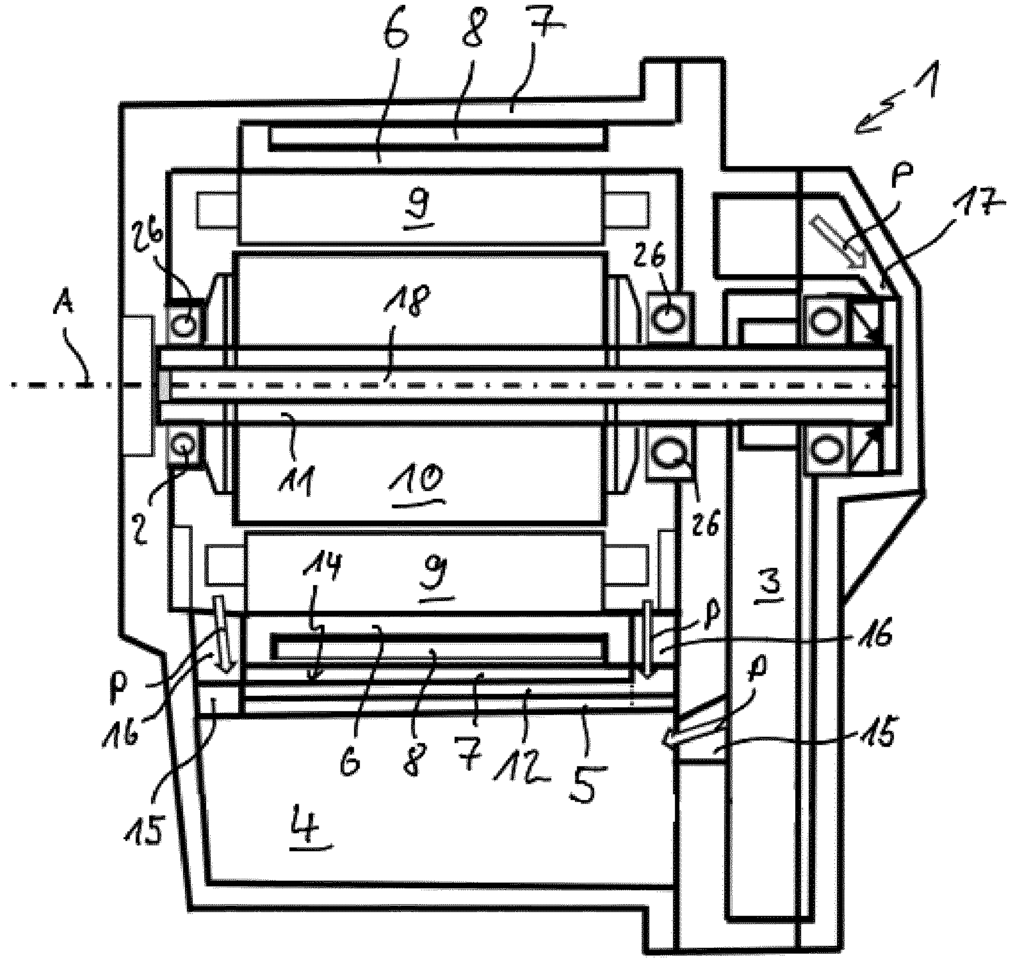
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Fig. 2

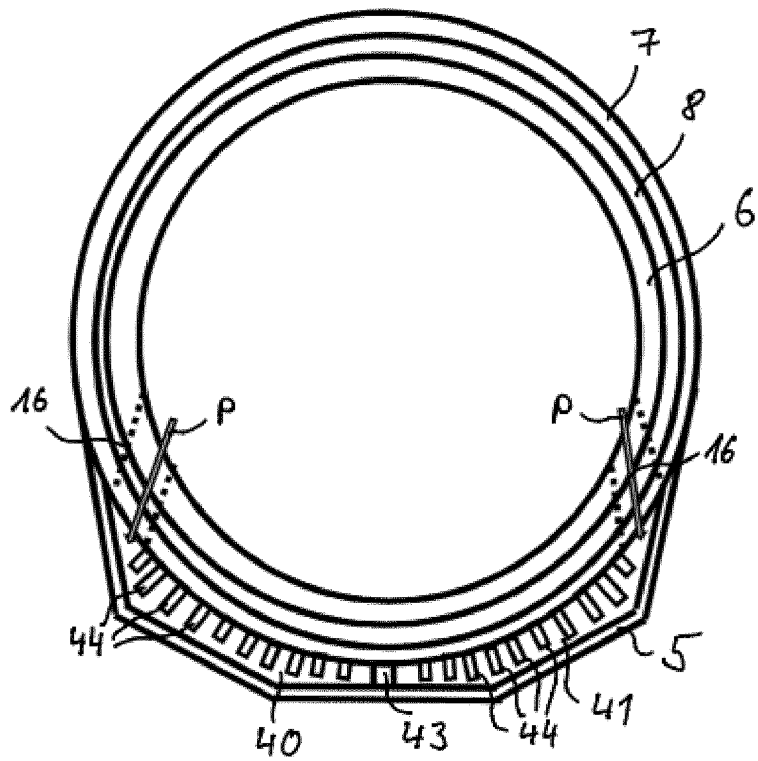
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Fig. 3

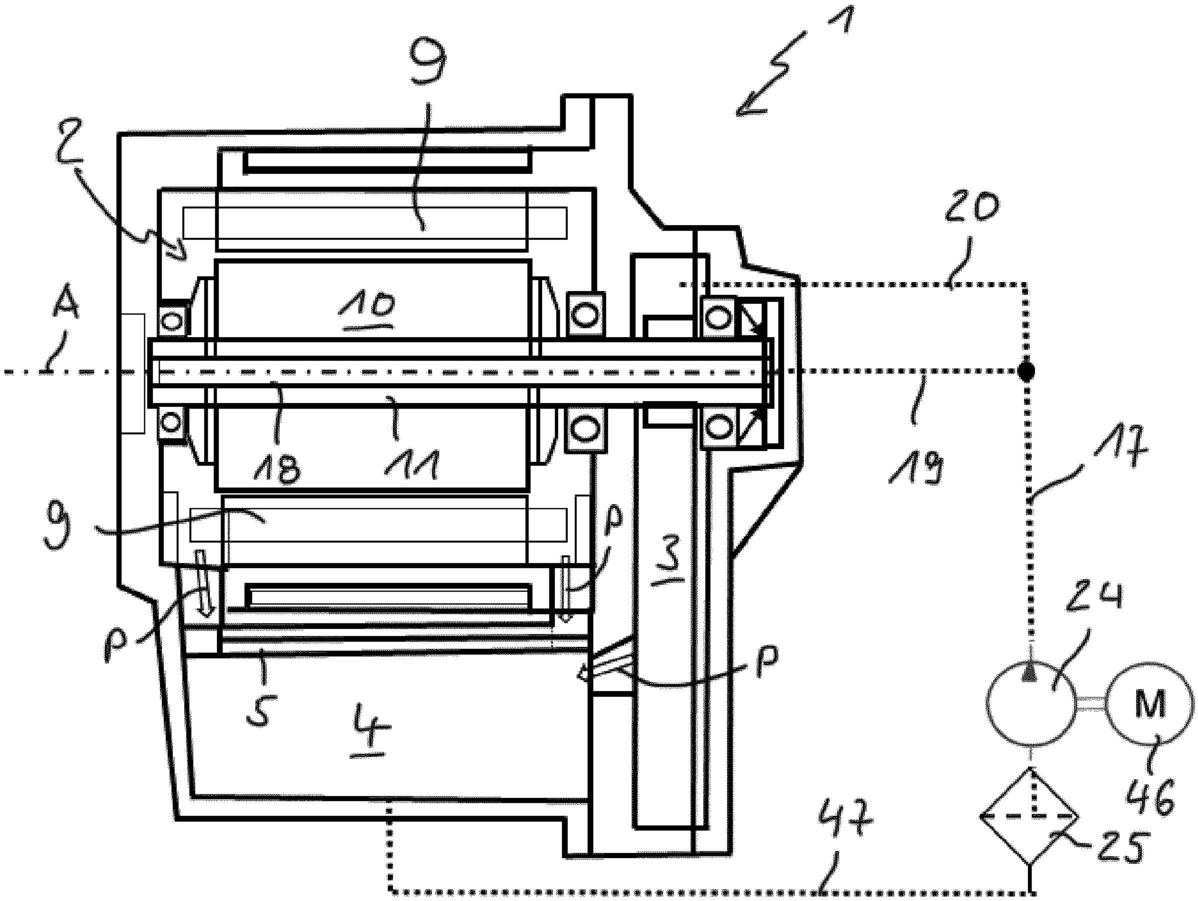

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/071443

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16H57/04 H02K7/116 F28D15/00
ADD. F16H61/00 F16H57/02 B60K1/00

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)
F16H H02K F28F F28D B60K

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 2009 303367 A (HONDA MOTOR CO LTD) 24 December 2009 (2009-12-24) figures 1-6 paragraphs [0013] - [0036] -----	1-4,6-9, 14,15 5 13
X Y A	WO 2020/067707 A1 (LG ELECTRONICS INC [KR]) 2 April 2020 (2020-04-02) figures 9-11 paragraphs [0129] - [0164] -----	1-4, 6-10,15 5,11,12 13
Y	EP 3 530 990 A1 (VALEO SIEMENS EAUTOMOTIVE GERMANY GMBH [DE]) 28 August 2019 (2019-08-28) figure 3 paragraphs [0036] - [0038] ----- -/--	5

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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1 April 2022	08/04/2022

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PCT/EP2021/071443

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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