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(71) Applicant: **VALEO SYSTÈMES D'ESSUYAGE** [FR/FR]; CS 90581, ZA L' Agiot, 8 Rue Louis Lormand, CS 90581 LA VERRIERE, 78322 LE MESNIL SAINT DENIS (FR).

(72) Inventors: **SCHAEUBLE, Michael**; Valeo Wischersysteme Gmbh, Valeostrasse 1, 74321 Bietigheim-Bissingen (DE). **STUBBE, Markus**; Valeo Wischersysteme Gmbh, Valeostrasse 1, 74321 Bietigheim-Bissingen (DE). **KAPITZA, Harald**; Valeo Wischersysteme Gmbh, Valeostrasse 1, 74321 Bietigheim-Bissingen (DE).

(74) Agent: **GUTLE, Nicolas**; VALEO SYSTEMES D'ESSUYAGE ZA L' Agiot, 8 rue Louis Lormand, CS 90581 LA VERRIERE, 78322 LE MESNIL ST DENIS (FR).

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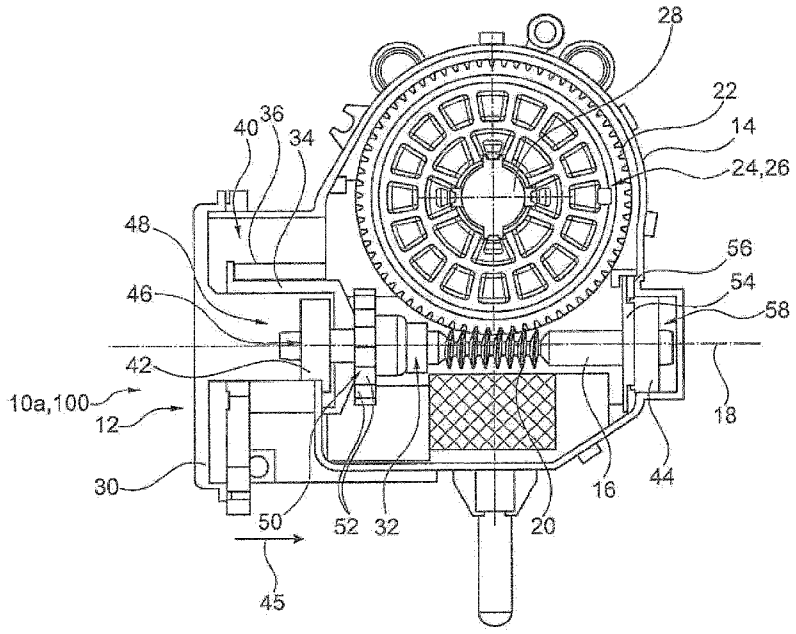


Fig. 1

(57) Abstract: The invention relates to an electric drive device (10a to 10e), comprising a brushless electric motor (12) which has a stator (40) having wire windings (38) and a rotor (32) mounted to rotate around an axis (18) and having a shaft (16), the rotor (32) having at least one magnetic element, preferably a plurality of magnetic elements (36) which interact with the wire windings (38), the shaft (16) protruding into a transmission housing (14) or being disposed within a transmission housing (14), where it interacts with a transmission gearwheel (24) via a toothing (20), the shaft (16) being mounted by means of at least two bearing devices (42, 44) which are spaced apart from each other in the direction of the axis (18) and being disposed without axial clearance by means of an axial-clearance compensation device (54; 54a), and comprising a magnetic- element ring (50; 50a; 50b; 50c) as part of a device for detecting the rotation angle position of the shaft (16).

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Electric drive device and windshield-wiper motor

Prior art

The invention relates to an electric drive device according to the preamble of the independent claims. The invention also relates to a windshield-wiper motor comprising an electric drive device according to the invention.

An electric drive device comprising the features of the preamble of the independent claims and a windshield-wiper motor comprising a corresponding electric drive device are known from WO 2016/010 023 A1. The known electric drive device has a brushless electric motor which has a stator having wire windings and a rotor mounted to rotate around an axis and having a shaft. The rotor carries magnetic elements which interact with the wire windings, the shaft protruding into a transmission housing or being disposed within a transmission housing, where it interacts with a mating toothing on a transmission gearwheel via a toothing on the shaft. For mounting of the shaft, the latter has at least one bearing device, preferably two bearing devices which are spaced apart from one another in the direction of the axis, the shaft being disposed without axial clearance by means of an axial-clearance compensation device. A magnetic-element ring is also provided as part of a device for detecting the rotation angle position of the shaft or of the rotor, and thus of the magnetic elements on the magnetic-element ring. In the case of the prior art which has been described thus far, the individual elements mentioned above are disposed in the longitudinal direction of the shaft of the rotor, in the direction from the magnetic elements to the transmission gearwheel, such that the magnetic elements are followed first of all by the axial-clearance compensation device and then by a first bearing element. The first bearing element is followed, in turn, by the magnetic-element ring and a second bearing device.

Disclosure of the invention

In comparison with the prior art, the electric drive device comprising the features of the independent claims presents an alternative arrangement of the at least one bearing device, of the magnetic-element ring and of the magnetic elements (which interact with the wire windings of the stator). Depending on the particular application case, this results in design-related improvements in respect of the amount of space required, of the electrical and/or mechanical function and, possibly, in a reduction in the amount of volume required and in lower production costs.

For this purpose, a first basic design of the electric drive device makes provision for a first bearing device to be disposed on the side of the rotor facing away from the transmission gearwheel in an end portion of the shaft or in axial overlap with the magnetic elements of the rotor.

A development of this basic embodiment provides for the rotor to have a drum-shaped or pot-shaped magnetic-element support which radially surrounds the first bearing device. This makes it possible to minimize the axial overall length of the drive device.

A preferred development makes provision so that in the axial direction of the shaft, the first bearing device is followed by the magnetic-element ring, the axial-clearance compensation device, and the second bearing device when viewed in the direction of the transmission gearwheel, the axial-clearance compensation device interacting with the second bearing device.

As an alternative to the previously made proposal, it is possible that in the axial direction of the shaft, the first bearing device is followed by the magnetic-element ring, a second bearing device, and the axial-clearance compensation device, which interacts with the second bearing device, when viewed in the direction of the transmission gearwheel.

A further alternative to this makes provision so that in the axial direction of the shaft, the first bearing device is followed by a second bearing device, the axial-clearance compensation device, which interacts with the second bearing device, and the magnetic-element ring when viewed in the direction of the transmission gearwheel.

As an alternative to this, provision may also be made so that in the axial direction of the shaft, the first bearing device is followed by the magnetic-element ring, the axial-clearance compensation device and a second bearing device, which interacts with the axial-clearance compensation device, when viewed in the direction of the transmission gearwheel.

In a further alternative concept here, provision may be made so that in the axial direction of the shaft, the first bearing device is followed by the axial-clearance compensation device, a second bearing device, which interacts with the axial-clearance compensation device, and the magnetic-element ring when viewed in the direction of the transmission gearwheel.

In the case of some of the previously made proposals, provision may be made so that in the axial direction of the shaft, the magnetic elements follow the first bearing device and precede the magnetic-element ring, the axial-clearance compensation device, or the second bearing device when viewed in the direction of the transmission gearwheel.

In an arrangement of the elements of the electric drive device which differs fundamentally from the above, provision is made so that in the axial direction of the shaft, the magnetic elements are followed by the magnetic-element ring, the axial-clearance compensation device, a first bearing device, which interacts with the axial-clearance compensation device, and a second bearing device when viewed in the direction of the transmission gearwheel.

A third basic design of the electric drive device makes provision so that in the axial direction of the shaft, the magnetic elements are followed by the magnetic-

element ring, a first bearing device, the axial-clearance compensation device, and a second bearing device, which interacts with the axial-clearance compensation device, when viewed in the direction of the transmission gearwheel.

As a further alternative to this, provision may also be made so that in the axial direction of the shaft, the magnetic elements are followed by a first bearing device, the magnetic-element ring, the axial-clearance compensation device and a second bearing device, which interacts with the axial-clearance compensation device, when viewed in the direction of the transmission gearwheel.

In the case of all the previously described designs of the electric drive device, provision may be made for the axial-clearance compensation device to be a curved sheet-metal part which is disposed under spring pre-load between a housing portion and one of the two bearing devices.

As an alternative to this, provision may be made for the axial-clearance compensation device to be composed of two elements which are mobile in relation to each other in the direction of the shaft and which are forced into a position in which they are axially spaced apart from each other by means of a spring element.

Finally, the invention also covers a windshield-wiper motor comprising an electric drive device according to the invention described thus far.

Further advantages, features and details of the invention can be gathered from the following description of preferred exemplary embodiments and with reference to the drawing.

Figures 1 to 7 of the drawing each show partially sectional, and to some extent simplified, illustrations of a windshield-wiper motor comprising electric drive devices of different designs.

In the figures, identical elements, or elements with identical functions, are denoted by identical reference numerals.

Figure 1 illustrates a simplified version of a first electric drive device 10a comprising a brushless electric motor 12. The electric drive device 10a is designed in the form of a windshield-wiper motor 100 which serves for cleaning a vehicle window, at least indirectly, by means of at least one wiper blade (not shown). The electric drive device 10a has a transmission housing 14, in which is disposed a shaft 16 which can be rotated about an axis 18 at least indirectly, preferably directly by the brushless electric motor 12. The shaft 16 has a toothing portion 20, which meshes with an outer toothing 22 of a transmission gearwheel 24. The transmission gearwheel 24 is part of a single-stage or multi-stage transmission 26 which serves for driving an output shaft 28, which in turn is coupled, for example, to a wiper linkage of the wiper system (not shown). The transmission housing 14 can be closed by means of a housing cover 30, which is illustrated merely in Figures 1 to 4.

It is additionally mentioned that it is also possible, in addition to the transmission housing 14, to use a motor housing (not shown in the figures) for accommodating the essential parts of the electric motor 12. In this case, the electric motor 12 protrudes into the transmission housing 14 by way of the shaft 16 and the motor housing is connected to the transmission housing 14, for example by being flanged on in a connection region.

The shaft 16 is part of a rotor 32 and is connected in a rotationally fixed manner to a magnetic-element support 34, which is illustrated merely in Figures 1 and 2. In the exemplary embodiment, the magnetic-element support 34 is designed in the form of a deep-drawn part made of sheet metal and, on its outer circumference, it supports a plurality of elongate magnetic elements 36, which are illustrated merely in Figure 1. The magnetic elements 36 interact with wire windings 38, which can be seen in Figures 2 to 7 and belong to a fixed-position stator 40 composed of laminations. The stator 40 is likewise disposed within the

transmission housing 14 and surrounds the outer circumference of the magnetic-element support 34 in a known manner. By virtue of the individual wire windings 38 being energized in dependence on the rotation angle position of the rotor 32 and/or the positioning of the magnetic elements 36, the rotor 32 is made to rotate, in order to drive the transmission gearwheel 24.

The rotor 32 is mounted to rotate in two bearing devices 42, 44, which are spaced apart axially from each other in relation to the axis 18. For this purpose, the two bearing devices 42, 44 are pushed onto the outer circumference of the shaft 16 and disposed in appropriate mounts in the transmission housing 14. The first bearing device 42 is disposed in an end portion 46 of the shaft 16, to be precise in the interior 48 of the pot-shaped or cup-shaped magnetic-element support 34. In the direction of the axis 18, the outside of the magnetic-element support 34 is followed directly, when viewed in the direction of the transmission gearwheel 24, i.e. in the direction of the arrow 45, by a magnetic-element ring 50 comprising magnetic elements 52, said magnetic-element ring likewise being connected in a rotationally fixed manner to the shaft 16. The magnetic-element ring 50 is part of a Hall effect sensor for detecting the rotation angle position of the shaft 16 and/or of the magnetic elements 36, in order for it to be possible for the wire windings 38 to be energized in a known manner. It can also be seen with reference to Figure 1 that the first bearing device 42 is disposed in partially axial overlap with the magnetic elements 36.

An axial-clearance compensation device 54 is disposed on that side of the toothing portion 20 of the shaft 16 which is located opposite the magnetic-element ring 50. In the exemplary embodiment illustrated, the axial-clearance compensation device 54 is designed in the form of a curved sheet-metal part which butts axially against the second bearing device 44, and subjects the latter to force, by way of an end surface. For this purpose, the axial-clearance compensation device 54 is supported in an appropriate mount 56, or a portion of the transmission housing 14, which forms an abutment. Both the axial-clearance compensation device 54 and the second bearing device 44 are disposed in a second end portion 58 of the shaft 16.

The electric drive device 10b illustrated in Figure 2 differs from the electric drive device 10a essentially in that in the axial direction of the shaft 16, the first bearing device 42 is followed by the magnetic-element ring 50, the second bearing device 44, and the axial-clearance compensation device 54a, which interacts with the second bearing device 44, when viewed in the direction of the transmission gearwheel 24 or in the direction of the arrow 45.

It can also be seen with reference to Figure 2 that, in the case of a drive device 10c, the magnetic-element ring 50 in the form of a magnetic-element ring 50a or 50b may also be arranged on that side of the axial-clearance compensation device 54a which faces away from the first bearing device 42, in particular in the respective end region of the toothing portion 20.

It can also be seen that the first bearing device 42 is disposed in the region of the housing cover 30, or has been pressed into this region, and that the first bearing device 42, when viewed in the axial direction, is disposed at least essentially outside the stator 40. Furthermore, the axial-clearance compensation device 54a is formed by two elements 60, 62 which are forced into a position in which they are spaced apart from each other in the direction of the axis 18 by means of a spring element 64.

The electric drive device 10d according to Figure 3 is distinguished in that in the axial direction of the shaft 16, the first bearing device 42 is followed by the magnetic-element ring 50, the axial-clearance compensation device 54 and the second bearing device 44, which interacts with the axial-clearance compensation device 54, when viewed in the direction of the transmission gearwheel 24 or in the direction of the arrow 45. Both the axial-clearance compensation device 54 and the second bearing device 44 are also disposed in front of the toothing portion 20 on that side of the shaft 16 which faces the first bearing device 42. Provision may also be made for the end portion 58 of the shaft 16 to be supported by means of a supporting element 66 in the form of a supporting sleeve, so that a radial yielding movement of the shaft 16 is avoided.

The electric drive device 10e illustrated in Figure 4 is distinguished in that in the axial direction of the shaft 16, the first bearing device 42 is followed by the axial-clearance compensation device 54, the second bearing device 44, which interacts with the axial-clearance compensation device 54, and the magnetic-element ring 50, as seen in the direction of the transmission gearwheel 24 or in the direction of the arrow 45. Here too, provision may be made so that, as an alternative to the magnetic-element ring 50, the latter may be disposed in the form of the magnetic-element ring 50c in the end portion 58 of the shaft 16.

The electric drive device 10f illustrated in Figure 5 is distinguished in that in the axial direction of the shaft 16, the magnetic elements 36 are followed by the magnetic-element ring 50, the axial-clearance compensation device 54, the first bearing device 42, which interacts with the axial-clearance compensation device 54, and the second bearing device 44 when viewed in the direction of the transmission gearwheel 24 or in the direction of the arrow 45. The two bearing devices 42, 44 here are disposed on opposite sides of the toothing portion 20, and the second bearing device 44 is designed, for example, in the form of a straightforward plain bearing or of a sleeve-like body.

The electric drive device 10g illustrated in Figure 6 is distinguished in that in the axial direction of the shaft 16, the magnetic elements 36 are followed by the magnetic-element ring 50, the first bearing device 42, the axial-clearance compensation device 54 and the second bearing device 44, which interacts with the axial-clearance compensation device 54, when viewed in the direction of the transmission gearwheel 24 or in the direction of the arrow 45.

Finally, the electric drive device 10h illustrated in Figure 7 is distinguished in that in the axial direction of the shaft 16, the magnetic elements 36 are followed by the first bearing device 42, the magnetic-element ring 50, the axial-clearance compensation device 54, and the second bearing device 44, which interacts with the axial-clearance compensation device 54, when viewed in the direction of the transmission gearwheel 24 or in the direction of the arrow 45. An

alternative arrangement of the magnetic-element ring 50 is illustrated by the magnetic-element ring 50d.

The electric drive devices 10a to 10h described thus far can be altered or modified in various ways without departing from the concept of the invention.

List of reference signs

10a - 10h	Drive device
12	Electric motor
14	Transmission housing
16	Shaft
18	Axis
20	Toothing portion
22	Outer toothing
24	Transmission gearwheel
26	Transmission
28	Output shaft
30	Housing cover
32	Rotor
34	Magnetic-element support
36	Magnetic element
38	Wire winding
40	Stator
42	First bearing device
44	Second bearing device
45	Arrow
46	End portion
48	Interior
50	Magnetic-element ring
50a – 50d	Magnetic-element ring
52	Magnetic element
54, 54a	Axial-clearance compensation device
56	Mount
58	End portion
60	Element
62	Element

64 Spring element

66 Supporting element

100 Windshield-wiper motor

Claims

1. An electric drive device (10a to 10e), comprising a brushless electric motor (12) which has a stator (40) having wire windings (38) and a rotor (32) mounted to rotate around an axis (18) and having a shaft (16), the rotor (32) having at least one magnetic element, preferably a plurality of magnetic elements (36) which interact with the wire windings (38), the shaft (16) protruding into a transmission housing (14) or being disposed within a transmission housing (14), where it interacts with the transmission gearwheel (24) via a toothing (20), the shaft (16) being mounted by means of at least two bearing devices (42, 44) which are spaced apart from each other in the direction of the axis (18) and being disposed without axial clearance by means of an axial-clearance compensation device (54; 54a), and comprising a magnetic-element ring (50; 50a; 50b; 50c) as part of a device for detecting the rotation angle position of the shaft (16),

   characterized in that

   a first bearing device (42) is disposed on the side of the rotor (32) facing away from the transmission gearwheel (24) in an end portion (46) of the shaft (16) or in axial overlap with the at least one magnetic element (36) of the rotor (32).

2. The drive device (10a) according to Claim 1,
   characterized in that
   the rotor (32) has a drum-shaped or pot-shaped magnetic-element support (34) which radially surrounds the first bearing device (42).

3. The drive device (10a) according to Claim 1 or 2,

characterized in that
in the axial direction of the shaft (16), the first bearing device (32) is followed by the magnetic-element ring (50), the axial-clearance compensation device (54), and a second bearing device (44) when viewed in the direction of the transmission gearwheel (24), the axial-clearance compensation device (54) interacting with the second bearing device (44).

4. The drive device (10b) according to Claim 1 or 2,
characterized in that
in the axial direction of the shaft (16), the first bearing device (42) is followed by the magnetic-element ring (50), a second bearing device (44), and the axial-clearance compensation device (54a), which interacts with the second bearing device (44), when viewed in the direction of the transmission gearwheel (24).

5. The drive device (10c) according to Claim 1 or 2,
characterized in that
in the axial direction of the shaft (16), the first bearing device (42) is followed by a second bearing device (44), the axial-clearance compensation device (54a), which interacts with the second bearing device (44), and the magnetic-element ring (50a; 50b) when viewed in the direction of the transmission gearwheel (24).

6. The drive device (10d) according to Claim 1 or 2,
characterized in that
in the axial direction of the shaft (16), the first bearing device (42) is followed by the magnetic-element ring (50), the axial-clearance compensation device (54) and a second bearing device (44), which interacts with the axial-clearance compensation device (54), when viewed in the direction of the transmission gearwheel (24).

7. The drive device (10e) according to Claim 1 or 2,
characterized in that

in the axial direction of the shaft (16), the first bearing device (42) is followed by the axial-clearance compensation device (54), a second bearing device (44), which interacts with the axial-clearance compensation device (54), and the magnetic-element ring (50; 50c) when viewed in the direction of the transmission gearwheel (24).

8. The drive device (10b, 10c, 10d, 10e) according to any one of Claims 4 to 7,
characterized in that
in the axial direction of the shaft (16), the magnetic elements (36) follow the first bearing device (42) and precede the magnetic-element ring (50; 50a; 50b; 50c), the axial-clearance compensation device (54; 54a), or the second bearing device (44) when viewed in the direction of the transmission gearwheel (24).

9. An electric drive device (10f), comprising a brushless electric motor (12) which has a stator (40) having wire windings (38) and a rotor (32) mounted to rotate around an axis (18) and having a shaft (16), the rotor (32) having at least one magnetic element, preferably a plurality of magnetic elements (36) which interact with the wire windings (38), the shaft (16) protruding into a transmission housing (14) or being disposed within a transmission housing (14), where it interacts with a transmission gearwheel 924) via a toothing (20), the shaft (16) being mounted by means of at least two bearing devices (42, 44) which are spaced apart from each other in the direction of the axis (18) and being disposed without axial clearance by means of an axial-clearance compensation device (54), and comprising a magnetic-element ring (50) as part of a device for detecting a rotation angle position of the shaft (16),

characterized in that

in the axial direction of the shaft (16), the magnetic elements (36) are followed by the magnetic-element ring (50), the axial-clearance

compensation device (54), a first bearing device (42), which interacts with the axial-clearance compensation device (44) when viewed in the direction of the transmission gearwheel (24).

10. An electric drive device (10g), comprising a brushless electric motor (12) which has a stator (40) having wire windings (38) and a rotor (32) mounted to rotate around an axis (18) and having a shaft (16), the rotor (32) having at least one magnetic element, preferably a plurality of magnetic elements (36) which interact with the wire windings (38), the shaft (16) protruding into a transmission housing (14) or being disposed within a transmission housing (14), where it interacts with the transmission gearwheel (24) via a toothing (20), the shaft (16) being mounted by means of at least two bearing devices (42, 44) which are spaced apart from each other in the direction of the axis (18) and being disposed without axial clearance by means of an axial-clearance compensation device (54), and comprising a magnetic-element ring (50) as part of a device for detecting the rotation angle position of the shaft (16),

characterized in that

in the axial direction of the shaft (16), the magnetic elements (36) are followed by the magnetic-element ring (50), a first bearing device (42), the axial-clearance compensation device (54), and a second bearing device (44), which interacts with the axial-clearance compensation device (54), when viewed in the direction of the transmission gearwheel (24).

11. An electric drive device (10h), comprising a brushless electric motor (12) which has a stator (40) having wire windings (38) and a rotor (32) mounted to rotate around an axis (18) and having a shaft (16), the rotor (32) having at least one magnetic element, preferably a plurality of magnetic elements (36) which interact with the wire windings (38), the shaft (16) protruding into a transmission housing (14) or being disposed within a transmission housing (14), where it interacts with a transmission gearwheel 924) via a

toothing (20), the shaft (16) being mounted by means of at least two bearing devices (42, 44) which are spaced apart from each other in the direction of the axis (18) and being disposed without axial clearance by means of an axial-clearance compensation device (54), and comprising a magnetic-element ring (50; 50d) as part of a device for detecting the rotation angle position of the shaft (16),

characterized in that

in the axial direction of the shaft (16), the magnetic elements (36) are followed by a first bearing device (42), the magnetic-element ring (50; 50d), the axial-clearance compensation device (54), and a second bearing device (44), which interacts with the axial-clearance compensation device (54), when viewed in the direction of the transmission gearwheel (24).

12. The electric drive device (10a to 10h) according to any of Claims 1 to 11, characterized in that
the axial-clearance compensation device (54) is a curved sheet-metal part which is disposed under spring pre-load between a housing portion (56) and one of the at least two bearing devices (42, 44).

13. The electric drive device (10a to 10h) according to any one of Claims 1 to 11,
characterized in that
the axial-clearance compensation device (54a) is composed of two elements (60, 62) which are mobile in relation to each other in the direction of the shaft (16) and which are forced into a position in which they are axially spaced part from each other by means of a spring element (64).

14. The electric drive device (10a to 10h) according to any one of Claims 1 to 13,
characterized in that

a separate motor housing connected to the transmission housing (14) is provided for accommodating a stator (40) and the rotor (32).

15. A windshield-wiper motor (100) comprising an electric drive device (10a to 10h) configured according to any one of Claims 1 to 14.

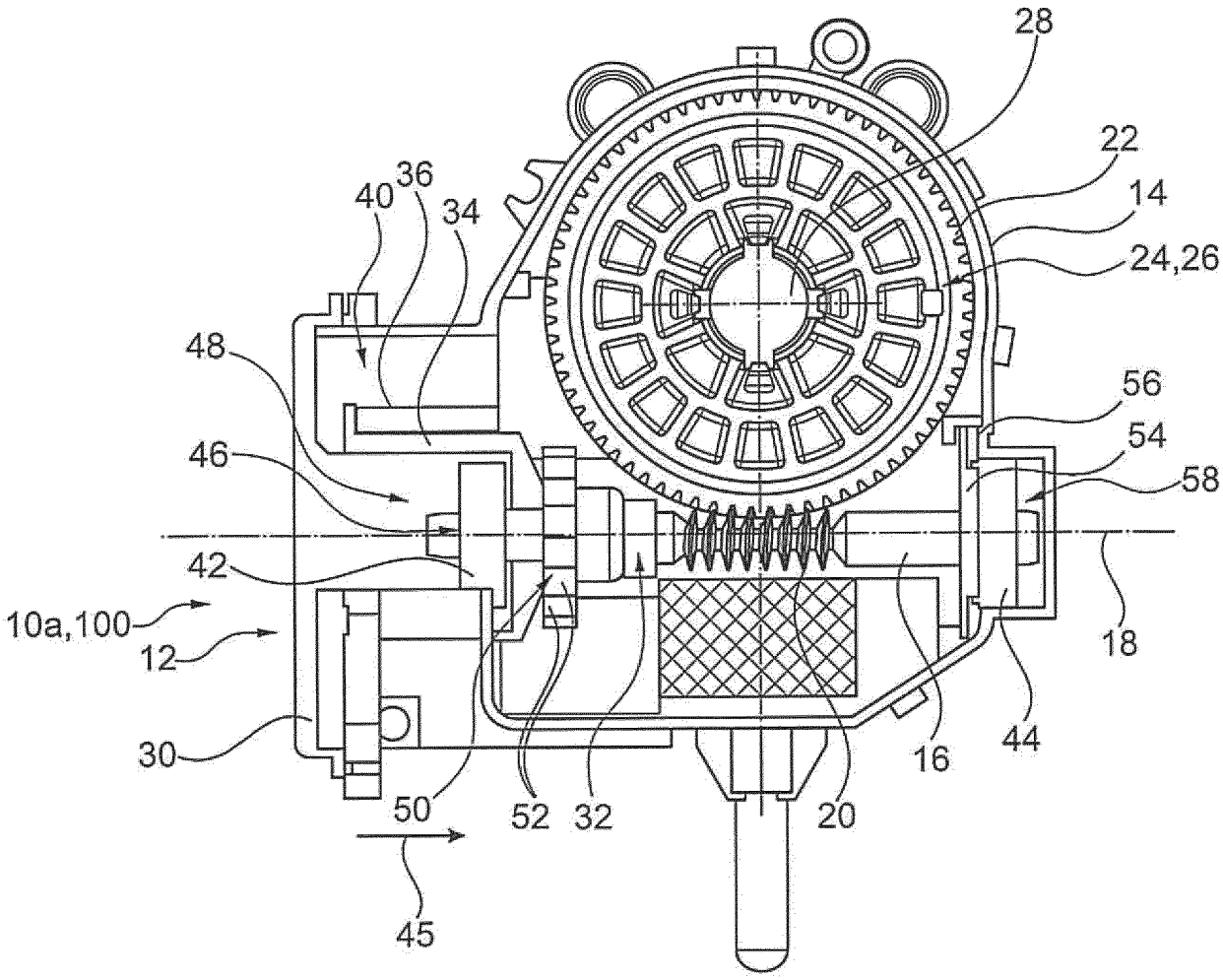

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Fig. 1

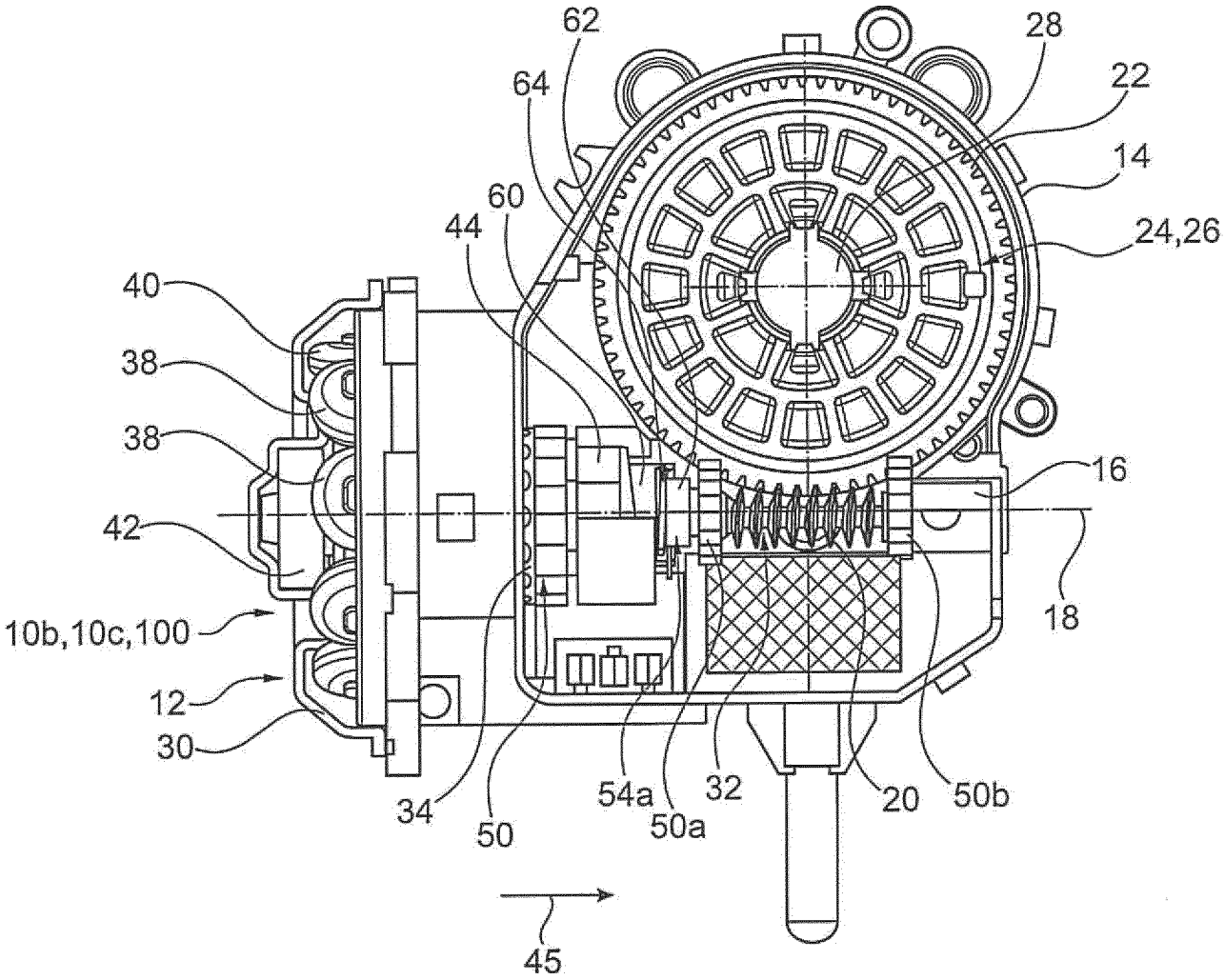

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Fig. 2

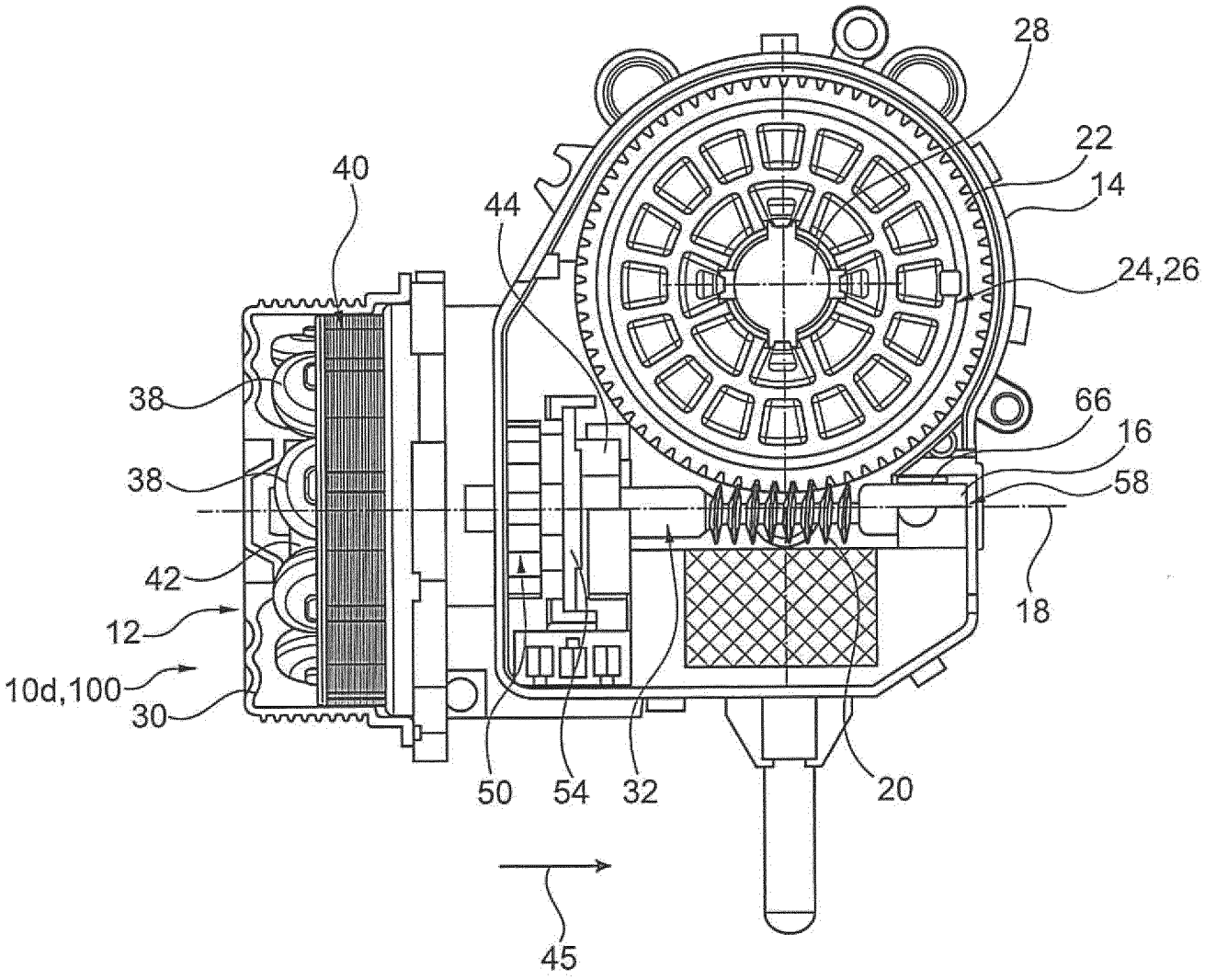


Fig. 3

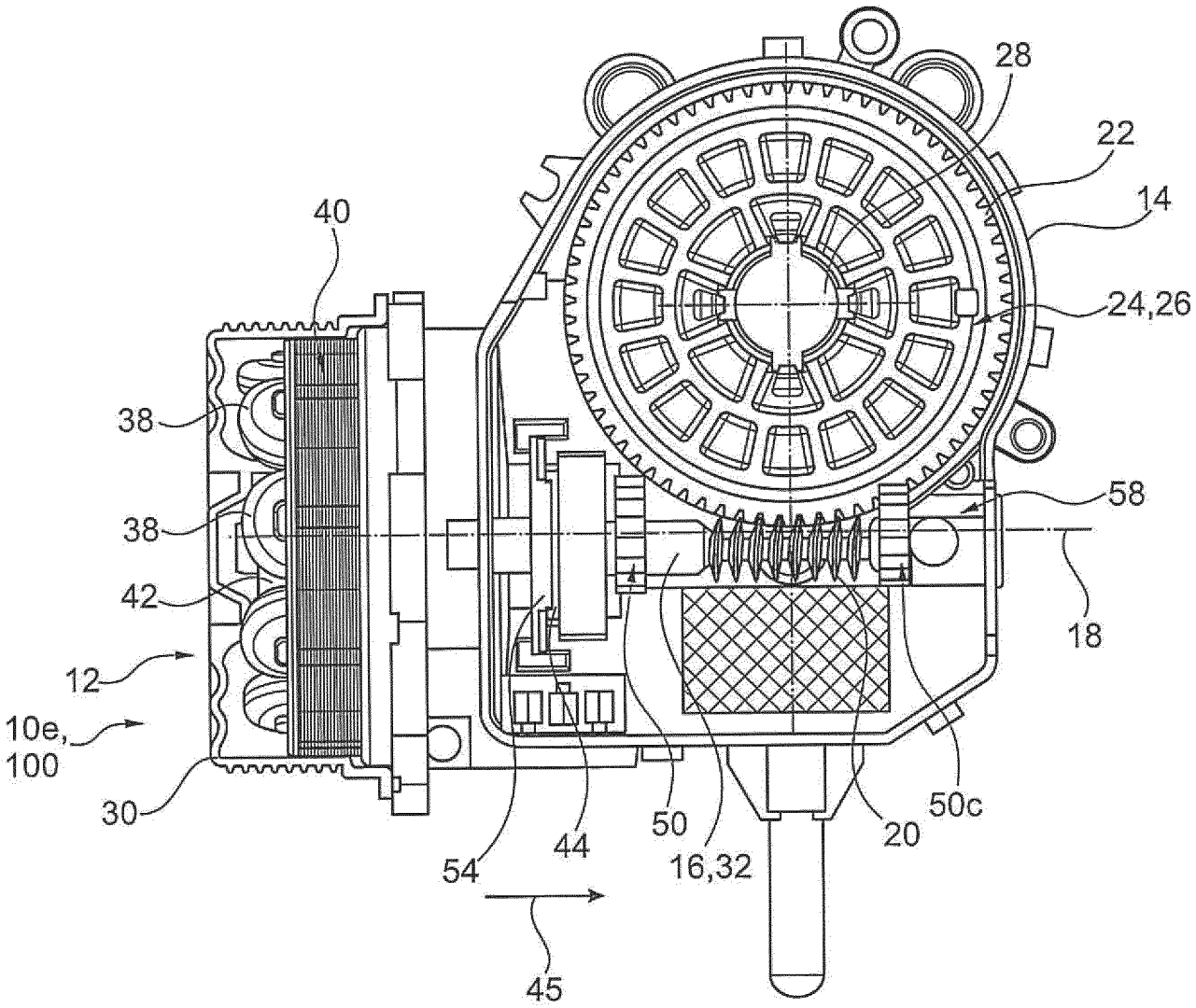


Fig. 4

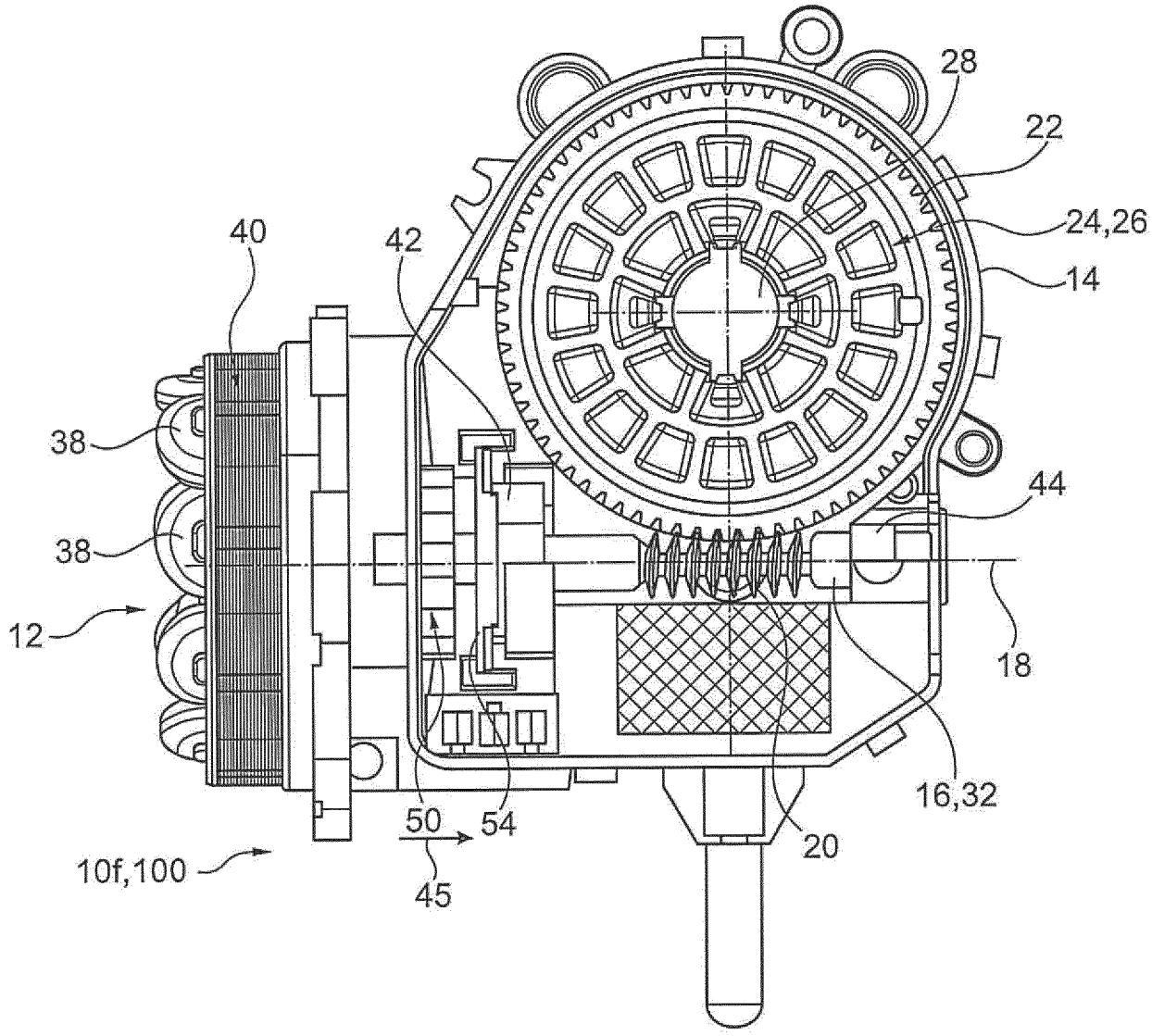


Fig. 5

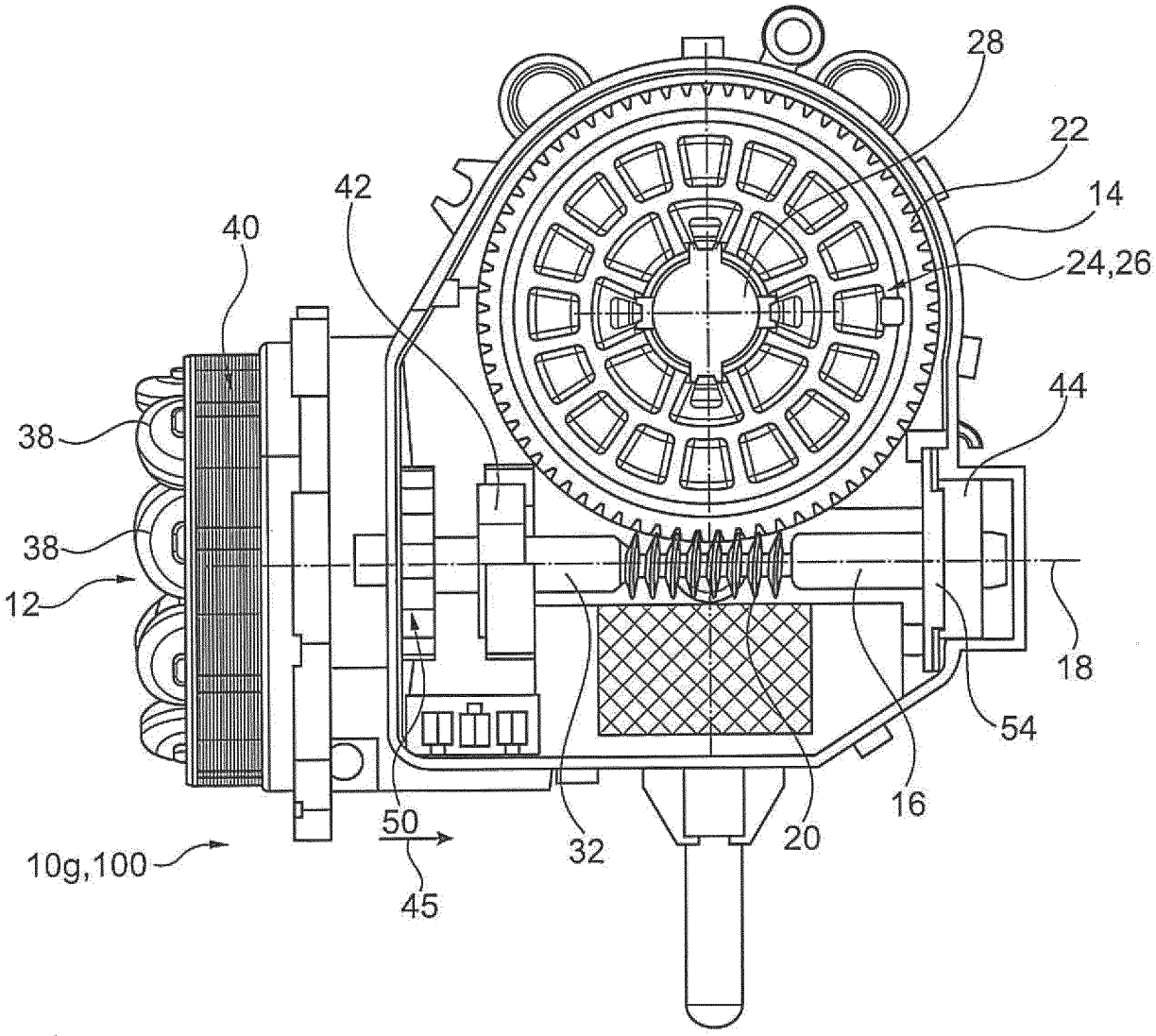


Fig. 6

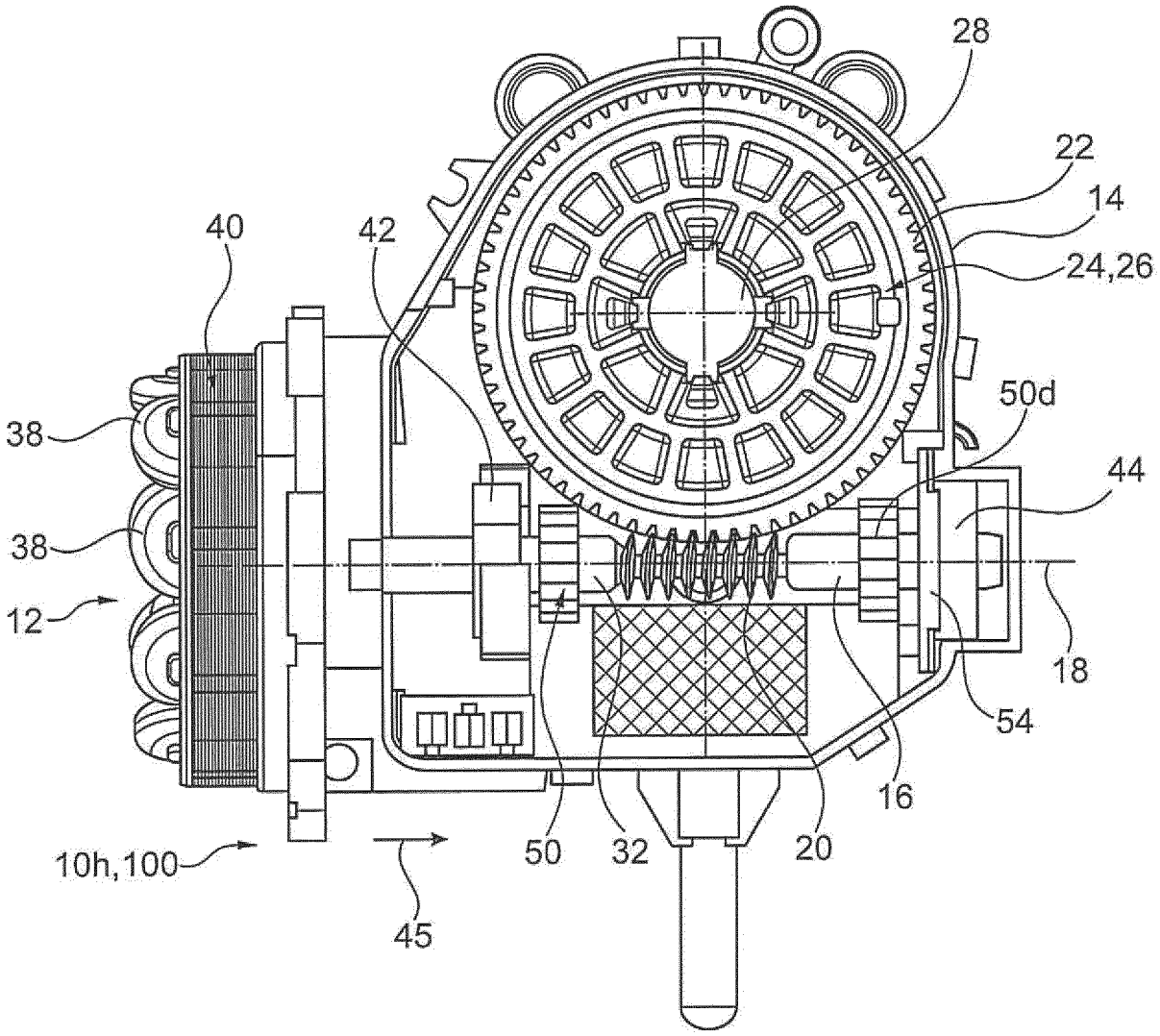


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/061030

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02K7/08 H02K29/08 H02K5/16 H02K7/116 H02K11/215
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)
H02K

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 Y	WO 2018/054573 A1 (VALEO SYSTEMES DESSUYAGE [FR]) 29 March 2018 (2018-03-29) abstract figure 2	1-3,6,9, 11,15 13
X	US 8 408 353 B2 (NAGASE SHIGEKI [JP]; MATSUBARA KEN [JP] ET AL.) 2 April 2013 (2013-04-02) figure 8	1,4,8, 10,12,14
X	US 7 183 681 B2 (NSK STEERING SYS CO LTD [JP]) 27 February 2007 (2007-02-27) figure figure 1	1,5,7
Y	EP 3 171 491 A1 (MITSUBA CORP [JP]) 24 May 2017 (2017-05-24) paragraph [0043] - paragraph [0047] figures 3-5	13

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

☒ See patent family annex.

* Special categories of cited documents :

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"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	Date of mailing of the international search report
15 July 2019	24/07/2019

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Arpaci, Mutlu

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2019/061030

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		WO 2016010021 A1	21-01-2016