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(54) **Title:** ARRANGEMENT FOR DETERMINING THE ANGULAR POSITION OF A SHAFT OF AN ELECTRIC MOTOR,
AND WINDSCREEN WIPER MOTOR WITH AN ARRANGEMENT FOR DETERMINING THE ANGULAR POSITION

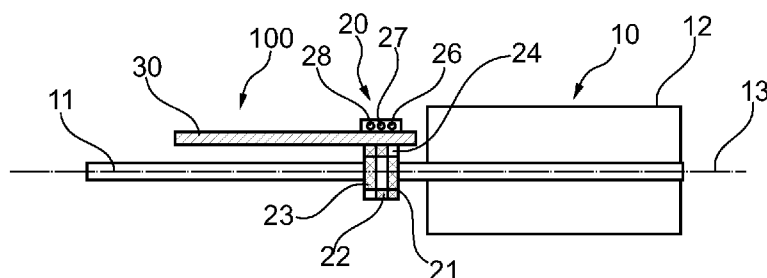


Fig. 1

(57) **Abstract:** The invention relates to an arrangement (20) for determining the angular position of a shaft (11) of an electric motor (10), in particular of a shaft (11) of a windscreen wiper motor (100), with a magnet element arrangement, connected with the shaft (11), and several magnetic field sensors (26, 27, 28), wherein the angular position of the shaft (11) is inferred from the different signals of the magnetic field sensors (26, 27, 28). Provision is made, according to the invention, for the magnet element arrangement to comprise at least one magnet element, preferably several separate magnet elements (21, 22, 23), which are arranged one behind the other in the longitudinal direction of the shaft (11), and for the magnetic field sensors (26, 27, 28) to be arranged on a printed circuit board (30) which is arranged at a slight distance from the shaft (11), such that the magnetic fields of the magnet elements (21, 22, 23) are able to be determined by the magnetic field sensors (26, 27, 28).



Arrangement for determining the angular position of a shaft of an electric motor, and windscreen wiper motor with an arrangement for determining the angular position

5

Prior art

The invention relates to an arrangement for determining the angular position of a shaft of an electric motor, in particular a shaft of a windscreen wiper motor, according to the preamble of Claim 1. The invention also relates to a windscreen wiper motor using an arrangement according to the invention.

15 An arrangement according to the preamble of Claim 1 is known in practice and serves to determine the exact position of a drive shaft of an electric motor so that said electric motor, when used as a windscreen wiper motor, can be driven by a control arrangement in such a way that the wiper blades of a windscreen wiper arrangement, which wiper blades are operatively connected to the windscreen wiper motor, can be stopped, for example, at a specific point in time. The arrangements known from the prior art use Hall sensors for this purposes, said Hall sensors determining the magnetic field of a magnet element which is arranged on the shaft of the electric motor. In this case, the Hall sensors are arranged in different radial positions around the shaft of the electric motor, with the result that a specific angular position of the shaft can be inferred from the combination of signals determined by the Hall sensors. The Hall sensors are each in the form of separate components and are connected to a control arrangement or an evaluation circuit by means of corresponding electrical connecting lines, said control arrangement or evaluation circuit being arranged on a printed circuit board which is arranged inside the electric motor and serves to control the electric motor.

Disclosure of the invention

Proceeding from the described prior art, the invention
5 is based on the object of developing an arrangement for
determining the angular position of a shaft of an
electric motor according to the preamble of Claim 1 in
such a way that said arrangement can be produced in a
particularly simple and cost-effective manner and
10 furthermore is relatively flexible in respect of the
arrangement on the electric motor. According to the
invention, this object is achieved with an arrangement
for determining the angular position of a shaft of an
electric motor with the features of Claim 1 in that the
15 magnet arrangement comprises at least one magnet
element, preferably several separate magnet elements,
which are arranged one behind the other in the
longitudinal direction of the shaft, and in that the
magnetic field sensors are arranged on a printed
20 circuit board which is arranged at a slight distance
from the shaft, such that the magnetic fields of the
magnet arrangement are able to be determined by the
magnetic field sensors. In other words, this means that
special arrangement of the magnet elements in the
25 longitudinal direction of the shaft makes it possible
to arrange the magnetic field sensors directly on the
printed circuit board, so that said magnetic field
sensors can determine the magnetic fields of the magnet
arrangement. Therefore, additional and complex and also
30 expensive cabling means between the magnetic field
sensors and the evaluation circuit on the printed
circuit board are avoided.

Advantageous developments of the arrangement according
35 to the invention for determining the angular position
of a shaft of an electric motor are cited in the
dependent claims. All combinations of at least two
features which are disclosed in the claims, the

description and/or the figures fall within the scope of the invention.

5 An arrangement of the magnetic field sensors on that printed circuit board which serves at the same time to receive the components for controlling the windscreen wiper motor is very particularly preferred. As a result, an additional printed circuit board is not required for the windscreen wiper motor; rather, the
10 usually single printed circuit board for receiving the magnetic field sensors which is already present suffices.

In a refinement which is preferred from a structural
15 respect, the at least one magnet element is constructed in a ring shape and surrounds the (armature or rotor) shaft radially.

In order to be able to determine the rotation angle
20 position of the shaft, provision is made for the magnet elements to be arranged at a differing rotation angle position on the shaft. As a result, different magnetic fields (north/south pole combinations) are generated by the individual magnet elements at a specific angular
25 position of the shaft and can be evaluated by means of an evaluation circuit in order to thereby be able to determine the respective angular position of the shaft within the scope of a specific resolution.

30 The use of the invention in brushless electric motors in which the rotor position has to be determined for the purpose of correct commutation is particularly preferred. However, it goes without saying that, in principle, it is also expedient and possible in
35 conventional (brush) electric motors where it may likewise be necessary to know the angular position of the rotor shaft. When used in brushless electric motors, the arrangement according to the invention is

suitable both for two-pole electric motors and for four-pole electric motors and also for eight-pole electric motors (in general for n-pole motors). In this case, provision is made, depending on the respective
5 number of poles of the electric motor, for each magnet element, depending on the number of poles of the electric motor, to have respectively 2 poles in a 2-pole electric motor, respectively 4 poles in a 4-pole electric motor and respectively 8 poles in an 8-pole
10 electric motor.

In order to simplify evaluation of the signals from the magnetic field sensors, provision is made for three magnet elements to be provided, these magnet elements
15 preferably being arranged offset with respect to each other by respectively 120° . An arrangement of this kind makes it possible, in practice, for the angular position of the shaft of the electric motor to be accurately determined with a resolution of 10° , this
20 often having proven sufficient in practice.

A structure of the arrangement which is as compact as possible is furthermore achieved when the magnet elements (be they realized as elements in the shape of
25 a ring or in the form of several elements in the shape of a ring) adjoin each other directly, viewed in the axial direction of the shaft. In this case, it is also possible, for example, to adhesively bond the individual magnet elements to one another, so that they
30 can be mounted on the shaft in a relatively simple manner as a composite component and at the same time have a high strength as an assembly. As an alternative, a single magnet element is also feasible, this being suitable for use with several magnetic field sensors by
35 virtue of corresponding magnetization.

Furthermore, a position of the magnet elements outside a motor housing of the electric motor is preferably

provided. As a result, firstly the installation space for the motor housing can be very compact since the magnet elements and the magnetic field sensors do not have to be arranged within the motor housing, and
5 secondly it is possible to use the (single) printed circuit board of the electric motor since it can be of a size which is, for example, larger than the diameter of the motor housing.

10 Production is further simplified when the magnetic field sensors are constructed as Hall sensors in SMD construction. SMD components of this kind are used in large numbers in industry and connected to the printed circuit board by reflow soldering in particular, as a
15 result of which cost-effective production processes with a high level of manufacturing quality can be achieved.

The invention also comprises a windscreen wiper motor
20 with an arrangement according to the invention. A windscreen wiper motor of this kind can be produced at relatively low cost and with a particularly compact structure.

25 Further features, advantages and details of the invention can be found in the following description of preferred exemplary embodiments and with reference to the drawing, in which:

30 Fig. 1 shows a simplified side view of parts of a windscreen wiper motor using an arrangement according to the invention for determining the angular position of a shaft of a brushless electric motor,

35 Fig. 2 shows a plan view of the arrangement according to Fig. 1,

Fig. 3 shows a perspective view of a magnet arrangement which comprises three magnet elements in the shape of a ring, and

5 Fig. 4 shows a side view of the magnet arrangement according to Fig. 3.

Identical components or components with the same function are provided with the same reference numerals
10 in the figures.

Figs 1 and 2 show highly simplified parts of a windscreen wiper motor 100 which is a constituent part of a windscreen wiper system of a vehicle, for example
15 a windscreen wiper system for cleaning a front windscreen of the vehicle. The windscreen wiper motor 100 comprises a brushless electric motor 10 which has a rotor shaft 11 with magnet elements which is rotatably mounted within a cylindrical motor housing 12, and
20 which interacts with stator windings (not illustrated in the figures) which are likewise arranged in the motor housing 12.

The use of a conventional (brush) electric motor 10
25 likewise lies within the scope of the invention. Shell-like magnet elements which are arranged within the motor housing 12 in the form of constituent parts of the electric motor and an iron-containing magnetic return path element if the motor housing 12 does not
30 already contain iron or is composed of steel are not illustrated either.

The rotation speed of the electric motor 10 can likewise be reduced in a manner which is known per se
35 by means of a step-down gear mechanism (not illustrated) by a tooth geometry which is formed on the rotor shaft 11 on the side averted from the motor

housing 12 meshing with a mating tooth system on an output drive wheel.

In order to drive the windscreen wiper motor 100 or to
5 move the windscreen wiper in a positionally accurate manner, it is necessary to be able to accurately determine the (rotation) angle position of the rotor shaft 11. It is also necessary to know the rotor position in order to correctly electrically commutate
10 the electric motor 10. In the case of brush electric motors, it may possibly be necessary to additionally know the position of a gear wheel which interacts with the rotor shaft 11. In practice, it is usually sufficient to be able to accurately determine the
15 angular position of the rotor shaft 11 with a degree of accuracy or a resolution of 10° . In order to allow this, the electric motor 10 has an arrangement 20 according to the invention. In the illustrated exemplary embodiment, in which it is assumed that the
20 electric motor 10 is in the form of a 2-pole (brushless) electric motor 10, the arrangement 20 comprises three magnet elements 21 to 23 which are each in the shape of a ring and are identical and are arranged one behind the other in relation to the
25 longitudinal axis 13 of the rotor shaft 11. As can be seen with reference to Fig. 3 in particular, the three magnet elements 21 to 23 adjoin one another directly as viewed in the axial direction of the rotor shaft 11 and are, for example, adhesively bonded to one another. The
30 magnet elements 21 to 23 radially surround the rotor shaft 11.

It should additionally be mentioned that, instead of three magnet elements 21 to 23, it is also possible to
35 use a single magnet element with a corresponding magnetization.

Each of the three magnet elements 21 to 23 comprises in each case a magnetic south pole 24 and a magnetic north pole 25 which each have a rotational angle range of 180°. The three magnet elements 21 to 23 are arranged
5 offset with respect to each other by respectively 120° in the exemplary embodiment.

It should additionally be mentioned that, in the case of a 4-pole (brushless) electric motor 10, the magnet
10 elements 21 to 23 have respectively four poles, and when used on an 8-pole (brushless) electric motor 10, the magnet elements 21 to 23 have respectively eight poles.

15 When the rotor shaft 11 rotates about the longitudinal axis 13, the three magnet elements 21 to 23 generate magnetic fields, it being possible to determine the intensity and orientation of said magnetic fields by means of three magnetic field sensors 26 to 28. The
20 magnetic field sensors 26 to 28 which are constructed as Hall sensors are preferably constructed as SMD components and arranged in a manner oriented with respect to the magnet elements 21 to 23 in this case. As seen with reference to Figs 2 and 3, the magnetic
25 field sensors 26 to 28 are arranged directly on a printed circuit board 30 or are connected to said printed circuit board, with the printed circuit board 30 being arranged outside the motor housing 12, as are the magnet elements 21 to 23. In addition to the
30 magnetic field sensors 26 to 28 (which may possibly be arranged in a common housing or constructed on a common chip), the printed circuit board 30 is fitted with further components (not shown in Figs 1 and 2) which serve, in particular, to control the windscreen wiper
35 motor 100, for example resistors, capacitors, ICs. In the illustrated exemplary embodiment, the magnetic field sensors 26 to 28 are arranged on that side of the printed circuit board 30 which is averted from the

magnet elements 21 to 23. It goes without saying that the scope of the invention also covers the situation of the magnetic field sensors 26 to 28 being arranged directly opposite the magnet elements 21 to 23 in such a way that the printed circuit board 30 is located on that side of the magnetic field sensors 26 to 28 which is averted from the magnet elements 21 to 23.

The three magnet elements 21 to 23 form, as can be seen with reference to Fig. 4 in particular, three tracks 31 to 33 which can be determined by the magnetic field sensors 26 to 28.

The arrangement 20 according to the invention described up to this point can be modified in a variety of ways without departing from the concept of the invention. Other possible uses in addition to determining the (rotation) angle position of a windscreen wiper motor 100 are likewise feasible.

List of reference symbols

10	Electric motor
11	Rotor shaft
12	Motor housing
13	Longitudinal axis
20	Arrangement
21	Magnet element
22	Magnet element
23	Magnet element
24	South pole
25	North pole
26	Magnetic field sensor
27	Magnetic field sensor
28	Magnetic field sensor
30	Printed circuit board
31	Track
32	Track
33	Track
100	Windscreen wiper motor

CLAIMS

1. An arrangement (20) for determining the angular position of a shaft (11) of an electric motor (10), in particular of a shaft (11) of a windscreen wiper motor (100), with a magnet element arrangement, connected with the shaft (11), and several magnetic field sensors (26, 27, 28), wherein the angular position of the shaft (11) is inferred from the different signals of the magnetic field sensors (26, 27, 28),

characterized in that

the magnet element arrangement comprises at least one magnet element (21, 22, 23), preferably several separate magnet elements (21, 22, 23), which are arranged one behind the other in the longitudinal direction of the shaft (11), and that the magnetic field sensors (26, 27, 28) are arranged on a printed circuit board (30) which is arranged at a slight distance from the shaft (11), such that the magnetic fields of the at least one magnet element (21, 22, 23) are able to be determined by the magnetic field sensors (26, 27, 28).

2. The arrangement according to Claim 1, characterized in that the printed circuit board (30) serves at the same time to receive the components for controlling the windscreen wiper motor (100).

3. The arrangement according to Claim 1 or 2, characterized in that the at least one magnet element (21, 22, 23) is constructed in a ring shape and surrounds the shaft (11) radially.

4. The arrangement according to Claim 3,
characterized in that
with the presence of several magnet elements (21,
5 22, 23), these are arranged at a differing
rotation angle position on the shaft (11).
5. The arrangement according to Claim 4,
characterized in that
10 each magnet element (21, 22, 23), depending on the
number of poles of the brushless electric motor
(10), has respectively 2 poles in a 2-pole
electric motor (10), respectively 4 poles in a 4-
pole electric motor and respectively 8 poles in an
15 8-pole electric motor.
6. The arrangement according to Claim 4 or 5,
characterized in that
three magnet elements (21, 22, 23) are provided,
20 which are preferably arranged offset with respect
to each other by respectively 120°.
7. The arrangement according to one of Claims 4 to 6,
characterized in that
25 the magnet elements (21, 22, 23) adjoin each other
directly, viewed in axial direction of the shaft
(11).
8. The arrangement according to one of Claims 1 to 7,
30 characterized in that
the at least one magnet element (21, 22, 23) is
arranged outside a motor housing (12).
9. The arrangement according to one of Claims 1 to 8,
35 characterized in that
the magnetic field sensors (26, 27, 28) are
constructed as Hall sensors in SMD construction.

10. A windscreen wiper motor (100) with an arrangement (20) according to one of Claims 1 to 9.

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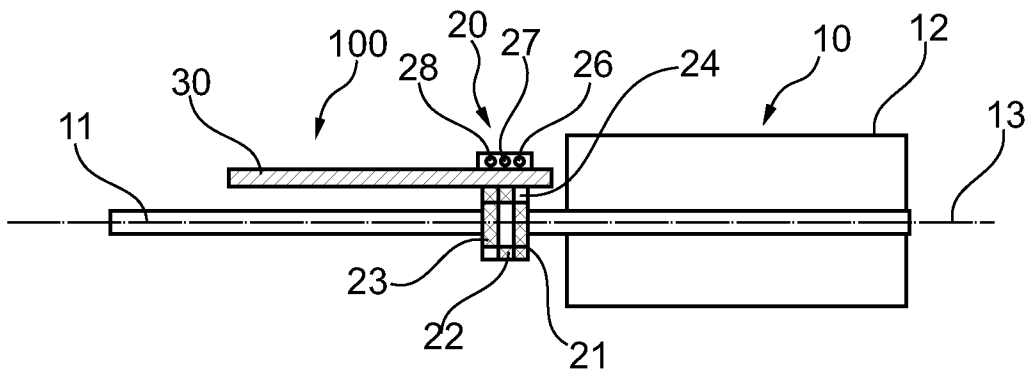


Fig. 1

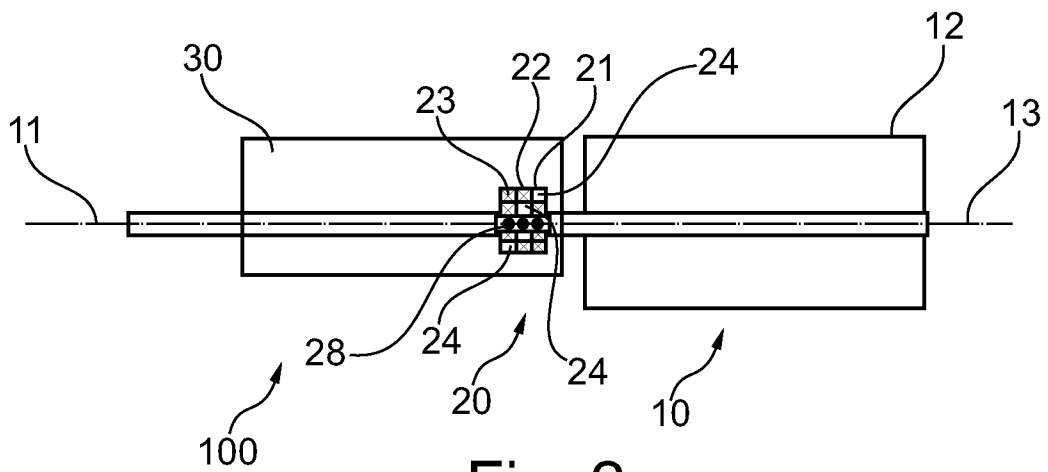


Fig. 2

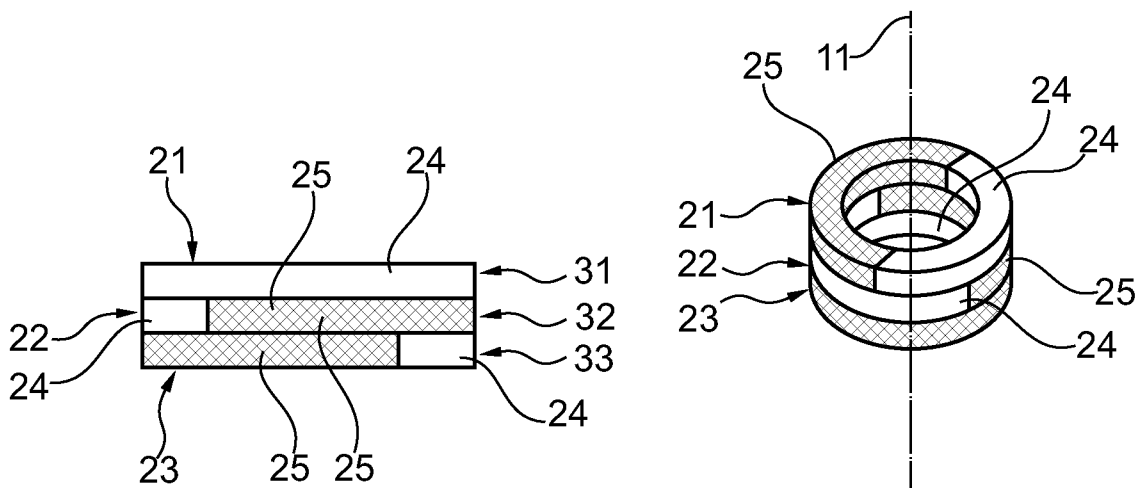


Fig. 4

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/051862

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60S1/08 H02K29/08
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)
B60S 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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 4 982 125 A (SHIRAKAWA HIROYUKI [JP]) 1 January 1991 (1991-01-01) column 2, line 10 - line 59; figures -----	1,3,10
X	EP 1 780 875 A2 (LEROY SOMER MOTEURS [FR]) 2 May 2007 (2007-05-02) paragraph [0014] - paragraph [0050]; figures paragraph [0052] - paragraph [0093] ----- -/-	1,3,9



Further documents are listed in the continuation of Box C.



See patent family annex.

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"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

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/051862

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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