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(54) Title: A MAGNET HOLDER AND STROKE SENSOR WITH THE MAGNET HOLDER

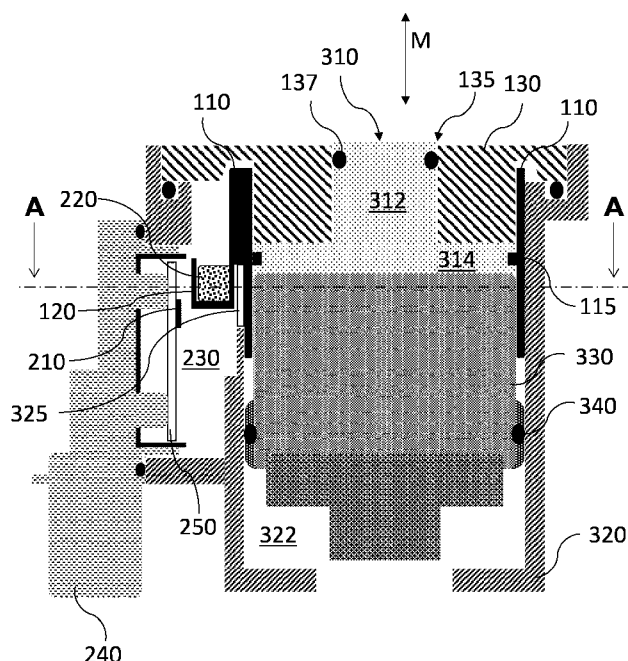


Fig. 1A

(57) Abstract: A magnet holder and stroke sensor with the magnet holder A magnet holder for a stroke sensor is disclosed, wherein the stroke sensor comprises a magneto-resistive sensor (210) with a magnet (220) and is configured to sense a linear displacement (M) of a plunger (310) in a cylindrical body (320) of a plunger/cylinder arrangement. The magnet holder includes a sleeve (110) enveloping the plunger (310); a mounting (120) for the magnet (220) radially protruding from the sleeve (110); and a cover (130) for closing the sleeve (110) on one side comprising an opening (135) for allowing the linear displacement of the plunger (310). The sleeve (110) and the cover (130) move relative to each other, when the plunger (310) performs the linear displacement (M) in the cylindrical body (320).

## DESCRIPTION

**A magnet holder and stroke sensor with the magnet holder**

- 5 The present invention relates to a magnet holder and a stroke sensor with the magnet holder to determine an axial displacement in a plunger/cylinder arrangement.

Electronic braking systems become more and more widespread in commercial vehicles. These systems rely on accurate measurements of driver demands for a brake action.

- 10 Also, for conventional pneumatic or hydraulic braking systems, there is an increasing demand to determine a brake actuation correctly as intended by the driver of the vehicle. It is thus important to measure accurately axial displacements by stroke sensors, for example of plunger or piston relative to a cylinder.
- 15 DE 196 37 296 A1 discloses a conventional stroke sensor for a piston with a magneto-resistive element arranged in a cylindrical body, wherein the associated magnet is mounted on the piston. Upon an axial displacement of the piston an electric signal is generated in the magneto-resistive element dependent on the axial position of the piston. This sensor is, however, arranged within the cylinder and as such it is exposed
- 20 to moisture or dirt inside the cylinder. Another conventional sensor module for a master cylinder is disclosed in US 9,266,517 B2, which also relies on a magneto-resistive element and includes a corresponding magnet. This sensor module uses a separate sensor chamber in which the magnet is mounted on an end portion of an additional plunger that moves back and forth unisonous with a plunger of the master cylinder
- 25 whose position shall be sensed. Although this sensor module provides a separate chamber for the magneto-resistive element and is thus less prone to moisture and dirt, the additional plunger as magnet holder with its guiding makes the sensor arrangement more complicated.
- 30 Therefore, there is a demand for further magnet holder and stroke sensors that provide a high reliability, are simple to manufacture, and provide accurate sensor results.

At least some of the problems of the conventional systems as described before are overcome by a magnet holder of claim 1, a stroke sensor of claim 5, and a plunger/cylinder arrangement according to claim 9. The dependent claims refer to further advantageous realizations of the subject matter of the independent claims.

5

The present invention relates to a magnet holder for a stroke sensor. The stroke sensor comprises a magneto-resistive sensor with a magnet and is configured to sense a linear displacement of a plunger in a cylindrical body of a plunger/cylinder arrangement. The magnet holder comprises a sleeve enveloping the plunger, a mounting for the magnet  
10 radially protruding from the sleeve, and a cover for closing the sleeve on one side. The cover comprises an opening for allowing the linear displacement of the plunger (e.g. by guiding the plunger rod). The sleeve and the cover move relative to each other, when the plunger performs the linear displacement in the cylindrical body.

15 The term “enveloping” shall indicate, that the sleeve may encircle the plunger completely around the plunger in a cross-section perpendicular to the axial displacement direction. However, enveloping does not imply that plunger is encircled in the axial direction. Instead, with respect to the axial direction at least part of the plunger (e.g. a plunger rod) may protrude out of the sleeve.

20

It is understood that the magneto-resistive sensors can be any sensor that generates a sensor signal dependent on a change of a magnet field resulting in a change of a resistance in a sensor element. The change in the magnetic field is caused by the axial displacement of the magnet relative to the magneto-resistive sensor. Examples for such  
25 magneto-resistive sensors uses the Hall-effect, GMR- (giant magneto-resistance), AMR- (anisotropic magneto-resistance), TMR- (tunnel magneto-resistance) effect to generate respective sensor signals. The corresponding Hall-sensor does not need magnet material, whereas the corresponding GMR-, TMR-, AMR-sensor rely at least in part on magnetic materials. The present invention shall not be limited on a particular  
30 example for the magneto-resistive sensor.

Optionally the plunger/cylinder arrangement comprises a piston configured to move together with the plunger inside the cylindrical body. In this embodiment, the sleeve may

be formed to envelope at least an upper portion of the piston. The piston and the plunger are, however, separate elements which are detachable from one another.

- 5 The plunger may perform a rotation and the linear displacement relative to the cylindrical body. In this case, the mounting may form together with the sleeve an integral part and may be configured to provide a rotational interlock between the sleeve and the cylindrical body, while allowing the linear displacement (linear movement) within the cylindrical body. The rotational interlock may be provided by an axial slot (elongated/linear opening) within the cylindrical body and the sleeve may comprise a pin
- 10 that engages to the axial slot and prevents the relative rotation. The mounting of the magnet holder may act as such a pin. As a result of this interlocking engagement the magnet will move linearly relative to the magneto-resistive sensor and thus provides a well-defined sensor signal.
- 15 Optionally the sleeve is adapted to perform the linear displacement together with the plunger and/or the piston. This may likewise be implemented by a pin/groove engagement between the sleeve and the plunger. A pin/groove engagement may likewise be formed between the sleeve and the piston.
- 20 The present invention relates also to a stroke sensor comprising a magneto-resistive sensor with a magnet, which may be a Hall sensor and is configured to sense a linear displacement of a plunger in a cylindrical body. The stroke sensor includes a magnet holder as described before.
- 25 Optionally, the stroke sensor includes a chamber arranged at a side portion of the cylindrical body and sealed from an interior space of the cylindrical body. Moreover, the stroke sensor may include a removable side cover that provides a closure for the chamber. The magneto-resistive sensor may be arranged together with its magnet inside the chamber. The cover may be adapted to close the cylindrical body and the
- 30 chamber.

Optionally, a printed circuit board is attached to the removable side cover, wherein the printed circuit board holds the magneto-resistive sensor in the chamber.

The present invention relates also to a plunger/cylinder arrangement for a brake system of a vehicle, in particular a commercial vehicle. The plunger/cylinder arrangement includes a cylindrical body, a plunger, and a stroke sensor as described before. The  
5 plunger is able to perform a linear displacement in the cylindrical body, which may correspond to a brake demand. The stroke sensor may sense this brake demand for the vehicle.

Optionally, the cylindrical body comprises an axial slot (split-like opening) for receiving  
10 part of the mounting to provide an axial guidance for the sleeve while preventing relative rotations between the sleeve and the cylindrical body.

Optionally, the plunger/cylinder arrangement includes a piston configured to move in at least one direction together with the plunger inside the cylindrical body, wherein the  
15 sleeve is adapted to slide inside the cylindrical body and to encircle at least an upper portion of the piston. Furthermore, a sealing between a lower portion of the piston and the cylindrical body may be provided to seal the chamber from an interior space of the cylindrical body. Hence, this arrangement provides a secure protection the magneto-resistive sensor in the chamber, e.g. from moisture, dirt etc., without needing addition  
20 elements like additional plungers as in the conventional arrangements.

Embodiments of the present invention relates also to a vehicle with the plunger/cylinder arrangement as described before. The vehicle may be a commercial vehicle and the  
25 plunger/cylinder arrangement may be part of a braking system of the vehicle.

Some examples of the systems will be described in the following by way of examples only, and with respect to the accompanying figures, in which:

Fig. 1A, B depict a magnet holder with a stroke sensor for a plunger/cylinder  
30 arrangement system according to an embodiment of the present invention.  
Fig. 2 shows a cross-section view of the stroke sensor of Fig. 1A or Fig. 1B along the cross-sectional line A-A.

**Fig. 1A** and **Fig. 1B** depict a magnet holder with a stroke sensor for a plunger/cylinder arrangement. The stroke sensor comprises a magneto-resistive sensor 210 with a magnet 220 and the plunger/cylinder arrangement comprises a plunger 310 and a cylindrical body 320 that can move relative to each other along the axial direction M (linear displacement). The magnet holder comprises a sleeve 110 encircling the plunger 310, a mounting 120 for the magnet 220 protruding radially outward from the sleeve 110, and a cover 130 for closing the sleeve 110 on one side. The cover 130 has an opening 135 for allowing the linear displacement of the plunger 310 therethrough. More precisely, the plunger 310 may comprise a plunger rod 312 extending through the opening 135 and a piston part 314 (broadened portion) arranged in an interior space 322 of the cylindrical body 320. The sleeve 110 and the cover 130 move relative to each other, when the plunger 310 performs the linear displacement M through the interior space 322 of the cylindrical body 320.

In the embodiment of Fig. 1A, the plunger 310 abuts to a piston 330 to push the piston 330 upon the linear displacement M. The plunger/cylinder arrangement may further include at least one spring (not shown in Fig. 1A) to provide a bias force pressing the piston 330 to the plunger 310 (in Fig. 1A upward). It is also possible that the piston 330 couples to the plunger 310 via other coupling elements (e.g. a snap or click connection).

The plunger 310 couples likewise to the sleeve 110 preventing a relative displacement of the sleeve 110 and the plunger 310 in the axial direction M. The sleeve 110 may be coupled to the piston 330 rather than to the plunger 310. However, the plunger 310 and the sleeve 110 may rotate relative to each other about the axial direction M. This coupling may be implemented by groove/pin coupling 115 involving e.g. protrusions or a protruding ring extending radially inwards from the sleeve 110 and corresponding recesses or grooves formed at an outer circumference of the plunger 310 or of the piston 330 (or its broadened portion). It may also be implemented the other way around, i.e. the groove/recess is formed in the sleeve 110 and the protrusion(s) on the plunger 310.

The embodiment depicted in Fig. 1B differs from the embodiment in Fig. 1A only in that the groove/pin coupling 115 involves now the sleeve 110 and the piston 330 (not the plunger). All other components may be arranged in the same way.

The mounting 120 for the magnet 220 extends radially outwards from the sleeve 110 such that the magnet 220 is held within a chamber 230 separate from the interior space 322 of the cylindrical body 320. The chamber 230 is formed at a side portion of the cylindrical body 320 and is covered by a removable side cover 240. The magneto-resistive sensor 210 is arranged together with the magnet 220 inside the chamber 230, which is sealed from the interior space 322 of the cylindrical body 320 by sealing means 340 (e.g. a sealing ring). The magneto-resistive sensor 210 may be arranged on a printed circuit board 250 that in turn may be attached to the removable side cover 240 of the chamber 230.

The cover 130 is adapted to provide a closure for the cylindrical body 320 and the sleeve 110 and/or the chamber 230. The cover 130 is mounted on the cylindrical body 320 and comprises the opening 135 through which the piston rod 312 extends and moves along the linear direction M. Optional sealing elements 137 may be formed between the cover 130 and the piston 310 to provide a sealing during the linear motion M (displacement).

**Fig. 2** shows a cross-sectional view along the cross-sectional line A-A through the piston 330, the sleeve 110, the cylindrical body 320, the magnet 220, and the side cover 240 with the circuit board 250.

As it is apparent from the cross-sectional view, the sleeve 110 extends through a slot 325 of the cylindrical body 320. This engagement provides a rotational fixation of the sleeve 110 relative to the cylindrical body 320 so that the sleeve 110 is prevented from rotating relative to the cylindrical body 320. As a result, the magnet 120 has to remain at the same angular position in Fig. 2 (the axial displacement M is perpendicular to the drawing plane in Fig. 2). Thus, sensor signals generated by the magneto-resistive element 210 remains in the linear operation range (the linearity is maintained).

Advantageous aspects of embodiments can be summarized as follows:

The described arrangement provides a stroke sensor based, e.g., on Hall effect technology for the purpose to provide electrical signal proportional to a stroke of the

plunger 310. The sensor is sensitive to magnetic field variation therefore a permanent magnet 220 is placed near the core element of the sensor (e.g. a Hall chip 210), and properly guided to allow a variation of the magnetic field density once the plunger 310 is actuated. Any other direction of movement of the magnet 220 that differs from the  
5 direction of the plunger 310 would cause a deviation in the linearity of the sensor signal.

The plunger 310 and the piston 330 are sliding inside an upper (cylindrical) body 320 together with the sleeve 110 that act as magnet holder (the sleeve 110 and the mounting 120 can be one integral part). The sleeve 110 envelops both the plunger 310  
10 and piston 330 and is open for easy assembly, the opening is opposite oriented with respect to the magnet 220. The magnet holder embraces also the cover 130 and slides on it for the complete stroke of the plunger 310. The sleeve 110 cannot rotate as the magnet seat (mounting 220) moves inside a slot 325 of the upper body 320.

15 The magnet holder is designed to deliver three functions:

- allow smooth sliding of the plunger 110 and Piston 330 inside the upper body 320;
- clamp the magnet 220, move it together with the plunger 310 and avoid transversal movement despite any possible rotation of the plunger 310;
- 20 - protect the chamber 230, where both the printed circuit board 250 and the magnet 220 are placed.

The description and drawings merely illustrate the principles of the disclosure. It will thus be appreciated that those skilled in the art will be able to devise various  
25 arrangements that, although not explicitly described or shown herein, embody the principles of the disclosure and are included within its scope.

Furthermore, while each embodiment may stand on its own as a separate example, it is to be noted that in other embodiments the defined features can be combined differently,  
30 i.e. a particular feature described in one embodiment may also be realized in other embodiments. Such combinations are covered by the disclosure herein unless it is stated that a specific combination is not intended.

## LIST OF REFERENCE SIGNS

|    |     |                                             |
|----|-----|---------------------------------------------|
|    | 110 | sleeve                                      |
| 5  | 115 | protrusion/pin with recess                  |
|    | 120 | mounting (support) for the magnet           |
|    | 130 | cover                                       |
|    | 135 | opening in cover                            |
|    | 137 | sealing                                     |
| 10 | 210 | magneto-resistive sensor (e.g. Hall sensor) |
|    | 220 | magnet                                      |
|    | 230 | chamber                                     |
|    | 240 | removable side cover                        |
|    | 250 | printed circuit board                       |
| 15 | 310 | plunger                                     |
|    | 312 | plunger rod                                 |
|    | 314 | piston part of the plunger                  |
|    | 320 | cylindrical body                            |
|    | 322 | interior space                              |
| 20 | 325 | slot, gap, split-like opening               |
|    | 330 | piston                                      |
|    | 340 | sealing                                     |
|    | M   | linear displacement                         |

## CLAIMS

1. A magnet holder for a stroke sensor, the stroke sensor comprising a magneto-resistive sensor (210) with a magnet (220) and being configured to sense a linear  
5 displacement (M) of a plunger (310) in a cylindrical body (320) of a plunger/cylinder arrangement,

**characterized by:**

- a sleeve (110) enveloping the plunger (310);
- a mounting (120) for the magnet (220) radially protruding from the sleeve (110);  
10 and
- a cover (130) for closing the sleeve (110) on one side comprising an opening (135) for allowing the linear displacement of the plunger (310),

wherein the sleeve (110) and the cover (130) move relative to each other, when the plunger (310) performs the linear displacement (M) in the cylindrical body (320).

15 2. The magnet holder of claim 1, wherein the plunger/cylinder arrangement further comprises a piston (330) configured to move together with the plunger (310) inside the cylindrical body (320),

**characterized in that**

20 the sleeve (110) is formed to envelope at least an upper portion of the piston (330).

3. The magnet holder of claim 1 or claim 2, wherein the plunger (310) is able to perform the linear displacement and/or a rotation relative to the cylindrical body (320),

**characterized in that**

25 the mounting (120) is configured to provide a rotational interlock between the sleeve (110) and the cylindrical body (320), while allowing the linear displacement (M) within the cylindrical body (320).

4. The magnet holder according to claim 2 or claim 3,

**characterized in that**

30 the sleeve (110) is adapted to perform the linear displacement together with the plunger (310) and/or the piston (330).

5. A stroke sensor comprising a magneto-resistive sensor (210) with a magnet (220), in particular a Hall sensor, configured to sense a linear displacement (M) of a plunger (310) in a cylindrical body (320),

**characterized by**

5 a magnet holder according to one of the preceding claims.

6. The stroke sensor of claim 5,

**characterized by**

10 a chamber (230) arranged at a side portion of the cylindrical body (320) sealed from an interior space (322) of the cylindrical body (320); and  
a removable side cover (240) providing a closure for the chamber (230), wherein the magneto-resistive sensor (210) is arranged together with its magnet (220) inside the chamber (230).

15 7. The stroke sensor of claim 6,

**characterized by**

a printed circuit board (250) attached to the removable side cover (240) and adapted to hold the magneto-resistive sensor (210) in the chamber (230).

20 8. The stroke sensor according to claim 6 or claim 7,

**characterized in that**

the cover (130) is adapted to close the cylindrical body (320) and the chamber (230).

9. A plunger/cylinder arrangement for a brake system of a vehicle,

25 **characterized by**

a plunger (310);

a cylindrical body (320) within which the plunger (310) is able to perform a linear displacement (M); and

30 a stroke sensor according to one of claims 5 to 8, which is configured to generate a sensor signal based/depending on the linear displacement (M).

10. The plunger/cylinder arrangement of claim 9,

**characterized in that**

the cylindrical body (320) comprises an axial slot (325) for receiving part of the mounting (120) to provide an axial guidance for the sleeve (110) while preventing relative rotations between the sleeve (110) and the cylindrical body (320).

5 11. The plunger/cylinder arrangement of claim 9 or claim 10,

**characterized by**

a piston (330) configured to move in at least one direction together with the plunger (310) inside the cylindrical body (320), wherein the sleeve (110) is adapted to slide inside the cylindrical body (320) and to encircle at least an upper portion of piston (330);

10 and

a sealing (340) between a lower portion of the piston (330) and the cylindrical body (320) to seal the chamber (230) from an interior space (322) of the cylindrical body (320).

15

12. A vehicle with a plunger/cylinder arrangement according to one of claims 9 to 11.

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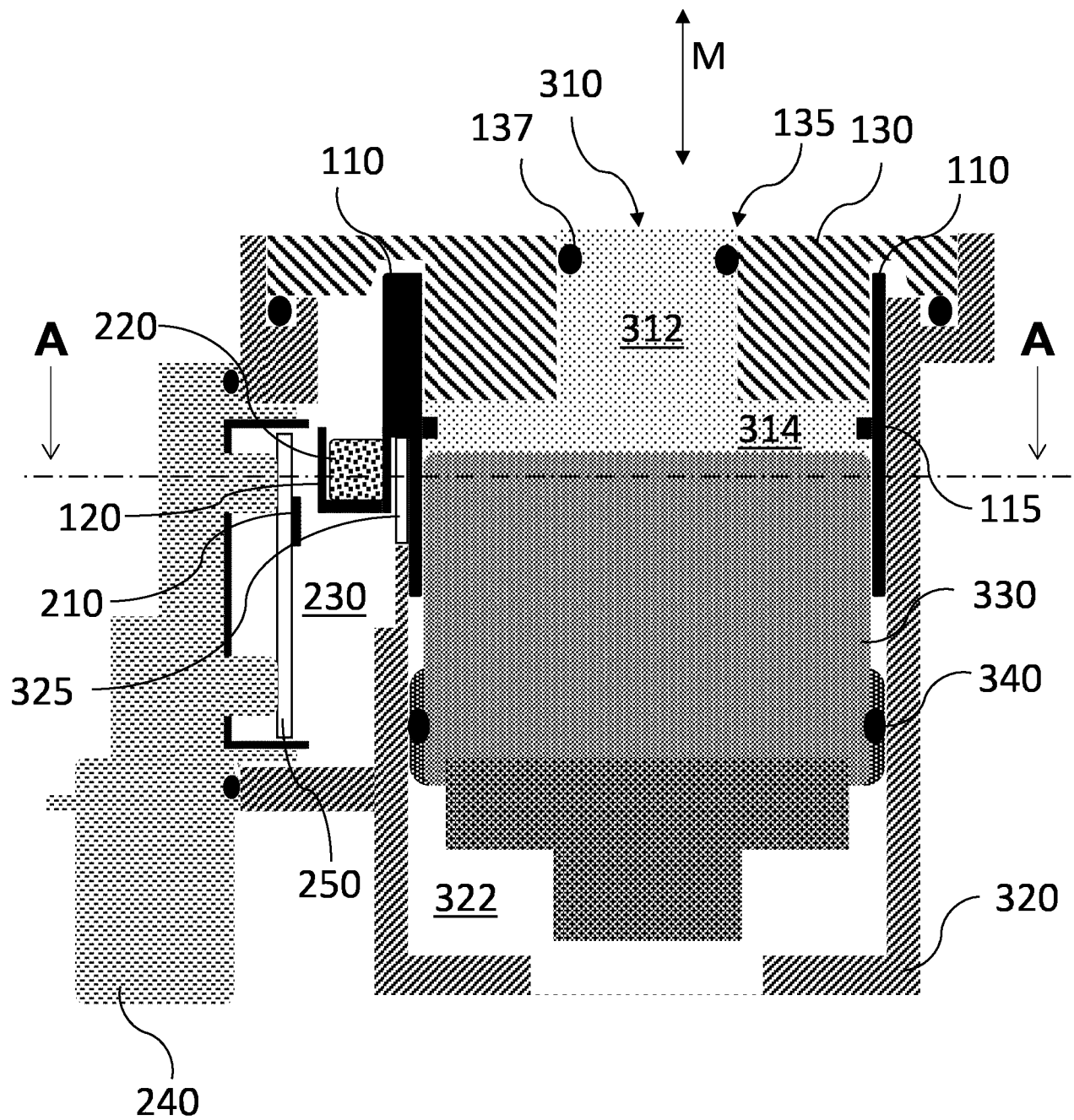


**Fig. 1A**

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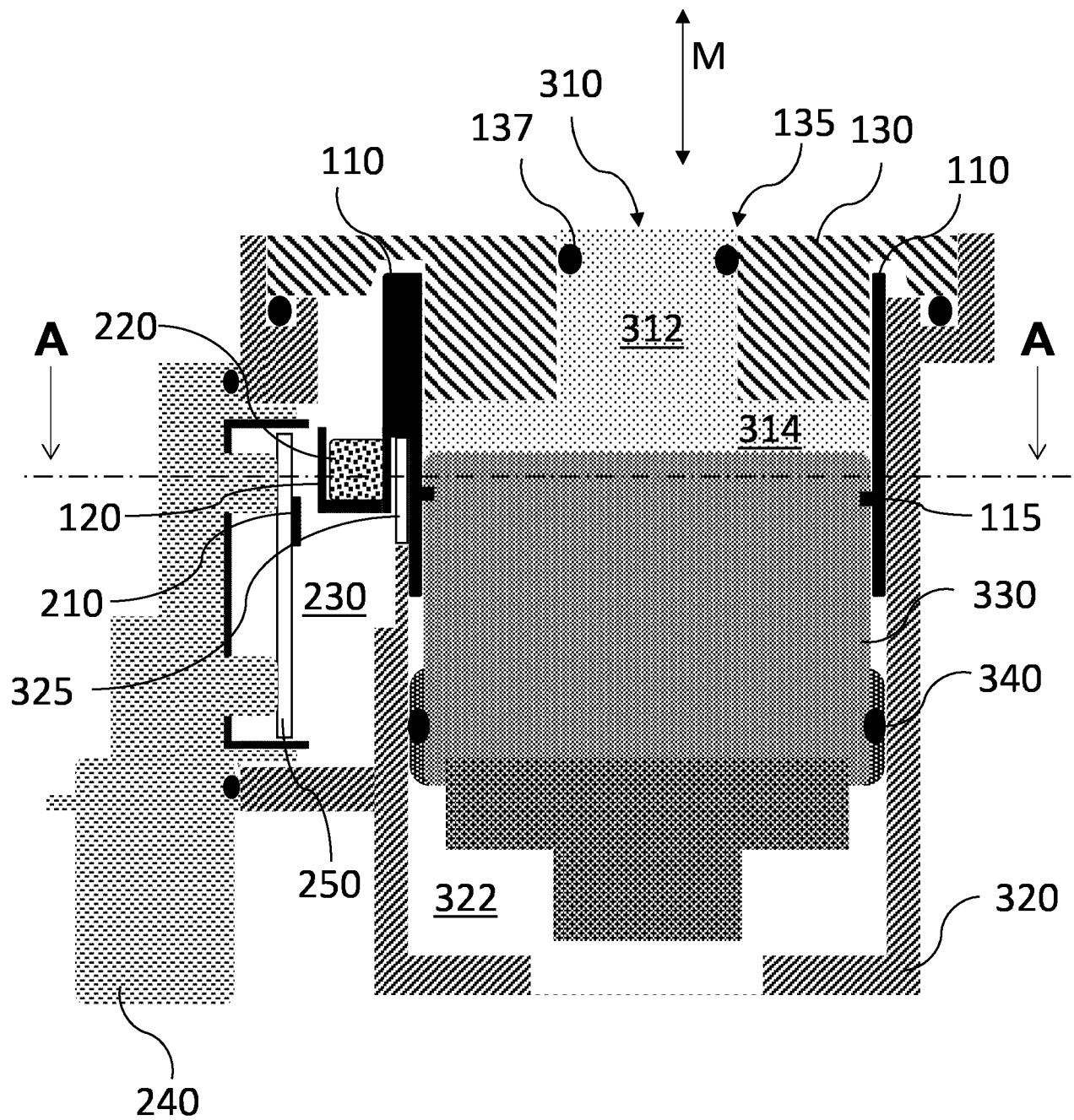


**Fig. 1B**

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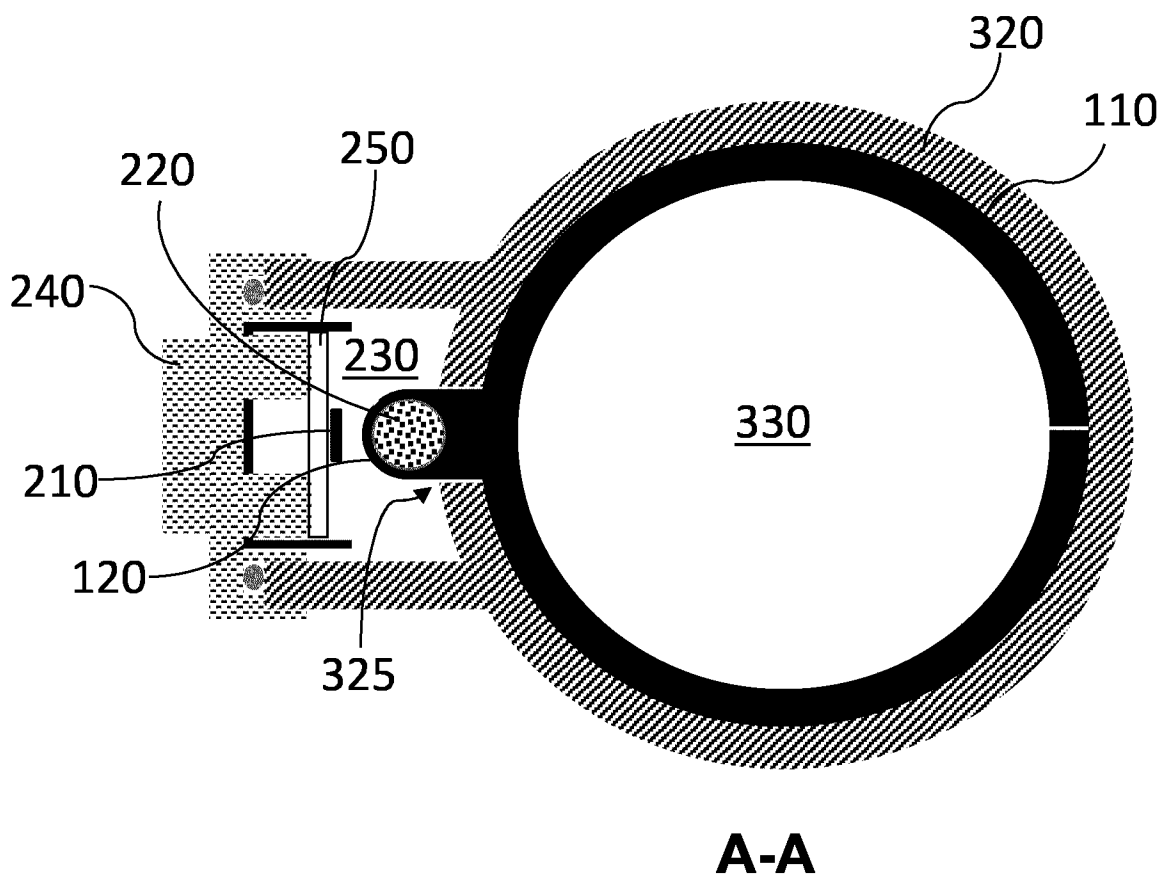


Fig. 2

## INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2019/072774

A. CLASSIFICATION OF SUBJECT MATTER  
INV. G01D11/24  
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)  
G01D

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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| Y         | the whole document                                                                                                                                             | 10-12                 |
| X         | DE 10 2008 052416 A1 (SCHAEFFLER KG [DE])<br>22 April 2010 (2010-04-22)<br>abstract; figure 1<br>paragraphs [0006], [0007], [0011] -<br>[0013], [0017], [0023] | 1-12                  |
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| A         | the whole document                                                                                                                                             | 1-9, 11,<br>12        |
|           | -----<br>-/--                                                                                                                                                  |                       |



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

30 October 2019

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12/11/2019

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Fax: (+31-70) 340-3016

Authorized officer

Springer, Oliver

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International application No

PCT/EP2019/072774

| C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                     |                       |
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2019/072774

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