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Description

The present invention relates to electric motors and more particularly, but not exclusively, those intended to produce actuators, in particular for robotized arms.

These motors are subject, in their operation, to loads which are exerted alternately on the shaft and the rotation of the shaft has to be performed without axial play, with accuracy.

The applicant has proposed, in the past, an electric motor whose shaft is produced in two parts assembled with one another by screwing, namely a front part on which is produced an outer helical thread which cooperates with a toothed wheel to produce the actuator, and a rear part internal to the casing of the motor. The front part is guided in rotation by two angular contact rolling bearings, blocked axially between a shoulder of the front part of the shaft and the rear part of the shaft. The latter is guided in rotation by a rear rolling bearing. A brake acts on the rear part of the shaft. A lip seal is arranged inside the motor, being borne by a front flange which also holds the angular contact rolling bearings. This lip seal is applied to the rear part of the shaft. A wiper seal is present in front of the motor, and defines, with the lip seal, a space containing a lubricant for the front rolling bearings.

The patent application EP 1 437 819 describes an electric motor comprising a monolithic shaft and permanent magnets rotating with the shaft and interacting mechanically with a stator.

There is a need to further refine motors intended in particular to produce actuators, in particular to enhance their compactness, their accuracy and their reliability.

Thus, the subject of the invention is an electric motor, comprising:

- a rotor comprising a shaft having a shoulder,

- at least one front rolling bearing guiding the shaft,

- at least one rear rolling bearing guiding the shaft,

- permanent magnets rotating with the shaft and interacting mechanically with a stator,

characterized in that the shaft is monolithic and the front rolling bearing or bearings are blocked axially against the shoulder by a nut screwed onto the shaft, the shaft having a threaded portion engaged with the nut, this threaded portion extending behind the front rolling bearing or bearings, on the rear side of the stator.

Preferably, the magnets are borne by the nut.

“Monolithic” should be understood to mean that the shaft is machined from a single block.

Preferably, the nut engages on an internal threaded part of the shaft, which is situated on the rear side of the stator, which makes it possible, by tightening the nut, to exert a tensile stress on the shaft over a portion thereof of relatively significant length, extending from the abovementioned shoulder to the rear of the stator. In the known solution detailed above, the portion of shaft under tensile stress is limited to that in contact with the front rolling bearings. A greater length of shaft under tensile stress makes it possible to rigidify said shaft over a greater distance, and therefore further enhance the performance levels of the motor and in particular the accuracy of alignment and of rotation, and to eliminate the risk of the nut loosening.

The above threaded part extends preferentially, along the axis of the shaft, from a front end positioned at the rear half of the stator. The threaded part is extended axially advantageously to the rear of the stator.

The motor can comprise two front guiding rolling bearings, between the shoulder and the nut. This or these front rolling bearing or bearings can each have oblique contacts, the front rolling bearing or bearings being preferably seal-tight and greased. The use of seal-tight and greased rolling bearings makes it possible to avoid the use of a lip seal behind the front rolling bearing or bearings, and eliminate the corresponding frictions.

Furthermore, that can make it possible to produce the nut with a thickness which corresponds substantially to that of the radially internal ring of the front rolling bearing in its contact, in particular with a thickness equal to that of the ring to ±20%. An excessively strong contact pressure against this radially internal ring is thus avoided.

The electric motor can comprise a one-piece casing which houses the stator and a brake, this casing being preferably cylindrical of revolution. The front flange can be added to this casing, as can a rear flange which supports the rear rolling bearing.

The stator preferably comprises a part made of injected thermoplastic material, serving as support for at least one thermal sensor.

This support piece can be arranged to cap the heads of coils of the stator at one end, preferably its rear end.

The support piece preferably has an annular form, with concentric radially internal and external tubular skirts, linked by an openwork intermediate wall, the holes of which allow the passage of the wires or of the sensors and allows the passage of a stator coating resin.

The stator can comprise end insulators behind which the radially internal skirt is slipped, when mounting the support piece in the casing of the motor.

The support piece comprises at least one sensor securing tab, moulded with at least one of the intermediate wall and of the internal and external skirts. This tab can be elastically deformable, so as to exert a slight pressure on the sensor awaiting coating of the stator by the resin. The sensor is preferably a thermocouple.

The shaft can be produced with an external helical thread.

The shaft can have a diameter that is substantially constant between the shoulder which serves as abutment for the front rolling bearing(s) and the threaded portion on which the nut engages.

The invention will be better understood on reading the following detailed description of nonlimiting exemplary implementations thereof, and on studying the attached drawing, in which:

- Figure 1 is a schematic and partial longitudinal cross section of a motor produced in accordance with the invention,

- Figure 2 represents the thermal sensor support piece on its own, and

- Figures 3 to 5 are views similar to Figure 1, of variant embodiments of the motor.

The motor 1 according to the invention, represented in Figure 1, comprises a shaft 2 rotating about an axis X.

The shaft 2 is preferably metal and machined from a single block, of steel for example.

The shaft 2 has, externally, a driving means, such as, for example, as illustrated, an external helical thread 3, which can engage with a toothed wheel that is not represented, the motor 1 belonging for example to an actuator of a robotized arm.

The helical thread 3 can have been machined from the block, as illustrated.

The shaft 2 is guided in its rotation, at the front, by two rolling bearings 4, preferably with oblique contacts, as illustrated, arranged one behind the other, and at the rear by a rear rolling bearing 5.

The rolling bearings 4 and 5 are known in themselves, and are seal-tight and greased, comprising sealing discs 6 which contain the lubricant between the rings in contact with which the rolling elements 7 are displaced.

The front rolling bearings 4 are borne by a front flange 10 which also houses a wiper seal 11 that presses on the shaft 2.

The radially external rings 13 of the front rolling bearings 4 are blocked axially on the flange between a front-end wall thereof and by a circlip 12. The radially internal rings 79 are blocked axially to the front by a shoulder 16 of the shaft 2.

The flange 10 is assembled with a casing 14 that is cylindrical of axis X, which houses a stator 15 and a spring-applied brake 16, that is known in itself, comprising a mobile armature 17 that is returned to braking position against a brake friction lining of a brake disc by one or more springs that are not represented. A solenoid 27, when powered, moves the armature 17 away from the brake friction lining 26, against the action of the spring or springs.

The casing 14 is closed at the rear by a rear flange 18 which bears the rear rolling bearing 5, and on which can be fixed, as illustrated, a coder 19 that is known in itself, this coder comprising a fixed part 20 that is fixed using screws 21 onto the flange 18 and a mobile part that is fixed onto the shaft 2 using a screw 22.

The rotor comprises permanent magnets 25 which interact magnetically with the stator 15, so as to generate the motor torque.

These magnets 25 are borne in the example considered by a nut 30 which is screwed onto a threaded portion 32 of the shaft 2.

The threaded portion 32 is situated on the rear side of the stator 15, and extends, for example, as illustrated, axially along the axis X from a front end 32a situated at the rear half 15a of the stator 15. A rear end 32b of the threaded portion is situated to the rear of the stator 15. The latter is of length L.

The front end 32a can be situated substantially at a shoulder 48 of the nut 30, against which the magnets 25 come to bear by their rear end.

The brake disc 26 is borne by a hub 53 which comes to bear by its front end 53a against the rear end of the nut 30 and by its rear end 53b against the radially internal ring 38 of the rear rolling bearing 5.

An elastically deformable washer 39 for preloading the rear rolling bearing 5, is interposed axially between the rear rolling bearing 5 and the rear flange 18. Thus, in case of thermal expansion and of elongation of the shaft 2, the rear rolling bearing 5 can retract towards the rear flange 18, the shaft having no axial play relative to the front flange 10 by virtue of the presence of the angular contact front rolling bearings 4.

The nut 30 comes to bear axially, at the front, by an end 35, against the radially internal ring 79 of the second front rolling bearing 4.

Thus, by screwing the nut 30 onto the shaft 2 using the threaded portion 32, it is possible to exert an axial stress on the front

rolling bearings 4 to block them axially against the shoulder 16 of the shaft 2. This axial stress is accompanied, in reaction, by a tensile stress which is exerted on the portion of shaft 40 extending axially between the shoulder 16 and the threaded portion 32. This tensile stress tends to rigidify the shaft.

The thickness e_e of the end of the nut 30 which comes into contact with the ring 79 is substantially the same as that e_b of the ring. Preferably $e_e = e_b \pm 20\%$.

The stator 15 comprises a support piece 60, represented more particularly in Figure 2, made of injected thermoplastic material, which holds at least one temperature sensor 80 of the stator.

The support piece 60 comprises a radially external tubular skirt 91 and a radially internal skirt 92 which are concentric to the axis X and linked to one another by an intermediate wall 93 extending at right angles to the axis X.

The intermediate wall 93 comprises holes 94. A tab 95 for securing the sensor 80 is moulded with the intermediate wall 93.

The stator 15 comprises coils and end insulators that are not represented. The internal skirt 92 is placed behind these end insulators, whereas the external skirt 91 faces the radially internal surface of the casing 14. A resin 96 coats the stator winding and the support piece 60, owing to the holes 94 thereof.

The nut 30 has blind tightening holes 50, at its rear end.

Figures 3 to 5 show variant embodiments of the motor according to the invention.

The variant of Figure 3 differs from that of Figure 1 by the fact that the nut 30 no longer bears the magnets 25, the latter being borne by a hub 110 added to the shaft 2. The threaded part 32 extends between the second front rolling bearing 4 and the

stator 15.

In the variant of Figure 4, the shoulder 16 of the shaft is turned towards the front and the front rolling bearing 4 is duplicated.

The nut 30 is situated at the front of the motor, at an opening 116 of the front flange 10. The threaded part 32 extends in front of the front rolling bearing 4, into the opening 116. The magnets 25 are borne directly by the shaft 2.

The variant of Figure 5 differs from that of Figure 4 by the fact that the front flange 10 is extended frontwards beyond the nut 30 and by the fact that the brake is no longer borne by the casing 14 but by the rear flange 18.

Obviously, the invention is not limited to the examples which have just been described.

In particular, the front rolling bearing or bearings can be other than those described, as can the rear rolling bearing.

Patentkrav

1. Elektromotor (1) der omfatter:
- en rotor med en aksel (2),
- mindst et forreste leje (4) til styring af akslen,
- mindst et bageste leje (5) til styring af akslen,
- permanente magneter (25) der drejer med akslen og interagerer mekanisk med en stator,
kendetegnet ved, at akslen (2) er monolitisk og har en skulder (16), og det eller de forreste lejer (4) er aksialt blokeret mod skulderen (16) med en møtrik (30), der er skruet på akslen (2), hvilken aksel har en gevinddel (32) der er i indgreb med møtrikken (30), hvilken gevinddel (32) strækker sig bag det eller de forreste lejer (4) på bagsiden af statoren.

2. Motoren ifølge krav 1, hvor magneterne (25) bæres af møtrikken (30).

3. Motor ifølge krav 1 eller 2, hvor gevinddelen (32) har en forreste ende (32a), der ligger på niveauet med statorens bageste halvdel (15a).

4. Motor ifølge et hvilket som helst af de foregående krav der omfatter to forreste lejer (4) mellem skulderen (16) og møtrikken (30).

5. Motor ifølge et hvilket som helst af de foregående krav, hvor det eller de forreste lejer (4) hver er med skrå kontakter.

6. Motor ifølge et hvilket som helst af de foregående krav, hvor det eller de forreste lejer (4) er forseglet og smurt.

7. Elektrisk motor ifølge et hvilket som helst af de foregående krav, der omfatter et monoblokhus (14), som rummer statoren (15) og en bremse (16), hvilket hus (14) fortrinsvis er rotationscylindrisk.

8. Motor ifølge et hvilket som helst af de foregående krav,

hvor statoren (15) omfatter en del (60) der er fremstillet af injiceret termoplastisk materiale, som tjener som understøtning for en termisk sensor (80).

9. Motor ifølge det foregående krav, hvor understøtningsdelen (60) omfatter radialt indre (92) og ydre (91) koncentriske skørter, der er forbundet sammen af en perforeret mellemvæg (93).

10. Motor ifølge krav 8 eller 9, hvor understøtningsdelen (60) omfatter en flig (95) til at holde sensoren (80).

11. Motor ifølge et hvilket som helst af de foregående krav, hvor akslen (2) er fremstillet med et ydre spiralformet gevind (3).

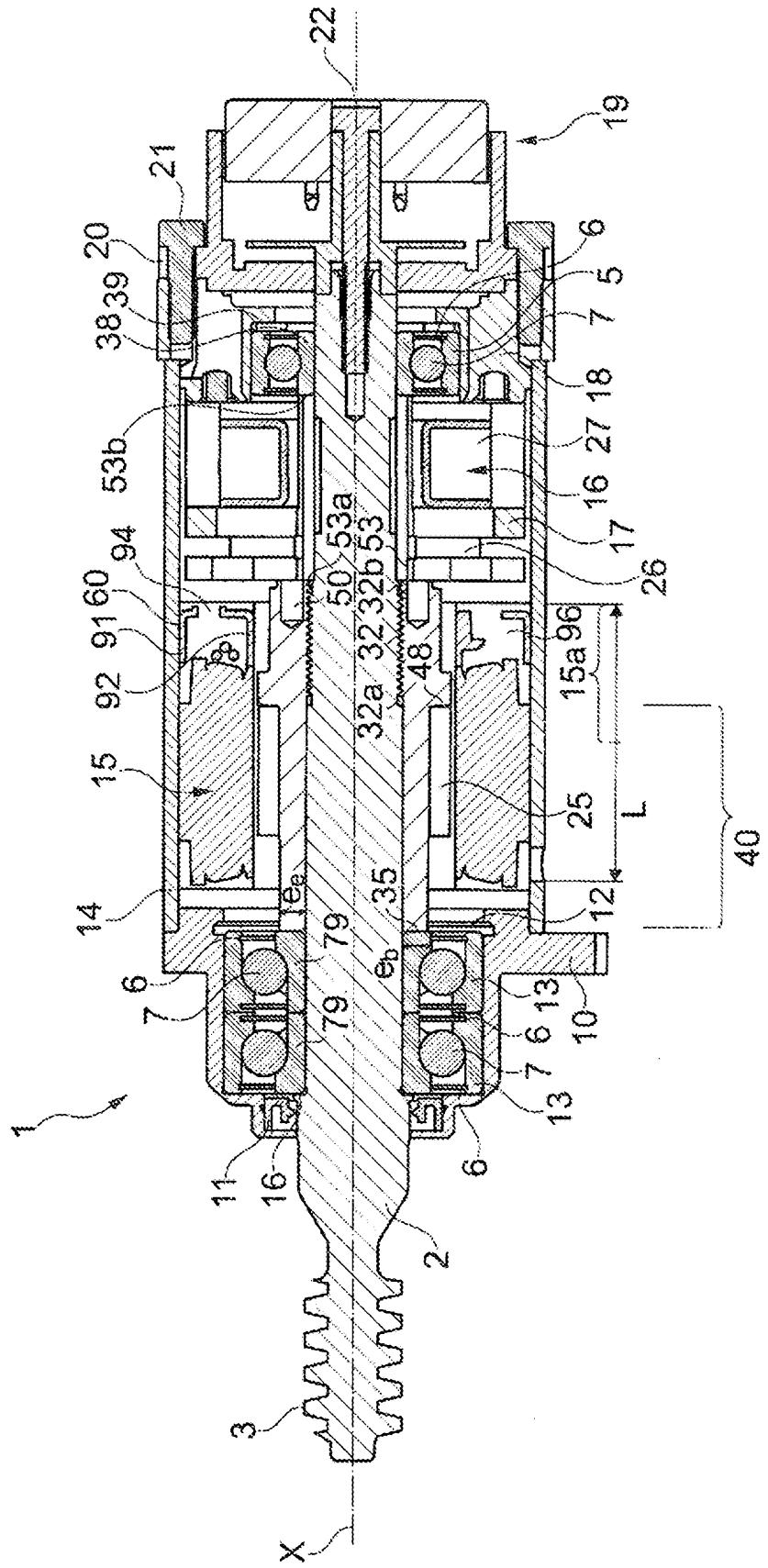
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Fig. 1

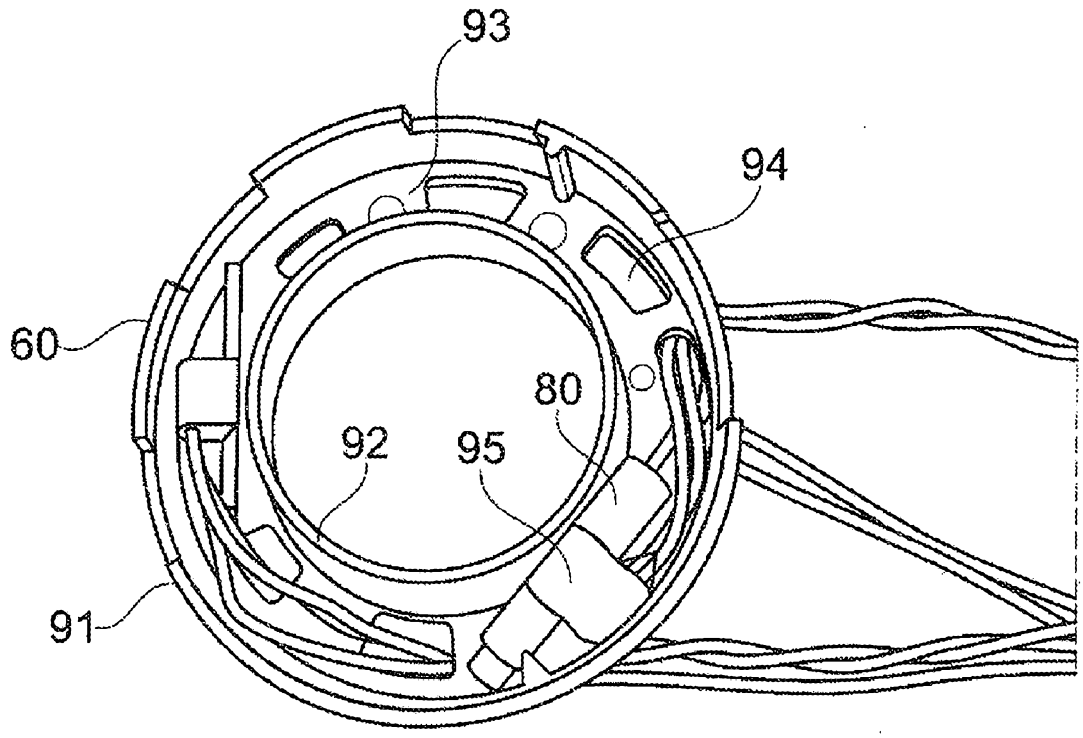

Fig. 2

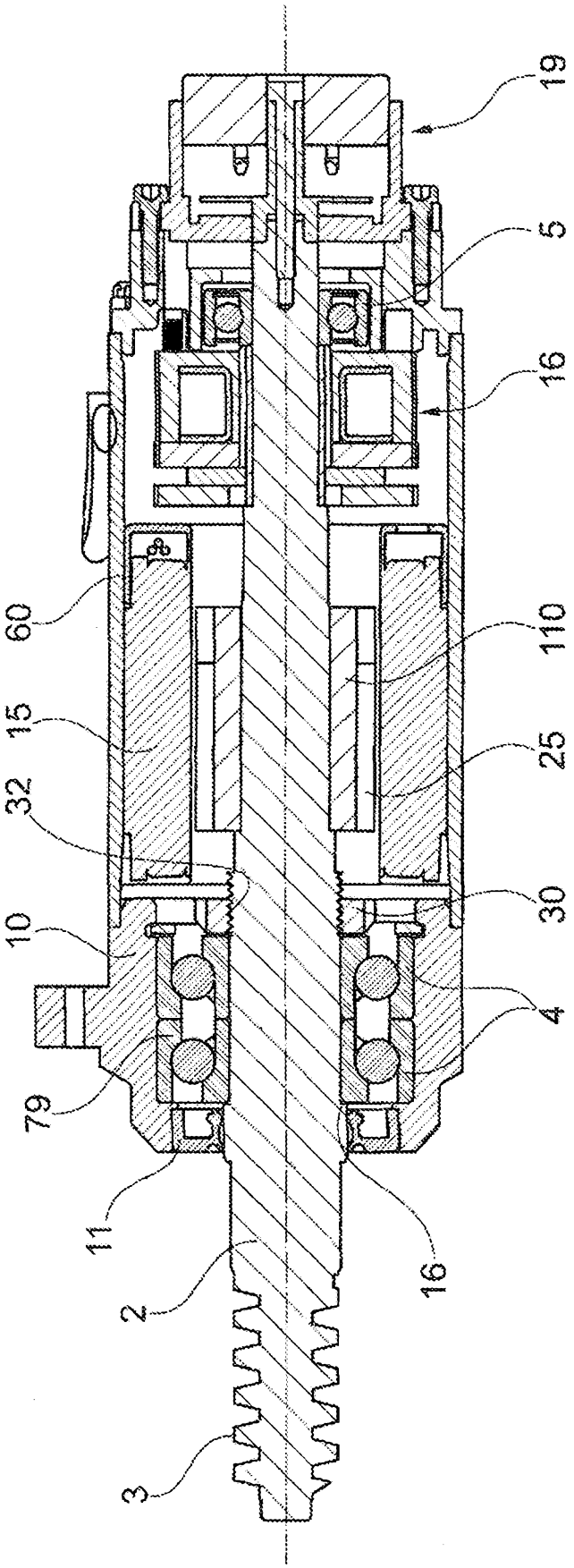

Fig. 3

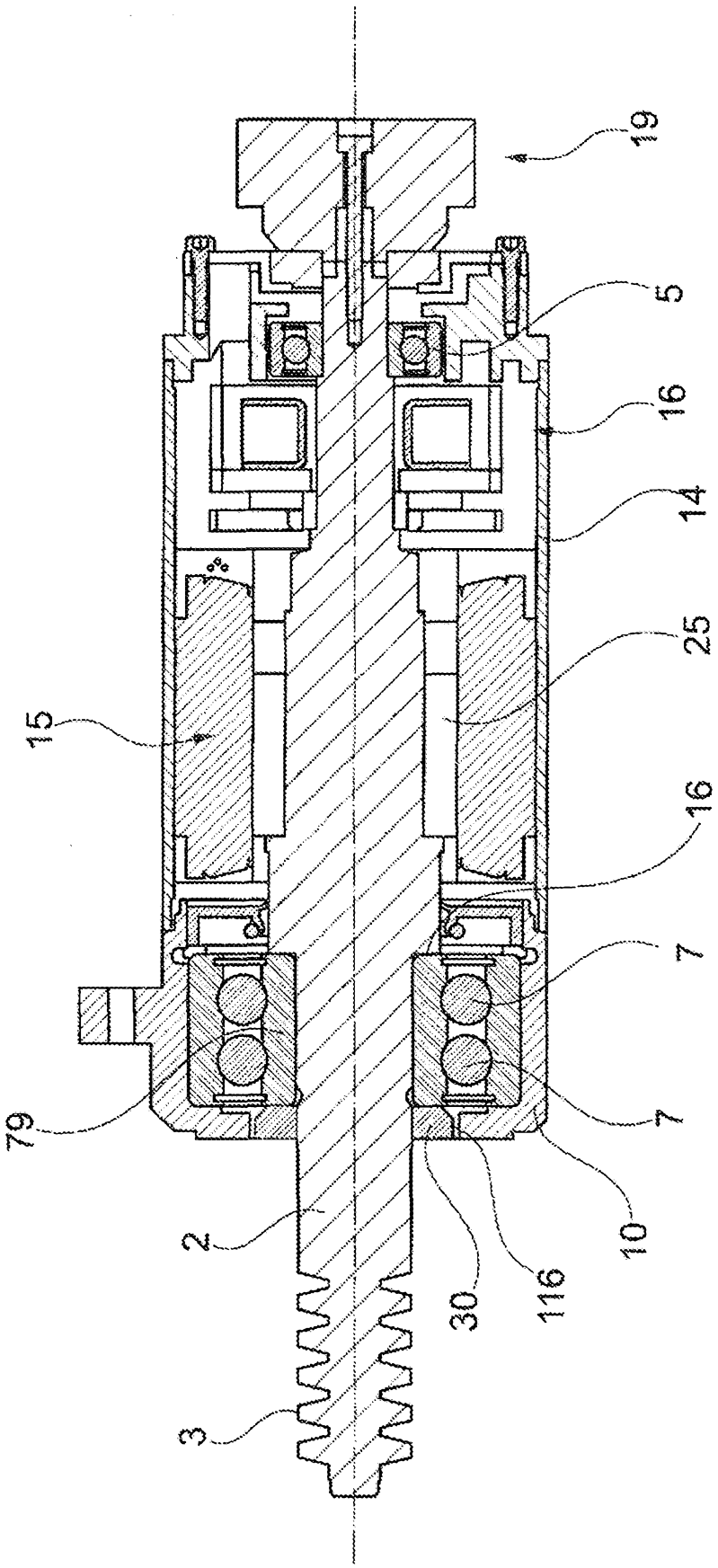

Fig. 4

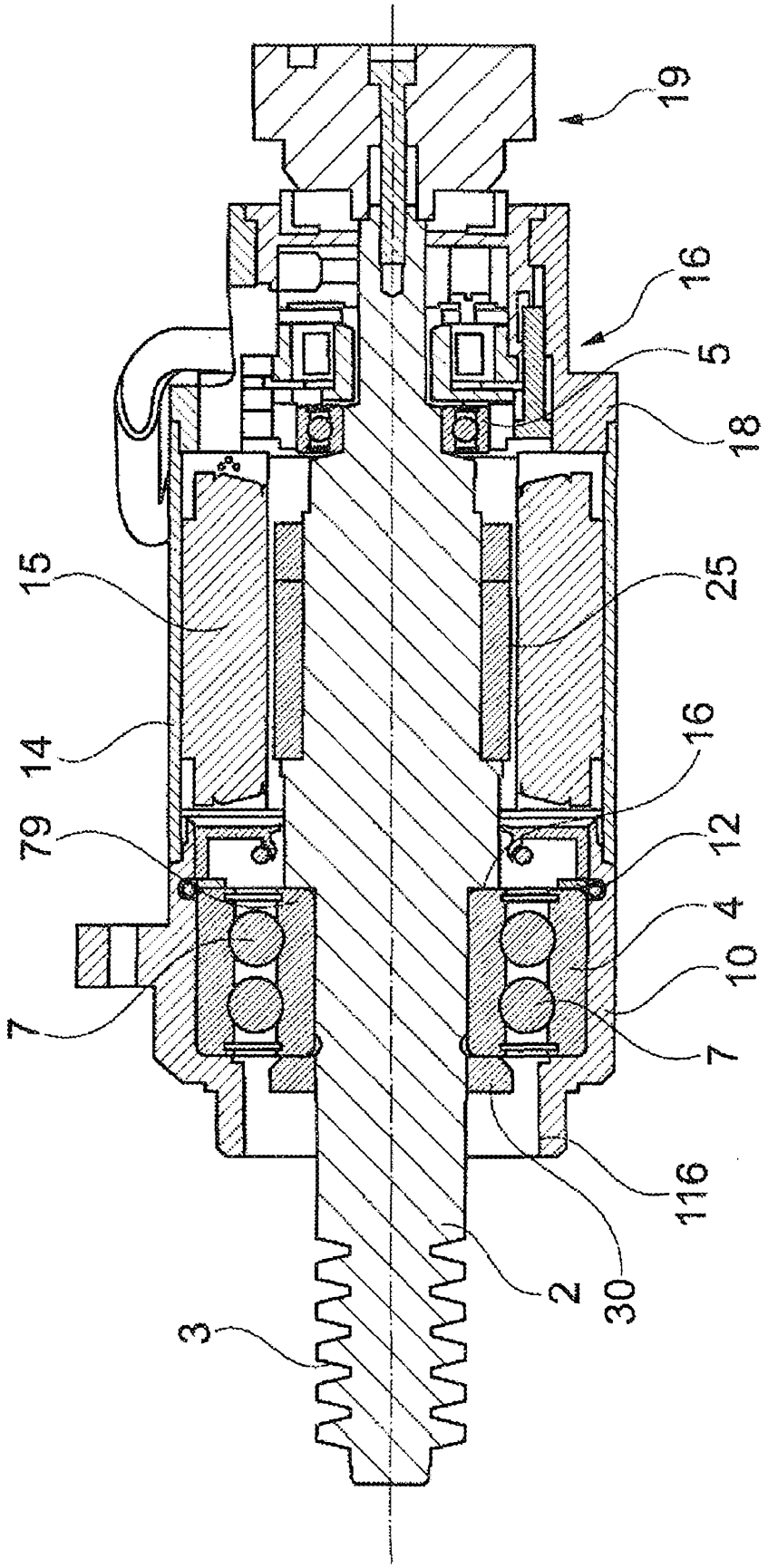

Fig. 5