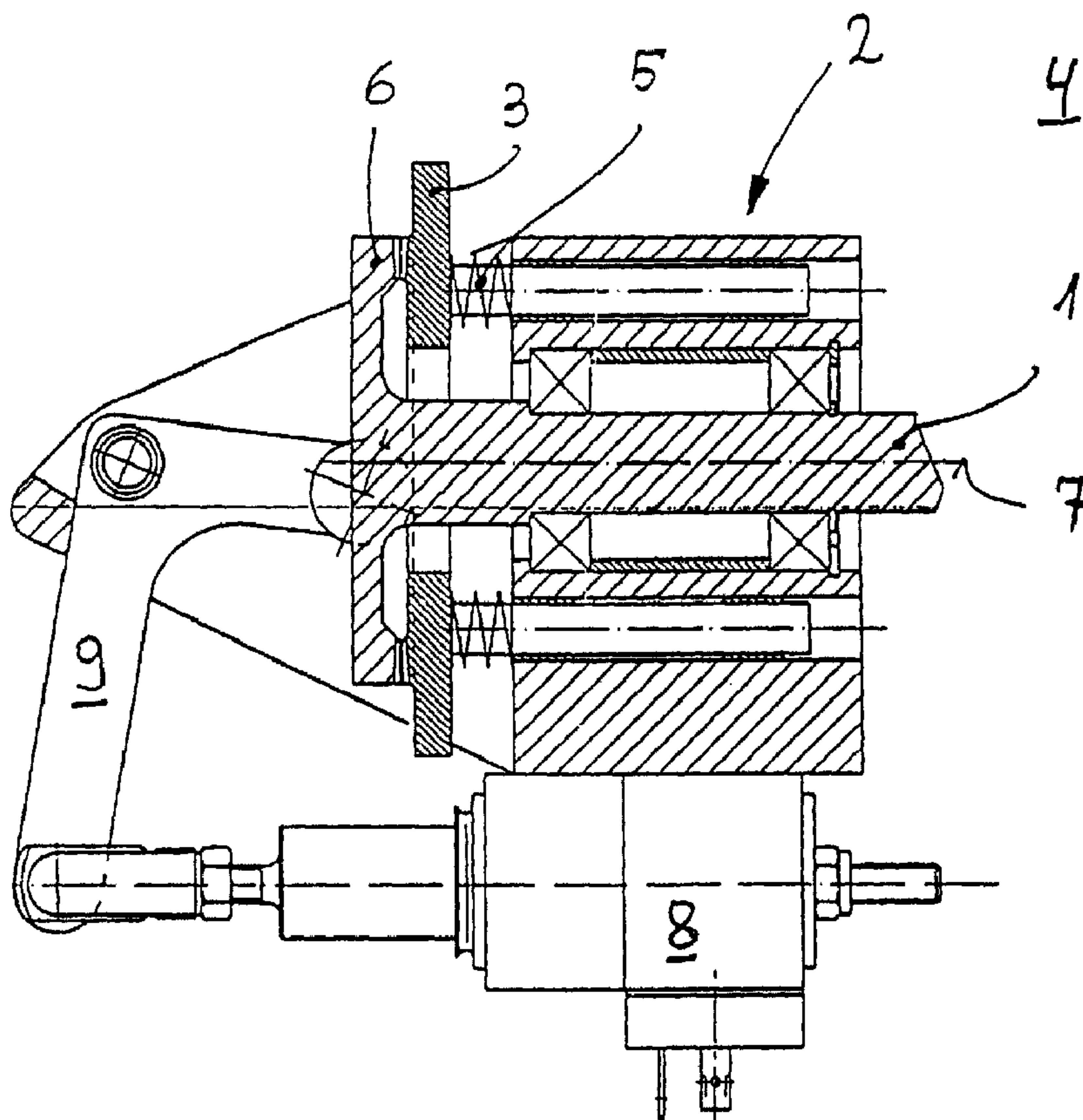




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 (72) Inventeur/Inventor:
 KOSSL, WOLFGANG, AT
 (73) Propriétaire/Owner:
 KNORR-BREMSE GES. M.B.H., AT
 (74) Agent: FETHERSTONHAUGH & CO.

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 (54) Title: DOOR ACTUATOR



(57) Abrégé/Abstract:

The invention relates to a door actuator, in particular the door lock, for rail vehicles, comprising a spindle drive, the spindle of which is connected to a freewheel, permitting rotation in the direction corresponding to the closing of the door and preventing rotation in

(57) **Abrégé(suite)/Abstract(continued):**

the direction corresponding to the opening of the door. The part of the freewheel furthest from the spindle is mounted such as to rotate, but with a releasable fixing relative to a release device, achieved by means of a coupling which may be released by means of a solenoid. The invention is characterised in that the brake, coupling or similar is or may be fixed in the open position and a closing magnet is provided. In a first version, the coupling is operated by means of a bar, and between the released position of the bar and the locked position of the bar there is a dead-point. In a second version, the open position is maintained by a permanent magnet.

ABSTRACT

The invention relates to a door actuator, in particular the door lock, for rail vehicles, comprising a spindle drive, the spindle of which is connected to a freewheel, permitting rotation in the direction corresponding to the closing of the door and preventing rotation in the direction corresponding to the opening of the door. The part of the freewheel furthest from the spindle is mounted such as to rotate, but with a releasable fixing relative to a release device, achieved by means of a coupling which may be released by means of a solenoid. The invention is characterised in that the brake, coupling or similar is or may be fixed in the open position and a closing magnet is provided. In a first version, the coupling is operated by means of a bar, and between the released position of the bar and the locked position of the bar there is a dead-point. In a second version, the open position is maintained by a permanent magnet.

DOOR ACTUATOR

5 The invention relates to a door actuator, particularly a door lock, of rail
vehicles, having a spindle drive whose spindle is connected with a freewheel
permitting the rotation of the spindle in the direction corresponding to the closing
direction of the door and preventing the rotation of the spindle in the direction
corresponding to the opening direction, the part of the freewheel away from the
10 spindle being mounted in a rotatable manner but being releasably fixed with respect
to a release device against the force of at least one contact pressure spring by
means of a clutch, brake or the like, which can be released by means of a lifting
magnet, and the brake, clutch or the like is fixed or can be fixed in its open position.

15 Such a door actuator according to the preamble of Claim 1 is known from U.S.
Patent Document US 3,745,705 A. A swinging-sliding door is described therein
whose drive takes place by way of a spindle moving a door leaf by way of a nut. The
freewheel connected with the spindle permits the movement of the door leaf in the
closing direction but prevents a movement in the opening direction. A gearwheel
20 connected with the freewheel can be locked by way of a locking pawl which can
engage in the indentations of the gearwheel. This takes place in the closed position
of the door. In order to permit the opening of the door, the locking pawl is moved by
means of a magnet into a position releasing the gearwheel, whereby the freewheel
as a whole can be rotated about the spindle axis. By means of a holding bar, the
25 locking pawl is fixed in the position releasing the gearwheel, whereby a de-energizing
of the magnet becomes possible during the opening and closing of the door. During
the entire opening and closing operation of the door, the locking pawl remains in the
released position. Only immediately before the door edges mutually abut or abut on
a door frame during the closing, will the holding bar be displaced by a pin moved
30 together with the door leaf, whereby the locking pawl engages in the gearwheel. As

a result of the freewheel, despite the locked gearwheel, an end position can now be reached which is acted upon by tension for the purpose of an optimal tightness.

British Patent Document GB 2 283 054 A and International Patent Document
5 WO 95/09959 describe a swinging sliding door whose drive takes place by way of a spindle moving the door by way of a nut. The end of the spindle facing away from the drive is connected with a receiving device by way of a freewheel. The freewheel permits the rotation of the spindle in the direction corresponding to the closing movement of the door, even when the receiving device is held. This receiving device
10 is optionally non-rotatably or rotatably disposed under the effect of a brake or clutch. By way of a shaft, the receiving device is connected with a clutch disc. A rod acts upon two opposite discs which are non-rotatable with respect to the car body and axially displaceable with respect to the shaft. When the rod is displaced in the defined direction, the clutch disc and therefore also the receiving device are
15 released, whereby an opening of the door is permitted. In the normal operation, this release takes place by a solenoid or, in an emergency, by means of a Bowden cable. The brake or clutch remains released as long as the solenoid is acted upon by current. When the current is interrupted, the brake or the clutch is moved into the non-released position by means of springs.

20

Numerous rail vehicles have door actuators which contain a spindle drive. In order to permit a closing of the door at any time, also a manual closing, a freewheel is arranged on one end of the spindle, which freewheel permits the rotating of the spindle in the direction corresponding to the closing movement of the door, but
25 prevents a rotating of the spindle in the direction corresponding to the opening movement. In order to nevertheless be able to open the door, the part of the freewheel away from the spindle is rotatably mounted with respect to the body and is generally fixed by a brake, a clutch or the like. When now the door is opened in the course of the normal operation, this brake, clutch or the like is released by a lifting
30 magnet so that the door actuator can rotate the spindle in the direction corresponding

to the opening movement of the door, in which case it naturally takes along the entire freewheel. If a manual opening occurs in emergency and danger situations, this brake, the clutch or the like can be released by the door emergency handle and the door can be opened manually.

5

These doors have been very successful during the operation and, particularly, because of their compact construction, their robust method of operation and their operational reliability, represent a wide-spread standard solution for the doors of rail vehicle.

10

The lifting magnet represents a certain disadvantage of doors of this type. It has to be activated during each opening of the door for the entire opening time and therefore has to be designed for fairly long operating periods. Since it also has to overcome considerable forces, it is necessary to provide a correspondingly sturdy and therefore large, expensive and current-requiring lifting magnet.

15

In addition, in the parked condition of the cars, thus, when the door actuator is without current or power, it is difficult for cleaning personnel or inspection personnel to enter the vehicle because, for this purpose, the emergency door handle has to be operated which extends to the outside at a relatively inaccessible point. On the inside, the emergency door handle is naturally provided in the direct vicinity of the door.

20

According to today's demands, many railroad administrations require that the door actuator has to have an accumulator, in practice, always a condenser which, even 24 hours after the parking of the vehicle, permits the releasing of the brake, clutch or the like by operating a corresponding button and thus the opening of the door. This results in problems when a door is closed again after the opening because, for the opening, a releasing of the brake, the clutch or the like is required

25

under all conditions, but during the second attempt, the condenser is usually already empty.

5 It is therefore desirable to provide a device by means of which, in the case of a door actuator of the initially mentioned type, the above-mentioned problems do not occur and it becomes possible, in particular to be able to satisfactorily use smaller lifting magnets and to open the door several times by means of the energy stored in the conventional condensers.

10 It has been recognized that when a closing magnet for locking the brake, clutch or the like is provided. As a result, the brake or clutch can be moved into the locked position at any time, whereby a movement of the door in the opening direction is prevented.

15 In accordance with one aspect of the present invention, there is provided a door actuator of rail vehicles, comprising: a spindle drive and a freewheel, wherein the spindle drive has a spindle that is connected with the freewheel permitting rotation of the spindle in a direction corresponding to a closing direction of a door and preventing the rotation of the spindle in a direction corresponding to an
20 opening direction of the door, a part of the freewheel positioned away from the spindle being rotatably mounted but being releasably fixed with respect to a release device by force of at least one contact pressure spring in cooperation with a releasable coupling, wherein the coupling is fixable in an open released position; and a bidirectional lifting magnet configured to release the releasable coupling from
25 a closed locked position, wherein the lifting magnet is configured to act as a closing magnet configured to lock the coupling in the closed locked position, wherein the releasable coupling is configured to operate by a linkage having a dead center position between a released position of the linkage and a locked position of the linkage, and the linkage has a swiveling lever which can be swiveled about a lever
30 axis, wherein the swiveling lever comprises a first arm connected to the bidirectional lifting magnet and a second arm carrying rollers with an axis of rotation parallel to the lever axis, and wherein the lever is configured to move a movable part of the releasable coupling between the released and locked positions, and the

dead-center position is reached when a connection plane between an axis of rotation of the rollers and the lever axis is parallel to the moving direction of the movable part of the releasable coupling.

5 In accordance with another aspect of the present invention, there is provided a door actuator of rail vehicles, comprising a spindle drive and a freewheel, wherein the spindle drive has a spindle that is connected with the freewheel permitting rotation of the spindle in a direction corresponding to a closing direction of a door and preventing the rotation of the spindle in a direction corresponding to an
10 opening direction of the door, a part of the freewheel positioned away from the spindle being rotatably mounted but being releasably fixed with respect to a release device by force of at least one contact pressure spring in cooperation with a releasable coupling, wherein the coupling is fixable in an open released position; and a lifting magnet configured to release the releasable coupling from a closed
15 locked position, wherein the lifting magnet is configured to act as a closing magnet configured to lock the coupling in the closed locked position, wherein a movable part of the releasable coupling comprises a ferromagnetic material, and is attracted towards a permanent magnet by an attraction force that exceeds the force of the at least one contact pressure spring when the release coupling is in the released
20 position.

 In accordance with another aspect of the present invention, there is provided a door actuator of rail vehicles, comprising a spindle drive and a freewheel, wherein the spindle drive has a spindle that is connected with the freewheel permitting
25 rotation of the spindle in a direction corresponding to a closing direction of a door and preventing the rotation of the spindle in a direction corresponding to an opening direction of the door; a part of the freewheel positioned away from the spindle being rotatably mounted but being releasably fixed with respect to a release device by force of at least one contact pressure spring in cooperation with a
30 releasable coupling, wherein the releasable coupling is fixable in an open released position; a lifting magnet configured to release the releasable coupling from a closed locked position; and a closing magnet configured to lock the releasable coupling in the closed locked position.

An embodiment of the invention may provide the closing magnet and the lifting magnet in the form of a double-acting magnet. In this case, simple small double-acting magnets can be used.

5 In a further variant, the fixing may take place by means of a linkage for the movement of the brake, or clutch or the like which, in the course of the release movement, is guided by way of a dead center. Thus, despite the contact pressure spring, the brake or the clutch will also remain in the open position when the lifting magnet is de-energized.

10

In another variant, the brake, clutch or the like or a magnetizable component connected therewith, in the open position, is caused to approach a permanent magnet such that its attraction force will hold the brake open against the force of the contact pressure spring also when the magnet is de-energized.

15

In this manner, the activating of the lifting magnet is required only during the releasing or locking movement of the brake, clutch or the like, but not for the holding in the open position, and therefore small double-acting magnets can be used which permit several opening operations also by means of conventional condensers.

5

In the following, the invention will be explained in detail with reference to the drawing.

Figure 1 is a sectional view of a device according to the invention in its released position along Line I-I of Figure 2;

10

Figure 2 is a sectional view of the device of Figure 1 rotated by 90° with respect to that of Figure 1;

Figures 3 and 4 are sectional views of the device according to Figures 1 and 2 in the locked condition; and

15

Figures 5 and 6 are views of variants of the invention with permanent magnets.

20

The drawing shows one of the ends of a door actuator of the above-mentioned type in the area of the pertaining release device 2. A spindle 1 of the door actuator, which is connected with the (not shown) end of the freewheel, of the brake, or the like away from the door, which as the above-explained function, carries a toothed spindle disc 6 in a non-rotatable manner. In the illustrated embodiment, the release device 2 consists of a toothed disc 3 which is non-rotatably but axially displaceably arranged with respect to the car body 4 and is pressed by means of contact pressure springs 5 in the direction of the axis 7 of the spindle 1 against the toothed spindle disc 6.

25

In order to permit the opening of the door, it is known from the prior art to provide a lifting magnet 8 in the case of the release device 2, which lifting magnet 8, by means of a mechanism which, as a whole, is called a linkage or lever 9, moves the non-rotatable toothed disc 3 against the force of the contact pressure
5 springs 5 axially so far away from the toothed spindle disc 6 that, as illustrated in Figure 1, the combs of the tothing have little play in the axial direction with respect to one another, so that the spindle disc 6 can also rotate in the direction blocked by the (not shown) freewheel. The parts of the freewheel away from the door rotate
10 along in this case, so that the entire freewheel rotates along with the spindle 1.

In the case of the release device 2, it is now provided according to an exemplary embodiment to construct the linkage or the lever 9 such that, in the position in which it disengages the non-rotatable toothed disk 3 sufficiently far, it will also be held when the lifting magnet 8 is de-energized. In the illustrated
15 embodiment this takes place in that, in the course of the releasing movement, the lever 9 arrives over a so-called dead-center position and, also in the end position on the other side of the dead center, as illustrated in Figure 1, the toothings are in a disengaged position.

The entire mechanism of the lever 9 is clearly illustrated in Figure 2. It consists of the angular, optionally multipart lever 9, whose hinge is swivellably disposed in the release device 2 in a bearing 11 and, by means of rollers 10, acts upon the periphery of the non-rotatable but axially movable toothed disc 3. The rollers describe a circular arc about the axis of the bearing 11, in which case, as
20 illustrated by the comparison between Figures 1 and 3, in the locked position illustrated in Figure 3, the toothings of the non-rotatable toothed disc 3 and of the toothed spindle disc 6 are engaged, while, in the position illustrated in Figure 1, these toothings are spaced away from one another and thus are released.

In order to return from the released position illustrated in Figure 1 into the locked position, it is, in contrast to the prior art, required to activate the lifting magnet 8 into the other direction, which requires that, instead of a lifting magnet in the actual sense, a reversible lifting magnet or a double-acting magnet be used
30

which now has the purpose of overcoming the dead center because both end positions are maintained in a stable manner.

The invention is not limited to the illustrated embodiment but can also be
5 modified in different fashions. Thus, it is also conceivable to, instead of the over-
dead-center mechanism, provide the lifting magnet 8 on its one face with such a
strong permanent magnet that it balances the force of the contact pressure springs
5 without the requirement of providing a dead center mechanism in the linkage 9.
This can be easily achieved particularly if the rollers 10 or the respective equivalent
10 component in the released position is close to a dead center because then the
forces required for the holding will be minimal, in the dead center, theoretically zero.

In the illustrated embodiment, the dead-center mechanism is based on the
arrangement of the two end positions of the linkage 9, as illustrated in Figures 1
15 and 3 respectively, in connection with the force and the direction of the force of the
contact pressure springs 5. The roller 10, actually its axis of rotation, once takes up
a position between the two end positions in which the connection plane between
the bearing axis 12 and the axis of rotation extends parallel to the displacing
direction of the toothed disc 3 (in the direction of the spring force). This position
20 corresponds to the dead center because, on both sides, as a result of the angular
position of the connection plane with respect to the displacing direction, a
component of the spring force away from the dead center acts upon the linkage.

It is easy for a person skilled in the field of mechanics to find other
25 arrangements which fulfill the same purpose. The variant illustrated in the drawing
is not only robust but also permits an easy adjustment and, as a result of the
appropriate selection of the length of the lever arms of the lever 9, a favorable
translation, so that also, by means an extremely small lifting magnet 8

which consumes only little current, a high force of the contact pressure springs 5 can be overcome, which is easily visible when comparing Figures 1 and 3.

5 Figures 5 and 6 show the variant of the invention with at least one, preferably more permanent magnets 13 uniformly arranged along the periphery of a circle in the housing.

Figure 5 shows the locked position in which an air gap H exists between the housing and the toothed disc 3, but the toothed disc 3, which is non-rotatable with
10 respect to the car body 4, meshes with the toothed spindle disc 6 and thus prevents the rotation of the spindle 1 in the opening direction.

Figure 6 shows the released position in which the tothing is disengaged, as shown by the tooth gap 15 between the two tooth areas; in contrast, the air gap H is
15 closed; the toothed disc 3 rests against the housing in the contact area 16, or has a minimal distance which can hardly be indicated, because the toothed disc 3 rests on the permanent magnet 13, and can be considered to be a type of yoke. The holding force of the permanent magnets 13 is greater than the force of the contact pressure springs 5, so that, also when the lifting magnets 8' are switched off, the brake, the
20 coupling or the like remains released in a stable manner.

In order to return into the locked position, the lifting magnets 8' are energized in the opposite direction; the combined force of the lifting magnets and the contact pressure springs overcomes the attraction force of the permanent magnets; and the
25 position according to Figure 5 is reached again. In this position, the force of the contact pressure springs 5 (linear power drop as the distance increases) is greater than the attraction force of the permanent magnets (square power drop as the distance increases); and also this position is therefore stable when the lifting magnets 8' are de-energized.

30

Thus, every change of the position can be caused by a brief rush of current by the double-acting lifting magnets 8', or alternately by two opposite sets of single-acting lifting magnets, whereby current is saved, on the one hand, and it becomes possible, on the other hand, to use stronger magnets, since their thermal stressing by
5 the brief activation results in no problems.

The tothing between the stationary toothed disc 3 and the toothed spindle disc 6 may have a symmetrical or asymmetrical construction and, in the latter case, may be constructed to be so flat in a direction corresponding to the closing direction
10 of the door that it represents an additional freewheel; that is, that in emergency cases or the like, the user of the door, by means of a defined force against the contact pressure springs 5, can rotate the two discs 3, 6, tooth after tooth against one another. Furthermore, particularly asymmetrical tooth faces make it possible to drive the torque required for the overcoming in the opening direction arbitrarily high. In this
15 case, the mechanical stability and optionally a possibility for an overcoming desired in a not completely released condition may be considered to be the practical boundary.

What is claimed is:

1. A door actuator of rail vehicles, comprising:

a spindle drive and a freewheel, wherein the spindle drive has a spindle that is connected with the freewheel permitting rotation of the spindle in a direction corresponding to a closing direction of a door and preventing the rotation of the spindle in a direction corresponding to an opening direction of the door,

a part of the freewheel positioned away from the spindle being rotatably mounted but being releasably fixed with respect to a release device by force of at least one contact pressure spring in cooperation with a releasable coupling, wherein the coupling is fixable in an open released position; and

a bidirectional lifting magnet configured to release the releasable coupling from a closed locked position, wherein the lifting magnet is configured to act as a closing magnet configured to lock the coupling in the closed locked position,

wherein the releasable coupling is configured to operate by a linkage having a dead center position between a released position of the linkage and a locked position of the linkage, and the linkage has a swiveling lever which can be swiveled about a lever axis,

wherein the swiveling lever comprises a first arm connected to the bidirectional lifting magnet and a second arm carrying rollers with an axis of rotation parallel to the lever axis, and

wherein the lever is configured to move a movable part of the releasable coupling between the released and locked positions, and the dead-center position is reached when a connection plane between an axis of rotation of the rollers and the lever axis is parallel to the moving direction of the movable part of the releasable coupling.

2. The door actuator of claim 1 wherein the releasable coupling is movable between a releasable coupling released position and a releasable coupling

locked position, and the releasable coupling includes a non-rotatable toothed disc which is displaceable with respect to the release device axially against the force of the at least one contact pressure spring.

3. A door actuator of rail vehicles, comprising:

a spindle drive and a freewheel, wherein the spindle drive has a spindle that is connected with the freewheel permitting rotation of the spindle in a direction corresponding to a closing direction of a door and preventing the rotation of the spindle in a direction corresponding to an opening direction of the door,

a part of the freewheel positioned away from the spindle being rotatably mounted but being releasably fixed with respect to a release device by force of at least one contact pressure spring in cooperation with a releasable coupling, wherein the coupling is fixable in an open released position; and

a lifting magnet configured to release the releasable coupling from a closed locked position, wherein the lifting magnet is configured to act as a closing magnet configured to lock the coupling in the closed locked position,

wherein a movable part of the releasable coupling comprises ferromagnetic material, and is attracted towards a permanent magnet by an attraction force that exceeds the force of the at least one contact pressure spring when the release coupling is in the released position.

4. The door actuator of claim 3, wherein the movable part consists essentially of the ferromagnetic material.

5. The door actuator of claim 3 or claim 4, wherein the movable part rests on the permanent magnet when the release coupling is in the released position.

6. The door actuator of any one of claims 3 to 5, wherein the permanent magnet comprises one permanent magnet.

7. The door actuator of any one of claims 3 to 5, wherein the permanent magnet comprises a plurality of permanent magnets.
8. The door actuator of claim 7, wherein the plurality of permanent magnets are positioned along a circle extending concentrically with respect to an axis of the spindle.
9. A door actuator of rail vehicles, comprising:
 - a spindle drive and a freewheel, wherein the spindle drive has a spindle that is connected with the freewheel permitting rotation of the spindle in a direction corresponding to a closing direction of a door and preventing the rotation of the spindle in a direction corresponding to an opening direction of the door,
 - a part of the freewheel positioned away from the spindle being rotatably mounted but being releasably fixed with respect to a release device by force of at least one contact pressure spring in cooperation with a releasable coupling, wherein the releasable coupling is fixable in an open released position;
 - a lifting magnet configured to release the releasable coupling from a closed locked position; and
 - a closing magnet configured to lock the releasable coupling in the closed locked position.
10. The door actuator of 9, wherein a movable part of the releasable coupling comprises a ferromagnetic material, and is attracted towards a permanent magnet by an attraction force that exceeds the force of the at least one contact pressure spring when the release coupling is in the released position.
11. The door actuator of claim 10, wherein the movable part consists essentially of the ferromagnetic material.

12. The door actuator of claim 10 or claim 11, wherein the movable part rests on the permanent magnet when the release coupling is in the released position.
13. The door actuator of any one of claims 10 to 12, wherein the permanent magnet comprises one permanent magnet.
14. The door actuator of any one of claims 10 to 13, wherein the permanent magnet comprises a plurality of permanent magnets.
15. The door actuator of claim 14, wherein the plurality of permanent magnets are positioned along a circle extending concentrically with respect to an axis of the spindle.
16. The door actuator of claim 9, wherein the lifting magnet is configured to also act as the closing magnet.
17. The door actuator of claim 10, wherein the lifting magnet is a bidirectional magnet.
18. The door actuator of any one of claims 9, 16, and 17, wherein the releasable coupling is configured to operate by a linkage having a dead center position between a released position of the linkage and a locked position of the linkage, and the linkage has a swiveling lever which can be swiveled about a lever axis.
19. The door actuator of claim 18, wherein the swiveling lever comprises a first arm connected to the lifting magnet and a second arm carrying rollers with an axis of rotation parallel to the lever axis.
20. The door actuator of claim 18, wherein the lever is configured to move a movable part of the releasable coupling between the released and locked positions, and the dead-center position is reached when a connection plane between an axis of rotation of the rollers and the lever axis is parallel to the moving direction of the movable part of the releasable coupling.

21. The door actuator of any one of claims 9 to 20, wherein the releasable coupling is movable between a releasable coupling released position and a releasable coupling locked position, and the releasable coupling includes a non-rotatable toothed disc which is displaceable with respect to the release device axially against the force of the at least one contact pressure spring.

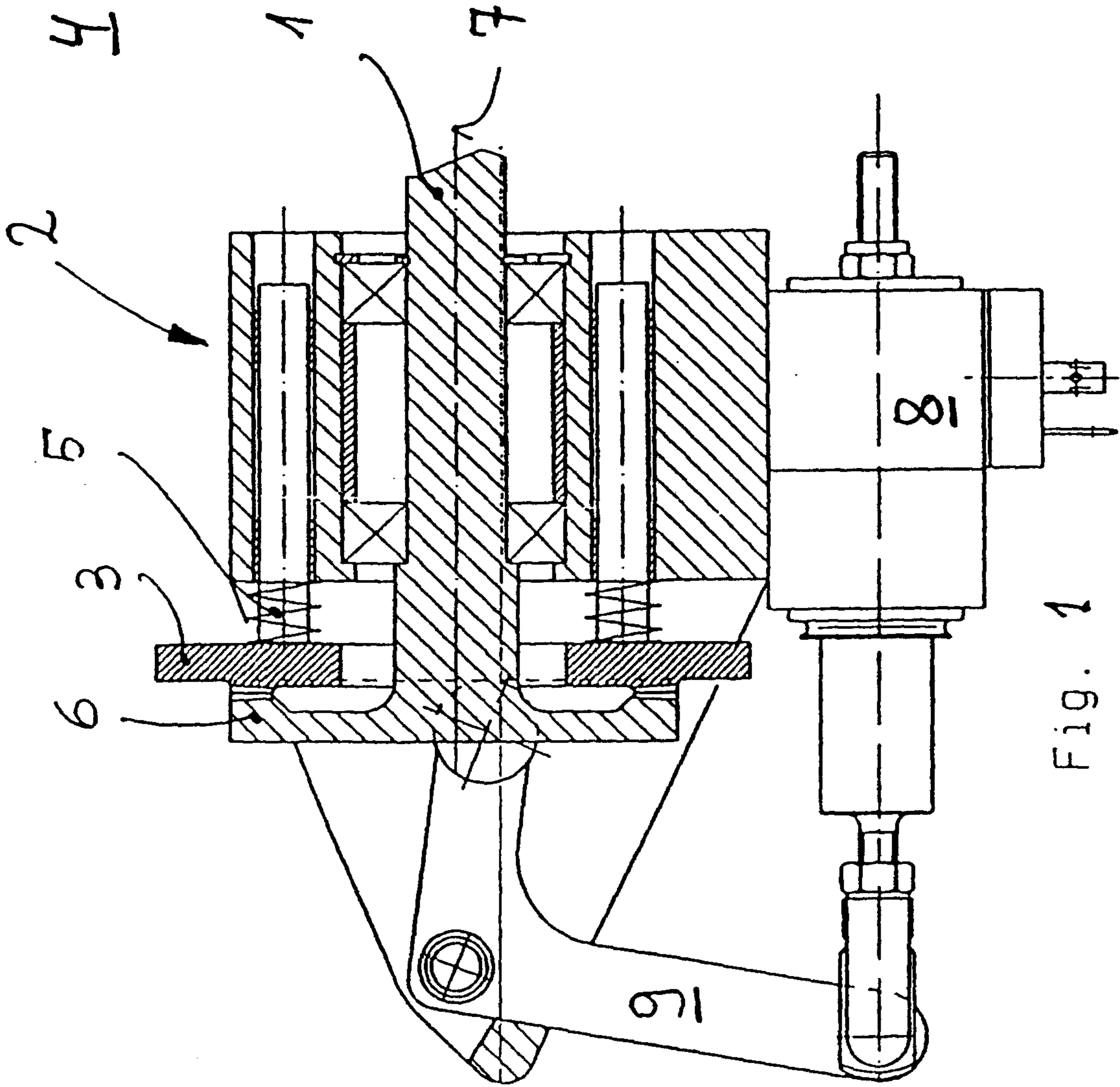


Fig. 1

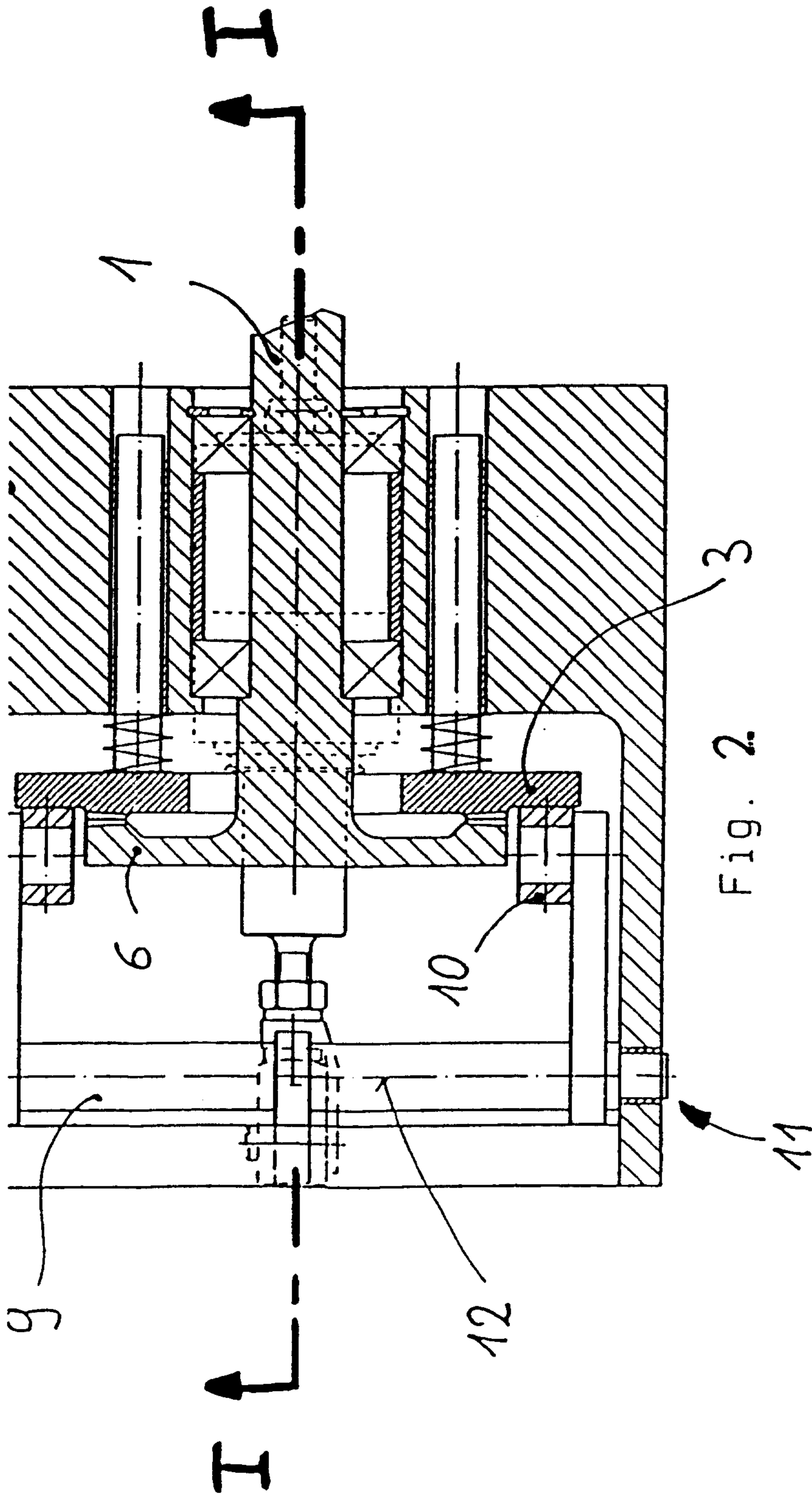


Fig. 2

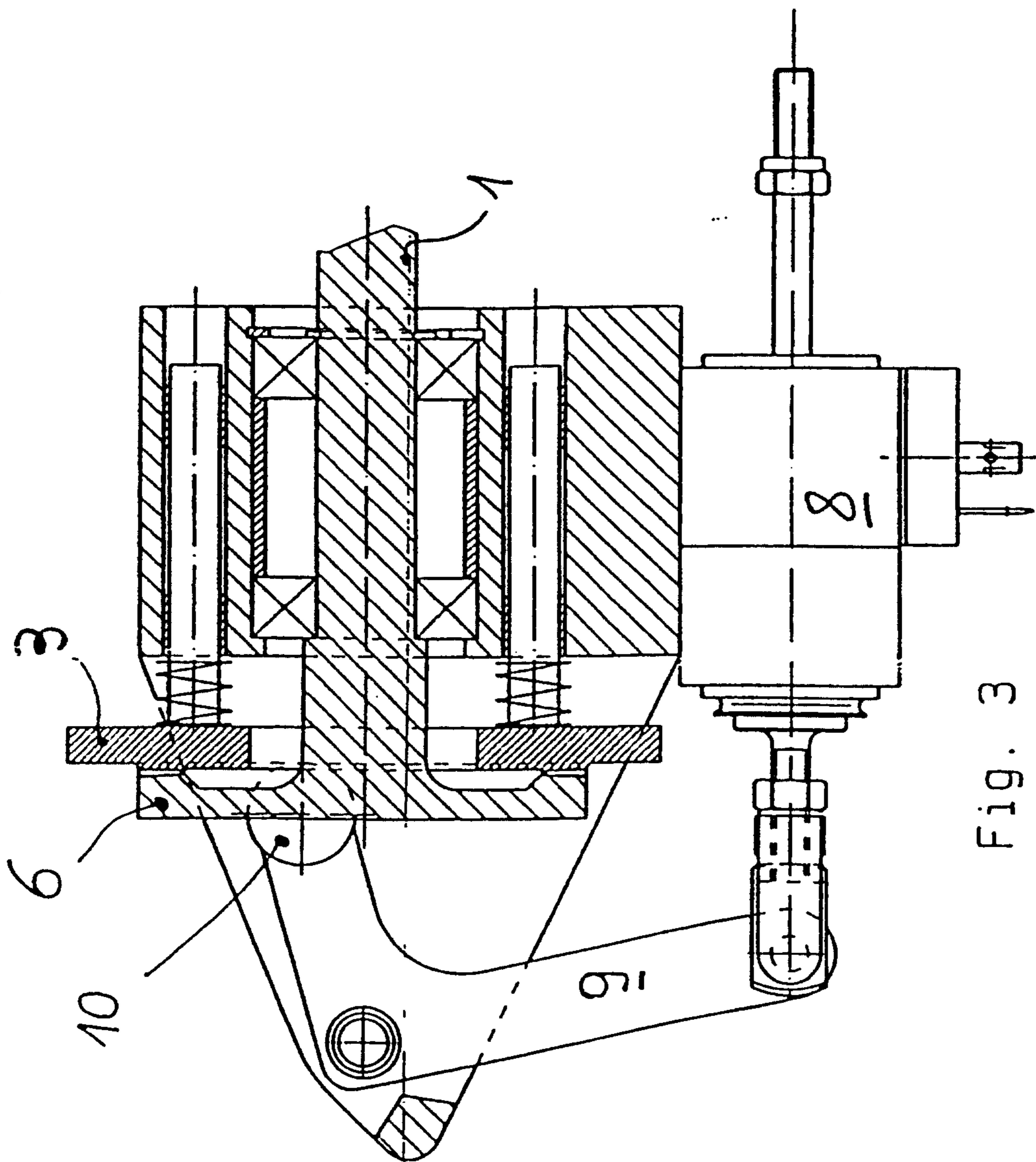


Fig. 3

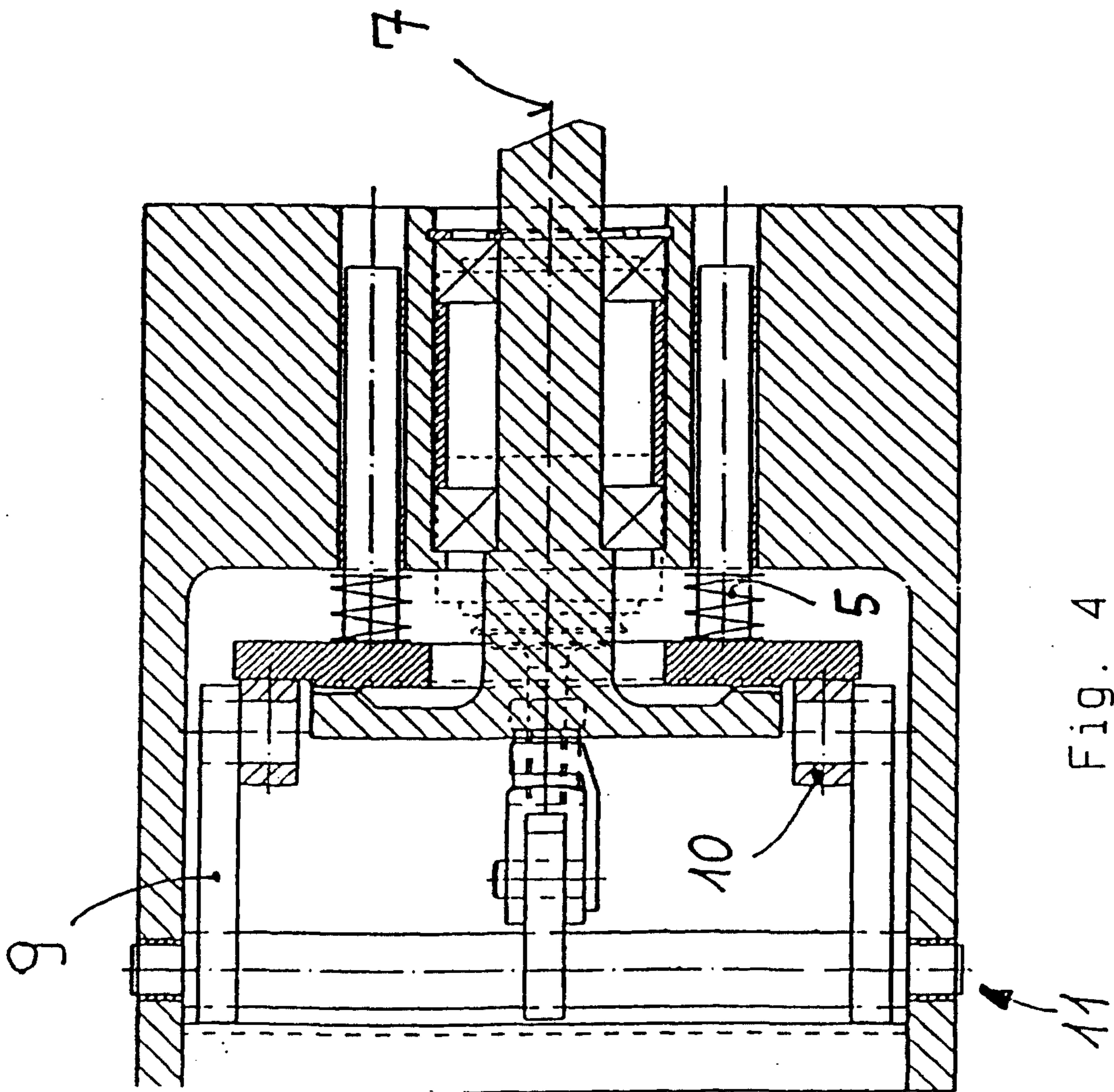


Fig. 4

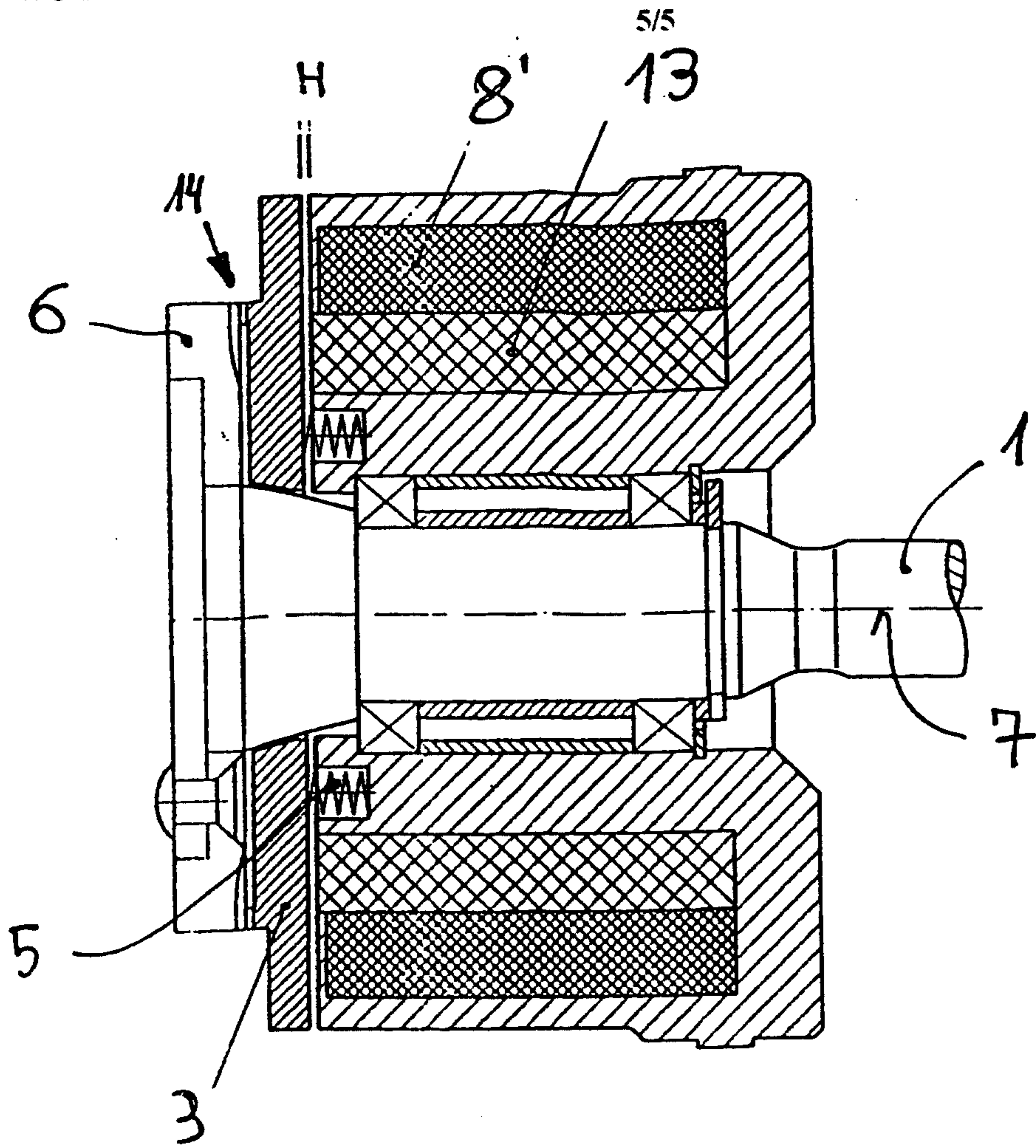


Fig. 5

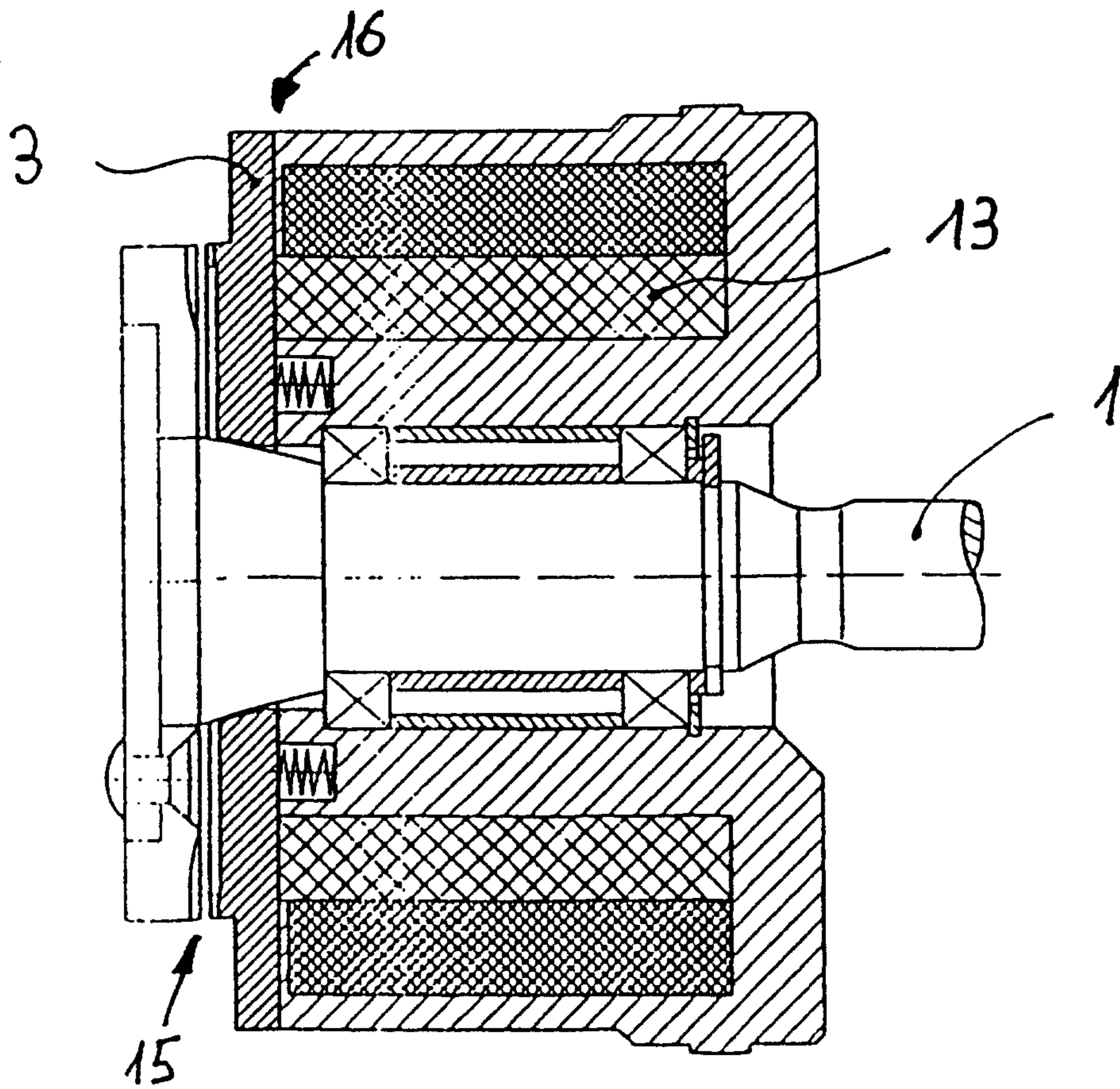


Fig. 6

