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Electrically driven rack and pinion steering system of a motor vehicle

Abstract

An electrically driven rack and pinion steering system of a motor vehicle has an axially displaceably mounted rack which transmits a steering movement for steered wheels of the motor vehicle, has an electric drive which provides a steering force and interacts with the rack, and has a housing which receives the rack and a drive element of the drive. The drive element is in engagement with a toothing system of the rack. A bearing assembly is arranged on a section of the rack without a toothing system axially on each side of the drive element, with a carrier cylinder, on the outer shell face of which an outer contact seal is arranged and on the inner shell face of which an inner contact seal is arranged, the contact seals sealing the housing with respect to the rack.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

(1) This application claims priority to German Patent Application No. 102021209996.3, filed Sep. 9, 2021, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

(2) The disclosure relates to an electrically driven rack and pinion steering system of a motor vehicle.

BACKGROUND

(3) A steering movement which a driver carries out on a steering wheel is conventionally transmitted to an axially displaceably mounted rack, the movement of which in turn moves the steered wheels of the motor vehicle in accordance with the steering movement. To this end, the rack is connected at the two ends in each case to a track rod which is in turn coupled to the steered wheels.

(4) The rack runs through a housing of the rack and pinion steering system and protrudes at two opposite ends out of the housing. A penetration of dirt and moisture into the housing has been prevented up to now by way of gaiters which are attached to the housing and cover a ball joint between the track rod and the rack.

(5) If damage occurs to a gaiter, this can be detected, for example, by way of corresponding sensors in the housing of the rack and pinion steering system. Damage is often, however, noticed first of all by the driver himself/herself on account of the changed behavior of the steering system. This option does not arise in the case of autonomously steered motor vehicles, however.

SUMMARY

(6) What is needed is to improve a rack and pinion steering system with regard to the protection against environmental influences, with the result that it can also be used, in particular, in autonomously driving vehicles.

(7) An electrically driven rack and pinion steering system of a motor vehicle, which rack and pinion steering system has an axially displaceably mounted rack which transmits a steering movement for steered wheels of the motor vehicle. Moreover, the rack and pinion steering system comprises an electric drive which provides a steering force and which interacts with the rack, and a housing which receives the rack and a drive element of the drive, the drive element being in engagement with a toothing system of the rack. A bearing assembly is arranged on a section of the rack without a toothing system axially on each side of the drive element, which bearing assembly comprises a carrier cylinder, on the outer shell face of which an outer contact seal is arranged and on the inner shell face of which an inner contact seal is arranged, the contact seals sealing the housing with respect to the rack.

(8) The bearing assemblies seal an interior space of the housing with respect to the surrounding area at the passage points of the rack, in one exemplary arrangement, in a hermetically water-tight and dust-tight manner, and thus protect the region, in which the drive element is in engagement with the rack, against the penetration of moisture and foreign bodies, and therefore provide increased protection against environmental influences. As a result, the service life of the rack and pinion steering system is increased, with the result that it can also be used without problems, in particular, for autonomously driving vehicles.

(9) The conventional gaiters between the housing and the track rod which, in particular, cover the ball joints, via which the rack is connected to the track rods, can be provided in addition.

(10) Since the conventional steering rod can be completely dispensed with in the case of autonomously driving vehicles and also in the case of steer-by-wire systems, the housing can be of considerably more compact design than in the case of conventional rack and pinion steering systems. The electric drive which is connected to the housing is then the only source for a steering force.

(11) The bearing assemblies are arranged at the axial ends of the housing.

(12) It is possible to fill the interior space of the housing axially between the bearing assemblies with a liquid lubricant on account of the satisfactory sealing action of the bearing assemblies.

(13) The carrier cylinder is advantageously generally sleeve-shaped, with the result that it can be simply pushed onto the rack.

(14) In order to seal the bearing assembly with respect to the rack, the inner contact seal has a radially inwardly pointing, peripheral sealing lip which slides on the rack. The sealing lip can be fixed in the bearing assembly, for example, in an annular groove on the inner side of the bearing assembly. The sealing lip can be part of a known shaft sealing ring.

(15) The actual mounting of the rack in the bearing assembly takes place, for instance, by way of a sliding sleeve which is inserted into the carrier cylinder and minimizes the friction between the carrier cylinder and the rack, but does not have to contribute to the sealing action.

(16) In order to seal the bearing assembly with respect to the housing, the outer contact seal is preferably in contact over the entire periphery with an inner wall of the housing, it being possible for the carrier cylinder to be supported elastically with respect to the inner wall of the housing.

(17) The carrier cylinder can generally be arranged in a radially movable manner with respect to the housing, at least on one side of the housing. In one exemplary arrangement, the bearing assembly and therefore also the rack can have a small amount of radial play with respect to the

housing as a result of the outer contact seal. For example, a radial play of from ±0.25 mm to ±0.35 mm is provided. This prevents the radial guidance of the rack via the two bearing assemblies at the ends and the additional guidance by way of the drive element in between being overdetermined, which might lead to increased friction.

(18) The outer contact seal can be realized, for example, by way of one or more O-rings.

(19) In one exemplary arrangement, the outer contact seal is arranged axially between the electric drive and a threaded sleeve which is screwed laterally into the housing.

(20) The actual mounting and the sealing of the rack with respect to the housing takes place exclusively by way of the bearing assembly, whereas the rack runs through the threaded sleeve without contact.

(21) A gaiter which seals the ball joint with respect to the track rod can be attached to the threaded sleeve which, to this end, should then have corresponding fastening structures.

(22) The two gaiters are conventionally flow-connected to one another via the interior space of the housing, with the result that pressure differences which arise in the case of the steering movements can be equalized. Since the bearing assemblies seal the interior space of the housing hermetically, a flow connection via an external pressure equalization line is provided.

(23) To this end, there can be a flow connection, for example in the threaded sleeve, in the bearing assembly and in the housing, from a gaiter which adjoins the housing to a pressure equalization line. For example, the threaded sleeve is designed in such a way that an annular space is formed between the threaded sleeve and the rack, through which annular space the air can pass from the gaiter to the inner side of the housing and, via the latter, to the pressure equalization line. The threaded sleeve and/or the bearing assembly possibly have/has suitable further structures for the flow connection.

(24) The pressure equalization line runs, for example, externally outside the housing, it being possible for connector pieces to be used in the housing, to which connector pieces the pressure equalization line is connected, and which connector pieces are flow-connected to the interior space of the housing.

(25) In one possible variant, the carrier cylinder is connected in one piece to the threaded sleeve. The radial and axial position of the bearing assembly is then defined via the threaded sleeve, and the bearing assembly is received in the housing without axial and radial play.

(26) In order to establish a flow connection to the pressure equalization line from the threaded sleeve, the threaded sleeve has, in this case, a radial through opening, for example, to the annular space between the inner side of the housing and the outer side of the rack.

(27) In another possible variant, the carrier cylinder and the threaded sleeve are separate components which are arranged directly adjacently. In this case, the threaded sleeve preferably defines an axially outer stop for the bearing assembly.

(28) The bearing assembly itself can be received in the housing radially and/or axially with play. In particular, the bearing assembly can be received in the housing such that it can be displaced radially and/or axially.

(29) A combination of the two variants at opposite ends of the housing is advantageous, in order to avoid overdetermination of the position of the rack.

(30) The axial positioning of the bearing assembly with respect to the housing can be fixed simply by way of a shoulder which is configured on the inner side of the housing and with which the bearing assembly is in contact in the inserted state. It can also be defined via the arrangement of the shoulder whether the bearing assembly is arranged axially non-displaceably with respect to the housing or is given a small amount of axial play.

(31) In this case, identical threaded sleeves and bearing assemblies can be used at the two axial ends of the housing, the position of the shoulder at one end being selected in such a way that the bearing assembly is held in the housing without axial play and, at the opposite end, the shoulder is arranged at a somewhat greater axial spacing from the end of the housing, with the result that the

bearing assembly has a predefined small amount of axial play in the housing.
(32) If axial play of the bearing assembly is to be avoided, the carrier cylinder of the bearing assembly can also be fixed, for example, via a circlip on the inner side of the housing.
(33) A flow connection from the annular space of the threaded sleeve to the pressure equalization line can possibly be formed by way of a radial groove at that end of the carrier cylinder which points toward the threaded sleeve, which radial groove forms a flow channel to the pressure equalization line.
(34) A pressing apparatus which acts on the drive element and the rack is preferably provided, which pressing apparatus ensures a satisfactory mechanical contact between the drive element and the toothing system of the rack. Here, for example, a variable yoke can be used which engages around the rack and is prestressed resiliently in the direction of the drive element.
(35) The drive element is positioned approximately in the axial center of the rack, such that a homogeneous distribution of force to the rack results.
(36) In order to achieve low-tolerance positioning of the drive element, the housing has two bearing points for the drive element. It is advantageous, if the bearing points are configured in one piece with the housing and are thus defined by way of a shape of the housing. The housing can be, for example, a high-pressure diecast component.
(37) A pinion, for example, has proven suitable as a drive element, since it makes a smaller overall size of the housing possible than with a conventional recirculating ball mechanism.

Description

BRIEF DESCRIPTION OF DRAWINGS
(1) In the following text, the disclosure will be described in greater detail on the basis of a plurality of exemplary arrangements with reference to the appended figures, in which:
(2) FIG. **1** shows a diagrammatic perspective illustration of a rack and pinion steering system according to the disclosure,
(3) FIG. **2** diagrammatically shows the construction of the rack and pinion steering system from FIG. **1**,
(4) FIG. **3** shows a diagrammatic perspective illustration of a bearing assembly of the rack and pinion steering system according to the disclosure,
(5) FIGS. **4** and **5** show diagrammatic sectional views of the rack and pinion steering system according to the disclosure in accordance with a first exemplary arrangement, FIG. **4** showing the arrangement of the bearing assembly at one axial end of the housing, and FIG. **5** showing the arrangement of the bearing assembly at the opposite axial end of the housing,
(6) FIGS. **6** and **7** show diagrammatic sectional views of the rack and pinion steering system according to the disclosure in accordance with a second exemplary arrangement, FIG. **6** showing the arrangement of the bearing assembly at one axial end of the housing, and FIG. **7** showing the arrangement of the bearing assembly at the opposite axial end of the housing,
(7) FIG. **8** shows a diagrammatic sectional view of the rack and pinion steering system from FIG. **1** in the region of a drive, and
(8) FIG. **9** shows a diagrammatic partially sectioned illustration of the drive of the rack and pinion steering system according to the disclosure.
DETAILED DESCRIPTION
(9) The figures show an electrically driven rack and pinion steering system **10**, the housing **12** of which surrounds an axially displaceably mounted rack **14** peripherally, the rack **14** protruding out of the housing **12** at the axial ends of said housing **12**. In an axial central section, the rack **14** has a toothing system **16** (see FIG. **8**). The axial ends are configured as sections **18** without a toothing system.

(10) The axial direction A is specified by way of the longitudinal direction of the rack **14**.
(11) An electric drive **20**, an electric motor here, moves a drive element **22** which is in engagement with the toothing system **16**, with the result that the rack **14** can be displaced in both directions along the axial direction A by way of operation of the drive **20** (see also FIG. **9**). As a result, a steering force is provided for the steered wheels of the vehicle.
(12) Here, the rack **14** is connected at the two axial ends via a ball joint **24** to a track rod **26**, with the result that an axial movement of the rack **14** can be transmitted via the track rods **26** as a steering movement to the steered wheels (not shown) of a motor vehicle.
(13) The transition from the track rod **26** to the housing **12** is protected against environmental influences in each case by way of a gaiter **28**. The gaiter **28** also covers the ball joint **24**.
(14) As FIG. **8** shows, for example, in each case one bearing assembly **30** is inserted into the housing **12** at the axial ends of the housing **12**, through which bearing assemblies **30** the rack **14** extends. Therefore, in each case one bearing assembly **30** is arranged on the two sides of the drive **20**. The bearing assemblies **30** are situated on the sections **18** of the rack **14** without a toothing system.
(15) The bearing assemblies **30** close off an interior space **32** of the housing **12** hermetically with respect to the surrounding area.
(16) In this example, the interior space **32** is filled with a liquid lubricant which fills, in particular, an annular space between an inner side **34** of the housing **12** and the rack **14**. Here, the interior space **32** is accessible from the outside via openings **36** (shown in FIG. **1**) in the wall of the housing **12**, in order to pour in lubricant.
(17) The bearing assembly **30** is shown separately in FIG. **3**.
(18) A main constituent part is a dimensionally stable carrier cylinder **31** which is single-piece and substantially sleeve-shaped here.
(19) In order to seal the carrier cylinder **31** with respect to the rack **14**, an inner contact seal **40** is arranged on a radially inner shell face **38**, which inner contact seal **40** comprises, here, a radially inwardly pointing sealing lip which runs around peripherally and bears in a peripherally closed manner against one of the sections **18** of the rack **14** without a toothing system.
(20) The inner shell face **38** optionally has an annular groove **43** which receives, for example, a circlip which fixes the contact seal **40** axially on the carrier cylinder **31** between the circlip and a shoulder on the radially inner shell face **38**, as is shown in FIGS. **6** and **7**. The contact seal **40** can also optionally bear against other suitable bearing faces on the inner shell face **38**, as FIGS. **4** to **7** show.
(21) A radially outer contact seal **44**, in the form here of two parallel O-rings, is arranged on a radially outer shell face **42** of the carrier cylinder **31** for a sealing action with respect to the inner side **34** of the housing **12**. Here, the O-rings are inserted into two parallel annular grooves on the outer shell face **42** of the carrier cylinder **31** (see also FIGS. **4** to **7**).
(22) For mounting, the carrier cylinder **31** can be pushed simply onto the sections **18** of the rack **14**. The outer shell face **42** of the carrier cylinder **31** and the inner side **34** of the housing **12** in the region of the bearing assembly **30** are circular-cylindrical in these examples.
(23) The rack **14** extends through the two bearing assemblies **30**, and can be displaced axially with respect to the latter for the transmission of the steering movement to the steered wheels.
(24) In order to reduce the friction, a sliding sleeve **46** is received here in each carrier cylinder **31**, which sliding sleeve **46** is arranged radially between the rack **14** and the carrier cylinder **31** and is in direct contact with the section **18** of the rack **14** and with the inner shell face **38** of the carrier cylinder **31**. The sliding sleeve **46** is arranged offset axially toward the drive **20** with respect to the inner contact seal **40** and therefore does not need to develop any sealing action.
(25) The outer contact seal **44** optionally makes a small amount of radial play of the bearing assembly **30** with respect to the inner side **34** of the housing **12** possible, since the bearing assembly **30** is supported elastically on the inner side **34** by means of the contact seal **44**. In this

case, a small radial relative movement is possible between the rack **14** and the housing **12**.
(26) The bearing assemblies **30** are secured in the direction of the axial housing ends in each case by way of a threaded sleeve **48**, each threaded sleeve **48** having an external thread **50** which engages into a corresponding internal thread **52** on the inner side **34** of the housing **12**. An axial shoulder **54** on the threaded sleeve **48**, which axial shoulder **54** comes into contact with an axial end face **56** of the housing **12**, defines the correct screw-in position of the threaded sleeve **48**.
(27) The threaded sleeve is not in direct contact with the rack **14**.
(28) In this example, the gaiter **28** is fixed at the free axial end of the threaded sleeve **48**.
(29) In the case of the first exemplary arrangement which is shown in FIGS. **4** and **5**, one of the bearing assemblies **30** (here, the bearing assembly **30** shown in FIG. **4** at the left-hand axial end of the housing **12**) is connected in one piece to the threaded sleeve **48**. The axial and the radial position of the bearing assembly **30** is therefore determined completely by way of the threaded sleeve **48**.
(30) FIG. **5** shows the opposite axial end of the housing **12**. Here, the bearing assembly **30** and the threaded sleeve **48** are designed as separate components. The bearing assembly **30** is arranged in the housing **12** at an axial spacing from the threaded sleeve **48**, a shoulder **58** on the inner side **34** of the housing **12** forming a stop for an axial end **60** of the bearing assembly **30**. In order to fix the bearing assembly **30** axially, a circlip **62** is provided here which bears against a shoulder **63** at that axial end **64** of the carrier cylinder **31** which lies opposite the axial end **60**, and engages into a radial groove on the inner side **34** of the housing **12**.
(31) In this way, an axial intermediate space **65** is produced between the carrier cylinder **31** and the threaded sleeve **48**.
(32) In this example, the bearing assembly **30** is fixed axially, but has a certain amount of radial play radially as a result of the contact seal **44** on its outer shell face **42**.
(33) The interior spaces of the two gaiters **28** are flow-connected to one another via a pressure equalization line **66** which runs outside the housing **12**. To this end, the threaded sleeve **48**, the housing **12** and the bearing assembly **30** have suitable structures.
(34) At that axial end of the rack **14** which is shown in FIG. **4**, the flow connection from the interior space of the gaiter **28** to the pressure equalization line **66** takes place via an annular space **68** between the inner side of the threaded sleeve **48** and the outer side of the section **18** of the rack **14**, via an annular groove **69** on the inner shell face **38** of the carrier cylinder **31**, into which annular groove **69** the annular space **68** merges, and via a branch duct **70** which runs from the annular groove **69** radially through the threaded sleeve **48** to a connector piece **72** which is inserted radially into the housing **12** and to which the pressure equalization line **66** is connected.
(35) At that axial end of the rack **14** which is shown in FIG. **5**, the axial intermediate space **65** between the threaded sleeve **48** and the carrier cylinder **31** is in a flow connection to the annular space **68** of the threaded sleeve **48**, with the result that air can pass from the interior of the gaiter **28** through the annular space **68** into the intermediate space between the threaded sleeve **48** and the bearing assembly **30**. Said intermediate space **65** is in a flow connection to a connector piece **72** in the housing **12**.
(36) The two connector pieces **72** are connected to one another via the pressure equalization line **66**.
(37) As an alternative to the pressure equalization line **66**, an axial bore might also be provided in the rack **14**, which axial bore connects the interior spaces of the two gaiters **28** to one another.
(38) Here, the housing **12** is of identical design at the two axial ends, with the result that the arrangement of the fixed bearing assembly **30** and the bearing assembly **30** which is mounted in a floating manner can be selected depending on the situation.
(39) In the case of the second exemplary arrangement which is shown in FIGS. **6** and **7**, a threaded sleeve **48** and a bearing assembly **30** which is separate from it are arranged in each case at the two axial ends of the housing **12**. The threaded sleeves **48** and the bearing assemblies **30** are identical

for the two housing ends here.
(40) As in the above-described first exemplary arrangement, the bearing assembly **30** is pushed onto the rack **14**, and the threaded sleeve **48** is screwed into the axial end of the housing **12**, with the result that the threaded sleeve **48** is firmly fixed axially and radially with respect to the housing **12**.
(41) At that axial end of the housing **12** which is shown in FIG. **6**, the shoulder **58** is arranged on the inner side **34** of the housing **12**, against which the axial end **60** of the bearing assembly **30** bears, at an axial spacing d.sub.1 from the shoulder **54**, by way of which the threaded sleeve **48** bears against the end face **56** of the housing **12**. The spacing d.sub.1 is selected in such a way that the bearing assembly **30** is axially directly in contact with the threaded sleeve **48**, and therefore does not have any axial play in the interior of the housing **12**.
(42) At the opposite end which is shown in FIG. **7**, the shoulder **58** is arranged at a spacing d.sub.2 from the shoulder **54**, which spacing d.sub.2 is slightly greater than the spacing d.sub.1. Therefore, the bearing assembly **30** is arranged at this axial end of the housing **12** such that it can be moved within the housing **12** in the axial direction A with a small amount of play.
(43) The pressure equalization between the two gaiters **28** likewise takes place in this example via a pressure equalization line **66** (not shown here) which is connected via connector pieces **72** (likewise not shown) to the inner side **34** of the housing **12**. In order to provide a flow connection from the annular space **68** within the threaded sleeve **48** to the pressure equalization line **66**, the carrier cylinder **31** of the bearing assembly **30** has a radial groove **74** at the axial end **64**, which radial groove **74** leads from the inner shell face **38** of the carrier cylinder **31** to its outer shell face **42**.
(44) In the region of the radial groove **74**, the outer shell face **42** is offset radially inward slightly starting from the end **64**, by way of which the shoulder **63** is also formed. The radial groove **74** extends from the end **64** as far as the shoulder **63**. In this way, a further annular space is formed in the region of the axial end **64** of the bearing assembly **30**, which further annular space is arranged between the threaded sleeve **48** and the carrier cylinder **31**, and via which further annular space a flow connection to the pressure equalization line **66** is established.
(45) In the examples which are shown here, the drive element **22** is configured as a pinion which engages into the toothing system **16** of the rack **14**. This is shown in FIGS. **8** and **9**.
(46) The housing **12** has an integrally formed receptacle **76** for the drive element **22** and further parts of the drive **20**, in particular for a driven worm gear **77** which is connected via a shaft to the pinion. A pressing apparatus **78** is also arranged in the receptacle **76**, which pressing apparatus **78** applies a pressing force F laterally in the direction of the rack **14** and of the drive element **22**, and thus ensures satisfactory contact between the rack **14** and the drive element **22**.
(47) Moreover, the receptacle **76** has two bearing points **80** for the drive element **22**, which two bearing points **80** are provided on the two axial sides of the pinion. Since both the pressing apparatus **78** and the two bearing points **80** are arranged in regions which are connected in one piece to the housing **12**, very small tolerances can be implemented and undesired relative movements between the drive element **22** and the rack **14** can be reduced.

Claims

1. An electrically driven rack and pinion steering system of a motor vehicle with an axially displaceably mounted rack which transmits a steering movement for steered wheels of the motor vehicle, comprising an electric drive which provides a steering force and interacts with the rack, a housing which receives the rack and a drive element of the electric drive, wherein the drive element is in engagement with a toothing system of the rack, a bearing assembly being arranged on a section of the rack without a toothing system axially on each side of the drive element, with a carrier cylinder, on the outer shell face of which an outer contact seal is arranged and on an inner

shell face of which an inner contact seal is arranged, the contact seals sealing the housing with respect to the rack; wherein the carrier cylinder is arranged such that it can be moved radially with respect to the housing.

2. The rack and pinion steering system as claimed in claim 1, wherein the inner contact seal has a radially inwardly pointing, peripheral sealing lip which slides on the rack.

3. The rack and pinion steering system as claimed in claim 1, wherein the outer contact seal is arranged axially between the electric drive and a threaded sleeve which is screwed laterally into the housing.

4. The rack and pinion steering system as claimed in claim 3, the threaded sleeve having a flow connection from a gaiter, adjoining the housing, and a pressure equalization line.

5. The rack and pinion steering system as claimed in claim 3, the carrier cylinder and the threaded sleeve being separate components which are arranged directly adjacently.

6. The rack and pinion steering system as claimed in claim 5, the carrier cylinder being received radially and/or axially displaceably in the housing.

7. The rack and pinion steering system as claimed in claim 1, further comprising, a pressing apparatus which acts on the drive element and the rack.

8. The rack and pinion steering system as claimed in claim 7, the housing having two bearing points for the drive element.

9. The rack and pinion steering system as claimed in claim 1, wherein the outer contact seal is in contact with an inner side of the housing and supports the carrier cylinder elastically with respect to the inner side of the housing.

10. The rack and pinion steering system as claimed in claim 1, wherein the carrier cylinder is arranged such that it can be moved radially with respect to the housing.

11. The rack and pinion steering system as claimed in claim 1, the outer contact seal is arranged axially between the electric drive and a threaded sleeve which is screwed laterally into the housing.

12. The rack and pinion steering system as claimed in claim 4, the carrier cylinder being connected in one piece to the threaded sleeve.

13. The rack and pinion steering system as claimed in claim 4, the carrier cylinder and the threaded sleeve being separate components which are arranged directly adjacently.

14. The rack and pinion steering system as claimed in claim 13, the carrier cylinder being received radially and/or axially displaceably in the housing.

15. The rack and pinion steering system as claimed in claim 1, further comprising, a pressing apparatus which acts on the drive element and the rack.

16. An electrically driven rack and pinion steering system of a motor vehicle with an axially displaceably mounted rack which transmits a steering movement for steered wheels of the motor vehicle, comprising an electric drive which provides a steering force and interacts with the rack, a housing which receives the rack and a drive element of the electric drive, wherein the drive element is in engagement with a toothing system of the rack, a bearing assembly being arranged on a section of the rack without a toothing system axially on each side of the drive element, with a carrier cylinder, on the outer shell face of which an outer contact seal is arranged and on an inner shell face of which an inner contact seal is arranged, the contact seals sealing the housing with respect to the rack, wherein the outer contact seal is arranged axially between the electric drive and a threaded sleeve which is screwed laterally into the housing, and wherein the carrier cylinder is connected in one piece to the threaded sleeve.