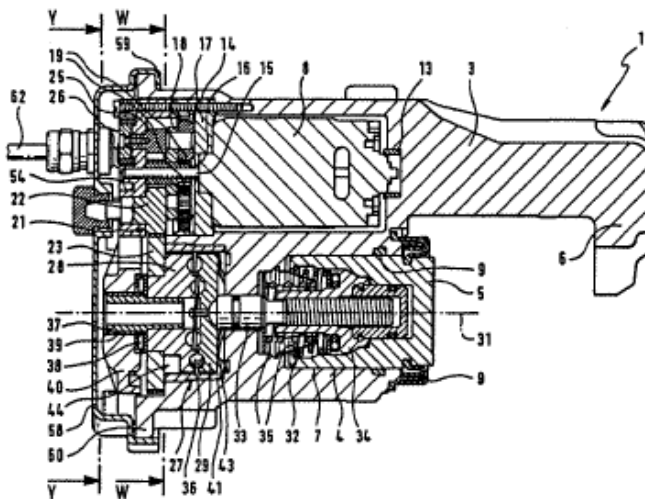


INTERNATIONAL APPLICATION PUBLISHED IN ACCORD WITH THE
INTERNATIONAL PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷: F16D 65/21, 55/224, B60T 13/74	A1	(11) International Publication Number: WO 00/61962 (43) International Publication Date: October 19, 2000 (10.19.00)
(21) International Filing Number: PCT/EP00/03342 (22) International Filing Date: April 13, 2000 (04.13.00) (30) Priority Data: 199 16 737.0 April 13, 1999 (04.13.99) DE (71) Applicant (for all Designated States except the US): CONTINENTAL TEVES AG & CO. OHG (DE/DE); Guerickestrasse 7, D-60488 Frankfurt (DE) (72) Inventor; and (75) Inventor/Applicant (US only): Rolf WEILER (DE/DE), Zum Kohlwaldfeld 20, D-65817 Eppstein (DE); Jürgen BALZ (DE/DE), Birkenstrasse 20, D-65510 Hünstetten- Oberlibbach (DE); Werner DENHARD (DE/DE), An den Dippenäckern 10, D_36396 Steinau (DE); Stephan HEIDRICH (DE/DE), Ludwigstrasse 18, D-64572 Büttelborn (DE). (74) Joint Representative: CONTINENTAL TEVES AG & CO. OHG; Guerickestrasse 7, D-60488 Frankfurt (DE).		(81) Designated States: DE, JP, US, European Patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international research report</i>
(54) Title: PARTIALLY LINED DISK BRAKE WITH ELECTROMECHANICAL ACTUATOR UNIT (57) Abstract The invention relates to an electromechanically actuated partially lined disk brake that can be used both to realize a service brake and a parking brake function. The partially lined disk brake has a caliper (1) with an electromechanical actuator unit (8) which clamps the partially lined disk brake via at least one interposed actuator element (5, 32). The aim of the invention is to provide a compact design and a parking brake that can be electrically actuated. To this end, the caliper (1) has a multi-step reduction gear (10) that is arranged between the integrated actuator unit (8) and an actuator element (5, 32). Said actuator unit (8), said reduction gear (10) and said actuator element (5, 32) are located in a recess (12, 12') of the caliper (1) that is configured as a housing. According to the invention, the multi-step reduction gear (10) is configured as a non-self-locking device, that is, it has an overall efficiency of $\eta > 50\%$, and it is also provided with an engageable free-wheel (44) which facilitates switching between the operating brake and the parking brake function.		



FOR INFORMATION PURPOSES ONLY

Codes for the identification of PCT contracting states on the cover sheets of the documents that publish the international applications in accordance with the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Vietnam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakhstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

Partially lined disk brake with electromechanical actuator unit

The present invention relates to an electromechanically actuated partially lined disk brake suitable that can be used both to realize a service and a parking brake function. For this purpose, the partially lined disk brake has a brake caliper with an electromechanical actuator unit, at least two brake linings arranged to be movable in the brake caliper, each interacting with a friction surface of a brake disk, one of which can be brought into engagement directly with the brake disk through the actuator unit by means of at least one actuator element and the other brake lining indirectly through the action of a reaction force applied by the brake caliper. A multi-stage reduction gear is functionally provided between the actuator unit and the actuator element, the actuator unit, the reduction gear and the actuator element being arranged in a housing-like recess of the brake caliper.

This type of electromechanically actuated disk brake is known from EP 0 728 089 B1. The disk brake described therein has a floating brake caliper as well as an actuator unit arranged on the brake caliper. The actuator unit has an electric motor which, with an interposed reduction gear, adjusts an actuator element, by means of which one of two brake linings displaceably arranged in the brake caliper is engaged directly with a brake disk. The second brake lining also is also pressed against the brake disk due to a reaction force acting on the brake caliper. Despite its compact construction, this disk brake has the drawback that it can only develop a limited braking force in both service and parking brake functions.

DE 197 32 168 C1 discloses a hydraulic vehicle brake with parking brake device, in which a brake piston is accommodated displaceably within a hydraulic chamber of the vehicle brake. The brake piston can be moved into an actuated position within the brake caliper by means of hydraulic pressure in which it interacts with a brake lining

- 2 -

1 in such a way that the brake piston presses the brake lining against a brake disk. So
2 that the vehicle brake also can be used as a parking brake in addition to its function
3 as a hydraulic service brake, a spindle/nut configuration, which is driven by an
4 electric motor, is arranged coaxially with the axis of the brake piston. Further, in
5 addition to the electric motor, a complex reduction gear is required in order to apply
6 the necessary clamping forces for the parking brake function. The aforementioned
7 vehicle brake therefore requires two independent actuation paths, viz., a hydraulic
8 and an electromechanical one. This requires not only a complex overall structural
9 design of the vehicle brake, but also a complicated method of operating or
10 controlling the vehicle brake.

11
12 In light of the foregoing, the task of the present invention is to specify a simply
13 constructed, electromechanically actuated partially lined disk brake that can be used
14 both as a service brake and as parking brake and that can be operated with
15 economically and conveniently.

16
17 This task is realized by means of an electromechanically actuated partially lined disk
18 brake which has the features of patent claim 1. Accordingly, the partially lined disk
19 brake of the present invention comprises a brake caliper with an electromechanical
20 actuator unit with at least two brake linings displaceably arranged in the brake
21 caliper, each of which interacts with a friction surface of a brake disk and one of
22 which can be brought into engagement with the brake disk by means of at least one
23 actuator element through the actuator unit. A multi-stage reduction gear is
24 functionally arranged between the actuator unit and actuator element, wherein the
25 actuator unit, reduction gear, and actuator element are disposed in a housing-like
26 recess of the brake caliper. This allows a particularly compact design of the brake
27 caliper, wherein the brake caliper is capable of implementing both the service and
28 parking brake functions. The multi-stage reduction gear is, on the whole, configured
29 as a non-self-locking device, i.e., it exhibits an overall efficiency of $\eta > 50\%$.

- 3 -

1 Consequently, the clamping force is transmitted from the electromechanical actuator
2 unit to the brake linings with as little loss as possible and, hence, very efficiently.
3 Moreover, a switchable freewheel cooperating with the reduction gear is included.
4 By means of this switchable freewheel, it is possible to lock the clamped brake
5 caliper like a return lock in order to implement the parking brake function when
6 activated. In the direction of rotation of clamping of the actuator unit or non-self-
7 locking reduction gear, the transmission of the brake clamping force from the
8 actuator unit to the brake linings is unaffected.

9
10 A particularly advantageous embodiment of the partially lined disk brake is realized
11 in that the reduction gear comprises a rolling-element ramp-type gear. This type of
12 gear allows a rotary input variable to be converted into a translational output variable
13 while maintaining a high reduction ratio. For this purpose, the rolling-element ramp-
14 type gear preferably has a plurality of nested ramps arrangements, which enable a
15 large usable torsion angle. The translational stroke of this gear design is matched to
16 the respective actuation stroke of the brake piston, specifically, the translational
17 stroke corresponds to this actuation stroke. The rolling-element ramp-type gear
18 preferably comprises two ramp halves which can be twisted relative to one another;
19 of which, a first ramp half is coupled to the drive-side end of the electromechanical
20 actuator unit and a second ramp half is operatively connected to the actuator element.
21 During operation of the partially lined disk brake, the two ramp halves can be twisted
22 one against the other in order to generate the actuating stroke and transmit it to at
23 least one of the brake linings via the actuator element. The second ramp half, i.e., the
24 one that is operatively connected to the actuator element, is preferably disposed in
25 the brake caliper housing so as to be non-rotatable but capable of being displaced at
26 least by the amount of the actuating stroke of the brake lining.

27
28 According to a preferred embodiment of the invention, the switchable freewheel is
29 designed as a return lock that acts counter to the direction of rotation of clamping of

- 4 -

1 the reduction gear. When the brake is clamped, the aforementioned return lock has
2 no effect on the functioning of the reduction gear. The non-self-locking reduction
3 gear is prevented from reversing only when clamped and the freewheel is locked.
4 The brake can thus be locked in the clamped state, and thereby secured against
5 release of the brake due to decreasing clamping force of the brake. To release the
6 brake, the locking function of the freewheel can again be cancelled by means of a
7 switching function when the reduction gear is rotated in the direction of release.

8
9 According to an advantageous embodiment of the invention, the multi-stage
10 reduction gear includes a planetary gear stage coupled to drive side of the
11 electromechanical actuator unit and a spur gear stage connected thereto, which
12 interacts with the rolling-element ramp-type gear on the output side. By means of the
13 planetary gear stage in connection with the spur gear stage, a particularly high
14 reduction ratio can be realized for the entire reduction gear despite very low spatial
15 requirements.

16
17 A particularly effective and easily implementable version of the partially lined disk
18 brake is realized according to the present invention by providing the actuator element
19 with a brake piston that is displaceably disposed in the brake caliper as well as at
20 least one brake piston operatively connected to a brake lining, which is connected to
21 the rolling-element ramp-type gear on the output side. Known design features of a
22 brake caliper with a hydraulic actuator unit may be used in regard to the overall
23 construction of the brake caliper.

24
25 In order to keep the translational stroke of the reduction gear constant when the
26 partially lined disk brake is operated, the actuator element preferably also includes an
27 adjusting device that is displaceably disposed in the brake caliper and that can be
28 extended in the clamping direction of the partially lined disk brake, where the
29 adjusting device is operatively connected to at least one brake lining on the one hand,

- 5 -

1 and to the rolling-element ramp-type gear to the output side, on the other. The
2 extendable adjusting device takes into account the wear of the brake linings and is
3 extended as the wear of the brake linings progresses. Each actuating stroke of the
4 brake piston or the stroke of the ramp half of the rolling-element ramp-type gear
5 arranged displaceably in the direction of clamping in the brake caliper housing is
6 maintained over the entire service life of the brake. Advantageously, the adjusting
7 device includes a nut-spindle arrangement which interacts, on the one hand, with the
8 brake piston and, on the other, with the rolling-element ramp-type gear. The nut and
9 spindle are connected by threads so that they can be rotated in relation to one
10 another, wherein the spindle is connected in a torsion-free manner to the second
11 ramp half, which is disposed displaceably in the brake caliper housing.

12
13 According to a further advantageous embodiment of the invention, the partially lined
14 disk brake has a hydraulic actuator device that is independent of the
15 electromechanical actuator unit. Specifically, the aforementioned hydraulic actuator
16 device is formed by a cylinder bore in the brake caliper in connection with the brake
17 piston. Within such an arrangement, the hydraulic actuator device can be used for
18 service braking and the electromechanical actuator unit for parking braking. The two
19 different actuation modes can thus be specifically designed and configured for their
20 respective functions.

21
22 A particularly cost-effective partially lined disk brake according to the present
23 invention is realized in that the electromechanical actuator unit is formed by a DC or
24 direct current electric motor. Such electric motors are known in many designs and
25 can be used as a standardized component within the brake.

26
27 In a preferred embodiment of the partially lined disk brake, the electric motor has an
28 angular position sensor which is coupled to the rotational movement of the electric
29 motor, and which can be integrated in particular in the reduction gear or electric

- 6 -

1 motor. The current motor position and motor movement with direction of rotation
2 and rotational speed can thus be detected at any time, and consequently provides
3 information about the associated actuation state of the partially lined disk brake.

4
5 According to a refinement of the invention, the reduction gear has a tool holding
6 fixture for attachment of an emergency actuator element. Thus, emergency actuation
7 of the brake, i.e., releasing or clamping, is possible in the event of a malfunction,
8 e.g., if insufficient electrical power is available.

9
10 An advantageous embodiment of the invention results from the fact that at least the
11 electromechanical actuator unit, the planetary gear, and a drive wheel of the spur
12 gear form a first independent subassembly, which is disposed and fixed in the
13 housing-like recess of the brake caliper. Further, this first subassembly can be
14 supplemented with other useful individual components. This module can thus easily
15 be preassembled outside of the brake caliper and, after insertion into the brake
16 caliper recess, fastened, for example, with screws. In the same way, it would be
17 reasonable that at least the rolling-element ramp-type gear, the switchable freewheel,
18 and an output gear of the spur gear form another independently manageable
19 subassembly. This second subassembly can also easily be preassembled and finally
20 fastened in the housing-like recess of the brake caliper. These subassemblies provide
21 a particularly easily assemblable modular design of the partially lined disk brake.

22
23 According to a preferred embodiment of the invention, the electromechanical
24 actuator unit, the actuator element, and the multi-stage reduction gear are disposed
25 and fastened within the brake caliper and sealed off against the outside by means of a
26 housing cover. This results, on the one hand, in a particularly compact design of the
27 brake caliper, and, on the other, of an installation-friendly accessibility of the
28 individual components of the partially lined disk brake simply by removing the

- 7 -

1 housing cover. The housing cover prevents contamination of the individual
2 subassemblies, and thereby ensures the functionally reliable operation of the brake.

3

4 Further embodiment examples according to the invention are found in the figures
5 below and the in the corresponding sections of the description.

6 Shown are

7 Figure 1 an embodiment according to the invention of a combined brake caliper of
8 a partially lined disk brake for service and parking braking functions in a
9 partially sectioned view;

10

11 Figure 2 a sectional view of the brake caliper of Figure 1 along line X-X;

12

13 Figure 3 a sectional view of the brake caliper along line Y-Y in Figure 2;

14

15 Figure 4 a sectional view of the brake caliper along line W-W in Figure 2;

16

17 Figure 5 an embodiment of a rolling-element ramp-type gear with a freewheel in
18 several partially sectioned views;

19

20 Figure 6 an embodiment of a ramp half of the rolling element ramp-type gear in
21 several partially sectioned views.

22

23 The combined brake caliper 1 of a partially lined disk brake shown in Figures 1-4 is
24 suitable for implementing both service and parking braking functions. It is designed
25 as a floating caliper, i.e., it is mounted displaceably in relation to the clamping
26 direction of the partially lined disk brake by means of guide bush 2 of a bolt guide,
27 not shown, on a brake holder attached to the vehicle. The brake caliper 1 overlaps
28 with a bridge section 3, a brake disk, not shown, as well as brake linings arranged on
29 both sides of the brake disk, which tribologically interact with the brake disk in a

- 8 -

known manner. In this regard, one of the brake linings is connected to a brake piston 5 that is displaceably accommodated in a cylinder bore 4. The other brake lining is connected to a brake caliper side 6 lying axially outside the vehicle axis. The actual clamping force of the floating caliper-partially lined disk brake is transmitted in a known manner to the inner brake lining by means of the brake piston 5 acting as an actuator element. Due to the reaction force and the resulting displacement of the brake caliper, the outer brake lining is then also pressed against the brake disk.

To apply the required clamping force, a hydraulic actuator device 7, on the one hand, and an electromechanical actuator unit 8, on the other, are provided in the brake caliper 1. The hydraulic actuator device 7 essentially comprises the cylinder bore 4 and the brake piston 5 and is usually provided for the service braking function. The hydraulic pressure chamber formed by the cylinder bore 4 and the interior of the brake piston 5 is sealed off from the outside by means of sealing elements 9.

The electromechanical actuator unit 8 is essentially responsible for the implementation of the parking braking function and acts on the inner brake lining via an interposed multi-stage reduction gear 10 and an actuator element 11. The electromechanical actuator unit 8, together with the reduction gear 10 and the actuator element 11, is integrated in the brake caliper 1 and arranged in a housing-like recess 12, 12' of the brake caliper. The electromechanical actuator unit 8 is preferably designed as an electric motor. Specifically, this should be a direct current motor (or DC motor) which can be used in the form of a standardized motor design, for example. Within the brake caliper 1, the electric motor 8 [sic; formerly, actuator unit 8] is accommodated on both sides via a bearing bush 13 and a bearing plate 14.

The output side of the electric motor 8 has an actuator shaft 15 to which a sun gear 16 is attached. The sun gear 16 is part of planetary gear 17 connected to actuator unit 8, which provides a high reduction of motor speed while simultaneously increasing

- 9 -

1 torque. The planetary gear 17 comprises a planetary carrier 18 with planetary gears
2 19, which engage in a ring gear 20. The ring gear 20 is either preformed with the
3 brake caliper or, as shown in Figures 1-4, integrated in bearing plate 14, which is
4 screwed together with brake caliper 1. On the output side, the planetary gear 17 is
5 connected to a spur gear 21, which comprises a driving wheel 22 and an output gear
6 23. At the same time, the speed at the output side of the planetary gear 17 is
7 transmitted to an angular position sensor 26 via a sensor shaft 24 with gearwheel 25.
8 The angular position sensor 26 is coupled to the electric motor 8, and thereby allows
9 the current determination of the angular position or the rotary motion of the electric
10 motor 8 in relation to the direction of rotation and the speed of rotation at any given
11 time. Finally, this provides information on the current actuating state of the brake.
12 The angular position sensor 26 can be implemented in a particularly simple manner
13 by means of a Hall sensor. For this purpose, it is generally required to have a
14 connection to the rotary motion of electric motor 8, so that the angular position
15 sensor 26 can be disposed directly on the electric motor 8 or at a suitable position on
16 the reduction gear 10. Due to the high speeds and thus the high resolution, the
17 angular position sensor 26 should be arranged as close as possible to the electric
18 motor 8.
19
20 The spur gear stage 21 following at the output side of planetary gear 17 causes a
21 further reduction in speed as well as increase in torque and is used to drive a rolling-
22 element ramp-type gear 27 that is arranged coaxially with the brake piston 5. The
23 rolling-element ramp-type gear 27 in particular comprises several highly reducing
24 ramp configurations which are formed onto two ramp halves 28, 29 in the form of
25 ramp guideways 30, in which the two ramp halves 28, 29 can be rotated relative to
26 one another. The ramp guideways 30 can be seen in more detail in Figure 6, using
27 the second ramp half 29 as an example. Preferably, they are two concentrically
28 nested ramp guideways 30 that are additionally shifted by 180° in their angular
29 position. Both ramp guideways have the same inclination. The rolling-type bearing

- 10 -

elements 36, in particular balls or rolling bodies, which can roll in the ramp guideways 30, are arranged in the ramp guideways 30. To increase the gear stroke on the output side, it is advantageous that the ramp guideways 30 correspond to one another on both ramp halves 28, 29. The nested arrangement of the ramp guideways 30 together with the angular displacement of ramp guideways 30, compared with known ramp configurations, allows an additional increase in the reduction ratio of the rolling-element ramp-type gear 27. This also is achieved through the substantially increased twisting angle of the two ramp halves 28, 29, compared with known ramp configurations, which is possible through the arrangement of ramp guideways 30. Thus, useable twisting angles of up to approximately 270° can be realized.

The first ramp half 28 is rigidly connected to the output gear 23 of the spur gear 21 and arranged with bearings 38 in brake caliper 1 via a hollow shaft 37. For this purpose, the hollow shaft 37 with the bearing bush 39 is held rotatably in a traverse 40. The traverse 40 is of very high strength, i.e., it is preferably made of steel and is firmly screwed to brake caliper 1. In contrast, the second ramp half 29 is torsion-resistant, but is accommodated so that it can be displaced in the recess 12' of brake caliper 1 in the direction of the brake piston axis 31. For this purpose, a bush 41 is rigidly fastened in the brake caliper 1, preferably by being pressed in, and the second ramp half 29 is in turn arranged in a torsion-proof manner on bush 41. For this purpose, the second ramp half 29 preferably has recesses 42 on its surface which interact with the associated beads of the bush 41. A corresponding anti-torsion device with recesses and associated beads also can be used between the bush 41 and the brake caliper 1. The bush 41 is preferably provided with an outer knurling 48 at one end and is pressed into brake caliper 1 with this end in a torsion-proof manner. However, the exact design of this anti-torsion device is not definitive for the invention. Analogously acting anti-torsion devices, which rigidly fix the second half of the ramp 29 in the brake caliper 1 are also possible. The two ramp halves 28, 29

- 11 -

1 are pressed together by the action of a spring 43, where the rolling-type bearing
2 elements 36 are always held in their correct positions within the ramp guideways.

3

4 In detail, the rolling-element ramp-type gear 27 causes the rolling-type bearing
5 elements 36 to roll in ramp guideways 30 by twisting the two ramp halves 28, 29
6 against each other. This means, on the one hand, a very high speed reduction, and, on
7 the other hand, causes the rotary input variable (output-side speed of the spur gear
8 21) to be converted into a translational output variable (gear stroke) in the form of a
9 "rot-trans-gear". A gear stroke in the direction of the brake piston axis 31 is
10 generated as a translational output variable. When brake caliper 1 is clamped
11 electromechanically by means of actuator unit 8, this gear stroke is transmitted to
12 brake piston 5 by means of a mechanical adjusting device 32, which acts as an
13 actuator element. The gear stroke essentially corresponds to the clamping stroke of
14 the brake piston.

15

16 The adjusting device 32 takes into account the wear on the brake linings and
17 compensates for this by extending in the direction of the brake piston axis 5. Thus,
18 the required clamping stroke of brake piston 5, and thus the gear stroke of the
19 rolling-element ramp-type gear 27 can be kept constant. The adjusting device 32 is
20 rigidly connected to rolling-element ramp-type gear 27, on the one hand, and to
21 brake piston 5, on the other. It can be extended in the direction of the brake piston
22 axis 5 and essentially comprises a nut-spindle configuration with a spindle 33, which
23 is rigidly attached to the second ramp half 29, and a nut 34, which is rotatably
24 disposed on the spindle 33, which is supported on the brake piston 5. The nut 34 and
25 the spindle 33 are tensioned against one another by means of several springs 35, so
26 that when the brake lining wears, the adjusting device 32 is extended in the direction
27 of the brake piston axis 31. The basic structure of such an adjusting device 32 as well
28 as its function are known and will not be explained in more detail here. In regard to
29 further details of the adjusting device 32 with respect to construction and function,

- 12 -

1 reference is made to DE 195 21 634 A1. The features of the adjusting device
2 mentioned there can be transferred to the adjusting device of the present invention.

3

4 In principle, the entire multi-stage reduction gear 10 with planetary gear 17, spur
5 gear 21, and rolling-element ramp-type gear 27 is designed to achieve a high overall
6 efficiency. Thus, the reduction gear 10 has an overall efficiency of $\eta > 50\%$, i.e., the
7 reduction gear 10 is non-self-locking.

8

9 In order to implement a parking brake function when the brake is clamped
10 electromotively by means of the actuator unit 8, it is therefore necessary to lock
11 brake caliper 1 in the clamped state. This is realized by a switchable freewheel 44
12 that interacts with the rolling-element ramp-type gear 27. The switchable freewheel
13 44 is arranged between output gear 23 of spur gear 21 and the first ramp half 28. It
14 works like a return lock. In the rotary clamping direction of actuator unit 8 and the
15 reduction gear 17 or in the rotary clamping direction 50 of the first ramp half 28, the
16 freewheel 44 is always free and does not impede the transmission of the clamping
17 forces to the two brake linings, not shown. If, however, the brake caliper 1 is in the
18 clamped state, the reaction force resulting from the clamping force is taken up by the
19 rolling-element ramp-type gear 27 via brake piston 5 and adjusting device 32. As a
20 result of the high level of efficiency, the first ramp half 28 thereby tends to turn in
21 the direction of "releasing the brake." However, this is prevented by the freewheel
22 44. Clamping elements 46, preferably clamping rolls, each acted upon by the spring
23 force of a pressure spring 45, roll along a sloped guide surface 47 and jam the first
24 ramp half 28 with respect to brake caliper 1 or intermediate bush 41. Thus, the
25 rolling-element ramp-type gear 27 is fixed in place and an undesired easing of the
26 brake caliper 1 is prevented. The output gear 23 and the first ramp half 28 are
27 coupled to one another via pins 51 in terms of their rotational movement, wherein
28 there is slack between the output gear 23 and the first ramp half 28. The pins 51 are
29 fastened to the first ramp half 28 and project in the direction of the output gear 23,

- 13 -

1 extending into associated recesses 52 of output gear 23 due to the aforementioned
2 slack , i.e., play. By means of this slack or play, freewheel 44 is locked by the
3 reaction force of the brake clamping force, and the brake clamping force is
4 maintained. This also applies when the electric motor 8 is switched off. This also
5 allows the parking brake function to be realized.

6
7 To release the brake caliper 1 after electromotive actuation, the actuator unit 8 is
8 operated in the direction of rotation of release. The reduction gear 10 thus also
9 causes the first ramp half 28 to turn in the direction of rotation of release 49. The
10 output wheel 23 with the actuator pins 53 rigidly connected thereto then rotates
11 slightly with respect to the first ramp half 28, which is jammed with the brake caliper
12 1, without initially transmitting any torque due to the clearance. This relative rotation
13 of output gear 23 and ramp half 28 causes the clamping elements 46 to be loosened
14 because actuator pins 53 extending into the first ramp half 28 push clamping
15 elements 46 from their locked position and release the freewheel 44. The position of
16 the actuator pins 53, the pins 51, the recesses 52, and the clamping elements 46 in
17 their locked position are matched to one another in such a way that, in order to
18 release the locked freewheel 44, the actuator pins 53 first come into contact with
19 clamping elements 46 and release the locking function before the pins 51 become
20 engaged with the associated recesses 52 in order to transmit torque. The switching
21 function of freewheel 44 thus allows the rolling-element ramp-type gear 27 to be
22 unlocked by operating the actuator unit 8 in the release direction of rotation, and thus
23 release of the brake. As can be seen from Figures 4 and 5, the number of actuator
24 pins 53, pins 51, clamping elements 46, and compression springs 45 is not limited to
25 a certain number according to the invention. The figures merely show advantageous
26 embodiments.

27
28 The arrangement of the electromechanical actuator unit 8 parallel to the brake piston
29 axis 31 allows a particularly compact design of the brake caliper 1, on the one hand,

- 14 -

1 and the possibility of a modular design, on the other. Such a first subassembly
2 essentially comprises the actuator unit 8, the planetary gear 17, the bearing plate 14
3 with ring gear 20, the angular position sensor 26, the drive wheel 22 as well as a gear
4 cover 54. Due to the gear cover 54, this first subassembly can be preassembled
5 outside of the brake caliper 1 and finally fastened in the brake caliper 1 with
6 fastening screws 55. The gear cover 54 also serves to support the sensor shaft 24 and
7 the drive wheel 22 of the spur gear 21. Further, the electrical lines 56 for the actuator
8 unit 8 and the angular position sensor 26 can be guided [sic; can be guided through
9 the gear cover 54] as shown in Figure 3.

10
11 Further, a second subassembly comprising the rolling-element ramp-type gear 27,
12 the switchable freewheel 44, the output gear 23, the hollow shaft 37 with the bearing
13 bush 39 as well as the bearing 38 and the traverse 40 can be formed. The hollow
14 shaft 37 is mounted via bearing bush 39 and bearing 38 on the traverse 40. The
15 bearing 38 can be formed as a thrust bearing or an angular ball bearing or a shoulder
16 bearing in order to improve the radially effective bearing properties. This second
17 subassembly also can be preassembled as an independently manageable module
18 outside brake caliper 1. After the second subassembly is mounted in the recess 12' of
19 the brake caliper, screws 57 are used to attach the subassembly to the brake caliper 1
20 via the traverse 40. The traverse 40 and the screws 57 must be stable, since they are
21 used to take up the reaction force of the brake clamping force.

22
23 Finally, the brake caliper 1 is closed by a housing cover 58, which seals off the brake
24 caliper 1 from the outside. For this purpose, the housing cover 58 has several bent
25 straps 59 distributed over its circumference, with which it is fastened to an associated
26 collar 60 on brake caliper 1. To improve the sealing effect, an additional seal 61 can
27 be provided between the housing cover 58 and the brake caliper 1. The electrical
28 supply line 62 for the actuator unit 8 and the angular position sensor 26 is also routed
29 through the housing cover 58.

- 15 -

1

2 To implement a mechanical emergency actuation of the brake, e.g., in the event of a
3 power failure, a hole closed with a removable plug 63 is provided in housing cover
4 58. This hole provides access to a tool holding fixture 64 at the drive wheel 22 of the
5 spur gear 21. When a suitable tool is inserted in the tool holding fixture 64, the
6 reduction gear 10 can be rotated to release or clamp the brake. The tool holding
7 fixture can, of course, also be arranged at any suitable position of the reduction gear
8 10 or the actuator unit 8.

9

10 Although the embodiment example of the brake caliper according to the present
11 invention shown in the figures has both a hydraulic actuator device 7 and an
12 electromechanical actuator unit 8, this is not mandatory. If the actuator unit 8 and the
13 reduction gear 10 are sufficiently dimensioned, i.e., if sufficiently high clamping
14 forces can be generated, the additional hydraulic actuator device 7 can be omitted.
15 By means of the switchable freewheel 44, both the service and parking braking
16 functions can be implemented solely by means of the electromechanical actuator
17 unit.

Claims

1. Electromechanically actuated partially lined disk brake for vehicles with a brake caliper (1), with an electromechanical actuator unit (8), with at least two brake linings displaceably arranged in the brake caliper (1), each cooperating with a friction surface of a brake disk, one of which can be brought into engagement with the brake disk indirectly by the actuator unit (8) by means of at least one actuator element (5, 32) and the other brake lining indirectly through the action of a reaction force applied from the brake caliper (1), and with a multi-stage reduction gear (10) functionally arranged between the actuator unit (8) and the actuator element (5, 32), wherein the actuator unit (8), the reduction gear (10), and the actuator element (5, 32) are arranged in a housing-like recess (12, 12') of brake caliper (1), **characterized in that** the multi-stage reduction gear (10) is designed to be non-self-locking, i.e., with a total efficiency $\eta > 50\%$, and includes a switchable freewheel (44).
2. Partially lined brake disk according to claim 1, **characterized in that** the reduction gear (10) includes a rolling element ramp-type gear (27).
3. Partially lined brake disk according to claim 2, **characterized in that** the rolling element ramp-type gear (27) has a plurality of nested ramp arrangements (30).
4. Partially lined brake disk according to one of the claims 2 or 3, **characterized in that** the rolling element ramp-type gear (27) has two ramp halves (28, 29) which can be rotated relative to each other, a first ramp half of which (28) is coupled to the output side end of the electromechanical actuator unit (8), and a second ramp half (23) of which is operatively connected to the actuator element (5, 32).

- 2 -

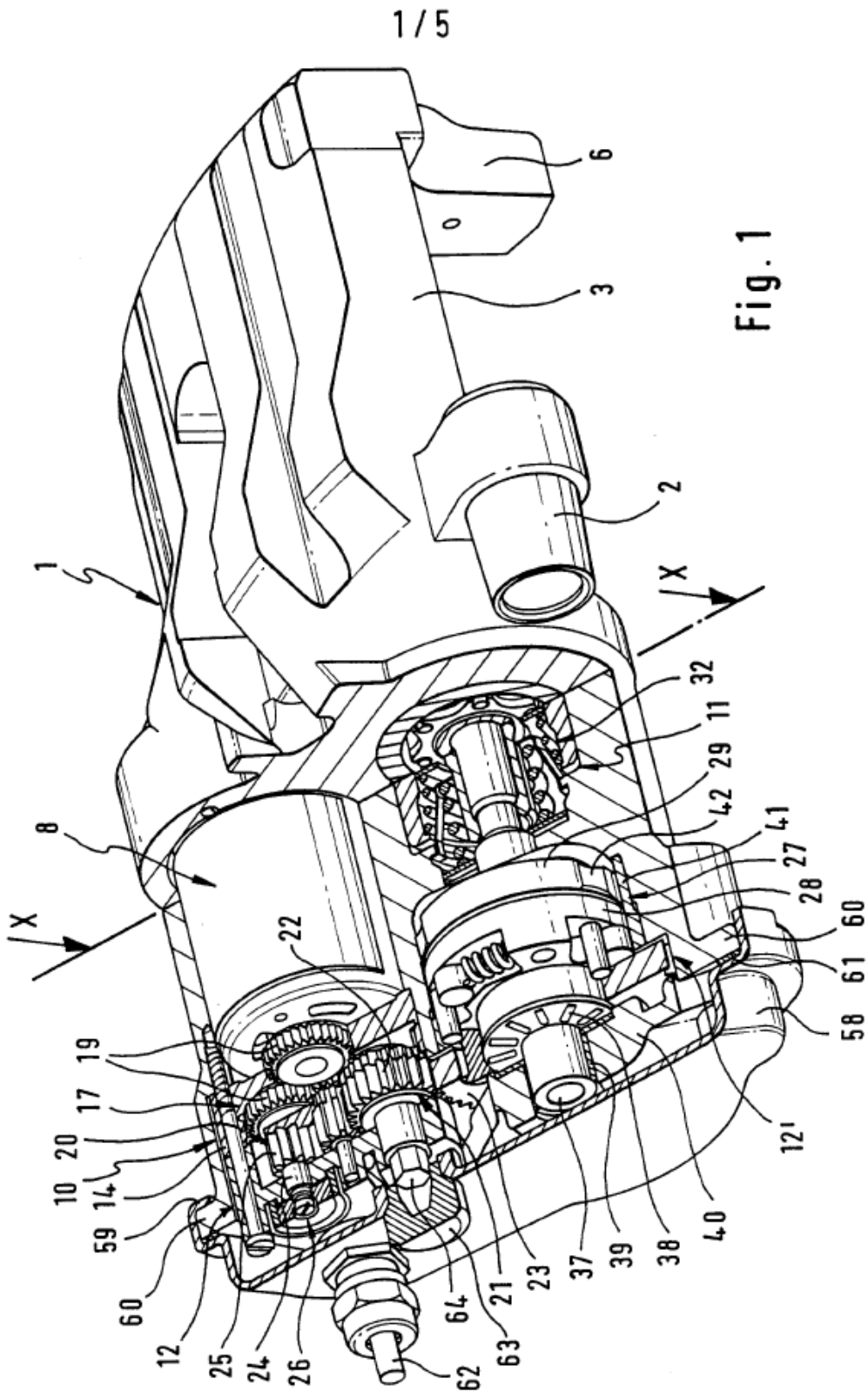
5. Partially lined brake disk according to claim 4, **characterized in that** the second ramp half (23) is arranged in brake caliper (1) so as to be rotationally rigid.
6. Partially lined brake disk according to one of the preceding claims, **characterized in that** the switchable freewheel (44) is designed as a return lock that acts counter to the direction of rotation of clamping.
7. Partially lined brake disk according to one of the preceding claims, **characterized in that** the reduction gear (10) includes a planetary gear (17) coupled to the electromechanical actuator unit (8) on the drive side.
8. Partially lined brake disk according to claim 7, **characterized in that** the reduction gear (10) includes a spur gear (21) coupled on the drive side to the planetary gear (17) and to the rolling element ramp gear (27) on the output side.
9. Partially lined brake disk according to one of the preceding claims, **characterized in that** the actuator element (5, 32) has a brake piston (5) arranged to be movable in brake caliper (1) and operatively connected to at least one brake lining, which is coupled to the rolling element ramp gear (27) on the output side.
10. Partially lined brake disk according to one of the preceding claims, **characterized in that** the actuator element (5, 32) has an adjusting device (32) displaceably arranged in the brake caliper (1) and extendable in the clamping direction of the partially lined disk brake, which is functionally connected on one side to at least one brake lining and on the other side is coupled to the rolling element ramp gear (27) on the output side.

- 3 -

11. Partially lined brake disk according to claims 9 and 10, **characterized in that** the adjusting device (32) includes a nut-spindle arrangement (33, 34) rotatable relative to each other, which cooperates on one side with the brake piston (5).
12. Partially lined brake disk according to claims 5 and 11, **characterized in that** the spindle (33) of the nut-spindle arrangement (33, 34) is rigidly connected to the second ramp half (28).
13. Partially lined brake disk according to claim 9, **characterized in that** the partially lined disk brake has a hydraulic actuator device (7) independent of the electromechanical actuator unit (8).
14. Partially lined brake disk according to one of the preceding claims, **characterized in that** the electromechanical actuator unit (8) includes a DC electric motor.
15. Partially lined brake disk according to claim 14, **characterized in that** the electric motor (8) has an angular position sensor (26) that is coupled to the rotational movement of the electric motor (8) and is integrated in the electric motor (8) or the reduction gear (10).
16. Partially lined brake disk according to claim 14, **characterized in that** the angular position sensor (26) is preferably designed as a Hall sensor.
17. Partially lined brake disk according to one of the preceding claims, **characterized in that** the reduction gear (10) has a tool holding fixture (64) for mounting an emergency actuator element.

- 4 -

18. Partially lined brake disk according to one of the preceding claims,
characterized in that at least the electromechanical actuator unit (8) as well as the reduction gear (10) are sealed off against the outside by means of a housing cover fastened to the brake caliper (1).
19. Partially lined brake disk according to claims 7 and 8, **characterized in that** at least the electromechanical actuator unit (8), the planetary gear (17) and a drive wheel (22) of the spur gear (21) form a first, independently manageable, subassembly that is fastened in the housing-like recess (12) of the brake caliper (1).
20. Partially lined brake disk according to claims 1, 2 and 8, **characterized in that** at least the rolling element ramp device (27), the switchable freewheel (44), and an output gear (23) of the spur gear (21) are designed as a second, independently manageable, subassembly, which is fastened in the housing-like recess (12') of the brake caliper (1).



2 / 5

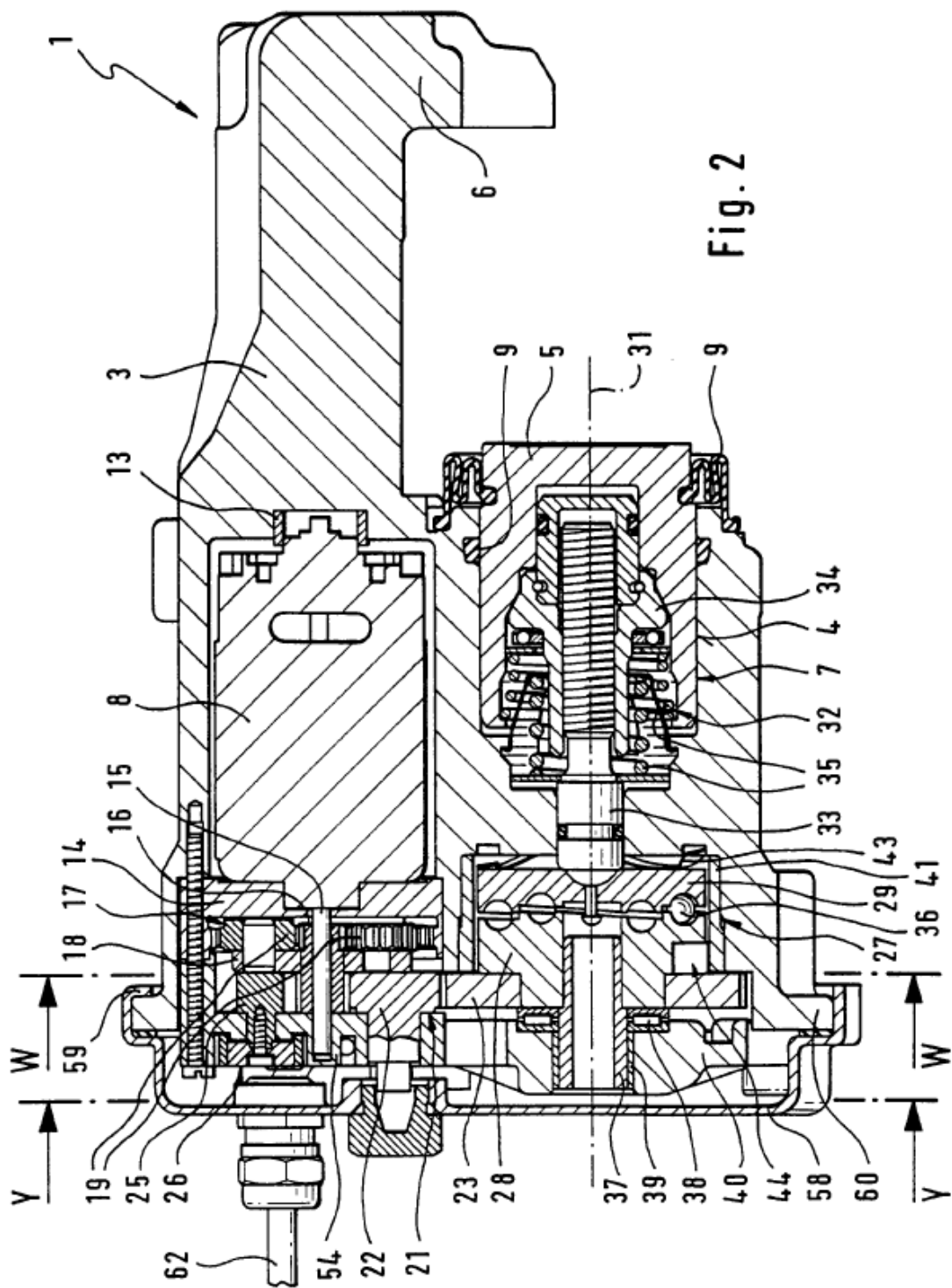


Fig. 2

3 / 5

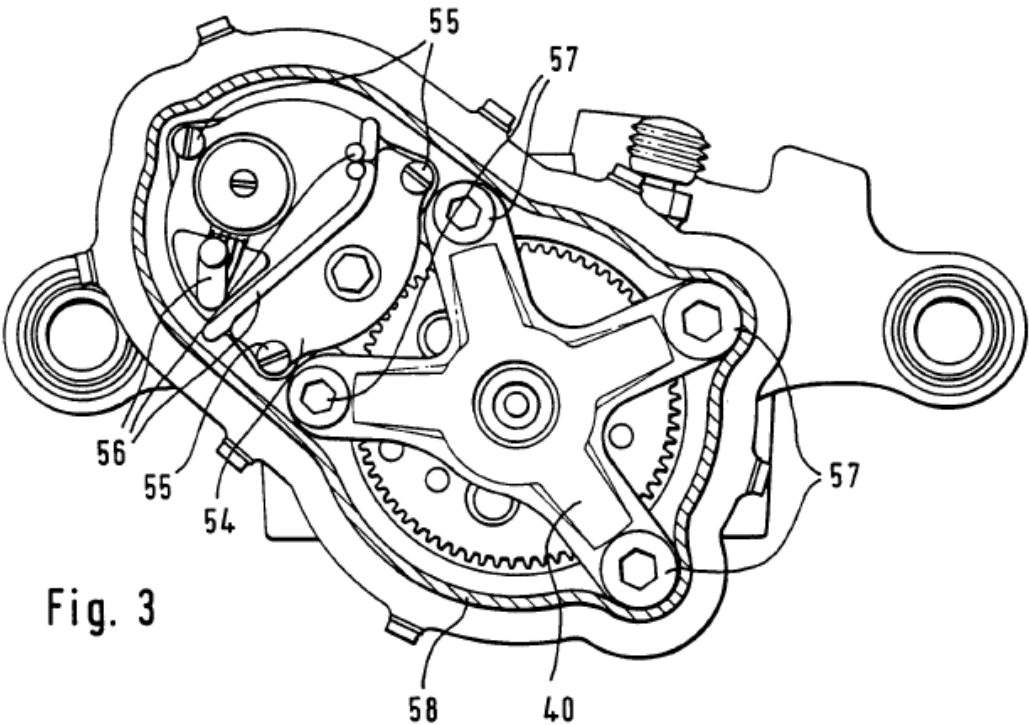


Fig. 3

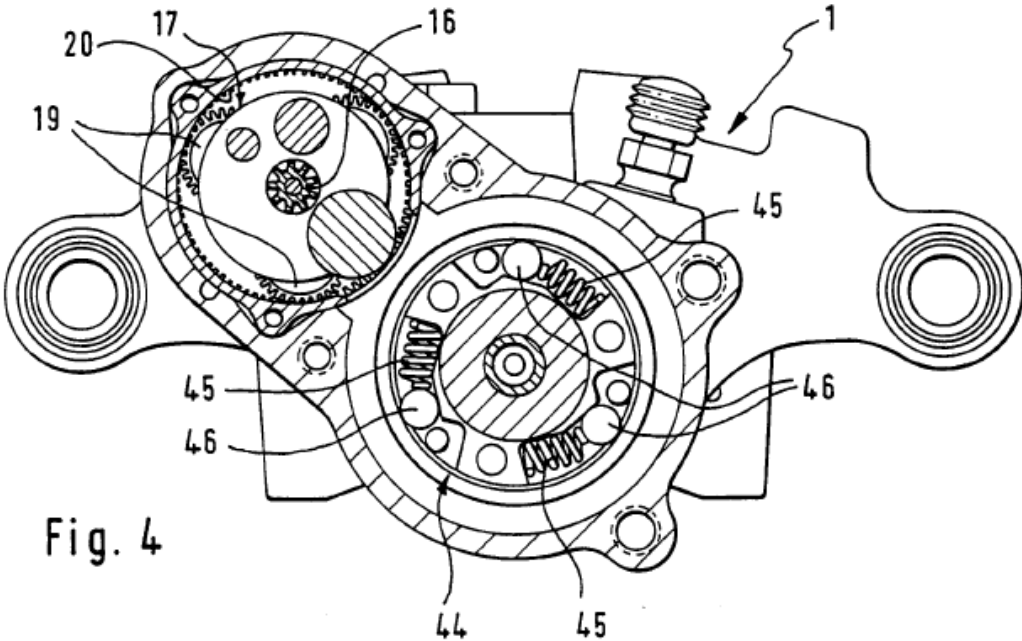
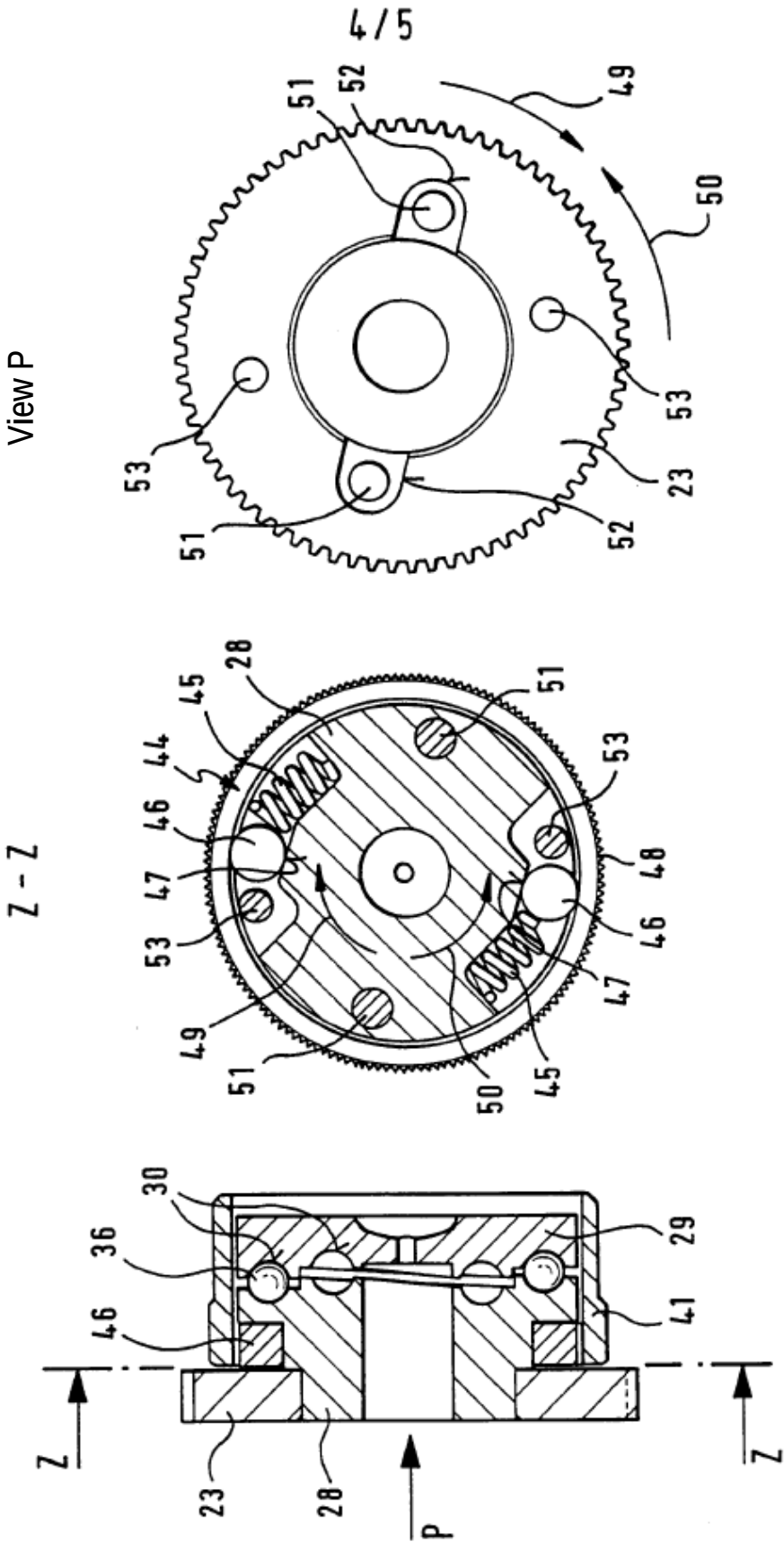


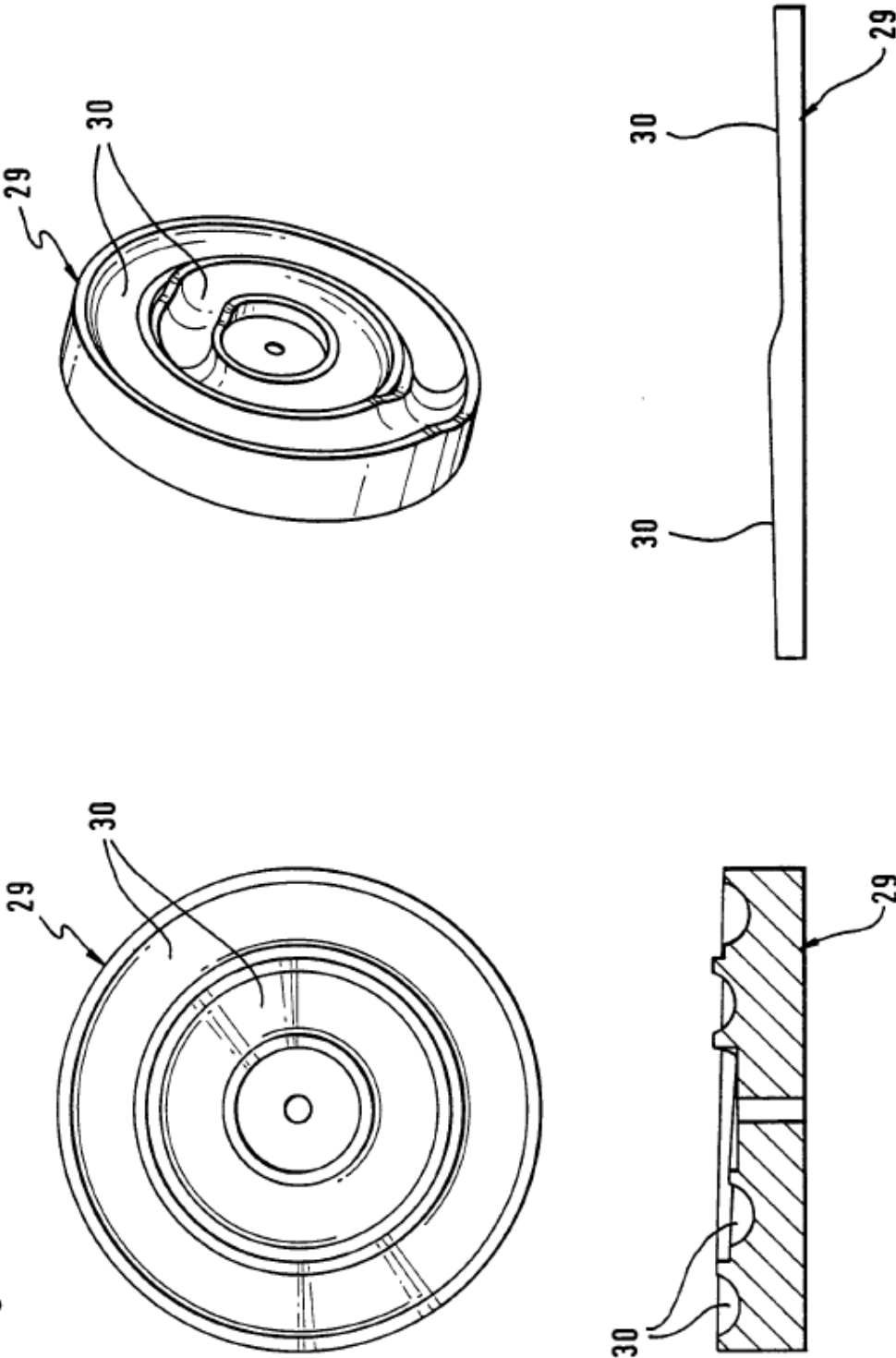
Fig. 4

Fig. 5



5 / 5

Fig. 6



INTERNATIONAL SEARCH REPORT

Inter. Appl. Application No
PCT/EP 00/03342

A. CLASSIFICATION OF SUBJECT MATTER IPC 7 F16D65/21 F16D55/224 B60T13/74		
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) IPC 7 F16D B60T		
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 practical, search terms used) EPO-Internal, WPI Data, PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	FR 2 757 918 A (BOSCH GMBH ROBERT) 3 July 1998 (1998-07-03) the whole document	1,2,4-6, 10 8,9,11, 18
X A	US 4 836 338 A (TAIG ALISTAIR G) 6 June 1989 (1989-06-06) column 3, line 42 -column 4, line 68; figures column 5, line 41 - line 63	1,6,7 19
A	DE 43 12 524 A (BOSCH GMBH ROBERT) 20 October 1994 (1994-10-20) column 3, line 25 -column 4, line 55; figures --- -/-	1,2,7-9
☒ Further documents are listed in the continuation of box C. ☒ Patent family members are listed in annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
Date of the actual completion of the international search 21 July 2000		Date of mailing of the international search report 28/07/2000
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3018		Authorized officer Gertig, I

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inter national Application No
PCT/EP 00/03342

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 96 03301 A (HALASY WIMMER GEORG ;TEVES GMBH ALFRED (DE); BALZ JUERGEN (DE); BI) 8 February 1996 (1996-02-08) page 11, paragraph 2 -page 13, paragraph 1; figure 4 -----	1,7, 14-16
A	DE 196 45 825 A (BRAREN RUDOLF) 2 January 1998 (1998-01-02) -----	

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

page 2 of 2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 00/03342

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2757918 A	03-07-1998	DE 19654729 A JP 10196689 A US 6012556 A	22-07-1999 31-07-1998 11-01-2000
US 4836338 A	06-06-1989	CA 1319329 A DE 68907481 D DE 68907481 T EP 0402421 A JP 3500920 T JP 5063655 B WO 8910495 A US 4877113 A	22-06-1993 12-08-1993 16-12-1993 19-12-1990 28-02-1991 13-09-1993 02-11-1989 31-10-1989
DE 4312524 A	20-10-1994	WO 9424453 A DE 59401951 D EP 0694132 A JP 8510316 T	27-10-1994 10-04-1997 31-01-1996 29-10-1996
WO 9603301 A	08-02-1996	DE 19511287 A CZ 9600594 A DE 59507612 D EP 0728089 A HU 75406 A, B PL 313522 A SK 29496 A US 5829557 A	25-01-1996 17-07-1996 17-02-2000 28-08-1996 28-05-1997 08-07-1996 01-10-1996 03-11-1998
DE 19645825 A	02-01-1998	NONE	



May 23, 2022

Re: WO0061962

To Whom It May Concern:

This is to certify that the above-referenced documents **(482-44732_WO0061962_DE TO EN)** have been translated from German into English by a professional translator on our staff who is skilled in the German language.

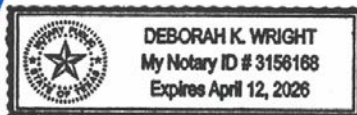
The English translation conforms essentially to the original German except for those words or phrases for which there are no equivalents. Such words or phrases are noted in the translation along with the best English meaning.

All statements made in this declaration of our own knowledge are true, and all statements made on information and belief are believed to be true. We certify these statements under the understanding that willful false statements and the like are punishable by fine or imprisonment, or both (18 U.S.C. 1001). To the best of our knowledge, the aforementioned documents are a true, full, and accurate translation into English of the specified document.

Tonja Shepard
TONJA SHEPARD

Subscribed and sworn to before me on May 23, 2022.

Deborah K. Wright
Deborah K. Wright
Notary Public, State of Texas



My commission expires on April 12, 2026