



(19) FEDERAL REPUBLIC
OF GERMANY



GERMAN
PATENT AND
TRADEMARK OFFICE

(12) Patent
(10) DE 197 32 168 C 1

(51) Int. Cl.⁶:
F 16 D 65/16
B 60 T 17/16
F 16 D 65/21

(21) Application No.: 197 32 168.2-12
(22) Filing Date: July 25, 1997
(43) Disclosure Date: –
(45) Publication Date of
Granted Patent: January 7, 1999

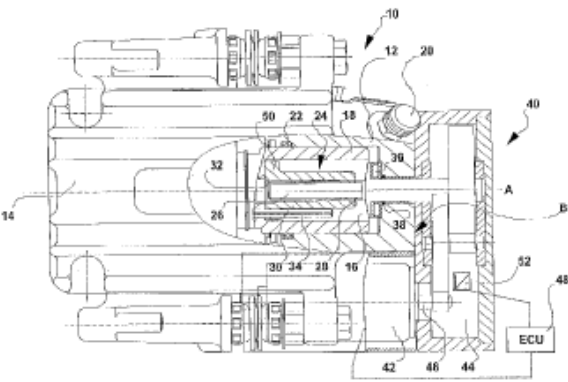
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(54) Hydraulic vehicle brake with locking device and method for operating same

(57) A hydraulic vehicle brake (10) has a hydraulic chamber (16) which sealingly accommodates a brake piston (18) slidable along an axis (A). The brake piston (18) acts upon a friction element and can be moved by means of hydraulic pressure supplied to the hydraulic chamber (16) into an actuating position in which it presses the friction element against a rotor (brake disk, brake drum, etc.). In order to be able to use the vehicle brake (10) as a parking brake, in addition to its function as a hydraulic service brake, a spindle/nut arrangement (24) is provided, which is driven by an electric motor (42) and arranged coaxial to the axis (A) of the brake piston (18), the nut (30) of said arrangement (24) being secured against rotation, and by rotation of the spindle (26) and depending on the direction of rotation, can either be moved into contact with the brake piston (18) or moved linearly away from the brake piston (18) along the axis (A).



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Description

The invention relates to a hydraulic vehicle brake according to the preamble of Claim 1 and to a method for operating same.

A hydraulic vehicle brake according to the preamble of Claim 1 is known from EP 0 729 871 A1, in which a friction pad can be pressed against a brake disk by means of a brake piston using hydraulic fluid, in order to brake its rotation. For this purpose, hydraulic fluid is fed under pressure in a conventional manner into a hydraulic chamber, the boundary wall of which is formed by the brake piston. The pressure in the hydraulic chamber then leads to a displacement of the brake piston and thus of the friction pad towards the brake disk. In order to enable this known vehicle brake to be used not only as a service brake, but also as a hand brake – also referred to as parking brake – it comprises a spindle/nut arrangement to mechanically lock the brake piston in a state in which the friction pad is in engagement with the brake disk.

The underlying task of the invention is to provide a hydraulic vehicle brake that can be used both as a service brake and a parking brake, and the design of which is more compact than that of the vehicle brake known from EP 0 729 871 A1. In addition, the hydraulic vehicle brake to be provided must be cost effectively adaptable to various vehicle models.

According to the invention, this task is solved by a hydraulic vehicle brake which comprises the features of the present invention.

The electric motor which rotates the spindle according to the invention is arranged in such a manner that its output shaft, which extends at a distance from and parallel to the longitudinal center axis of the brake piston, exits the electric motor at the side facing away from the brake piston. This arrangement is space-saving, in particular with respect to the length of the design. The reduction gear connected between the electric motor and the spindle with its reduction ratio on the order of 200:1 enables the use of a small space-saving electric motor.

The electric motor and the reduction gear coupled thereto are designed as a standardized subassembly that can be manipulated independently and combined with various vehicle brakes of one type. The production quantities of such a motor/gear unit increase on this account, which has a favorable effect on the unit cost. Moreover, the motor/gear unit designed as an independent assembly enables attachment to the brake housing in a simple manner in any desired angular position so that spatial restrictions at the installation site of the brake can easily be accommodated by a correspondingly different positioning of the subassembly.

The reduction gear is advantageously designed as a planetary gear, a harmonic drive gear, an eccentric disk gear, or a swash plate gear, because these gear types are compact and, at a small weight, have good efficiency. The reduction gear can be designed to be single-stage, but also multistage, in particular, two-

1 stage. A two-stage gear is particularly advantageous with respect to saving installation space, one stage of
2 which is formed by one of the previously mentioned gear types with a reduction ratio in the range of 50:1,
3 upstream or downstream of which a second stage with a reduction ratio in the range of 4:1 is connected, so
4 that an overall reduction ratio in the range of 200:1 is achieved. In a multistage reduction gear, in particular
5 in a two-stage reduction gear, preferably the stage with the lower reduction ratio is designed as a simple
6 spur gear or, more advantageously, as a belt gear, in particular, as a toothed-belt gear. The use of a belt gear
7 or a toothed-belt gear results in particularly good noise decoupling between the driving electric motor and
8 the remaining parts of the vehicle brake, and thus to a comfortable, low-noise operation.

9 In all embodiments of the vehicle brake according to the invention the spindle/nut arrangement is
10 advantageously designed to be self-locking, generally by a suitable selection of the pitch of a thread which
11 connects the nut with the spindle. A self-locking spindle/nut arrangement allows a locking device to be
12 dispensed with after the vehicle brake has been locked by rotating the spindle.

13 The spindle/nut arrangement is preferably arranged in the hydraulic chamber. This leads to a still more
14 compact design and, moreover, ensures lubrication of the spindle/nut arrangement. According to a further
15 development of this embodiment, the brake piston is designed as a hollow piston open at one side so that
16 the spindle/nut arrangement is at least partially accommodated in the brake piston in a space-saving manner.

17 In preferred embodiments of the vehicle brake according to the invention, the translational movement
18 of the nut, which is caused by rotation of the spindle, is detected by means of a sensor. In this manner, a
19 predetermined small distance between the brake piston and the nut, and thus an optimum function of the
20 hand brake or the emergency brake, respectively, can be ensured. In practical use with the hand brake or
21 the emergency brake, respectively, not actuated, a distance between the nut and the brake piston of
22 approximately 0.5 mm is desired. A distance between the nut and the brake piston, which remains constant
23 at all times, makes it possible, on the one hand, to achieve the desired maximum clamping force of the hand
24 brake within a short period of time, i.e., within the range of approximately 1 second, and, on the other hand,
25 allows the brake piston to return after an actuation in accordance with the so-called "rollback" principle,
26 and to not contact the nut prematurely, which might result in a residual sliding moment between the friction
27 element and the rotor being braked. Those skilled in the art understand the rollback principle as the resetting
28 of the brake piston following a braking operation, which is caused by the resetting force of the elastomeric
29 seal sealing the brake piston, said seal having been elastically deformed during the braking operation. The
30 aforementioned sensor for detecting the translational movement of the nut can, for example, be a sensor
31 that directly detects the travel of the nut. For this purpose, resistive sensors, inductive sensors, or even
32 capacitive sensors are suitable. In order to improve the brake control, in addition to detecting the nut's travel,
33 a force sensor detecting the clamping force can be provided which, for example, can be arranged in or on
34 the friction element, or in the brake piston as well.

1 The sensor that detects the translational movement of the nut can alternatively be a sensor that measures
2 the revolutions of the output shaft of the electric motor driving the spindle. Instead of measuring the
3 revolutions of the output shaft of the electric motor itself, it is also possible to measure the revolutions of a
4 gear in the downstream reduction gear. For measuring the revolutions, a Hall sensor is particularly suitable,
5 which provides a square wave output signal. If such a Hall sensor is aligned, for example, with the teeth of
6 a gear coupled with the output shaft of the electric motor, one revolution of the output shaft will correspond
7 to a certain number of square wave pulses, i.e., to the number of teeth of the gear. With the high resolution
8 of the rotational movement of the output shaft of the electric motor, which is achieved in this manner, the
9 translational movement of the nut, which is caused by the rotation of the spindle, can be detected with a
10 very high accuracy since there is a fixed correlation given by the existing reduction between the revolutions
11 of the electric motor, on the one hand, and the translational movement of the nut, on the other hand.
12 Moreover, a Hall sensor is very well suited for integration into the already mentioned unit consisting of the
13 electric motor and the reduction gear, so that long electrical connections, which are potentially more
14 susceptible to failure between the Hall sensor and the electric motor, are avoided. A control unit controlling
15 the functional sequences of the vehicle brake according to the invention is advantageously also arranged in
16 the motor/gear unit.

17 Since the clamping force of the brake can be deduced from the time characteristics of the current
18 consumption of the electric motor, the above-mentioned travel sensor or the force sensor as well are no
19 longer necessary, if a Hall sensor or another sensor is provided which directly or indirectly measures the
20 revolutions of the output shaft of the electric motor. This means that it is no longer required to install sensors
21 in the vehicle brake housing itself so that electrical connections are no longer necessary between the vehicle
22 brake proper and the unit consisting of the electric motor and the reduction gear. Thus, a mechanical
23 connection between the spindle and the reduction gear exists merely between the motor/gear unit and the
24 vehicle brake proper.

25 The vehicle brake according to the invention is also advantageous in that the spindle/nut arrangement
26 cooperating with the brake piston can be used not only as a locking means, but in that the spindle/nut
27 arrangement also provides a mechanical emergency actuation by means of which the friction pad can be
28 pressed against the rotating rotor of the brake, e.g. in the case of a failure of hydraulic actuation. The vehicle
29 brake according to the invention can also be designed as a disk brake or a drum brake.

30 An advantageous method that enables the use of a generic vehicle brake as a hand brake, in which the
31 spindle is driven by means of an electric motor, will be described below. For this purpose, the spindle is
32 first rotated in a first direction of rotation by the electric motor in such a manner that the nut of the
33 spindle/nut arrangement is moved towards the brake piston. The characteristics of speed and current
34 consumption of the electric motor are measured as a function of time. If a sudden speed drop and an increase

1 in current consumption corresponding to this occur, which means that the nut has come into contact with
2 the brake piston, the values of speed and/or current consumption applicable before the speed drop or the
3 increase in current consumption, respectively, are stored in a memory as reference values. The spindle is
4 further rotated in the first direction of rotation until the continued measurement of the current consumption
5 shows that a previously defined maximum value of the current consumption has been reached, which
6 corresponds to the desired clamping force. As soon as this value is reached the electric motor will be
7 switched off, and the vehicle brake fulfils its locking function.

8 If the hand brake is to be released again, the spindle is rotated counter to the first direction of rotation,
9 and the instantaneous speed and/or the instantaneous current consumption of the electric motor are
10 compared with the corresponding reference value that was previously stored. The point of time at which
11 the instantaneous speed and/or the instantaneous current consumption is identical to the corresponding
12 reference value, which is equivalent to the nut clearing the brake piston, is detected, and the spindle is
13 further rotated counter to the first direction of rotation in order to set a desired distance between the nut and
14 the brake piston, which is mandatory for a satisfactory functioning of the vehicle brake.

15 Setting of a desired distance between the nut and the brake piston can be accomplished, for example,
16 so that the spindle from the point of time onward at which the instantaneous speed and/or the instantaneous
17 current consumption is identical to the corresponding reference value is rotated for a specified period of
18 time counter to the first direction of rotation, with the period of time being specified in consideration of the
19 existing speed reduction of the electric motor so that the desired distance is exactly achieved. Alternatively,
20 the continued rotation of the spindle counter to the first direction of rotation can be performed from said
21 point of time onward until a certain number of revolution count pulses is reached, which for example is
22 detected by the above described Hall sensor. The specific number of revolution count pulses, in turn, is
23 stipulated so that, at a given reduction of the speed of the electric motor, it results in the desired distance
24 between the nut and the brake piston.

25 It is of particular advantage if, in the previously explained method, both the speed and the current
26 consumption of the electric motor are utilized for control because this results in a certain redundancy. In a
27 properly functioning brake, the inflection points in the time characteristics of the speed and the current
28 consumption of the electric motor each must occur nearly simultaneously. Potential malfunctions can thus
29 be detected early by monitoring the two parameters.

30 According to a preferred embodiment of the method for operating the vehicle brake as a hand brake
31 according to the invention, one average value each is formed from several of the speed and/or current
32 consumption reference values stored in the memory in order to compensate for tolerances that can occur
33 due to normal wear as well as temperature fluctuations. Averaging can be done over a certain number of
34 actuations, but also continuously.

1 In a particularly preferred manner, the method according to the invention is developed further in that
2 the maximum current consumption of the electric motor, representing a certain clamping force, is
3 automatically varied as a function of one or several parameters. For example, the clamping force can, in
4 this manner, be automatically adapted to the vehicle load and/or the inclination or steepness, respectively,
5 of the roadway, because it is reasonable that with a level roadway or an empty vehicle a lower clamping
6 force is required for locking.

7 A generic vehicle brake, besides its normal function as a hydraulic service brake, however, is capable
8 of being used not only as a hand brake, but also as an emergency brake. For this purpose, the spindle of the
9 spindle/nut arrangement is driven by the electric motor in a first direction of rotation similarly to the
10 approach in the use as a hand brake in such a manner that the nut is moved towards the brake piston and
11 eventually contacts the brake piston. The spindle is then further rotationally driven in the first direction of
12 rotation by means of which the brake piston is displaced and the friction element is moved into contact with
13 the rotor to be braked. The vehicle deceleration which is thereby achieved is then compared to a specified
14 minimum deceleration. For this purpose, e.g. the vehicle deceleration which is determined anyway in an
15 anti-slip brake control system (ABS system), which is installed as standard in most road vehicles today, can
16 be utilized, while the specified minimum deceleration can, e.g. be a statutorily specified minimum
17 deceleration. The spindle, with the aid of an electronic control unit which can be combined e.g. with the
18 control unit of the brake pressure regulating system, is then rotationally driven depending on the result of
19 the previously performed comparison between the instantaneous vehicle deceleration and the specified
20 minimum deceleration in the first direction of rotation or opposite this in a controlled manner so that, on
21 the one hand, the value does not drop below the specified minimum deceleration and, on the other hand,
22 the vehicle wheels do not lock. In an emergency situation, for example, a failure of the hydraulic actuation
23 of the vehicle brake, a vehicle can be brought to a standstill in this manner with at least the specified
24 minimum deceleration. Such a metered operation of the vehicle brake according to the invention can also
25 be used for facilitating hill climbing in that a rolling back of the vehicle is initially prevented by the already
26 described locking function of the brake (so-called "hillholder" function) and in that upon starting, the brake
27 is released slowly and controlled in a manner corresponding to the velocity increase of the vehicle.

28 According to a preferred further development of the previously described method a control device, e.g.
29 the previously mentioned control unit, which cooperates with the vehicle brake(s) enables the execution of
30 the method in a vehicle brake only if both the vehicle wheel associated with this vehicle brake as well as
31 the diagonally opposite vehicle wheel are rotating. If two diagonally opposite vehicle wheels are rotating,
32 this means that the vehicle is moving. The previously mentioned control is necessary, for example, to enable
33 a function check of the hand brake in a brake test stand wherein the wheels of one vehicle axle are
34 rotationally driven.

One embodiment of the vehicle brake according to the invention together with a method for operating the vehicle brake will be described in more detail below with reference to the attached schematic figures, in which:

Figure 1 shows the partially broken away plan view of a hydraulic vehicle brake according to the invention with locking and emergency braking function; and

Figures 2A-2C show diagrams illustrating a method for operating the vehicle brake shown in **Figure 1** as a hand brake.

The vehicle brake shown in **Figure 1** and generally identified by **10** is designed here as a floating caliper disk brake, which in a known manner comprises a housing **12** on which a floating caliper **14** is integrally formed, which straddles a brake disk not shown here.

A hydraulic chamber **16**, which sealingly accommodates a brake piston **18** slidable along its longitudinal center axis A, is situated in housing **12**. For supplying the hydraulic chamber **16** with hydraulic fluid, a connection **20** is provided at the outside of the vehicle brake **10**, which is connected to a brake pressure generator unit not shown here, e.g. a brake booster/master cylinder unit which can be actuated via a brake pedal. Upon actuation of the brake pressure generator unit, the hydraulic fluid in the hydraulic chamber **16** is pressurized so that the brake piston **18** moves to the left along the axis A in order to bring friction pads (not shown) into frictional engagement with the brake disk (also not shown). Upon termination of the actuation of the brake pressure generator unit, hydraulic fluid can flow back from the hydraulic chamber **16** towards the brake pressure generator unit so that the brake piston **18** moves back along the axis A in order to disengage the friction pads from the brake disk. A radially circumferential sealing element identified by **22**, which seals the brake piston **18** in the hydraulic chamber **16**, aids in the resetting of the brake piston **18** in that it subjects the brake piston **18** to an elastic resetting force according to the rollback principle. The function of the disk brake **10** that has just been described, which is caused by hydraulic actuation as well as its further structural design, is well known to those skilled in the art and therefore need not be described in more detail.

In order to enable the shown vehicle brake **10** to not only fulfil the previously explained function of a hydraulic service brake, but also to be used as a parking or hand brake, a spindle/nut arrangement generally identified by **24** is provided, which comprises a spindle **26** arranged coaxial to the axis A and having a male thread **28** and an essentially sleeve-shaped nut **30**, which is provided with a female thread **32** matching the male thread **28**.

The purpose of the spindle/nut arrangement **24** is to convert a rotational movement of the spindle **26** into a translational movement of the nut **30** which, to this end, is prevented from rotation by means of a guide pin **34** engaging therewith, secured to the brake piston **18** and projecting therefrom parallel to the axis A. As can clearly be seen from **Figure 1**, the brake piston **18** is designed as a hollow piston open on

its right side, and the spindle/nut arrangement **24** is mostly accommodated in the hollow brake piston **18** and thus in the hydraulic chamber **16**. The spindle **26** is supported in the housing **12** and rotatably supported by means of a bearing **36**. A shaft seal **38** seals the spindle **26** in the housing **12** in order to ensure tightness of the hydraulic chamber **16**.

The rotational drive of the spindle **26** is provided by a unit generally identified by **40**, which consists of an electric motor **42** and a reduction gear **44** coupled thereto, which in turn is functionally coupled to the end section of the spindle **26** protruding from the housing **12**. The reduction gear **44** has an overall reduction ratio of 200:1 so that a relatively small electric motor **42** may be chosen and nevertheless a sufficiently high clamping force be ensured. The unit **40** of electric motor **42** and reduction gear **44** is a subassembly which can be handled separately and which can be combined not only with the illustrated disk brake **10** but also with other disk brakes. The electric motor **42** is arranged in such a manner that its output shaft **46** extends parallel to the axis A and exits the housing of the electric motor **42** at the side facing away from the brake piston **18**. This arrangement is particularly space-saving and, in addition, allows the installation of the unit **40** on the housing **12** of the vehicle brake **10** relative to the surface B in any desired angular position. An adaptation to specified restrictions, which may result from chassis components located near the vehicle brake **10**, can therefore be made in a simple manner.

The brake locking function of the illustrated vehicle brake **10** will now be described: For locking, the electric motor **42** is first driven by an electronic control unit **48** so that its output shaft **46** rotates in a first direction. The rotation of the output shaft **46** is transferred via the reduction gear **44** to the spindle **26**, which therefore also rotates in a first direction in which an extension of the spindle/nut arrangement **24** is produced by loosening the nut **30**. With reference to **Figure 1**, the nut **30** is thus moved linearly to the left along the axis A, and with its annular flange **50** comes into contact with the bottom of the brake piston **18**. With a continued rotation of the spindle **26** in the first direction of rotation the nut **30** forces the brake piston **18** to the left so that the latter forces the friction pad (not shown) against the brake disk (also not shown). When this condition is reached, the electric motor **42** can be switched off. Owing to the fact that the mating threads of the two threads **28** and **32** are self-locking, the achieved position of the spindle/nut arrangement **24** is maintained even after the electric motor **42** has been switched off.

For releasing the parking brake, the electric motor **42** is driven by the control unit **48** so that its output shaft **46** rotates in the opposite direction. This rotation is in turn transferred to the spindle **26** so that it also rotates opposite to the first direction of rotation and is screwed into the nut **30**, whereby the nut **30** is moved linearly to the right along the axis A. The brake piston **18** is thus relieved of pressure and can subsequently also return to the right so that the friction pads disengage from brake disk.

In order to enable the locked vehicle brake **10** to be released also without the motor/gear unit **40**, for example, the spindle **26** or the output shaft **46** of the electric motor **42** as well can be accessible from the

outside so that, by means of an attachable crank, the nut **30** can be moved to the right by a corresponding rotation. Such manual resetting of the nut **30** may also be required when the friction pads are changed.

In order to ensure optimal functioning of the vehicle brake **10**, a distance X between the nut **30** and the bottom of the brake piston **18** must not exceed a certain value in the non-actuated condition of the vehicle brake **10**. In practical use, a distance X of 0.5 mm is considered optimal. Maintaining this distance X is required, on the one hand, to achieve the desired maximum clamping force of the hand brake in as short as possible of a time period, i.e., within about 1 second. On the other hand, resetting of the brake piston after a hydraulic service braking operation should not be impeded by the brake piston **18** prematurely contacting the nut **30**, since otherwise a residual sliding moment between the rotating brake disk and the friction pads might result.

A method for operating the vehicle brake **10** as a hand brake will be described hereinbelow with reference to **Figure 2**, by means of which an exact adjustment of the distance X is ensured.

Figure 2A shows the speed n of the output shaft **46** of the electric motor **42** as a function of time; in **Figure 2B** the current consumption I of the electric motor **42** as a function of time, and in **Figure 2C** the clamping force F of the vehicle brake **10** as a function of time is plotted, with the time scale in **Figures 2A**, **2B**, and **2C** each being identical.

For locking the vehicle brake **10** by means of the spindle/nut arrangement **24**, the nut **30** must first be moved into contact with the brake piston **18** by means of rotating the spindle **26** driven by the electric motor **42**. From **Figures 2A** to **2C**, it can be seen that from the point of time, i.e., from the point of time at which the control unit **48** receives the command to mechanically lock the vehicle brake **10**, to the point of time t_1 , the electric motor **42** is operated at a nearly constant high speed and a nearly constant low current consumption because no clamping force need yet be applied.

When, at time t_1 , the nut **30** comes into contact with the bottom of the brake piston **18**, this can be determined by an inflection point in the trend of the speed n as well as the current consumption I. The values for speed and current consumption applicable before the inflection point are stored as reference values n_0 and I_0 in a memory of the control unit **48**. As can be seen from the diagrams, the speed n of the electric motor **42** decreases rapidly from the time t_1 and, the current consumption I together with the clamping force F increases distinctly until at time t_2 the desired clamping force $F_{\max}$ is reached. The electric motor **42** is now switched off and, accordingly, the speed n and the current I assume the value 0. The clamping force remains at the value $F_{\max}$ because of the self-locking design of the spindle/nut arrangement **24**.

If the parking brake is released later, namely at time t_3 , by switching on the electric motor **42**, this can first be seen by a switch-on surge pulse in the trend of the current consumption I, upon which the latter decreases nearly proportionally with the clamping force F, while the speed n simultaneously increases

1 accordingly. During this phase the speed n and the current I are continuously compared with the reference
 2 values n_0 and I_0 that were previously stored in the control unit until at time t_4 the speed n and the current I
 3 are equal to the reference values n_0 and I_0 , respectively. This means that the nut **30** starts to no longer be in
 4 contact with the bottom of the brake piston **18**, i.e., no clamping force F is present. For this reason, a nearly
 5 constant low current I and a nearly constant high speed n will be obtained again from the point of time t_4
 6 onward until at time t_5 the desired distance X between the nut **30** and the bottom of the brake piston **18** is
 7 reached, whereupon the electric motor **42** is switched off.

8 Because of the known reduction ratio between the output shaft **46** of the electric motor **42** and the
 9 spindle **26** the desired distance X can be set simply by appropriately selecting the time interval between
 10 points of time t_4 and t_5 . In the illustrated embodiment, however, a Hall sensor **52** is used, which measures
 11 the revolutions per time of the output shaft **46** of the electric motor **42**. This Hall sensor **52** is directed
 12 towards an output pinion not specifically shown, which is coupled secured against rotation with the free
 13 end of the output shaft **46** of the electric motor **42**, and provides a number of square wave pulses per
 14 revolution of the output pinion, said number corresponding to the number of teeth of the output pinion and,
 15 which are processed as revolution count pulses by the control unit **48**. Due to the fact that the correlation
 16 between the rotational movement of the output shaft **46** and the translational movement of the nut **30** at a
 17 given reduction is known, the desired distance X can be adjusted very precisely by specifying a certain
 18 number of revolution count pulses. To that end, starting with the point of time t_4 , all that need be done is to
 19 add up the predetermined number of revolution count pulses in a counter, and the electric motor **42** is
 20 switched off upon reaching the predetermined number.

Claims

1. A hydraulic vehicle brake (**10**) with a housing (**12**) and a brake piston (**18**) arranged therein, which
 acts on a friction element and which, by means of hydraulic pressure that can be supplied to a hydraulic
 chamber (**16**) cooperating with the brake piston (**18**), is movable into an actuating position in which it
 forces the friction element against a rotor of the vehicle brake, and having a spindle/nut arrangement
 (**24**) coaxial to the center axis (A) of the brake piston (**18**), driven by an electric motor (**42**) for
 mechanical locking of the brake piston (**18**) in the actuation position, the nut (**30**) of which is secured
 against rotation and, by rotation of the spindle (**26**), is moved in a translational movement along axis
 (A) depending on the direction of rotation either against the brake piston (**18**) or away from the brake
 piston (**18**), **characterized in that**

– the output shaft (**46**) of electric motor (**42**) extends at a lateral distance parallel to axis (A) and
 exits from the electric motor (**42**) on the side facing away from the brake piston (**18**),

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- a reduction gear (44) with a reduction ratio on the order of 200:1 is connected between the electric motor (42) and the spindle (26) and
 - the electric motor (42) and the reduction gear (44) are designed as a separately manipulable subassembly (40).
2. The vehicle brake according to claim 1, characterized in that the subassembly (40) can be mounted on the housing (12) in any angular position relative to the surface (B) thereof.
 3. The vehicle brake according to claim 1 or 2, characterized in that the spindle/nut arrangement (24) is self-locking.
 4. The vehicle brake according to one of the claims 1 to 3, characterized in that the spindle/nut arrangement (24) is arranged in the hydraulic chamber (16), especially in the brake piston (18) formed as a hollow piston open on one side.
 5. The vehicle brake according to one of the preceding claims, characterized in that the reduction gear (44) is a planetary gear, a harmonic drive, an eccentric disk gear or a swash plate gear.
 6. The vehicle brake according to one of the preceding claims, characterized in that the reduction gear (44) is designed multistage, especially two-stage and that a gear stage is formed as a belt drive, especially a toothed-belt gear.
 7. The vehicle brake according to one of the preceding claims, characterized in that the translational movement of nut the (30) is detected by means of a sensor.
 8. Vehicle brake according to claim 7, characterized in that the sensor is a Hall sensor (52) that measures the revolutions of the output shaft (46) of the electric motor (42) that rotates the spindle (26).
 9. A method for operating a hydraulic vehicle brake (10) as a parking brake, which has a brake piston (18) that acts on a friction element and, by means of hydraulic pressure that can be supplied to a hydraulic chamber (16) cooperating with the brake piston (18), is movable into an actuation position in which it forces the friction element against a rotor of the vehicle brake, and a spindle/nut arrangement (24) coaxial to the center axis (A) of the brake piston (18) driven by an electric motor (42) for mechanical locking of the brake piston (18) in the actuation position, the nut (30) of which is secured against rotation and moved in translation along the axis (A) by rotation of the spindle (26), depending on the direction of rotation either against the brake piston (18) or away from the brake piston (18), comprising the steps of:
 - rotating the spindle (26) by means of the electric motor (42) in a first direction of rotation so that the nut (30) of the spindle/nut arrangement (24) is moved toward the brake piston (18), characterized by the steps of
 - measuring a speed n and current consumption I of the electric motor (42) as a function of time,

- detecting a sudden speed reduction and a corresponding rise in current consumption and storage of the previously applicable value for speed and/or current consumption in a memory as reference value(s) n_0 or I_0 ,
- further rotating the spindle (26) in the first direction of rotation until a stipulated maximum current consumption $I_{\max}$ is reached, which corresponds to a stipulated braking force, and subsequent switching off of the electric motor,
- rotating the spindle (26) in a second direction of rotation opposite the first direction of rotation and comparing the instantaneous speed n and/or the instantaneous current consumption I with the reference value n_0 or I_0 ,
- detecting a time (t_4) at which $n = n_0$ and/or $I = I_0$ and
- further rotating the spindle (26) in the second direction of rotation to set a stipulated distance X between the nut (30) and the brake piston (18).

10. The method according to claim 9, characterized in that additional rotation of the spindle (26) in the second direction of rotation from time (t_4) occurs for a fixed time corresponding to the desired distance X .

11. The method according to claim 9, characterized in that further rotation of the spindle (26) in the second direction of rotation occurs from time (t_4) until a specified number of revolution count pulses is reached corresponding to the desired distance X .

12. The method according to one of the claims 9 to 11, characterized in that a mean value n_{0m} and/or I_{0m} is formed from the series of reference values n_0 and/or I_0 stored in the memory.

13. The method according to one of the claims 9 to 12, characterized in that the established maximum current consumption $I_{\max}$ is varied automatically as a function of parameters, especially as a function of the vehicle load and/or steepness of the road surface.

14. A method for operating a hydraulic vehicle brake (10) as an emergency brake, which has a brake piston (18) that acts on a friction element and, by means of hydraulic pressure, which can be supplied to a hydraulic chamber (16) cooperating with the brake piston (18), is movable into an actuating position in which it forces the friction element against a rotor of the vehicle brake, and a spindle/nut arrangement (24) coaxial to the center axis (A) of the brake piston (18) driven by an electric motor (42) for mechanical locking of the brake piston (18) in the actuating position, the nut (30) of which is secured against rotation and moved in translation along the axis (A) by rotation of a spindle (26), depending on the direction of rotation either against the brake piston (18) or away from the brake piston (18), characterized by the steps of:

- rotating the spindle (26) by means of the electric motor (42) in a first direction of rotation so that the nut (30) of the spindle/nut arrangement (24) stops against the brake piston (18),

- further rotating the spindle (26) in the first direction of rotation and comparing the achieved vehicle deceleration with an established minimum deceleration,
- controlling the rotation of the spindle (26) in the first direction of rotation or opposite this direction, depending on the result of the previously performed comparison, so that the established minimum deceleration is not undershot.

15. The method according to claim 14, characterized in that a control device (control device 48) cooperating with the vehicle brake or brakes enables execution of the method only if the two vehicle wheels assigned to two diagonally opposite vehicle brakes are in rotation.

2 pages of drawings follow

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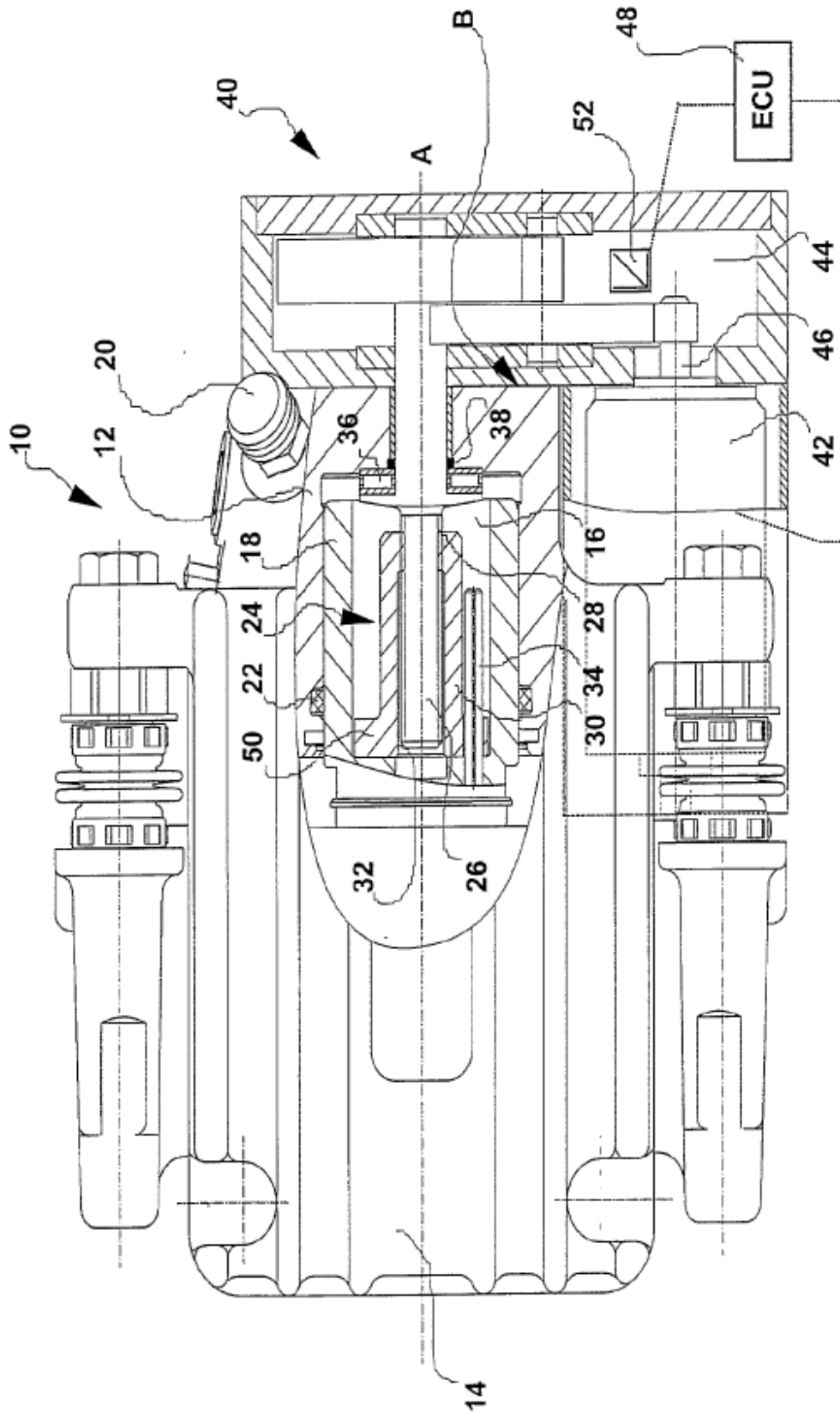


Fig. 1

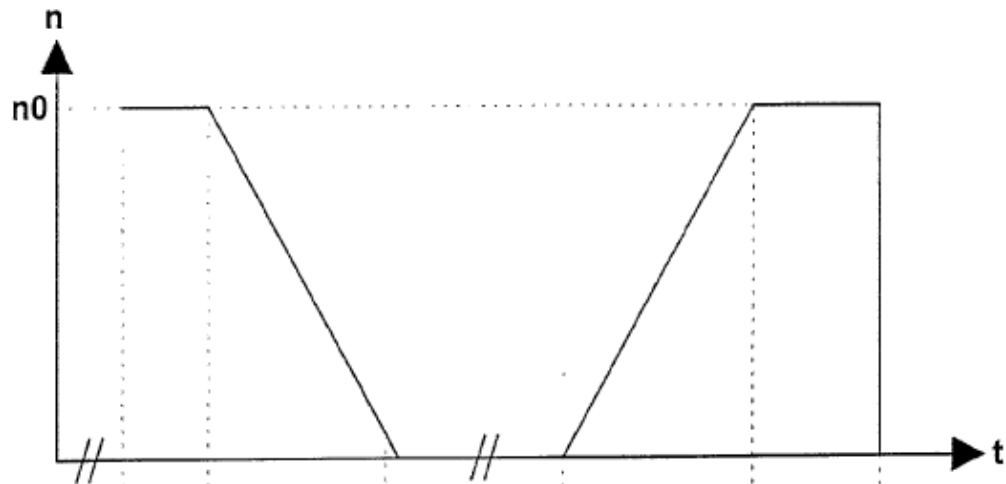


Fig. 2A

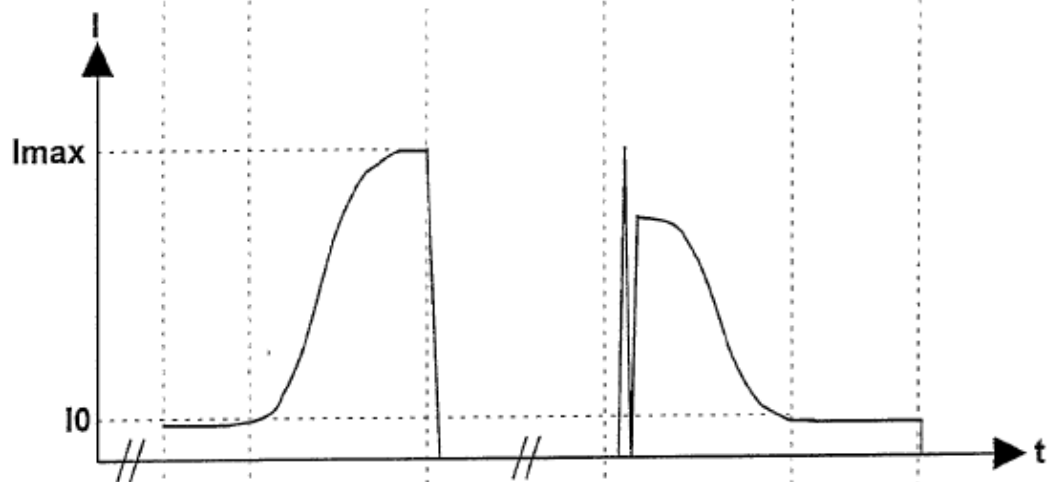


Fig. 2B

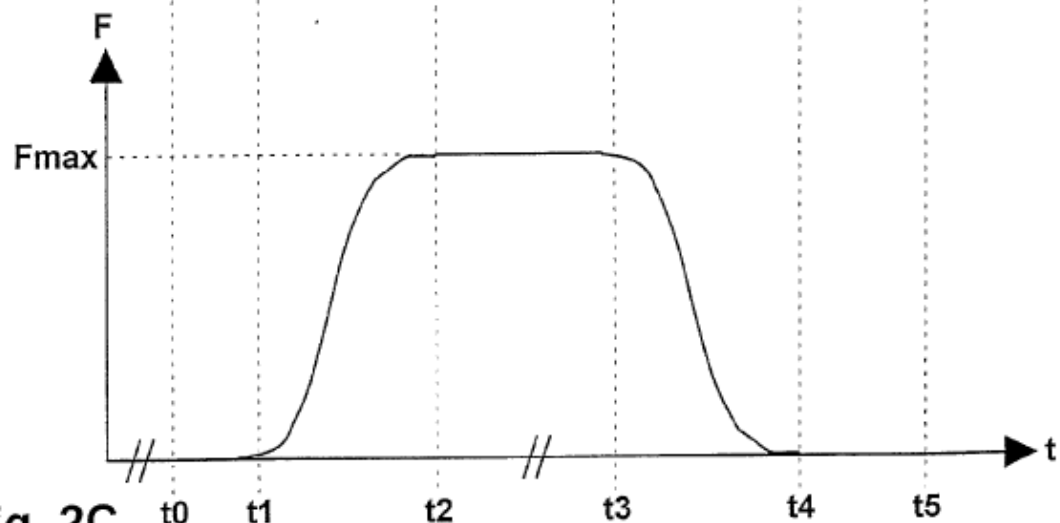


Fig. 2C



May 18, 2022

Re: DE19732168__D4

To Whom It May Concern:

This is to certify that the above-referenced documents **(482-44729_DE19732168__D4__DE into EN)** have been translated from German into English by a professional translator on our staff who is skilled in the German language.

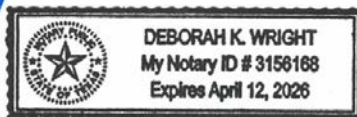
The English translation conforms essentially to the original German except for those words or phrases for which there are no equivalents. Such words or phrases are noted in the translation along with the best English meaning.

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 18, 2022.

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



My commission expires on April 12, 2026