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(54) Title: BRAKE ACTUATOR FOR A VEHICLE, IN PARTICULAR COMMERCIAL VEHICLE

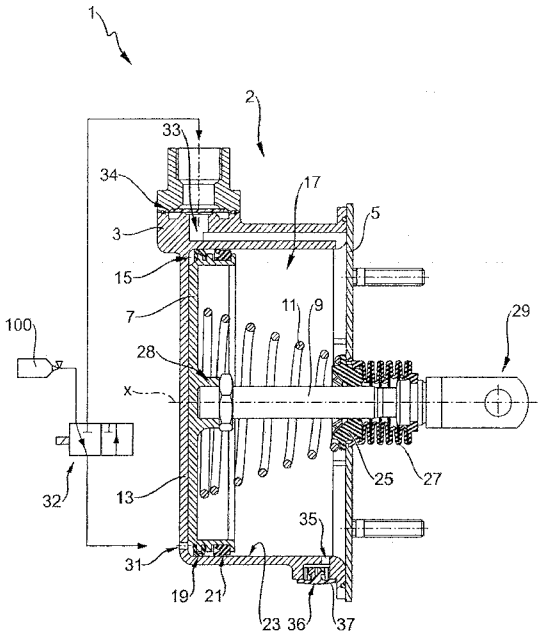

FIG.

(57) Abstract: The invention relates to a brake actuator (1) for a vehicle, in particular commercial vehicle, the brake actuator comprising an actuator housing (3) having a piston chamber (15,17) and a first fluid opening (31) for providing pressurized fluid to the piston chamber from a pressure source (100), a push rod (9) mounted inside the actuator housing (3), the push rod (9) having a mounting interface (29) for coupling the push rod (9) to a brake mechanism and being configured for reciprocating movement between a retained position and an extended position, and a piston (7) that is coupled to the push rod (9). In particular, the invention suggests that the piston (7) sealingly abuts against the actuator housing (3) and divides the piston chamber into a pressure chamber (15) and a non-pressure chamber (17), the first fluid opening (31) being in fluid communication with the pressure chamber (15) such that pressurized fluid entering the pressure chamber (15) through the first fluid opening (31) acts directly on the piston (7).

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[Continued on next page]

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Brake actuator for a vehicle, in particular commercial vehicle

The invention relates to a brake actuator for a vehicle, in particular commercial vehicle, the brake actuator comprising an actuator housing having a piston chamber and a first fluid opening for providing pressurized fluid to the piston chamber from a pressure source, a push rod mounted inside the housing, the push rod having a mounting interface for coupling the push rod to a brake mechanism and being configured for reciprocating movement between a retained position and an extended position, and a piston that is coupled to the push rod.

Brake actuators of the aforementioned type are widely used in the vehicle industry to provide braking force for brake mechanisms. Under commercial vehicle, in particular busses, cargo vehicles such as trucks and other heavy duty vehicles are to be understood. The aforementioned brake actuators operate as a function of pressurized fluid being provided from a pressure source to the brake actuator. By pressurizing the piston chamber with pressurized fluid, the piston is moved from its retained position towards an extended position in which braking force is transmitted via the push rod to an externally coupled brake mechanism such as a brake caliper of a disk brake or a drum brake, for instance.

Conventional brake actuators and in particular service brake actuators comprise a diaphragm which is sealingly mounted to the actuator housing and together with corresponding walls of the housing defines a pressure chamber. The first fluid opening opens into said pressure chamber and the pressurized fluid entering the pressure chamber is effective to deform the diaphragm, thereby expanding the volume of the pressure chamber. The diaphragm is then pushed

against the adjacently mounted piston and push rod, which leads to the movement of the push rod and transmission of the braking force.

While these so-called diaphragm-type brake actuators generally function satisfactorily, it has been found that in certain circumstances, fluid leakage between the actuator housing and the diaphragm may occur. In order to reliably prevent this, high effort must be undertaken to ensure the sealing between the diaphragm and the actuator housing such that pressurized fluid is exclusively contained in the pressure chamber.

Furthermore, it has been found that due to its flexible nature, the diaphragm does not always form a constant contact surface with the adjacent piston along the entire travel path of the piston/push rod when being deformed by pressurized fluid. The variation in contact surface and geometry of the diaphragm influences the transmission function between the input of pressurized fluid on the one hand side and the force transmitted by the push rod on the other hand side such that the forced transmission is not in every state exactly linear. For modern vehicles, reliable brake control and a precise predictability of the generated braking force as a function of the pressure input are increasingly important aspects.

It has therefore been an object of the invention to provide an improved brake actuator that overcomes the aforementioned deficiencies as much as possible. In particular, it has been an object of the invention to provide a brake actuator that improves linearity of the force transmission, preferably while minimizing the risk of leakage of pressurized fluid out of the actuator housing. In the least, it has been an object of the invention to provide an alternative brake actuator.

The invention consequently suggests a brake actuator according to claim 1. The invention in particular suggests a brake actuator of the initially mentioned type wherein the piston sealingly abuts against the actuator housing and divides the piston chamber into a pressure chamber and a non-pressure chamber, the first fluid opening being in fluid communication with the pressure chamber such that

pressurized fluid entering the pressure chamber through the first fluid opening acts directly on the piston. The inventive brake actuator preferably is a service brake actuator.

The invention is based upon the realization that by removing the diaphragm from the service portion of a conventional brake actuator, the issue of leakage of pressurized fluid out of the actuator housing can reliably be prevented. At the same time, the sealing function can be as reliably performed by an internal sealing in between the piston and the actuator housing. Furthermore, since the piston is directly in contact with the pressurized fluid, and is slidingly movable inside the actuator housing, the contact surface between the pressurized fluid and the piston is constant such that linear force transmission as a function of the input pressure is reliably provided.

In a preferred embodiment, the piston comprises a sealing element abutting sealingly against the actuator housing, and a separate sliding bearing, the sliding bearing having at least one bearing element protruding radially from the piston and contacting the actuator housing. The bearing element preferably is a single bearing ring. In alternative preferred embodiments, the at least one bearing element may however also be formed as a plurality of bearing elements distributed over the circumference of the piston. Particularly preferred, the at least one bearing element has a convex surface that is elastically deformed when in contact with the actuator housing. A particular advantage of this configuration is that the convex surface of the bearing element ensures a low contact surface, depending on the amount of elastic deformation. At the same time, the contact surface is still reliably provided when the piston is slightly tilted sideways with respect to its normal sliding direction between the retained position and the extended position.

Preferably, the sealing element projects radially outwards from the piston such that the piston can pivot with respect to the actuator housing. The piston is thus configured as a rocking piston which significantly improves the articulation of the piston while at the same time reducing the risk of mechanical damage to the piston or the actuator housing.

In a further preferred embodiment, the brake actuator comprises a second fluid opening that is in fluid communication with the non-pressure chamber. The second fluid opening is preferably configured for providing fluid to the non-pressure chamber when the piston is moved towards the retained position. Hereby an unwanted build-up of negative pressure inside the non-pressure chamber is prevented. Alternatively or additionally, the second fluid opening is preferably configured to allow venting of the non-pressure chamber when moving the piston towards the extended position in order to prevent build-up of unwanted residual positive pressure inside the non-pressure chamber.

The brake actuator preferentially comprises a manifold valve that is in fluid communication with the first fluid opening, the second fluid opening, and a pressure source, and configured to supply pressurized fluid from the pressure source to the first fluid opening when the pressure source is engaged, and redirect pressurized fluid from the first fluid opening to the second fluid opening when the pressure source is released. Herein, "engaged" means that pressurized fluid is being provided from the pressure source towards the manifold valve, and "released" is understood to mean that no pressurized fluid is being provided from the pressurized source towards the first fluid opening, in particular because of the operation of the manifold valve. The benefit of having the manifold redirect pressurized fluid from the first fluid opening to the second fluid opening is that positive fluid pressure can be maintained inside also the non-pressure chamber of the brake actuator housing. The redirection usually takes place when the operator of a vehicle does not provide a braking signal or has ended providing a braking signal, e.g. by taking the foot off the brake pedal. The pressure source is released, and the pressurized fluid in the pressure chamber can escape through the first fluid opening towards the second fluid opening which allows the piston to return from its extended position towards the retained position.

In a further preferred embodiment, the brake actuator comprises a quick return valve that is associated with the second fluid opening. The quick return valve is

configured to close and open, i.e. establish, fluid communication with the associated non-pressure chamber.

In a further preferred embodiment, the brake actuator comprises a third fluid opening that is in fluid communication with the non-pressure chamber, and an exhaust check valve associated with the third fluid opening, wherein the exhaust check valve is operable between a closed state and an open state. In the closed state, the exhaust check valve prevents fluid passage through the third fluid opening, while in the open state, fluid can pass by the exhaust check valve in the direction of the pressure radiant. Particularly preferred, the exhaust valve is configured such that pressurized fluid can exit the non-pressure chamber but cannot enter the non-pressure chamber.

Preferably, the exhaust check valve has a valve element that is biased with a pre-load towards the closed state such that the pre-load must be overcome in order to move the valve element from the closed state towards the open state. The bias towards the closed position ensures that the pressure inside the non-pressure chamber is always slightly above ambient pressure, as a certain predefined pressure must be applied to the valve element from within the non-pressure chamber in order to overcome the pre-load. The valve element may comprise or consist of an elastically deformable membrane or flap, for example.

In a further preferred embodiment, the brake actuator comprises a return spring that is mounted inside the actuator housing, in particular inside the non-pressure chamber, and is effective to move the piston towards its retained position.

In a further preferred embodiment, the brake actuator comprises a seal bushing that is mounted to the actuator housing on the side of the non-pressure chamber, wherein the seal bushing sealingly and slidably supports the push rod. Preferably, the seal bushing comprises a gaiter extending outwards of the actuator housing in the direction of the push rod, covering and sealingly abutting against the push rod. The gaiter is preferably effective to seal the actuator

housing against entry of fluid and debris. The seal bushing preferably consists at least in part of a thermoplastic polymer, preferably a polyacetal polymer, preferably an acetal homopolymer. Polyacetal is also referred to as polyoxymethylene (POM).

For a more complete understanding of the invention, the invention will now be described in more detail with reference to the accompanying drawing. The detailed description will illustrate and describe or is considered as a preferred embodiment of the invention. It should of course be understood that various modifications and changes in form or detail could readily be made without departing from the scope of the invention. It is therefore intended that the invention may not be limited to the exact form and detail shown and described herein, nor to anything less than the whole of the invention disclosed herein and disclaimed hereinafter. Further, the features described in the description, the drawing and the claims disclosing the invention may be essential for the invention considered alone or in combination. In particular, any reference signs in the claims shall not be construed as limiting the scope of the invention. The word "comprising" does not exclude other elements or steps. The wording "a" or "an" does not exclude a plurality.

In brief, the figure to which reference will be made shows:

a schematic cross-sectional view of a brake actuator according to a preferred embodiment.

The accompanying figure shows a brake actuator 1 according to a preferred embodiment of the invention. The brake actuator 1 is a service brake actuator and thus consists of a service portion 2. In other types of actuators which are understood to fall under the scope of the invention, the inventive actuator 1 would comprise a service portion in addition to other functional portions such as a spring portion for emergency and park brake functions.

The brake actuator 1 comprises an actuator housing 3. The actuator housing 3 is closed by a housing cover 5.

A piston 7 is mounted inside the actuator housing 3 and configured to reciprocatingly move between a retained position (shown in the figure) and an extended position. In order to reach the extended position, the piston 7 is moved along axis X to the right in the orientation according to the figure.

The piston 7 is coupled to a push rod 9 configured to transfer the movement of the piston 7 to an externally coupled braking mechanism.

A return spring 11 is positioned inside the actuator housing 3 and effective to push the piston 7 and push rod 8 towards the retained position.

In the retained position, the piston 7 abuts against a housing base 13 of the actuator housing 3.

The actuator housing 3 contains a piston chamber which is divided by the piston 7 into a pressure chamber 15 and a non-pressure chamber 17. In order to do so, the piston 7 abuts sealingly with a sealing element 21 against a chamber wall 23 of the actuator housing 13.

The piston 7 is guided by a sliding bearing 19 having an annular bearing element that is convexly shaped and in contact with the chamber wall 23 of the actuator housing. Preferably, the sliding bearing 19 is elastically deformed when in contact with the chamber wall 23.

Additionally, the piston 7 is slidably held by a seal bushing 25 that is mounted to the housing cover 5 of the brake actuator 1. The seal bushing 25 is coupled with a gaiter 27 that extends externally to the actuator housing 3 protects the actuator 1 from e.g. water or debris.

The push rod 9 comprises in one end portion a connection interface 28 which is coupled with the piston 7, preferably by a thread connection. On the opposite

end portion, the push rod 9 comprises an external connection interface 29 for coupling the push rod 9 to a brake mechanism.

For operation of the brake actuator 1, the actuator housing 3 comprises a first fluid opening 31 which is in fluid communication with the pressure chamber 15 and connectable to a pressure source 100 of a vehicle.

The brake actuator 1 further comprises a second fluid opening 33 that is laterally provided on the actuator housing 3. The brake actuator 1 comprises a manifold valve 32 that is configured to either fluidly connect the pressure source 100 to the first fluid opening 31, or, in a second switching state, fluidly connect the first fluid inlet 31 to the second fluid inlet 33.

Preferably, a quick return valve 34 is associated with the second fluid inlet 33 and operative to open and close the fluid communication with the associated non-pressure chamber 17.

The brake actuator 1 further comprises a third fluid opening 35 and an exhaust check valve 36 associated with the third fluid opening 35 and effective to allow venting of the non-pressure chamber 17. The exhaust check valve 36 preferably comprises an elastically deformable valve element 37 in the shape of a flap. The valve element 37 is elastically deformable and biased towards the closed position which is shown in the figure. The bias produces a pre-load that has to be overcome by positive pressure inside the non-pressure chamber 17. Hereby, inadvertent buildup of negative pressure inside the non-pressure chamber 17 is prevented.

Claims

1. A brake actuator (1) for a vehicle, in particular commercial vehicle, the brake actuator comprising:
- an actuator housing (3) having a piston chamber (15,17) and a first fluid opening (31) for providing pressurized fluid to the piston chamber from a pressure source (100),
- a push rod (9) mounted inside the actuator housing (3), the push rod (9) having a mounting interface (29) for coupling the push rod (9) to a brake mechanism and being configured for reciprocating movement between a retained position and an extended position, and
- a piston (7) that is coupled to the push rod (9),
characterized in that the piston (7) sealingly abuts against the actuator housing (3) and divides the piston chamber into a pressure chamber (15) and a non-pressure chamber (17), the first fluid opening (31) being in fluid communication with the pressure chamber (15) such that pressurized fluid entering the pressure chamber (15) through the first fluid opening (31) acts directly on the piston (7).

2. The brake actuator of claim 1,
wherein the piston (7) comprises a sealing element (21) abutting sealingly against the actuator housing, and a separate sliding bearing (19), the sliding bearing having at least one bearing element protruding radially from the piston (7) and contacting the actuator housing (3).

3. The brake actuator of claim 2,
wherein the at least one sliding bearing (19) has a convex surface and is elastically deformed when in contact with the actuator housing (31).

4. The brake actuator of any one of the preceding claims,
comprising a second fluid (33) opening that is in fluid communication with the non-pressure chamber (17).

5. The brake actuator of claim 4,
wherein the brake actuator comprises a manifold valve (32) that is in fluid communication with the first fluid opening (37), the second fluid opening (33), and a pressure source (100), and configured to
supply pressurized fluid from the pressure source (100) to the first fluid opening (37) when the pressure source is engaged, and
redirect pressurized fluid from the first fluid opening (31) to the second fluid opening (33) when the pressure source (100) is released.

6. The brake actuator of claim 4,
comprising a quick return valve (34) that is associated with the second fluid opening (33).

7. The brake actuator of any one of claims 4 to 6,
comprising a third fluid opening (35) that is in fluid communication with the non-pressure chamber (17), and an exhaust check valve (36) associated with the third fluid opening (35), wherein the exhaust check valve (36) is operable between a closed state and an open state.

8. The brake actuator of claim 7,
wherein the exhaust check valve (36) has a valve element (37) that is biased with a pre-load towards the closed state such that the pre-load must be overcome in order to move the valve element (37) from the closed state towards the open state.

9. The brake actuator of any one of the preceding claims,
comprising a return spring (11) that is mounted inside the actuator housing (3), in particular inside the non-pressure chamber (17), and is effective to move the piston (7) towards its retained position.

10. The brake actuator of any one of the preceding claims, comprising a seal bushing (25) that is mounted to the actuator housing (3) on the side of the non-pressure chamber (17), wherein the seal bushing (25) sealingly and slidably supports the push rod (9).

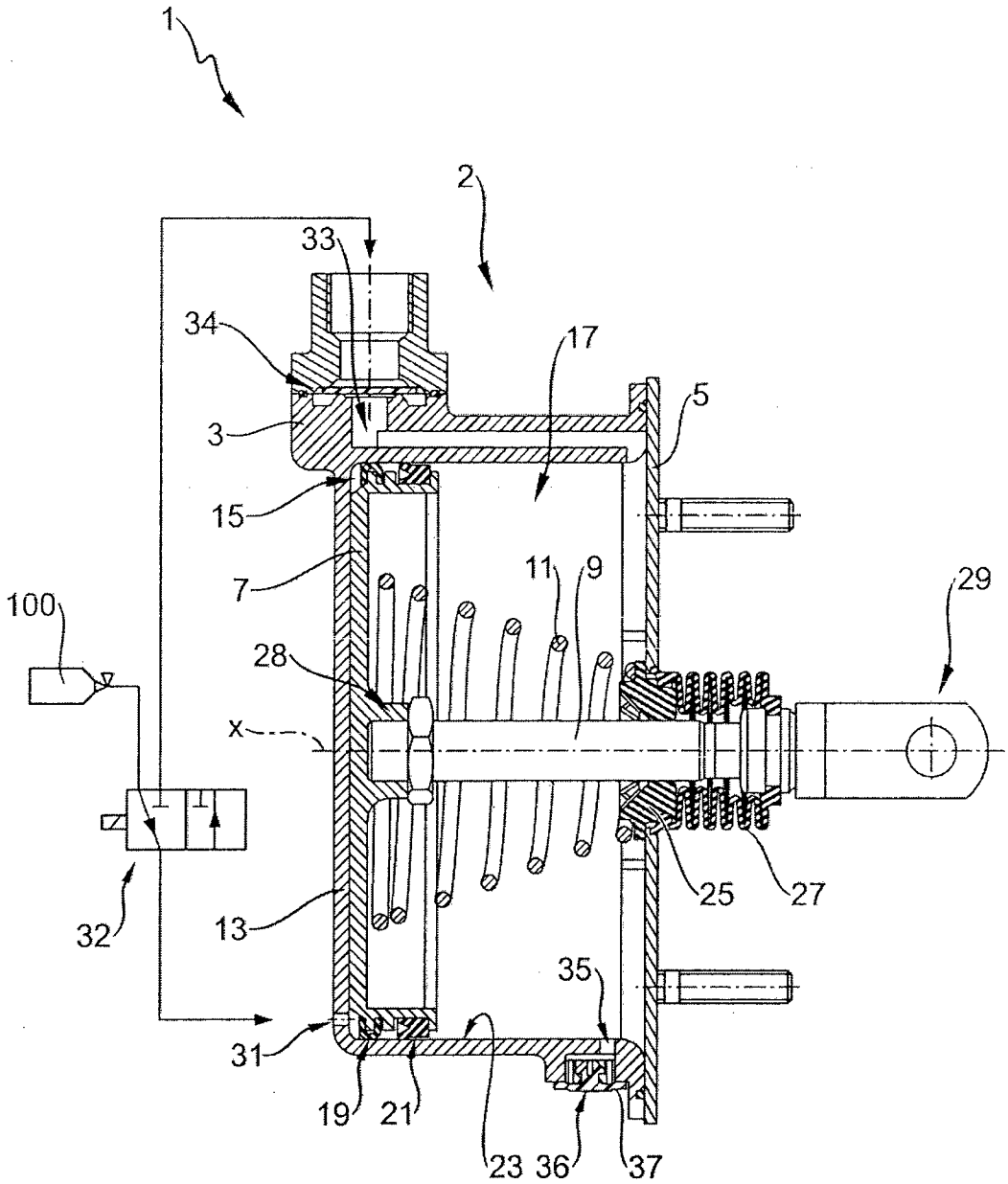

FIG.

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/000762

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60T17/08
ADD.

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)
B60T F16D

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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2009/103431 A2 (KNORR BREMSE SYSTEME [DE]; IRASCHKO JOHANN [DE]) 27 August 2009 (2009-08-27)	1-6,9,10
A	abstract; figure 2 page 8, paragraph 2 - paragraph 2	7,8

X	WO 2010/040509 A1 (KNORR BREMSE SYSTEME [DE]; HERGES MICHAEL [DE] ET AL.) 15 April 2010 (2010-04-15)	1-3,9
A	abstract; figure 3 claims 1,4,5; figure 4	4-8,10

X	EP 2 353 953 A1 (KNORR BREMSE SYSTEME [DE]) 10 August 2011 (2011-08-10) paragraph [0032] - paragraph [0038]; figures 1,2	1-4,9,10

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family 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 application or patent but published on or after the international filing date

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"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	Date of mailing of the international search report
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Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 39 35 663 A1 (BOSCH GMBH ROBERT [DE]) 2 May 1991 (1991-05-02) figure 1	1-3,9,10
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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