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(71) Applicant
Alfred Teves GmbH

(Incorporated in the Federal Republic of Germany)

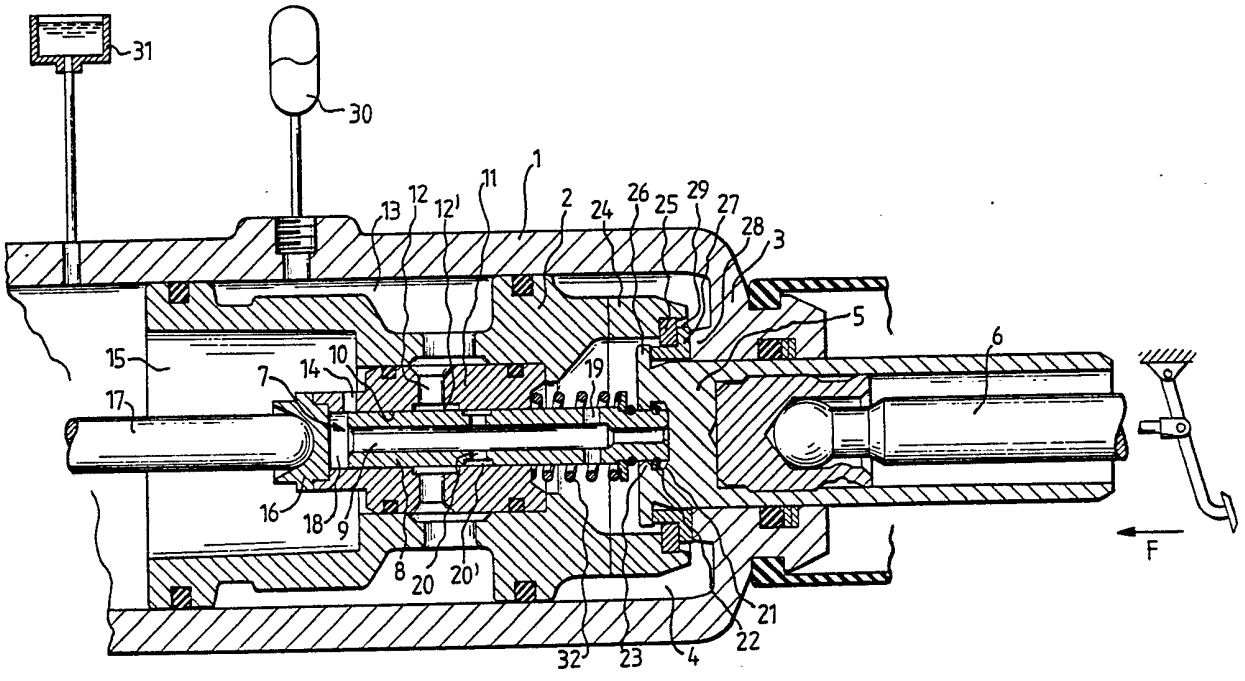
7 Guerickestrasse, 6000 Frankfurt am Main, Federal Republic of Germany

(72) Inventor
Klaus Engert

(74) Agent and/or Address for Service
Ruffhead & Vaufrouard
Maidstone Road (STC Site), Foots Cray, Sidcup, Kent, DA14 5HT, United Kingdom

(54) Hydraulic booster for a vehicle brake system

(57) In a brake power hydraulic booster, the initial positions of booster piston (2) and control slide (8) and/or actuating piston (5) are defined by a stop (27) on the housing such that a fluid return bore (14) to a reservoir (31) is almost closed when the pistons are in their initial positions. Upon actuation and subsequent release of the brake, the control slide (8) is slid back relative to the booster piston (2) so far that the cross-section of the fluid return bore (14) is completely open, thereby permitting the pressure fluid to discharge from the booster chamber (4) into the supply reservoir (31) without resistance. This combines a small lost travel on initial actuation with a rapid release of the brake. The stop for the pistons (2, 5) is provided suitably by an L-shaped sleeve (27).



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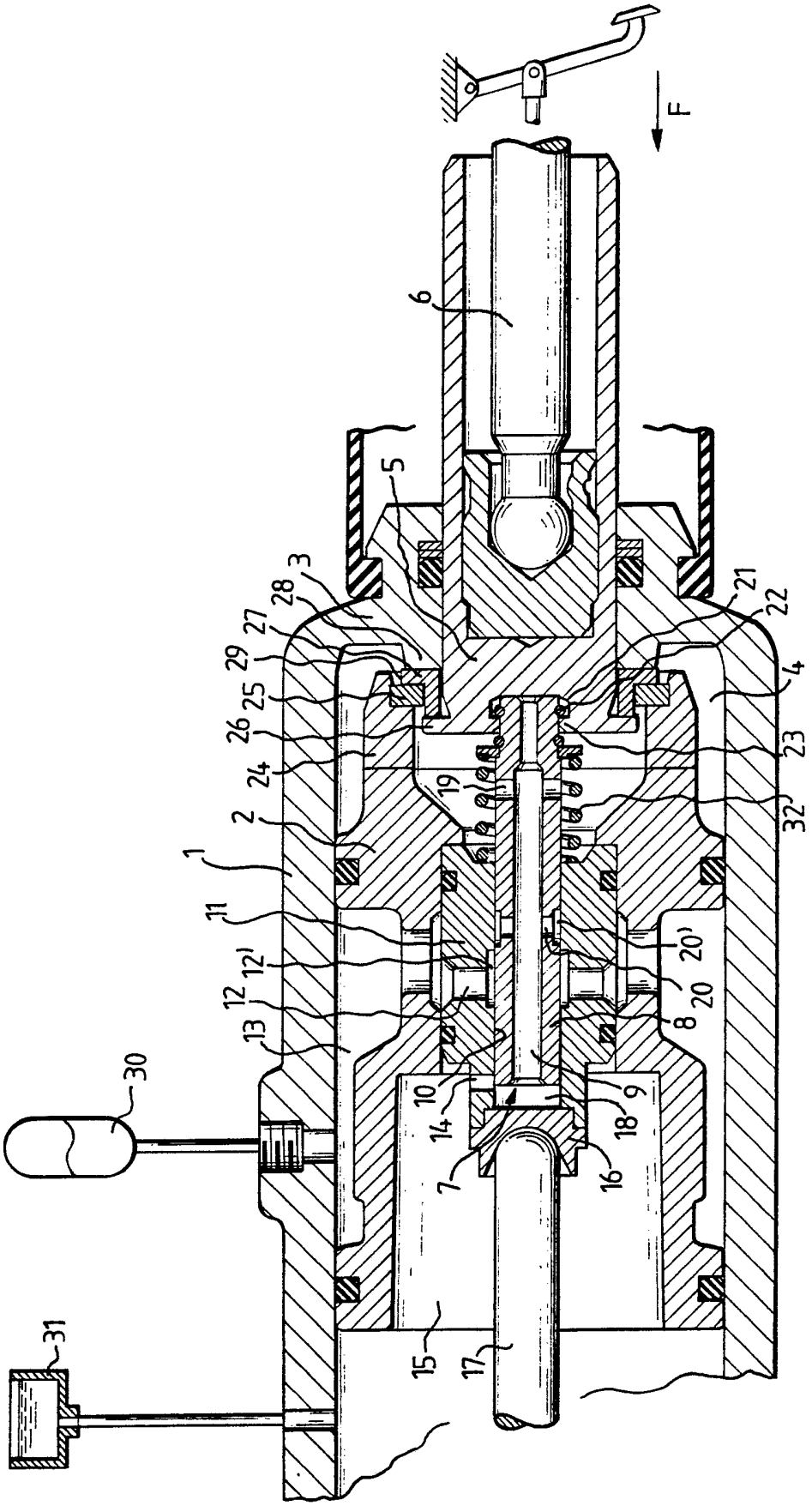
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HYDRAULIC BOOSTER FOR A VEHICLE BRAKE SYSTEM

The present invention relates to a hydraulic booster especially for a vehicle brake system the booster comprising a booster piston sealingly guided and slidable in a housing bore, which booster piston confines at one frontal end thereof a booster chamber and which abuts against a stop on the housing in its initial position, a brake valve having an actuating piston which is displaceable in relation to the booster piston under the action of pedal force and whose initial position is also defined by a stop on the housing, wherein a connection from the booster chamber to a supply reservoir is established and that a connection to an auxiliary-pressure source is interrupted in the initial position of the pistons, whereas on displacement of the actuating piston in the actuating direction in relation to the booster piston the pressure-fluid connection to the supply reservoir is interrupted, while the connection to the auxiliary-pressure source is established or constituted.

A hydraulic booster of the foregoing general construction is described on pages 98 and 99 of the ATE Brake Handbook, Bartsch publishing house, Munich 1979. The brake valve of such booster is substantially composed of a control slide which is sealingly guided in a longitudinal bore of the booster piston. Two transverse bores terminate into the longitudinal bore of the booster. One of the transverse bores communicates with an auxiliary-pressure

source, while the other one connects to a supply reservoir. In the initial position of the control slide (the brake is not applied), the first bore is closed and the second one is open so that there is a pressure-fluid connection between the booster chamber and the supply reservoir. The control slide can now be displaced by application of the brake actuating pedal, whereupon first the bore to the supply reservoir will be closed and then the bore to the auxiliary-pressure source will be opened. Pressure fluid flows out of the auxiliary-pressure source into the booster chamber and pushes the booster piston towards the master cylinder. A tappet bearing against the booster piston actuates the master brake cylinder. Upon release of the brake, the first bore will be closed again, the second bore to the supply reservoir will be opened so that the pressure fluid can escape from the booster chamber and the booster piston is allowed to return to its initial position.

This brake release action must take place quickly which means that the relevant cross-section of the fluid return bore must be sufficiently large. The faster the release action is to be performed, the larger the bore must be. On the other hand, the construction must comply with the demand that the lost travel of brake actuation is desired to be as small as possible. The first phase of pedal actuation serves merely to close the fluid return bore. Only after this phase is completed and the pressure port is opened will the actual brake application take place. The distance covered by the pedal in the first phase is referred to as lost travel. In order to minimise the latter, it is required that the pressure-fluid cross-section of the fluid return bore be as small as possible.

This conflict in objectives has been in favour of the speed of release so far whilst a large lost travel has been tolerated.

The present invention has for an object therefore to devise a hydraulic booster in such a way that the lost

travel is shortened, while the speed of release is preserved.

According to the present invention there is provided a hydraulic booster especially for a vehicle brake system, the booster comprising a booster piston sealingly guided and slidable in a housing bore, which booster piston confines at one frontal end thereof a booster chamber and which abuts against a stop on the housing in its initial position, a brake valve having an actuating piston which is displaceable in relation to the booster piston under the action of pedal force and whose initial position is also defined by a stop on the housing, wherein a connection from the booster chamber to a supply reservoir is established and that a connection to an auxiliary-pressure source is interrupted in the initial position of the pistons, whereas on displacement of the actuating piston in the actuating direction relative to the booster piston the pressure-fluid connection to the supply reservoir is interrupted, while the connection to the auxiliary-pressure source is established, characterised in that the cross-section of the pressure-fluid connection to the supply reservoir is opened only partly in the initial position of the pistons, and in that the cross-section of the connecting channel to the supply reservoir is opened completely on movement of the actuating piston relative to the booster piston in the direction of release.

Since the fluid return bore is already closed to a large extent in the initial position of the pistons, only a small travel is still required in order to entirely close the bore so that, subsequent thereto, the pressure port can be opened. The lost travel is very short. On the other hand, the control slide can be displaced in relation to the booster piston in the direction of release when the brake is released so that the fluid return channel is opened completely. Hence follows that the speed of release remains the same.

In a particularly simple manner, the booster of the

present invention may comprise a brake valve including a control slide. To this end, the control slide is merely required to be positioned in its initial position such that the slide closes the transverse bore of the fluid return channel to a large extent.

However, the present invention may also be used on boosters with seat valves as is described e.g. in German published patent application 29 09 685. The stops for the pistons solely must be arranged such that the valve closure member of the fluid return bore is disposed directly in front of the valve seat. Another field of application is with hydraulic boosters wherein the brake valve is not arranged within the booster piston, but is guided in a separate housing bore and is actuated by way of a lever assembly, with the lever arms making catch at the actuating piston, on the one hand, and on the booster piston, on the other hand. German published patent application 35 07 488 is referred to herein.

To enable existing boosters to be easily adapted if so required and/or an existing production line to be adapted, a sleeve may be positioned on the actuating piston between a circumferential edge on the actuating piston and the stop formed fast with the housing. In this way the actuating piston and thus the control slide will be returned in the initial position thereof only so far that the fluid return bore is not opened entirely.

By way of example an embodiment of the present invention will now be described with reference to the accompanying single-figure drawing of a hydraulic booster in cross-section.

The hydraulic booster is composed of a housing 1 in which a booster piston 2 is sealingly guided. A booster chamber 4 is designed between a booster piston 2 and a back wall 3 of the booster housing 1. An actuating piston 5 extends sealingly through the back wall 3. A pedal rod 6 is coupled at the right-hand end as viewed in the drawing with the symbolically indicated pedal assembly. A brake valve 7

is essentially composed of a control slide 8 with a longitudinal bore 9. The control slide 8 is guided in a bore 10 of the booster piston 2 or an insert member 11 inserted into the booster piston. Terminating into the bore 10 is a pressure channel 12 which extends into an annular groove 12' in the inner surface of the bore 10. The pressure channel 12 leads into an annular chamber 13 around the outer peripheral surface of the booster piston 2 which communicates via a housing port with an auxiliary-pressure source 30.

Further, a fluid return bore 14 terminates in the bore 10 and connects to an unpressurised chamber 15 on the side of the booster piston 2 opposite to the booster chamber 4. The unpressurised chamber 15 is permanently communicating with a supply reservoir 31 via a connecting bore in the housing 1. On the side of the piston 2 adjacent to the unpressurised chamber 15, the bore 10 is closed by a closure member 16. Abutting on the closure member 16 is a tappet 17 which transmits the movement of the booster piston 2 to a master cylinder piston (not shown). A chamber 18 is designed between the closure member 16 and the control slide 8 and the longitudinal bore 9 of the control slide terminates in the chamber 18. The longitudinal bore 9 is in constant pressure-fluid connection with the booster chamber 4 via a first transverse channel 19. A second transverse channel which may likewise be referred to as control channel 20 connects the longitudinal channel 9 with a control groove 20' on the outside surface of the control slide 8.

The control slide 8 itself is rigidly connected with the actuating piston 5 by way of a detent. On the end of the slide 8 close to the actuating piston 5 a projecting circlip 22 on the slide engages behind a circumferential edge 23 on the actuating piston 5.

The booster piston 2 includes a sleeve-shaped extension 24 which projects into the booster chamber 4. An annular washer 25 serving as a stop is inserted into a recess in the inner surface of the sleeve 24. On the end of

the piston 5 extending into the booster chamber 4 a circumferential flange or edge 26 is provided.

Bearing directly against the circumferential flange or edge 26 on the actuating piston 5 is a sleeve 27 with a radially outwardly directed edge 29. Thus, the sleeve has an L-shaped profile when viewed in cross-section.

The base member of the sleeve is arranged between the circumferential edge 26 and a stop abutment 28 on the back wall 3, whilst the edge 29 is positioned between the annular washer 25 and the stop 28. When in abutment on the stop 28, the sleeve defines thus the initial position for the actuating piston 5, on the one hand, and for the booster piston 2, on the other hand.

A spring 19 which is interposed between the insert member 11 an a counterpart or abutment member on the control slide 8 defines the initial position of the control slide 8 relative to the booster piston 2.

The booster operates according to the following principle:

The Figure shows the initial position of the booster. The grooves 12', 20' do not overlap each other. The control slide 8 closes the largest part of the fluid return bore 14. There remains only a small cross-section or circular segment, the surface of which is considerably smaller than the entire circular surface of the fluid return bore. The remaining cross-section is sufficient in order to bring about pressure balance in case the fluid in the booster chamber expands or compresses as a result of temperature, for instance.

To actuate the brake, the pedal is applied and the actuating piston 5 and thus the control slide 8 are displaced in the actuating direction (to the left, according to the illustration of the Figure). The fluid return bore 14 is closed completely after the slide 8 moves a short distance. Another small displacement results in the grooves 12',20' overlapping each other so that pressure fluid out of the auxiliary-pressure source 30 propagates via the annular

chamber 13, the channel 12, the control channel 20 of the longitudinal bore 9 and the transverse channel 19 into the booster chamber 4.

The pressure fluid urges the booster piston 2 in the actuating direction so that the member acted upon by the tappet 17, e.g. a master brake cylinder, is actuated. In this respect, the booster piston 2 advances the control slide 8, and the grooves 12',20' no longer overlap, so that further actuation may take place only if the actuating piston 5 is displaced further under the action of the pedal force. In the event of brake application, both the actuating piston 5 and the booster piston 2 detach from their stop on the sleeve 27. They are now freely movable in relation to each other.

When now the driver releases the pedal during braking, the actuating piston 5 and thus the control slide 8 are no longer applied by force. The pressure prevailing in the booster chamber 4 as well as the force of the spring 29 urge the control slide relative to the booster piston 2 in the direction of brake release. In doing so, the control slide 8 is slid back so far that the cross-section of the fluid return bore 14 will be opened completely. The pressure fluid in the booster chamber 4 may escape in an unrestricted fashion through this sufficiently large cross-section fluid return bore 14 so that the booster piston 2 is reset quickly into its initial position under the effect of a resetting spring (not shown). A cross-section of the fluid return bore 14 that is too small would inhibit the return flow of pressure fluid out of the booster chamber 4 into the supply reservoir 31 and would greatly reduce the speed of resetting.

The diameter of the fluid return bore 14 may be approximately 1.7 mms.

The sleeve 27 that is L-shaped in cross-section may be designed as part of the housing 1. However, a separate sleeve permits adaptation to existing brake power boosters, and/or there is the possibility of adopting an existing

production process for such a booster, it being merely required to add one production step during which the sleeve 27 is slid on to the actuating piston 5.

CLAIMS:

1. A hydraulic booster especially for a vehicle brake system the booster comprising a booster piston sealingly guided and slidable in a housing bore, which booster piston confines at one frontal end thereof a booster chamber and which abuts against a stop on the housing in its initial position, a brake valve having an actuating piston which is displaceable in relation to the booster piston under the action of pedal force and whose initial position is also defined by a stop on the housing, wherein a connection from the booster chamber to a supply reservoir is established and that a connection to an auxiliary-pressure source is interrupted in the initial position of the pistons, whereas on displacement of the actuating piston in the actuating direction relative to the booster piston the pressure-fluid connection to the supply reservoir is interrupted, while the connection to the auxiliary-pressure source is established, characterised in that the cross-section of the pressure-fluid connection (14) to the supply reservoir is opened only partly in the initial position of the pistons, and in that the cross-section of the connecting channel (14) to the supply reservoir is opened completely on movement of the actuating piston (5) relative to the booster piston (2) in the direction of release.

2. A hydraulic booster as claimed in claim 1, characterised in that the brake valve (7) comprises a control slide (8) which is coupled to the actuating piston (5).

3. A hydraulic booster as claimed in claim 2, characterised in that an edge of the control slide remote from the piston (5) overlaps a transverse channel (14) in the booster piston (2), the largest part of the transverse bore (14) being covered in the initial position of the pistons (2,5), while the transverse channel (14) will be closed completely when the control slide is operated in the actuating direction.

4. A hydraulic booster as claimed in any of claims

1 to 3, characterised in that the booster piston 2 is furnished with a sleeve-shaped extension (24), at the end of the piston (2) adjacent the booster chamber (4), an annular washer (25) being inserted into a recess in the inner surface of the extension.

5. A hydraulic booster as claimed in any preceding claim, characterised in that the actuating piston (5) comprises a circumferential edge (26) on its outer rim where one end of the piston projects into the booster chamber (4).

6. A hydraulic booster as claimed in claim 5, characterised in that a sleeve (27) is arranged between the circumferential edge (26) and the stop (28) formed fast with the housing.

7. A hydraulic booster as claimed in claims 4,5 and 6, characterised in that the sleeve (27) comprises a radial extension (29) so that the sleeve (27) is L-shaped in its cross-section, and in that the radial extension (29) projects into the space between the annular washer (25) and the stop (28) formed fast with the housing.

8. A hydraulic booster as claimed in any one of the preceding claims, characterised in that the fluid return bore (14) has a diameter of approximately 1.7 mms.

9. A hydraulic booster substantially as hereinbefore described with reference to the accompanying drawing.

10. A vehicle brake system including a hydraulic booster as claimed in any preceding claim.

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