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(54) Anti-skid Braking Systems

(57) A multi-circuit pressure-medium-operated brake circuit for a passenger motor vehicle has an antilock system (48) for holding the brake pressure below the locking limit and also has control means (49), e.g. an inertia valve, whereby the pressure at the brake wheel cylinders of the rear axle of the vehicle is reduced or limited when the anti-lock system (48) is intact but is not operating.

The control means (49) are located between the high pressure supply and a booster inlet, or alternatively, between the booster and the rear wheel cylinders.

FIG.1

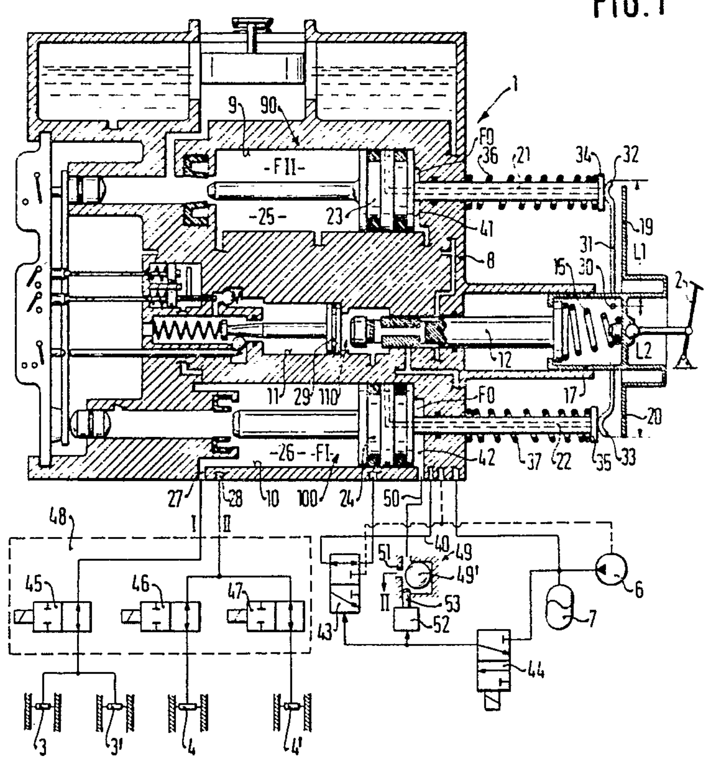

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FIG.1

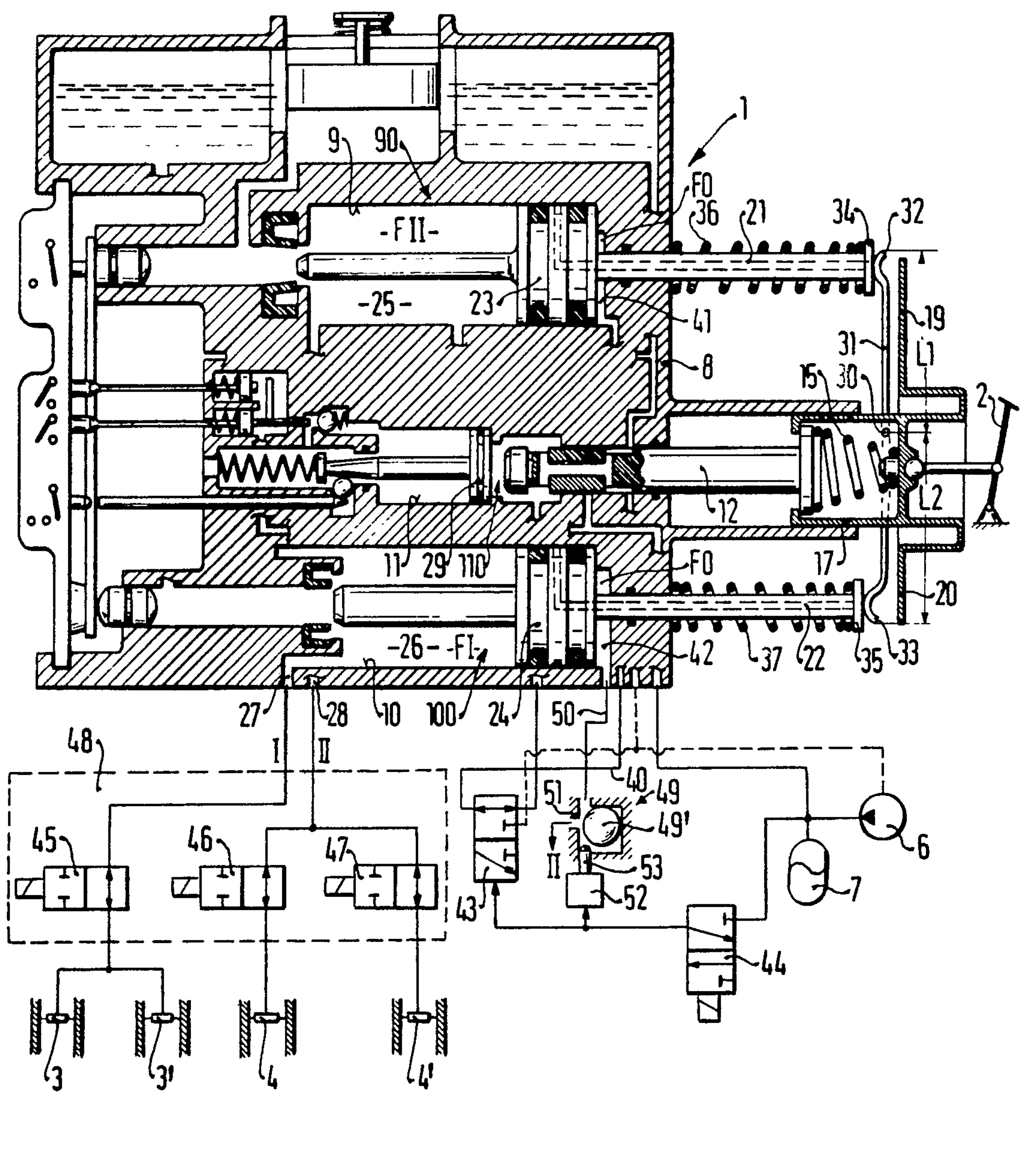

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FIG. 2

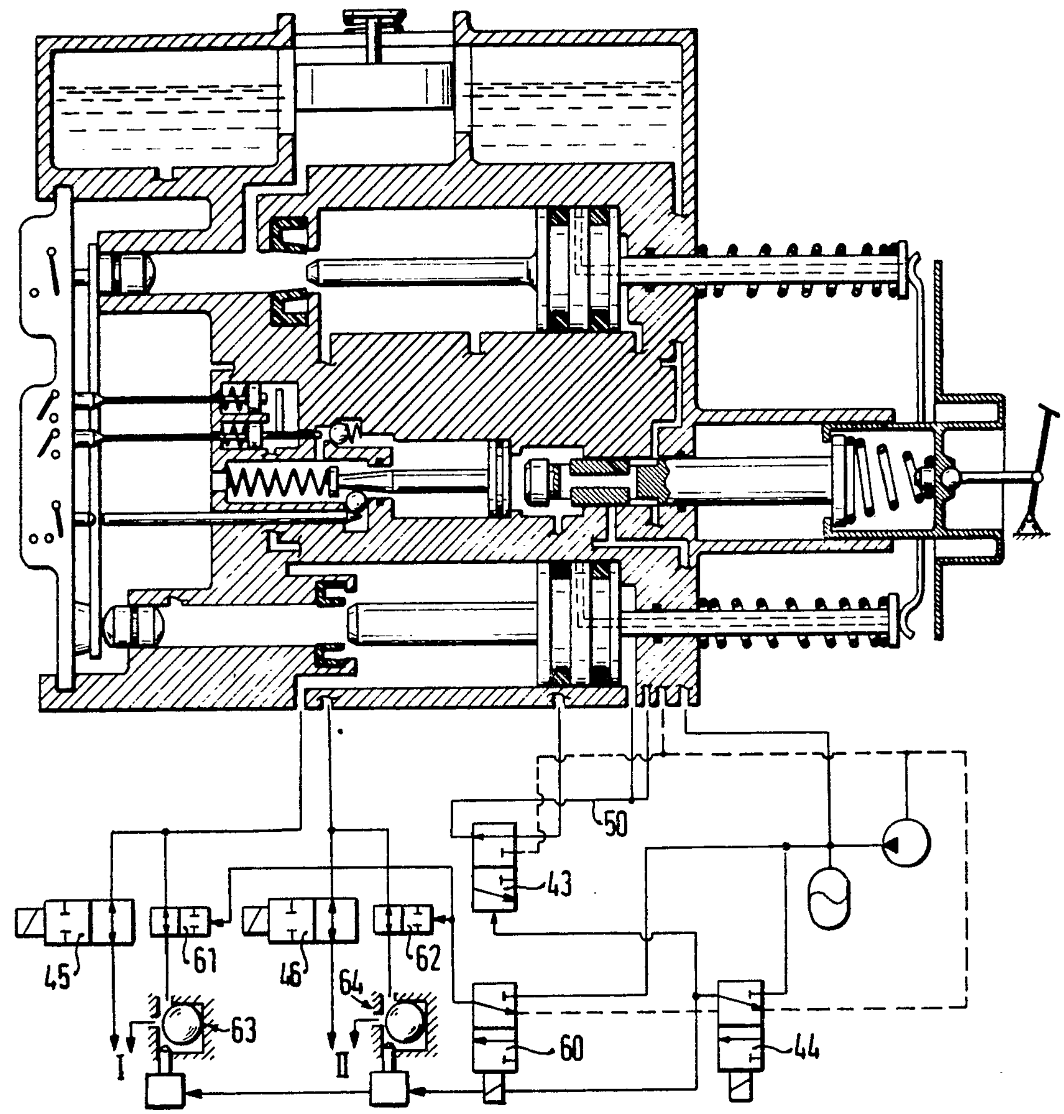

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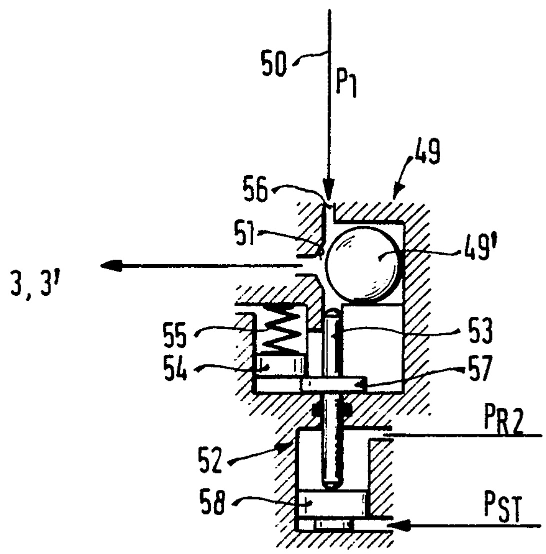
FIG. 3



SPECIFICATION

A Multi-Circuit Pressure-Medium-Operated Brake System

The invention relates to a multi-circuit pressure-medium-operated brake system for a motor vehicle having an anti-lock system by means of which the brake pressure can be held below the wheel locking limit. A pressure-medium-operated brake system of this kind is known (German Offenlegungsschrift 27 02 819).

Brake systems of this kind involve problems with respect to boosting the brake force, adjusting the brake force and regulating the brake force. Many types of brake boosters are known.

With respect to the problem of adjusting the brake force, it may be said that increasing use is being made of systems which reduce the brake force, that is to say, so-called pressure reducers, or, alternatively, systems which limit the brake force, that is to say, pressure limiters. Both these systems operate in dependence upon the retardation of the vehicle. On the one hand, these systems are virtually indispensible in vehicles whose rear axles are subjected to considerable changes of wheel load, such as in the case of front-wheel drive vehicles and commercials. On the other hand, endeavours are being made to reduce the wear on the brake linings and to prolong the intervals of time at which the brake linings have to be changed. Consequently, the rear axle has to contribute to a greater extent to the braking efficiency, particularly in the range of partial braking.

When a brake system is designed in this manner, greater retardation of the vehicle, that is to say, greater dynamic relief of the load on the rear axle, there is the risk that the wheels of this axle will lock before the front wheels. It is common knowledge that this can cause a dangerous state of travel (i.e. rear wheel skid).

When adjusting the brake circuits, a basic requirement is to ensure that the front wheels lock before the rear wheels. However, the pressure reducers or pressure limiters which are used nowadays have a considerable disadvantage in the event of failure of the brake circuit of the front axle, the brakes having to be applied with a greatly increased brake force (high applied pedal forces) when, for example, using a pressure reducer, which frequently overtakes the driver.

Basically, verhicles having anti-lock systems could dispense with devices of this kind. However, there are two objections to this:

1. When a brake force adjustment is chosen in which the desired greater braking action of the rear axle is effective in the range of partial braking, this design is extremely critical in the event of a fault occurring in the anti-lock system, which would result in over-braking of the rear axle.

2. The travelling stability would not be optimal in the event of greater braking efficiency of the rear axle, which, in the range of greater retardation, might result in the rear axle already being in the regulating range and the rear axle not yet being in the regulation range. This means that the rear axle operates with greater brake slip than the front axle. In this range, the travelling stability would be endangered, specially when braking from high vehicle velocities.

According to the present invention there is provided a multi-circuit pressure-medium-operated brake system for a motor vehicle, having an anti-lock system by means of which the brake pressure can be held below the wheel-locking limit, and control means for independently reducing or limiting the brake pressure at the brakes of the rear axle of the vehicle when the anti-lock system is intact but the conditions to which the anti-lock system responds are absent.

The multi-circuit pressure-medium-operated brake system in accordance with the invention has the advantage that the pressure at the rear axle is limited or reduced, and that, nevertheless, greater braking efficiency of the rear axle is possible in the range of partial braking. To ensure that the full braking efficiency of the rear axle can be utilised, the limiting or reducing of the pressure is to be rendered inoperative when the anti-lock system is operative either at the front axle or at the rear axle.

This results in the following advantages:

Enhancement of the braking action of the rear axle in the range of partial braking, thus resulting in more favourable effects with respect to wear on the brake linings. Reducing the risk of locking of the rear axle in the event of failure of the anti-lock systems. If a mechanical hydraulic solution is chosen, the function is effective without servo assisting power, that is to say, independently of the electrical power supply.

In accordance with further features of the invention, a change pressure step-up for the rear axle can be used with corresponding design and construction of a hydraulic booster, thus resulting in a higher brake pressure in this circuit than in that of the front axle. This pressure step-up can be rendered inoperative in the event of failure of the pressure supply or the hydraulic booster system.

The pressure supply can be fixed at a lower level by using pressure step-up of this kind in the case of the master cylinder pistons. Furthermore, the brake force booster can be of reduced dimensions, at least in the region which is subjected to the lower pressures, thus resulting in a considerable saving of weight.

The cost of construction is kept at a particularly low level by combining or integrating the above-described pressure limiter or pressure reducer in the hydraulic booster system or, alternatively, in the pressure-control valve of the anti-lock system.

The present invention will now be further described, by way of example only with reference to the accompanying drawings, in which:—

Figure 1 shows a pressure-medium-operated brake system with conventional brake force distribution,

Figure 2 shows a pressure-medium-operated brake system having diagonal brake force distribution, and

Figure 3 shows a change-over device of the pressure-medium-operated brake system.

A hydraulic brake booster 1 is arranged in a hydraulic two-circuit brake system between a brake pedal 2 and a pair 3, 3′ of wheel brake cylinders of the front axle and separate wheel brake cylinders 4 and 4′ of the rear axle. The pair 3, 3′ of wheel cylinders forms part of a brake circuit I, and the other two wheel cylinders 4, 4′ are parts of a brake circuit II.

Brake boosting is effected by a pressure source which comprises a pump 6 and an accumulator 7 and which is connected to a housing 8 of the brake force booster 1, three parallel bores 9, 10 and 11 are chiefly provided in a housing 8 of the brake force booster 1, the two bores 9 and 10 being intended for two master cylinders 90 and 100. The bore 11 is located between the two master cylinders 90 and 100 accommodates a control valve 110 in the form of a slide valve.

One end of a spool 12 of the control valve 110 extends out of the housing 8 where it is connected to the brake pedal 2 by way of a travel giving spring 15 and a guide tube 17 in the form of a tubular body. The guide tube 17 carries two arms 19 and 20 whose ends are located opposite two push rods 21 and 22 which in turn extend into the master cylinders 90 and 100 where they each carry a respective master cylinder piston 23 of 24.

A respective pressure chamber 25 and 26 is located at the secondary side of each piston 23 and 24, one (26) of which pressure chambers is connected to the brake circuit I by way of a passage 27, and the other (25) of which pressure chambers is connected to the brake circuit II by a passage 28. The brake circuit II is the rear axle brake circuit. A stop piston 29 is located coaxially downstream of the control spool 12 and limits the stroke of the travel giving spring 15 when the supply of pressure medium is intact.

A support point 30 for a lever 31 is arranged centrally between the axis of the two master cylinders 90 and 100 and within the outer wall of the guide tube 17, the lever 31 having two arms 32 and 33 of equal length (length L_1 and L_2). The arms 32 and 33 abut against the free ends of the respective push rods 21 and 22 provided with respective enlarged portions 34 and 35, and a respective return spring 36 or 37 for the master-cylinder pistons 23 and 24 connected to the push rods 21 and 22 surrounds the respective push rods between each enlarged portion 34 or 35 and the housing 8.

A pressure limiter 49 is disposed between the control valve 110 and the master cylinder piston 24 in the present embodiment and acts as control means, it is also possible to fit the pressure limiter (control means) in the secondary circuit between the master cylinder piston 24 and the brake cylinder 3, 3′.

The general mode of operation of the brake booster is described in the initially mentioned German Offenlegungsschrift 27 02 819. The lever 31 constitutes a safety device in the event of a defect in the pressure supply.

A three-port, two-position main valve 43, pilot-controlled by way of a three-port, two-position solenoid valve 44, is located in a connection line 40 leading from the control valve 110 to the primary sides 41 and 42 of the master cylinder pistons 23 and 24. Two-port, two-position solenoid valves 45, 46 and 47 are arranged at the secondary side of the master cylinder pistons 23 and 24 and performs a pressure-holding function. The valves 43, 44, 45, 46, and 47 are parts of an anti-lock system 48 which also includes wheel sensors (not illustrated) and an electronic switching device which is also not illustrated. A pressure limiter 49 equipped in a simple manner with a ball 49′ acting as a carrier mass, is fitted in a line 50 leading from the primary side 42 to the rear axle brake circuit II. Alternatively, the control means may be a cut off valve which closes at a specific pressure and which may be used instead of the simple pressure limiter 49. It is also conceivable to use, as the control means a so-called pressure reducer having a fixedly set change-over pressure (gradient change), although this involves greater structural expense.

In the present embodiment, when a specific force due to interia acts upon the ball 49′ as a result of retardation of the vehicle, the ball is applied to a seat 51 to close the passage. Consequently, no further pressure rise can be effected in the corresponding brake circuit from the primary side. However, this only applies when the anti-lock system is not operating.

A pressure-medium-operated adjusting member 52 acting as a disabling device is assembled with the retardation-dependent pressure limiter 49 and has a push rod 53 which can enter in the region of the ball 49′. When the anti-lock system is rendered operative, the three-port, two-position valve 44 changes over, and the push rod 53 moves upwardly in dependence upon pressure and presses the ball 49′ away from its seat 51. The passage is thereby opened again, so that it is subsequently possible for pressure to build up at the rear axle of the vehicle in an unobstructed manner.

The pressure limiter 49 is shown again in Figure 3, drawn to an enlarged scale. It will be seen that an arresting piston 54 is combined with the push rod 53 and is subjected, against the force of a spring 55, to the primary pressure fed at a connection 56. The seat 51 forms the start of the brake line leading to the wheel brake cylinders 3, 3′ of the rear axle. The push rod 53 is actuated by a shift piston 48 which is subjected to the pressure introduced by the three-port, two-position valve 44. Furthermore, the push rod 53 has a radial extension 57 against which the arresting piston 54 normally abuts.

When a specific brake pressure is introduced into the rear axle brake circuit II, the arresting piston 54 moves upwardly against the force of the spring 55 even after a slight pressure rise.

Thus, although the push rod 53 is free, it does not move. The brakes can be applied in an unobstructed manner, and the brake pressure can be limited in dependence upon the retardation of the vehicle.

However, if the anti-lock system when it comes into operation, the three-port, two-position valve 44 is actuated and a pressure is produced below the shift piston 58, with the result that the push rod 53 pushes away the ball 49′ if it is abutting against the seat 51. Thus, pressure limitation by the pressure-limiting valve 49 is rendered inoperative.

The said actuation can be designed for bistable function, that is to say, the push rod 43 remains in its change-over position as a result of a single triggering operation. It is returned to its starting position only when the brake pressure in the line 50 has dropped to zero, this being tantamount to termination of the braking operation. The diameter of the push rod 53 is sufficiently small to ensure that the frictional force of its necessary seal is greater than the effective pressure force resulting from the pressures upstream and downstream of the solenoid valve 44. Alternatively, instead of using an arresting piston 54, it is also possible to use the pressure difference which occurs between the pressure of the control valve and the regulated wheel brake cylinder pressure during operation of the anti-lock system. A solution of this kind is particularly advantageous in an anti-lock system for a pneumatic brake system.

In the illustrated embodiment, by virtue of the ratios of the areas F II to F O and F I to F O, the hydraulic booster system is designed such that a larger pressure step-up is effective for the brake circuit I than that of brake circuit II. This pressure step-up is ineffective if the pressure supply should fail. In this case, the applied pedal force is transmitted to the two master brake cylinder pistons 23 and 24 by way of the lever 31. The same brake pressure can be ensured for the two brake circuits by corresponding leverage.

In order to save space, and to reduce the number of lines and sealed locations susceptible to trouble, it is possible to integrate the pressure limiter directly in the brake booster 1 or in the anti-lock system 48.

Using the same reference numerals for the parts corresponding to the construction of Figure 1, the modification of Figure 2 relates to a two-circuit brake system with diagonal distribution of the brake circuits. In a brake system of this kind, the rear axle brake circuit II is regulated by the so-called "select-low" principle by way of a common adjusting member. The pilot-control function is assumed by a solenoid valve 60 which controls two-port, two-position valves 61 and 62 in the corresponding brake circuits I and II. Since two different brake circuits I and II are provided on the rear axle in this system configuration, an individual pressure reducer or pressure limiter 63 or 64 is required for each rear wheel. The mode of operation is identical to that of the embodiment of Figure 1.

Claims

1. A multi-circuit pressure-medium-operated brake system for a motor vehicle, having an anti-lock system by means of which the brake pressure can be held below the wheel-locking limit, and control means for independently reducing or limiting the brake pressure at the brakes of the rear axle of the vehicle when the anti-lock system is intact but the conditions to which the anti-lock system responds are absent.

2. A multi-circuit pressure-medium-operated brake system as claimed in claim 1, further comprising a hydraulic brake force booster, in which the control means is connected in a primary circuit of the brake booster between a control valve and a master cylinder piston.

3. A multi-circuit pressure-medium-operated brake system as claimed in claim 1, further comprising a hydraulic brake force booster, in which the control means is fitted in a secondary circuit of the brake booster between a master cylinder piston and a wheel brake cylinder.

4. A multi-circuit pressure-medium-operated brake circuit as claimed in claim 2 or 3, in which a disabling device is provided for rendering the pressure reducer or the pressure limiter inoperative.

5. A multi-circuit pressure-medium-operated brake system as claimed in claim 4, in which the arresting piston is provided by means of which the disabling device can be itself rendered inoperable in dependence upon the supply of pressure medium for the hydraulic brake force booster.

6. A multi-circuit pressure-medium-operated brake system as claimed in claim 4, in which the disabling device is provided with an actuating member by means of which the said device can be itself rendered inoperable in dependence upon the operation of the anti-lock system.

7. A multi-circuit pressure-medium-operated brake system as claimed in claim 4, 5 or 6, in which the disabling device includes a shift piston.

8. A multi-circuit pressure-medium-operated brake system as claimed in any of claims 2 to 7, in which a differing pressure step-up is provided in the brake force booster between a front axle circuit and a rear axle circuit.

9. A multi-circuit pressure-medium-operated brake system as claimed in claim 8, in which the rear axle circuit has the higher pressure step-up.

10. A multi-circuit pressure-medium-operated brake circuit as claimed in claim 8 or 9, comprising a pressure failure safety device by means of which the brake pressures in both circuits can be equalized in the event of failure of the supply of pressure medium, this device being in the form of levers or piston surfaces.

11. A multi-circuit pressure-medium-operated brake system as claimed in any of claims 2 to 10, in which the control means is integrated in the hydraulic brake booster.

12. A multi-circuit pressure-medium-operated brake system as claimed in any of the claims 1 to 10, in which the control means is integrated in the anti-lock system.

13. A multi-circuit pressuremedium-operated brake system as claimed in claim 12 in which the control means is incorporated in a combined pressure-control valve of the anti-lock system.

14. A multi-circuit pressure-medium-operated brake system constructed and arranged and adapted to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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