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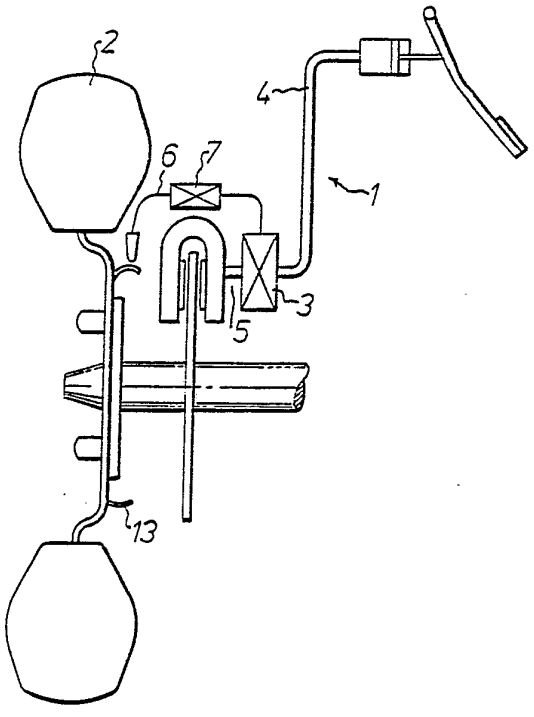
(57) Abstract

Brake control system for vehicles with hydraulic brakes, for preventing wheel blocking and/or spinning. The system is characterised in that the brake system is separable, by means of a valve (3), one for each wheel, into a primary circuit (4) and a secondary circuit (5). Sensors (6) are provided on each wheel for sensing the rotational speed thereof. A control device compares the speeds sensed by said sensor. In the event of a sensed abnormal condition (wheel blocking or spinning) of one or more wheels, the control device activates the respective valve. A pressure control system in the respective secondary circuit controls the pressure therein, independently of the pressure in the primary circuit, in order to cancel the abnormal condition of the corresponding wheel.



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BRAKE CONTROL SYSTEM FOR PREVENTING WHEEL BLOCKING AND/OR SPINNING

The present invention relates to a brake control system for vehicles with hydraulic brakes, for preventing wheel blocking and/or spinning.

Ever since the Maxaret antiblocking brake system was introduced for aircraft and purpose-built vehicles, a great deal of effort has been put into finding a system sufficiently inexpensive to be used in ordinary cars.

The ABS system by Bosch was the first to be used by the motor industry. Since then, further systems have been developed, for example ATE and ALB. The ATE system is the first to be used as factory-assembled equipment and has received lively publicity. Reviewers have been unanimous in nominating the factory-assembled antiblocking brake system the greatest contribution to traffic safety in the last decades.

From a general point of view, the shortcomings of presentday antiblocking systems therefore have no connection with the proper functioning, but are primarily of a technical and economic character. Presentday systems are technically highly sophisticated, but are far too expensive to justify installation in existing cars. As optional equipment, presentday systems cost about SEK. 10,000-25,000, depending upon the type of the system and the make of the car.

It therefore is the object of this invention to provide an antiblocking brake system which eliminates the above-mentioned shortcomings and still gives the same effect. The system can also be used for controlling wheel spinning.

Briefly, the system comprises a valve unit which is mounted at the brake yoke of a standard brake system and which, when there is a risk of wheel blocking

or spinning, separates the brake system into a primary circuit and a secondary or wheel circuit. A pressure control system is provided for separately controlling the brake pressure in the wheel circuit. The valve unit is activated by means of a sensor which is mounted at the wheel and directly or indirectly controls the function of the valve unit. The pressure in the secondary circuit is controlled by the pressure control system such that, when there is a risk of wheel blocking, the pressure in the secondary circuit is reduced, whereby the wheels are unblocked, and such that, when there is a risk of wheel spinning, the pressure in the secondary circuit is increased, whereby the spinning wheel is braked and the motive power is transmitted to the nonspinning driving wheel. If the valve unit is controlled by rotation indicators on the driving wheels, the valve unit is able, at different wheel speeds, to automatically control the motive power distribution between the wheels.

The system can be combined, in an automated function, with power-reducing facilities, such as throttle, fuel and ignition controls, or combinations thereof.

The advantages of the system are that it comprises but few components, is readily mounted in all cars with hydraulic brakes and also is eminently suitable for subsequent installation. The system does not affect the brake system of the car in the event of a breakdown. The low production cost gives a low-priced market. The system can be used for controlling two or more wheels, as one desires. With minor modifications, the system can also be used for controlling wheel spinning, separately or in combination with the antiblocking system. Because the system comprises but few components of small dimensions, and because alternative drives and control devices can be used, the system is applicable to most cars.

Preferred embodiments of the invention will now be described with reference to the accompanying drawings in which

Fig. 1 illustrates schematically part of the brake system of a car, equipped with a brake control system according to the invention;

Fig. 2 shows the valve unit in the deactivated and the activated state, respectively;

Fig. 3 shows an alternative embodiment of the valve unit, equipped with a pressure control system and a mechanical sensor;

Fig. 4 shows a further alternative embodiment of the pressure control system, equipped with an external pressure source;

Fig. 5 shows another embodiment of the valve unit and the pressure control system;

Fig. 6 shows a combined valve unit for wheel blocking control and wheel spinning control; and

Fig. 7 shows a brake characteristic of a brake control system according to the present invention.

Fig. 1 illustrates schematically part of the hydraulic brake system of a car, said system being generally designated 1. The Figure shows how the brake control system is mounted in the brake pipe adjacent the brake yoke of a disk brake for a wheel 2. The brake control system comprises a valve 3 which, when actuated, separates the brake system into a primary circuit 4 including the brake pedal, the main cylinder or cylinders, and the brake fluid tank, and a secondary circuit 5 including the wheel cylinder. The valve 3 is activated by a sensor 6 which senses the rotational speed of the wheel, and a control device 7 which compares the instantaneous rotational speed of the wheel with previously sensed values and, in the event of rapid changes, activates the system. In some applications, the control device may also compare the rotational speed of the wheel with an accelerometer built

into the car. When an abnormal wheel condition is sensed, i.e. a condition in which the wheel is blocked or spinning, the control device 7 actuates the valve 3 such that a pressure control system in the secondary circuit can control the pressure therein, independently of the pressure in the primary circuit, thereby to cancel the abnormal wheel condition.

Fig. 2 illustrates an embodiment of the valve 3 including a pressure control system. The valve comprises a housing within which a piston 9 is reciprocable. The piston 9 is held by a return spring (not shown) in its normally open position, as shown to the left in the drawing, such that communication is established between the primary circuit 4 and the secondary circuit 5. An electromagnet 11 activated by the control device 7 moves the piston 9 to the position shown to the right in the drawing, where communication between the primary circuit 4 and the secondary circuit 5 is closed. A connecting pipe 12 connects the secondary circuit 5 to the space accommodated by the piston in the open valve position. In the activated condition of the valve, i.e. when there is a risk of wheel blocking, the secondary circuit 5 thus is separated from the remainder of the brake system 1, and part of the brake fluid in the secondary circuit will flow through the pipe 12 into the space underneath the piston 9 so that the pressure in the secondary circuit is reduced. Less braking power is thus applied to the wheel which is no longer blocked. When wheel blocking ceases, the valve is deactivated, and the return spring urges the piston back into the open valve position and presses the brake fluid into the brake system which now is open again.

If the valve is inversely connected into the brake system, i.e. if the primary circuit is connected to the valve port 5 and the secondary circuit to the valve port 4, it may also be used for controlling

wheel spinning. In this case, when the valve is actuated, the communication between the primary circuit and the secondary circuit is closed, and the continued movement of the piston past the closing position will then press the brake fluid above the piston out into the secondary circuit in which a braking pressure is generated which brakes the wheel. In this manner, the motive power can be transmitted to the nonspinning wheel.

The embodiment illustrated in Figs. 1 and 2 comprises an inductive sensor 6 which comprises an inductive transducer sensing the rotational speed of the wheel by means of a toothed disk 13 or the like, connected to the wheel. The disk may be mounted between the wheel flange and the wheel hub by means of the wheel fastening bolts or in some similar manner.

Fig. 3 illustrates an alternative embodiment of the sensor which in this case comprises a rotating roller 14 engaging the brake disk or some other part connected to the wheel. The roller 14 is directly and mechanically connected to the piston 9 of the valve 3. By selecting a suitable mass for the roller and by applying a suitable pressure against the brake disk, a spontaneous change of the wheel speed will impart to the roller a tractive or compressive force which is sufficient for directly controlling the valve 3.

In this embodiment, the pressure control system comprises a separate cylinder 15 in which a piston 16 is movable. A spring 17 normally keeps the piston in the left-hand position of the drawing. The common valve housing of the valve 3 and the pressure control system 8 comprises a connecting pipe 12 which is normally closed by the valve spool 9. Upon actuation of the valve 3, the spool 9 opens the pipe 12, while simultaneously closing the communication between the primary circuit 4 and the secondary circuit 5. The pressure in the secondary circuit causes brake fluid

to flow through the pipe 12 into the cylinder 15 and to urge the piston to the right against the action of the spring 17. In this case, also a nonreturn valve 19 is provided between the cylinder 15 and the brake system, whereby the brake fluid can be pressed back into the system when activation of the valve 3 ceases.

Fig. 4 illustrates another embodiment of the pressure control system 8. In this case, the pressure control system is separate from the valve 3 which is only schematically shown in the drawing, and is connected to the secondary circuit 5. A piston 16 in a cylinder 15 is arranged to control the pressure in the secondary circuit. In this case, however, an outer compressed air source 18 which comprises for example a compressor and an accumulator, is adapted to urge the piston to the left in the drawing. A second valve 20 which also is shown only schematically, is adapted to control the communication with the compressed air source 18.

Fig. 5 illustrates a further embodiment of the pressure control system. In this embodiment, the sensor is the roller 14 which is directly and mechanically connected to the valve 3 which in turn is directly connected to said second valve 20. The valves have a common spool which, upon actuation of said valves, closes the communication between the primary circuit 4 and the secondary circuit 5, opens the connecting pipe 12 and closes the connection between the cylinder 15 and the outer compressed air source 18. Brake fluid will now flow through the pipe 12 and urge the piston 12 to the right in the drawing. When the valves are no longer activated, the compressed air urges the piston 16 to the left, and the piston again presses the brake fluid into the system via the nonreturn valve 19.

Fig. 6 illustrates a further embodiment of the valve unit which, in this case, is a combination of

two coupled-together valves according to Fig. 2. The two valves have a common valve spool 9 which is actuated by the respective electromagnet 11 to move upwardly and downwardly, respectively, within the common valve housing. Upward movement in the drawing, which implies wheel blocking, closes the communication between the primary and secondary circuits 4 and 5 and, as has been mentioned before, the brake fluid in the secondary circuit is urged back into the space beneath the spool 9. Similarly, downward movement, which implies wheel spinning, builds up a pressure in the secondary circuit 5, as has also been explained above, and the spinning wheel is retarded.

When the valve is not activated, the valve spool 9 is arranged, by means of return springs (not shown), to assume the neutral position shown in the drawing. To facilitate return of the valve spool to neutral position and also to minimise the requisite spring force, a by-pass 21 may be provided in the valve housing. The by-pass 21 opens at the top of the space of the valve spool on the primary circuit side directly below the neutral spool position on the secondary circuit side. A pressure-controlled nonreturn valve 22 in said by-pass allows brake fluid to flow through the by-pass 21 when the valve is no longer activated and facilitates the return stroke of the spool 9. This is especially advantageous if the pressure in the primary circuit is low, i.e. if the brake pedal is no longer depressed; without the by-pass 21 the pressure within the secondary circuit 5 could prevent the return stroke of the spool 9 under the action of the return springs.

In all of the embodiments described above, the various units are of course dimensioned such that sufficient brake fluid volumes can be evacuated from and introduced into the secondary circuit in order to provide the requisite pressure reduction or pres-

sure increase and thus control blocking or spinning of the wheels.

Fig. 7 is an example of a brake characteristic for a brake control system according to the present invention.

It will be appreciated that the invention is not restricted to the embodiments described above and illustrated in the drawings, but may be modified within the scope of the appended claims.

CLAIMS

1. A brake control system for vehicles with hydraulic brakes, for preventing wheel blocking and/or spinning, c h a r a c t e r i s e d in that the brake system (1) is separable, by means of a valve (3), one for each wheel (2), into a primary circuit (4) including the brake pedal, the main cylinder/cylinders, and the brake fluid tank, and a secondary circuit (5) including the wheel cylinder/cylinders; that sensors (6) are provided for each wheel for sensing the rotational speed thereof; that a control device (7) is provided for comparison between the speeds sensed by the sensor (6), said control device (7) being adapted, at a sensed abnormal condition (wheel blocking or spinning) of one or more wheels, to activate the respective valve (3); and that a pressure control system (8) in the respective secondary circuit (5) is adapted to control the pressure therein independently of the pressure in the primary circuit (4), in order to cancel the abnormal condition of the corresponding wheel.

2. A brake control system as claimed in claim 1, c h a r a c t e r i s e d in that the valve is a valve which is normally open in the brake system and which, upon actuation by means of said control device (7), closes the communication between the primary circuit (4) and the secondary circuit (5) and opens a communication (12) with the pressure control system (8).

3. A brake control system as claimed in claim 2, c h a r a c t e r i s e d in that the valve (3) includes a piston or spool (9) which, by means of a return spring (10) or the like, is held in a normally open position, and which is adapted to be activated by means of an electromagnet (11) or the like.

4. A brake control system as claimed in claim 3, c h a r a c t e r i s e d in that the pressure control system (8) comprises a connecting pipe (12) between the secondary circuit side (5) of the valve (3) and the volume accommodating the piston (9) in the open valve position, such that, when the wheels are blocked and the valve thus is activated, movement of the piston to the closed valve position causes an increase of the volume of the secondary circuit (5) and thus a reduction of the pressure therein.

5. A brake control system as claimed in any one of claims 1-4, c h a r a c t e r i s e d in that the sensor (6) includes an inductive transducer which senses a toothed disk or the like, attached to the wheel hub or connected to the wheel in some other manner.

6. A brake control system as claimed in any one of claims 1-2, c h a r a c t e r i s e d in that the sensor includes a roller which revolves against the brake disk or some other part connected to the wheel, and which is mechanically connected to the valve (3) for activation thereof.

7. A brake control system as claimed in claim 6, c h a r a c t e r i s e d in that contact of the roller with the brake disk is controlled by the brake pressure within the primary circuit or by a magnet activated by, for example, the brake wheel contact; and that the roller, if no braking occurs, does not come into contact with the disk.

8. A brake control system as claimed in any one of claims 1-5, c h a r a c t e r i s e d in that the control device (7) includes an electronics unit which, if there is a risk of wheel blocking or spinning, activates the respective pressure control system.

9. A brake control system as claimed in claim 8, c h a r a c t e r i s e d in that the control device

during braking deactivates the pressure control system at a suitable minimum vehicle speed.

10. A brake control system as claimed in any one of the preceding claims, c h a r a c t e r i s e d in that the pressure control system includes a piston (16) which is movable within a cylinder (15) and which, by means of a spring (17) or an external pressure source (18) for, for example, compressed air, is urged towards its one end position in which the cylinder space, when the valve is activated, is connected to the secondary circuit (5), such that the pressure therein urges the piston (16) towards its other end position, whereby the volume in the secondary circuit side of the cylinder is increased and the pressure therein is reduced.

11. A brake control system as claimed in claim 10, c h a r a c t e r i s e d in that the return spring (17) or the external pressure source (18) on deactivation of the valve (3) urges the piston back into its first end position, whereby the brake fluid within the cylinder space is pressed back to the brake circuit via a nonreturn valve (19).

12. A brake control system as claimed in claim 10 or 11, c h a r a c t e r i s e d in that the pressure control system also includes a second valve (20) between the external compressed air source (18) and the piston (16), said second valve (20) opening and closing the connection in cooperation with the activating valve (3).

13. A brake control system as claimed in claim 12, c h a r a c t e r i s e d in that the second valve (20) is mechanically connected to the activating valve (3).

14. A brake control system as claimed in claim 13, c h a r a c t e r i s e d in that the connection of the pressure control system with the brake system is in the form of a duct, the throughflow resistance of which controls the piston speed.

15. A brake control system as claimed in claim 1, c h a r a c t e r i s e d in that the valve (3) includes a spool (9) which is maintained, by means of the return spring, in a normal open intermediate position, and the connecting pipe (12) between the primary circuit side (4) and the secondary circuit side (5) of the valve and the spool bore; and that the spool (9) is movable, by means of electromagnets (11), in either direction and adapted to close the connection between the primary and the secondary circuit, movement of said spool in one direction increasing the volume of the secondary circuit (5) and thus reducing the pressure therein, and movement in the opposite direction reducing the volume of the secondary circuit and thus increasing the pressure therein.

16. A brake control system as claimed in claim 15, c h a r a c t e r i s e d in that the valve includes a by-pass (21) between the primary side and the secondary side of the spool (9), said by-pass on the primary side opening in the spool bore adjacent the spool end position and on the secondary side opening in said bore in the neutral spool position, a pressure-controlled nonreturn valve (22) in said by-pass permitting brake fluid flow from the secondary side to the primary side.

AMENDED CLAIMS

[received by the International Bureau on 01 March 1988 (01.03.88);
original claims 1–16 replaced by amended claims 1–13 (3 pages)]

1. A brake control system for vehicles with hydraulic brakes, for preventing wheel blocking and/or spinning, comprising a valve (3), one for each wheel (2), which when activated separates the brake system (1) into a primary circuit (4) including the brake pedal, the main cylinder/cylinders, and the brake fluid tank, and a secondary circuit (5) including the wheel cylinder/cylinders; sensors (6) for each wheel for sensing the rotational speed thereof; a control device (7) for comparison between the speeds sensed by the sensor (6), said control device (7) being adapted, at a sensed abnormal condition (wheel blocking or spinning) of one or more wheels, to activate the respective valve (3); and a pressure control system in the respective secondary circuit (5) adapted to control the pressure therein independently of the pressure in the primary circuit (4), in order to cancel the abnormal condition of the corresponding wheel, c h a r a c t e r i s e d in that the pressure control system includes a piston or spool (9,16) which is movable within a cylinder (15) and which, by means of a spring (17) or an external pressure source (18) for, for example, compressed air, is urged towards its one end position in which the cylinder space, when the valve is activated, is connected to the secondary circuit (5), such that the pressure therein urges the piston (16) towards its other end position, whereby the volume in the secondary circuit side of the cylinder is increased and the pressure therein is reduced.

2. A brake control system as claimed in claim 1, c h a r a c t e r i s e d in that the return spring (17) or the external pressure source (18) on deactivation of the valve (3) urges the piston back into its first end position, whereby the brake fluid within the cylinder space is pressed back to the brake circuit via a nonreturn valve (19).

3. A brake control system as claimed in claim 1 or 2, c h a r a c t e r i s e d in that the pressure control system also includes a second valve (20) between the external compressed air source (18) and the piston (16), said second valve (20) opening and closing the connection in cooperation with the activating valve (3).

4. A brake control system as claimed in claim 3, c h a r a c t e r i s e d in that the second valve (20) is mechanically connected to the activating valve (3).

5. A brake control system as claimed in claim 4, c h a r a c t e r i s e d in that the connection of the pressure control system with the brake system is in the form of a duct, the throughflow resistance of which controls the piston speed.

6. A brake control system as claimed in claim 1, c h a r a c t e r i s e d in that the valve (3) and the pressure control system form an integral unit including a spool (9) which is maintained, be means of the return spring, in a normal open intermediate position, and connecting pipes (12) between the primary circuit side (4) and the secondary circuit side (5) respectively of the valve and the spool bore outwards of the spool as seen from the through flow opening of the valve; and that the spool (9) can be activated to be moveable in either direction and is adapted to close the connection between the primary and the secondary circuit, movement of said spool in one direction increasing the volume of the secondary circuit (5) and thus reducing the pressure therein, and movement in the opposite direction reducing the volume of the secondary circuit and thus increasing the pressure therein.

7. A brake control system as claimed in claim 6, c h a r a c t e r i s e d in that the valve includes a by-pass (21) between the primary side and the secondary side of the spool (9), said by-pass on the primary side opening in the spool bore adjacent the spool end position and on the secondary side opening in said bore in the

neutral spool position, a pressure-controlled nonreturn valve (22) in said by-pass permitting brake fluid flow from the secondary side to the primary side.

8. A brake control system as claimed in any one of claims 1-7, c h a r a c t e r i s e d in that the valve is adapted to the activated by means of electromagnets (11) or the like.

9. A brake control system as claimed in any one of claims 1-8, c h a r a c t e r i s e d in that the sensor (6) includes an inductive transducer which senses a toothed disk or the like, attached to the wheel hub or connected to the wheel in some other manner.

10. A brake control system as claimed in any one of claim 1-7, c h a r a c t e r i s e d in that the sensor includes a roller which revolves against the brake disk or some other part connected to the wheel, and which is mechanically connected to the valve (3) for activation thereof.

11. A brake control system as claimed in claim 10, c h a r a c t e r i s e d in that contact of the roller with the brake disk is controlled by the brake pressure within the primary circuit or by a magnet activated by, for example, the brake light contact; and that the roller, if no braking occurs, does not come into contact with the disk.

12. A brake control system as claimed in any one of claims 1-9, c h a r a c t e r i s e d in that the control device (7) includes an electronics unit which, if there is a risk of wheel blocking or spinning, activates the respective pressure control system.

13. A brake control system as claimed in claim 12, c h a r a c t e r i s e d in that the control device during braking deactivates the pressure control system at a suitable minimum vehicle speed.

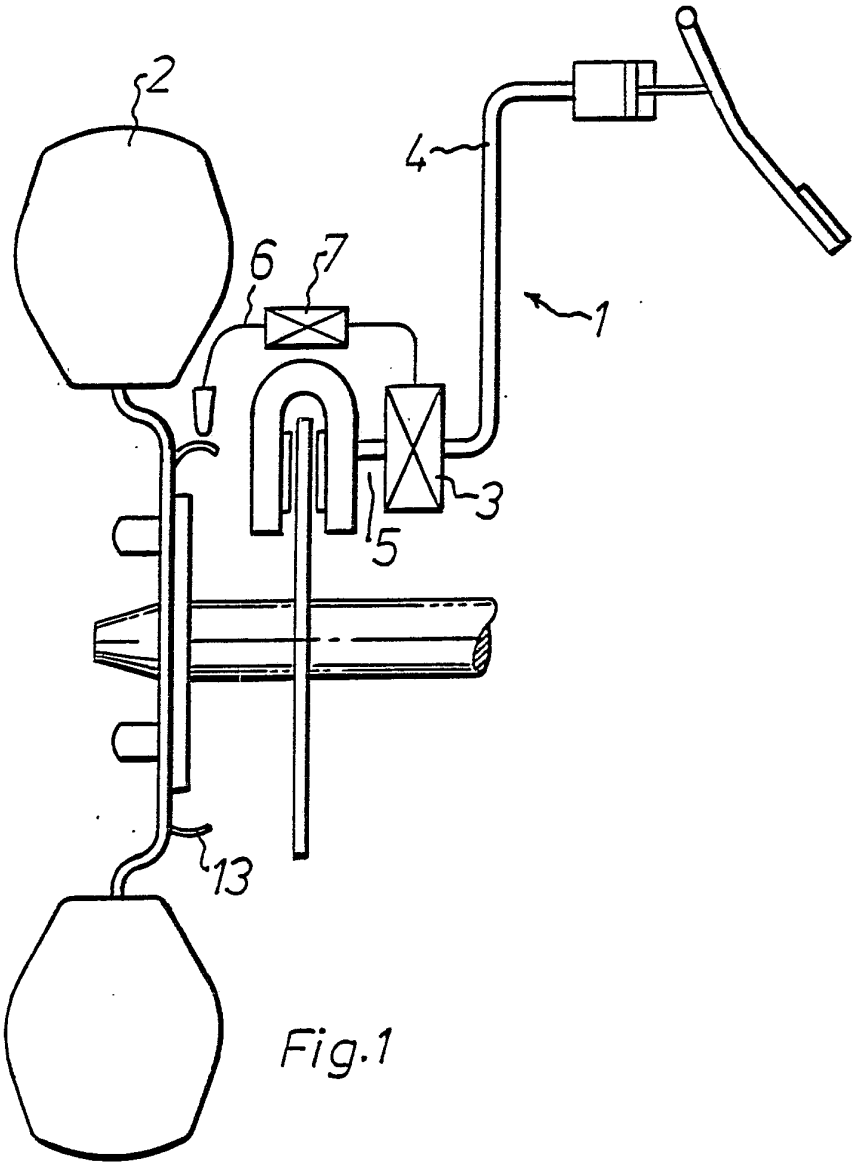


Fig.1

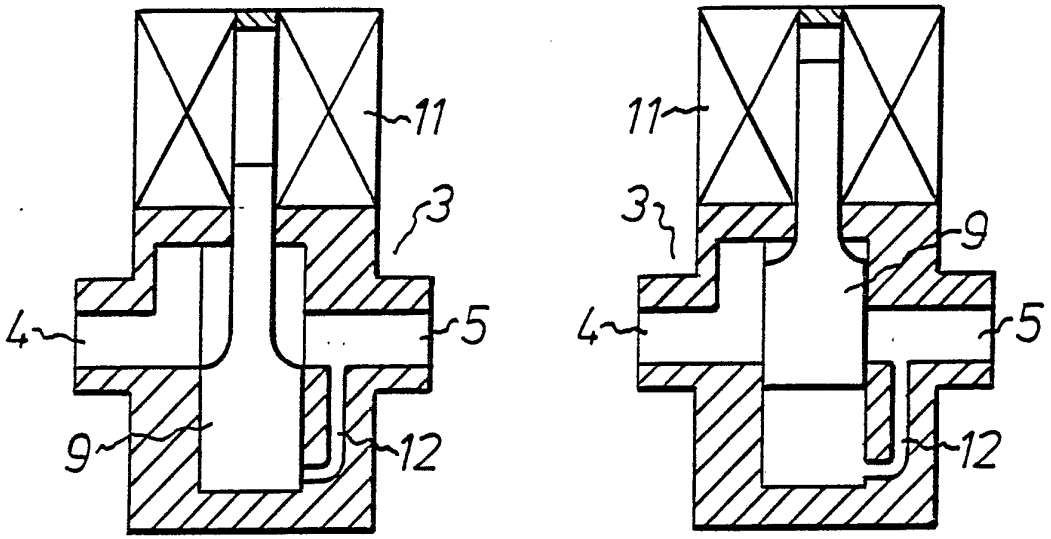


Fig. 2

Fig. 3

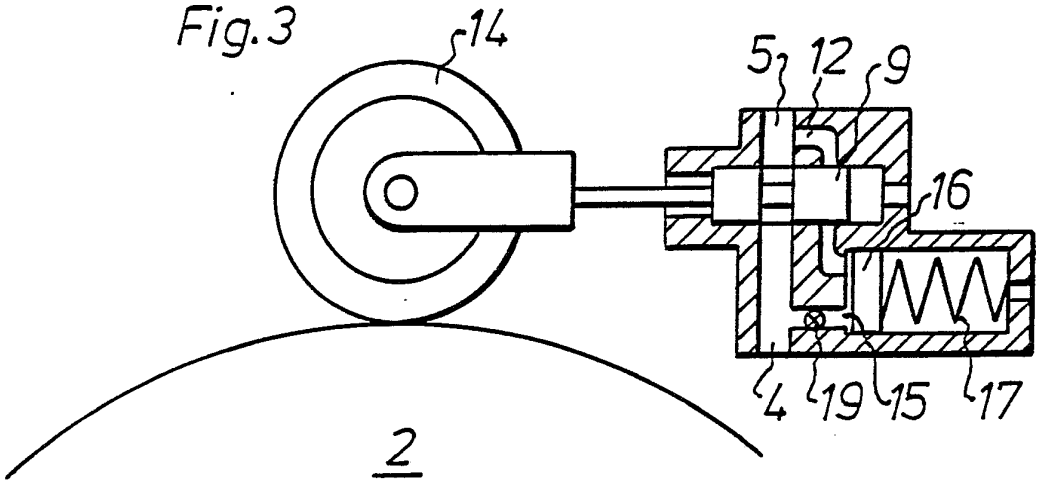
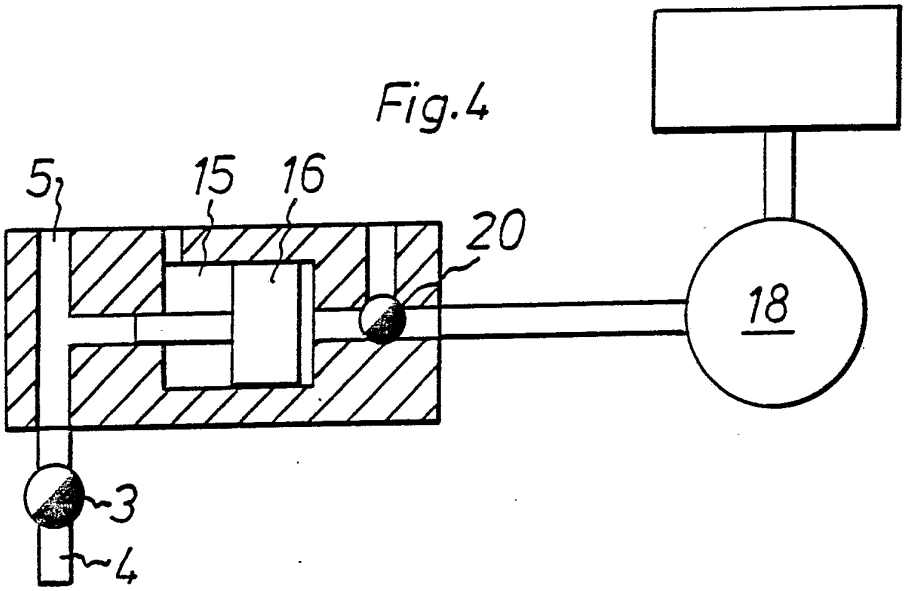


Fig.4



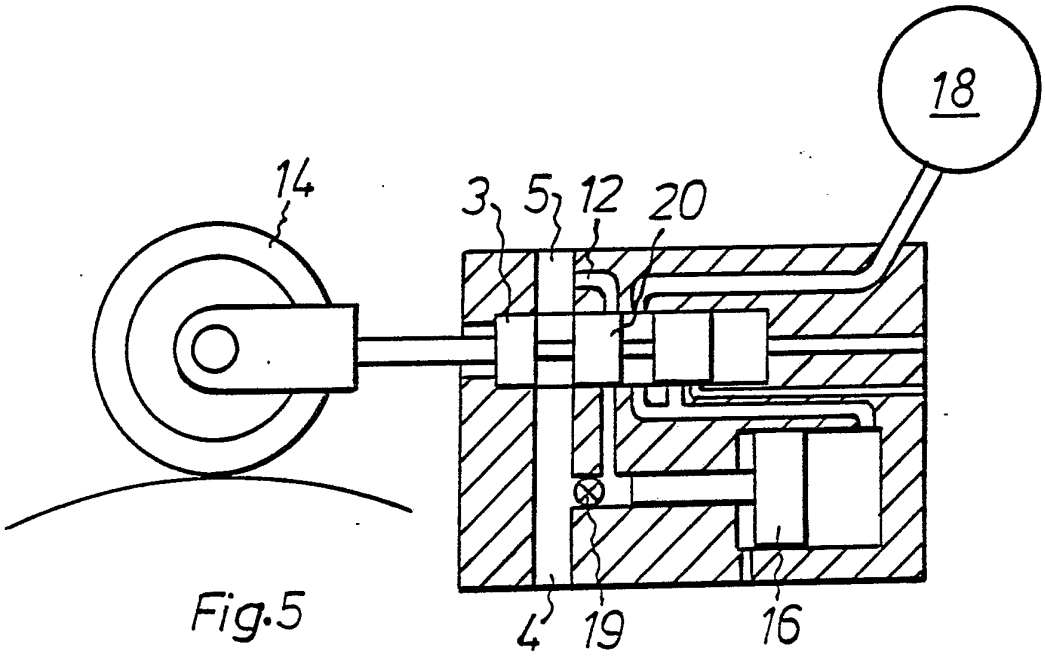


Fig.5

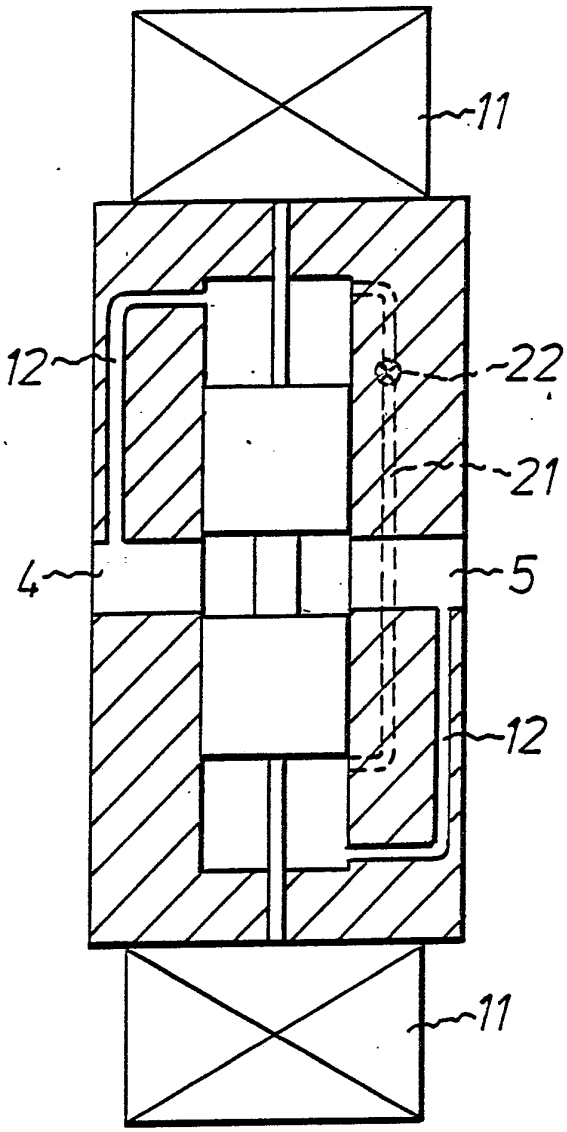


Fig.6

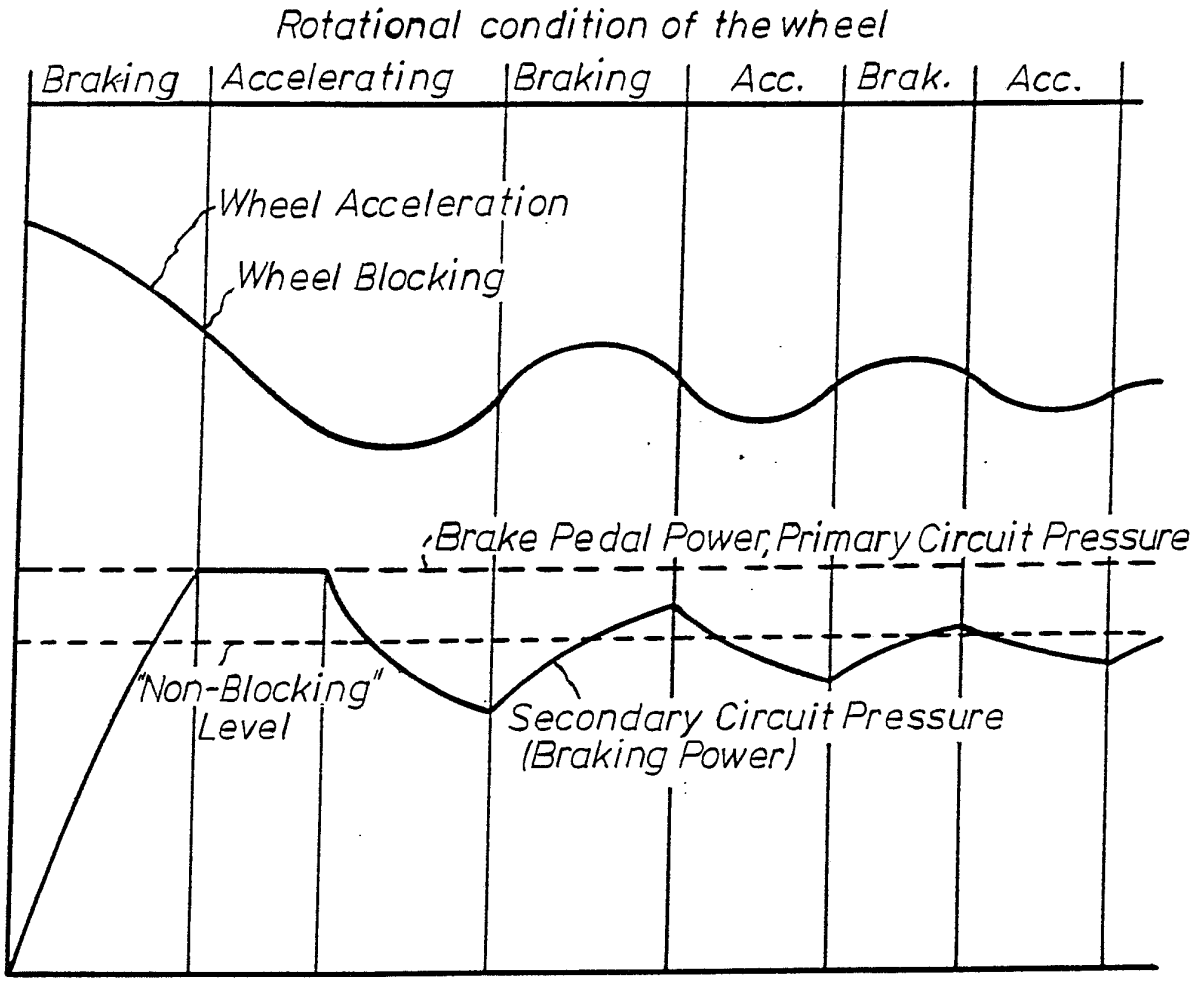

Rotational condition of the wheel
Braking
Accelerating
Braking
Acc.
Brak.
Acc.
Wheel Acceleration
Wheel Blocking
Brake Pedal Power, Primary Circuit Pressure
"Non-Blocking" Level
Secondary Circuit Pressure (Braking Power)

Fig.7

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE87/00521

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

B 60 T 8/42

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	B 60 T 8/00, /02, /32-/48; B 60 K 28/00
US Cl	303: 13-19, 115-119

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	DE, A1, 3 603 074 (FAG KUGELFISCHER GEORG SCHÄFER KGaA) 5 March 1987 & SE, 8603251 FR, 2586389	1,2,3,4,8
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X	DE, A1, 3 322 422 (ALFRED TEVES GmbH) 3 January 1985	1,2,3,4,8
X	US, A, 4 436 348 (FARR) 13 March 1984 & GB, 2107416 FR, 2514307 FR, 2514308 DE, 3237813 DE, 3237792 JP, 58076351 GB, 2109493 US, 4457563	1,2,3,4,8, 15

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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

"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

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1987-01-08	1988 -02- 03
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	C-G Elander

MJ

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
X	US, A, 3 574 416 (DEREK ROBERT SKOYLES) 13 April 1971 & NL, 6815508 DE, 1806478 GB, 1227950 FR, 1604396 SE, 354615	1,2,3,4,8