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B60T 8/48

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UK CL (Edition J) F2F FFE
INT CL⁴ B60T

(54) Vehicle anti-skid and drive slip control system

(57) A drive-slip control system adapted to an anti-skid control system comprises a third valve arrangement (12), associated with at least one driven wheel (4; 4a) and disposed between a pressure medium reservoir (1) and a first anti-skid valve arrangement (7, 7a), establishes a line to an inlet (20) of a pump (21) which, in the case of drive-slip control, delivers a quantity of pressure medium at a predetermined pressure set by valve (33) into a brake line, (3, 26) closed during drive-slip control by a second valve arrangement (5), between the first valve arrangement (7, 7a) and the second valve arrangement (5). In alternative constructions the second valve is by-passed. (Fig 5, not shown), a second reservoir is provided (Figs 6, 7, not shown) and a second pump is provided (Figs 8 to 11, not shown).

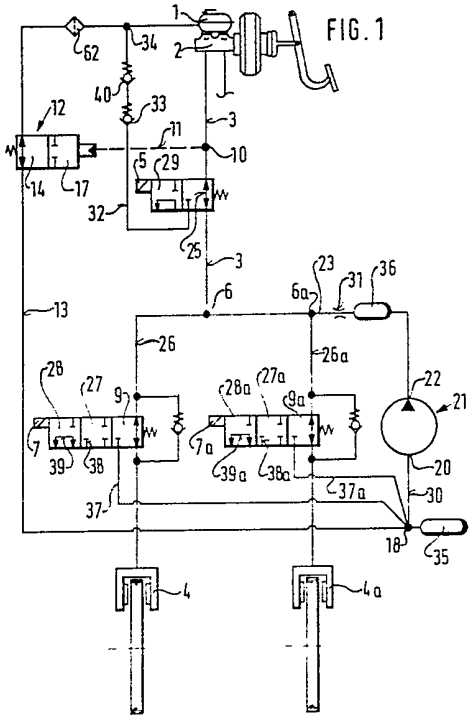

FIG. 1

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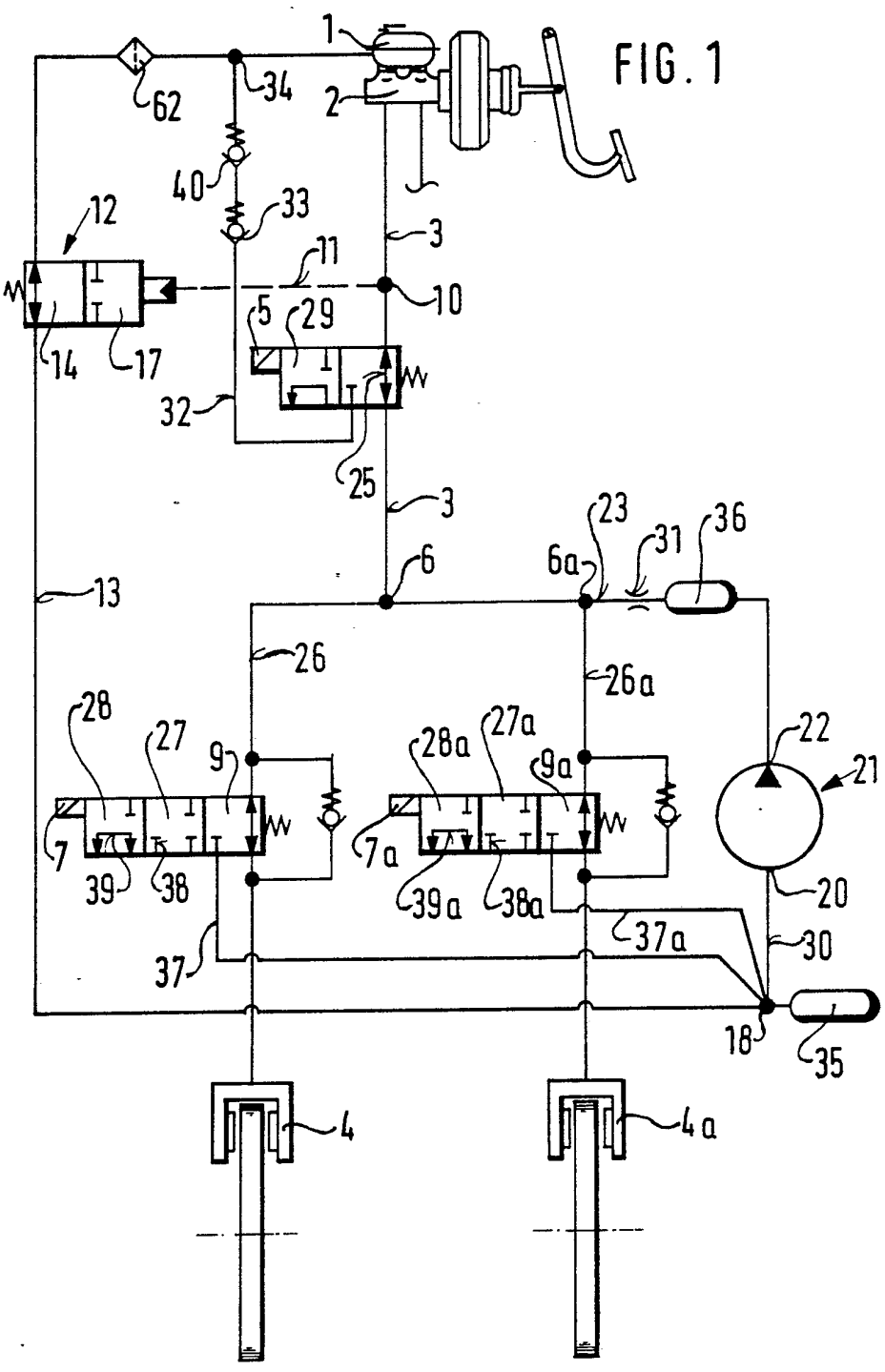
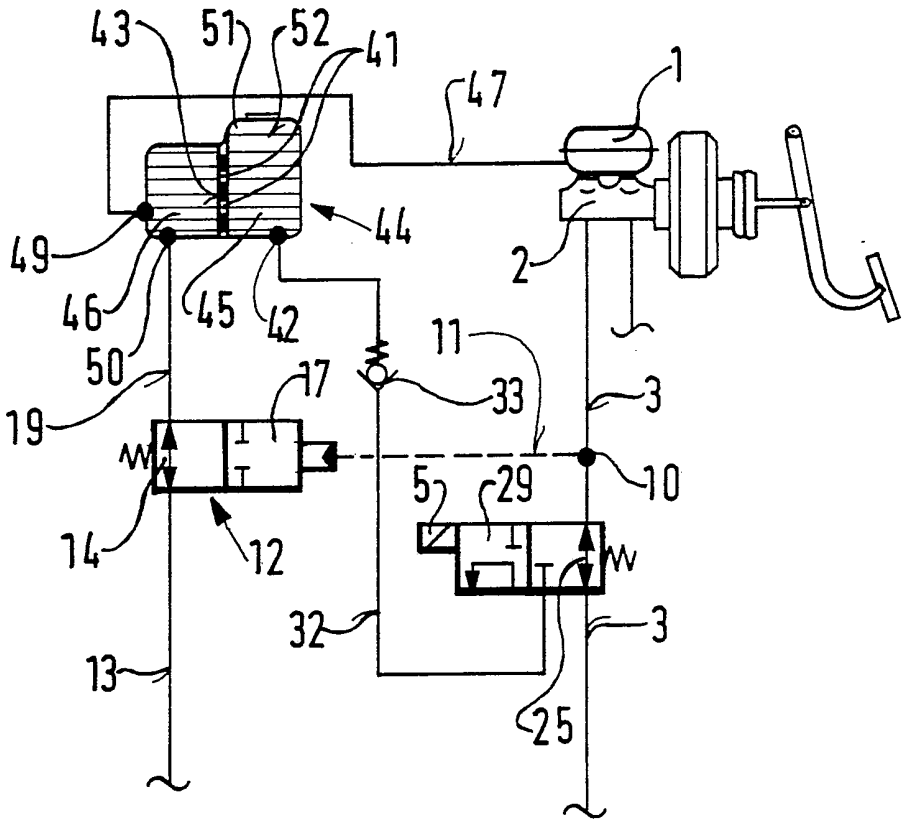


FIG. 1

FIG. 2



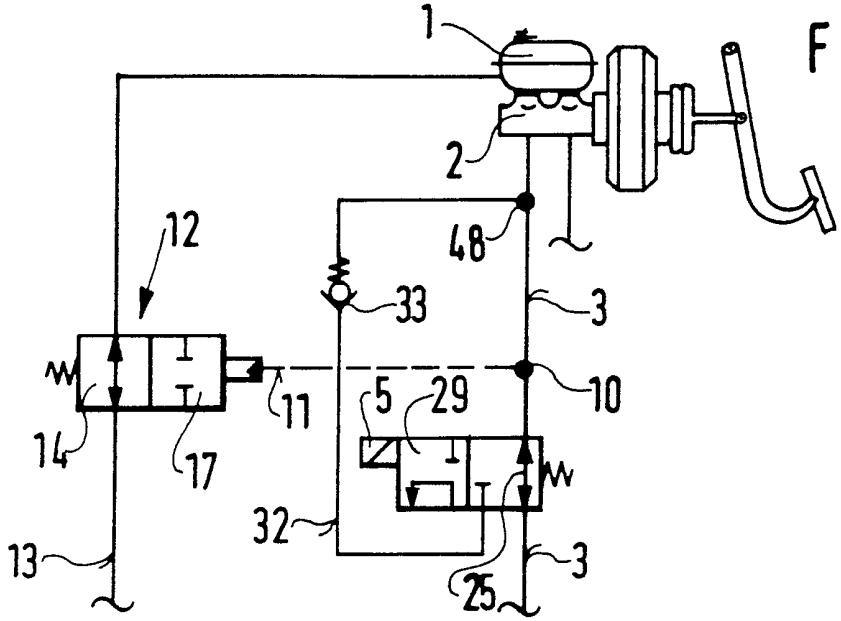

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FIG. 3

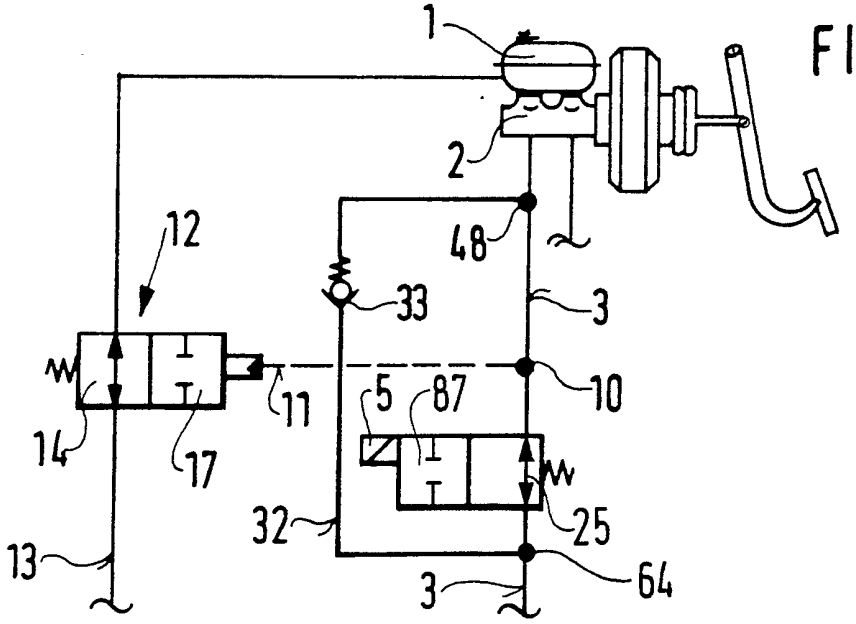
1
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FIG. 5

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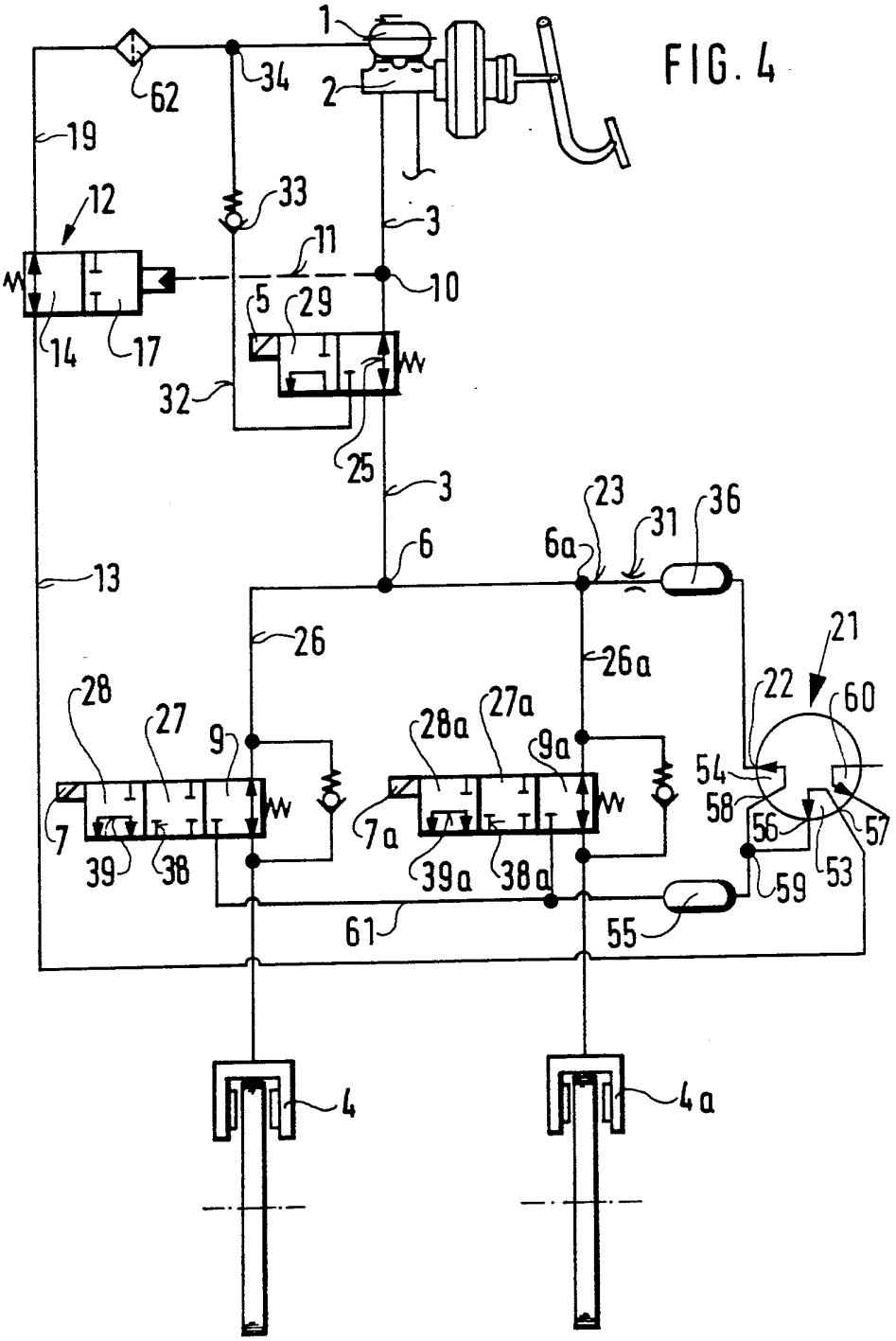
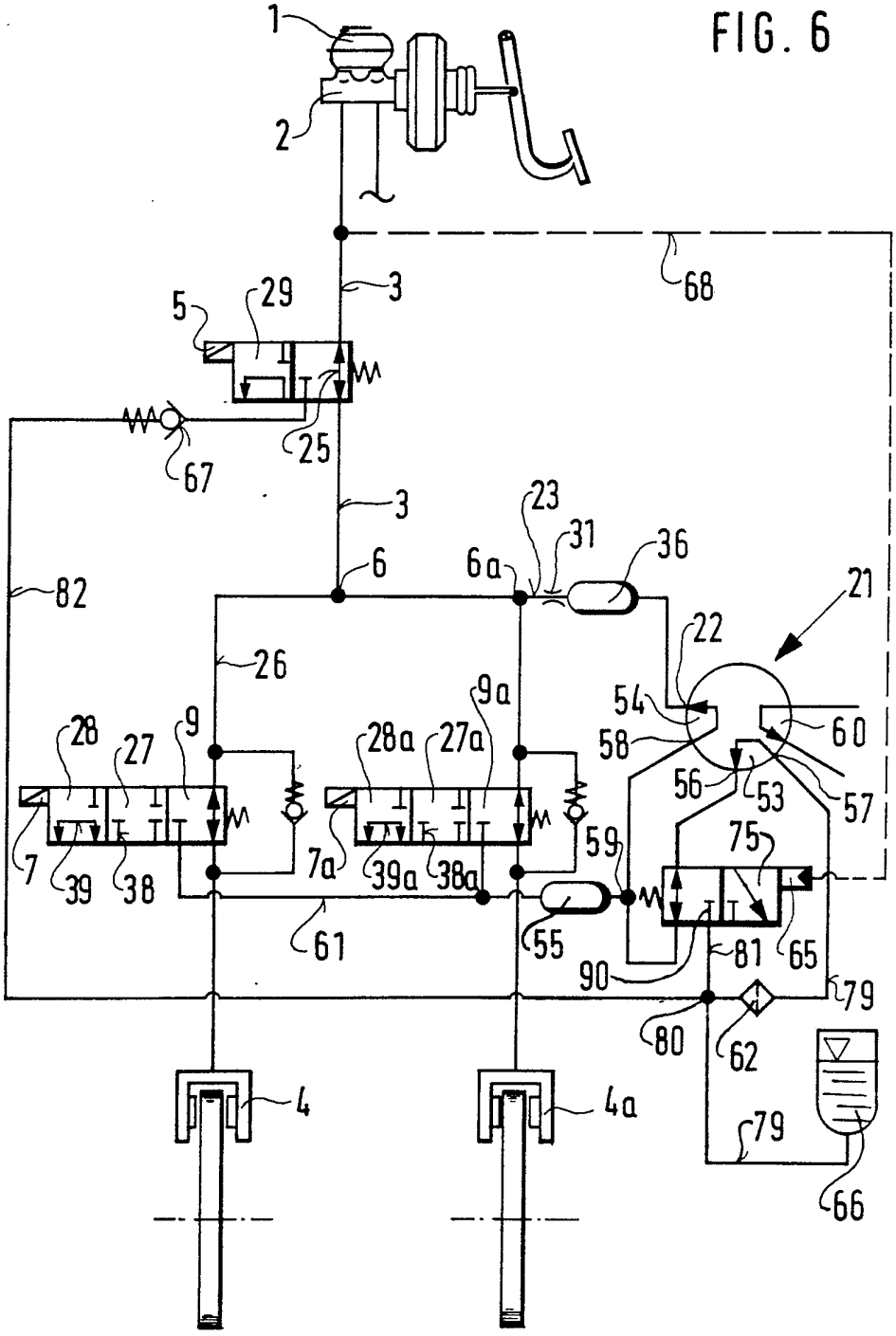


FIG. 4

FIG. 6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6a
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9a
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27
9
28a
27a
58
60
56
53
57
59
75
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90
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65
79
80
62
4
4a
79
66

FIG. 7

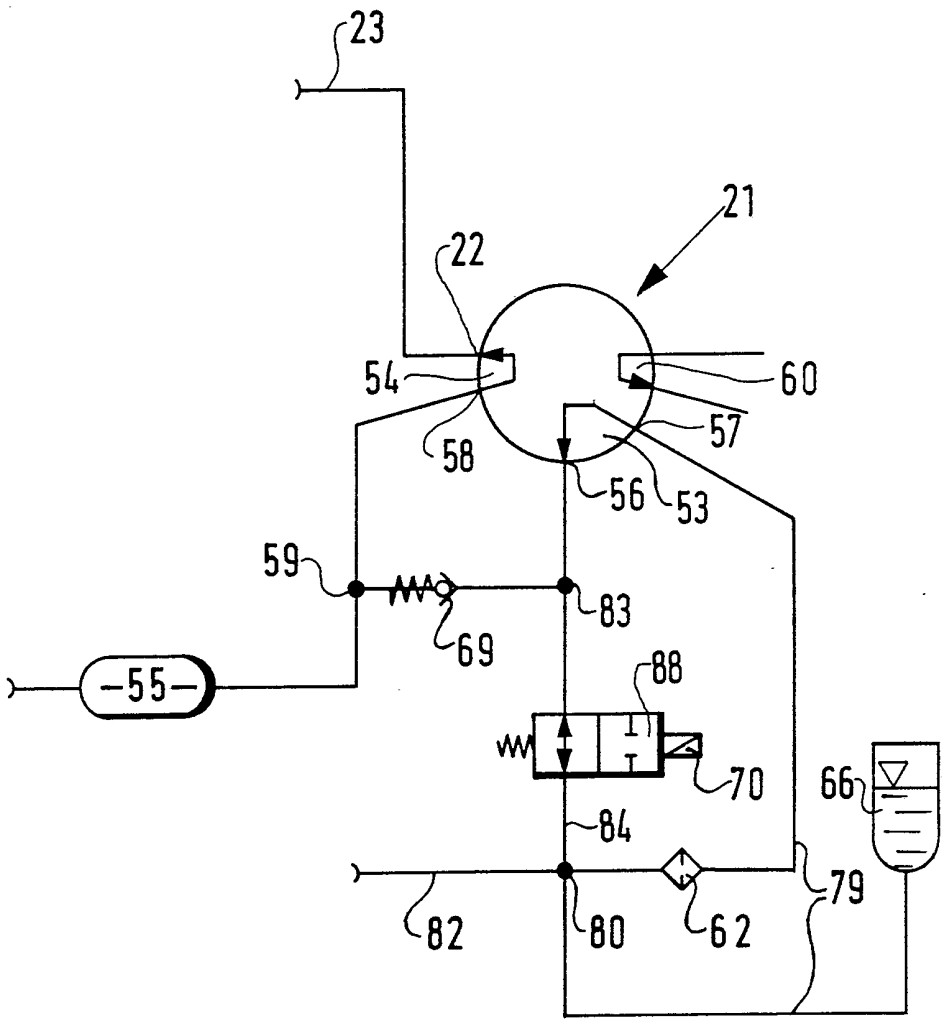

FIG.8

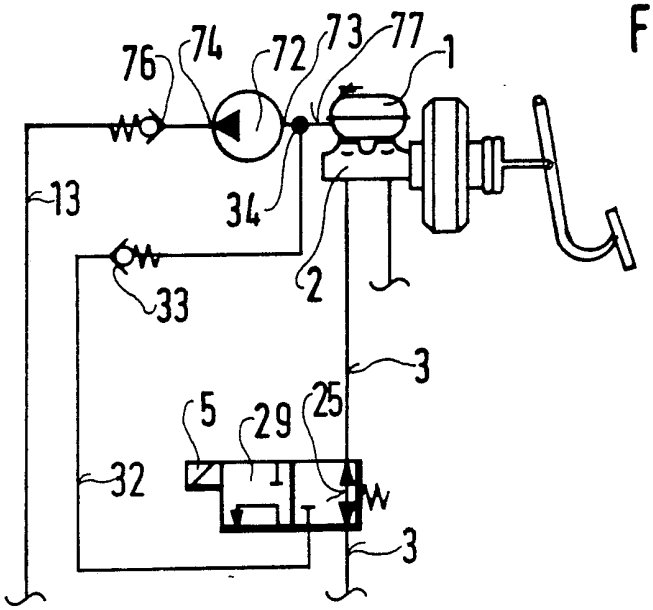
76
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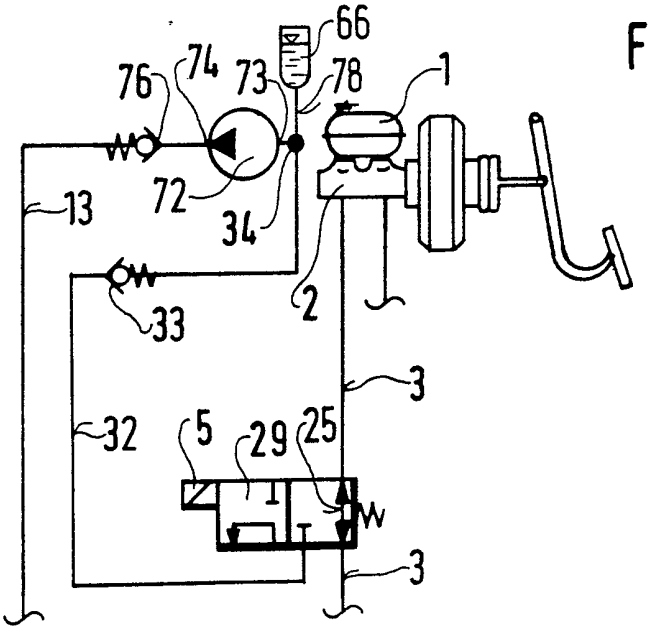
FIG.9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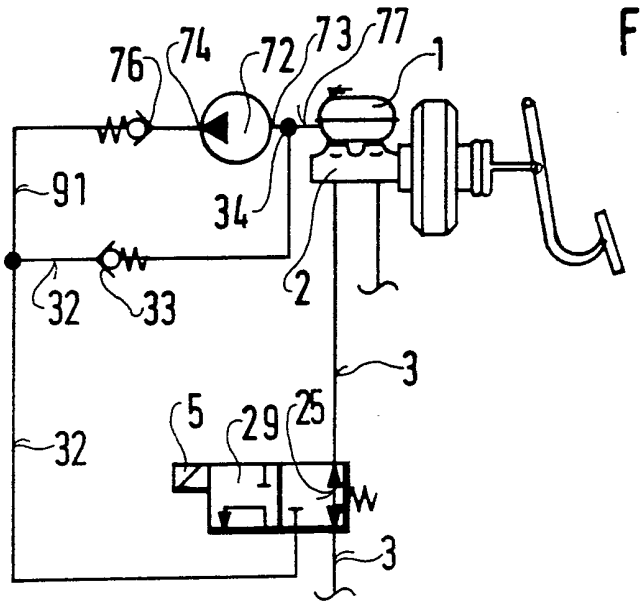
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FIG.10

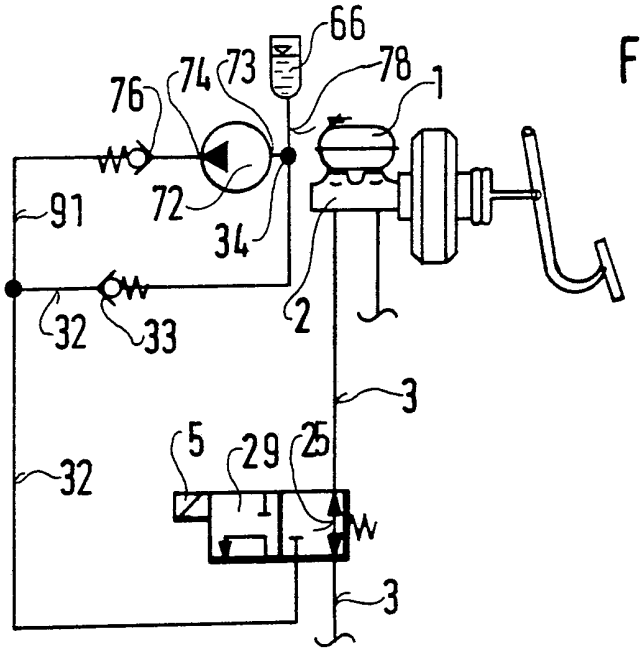
66
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FIG.11

DESCRIPTION

ANTI-SKID AND DRIVE-SLIP CONTROL SYSTEM

The invention relates to an anti-skid and drive-slip control system for a vehicle whose wheels each have an associated brake cylinder which is connected to a master cylinder by way of a brake line and to at least one pressure medium reservoir, having at least one first valve arrangement which is associated with one of the driven wheels and is located in the brake line and which, in the case of anti-skid and drive-slip control, can assume at least switching positions for the build-up of pressure and the reduction of pressure at a wheel brake, and a second valve arrangement which is associated with at least one of the brake circuits and which is located between the master cylinder and the first valve arrangement and by which the connection between the master cylinder and the first valve arrangement in one of the brake circuits is controllable only during drive-slip control, and at least one self-priming pump whose inlet side is connectible to the wheel brake cylinders upon pressure reduction by the first valve arrangement and by which pressure medium is pumpable into the brake line between the first and the second valve arrangements. Furthermore a third valve arrangement can be provided which is associated with

at least one driven wheel and by which a line existing between the pressure medium reservoir and the first valve arrangement of the brake circuit may be opened or closed, and the inlet side of the at least one self-priming pump being also connected to the third valve arrangement which is opened in the case of drive slip control.

An anti-skid and drive-slip control system of this type is known from German Offenlegungsschrift 36 27 809. In this known anti-skid and drive-slip control system, a predetermined quantity of pressure medium is taken from a pressure medium reservoir by a pump by way of a valve element for the purpose of controlling the drive-slip of the driven wheels of a vehicle. The valve element, together with lines leading to the valve element, effects a high throttling resistance. Consequently, it is not always ensured that a quantity of pressure medium will be made available with sufficient rapidity in the case of drive-slip control. A further disadvantage resides in the fact that an additional shut-off valve is required in a return line from the outlet of the pump to the pressure medium reservoir.

In accordance with the present invention, an anti-skid and drive-slip control system for vehicles is provided where a first pressure-controlled valve,

opening towards the pressure medium reservoir, is disposed in a return line which leads from the second valve arrangement and which is connected to the pressure medium reservoir, and wherein the second valve arrangement shuts off the return line towards the brake line during anti-skid control and, during drive-slip control, opens the return line towards the brake line between the second valve arrangement and the first valve arrangement.

A further embodiment of an anti-skid and drive slip control system is provided where a return line by-passing the second valve arrangement is provided with a first pressure-controlled valve which opens towards the master cylinder, which return line leads to the brake line between the second valve arrangement and the master cylinder, wherein the second valve arrangement closes the return line towards the brake line during anti-skid control and, during drive-slip control, opens the return line to the brake line between the second valve arrangement and the first valve arrangement.

In a further embodiment the self-priming pump is connected by a first inlet of a first pump element to an additional pressure medium reservoir, and to the second valve arrangement by way of a further line and a non-return valve opening towards the first inlet

and, in the case of drive-slip control, a fourth valve arrangement connects an outlet of the first pump element to an inlet of a second pump element of the pump, the brake line between the second valve arrangement and the first valve arrangement being connectible to the further line when the second valve arrangement is in a position in which the brake line between the master cylinder and the first valve arrangement is closed.

In a further embodiment the inlet of an additional feed pump is connected to the pressure medium reservoir and the outlet of the said additional feed pump is connectible to the first valve arrangement, and that a first pressure-controlled valve, opening towards the pressure medium reservoir, is diposed in a return line which leads from the second valve arrangement and is connected to the pressure medium reservoir, wherein the second valve arrangement closes the return line towards the brake line in the case of anti-skid control and, in the case of drive-slip control, opens the return line towards the brake line between the second valve arrangement and the first valve arrangement.

The above has the advantage of simple design and a small number of individual units, and that, in the case of drive-slip control, the pressure medium is not

throttled between the pressure medium reservoir and the pump.

A further advantage resides in the fact that the second valve arrangement at the same time controls the return line to the pressure medium reservoir. The return line leading through the master cylinder to the pressure medium reservoir has the advantage that a second pressure-controlled valve is not required. Advantageously, a higher degree of filling may be obtained by constructing the pump from two pump elements.

The arrangement of the additional pump has the further advantage that a higher degree of filling of the system is achieved.

The quantity of pressure medium flowing back to the pressure medium reservoir can be steadied by an intermediate reservoir, disposed in the return line to the pressure medium reservoir, and a second pressure-controlled valve.

A control line branching to the third valve arrangement from the brake line can be provided which has the advantage that a further valve is not required.

Advantageously, the suction operation of the pump can be effected by way of short line portions, in order to avoid throttling losses.

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

Fig. 1 shows a first embodiment of an anti-skid and drive-slip control system constructed in accordance with the present invention;

Fig. 2 is a partial view of an anti-skid and drive-slip control system of a second embodiment of the present invention;

Fig. 3 is a partial view of an anti-skid and drive-slip control system of a third embodiment of the present invention;

Fig. 4 shows a fourth embodiment of an anti-skid and drive-slip control system;

Fig. 5 is a partial view of an anti-skid and drive-slip control system in accordance with a fifth embodiment of the present invention;

Fig. 6 shows a sixth embodiment of an anti-skid and drive-slip control system;

Fig. 7 is a partial view of an anti-skid and drive-slip control system of a seventh embodiment of the present invention;

Fig. 8 is a partial view of an anti-skid and drive-slip control system of an eigth embodiment of the present invention;

Fig. 9 is a partial view of a ninth embodiment of an anti-skid and drive-slip control system;

Fig. 10 is a partial view of an anti-skid and drive-slip control system in accordance with a tenth embodiment of the present invention; and

Fig. 11 is a partial view of an anti-skid and drive-slip control system of an eleventh embodiment of the present invention.

In the various embodiments like reference numerals are used for components which are the same and which operate in the same way.

Referring to Fig. 1, an anti-skid and drive-slip control system for vehicles has a pressure medium reservoir 1 for brake fluid, and a multi-circuit master cylinder 2 of known construction. A brake line 3 commences from the said multi-circuit master cylinder 2 from at least one brake circuit chamber and leads to at least one wheel-lock or drive-slip controlled wheel brake cylinder 4, 4a.

The brake line 3 leads from the multi-circuit master cylinder 2 to an electromagnetically operable second valve arrangement 5, and then, by way of feed points 6, 6a, to a respective one of electro-magnetically operable first valve arrangement 7, 7a which, when in their respective flow-through positions 9, 9a, establish communication with at least one

wheel brake cylinder 4, 4a, for each wheel. The first valve arrangement may comprise a three-port, three-position valve as illustrated, or two two-port, two-position valves of known construction. The second valve arrangement 5 is a three-port, two-position solenoid valve.

A connection point 10 is provided in the brake line 3 between the multi-circuit master cylinder 2 and the second valve arrangement 5 and is connected to an adjusting device of a pressure-controlled third valve arrangement 12 by way of a control line 11. The valve arrangement 12 is disposed in a line portion 13 which is provided between the pressure medium reservoir 1 and the first valve arrangement 7, 7a and the valve arrangement 12 has a flow-through position 14 and is switchable into a closed position 17 by a predetermined hydraulic pressure acting upon the adjusting device of the third valve arrangement 12. The line portion 13 leading from the third valve arrangement 12 towards the first valve arrangement 7, 7a, has a feed point 18 which is connected to the first valve arrangement 7, 7a by way of line portions 37, 37a of the line portion 13. An inlet end 20 of a self-priming pump 21 is at the same time connected to the feed point 18 by way of a line portion 30. Alternatively, the pump 21 could have a plurality of

pump elements hydraulically connected in series, and a plurality of inlets forming the inlet end. At least one of the wheel brake cylinders 4, 4a is connectible to the inlet end 20 of the self-priming pump 21 by way of line portions 37, 37a connected to the feed point 18. A line 23 leads from an outlet 22 of the self-priming pump 21 to the feed points 6, 6a which, in the case of anti-skid control, are connected to the multi-circuit master cylinder 2 by way of the brake line and a flow-through position 25 of the second valve arrangement 5 and, by way of respective line portions 26, 26a to the first valve arrangement 7, 7a which have pressure-holding positions designated 27, 27a and pressure-reducing positions designated 28, 28a.

In the event of drive-slip control becoming necessary at a wheel brake cylinder 4, 4a associated with at least one wheel, the third valve arrangement 12 remains in its flow-through position 14, and the inlet end 20 of the pump 21 is then connected to a predetermined volume of pressure medium in the pressure medium reservoir 1 by way of the line portion 30 and the line portion 13 connected thereto, while the outlet 22 of the pump 21 is connected to one of the wheel brake cylinders 4, 4a by the line 23 by way of the feed points 6, 6a and at least one of the first valve arrangement 7, 7a, and, by way of the feed

point 6, to the second valve arrangement 5 which has been brought into a switching position 29. With the second valve arrangement 5 in its switching position 29, a return line 32 leading from the second valve arrangement 5 is connected to the line 23 leading from the outlet 22 of the pump 21 by way of the feed point 6, and a portion of the brake line 3. A first pressure-controlled valve 33 is disposed in the return line 32 and remains tightly closed during the build-up of pressure during the drive-slip control operation, and only opens in the direction towards the pressure medium reservoir 1 when a large increase in hydraulic operating pressure occurs during the drive-slip control operation. A second pressure-controlled valve 40, having a substantially lower opening pressure than the first pressure-controlled valve 33, is disposed downstream of the first-controlled valve 33. The return line 32 connects the second pressure-controlled valve 40, by way of a feed point 34, to the line portion 13 leading to the pressure medium reservoir 1 and to the third valve arrangement 12.

In the embodiment of Fig. 2, for the sake of simplicity, that part of the embodiment of Fig. 2 which is identical to Fig. 1 and which is contiguous to the lines of intersection of the lines 3, 13 downstream of the second valve arrangement 5 and the

third valve arrangement 12, has not been illustrated again. At least one first chamber 45 in an intermediate reservoir 44 is disposed in the return line 32 downstream of the first pressure-controlled valve 33 and communicates with a second chamber 46 of the intermediate reservoir 44 by means of a partition 43 provided with openings 41. A predetermined quantity of pressure medium flowing from the open first pressure-controlled valve 33 can enter the first chamber 45 through an inlet connection 42 of the intermediate reservoir 44. A space 51, free from pressure medium, in the first chamber 45 will receive a predetermined quantity of pressure medium and will allow air bubbles to escape from the pressure medium flowing back.

Pressure medium can overflow from the first chamber 45 into the second chamber 46 by way of the openings 41 provided in the partition 43, and then towards the pressure medium reservoir 1 through a first connection 49.

A second connection 50 on the second chamber 46 is connected to a line portion 19 leading to the third valve arrangement and, by means of the third valve arrangement 12, may be switched to the inlet side of the pump and isolated therefrom.

In the embodiment of Fig. 3, which is similarly only a partial illustration corresponding to Fig. 2, the return line 32 downstream of the first pressure-controlled valve 33 is connected to a feed point 48 to the brake line 3 between the second valve arrangement 5 and the multi-circuit master cylinder 2. A predetermined quantity of pressure medium can be returned through the multi-circuit master cylinder 2 into the pressure medium reservoir 1 communicating with the multi-circuit master cylinder 2.

In the embodiment of Fig. 4, the self-priming pump 21 is provided with a first pump element 53 and a second pump element 54. The inlet end of the pump 21 is formed by a first inlet 57 associated with the first pump element 53, and a second inlet 58 associated with the second pump element 54. The first inlet 57 associated with the first pump element 53 is connected to the line portion 13 connected to the third valve arrangement 12. A feed point 59 is disposed downstream, between an outlet 56 of the first pump element 53 and the second inlet 58 of the second input element 54, a third reception chamber 55 being connected to the feed point 59 and to a line portion 61 leading to the first valve arrangement 7, 7a.

The pump 21 may be equipped with further pump elements for a brake circuit which may additionally

be provided for the anti-skid and drive-slip control system, which pump elements may operate individually like a third pump element 60 (as illustrated), or operate together like the two pump elements 53, 54.

A filter 62 is disposed in a line portion 19 between the pressure medium reservoir 1 and the third valve arrangement 12 in such a way that, if required for drive-slip control, a pressure medium flowing downstream in the return line 32 can flow by way of the filter 62 to the third valve arrangement 12 and to the inlet end of the pump 21.

In the embodiment of Fig. 5, which is a partial illustration as above, a further feed point 64 is disposed in the brake line 3 between the second valve arrangement 5 and the first valve arrangement, and the return line 32 downstream of the first pressure-controlled valve 33 leads from the feed point 64 to the feed point 48 in the brake line 3 between the second valve arrangement 5 and the multi-circuit master cylinder 2. The second valve arrangement 5 is a two-port, two-position solenoid valve having a flow-through position 25 and a closed position 87.

In the embodiment of Fig. 6, a pressure medium line 79 leads from an additional pressure medium reservoir 66 to the first inlet 57 of the first pump element 53, and from the outlet 56 of the first

pump element 53 to the second inlet 58 of the second pump element 54 by way of a fourth valve arrangement 65 in the form of a three-port, two-position valve. The fourth valve arrangement 65 is either a solenoid valve or a pressure-controlled valve as illustrated, and is controlled from the brake line 3 by way of a control line 68. A line portion 81 branches from a feed point 80 between the additional pressure medium reservoir 66 and the first inlet 57 of the first pump element 53, and is connected to the fourth valve arrangement 65 and, in the event of drive-slip control, to the outlet 56 of the first pump element 53.

A further line 82 leads from the feed point 80 to a non-return valve 67 opening towards the feed point 80, and then to the second valve arrangement 5.

In the embodiment of Fig. 7, which is a partial illustration corresponding to Fig. 6, a non-return valve 69 opening towards the second pump element 54 is provided between the outlet 56 of the first pump element 53 and the inlet 58 of the second pump element 54. A line 84 leads from the outlet 56 of the first pump element 53 by way of a feed point 83, connected to the non-return valve 69, and through the fourth valve arrangement 70 to the feed point 80. The fourth valve arrangement 70 is a two-port, two-position solenoid valve.

In the embodiment of Fig. 8, which is a partial illustration of Fig. 1, an inlet 73 of an additional feed pump 72 is connected to the pressure medium reservoir 1 by way of a line portion 77. An outlet 74 of the additional feed pump 72 is connected by way of a non-return valve 76 to the line system 13 which leads to the inlet side of the pump and to the first valve arrangement without an interposed third valve arrangement. The return line 32 leads from the second valve arrangement 5, through the first pressure-controlled valve 33, and to the feed point 34 into the line portion 77 between the pressure medium reservoir 1 and the inlet 73 of the additional feed pump 72.

In the embodiment of Fig. 9, which is a partial illustration of Fig. 1, the additional pressure medium reservoir 66, is, in contrast to the embodiment of Fig. 8, connected to the inlet 73 of the additional feed pump 72 by way of a line 78, and the connection to the pressure medium reservoir 1 is omitted.

In the embodiment of Fig. 10, referring back to Fig. 8, a delivery line 91 is connected to the return line 32 between the second valve arrangement 5 and the first pressure-controlled valve 33, and to the outlet 74 of the additional feed pump 72 by way of the non-return valve 76.

In the embodiment of Fig. 11, the inlet 73 of the additional feed pump 72 is connected to the additional pressure medium reservoir 66 by way of the line 78 in the same way as in the embodiment of Fig. 9, and not to the pressure medium reservoir 1 in the manner shown in Fig. 10.

During a braking operation, the mode of operation of the conventional brake system in all embodiments is not affected by a specific valve arrangement nor by the arrangement of the pump 21 in the overall system. If one of the wheels, or a plurality of the wheels, tend to lock, sensors disposed on the wheels transmit, in a known manner, signals to an electronic control unit by which the first valve arrangement 7, 7a are then actuated electromagnetically and switched into a second position 27, 27a "pressure-holding" or into a third position 28, 28a "reduction of pressure", whereby pressure modulation occurs in the wheel brake cylinders 4, 4a. The pump 21 is also switched on when the valves are energised, in order to be able to relieve the wheel brake cylinders of the surplus quantity of pressure medium. In the case of the wheel brake cylinder 4, the first valve arrangement 7 switches into the second position 27 when required during "pressure-holding", and the first valve arrangement 7a will remain in the flow-through

position 9a. If the pressure in the wheel brake cylinder 4 subsequently has to be reduced, the first valve arrangement 7 is switched into the third position 28, and pressure medium which has become surplus is taken from the connected lines by a first reception chamber 35 connected in the line portion 13, and by the pump 21. The line portion 13 between the first valve arrangement 7, 7a and the pressure medium resevoir 1 is closed by the pressure-controlled third valve arrangement 12 when the value of the hydraulic presure in the brake line 3 is in excess of approximately 10 bar. Such a pressure will also develop very rapidly in the brake line 3 in the case of anti-skid regulation occurring on a smooth roadway, since a specific pressure medium is returned from the outlet 22 of the pump 21 into the line portions 26, 26a, offering a small volumetric capacity, and into the brake line 3, by way of a second reception chamber 36 connected to the line 23, a throttle 31 and the feed points 6, 6a, pressure is built up, and at the same time a specific hydraulic pressure from the multi-circuit master cylinder 2 continues to have an effect in the brake line 3 during a continuing deceleration phase of a vehicle.

In the embodiments of Figs. 4, 6 and 7, the second pump element 54 of the pump 21 is used on its

own to return the quantity of pressure medium, which has become surplus, from the wheel brake cylinders 4, 4a in the case of anti-skid control. Communication between the first pump element 53 and the second pump element 54, and hence communication between the additional pressure medium reservoir 66 and the second pump element 54, is interrupted by the fourth valve arrangement 65, 70.

In the embodiments of Figs. 8 to 11, pressure medium is returned in a known manner from the first valve arrangement 7, 7a to the multi-circuit master cylinder 2 by the pump 21, while the additional feed pump 72 remains out of operation in the case of drive-slip control. The second valve arrangement 5 assumes its position 25 in which the brake circuit line 3 is opened.

If one of the wheels is about to leave its state serving for propulsion during moving-off, this is detected in a known manner by a sensor and is transmitted by a signal of the electronic control unit to at least one first valve arrangement associated with a drive wheel. The wheel brake cylinders 4, 4a are associated with at least one drive wheel and may be controlled individually or collectively for the purpose of drive-slip control.

The mode of operation in the case of drive-slip control, which is the same in all embodiments, will now be described. In the case of drive-slip control, the second valve arrangement 5 is put into switching position 29 or 87 by a controlled change-over operation, so that the return line 32 is connected to the brake line 3 in every case. An inlet 20 or 57 of the pump 21, which is simultaneously switched on, is in continuous communication with one of the pressure medim reservoirs 1, 66 and the outlet 22 of the pump 21 can deliver pressure medium into the line 23 at a predetermined hydraulic pressure. If the pump 21 comprises two pump elements 53, 54, the two pump elements deliver pressure medium. The line portions between one of the pressure medium reservoirs 1, 66 and one of the inlets 20, 57 of the pump 21 must be kept as short as possible, in order to keep the flow resistance in the suction line of the pump 21 as low as possible.

In the case of drive-slip control, the additional feed pump 72 in the embodiments of Figs. 8 and 9 additionally delivers pressure medium towards the inlet side 20 of the pump 21 simultaneously switched on.

Pressure medium is delivered from the outlet 22 of the pump 21 into the brake line 3 between the

second valve arrangement 5 and the first valve arrangement 7, 7a, and may then be fed to at least one wheel brake cylinder 4, 4a. If, during a pressure modulation by at least one of the valve arrangements 7, 7a, an increased hydraulic pressure occurs in the return line 32 provided with the first pressure-controlled valve 33, the first pressure-controlled valve 33 opens towards the pressure medium reservoir 1 or 66 and maintains the pressure in the return line 33 approximately constant.

In the embodiments of Figs. 10 and 11, the additional feed pump 72 delivers pressure medium towards the outlet 22 of the pump 21 by way of the brake line 3, and at the same time towards the first valve arrangement 7, 7a and into the connected return line 32. The pressure medium for the drive-slip control operation can be taken on the one hand from the pressure medium reservoir 1 (Fig. 10) connected to the multi-circuit master cylinder 2 and, on the other hand, from the separately disposed additional pressure medium reservoir 66 (Fig. 11).

Alternatively, the first pressure-controlled valve 33 may be accommodated in the switching position 29 of the second valve arrangement 5 in a known manner, wherein the second valve arrangement 5 may be a two-port, two-position solenoid valve.

If only one drive wheel is associated with one brake circuit in a split-up brake circuit, the volume of pressure medium is delivered by one of the first valve arrangement 7, 7a to one of the wheel brake cylinders 4, 4a associated with the drive wheel, and the other first valve arrangement 7a, 7 is switched to a shut-off position relative to the other wheel brake cylinder 4a, 4. The pressure modulation in one of the first wheel brake cylinders 4, 4a can be achieved by electromagnetic triggering of one of the first valve arrangement 7, 7a into the positions "pressure-holding" 27, 27a and "pressure reduction" 28, 28a. In this connection, at least one inlet of the switched-on pump 21 is connected to a respective shut-off connection 38, 38a of the respective second position 27, 27a, or to a respective flow-through connection 39, 39a of the respective third position 28, 28a of the first valve arrangement 7, 7a.

In the case of a quantity of pressure medium delivered from the outlet 22 of the pump 21 into the brake line 3 and into the return line 32, the pressure-controlled first valve 33 will open towards the pressure medium reservoir 1 or 66 at a pressure value of approximately 100 bar, and will not allow the pressure value in the brake line 3 to increase any further.

If the pressure drops below this pressure value at the fitst pressure-controlled valve 33, the first pressure-controlled valve 33 returns to its initial position and closes the return line 32.

The second pressure-controlled valve 40 disposed downstream of the first pressure-controlled valve 33 in the embodiment of Fig. 1 opens towards the pressure medium reservoir 1 at a pressure value of less than 10 bar, and hence provides for a stepped reduction in pressure in the return line 32, wherein the quantity of pressure medium flowing back is steadied and retarded, and evaporation is avoided.

In the embodiment of Fig. 2, a specific reduction in pressure of the quantity of pressure medium flowing downstream from the first pressure-controlled valve 33 into the intermediate reservoir 44 is achieved in that the pressure medium is first conducted through the inlet connection 42 into the first chamber 45 in which it can rapidly spread into the free space 51. Air bubbles entrained by the pressure medium can escape to the pressure medium level 52, communicating with the atmosphere, of the first chamber 45. Openings 41 in the partition 43 ensure a slow flow-through from a first chamber 45 into the second chamber 46 and then towards the pressure medium reservoir 1.

In the embodiment of Fig. 3, the quantity of pressure medium in the return line 32, flowing out of the first pressure-controlled valve 33, is conducted into the pressure medium reservoir 1 through the multi-circuit master cylinder 2, wherein the pressure can be reduced to the level of the pressure medium reservoir 1, and the quantity of pressure medium returned can be steadied and de-gassed.

In the embodiment of Fig. 4, the pump 21 is constructed with a first pump element 53 and a second pump element 54. The first pump element 53 co-operates, in the following manner, as a so-called pre-charging pump with the second pump element 54 to be designated "return pump". Pressure medium is sucked with low line loss through the shortest possible line portion 13 to the first inlet 57 of the first pump element 53 and is delivered with a pre-pressure into the shortest possible line between the outlet 56 of the first pump element 53 and the second inlet 58 of the second pump element 54. A pressure medium delivered with pre-pressure by the first pump element 53 is taken by the second pump element 54 and is conveyed, with increased pressure, from the outlet 22 of the pump 21 into the line portion 23. The pumps 21 of the embodiments of Figs. 6 and 7 operate in the same manner.

A self-priming pump having two pump elements operating at different pressures is known from DE-PS 26 46 583, so that its function and its advantages do not need to be further explained. The third reception chamber 55 serves as an accumulator for the pressure medium flowing through the lines connected thereto.

In the embodiment of Fig. 5, the second valve arrangement 5 is switched into a closed position during the drive-slip control operation.

If an increased value of the pressure of the pressure medium occurs in the return line 32, the first pressure-controlled valve 33 opens towards the multi-circuit master cylinder 2 and does not allow the pressure to rise any further. The second valve arrangement 5 has a simplified mode of operation and is in the form of a two-port, two-position solenoid valve.

In the embodiment of Fig. 6, pressure medium for the drive-slip control operation is drawn from the additional pressure medium reservoir 66 by the first pump element 53 of the pump 21 and is delivered towards the second pump element 54 of the pump 21 by way of the fourth valve arrangement 65 which is in the position illustrated.

The pressure medium is delivered at increased pressure by the second pump element 54 into the lines

between the second valve arrangement 5 and the first valve arrangement 7, 7a. The second valve arrangement 5 is switched into the switching position 29 during drive-slip control.

If the pressure in the brake line 3 reaches an increased value of approximately 100 bar, the non-return valve 67 in the further line 82, forming a return line, opens towards the additional pressure medium reservoir 66 and towards the first inlet 57 of the first pump element 53 of the pump 21. The fourth valve arrangement 65 is controlled by way of the hydraulic control line 68 in such a way that, at a pressure in excess of approximately 10 bar in the brake line 3, the fourth valve arrangement 65 is, in the manner described above, brought into a position 75 in which the outlet 56 of the first pump element 53 is connected to the inlet 57 and to the additional pressure medium reservoir 66.

In the embodiment of Fig. 7, the non-return valve 69 disposed between the outlet 56 of the first pump element 53 and the inlet 58 of the second pump element 54 of the pump 21, in conjunction with the fourth valve arrangement 70 switchable into a closed position 88 in the case of anti-skid control, opens a pressure medium passage between the outlet 56 of the first pump element 53 and the inlet 58 of the second pump element

54 of the pump 21, the inlet 57 of the first pump element 53 being connected to the additional pressure medium reservoir 66.

In the embodiment of Fig. 8, communication between the pressure medium resevoir 1 and the return line 32 connected to the brake line 3 is established by the switching position 29 of the second valve arrangement 5 during drive-slip control when the pressure value in the return line 32 reaches approximately 100 bar and the second pressure-controlled valve 33 opens.

In the embodiment of Fig. 9, pressure medium in excess of approximately 100 bar flows through the return line 32 into the additional pressure medium reservoir 66 or to the inlet of the additional feed pump 72 during drive-slip control, as described with reference to Fig. 8.

In the embodiments of Figs. 10 and 11, the first pressure-controlled valve 33 will open and pressure medium will flow back through the return line during drive-slip control when a pressure value in excess of approximately 100 bar is produced in the brake line 3 by the pump 21 and the additional feed pump 72.

If two drive wheels are associated with one brake circuit in the case of a split brake circuit, a quantity of pressure medium for drive-slip control may

be introduced into at least one of the wheel brake cylinders 4, 4a by at least one of the first valve arrangement 7, 7a, and the first valve arrangement 7a, 7 associated with another wheel brake cylinder 4a, 4 can be switched into a cut-off position.

If it is necessary to use two drive wheels in a brake circuit, a specific pressure may be admitted commonly to the two wheel brake cylinders 4, 4a, as well as a pressure differing from wheel brake cylinder to wheel brake cylinder.

The drive wheels may be brought into a state for propulsion by way of pressure modulation which can be performed individually by each first valve arrangement 7, 7a for each wheel brake cylinder 4, 4a.

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CLAIMS

1. An anti-skid and drive-slip control system for a vehicle whose wheels each have an associated brake cylinder which is connected to a master cylinder by way of a brake line and to at least one pressure medium reservoir, having at least one first valve arrangement which is associated with one of the driven wheels and is located in the brake line and which, in the case of anti-skid and drive-slip control, can assume at least switching positions for the build-up of pressure and the reduction of pressure at a wheel brake, and a second valve arrangement which is associated with at least one of the brake circuits and which is located between the master cylinder and the first valve arrangement and by which the connection between the master cylinder and the first valve arrangement in one of the brake circuits is controllable only during drive-slip control, and at least one self-priming pump whose inlet side is connectible to the wheel brake cylinders upon pressure reduction by the first valve arrangement and by which pressure medium is pumpable into the brake line between the first and the second valve arrangements, and a third valve arrangement which is associated with at least one driven wheel and by which a line between the pressure medium reservoir and the first valve

arrangement of the brake circuit may be opened or closed, and the inlet side of the at least one self-priming pump being also connected to the third valve arrangement which is opened in the case of drive slip control, wherein a first pressure-controlled valve, opening towards the pressure medium reservoir, is disposed in a return line which leads from the second valve arrangement and which is connected to the pressure medium reservoir, and wherein the second valve arrangement shuts off the return line towards the brake line during anti-skid control and, during drive-slip control, opens the return line towards the brake line between the second valve arrangement and the first valve arrangement.

2. An anti-skid and drive-slip control system as claimed in claim 1, wherein a second pressure-controlled valve, opening towards the pressure medium reservoir, is disposed in the return line downstream of the first pressure-controlled valve and opens at a substantially lower pressure than the first pressure-controlled valve.

3. An anti-skid and drive-slip control system as claimed in claim 1, wherein an intermediate reservoir having at least two chambers is disposed in the return line downstream of the first pressure-controlled valve, and the return line opens by way of at least

one inlet connection into at least one first chamber of the intermediate reservoir which is connected to a second chamber and from which a first connection leads to the pressure medium reservoir and a second connection leads to the third valve arrangement.

4. An anti-skid and drive-slip control system as claimed in any preceding claim, wherein a control line, branching from the brake line between the master cylinder and the second valve arrangement, leads to the third valve arrangement, and the third valve arrangement may be brought into a closed position during braking and anti-skid control when the control pressure in the control line is above a specific value.

5. An anti-skid and drive-slip control system as claimed in any preceding claim, wherein a first reception chamber is connected to a portion of the line existing between the first valve arrangement and the third valve arrangement.

6. An anti-skid and drive-slip control system as claimed in any preceding claim, wherein a second reception chamber is connected by way of a throttle valve to the brake line between the first valve arrangement and the second valve arrangement.

7. An anti-skid and drive-slip control system as claimed in any preceding claim, wherein a line portion establishing communication between the pressure medium

reservoir and the first valve arrangement has a feed point to which are connected line portions leading to the first valve arrangement and a line portion leading to the inlet side of the pump.

8. An anti-skid and drive-slip control system as claimed in claim 7, wherein the line portions between pressure medium reservoir and feed point, and between feed point and inlet side of the pump, are kept as short as possible.

9. An anti-skid and drive-slip control system as claimed in claim 1, wherein a filter is disposed in a line portion between the pressure medium reservoir and the third valve arrangement, and the return line opens into the line portion between filter and pressure medium reservoir.

10. An anti-skid and drive-slip control system for a vehicle whose wheels each have an associated brake cylinder which is connected to a master cylinder by way of a brake line and to at least one pressure medium reservoir, having at least one first valve arrangement which is associated with one of the driven wheels and is located in the brake line and which, in the case of anti-skid and drive-slip control can assume at least switching positions for the build-up of pressure and the reduction of pressure at a wheel brake, and a second valve arrangement which is

associated with at least one of the brake circuits and which is located between the master cylinder and the first valve arrangement and by which the connection between the master cylinder and the first valve arrangement in one of the brake circuits is controllable only during drive-slip control, and at least one self-priming pump whose inlet side is connectible to the wheel brake cylinders upon pressure reduction by the first valve arrangement and by which pressure medium is pumpable into the brake line between the first and the second valve arrangements, and a third valve arrangement which is associated with at least one driven wheel and by which a line between the pressure medium reservoir and the first valve arrangement of the brake circuit may be opened or closed, and the inlet side of the at least one self-priming pump being also connected to the third valve arrangement which is opened in the case of drive-slip control, wherein a return line by-passing the second valve arrangement is provided with a first pressure-controlled valve which opens towards the master cylinder, which return line leads to the brake line between the second valve arrangement and the master cylinder, and wherein the second valve arrangement closes the return line towards the brake line during anti-skid control and, during drive-slip control,

opens the return line to the brake line between the second valve arrangement and the first valve arrangement.

11. An anti-skid and drive-slip control system as claimed in claim 10, wherein a control line, branching from the brake line between the master cylinder and the second valve arrangement, leads to the third valve arrangement, and the third valve arrangement can be brought into a closed position during braking and anti-skid control when the control pressure in the control line is in excess of a specific value.

12. An anti-skid and drive-slip control system as claimed in claim 10 or 11, wherein a first reception chamber is connected to the line between the first valve arrangement and the third valve arrangement.

13. An anti-skid and drive-slip control system as claimed in claim 10, wherein a line portion, establishing communication between the pressure medium reservoir and the first valve arrangement, has a feed point to which are connected line portions leading to the first valve arrangement, and a line portion leading to the inlet side of the pump.

14. An anti-skid and drive-slip control system as claimed in claim 13, wherein the line portion

between pressure medium reservoir and feed point and between feed point and inlet side of the pump, are kept as short as possible.

15. An anti-skid and drive slip control system as claimed in claim 1 or 10, wherein the self-priming pump comprises a first pump element and a second pump element, and the inlet side of the pump is formed by a first inlet associated with the first pump element and a second inlet associated with the second pump element, and the outlet of the first pump element is connected to the inlet of the second pump element.

16. An anti-skid and drive-slip control system as claimed in claim 15, wherein the outlet of the first pump element and the inlet of the second pump element are connected to a third reception chamber to which the first valve arrangement is also connected.

17. An anti-skid and drive-slip control system as claimed in claim 16, wherein the line portions between the third valve arrangement and the inlet of the pump, and between the outlet of the first pump element and the inlet of the second pump element, are kept as short as possible.

18. An anti-skid and drive-slip control system as claimed in claim 10, wherein the return line leads from an outlet of the second valve arrangement in the form of a three-port, two-position solenoid valve.

19. An anti-skid and drive-slip control system as claimed in claim 10, wherein a feed point, from which the return line branches, is disposed in the line existing between the outlet side of the pump and the second valve arrangement.

20. An anti-skid and drive-slip control system as claimed in claim 19, wherein the second valve arrangement comprises a two-port, two-position solenoid valve.

21. An anti-skid and drive-slip control system for a vehicle, whose wheels each have an associated brake cylinder which is connected to a master cylinder by way of a brake line and to at least one pressure medium reservoir, having at least one first valve arrangement which is associated with one of the driven wheels and is located in the brake line and which, in the case of anti-skid and drive-slip control, can assume at least switching positions for the build-up of pressure and the reduction of pressure at a wheel brake, and a second valve arrangement which is associated with at least one of the brake circuits and which is located between the master cylinder and the first valve arrangement and by which the connection between the master cylinder and the first valve arrangement in one of the brake circuits is controllable only during drive-slip control, and at least one self-priming pump whose inlet side is

connectible to the wheel brake cylinders upon pressure reduction by the first valve arrangement and by which pressure medium is pumpable into the brake line between the first and the second valve arrangements, wherein the self-priming pump is connected by a first inlet of a first pump element to an additional pressure medium reservoir, and to the second valve arrangement by way of a further line and a non-return valve opening towards the first inlet and, in the case of drive-slip control, a fourth valve arrangement connects an outlet of the first pump element to an inlet of a second pump element of the pump, the brake line between the second valve arrangement and the first valve arrangement being connectible to the further line when the second valve arrangement is in a position in which the brake line between the master cylinder and the first valve arrangement is closed.

22. An anti-skid and drive-slip control system as claimed in claim 21, wherein a non-return valve opening towards the second pump element is disposed in the line between the outlet of the first pump element and the inlet of the second pump element of the pump.

23. An anti-skid and drive-slip control system as claimed in claim 21, wherein the fourth valve arrangement establishes communication between outlet and inlet of the first pump element during braking and anti-skid control.

24. An anti-skid and drive-slip control system as claimed in claim 23, wherein a control line, connected to the brake line between the master cylinder and the second valve arrangement, leads to the fourth valve arrangement and, when the control pressure is above a specific value, displaces the fourth valve arrangement into a position in which it establishes communication between the outlet and the inlet of the first pump element.

25. An anti-skid and drive-slip control system as claimed in claim 22, wherein, in the case of drive-slip control, the fourth valve arrangement shuts off communication between the outlet and the inlet of the first pump element, and connects the outlet to the inlet of the second pump element by way of a non-return valve.

26. An anti-skid and drive-slip control system for a vehicle whose wheels each have an associated brake cylinder which is connected to a master cylinder by way of a brake line and to at least one pressure medium reservoir, having at least one first valve arrangement which is associated with one of the driven wheels and is located in the brake line and which, in the case of anti-skid and drive-slip control, can assume at least switching positions for the build-up of pressure and the reduction of pressure at a wheel brake, and a second valve arrangement which is

associated with at least one of the brake circuits and which is located between the master cylinder and the first valve arrangement and by which the connection between the master cylinder and the first valve arrangement in one of the brake circuits is controllable only during drive-slip control, and at least one self-priming pump whose inlet side is connectible to the wheel brake cylinders upon pressure reduction by the first valve arrangement and by which pressure medium is pumpable into the brake line between the first and the second valve arrangements, wherein the inlet of an additional feed pump is connected to the pressure medium reservoir, and the outlet of the said additional feed pump is connectible to the first valve arrangement, and that a first pressure-controlled valve, opening towards the pressure medium reservoir, is disposed in a return line which leads from the second valve arrangement and is connected to the pressure medium reservoir, and wherein the second valve arrangement closes the return line towards the brake line in the case of anti-skid control and, in the case of drive-slip control, opens the return line towards the brake line between the second valve arrangement and the first valve arrangement.

27. An anti-skid and drive-slip control system as claimed in claim 26, wherein the outlet of the

additional feed pump is connected to the inlet of the self-priming pump by way of a line, and a non-return valve, opening towards the self-primiing pump, is disposed in the said line.

28. An anti-skid and drive-slip control system as claimed in claim 26, wherein the return line leads downstream into a line portion between the inlet of the additional feed pump and the pressure medium reservoir.

29. An anti-skid and drive-slip control system as claimed in claim 26, wherein the outlet of the additional feed pump is connected to the return line between the second valve arrangement and the first pressure-controlled valve.

30. An anti-skid and drive-slip control system as claimed in any one of claims 26 or 29, wherein two pressure medium reservoirs are provided, one of which reservoirs serves as a pressure medium reservoir of the master cylinder, and the other reservoir serves as an additional pressure medium reservoir to which the inlet of the additional feed pump is connected.

31. An anti-skid and drive-slip control system constructed and adapted to operate as described herein with reference to and as illustrated in the accompanying drawings.

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