1 588 909

PATENT SPECIFICATION

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(54) ANTI-SKID DEVICE

(71) We, ROBERT BOSCH GMBH, a German company of Postfach 50, 7 Stuttgart 1, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

The present invention relates to a brake anti-skid device in which there is a common regulation of the brake pressure in at least two brake cylinders. More particularly the present invention is an improvement in or relating to the brake anti-locking device as described and claimed in copending application No. 23370/77 (Serial No. 1 578 068). Claim 1 of the copending application claims a brake anti-locking device for the wheel brakes of a motor vehicle having joint regulation of the brake pressure in two or more brake cylinders of the vehicle, wherein a common 3/2-directional valve is placed in the brake line leading to the brake cylinders, the brake line is directed downstream of the 3/2-direction valve through respective line branches to the respective brake cylinders, and each of the line branches contains its own 2/2-directional valve; means being provided for controlling the valves in accordance with a signal indicative of brake locking.

A brake anti-skid device is already known from German Offenlegungsschrift 2 212 566, in which due to the nature of the regulation employed, distinct under-braking or over-braking of individual wheels takes place on asymmetric road surfaces and in the case of unsymmetrical vehicle brakes. This results in inadmissably long brake paths or very poor lateral guidance of the vehicle.

Although it is already known to avoid this disadvantage by individually monitoring each vehicle wheel, devices of this type are complicated and expensive.

There is provided by the present invention a brake anti-skid device for the wheel brakes of a motor vehicle, having common regulation of the brake pressure in at least two brake cylinders of a vehicle, in which anti-skid device a pressure-control valve combination is provided comprising a solenoid operated common 3 port, 2 position valve for connection in the brake line so that the brake line downstream of the 3 port, 2 position valve leads to a respective brake cylinder by way of a respective line branch, and a solenoid operated individual 2 port, 2 position valve for connection in each line branch wherein the multi-position valves, that is, the 3 and 2 port 2 position valves, are pneumatic pressure-control valves, and a unit comprising a pneumatic pressurizing cylinder and a hydraulic master cylinder, is fitted between said valves and each brake cylinder for the hydraulic actuation of the brakes of at least two vehicle wheels.

In contrast to the known anti-skid device, the device in accordance with the invention has the advantage that the brake pressure in at least two brake system cylinders or two wheel brake cylinders can be regulated individually by means of the pressure-control valve combination. By virtue of the choice of the arrangement of the pilot-control valves relative to the main valves, it is possible for the driver to release the brakes at any time and irrespective of the switching position of the pilot-control valves.

In the case of regulation in a wholly hydraulic circuit, this advantage would have to be ensured by additional non-return valves.

Furthermore, in the case of regulation in a wholly hydraulic circuit, differing solenoid valve control times would have to be accurately adjusted because of the incompressibility of the hydraulic brake medium. This is generally only achieved by close-tolerance throttle cross section or by additional electronic measures.

As a result of the compressibility of the compressed air, the compressed air control in accordance with the invention is not subject to this disadvantage, and differing solenoid valve control times conditioned by tolerance are negligible.

Thus, the control condition can be chosen to be the same for all solenoid valves.

This advantage becomes particularly evident if, when using units comprising pneumatic pressurizing cylinders and hydraulic master cylinders on only one vehicle axle, and the brake cylinders of the other axle are

actuated by compressed air, the two axles can be controlled identically despite their using brakes with an entirely different brake medium.

Furthermore, it is also advantageous that 3-channel brake-pressure modulation with transition from compressed air to hydraulics is rendered possible with a single pressure-control valve combination which is possibly arranged centrally. Finally, the piping and wiring is very simple when using a central pressure-control valve. This is particularly the case when arranging a central valve connector socket on the pressure-control valve.

Several embodiments of the invention are illustrated in the accompanying drawings, in which: —

Fig. 1 shows an anti-skid device of the invention having a 2-channel pressure-control valve combination for compressed air, and used with hydraulic actuation of the brake cylinders;

Fig. 2 is a diagram of a vehicle having two hydraulically braked axles each having such a 2-channel pressure-control valve combination for compressed air;

Fig. 3 shows different mode of control of two axles;

Fig. 4 shows a 3-channel pressure-control valve combination of the invention;

Fig. 5 shows the pressure-control valve of Fig. 4 in a vehicle having two hydraulically braked axles;

Fig. 6 shows the pressure-control valve of Fig. 4 in a vehicle having an hydraulically braked axle and an axle braked by compressed air;

Fig. 7 shows an arrangement of two 2-channel pressure-control valve combinations of a device of the invention, and

Fig. 8 is a reproduction of Figure 4 of the Parent Application.

Referring to Fig. 1 a compressed-air reservoir 1 is connected to a brake valve 2 which initiates actuation of two hydraulic brake cylinders 3 and 4. The two brake cylinders 3 and 4 actuate the wheel brakes of two vehicle wheels 5 and 6 which, for example, may be associated with a common vehicle axle 7.

A line comprising sections 8, 9 and 10, leading from the brake valve 2 to the brake cylinders 3 and 4, accommodates three solenoid pilot-control valves 11 and 12 and 13, each of which valves controls a line connection 14, 15 and 16 leading to respective main valves 17, 18 and 19. The central main valve 18 is connected directly to the line portion 8 and thus communicates directly with the brake valve 2. The main valve 18 is in the form of a 3 port, 2 position valve and controls a respective line branch 20 and 21 leading to the two other main valves 17 and 19 which are only 2 port, 2 position valves.

It will be seen that, in this manner, the 3 port, 2 position valve 18 is fitted in the line 8, 9, 10, that the conduit downstream of the 3 port, 2 position valve 18 leads to brake cylinders 3 and 4 by way of respective line branches 20 and 21, and that individual 2 port, 2 position valves 17 and 19 are fitted in each conduit branch 20 and 21 respectively.

The combination of the three solenoid pilot-control valves 11, 12 and 13 and the three main valves 17, 18 and 19 are commonly housed to form a pressure-control valve unit generally indicated by reference numeral 22. The pressure-control valve unit 22 accommodates four valve seats 23, 24, 24′ and 25 whose passages are controlled by diaphragm members, acting as valve closure members, namely, member 26 in respect of seat 23, diaphragm member 27 in respect of seats 24, 24′ and diaphragm member 28 in respect of seat 25. The line connections 14, 15 and 16 leading to the pilot-control valves 11, 12 and 13 open into working chambers 29, 30 and 31 which are defined by the diaphragm members 26, 27 and 28 respectively. The brake line 8 is connected to a valve inlet 32. The inlet 32 leads to the inlet valve seat 24′ of the 3 port, 2 position main valve 18, to the diaphragm member 27 of which is secured a rod 33 which passes into and through the aperture of the seat 24. The end of the rod 33 adjacent to the seat 24, carries a closure member 34. The closure member 34 and the valve seat 24 form an outlet valve 24/34 of the 3 port, 2 position valve 18 which controls an atmospheric air connection 36.

A unit 37 comprising a pneumatic pressurizing cylinder 39 and an hydraulic master cylinder 40 is fitted in the line 9 upstream of the brake cylinder 3, and a unit 38 comprising a pneumatic pressurizing cylinder 39′ and an hydraulic master cylinder 40′ is fitted in the line 10 upstream of the brake cylinder 4.

During normal braking, a free brake line passage exists between the brake valve 2 and the units 37 and 38 by way of the line 8, 9, 10. The units 37 and 38 convert the air brake pressure to an hydraulic brake pressure which enters the hydraulic brake cylinders 3 and 4.

The operation of the anti-skid device is now described with reference to Figure 8 which illustrates the regulating characteristic of the device in the form of a graph. In this graph, the time t is on the abscissa and on the ordinate there is plotted the brake pressure (dotted line for the brake cylinder 4 and solid line for the brake cylinder 3) and thereabove the vehicle- and wheel-speed.

If a wheel, for example, the wheel 6 having brake cylinder 4 is overbraked, the anti-locking device responds and the pilot valves 11 and 12 change over. The 3/2-directional main valve 18 is therefore changed over and allows air to flow from the cylinder 39′ to

the outside air. At the same time, the 2/2-directional main valve 17 switches to a closed position so that the pressure in the cylinder 39 actuating brake cylinder 39 not about to lock is maintained. At the end of the pressure reducing phase of cylinder 39', all the pilot valves 11, 12 and 13 change over. The 3/2-directional main valve 18 and the 2/2-directional main valve 17 switch to passage, the pressure in the cylinder 39 rises again and the 2/2-directional main valve 19 is disconnected so that the reduced brake pressure in the cylinder 39' is maintained. After a specific time at the end of the holding phase, the pilot valve 13 is disconnected again so that the main valve 19 again moves into its starting position for pressure increase. The reduced brake pressure in the cylinder 39' is stepped up again by switching the pilot valve 13 on and off. How the brake pressure course continues is easily discernible from the diagram.

It is advantageous that the brake pressure reduction and the brake pressure build-up of the two cylinders 39 and 39', are effected jointly by means of the 3/2-directional main valve 18 and that the common brake pressure modulation obtainable thereby by pressurizing and depressurizing those cylinders may be interrupted at any time by the 2/2-directional valves 17 and 19 which are connected in series to the relevant brake cylinder. It is therefore possible, despite economizing on a valve compared with a device having single wheel regulation, to control each of the two brake cylinders 3 and 4 individually. Only during the pressure-reducing phase of one cylinder 39 or 39' is the pressure increase in the other cylinder interrupted for the short duration of the reducing time by a holding phase.

Naturally, it is also possible with the proposed device to reduce the pressure in both cylinders 39 and 39' simultaneously.

The construction of the pressure-control valve unit 22 shows that, in the present instance, identical control solenoids having armatures, equipped with closure members, i.e. pilot-control valves 11, 12 and 13, are associated with the three multi-position valves 17, 18 and 19 used as main valves, and that the diaphragm member valve members 26, 27 and 28 of the multi-position valves 17, 18 and 19 are also the same on the pressure side. When in the non-energized closed position, communication with the working chamber is shut off by the armatures of the solenoids 11, 12 and 13. The pressure-control valve unit 22 it may be noted is of 2-channel construction, that is, it provides two separate supplies of pneumatic pressure, in this instance, for respective brake cylinders.

This 2-channel construction directly controls the pressure of the compressed air in the pressurizing cylinders 39 and 39' and thus controls indirectly, but accurately (by way of the master cylinders 40 and 40'), the pressure in the wheel brake cylinders 3 and 4. In this manner, identical control conditions can be obtained as in the case of a pure compressed air brake. In this instance, it is possible to omit throttles or other measures that are otherwise required in hydraulic control in the interests of accuracy of operations.

When the brake pressure introduced by the brake valve 2 is relieved the pressure is also reduced in the pressurizing cylinders 39 and 39' and, as a result of the direct communication thereof with the master cylinders 40 and 40', also in the wheel brake cylinders 3 and 4. When the solenoid valves 11, 12 and 13 are energized, pressure is in the first instance built up in the working chambers 29, 20 and 31 by way of the line connection 14, 15 and 16 leading to the valve inlet 32. The valve seats 23, 24 and 25 then open, and the pressure in the pressurizing cylinders 39 and 39' is reduced.

Fig. 2 shows a diagram of a vehicle having two hydraulically braked axles 41 and 42. 2-channel pressure-control valve units 43 and 44 respectively are used for the axles, and a unit 45, 46 and 47, 48 is used to operate the brake cylinder of each wheel, the construction of the pressure-control valve units 43 and 44 corresponding to that of valve unit 22 in Fig. 1, and the construction of the units 45 to 48 corresponding to that of units 37, 38 shown in Fig. 1. A two-circuit compressed air brake valve 49 is used as a brake valve.

Fig. 3 shows a diagram of a vehicle whose front axle 51 is braked hydraulically and whose rear axle 52 is braked with compressed air. It will be seen that, compared with the construction of Fig. 2, the units 47 and 48 have been omitted in the rear axle brake circuit, and a 2-channel pressure-control valve unit 53 is connected directly to two compressed air brake cylinders 54 and 55. Otherwise, the illustration is the same as that shown in Fig. 2. In this manner, despite the different pressure media on the front axle 51 and on the rear axle 52, the brakes of both axles can be controlled identically.

Fig. 4 shows a 3-channel pressure-control valve unit 56 which is of similar construction to that of the pressure-control valve unit 22. In the present instance, in contrast to the pressure-control valve unit 22, a third 2 port, 2 position valve 57 is provided with a pilot-control valve 58. An associated brake system is of single-circuit construction, and a respective unit 62, 63, 64, comprising a pressurizing cylinder and a master cylinder, is fitted in each outlet line 59, 60 and 61.

A single-circuit brake system of this type is intended for light lorries. Here also, a compressed air pressure-control valve is used, and the transmission of force to the wheel brakes is effected hydraulically. It is advantageous that 3-channel brake-pressure modula-

tion can be effected by means of a single central pressure-control valve unit. Thus, the piping and wiring required for the line connections can be very simple.

Fig. 5 shows a 3-channel pressure-control valve unit 56 of this type as it would be used in a vehicle.

As is shown in Fig. 6, it is also possible to use the said 3-channel pressure-control valve unit 56 in a vehicle having an axle which is braked hydraulically and an axle which is braked by compressed air.

Fig. 7 is a diagram of a vehicle having a 2-circuit brake system. A two-circuit brake valve 66 controls compressed air fed to two 2-channel pressure-control valve units 67 and 68 which are of the same construction as that of the pressure-control valve unit 22. Hydraulic wheel brake cylinders (not illustrated) on a front axle 73 and on a rear axle 74 can be supplied with hydraulic pressure medium by way of respective pairs of units 69, 70 and 71, 72, each comprising a compressed air pressurizing cylinder and a master brake cylinder, which are disposed downstream of each pressure-control valve unit 67 and 68 respectively.

The two pressure-control valve units 67 and 68 are flanged together and form a built-up unit, although, preferably, they are combined in a single housing, and such a housing may have a central connector socket 75 for connecting the leads required for the solenoids of the pilot-control valves.

Thus, the wiring is simplified and the device can be readily subjected to examination.

WHAT WE CLAIM IS:—

1. A brake anti-skid device for the wheel brakes of a motor vehicle, having common regulation of the brake pressure in at least two brake cylinders of a vehicle, in which anti-skid device there is provided a pressure-control valve combination comprising a solenoid operated common 3 port, 2 position valve for connection in the brake line so that the brake line downstream of the 3 port, 2 position valve leads to a respective brake cylinder by way of a respective line branch and a solenoid operated individual 2 port, 2 position valve for connection in each line branch means being provided for controlling the valves in accordance with a signal indicative of brake locking wherein the multi-position valves, that is, the 3 and 2 port 2 position valves, are pneumatic pressure-control valves, and a unit comprising a pneumatic pressurizing cylinder and a hydraulic master cylinder, is fitted between said valves and each brake cylinder for the hydraulic actuation of the brakes of at least two vehicle wheels.

2. An anti-skid device as claimed in claim 1, wherein the multi-position valves are constituted to form a 3-channel pressure-control valve, using three 2 port 2 position valves, namely, one for each of three line branches.

3. An anti-skid device as claimed in claim 1 or 2, wherein the pressure-control valves of a plurality of vehicle axles are constituted to form a single structural unit.

4. An anti-skid device as claimed in claim 3, wherein the structural unit, comprising the pressure-control valves, is provided with a central electrical plug connection for the solenoid valves thereof.

5. An anti-skid device as claimed in any of claims 1 to 4, wherein the pressure-control valves are used without non-return valves otherwise used with hydraulic wheel brakes.

6. An anti-skid device as claimed in any of the preceding claims, wherein the device is such that the brake pressures of the wheels connected to each pressure-control valve are simultaneously reducible or, in the case of pressure reduction in one wheel or pair of wheels, the other connected wheel or pair of wheels is settable to maintain pressure.

7. An anti-skid device substantially as hereinbefore described with reference to Figure 1 or to Figure 4 of the accompanying drawings.

8. An anti-skid braking system substantially as hereinbefore described with reference to Figure 1 and Figure 2, Figure 3 or Figure 7 of the accompanying drawings.

9. An anti-skid braking system substantially as hereinbefore described with reference to Figure 4 and Figure 5 or Figure 6 of the accompanying drawings.

10. An anti-skid braking system whenever incorporating an anti-skid device as claimed in any of preceding claims 1 to 7.

W. P. THOMPSON & CO.,
Coopers Building,
Church Street,
Liverpool L1 3AB,
Chartered Patent Agents.

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Sheet 1

Fig. 1

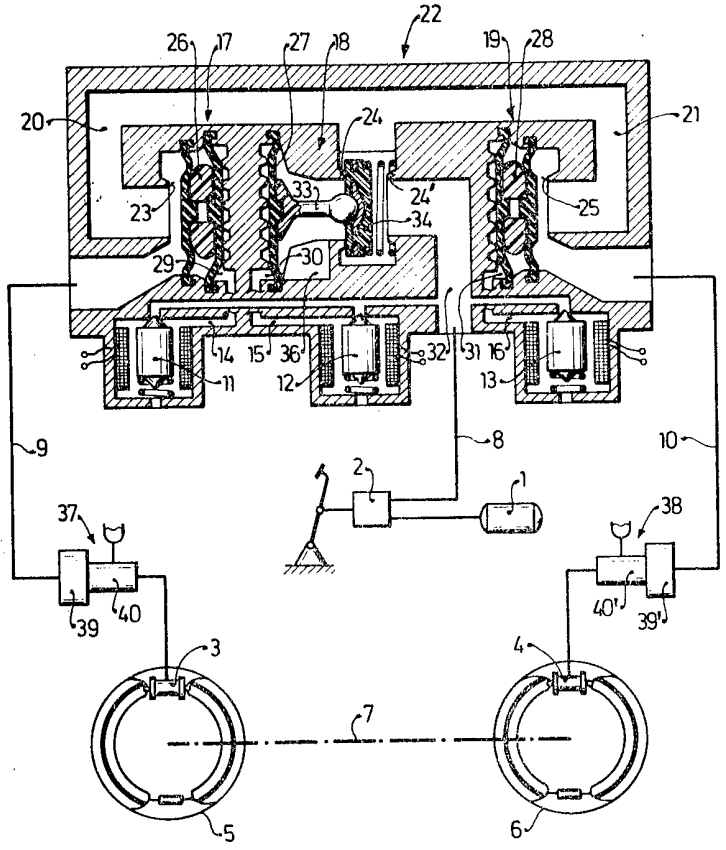


Fig.2

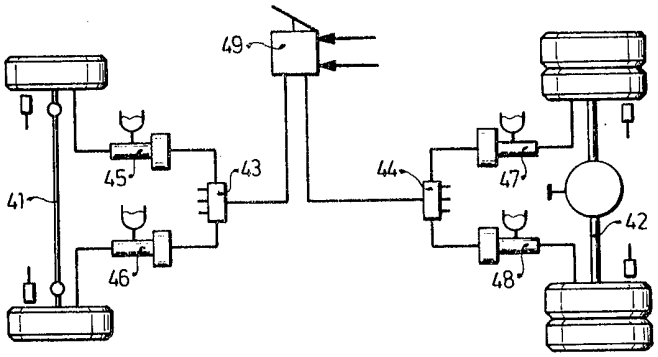
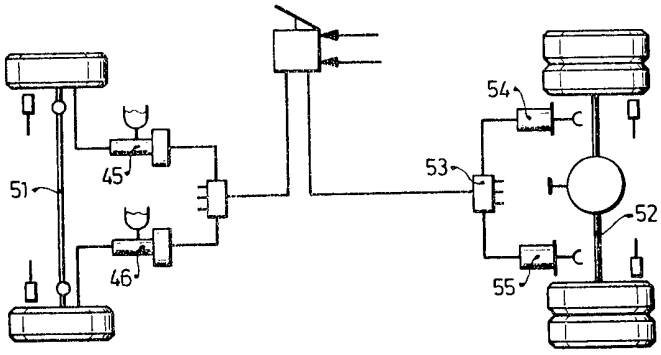


Fig.3



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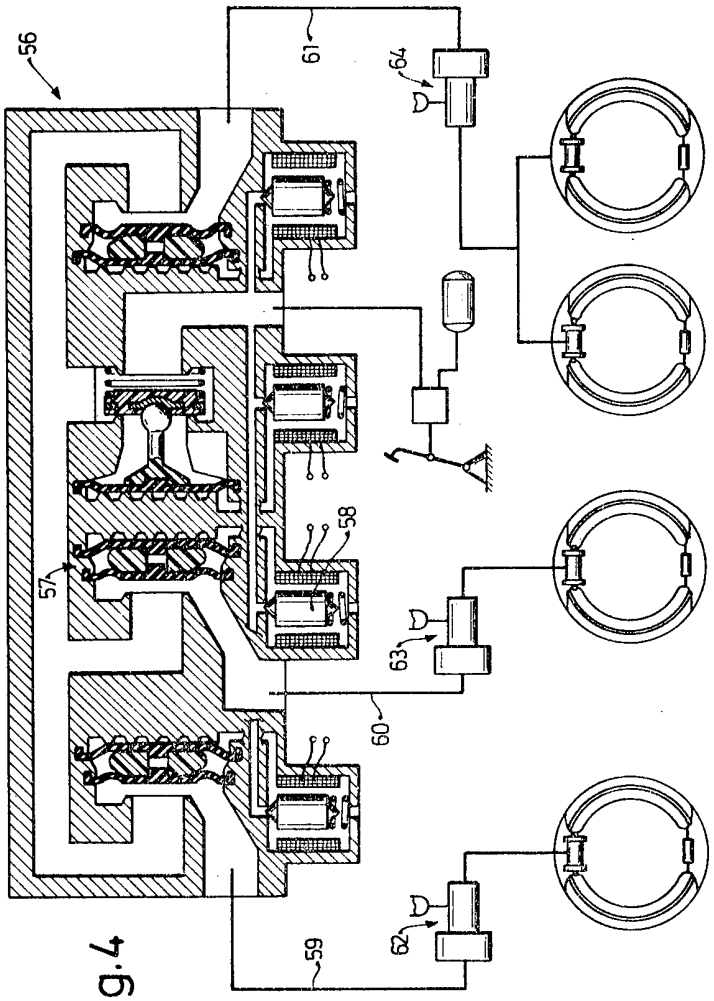


Fig.4

Fig.5

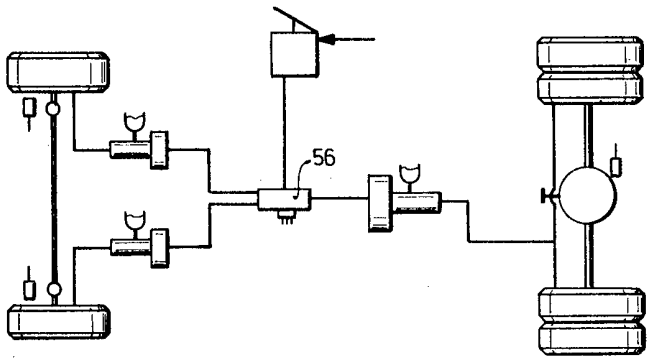
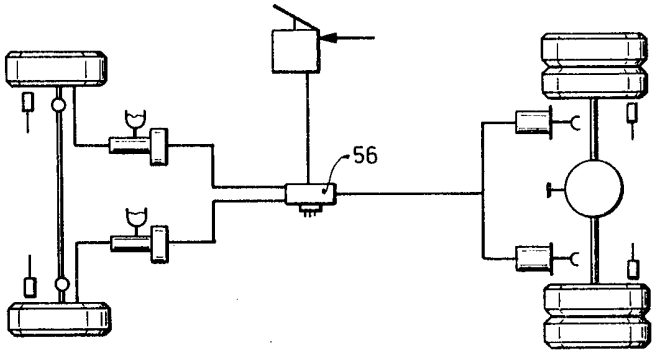


Fig. 6



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Sheet 5

Fig. 7

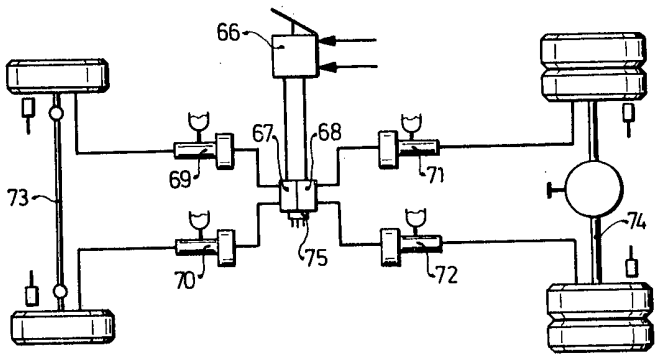

Fig. 8