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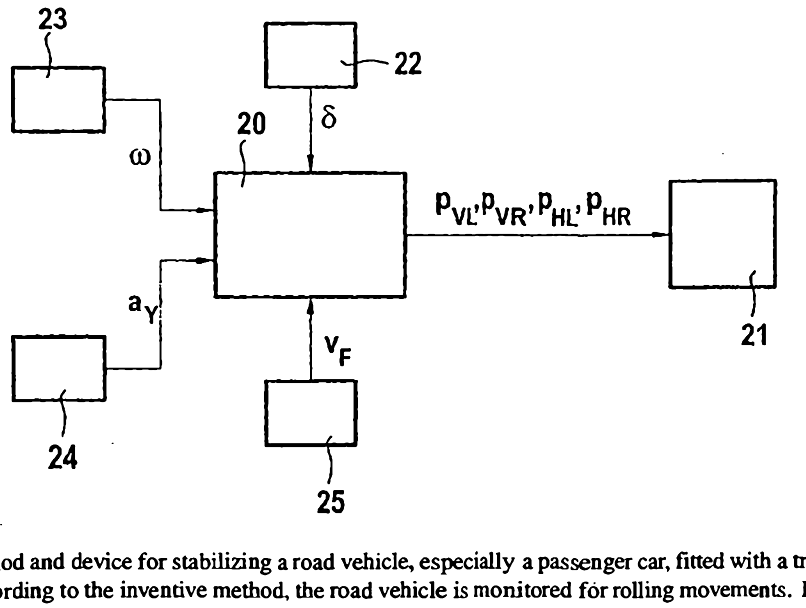
(54) Title: METHOD AND DEVICE FOR STABILIZING A VEHICLE

(54) Bezeichnung: VERFAHREN UND EINRICHTUNG ZUM STABILISIEREN EINES FAHRZEUGS



(57) Abstract: A method and device for stabilizing a road vehicle, especially a passenger car, fitted with a trailer which is pulled by said road vehicle. According to the inventive method, the road vehicle is monitored for rolling movements. If a rolling movement is detected, a yawing moment in opposition of phase to said rolling movement, is automatically applied to the road vehicle.

(57) Zusammenfassung: Verfahren und Einrichtung zum Stabilisieren eines Straßenfahrzeugs, insbesondere eines Personenkraftwagens, mit einem durch das Straßenfahrzeug gezogenen Anhänger, wobei das Straßenfahrzeug in bezug auf Schlingerbewegungen überwacht wird und daß dem Straßenfahrzeug beim Erkennen einer Schlingerbewegung automatisch ein Giermoment eingeprägt wird, das der Schlingerbewegung im wesentlichen gegenphasig ist.

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Method and device for stabilising a vehicle

The invention relates to a method and device for stabilising a road vehicle, in particular a motor car, with a trailer drawn by the road vehicle. In road vehicles with trailers, rolling of the connection of the road vehicle and the trailer can result determined by excessive speed, poor road conditions, side winds or similar,. Articles such as "FDR – die Fahrdynamicreglung von Bosch" [FDR – The Vehicle Dynamics Controller by Bosch] by A. van Zanten, R. Erhardt and G. Pfaff, ATZ Automobiltechnische Zeitschrift 96 (1994) 11 pages 674 to 689 and the SAE Paper 973184 "Vehicle Dynamics Controller for Commercial Vehicles" by F. Hecker, S. Hummel, O. Jundt, K.-D. Leimbach, I. Faye and S. Schramm have revealed very successful solutions for the stabilising of vehicle dynamics of cars and semitrailers, however, when trailers are drawn, in particular trailers which have no actuators or sensors for the stabilising of vehicle dynamics, particular difficulties result. This is especially the case with trailers, which are heavy compared with the drawing vehicle. In these cases, eg. in those of cars drawing caravans, particular stability problems arise.

If, in an articulation of vehicle and trailer, rolling or swinging movements result, the trailer will swing around its vertical axis and causes the drawing vehicle to swing also through the trailer coupling. If the travel speed lies under the so-called critical speed, then the swinging is absorbed. If the travel speed is equal to a critical speed, then the swinging is not absorbed. If the vehicle speed is above a critical speed the swinging begins. The value of the critical speed depends, among other things, on geometric data such as wheel base and shaft length, from the mass and the yaw inertia moment of the vehicle and the trailer and of the slip angle of the axles. This value moves typically in the case of coupled vehicles in motor cars in the area of 90 to 130 km/h.

The frequency of the rolling or the swinging movement amounts approximately to 0.5 to 1.5 Hz.

Therefore, the object of this invention is to provide a method and a device by means of which the driving stability in road vehicles, which draw a trailer, is improved. It is particularly desirable that the solution provided by the invention be kept to as low a sensor cost as possible.

According to the present invention there is provided a method for stabilising a road vehicle, in particular a motor car, with a trailer drawn by the road vehicle, wherein the road vehicle is monitored with respect to rolling movements and that a substantially periodic yawing moment is applied automatically with the recognition of a rolling movement, which is substantially in phase opposition to the rolling movement.

In a further aspect of the present invention also provides a stabilising device for stabilising a road vehicle, in particular a motor car with a trailer according to the method described in the preceding paragraph, wherein the stabilising means has means for recognising a rolling movement of the road vehicle and for applying of a substantially periodic yawing moment onto the vehicle at the recognition of a rolling movement, the yawing moment of the applied rolling movement being substantially in phase opposition.

This task is achieved by means of a method according to Claim 1 and a device according to Claim 12. For the stabilising of a road vehicle, in particular a motor car, with a trailer drawn by the road vehicle, the road vehicle is monitored with respect to rolling movements and, in the event of a rolling movement, a substantially periodic yawing moment, in particular at least two periods long is applied to the vehicle, that it is considerably in phase opposition. In this way, it is possible to reduce a rolling of the combination of vehicle and trailer and to stabilise the combination. By rolling, it is understood that in the vehicle which draws the trailer, a considerable periodic transverse acceleration and to a considerable yaw speed results. It is not strictly a periodic pendulum (the vehicle combination does not represent an ideal pendulum), rather temporal fluctuations in the periodic duration of the pendulum movement of the trailer arise. These reappear, for example, in the repeating or returning substantially periodic signals generated by a transverse acceleration sensor, i.e. this signal features a periodic duration changing in small limits, which is, however, ideally seen as constant with respect to time. Correspondingly, the applied, considerably periodic yawing moment is not strictly periodic. Correspondingly, the variations in the period of the pendulum movement of the vehicle combination are also changed in the periodic duration in the applied yawing moment.

For recognition of a rolling movement, it can be planned, for example, that the transverse acceleration of the road vehicle is measured with a transverse acceleration sensor. For the recognition of the rolling, the frequency and the amplitude of the signal obtained by the means of the transverse acceleration sensor are evaluated. The frequency results, eg. from the time gap of successive zero passages. A rolling is present, eg. when the frequency determined lies within a predetermined frequency band and when the amplitude is greater than the threshold value. In this connection, it is advantageous to observe the speed and/or the steering angle of the vehicle in order to distinguish a rolling of steering movements of the vehicle. An example for a recognition of roll is provided in Fig. 9.

It is particularly advantageous, in connection with the invention, to apply a roll recognition in which at least dynamics of lateral motion such as, for example, transverse acceleration, yaw speed or yaw acceleration and the speed of the vehicle, the rolling movement being determined dependent on at least a transverse dynamics size and the speed. This preferably takes place in that it is checked whether the transverse dynamics size and the speed are each greater than the threshold value allocated to them. It is especially advantageous to measure both the transverse acceleration and the yaw speed. Furthermore, it is of advantage for the determining of a rolling movement to measure the steering angle and to take into account rapid steering movements with the determining of the rolling movements. In addition, the use of a high pass filter would be an advantage, by means of which a signal corresponding to the steering angle is filtered. If this high pass filter is greater than a certain threshold value, then it can be assumed that no rolling movement exists.

In an advantageous embodiment of the invention, the applying of the yawing moment by means of an automatic braking of the road vehicle, different braking forces being applied to both sides of the road vehicle. In this way, the periodic yawing moment is applied particularly advantageously without the necessity of steering movements. In addition, according to this embodiment, it is possible to implement the invention particularly economically in vehicles equipped with ABS, also if these do not have vehicle dynamics control (VDC, ESP).

In the following advantageous embodiment of the invention, the applying of the substantially periodic yawing moment is made by means of the automatic one-sided braking of the vehicle. In this way, a particularly good stabilising of the combination of road vehicle and trailer is achieved.

In another advantageous embodiment of the invention, the road vehicle is monitored for instability and an applying of the yawing moment takes place only if no instability of the road vehicle is recognised.

In a further advantageous embodiment of the invention, the trailer has an overrunning brake. Following and/or additional to the applying of the substantially periodic yawing moment, the road vehicle is automatically briefly braked in so that the overrunning brake of the trailer is actuated.

In another advantageous embodiment of the invention, the briefly automatic braking of the road vehicle takes place around a fixed phase offset from the zero passage of the rolling movement. This takes into account the inactivity of the trailer. The braking takes place either around a certain fixed phase shortly before a zero passage or after it.

In the case that the inactivity of the trailer is negligible, the briefly automatic braking of the road vehicle can also take place in the zero passage of the rolling movement.

In a further advantageous embodiment of the invention, the brief automatic braking of the road vehicle only takes place when the applying of the substantially periodic yawing moment has previously led to a decrease in the rolling movement.

In another advantageous embodiment of the invention, the automatic brief braking for the actuating of the overrunning brake of the trailer takes place by means of the decreasing of the driving torque of a motor driving the road vehicle.

In a further advantageous embodiment of the invention, the road vehicle is automatically briefly braked.

The invention is particularly advantageous when used in conjunction with a hydraulic braking system. It can, however, also be used in electro-hydraulic or in pneumatic or in electro-pneumatic or in electro-mechanical brake systems.

The invention has, among others, the following advantages:

- The procedure of the invention operates on the drawing vehicle and is therefore independent of the respective trailer. Correspondingly, in an advantageous embodiment of the invention of the invention, no additional sensors or actuators are implemented on the trailer.
- The procedure of the invention can fall back upon the sensors, which are made available by brake slip controllers (ABS), traction control (ASR) and vehicle dynamics control. Usually no further sensors are necessary.
- The rolling frequency can be learned, ie. the rolling recognition adapts itself to the respective vehicle.
- When using the method and device of the invention, a mechanical device on the trailer coupling for recognising the roll deviation can be dispensed with.

Further advantages and details result from the following description of embodiments. Shown in detail are:

Fig. 1 a combination of a road vehicle and a trailer,

Fig. 2 the displacement of the trailer coupling of the road vehicle with the rolling of the combination,

Fig. 3 transverse acceleration and yaw speed of the road vehicle with the rolling of the combination,

Fig. 4 the speeds of the left and right rear wheels of the road vehicle with the rolling of the combination,

Fig. 5 an example of the applying of brake pressure of the invention on the right rear wheel of the road vehicle,

Fig. 6 an example of the applying of brake pressure of the brake pressure on the left rear wheel of the road vehicle,

Fig. 7 an embodiment for a stabilising device,

Fig. 8 an especially advantageous embodiment for stabilising a combination of a vehicle and a trailer,

Fig. 9 the internal construction of a stabilising device and

Fig. 10 the internal construction of a brake pressure calculator of Fig. 9.

Figure 1 shows a combination of a road vehicle 1 and a trailer 2, the trailer 2 being attached to a trailer coupling 3 of the road vehicle. R_{VR} indicates the right front wheel, R_{VL} the left front wheel, R_{HR} the right rear wheel and R_{HL} the left rear wheel of the road vehicle 1. ω indicates the yaw speed of the road vehicle and a_y the transverse acceleration of the road vehicle 1. S indicates the displacement of the trailer coupling of the road vehicle 1.

In Fig. 2 the displacement S of the trailer coupling 3 of the road vehicle with the rolling of the road vehicle is represented over time t. Positive values of the displacement S correspond to a displacement to the right and negative values of the displacement to a displacement to the left.

In Fig. 3 a process of the rolling movement corresponding to the transverse acceleration a_y in Fig. 2 and the yaw speed ω corresponding to the rolling movement in Fig. 2 is provided by way of example.

In rolling, the speeds of the individual wheels depart from the course of their mean speed, which corresponds substantially to the vehicle speed VF. This is shown by way of example in Fig. 4 for the speed V_{HR} of the right rear wheel R_{HR} and the speed V_{HL} of the left rear wheel R_{HL}. According to the invention is planned that the road vehicle 1 is monitored with respect to rolling movements and that a yawing moment is applied the street vehicle particularly advantageously through automatic one-sided braking, in particular in the rear wheels of the vehicle.

Fig. 5 and Fig. 6 show the brake pressures p_{HR} on the right rear wheel R_{HR} and p_{HL} on the left rear wheel R_{HL} to apply antiphase (substantially periodic) yawing moment through automatic one-sided braking of the vehicle 1 in an embodiment. As Fig. 5

and 6 show, the brake pressures pressures p_{HR} and p_{HR} are antiphase and generate, according to the control depicted, a yawing moment in phase opposition to the rolling movement of the combination.

Fig. 7 shows an embodiment of a stabilising device 20. The stabilising device 20 is connected to a steering angle sensor 22 for the measuring of the steering angle δ, a yaw speed sensor 23 for measuring the yaw speed ω of the road vehicle 1, a transverse acceleration sensor 24 for measuring the transverse acceleration ay of the road vehicle 1 and a speed sensor 25 for measuring the vehicle speed VF. In an advantageous embodiment, it is planned that the road vehicle 1 features a vehicle dynamic control, such as is revealed, eg. in the article "FDR – die Fahrdynamicreglung von Bosch" [FDR – The Vehicle Dynamics Controller by Bosch] by A. van Zanten, R. Erhardt and G. Pfaff, ATZ Automobiltechnische Zeitschrift 96 (1994) 11 pages 674 to 689. In this case, the travelling speed VF is not provided by the vehicle speed sensor 25, but from the vehicle dynamics controller.

The output dimensions of the stabilising device 20 are, eg. the braking pressures p_{VL}, p_{VR}, p_{HL}, p_{HL} for the wheels R_{VR}, R_{VL}, R_{HR}, R_{HL} of the road vehicle 1 or corresponding control variables which effect the adjusting of the brake pressures p_{VL}, p_{VR}, p_{HL}, p_{HL} in the brake 21 of the road vehicle 1.

Fig. 8 shows a particularly advantageous embodiment to stabilise a combination of a vehicle and trailer using the principle of the invention. In a first step 10 measurement values of the sensors are read in on the vehicle 1, which Fig. 7 shows. In a second step 11 the general movement equations of the road vehicle without the trailer are calculated. The calculations according to Step 11 are described in further detail according to Fig. 9.

The movement equations correspond to mathematic relationships which are described on the basis of a simple mathematical model of vehicular movement, *cf.* "FDR – die Fahrdynamicreglung von Bosch" [FDR – The Vehicle Dynamics Controller by Bosch] by A. van Zanten, R. Erhardt and G. Pfaff, ATZ Automobiltechnische

Zeitschrift 96 (1994) 11 pages 674 to 689. The equation 4 contained in this article, which is also known as the Ackermann relationship, represents such a movement equation.

In a decision block 12, it is checked whether a transverse acceleration or a yaw speed exists in the vehicle, which is not attributable to a steering movement of the driver. If this condition is not fulfilled, action will not be taken to stablise the vehicle according to the invention. However, other possible methods of vehicle stabilising remain unaffected by this, determined, for example, by an above named vehicle dynamics control. If, however, a rolling of the rear of the road vehicle 1 is detected without the road vehicle 1 being unstable, the frequency and phase of the rolling movement is determined in the next step 13. That is, in this case, intervention for the stabilising of the vehicle combination in terms of the invention is necessary.

After determining the frequency and phase of the rolling frequency, in the next step an yawing moment is applied in phase opposition to the rolling movement to the road vehicle 1. This takes place advantageously in that, on both sides of the road vehicle 1, differing braking forces are applied, the applying of the yawing moment taking place advantageously through the one-sided braking of the road vehicle 1, as is shown, by way of example, in Fig. 5 and 6.

In one embodiment, a further decision block 15 and a further step 16 are provided. It is checked with the decision block 15, whether by means of the application of a substantially antiphase yawing moment (cf. Step 14) a diminishing of the rolling movement has been achieved. If this is not the case, Step 13 takes place. If the applying of the substantially antiphase yawing moment leads, for example, to a decreasing of the rolling movement of the combination of road vehicle 1 and trailer 2, then the road vehicle will automatically be briefly braked (Step 16), so that the overrunning brake of the trailer 2 is actuated. This braking movement takes place advantageously in a substantially fixed phase offset from the zero passage of the rolling movement.

In an advantageous design of the invention, it is planned that the speed of the combination is so far reduced that it drops below a critical speed.

Fig. 9 shows the inner construction of a stabilising device 20 in an embodiment. A reference sign 40 indicates a desired yaw speed calculator for calculating a desired yaw speed ω^*. The calculation of the desired yaw speed ω^* takes place eg. in accordance with the desired yaw speed calculation as is revealed in the article "FDR – die Fahrdynamicreglung von Bosch" [FDR – The Vehicle Dynamics Controller by Bosch] by A. van Zanten, R. Erhardt and G. Pfaff, ATZ Automobiltechnische Zeitschrift 96 (1994) 11 pages 674 to 689. Alternative to this, it can be planned that, if the road vehicle 1 has a vehicle dynamic control as described above, the stabilising device 20 does not calculate the desired yaw speed ω^* itself, but receives it from the vehicle dynamics control.

The movement equations correspond to mathematical relationships which, based on a simple mathematical model, describes the vehicle movement, cf. "FDR – die Fahrdynamicreglung von Bosch" [FDR – The Vehicle Dynamics Controller by Bosch] by A. van Zanten, R. Erhardt and G. Pfaff, ATZ Automobiltechnische Zeitschrift 96 (1994) 11 pages 674 to 689. The equation 4 contained in the article, which is also known as the Ackermann relationship, represents such a movement equation (see above). A desired value for the yaw speed of the vehicle is determined based on the desired yaw speed calculator, dependent on the vehicle speed and the steering angle. That is, the calculation of the desired yaw speed takes place by means of a movement equation.

Correspondingly, a movement equation can be evaluated, with which the transverse acceleration of the vehicle is calculated. In this case, the desired value for the transverse acceleration is compared with the measured value for the transverse acceleration.

The desired yaw speed ω^* is calculated together with the yaw speed ω input size in a differential creator 38 which calculates a yaw speed control deviation ω_e as the differential of the yaw speed ω^* and the yaw speed ω. The yaw speed control deviation ω_e is filtered by means of a filter 37. The filter 37 features a band pass filter 34, an amount creator 35 and a mean value creator 36. The mean value creator is preferably designed as a low pass filter. The band pass filter 34 is constructed in such a way that it only allows through parts of the yaw speed control deviation ω_e which lie in a frequency range characteristic for the pendulum movement of the vehicle 1. The band pass filter is constructed in such a way that it is only constant between the frequency range 0.5 and 1.5 Hz. The output signal of the filter 37 is indicated with ω_{ef}.

In the same way as the yaw speed control deviation ω_e, the transverse acceleration a_y is filtered. For this, the stabilising device 20 features a filter 33. The filter 33 is constructed corresponding to the filter 37. It features a band pass filter 30, which is identical to the band pass filter 34. The filter 33 further features an amount creator 31 which is identical with the amount creator 35. Furthermore, the filter 33 has a mean value creator 32, which is identical to the mean value creator 36. The output signal of the filter 33 is a signal indicated with a_{yf}.

In an advantageous embodiment of the invention, it is planned that the roller frequency is learned, ie. that the recognition of rolling is adapted independently to the respective vehicle combination. To this end, it is provided in an advantageous embodiment that the band pass filter 30 and 34 is set to the rolling frequency of the vehicle combination. The various filter sizes, for example the border frequencies of the band pass filters, adapt automatically or independently to the respective vehicle combination.

The stabilising device 20 features a steering angle evaluator 41. The steering angle evaluator 41 features a skip zone for the extracting of small steering angles δ, a high pass filter for extracting slowly running steering angle changes and an integrator for integrating the high pass filtered steering angle. The output dimensions of the steering angle filter 41 is indicated with δ_f.

The calculations taking place in the filters 33 and 37, in the differential creator 38, in the desired yaw speed calculator 40 and in the steering angle evaluator 41 are to be allocated to Step 11 in Fig. 8.

By means of a roll detector 39, which substantially represents an embodiment for a decision block 12 of the progress plan according to Fig. 8, it is decided whether a rolling movement exists or not. In addition, it will be tested according to the present invention whether the following conditions are fulfilled:

$\delta_F < S1$

$a_{yf} > S2$

$\omega_{ef} > S3$

$V_F > S4$

in which S1, S2, S3 and S4 are threshold values. The testing with reference to the threshold value S4 can also be left out. The initial quality of the roll detector 39 is a binary quality P1 which assumes the value 0, when no roll is evident and the value 1 when the above conditions are fulfilled, ie. when rolling is sensed. If rolling is sensed, the brake pressures p_{VL}, p_{VR}, p_{HL}, p_{HL} for the wheels R_{VR}, R_{VL}, R_{HR}, R_{HL} of the road vehicle 1 are determined by means of a brake pressure calculator 42 in accordance with the procedure described in Fig. 8. The Steps 13 and 14 as well as, provided it is implemented, Step 1 and the decision block 15 are to be allocated to the brake pressure calculator 42.

Alternative to the roll recognition described in Fig. 9, the transverse acceleration of the road vehicle is measured or the measurement values are derived from the number of wheel revolutions. The transverse acceleration measured or derived from the number of wheel revolutions is subjected to a frequency analysis (for example a Fourier analysis), i.e. the corresponding quantity will be analysed in its separate spectral components. On the basis of these spectral portions, it can be tested whether a portion exists with the frequency characteristic for the rolling movement. If this is the case, then the substantially periodic yawing moment results.

Fig. 10 shows the internal construction of the brake pressure calculator 42. A frequency analyser which, dependent on the transverse acceleration a_y and/or the yaw speed ω determines the frequency f_s, the phase φ_s and the amplitude A_s of the rolling movement show reference marks 50. According to this embodiment the frequency f_s, the phase φ_s and the amplitude A_s of the rolling movement are determined dependent on the yaw speed ω. Dependent on the frequency f_s and the phase φ_s of the rolling movement, a brake pressure controller 51 determines, provided the signal P1 indicates a swing movement, the brake pressures p_{VL}, p_{VR}, p_{HL}, p_{HL} for the wheels R_{VR}, R_{VL}, R_{HR}, R_{HL} of the road vehicle 1 or corresponding control variables, which effect the setting of the brake pressures p_{VL}, p_{VR}, p_{HL}, p_{HL} in the brake 21 of the road vehicle 1. The brake pressures set on the wheels change according to the rolling frequency f_s (see Fig. 2, Fig. 5 and Fig. 6).

It is planned in particular to brake only the rear wheels, as is shown in Fig. 5 and 6 if the road vehicle 1 has only traction control (ASR) or a brake slip controller (ABS). If, on the other hand, the road vehicle 1 has a vehicle dynamics control (FDR, ESP), then advantageously all wheels of the road vehicle 1 will be braked – if necessarily individually – in order to apply the yawing moment in phase opposition. Details with respect to ABS, ASR and VDC can, for example, be obtained from the article, "FDR – die Fahrdynamicreglung von Bosch" [FDR – The Vehicle Dynamics Controller by Bosch] by A. van Zanten, R. Erhardt and G. Pfaff, ATZ Automobiltechnische Zeitschrift 96 (1994) 11 pages 674 to 689.

In the case of a recognised rolling movement the application of the substantially periodic yawing moment takes place particularly advantageously exclusively through corresponding braking of the rear wheels. A corresponding influencing of the front wheel brakes does not lead to the desired stabilising of the trailer. If, due to the traction control implemented in the vehicle or if this intervention of the brakes according to the invention not be carried out exclusively on the rear wheels in the drive concept of the vehicle, then all the wheels of the vehicle are braked, leading to a slowing of the drawing vehicle and of the trailer and consequently to a confirmation of the overrunning brake. The anti-block system (ABS), traction control (ASR) and vehicle dynamics control (FDR) are to be distinguished between.

Anti-block system: The classic anti-block system does not make possible the carrying out of driver-independent braking intervention, with which the brake pressure in the wheel brake cylinders can be increased over the precompression set by the driver or with which a brake pressure can be built up. If the vehicle is equipped with an anti-block system, then a stabilising of the vehicle can only take place by means of the braking of all four wheels. By this means, the overrunning brake is activated, as described above.

Alternatively, the use of an anti-block system equipped with a pneumatic brake servo can also be implemented. In the case of a recognised rolling the pneumatic brake servo is activated. By this means the possibility of injecting a higher pressure into the wheel brake cylinders is created as the precompression set by the driver would allow it, if at all, to build up a brake pressure. The substantially periodic yawing moment is achieved by means of controlling the actuators allocated to the wheel brake cylinders.

An anti-block system is equipped with wheel speed sensors in series. It usually does not have a transverse acceleration sensor or a yawing rate sensor, i.e. in this case, the measured transverse acceleration or the yawing rate is not evaluated. Instead, in an advantageous embodiment a variable describing the yawing rate or transverse acceleration can be derived from the wheel speed using a mathematical model.

Instead of the transverse acceleration or the yawing rate, the differential of the number of wheel revolutions or the wheel speeds of the non-driven wheels can be evaluated.

Traction control (ASR): The drive moment is influenced by traction control on the driving gears of the vehicle. This takes place by braking interventions with which, independent of the driver, brake pressure is introduced or through motor intervention through which torque is reduced.

If the vehicle is equipped with traction control, then, with respect to the method and the device of the invention the drive concept is of importance. If the vehicle has rear or all wheel drive, then the substantially periodic yawing moment on the rear axle, which is necessary for the stabilising of the vehicle combination, can be applied. If, on the other hand, the vehicle is a front wheel vehicle, this possibility does not exist. In this case, only all wheels of the vehicle can be braked, leading to an activating of the overrunning brake. With respect to the sensors, the explanation provided for the anti-block system apply.

Vehicle dynamics control (VDC, ESP): In a vehicle, which is equipped with vehicle dynamics control, all wheels can be singly and independently braked by the driver, ie. the brake pressure can be increased or built up by the driver precompressing the brakes in order to apply the substantially periodic yawing moment. Furthermore, all wheels can be braked simultaneously, so that by this means the overrunning brake is activated. Furthermore, in the vehicle dynamics control, the possibility exists to reduce the motor performance by means of motor interventions and by this means to activate the overrunning brake.

In this case, as a corresponding sensor is available, the measured transverse acceleration or the yawing rate is evaluated.

The frequency analyser 50 is to be allocated to the Step 13 and the brake pressure adjuster 51 is to be allocated to the step 14. The brake pressure calculator 42 also features an amplitude monitoring 52 by means of which it is monitored as to whether the amplitude A_S of the rolling movement has decreased by means of the braking. The amplitude monitoring 52 emits a signal P2, which assumes the value 0 if the amplitude of the rolling movement is not diminished and the value 1 if the amplitude A_S of the rolling movement diminishes. The amplitude monitoring 52 is to be allocated to the decision block 15 in Fig. 8. Step 16 in Fig. 8 is also to be allocated to the brake pressure adjuster 51.

With respect to the carrying out of the braking intervention for the applying of the yawing moment the following will be noted in conclusion: In the above descriptions it has been assumed that the trailer has only an overrunning brake and not brakes over the wheels at its disposal. In the event that the trailer also has wheel brakes at its disposal, further possibilities result with respect to the interventions in the brakes. By this means, the braking of the drawing vehicle or that of the trailer can be carried out either alone or together.

The claims defining the invention are as follows:

1. A method for stabilising a road vehicle, in particular a motor car, with a trailer drawn by the road vehicle, wherein the road vehicle is monitored with respect to rolling movements and that a substantially periodic yawing moment is applied automatically with the recognition of a rolling movement, which is substantially in phase opposition to the rolling movement.

2. The method according to Claim 1, wherein the applying of the yawing moment takes place by automatic braking of the road vehicle, differing braking forces being applied on both sides of the road vehicle.

3. The method according to Claim 2, wherein the applying of the substantially periodic yawing moment takes place by means of the automatic one-sided braking of the vehicle.

4. The method according to any one of the preceding claims, wherein an applying of the substantially periodic yawing moment can only take place if the transverse acceleration and/or a yawing speed is present, which cannot be traced back to the steering movements of the driver.

5. The method according to any one of the preceding claims, having an overrunning brake, wherein the road vehicle is automatically briefly braked, that the overrunning brake of the trailer is actuated.

6. The method according to any one of the preceding claims, the trailer featuring an overrunning brake, wherein the road vehicle, after applying of the yawing moment, is briefly braked in such a way that the overrunning brake of the trailer is actuated.

7. The method according to Claim 5 or Claim 6, wherein the automatic brief braking for the actuating of the overrunning brake of the trailer through the decreasing of driving torque of a motor driving the road vehicle.

8. The method according to Claim 7, wherein the brief automatic braking of the road vehicle takes place offset by a fixed phase shortly before or after the zero passage of the rolling movement.

9. The method according to Claim 7 and Claim 8, wherein the brief, automatic braking of the road vehicle takes place only when the applying of the yawing moment has led to a diminishing of the rolling movement.

10. The method according to any one of the preceding claims, wherein the speed of the road vehicle is reduced in such a way that it is smaller than the critical speed.

11. The method according to any one of the preceding claims, wherein the road vehicle is automatically briefly braked.

12. A stabilising device for stabilising a road vehicle, in particular a motor car with a trailer according to the method as claimed in any one of the preceding claims, wherein the stabilising means has means for recognising a rolling movement of the road vehicle and for applying of a substantially periodic yawing moment onto the vehicle at the recognition of a rolling movement, the yawing moment of the applied rolling movement being substantially in phase opposition.

Dated this 11th day of December, 2002.

ROBERT BOSCH GMBH

By their Patent Attorneys:
CALLINAN LAWRIE

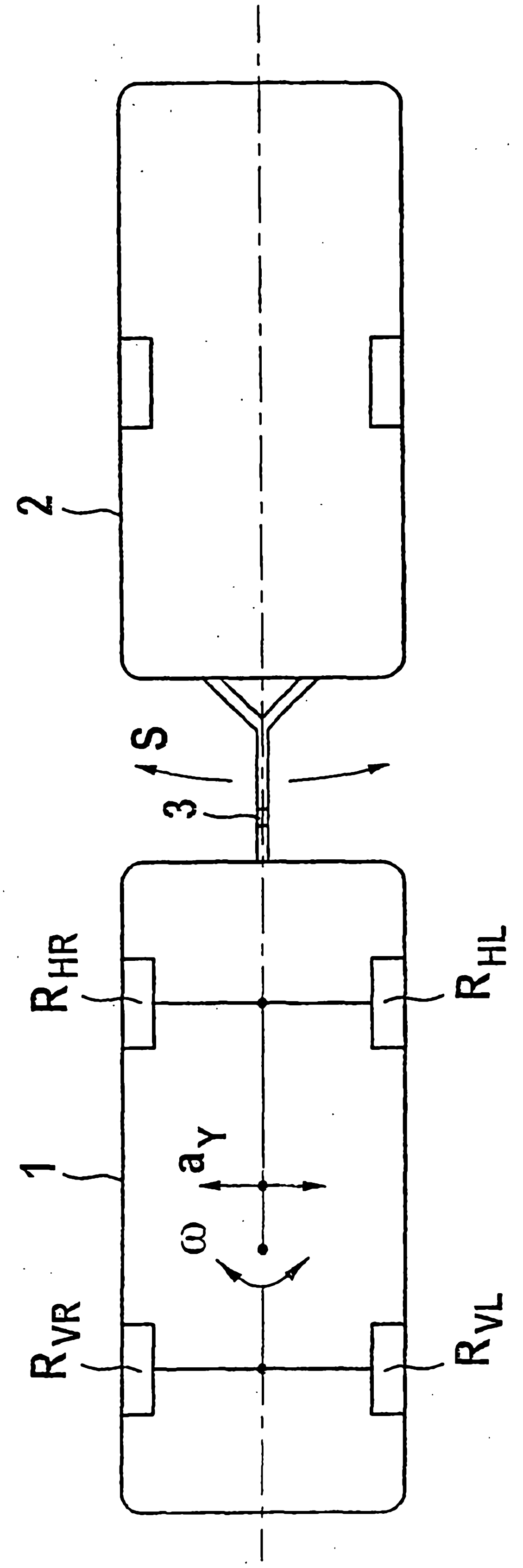

FIG. 1

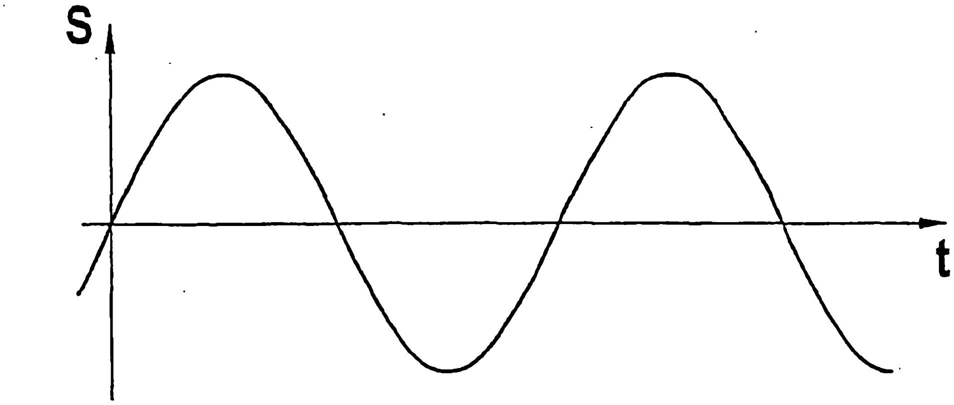

FIG. 2

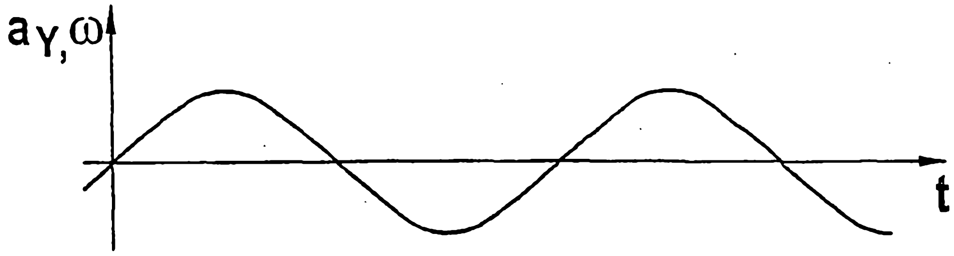

FIG. 3

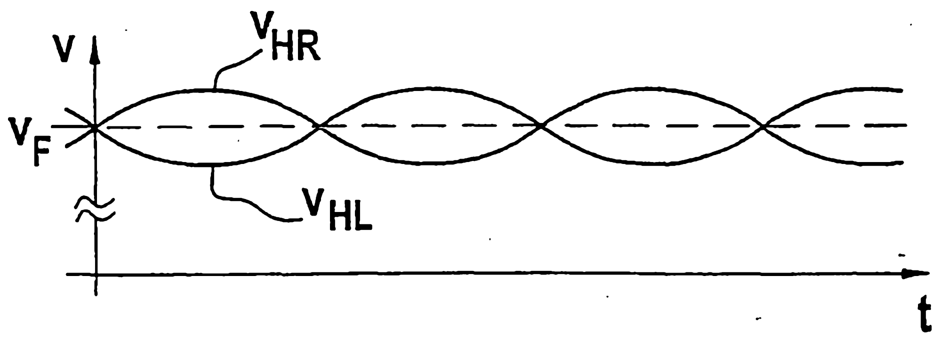

FIG. 4

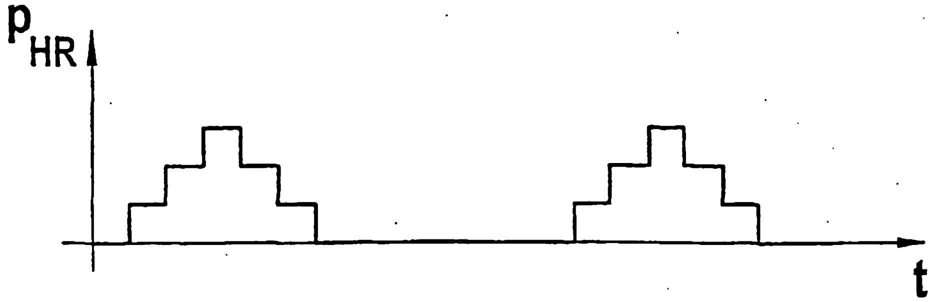

FIG. 5

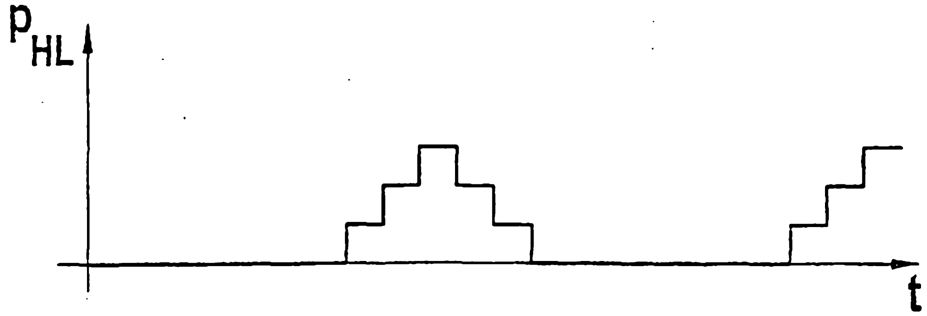

FIG. 6

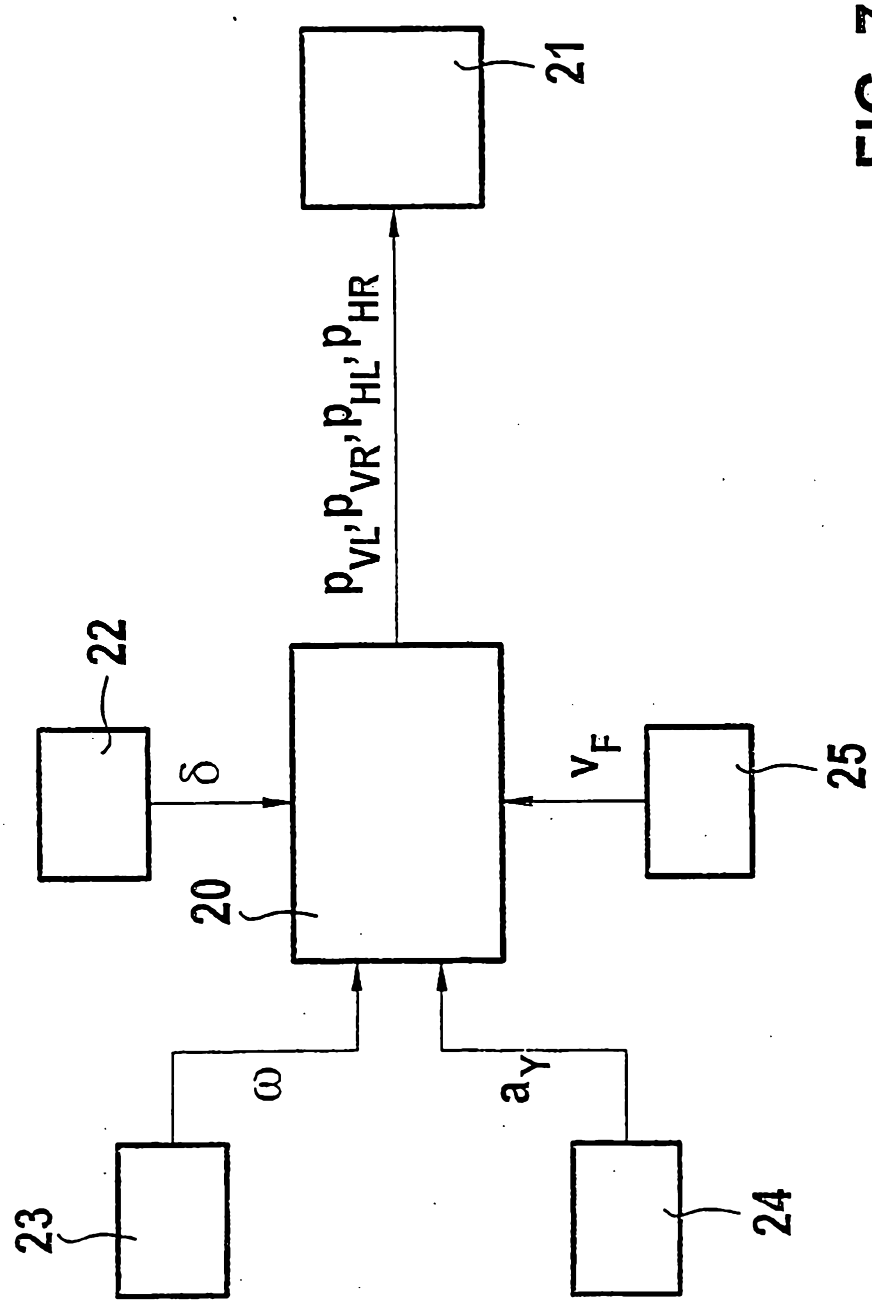

FIG. 7

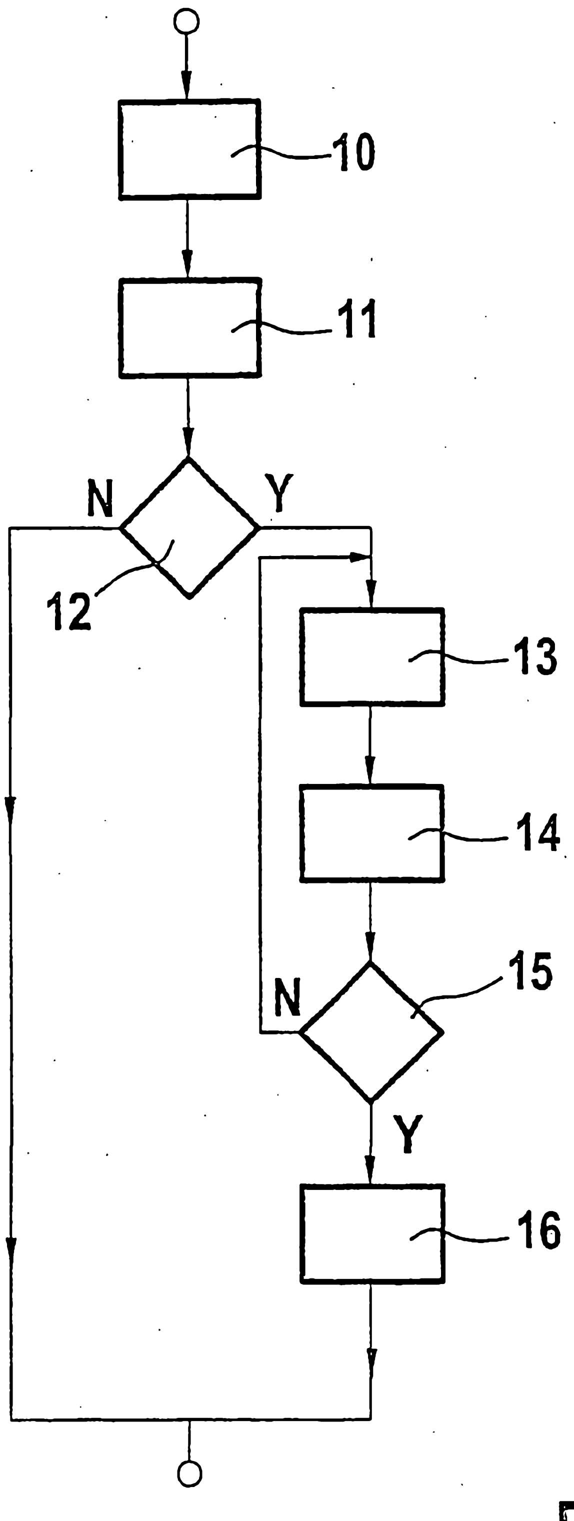

FIG. 8

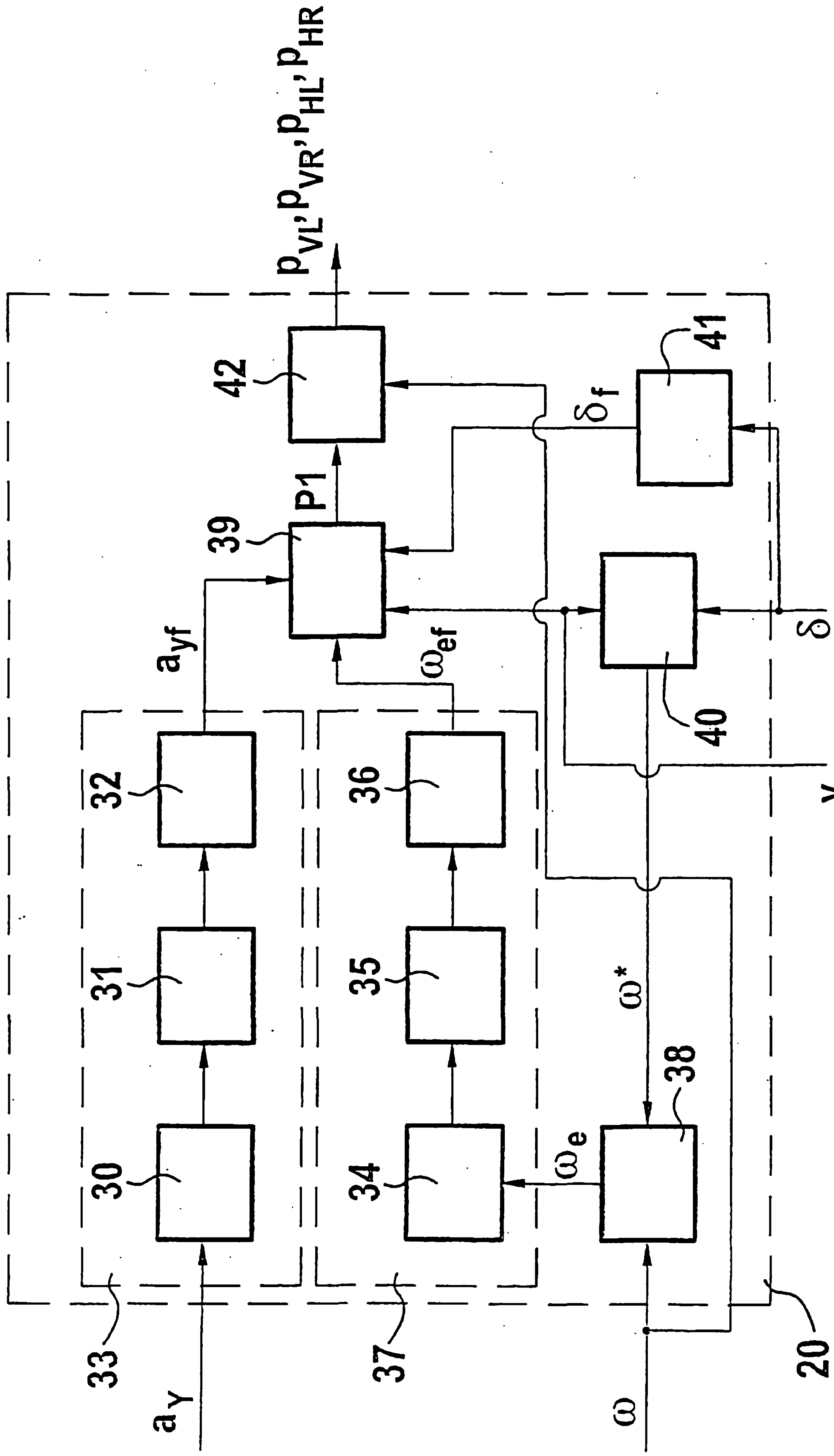
$p_{VL}, p_{VR}, p_{HL}, p_{HR}$
42
P1
39
a_{yf}
ω_{ef}
δ_f
41
40
δ
v_F
32
31
30
36
35
34
ω^*
38
ω_e
33
37
20
a_Y
ω

FIG. 9

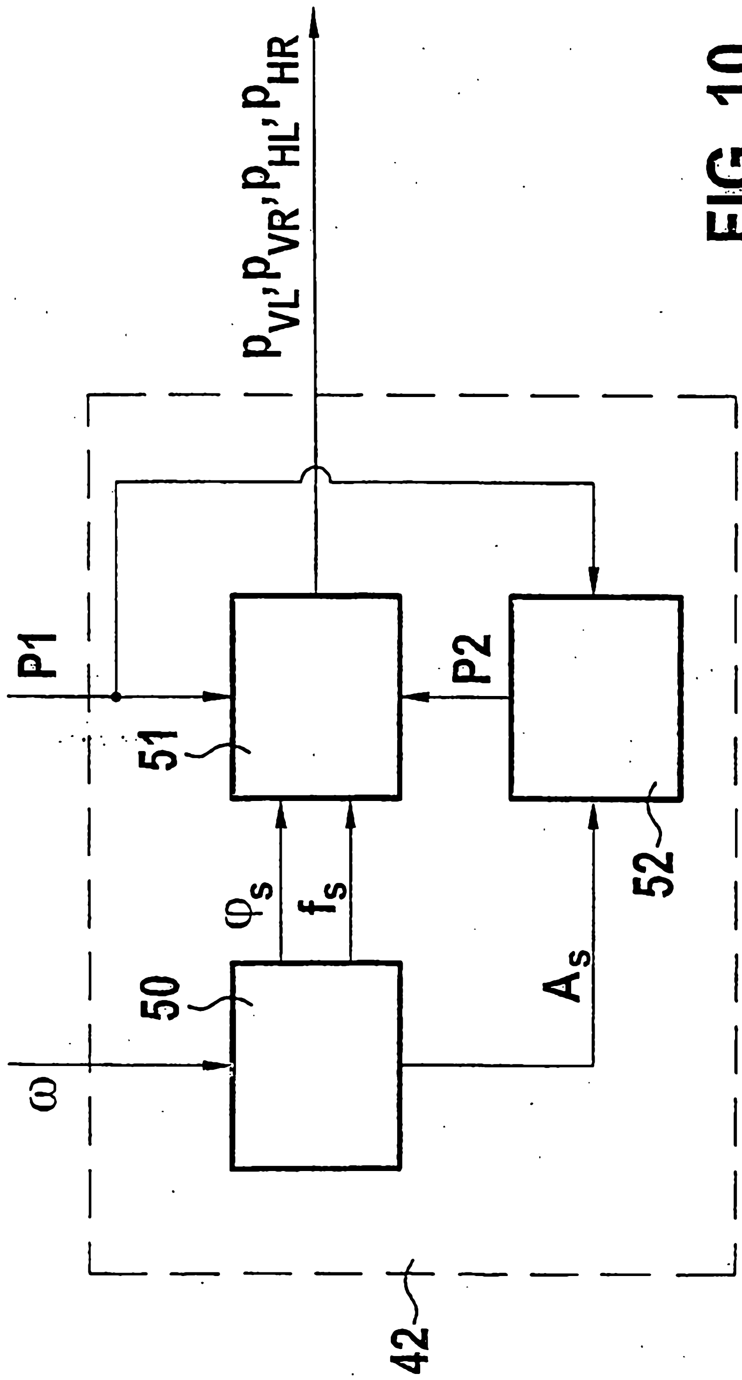

FIG. 10