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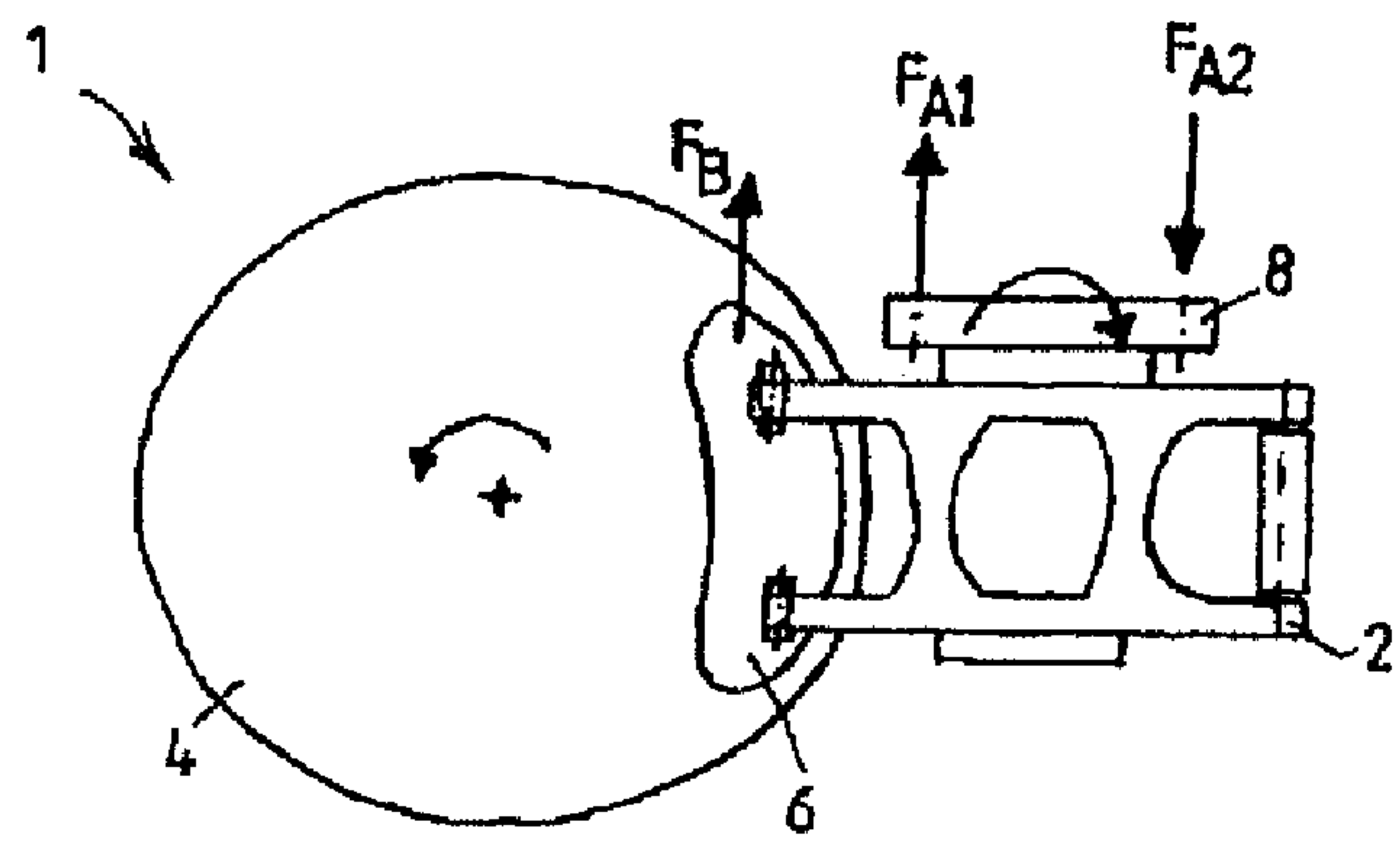
(54) Titre : SYSTEME DE FREINAGE DE VEHICULE FERROVIAIRE A COMPENSATION DES VARIATIONS DES CONDITIONS DE FROTTEMENT

(54) Title: BRAKE SYSTEM OF A RAIL VEHICLE WITH COMPENSATION OF FLUCTUATIONS IN THE FRICTION CONDITIONS



(57) Abrégé/Abstract:
A brake system of a rail vehicle, having at least one brake actuator comprising at least one brake disk and at least one brake lining, which interacts with the brake disk, for generating a braking force in response to a braking demand. At least one sensor device measures the time profile of at least one variable, such as wheel rotational speed, wheel circumferential acceleration, braking force, braking torque or brake pressure, which represents fluctuations in the friction conditions between the wheel or wheel set assigned to the brake actuator and the rail and/or between the brake disk and the at least one brake lining, and outputs a signal dependent on the measured variable to a control device that adapts the braking force generated by the brake actuator as a function of the deviation of the time profile of the measured variable from a predefined or expected time profile.

Abstract

A brake system of a rail vehicle, having at least one brake actuator comprising at least one brake disk and at least one brake lining, which interacts with the brake disk, for generating a braking force in response to a braking demand. At least one sensor device measures the time profile of at least one variable, such as wheel rotational speed, wheel circumferential acceleration, braking force, braking torque or brake pressure, which represents fluctuations in the friction conditions between the wheel or wheel set assigned to the brake actuator and the rail and/or between the brake disk and the at least one brake lining, and outputs a signal dependent on the measured variable to a control device that adapts the braking force generated by the brake actuator as a function of the deviation of the time profile of the measured variable from a predefined or expected time profile.

Brake system of a rail vehicle with compensation of fluctuations in the friction conditions

Description

Prior Art

The invention is based on a brake system of a rail vehicle, having at least one brake actuator which is assigned to a wheel or a wheel set and comprises at least one brake disk and at least one brake lining which interacts with the former in order to generate a braking force in response to a braking demand, and on a method for controlling such a brake system.

A brake system of the generic type and a method of the generic type are known, for example from DE 102 45 207 C1. In such brake systems, the friction conditions between the wheel or wheel set and the rail or, respectively, between the brake disks and the assigned brake linings fluctuate, in some cases considerably, depending on the weather, ambient temperature, state of wear and load profile. Furthermore, these friction conditions are also not constant along a rail vehicle or along a train composed of rail vehicles. In order to limit the influence of the friction conditions on the braking forces which can be generated or transmitted, very tight tolerances in terms of compliance with shape and dimensions, material composition, rigidity etc. are prescribed, in particular in the case of brake linings, which entails correspondingly high costs.

The present invention is therefore based, in contrast with the above, on developing a brake system or a method for controlling a brake system of the type mentioned at the beginning in such a way that the brake system entails fewer manufacturing and maintenance costs.

According to one embodiment, there is provided a brake system of a rail vehicle, having at least one brake actuator which is assigned to a wheel or a wheel set and comprises at least one brake disk and at least one brake lining which interacts with the former in order to generate a braking force in response to a braking demand, wherein at least one sensor device is provided for measuring the time profile of at least one variable, such as a wheel rotational speed, wheel circumferential acceleration, braking force, braking torque or brake pressure, which represents fluctuations in the friction conditions between the wheel or wheel set assigned to the brake actuator and the rail and/or between the brake disk assigned to the brake actuator and the at least one brake lining, and for modulating a signal which is dependent on the measured variable and is output to a control device, which brake system is embodied in such a way that it adapts the braking force generated by the brake actuator as a function of the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable; and wherein the brake system comprises a plurality of brake actuators, and the control device is embodied in such a way that, if the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable is greater than a permitted deviation at one brake actuator, the braking force at the one brake actuator is increased and, for the purpose of compensation, the braking force which is generated by a further brake actuator at which the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable is smaller than the permitted deviation is reduced in such a way that the sum of the actual braking forces, obtained in this way, of the brake actuators corresponds to an overall setpoint braking force corresponding to the braking demand.

According to another embodiment, there is provided a method for controlling a brake system of a rail vehicle, having at least one brake actuator which is assigned to a wheel or a wheel set and comprises at least one brake disk and at least one brake lining which interacts with the former in order to generate a braking force in response to a braking demand, wherein: a)measurement of the time profile of at least one variable, such as wheel rotational speed, wheel circumferential acceleration, braking force, braking torque or brake pressure, which represents fluctuations in the friction conditions between the wheel or wheel set assigned to the brake actuator and the rail and/or between the assigned brake disk and the at least one brake lining, b)adaptation of the braking force generated by the brake actuator as a function of the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable; and wherein if the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable is greater than a permitted deviation at one brake actuator, the braking force at the one brake actuator is increased and, for the purpose of compensation, the braking force which is generated by a further brake actuator at which the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable is smaller than the permitted deviation is reduced in such a way that the sum of the actual braking forces, obtained in this way, of the brake actuators corresponds to an overall setpoint braking force corresponding to the braking demand.

Disclosure of the invention

The invention provides at least one sensor device for measuring the time profile of at least one variable, such as a wheel rotational speed, wheel circumferential acceleration, braking force, braking torque or brake pressure, which represents fluctuations in the friction conditions between the wheel or wheel set assigned to the brake actuator and the rail and/or between the brake disk assigned to the brake actuator and the brake lining or brake linings, and for modulating a signal which is dependent on the measured variable and is output to a control device, which brake system is embodied in such a way that it adapts the braking force generated by the brake actuator as a function of the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable.

In other words a certain degree of fluctuations in the friction conditions between the wheel or wheel set and the rail and/or between the brake disk and the brake lining is to be tolerated, but starting from a limit value (permitted deviation) said fluctuations are to be compensated by adapting the braking force or the braking torque.

In the case of a rail vehicle, fluctuations in the friction conditions between the wheel or wheel set and the rail and/or between the brake linings and the brake disk on the braked axles have a fed-back effect on the time profile of the braking force generated by the respective or the assigned brake actuator.

The braking force in the circumferential direction of the brake disk or the braking torque is therefore preferably used as the variable which represents fluctuations in the friction conditions between the wheel or wheel set and the rail and/or between the brake disk and the brake linings, is measured as a time signal and is then evaluated using the control device. In the case of a constant braking demand, deviations or fluctuations in the braking force or in the braking torque at a brake actuator from an expected time profile of these variables therefore indicate fluctuations in the friction conditions between the assigned wheel or wheel set and the rail and/or between the assigned brake disk and the brake linings.

The sensor device is therefore preferably designed to measure the braking force or the braking torque at a brake actuator and the control device to adapt the braking force generated by the brake actuator as a function of the deviation of the time profile of the measured braking force from a predefined time profile of the braking force. Instead of the braking force, the braking torque can, of course, also be monitored.

However, any other variable on which the fluctuations in the friction conditions have an effect and by which said friction conditions can be measured or detected is conceivable as a variable which represents fluctuations in the friction conditions between the wheel or wheel set assigned to a brake actuator and the rail or, respectively, between the brake disk assigned to a brake actuator and the brake linings, and whose time profile is to be measured and compared. In the case of rail vehicles or in the case of trains which are composed of individual rail vehicles, the forces between the individual rail vehicles (train longitudinal forces) are, for example, also possible.

The use of the braking force in the circumferential direction of the brake disk and/or of the braking torque at a brake actuator during a braking demand as a variable which represents fluctuations in the friction conditions between the assigned wheel or wheel set and the rail and/or between the assigned brake disk and the brake linings has the advantage that brake systems of rail vehicles are usually equipped in any case with a braking force control and therefore the corresponding sensor system, as described DE 102 45 207 C1. The time profiles of the braking force and/or of the braking torque which are measured in any case at a brake actuator can then be used simultaneously as representative variables or as indicators of the occurrence of fluctuations in the friction conditions between the assigned wheel or wheel set and the rail and/or between the assigned brake disk and the brake linings as indicators for fluctuations in the friction conditions, without an additional sensor system being necessary.

By adapting the braking force during a braking demand as a function of the measured fluctuations in the friction conditions, the contact pressure of the brake lining against the brake disk or that against the wheel circumference or against the effective braking force is changed. It is particularly preferred here for the braking force to be increased somewhat compared to a setpoint braking force corresponding to the respective braking demand, in order to compensate for unfavorable friction conditions such as, for example, an excessively low coefficient of friction, caused by environmental conditions, between the wheel and the rail and/or the brake disk and the brake lining due to an increased braking force at the respective brake actuator.

The measures specified in the subclaims make advantageous developments and improvements of the invention specified in the independent claims possible.

The brake system particularly preferably comprises a plurality of brake actuators, wherein the control device is embodied in such a way that, if the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable is greater than a permitted deviation at one brake actuator, the braking force at the one brake actuator is increased and, for the purpose of compensation, the braking force which is generated by a further brake actuator at which the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable is smaller than the permitted deviation is reduced in such a way that the sum of the actual braking forces, obtained in this way, of the brake actuators corresponds to an overall setpoint braking force corresponding to the braking demand.

In this case, an increase in the braking force or in the braking torque compared to the braking demand at a brake actuator with unfavorable or no longer tolerable fluctuations in the friction conditions between an assigned wheel or wheel set and the rail and/or between the assigned brake disk and the brake linings no longer brings about over-braking because then, as a result of at least one further brake actuator at which no fluctuations, or tolerable fluctuations, occur in the friction conditions between the assigned wheel or wheel set and rail and/or between the assigned brake disk and the brake linings, a braking force or a braking torque is generated which is lower compared to the braking demand to such an extent that the overall braking force or the overall braking torque corresponds to the overall setpoint braking force or the overall setpoint braking torque. The sum of the braking torques which are generated in such a way at various brake actuators therefore remains unchanged.

More precise details can be found in the following description of an exemplary embodiment.

Drawing

An exemplary embodiment of the invention is illustrated in the drawing and explained in more detail in the following description. In the drawing:

fig. 1 is a schematic lateral illustration of a disk brake system of a rail vehicle according to a preferred embodiment of the invention; and

fig. 2 is a flowchart of a braking force adaptation or braking torque adaptation for compensating fluctuations in the friction conditions between the wheel or wheel set and rail or between the brake disk and brake linings according to a preferred embodiment of the invention.

Description of the exemplary embodiment

Fig. 1 shows a disk brake system 1 of a rail vehicle according to a preferred embodiment of the invention such as is basically also known, for example, from DE 102 45 207 C1 and is therefore only briefly described below.

The disk brake system 1 includes, as a brake actuator or brake application device a brake caliper unit 2 with a service brake unit and a stored-energy brake unit (not considered here). The brake caliper unit 2 comprises a brake disk 4 which interacts in a known fashion with, for example, two brake linings 6, only one of which can be seen in the side view in fig. 1. The brake caliper unit 2 is preferably activated pneumatically, in order to generate a braking force F_B, acting in the circumferential direction of the brake disk 4, in response to a braking demand. Alternatively, the brake caliper unit 2 could, of course, also be activated by pressure medium in some other way, for example be activated hydraulically or else electrically.

Since the brake caliper unit 2 is supported by means of a holder 8 on a bogie (not shown here) of the rail vehicle, a reaction torque M_A or reaction forces F_{A1}, F_{A2} acts on the holder 8, at attachment points of the holder 8 on the bogie which are spaced apart from one another and which can be measured by means of a force measuring sensor system such as, for example, a strain gauge on corresponding connecting components between the holder 8 and the bogie. The rail vehicle preferably comprises a plurality of bogies each with a plurality of such brake actuators or brake caliper units 2, with the result that the braking forces which are generated by at least some of these brake caliper units 2 can be measured and evaluated in a control device (not shown here). Only one of the brake caliper units 2 of the rail vehicle which are of, for example, identical design, is shown by way of example in fig. 1.

In particular, the sensor device which is assigned to a brake caliper unit 2 serves to measure the time profile of at least one variable, such as wheel rotational speed, wheel circumferential acceleration, braking force, braking torque or brake pressure, which represents fluctuations in the friction conditions between the wheel and the rail and/or between the brake disk 4 and brake lining 6, and to modulate the signal which is dependent on the measured time profile and is output to a control device, which brake system is embodied in such a way that it adapts the braking force generated by the brake actuator 2 which is assigned to the wheel or the wheel set and/or to the brake disk and the brake linings, as a function of the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable.

For example the wheel rotational speed, the wheel circumferential acceleration, the braking force, the braking torque M_A or else the brake pressure in the case of a pneumatically activated brake caliper unit are possible as such a variable. In the case of electrically activated brake caliper units 2, the variable could, for example, also be the activation current.

The braking force in the circumferential direction of the brake disk 4 or the braking torque M_A of a brake caliper unit 2 during a braking demand is preferably used as a variable which represents the fluctuations in the friction conditions between the wheel assigned to the brake caliper unit 2 or the wheel set assigned to the brake caliper unit 2 and/or between the brake disk 4 assigned to the brake caliper unit 2 and brake lining 6 assigned to the brake caliper unit 2, is measured as a time signal or time profile over a specific predefined time period, and is then evaluated using the control device (brake controller).

In other words, in this case the braking force or the braking torque or the time profile of the respective variable is measured, and then the braking force or the braking torque generated by the assigned brake caliper unit 2 is adapted as a function of the deviation of the time profile of the measured braking force from a predefined or expected time profile of the braking force. Instead of the braking force, the braking torque can, of course, also be monitored.

It is also possible that, instead of just one variable, a plurality of variables, which represent fluctuations in the friction conditions between the wheel or wheel set and rail and/or between the brake disk 4 and brake lining 6 and are assigned to the respective brake caliper unit 2, to be monitored in parallel. Given a constant braking demand, changes or fluctuations in the time profile of the measured braking force or of the measured braking torque M_A or deviations from the expected time profile then indicate fluctuations in the friction conditions between the wheel or wheel set assigned to the respective brake caliper unit 2 and the rail and/or between the brake disk 4 and the brake lining 6 at the respective brake caliper unit 2.

As is most clear from fig. 2, the time profiles of the braking force or of the braking torque M_A (torque sensing) at a brake caliper unit 2 are therefore measured, wherein the control device (brake controller) adapts the braking torque M_A generated by the respective brake caliper unit 2, as a function of the deviation of the measured time profile of the braking torque M_A, influenced, under certain circumstances, by fluctuations in the friction conditions between the assigned wheel or wheel set and the rail and/or between the assigned brake disk 4 and the brake lining 6, from a predefined or expected time profile of the braking torque (braking demand) at this brake caliper unit 2, for example by means of brake pressure prespecification for the preferably pneumatically activated brake caliper unit 2. Fluctuating friction properties between the assigned wheels and the rail and/or between the brake disk 4 and the brake lining 6 then act as interference variables on the braking mechanism of the brake caliper unit 2.

In practice, the brake system of a rail vehicle preferably comprises a plurality of brake actuators or brake caliper units 2, wherein the control device is then preferably embodied in such a way that, if in the case of one of the brake caliper units 2, the deviation of the measured time profile (preferably the measured time profile of the braking torque) from a predefined or an expected time profile is greater than a permitted deviation (intolerable fluctuations of the friction forces occur at this one brake caliper unit 2), said brake system increases the braking force or the braking torque at this one brake caliper unit 2, and, for the purpose of compensation, the braking force or braking torque generated by a further brake caliper unit 2, at which the deviation of the measured time profile from the predefined or expected time profile is smaller than the permitted deviation (i.e. tolerable fluctuations in the friction properties occur at this further brake caliper unit 2), is reduced in such a way that the sum of the actual braking forces and actual braking torques obtained in this way, for all or of at least some of the brake caliper units 2 corresponds to an overall setpoint braking force corresponding to the braking demand or to an overall setpoint braking torque corresponding to the braking demand.

In this case, for example an increase in the braking force or in the braking torque at the one brake caliper unit 2 compared to the braking demand due to disruptive or intolerable fluctuations in the friction conditions between the assigned wheel or wheel set and the rail and/or between the assigned brake disk 4 and the assigned brake lining 6 does not, for example, bring about over-braking of the rail vehicle because, due to at least one further brake caliper unit 2 at which no fluctuations, or tolerable fluctuations, in the friction conditions occur between the assigned wheel or wheel set and the rail and/or between the assigned brake disk 4 and the assigned brake lining 6, a braking force or a braking torque is generated which is lower compared to the braking demand to such an extent that the overall braking force or the overall braking torque corresponds to the overall setpoint braking force or the overall setpoint braking torque.

List of reference numbers

1	Brake system
2	Brake caliper unit
4	Brake disk
6	Brake linings
8	Holder

Patent Claims

1. A brake system of a rail vehicle, having at least one brake actuator which is assigned to a wheel or a wheel set and comprises at least one brake disk and at least one brake lining which interacts with the former in order to generate a braking force in response to a braking demand, wherein at least one sensor device is provided for measuring the time profile of at least one variable, such as a wheel rotational speed, wheel circumferential acceleration, braking force, braking torque or brake pressure, which represents fluctuations in the friction conditions between the wheel or wheel set assigned to the brake actuator and the rail and/or between the brake disk assigned to the brake actuator and the at least one brake lining, and for modulating a signal which is dependent on the measured variable and is output to a control device, which brake system is embodied in such a way that it adapts the braking force generated by the brake actuator as a function of the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable; and

wherein the brake system comprises a plurality of brake actuators, and the control device is embodied in such a way that, if the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable is greater than a permitted deviation at one brake actuator, the braking force at the one brake actuator is increased and, for the purpose of compensation, the braking force which is generated by a further brake actuator at which the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable is smaller than the permitted deviation is reduced in such a way that the sum of the actual braking forces, obtained in this way, of the brake actuators corresponds to an overall setpoint braking force corresponding to the braking demand.

2. The brake system as claimed in claim 1, wherein the variable which represents the fluctuations in the friction conditions between the wheel or the wheel set and rail and/or between the brake disk and the brake lining is the braking force generated by the assigned brake actuator or the braking torque generated by the assigned brake actuator.

3. A method for controlling a brake system of a rail vehicle, having at least one brake actuator which is assigned to a wheel or a wheel set and comprises at least one brake disk and at least one brake lining which interacts with the former in order to generate a braking force in response to a braking demand, wherein:

a) measurement of the time profile of at least one variable, such as wheel rotational speed, wheel circumferential acceleration, braking force, braking torque or brake pressure, which represents fluctuations in the friction conditions between the wheel or wheel set assigned to the brake actuator and the rail and/or between the assigned brake disk and the at least one brake lining,

b) adaptation of the braking force generated by the brake actuator as a function of the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable; and wherein if the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable is greater than a permitted deviation at one brake actuator, the braking force at the one brake actuator is increased and, for the purpose of compensation, the braking force which is generated by a further brake actuator at which the deviation of the time profile of the measured variable from a predefined or expected time profile of the variable is smaller than the permitted deviation is reduced in such a way that the sum of the actual braking forces, obtained in this way, of the brake actuators corresponds to an overall setpoint braking force corresponding to the braking demand.

4. The method as claimed in claim 3, wherein the variable which represents the fluctuations in the friction conditions between the wheel or wheel set and the rail and/or between the brake disk and the brake lining is the braking force generated by the brake actuator or the braking torque.

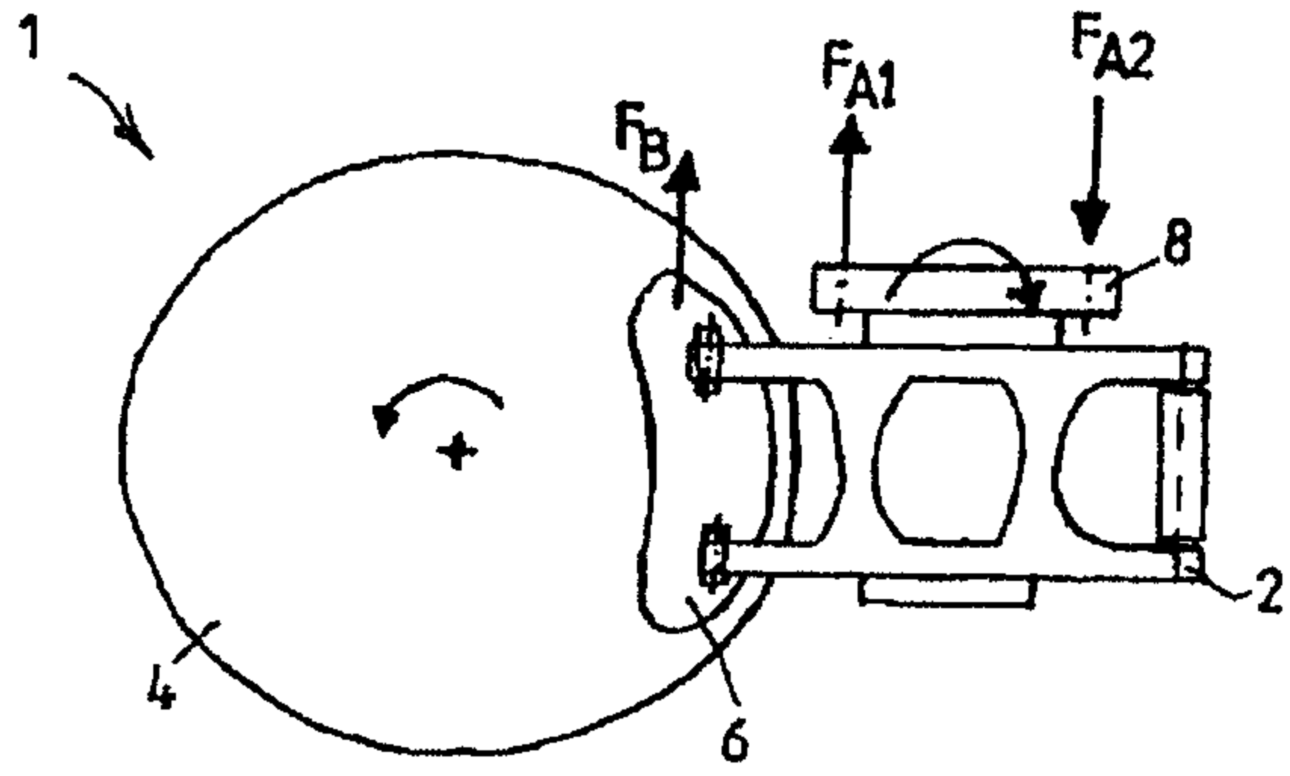
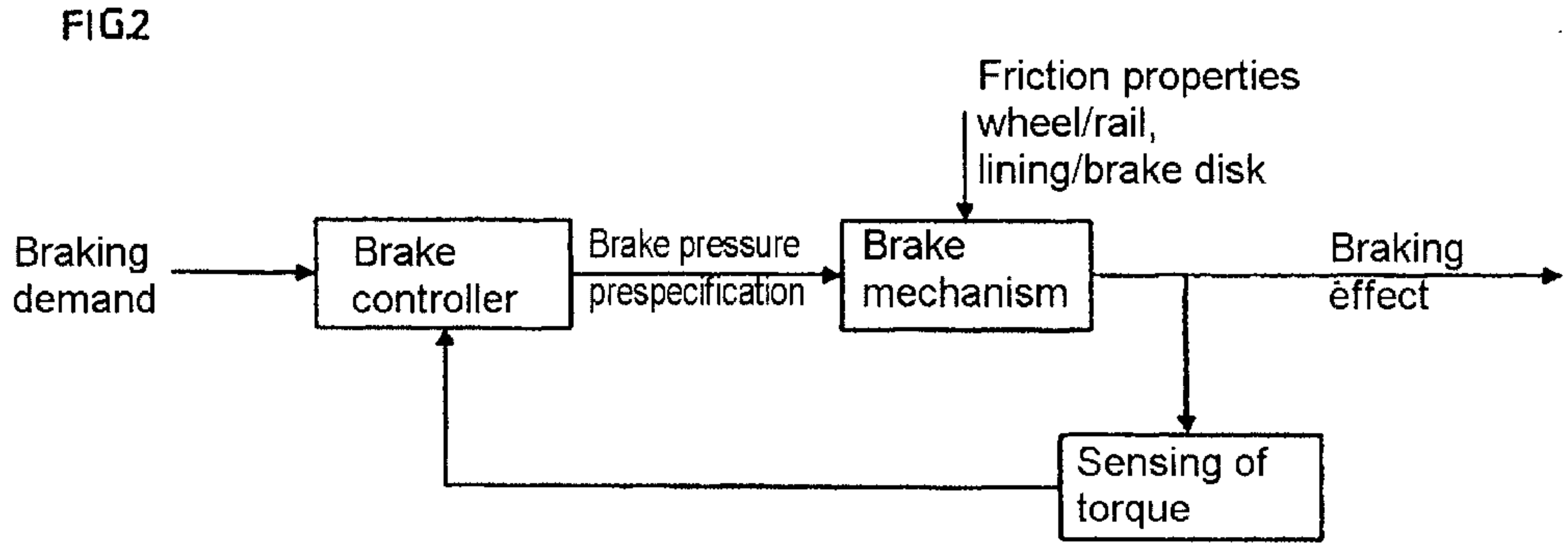


FIG.1

FIG.2



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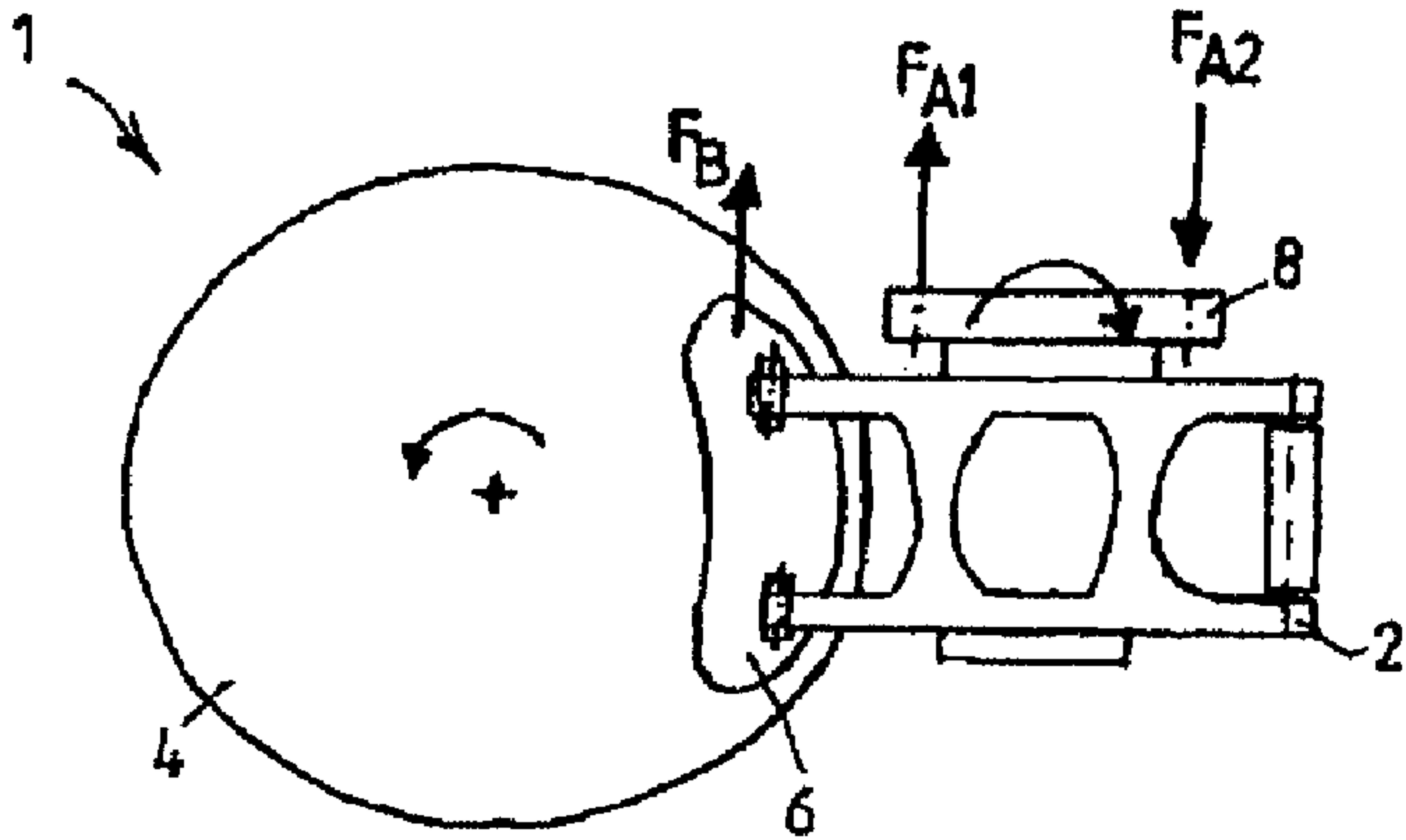
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F_B
F_A1
F_A2
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