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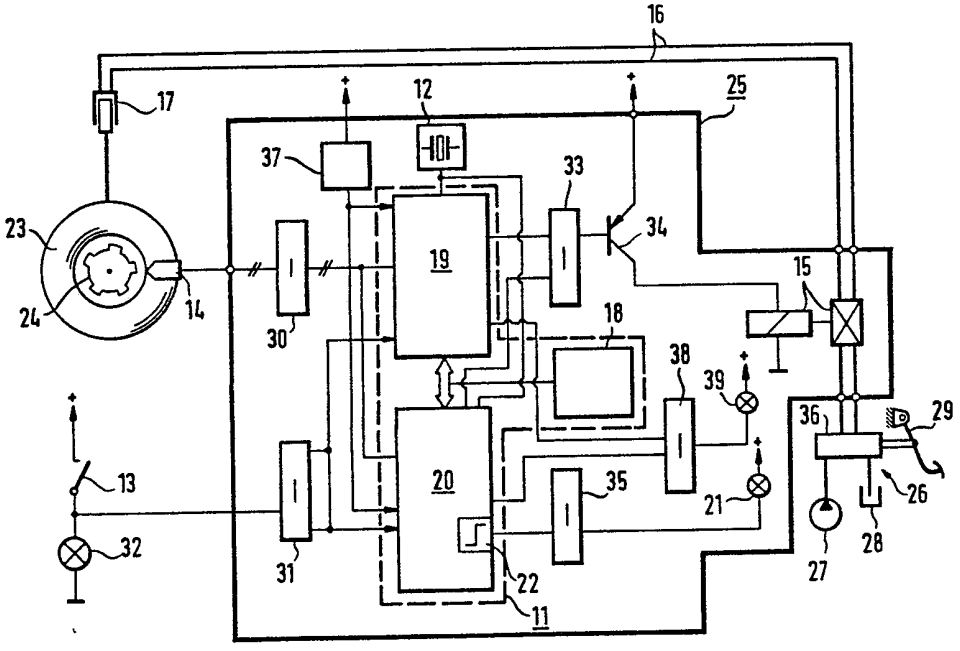
(54) Brake-monitoring device

(57) A brake-monitoring device for a brake system of an automotive vehicle equipped with an electronic anti-lock system (25) comprises two microprocessors (19,20) which have input signals formed by a clock signal, wheel speed signals as well as a brake-actuating signal. A programmable and erasable memory unit (18) is connected to at least one of the microprocessors (19,20) from which it receives the most important data indicative of the degree of wear of the brake system and thus memorises the history of the brake system since the last erasure. At least one of the microprocessors determines from the contents of the memory unit (18) the degree of wear of the individual components of the brake system and issues an alarm signal when a predetermined degree of wear is reached.



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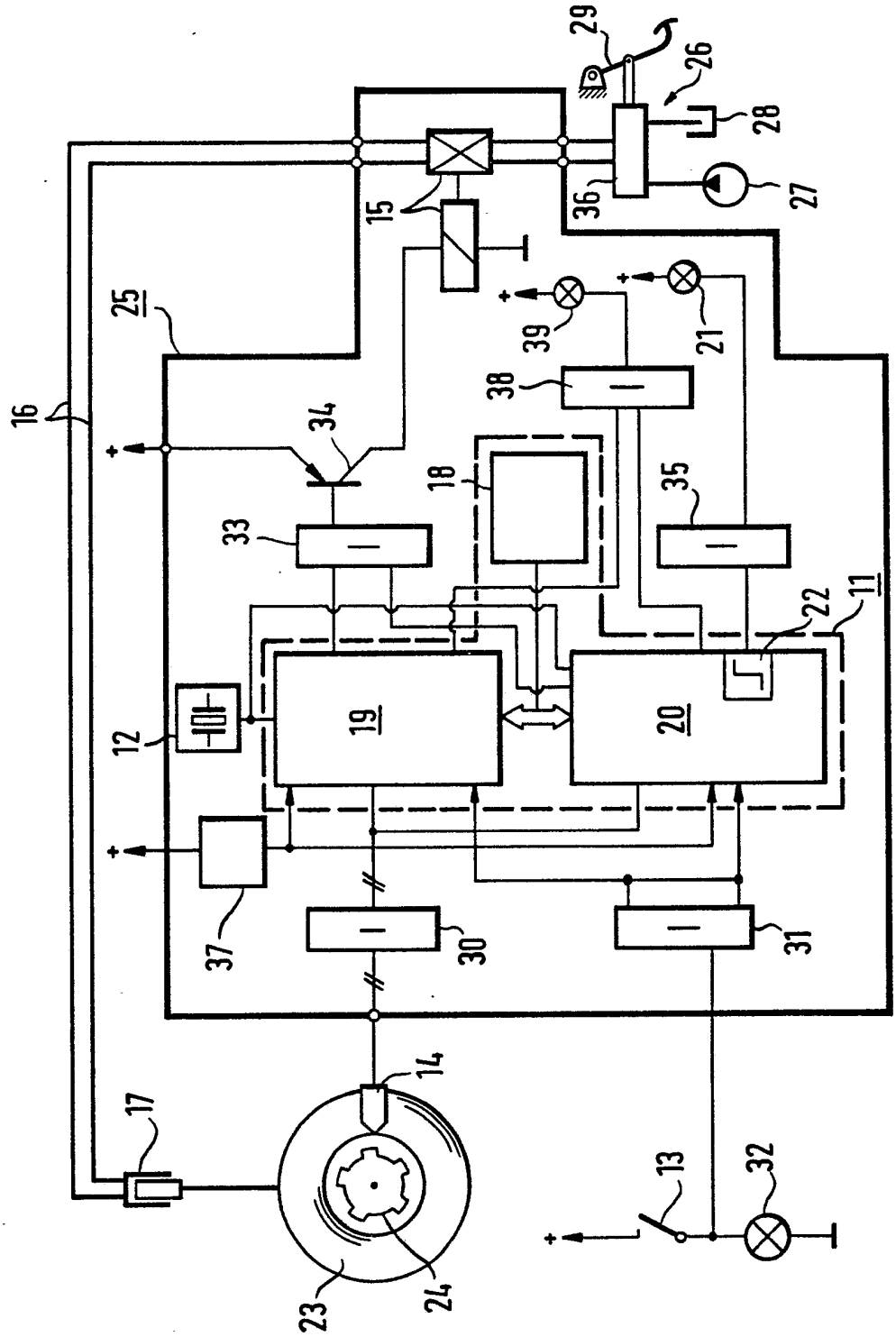
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BRAKE-MONITORING DEVICE

The present invention relates to a brake-monitoring device in a brake system of automotive vehicles equipped with an electronic anti-lock system, wherein, as input signals, each microprocessor of a pair of microprocessors is supplied with a clock signal by a clock generator, is supplied with wheel speed signals by wheel speed sensors and with a brake-actuation signal by a brake light switch, and wherein both microprocessors supply as output signals, derived from these input signals, actuating signals for solenoid valves in the wheel brake circuits, which valves at the onset of wheel slip reduce the braking pressure in the wheel brake cylinders to counteract wheel slip.

For safety reasons, two microprocessors are provided and the arrangement may be such that one of them can be redundent. In this case the sensor signals are supplied in parallel to the two microprocessors and are processed in them in the same manner in accordance with the same programme. The output signals of both microprocessors are checked for coincidence. If there is a discrepancy, due for example to a defect in any one of the two microprocessors, the control may be de-activated by a pertinent safety monitoring circuit. A suitable monitoring device is known from German published patent application 32 34 637.

Conventional brake warning devices function

inadequately in the event of worn brake pads, because they generally are based upon a direct measurement of brake pad wear by electric contacts which may become corroded or damaged particularly easily in the heavy-duty service of brakes. It has not been possible so far to generally monitor all important component parts of a brake system.

The present invention seeks to provide a brake-monitoring device of the species initially referred to in which the operating condition of at least the essential component parts of the brake system is constantly checked so that, upon the occurrence of a wear condition exceeding a predetermined value, an alarm signal is provided in sufficient time to permit the driver to report to a workshop for brake inspection.

According to the invention there is provided a brake-monitoring device for a brake system of an automotive vehicle equipped with an electronic anti-lock system, wherein, as input signals, each microprocessor of a pair of microprocessors, is supplied with a clock signal by a clock generator, is supplied with wheel speed signals by wheel speed sensors and with a brake-actuation signal by a brake light switch, and wherein both microprocessors supply as output signals, derived from these input signals, actuating signals for solenoid valves in the wheel brake circuits, which valves at the onset of wheel slip reduce the braking pressure in the wheel brake cylinders to counteract wheel slip, characterised in that a programmable and erasable memory unit is connected to at least one of the microprocessors and obtains therefrom at least that data which is most important for determining the degree of wear of the brake system, which data is

calculated from the input signals, and memorises the history of the brake system since the last erasure, in that at least one of the microprocessors is connected with the memory unit such that the degree of the brake system's wear is determined by the data stored in the memory unit, in that a warning device is connected to the microprocessor evaluating the contents of the memory unit, to which warning device an alarm signal is issued upon attainment of a predetermined degree of wear by the microprocessor evaluating the contents of the memory unit.

The present invention is based on the knowledge that in anti-lock brake systems working with one microprocessor all data necessary for determining the degree of wear of the individual component parts of the brake system is already available, so that all that is required is to utilise this existing information in a suitable manner. This is enabled by the provision of an additional programmable and erasable memory unit in which the complete history since the last brake service is stored. From this data, the microprocessor evaluating the contents of the memory unit determines the degree of wear of the individual brake components so that an alarm signal can be issued when a predefined degree of wear is reached. This signal can be supplied e.g. to a service interval display unit on the instrument panel. As soon as the corresponding lamp lights up, the driver will know that now he must have the brakes inspected. The brake pads will then be checked, the anti-lock apparatus will be adjusted and/or the brake fluid will be replaced in the workshop. Subsequent to this inspection, workshop personnel will erase the history of the brake system stored in the memory unit so that, starting from

this point of time, a new history of the individual brake components can be stored in the memory unit.

In order to obtain a general account as complete as possible of the degree of wear of the individual component parts of the brake system, it is provided according to a refinement of the invention that the microprocessors or one of the microprocessors forms from the input signals one or more of the following input parameters for the memory unit:-

frequency of brake application,

initial velocity and final velocity on each braking action,

duration of each braking action,

deceleration achieved during each braking action,

number of normal braking actions,

number of braking actions involving slip.

Furthermore, it is expedient if the microprocessor(s) evaluating the contents of the memory unit determines from the memory contents of the memory unit one or more of the following output parameters:-

degree of wear of the brake pads,

deterioration of the brake fluid's condition,

wear of the component parts of the anti-lock system.

In this case there may be provided a threshold unit at the output of the microprocessor to evaluate the contents of the memory unit, the thresholds of which threshold unit being conformed to the predetermined degrees of wear of the individual components of the brake system.

A practical realisation of this invention arranges for the memory unit to be an EEPROM.

In order that the invention and its various other preferred features may be understood more easily, an embodiment thereof will now be described, by way of example only with reference to the drawing, the single figure of which is a schematic block diagram of a brake-monitoring device constructed in accordance with the invention.

According to the drawing, the wheels 23 of an automotive vehicle, only one of which is illustrated for the sake of clarity, are each equipped with a sensor wheel 24 co-rotating with the wheel and generating upon rotation of the wheel, in a wheel speed sensor 14 located closely thereto, an electric signal representative of the rotational speed of the wheel 23. One inductive wheel speed sensor 14 is arranged at each one of the generally four vehicle wheels.

Each wheel 23 comprises a hydraulic brake including a wheel brake cylinder 17 which is indicated only schematically in the drawing and which acts upon a non-illustrated brake disc. The wheel brake cylinders 17 are connected to a hydraulic wheel brake circuit 16 which - via a solenoid valve assembly 15 which is illustrated only schematically and belongs to an anti-lock system 25 - communicates with a hydraulic brake-actuating device 26 which e.g. is composed of a hydraulic pump 27, a return reservoir 28, a master cylinder 36 and a brake pedal 29. Upon depression of the brake pedal 29, hydraulic pressure is supplied via the solenoid valve assembly 15 and the wheel brake circuit 16 to the wheel brake cylinders 17, which pressure causes braking the vehicle wheels 23 in dependence upon the force exerted on the brake pedal 29.

The four wheel sensors 14 are connected to the anti-lock system 25. Via a pulse-forming circuit 30, the wheel speed signals are delivered to two parallel connected redundantly processing microprocessors 19,20 which form a microprocessor 11 which are each also supplied by a brake light switch 13 with a further input signal, via another pulse-forming, which switch signifies to the microprocessors 19,20 when the brake light switch 13 is closed. In this way, the microprocessors 19,20 assess how often the brake pedal is depressed. Additionally, the brake light switch 13 actuates the stop lights 32. The microprocessors 19,20 are supplied with a stabilised direct-current voltage via a voltage controller 37.

Connected to the microprocessors 19,20 is a clock generator 12 which signals to both microprocessors 19,20 the elapsed time since the last brake inspection and also supplies a clock signal required for the normal braking operation.

In a known way, the microprocessors 19,20 form from the input signals suitable output signals for the actuation of the solenoid valve assembly 15 which are routed via an adapting circuit 33 to an amplifier 34 which acts in a directly controlling manner upon the solenoid valve assembly 15. In the case of commencement of wheel slip at one of the wheels 23, despite the brake pedal 29 being depressed, the solenoid valve assembly 15 provided for the corresponding wheel brake cylinder 17 cause the braking pressure to be decreased so far that wheel slip no longer occurs. In a known way, each solenoid valve assembly comprises in closing valves establishing a connection to the pump 27 as well as opening valves establishing a connection to the

return reservoir 28. A function-monitoring stage 38 delivers a warning signal to an alarm lamp 39 when the anti-lock control is switched off e.g. due to failure of one of the two microprocessors 19,20.

A memory unit 18 in the form of an EEPROM is connected to the microprocessors 19,20 in which the entire history of the brake system since the last brake inspection is stored. This data includes the frequency of brake light switching, the initial velocity and final velocity on each braking action, the duration of each braking action, the attained deceleration during each braking action as well as the duration of use. Additionally, there is stored in the memory unit 18 information about whether a normal braking action or a braking action with brake slip control was performed, which latter required the operation of the components of the anti-lock system 25.

The microprocessor 20 evaluates the contents of the memory unit 18 by constantly interrogating the contents of the memory unit 18 and by ascertaining from the data stored in the memory unit 18 the degree of wear of the brake system. This arrangement allows recognition of the wear condition of all individual components of the brake system, such as the degree of wear of the brake pads, the consumption of brake fluid and its deterioration as well as the wear of the mechanic and the hydraulic components of the anti-lock system. These wear phenomena are computed from the input signals available.

A warning device, in the form of a service tell-tale lamp 21, is connected to the microprocessor 20 via a threshold unit 22 and another adapting circuit 35. As soon as any one of

the brake components has reached a specific degree of wear or consumption, as defined by predetermined threshold levels set in the unit 22, the service tell-tale lamp 21 will light up and thus signal to the driver that he must take the vehicle for inspection.

Although in the embodiment illustrated, the programmable memory unit 18 is connected to both of the microprocessors it may be connected to only one of the microprocessors.

Although in the embodiment illustrated, only one of the microprocessors are connected to the solenoid valve and the function monitoring stage 38 and tell-tale lamp 21 both microprocessors could be so connected to provide a fail safe system where one microprocessor can be redundent.

CLAIMS:

1. A brake-monitoring device for a brake system of an automotive vehicle equipped with an electronic anti-lock system, wherein, as input signals, each microprocessor of a pair of microprocessors, is supplied with a clock signal by a clock generator, is supplied with wheel speed signals by wheel speed sensors and with a brake-actuation signal by a brake light switch, and wherein both microprocessors supply as output signals, derived from these input signals, actuating signals for solenoid valves in the wheel brake circuits, which valves at the onset of wheel slip reduce the braking pressure in the wheel brake cylinders to counteract wheel slip, characterised in that a programmable and erasable memory unit (18) is connected to at least one of the microprocessors (19,20) and obtains therefrom at least that data which is most important for determining the degree of wear of the brake system, which data is calculated from the input signals, and memorises the history of the brake system since the last erasure, in that at least one of the microprocessors (19,20) is connected with the memory unit (18) such that the degree of the brake system's wear is determined by the data stored in the memory unit (18), in that a warning device (21) is connected to the microprocessor (20) evaluating the contents of the memory unit (18) , to which warning device an alarm signal is issued upon attainment of a predetermined degree of wear by the microprocessor (20) evaluating the contents of the memory unit (18).

2. A brake-monitoring device as claimed in claim 1, characterised in that the programmable memory unit (18) is connected to both of the

microprocessors (19,20) and only one of the microprocessors (20) is connected with the warning device (21).

3. A device as claimed in claim 1 or 2, characterised in that the microprocessors (19,20) determine from the input signals one or more of the following input parameters for the memory unit (18):-

frequency of brake application,

initial velocity and final velocity on each braking action,

duration of each braking action,

deceleration achieved during each braking action,

number of normal braking actions,

number of braking actions involving wheel slip.

4. A device as claimed in any one of the preceding claims, characterised in that the microprocessor (20) evaluating the contents of the memory unit (18) determines from the content of the memory unit (18) one or more of the following output parameters:-

degree of wear of the brake pads,

deterioration of the brake fluid's condition,

wear of the component parts of the anti-lock system.

5. A device as claimed in any one of the preceding claims, characterised in that a threshold unit (22) is provided at the output of the microprocessor (20) which evaluates the contents of the memory unit (18), the thresholds of the threshold unit being conformed to predetermined degrees of wear or consumption of individual components of the brake system.

6. A device as claimed in any one of the

preceding claims, characterised in that the memory unit (18) is an EEPROM.

7. A brake monitoring device substantially as described herein with reference to the drawing.

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