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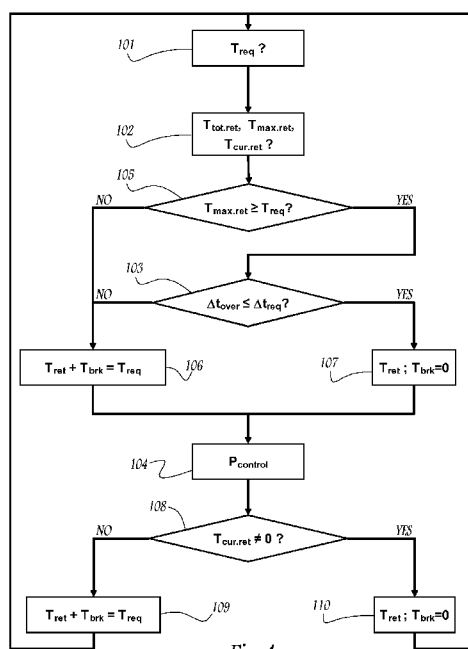
(54) **Title:** METHOD FOR CONTROLLING A BRAKING SYSTEM OF A HYBRID VEHICLE

Fig. 4

(57) **Abstract:** This method controls a braking system, which comprises: a controller area network (10); a friction brake unit; a group (3) of retarders (4-8); an electronic control unit (1). The method comprising the steps: c) said electronic control unit (1) receives, from said controller area network (10), a response time information relating to the response time (Δt_{over}) to have said group (3) of retarders (4-8) delivering a predetermined torque; d) said electronic control unit (1) checks (103) whether said response information complies with the delivery of a required braking torque (T_{req}); e) depending on said response time information compliance, said electronic control unit (1) only requests the activation of said group (3) of retarders (4-8).

METHOD FOR CONTROLLING A BRAKING SYSTEM OF A HYBRID VEHICLE

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a method for controlling a braking system of a hybrid vehicle.

BACKGROUND ART OF THE INVENTION

A hybrid vehicle is known to have an internal combustion engine and a reversible electrical machine, both of which can provide kinetic energy to the driveline of the hybrid vehicle. A hybrid vehicle also has a braking system, which generally comprises a brake pedal, an electronic control unit (ECU), a controller area network (CAN), a friction brake unit and several retarders.

Each retarder can supply the braking system with braking torque so as to decrease the speed of the vehicle. The retarders have different ways of providing braking torque and can therefore be discriminated depending upon their respective response time. Accordingly, slowly responding retarders have long response times, whereas quickly responding retarders have short response times.

On the one hand, slowly responding retarders comprise for instance a hydraulic retarder, an engine retarder, an exhaust retarder, etc. The response times of such slowly responding retarders range from 800 ms to 1000 ms.

On the other hand, quickly responding retarders comprise for instance the reversible electrical machine when working as a current generator or an eddy current retarder. The response times of quickly responding retarders range from 5 ms to 100 ms.

The braking system of a hybrid vehicle is controlled by a method that defines which and when the retarders and the friction brake unit have to be actuated. Prior art braking systems and controlling methods, as described in US-B-7,136,737, usually actuate the friction brake unit as soon as the driver depresses the brake pedal, because the friction brake unit has a quite short response time and can immediately deliver a braking torque. Simultaneously, the controlling method actuates the retarders, subsequently retrieves the braking torques delivered by

each retarder, and consequently modifies the command of the friction brake unit, in order to fit in the braking torque required by the driver.

However, the kinetic energy of the vehicle is firstly converted by the friction brake unit into thermal energy, which is useless. Moreover, the friction brake unit is always actuated, even when the required braking torque is relatively small and could be fully delivered by the retarders. Besides, actuating the friction brake unit not only wears the brake components, like pads, but it also wastes pneumatic energy produced by an energy consuming compressor.

SUMMARY OF THE INVENTION

One object of the present invention is to solve the here-above listed drawbacks by providing a method for controlling the braking system of a hybrid vehicle, which spares pneumatic energy, reduces the wear of the friction brake components and increases the conversion of kinetic energy into electrical energy.

This object is achieved by a method for controlling a braking system of a hybrid vehicle, said vehicle having an internal combustion engine and a reversible electrical machine, said braking system comprising at least:

- a controller area network;
- a friction brake unit;
- a group of retarders comprising at least one retarder;
- an electronic control unit configured to at least request the activation of said friction brake unit and/or of said group of retarders;

the method comprising the steps:

c) said electronic control unit receives, from said controller area network, a response time information relating to the response time to have said group of retarders delivering a predetermined torque;

d) said electronic control unit checks whether said response time information complies with the delivery of a required braking torque;

e1) depending on said response time information compliance, said electronic control unit only requests the activation of said group of retarders.

According to other advantageous but optional features of the present invention, considered on their own or in any technically possible combination:

- in said activation step e1), said electronic control unit only requests the activation of said group of retarders to such an extent that said torque currently deliverable by said group of retarders matches said required braking torque;
- the method further comprises the step:
 - e2) depending on said response time information non-compliance, said electronic control unit cumulatively requests the activation of said friction brake unit and of said group of retarders;
- in said activation step e2), said electronic control unit cumulatively requests the activation of said friction brake unit and of said group of retarders to such an extent that the sum of the friction brake unit torque plus said torque currently deliverable by said group of retarders matches said required braking torque;
- said group of retarders comprises at least one slowly responding retarder having a long response time and a least one quickly responding retarder having a short response time;
- the method further comprises the steps:
 - a) said electronic control unit receives, from said controller area network, a dataset comprising:
 - the maximum possible torque of said group,
 - the torque currently deliverable by said group,
 - the torque currently delivered by said group;
 - b) said electronic control unit subsequently stores said dataset;
- the method further comprises the step:
 - l) after a predetermined control period has elapsed, depending on whether said group of retarders delivers a predetermined torque or not, said electronic control unit performs either said activation step e1) or said activation step e2);
- the method further comprises the step:
 - k) said electronic control unit predetermines said control period as a function of said response time information;
- said braking system comprises several retarders, and said electronic control unit predetermines said control period as a function of the shortest

response time, i.e. the response time of the retarder which said electronic control unit initially memorized as being the quickest among said retarders;

- said response time information comprises an overall response time for said group of retarders;
- said response time information comprises the respective response time of every retarder of said group of retarders;
- said predetermined torque corresponds to a fraction of the maximum possible torque of at least one of said retarders or a fraction of the maximum possible torque of said group of retarders;
- said electronic control unit frequently retrieves predetermined driving parameters which induce a deceleration of said vehicle, like the current road slope, the vehicle weight, the vehicle air drag, the tyres friction, the gear ratio etc. and in that said electronic control unit actuates said retarders and/or said friction brake unit depending upon said predetermined driving parameters;
- said steps a) to b) are iterated every 10 ms to 100 ms; and
- said steps c) to d) are iterated every 10 ms to 100 ms.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention and its advantages will be better understood on the basis of the following description, which is given as an illustrative example, without restricting the scope of the invention, in relation with the annexed drawings, among which:

- Figure 1 is a schematic and partial view of a braking system,
- Figure 2 is a flowchart showing a first embodiment of a method according to the invention for controlling the braking system of figure 1,
- Figure 3 is a flowchart showing a second embodiment of a method according to the invention for controlling the braking system of figure 1,
- Figure 4 is a flowchart showing a third embodiment of a method according to the invention for controlling the braking system of figure 1,
- Figure 5 is a schematic time chart illustrating the data received by and the command signals emitted by an electronic control unit belonging to the braking system of figure 1, and

- Figure 6 is an operation time chart showing the actuation of different components of the braking system of figure 1.

DETAILED DESCRIPTION OF SOME EMBODIMENTS

Figure 1 illustrates a braking system S of a non-shown hybrid vehicle. As known from the prior art, the hybrid vehicle has an internal combustion engine 4 and a reversible electrical machine 5, which together form a drive train 2 which can deliver power to the vehicle.

The braking system S cooperates with a non-shown conventional brake pedal, which is arranged to move along a depression stroke selected by a driver of the vehicle. The braking system S has a non-shown conventional friction brake unit, which can generate a braking torque by supplying a hydraulic pressure to a non-shown wheel cylinder provided for each non-shown driving wheel. Furthermore, the braking system S has a group 3 of retarders which may be of two kinds. The first kind is comprised of so-called slowly responding retarders, which have a relatively long response time, and of quickly responding retarders, which have a relatively short response time.

The braking system S also comprises an electronic control unit 1, configured to at least request the activation of said friction brake unit and/or of said group 3 of retarders. The electronic control unit 1 is adapted to calculate a required braking torque T_{req} based upon the depression stroke of the brake pedal. The braking system S further comprises a controller area network or CAN 10 supporting a communication bus, in order to retrieve data from the components of the braking system S, on the one hand, and to forward command signals back to these components, on the other hand.

Slowly responding retarders may comprise a hydraulic retarder 6 and an exhaust retarder 8. The hydraulic retarder 6 or the exhaust retarder 8 can generate a braking torque within a response time of about 0.8 s to 1 s. In the present application, the expression "braking torque" not only defines the torque delivered by the friction brake unit, but also the torque delivered by any one of the retarders 4 to 8.

Besides, slowly responding retarders may comprise the engine brake from the internal combustion engine 4, and a non-shown exhaust brake, which is made

of a valve arranged on the exhaust pipe of the internal combustion engine 4. The engine brake and the exhaust brake have relatively long response times of more than 1 s.

The quickly responding retarders mainly comprise the reversible electrical machine 5, when it is operated as a generator in order to convert mechanical energy, often rotational energy, into electric energy. The reversible electrical machine 5 can generate a braking torque within a response time of about 10 ms to 50 ms. An eddy current retarder 7 can generate a braking torque within a response time of about 100 ms. Such a short response time is comparable to the response time of the friction brake unit.

Figure 2 illustrates a first embodiment of a method for controlling the braking system S. This controlling method comprises several steps, usually iterative, which are hereafter described in relation with figure 2.

In a step 101, the electronic control unit 1 receives, from controller area network 10, the required braking torque T_{req} that the driver orders the braking system S to generate. As a numerical example, the driver can depress the brake pedal to a depression stroke of 20% of the total stroke available. This order from the driver corresponds to a certain deceleration, say 1.5 m/s^2 . The electronic control unit 1 receives the command signal from the brake pedal, or any intermediate component, and calculates the corresponding required braking torque T_{req} , say 10000 N.m.

In a step 102, the electronic control unit 1 receives, via the controller area network 10, a dataset comprising the maximum possible torque $T_{\text{tot.ret.}}$ of the group 3, the torque currently deliverable $T_{\text{max.ret.}}$ by the group 3 and the torque currently delivered $T_{\text{cur.ret.}}$ by the group 3. Alternatively, such a dataset can comprise the maximum possible torque deliverable by only one or several retarder(s) belonging to group 3.

The maximum possible torque $T_{\text{tot.ret.}}$ corresponds to the total sum of the maximum braking torques that can be delivered by all retarders, i.e. when each retarder 4 to 8 works at its full potential. Depending on its working state and on the driving conditions, each retarder might not be able to work at its full potential, so that it does not deliver its specific maximum possible torque, but only a fraction, e.g. 20% or 80%, of such a maximum possible torque.

When a retarder 4, 5, 6 or 7 is not able to deliver its specific maximum possible torque, the group 3 cannot deliver the maximum possible torque $T_{\text{tot.ret.}}$. In this case, each retarder 4 to 8 is in a working state where it can deliver a certain amount of braking torque. The sum of the amounts of braking torques that the retarders 4 to 8 can currently deliver is called the torque currently deliverable $T_{\text{max.ret.}}$ by the group 3.

The torque currently delivered $T_{\text{cur.ret.}}$ by the group 3 corresponds to the sum of all braking torques that are presently or currently delivered by the retarders 4 to 8. The torque currently delivered $T_{\text{cur.ret.}}$ varies over the operation time between a null value, when the driver does not depress the brake pedal, and the torque currently deliverable $T_{\text{max.ret.}}$ as a maximum braking torque depending on the driving conditions and on the working state of each retarder 4 to 8.

Subsequent to the completion of step 102, electronic control unit 1 stores this dataset, comprising the maximum possible torque $T_{\text{tot.ret.}}$, the torque currently deliverable $T_{\text{max.ret.}}$ and the torque currently delivered $T_{\text{cur.ret.}}$.

Afterwards, in a step 103, the electronic control unit 1 receives, via the controller area network 10, a response time information relating to the response time to have the group 3 delivering a predetermined torque, which is not null, i.e. different from zero. This predetermined torque can be set at a fixed value, say 2000 N.m, or at a certain fraction, say 50%, of the maximum possible torque $T_{\text{tot.ret.}}$ or of the maximum possible torque of one particular retarder.

The response time information herein comprises the overall response time Δt_{over} , which corresponds to the shortest response time of all retarders 4 to 8 of the group 3, be it the response time of a quickly responding retarder 5 or the response time of a slowly responding retarder 6 or 7. Normally, this shortest response time is determined by a quickly responding retarder, like the reversible electrical machine 5.

Alternatively, such a response time information on CAN 10 can comprise the respective response times of every retarder 4 to 8. According to a further embodiment, instead of one single couple of torque and time values, the response time information can comprise a curve, i.e. a series of values plotting the time evolution of the fraction of the maximum possible torque that can be delivered by the group 3 or by a specific retarder 4 to 8.

Then, still in step 103, the electronic control unit 1 firstly checks whether the response time information, i.e. the overall response time Δt_{over} in this example, complies with the required time Δt_{req} for the delivery of the required braking torque T_{req} . This required time Δt_{req} can be set at a fixed duration, for instance 100 ms or 200 ms, preferably under the driver's detection threshold which is generally greater than 200 ms. Alternatively, the required time Δt_{req} can depend upon the speed of travel of the brake pedal during its depression.

In this example, the overall response time Δt_{over} is in compliance with the delivery of the required braking torque T_{req} , when the overall response time Δt_{over} is smaller or shorter than the required time Δt_{req} .

Depending on compliance or non-compliance of said response time information, the electronic control unit 1 either only requests activation of the retarders 4 to 8 or cumulatively requests the activation of said friction brake unit and of the retarders 4 to 8.

If this first check returns YES, i.e. if its answer is YES, in a step 107, the electronic control unit 1 sends a command signal on CAN 10 to actuate only the retarders 4 to 8, to such an extent that the torque currently deliverable $T_{\text{max.ret.}}$ by the group 3 matches the required braking torque T_{req} . In such a case, the friction brake unit is not actuated, i.e. the friction brake unit torque T_{brk} is null, since the retarders 4 to 8 are likely to deliver the whole required braking torque T_{req} .

On the contrary, if the first check returns NO in step 103, i.e. if its answer is NO, in a step 106, the electronic control unit 1 cumulatively requests the activation of the friction brake unit and of the retarders 4 to 8, to such an extent that the sum of the friction brake unit torque T_{brk} , visible on figures 5 and 6, plus the torque currently deliverable $T_{\text{max.ret.}}$ by the group 3 matches the required braking torque T_{req} .

Following either of these answers to this first check, YES or NO, the braking torque shall match the required braking torque $T_{\text{req.}}$, for instance 10000 N.m. At this stage, the controlling method according to the invention can close the loop and repeat the here-above described iterative steps, in order to continuously control the braking system S.

Figure 3 illustrates a second embodiment of a method for controlling the braking system S. This controlling method according to the invention comprises

further steps, usually iterative, as hereafter described in relation with figure 3. The steps 101, 102, 103, 106 and 107 being common to the first embodiment shown on figure 2, they are not described hereafter.

In a step 104, which occurs after step 103 and step 106 or 107, the electronic control unit 1 predetermines a control period P_{control} as a function of the overall response time Δt_{over} . The electronic control unit 1 can set or predetermine the control period P_{control} as a function of the shortest response time, which is the response time of the retarder which the electronic control unit 1 initially memorized as being the quickest among said quickly responding retarders 5.

For instance, the electronic control unit 1 can set the control period P_{control} to be twice, at most four times, the shortest response time amongst all retarders 4 to 8. If the braking system S comprises several quickly responding retarders 5, the electronic control unit 1 predetermines the control period P_{control} as a function of the shortest response time, i.e. the response time of the retarder which the electronic control unit 1 initially memorized as being the quickest among the quickly responding retarders 5.

Alternatively, the control period P_{control} can be set as a constant, say 50 ms or 150 ms respectively when the group 3 comprises only the electrical reversible machine 5 or also an eddy current retarder like 7.

After the control period P_{control} has elapsed, in a step 108, the electronic control unit 1 secondly checks whether the group 3 of retarders 4 to 8 delivers a torque or not. In other words, the electronic control unit 1 secondly checks whether the torque currently delivered $T_{\text{cur.ret.}}$ by group 3 is different or not from a null value.

Whether the second check returns NO or YES, the controlling method respectively goes into a step 109 or into a step 110. The step 109 is the same as the step 106, i.e. if the first check returns NO, the electronic control unit 1 cumulatively requests the activation of the friction brake unit and of the retarders 4 to 8, e.g. by emitting command signals, so that the sum of the friction brake unit torque T_{brk} plus the torque currently deliverable $T_{\text{max.ret.}}$ by group 3 matches the required braking torque $T_{\text{req.}}$

In a step 110, if the second check returns YES, the electronic control unit 1 only requests the activation of the retarders 4 to 8, so that the torque currently deliverable $T_{\text{max.ret.}}$ by group 3 matches the required braking torque $T_{\text{req.}}$

The second check of step 108, after computation of the control period P_{control} , permits to switch from a retarder(s) only actuation to a retarder(s) plus friction brake unit actuation, when group 3 is found out not be able to currently deliver any torque. The failure of the retarders 4 to 8 to deliver a braking torque can occur in various conditions. For instance, the electrical reversible machine 5 might be unable to operate as a generator because the batteries are full or because the electrical module is overheating.

Figure 4 illustrates a third embodiment of a method for controlling the braking system S. The controlling method according to the invention further comprises a third check illustrated on figure 4 as step 105. The steps 101, 102, 103, 104, 106, 107, 108, 109 and 110 being common to the second embodiment shown on figure 3, they are not described hereafter.

In step 105, which occurs before step 103 or 106, the electronic control unit 1 checks whether the torque currently deliverable $T_{\text{max.ret.}}$ by group 3 is more than the required braking torque $T_{\text{req.}}$, i.e. whether group 3 can meet the required braking torque $T_{\text{req.}}$. This third check 105 is an intermediate step. If the answer to this third check 105 is NO, the braking system S enters step 106, whereas, if the answer to the third check 105 is YES, the braking system S enters checking step 103.

Moreover, the electronic control unit 1 can frequently retrieve some predetermined driving parameters which induce a deceleration of the vehicle. Such driving parameters for instance include the current road slope, together with the vehicle weight, when the vehicle is rising, also the vehicle air drag, the tyres friction on the road, the gear ratio etc. Any of these parameters induces a deceleration of the vehicle and hence reduces the torque that the retarders must deliver to match the required braking torque. Accordingly, the electronic control unit 1 can actuate the retarders 4 to 8 and/or the friction brake unit depending upon the here-above listed predetermined driving parameters.

The here-above described steps 101 to 110 can be iterated with various periods. For instance, step 102 and the subsequent storage of the dataset can be repeated every 15 ms. In practice, this repeat period can range from 10 ms to 100 ms. Steps 103 to 106 or 107 can be repeated every 20 ms. In practice, this

repeat period can range from 10 ms to 100 ms. On a same way, steps 104 and 105 can be iterated repeatedly or they can be performed once for all.

Figures 5 and 6 are time charts showing the execution of a controlling method according to the invention.

On figure 5, distinct arrows extend vertically from or to the time axis thus constituting a “fish bone” diagram. The arrows pointing at the time axis represent data or signals arriving into the electronic control unit 1, whereas the arrows pointing opposite the time axis represent activation requests emitted by the electronic control unit 1.

As can be seen on figure 5, the electronic control unit 1 periodically receives data:

- at a period P1, the dataset comprising the torque currently deliverable $T_{\max.\text{ret.}}$ and the torque currently delivered $T_{\text{cur.ret.}}$;
- at a period P3, the overall response time Δt_{over} , i.e. the response time information.

Furthermore, as long as the brake pedal is depressed, the electronic control unit 1 emits command signals $T_{\text{ret.}}$ with a period P2, to actuate the retarders 4 to 8.

Figure 6 is an operation time chart showing the actuation of different components of the braking system of figure 1. On figure 6, a curve 51 represents the required braking torque $T_{\text{req.}}$. A curve 52 represents the torque currently delivered $T_{\text{cur.ret}}$ by group 3. A curve 53 represents the torque delivered by the friction brake unit.

At a first instant t_1 , the driver depresses the brake pedal, inducing the electronic control unit 1 to calculate the required braking torque $T_{\text{req.}}$. In a prior art braking system, the controlling method would have actuated instantaneously the friction brake unit, as shown by curve 54, to match the required braking torque T_{req} of curve 51. Then, the prior art controlling method would decrease the friction brake unit torque proportionate to the increase of the torque currently delivered by the retarders. However, the area under the curve 54, visible in grey on figure 6, shows a waste of kinetic energy which could be otherwise converted into electrical energy.

Indeed, the controlling method according to the invention waits until instant t_2 to actuate the friction brake unit, because the electronic control unit 1 has been

able to first actuate the group 3 of retarders 4 to 8, since their overall response time Δt_{over} has been checked and proved to comply with the delivery of the required braking torque T_{req} . Therefore, electronic control unit 1 only actuates the friction brake unit at instant t_2 . Thus, a controlling method according to the invention permits to spare the energy otherwise wasted in the friction brake unit as shown by curve 54. The thermal energy saved can be stored as electrical energy into the batteries of the vehicle.

Depending upon the communication protocol of the controller area network, there can be a limitation on the number of data that can be loaded in the communication bus. Some protocols would make it difficult to accurately know the current state of every retarder, hence their respective response times.

In fact, a quickly responding retarder like the reversible electrical machine may not be available, for instance when the storage battery is full or when the electrical machine is out of order or overheating. Due to the communication protocol, the electronic control unit of the braking system cannot detect such a failing state, prior art controlling methods need to actuate the friction brake unit at first, thus inducing the here-above listed drawbacks.

The availability of a retarder depends on whether its currently deliverable torque represents a significant fraction of its maximum possible torque or of the required braking torque T_{req} . For instance, a retarder can be considered available when it can deliver more than 80% of its maximum possible torque.

On the contrary, a controlling method according to the invention enables the braking system to spare energy, despite a possible limitation of the communication protocol.

As can be seen on figure 6, the variations in the depression stroke 51 of the brake pedal can be compensated by the friction brake unit, the response time of which is pretty short.

When the driver releases the brake pedal, as shown by arrow $T_{\text{brk}} = 0$ on figure 5, the braking system S stops delivering torque.

A controlling method according to the invention has been herein described with several retarders. However, the present invention could also apply to a braking system comprising a single retarder, especially in the case of a hybrid vehicle comprising only the reversible electrical machine as sole retarder. The

method controls the braking components, retarder and friction brake unit, depending on the different states of this retarder, i.e. on its currently deliverable torque and on its response time information. The currently deliverable torque of this single retarder can be a fraction, say 80%, of its maximum possible torque.

CLAIMS

1. Method for controlling a braking system (S) of a hybrid vehicle, said vehicle having an internal combustion engine (4) and a reversible electrical machine (5), said braking system (S) comprising at least:

- a controller area network (10);
- a friction brake unit;
- a group (3) of retarders (4-8) comprising at least one retarder (4, 5, 6, 7, 8);
- an electronic control unit (1) configured to at least request the activation of said friction brake unit and/or of said group (3) of retarders;

the method comprising the steps:

c) said electronic control unit (1) receives, from said controller area network (10), a response time information relating to the response time (Δt_{over}) to have said group (3) of retarders (4-8) delivering a predetermined torque;

d) said electronic control unit (1) checks (103) whether said response time information complies with the delivery of a required braking torque (T_{req});

e1) depending on said response time information compliance, said electronic control unit (1) only requests the activation of said group (3) of retarders (4-8).

2. Method according to claim 1, characterized in that, in said activation step e1), said electronic control unit (1) only requests the activation of said group (3) of retarders (4-8) to such an extent that said torque currently deliverable ($T_{\text{max.ret.}}$) by said group (3) of retarders (4-8) matches said required braking torque (T_{req}).

3. Method according to any preceding claim, characterized in that it further comprises the step:

e2) depending on said response time information non-compliance, said electronic control unit (1) cumulatively requests the activation of said friction brake unit and of said group (3) of retarders (4-8).

4. Method according to claim 3, characterized in that, in said activation step e2), said electronic control unit (1) cumulatively requests the activation of said friction brake unit and of said group (3) of retarders (4-8) to such an extent that the sum of

the friction brake unit torque plus said torque currently deliverable ($T_{\max.\text{ret.}}$) by said group (3) of retarders (4-8) matches said required braking torque ($T_{\text{req.}}$).

5. Method according to any preceding claim, characterized in that said group (3) of retarders (4-8) comprises at least one slowly responding retarder (4, 6, 8) having a long response time and a least one quickly responding retarder (5) having a short response time.

6. Method according to any preceding claim, characterized in that it further comprises the steps:

a) said electronic control unit (1) receives (102), from said controller area network (10), a dataset comprising:

- the maximum possible torque ($T_{\text{tot.ret.}}$) of said group (3),
- the torque currently deliverable ($T_{\max.\text{ret.}}$) by said group (3),
- the torque currently delivered ($T_{\text{cur.ret.}}$) by said group (3);

b) said electronic control unit (1) subsequently stores said dataset.

7. Method according to claim 3, characterized in that it further comprises the step:

l) after a predetermined control period (P_{control}) has elapsed, depending on whether said group (3) of retarders (4-8) delivers a predetermined torque or not, said electronic control unit (1) performs either said activation step e1) or said activation step e2).

8. Method according to claim 7, characterized in that it further comprises the step:

k) said electronic control unit (1) predetermines (104) said control period (P_{control}) as a function of said response time information.

9. Method according to claim 7 or 8, characterized in that said braking system (S) comprises several retarders (5), and in that said electronic control unit (1) predetermines said control period (P_{control}) as a function of the shortest response

time, i.e. the response time of the retarder which said electronic control unit (1) initially memorized as being the quickest among said retarders (5).

10. Method according to any preceding claim, characterized in that said response time information comprises an overall response time (Δt_{over}) for said group (3) of retarders (4-8).

11. Method according to any claim 1 to 9, characterized in that said response time information comprises the respective response time of every retarder (4-8) of said group (3) of retarders (4-8).

12. Method according to any preceding claim, characterized in that said predetermined torque corresponds to a fraction of the maximum possible torque of at least one of said retarders (4-8) or a fraction of the maximum possible torque ($T_{\text{tot.ret.}}$) of said group (3) of retarders (4-8).

13. Method according to any preceding claim, characterized in that said electronic control unit (1) frequently retrieves predetermined driving parameters which induce a deceleration of said vehicle, like the current road slope, the vehicle weight, the vehicle air drag, the tyres friction, the gear ratio etc. and in that said electronic control unit (1) actuates said retarders and/or said friction brake unit depending upon said predetermined driving parameters.

14. Method according to claim 6, characterized in that said steps a) to b) are iterated every 10 ms to 100 ms.

15. Method according to any preceding claim, characterized in that said steps c) to d) are iterated every 10 ms to 100 ms.

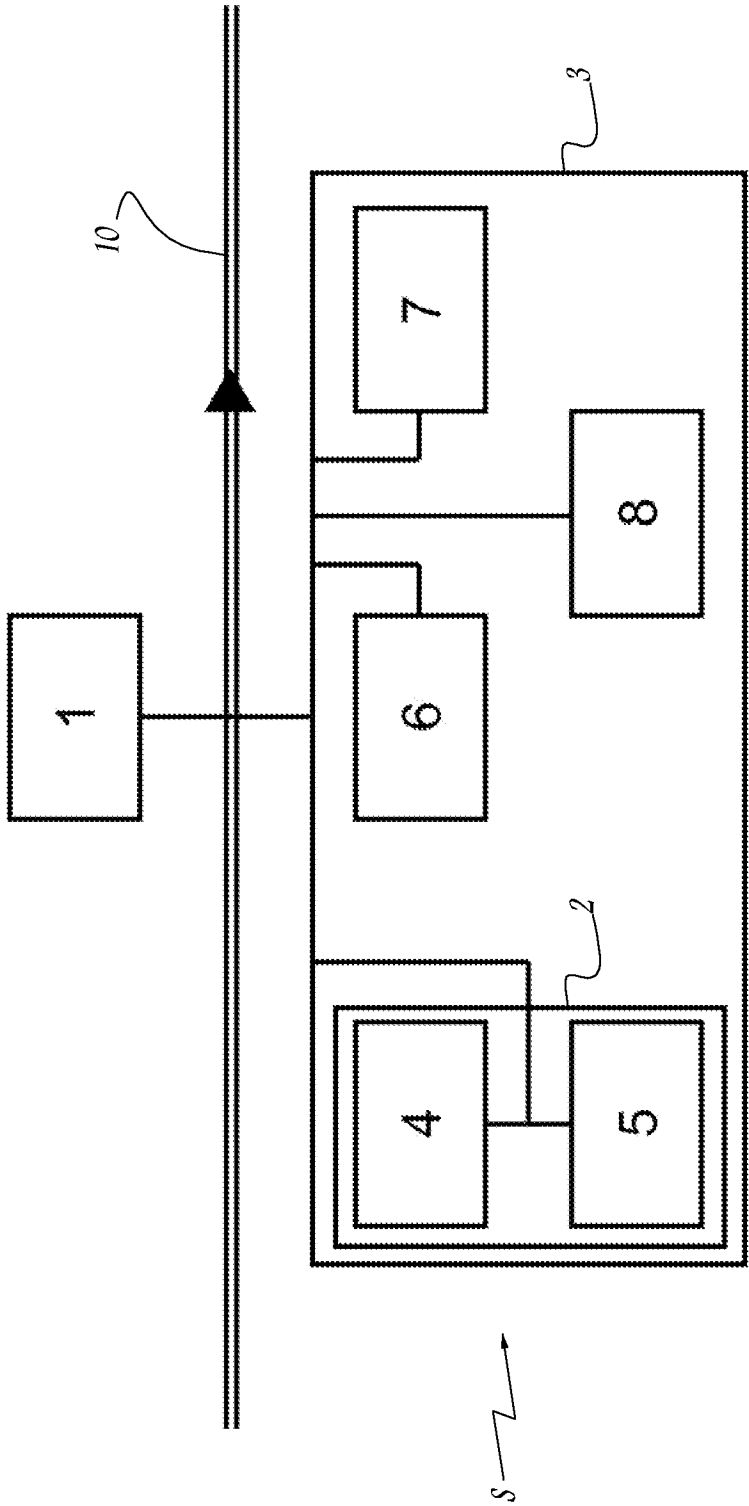


Fig. 1

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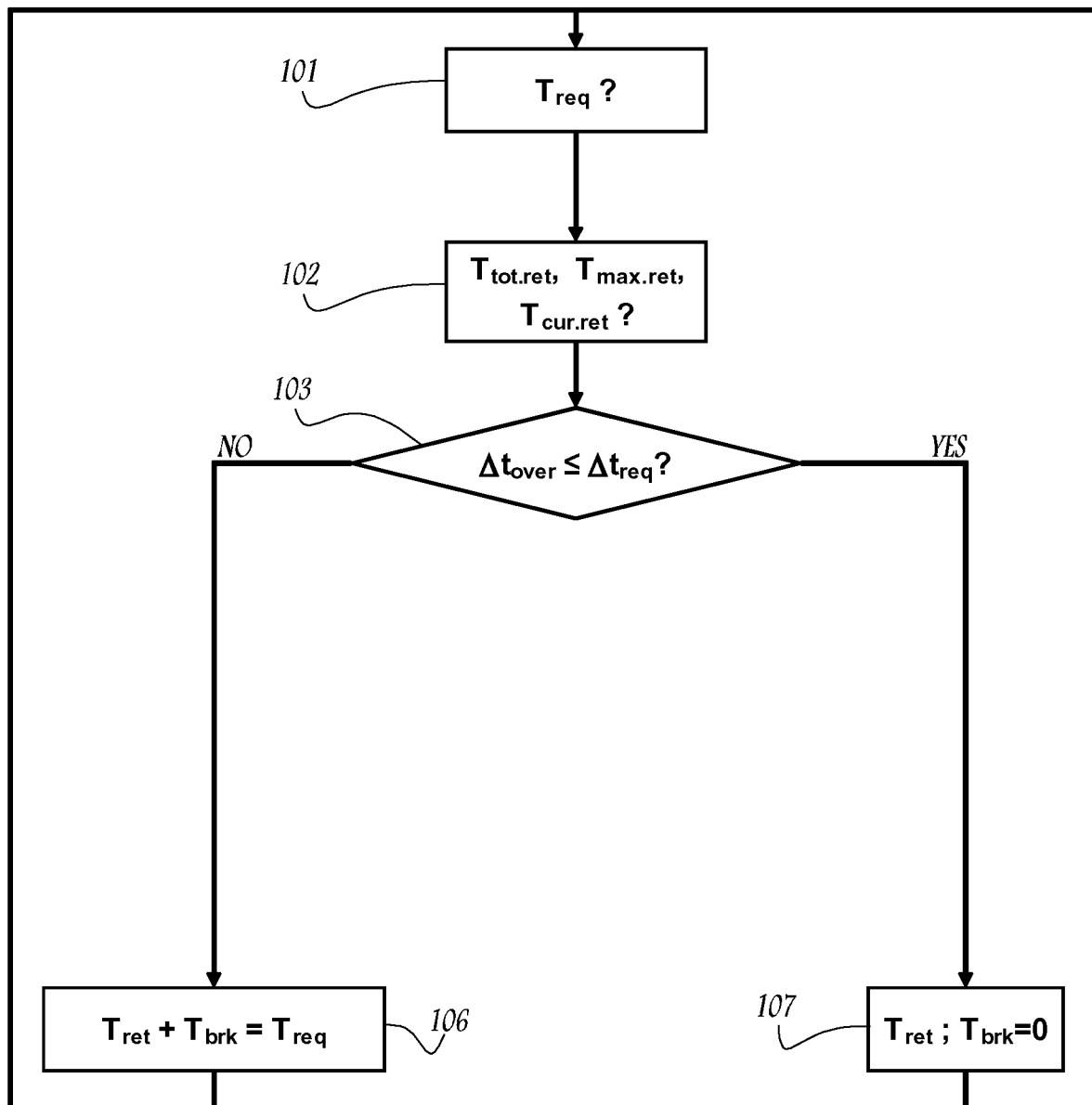


Fig.2

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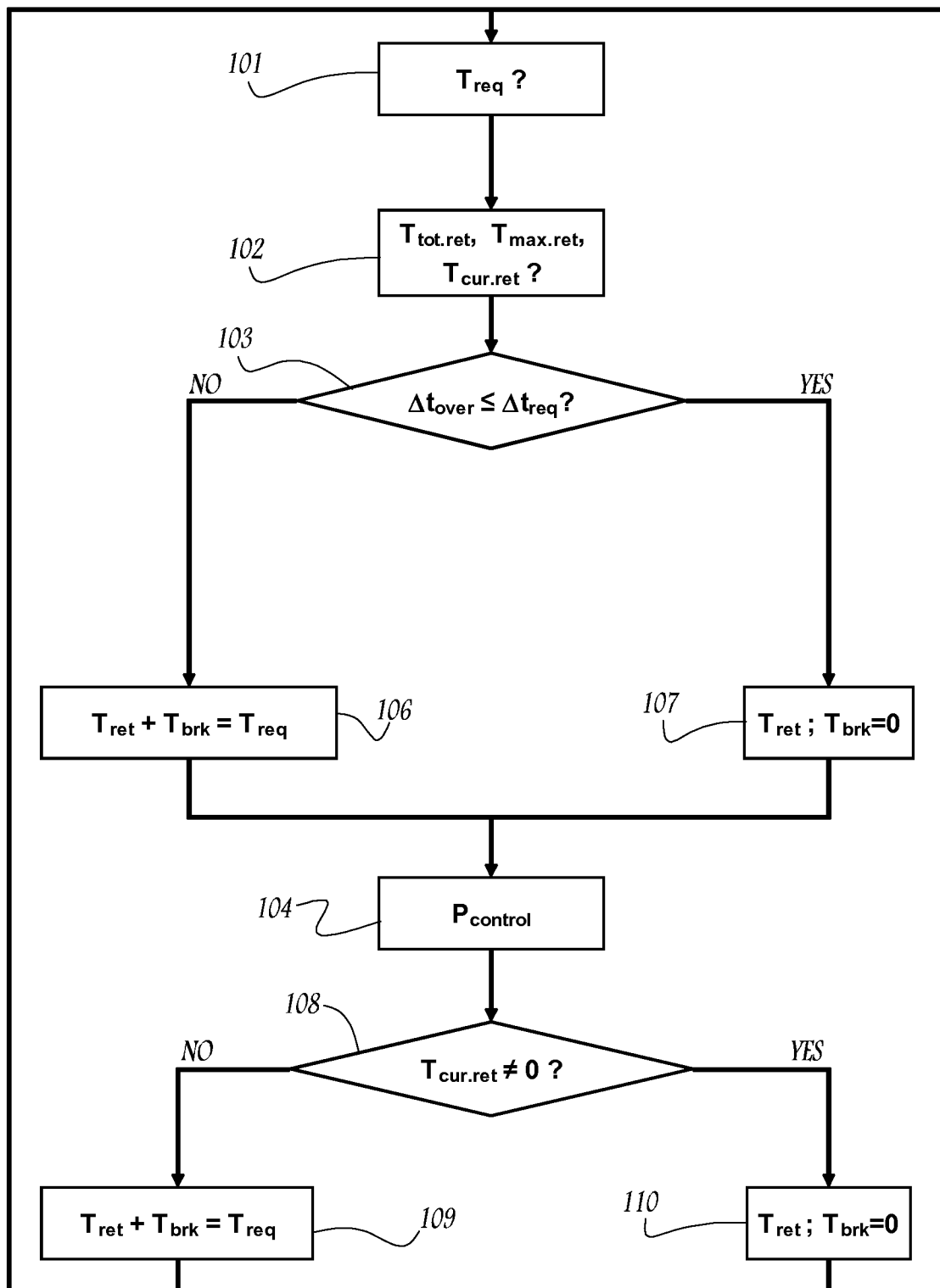


Fig. 3

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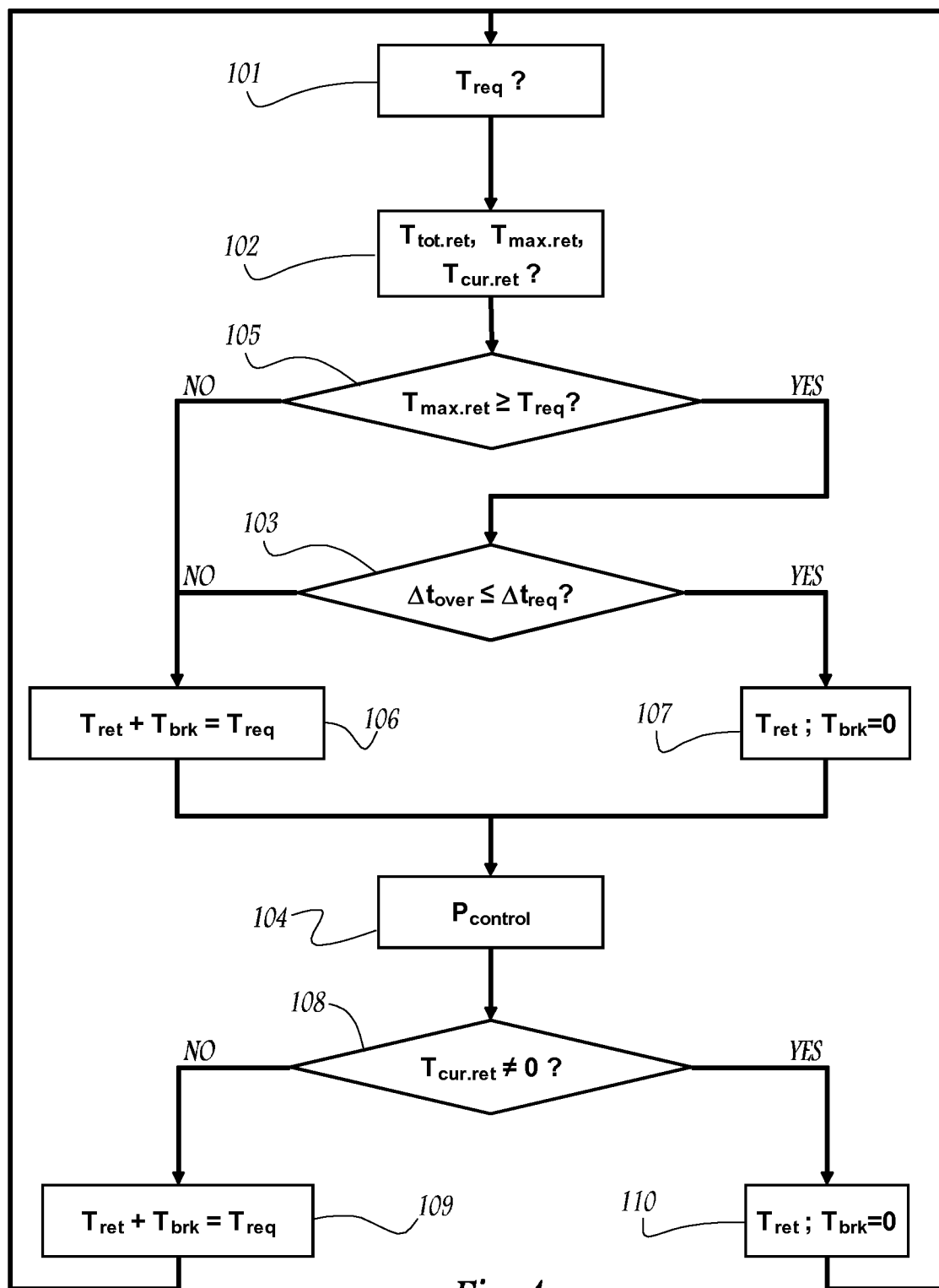
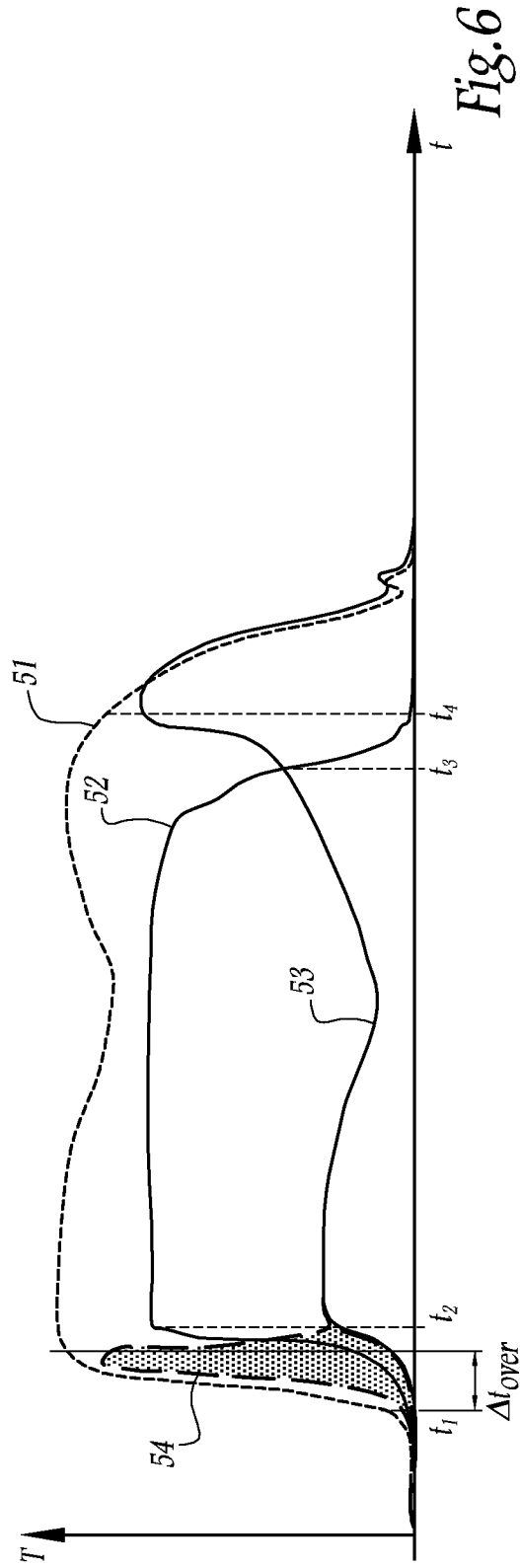
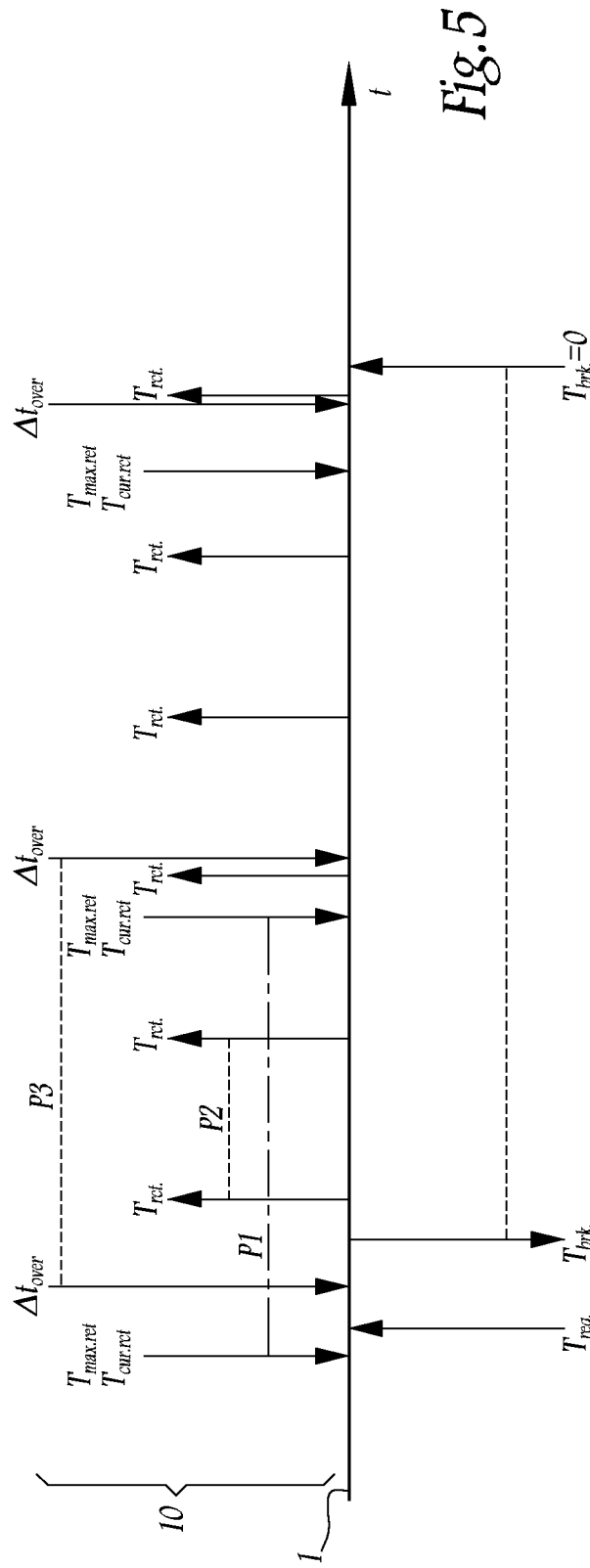


Fig. 4



INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2008/055692

A. CLASSIFICATION OF SUBJECT MATTER

INV. B60L7/24 B60L7/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B60L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 7 136 737 B2 (ASHIZAWA HIROYUKI [JP] ET AL ASHIZAWA HIROYUKI [JP] ET AL) 14 November 2006 (2006-11-14) column 2, line 65 - column 13, line 61; figures 1-12	1-15
X	US 2004/195911 A1 (HUTHER SEBASTIAN [DE] ET AL) 7 October 2004 (2004-10-07) paragraph [0019] - paragraph [0021]; figure 1	1
A	US 5 511 859 A (KADE ALEXANDER [US] ET AL) 30 April 1996 (1996-04-30) column 2, line 9 - column 8, line 13; figures 1-3	1
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

25 September 2009

Date of mailing of the international search report

06/10/2009

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INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 868 150 A (MASKERY ARTHUR) 25 February 1975 (1975-02-25) column 2, line 26 - column 8, line 13; figures 1-4 -----	1
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Information on patent family members

International application No

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