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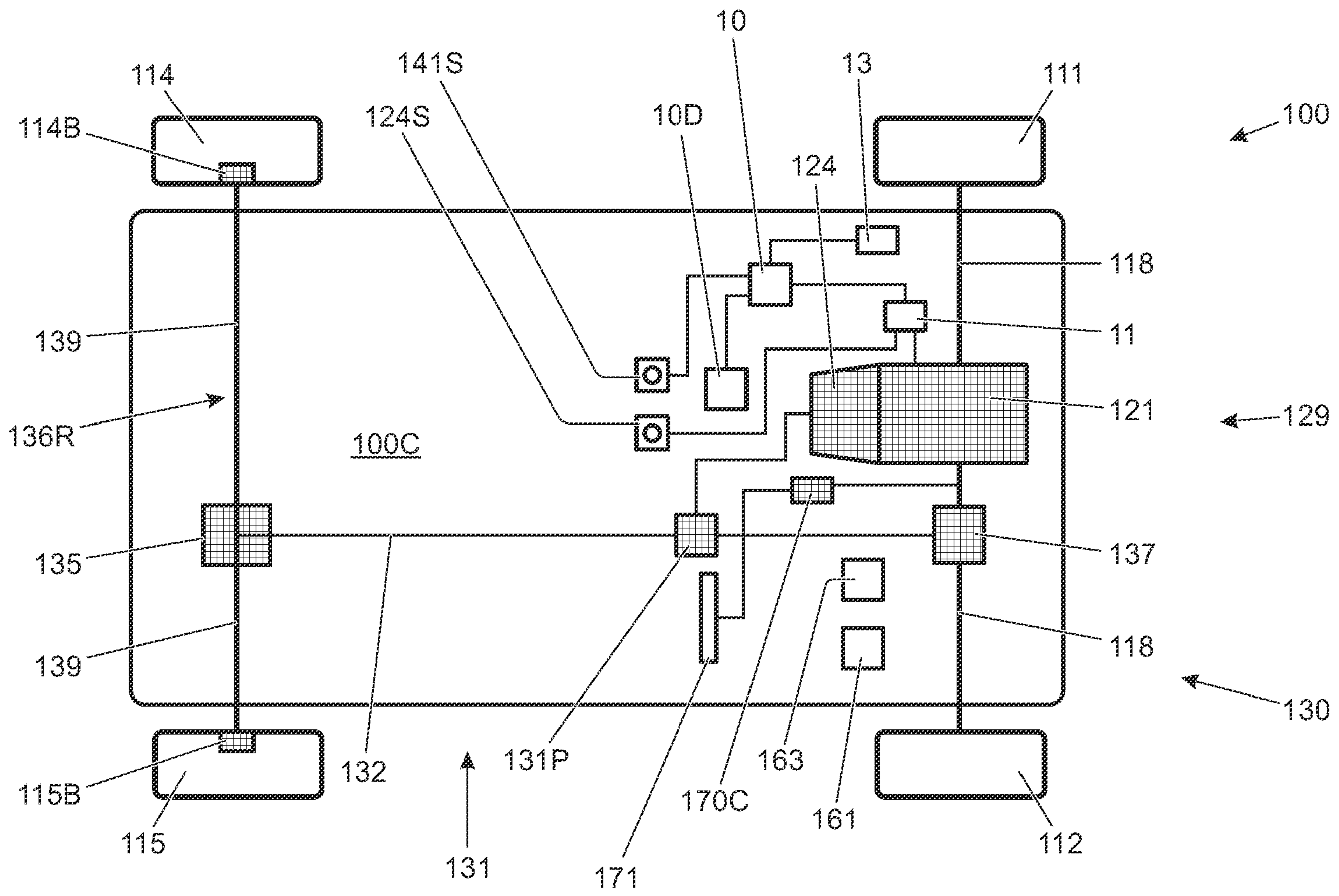
GB 2565819 B

31 07 18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129
130
111
112
114
115
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118
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135
132
131
131P
171
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163
161
137
121
124
11
13
10
10D
141S
124S
100C

Fig. 1

31 07 18

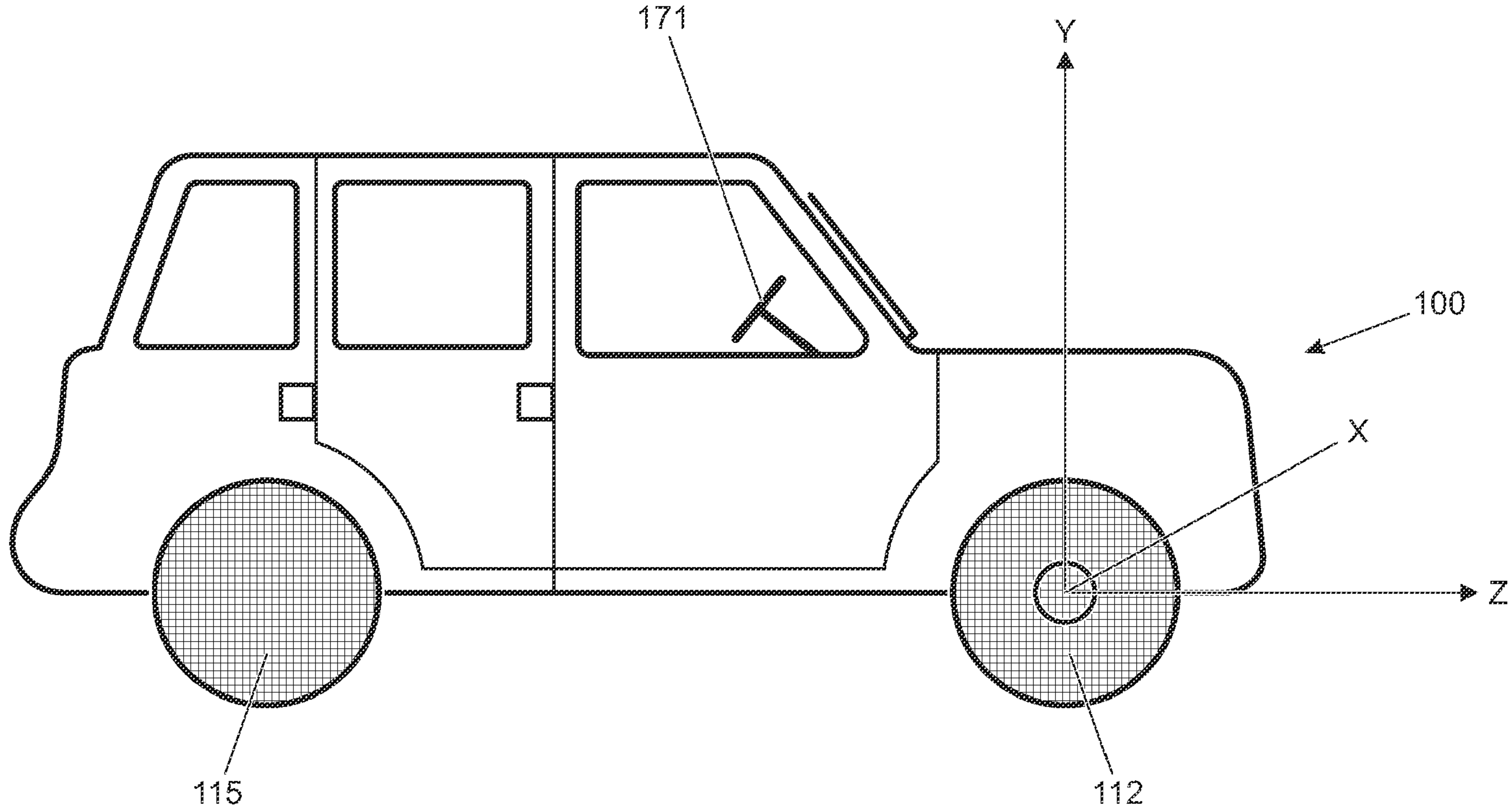



Fig. 2

31 07 18

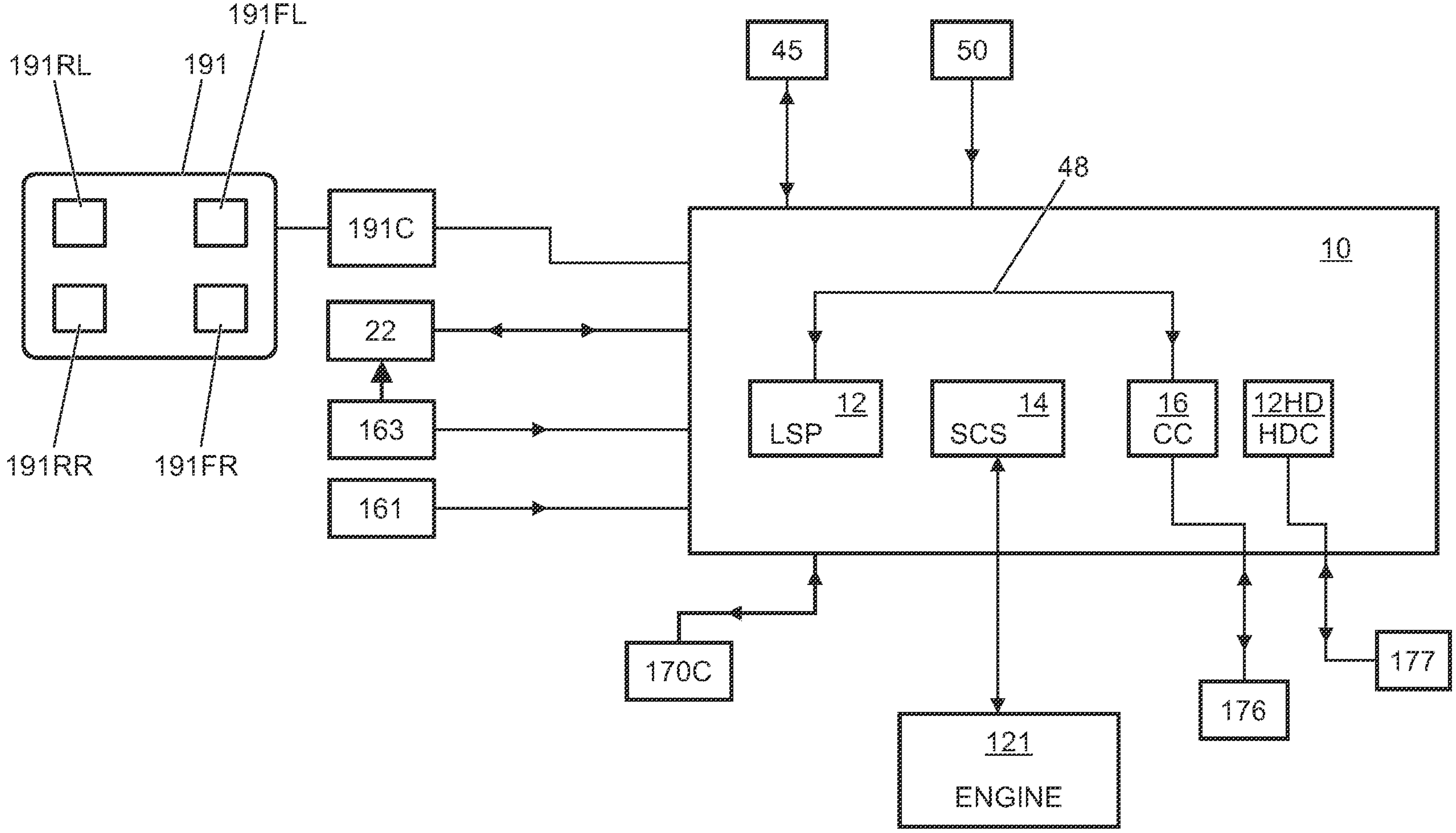

191RL
191
191FL
191RR
191FR
191C
22
163
161
45
50
48
10
LSP 12
SCS 14
16 CC
12HD HDC
170C
121 ENGINE
176
177

Fig. 3

31 07 18

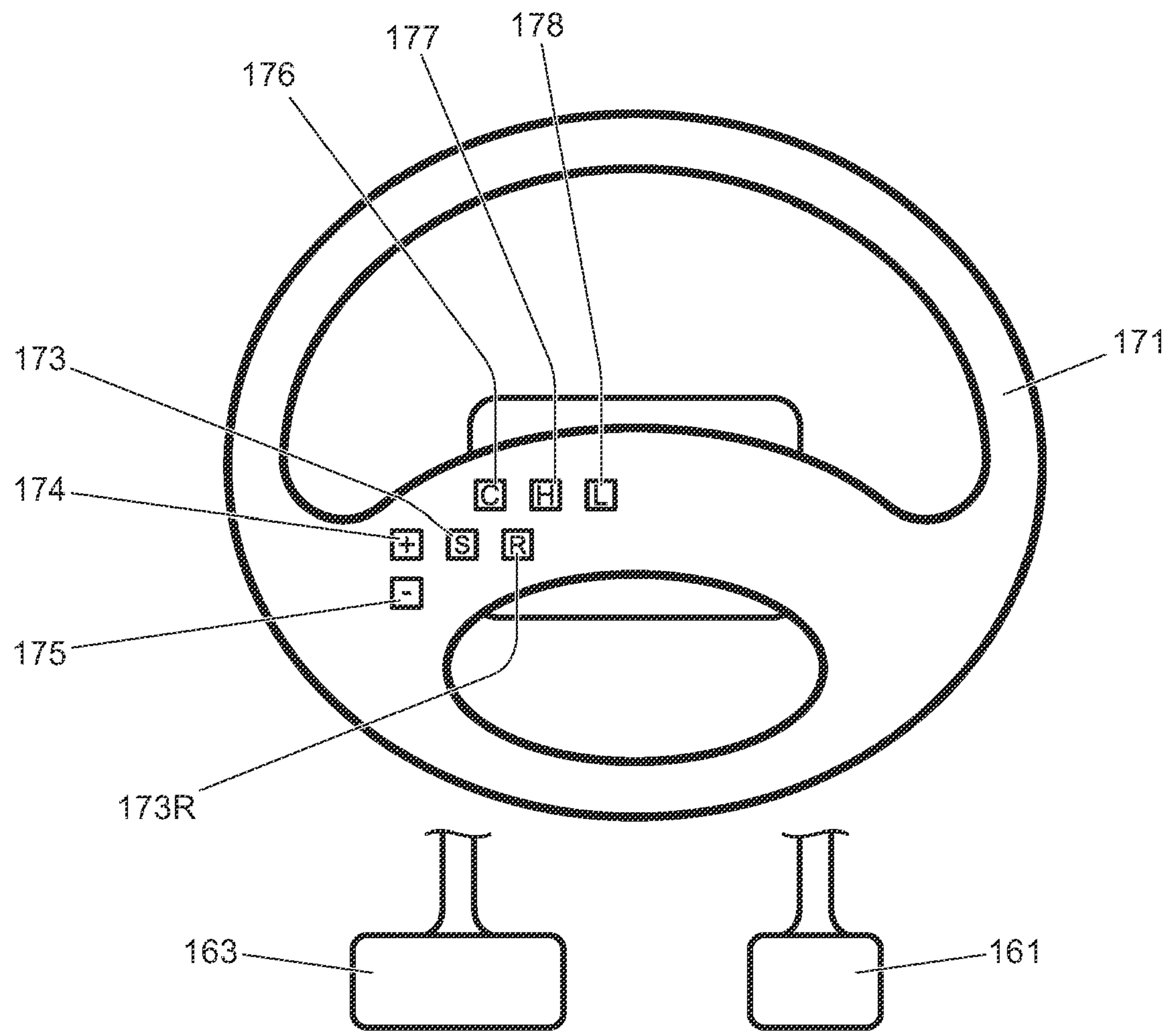



Fig. 4

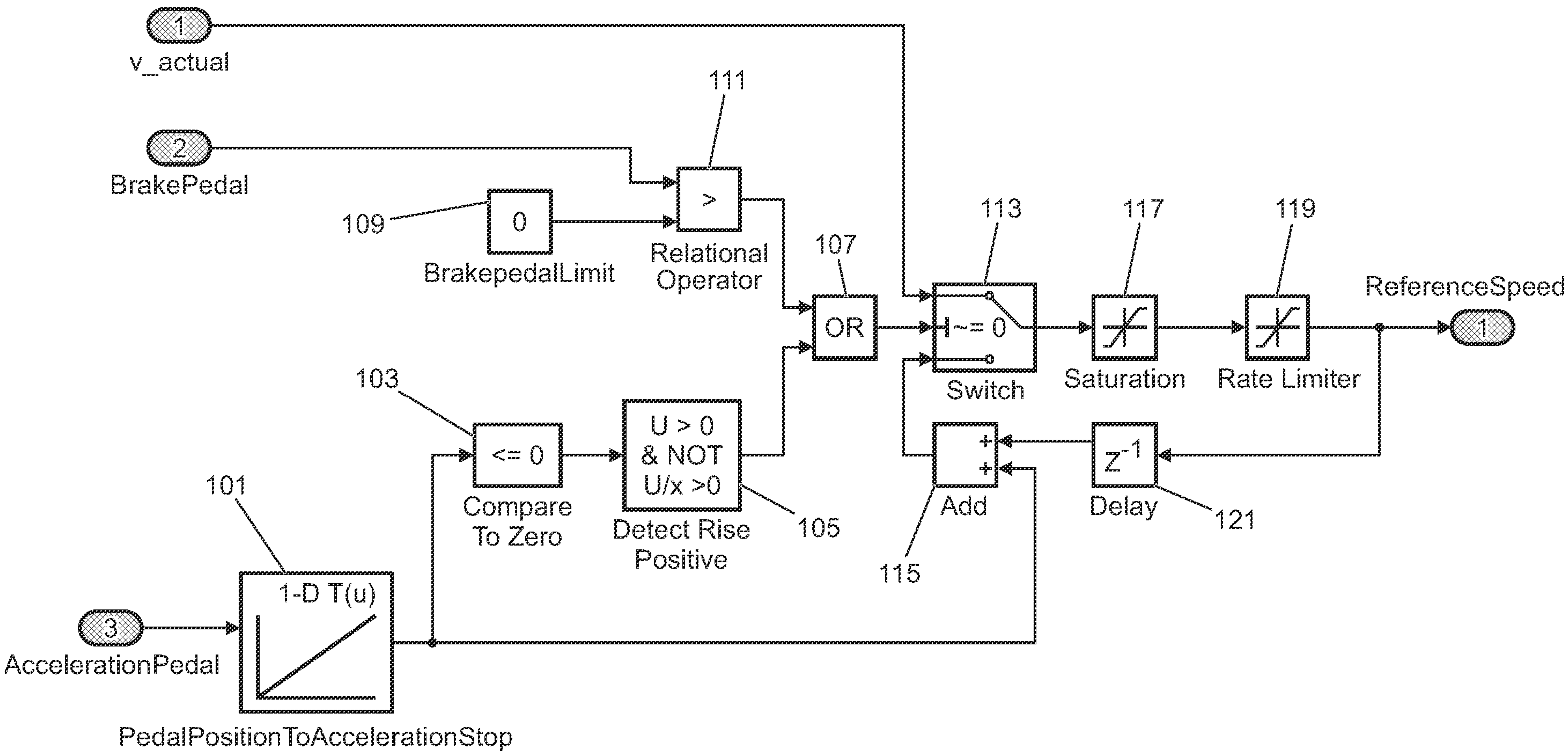

1
v_actual
2
BrakePedal
0
BrakepedalLimit
109
>
Relational Operator
111
OR
107
~= 0
Switch
113
Saturation
117
Rate Limiter
119
ReferenceSpeed
1
103
<= 0
Compare To Zero
U > 0 & NOT U/x >0
Detect Rise Positive
105
+
+
Add
115
$z^{-1}$
Delay
121
101
1-D T(u)
3
AccelerationPedal
PedalPositionToAccelerationStop

Fig. 5

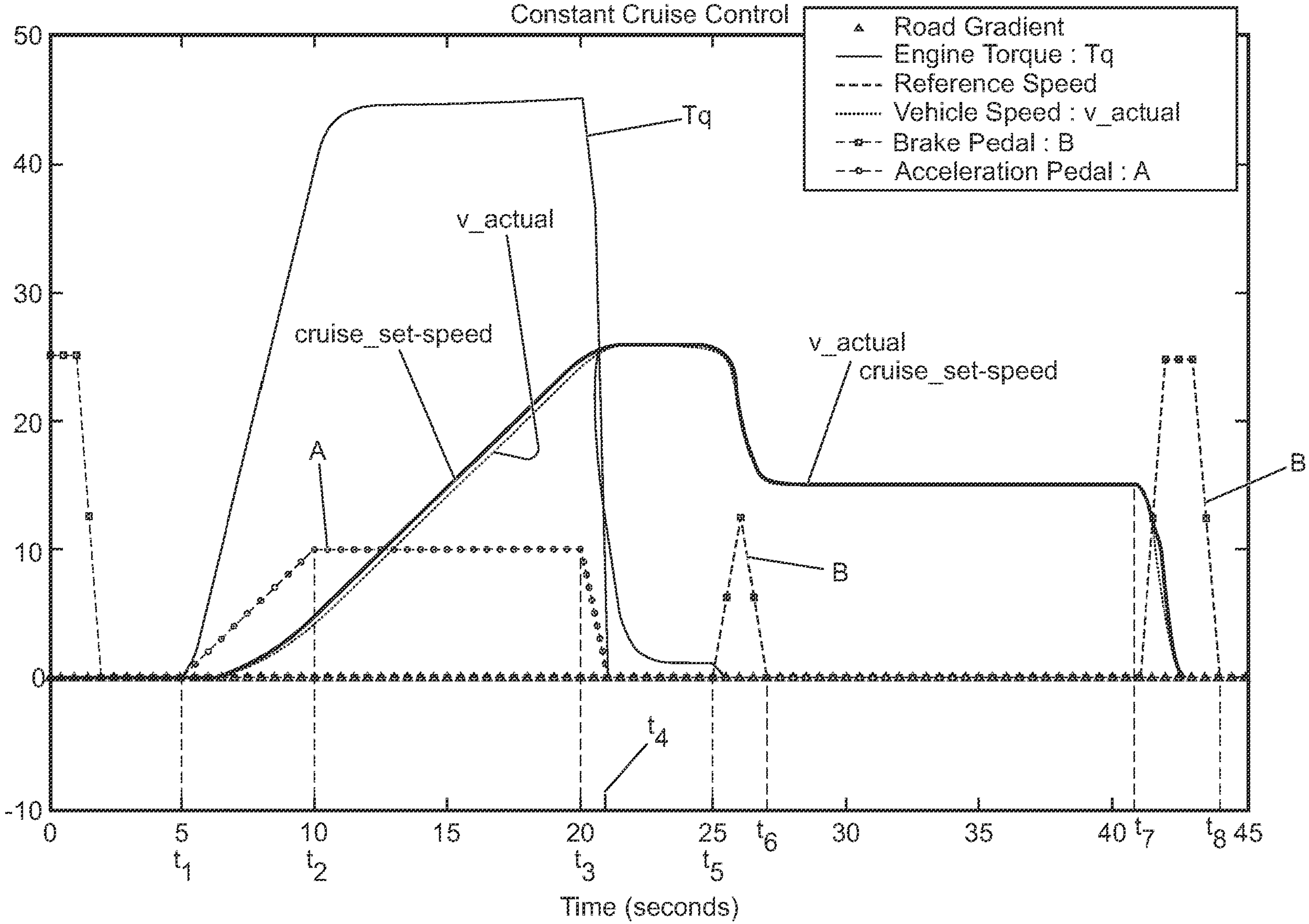
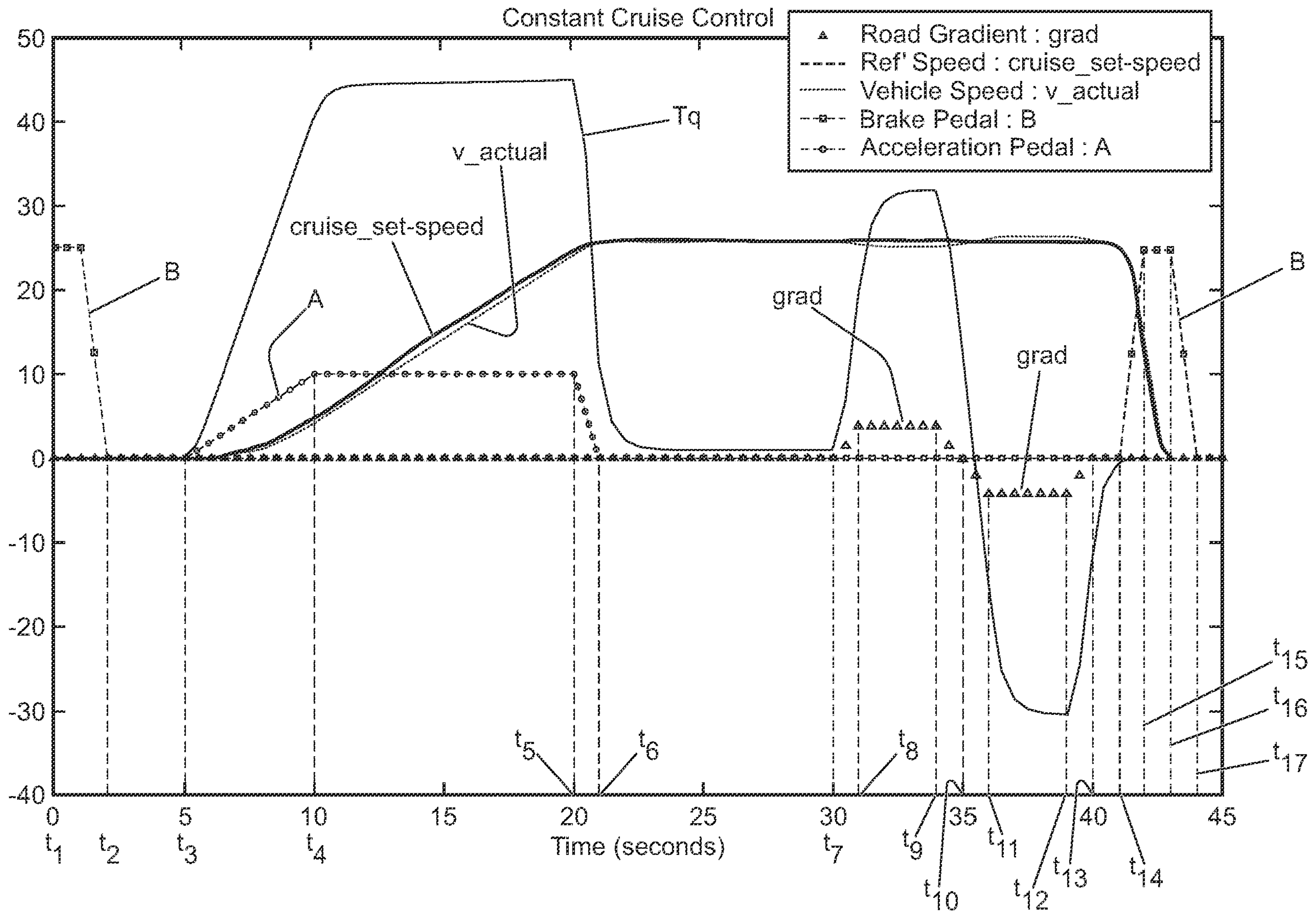

Constant Cruise Control
Road Gradient
Engine Torque : Tq
Reference Speed
Vehicle Speed : v_actual
Brake Pedal : B
Acceleration Pedal : A
Tq
v_actual
cruise_set-speed
A
B
v_actual
cruise_set-speed
B
t4
50
40
30
20
10
0
-10
0
5
10
15
20
25
30
35
40
45
t1
t2
t3
t5
t6
t7
t8
Time (seconds)

Fig. 6

31 07 18

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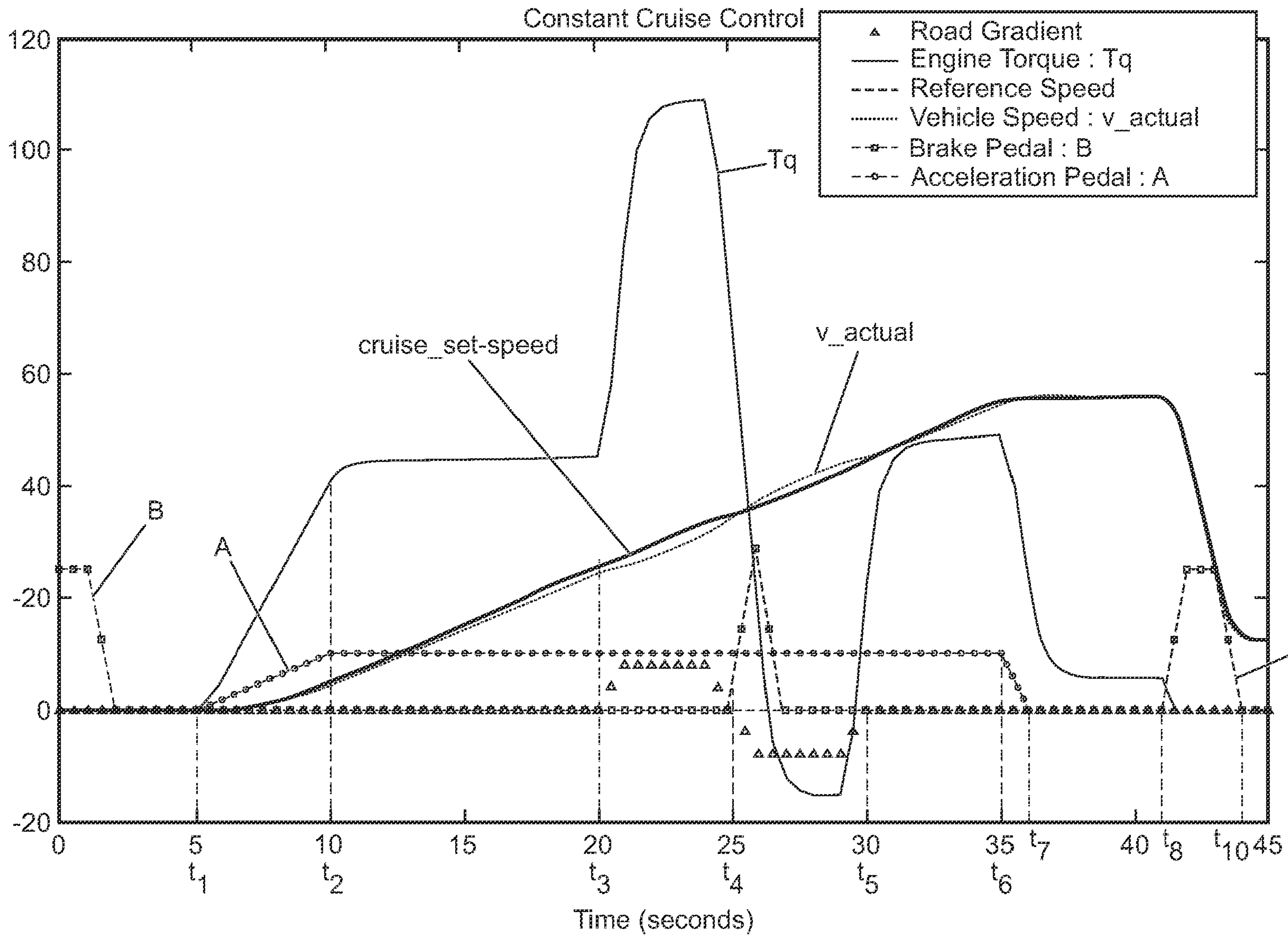
Road Gradient : grad
Ref' Speed : cruise_set-speed
Vehicle Speed : v_actual
Brake Pedal : B
Acceleration Pedal : A
Tq
v_actual
cruise_set-speed
A
B
grad
grad
B
50
40
30
20
10
0
-10
-20
-30
-40
0
5
10
15
20
25
30
35
40
45
Time (seconds)
t1
t2
t3
t4
t5
t6
t7
t8
t9
t10
t11
t12
t13
t14
t15
t16
t17

Fig. 7



Constant Cruise Control
Road Gradient
Engine Torque : Tq
Reference Speed
Vehicle Speed : v_actual
Brake Pedal : B
Acceleration Pedal : A
120
100
80
60
40
-20
0
-20
Tq
cruise_set-speed
v_actual
A
B
B
0
5
10
15
20
25
30
35
40
45
$t_1$
$t_2$
$t_3$
$t_4$
$t_5$
$t_6$
$t_7$
$t_8$
$t_{10}$
Time (seconds)


Fig. 8

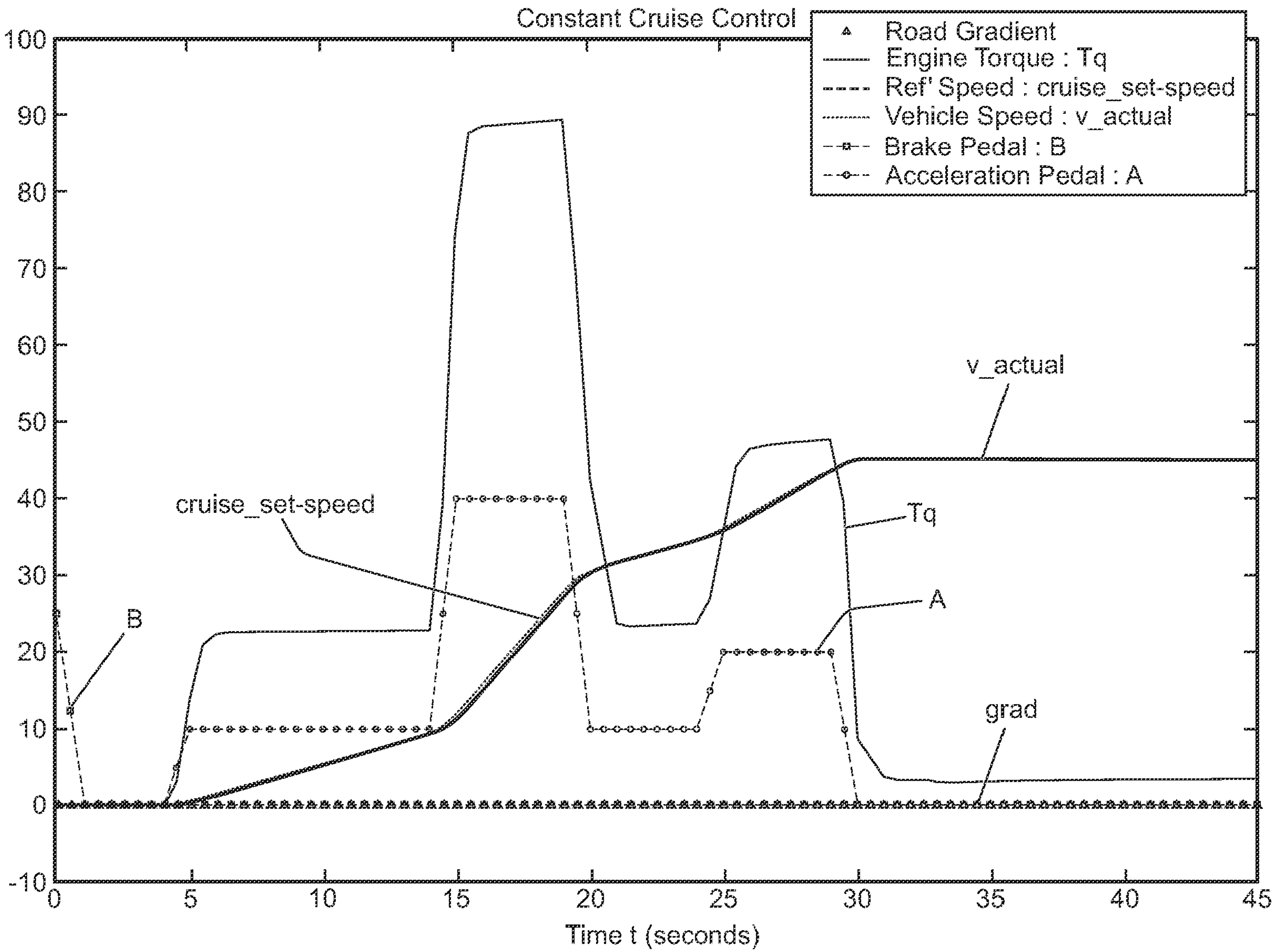

Constant Cruise Control
Road Gradient
Engine Torque : Tq
Ref' Speed : cruise_set-speed
Vehicle Speed : v_actual
Brake Pedal : B
Acceleration Pedal : A
100
90
80
70
60
50
40
30
20
10
0
-10
0
5
10
15
20
25
30
35
40
45
Time t (seconds)
B
cruise_set-speed
v_actual
Tq
A
grad

Fig. 9

# VEHICLE CONTROLLER AND METHOD

## INCORPORATION BY REFERENCE

The content of co-pending UK patent applications GB2507622 and GB2499461 are hereby incorporated by reference. The content of US patent no US7349776 and co-pending international patent applications WO2013124321 and WO2014/139875 are incorporated herein by reference. The content of UK patent applications GB2492748, GB2492655 and GB2499279 and UK patent GB2508464 are also incorporated herein by reference.

## FIELD OF THE INVENTION

Embodiments of the invention relates to a controller for controlling a vehicle and a method of controlling a vehicle. Some embodiments of the invention relate to a controller for controlling a vehicle adapted for driving in an off-road environment. Some embodiments of the invention relate to a controller for controlling a vehicle adapted for driving substantially only in on-road environments, i.e. not being adapted for off-road driving.

## BACKGROUND



When a user is driving off-road, variations in terrain height can be relatively abrupt and result in occupant discomfort as a vehicle negotiates the terrain. If the vehicle is travelling at too high a speed, damage to the vehicle may occur due for example to a suspension component such as a suspension arm abruptly reaching a limit of travel.

It is also known to provide a control system for a motor vehicle for controlling one or more vehicle subsystems. US7349776 discloses a vehicle control system comprising a plurality of subsystem controllers including an engine management system, a transmission controller, a steering controller, a brakes controller and a suspension controller. The subsystem controllers are each operable in a plurality of subsystem function or configuration modes. The subsystem controllers are connected to a vehicle mode controller which controls the subsystem controllers to assume a required function mode so as to provide a number of driving modes for the vehicle. Each of the driving modes corresponds to a particular driving condition or set of driving conditions, and in each mode each of the sub-systems is set to the function mode most appropriate to those conditions. Such conditions are linked to types of terrain over which the vehicle may be driven such as grass/gravel/snow, mud and ruts, rock crawl, sand and a highway mode known as ‘special programs off’ (SPO). The vehicle mode controller may be referred to as a Terrain Response (TR) (RTM) System or controller. The driving modes may also be referred to as terrain modes, terrain response modes, or control modes.

GB2492655B discloses a control system for a motor vehicle in which the most appropriate terrain mode for the prevailing terrain over which the vehicle is driving is determined automatically by the control system. The control system then causes the vehicle to operate in the terrain mode determined to be the most appropriate.

It is against this background that the present invention has been conceived. Embodiments of the invention may provide a controller, a vehicle or method which addresses the above problems. Other aims and advantages of the invention will become apparent from the following description, claims and drawings.

SUMMARY OF THE INVENTION

In one aspect of the invention for which protection is sought there is provided a speed control system operable to control a motor vehicle to operate in accordance with a set-speed value, the control system being operable to adjust the set-speed value in response to actuation of a vehicle accelerator control member, the accelerator control member being movable over a range of travel, the system being configured to adjust the rate of change of set-speed value in dependence at least in part on the position of the accelerator control member with respect to its range of travel.



It is to be understood that the accelerator control member may comprise a pedal movable in a substantially linear manner over a range of travel. Alternatively the accelerator control member may comprise a manually rotatable accelerator control, for example of the type typically employed on a motorcycle handlebar, the range of travel being a range of rotational angles or positions of the accelerator control member.

The speed control system may be configured to set the set-speed value to the instant value of vehicle speed when the accelerator control member is at a neutral position.

Optionally, the neutral position corresponds to a position of substantially zero travel with respect to a range of travel of the accelerator control member.

Optionally, the neutral position corresponds to a position of non-zero travel with respect to a range of travel of the accelerator control member, the speed control system being configured to cause the set-speed value to increase when the amount of accelerator control member travel exceeds the neutral position, the rate of increase being dependent on the extent of travel beyond the neutral position, and to cause the set-speed value to decrease when the amount of accelerator control member travel is less than the neutral position, the rate of decrease being dependent on the extent of travel before the neutral position.

It is to be understood that the rate of increase may be higher the greater the distance of travel of the accelerator control member beyond the neutral position. The rate of decrease may be higher the greater the amount of accelerator control member travel from the neutral position before the neutral position.

Optionally, the speed control system is configured to detect a position of a brake control member, wherein when the brake control member is released following actuation of the brake control member, the control system is configured to set the value of set-speed to the instant vehicle speed and to continue to control operation of the motor vehicle in accordance with the set-speed value.

This feature has the advantage that, whilst a driver may reduce vehicle speed by means of the brake control member, such as a brake pedal, in the conventional manner, the speed control system continues controlling vehicle speed following release of the brake control member by the driver. Thus, the control system does not automatically cancel vehicle speed control when the brake pedal is depressed. Accordingly, the driver is not required to reselect operation of the vehicle speed control system following actuation of the brake control. The workload on a driver may therefore be reduced in some embodiments. This may be particularly beneficial to a driver who is endeavouring to negotiation challenging off-road terrain.



It is to be understood that the speed control system may temporarily suspend controlling vehicle speed when the brake control member is actuated, i.e. not in the released condition. Thus the speed control system may cease causing the vehicle to attempt to maintain the set-speed value so as not to oppose operation of a braking system of the vehicle in response to actuation of the brake control member.

The speed control system may comprise processing means, wherein the processing means comprises an electronic processor having an electrical input for receiving information indicative of accelerator pedal position and an electronic memory device electrically coupled to the electronic processor and having instructions stored therein,

wherein the processor is configured to access the memory device and execute the instructions stored therein such that it is operable to adjust the rate of change of set-speed value in dependence at least in part on the position of the accelerator control member with respect to its range of travel.

In an aspect of the invention for which protection is sought there is provided a vehicle comprising a speed control system according to another aspect.

In a further aspect of the invention for which protection is sought there is provided a method of controlling a vehicle by means of a speed control system, comprising:

causing a motor vehicle to operate in accordance with a set-speed value;

allowing a user to adjust the set-speed value by actuation of a vehicle accelerator control member, the accelerator control member being movable over a range of travel, and

adjusting the rate of change of set-speed value in dependence at least in part on the position of the accelerator control member with respect to its range of travel.

The method may comprise setting the set-speed value to the instant value of vehicle speed when the accelerator control member is at a neutral position.



Optionally, the neutral position corresponds to a position of substantially zero travel with respect to a range of travel of the accelerator control member.

Optionally, the neutral position corresponds to a position of non-zero travel with respect to a range of travel of the accelerator control member, the method comprising causing the set-speed value to increase when the amount of accelerator control member travel exceeds the neutral position, the rate of increase being dependent on the extent of travel beyond the neutral position, and causing the set-speed value to decrease when the amount of accelerator control member travel is less than the neutral position, the rate of decrease being dependent on the extent of travel before the neutral position.

It is to be understood that the rate of increase may be higher the greater the distance of travel of the accelerator control member beyond the neutral position. The rate of decrease may be higher the greater the amount of accelerator control member travel from the neutral position before the neutral position, i.e. behind the neutral position.

The method may comprise detecting a position of a brake control member, the method further comprising, when the brake control member is released following actuation of the brake control member, setting the value of set-speed to the instant vehicle speed and continuing to control operation of the motor vehicle in accordance with the set-speed value.

In an aspect of the invention for which protection is sought there is provided a non-transitory carrier medium carrying a computer readable code for controlling a vehicle to carry out the method of another aspect.

In an aspect of the invention for which protection is sought there is provided a computer program product executable on a processor so as to implement the method of another aspect.

In an aspect of the invention for which protection is sought there is provided a non-transitory computer readable medium loaded with the computer program product of another aspect.

In an aspect of the invention for which protection is sought there is provided a processor arranged to implement the method of another aspect, or the computer program product of another aspect.



Some embodiments of the present invention have the feature that a user does not have to push a button every time they wish to change the cruise control set-speed value.

Some embodiments of the present invention have the feature that the vehicle does not have only one rate of change of speed (acceleration rate) when the cruise control set-speed is adjusted by a user, as in the case of known cruise control systems with 'set +' and 'set –' controls.

Some embodiments of the present invention have the feature that a vehicle may be operated over a wider speed range under the control of a cruise control system compared with known vehicles, which are typically limited to operation between a minimum and a maximum speed range, for example 30-130mph (ie. 48-208kph). In some embodiments of the invention, the speed control system may be configured to operate over substantially the entire speed range of the vehicle, from the maximum speed in a reverse gear , such as 20 or 30mph (i.e. 32 or 48kph) in a reverse gear (-20 or -30mph, ie. -32 or -48kph), to the maximum speed in a forward gear, for example 120mph or 130mph (i.e. 192kph or 208kph).

Some embodiments of the present invention have the feature that a relatively constant rate of acceleration according to accelerator pedal position may be accomplished. It is to be understood that this is very difficult to accomplish with a torque based system in which accelerator pedal position is employed to determine powertrain torque demand, with additional calculations to take into account driving surface gradient, vehicle load, and other factors in order to compensate for their effects.

It is to be understood that factors affecting vehicle speed in a given situation are complex, since the whole powertrain torque path must be taken into consideration so as to identify possible unwanted effects

Some embodiments of the invention have the feature that a vehicle may be more economical in terms of energy consumption when driven at a relatively constant speed. Some embodiments of the invention enable a more steady speed to be maintained than is typically obtained when driving a conventional vehicle without cruise control.

Some embodiments of the invention have the feature that, whilst traveling at a substantially constant speed in a vehicle having an accelerator control in the form of a pedal, a driver is not required to keep a foot on the pedal. Rather, the driver may hold their foot in close proximity to a brake pedal. This can reduce reaction time in the event that sudden braking is required. Such a feature can reduce the time taken to apply pressure to the accelerator pedal by half a second or more, corresponding to around 17 meters (3-4 car length) at typically motorway speeds, and 6 meters (a length of a pedestrian crossing) at typically urban speeds.



Some embodiments of the invention have the feature that the can be combined relatively easily with other speed related features of motor vehicles. Thus, for example, the feature may be employed in conjunction with a low speed cruise control system such as a system adapted for off-road driving, an autopilot system such as a system employed in an autonomous vehicle, an auto parking system or any other suitable system.

Within the scope of the claims of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination, unless such features are incompatible.

## BRIEF DESCRIPTION OF DRAWINGS

The present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

FIGURE 1 is a schematic illustration of a vehicle according to an embodiment of the invention in plan view;

FIGURE 2 shows the vehicle of FIG. 1 in side view;

FIGURE 3 is a schematic illustration of a portion of a control system of the vehicle of FIG. 1;

FIGURE 4 is a schematic illustration of a steering wheel and pedals of the vehicle of FIG. 1;

FIGURE 5 is a diagram illustrating operation of a portion of a speed control system according to the embodiment of FIG. 1;

FIGURE 6 illustrates operation of a vehicle 100 according to an embodiment of the present invention in an example drive cycle;

FIGURE 7 illustrates operation of a vehicle 100 according to an embodiment of the present invention in a further example drive cycle;

FIGURE 8 illustrates operation of a vehicle 100 according to an embodiment of the present invention in a still further example drive cycle; and

FIGURE 9 illustrates operation of a vehicle 100 according to an embodiment of the present invention in a further example drive cycle.



DETAILED DESCRIPTION

References herein to a block such as a function block are to be understood to include reference to software code for performing the function or action specified which may be an output that is provided responsive to one or more inputs. The code may be in the form of a software routine or function called by a main computer program, or may be code forming part of a flow of code not being a separate routine or function. Reference to function block is made for ease of explanation of the manner of operation of embodiments of the present invention.

FIG. 1 shows a vehicle 100 according to an embodiment of the present invention. The vehicle 100 has a powertrain 129 that includes an engine 121 that is connected to a driveline 130 having an automatic transmission 124. It is to be understood that embodiments of the present invention are also suitable for use in vehicles with manual transmissions, continuously variable transmissions or any other suitable transmission.

In the embodiment of FIG. 1 the transmission 124 may be set to one of a plurality of transmission operating modes, being a park mode, a reverse mode, a neutral mode, a drive mode or a sport mode, by means of a transmission mode selector dial 124S. The selector dial 124S provides an output signal to a powertrain controller 11 in response to which the powertrain controller 11 causes the transmission 124 to operate in accordance with the selected transmission mode.

The driveline 130 is arranged to drive a pair of front vehicle wheels 111,112 by means of a front differential 137 and a pair of front drive shafts 118. The driveline 130 also comprises an auxiliary driveline portion 131 arranged to drive a pair of rear wheels 114, 115 by means of an auxiliary driveshaft or prop-shaft 132, a rear differential 135 and a pair of rear driveshafts 139.



Embodiments of the invention are suitable for use with vehicles in which the transmission is arranged to drive only a pair of front wheels or only a pair of rear wheels (i.e. front wheel drive vehicles or rear wheel drive vehicles) or selectable two wheel drive/four wheel drive vehicles. In the embodiment of FIG. 1 the transmission 124 is releasably connectable to the auxiliary driveline portion 131 by means of a power transfer unit (PTU) 131P, allowing operation in a two wheel drive mode or a four wheel drive mode. It is to be understood that embodiments of the invention may be suitable for vehicles having more than four wheels or where only two wheels are driven, for example two wheels of a three wheeled vehicle or four wheeled vehicle or a vehicle with more than four wheels.

A control system for the vehicle includes a central controller 10, referred to as a vehicle control unit (VCU) 10, the powertrain controller 11, a brake controller 13 (an anti-lock braking system (ABS) controller), a steering controller 170C and a suspension system controller 191C. The ABS controller 13 forms part of a braking system 22 (FIG. 3). The VCU 10 receives and outputs a plurality of signals to and from various sensors and subsystems (not shown) provided on the vehicle. The VCU 10 includes a low-speed progress (LSP) control system 12 shown in FIG. 3, a stability control system (SCS) 14, a cruise control system 16 and a hill descent control (HDC) system 12HD. The SCS 14 improves the safety of the vehicle 100 by detecting and managing loss of traction or steering control. When a reduction in traction or steering control is detected, the SCS 14 is operable automatically to command the ABS controller 13 to apply one or more brakes of the vehicle to help to steer the vehicle

100 in the direction the user wishes to travel. In the embodiment shown the SCS 14 is implemented by the VCU 10. In some alternative embodiments the SCS 14 may be implemented by the ABS controller 13. It is to be understood that the LSP control system 12 and cruise control system 16 are both speed control systems, although configured to operate over respective different (and potentially overlapping, in some embodiments) speed ranges.

Although not shown in detail in FIG. 3, the VCU 10 further includes a Traction Control (TC) function block. The TC function block is implemented in software code run by a computing device of the VCU 10. The ABS controller 13 and TC function block provide outputs indicative of, for example, TC activity, ABS activity, brake interventions on individual wheels and engine torque requests from the VCU 10 to the engine 121 in the event a wheel slip event occurs. Each of the aforementioned events indicate that a wheel slip event has occurred. In some embodiments the ABS controller 13 implements the TC function block. Other vehicle sub-systems such as a roll stability control system or the like may also be included.



As noted above the vehicle 100 also includes a cruise control system 16 which is operable to automatically maintain vehicle speed at a selected speed when the vehicle is travelling at speeds in excess of 25 kph. The cruise control system 16 is provided with a cruise control HMI (human machine interface) 18 by which means the user can input a target vehicle speed to the cruise control system 16 in a known manner. In one embodiment of the invention, cruise control system input controls are mounted to a steering wheel 171 (FIG. 4). The cruise control system 16 may be switched on by pressing a cruise control system selector button 176. When the cruise control system 16 is switched on, depression of a 'set-speed' control 173 sets the current value of a cruise control set-speed parameter, cruise_set-speed to the current vehicle speed. Depression of a '+' button 174 allows the value of cruise_set-speed to be increased whilst depression of a '-' button 175 allows the value of cruise_set-speed to be decreased. A resume button 173R is provided that is operable to control the cruise control system 16 to resume speed control at the instant value of cruise_set-speed following driver over-ride. It is to be understood that known on-highway cruise control systems including the present system 16 are configured so that, in the event that the user depresses the brake or, in the case of vehicles with a manual transmission, a clutch pedal, control of vehicle speed by the cruise control system 16 is cancelled and the vehicle 100 reverts to a manual mode of operation which requires accelerator or brake pedal input by a user in order to maintain vehicle speed. In addition, detection of a wheel slip event, as may be initiated by a loss of traction, also has the effect of cancelling control of vehicle speed by the cruise control system 16. Speed control by the system 16 is resumed if the driver subsequently depresses the resume button 173R.

The cruise control system 16 monitors vehicle speed and any deviation from the target vehicle speed is adjusted automatically so that the vehicle speed is maintained at a substantially constant value, typically in excess of 25 kph. In other words, the cruise control system is ineffective at speeds lower than 25 kph. The cruise control HMI 18 may also be configured to provide an alert to the user about the status of the cruise control system 16 via a visual display of the HMI 18. In the present embodiment the cruise control system 16 is configured to allow the value of cruise_set-speed to be set to any value in the range 25-150kph.

The LSP control system 12 also provides a speed-based control system for the user which enables the user to select a very low target speed at which the vehicle can progress without any pedal inputs being required by the user to maintain vehicle speed. Low-speed speed control (or progress control) functionality is not provided by the on-highway cruise control system 16 which operates only at speeds above 25 kph.



In the present embodiment, the LSP control system 12 is activated by pressing LSP control system selector button 178 mounted on steering wheel 171. The system 12 is operable to apply selective powertrain, traction control and braking actions to one or more wheels of the vehicle 100, collectively or individually.

The LSP control system 12 is configured to allow a user to input a desired value of vehicle target speed in the form of a set-speed parameter, user_set-speed, via a low-speed progress control HMI (LSP HMI) 20 (FIG. 1, FIG. 3) which shares certain input buttons 173-175 with the cruise control system 16 and HDC control system 12HD. Provided the vehicle speed is within the allowable range of operation of the LSP control system 12 (which is the range from 2 to 30kph in the present embodiment although other ranges are also useful) and no other constraint on vehicle speed exists whilst under the control of the LSP control system 12, the LSP control system 12 controls vehicle speed in accordance with a LSP control system set-speed value LSP_set-speed which is set substantially equal to user_set-speed. Unlike the cruise control system 16, the LSP control system 12 is configured to operate independently of the occurrence of a traction event. That is, the LSP control system 12 does not cancel speed control upon detection of wheel slip. Rather, the LSP control system 12 actively manages vehicle behaviour when slip is detected.

The LSP control HMI 20 is provided in the vehicle cabin so as to be readily accessible to the user. The user of the vehicle 100 is able to input to the LSP control system 12, via the LSP HMI 20, the desired value of user_set-speed as noted above by means of the ‘set-speed’ button 173 and the ‘+’/ ‘-‘ buttons 174, 175 in a similar manner to the cruise control system 16. The LSP HMI 20 also includes a visual display by means of which information and guidance can be provided to the user about the status of the LSP control system 12.

The LSP control system 12 receives an input from the ABS controller 13 of the braking system 22 of the vehicle indicative of the extent to which the user has applied braking by means of the brake pedal 163. The LSP control system 12 also receives an input from an accelerator pedal 161 indicative of the extent to which the user has depressed the accelerator pedal 161, and an input from the transmission or gearbox 124. This latter input may include signals representative of, for example, the speed of an output shaft of the gearbox 124, an amount of torque converter slip and a gear ratio request. Other inputs to the LSP control system 12 include an input from the cruise control HMI 18 which is representative of the status (ON/OFF) of the cruise control system 16, an input from the LSP control HMI 20, and an input from a gradient sensor 45 indicative of the gradient of the driving surface over which the vehicle 100 is driving. In the present embodiment the gradient sensor 45 is a gyroscopic sensor. In some alternative embodiments the LSP control system 12 receives a signal indicative of driving surface gradient from another controller such as the ABS controller 13. The ABS controller 13 may determine gradient based on a plurality of inputs, optionally based at least in part on signals indicative of vehicle longitudinal and lateral acceleration and a signal indicative of vehicle reference speed (v_actual) being a signal indicative of actual vehicle speed over ground. Methods for the calculation of vehicle reference speed based for example on vehicle wheel speeds are well known. For example in some known vehicles the vehicle reference speed may be determined to be the speed of the second slowest turning wheel, or the average speed of all the wheels. Other ways of calculating vehicle reference speed may be useful in some embodiments, including by means of a camera device or radar sensor.



The HDC system 12HD is activated by depressing button 177 comprised by HDC system HMI 20HD and mounted on the steering wheel 171. When the HDC system 12HD is active, the system 12HD controls the braking system 22 in order to limit vehicle speed to a value corresponding to that of a HDC set-speed parameter HDC_set-speed which may be controlled by a user in a similar manner to the set-speed of the cruise control system 16 and LSP control system, using the same control buttons 173, 173R, 174, 175. The HDC system 12HD is operable to allow the value of HDC_set-speed to be set to any value in the range from 2-30kph. The HDC set-speed parameter may also be referred to as an HDC target speed. Provided the user does not override the HDC system 12HD by depressing the accelerator pedal 161 when the HDC system 12HD is active, the HDC system 12HD controls the braking system 22 (FIG. 3) to prevent vehicle speed from exceeding HDC_set-speed. In the present embodiment the HDC system 12HD is not operable to apply positive drive torque. Rather, the HDC system 12HD is only operable to cause negative brake torque to be applied, via the braking system 22.

It is to be understood that the VCU 10 is configured to implement a known Terrain Response (TR) (RTM) System of the kind described above in which the VCU 10 controls settings of one or more vehicle systems or sub-systems including the powertrain controller 11 in dependence on a selected driving mode. The driving mode may be selected by a user by means of a driving mode selector 141S (FIG. 1). The driving modes may also be referred to as terrain modes, terrain response (TR) modes, or control modes. Further sub-systems under the control of the TR system include the suspension system controller 191C, the SCS system and steering controller 170C. The suspension controller 191C is configured to control an air suspension system 191 (FIG. 3) to allow vehicle ride height to be set to one of four settings corresponding to different heights of the vehicle 100 above level ground. In each driving mode, the VCU 10 sets the value of ride height of the vehicle to a predetermined value associated with the selected driving mode.



In the embodiment of FIG. 1 four driving modes are provided: an ‘on-highway’ driving mode suitable for driving on a relatively hard, smooth driving surface where a relatively high surface coefficient of friction exists between the driving surface and wheels of the vehicle; a ‘sand’ driving mode suitable for driving over sandy terrain, being terrain characterised at least in part by relatively high drag, relatively high deformability or compliance and relatively low surface coefficient of friction; a ‘grass, gravel or snow’ (GGS) driving mode suitable for driving over grass, gravel or snow, being relatively slippery surfaces (i.e. having a relatively low coefficient of friction between surface and wheel and, typically, lower drag than sand); a ‘rock crawl’ (RC) driving mode suitable for driving slowly over a rocky surface; and a ‘mud and ruts’ (MR) driving mode suitable for driving in muddy, rutted terrain. Other driving modes may be provided in addition or instead. In the present embodiment the selector 141S also allows a user to select an ‘automatic driving mode selection condition’ of operation in which the VCU 10 selects automatically the most appropriate driving mode as described in more detail below. The on-highway driving mode may be referred to as a ‘special programs off’ (SPO) mode in some embodiments since it corresponds to a standard or default driving mode, and is not required to take account of special factors such as relatively low surface coefficient of friction, or surfaces of high roughness.

The LSP control system 12 causes the vehicle 100 to operate in accordance with the value of LSP_set-speed.

In order to cause application of the necessary positive or negative torque to the wheels, the VCU 10 may command that positive or negative torque is applied to the vehicle wheels by the powertrain 129 and/or that a braking force is applied to the vehicle wheels by the braking system 22, either or both of which may be used to implement the change in torque that is necessary to attain and maintain a required vehicle speed. In some embodiments torque is applied to the vehicle wheels individually, for example by powertrain torque vectoring, so as to maintain the vehicle at the required speed. Alternatively, in some embodiments torque may be applied to the wheels collectively to maintain the required speed, for example in vehicles having drivelines where torque vectoring is not possible. In some embodiments, the powertrain controller 11 may be operable to implement torque vectoring to control an amount of torque applied to one or more wheels by controlling a driveline component such as a rear drive unit, front drive unit, differential or any other suitable component. For example, one or more components of the driveline 130 may include one or more clutches operable to allow an amount of torque applied to one or more wheels to be varied. Other arrangements may also be useful.



Where a powertrain 129 includes one or more electric machines, for example one or more propulsion motors and/or generators, the powertrain controller 11 may be operable to modulate torque applied to one or more wheels in order to implement torque vectoring by means of one or more electric machines.

In some embodiments the LSP control system 12 may receive a signal wheel_slip (also labelled 48 in FIG. 3) indicative of a wheel slip event having occurred. This signal 48 is also supplied to the on-highway cruise control system 16 of the vehicle, and which in the case of the latter triggers an override or inhibit mode of operation in the on-highway cruise control system 16 so that automatic control of vehicle speed by the on-highway cruise control system 16 is suspended or cancelled. However, the LSP control system 12 is not arranged to cancel or suspend operation on receipt of wheel_slip signal 48. Rather, the system 12 is arranged to monitor and subsequently manage wheel slip so as to reduce driver workload. During a slip event, the LSP control system 12 continues to compare the measured vehicle speed with the value of LSP_set-speed, and continues to control automatically the torque applied to the vehicle wheels (by the powertrain 129 and braking system 22) so as to maintain vehicle speed at the selected value. It is to be understood therefore that the LSP control system 12 is configured differently to the cruise control system 16, for which a wheel slip event has the effect of overriding the cruise control function so that manual operation of the vehicle must be resumed, or speed control by the cruise control system 16 resumed by pressing the resume button 173R or set-speed button 173.

The vehicle 100 is also provided with additional sensors (not shown) which are representative of a variety of different parameters associated with vehicle motion and status. These may be inertial systems unique to the LSP or HDC control systems 12, 12HD or part of an occupant restraint system or any other sub-system which may provide data from sensors such as gyros and/or accelerometers that may be indicative of vehicle body movement and may provide a useful input to the LSP and/or HDC control systems 12, 12HD. The signals from the sensors provide, or are used to calculate, a plurality of driving condition indicators (also referred to as terrain indicators) which are indicative of the nature of the terrain conditions over which the vehicle 100 is travelling.



The sensors (not shown) on the vehicle 100 include, but are not limited to, sensors which provide continuous sensor outputs to the VCU 10, including wheel speed sensors, as mentioned previously, an ambient temperature sensor, an atmospheric pressure sensor, tyre pressure sensors, an engine torque sensor (or engine torque estimator), a steering angle sensor, a steering wheel speed sensor, a brake pedal position sensor, a brake pressure sensor, an accelerator pedal position sensor, and water detection sensors forming part of a vehicle wading assistance system (not shown). In other embodiments, only a selection of the aforementioned sensors may be used.

The vehicle as an inertial measurement unit (IMU) 50 configured to output to the VCU 10 signals indicative of longitudinal, lateral and vertical acceleration, and yaw rate. In some embodiments the IMU 50 may in addition be configured to output a signal indicative of pitch rate and/or roll rate.

The VCU 10 also receives a signal from the steering controller 170C. The steering controller 170C is in the form of an electronic power assisted steering unit (ePAS unit) 170C. The steering controller 170C provides a signal to the VCU 10 indicative of the steering force being applied to steerable road wheels 111, 112 of the vehicle 100. This force corresponds to that applied by a user to the steering wheel 171 in combination with steering force generated by the ePAS unit 170C. The ePAS unit 170C also provides a signal indicative of steering wheel rotational position or angle.

In the present embodiment, the VCU 10 evaluates the various sensor inputs to determine the probability that each of the plurality of different TR modes (control modes or driving modes) for the vehicle subsystems is appropriate, with each control mode corresponding to a particular terrain type over which the vehicle is travelling (for example, mud and ruts, sand, grass/gravel/snow) as described above.

If the user has selected operation of the vehicle in the automatic driving mode selection condition, the VCU 10 then selects the most appropriate one of the control modes and is configured automatically to control the subsystems according to the selected mode. This aspect of the invention is described in further detail in our co-pending patent applications GB2492748, GB2492655 and GB2499279, the contents of each of which is incorporated herein by reference as noted above.

As indicated above, the nature of the terrain over which the vehicle is travelling (as determined by reference to the selected control mode) may also be utilised in the LSP control system 12 to determine an appropriate increase or decrease in vehicle speed. For example, if the user selects a value of user_set-speed that is not suitable for the nature of the terrain over which the vehicle is travelling, the system 12 is operable to automatically adjust the value of LSP_set-speed to a value lower than user_set-speed. In some cases, for example, the user selected speed may not be achievable or appropriate over certain terrain types, particularly in the case of uneven or rough surfaces. If the system 12 selects a set-speed (a value of LSP_set-speed) that differs from the user-selected set-speed user_set-speed, a visual indication of the speed constraint is provided to the user via the LSP HMI 20 to indicate that an alternative speed has been adopted.

In the present embodiment, the cruise control system 16 is operable in a ‘constant cruise control’ mode by selection of this mode via the cruise control HMI 18. In this mode, the cruise control system 16 is configured to adjust the value of cruise_set-speed in dependence on the position of the accelerator pedal 161, and brake pedal 163, over a range of speeds from substantially -30kph (i.e. with the vehicle reversing) to 150kph. It is to be understood that, in some alternative embodiments, the cruise control system 16 can only be operated in the constant cruise control mode. In some still further embodiments, the constant cruise control mode may be the only ‘mode’ of operation of the vehicle 100. Other arrangements may be useful in some embodiments.

In the present embodiment the cruise control system 16 monitors the position of the accelerator pedal 161 and increases the value of cruise_set-speed when the accelerator pedal 161 is depressed. When the accelerator pedal 161 is depressed, the cruise control system 16 is configured to increase the value of cruise_set-speed at a rate that depends on the amount of travel of the accelerator pedal 161 from a position of zero travel (or ‘released condition’). The greater the amount of travel of the accelerator pedal 161 from the released condition, the greater the rate of increase of cruise_set-speed.

When the accelerator pedal 161 is in the released condition, the cruise control system 16 sets the value of cruise_set-speed to the instant vehicle speed at the moment the pedal 161 is released. Thus, if a driver wishes to accelerate the vehicle 100 from one speed (such as zero kph, with the vehicle stationary, or any other speed within the range of operation of the system 16 in the constant cruise control mode) the driver may depress the accelerator pedal 161 until the vehicle speed reaches the desired speed, and then simply release the accelerator pedal 161. At this point, the cruise control system 16 sets the value of cruise_set-speed to the instant value of v_actual at the moment the accelerator pedal 161 is released. The cruise control system 16 therefore attempts to cause the vehicle 100 to maintain the speed at which the vehicle 100 was travelling when the accelerator pedal 161 was released. In the present embodiment the instant vehicle speed is determined by the cruise control system 16 by reference to vehicle reference speed v_actual as noted above.

The cruise control system 16 also monitors actuation of the brake pedal 163 as noted above. When the brake pedal 163 is depressed, the cruise control system 16 is temporarily disabled but causes the value of cruise_set-speed to track v_actual until the brake pedal 163 is released. Thus, when the brake pedal 163 is released, the value of cruise_set-speed is set to the instant value of v_actual at the moment the brake pedal 163 is released. The cruise control system 16 then resumes attempting to cause v_actual to track cruise_set-speed.

FIG. 5 illustrates the operation of a portion of the cruise control system 16.

A lookup table function block 101 receives an input signal Accleration_Pedal indicative of the position of the accelerator pedal 161 with respect to an allowable range of travel of the pedal 161. The function block 101 applies the input signal to a lookup table and outputs a signal Acceleration_Step to a comparison function block 103 and an addition function block 115.

The comparison function block 103 outputs a logical ‘1’ signal if the condition is met that the signal Acceleration_Step is zero or less. This condition will be met only if the accelerator pedal is in the released (zero travel condition). The signal output by comparison function block 103 is provided to positive rise detection function block 105, which outputs a logical ‘1’ signal if the input received from the comparison function block 103 is logical ‘1’ and the function block 105 detects that the signal received has just risen to logical ‘1’ from logical ‘0’. The positive rise detection function block 105 output is supplied to OR function block 107.

Operator function block 111 receives an input signal Brake_Pedal indicative of the position of brake pedal 163 with respect to an allowable range of travel of the brake pedal 163. The operator function block 111 also receives a signal from function block 109 indicative of the value of parameter Brake_Pedal_Limit. Parameter Brake_Pedal_Limit indicates the threshold value of signal Brake_Pedal above which the brake pedal 163 is considered to be in a depressed (actuated) condition as opposed to the released condition.

Operator function block 111 outputs a logical ‘1’ signal to OR function block 107 if the signal Brake_Pedal has a value exceeding Brake_Pedal_Limit, i.e. if the brake pedal 163 has been depressed.



The output of OR function block 107 is provided to switch function block 107. Switch function block also receives the signal v_actual and the output of addition function block 115. The switch function block 113 is configured to output the signal v_actual if the input received from the OR function block 107 indicates that the condition is met that (1) the accelerator pedal has just been released (signal Accelerator_Pedal indicated a decreasing amount of travel to a value of zero travel) or (2) the signal Brake_Pedal indicates that the brake pedal 163 is depressed. If neither of conditions (1) and (2) are met, the switch function block 107 outputs the input received from addition function block 115.

The output from switch function block 113 is passed to saturation function block 117 which outputs the signal received from switch function block 113 within predefined limits. In the present embodiment the range of allowable output values of saturation function block 117 corresponds to the allowable range of values of cruise_set-speed when the cruise control system 16 is in the ‘constant cruise control’ mode. In the present embodiment this range is from substantially -30kph to 150kph although other values may be useful in some embodiments.

The signal output by saturation function block 117 is passed to rate limiter function block 119. Rate limiter function block 119 is configured to limit the rate at which the value of cruise_set-speed can change so as to limit passenger discomfort that may arise due to relatively high rates of change of cruise_set-speed. The rate limiter function block 119 may limit the rate of change of cruise_set-speed to plus or minus 1.2 metres per second per second. Other values may be useful in some embodiments. The signal output by rate limiter function block 119 is used by the cruise control system 16 as the final value of cruise_set-speed used by the cruise control system 16 to control vehicle speed. That is, the cruise control system 16 endeavours to cause the vehicle 100 to travel at a speed substantially equal to cruise_set-speed in the absence of traffic in the path of the vehicle.

The output from the rate limiter function block 119 is passed to a time delay function block 121 that outputs the signal input thereto (cruise_set-speed) subject to introducing a predetermined time delay. In the present embodiment the time delay is approximately 10ms although other values may be useful in some embodiments.



The output from time delay function block 121 is passed to the addition function block 115. The addition function block adds the (time delayed or ‘stored’) value of cruise_set-speed to the value of the signal output by function block 101 and outputs the summed value to switch function block 113 as described above.

FIG. 6 illustrates operation of a vehicle 100 according to an embodiment of the present invention in an example drive cycle. In this example drive cycle the driving surface is substantially flat (with substantially no gradient encountered) throughout the drive cycle.

In FIG.’s 6 to 8, trace A represents accelerator pedal position (parameter Accelerator_Pedal) and trace B represents brake pedal position (parameter Brake_Pedal). The values of v_actual and cruise_set-speed are shown by respective traces whilst engine drive torque is shown by trace Tq.

At time t1 the driver of the vehicle 100 (which is at rest) begins depressing the accelerator pedal 161 and at time t2 holds the accelerator pedal 161 at a constant distance of travel from the released position. This causes the value of cruise_set-speed to begin to increase at a substantially constant rate, causing the cruise control system 16 to demand a substantial amount of engine torque Tq in order to cause v_actual to track cruise_set-speed. The value of Tq remains substantially constant after t2 until at time t3 the driver releases the accelerator pedal 161, the pedal 161 being fully released by time t4. At time t4 the value of cruise_set-speed is set to the instant value of v_actual.

As shown in FIG. 6, the value of cruise_set-speed becomes substantially constant from time t3. During the period from t1 the value of v_actual lags behind cruise_set-speed very slightly as the cruise control system 16 endeavours to match v_actual to cruise_set-speed.

From time t4, since the vehicle 100 is now no longer required to accelerate (cruise_set-speed remains substantially constant), the amount of engine torque Tq reduces substantially. At time t5 the driver depresses the brake pedal before immediately releasing it by time t6. During the period t5 to t6 the value of cruise_set-speed tracks v_actual as v_actual decreases, the value of cruise_set-speed being set to the instant value of v_actual from time t6 following release of the brake pedal 163.

At time t7 the driver depresses the brake pedal 163 until the vehicle 100 becomes stationary at time t8, at which time the driver releases the brake pedal 163. It can be seen that, again, cruise_set-speed follows v_actual as vehicle speed falls, cruise_set-speed having a value of zero when the vehicle 100 finally become stationary.



FIG. 7 illustrates operation of a vehicle 100 according to an embodiment of the present invention in a further example drive cycle. In this example drive cycle the driving surface has an uphill gradient and a downhill gradient as described below.

At time t1 the vehicle 100 is substantially stationary with the brake pedal 163 depressed. At time t2 the driver releases the brake pedal 163. The vehicle 100 remains stationary (v_actual zero) with cruise_set-speed also zero. Between times t3 and t4 the driver progressively depresses the accelerator pedal 161. The value of cruise_set-speed increases progressively, resulting in an increase in engine torque Tq and a consequent increase in v_actual.

From time t4 to time t5 the accelerator pedal remains depressed at a substantial constant amount before being progressively released such that at time t6 it is fully released. During the period t4 to t5, the amount of engine torque Tq remains substantially constant to meet the demand for vehicle acceleration at a substantially constant rate (determined by the rate of change of cruise_set-speed). Consequently, v_actual progressively increases.

Between times t5 and t6 engine torque Tq drops substantially and both cruise_set-speed and v_actual remain substantially constant from time t6 onwards.

From time t7 to time t10 the vehicle 100 encounters an uphill gradient as indicated by gradient trace “grad”, FIG. 7, before encountering a downhill gradient from time t10 to t13. From time t13 onwards the driving surface is substantially flat.

When the uphill gradient is encountered, at time t7, engine torque Tq increases to compensate for the weight of the vehicle 100 in order to maintain v_actual substantially equal to cruise_set-speed. When the downhill gradient is encountered from time t10, the amount of engine torque Tq drops substantially and becomes negative (the engine 100 providing brake torque). From time t12, when the driving surface begins to level, the amount of negative engine torque (engine braking torque) decreases to substantially zero at time t14. At time t14, the driver depresses the brake pedal 163 and the values of both cruise_set-speed and v_actual fall to zero at time t16. The driver then releases the brake pedal at time t17.



It can be seen that only a relatively small deviation of v_actual from cruise_set-speed takes place when the uphill gradient is encountered (between time t7 and t10 v_actual falls slightly below cruise_set-speed, which remains substantially constant) and when the downhill gradient is encountered (between t10 and t13 v_actual rises slightly above cruise_set-speed, which remains substantially constant).

It is to be understood that, in the event v_actual rises above cruise_set-speed and engine braking is insufficient to correct the deviation, the cruise control system 16 of the present embodiment is configured to demand application of brake force by means of the ABS system in order to slow the vehicle 100.

FIG. 8 illustrates operation of a vehicle 100 according to an embodiment of the present invention in a further example drive cycle. In this example drive cycle the vehicle experiences a demand for a substantially constant rate of acceleration whilst encountering uphill and downhill gradients.

As shown in FIG. 8, the driver depresses the accelerator pedal 161 with the vehicle stationary starting at time t1 and holds a constant amount of accelerator pedal depression (signal Accelerator_Pedal) from time t2 to time t6. At time t6 the driver releases the accelerator pedal, and then applies the brake pedal 163 between times t8 and t10.

It can be seen that, from time t2 to time t6, the value of cruise_set-speed increases at a substantially constant rate, with the value of v_actual increasing to follow cruise_set-speed as closely as possible. A slight deviation of v_actual below cruise_set-speed occurs between times t3 and t4 as the vehicle climbs a gradient, and a slight deviation of v_actual above cruise_set-speed occurs between times t4 and t5 as the vehicle descends a gradient. Engine torque increases substantially during the period the gradient is being climbed, before rapidly swinging negative for the period the vehicle 100 is descending the gradient, as the cruise control system 16 attempts to prevent overshoot of v_actual above cruise_set-speed. The value of cruise_set-speed (and consequently of v_actual also) remains substantially constant during the period from t7 to t8 whilst the accelerator pedal 161 is undepressed. During the period of brake pedal depression from t8 to t10 v_actual decreases, with cruise_set-speed tracking v_actual. When the brake pedal is released at time t10 the value of cruise_set-speed is set to the prevailing value of v_actual.

It is to be understood that the constant cruise control mode of the cruise control system 16 allows the accelerator pedal to be maintained in a given position before, during and after an increase/decrease in road gradient (e.g. from time t3 to t5 on figure 8). The system 16 automatically monitors v_actual and adjusts engine torque demand in an attempt to cause v_actual to track cruise_set-speed despite changes in driving surface gradient. This has the advantage that additional parameters, such as road gradient and vehicle mass, are not required for the calculation of engine torque demand based on the accelerator pedal position.



In an alternative embodiment, the cruise control system 16 may be configured to cause an increase in the value of cruise_set-speed only when the accelerator pedal 161 exceeds a predetermined non-zero baseline amount of travel, which may be referred to as a baseline accelerator pedal position, the rate of increase of cruise_set-speed being higher the further the pedal is depressed beyond the baseline position. The cruise control system may, in some embodiments, be further configured to cause the value of cruise_set-speed to decrease when the accelerator pedal is at a position corresponding to an amount of depression that is less than the baseline amount, including a position of substantially no depression. The rate of decrease of cruise_set-speed may increase for progressively lower amounts of travel of the accelerator pedal 161 below the baseline amount. Thus, release of the accelerator pedal 161 to positions before (or ‘below’) the baseline position, including full release, may result in the cruise control system 16 effectively simulating an engine braking scenario.

The cruise control system 16 may be configured to vary the baseline position of the accelerator pedal in dependence on vehicle speed, in some embodiments.

As noted above, in the present embodiment, when in the constant cruise control mode the cruise control system 16 is configured to adjust the rate at which the cruise control system 16 causes the vehicle to accelerate in order to cause the value of v_actual to correspond substantially to the value of cruise_set-speed. The rate of acceleration is determined by the cruise control system 16 in dependence at least in part on accelerator pedal position. FIG. 9 illustrates the operation of an embodiment of the invention during an example drive cycle in which the accelerator pedal 161 is held at different positions with respect to the range of allowable travel of the accelerator pedal 161 during the drive cycle.

Throughout the drive cycle illustrated in FIG. 9 the gradient of the driving surface is level, i.e. the gradient is substantially zero.



At time t=0 (seconds), the driver releases the brake pedal 163 (trace B). From time t=4 to t=5 the driver depresses the accelerator pedal 161 to a depression of 10% of full travel. The cruise control system 16 causes the value of cruise_set-speed to increase at a rate that is set in dependence on the accelerator pedal position. The cruise control system 16 requests an amount of engine torque Tq in order to cause v_actual to follow the value of cruise_set-speed.

From time t=5 to t=14s, the vehicle 100 experiences a substantially constant accelerator pedal position, resulting in a constant rate of change of crusie_set-speed, which in turns results in a constant rate of change of vehicle speed v_actual, i.e. a constant rate of acceleration of the vehicle.

From time t=14 to t=15s, the accelerator pedal 161 is further depressed from a travel of 10% to a travel of 40% of full travel. The rate of change of the value of cruise_set-speed therefore increases, and an increase in engine torque Tq is demanded by the cruise control system 16 in order to enable v_actual to follow the new rate of acceleration.

From time t=15 to t=19s the accelerator pedal 161 is maintained at the new position (40% of full travel) resulting in a substantially constant but higher rate of change of cruise_set-speed, leading to a substantially constant rate of change of v_actual that is higher than that experienced over the period t=5 - 14s.

Over the period t=19-20s the accelerator pedal 161 is decreased from 40% to 10% of full travel, in response to which the cruise control system 16 reduces the rate of change of cruise_set-speed. Accordingly, a lower value of Tq is required in order to meet the new required rate of acceleration of the vehicle 100.

Over the period t=20-24s, the accelerator pedal is maintained in a substantially constant position (10% of full travel) resulting in a substantially constant rate of acceleration that is substantially the same as that over the period t=5-14s.

Over the period t=24-25s, the accelerator pedal 161 is depressed to a position of substantially 20% of full travel, resulting in an increase in the rate of increase of cruise_set-speed.

Over the period t=25-29s, the accelerator pedal 161 is maintained at the position of 20% of full travel, and cruise_set-speed increases at a substantially constant rate, higher than that over the period t=20-24s.



Over the period t=29-30s the acceleration pedal 161 is released to a position of substantially zero travel, at which time the cruise control system 16 freezes the value of cruise_set-speed. The cruise control system 16 therefore endeavours to maintain the vehicle 100 at a substantially constant speed, substantially equal to the value of cruise_set-speed.

Throughout the description and claims of this specification, the words “comprise” and “contain” and variations of the words, for example “comprising” and “comprises”, means “including but not limited to”, and is not intended to (and does not) exclude other moieties, additives, components, integers or steps.

Throughout the description and claims of this specification, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

Features, integers, characteristics, compounds, chemical moieties or groups described in conjunction with a particular aspect, embodiment or example of the invention are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith, and providing they are within the scope of the claims of the invention.

**CLAIMS:**

1. A speed control system operable to control a motor vehicle to operate in accordance with a set-speed value, the control system being operable to adjust the set-speed value in response to actuation of a vehicle accelerator control member, the accelerator control member being movable over a range of travel, the system being configured to adjust the rate of change of the set-speed value in dependence at least in part on the position of the accelerator control member with respect to its range of travel.

2. A speed control system according to claim 1 configured to set the set-speed value to the instant value of vehicle speed when the accelerator control member is at a neutral position.

3. A speed control system according to claim 2 wherein the neutral position corresponds to a position of substantially zero travel with respect to a range of travel of the accelerator control member.

4. A speed control system according to claim 2 wherein the neutral position corresponds to a position of non-zero travel with respect to a range of travel of the accelerator control member, the speed control system being configured to cause the set-speed value to increase when the amount of accelerator control member travel exceeds the neutral position, the rate of increase being dependent on the extent of travel beyond the neutral position, and to cause the set-speed value to decrease when the amount of accelerator control member travel is less than the neutral position, the rate of decrease being dependent on the extent of travel before the neutral position.

5. A speed control system according to any preceding claim configured to detect a position of a brake control member, wherein when the brake control member is released following actuation of the brake control member, the control system is configured to set the value of set-speed to the instant vehicle speed and to continue to control operation of the motor vehicle in accordance with the set-speed value.

6. A speed control system according to any preceding claim comprising processing means, wherein the processing means comprises an electronic processor having an electrical input for receiving information indicative of the position of the accelerator control member and an electronic memory device electrically coupled to the electronic processor and having instructions stored therein,

wherein the processor is configured to access the memory device and execute the instructions stored therein such that it is operable to adjust the rate of change of the set-speed value in dependence at least in part on the position of the accelerator control member with respect to its range of travel.

7. A vehicle comprising a speed control system according to any preceding claim.

8. A method of controlling a vehicle by means of a speed control system, comprising:

causing a motor vehicle to operate in accordance with a set-speed value;

adjust the set-speed value in response to actuation of a vehicle accelerator control member, the accelerator control member being movable over a range of travel; and

adjusting the rate of change of the set-speed value in dependence at least in part on the position of the accelerator control member with respect to its range of travel.

9. A method according to claim 8 comprising setting the set-speed value to the instant value of vehicle speed when the accelerator control member is at a neutral position.

10. A method according to claim 9 whereby the neutral position corresponds to a position of substantially zero travel with respect to a range of travel of the accelerator control member.

11. A method according to claim 9 whereby the neutral position corresponds to a position of non-zero travel with respect to a range of travel of the accelerator control member, the method comprising causing the set-speed value to increase when the amount of accelerator control member travel exceeds the neutral position, the rate of increase being dependent on the extent of travel beyond the neutral position, and causing the set-speed value to decrease when the amount of accelerator control member travel is less than the neutral position, the rate of decrease being dependent on the extent of travel before the neutral position.

12. A method according to any one of claims 8 to 11 comprising detecting a position of a brake control member, the method further comprising, when the brake control member is released following actuation of the brake control member, setting the value of the set-speed to the instant vehicle speed and continuing to control operation of the motor vehicle in accordance with the set-speed value.

13. A non-transitory computer readable carrier medium carrying computer readable code for controlling a vehicle to carry out the method of any one of claims 8 to 12.

14. A computer program product executable on a processor so as to implement the method of any one of claims 8 to 12.

15. A non-transitory computer readable medium carrying computer readable code which when executed causes a vehicle to carry out the method of any one of claims 8 to 12.

16. A processor arranged to implement the method of any one of claims 8 to 12, or the computer program product of claim 14.