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(71) Applicant: SCANIA CV AB [SE/SE]; 151 87 Södertälje (SE).

(72) Inventors: JARNGREN, Fredrik; Skonertvägen 9B, 1101, 117 68 Stockholm (SE). GUSTAFSSON, Erik; Finbergsvägen 30, 131 31 Nacka (SE).

(74) Agent: WESTMAN, Mimmi; Scania CV AB, 151 87 Södertälje (SE).

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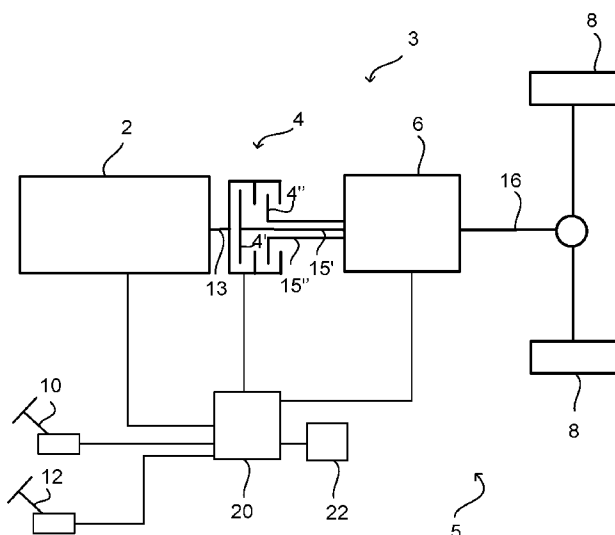


Fig. 2

(57) Abstract: The invention relates to a vehicle system (5), comprising a dual clutch device (4) arranged between an internal combustion engine (2) and a gearbox (6) in a powertrain (3); a first accelerator pedal (12) and a clutch pedal (10), wherein the dual clutch device (4) comprises a first clutch (4') connected to a first gear set in the gearbox (6) and a second clutch (4'') connected to a second gear set in the gearbox (6), wherein an electronic control unit (20) is adapted to control the dual clutch device (4) based on the operation of the clutch pedal (10) in a manual mode and based on the operating state of the vehicle (1) in an automatic mode. The clutch pedal (10) is adapted to be able to constitute a second accelerator pedal (10), wherein the control unit (20) is adapted to control the gearbox (6) such that a reverse gear connected to the first clutch (4'), and a forward gear connected to the second clutch (4'') are engaged, and wherein the control unit (20) is adapted to control the first clutch (4') based on the operation of one of the accelerator pedals (10; 12) and the second clutch (4'') based on the operation of the other accelerator pedal (10; 12). The invention also relates to a method to control such a vehicle system, a vehicle (1), a computer program (P) and a computer program product.

System and method for controlling a dual clutch device in a vehicle powertrain

TECHNICAL FIELD

5 The present invention relates to a vehicle system according to the preamble of claim 1 and a method to control a vehicle system according to claim 10. The invention also relates to a vehicle comprising such a vehicle system according to claim 17. The invention further relates to a computer program according to claim 18 and a computer program product comprising program code according to claim 19.

BACKGROUND

There are many different types of vehicle systems available for vehicles today.

15 In clutch-by-wire systems the mechanical connection between the clutch pedal and the clutch is removed and the clutch is controlled by an electronic control unit. When the clutch pedal is depressed a position sensor typically determines the position of the clutch pedal and the control unit controls a clutch actuator which affects the clutch to change position, based on the position of the clutch

20 pedal. In a clutch-by-wire system the clutch may alternatively be controlled by the control unit independently of the clutch pedal position. In this case, the clutch is controlled based on the operating state of the vehicle, just like in a vehicle system with an automatic transmission and no clutch pedal.

25 Some vehicles of today are equipped with dual clutch transmissions (DCT) which is a type of semi-automatic or automatic transmission. Such transmissions comprise two separate clutches, each connected to a different gear set. This way, two gears may be engaged at the same time and gear shifts may be performed by controlling which clutch to be engaged. Such

30 solutions are advantageous in that gear shifts may be performed without torque interruption to the output shaft of the transmission. A dual clutch transmission may be combined with a clutch-by-wire system, wherein the two

clutches are controlled either based on the position of the clutch pedal in a manual mode or based on the operating state of the vehicle in an automatic mode. The automatic mode is advantageous for example in that a more precise and accurate gear shift may be achieved without the interaction of the operator of the vehicle. However, in some situations the operator of the vehicle wants to control the speed of the internal combustion engine independently of the driving torque on the driving wheels and in these situations manually controlled clutches are advantageous. Despite the advantages with dual clutch transmissions and clutch-by-wire systems, shifting to the reverse gear may still be cumbersome. The operator typically has to stop the vehicle and manually operate the gear shifting means in order to shift to the reverse gear and this may be very inconvenient, especially in applications where the operator repeatedly drives back and forth.

Document EP1266788 A2 describes a vehicle system with a dual clutch transmission, where a forward gear and a reverse gear are engaged simultaneously for rocking the vehicle. Document EP 1455119 A2 describes a vehicle system with a hydrostatic transmission, comprising a first pedal acting as an accelerator pedal and an inching pedal acting as brake and clutch pedal.

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SUMMARY OF THE INVENTION

Despite known solutions in the field, there is still a need to develop a vehicle system which makes it convenient to shift between forward driving and reversing.

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An object of the present invention is to achieve a vehicle system, which enables efficient manoeuvring of a vehicle.

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A further object of the invention is to achieve a method to control a vehicle system for enabling efficient manoeuvring of a vehicle.

Another object of the present invention is to achieve a new and advantageous computer program for controlling a vehicle system.

- 5 The herein mentioned objects are achieved by a vehicle system characterized by the features in the characterizing part of claim 1.

The herein mentioned objects are achieved by a method characterized by the features in the characterizing part of claim 10.

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The herein mentioned objects are also achieved by a vehicle characterized by the features in the characterizing part of claim 17.

- 15 The herein mentioned objects are also achieved by a computer program for controlling a vehicle system characterized by the features in the characterizing part of claim 18.

- 20 The herein mentioned objects are also achieved by a computer program product for controlling a vehicle system characterized by the features in the characterizing part of claim 19.

- 25 According to an aspect of the present invention a vehicle system is provided. The vehicle system comprises a dual clutch device arranged between an internal combustion engine and a gearbox in a powertrain; a first accelerator pedal and a clutch pedal, wherein the dual clutch device comprises a first clutch connected to a first gear set in the gearbox and a second clutch connected to a second gear set in the gearbox, wherein an electronic control unit is adapted to control the dual clutch device based on the operation of the clutch pedal in a manual mode and based on the operating state of the vehicle
30 in an automatic mode. The clutch pedal is adapted to be able to constitute a second accelerator pedal, wherein the control unit is adapted to control the gearbox such that a reverse gear connected to the first clutch is engaged, and

- such that a forward gear connected to the second clutch is engaged, and wherein the control unit is adapted to control the first clutch based on the operation of one of the accelerator pedals and the second clutch based on the operation of the other accelerator pedal. Thus, the clutch pedal is enabled to
- 5 constitute a second accelerator pedal by engaging a forward gear connected to one of the clutches and a reverse gear connected to the other clutch and by controlling the two clutches based on the first accelerator pedal and the clutch pedal constituting a second accelerator pedal.
- 10 In vehicle systems having two control pedals (an accelerator pedal and a brake pedal) the transmission is automatic and a control unit thus controls the internal combustion engine, the clutch and the gearbox based on the operation of the accelerator pedal and the operation of the brake pedal. In vehicle systems having three control pedals (an accelerator pedal, a brake pedal and
- 15 a clutch pedal) and a manual transmission, the clutch is mechanically controlled based on the operation of the clutch pedal. If the mechanical connection between the clutch pedal and the clutch is excluded and the vehicle system thus constitutes a clutch-by-wire system with a semi-automatic or manual transmission, a control unit controls the clutch based on the
- 20 operation of the clutch pedal in a manual mode and based on the operating state of the vehicle in an automatic mode. This means that in the automatic mode, the control unit controls the clutch just like when no clutch pedal is available. The vehicle system according to the invention is a clutch-by-wire system comprising a dual clutch transmission. The dual clutch device is
- 25 connected to the internal combustion engine and thus transfers torque from the internal combustion engine to the gearbox and on to the driving wheels of the vehicle. By enabling the clutch pedal to constitute a second accelerator pedal such that the vehicle system comprises two accelerator pedals, one of the accelerator pedals controls the first clutch and the other accelerator pedal
- 30 controls the other clutch. This also means that the accelerator pedals indirectly control the internal combustion engine and the gearbox just like a vehicle system without a clutch pedal. The control unit is thus adapted to control, not

only the clutches of the dual clutch device, but also the internal combustion engine and the gearbox based on the operation of the first and the second accelerator pedal. This way, one of the accelerator pedals may be operated to drive the vehicle forwards and the other accelerator pedal may be operated to drive the vehicle in the reverse direction. It is thereby possible to change the driving direction by just operating the two accelerator pedals, and the need to manually operate a gear shifting means is avoided. A vehicle system is thus achieved, which enables efficient manoeuvring of a vehicle. This is advantageous especially in applications where the operator repeatedly changes between driving forwards and backwards. By enabling the clutch pedal to constitute a second accelerator pedal a vehicle system is also achieved, which is flexible in that it may function like a general clutch-by-wire system but also like a vehicle system having two accelerator pedals, depending on the operating situation.

According to an embodiment of the invention the control unit is adapted to control the first clutch based on the operation of the clutch pedal constituting the second accelerator pedal, and the second clutch based on the operation of the first accelerator pedal. This way, the clutch pedal constituting the second accelerator pedal is connected to the reverse gear through the first clutch. When the second accelerator pedal is depressed, the control unit is adapted to control the first clutch such that it is engaged, whereby the torque from the internal combustion engine is transferred through the first clutch to the engaged reverse gear, to an output shaft of the gearbox and on to the driving wheels. By depressing the second accelerator pedal, the vehicle is thus reversing. When the second accelerator is no longer depressed, the control unit controls the first clutch such that it is disengaged. When the first accelerator pedal is depressed, the control unit is adapted to control the second clutch such that it is engaged, whereby the torque from the internal combustion engine is transferred through the second clutch to the engaged forward gear, to the output shaft of the gearbox and on to the driving wheels. By depressing the first accelerator pedal, the vehicle is thus moving forwards. When the first

accelerator is no longer depressed, the control unit controls the second clutch such that is disengaged.

Alternatively, the control unit is adapted to control the first clutch based on the
5 operation of the first accelerator pedal, and the second clutch based on the operation of the second accelerator pedal.

According to an embodiment of the invention the control unit is adapted to control the dual clutch device based on the accelerator pedal which was the
10 latest to be depressed, if the first accelerator pedal and the second accelerator pedal are operated simultaneously. This means that if the first accelerator pedal is depressed first, the control unit controls the clutch associated with the first accelerator pedal to be engaged. If the second accelerator pedal is depressed while the first accelerator pedal is still depressed, the control unit
15 controls the clutch associated with the first accelerator pedal to be disengaged and simultaneously controls the clutch associated with the second accelerator pedal to be engaged. Thus, the control unit is adapted to engage the clutch associated with the accelerator pedal which is the latest to be depressed and to disengage the other clutch. This way, one of the accelerator pedals may be
20 kept depressed continuously and the other accelerator pedal may be temporarily depressed to control the change of driving direction. For example, the accelerator pedal associated with the forward gear may be depressed continuously. When the operator depresses the accelerator pedal associated with the reverse gear the control unit controls the clutch connected to the
25 forward gear to disengage and the clutch connected to the reverse gear to engage and the vehicle is driven backwards. When the operator releases the accelerator pedal associated with the reverse gear, only the accelerator pedal associated with the forward gear is depressed and the control unit thus controls the clutch connected to the reverse gear to disengage and the clutch
30 connected to the forward gear to engage. The vehicle is thereby driven forwards again.

Alternatively, the control unit is adapted to control the dual clutch device based on the accelerator pedal which was the first to be depressed, if the first accelerator pedal and the second accelerator pedal are operated simultaneously.

5

In the case where the first accelerator pedal and the second accelerator pedal are depressed exactly at the same time, or substantially the same time, the control unit is adapted to control the dual clutch device such that both clutches are disengaged and the vehicle thus stands still. The control unit is suitably adapted to control the dual clutch device such that both clutches are disengaged if the first and the second accelerator pedals are depressed within a specific time limit. Said specific time limit may be in the interval between 0-5 seconds. The control unit may be adapted to control the dual clutch device such that both clutches are disengaged if the first and the second accelerator pedals are depressed with less than 1 second, preferably less than 500 milliseconds in-between.

According to an embodiment of the invention, the vehicle system is adapted to enable the clutch pedal to constitute a second accelerator pedal based on a manual request for activation. The request for activation is preferably a request for activation of an efficient manoeuvring function. The manual request for activation is suitably provided by the operator of the vehicle, or any other person inside the vehicle, by operation of an activation means. The activation means could be a lever, button, switch or similar. The vehicle system may also be adapted to disable the clutch pedal to constitute a second accelerator pedal based on a manual request for inactivation. The request for inactivation is suitably provided by operation of an inactivation means or by resetting the activation means.

According to an embodiment of the invention a predetermined activation criterion must be fulfilled in order to be able to enable the clutch pedal to constitute a second accelerator pedal. Thus, a predetermined activation criterion must be fulfilled in order to allow activation of the efficient

manoeuvring function. This way, safety is ensured and the clutch pedal will not be enabled to function as an accelerator pedal, and the clutches will not be controlled accordingly, unless the activation criterion is fulfilled.

- 5 The predetermined activation criterion may be that the vehicle is at standstill. Alternatively the predetermined activation criterion is that the current vehicle speed is below a predetermined vehicle speed, for example below 10 km/h, 20 km/h or 30 km/h. This way is ensured that the vehicle is not travelling with a high speed and suddenly changes direction, which could be dangerous for the operator, passengers in the vehicle and the other road users. Also unnecessary wear and tear on the dual clutch device is avoided. The predetermined activation criterion may be that the clutch pedal currently is not depressed. This way, it is ensured that the clutch pedal is not used in the manual mode in order to control the clutch and suddenly starts driving the vehicle in a forward or reverse direction. Alternatively, the predetermined activation criterion is that a low gear is engaged in the gearbox.

- According to an embodiment of the invention the control unit is adapted to disable the clutch pedal to constitute a second accelerator pedal when the clutch associated with the first accelerator pedal is engaged and the vehicle speed exceeds a predetermined speed limit. This way, sudden changes of driving direction are avoided at unsuitable vehicle speeds. The predetermined speed limit may be between 20-40 km/h. Alternatively the predetermined speed limit is between 40-60 km/h. By disabling the clutch pedal to constitute a second accelerator pedal, the clutch pedal once again functions as a regular clutch pedal and the control unit controls the dual clutch device, the internal combustion engine and the gearbox as in a regular clutch-by-wire system. The efficient manoeuvring function is thus inactivated. When the vehicle speed exceeds a certain speed limit it is no longer suitable to repeatedly change driving direction. Therefore, by disabling the clutch pedal to constitute a second acceleration pedal when the clutch associated with the first accelerator pedal is engaged and the vehicle speed exceeds a predetermined speed limit

safety is ensured. Also, unnecessary wear and tear of the dual clutch device is avoided.

According to an embodiment of the invention, if the vehicle speed exceeds a
5 predetermined speed limit by means of one of the accelerator pedals and the
other accelerator pedal is depressed, the control unit is adapted to delay the
engagement of the clutch associated with said other accelerator pedal, until
the vehicle speed is below the predetermined speed limit. Thus, if the vehicle
speed exceeds a predetermined speed limit while a clutch associated with one
10 of the accelerator pedals is engaged, and the other accelerator pedal is
depressed, the control unit is adapted to delay the engagement of the clutch
associated with said other accelerator pedal until the vehicle speed is below
the predetermined speed limit. The control unit is thus also adapted to delay
the disengagement of the clutch associated with the accelerator pedal which
15 was depressed first. The predetermined speed limit may be between 20-40
km/h. Alternatively the predetermined speed limit is between 40-60 km/h. This
way, if the clutch associated with the second accelerator pedal (clutch pedal) is
engaged and the vehicle is driven in a forward direction or a reverse direction
by means of the second accelerator pedal with a vehicle speed exceeding the
20 predetermined speed limit, the clutch associated with the first accelerator pedal
will not be engaged if the first accelerator pedal is depressed, until the vehicle
speed is below the predetermined speed limit. The control unit may be
adapted to control brakes of the vehicle in this case, such that the vehicle
speed becomes below the predetermined speed limit. This way, sudden
25 changes of driving direction are avoided at unsuitable vehicle speeds, whereby
safety is ensured and unnecessary wear and tear of the dual clutch device is
avoided.

Suitably, the control unit is adapted to delay the accelerator pedal function of
30 the clutch pedal when the clutch associated with the first accelerator pedal is
engaged and the vehicle speed exceeds a predetermined speed limit. The
accelerator pedal function of the clutch pedal is suitably delayed until the

vehicle speed is below the predetermined speed limit. The control unit is preferably adapted not to engage the clutch associated with the clutch pedal until the vehicle speed has decreased below the predetermined speed limit. A reverse gear connected to the first clutch and a forward gear connected to the second clutch, are thus engaged but engagement of the clutch associated with the clutch pedal (the second accelerator pedal) is delayed until the vehicle speed is allowable. The disengagement of the clutch associated with the first accelerator pedal is thus also delayed until the vehicle speed is allowable. This way, the accelerator pedal function of the clutch pedal is passive as long as the vehicle speed exceeds the predetermined speed limit. Thus, if the efficient manoeuvring function has been requested and the clutch pedal is depressed when the vehicle speed exceeds the predetermined speed limit by means of the first accelerator pedal, the vehicle will not change driving direction until the vehicle speed is below the predetermined speed limit.

According to an embodiment of the invention the control unit is restricted to only be able to engage certain low gears in the gearbox when the clutch pedal constitutes a second accelerator pedal. The control unit is preferably restricted to be able to engage a first, second and third gear. This way it is ensured that the vehicle speed is kept suitably low and that the efficient manoeuvring function, with the clutch pedal constituting a second accelerator pedal, only is available at safe vehicle speeds.

According to an embodiment of the invention a method to control a vehicle system for enabling efficient manoeuvring of a vehicle is provided. The vehicle system comprises a dual clutch device arranged between an internal combustion engine and a gearbox in a powertrain; a first accelerator pedal and a clutch pedal, wherein the dual clutch device comprises a first clutch connected to a first gear set in the gearbox and a second clutch connected to a second gear set in the gearbox, wherein an electronic control unit is adapted to control the dual clutch device based on the operation of the clutch pedal in a manual mode and based on the operating state of the vehicle in an automatic

mode. The method comprises the steps to a) identify a request for activation of an efficient manoeuvring function; b) ensure that a reverse gear connected to the first clutch, and a forward gear connected to the second clutch are engaged; and c) enable the clutch pedal to constitute a second accelerator
5 pedal by controlling the first clutch based on the operation of one of the accelerator pedals and the second clutch based on the operation of the other accelerator pedal.

The control unit suitably identifies a request for activation from a manual
10 activation means in step a). The manual request for activation is suitably provided by the operator of the vehicle or any other person inside the vehicle. The activation means could be a lever, button, switch or similar. The activation means may alternatively be a setting in a menu on a display. The efficient manoeuvring function, where the clutch pedal constitutes a second accelerator
15 pedal, may thus be activated manually. The efficient manoeuvring function may also be inactivated manually. The disabling of the clutch pedal to constitute a second accelerator pedal may thus be performed after receiving a manual request for inactivation. The request for inactivation is suitably provided by operation of an inactivation means or by resetting the activation
20 means.

In method step b) the control unit controls the gearbox such that a reverse gear connected to the first clutch is engaged and a forward gear connected to the second clutch is engaged. This way, when the first clutch is engaged the
25 vehicle is reversing and when the second clutch is engaged the vehicle is driving forwards. It is to be understood that the control unit just as well could control the gearbox such that a forward gear connected to the first clutch is engaged and such that a reverse gear connected to the second clutch is engaged. The control unit thus controls the gearbox such that a reverse gear is
30 engaged and a forward gear is engaged, wherein the forward gear and the reverse gear are connected to different clutches.

The control unit preferably controls the first clutch based on the operation of the second accelerator pedal and the second clutch based on the first accelerator pedal in step c). This way, the clutch pedal constituting the second accelerator pedal is connected to the reverse gear through the first clutch.

- 5 When the second accelerator pedal is depressed, the control unit controls the first clutch such that it is engaged, whereby the torque from the internal combustion engine is transferred through the first clutch to the engaged reverse gear, to the output shaft of the gearbox and on to the driving wheels. By depressing the second accelerator pedal, the vehicle is thus reversing.
- 10 When the second accelerator is no longer depressed, the control unit controls the first clutch such that it is disengaged. When the first accelerator pedal is depressed, the control unit controls the second clutch such that it is engaged, whereby the torque from the internal combustion engine is transferred through the second clutch to the engaged forward gear, to the output shaft of the
- 15 gearbox and on to the driving wheels. By depressing the first accelerator pedal, the vehicle is thus moving forwards. When the first accelerator is no longer depressed, the control unit controls the second clutch such that it is disengaged.
- 20 If the first accelerator pedal and the second accelerator pedal are operated simultaneously, the control unit controls the dual clutch device in step c) based on the accelerator pedal which was the latest to be depressed. This means that if the first accelerator pedal is depressed first, the control unit controls the clutch associated with the first accelerator pedal to be engaged. If the second
- 25 accelerator pedal is depressed while the first accelerator pedal is still depressed, the control unit controls the clutch associated with the first accelerator pedal to be disengaged and simultaneously controls the clutch associated with the second accelerator pedal to be engaged. Thus, the control unit is adapted to engage the clutch associated with the accelerator pedal
- 30 which is the latest to be depressed and to disengage the other clutch. Alternatively, the control unit controls the dual clutch device in step c) based on the accelerator pedal which was the first to be depressed. This means that

if the first accelerator pedal is depressed first, the control unit controls the clutch associated with the first accelerator pedal to be engaged. If the second accelerator pedal is depressed while the first accelerator pedal is still depressed, the clutch associated with the first accelerator pedal is maintained engaged.

If the first accelerator pedal and the second accelerator pedal are depressed exactly at the same time, or substantially the same time, the control unit controls the dual clutch device such that both clutches are disengaged and the vehicle thus stands still in step c). The control unit suitably controls the dual clutch device such that both clutches are disengaged if the first and the second accelerator pedals are depressed within a specific time limit. The specific time limit may be within an interval between 0-5 seconds. Suitably, the control unit controls the dual clutch device such that both clutches are disengaged if the first and the second accelerator pedals are depressed with 0-1 seconds in-between.

According to an embodiment of the invention the method comprises the step a1) to, after step a) and prior to step b), determine if a predetermined activation criterion is fulfilled. If the predetermined activation criterion is fulfilled, activation of the efficient manoeuvring function as requested for in step a) is allowed and the method steps b) and c) are performed. If the predetermined activation criterion is not fulfilled, activation of the efficient manoeuvring function as requested for in step a) is not allowed and the method steps b) and c) are not performed. The predetermined activation criterion may be that the vehicle is at standstill. Alternatively the predetermined activation criterion is that the current vehicle speed is below 10 km/h, 20 km/h or 30 km/h. The predetermined activation criterion may be that the clutch pedal currently is not depressed. Alternatively, the predetermined activation criterion is that a low gear is engaged in the gearbox.

- Step c) may include to continuously determining if the vehicle speed exceeds a predetermined speed limit while the clutch associated with the first accelerator pedal is engaged, and if so, disabling the clutch pedal to constitute a second accelerator pedal. The efficient manoeuvring function is thus inactivated if the vehicle speed exceeds a predetermined speed limit while the clutch associated with the first accelerator pedal is engaged and the method step c) is terminated. The predetermined speed limit may be between 20- 40 or 40-60 km/h.
- Step c) may include to continuously determining if the vehicle speed exceeds a predetermined speed limit while one of the accelerator pedals is depressed, and if so, delay the engagement of the clutch associated with the other accelerator pedal if said other accelerator pedal is depressed, until the vehicle speed is below the predetermined speed limit. The disengagement of the clutch associated with the accelerator pedal which was depressed first is obviously also delayed until the vehicle speed is below the predetermined speed limit. This way, if the clutch associated with the second accelerator pedal (clutch pedal) is engaged and the vehicle is driven in a forward direction or a reverse direction by means of the second accelerator pedal with a vehicle speed exceeding the predetermined speed limit, the clutch associated with the first accelerator pedal will not be engaged if the first accelerator pedal is depressed, until the vehicle speed is below the predetermined speed limit. This way, sudden changes of driving direction are avoided at unsuitable vehicle speeds. The predetermined speed limit may be between 20- 40 or 40-60 km/h.
- Step c) may further include to continuously determining if the clutch associated with the first accelerator pedal is engaged and if the vehicle speed exceeds a predetermined speed limit, and if so, delaying the accelerator pedal function of the clutch pedal if the clutch pedal is depressed. The accelerator pedal function of the clutch pedal is suitably delayed until the vehicle speed is below the predetermined speed limit. The control unit does thus not engage the clutch associated with the clutch pedal until the vehicle speed has decreased

- below the predetermined speed limit if the clutch pedal is depressed while the clutch associated with the first accelerator pedal is engaged and the vehicle speed exceeds a predetermined speed limit. The engagement of the clutch associated with the clutch pedal and the disengagement of the clutch
- 5 associated with the first accelerator pedal is thus delayed until the vehicle speed is allowable. This way, the accelerator pedal function of the clutch pedal is passive as long as the vehicle speed exceeds the predetermined speed limit.
- 10 According to an embodiment of the invention only certain low gears are allowed to be engaged as long as the efficient manoeuvring function is activated and the clutch pedal is enabled to constitute a second accelerator pedal. Preferably a first, second and third gear are allowed.
- 15 According to an aspect of the invention, a computer program is provided, wherein said computer program comprises program code for causing an electronic control unit or a computer connected to the electronic control unit to perform the steps according to the herein mentioned method.
- 20 According to an aspect of the invention a computer program product is provided, comprising a program code stored on a computer-readable medium for performing the method steps according to the herein mentioned method, when said computer program is run on an electronic control unit or a computer connected to the electronic control unit.
- 25 Further objects, advantages and novel features of the present invention will become apparent to one skilled in the art from the following details, and also by putting the invention into practice. Whereas the invention is described below, it should be noted that it is not restricted to the specific details
- 30 described. Specialists having access to the teachings herein will recognise further applications, modifications and incorporations within other fields, which are within the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

5

For fuller understanding of the present invention and further objects and advantages of it, the detailed description set out below should be read together with the accompanying drawings, in which the same reference notations denote similar items in the various diagrams, and in which:

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Figure 1 schematically illustrates a vehicle according to an embodiment of the invention;

Figure 2 schematically illustrates a vehicle system of a vehicle according to an embodiment of the invention;

15 Figure 3a illustrates a flow chart for a method according to an embodiment of the invention;

Figure 3b illustrates a flow chart for a method according to an embodiment of the invention;

Figure 4 schematically illustrates a control unit or computer according to an
20 embodiment of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

25 Figure 1 schematically shows a side view of a vehicle 1 according to an embodiment of the invention. The vehicle 1 comprises a vehicle system 5 with a dual clutch device 4 (not shown) arranged in a powertrain 3 between an internal combustion engine 2 and a gearbox 6. The dual clutch device 4 is connected to the internal combustion engine 2 and the gearbox 6. The
30 gearbox 6 is also connected to the driving wheels 8 of the vehicle 1 through an output shaft 16 of the gearbox 6. The vehicle 1 may be a heavy vehicle, e.g. a truck or a bus. The vehicle 1 may alternatively be a passenger car.

Figure 2 schematically shows a vehicle system 5 for a vehicle 1 according to an embodiment of the invention. The vehicle system 5 comprises a dual clutch device 4 arranged in a powertrain 3 between an internal combustion engine 2 and a gearbox 6. The gearbox 6 comprises an output shaft 16 which is connected to the driving wheels 8 of the vehicle 1. Only two driving wheels 8 are illustrated in Fig. 2, however, any number of driving wheels 8 may be driven by the powertrain 3 within the scope of the invention. The dual clutch device 4 comprises a first clutch 4' connected to a first gear set (not shown) in the gearbox 6 and a second clutch 4'' connected to a second gear set (not shown) in the gearbox 6. The first clutch 4' and the second clutch 4'' may be friction clutches. The first clutch 4' is connected to the first gear set through a first input shaft 15' of the gearbox 6 and the second clutch 4'' is connected to the second gear set through a second input shaft 15'' of the gearbox 6. One gear of the first gear set and one gear of the second gear set may thereby be engaged simultaneously and gear shifting may be performed by controlling which clutch 4', 4'' to be engaged. This way, shifting of gears may be performed without torque interruption on the driving wheels 8. Each clutch 4', 4'' is connected to the flywheel (not shown) and thus the crankshaft 13 of the internal combustion engine 2. The first and the second clutch 4', 4'' of the dual clutch device 4 may be arranged concentrically along the same centre line as the crankshaft 13 of the internal combustion engine 2. In this case, the first input shaft 15' extends inside a through hole of the second input shaft 15''. Alternatively, the first and the second clutch 4', 4'' are arranged in parallel. The vehicle system 5 further comprises a clutch pedal 10 and a first accelerator pedal 12 arranged inside the vehicle 1 in connection with the operator of the vehicle 1. The vehicle system 5 also comprises a brake pedal (not shown) connected to wheel brakes (not shown) for decelerating the vehicle.

30 An electronic control unit 20 is arranged in communication with the internal combustion engine 2, the dual clutch device 4 and the gearbox 6. The control unit 20 may constitute a system of a plurality of control units 20 arranged in

communication with the internal combustion engine 2, the dual clutch device 4 and the gearbox 6. The control unit 20 is adapted to control the internal combustion engine 2, the dual clutch device 4 and the gearbox 6. A computer 22 may be connected to the control unit 20. The control unit 20 is adapted to control the dual clutch device 4, and thus the clutches 4' 4'', based on the operation of the clutch pedal 10 when the vehicle 1 is operated in a manual mode. The vehicle system 5 typically comprises at least one clutch actuator (not shown) which is adapted to affect the degree of engagement of the first and the second clutch 4', 4'' respectively, wherein the control unit 20 is adapted to control the clutch actuator based on the operation of the clutch pedal 10. A position sensor (not shown) may be arranged in connection with the clutch pedal 10, wherein the control unit 20 is adapted to control the dual clutch device 4 based on the position of the clutch pedal 10. The control unit 20 is further adapted to control the dual clutch device 4 based on the operating state of the vehicle 1 when the vehicle 1 is operated in an automatic mode. In the automatic mode the clutch pedal 10 is thus redundant and the dual clutch device 4 is automatically controlled based on factors such as vehicle speed, requested driving torque, requested brake effect etc. This way, gear shifting is performed without the clutch pedal 10. The vehicle system 5 thus constitutes a clutch-by-wire system.

The clutch pedal 10 is adapted to be able to constitute a second accelerator pedal 10, such that the vehicle system 5 comprises two accelerator pedals 10, 12. In order to enable the clutch pedal 10 to constitute a second accelerator pedal, the control unit 20 is adapted to control the gearbox 6 such that a reverse gear and a forward gear are engaged and to control the first clutch 4' based on the operation of one of the accelerator pedals 10, 12 and the second clutch 4'' based on the operation of the other accelerator pedal 10, 12. This way, one of the accelerator pedals 10, 12 controls forward driving of the vehicle 1 and the other accelerator pedal 10, 12 controls reversing of the vehicle 1.

Figure 3a shows a flowchart for a method to control a vehicle system 5 for enabling efficient manoeuvring of a vehicle 1 according to an embodiment of the invention. The vehicle system 5 is preferably configured as described in Fig. 2 and comprises a dual clutch device 4 arranged between an internal combustion engine 2 and a gearbox 6 in a powertrain 3; a first accelerator pedal 12 and a clutch pedal 10, wherein the dual clutch device 4 comprises a first clutch 4' connected to a first gear set in the gearbox 6 and a second clutch 4'' connected to a second gear set in the gearbox 6, wherein an electronic control unit 20 is adapted to control the dual clutch device 4 based on the operation of the clutch pedal 10 in a manual mode and based on the operating state of the vehicle 1 in an automatic mode. The method comprises the steps to:

- a) identify a request for activation of an efficient manoeuvring function;
- b) ensure that a reverse gear connected to the first clutch 4', and a forward gear connected to the second clutch 4'' are engaged; and
- c) enable the clutch pedal 10 to constitute a second accelerator pedal by controlling the first clutch 4' based on the operation of one of the accelerator pedals 10, 12 and the second clutch 4'' based on the operation of the other accelerator pedal 10, 12.

20

The method steps are preferably performed in chronologic order from a) to c).

The step c) preferably includes to control the internal combustion engine 2 based on the operation of the two accelerator pedals 10, 12. By enabling the clutch pedal 10 to function as a second accelerator pedal, one of the accelerator pedals 10, 12 may drive the vehicle 1 forwards and the other may reverse the vehicle 1. This way, manual operation of a gear shifting means is avoided and an efficient manoeuvring of the vehicle 1 is achieved.

The control unit 20 suitably identifies the request for activation from a manual activation means in step a). The request for activation is suitably provided by the operator of the vehicle 1, or any other person inside the vehicle, by manual

operation of the activation means. The activation means could be a lever, button, switch or similar. The efficient manoeuvring function, where the clutch pedal 10 constitutes a second accelerator pedal, may thus be activated manually. The control unit 20 identifies the request for activation of efficient
5 manoeuvring by receiving a signal from the activation means.

The efficient manoeuvring function may also be inactivated manually. The disabling of the clutch pedal 10 to constitute a second accelerator pedal may thus be performed after receiving a manual request for inactivation. The
10 request for inactivation is suitably provided by operation of an inactivation means or by resetting the activation means used for activating the efficient manoeuvring function.

In method step b) the control unit 20 controls the gearbox 6 such that a
15 reverse gear connected to the first clutch 4' is engaged and a forward gear connected to the second clutch 4' is engaged. This way, when the first clutch 4' is engaged the vehicle 1 is reversing and when the second clutch 4' is engaged the vehicle 1 is driving forwards.

20 The control unit 20 preferably controls the first clutch 4' based on the operation of the second accelerator pedal 10 and the second clutch 4'' based on the first accelerator pedal 12 in step c). This way, the clutch pedal 10 constituting the second accelerator pedal 10 is connected to the reverse gear through the first clutch 4'. When the second accelerator pedal 10 is depressed, the control unit
25 20 controls the first clutch 4' such that it is engaged, whereby the torque from the internal combustion engine 2 is transferred through the first clutch 4' to the engaged reverse gear, to the output shaft 16 of the gearbox 6 and on to the driving wheels 8. By depressing the second accelerator pedal 10, the vehicle 1 is thus reversing. When the second accelerator 10 is no longer depressed, the
30 control unit 20 controls the first clutch 4' such that it is disengaged. When the first accelerator pedal 12 is depressed, the control unit 20 controls the second clutch 4'' such that it is engaged, whereby the torque from the internal

combustion engine 2 is transferred through the second clutch 4'' to the engaged forward gear, to the output shaft 16 of the gearbox 6 and on to the driving wheels 8. By depressing the first accelerator pedal 12, the vehicle 1 is thus moving forwards. When the first accelerator 12 is no longer depressed, 5 the control unit 20 controls the second clutch 4'' such that is disengaged.

If the first accelerator pedal 12 and the second accelerator pedal 10 are operated simultaneously, the control unit 20 controls the dual clutch device 4 in step c) based on the accelerator pedal 10, 12 which was the latest to be 10 depressed. This means that if the first accelerator pedal 12 is depressed first, the control unit 20 controls the clutch 4', 4'' associated with the first accelerator pedal 12 to be engaged. If the second accelerator pedal 10 is depressed while the first accelerator pedal 12 is still depressed, the control unit 20 controls the clutch 4', 4'' associated with the first accelerator pedal 12 to be disengaged 15 and simultaneously controls the clutch 4', 4'' associated with the second accelerator pedal 10 to be engaged. Thus, the control unit 20 is adapted to engage the clutch 4', 4'' associated with the accelerator pedal 10, 12 which is the latest to be depressed and to disengage the other clutch 4', 4''. This way, one of the accelerator pedals 10, 12 may be kept depressed continuously and 20 the other accelerator pedal 10, 12 may be temporarily depressed to control the change of direction of the vehicle 1. For example, the accelerator pedal 10, 12 associated with the forward gear may be depressed continuously. When the operator depresses the accelerator pedal 10, 12 associated with the reverse gear the control unit 20 controls the clutch 4', 4'' connected to the forward gear 25 to disengage and the clutch 4', 4'' connected to the reverse gear to engage and the vehicle 1 is driven backwards. When the operator releases the accelerator pedal 10, 12 associated with the reverse gear, only the accelerator pedal 10, 12 associated with the forward gear is depressed and the control unit 20 thus controls the clutch 4', 4'' connected to the reverse gear to disengage 30 and the clutch 4', 4'' connected to the forward gear to engage. The vehicle 1 is then driven forwards again.

If the first accelerator pedal 12 and the second accelerator pedal 10 are depressed exactly at the same time, or substantially the same time, the control unit 20 controls the dual clutch device 4 in step c) such that both clutches 4', 4'' are disengaged and the vehicle 1 thus stands still. The control unit 20
5 suitably controls the dual clutch device 4 in step c) such that both clutches 4', 4'' are disengaged if the first and the second accelerator pedals 12, 10 are depressed with 0-1 seconds in-between.

Step c) may include to continuously determining if the vehicle speed exceeds a
10 predetermined speed limit while the clutch associated with the first accelerator pedal is engaged, and if so, disabling the clutch pedal 10 to constitute a second accelerator pedal. The efficient manoeuvring function is thus inactivated if the clutch associated with the first accelerator pedal is engaged and if the vehicle speed exceeds a predetermined speed limit and the method
15 step c) is terminated. Information regarding the inactivation may be presented to the operator. The predetermined speed limit may be between 20-40 or 40-60 km/h.

Step c) may include to continuously determining if the vehicle speed exceeds a
20 predetermined speed limit while one of the accelerator pedals 10, 12 is depressed, and if so, delay the engagement of the clutch 4', 4'' associated with the other accelerator pedal 10, 12 if said other accelerator pedal 10, 12 is depressed, until the vehicle speed is below the predetermined speed limit. The disengagement of the clutch 4', 4'' associated with the accelerator pedal which
25 was the first to be depressed 10, 12 is obviously also delayed until the vehicle speed is below the predetermined speed limit. This way, if the clutch 4', 4'' associated with the second accelerator pedal 10 is engaged and the vehicle 1 is driven in a forward direction or a reverse direction by means of the second accelerator pedal 10 with a vehicle speed exceeding the predetermined speed
30 limit, the clutch 4', 4'' associated with the first accelerator pedal 12 will not be engaged if the first accelerator pedal 12 is depressed, until the vehicle speed is below the predetermined speed limit. The predetermined speed limit may be

between 20-40 or 40-60 km/h. This way, sudden changes of driving direction are avoided at unsuitable vehicle speeds.

Step c) may include to continuously determining if the clutch 4', 4'' associated
5 with the first accelerator pedal 12 is engaged and if the vehicle speed exceeds
a predetermined speed limit, and if so, delaying the accelerator pedal function
of the clutch pedal 10 if the clutch pedal 10 is depressed. The accelerator
pedal function of the clutch pedal 10 is suitably delayed until the vehicle speed
is below the predetermined speed limit. The control unit 20 does thus not
10 engage the clutch 4', 4'' associated with the clutch pedal 10 until the vehicle
speed has decreased below the predetermined speed limit if the clutch pedal
10 is depressed while the clutch 4', 4'' associated with the first accelerator
pedal 12 is engaged and the vehicle speed exceeds a predetermined speed
limit. The engagement of the clutch 4', 4'' associated with the clutch pedal 10
15 and the disengagement of the clutch 4', 4'' associated with the first accelerator
pedal 12 is thus delayed until the vehicle speed is allowable. The
predetermined speed limit may be between 20-40 or 40-60 km/h.

The method step c) is suitably performed continuously until manual inactivation
20 of the efficient manoeuvring function or until the vehicle speed exceeds a
predetermined speed limit.

According to an embodiment of the invention only certain low gears are
allowed to be engaged as long as the efficient manoeuvring function is
25 activated and the clutch pedal 10 is enabled to constitute a second accelerator
pedal. Preferably a first, second and third gear are allowed. Information
regarding this gear restriction may be presented to the operator at the
activation of the efficient manoeuvring function.

30 Figure 3b shows a flowchart for a method to control a vehicle system 5 for
enabling efficient manoeuvring of a vehicle 1 according to an embodiment of

the invention. The method comprises the steps according to the method described in Fig. 3a with the further step to, after step a) and prior to step b):
a1) determine if a predetermined activation criterion is fulfilled.

- 5 If the predetermined activation criterion is fulfilled activation of the efficient manoeuvring function as requested for in step a) is allowed and the method steps b) and c) are performed. If the predetermined activation criterion is not fulfilled, activation of the efficient manoeuvring function is not allowed and the method steps b) and c) are not performed. The predetermined activation
10 criterion may be that the vehicle 1 is at standstill. Alternatively the predetermined activation criterion is that the current vehicle speed is below 10 km/h, 20 km/h or 30 km/h. The predetermined activation criterion may be that the clutch pedal 10 currently is not depressed. Alternatively, the predetermined activation criterion is that a low gear is engaged in the gearbox 6.

15 In the case where the activation criterion is not fulfilled and the method steps b) and c) are not performed, the control unit 20 preferably provides information to the operator that the request for activation was not allowed. The information may be presented on a display or it may be presented audibly.

20 If the predetermined activation criterion is unfulfilled at a first stage but is fulfilled at a later stage, and the request for activation is still valid, the request for activation is allowed and the method steps b) and c) are performed when the activation criterion is fulfilled.

25 Figure 4 is a diagram of a version of a device 500. The control unit 20 and/or computer 22 described with reference to Fig. 2 and Fig. 3 may in a version comprise the device 500. The term "link" refers herein to a communication link which may be a physical connection such as an optoelectronic communication
30 line, or a non-physical connection such as a wireless connection, e.g. a radio link or microwave link. The device 500 comprises a non-volatile memory 520, a data processing unit 510 and a read/write memory 550. The non-volatile

memory 520 has a first memory element 530 in which a computer program, e.g. an operating system, is stored for controlling the function of the device 500. The device 500 further comprises a bus controller, a serial communication port, I/O means, an A/D converter, a time and date input and transfer unit, an
5 event counter and an interruption controller (not depicted). The non-volatile memory 520 has also a second memory element 540.

There is provided a computer program P which comprises routines for a method to control a vehicle system 5 for enabling efficient manoeuvring of a
10 vehicle 1. The computer program P comprises routines for identifying a request for activation of efficient manoeuvring. The computer program P comprises routines for ensuring that a reverse gear connected to the first clutch 4', and a forward gear connected to the second clutch 4'' are engaged. The computer
program P comprises routines for enabling the clutch pedal 10 to constitute a
15 second accelerator pedal and control the first clutch 4' based on the operation of one of the accelerator pedals 10, 12 and the second clutch 4'' based on the operation of the other accelerator pedal 10, 12. The computer program P
comprises routines for determining if a predetermined activation criterion is fulfilled. The computer program P comprises routines for determining if the
20 vehicle speed exceeds a predetermined speed limit. The computer program P comprises routines for providing information to the operator that the request for activation is not allowed. The computer program P comprises routines for providing information to the operator that the request for activation is allowed.
The program P may be stored in an executable form or in a compressed form
25 in a memory 560 and/or in a read/write memory 550.

Where the data processing unit 510 is described as performing a certain function, it means that the data processing unit 510 effects a certain part of the program stored in the memory 560 or a certain part of the program stored in
30 the read/write memory 550.

The data processing device 510 can communicate with a data port 599 via a data bus 515. The non-volatile memory 520 is intended for communication with the data processing unit 510 via a data bus 512. The separate memory 560 is intended to communicate with the data processing unit 510 via a data bus 511.

- 5 The read/write memory 550 is adapted to communicating with the data processing unit 510 via a data bus 514.

When data are received on the data port 599, they are stored temporarily in the second memory element 540. When input data received have been
10 temporarily stored, the data processing unit 510 is prepared to effect code execution as described above.

Parts of the methods herein described may be effected by the device 500 by means of the data processing unit 510 which runs the program stored in the
15 memory 560 or the read/write memory 550. When the device 500 runs the program, methods herein described are executed.

The foregoing description of the preferred embodiments of the present invention is provided for illustrative and descriptive purposes. It is not intended
20 to be exhaustive or to restrict the invention to the variants described. Many modifications and variations will obviously be apparent to one skilled in the art. The embodiments have been chosen and described in order best to explain the principles of the invention and its practical applications and hence make it possible for specialists to understand the invention for various embodiments
25 and with the various modifications appropriate to the intended use.

Claims

1. A vehicle system (5), comprising a dual clutch device (4) arranged between an internal combustion engine (2) and a gearbox (6) in a powertrain (3); a first accelerator pedal (12) and a clutch pedal (10), wherein the dual clutch device (4) comprises a first clutch (4') connected to a first gear set in the gearbox (6) and a second clutch (4'') connected to a second gear set in the gearbox (6), wherein an electronic control unit (20) is adapted to control the dual clutch device (4) based on the operation of the clutch pedal (10) in a manual mode and based on the operating state of the vehicle (1) in an automatic mode,
10 **characterized in that** the clutch pedal (10) is adapted to be able to constitute a second accelerator pedal (10), wherein the control unit (20) is adapted to control the gearbox (6) such that a reverse gear connected to the first clutch (4'), and a forward gear connected to the second clutch (4'') are engaged, and wherein the control unit (20) is adapted to control the first clutch (4') based on
15 the operation of one of the accelerator pedals (10; 12) and the second clutch (4'') based on the operation of the other accelerator pedal (10; 12).
2. A vehicle system according to claim 1, **characterized in that** the control unit (20) is adapted to control the first clutch (4') based on the operation of the
20 clutch pedal (10) constituting the second accelerator pedal (10), and the second clutch (4'') based on the operation of the first accelerator pedal (12).
3. Vehicle system according to claim 1 or 2, **characterized in that** if the first accelerator pedal (12) and the second accelerator pedal (10) are operated
25 simultaneously, the control unit (20) is adapted to control the dual clutch device (4) based on the accelerator pedal (10; 12) which was the latest to be depressed.
4. A vehicle system according to any of the preceding claims, **characterized in**
30 **that** a predetermined activation criterion must be fulfilled in order to be able to enable the clutch pedal (10) to constitute a second accelerator pedal (10).

5. A vehicle system according to claim 4, **characterized in that** the predetermined activation criterion is that the vehicle (1) is at standstill.

6. A vehicle system according to claim 4, **characterized in that** the
5 predetermined activation criterion is that the vehicle speed is below 10 km/h.

7. A vehicle system according to any of claim 4-6, **characterized in that** the predetermined activation criterion is that the clutch pedal (10) is not depressed.

10

8. A vehicle system according to any of the preceding claims, **characterized in that** the control unit (20) is adapted to disable the clutch pedal (10) to constitute a second accelerator pedal (10) when the vehicle speed exceeds a predetermined speed limit while the clutch (4', 4'') associated with the first
15 accelerator pedal (12) is engaged.

9. A vehicle system according to any of the preceding claims, **characterized in that**, when the clutch pedal (10) constitutes a second accelerator pedal (10), the control unit (20) is restricted to only be able to engage certain low gears in
20 the gearbox (6).

10. A method to control a vehicle system (5) for enabling efficient manoeuvring of a vehicle (1), the vehicle system (5) comprising a dual clutch device (4) arranged between an internal combustion engine (2) and a gearbox (6) in a
25 powertrain (3); a first accelerator pedal (12) and a clutch pedal (10), wherein the dual clutch device (4) comprises a first clutch (4') connected to a first gear set in the gearbox (6) and a second clutch (4'') connected to a second gear set in the gearbox (6), wherein an electronic control unit (20) is adapted to control the dual clutch device (4) based on the operation of the clutch pedal (10) in a
30 manual mode and based on the operating state of the vehicle (1) in an automatic mode, **characterized by** the steps to:
a) identify a request for activation of an efficient manoeuvring function;

b) ensure that a reverse gear connected to the first clutch (4'), and a forward gear connected to the second clutch (4'') are engaged; and

c) enable the clutch pedal (10) to constitute a second accelerator pedal by controlling the first clutch (4') based on the operation of one of the accelerator pedals (10; 12) and the second clutch (4'') based on the operation of the other accelerator pedal (10; 12).

11. A method according to claim 10, **characterized in that** in step a) the control unit (20) identifies the request for activation from a manual activation means.

12. A method according to claim 10 or 11, **characterized in that** in step c) the control unit (20) controls the first clutch (4') based on the operation of the second accelerator pedal (10) and the second clutch (4'') based on the first accelerator pedal (12).

13. A method according to any of claims 10-12, **characterized in that** if the first accelerator pedal (12) and the second accelerator pedal (10) are operated simultaneously, the control unit (20) controls the dual clutch device (4) in step c) based on the accelerator pedal (10; 12) which was the latest to be depressed.

14. A method according to any of claims 10-13, **characterized in** the step to, after step a) and prior to step b),
a1) determine if a predetermined activation criterion is fulfilled.

15. A method according to any of claims 10-14, **characterized in that** step c) further includes to continuously determining if the vehicle speed exceeds a predetermined speed limit while the clutch (4', 4'') associated with the first accelerator pedal (12) is engaged, and if so, disabling the clutch pedal (10) to constitute a second accelerator pedal.

16. A method according to any of claims 10-14, **characterized in that** step c) further includes to continuously determining if the vehicle speed exceeds a predetermined speed limit while one of the accelerator pedals (10, 12) is depressed, and if so, delay the engagement of the clutch (4', 4'') associated
5 with the other accelerator pedal (10, 12) if said other accelerator pedal (10, 12) is depressed, until the vehicle speed is below the predetermined speed limit.

17. A vehicle (1), **characterized by** a vehicle system (5) according to any of the claims 1-9.

10

18. A computer program (P), wherein said computer program comprises program code for causing an electronic control unit (20; 500) or a computer (22; 500) connected to the electronic control unit (20; 500) to perform the steps according to any of the claims 10-16.

15

19. A computer program product comprising a program code stored on a computer-readable medium for performing the method steps according to any of claims 10-16, when said computer program is run on an electronic control unit (20; 500) or a computer (22; 500) connected to the electronic control unit
20 (20; 500).

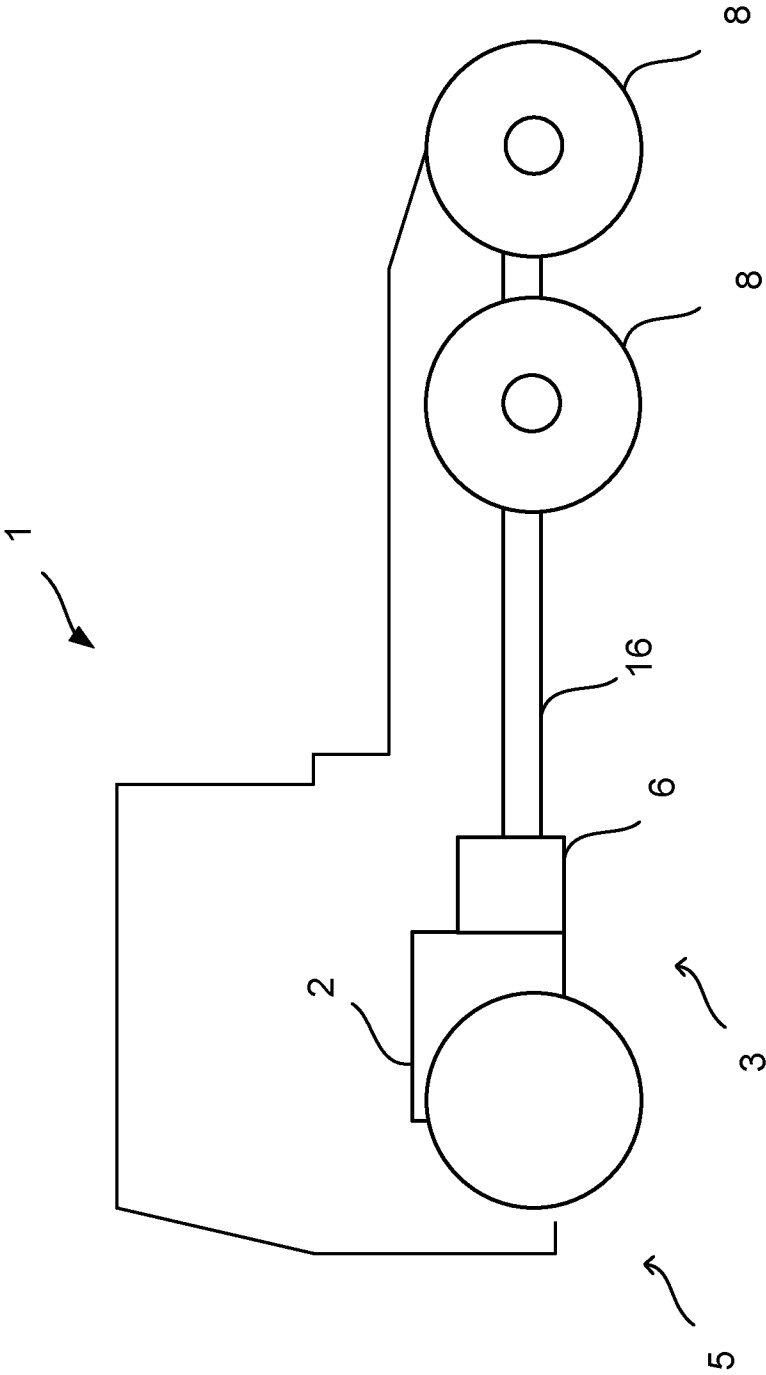


Fig. 1

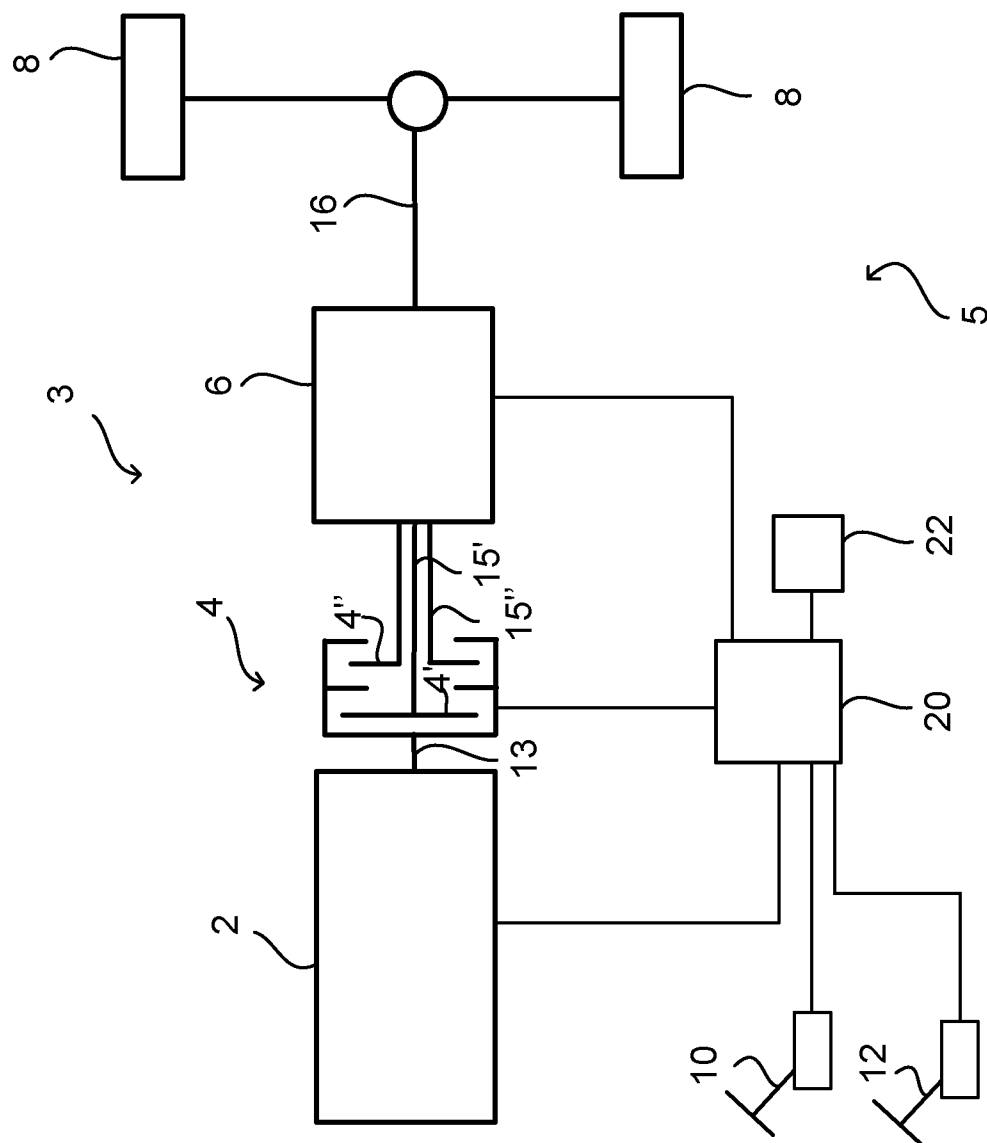


Fig. 2

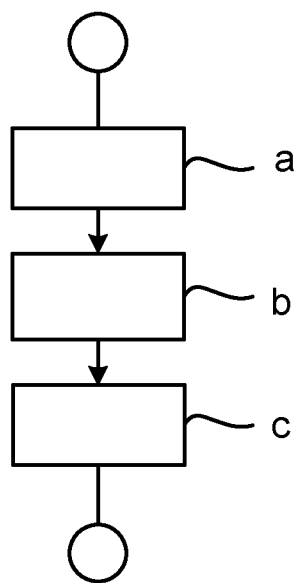


Fig. 3a

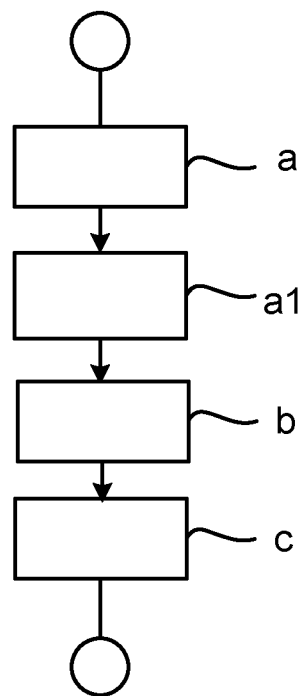


Fig. 3b

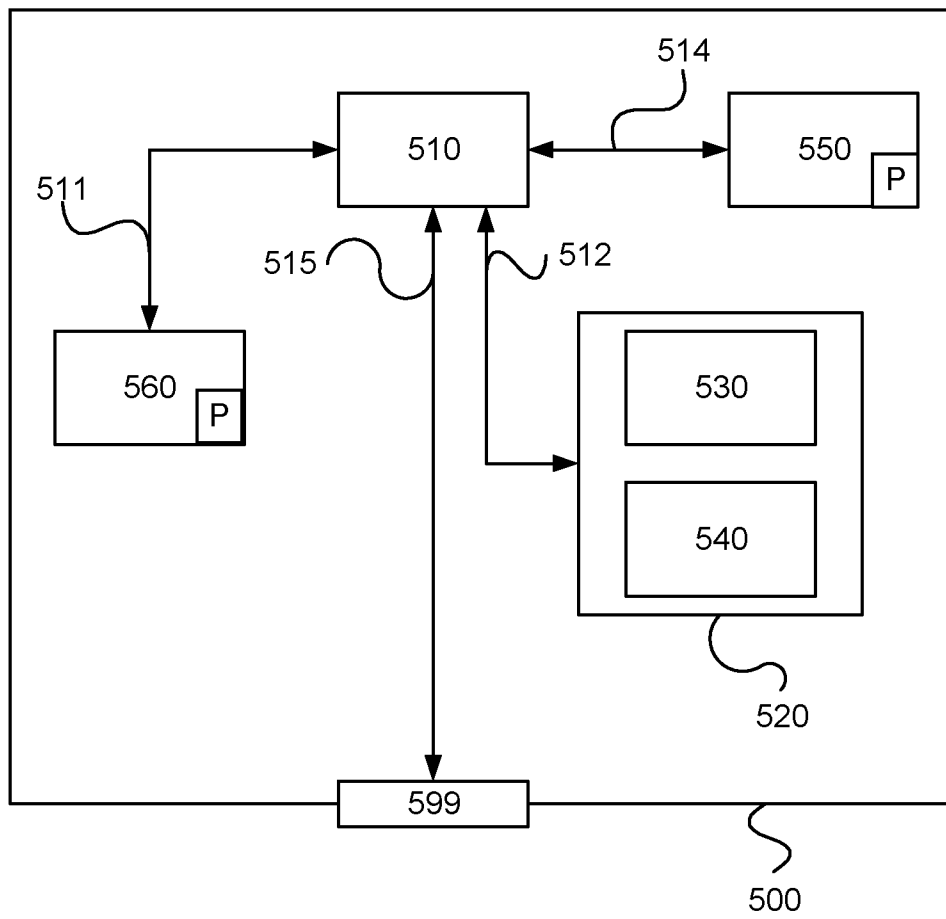


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2016/050226

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: A01D, B60K, B60W, E02F, F16D, F16H

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 10109662 A1 (VOLKSWAGEN AG), 5 September 2002 (2002-09-05); abstract; paragraphs [0001]-[0013], [0017]-[0018], [0026]-[0027]; figure 1; claims 1,15,16 --	1-19
A	US 4680983 A1 (BROWN DAVID J), 21 July 1987 (1987-07-21); abstract; column 1, line 21 - column 2, line 2; column 3, line 24 - column 4, line 32; figure 1 --	1-19
A	US 20070051196 A1 (BALDWIN REID A), 8 March 2007 (2007-03-08); abstract; paragraphs [0014], [0027], [0058]-[0061]; claim 1 --	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

19-05-2016

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20-05-2016

Name and mailing address of the ISA/SE
Patent- och registreringsverket
Box 5055
S-102 42 STOCKHOLM
Facsimile No. + 46 8 666 02 86

Authorized officer

Astrid Hagqvist

Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2016/050226

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20090045026 A1 (ISHII NORIHIRO ET AL), 19 February 2009 (2009-02-19); abstract; paragraphs [0007]-[0008], [0109]; claim 1 -- -----	1-19

Continuation of: second sheet

International Patent Classification (IPC)

F16H 61/688 (2006.01)

B60W 30/18 (2012.01)

B60W 10/113 (2012.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2016/050226

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