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(71) Applicant(s):
Ford Global Technologies, LLC
(Incorporated in USA - Delaware)
Suite 800, Fairlane Plaza South,
330 Town Center Drive, Dearborn 48126, Michigan,
United States of America

(72) Inventor(s):
Themi Philemon Petridis
Ian Halleron
David Hesketh
Urs Christen

(74) Agent and/or Address for Service:
Ford of Europe
Room 1/445, Eagle Way, Warley, Brentwood, Essex,
CM13 3BW, United Kingdom

(54) Title of the Invention: **A method of controlling the stopping and starting of an engine**
Abstract Title: **Controlling the in-gear stopping and starting of an engine of a motor vehicle**

(57) A method of controlling the stopping and starting of an engine of a motor vehicle 1 having a manual transmission while a transmission of the motor vehicle remains in gear is disclosed in which a set of predefined conditions that have to be met are based upon the respective states of a clutch pedal and brake pedal in a preceding primary engine stopped state. There are at least two primary engine stopped states 110, 140 from which the engine can be directly started and at least two secondary stopped states 130, 160 from which starting of the engine is not directly possible. The method adapts the conditions required to start the engine based upon how a driver of the motor vehicle manipulates the clutch and brake pedals while the engine is stopped. In a modification of the method the engine is not started until an accelerator pedal state is determined to be pressed thereby further reducing the amount of fuel inefficiently used by the motor vehicle.

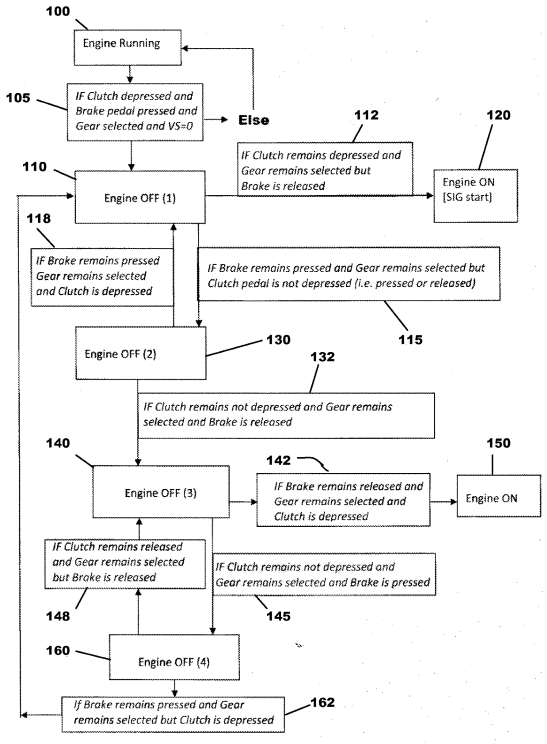

Fig.3a

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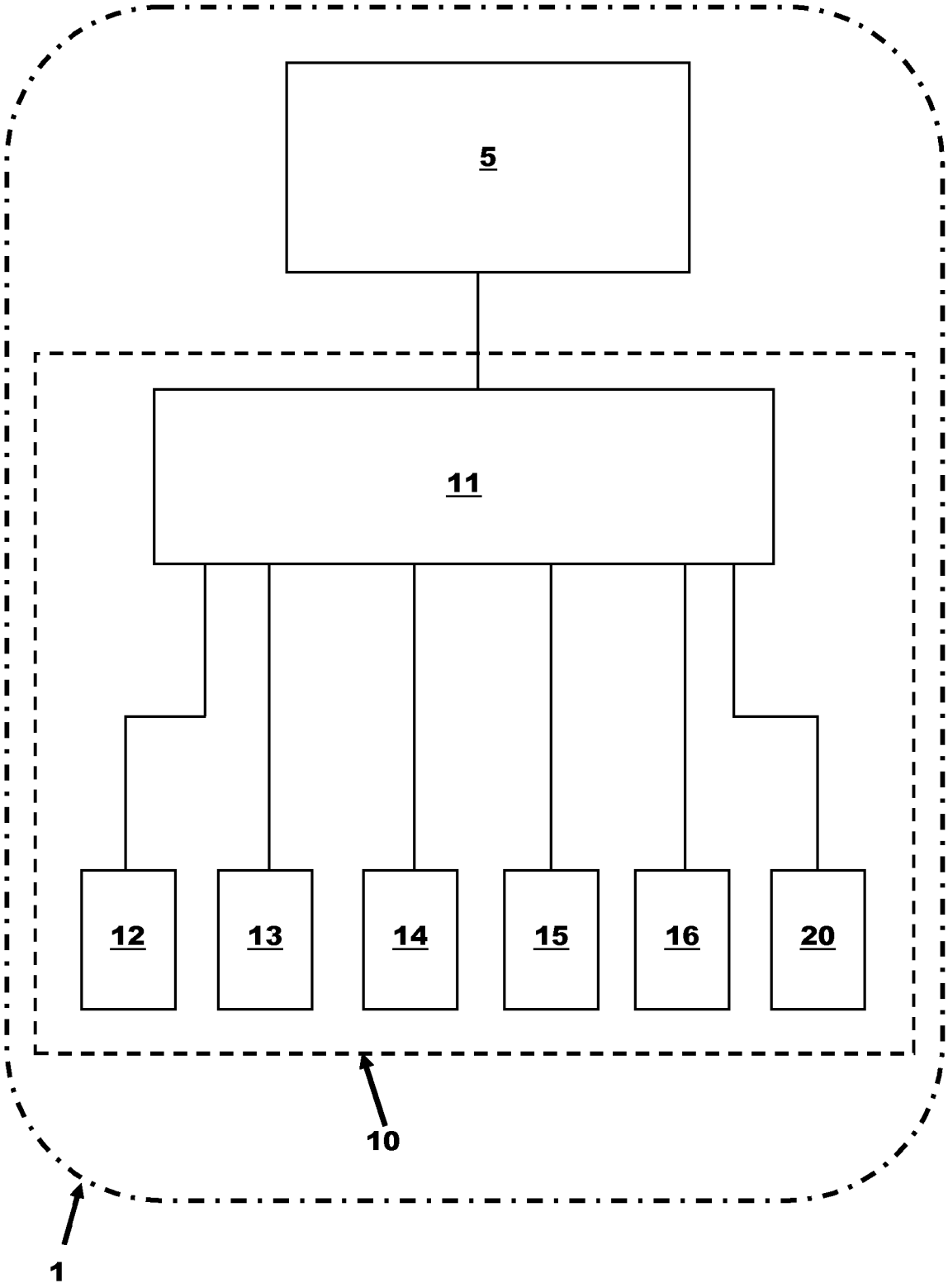

Fig.1

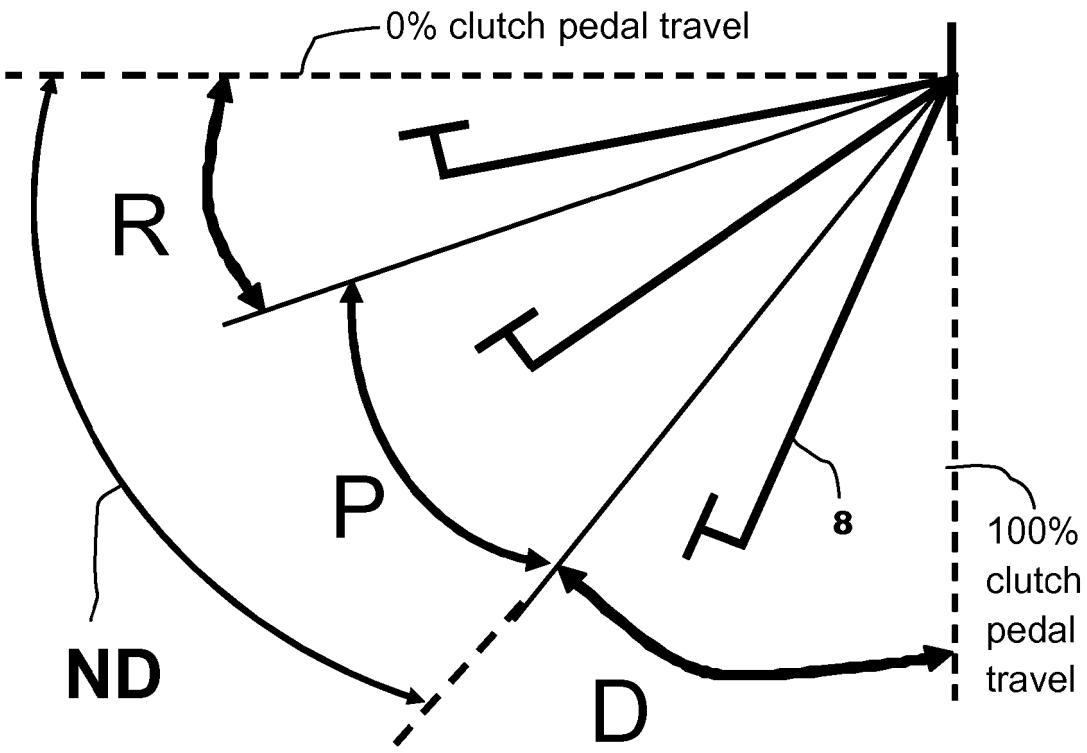

Fig.2

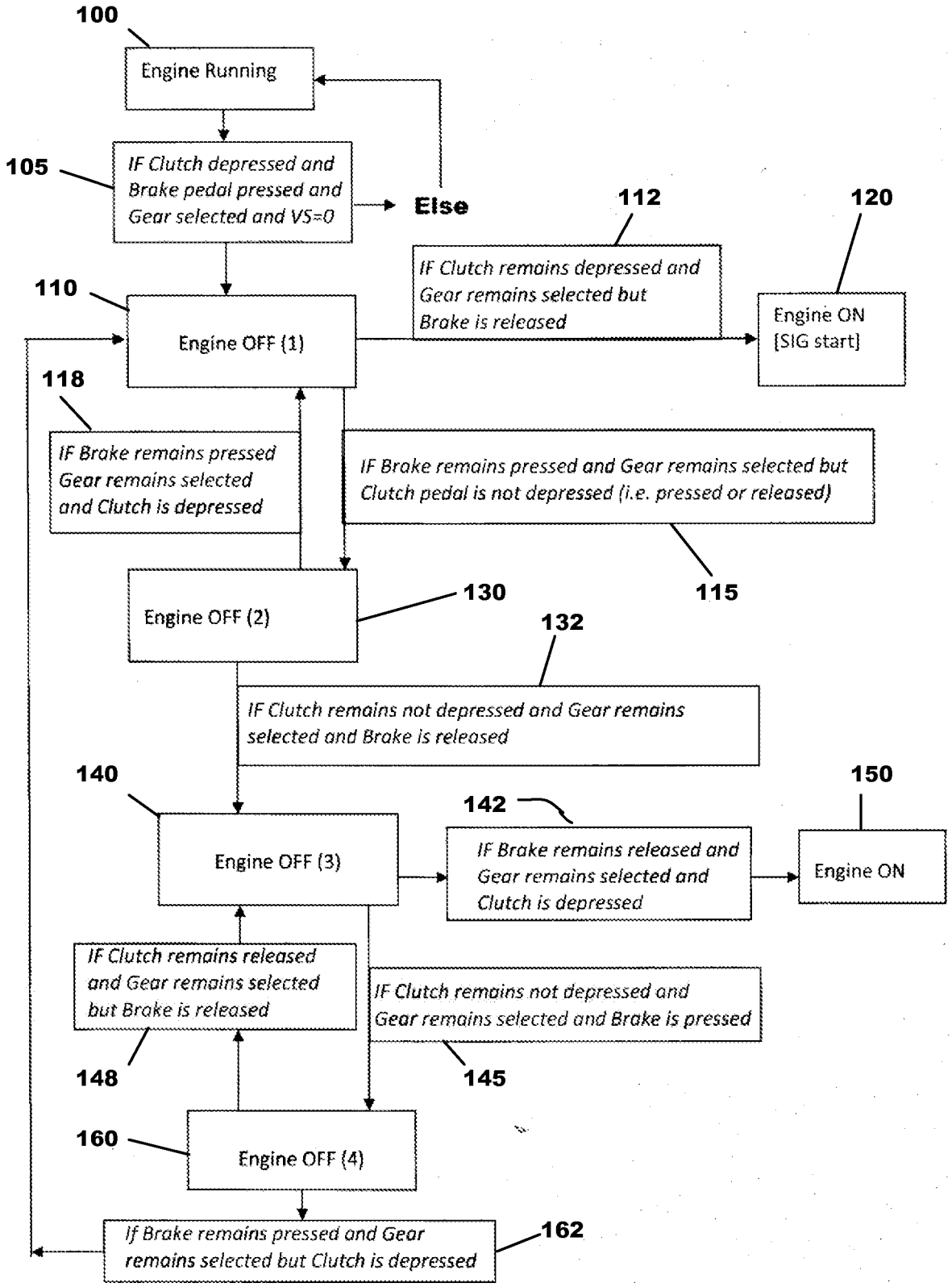
100
Engine Running
105
IF Clutch depressed and Brake pedal pressed and Gear selected and VS=0
Else
112
IF Clutch remains depressed and Gear remains selected but Brake is released
120
Engine ON [SIG start]
110
Engine OFF (1)
118
IF Brake remains pressed Gear remains selected and Clutch is depressed
IF Brake remains pressed and Gear remains selected but Clutch pedal is not depressed (i.e. pressed or released)
115
Engine OFF (2)
130
132
IF Clutch remains not depressed and Gear remains selected and Brake is released
140
Engine OFF (3)
142
IF Brake remains released and Gear remains selected and Clutch is depressed
150
Engine ON
IF Clutch remains released and Gear remains selected but Brake is released
148
IF Clutch remains not depressed and Gear remains selected and Brake is pressed
145
160
Engine OFF (4)
If Brake remains pressed and Gear remains selected but Clutch is depressed
162

Fig.3a

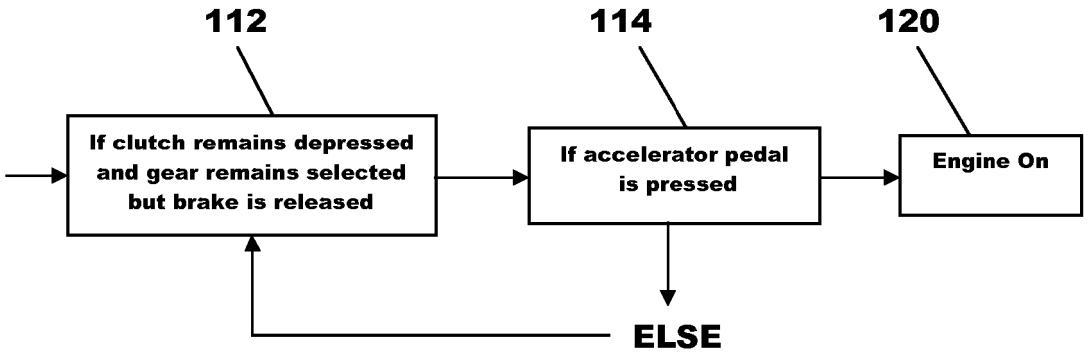
112
114
120
If clutch remains depressed and gear remains selected but brake is released
If accelerator pedal is pressed
Engine On
ELSE

Fig.3b

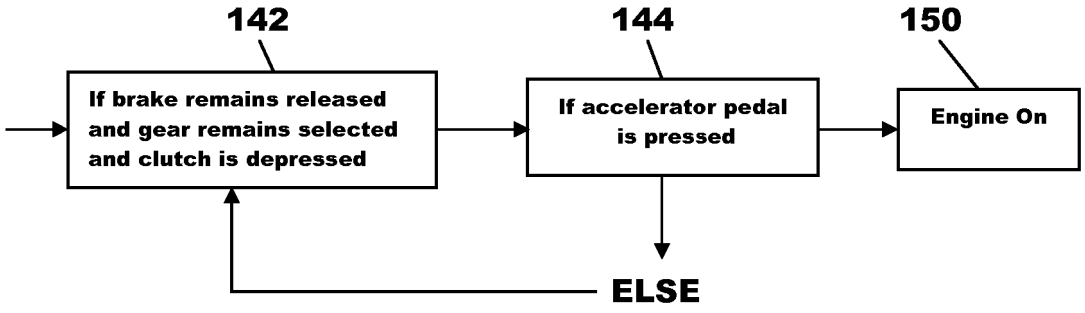
142
144
150
If brake remains released and gear remains selected and clutch is depressed
If accelerator pedal is pressed
Engine On
ELSE

Fig.3c

A Method of Controlling the Stopping and Starting of an Engine

This invention relates to the stopping and starting an engine of a motor vehicle in response to driver actions and, in particular, to an adaptive method for controlling the starting of the engine following an engine stop.

The primary objective of a stop-start system is to maximise engine off time, it is therefore desirable to avoid unnecessary or premature engine restarts.

In a conventional stationary stop-in-gear (SIG) system, provided there are no stop inhibitors present such as, for example, a climate control requirement, a battery state of charge requirement or an engine operating temperature requirement, then an engine stop event is initiated if the vehicle is stationary and the clutch pedal is in the depressed state and the transmission is in gear and the brake pedal is pressed.

If from a SIG stop event, the brake pedal is moved to a non-pressed or released state, then the engine is immediately restarted.

Once the engine has stopped the driver may in some cases release the brake pedal without negative effect to the safety of the motor vehicle but an engine start will then occur even though the driver does not intend to take-off.

It is an object of this invention to provide a method of controlling the stopping and starting of an engine of a motor vehicle that provides more driver flexibility without resulting in inappropriate engine restarts.

According to a first aspect of the invention there is provided a method of controlling the stopping and starting

an engine of a motor vehicle having a manual transmission, a clutch pedal and a brake pedal, wherein there are least two primary engine stopped states from which the engine can be directly restarted and at least two secondary engine stopped states from which the engine cannot be directly started and the method comprises restarting the engine from one of the primary engine stopped states if the transmission is in the engaged state and a predefined combination of brake pedal and clutch pedal states is present, the required predefined combination depending upon the brake pedal and clutch pedal states in the primary engine stopped state from which starting is to take place.

If in the primary engine stopped state the clutch pedal state is depressed and the brake pedal state is pressed, the predefined combination of states may be the continuation of a clutch depressed state and the changing of the brake pedal state from pressed to released.

If in the stopped state the clutch pedal is in a non-depressed state and the brake pedal is in a released state, the predefined combination of states may be the continuation of a brake released state and the changing of the clutch pedal state from non-depressed to depressed.

The method may further comprise restarting the engine only if an accelerator pedal of the motor vehicle is in a pressed state.

According to a second aspect of the invention there is provided an engine stop-start control system for an engine of a motor vehicle having a manual transmission, a clutch pedal and a brake pedal the system comprising an electronic controller, a sensor to sense the state of the clutch pedal and supply a signal indicative of the clutch pedal state to the electronic controller, a sensor to sense the state of the brake pedal and supply a signal indicative of the brake

pedal state to the electronic controller, a sensor to sense the engagement state of the transmission and supply a signal indicative of the engagement state of the transmission to the electronic controller and means to sense motion of the motor vehicle and supply a signal indicative of the motion of the motor vehicle to the electronic controller wherein there are least two primary engine stopped states from which the engine can be directly restarted by the electronic controller and at least two secondary engine stopped states from which the engine cannot be directly started by the electronic controller and the electronic controller is operable to restart the engine from one of the primary engine stopped states if the signal from the transmission state sensor indicates that the transmission is in the engaged state and the signals from the brake pedal and clutch pedal sensors indicate that a predefined combination of brake pedal and clutch pedal states is present, the required predefined combination depending upon the brake pedal and clutch pedal states in the primary engine stopped state from which starting is to take place.

If in the primary engine stopped state the clutch pedal state is depressed and the brake pedal state is pressed, the predefined combination of states may be the continuation of the clutch depressed state and the changing of the brake pedal state from pressed to released.

If in the primary engine stopped state the clutch pedal is in a non-depressed state and the brake pedal is in a released state, the predefined combination of states may be the continuation of the brake released state and the changing of the clutch pedal state from non-depressed to depressed.

The motor vehicle may have an accelerator pedal and the system may further comprise a sensor to sense the state of the accelerator pedal and supply a signal indicative of the

state of the accelerator pedal to the electronic controller and the electronic controller may be operable to restart the engine only if the signal from the accelerator pedal sensor indicates that the accelerator pedal is in a pressed state.

According to a third aspect of the invention there is provided a motor vehicle having an engine and a stop-start control system constructed in accordance with said second aspect of the invention.

The invention will now be described by way of example with reference to the accompanying drawing of which:-

Fig.1 is a schematic diagram of a motor vehicle having an engine stop-start control system according to a second aspect of the invention;

Fig.2 is a diagram showing various clutch pedal positions and their corresponding states;

Fig.3a is a high level flow chart of first embodiment of a method of controlling the stopping and starting of an engine of a motor vehicle;

Fig.3b shows a first modification to the method shown in Fig.3a; and

Fig.3c shows a second modification to the method shown in Fig.3a.

With reference to Fig.1 there is shown a motor vehicle 1 having an engine 5 which in this case is a reciprocating piston internal combustion engine.

The engine 5 is arranged to drive at least one road wheel (not shown) via a manual transmission (not shown) having a number of selectable gears. A driver operable

input device in the form of a gear lever (not shown) is provided to permit a driver of the motor vehicle 1 to select a desired one of the gears of the transmission. A clutch (not shown) is interposed between the engine 5 and the transmission to allow the transmission to be disengaged from the engine 5. The clutch has engaged and disengaged states and is controlled by a driver operable clutch pedal 8 (Fig.2).

The motor vehicle 1 has a braking system (not shown) including a number of road wheel brakes and a driver operable foot brake pedal (not shown) to apply or release the road wheel brakes.

The motor vehicle 1 includes a stop-start control system 10 having an electronic controller 11 and a number of inputs 12, 13, 14, 15, 16 and 20 used by the electronic controller 11 to determine whether the engine 5 should be stopped or started.

The first input to the electronic controller 11 is from a clutch pedal sensor 12. The clutch pedal sensor 12 senses the position of the clutch pedal 8. The position of the clutch pedal 8 determines the engagement state of the clutch. The clutch pedal state is used in the example given in this description because it is a convenient way to describe the monitoring of the engagement state of the clutch. However, it will be appreciated that instead of sensing clutch pedal position other means could be used to monitor and provide a feedback of clutch engagement state.

To aid understanding of the clutch pedal states referred to in this description, Fig. 2 shows the clutch pedal states 'R' (released), 'P' (pressed), 'D' (depressed) and 'ND' (not-depressed). The state transition thresholds of the clutch sensor 12 are calibrated so that the bite point of the clutch is located within the 'pressed' state.

That is to say, if the clutch pedal 8 is in the depressed state (D) the clutch is definitely disengaged, if the clutch pedal 8 is in the released state (R) the clutch is definitely in the engaged state and if the clutch pedal 8 is in the pressed state (P) the engagement state of the clutch can be either engaged or disengaged depending upon the location of the bite point within the range of clutch pedal positions defined as 'pressed' and the actual position of the clutch pedal 8 within this 'pressed' range.

For the purposes of this invention it is only necessary to determine whether the clutch pedal 8 is depressed (D) or not-depressed (ND).

The second input is from a brake pedal sensor 13 which senses the position of the brake pedal from which the state of the brake pedal can be deduced. When the brake pedal is pressed the road wheel brakes are applied and when the brake pedal is released the road wheel brakes are not applied. It will be appreciated that the brake pedal state sensor need not sense actual brake pedal position it could be inferred from, for example, the pressure of hydraulic fluid in the braking system.

The third input is from a transmission state sensor 15 which provides a signal indicative of the engagement state of the transmission. The transmission has two operating states a driving state when one of the gears of the transmission is in an in-gear condition which is referred to as a transmission engaged state and a non-driving state when none of the gears of the transmission are in-gear which is referred to as a transmission neutral state. The transmission state sensor 15 can either sense when the transmission is in the engaged state or when it is in the neutral state or there can be sensors for sensing both states for corroboration purposes.

The fourth input is from a vehicle speed sensing means 16 which can be of any convenient form but in this case is a road wheel rotation sensor (vehicle speed sensor) formed as part of an anti-lock brake system of the motor vehicle 1.

A fifth input is any other input 20 required for control of the stopping and starting of the engine 5, that is to say, inputs for indicating that one or more stop inhibitors are present.

A sixth input required for certain embodiments is an accelerator pedal sensor 14 that provides an input indicative of whether an accelerator pedal (not shown) of the motor vehicle 1 is being pressed or not. If the accelerator pedal is pressed a torque demand for the engine 5 is generated and when the accelerator pedal is not being pressed but is released then the engine 5 is operated in an idle mode. It will be appreciated that fuelling and general running of the engine 5 is controlled as usual by an engine control unit (not shown). The electronic controller 11 and the engine control unit (ECU) can be separate components of the motor vehicle 1 or could be combined as part of a larger powertrain control unit.

Operation of the stop-start system is as follows.

The electronic controller 11 continuously monitors motion of the motor vehicle 1 via the vehicle speed sensor 16, the states of the clutch pedal 8 and the brake pedal via their respective sensors 12 and 13 and the state of the transmission via the transmission state sensor 15.

If the inputs from the sensors 12, 13, 15, 16 indicate that the motor vehicle 1 is stationary, the state of the transmission is engaged, the clutch pedal 8 is in the depressed state and the brake pedal is in the pressed state

then the electronic controller 11 acts so as to stop the engine 5.

The engine 5 will then remain in the engine off or engine stopped state until a predefined combination of start conditions are established by the electronic controller 11 to be present. The required conditions are not limited to one set of conditions but vary based upon the state of the clutch pedal 8 and the brake pedal during the period when the engine 5 is stopped and form a number of alternative stopped states from which the engine 5 is restarted either directly in the case of a primary engine stopped state or indirectly in the case of a secondary engine stopped state.

If in the stopped state the transmission is in an engaged state, the clutch pedal 8 is in a depressed state and the brake pedal is in a pressed state then the predefined combination of start condition are that the transmission remains in the engaged state, the clutch pedal 8 remains in the depressed state and the brake pedal state changes from pressed to released. This represents a first example of a transition from a primary engine stopped state to an engine running state.

If in the stopped state the transmission remains in an engaged state, the clutch pedal 8 is not in the depressed state and the brake pedal is not in the pressed state but released then the predefined combination of start conditions are that the clutch pedal 8 is depressed and the state of the brake pedal remains released. This represents a second example of a transition from a primary engine stopped state to an engine running state.

It will be appreciated that in both cases, because the invention relates to a stop in gear stationary control system, the transmission 5 will remain engaged throughout and the motor vehicle 1 will remain substantially

stationary. If the state of the transmission is changed from engaged to not-engaged during the stopped state then a different set of start conditions (SIN conditions) would be used to control the starting of the engine 5. The stop-start system 11 may also be arranged to control stopping and starting of the engine 5 when the transmission is not-engaged using SIN conditions but this aspect of its operation does not form part of this invention and is not described further.

In addition to the two primary engine stopped states referred to above, there are two further engine stopped states referred to as secondary engine stopped states because it is not possible to directly start the engine 5 when in these stopped states. In order to start the engine 5 from a secondary stopped state it is first necessary to transition to one of the primary engine stopped states and then fulfil the conditions required to transition from the respective primary engine stopped state to an engine running state.

By providing alternative engine stopped states greater flexibility for a driver of the motor vehicle 1 is provided. Normally it would not be possible for the driver to remove their feet from the brake and clutch pedals because releasing the brake pedal would start the engine 5. But by providing alternative secondary states in which engine starting will not occur it is possible to allow the driver to release the clutch pedal and then the brake pedal without starting the engine 5. The driver can then rest both feet during a prolonged engine stop.

In some circumstances the driver may effect the required predefined combination of brake and clutch pedal changes from a primary engine stopped state prior to the need for the motor vehicle 1 to move away. That is to say, the driver can release the brake pedal prematurely or

depress the clutch pedal prematurely. The result of such actions is to waste fuel by allowing the engine 5 to idle unnecessarily. Therefore the electronic controller 11 could be constructed and be operable to delay starting until the signal from the accelerator pedal sensor 14 indicates that accelerator pedal is being pressed.

Referring now to Fig.3a there is shown a method of controlling the stopping and starting the engine 5 of the motor vehicle 1 which is used by the electronic controller 11 to control the stopping and starting of the engine while the transmission of the motor vehicle 1 is engaged (in-gear).

The method starts in box 100 where the engine 5 is running and will continue to do so provided a key-off event does not occur until predefined engine off conditions are present. The predefined engine off conditions are that, the motor vehicle 1 is stationary, the transmission is engaged, the clutch pedal state is depressed and the brake pedal state is pressed. If all of these conditions are present then the engine is stopped as indicated in box 110 otherwise the engine 5 will continue to run.

In box 110 the engine 5 is in a first engine stopped state in which the transmission state is engaged, the clutch pedal state is depressed and the brake pedal state is pressed. This is a primary engine stopped state. From the first engine stopped state indicated in box 110, the engine 5 will be restarted directly if the transmission remains in the engaged state, the clutch pedal state remains depressed and the brake pedal state changes from pressed to released as indicated by the boxes 112 and 120.

However, from the first engine stopped state indicated in box 110, the engine 5 will not be restarted if the transmission remains in the engaged state, the clutch pedal

state is no longer depressed and the brake pedal state remains pressed but will instead enter a second engine stopped state which is an engine secondary stopped state as indicated by the boxes 115 and 130.

In the second engine stopped state indicated in box 130 the transmission state is engaged, the clutch pedal state is not-depressed and the brake pedal state is pressed. If the clutch pedal state changes from not-depressed to depressed while in the second engine stopped state the method will return to the first engine stopped state as indicated by the boxes 118 and 110.

However, if in the second engine stopped state 130 the brake pedal state changes from pressed to released as indicated by box 132 then the method advances to box 140 which constitutes a third engine stopped state which is a primary engine stopped state. Therefore the engine cannot be directly started from the second engine stopped it can only be started when the stopped state is transformed to a primary stopped state.

In the third engine stopped state 140 the brake pedal state is released, the transmission state is engaged and the clutch pedal state is non-depressed.

If the brake pedal state remains released, the transmission state remains engaged and the clutch pedal state changes from the non-depressed state to the depressed state then the engine 5 is immediately restarted as indicated by the boxes 142 and 150.

However, if the clutch pedal state remains non-depressed, the transmission state remains engaged and the brake pedal state changes from released to pressed then the engine 5 is not started but instead the method advances to a fourth engine stopped state as indicated by boxes 145 and

160. The fourth engine stopped state is a secondary engine stopped state because it is not possible to directly start the engine 5 from this stopped state.

In the fourth engine stopped state 160 if the clutch pedal state remains non-depressed, the transmission state remains engaged and the brake pedal state changes from pressed to released then the engine 5 is not started but instead the method returns to the third engine stopped state 140 as indicated by the box 148.

However, if the brake pedal state remains pressed, the transmission state remains engaged and the clutch pedal state changes from the non-depressed state to the depressed state the method returns from the fourth engine stopped state 160 to the first engine stopped state 110 as indicated by the box 162.

Therefore the engine cannot be directly started from the fourth engine stopped it can only be started when the stopped state is transformed to a primary stopped state.

The required conditions for starting the engine 5 depend on the respective states of the clutch pedal and brake pedal during the engine stopped state and because manipulation of the brake and clutch pedals by the driver can occur while the engine is stopped more than one combination of clutch and brake state change is provided to enable restarting of the engine 5.

Fig.3b shows a first modification of the method shown in Fig.3a which is identical in most respects to the method shown in Fig.3a and will not be described again in detail.

The only difference from the method shown in Fig.3a is that from box 112 the method will not advance to box 120

where the engine 5 is restarted until the state of the accelerator pedal is pressed as indicated by box 114.

It will be appreciated that this requirement for a pressed accelerator pedal state to be present could be combined with the requirements set out in box 112 that is to say, boxes 112 and 114 in Fig.3b could be replaced by a single box 112' (not shown) having the predefined combination:-

a/ transmission state remains engaged; and
b/ clutch pedal state remains depressed; and
c/ brake pedal state is released; and
d/ accelerator pedal state is pressed.

Fig.3c shows a second modification of the method shown in Fig.3a which is identical in most respects to the method shown in Fig.3a and will not be described again in detail.

The only difference to the method shown in Fig.3a is that from box 142 the method does not advance to box 150 where the engine 5 is restarted until the state of accelerator pedal is pressed as indicated by box 144.

It will be appreciated that this requirement for a pressed accelerator pedal state to be present could be combined with the requirements set out in box 142 that is to say, boxes 142 and 144 in Fig.3b could be replaced by a single box 142' (not shown) having the predefined combination:-

a/ transmission state remains engaged; and
b/ clutch pedal state is depressed; and
c/ brake pedal state is released; and
d/ accelerator pedal state is pressed.

It will be appreciated that both of the modifications disclosed in Figs.3b and 3c could be used in the same system with beneficial effect and if so combined for a second

embodiment of a method of controlling the stopping and starting of an engine of a motor vehicle.

Therefore in summary, it is accepted that for a SIG stop event, if the clutch pedal is moved to a non-depressed state, it is not appropriate to restart the engine because the transmission is in-gear (engaged) and the clutch plates might be in contact which could lead to unintended vehicle movement. Restart trigger conditions from this state that maximise engine off time by preventing unnecessary engine restarts are desirable. Furthermore restart trigger conditions should take into account how intuitive the behaviour of the system is to the driver and also provide the driver with the most convenient set of actions that have to be taken throughout the SIG stop and restart event.

It is important for a vehicle manufacturer to define possible use cases so that they can provide a system that maximises fuel economy while preventing engine restarts that occur when the driver does not require torque and may result in undesired vehicle movement or that produce a negative driver impression.

For example, a driver may find out either by accident or by actively seeking out convenient or minimal-effort stop and restart use cases not normally addressed by a conventional SIG system. These use cases may initially be considered as 'abuse-cases' and may not have been expected to be exercised during normal operation. Such unexpected behaviour could have implications for meeting durability targets or have unintended consequences relating to reduced starting performance and torque availability. For example, if from a SIG stop event the driver releases the clutch pedal and then the brake pedal, the vehicle will be conveniently prevented from rolling forwards or backwards since the engine is connected to the wheels via the transmission and the transmission is in the engaged state.

Therefore the driver does not need to press the brake pedal to hold the vehicle stationary during the stop and can benefit from resting both feet during an extended engine stop. It is important to consider such a use case and incorporate it into the functionality of the stop-start control system which can be achieved by constructing a stop-start control system in accordance with this invention.

It will be appreciated by those skilled in the art that although the invention has been described by way of example with reference to one or more embodiments it is not limited to the disclosed embodiments and that alternative embodiments could be constructed without departing from the scope of the invention as defined by the appended claims.

Claims

1. A method of controlling the stopping and starting an engine of a motor vehicle having a manual transmission, a clutch pedal and a brake pedal, wherein there are least two primary engine stopped states from which the engine can be directly restarted and at least two secondary engine stopped states from which the engine cannot be directly started and the method comprises restarting the engine from one of the primary engine stopped states if the transmission is in the engaged state and a predefined combination of brake pedal and clutch pedal states is present, the required predefined combination depending upon the brake pedal and clutch pedal states in the primary engine stopped state from which starting is to take place.

2. A method as claimed in claim 1 wherein, if in the primary engine stopped state the clutch pedal state is depressed and the brake pedal state is pressed, the predefined combination of states is the continuation of a clutch depressed state and the changing of the brake pedal state from pressed to released.

3. A method as claimed in claim 1 wherein, if in the stopped state the clutch pedal is in a non-depressed state and the brake pedal is in a released state, the predefined combination of states is the continuation of a brake released state and the changing of the clutch pedal state from non-depressed to depressed.

4. A method as claimed in any of claims 1 to 3 wherein the method further comprises restarting the engine only if an accelerator pedal of the motor vehicle is in a pressed state.

5. An engine stop-start control system for an engine of a motor vehicle having a manual transmission, a clutch

pedal and a brake pedal the system comprising an electronic controller, a sensor to sense the state of the clutch pedal and supply a signal indicative of the clutch pedal state to the electronic controller, a sensor to sense the state of the brake pedal and supply a signal indicative of the brake pedal state to the electronic controller, a sensor to sense the engagement state of the transmission and supply a signal indicative of the engagement state of the transmission to the electronic controller and means to sense motion of the motor vehicle and supply a signal indicative of the motion of the motor vehicle to the electronic controller wherein there are least two primary engine stopped states from which the engine can be directly restarted by the electronic controller and at least two secondary engine stopped states from which the engine cannot be directly started by the electronic controller and the electronic controller is operable to restart the engine from one of the primary engine stopped states if the signal from the transmission state sensor indicates that the transmission is in the engaged state and the signals from the brake pedal and clutch pedal sensors indicate that a predefined combination of brake pedal and clutch pedal states is present, the required predefined combination depending upon the brake pedal and clutch pedal states in the primary engine stopped state from which starting is to take place.

6. A system as claimed in claim 5 wherein, if in the primary engine stopped state the clutch pedal state is depressed and the brake pedal state is pressed, the predefined combination of states is the continuation of the clutch depressed state and the changing of the brake pedal state from pressed to released.

7. A system as claimed in claim 5 wherein, if in the primary engine stopped state the clutch pedal is in a non-depressed state and the brake pedal is in a released state, the predefined combination of states is the continuation of

the brake released state and the changing of the clutch pedal state from non-depressed to depressed.

8. A system as claimed in any of claims 5 to 7 wherein the motor vehicle has an accelerator pedal and the system further comprises a sensor to sense the state of the accelerator pedal and supply a signal indicative of the state of the accelerator pedal to the electronic controller and the electronic controller is operable to restart the engine only if the signal from the accelerator pedal sensor indicates that the accelerator pedal is in a pressed state.

9. A motor vehicle having an engine and a stop-start control system as claimed in any of claims 5 to 9.

10. A method of controlling the stopping and starting an engine of a motor vehicle substantially as described herein with reference to the accompanying drawing.

11. An engine stop-start control system for an engine of a motor vehicle substantially as described herein with reference to the accompanying drawing.

13. A motor vehicle substantially as described herein with reference to the accompanying drawing.

Application No: GB1313461.4 **Examiner:** John Twin

Claims searched: 1 to 13 **Date of search:** 17 February 2014

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	GB 2427440 A (Ford Global Technologies)

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

B60W; F02D; F02N

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
F02N	0011/08	01/01/2006
F02D	0017/04	01/01/2006