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(54) **Pedal calibration for motor vehicles**

Pedalkalibrierung für Kraftfahrzeuge

Calibration d'une pédale pour des véhicules à moteur

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(73) Proprietor: **Scania CV AB**
151 87 Södertälje (SE)

(72) Inventor: **Dersjö, Jan**
644 33 Torshälla (SE)

(74) Representative: **von Hellfeld, Axel**
Wuesthoff & Wuesthoff
Patent- und Rechtsanwälte
Schweigerstrasse 2
81541 München (DE)

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EP 1 375 873 B1

Description

Field of the Invention

[0001] The present invention relates to determination of positions of pedals in motor vehicles such as accelerator pedals, brake pedals and clutch pedals, and, in particular, a calibration of pedal positions.

Background of the Invention

[0002] Positions of a pedal in a motor vehicle, such as an accelerator pedal, a brake pedal or a clutch pedal indicate desired driving conditions for the motor vehicle given by a driver thereof. A position of an accelerator pedal corresponds with a desired vehicle speed or a desired vehicle acceleration in case a desired vehicle speed is not reached or exceeded. For example, if the accelerator pedal of a vehicle equipped with an automatic transmission is actuated for a driving condition referred to as "kick-down", the automatic transmission is operated such that in dependence from an initial vehicle speed the maximal vehicle acceleration is obtained. In general, here it is required that the accelerator pedal is fully depressed.

[0003] This applies correspondingly for brake pedals and clutch pedals. Positions of a brake pedal determine desired braking procedures. For example, comparable to an actuation of an accelerator pedal for a kick-down operation, a full actuation of a brake pedal with a rapid pedal displacement by a driver can initiate an emergency braking to obtain a maximal vehicle deceleration. A further characteristic brake pedal condition is a full driver initiated brake pedal actuation over a longer period, usually with a rather slow preceding brake pedal displacement. The latter brake pedal condition can indicate that the vehicle should be maintained in a parked condition, i.e. that the associated brake system should operate comparable to a parking brake. Characteristic positions of a clutch pedal comprise the position where the clutch pedal is actuated so far that an associated clutch is released and the position of the clutch pedal where the clutch connects a vehicle motor with an associated transmission line of a vehicle.

[0004] Wear, temperature changes and other factors which effect pedals of a motor vehicle not only during its operation but also during a not operated condition affect relations of pedal positions to driving conditions of the vehicle which can be obtained in response thereto. For example, wear affecting an accelerator pedal can cause that the position of the accelerator pedal originally necessary for a desired vehicle speed signal is not sufficient any more to obtain this speed.

[0005] Such variations can be compensated by a driver itself in case of conventional pedals for vehicles that are mechanically interacting with a vehicle motor, a vehicle brake system and vehicle clutch system, respectively. Here, the driver varies the actuation of pedals such that positions of the pedals resulting there from lead to desired driving conditions.

[0006] For vehicles that determine positions of pedals by means of control units and sensors and use thus obtained pedal positions for control of the operation of the vehicle the above compensation by a driver is not sufficient to ensure a reliable operation of the vehicle. This applies for vehicles having pedals which interact, beside mechanical arrangements, with control units and sensors in order to, for example, control fuel injection systems, exhaust catalyst systems, controlled brake support systems, systems for stabilizing and controlling driving conditions and the like in dependence from measured pedal positions. In this respect, vehicles represent a particular problem wherein at least single pedals effect driving conditions without utilizing a mechanical interaction but control driving conditions of the vehicle utilizing electronic control units and sensors to measure pedal positions.

[0007] Actual positions of pedals are measured and desired driving conditions are determined there from. In case a prior pedal position does not correspond to an actual pedal position for example due to wear or temperature effects this can result in a situation wherein a previously effectible driving condition can not be obtained anymore.

[0008] To solve these problems it is necessary to calibrate pedal positions in a vehicle such that effects are compensated which influence relations between pedal positions and driving conditions-indicated thereby.

[0009] From US 5,445,126 it is known to calibrate an accelerator pedal of a vehicle by measuring the position of the accelerator pedal in a not actuated condition wherein the vehicle motor should be operated in an idle condition and to determine the position of the accelerator pedal in a fully activated condition wherein the maximum amount of fuel is to be supplied to the vehicle motor. By means of a wiper in a potentiometer being mechanically connected to an accelerator pedal the position of the accelerator pedal is measured. A switch indicates the not actuated condition of the accelerator pedal and opens the potentiometer circuit. The switch is opened when the accelerator pedal is actuated between approximately 3% to 10% of its total allowable travel. Then, the potentiometer circuit is closed and positions of the accelerator pedal can be measured therewith. The other way round, the potentiometer circuit is opened and the switch is closed if the accelerator pedal is positioned within or below this range.

[0010] At the beginning of a calibration a parameter that indicates the fully actuated position of the accelerator pedal is set to a value that corresponds approximately between 120% and 150% of a value which indicates a full actuation of the accelerator pedal during normal vehicle operation. Thereby it is resulted that, in comparison with a calibrated operation of the accelerator pedal, larger actuations of the accelerator pedal are required to obtain a desired fuel supply. As a

result, a driver will actually fully depress the accelerator pedal to obtain a maximal fuel supply. In case the accelerator pedal is fully actuated, the potentiometer circuit outputs a signal that indicates this position and lies in an upper calibration range. According to this signal, the parameter that indicates a full actuation of the accelerator pedal is varied. Thus, this parameter is increased, if for subsequently occurring actuations of the accelerator pedal a measuring signal is generated, which indicates a larger actuation.

[0011] For a calibration of the not actuated position, a parameter indicating this position is initially set to 0% of the above value which indicates a full pedal actuation during normal vehicle operation in ease-the switch is opened and the potentiometer circuit is interrupted. For a calibration of the parameter indicating the position of the accelerator pedal for the idle operating condition it is determined when the switch is opened and the potentiometer circuit is closed. Here, the potentiometer circuit outputs a measuring signal that lies in a low calibration range wherein the parameter indicating an idle operating condition for the vehicle is adjusted accordingly. This position parameter is decreased if a subsequently occurring position of the accelerator pedal effects an opening of the switch and a closing of the potentiometer circuit.

[0012] In case positions of the accelerator pedal are measured above the upper calibration range and below the low calibration range, diagnosis measures are initiated for a smaller range exceeding, while a large range exceeding is considered as fault. In the latter case, the parameters that indicate a full or not occurring actuation of the accelerator pedal are set to the above named initial values.

[0013] The approach known from US 5,445,126 has several drawbacks. For example, the calibration is specifically adapted to be used for an accelerator pedal and not suitable for a calibration of a brake pedal and a clutch pedal. Further, calibration is performed each time a position of an accelerator pedal is determined exceeding the parameter for the upper position and falling below the parameter for the low position. This increases the amount of calculations for a calibration of the accelerator pedal during an operation of the motor vehicle and requires high speed processing units to perform calibration fast enough for a re-calibration in response to each higher and lower value for the parameters for the high position and the low position, respectively. Moreover, this re-calibration can often vary the relation of positions of the accelerator pedal and fuel such that a driver also has often to "re-calibrate" his or her actuation strategy of the accelerator pedal accordingly during an operation of the motor vehicle. Also, this approach only relies on the mechanical arrangement of the accelerator pedal and physical pedal positions, but does not consider driving conditions of a vehicle.

[0014] US 6,058,349 describes a method and device for updating a reference value of an accelerator pedal of a motor vehicle. According to this prior art document, a single pedal position value indicating a static pedal position is smoothed in order to obtain a smoothed position value. In case, the smoothed pedal position value in relation to a reference value remains below a predefined threshold value for a given period of time, a so-called update condition is fulfilled, which indicates that the pedal is in a condition for calibration. Thereupon, the reference value is updated. Thus, the update is conducted merely based on detected pedal positions.

[0015] US 4,660,520 discloses to calibrate an accelerator pedal if its position remains unchanged for a given period of time. Thus, the calibration is conducted when the position of the pedal to be calibrated is static.

Object of the Invention

[0016] The object of the present invention is to provide a solution that overcomes the above-mentioned problems of prior art. In particular, the object of the present invention is to provide for an improved and more reliable detection and calibration of positions of pedals of a motor vehicle not being limited to a particular pedal and enabling pedal calibrations in view of related driving conditions.

Short Description of the Invention

[0017] The above object is solved by the method according to claim 1, the apparatus according to claim 11, the software program product according to claim 12 and the motor vehicle according to claim 14.

[0018] The present invention relies on the finding that specific driving conditions controlled by a vehicle pedal are related to specific positions of the pedal and in particular to (virtually) stable or solid pedal positions.

[0019] For example, in the case of an accelerator pedal such solid pedal positions will be present in the case of an idle operating condition for the vehicle wherein the accelerator pedal can be considered to be in a released position and in a full-load operating condition for the vehicle wherein the accelerator pedal is considered to be in a fully activated or depressed position in order to, for example, initiate a kick-down.

[0020] In a comparable manner, solid pedal positions will be present in the cases of brake and clutch pedals wherein a released pedal position is associated with a not activated operation of a vehicle braking system or a vehicle clutch arrangement, respectively. In general, brake and clutch pedals are not considered to exhibit solid positions for a full activation as in the case of an accelerator pedal. Nevertheless, comparable to a solid accelerator pedal position for a full-load operating condition, a brake pedal can be maintained in a solid, fully depressed position in order to, for example, initiate an emergency braking or to provide for brake forces for a parking brake function. In a similar way, a clutch pedal

can be maintained in a solid, fully depressed position to provide for a complete release of a clutch.

[0021] Starting there from, the present invention teaches to determine such a pedal position and to deduce there from whether a specific operating condition for a motor vehicle is prevailing. If this is the case the detected solid pedal position is considered as a calibration measure for a calibration of the pedal with respect to this specific vehicle operating condition. Such a calibration can be performed for any solid pedal position a vehicle pedal is expected to exhibit.

[0022] Vehicle pedals are operated by a driver of the vehicle and, thus, it is not ensured that a vehicle pedal will be actually positioned in a fixed or stable position to obtain an associated operating condition for the vehicle. Rather, it is likely that, even if a vehicle driver intends to maintain a vehicle pedal in solid position, small variations of pedal positions will occur. This can be taken into account by defining a solid pedal position as a small range of positions which will virtually effect an associated, desired operating condition for the vehicle, at least in a manner that the vehicle driver will percept that the desired operating condition is obtained.

[0023] In particular, the present invention provides a method for calibrating at least one position of a pedal in a motor vehicle wherein actual, physical positions of the pedal are assessed whether they are within a first variation range of pedal positions for a first calibration time. For such a determination actual pedal positions can be measured or provided by a respective unit of the vehicle. Further, such a determination can be performed when the vehicle is in a first predefined operating condition or can be used to check whether the vehicle is in the first predefined operating condition.

[0024] In case the determination has shown that the pedal is positioned within the first variation range during the first calibration time, a first calibrated value is associated with the first predefined operating condition. The first calibrated value indicates or characterizes a position of the pedal calibrated with respect to the first predefined operating condition such that in response to a positioning of the pedal in a position corresponding to the first calibrated value the first predefined operating condition can be effected.

[0025] As a result, the pedal is calibrated with respect to the first predefined operating condition.

[0026] In dependence from the type of operating condition and the type of pedal, it is possible to define a so-called first calibration hysteresis. The first calibration hysteresis indicates a range of pedal positions wherein the existence of the first predefined operating condition is assumed. Thus, the vehicle is considered to be in the first predefined operating condition as long as the pedal is positioned within the first calibration hysteresis wherein it is possible that variations of pedal positions within the first calibration hysteresis will affect the actually resulting operating condition for the vehicle. As an alternative or in addition, the first calibration hysteresis can indicate a range of pedal positions which has to be left before, if desired, a subsequent calibration of the pedal can be performed. In this manner it is possible to ensure that the pedal will be re-positioned in the solid position for the first predefined operating condition before a further pedal calibration can be started.

[0027] Further, it is possible to perform the pedal calibration with respect to the first predefined operating condition several times, at least twice. Preferably, such a multiple calibration of the pedal with respect to the first predefined operating condition is based on subsequently occurring calibrations as described above. The results of single pedal calibrations, i.e. calibrations during the first calibration time, are combined to obtain a first combined calibrated value. The combination can be based on averaging, interpolation and the like. Then, comparable to the above first calibrated value, the first combined calibrated value is associated with the first predefined operating condition.

[0028] In order to achieve a desired accuracy of pedal calibration, it is contemplated that the first combined calculated value is only based on such results of single calibrations which fall into a first allowable range for positions of the pedal.

[0029] A pedal calibration can also be performed with respect to further operating conditions for the vehicle. This is accomplished by carrying out the above described calibration steps with respect to a further predefined operating condition for the vehicle wherein respective further measures are defined. For example, for a calibration of the pedal with respect to a second predefined operating condition a second variation range, a second calibration time, a second calibrated value, a second calibrated hysteresis and a second combined calibrated value will be utilized.

[0030] In the case of a pedal calibration with respect to two predefined operating conditions for the vehicle, the pedal is calibrated with respect to the predefined operating conditions in dependence from the calibration results carried out for the different operating conditions. Thus, in the case of a first and a second predefined operating condition for the vehicle, it is possible to calibrate the pedal in dependence from the first and the second calculated values or in dependence from the second combined calculated values. In case no second predefined operating condition is used or can be ensured to occur, it is possible to use a suitable nominal or default value instead of the second calculated value or the second combined calculated value, respectively.

[0031] Preferably such a calibration of the pedal with respect to the first and the second operating condition is carried out by a linearization of actual, physical positions of the pedal in view of the first (combined) value and the second (combined) calculated value or a respective nominal or default value. Such a linearization can include measures or parameters for considering, for example, signal variations occurring in measuring actual positions of the pedal, vehicle vibrations, the resolution of measurements of actual pedal positions and the sampling rate used for measure actual pedal positions.

[0032] In case more than two predefined operating conditions associated with stable pedal positions are existing or

can be expected to occur, the above described pedal calibration can be performed with respect to all predefined operating conditions or combinations thereof.

[0033] For calculating a calibrated value resulting from a calibration during a respective calibration time, it is preferred that at least one of the actual positions of the pedal detected therein is used. By averaging, interpolation and the like more than one actual position of the pedal can be employed for calculating a respective calibrated value.

[0034] Further, it is preferred that variation ranges and/or calibration times are defined in dependence from the respective predefined operating condition of the vehicle. For example, it might be advantageous to define different variation ranges and/or calibration times for an idle operating condition and a full-load operating condition in case of an accelerator pedal.

[0035] Moreover, it is possible to define calibration ranges surrounding respective variation ranges to indicate a range of pedal positions which has to be entered before a pedal calibration will be initiated.

[0036] In addition to the above described calibration steps, the present invention contemplates an apparatus for calibrating a pedal in a motor vehicle, the apparatus having single or several units which have been adapted and/or programmed to perform, at least partially, the steps described above.

[0037] In view of enhanced control units in motor vehicles and particularly computer programmable control units, the present invention provides a software program product which comprises program code portions for, at least partially, carrying out the above described calibration.

[0038] Moreover, the present invention provides for a motor vehicle which comprises a pedal wherein at least one position thereof is calibrated by carrying out a method according to the invention, and/or a pedal wherein at least one position thereof is calibrated by means of an apparatus according to the invention, and/or a pedal and an apparatus according the invention, and/or a vehicle electronic control unit and an embodiment of a software program product according the invention being adapted to be executed by the vehicle electronic control unit.

Short Description of the Figures

[0039] In the following description of preferred embodiments, it is referred to the accompanying drawings wherein:

Fig. 1 shows a schematic illustration of a pedal calibration arrangement according to the present invention,

Fig. 2 shows a schematic illustration of an accelerator pedal calibration according to the present invention for a first vehicle operating condition,

Fig. 3 shows a schematic illustration of an accelerator pedal calibration according to the present invention for a second vehicle operating condition,

Fig. 4 shows a schematic illustration of a brake pedal calibration according to the present invention for a third vehicle operating condition,

Fig. 5 shows a schematic illustration of a brake pedal calibration according to the present invention for a fourth vehicle operating condition,

Fig. 6 shows a schematic illustration of a clutch pedal calibration according to the present invention for a fifth vehicle operating condition, and

Fig. 7 shows a schematic illustration of a clutch pedal calibration according to the present invention for a sixth vehicle operating condition.

Description of preferred Embodiments

Calibration principles

[0040] Calibration of a pedal in a motor vehicle can be performed each time when the vehicle is started, in predefined intervals during an operation of the vehicle, in predefined intervals during the lifetime of the vehicle or continuously during an operation of the vehicle. A continuous calibration or calibrations performed in small intervals are particularly advantageous for vehicles which are continuously operated over long periods such as trucks that has been operated for weeks without shut-off.

[0041] Further, calibration can be initiated if it is detected that relations of pedal positions to driving conditions are not as desired or defined, e.g. due to wear, temperature effects affecting the pedals and/or related equipment. Such a

detection can be accomplished by assessing fuel consumption, vehicle speed characteristics (e.g. was the top speed reached during last vehicle operations), braking characteristics, noise (e.g. generated by the vehicle transmission line or clutch, by the vehicle motor during idle operation), vehicle vibrations in response to clutch operation, etc.

[0042] If no calibration is to be performed, respective calibrated values for the pedals of the vehicle, which have been obtained in a previously performed calibration and stored in a memory associated with the pedal operation, are used.

[0043] If a calibration is to be performed, the pedals can initially be operated on the basis of respective calibrated values which have been obtained in previously performed calibrations and stored in a memory associated with the pedal operation. As an alternative, the pedals can initially be operated on the basis of respective default values. In both cases, the initial values used for the pedals are replaced by respective calibrated pedal position values obtained by the last calibration. The calibration of pedals will be effective in both directions, i.e. calibrated pedal position values can be independently adapted to higher and lower values.

[0044] In case a calibration can not be properly performed, e.g. values are obtained which are not plausible, it is contemplated to use default values or previous calibrations to calibrate pedal position values at least for the pedal the calibration of which has failed.

Calibration arrangement

[0045] Fig. 1 illustrates a calibration arrangement for performing the above described pedal calibration. For a calibration of a vehicle pedal 2 which can be moved between a released position and fully depressed position, a pedal position measuring unit 4 is used to detect or measure positions of the pedal 2. The pedal position measuring unit 4 can include suitable sensors such as electrical sensors, electronic sensors, optical sensors, mechanical sensors and combinations thereof.

[0046] It is contemplated that the pedal position measuring unit 4 comprises a sensor or sensors which output at least two separate signals indicating positions of the pedal 2. By means of such a redundancy it is possible to check whether the pedal position measuring unit 4 is properly working for example by comparing two position signals thereof. As an example, the pedal position measuring unit 4 can output two signals indicating pedal positions wherein a proper operation of the pedal position measuring unit 4 is indicated when the two signals exhibit a predefined ratio such as 1:2 or a predefined distance. In general, such an embodiment of the pedal position measuring unit 4 is utilized for accelerator pedals and brake pedals, but is also possible for clutch pedals.

[0047] Further, the pedal position measuring unit 4 can be adapted to output a signal that indicates that the pedal 2 is considered to be released. As a result, positions of the pedal 2 resulting from an actuation below an activation required to output such a signal are not considered for the actual driving or operating condition. For example, in case of an accelerator pedal such positions will maintain an idle operating condition and in case of a brake pedal such positions will not effect a braking. Such an embodiment of the pedal position measuring unit 4 can provide for a hysteresis behavior with respect to the released position of the pedal 2.

[0048] A hysteresis behavior of the pedal position measuring unit 4 can be obtained with respect to a fully depressed position of the pedal 2. With respect to the pedal 2 being an accelerator pedal this can be accomplished by a kick-down unit which is activated to initiate a kick-down operation in response to positions of the pedal 2 having a predefined value and/or interacting with a detection unit such as a magnet. Comparable provisions can be provided for the pedal 2 being a brake pedal in order to, for example, initiate an emergency braking in response to a respective brake pedal actuation by a driver (rapid and full brake pedal actuation) or a braking condition comparable to a parking brake in response to a respective brake pedal actuation by a driver (full brake pedal actuation over a long period).

[0049] Signals indicative of positions of the pedal 2 are provided by the pedal position measuring unit 4 to a processing unit 6. On the basis of received signals, the processing unit 6 initiates and executes a calibration of the pedal 2 in line with the following description and in view of the type of the pedal 2. After completion of a calibration of the pedal 2, the pedal position measuring unit 4 is accordingly adjusted under control of the processing unit 6. Subsequently measured signals being indicative of positions of the pedal 2 are transmitted to a vehicle control unit 8. The vehicle control unit 8 employs calibrated positions for the pedal 2 to control the operation of the vehicle in response to activations of the pedal 2. Although illustrated in Fig. 1 as separate components, the pedal position measuring unit 4 and/or the processing unit 6 can be integrally formed with the vehicle control unit 8.

[0050] The calibration of the pedal 2 can be supported by information being related to a vehicle component to be controlled by the pedal 2. As an example, Fig. 1 shows brakes or a brake system 10 and a clutch 12 which are connected to the processing unit 6 such that information relating to the operation of the brakes 10 and the clutch 12 and being relevant for a calibration of the pedal 2 can be provided to the processing unit 6.

[0051] For storing calibration results, default values for the pedal 2, software program code (portions) for operating the processing unit 6 and/or performing a calibration of the pedal 2, algorithms and/or functions for calibrating of positions on the basis of calibrated values e.g. for the released and fully depressed positions and the like, a memory unit 14 is provided. The memory unit 14 shown in Fig. 1 as a separate component can be embodied as an integral part of the

processing unit 6 or the vehicle control unit 8. Further, the memory unit 14 can be operated with interchangeable storage devices and/or any other suitable means in order to, for example, provide, modify, download, etc. default values, software (portions) and the like to adapt and vary the calibration of the pedal 2.

Calibration of an accelerator pedal

[0052] For calibrating an accelerator pedal of a motor vehicle, two operating conditions for the vehicle are defined.

[0053] The first vehicle operating condition is defined to be an idle operating condition wherein minimal or no power is to be supplied to a motor of the vehicle. In the case of vehicles utilizing fossil fuel, usually a minimal amount of power in the form of fuel has to be supplied in order to provide for an operating condition that allows for a vehicle acceleration by increasing the fuel supply (i.e. minimal power supply to keep the vehicle motor running). In the case of enhanced motor arrangements for vehicles including motors for fossil fuel with automatic shut-off, electro motors, hybrid motors, etc., usually the idle/inactive operating condition does not require a power supply in form of fuel, electrical energy or combinations thereof. Here, vehicle acceleration is accomplished by (re-)starting vehicle motors in response to an actuation of an accelerator pedal for example by means of a controlled motor ignition and/or operation of an electromotor.

[0054] The second vehicle operating condition is defined as a full-load condition wherein a maximal amount of power is to be supplied by the vehicle motor. In a particular case of a full-load condition, namely a kick-down condition, an increase of power supply starting from a lower power supply to the maximum power supply occurs at a maximal possible rate. In a further particular full-load operating condition, namely a long-term full-load condition, maximal power is supplied over a longer period for example while an up-hill drive or driving at top speed.

[0055] These two vehicle operating conditions are used to calibrate an accelerator pedal the position of which is detected or measured. In order to determine whether positions of the accelerator pedal are suitable for a calibration with respect to the above vehicle operating conditions, parameters characterizing the different vehicle operating conditions and parameters characterizing respected suitable positions of the accelerator pedal are defined.

[0056] For the accelerator pedal, a range is given wherein the accelerator pedal can be actuated, i.e. moved and positioned. This range of possible positions of the accelerator pedal ranges from an accelerator pedal position corresponding to a not actuated accelerator pedal (no force being applied to the accelerator pedal by a driver of the vehicle) and an accelerator pedal position corresponding to a fully activated accelerator pedal (maximal force being supplied to the accelerator pedal by a driver of the vehicle, the accelerator pedal is mechanically fully depressed). In the following, these two boundaries for accelerator pedal positions are referred to as a 0% position (no accelerator pedal actuation) and 100% position (full accelerator pedal actuation).

[0057] As illustrated in Fig. 2, a parameter CH_1 is defined for the idle operating condition which indicates an accelerator pedal position for which an exceeding (i.e. accelerator pedal positions having higher values, further activation/depressing of the accelerator pedal) results in an actual vehicle acceleration.

[0058] The threshold CH_1 does not necessarily represent a position of the accelerator pedal indicating a boundary for the idle operating condition. Rather, it is possible that for an accelerator pedal position corresponding to the threshold CH_1 the vehicle is not operated in the idle operating condition but in an operating condition having a higher power supply compared to the idle operating condition. For example, this is the case in vehicles equipped with motors for fossil fuel where positions of the accelerator pedal below the threshold CH_1 effect an increased fuel supply that is not sufficient to generate motor forces necessary for a vehicle acceleration. Depending on the type of vehicle and motor, respectively, it is possible that the threshold CH_1 coincides with a position of the accelerator pedal above which position the idle operating condition is left.

[0059] The threshold CH_1 can also correspond to a position of the accelerator pedal for which it is assumed that the accelerator pedal is released as set for above with respect to Fig. 1. Thus, positions of the accelerator pedal below the threshold CH_1 are considered as released position and the vehicle is operated in the idle operating condition.

[0060] Further referring to Fig. 2, a calibration range CR_1 is defined for positions of the accelerator pedal in which a calibration of the accelerator pedal can be performed. The calibration range CR_1 is limited by a lower calibration limit CL_{10} and an upper calibration limit CL_{11} and corresponding accelerator pedal positions, respectively. The lower calibration limit CL_{10} is selected to correspond with the x-axis (i.e. the physically 0% position of the accelerator pedal) whereas it is contemplated that the lower calibration limit CL_{10} can correspond with an accelerator pedal position in response to a (small) actuation. The accelerator pedal position corresponding to the upper calibration limit CL_{11} is selected to have a value smaller than the value of the accelerator pedal position corresponding to the threshold CH_1. This allows, for example, that the threshold CH_1 does not necessarily lead to an abandonment of the idle operating condition. Thus, it is possible that the upper calibration limit CL_{11} characterizes an accelerator pedal position for which the idle operating condition is maintained. Nevertheless, it is contemplated that the threshold CH_1 and the upper calibration limit CL_{11} may correspond and/or that upper calibration limit CL_{11} may indicate an accelerator pedal position above which the idle operating condition will be left.

[0061] As shown in Fig. 2, a so-called allowable range AR_1 is defined which characterizes a range of calibration results

for different calibrations wherein results of different calibrations, preferably subsequently executed calibrations, shall fall into as to be considered for a combined calibration on the basis of at least two different calibrations in the calibration range CR_1.

[0062] Referring to the detail illustration in Fig. 2, a so-called variation range VR_1 is defined for accelerator pedal positions. The variation range VR_1 characterizes a range of positions of the accelerator pedal in which accelerator pedal positions shall fall into so as to accelerator pedal positions are to be considered for a calibration of the accelerator pedal for the idle operating condition. In other words, positions of the accelerator pedal within the variation range VR_1 are used in a calibration for the idle operating condition, while accelerator pedal positions outside the variation range VR_1 are rejected for calibration.

[0063] Moreover, a calibration time CT_1 is defined which characterizes a time during which positions of the accelerator shall fall in the variation range VR_1 during calibration of the accelerator pedal for the idle operating condition. In the case a position of the accelerator pedal not within the variation range VR_1 occurs after a start of the calibration within the calibration time CT_1, the calibration is terminated and accelerator pedal positions determined so far in the calibration are dismissed.

[0064] For a calibration of the accelerator pedal with respect to the idle operating condition, it is determined whether an actual position of the accelerator pedal is below the upper calibration limit CL_{11}. As explained above, usually the position of the accelerator pedal is maintained in the substantially same position or in a small range of positions in the idle operating condition. In order to obtain a precise calibration it is not only determined whether the accelerator pedal position is within the calibration range CR_1, but it is further determined whether positions of the accelerator pedal are within the variation range VR_1 during the calibration time CT_1. If this is the case, at least one position of the accelerator pedal within the variation range VR_1 determined during the calibration time CT_1 is used for a calibration of the accelerator pedal for the idle operating condition. Depending, for example, from the way positions of the accelerator pedal are determined or measured more than one digitally sampled accelerator pedal position can serve as basis to calculate an averaged, interpolated, etc. value as position value for the accelerator pedal in calibration thereof with respect to the idle operating condition. Further, it is contemplated to utilize any method for obtaining a calculated accelerator pedal position on the basis of at-least a single accelerator pedal position obtained during the calibration time CT_1 on the basis of digital and/or analog signals provided by units or means for determining or measuring positions of the accelerator pedal.

[0065] In order to further increase the accuracy and reliability of calibration, the above described calibration of the accelerator pedal with respect to the idle operating condition is repeated wherein results of different calibrations are used for an actual calibration. As illustrated in Fig. 2, a first calibration indicated by reference numeral I_1 is performed as explained above. Then, the accelerator pedal is moved into a position above the threshold CH_1 and subsequently (at least partially) released to have a position within the calibration range CR_1. Comparable to the calibration I_1, a calibration indicated by II_1 in Fig. 2 is executed. For a calibration indicated by III_1, the accelerator pedal is actuated into a position above the threshold CH_1 and (at least) partially released to be positioned within the calibration range CR_1. This procedure is contemplated to be performed for two, three, four and more calibrations that can be required to occur subsequently or are allowed to occur with intermediate movements of the accelerator pedal deviating from the movements illustrated in Fig. 2.

[0066] Referring to the calibrations I_1, II_1 and III_1 of Fig. 2, the results of these different calibrations are used to calculate a combined calibrated value CV_1 for the accelerator pedal position with respect to the idle operating condition, i.e. a position of the accelerator pedal which indicates the 0% position. Such a calculation can be based on averaging, interpolating and the like of results of the calibrations I_1, II_1 and III_1. In order to obtain a reliable and precise calibration, the results of the calibrations I_1, II_1 and III_1 are used if they are within the allowable range AR_1. Otherwise, at least the calibration having a result outside the allowable range AR_1 is rejected or dismissed and replaced by a new calibration. It is also possible to reject or dismiss all of the calibrations I_1, II_1 and III_1 and to perform three new calibration procedures to obtain the combined calibrated value CV_1.

[0067] As illustrated in Fig. 3, a parameter CH_2 is defined for the full-load operating condition which can indicate an accelerator pedal position for which a falling below (i.e. accelerator pedal positions of lower values, less activation/depressing of the accelerator pedal) results in less power output from the vehicle motor. With respect to the full-load operating condition being a kick-down operating condition the threshold CH_2 can characterize a position of the accelerator pedal for which and above which the vehicle is operated in kick-down mode. Thus, positions of the accelerator pedal above the threshold CH_2 are considered as fully depressed position and the vehicle is operated in the full-load operating condition.

[0068] Further referring to Fig. 3, a calibration range CR_2 is defined for positions of the accelerator pedal in which a calibration of the accelerator pedal can be performed. The calibration range CR_2 is limited by a low calibration limit CL_{20} and an upper calibration limit CL_{21} and corresponding accelerator pedal positions, respectively. The accelerator pedal position corresponding to the low calibration limit CL_{20} is selected to have a value larger than the value of the accelerator pedal position corresponding to the threshold CH_2. Nevertheless, it is contemplated that the threshold CH_2 and the upper calibration limit CL_{11} may correspond and/or that the lower calibration limit CL_{20} may indicate an accelerator pedal

position below which the full-load operating condition will be left.

[0069] As shown in Fig. 3, a so-called allowable range AR_2 is defined which characterizes a range of calibration results for different calibrations wherein results of different calibrations, preferably subsequently executed calibrations, shall fall into as to be considered for a combined calibration on the basis of at least two different calibrations.

[0070] Referring to the detail illustration in Fig. 3, a so-called variation range VR_2 is defined for accelerator pedal positions. The variation range VR_2 characterizes a range of positions of the accelerator pedal in which accelerator pedal positions shall fall into so as to accelerator pedal positions are to be considered for a calibration of the accelerator pedal for the full-load operating condition. In other words, positions of the accelerator pedal within the variation range VR2 are used in a calibration for the full-load operating condition, while accelerator pedal positions outside the variation range VR_2 are rejected-for calibration.

[0071] Moreover, a calibration time CT_2 is defined which characterizes a time during which positions of the accelerator shall fall in the variation range VR_2 during calibrating the accelerator pedal for the full-load operating condition. In the case a position of the accelerator pedal not within the variation range VR_2 occurs after a start of the calibration within the calibration time CT_2, the calibration is terminated and accelerator pedal positions determined so far are dismissed.

[0072] For a calibration of the accelerator pedal with respect to the full-load operating condition, it is determined whether an actual position of the accelerator pedal is above the lower calibration limit CL_{20} and below the upper calibration limit CL_{21}. As explained above, usually the position of the accelerator pedal is maintained in the substantially same position or in a small range of positions in the full-load operating condition. In order to obtain a precise acceleration it is not only determined whether the accelerator pedal position is within the calibration range CR_2, it is further determined whether positions of the accelerator pedal are within the variation range VR_2 during the calibration time CT_2. If this is the case, at least one position of the accelerator pedal within the variation range VR_2 determined during the calibration time CT_2 is used for a calibration of the accelerator pedal for the full-load operating condition. Depending, for example, from the way positions of the accelerator pedal are determined or measured more than one digitally sampled accelerator pedal position can serve as basis to calculate an averaged, interpolated, etc. value as position value for the accelerator pedal in calibration thereof with respect to the full-load operating condition. Further, it is contemplated to utilize any method for obtaining a calculated accelerator pedal position on the basis of at least a single accelerator pedal position obtained during the calibration time CT_2 on the basis of digital and/or analog signals provided by units or means for determining or measuring positions of the accelerator pedal.

[0073] In order to further increase the accuracy and reliability of calibration, the above described calibration of the accelerator pedal with respect to the full-load operating condition is repeated wherein results of different calibrations are used for an actual calibration. As illustrated in Fig. 3, a first calibration indicated by reference numeral I_2 is performed as explained above. Then, the accelerator pedal is moved into a position below the threshold CH_2 and subsequently moved to have a position within the calibration range CR_2. Comparable to the calibration I_2, a calibration indicated by II_2 in Fig. 3 is executed. For a calibration indicated by III_2, the accelerator pedal is actuated into a position below the threshold CH_2 and moved to be positioned within the calibration range CR_2. This procedure is contemplated to be performed for two, three, four and more calibrations that can be required to occur subsequently or are allowed to occur with intermediate movements of the accelerator pedal deviating from the movements illustrated in Fig. 3.

[0074] Referring to the calibrations I_2, II_2 and III_2 of Fig. 3, the results of these different calibrations are used to calculate a combined calibrated value CV_2 for the accelerator pedal with respect to the full-load operating condition, i.e. a position of the accelerator pedal which indicates the 100% position. Such a calculation can be based on averaging, interpolating and the like of results of the calibrations I_2, II_2 and III_2. In order to obtain a reliable and precise calibration, the results of the calibrations I_2, II_2 and III_2 are used if they are within the allowable range AR_2. Otherwise, at least the calibration having a results outside the allowable range AR_2 is rejected or dismissed and replaced by a new calibration. It is also possible to reject or dismiss all of the calibrations I_2, II_2 and III_2 and to perform three new calibration procedures to obtain the combined calibrated value CV_2.

[0075] With respect to both the idle operating condition and the full-load operating condition, it is contemplated to further consider parameters related to these vehicle operating conditions and, for example, to use them for providing the thresholds CH_1 and CH_2.

[0076] For the idle operating condition, it is possible to determine whether the position of e.g. a throttle or a fuel injector pump associated with the accelerator pedal exceeds a predefined threshold indicating an accelerator pedal position for operating the vehicle in the idle condition (e.g. a threshold indicating a limit for accelerator pedal positions below which the accelerator pedal is considered to be in a released position). This provides for information, for example in form of a signal comparable to information provided by an idle switch associated with the accelerator pedal. Thus, such an idle switch, which is known in the art, can be avoided. Nevertheless, a combination of using information concerning positions of the throttle or fuel injector pump and information from an idle switch can be used in combination and/or substitution.

[0077] Before calibrating the accelerator pedal with respect to the idle operating condition, such information can be used to provide the threshold CH_1. For example, the threshold CH_1 can be defined to correspond to the accelerator pedal position for which the throttle exceeds the above named threshold. In this manner, a hysteresis behavior is obtained

leading to a further improvement of accuracy and reliability of a calibration of the accelerator pedal by defining a larger range of accelerator pedal position being considered as released. Here, it has to be noted that such "released" positions are not equivalent with the 0% position.

[0078] With respect to the full-load operating condition and, in particular, to a kick-down operating condition, it is contemplated to determine forces applied to the accelerator pedal to check whether the accelerator pedal is actually actuated for a kick-down operation of the vehicle and/or to utilize the above named kick-down unit (see section "calibration arrangement"). As an alternative thereto or in combination therewith it is further possible to determine whether the accelerator pedal is moved in a position exceeding the threshold CH_2 and/or the lower calibration limit CL_{20} with a predefined speed and/or in a predefined time. Further, the kick-down operating condition can be determined by analyzing whether the actual vehicle acceleration exceeds a predefined threshold or has reached a maximal value e.g. by means of an electronic control module of the vehicle. Comparable to the case of a calibration for the idle operating condition, such information can be used prior and/or subsequently to the respective calibration of accelerator pedal positions and/or in combination therewith to determine whether the full-load operating condition is actually existing. For example, it is possible to indicate the existence of a kick-down operating condition if a position of the accelerator pedal exceeds a first threshold (kick-down threshold) while an vehicle operating condition being no kick-down operating condition is indicated if a position of the accelerator pedal falls below a second threshold (no kick-down threshold). By defining the first and second thresholds being different from each other, a hysteresis behavior is obtained leading to a further improvement of accuracy and reliability of a calibration of the accelerator pedal by defining a larger range of accelerator pedal positions being considered as fully depressed. Here, it has to noted that such "fully depressed" positions are not equivalent with the 100% position.

[0079] On the basis of the combined calibrated values CV_1 and CV_2 or values resulting from single calibrations for the accelerator pedal positions characterizing the idle and the full-load conditions all accelerator pedal positions there between are calibrated. This can be accomplished by linearizing between the combined calibrated values CV_1 and CV_2. In order to obtain a progressive or degressive accelerator pedal characteristic, any other function can be used for obtaining calibrated accelerator pedal positions between the combined calibrated values CV_1 and CV_2.

[0080] As an example, calibrated values for positions of the accelerator pedal can be calculated in dependence from the combined calibrated values CV_1 and CV_2 according to the following equation (1):

$$CPP = (MPP\text{-}CV_1\text{-}OS) * R / (CV_2\text{-}CV_1\text{-}OS), \quad (1)$$

wherein CPP is a calibrated pedal position, MPP is a measured (physical) pedal position, OS is an optional offset value and R is a resolution defined for pedal positions.

[0081] An exemplary value for the resolution R with which positions of the accelerator pedal can be measured is 250. Due to different effects it is possible that the calibrated pedal position indicating the 0% position of the accelerator pedal will not lead a respective low level signal (e.g. zero signal). Such effects include vehicle vibrations (e.g. due to driving conditions and motor vibrations), small calibration errors, mechanical characteristics of the accelerator pedal in the released position, signal drifts and the like. In order to compensate such situations, the offset OS can be used to force the calibrated pedal position indicating the 0% position of the accelerator pedal to a value leading to a desired respective low level signal. The offset OS can be defined, for example, in dependence of the actual driving situation such as driving over rough surfaces, driving at high or low speed, stop-and-go conditions, etc.

[0082] If the offset OS will result in one or more values for calibrated pedal positions below an allowable value range (e.g. values smaller than zero) such values can be set to a minimal allowable value (e.g. zero). In such a case the offset OS should be adjusted and/or a re-calibration should be performed.

Calibration of a brake pedal

[0083] Usually, for a brake pedal of a motor vehicle only one operating condition can be defined. This operating condition is the released operating condition of the brake pedal wherein no braking is to be effected for the vehicle. As illustrated in Fig. 4, the calibration of the brake pedal with respect to the released operating condition is comparable to the above described calibration of the accelerator pedal with respect to the idle operating condition. Thus, the respective description given for the accelerator pedal calibration accordingly applies for this calibration of the brake pedal, wherein the letter "B" amended to the reference numerals of Fig. 4 indicate their relation to a brake pedal.

[0084] In general, no defined or "solid" operating condition comparable to the above full-load operating condition can be characterized for conventional vehicle brake systems.

[0085] In such situations, a nominal of default value is used for characterizing a fully activated or depressed position of the brake pedal.

[0086] Enhanced vehicle brake systems can be equipped with sensors detecting that the brake pedal has moved into an end position, force sensors measuring forces applied to the brake pedal, sensors detecting positions of brake shoes, units which correlate braking conditions and brake pedal positions (e.g. emergency braking corresponds with a fully activated brake pedal position), and the like. As result, it is possible to define a full-activation operating condition for the brake pedal and, thus, to calibrate the brake pedal with respect to this operating condition. This is illustrated in Fig. 5, wherein the letter "B" of the reference numerals indicates their relation to a brake pedal. The calibration of the brake pedal with respect to the full-activation operating condition is comparable to the above described calibration of the accelerator pedal with respect to the full-load operating condition. Thus, the respective description given for the accelerator pedal calibration accordingly applies for this calibration of the brake pedal.

[0087] On the basis of the combined calibrated value BCV_1 (released brake pedal) and the nominal value or the combined calibrated value BCV_2 (fully depressed brake pedal) all brake pedal positions there between are calibrated. This can be accomplished by linearizing between these values. Again, this can also be performed on the basis of values obtained from single calibrations. In order to obtain a progressive or degressive brake pedal characteristic, any other function can be used for obtaining calibrated accelerator pedal positions.

[0088] As an example, calibrated values for positions of the brake pedal can be calculated in dependence from the combined calibrated values BCV_1 and BCV_2 according to the following equation (2):

$$CBPP = (MBPP-BCV_1-BOS) * BR / (BCV_2- BCV_1-BOS), \quad (2)$$

wherein CBPP is a calibrated pedal position, MBPP is a measured (physical) pedal position, BOS is an optional offset value and BR is a resolution defined for pedal positions.

[0089] In case a nominal value is used instead of the combined calibrated value BCV_2, the parameter BCV_2 in the above equation is accordingly replaced.

[0090] An exemplary value for the resolution BR with which positions of the accelerator pedal can be measured is 250. Due to different effects it is possible that the calibrated pedal position indicating the 0% position of the brake pedal will not lead a respective low level signal (e.g. zero signal). Such effects include vehicle vibrations (e.g. due to driving conditions and motor vibrations), small calibration errors, mechanical characteristics of the brake pedal in the released position and the like. In order to compensate such situations, the offset BOS can be used to force the calibrated pedal position indicating the 100% position of the brake pedal to a value leading to a desired respective low level signal. The offset BOS can be defined, for example, in dependence of the actual driving situation such as driving over rough surfaces, driving at high or low speed, stop-and-go conditions, etc.

[0091] If the offset BOS will result in one or more values for calibrated pedal positions below an allowable value range (e.g. values smaller than zero) such values can be set to a minimal allowable value (e.g. zero). In such a case the offset BOS should be adjusted and/or a re-calibration should be performed.

Calibration of a clutch pedal

[0092] Usually, for a clutch pedal of a motor vehicle only one operating condition can be defined. This operating condition is the released operating condition of the clutch pedal wherein an associated clutch is engaged. As illustrated in Fig. 6, the calibration of the clutch pedal with respect to the released operating condition is comparable to the above described calibration of the accelerator pedal with respect to the idle operating condition, wherein the letters "Cl" of the reference numerals indicate their relation to a clutch pedal. Thus, the respective description given for the accelerator pedal calibration accordingly applies for this calibration of the clutch pedal.

[0093] In general, no defined or "solid" operating condition comparable to the above full-load operating condition can be characterized for conventional vehicle clutch systems. In such situations, a nominal of default value is used for characterizing a fully activated of depressed position of the clutch pedal.

[0094] Enhanced vehicle clutch systems can be equipped with sensors detecting that the clutch pedal has moved into an end position, force sensors measuring forces applied to the clutch pedal, sensors detecting positions of the clutch itself, units which correlate conditions of the clutch and clutch pedal positions (e.g. a complete release of the clutch corresponds with a fully activated clutch pedal position), and the like. As result, it is possible to define a full-activation operating condition for the clutch pedal and, thus, to calibrate the clutch pedal with respect to this operating condition. This is illustrated in Fig. 7, wherein the letters "Cl" of the reference numerals indicate their relation to a clutch pedal. The calibration of the clutch pedal with respect to the full-activation operating condition is comparable to the above described calibration of the accelerator pedal with respect to the full-load operating condition. Thus, the respective description given for the accelerator pedal calibration accordingly applies for this calibration of the clutch pedal.

[0095] On the basis of the combined calibrated value $CICV_1$ (released clutch pedal) and the nominal value or the combined calibrated value $CICV_2$ (fully depressed clutch pedal) all clutch pedal positions there between are calibrated. Again, this can also be performed on the basis of values obtained from single calibrations. This can be accomplished by linearizing between these values. In order to obtain a progressive or degressive clutch pedal characteristic, any other function can be used for obtaining calibrated clutch pedal positions.

[0096] As an example, calibrated values for positions of the clutch pedal can be calculated in dependence from the combined calibrated values BCV_1 and BCV_2 according to the following equation (3):

$$CCIPP = (MCIPP\text{-}CICV_1\text{-}CLOS) * CIR / (CICV_2\text{-}CICV_1\text{-}CIOS), \quad (3)$$

wherein CCIPP is a calibrated pedal position, MCIPP is a measured pedal position, CIOS is an optional offset value and CIR is a resolution defined for pedal positions.

[0097] In case a nominal value is used instead of the combined calibrated value $CICV_2$, the parameter $CICV_2$ in the above equation is accordingly replaced.

[0098] An exemplary value for the resolution CIR with which positions of the clutch pedal can be measured is 250. Due to different effects it is possible that the calibrated pedal position indicating the released position of the clutch pedal will not lead a respective low level signal (e.g. zero signal). Such effects include vehicle vibrations (e.g. due to driving conditions and motor vibrations), small calibration errors, mechanical characteristics of the clutch pedal in the released position and the like. In order to compensate such situations, the offset CIOS can be used to force the calibrated pedal position indicating the released position of the clutch pedal to a value leading to a desired respective low level signal. The offset CIOS can be defined, for example, in dependence of the actual driving situation such driving over rough surfaces, driving at high or low speed, stop-and-go conditions, etc.

[0099] If the offset CIOS will result in one or more values for calibrated pedal positions below an allowable value range (e.g. values smaller than zero) such values can be set to a minimal allowable value (e.g. zero). In such a case the offset CIOS should be adjusted and/or a re-calibration should be performed.

Claims

1. A method for calibrating at least one position of a pedal in a motor vehicle, comprising the steps of:

- determining actual positions of the pedal (2),
- determining the actual operating condition of the motor vehicle,
- comparing the determined actual operating condition of the vehicle with a first predefined operating condition,
- when the actual operating condition of the vehicle corresponds to the first predefined operating condition, determining whether the actual positions of the pedal (2) are within a first variation range (VR_1, BVR_1, $CIVR_1$) for a first calibration time (CT_1, BCT_1, $CICT_1$),
- in case the latter determination is positive, associating a first calibrated value indicating a position of the pedal (2) within the first variation range (VR_1, BVR_1, $CIVR_1$) with the first predefined operating condition for the vehicle, so as to calibrate the pedal (2) with respect to the first predefined operating condition, and defining a first calibration hysteresis (CH1, BCH1, CICH1) indicating a range of pedal positions wherein the existence of the first predefined operating condition is assumed and which has to be left before a subsequent calibration of the pedal (2) can be performed.

2. The method according to claim 1, comprising the steps of:

- repeating the steps according to claim 1 at least once,
- combining at least two of first calibrated values associated with the first predefined operating condition to obtain a first combined calibrated value (CV_1, BCV_1, $CICV_1$), and
- associating the first combined calibrated value (CV_1, BCV_1, $CICV_1$) indicating position of the pedal (2) to the first predefined operating condition for the vehicle so as to calibrate the pedal (2) with respect to the first predefined operating condition.

3. The method according to claim 2, comprising the step of:

basing the first combined calculated value (CV_1, BCV_1, $CICV_1$) only on first calculated values associated with

the first predefined operating condition within a first allowable range (AR_1, BAR_1, $CIAR_1$).

4. The method according to one of the preceding claims, comprising the steps of:

- determining whether actual positions of the pedal (2) are within a second variation range (VR_2, BVR_2, $CIVR_2$) for a second calibration time (CT_2, BCT_2, $CICT_2$), when the vehicle is in a second predefined operating condition, and
- associating, in case the determination is positive, a second calibrated value indicating a position of the pedal (2) with the second variation range (VR_2, BVR_2, $CIVR_2$) to the second predefined operating condition for the vehicle so as to calibrate the pedal (2) with respect to the second predefined operating condition.

5. The method according to claim 4, comprising the step of:

defining a second calibration hysteresis (CH_2, BCH_2, $CICH_2$) indicating a range of pedal positions wherein the existence of the second predefined operating condition is assumed and/or which has to be left before a subsequent calibration of the pedal (2) can be performed.

6. The method according to claim 4 or 5, comprising the steps of:

- repeating the steps according to claim 4 or 5 at least once,
- combining at least two of second calibrated values (CV_2, BCV_2, $CICV_2$) associated with the second predefined operating condition to obtain a second combined calibrated value (CV_2, BCV_2, $CICV_2$), and
- associating the second combined calibrated (CV_2, BCV_2, $CICV_2$) value indicating position of the pedal (2) to the second predefined operating condition for the vehicle so as to calibrate the pedal (2) with respect to the second predefined operating condition.

7. The method according to claim 6, comprising the step of:

basing the second combined calculated value (CV_2, BCV_2, $CICV_2$) only on second calculated values associated with the second predefined operating condition within an second allowable range (AR_2, BAR_2, $CIAR_2$).

8. The method according to one of the preceding claims, comprising the step of :

calculating calibrated values for positions of the pedal (2) by calibrating actual positions of the pedal (2) in dependence from

-- the first calibrated value according to claim 1, or
-- the first calibrated value according to claim 1 and second calibrated value according to claim 4, or
-- the first combined calculated value (CV_1, BCV_1,$CICV_1$) according to claim 2, or
-- the first combined calculated value (CV_1, BCV_1, $CICV_1$) according to claim 2 and second combined calculated value (CV_2, BCV_2, $CICV_2$) according to claim 6.

9. The method according to one of the preceding claims, comprising the steps of:

- calculating the first calibrated value according to claim 1 on the basis of at least one of the actual positions of the pedal (2) in the first variation range (VR_1, BVR_1, $CIVR_1$) during the first calibration time (CT_1, BCT_1, $CICT_1$), and/or
- calculating the second calibrated value according to claim 4 on the basis of at least one of the actual positions of the pedal (2) in the second variation range (VR2, BVR2, CIVR2) during the second calibration time (CT2, BCT2, CICT2).

10. The method according to one of the preceding claims, comprising the steps of:

- defining a first calibration range (CR_1, BCR_1, $CICR_1$) comprising the first variation range (VR_1, BVR_1, $CIVR_1$) and starting the determination step if an actual position of the pedal (2) is within the first calibration range (CR_1, BCR_1, $CICR_1$), and/or
- defining a second calibration range (CR_2, BCR_2, $CICR_2$) comprising the second variation range (VR_2, BVR_2, $CIVR_2$) and starting the determination step if an actual position of the pedal (2) is within the second calibration

range (CR_2, BCR_2, $CICR_2$).

11. An apparatus for calibrating a pedal in a motor vehicle, comprising:

- a pedal position measuring unit (4) for measuring positions of a pedal (2), and
- a processing unit (6) being coupled to the pedal position measuring unit (4) and being adapted to perform the steps according to one of the claims 1 to 10.

12. A software program product, comprising:

program code portions which when executed under control of a computer system causes the computer system to carry out the steps according one of the claims 1 to 10.

13. The software program product according to claim 12, being stored on a computer readable storage medium or in a computer readable storage device.

14. A motor vehicle, comprising:

- a pedal (2), wherein at least one position of the pedal (2) is calibrated by carrying out the steps according to one of the claims 1 to 10, or
- a pedal (2), wherein at least one position of the pedal (2) is calibrated by means of the apparatus according to claim 11, or
- a pedal (2) and an apparatus according to claim 11, or
- a vehicle electronic control unit and the software program product according to claim 12 or 13 being adapted to be executed by the vehicle electronic control unit.

Patentansprüche

1. Verfahren zum Eichen mindestens einer Stellung eines Pedals in einem Kraftfahrzeug, mit den Schritten:

- Feststellen von Iststellungen des Pedals (2),
- Feststellen des Istbetriebszustands des Kraftfahrzeugs,
- Vergleichen des festgestellten Istbetriebszustands des Fahrzeugs mit einem ersten vorbestimmten Betriebszustand,
- wenn der Istbetriebszustand des Fahrzeugs dem ersten vorbestimmten Betriebszustand entspricht, Feststellen, ob die Iststellungen des Pedals (2) während einer ersten Eichzeit (CT_1, PCT_1, $CICT_1$) innerhalb eines ersten Variationsbereichs (VR_1, BVR_1, $CIVR_1$) sind,
- wenn die letztgenannte Feststellung positiv ist, Zuordnen eines ersten, eine Stellung des Pedals (2) innerhalb des ersten Variationsbereichs (VR_1, BVR_1, $CIVR_1$) anzeigenden Eichwerts zu dem ersten vorbestimmten Betriebszustand des Fahrzeugs, so dass das Pedal (2) mit Bezug auf den ersten vorbestimmten Betriebszustand geeicht wird, und Festlegen einer ersten Eichhysterese (CH1, BCH1, CICH1), die einen Bereich von Pedalstellungen angibt, in welchem die Existenz des ersten vorbestimmten Betriebszustands angenommen wird, und welcher verlassen werden muss, ehe eine nachfolgende Eichung des Pedals (2) durchgeführt werden kann.

2. Verfahren nach Anspruch 1, mit den Schritten:

- mindestens einmaliges Wiederholen der Schritte gemäß Anspruch 1,
- Verbinden von mindestens zwei ersten Eichwerten, die dem ersten vorbestimmten Betriebszustand zugeordnet sind, um einen ersten kombinierten Eichwert (CV_1, BCV_1, $CICV_1$) zu erhalten, und
- Zuordnen des ersten, die Stellung des Pedals (2) anzeigenden kombinierten Eichwerts (CV_1, BCV_1, $CICV_1$) zu dem ersten vorbestimmten Betriebszustand für das Fahrzeug, so dass das Pedal (2) hinsichtlich des ersten vorbestimmten Betriebszustands geeicht wird.

3. Verfahren nach Anspruch 2 mit dem Schritt:

Aufbauen des ersten kombinierten errechneten Werts (CV_1, BCV_1, $CICV_1$) auf nur den ersten errechneten Werten, die dem ersten vorbestimmten Betriebszustand innerhalb eines ersten zulässigen Bereichs (AR_1, BAR_1,

$CIAR_1$) zugeordnet sind.

4. Verfahren nach einem der vorangehenden Ansprüche, mit den Schritten:

- Feststellen, ob Iststellungen des Pedals (2) innerhalb eines zweiten Variationsbereichs (VR_2, BVR_2, $CIVR_2$) während einer zweiten Eichzeit (CT_2, BCT_2, $CICT_2$) liegen, in der das Fahrzeug in einem zweiten vorbestimmten Betriebszustand ist, und
- falls die Feststellung positiv ist, Zuordnen eines zweiten Eichwerts, der eine Stellung des Pedals (2) in dem zweiten Variationsbereich (VR_2, BVR_2, $CICR_2$) anzeigt, zu dem zweiten vorbestimmten Betriebszustand des Fahrzeugs, so dass das Pedal (2) hinsichtlich des zweiten vorbestimmten Betriebszustand geeicht wird.

5. Verfahren nach Anspruch 4, mit dem Schritt:

Festlegen einer zweiten Eichhysterese (CH_2, BCH_2, $CICH_2$), die einen Bereich von Pedalstellungen angibt, in dem das Vorliegen des zweiten vorbestimmten Betriebszustands angenommen wird und/oder der verlassen werden muss, ehe eine nachfolgende Eichung des Pedals (2) durchgeführt werden kann.

6. Verfahren nach Anspruch 4 oder 5, mit den Schritten:

- mindestens einmaliges Wiederholen der Schritte gemäß Anspruch 4 oder 5,
- Kombinieren von mindestens zwei zweiten Eichwerten (CV_2, BCV_2, $CICV_2$), die dem zweiten vorbestimmten Betriebszustand zugeordnet sind, um einen zweiten kombinierten Eichwert (CV_2, BCV_2, $CICV_2$) zu erhalten, und
- Zuordnen des zweiten kombinierten Eichwerts (CV_2, BCV_2, $CICV_2$), der eine Stellung des Pedals (2) anzeigt, zu dem zweiten vorbestimmten Betriebszustand des Fahrzeugs, so dass das Pedal (2) hinsichtlich des zweiten vorbestimmten Betriebszustands geeicht wird.

7. Verfahren nach Anspruch 6, mit dem Schritt:

Aufbauen des zweiten kombinierten errechneten Werts (CV_2, BCV_2, $CICV_2$) auf nur zweite errechnete Werte, die dem zweiten vorbestimmten Betriebszustand innerhalb eines zweiten zulässigen Bereichs (AR_2, BAR_2, $CIAR_2$) zugeordnet sind.

8. Verfahren nach einem der vorangehenden Ansprüche, mit dem Schritt:

Errechnen von Eichwerten für die Stellungen des Pedals (2) durch Eichen von Iststellungen des Pedals (2) in Abhängigkeit von

-- dem ersten Eichwert gemäß Anspruch 1, oder
-- dem ersten Eichwert gemäß Anspruch 1 und dem zweiten Eichwert gemäß Anspruch 4, oder
-- dem ersten kombinierten errechneten Wert (CV_1, BCV_1, $CICV_1$) gemäß Anspruch 2, oder
-- dem ersten kombinierten errechneten Wert (CV_1, BCV_1, $CICV_1$) gemäß Anspruch 2 und dem zweiten kombinierten errechneten Wert (CV_2, BCV_2, $CICV_2$) gemäß Anspruch 6.

9. Verfahren nach einem der vorangehenden Ansprüche, mit den Schritten:

- Errechnen des ersten Eichwerts gemäß Anspruch 1 aufgrund mindestens einer der Iststellungen des Pedals (2) im ersten Variationsbereich (VR_1, BVR_1, $CIVR_1$) während der ersten Eichzeit (CT_1, BCT_1, $CICT_1$), und/oder
- Errechnen des zweiten Eichwerts gemäß Anspruch 4 aufgrund mindestens einer der Iststellungen des Pedals (2) im zweiten Variationsbereich (VR_2, BVR_2, $CIVR_2$) während der zweiten Eichzeit (CT_2, BCT_2, $CICT_2$).

10. Verfahren gemäß einem der vorangehenden Ansprüche, mit den Schritten:

- Festlegen eines ersten Eichbereichs (CR_1, BCR_1, $CICR_1$), der den ersten Variationsbereich (VR_1, BVR_1, $CIVR_1$) umfasst, und Beginnen des Feststellungsschritts, wenn eine Iststellung des Pedals (2) innerhalb des ersten Eichbereichs (CR_1, BCR_1, $CICR_1$) ist, und/oder
- Festlegen eines zweiten Eichbereichs (CR_2, BCR_2, $CICR_2$), der den zweiten Variationsbereich (VR_2, BVR_2, $CIVR_2$) umfasst, und Beginnen des Feststellungsschritts; wenn eine Iststellung des Pedals (2) innerhalb des zweiten Eichbereichs (CR_2, BCR_2, $CICR_2$) ist.

11. Einrichtung zum Eichen eines Pedals in einem Kraftfahrzeug, mit:

- einer Pedalstellungsmesseinheit (4) zum Messen von Stellungen eines Pedals (2), und
- einer Verarbeitungseinheit (6), die mit der Pedalsstellungsmesseinheit (4) verbunden und geeignet ist, die Schritte gemäß einem der Ansprüche 1 bis 10 auszuführen.

12. Softwareprogrammprodukt mit:

Programmcodeteilen, die bei ihrer Ausführung unter Kontrolle eines Computersystems dieses veranlassen, die Schritte gemäß einem der Ansprüche 1 bis 10 auszuführen.

13. Softwareprogrammprodukt gemäß Anspruch 2, das in einem computerlesbaren Speichermedium oder in einer computerlesbaren Speichereinrichtung gespeichert ist.

14. Kraftfahrzeug mit:

- einem Pedal (2), wobei mindestens eine Stellung des Pedals (2) durch Ausführen der Schritte nach einem der Ansprüche 1 bis 10 geeicht ist, oder
- einem Pedal (2), wobei mindestens eine Stellung des Pedals (2) mittels der Einrichtung gemäß Anspruch 11 geeicht ist, oder
- einem Pedal (2) und einer Einrichtung gemäß Anspruch 11, oder
- einer elektronischen Fahrzeugsteuereinheit und dem Softwareprogrammprodukt gemäß Anspruch 12 oder 13, das geeignet ist, von der elektronischen Fahrzeugsteuereinheit ausgeführt zu werden.

Revendications

1. Procédé de calibrage d'au moins une position d'une pédale dans un véhicule à moteur, comprenant les étapes consistant à :

- déterminer les positions réelles de la pédale (2),
- déterminer la condition de fonctionnement réelle du véhicule à moteur,
- comparer la condition de fonctionnement réelle déterminée du véhicule avec une première condition de fonctionnement prédéfinie,
- lorsque la condition de fonctionnement réelle du véhicule correspond à la première condition de fonctionnement prédéfinie, déterminer si les positions réelles de la pédale (2) se trouvent dans une première plage de variation (VR_1, BVR_1, $CIVR_1$) pour un premier moment de calibrage (CT_1, BCT_1, $CICT_1$),
- dans le cas dans lequel la dernière détermination est positive, associer une premier valeur calibrée indiquant une position de la pédale (2) à l'intérieur de la première plage de variation (VR_1, BVR_1, $CIVR_1$) avec la première condition de fonctionnement prédéfinie pour le véhicule, de telle manière à calibrer la pédale (2) par rapport à la première condition de fonctionnement prédéfinie et définir une première hystérèse de calibrage (CH1, BCH1, CICH1) indiquant une plage de positions de pédale dans laquelle l'existence de la première condition de fonctionnement prédéfinie est assumée et qui doit être quittée avant qu'un calibrage suivant de la pédale (2) ne puisse être réalisé.

2. Procédé selon la revendication 1, comprenant les étapes consistant à :

- répéter les étapes selon la revendication 1 au moins une fois,
- combiner au moins deux des premières valeurs calibrées associées avec la première condition de fonctionnement prédéfinie pour obtenir une première valeur calibrée combinée (CV_1, BCV_1, $CICV_1$), et
- associer la première valeur calibrée combinée (CV_1, BCV_1, $CICV_1$) indiquant la position de la pédale (2) avec la première condition de fonctionnement prédéfinie pour le véhicule de telle manière à calibrer la pédale (2) par rapport à la première condition de fonctionnement prédéfinie.

3. Procédé selon la revendication 2, comprenant l'étape consistant à :

baser la première valeur calculée combinée (CV_1, BCV_1, $CICV_1$) seulement sur des premières valeurs calculées associées avec la première condition de fonctionnement prédéfinie à l'intérieur d'une première plage permissible

(AR_1, BAR_1, $CIAR_1$).

4. Procédé selon l'une des revendications précédentes, comprenant les étapes consistant à :

- déterminer si les positions réelles de la pédale (2) se trouvent à l'intérieur d'une deuxième plage de variation (VR_2, BVR_2, $CIVR_2$) pendant un deuxième temps de calibrage (CT_2, BCT_2, $CICT_2$) lorsque le véhicule est dans une deuxième condition de fonctionnement prédéfinie, et
- associer, au cas où la détermination est positive, une deuxième valeur calibrée indiquant une position de la pédale (2) avec la deuxième plage de variation (VR_2, BVR_2, $CIVR_2$) à la deuxième condition de fonctionnement prédéfinie pour le véhicule de telle manière à calibrer la pédale (2) par rapport à la deuxième condition de fonctionnement prédéfinie.

5. Procédé selon la revendication 4, comprenant l'étape consistant à :

- définir une deuxième hystérèse de calibrage (CH_2, BCH_2, $CICH_2$) indiquant une plage de positions de pédale dans laquelle l'existence de la deuxième condition de fonctionnement est assumée et/ou doit être quittée avant qu'un calibrage suivant de la pédale (2) ne puisse être réalisé.

6. Procédé selon la revendication 4 ou 5, comprenant les étapes consistant à :

- répéter les étapes selon la revendication 4 ou 5 au moins une fois,
- combiner au moins deux des deuxièmes valeurs calibrées (CV_2, BCV_2, $CICV_2$) associées avec la deuxième condition de fonctionnement prédéfinie pour obtenir une deuxième valeur calibrée combinée (CV_2, BCV_2, $CICV_2$), et
- associer la deuxième valeur calibrée combinée (CV_2, BCV_2, $CICV_2$) indiquant la position de la pédale (2) à la deuxième condition de fonctionnement prédéfinie pour le véhicule de telle manière à calibrer la pédale (2) par rapport à la deuxième condition de fonctionnement prédéfinie.

7. Procédé selon la revendication 6, comprenant l'étape consistant à :

- baser la deuxième valeur calculée combinée (CV_2, BCV_2, $CICV_2$) seulement sur des deuxièmes valeurs calculées associées avec la deuxième condition de fonctionnement prédéfinie à l'intérieur d'une deuxième plage admissible (AR_2, BAR_2, $CIAR_2$).

8. Procédé selon l'une des revendications précédentes, comprenant l'étape consistant à :

calculer les valeurs calibrées pour les positions de la pédale (2) en calibrant des positions réelles de la pédale (2) en fonction de

-- la première valeur calibrée selon la revendication 1, ou
-- la première valeur calibrée selon la revendication 1 et la deuxième valeur calibrée selon la revendication 4, ou
-- la première valeur calculée combinée (CV_1, BCV_1, $CICV_1$) selon la revendication 2, ou
-- la première valeur calculée combinée (CV_1, BCV_1, $CICV_1$) selon la revendication 2 et la deuxième valeur calculée combinée (CV_2, BCV_2, $CICV_2$) selon la revendication 6.

9. Procédé selon l'une des revendications précédentes, comprenant les étapes consistant à :

- calculer la première valeur calibrée selon la revendication 1 sur la base d'au moins une des positions réelles de la pédale (2) dans la première plage de variation (VR_1, BVR_1, $CIVR_1$) pendant le premier temps de calibrage (CT_1, BCT_1, $CICT_1$), et/ou
- calculer la deuxième valeur calibrée selon la revendication 4 sur la base d'au moins une des positions réelles de la pédale (2) dans la deuxième plage de variation (VR2, BVR2, CIVR2) pendant le deuxième temps de calibrage (CT2, BCT2, CICT2).

10. Procédé selon l'une des revendications précédentes, comprenant les étapes consistant à :

- définir une première plage de calibrage (CR_1, BCR_1, $CICR_1$) comprenant la première plage de variation (VR_1,

BVR_1, $CIVR_1$) et commencer l'étape de détermination si une position réelle de la pédale (2) se trouve à l'intérieur de la première plage de calibrage (CR_1, BCR_1, $CICR_1$), et/ou
- définir une deuxième plage de calibrage (CR_2, BCR_2, $CICR_2$) comprenant la deuxième plage de variation (VR_2, BVR_2, $CIVR_2$) et commencer l'étape de détermination si une position réelle de la pédale (2) se trouve à l'intérieur de la deuxième plage de calibrage (CR_2, BCR_2, $CICR_2$).

11. Appareil pour calibrer une pédale dans un véhicule à moteur, comprenant :

- une unité de mesure de position de pédale (4) pour mesurer des positions d'une pédale (2), et
- une unité de traitement (6) étant couplée à l'unité de mesure de position de pédale (4) et étant adaptée à réaliser les étapes selon l'une des revendications 1 à 10.

12. Produit de programme logiciel, comprenant :

des parties de code de programme qui lorsqu'elles sont exécutées sous le contrôle d'un système d'ordinateur entraînent que le système d'ordinateur réalise les étapes selon l'une des revendications 1 à 10.

13. Produit de programme logiciel selon la revendication 12, étant stocké sur un support de stockage pouvant être lu par ordinateur ou dans un dispositif de stockage pouvant être lu par ordinateur.

14. Véhicule à moteur, comprenant :

- une pédale (2), dans lequel au moins une position de la pédale (2) est calibrée en réalisant les étapes selon l'une des revendications 1 à 10, ou
- une pédale (2), dans lequel au moins une position de la pédale (2) est calibrée au moyen de l'appareil selon la revendication 11, ou
- une pédale (2) et un appareil selon la revendication 11, ou
- une unité de commande électronique de véhicule et le produit de programme logiciel selon la revendication 12 ou 13 étant adapté à être exécuté par l'unité de commande électronique de véhicule.

"CALIBRATION ARRANGEMENT"

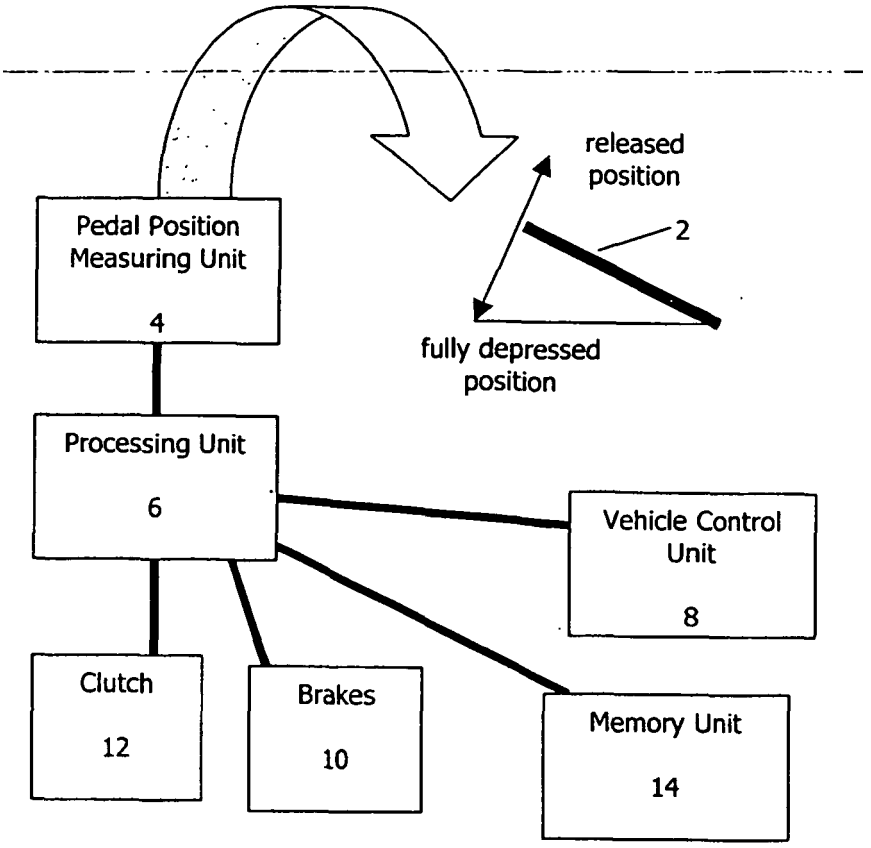


Fig. 1

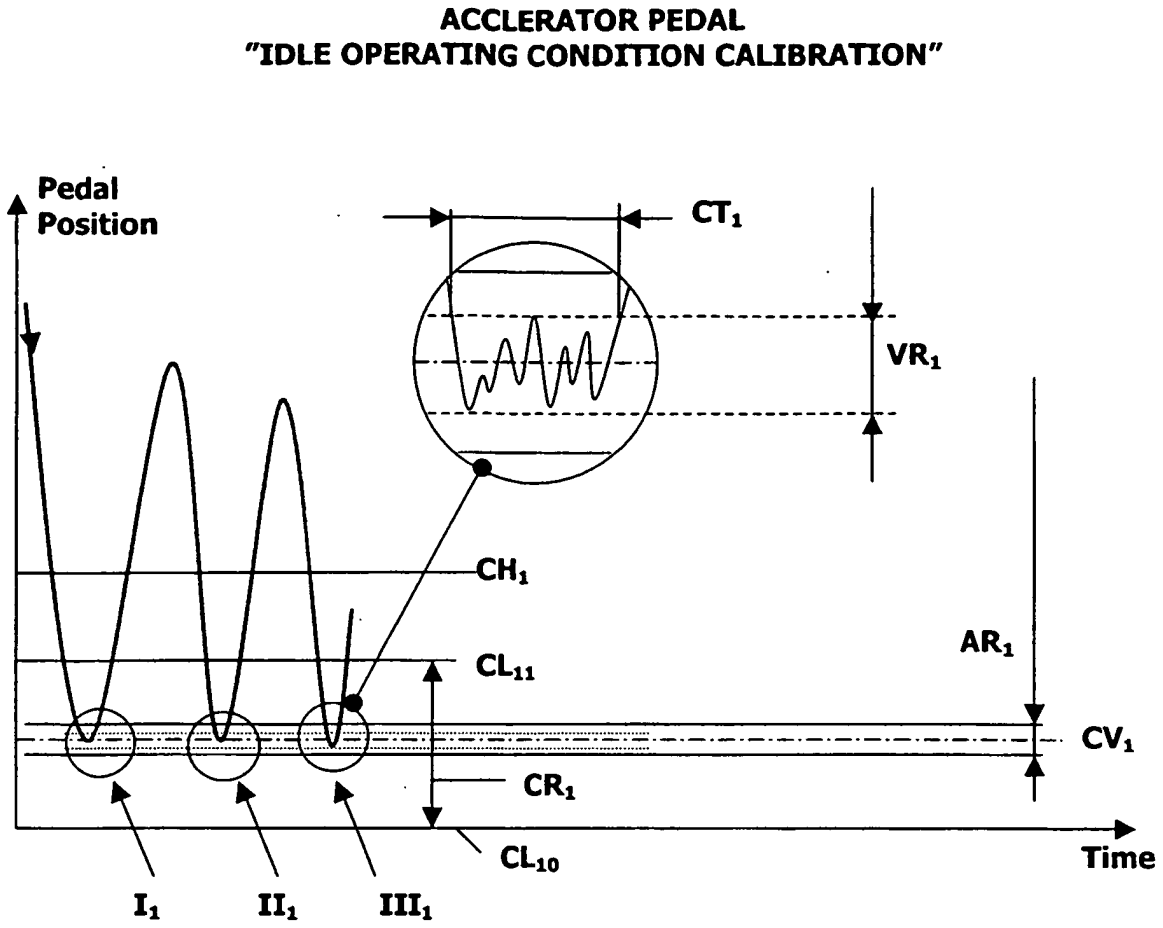

ACCLERATOR PEDAL
"IDLE OPERATING CONDITION CALIBRATION"
Pedal Position
CT1
VR1
CH1
CL11
AR1
CV1
CR1
CL10
Time
I1
II1
III1

Fig. 2

ACCLERATOR PEDAL
"FULL-LOAD OPERATING CONDITION CALIBRATION"

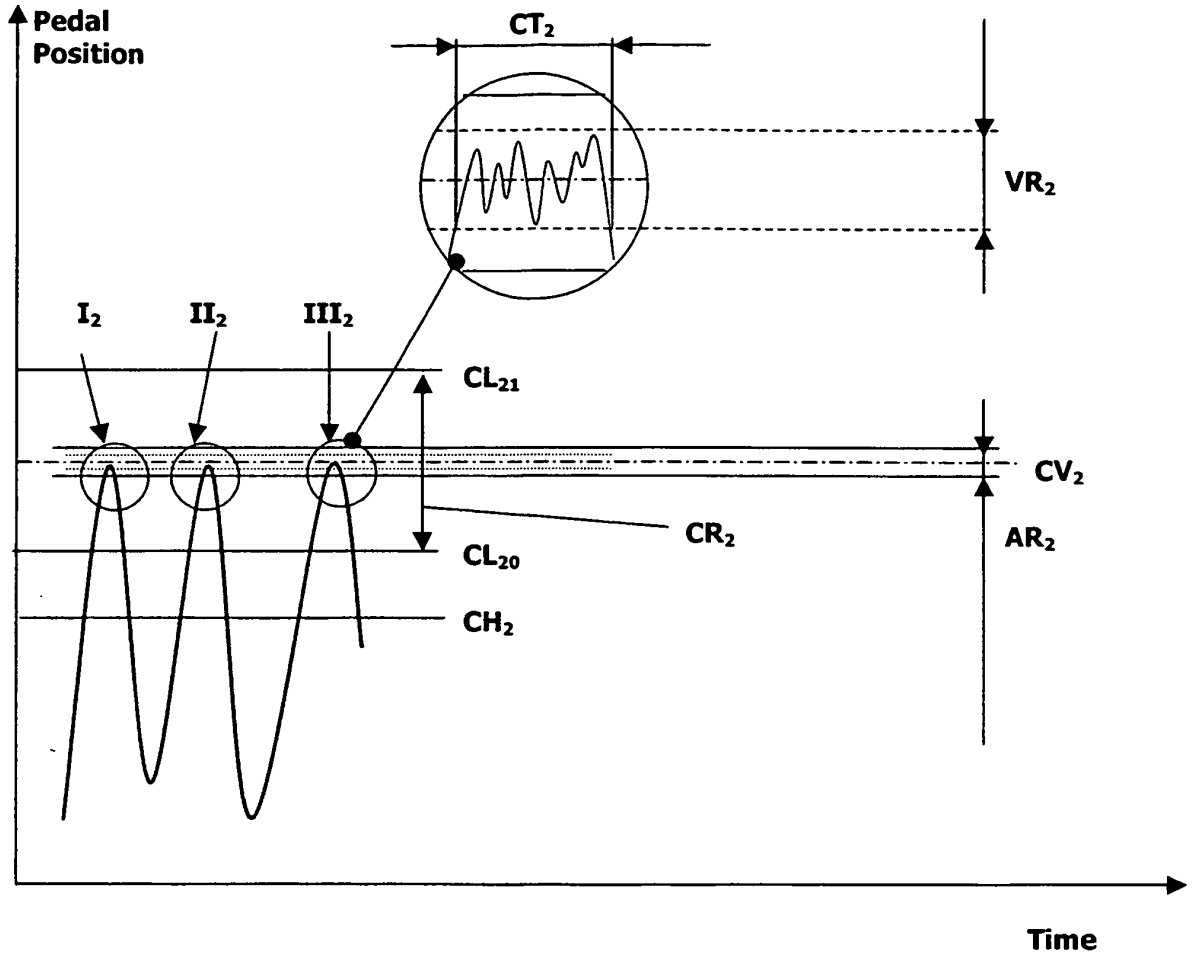


Fig. 3

BRAKE PEDAL
" RELEASED OPERATING CONDITION CALIBRATION"

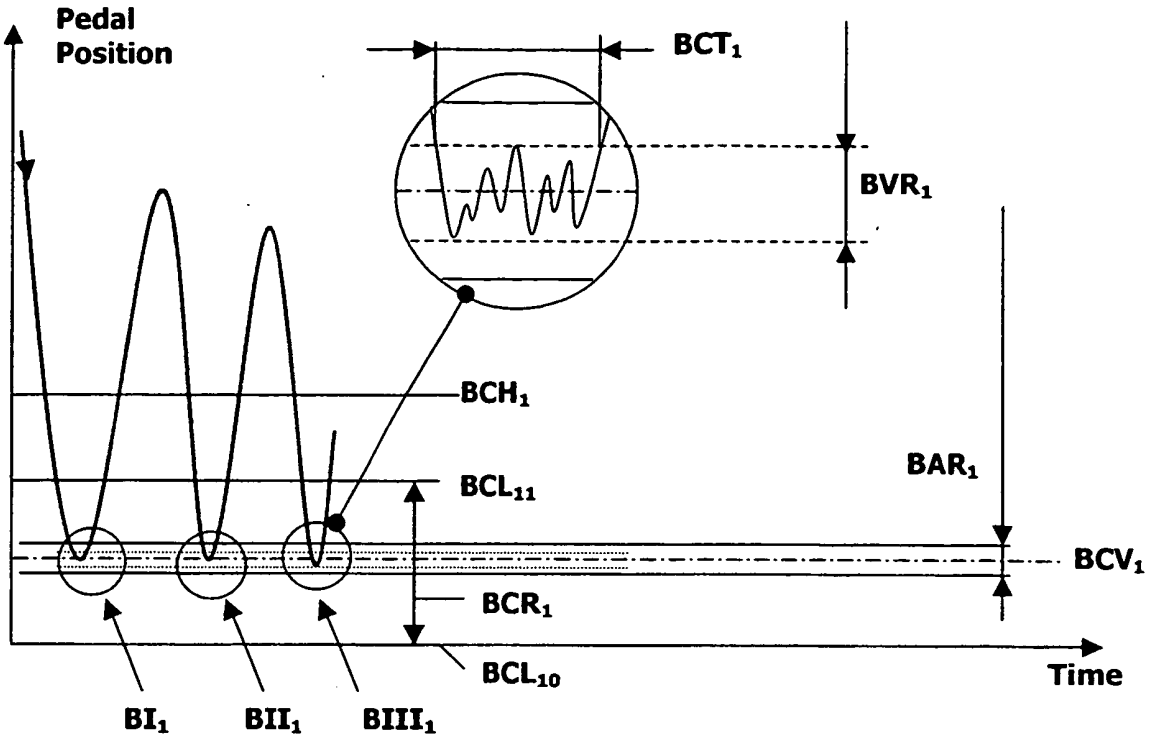


Fig. 4

BRAKE PEDAL
"FULL-ACTIVATION OPERATING CONDITION CALIBRATION"

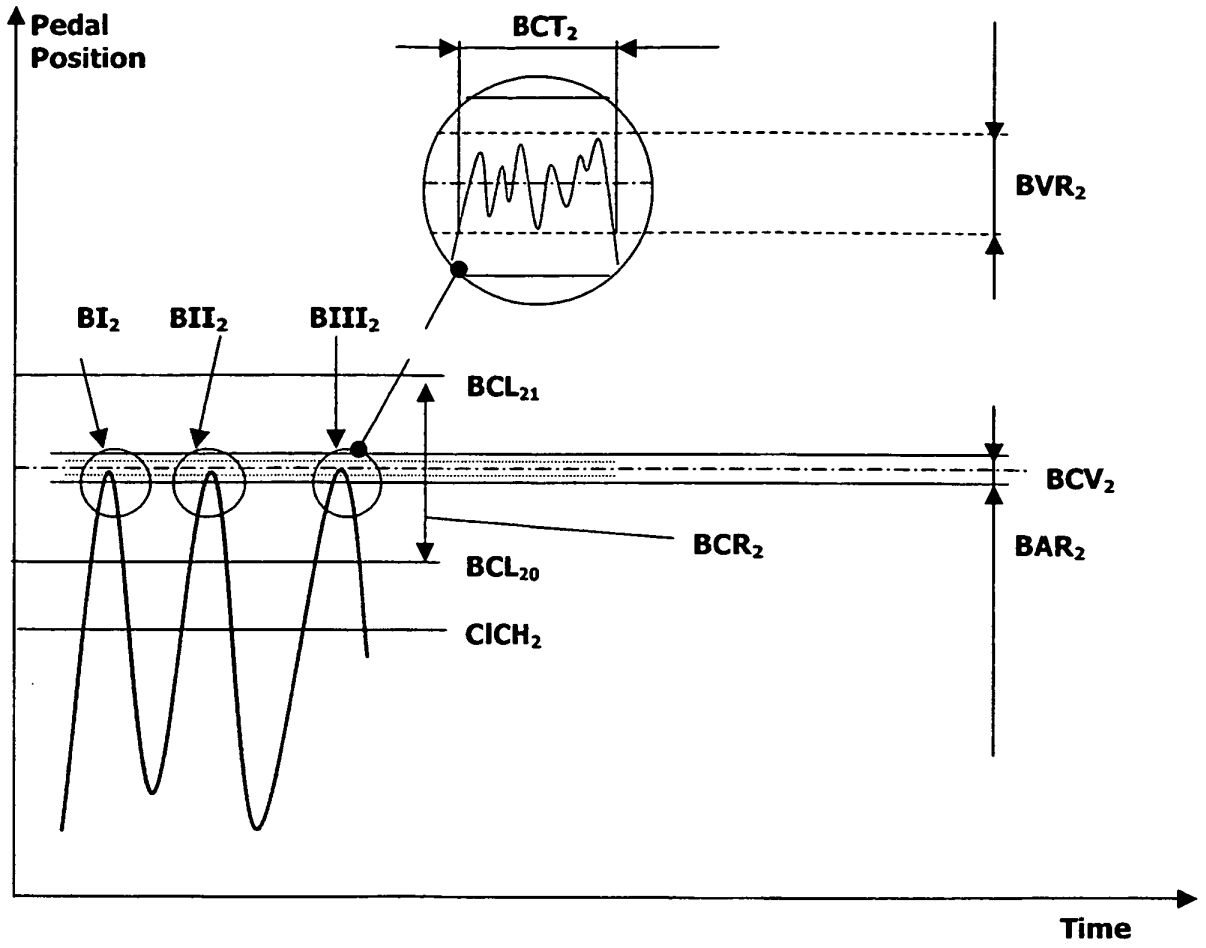


Fig. 5

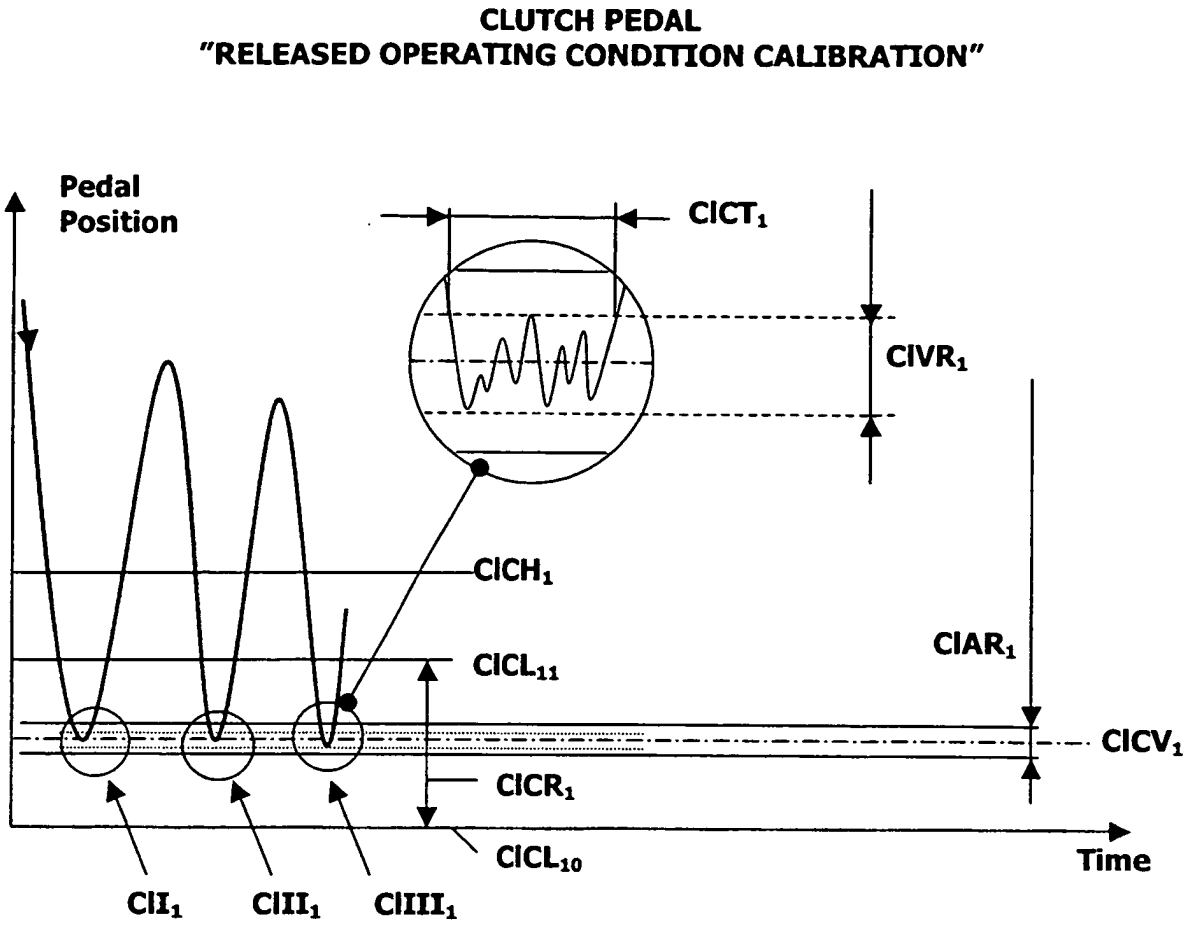

CLUTCH PEDAL
"RELEASED OPERATING CONDITION CALIBRATION"
Pedal Position
ClCT1
ClVR1
ClCH1
ClCL11
ClAR1
ClCV1
ClCR1
ClCL10
Time
ClI1
ClII1
ClIII1
ClIIII1

Fig. 6

CLUTCH PEDAL
"FULL-ACTIVATION OPERATING CONDITION CALIBRATION"

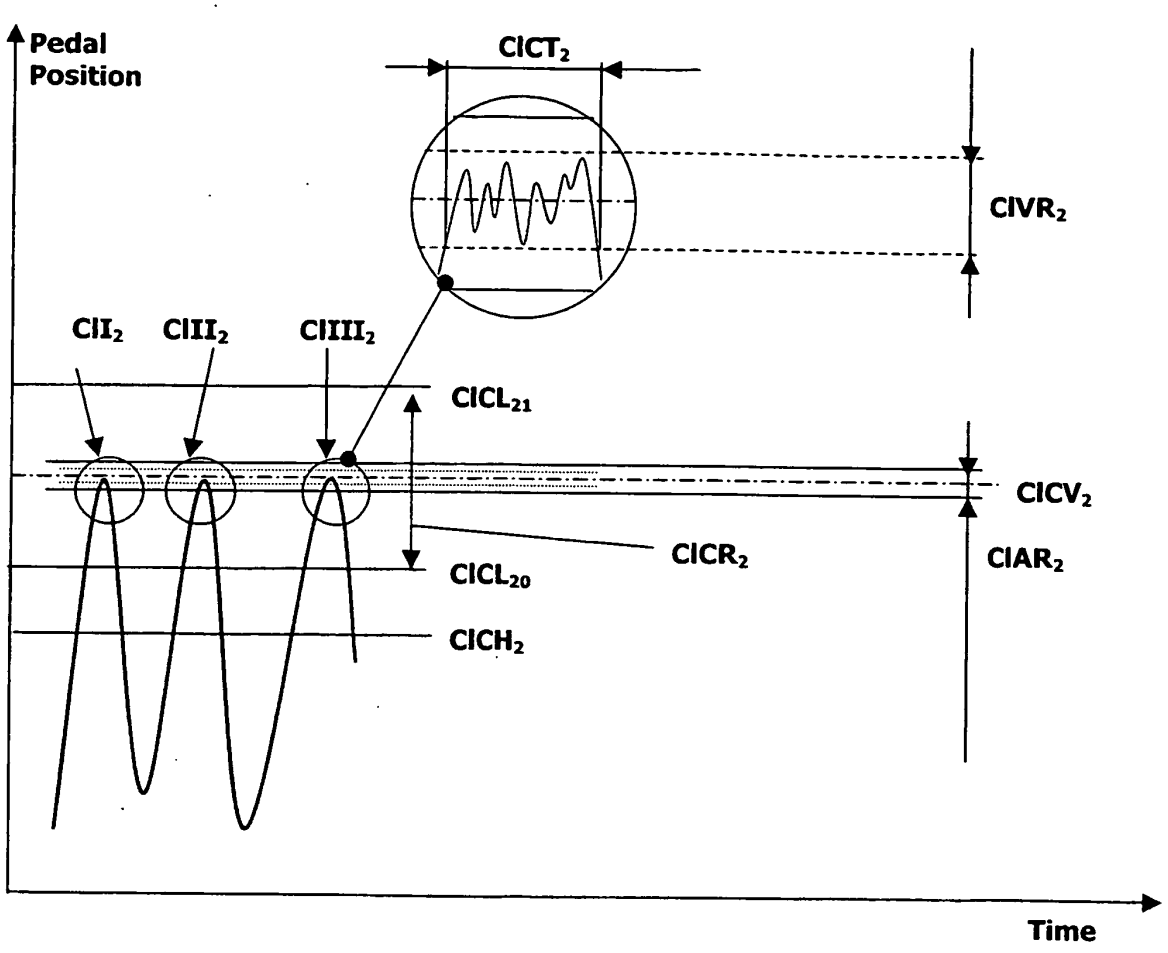


Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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