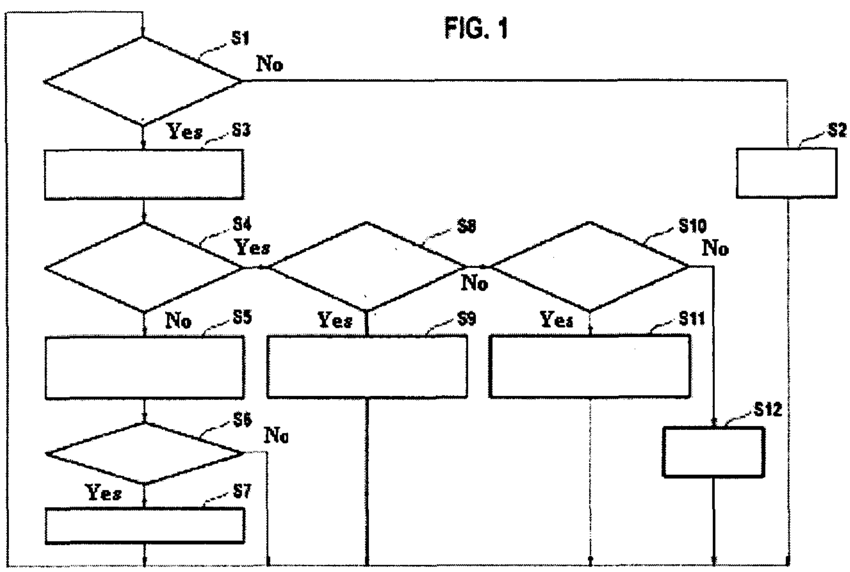
ORIGINAL

ABSTRACT

METHOD AND DEVICE FOR IMPROVING THE RESTART OF A VEHICLE WITH START-STOP SYSTEM

Described herein is a method for improving a restart of a vehicle equipped with start-stop operation, comprising an exciter winding associated to a starter generator of the vehicle and a control unit by which control signals of an exciting current influenced by the exciter winding flows. The method includes, through the control unit, checking, during a presence of a restart request occurring during phasing out of the internal combustion engine, whether an immediate restart is possible and sensible, and in case of an immediate restart is possible and sensible, guiding the immediate restart in a path. Further, control signals are provided during the phasing out the internal combustion engine in a stop phase of the start-stop operation, due to which the exciter winding is applied with a pre-excitation current in the stop phase and delays restart when an immediate restart is not possible or not sensible.

FIG. 1



I/We claim:

1. A method for improving a restart of a vehicle equipped with start-stop operation, comprising an exciter winding associated to a starter generator of the vehicle and a control unit by which control signals of an exciting current influenced by the exciter winding flows, the method comprising:

checking, by the control unit, during a presence of a restart request occurring during phasing out of the internal combustion engine, whether an immediate restart is possible and sensible; and

in case of an immediate restart is possible and sensible, guiding the immediate restart in a path;

characterized in that,

the method further comprises providing, by the control unit, control signals during the phasing out the internal combustion engine in a stop phase of the start-stop operation, due to which the exciter winding is applied with a pre-excitation current in the stop phase and delays restart when the immediate restart is not possible or not sensible.

2. The method as claimed in claim 1 further comprises, by the control unit, in the presence of restart request occurring during the phasing out of the internal combustion engine, checking whether an instantaneous speed of the internal combustion engine lies in a range of a resonance frequency of a flywheel arranged on the crankshaft of the internal combustion engine and, when this is the case, then delaying the restart is delayed.

3. The method as claimed in claim 1 or 2 further comprises, by the control unit, in the event of inability to restart immediately, initiating braking of the internal combustion engine in the path.

4. The method as claimed in claim 1 or 2 further comprises, by the control unit, in case an immediate restart is not possible or not sensible, phasing out the combustion engine while the starter generator of the vehicle is controlled for the purpose of influencing an outflow behavior of the internal combustion engine or for the purpose of achieving a passive behavior of the starter generator.

5. The method as claimed in one of the preceding claims further comprises, by the control unit, checking whether an immediate restart is possible and sensible by determining whether a current speed of the internal combustion engine lies in a predetermined speed range.

6. The method as claimed in one of the preceding claims further comprises, by the control unit, checking whether an immediate restart is possible and sensible by determining whether a crankshaft angle is in a predetermined angular range.

7. The method as claimed in any one of the preceding claims further comprises, by the control unit, checking whether an immediate restart is possible and sensible by checking whether an actuator of the vehicle is disposed in a predetermined state.

8. The method as claimed in one of the preceding claims, wherein initiating, by the control unit, the restart by controlling the stator of the starter generator in the path in the case of a possible and sensible immediate restart.

9. The method as claimed in one of the preceding claims further comprising, by the control unit, during the absence of the restart request occurring during the phasing out of the internal combustion engine, actuating the starter generator for the purpose of influencing the outflow behavior of the internal combustion engine or for the purpose of bringing about a passive behavior of the starter generator.

10. A device for improving the restart of a vehicle equipped with start-stop operation, comprising:

a starter generator (1) with an excitation winding; and

a control unit (6) connected with the starter generator via a line (7), wherein the control unit (6) is configured to perform a method as claimed in any preceding claim.

11. The device as claimed in claim 10, the device comprising:

a pulley (2) connected with the starter generator;

a crankshaft (8);

a pulley (5) arranged on the crankshaft; and a drive belt (3) placed around the pulley (2) of the starter generator (1) and the pulley (5) on the crankshaft (8).

12. The device as claimed in claim 10, wherein the starter generator is connected with the internal combustion engine or a drive of the vehicle by a chain, a shaft or a gear.

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To
The Controller of Patents
The Patent office at New Delhi

Applicant(s) Name: **ROBERT BOSCH GmbH** Sheet No.: 1

Application No.: Total No. of Sheets: 2

FIG. 1

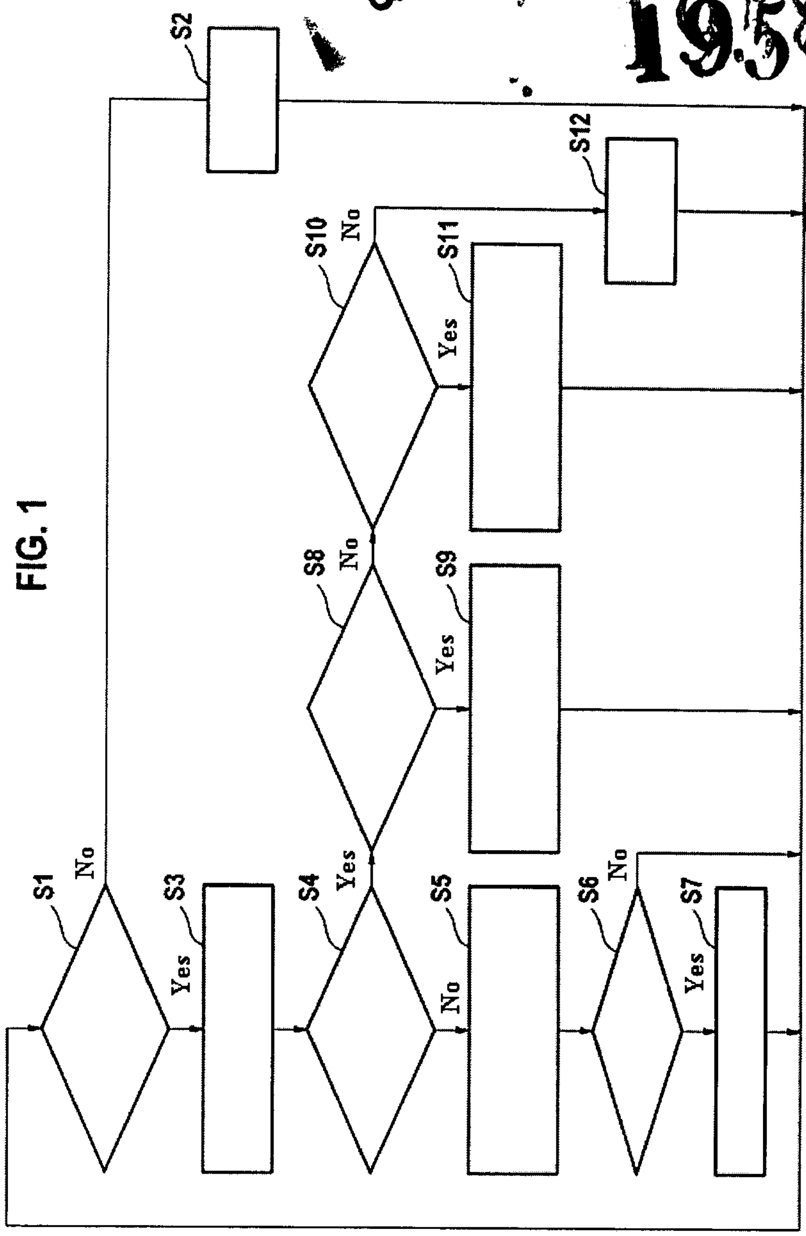

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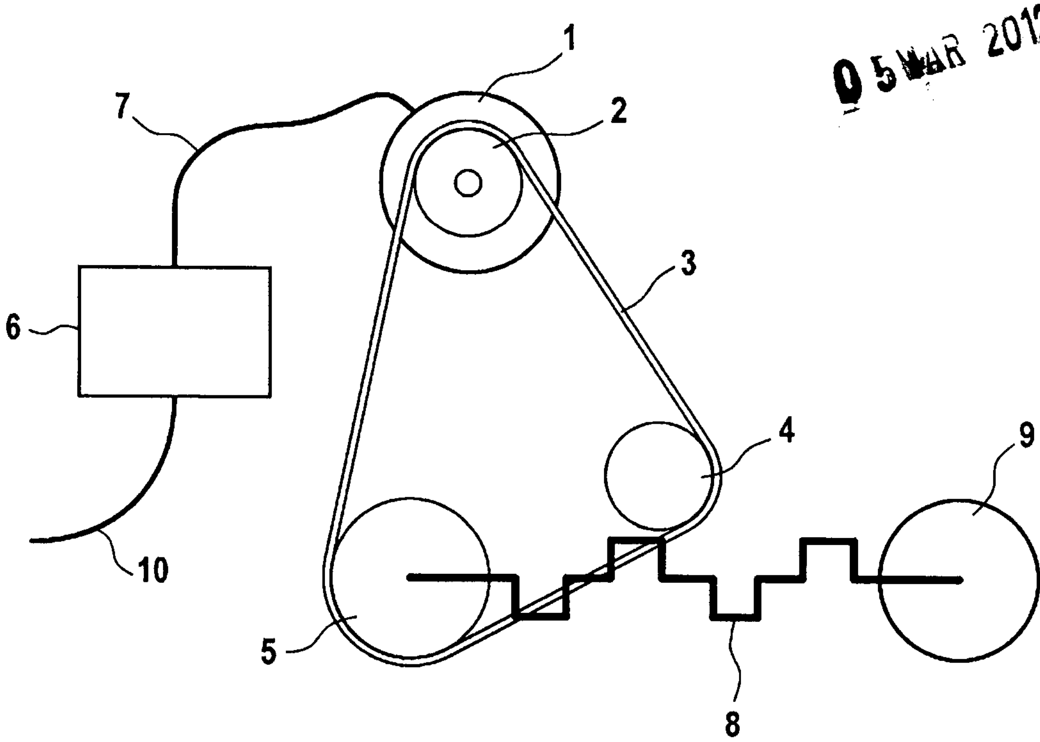
FIG. 2



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TECHNICAL FIELD

The present subject matter relates to a method and a device for improving a restart of a vehicle equipped with a start-stop operation.

BACKGROUND

Systems for stopping and restarting of internal combustion engines, particularly for the purpose of reducing fuel consumption and exhaust emissions, are known as start-stop systems.

Document EP 1 469 587 B1 discloses a device for improving the start-stop operation of a vehicle. This has a starter generator of an associated vehicle and energizing an exciter winding connected to an electrical system of the vehicle and a control unit. By the control signals provided from the control unit, the exciting current flowing through the excitation winding is influenced. In a stop phase of the start-stop operation, the control unit provides control signals, based on which the excitation winding in the stop phase is subjected to a pre-excitation.

Document DE 10 2006 057 892 A1 describes a method for biasing an electrical machine to automatically start an internal combustion engine of a motor vehicle with start-stop system. The biasing is done from a stop phase of the internal combustion engine initiated by an automatic engine stop within this stop phase, and the electric machine starts before the presence of a start-request for an automatic engine. Here, at least a starting time point of the parameters of the pre-magnetization, the amount of bias current, and a time duration for which a magnetization current is activated, are variable.

Document WO 2009/024724 A1 discloses a further method of stopping and restarting a motor vehicle. First the engine is stopped, an excitation current for a predetermined period is maintained and is turned-off at the end of the predetermined period of time.

SUMMARY

This summary is provided to introduce concepts related to a method and device for improving the restart of a vehicle with start-stop operation, and the concepts are further described below in the detailed description. This summary is neither intended to identify essential features of the claimed subject matter nor is it intended for use in determining or limiting the scope of the claimed subject matter.

In one embodiment, the subject matter describes a method for improving a restart of a vehicle equipped with start-stop operation, comprising an exciter winding associated to a starter generator of the vehicle and a control unit by which control signals of an exciting current influenced by the exciter winding flows. The method includes, through the control unit, checking, during a presence of a restart request occurring during phasing out of the internal combustion engine, whether an immediate restart is possible and sensible, and in case of an immediate restart is possible and sensible, guiding the immediate restart in a path. Further, control signals are provided during the phasing out the internal combustion engine in a stop phase of the start-stop operation, due to which the exciter winding is applied with a pre-excitation current in the stop phase and delays restart when an immediate restart is not possible or not sensible.

In another embodiment, the subject matter describes a device for improving the restart of a vehicle equipped with start-stop operation. The device includes a starter generator with an excitation winding, and a control unit connected with the starter generator via a line, wherein the control unit is configured to perform a method proposed according to the present subject matter.

BRIEF DESCRIPTION OF DRAWINGS

The detailed description is described with reference to the accompanying figures. Some embodiments of system and/or methods in accordance with embodiments of the present subject matter are now described, by way of example only, and with reference to the accompanying figures, in which:

Fig. 1 is a flowchart for explaining a method for improving the restart a vehicle equipped start-stop operation, in accordance with the present subject matter.

Fig. 2 shows a block diagram of a device for improving the restart of a vehicle equipped with start-stop operation, in accordance with the present subject matter.

DETAILED DESCRIPTION

A method for improving a restart of a vehicle equipped with start-stop operation specified in features of claim 1, has the advantage that in case of a restart request occurring during deceleration of the internal combustion engine, a time period to restart is held as small as possible, while ensuring that material loads are reduced and material destruction is avoided.

This applies, in particular, if a dual-mass flywheel is arranged on a crankshaft of the internal combustion engine. In this case, using the method according to the present subject matter, disturbing noises and vibrations that are caused by resonance effects of the dual mass flywheel are reduced, or avoided altogether. This also reduces costs, since the dual mass flywheel is relieved and can be sized accordingly cheaper.

Further, a reduction of fuel consumption and a reduction of exhaust gas emissions can be achieved. It can be made frequently by the use of a start-stop operation than in the state of the art.

Furthermore, road safety is improved because in case of a restart request occurring during the phasing out of the internal combustion engine restart, the engine can be started again. Thereby, the time period within which the vehicle can not be moved out of a danger zone, is reduced.

Further, the customer acceptance of start-stop systems is improved. Particularly, the present subject matter results in a reproducible starting behavior.

The present subject matter relates to a method for improving a restart of a vehicle equipped with start-stop operation having an exciter winding associated to a starter generator of the vehicle and a control unit, by which control signals of an exciting current influenced by the exciter winding is flowing, and where the control unit provides control signals in a stop phase of the start-stop operation, due to which the exciter winding is applied with a pre-excitation current in the stop phase, where, in case of a restart request occurring during the slow-down of the internal combustion engine, the control unit furthermore checks whether an immediate restart is possible and sensible, initiates an immediate restart if such immediate restart is possible and sensible, and delays restart if an immediate restart is not possible or not sensible.

Fig. 1 shows a flow chart for explaining a method for improving a restart of a vehicle equipped with start-stop operation.

The illustrated method assumes that the internal combustion engine of the vehicle is in operation. According to the shown method, it is determined, in a step S1, whether there exists a request to proceed to the stop mode. The request comes from a controller (not shown in the Fig. 1) and is generated automatically, for example, at traffic lights, when predetermined stop conditions are met. In addition, for example, a predetermined speed limit falls below during the simultaneous activation of the vehicle brake.

If there is no request before proceeding to the stop mode, then the normal operation of the vehicle continues in a subsequent step S2.

If, however, there is the request before proceeding to the stop mode, then the process transfers to a step S3. In step S3, the starter generator of the vehicle, which is a belt-driven starter generator or a directly-mounted starter-generator, is brought into a starting readiness status. The starting readiness status permits a rapid torque build-up in the case of the restart request occurring during the phase out of the internal combustion engine. For this purpose, the excitation current is switched on. In an embodiment, full excitation is possible, but not required. Consequently, in an embodiment, a partial excitation is set. The partial excitation is variable in dependence on the instantaneous operating state of the vehicle.

The starter generator is geared to a torque output according to step S3, and then in a step S4, a query takes place, whether there is restart request. Such a re-start request is triggered, for example, by actuation of an accelerator.

If there is no restart request, then in a step S5, it is ensured that the starter generator, whose exciter winding is supplied with an excitation current, gives neither an undesirably high electrical power nor gives an undesirably high mechanical performance. This is done by selecting an appropriate control of the stator of the starter generator, for example, by field-oriented control systems or by block-commutated systems by commutation. Here, the starter generator is actively driven in order to influence the outlet behavior using a controlled torque output. Thereby, the outlet of the internal combustion engine is controlled either by driving or braking, for example, for the purpose of a gentle outlet or for the purpose of positioning of the crankshaft in a desired angular position.

As an alternative to active control, a passive behavior of the starter generator can also be brought to drive the stator of the starter generator such that the starter generator is neutral to its mechanical interface.

In a subsequent step S6, a query whether the starter generator is stopped takes place. If this is the case, then, according to a step S7, the starter generator is maintained in the startup readiness state by ensuring that there is still an exciting current to hasten restart that occurs eventually. The elevation of the excitation current can be smaller than the maximum. Preferably, a variable adjustment of this excitation current takes place in dependence of the instantaneous operating state of the internal combustion engine.

The query in step S4 ensures that a restart request is present, and then a query takes place in a step S8 that whether an immediate restart is possible and is sensible. The criterion for whether an immediate restart is possible and sensible, it is checked whether the current speed of the combustion engine lies in a predetermined speed range.

Alternatively or additionally, it is determined whether a crankshaft angle is in a predetermined angular range. Alternatively or additionally, whether an immediate restart is possible and sensible to the current state of the electrical system and the nature and performance of the internal combustion engine serves as a criterion.

A not possible and not sensible, immediate restart is known, for example, if the current speed of the internal combustion engine lies in the range of a resonance frequency of a dual-mass flywheel arranged to the crankshaft.

One possible and sensible, immediate restart is known, if the current crankshaft angle is used in such a manner that a compression activity and an actual speed of the internal combustion engine lies in a desired speed range.

One possible and sensible, immediate restart is also known, for example, if special operating conditions of the internal combustion engine or a vehicle drive train are existing. For example, to wait until a butterfly valve or other actuator is so adjusted at the internal combustion engine such that a favorable condition exists for the restart.

In the query in step S8 however, it is recognized that an immediate restart is possible and sensible, then, in a step S9, the playback start initiated by the starter is controlled accordingly. Since the excitation current has been turned on and provides a rotor flux, where an appropriate control of the stator is required. Since the time constant of the stator is small, significant time savings while restarting is achieved by this procedure.

If the query in step S8, however, recognized that an immediate restart is not possible or sensible, then a query takes place in a step S10 whether deceleration of the internal combustion engine, for example, with the help of a braking torque built-up by the starter generator is required. This is, for example, the case when the rotational speed of the internal combustion engine is still larger than a predetermined speed threshold value.

If the query in the step S10 detects that the deceleration is required, then, according to a step S11, it is ensured that the required braking torque is built up.

If the query in step S10, however, recognizes that the braking is not required, then, according to a step S12, it is ensured that the internal combustion engine phases out. During this phase out, the control unit ensures that the starter generator, whose field winding is supplied with an excitation current, gives an undesirably high electrical power and an undesirably high level of mechanical performance. This is done by selecting the appropriate control of the stator of the starter generator, for example, by a field-oriented control or block commuting systems by commutation.

Here, the starter generator is actively controlled for the purpose of influencing the outlet behavior using a controlled-rotation torque. Thereby, the outlet of the internal combustion engine is controlled either by driving or by braking, for example, for the purpose of a gentle outlet or for positioning of the crankshaft in a desired angular position.

After performing the steps S2, S7, S9, S12 and S11, the flow returns to step S1. Even if the query in step S6 recognizes that the starter generator is not stopped, the flow returns to step S1.

The implementation of the method is described above for a control unit which is designed for performing the method described above. The control unit is shown as below with reference to Fig. 2 by a communication line in connection with other control units and sensors of the vehicle and is connected to the starter generator of the vehicle via a further line.

Fig. 2 shows a block diagram of a device for improving the restart of the vehicle equipped with start-stop operation.

The illustrated device comprises a belt-driven starter generator 1, a pulley 2 connected with the starter generator 1, a drive belt 3, a deflection and tensioning roller 4, a pulley 5 arranged on a crankshaft of the vehicle, a control unit 6, a line 7, a crank shaft 8, a dual-mass flywheel 9, and a communication line 10. The control unit 6 is provided to control the described method on the basis of Fig. 1.

The starter generator 1 is connected by a belt drive, which belongs to the pulley 2, the drive belt 3, the deflection and tensioning roller 4, and the pulley 5 connected with the crankshaft 8 of the combustion engine of the vehicle. The flywheel 9 is mounted on the crankshaft 8, wherein the flywheel is, for example, a dual-mass flywheel. In such a device, it is possible to transmit mechanical power between the crankshaft and the starter generator.

The control unit 6 is electrically connected to the starter generator 1 by the line 7. It can also be integrated into the starter generator 1. The performance-side activation of the starter generator is realized using the control unit 6. For this purpose, the control unit 6 has a pulse-controlled inverter built from semiconductor and a logic part. This includes a controller, on which the method described above is performed using a program code.

The control unit 6 is connected with other control units and sensors of the vehicle by the communication line 10 and exchanges data and information with these. For example, the control unit 6 communicates with an engine control unit, a transmission control unit, a network control unit and sensors for detecting the crankshaft angle and a battery state.

As an alternative to embodiment shown in the Fig. 2, the starter generator is also connected directly to the internal combustion engine or to the drive of the motor vehicle. In this case, the starter generator is connected with the internal combustion engine or the drive by means of a chain, a shaft, or a gear wheel.

The present subject matter allows a quick restart on restart request during the phasing out of the internal combustion engine. The driver of the motor vehicle can always rely on the fact that the internal combustion engine is all time available. This is achieved by the fact that the starter can accelerate the internal combustion engine through a torque input, before the internal combustion engine has stopped. This ensures that there is no annoying or even harmful material during operating conditions.

This is especially true when using a dual-mass flywheel connected with the crankshaft. Dual-mass flywheels inherently suffer from a resonance frequency, since they form as a dual-mass torsional oscillator. This resonance frequency is usually above the speed at which the internal combustion engine ignites for the first time, but below the idling speed of the internal combustion engine. Thus, the resonance range passes both when starting and when turning the internal combustion engine off.

The crankshaft speed staying in the resonance range leads to a noticeable vibration of the internal combustion engine. A damage of components can not be excluded up to the destruction of these components. Such operating states, in which damage or destruction of components can occur, are avoided in the present method.