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(54) **Starting control method and system for internal combustion engine**

(57) A starting control method for an internal combustion engine (E) in which output of the engine (E) is transmitted to an external component through a flywheel (F), characterized in that if an engine rotating speed remains in a resonance rotating speed region of the flywheel (F) for a predetermined period when the engine starts, a divergence control for controlling a fuel injection to make the engine rotating speed diverge from the resonance rotating speed region is performed. According to this, problems caused by the resonance between the crankshaft and the flywheel (F) at the time of engine starting can be prevented.

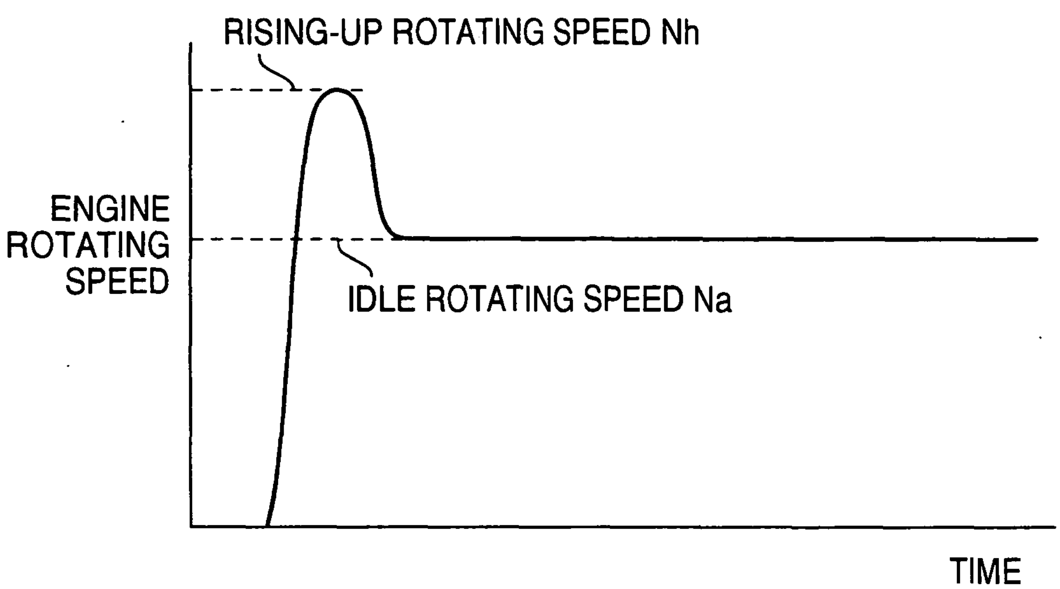

FIG.7a

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Description

[0001] This invention relates to a starting control method and system for an internal combustion engine, and in particular, a starting control method and system for an internal combustion engine which can prevent problems caused by resonance between a crankshaft and a flywheel when the engine starts.

[0002] Traditionally, a flywheel is coupled to an engine crankshaft, which transmits output of the engine to an external component such as a clutch or a transmission therethrough, in order to prevent an unstable rotating speed fluctuation and an eventual stop of the engine thereby at the time of starting or idol operation of the engine.

[0003] In recent years, so called dual mass flywheel has been proposed, which can restrict more transmitting engine output fluctuation (torque fluctuation) to the external component. Such a dual mass flywheel is disclosed in Japanese Patent Application published with No. 2003-48438.

[0004] This dual mass flywheel has a first mass, a second mass, and an elastic member (damper) which connects the first mass and the second mass to each other. According to this dual mass flywheel, since the torque fluctuation generated in the engine side can be absorbed by the damper and then reduced, transmission of the torque fluctuation to the external component can be prevented, and vibration and noise can be reduced.

[0005] In this dual mass flywheel, it is relatively free to set a resonance point (natural frequency) of the flywheel as a whole, by adjusting weights of the first mass and the second mass, and the elastic force of the elastic member.

[0006] Therefore, it is possible to set the resonance point of the flywheel at less than an idle rotating speed of the engine, and thereby to put the resonance point of the flywheel away from a rotating speed region used in a normal operation of the engine. This can prevent occurrence of large vibration during a normal operation of the engine, which is caused by the resonance between the crankshaft and the flywheel.

[0007] However, it becomes clear that, in the engine provided with such dual mass flywheel, when the engine is started in an extremely low temperature condition etc., the engine rotating speed may rather settle in the resonance point of the flywheel than rapidly going up to the idle rotating speed.

[0008] This phenomenon is now described using Fig. 7a and 7b.

[0009] As shown in Fig. 7a, in the case that the engine is started normally, the engine rotating speed rapidly increases beyond the idle rotating speed Na after the engine is started. This is because a starting control which makes an injection quantity of fuel approximately maximum is performed at the time of engine starting. And then, if the engine rotating speed reaches a predetermined rising-up rotating speed Nh which is more than the idle rotating speed Na, the fuel injection quantity is decreased to maintain the engine rotating speed at the idol rotating speed Na. Thereafter, the engine control shifts to the idle control.

[0010] On the other hand, in the extremely low temperature condition etc., although the starting control which makes the injection quantity of fuel approximately maximum is performed after engine starting, the engine rotating speed increases relatively gently. Consequently, as shown in Fig. 7b, the engine rotating speed may balance at the resonance point Rp (resonance rotating speed) of the flywheel, and may remain at the resonance point Rp. As a result, the engine crankshaft and the engine flywheel resonate with each other that may cause large noise and vibration, and further a possible damage against the engine or the flywheel at the worst.

[0011] In order to solve the above-mentioned problems, it is an objective of this invention to provide a starting control method and system for an internal combustion engine, which can prevent problems caused by resonance between a crankshaft and a flywheel when the engine starts.

[0012] In order to achieve the above-mentioned objective, this invention provides a starting control method for an internal combustion engine in which output of the engine is transmitted to an external component through a flywheel, characterized in that if an engine rotating speed remains in a resonance rotating speed region of the flywheel for a predetermined period when the engine starts, a divergence control for controlling a fuel injection to make the engine rotating speed diverge from the resonance rotating speed region is performed.

[0013] Here, the divergence control may comprise stopping the fuel injection.

[0014] Moreover, the divergence control may comprise decreasing a fuel injection quantity, and if the engine rotating speed diverges from the resonance rotating speed region by the divergence control, a retry control for increasing the fuel injection quantity may be performed.

[0015] In case that the engine rotating speed remains in the resonance rotating speed region of the flywheel for a predetermined period even if a predetermined number of time of the retry control is performed, the injection of fuel may be stopped.

[0016] The resonance rotating speed region is preferably set as a rotating speed region being equal to or less than an idle rotating speed.

[0017] The flywheel may be a dual mass flywheel.

[0018] The predetermined period is preferably set to be longer as an engine temperature is lower.

[0019] Furthermore, this invention provides a starting control system for an internal combustion engine in which output of the engine is transmitted to an external component through a flywheel, comprising; engine rotating speed detecting means for detecting an engine rotating speed, a fuel injection device for injecting fuel into a combustion chamber of the engine, and a control device for controlling a fuel injection conducted by the fuel injection device; characterized in that if the engine rotating speed detected by the engine rotating speed detecting means remains in a resonance rotating speed region of the flywheel for a predetermined period when the engine starts, the control device performs a divergence control for controlling the fuel injection by the fuel injection device to make the engine rotating speed diverge from the resonance rotating speed region.

[0020] Here, the divergence control may comprise stopping the fuel injection by the fuel injection device.

[0021] Moreover, the divergence control may comprise decreasing a quantity of fuel injection by the fuel injection device, and if the engine rotating speed diverges from the resonance rotating speed region by the divergence control, the control device may perform a retry control for increasing the quantity of fuel injection by the fuel injection device.

[0022] In case that the engine rotating speed remains in the resonance rotating speed region of the flywheel for a predetermined period even if a predetermined number of time of retry control is performed, the control device may stop the injection of fuel.

[0023] The resonance rotating speed region is preferably set as a rotating speed region being equal to or less than an idle rotating speed.

[0024] The flywheel may be a dual mass flywheel.

[0025] The predetermined period is preferably set to be longer as an engine temperature is lower.

[0026] Fig. 1 is a schematic diagram of a starting control system for an internal combustion engine concerning one embodiment of this invention.

[0027] Fig. 2 is a flow chart showing a control method concerning one embodiment of this invention when the engine starts.

[0028] Fig. 3 is a flow chart showing a control method concerning a first embodiment of this invention when the engine starts.

[0029] Fig. 4 is a flow chart showing a control method concerning one embodiment of this invention when the engine starts.

[0030] Fig. 5 is a flow chart showing a control method concerning a second embodiment of this invention when the engine starts.

[0031] Fig. 6a is a graph showing an example of transition of the engine rotating speed when the engine' starting method of the first embodiment of this invention is carried out.

[0032] Fig. 6b is a graph showing an example of transition of the engine rotating speed when the engine starting method of the second embodiment of this invention is carried out.

[0033] Fig. 7a is a graph showing transition of the engine rotating speed when the engine is started normally.

[0034] Fig. 7b is a graph showing a state where the engine rotating speed remains at a resonance rotating speed of a flywheel.

[0035] Preferred embodiments of this invention will now be described with reference to the accompanying drawings.

[0036] Fig. 1 is a schematic diagram of a starting control system for an internal combustion engine of this embodiment.

[0037] As shown in Fig. 1, the starting control system for the internal combustion engine of this embodiment is applied to an engine E in which output of the engine E is transmitted to an external component (a transmission in this embodiment) through a flywheel F. The starting control system comprises an engine rotating speed detection means (an engine rotating speed sensor) 2 for detecting a rotating speed of the engine E, a fuel injection device (an injector) 3 for injecting fuel into a combustion chamber of each cylinder of the engine E, and a control device (ECU; Electronic Control Unit) 5 for controlling injection of fuel by the injector 3.

[0038] Detection values of the engine rotating speed sensor 2 and other various sensors (for example, an accelerator opening degree sensor) are transmitted to the ECU 5. During a normal operation of the engine, the ECU 5 optimally controls a fuel injection timing and a fuel injection quantity, etc. in accordance with the detection values of the sensors.

[0039] The flywheel F attached to the engine E is a dual mass flywheel in this embodiment. As described above, this dual mass flywheel F is able to prevent the torque fluctuation generated in the engine E side to be transmitted to the transmission T/M side. And also, the resonance point (a natural frequency) of the flywheel as a whole can be set at a rotating speed being less than a normal rotating speed region of the engine E (e.g., less than an idle rotating speed). Also in this embodiment, the resonance point of the flywheel F is set at less than the idol rotating speed (approximately 300 - 400 rpm for example) of the engine E.

[0040] Here, the starting control system 1 for the internal combustion engine of this embodiment is such that if the rotating speed of the engine E remains in a resonance rotating speed region of the flywheel F which is less than the idle rotating speed when the engine starts, a divergence control for controlling the fuel injection by the fuel injection device 3 to make the engine rotating speed diverge from the resonance rotating speed region is performed.

[0041] This is now explained in more detail. If it is detected that the engine rotating speed detected by the engine rotating speed sensor 2 remains in the resonance rotating speed region of the flywheel F for a predetermined period, the ECU 5 stops or suspends the fuel injection by the injector 3. Accordingly, the engine rotating speed decreases and then diverges from (or falls below) the resonance rotating speed region of the flywheel F. Thereby, it can be prevented that the crankshaft and the flywheel F of the engine E continuously resonate with each other. Furthermore, occurrence of large noise and vibration, and a possibility of damage against the engine E or the flywheel F are avoidable.

[0042] An engine starting control method by the starting control system 1 of this embodiment will now be described using the flow chart of Figs. 2, 3, and 4. Following control is performed by the ECU 5.

[0043] Firstly, in step S1 of Fig. 2, it is judged whether the ignition key is turned ON by the driver.

[0044] If it is judged that the ignition key is ON, then the control proceeds to step S3. Step S2 shown in Fig. 2 will be used in the second embodiment described after, and therefore it is assumption that step 2 does not exist in this embodiment.

[0045] In step S3, it is judged whether rotation of the engine E is recognized (or detected) by the engine rotating speed sensor 2 in order to judge whether the engine E is rotated by the starter motor with, for example, further rotary operation of the ignition key from its ON position by the driver.

[0046] If the rotation of the engine E is recognized in step S3 (i.e., if the engine E is rotated by the starter motor), then the control proceeds to step S4 in which a drive signal is outputted to the injector 3 to inject a predetermined starting injection quantity of fuel. And also, a measuring value of a timer built in the ECU 5 is reset to zero. The starting injection quantity is set at an approximately maximum injection quantity of the injector 3 in this embodiment.

[0047] Next, the control proceeds to step S5 in which it is judged whether the engine rotating speed detected by the engine rotating speed sensor 2 is equal to or more than a lower limit value Knfw Lo of the resonance rotating speed region of the flywheel F. The lower limit value Knfw Lo is inputted into the ECU 5 in advance. That is, it is judged whether the engine rotating speed increases to the lower limit value Knfw Lo of the resonance rotating speed region of the flywheel F by the fuel injection. The judgment of step S5 is repeatedly conducted until the engine rotating speed becomes equal to or more than the lower limit value Knfw Lo.

[0048] In step S5, if it is judged that the engine rotating speed is equal to or more than the lower limit value Knfw Lo, then the control proceeds to step S6 in which a time measurement by the timer built in the ECU 5 is started.

[0049] Next, the control proceeds to step S7 in which it is judged whether the measuring value t of the timer is equal to or more than a comparison value Mt (2 sec for example). The comparison value Mt is a value for judging that the engine rotating speed balances in the resonance rotating speed region of the flywheel F, and remains within the region. In this embodiment, the comparison value Mt is a value which is changed according to temperature of the engine E, specifically cooling water temperature of the engine E, and is inputted into the ECU 5 in advance as a form of map or computing equation. The comparison value Mt is set to be longer as the cooling water temperature of the engine E is lower. This is because starting of the engine E takes longer time as the temperature of the engine E is lower.

[0050] When this control is performed at the first time, the measuring value t of the timer usually does not reach the comparison value Mt. Therefore a judgment in step S7 is No, then the control proceeds to step S8.

[0051] In step S8, it is judged whether the engine rotating speed detected by the engine rotating speed sensor 2 is equal to or more than an upper limit value Knfw Hi of the resonance rotating speed region of the flywheel F.

[0052] If the engine rotating speed does not reach the upper limit value Knfw Hi, the control returns to step S7, thereby it is repeatedly judged whether the measuring value t of the timer reaches the comparison value Mt.

[0053] If the engine rotating speed becomes equal to or more than the upper limit value Knfw Hi of the resonance rotating speed region of the flywheel F before the measuring value t of the timer reaches the comparison value Mt, then judgment in step S8 is Yes, and the control proceeds to step S31 of Fig. 4. The engine rotating speed becoming equal to or more than the upper limit value Knfw Hi means that the engine rotating speed diverges from (or exceeds) the resonance rotating speed region of the flywheel F, and it is possible to judge the starting control of the engine E being normally conducted.

[0054] Accordingly, in step S31, it is judged whether the engine rotating speed detected by the engine rotating speed sensor 2 becomes equal to or more than a rising-up rotating speed Nh inputted into the ECU 5 in advance. The rising-up rotating speed Nh is usually set at a value which is higher than the idle rotating speed of the engine E.

[0055] If the engine rotating speed becomes equal to or more than the rising-up rotating speed Nh, the control proceeds to step S32 in which the quantity of the fuel injection by the injector 3 is gradually reduced from the above-mentioned starting injection quantity. And then, in step S33, it is judged whether the engine rotating speed decreases to a value which is within the idle control region inputted into the ECU 5 in advance.

[0056] In step S33, if it is judged that the engine rotating speed decreases to such value, then the control proceeds to step S34 to shift to a predetermined idle control mode. This means that the starting of the engine E completes normally, as shown in Fig. 7a.

[0057] On the other hand, in step S7 of Fig. 2, if the measuring value t of the timer reaches the comparison value Mt before the engine rotating speed becomes equal to or more than the upper limit value Knfw Hi of the resonance rotating speed region of the flywheel F, the control proceeds to step S15 of Fig. 3.

[0058] In step S15, the fuel injection by the injector 3 is stopped, or the fuel injection quantity is gradually reduced (to zero eventually). And then, the control proceeds to step S16 in which it is judged whether the engine rotating speed detected by the engine rotating speed sensor 2 is zero, that is, it is judged whether the engine E stops.

[0059] These steps S15 and S16 forms the above-mentioned divergence control, and with this control the engine rotating speed can be decreased to diverge from (or fall below) the resonance rotating speed region of the flywheel F. Therefore, it can be prevented that the crankshaft and the flywheel F of the engine E continuously resonate with each other. If a stop of the engine E is judged in step S16, the control returns to step S3 of Fig. 2. Thereafter, if the engine E is rotated again because of an operation for driving the starter motor by the driver, then the control proceeds to step S4, and then the above-mentioned control will be performed again. In addition, even in the case that the engine temperature is extremely low at the first starting of the engine, since the engine temperature becomes higher at each time of the engine starting, a probability that the engine normally starts becomes higher from the second starting of the engine.

[0060] An example of transition of the engine rotating speed when the starting control of this embodiment is performed is now described with reference to Fig. 6a.

[0061] As shown, after the engine E starts, the time measurement by the timer starts if the engine rotating speed reaches the lower limit value Knfw Lo of the resonance rotating speed region R of the flywheel F at a time t1. And then, if the engine rotating speed is less than the upper limit value Knfw Hi of the resonance rotating speed region R of the flywheel F although the measuring value t of the timer reaches the comparison value Mt at a time t2 (that is, the engine rotating speed remains in the resonance rotating speed region R of the flywheel F for the predetermined period), then the fuel injection is stopped, or the fuel injection quantity is gradually reduced at the time t2. By this, the engine rotating speed decreases, and it becomes less than the lower limit value Knfw Lo of the resonance rotating speed region R of the flywheel F at a time t3. The engine E eventually stops.

[0062] Thus, according to this embodiment, if the engine rotating speed remains in the resonance rotating speed region R of the flywheel F, the engine rotating speed can be compulsorily diverged from the resonance rotating speed region R, by momentarily or gradually stopping the fuel injection. Therefore, the problems caused by the resonance between the crankshaft and the flywheel F of the engine E can be prevented.

[0063] Next, a second embodiment of this invention is described using the flow chart of Figs. 2, 4, and 5.

[0064] Description of the same steps of control as those of the above-mentioned first embodiment will be omitted.

[0065] In the second embodiment, if it is judged that the ignition key is ON in step S1 of Fig. 2, then the control proceeds to step S2 in which a measuring value n (a retry number) of a counter built in the ECU 5 is reset to zero, thereafter the control proceeds to step S3.
The retry number n will be explained after.

[0066] In step S8, if the engine rotating speed becomes equal to or more than the upper limit value Knfw Hi of the resonance rotating speed region of the flywheel F before the measuring value t of the timer reaches the comparison value Mt, then the control proceeds to the idle control mode via the steps S31, S32 and S33 of Fig. 4, similarly to the above first embodiment.

[0067] On the other hand, in step S7 of Fig. 2, if the measuring value t of the timer reaches the comparison value Mt before the engine rotating speed becomes equal to or more than the upper limit value Knfw Hi, the control proceeds to step S21 of Fig. 5.

[0068] In step S21, the quantity of fuel injection by the injector 3 is gradually reduced. And then, the control proceeds to step S22 in which it is judged whether the engine rotating speed detected by the engine rotating speed sensor 2 becomes less than the lower limit value Knfw Lo of the resonance rotating speed region of the flywheel F. That is, it is judged whether the engine rotating speed diverges from (or falls below) the resonance rotating speed region of the flywheel F.

[0069] While the engine rotating speed is equal to or more than the lower limit value Knfw Lo, the control returns to step S21, and thereby the fuel injection quantity is successively reduced.

[0070] These steps S21 and S22 forms the divergence control of this embodiment, in which the engine E is not completely stopped, but the fuel injection quantity is reduced until the engine rotating speed diverges from (or falls below) the lower limit value Knfw Lo.

[0071] In step S22, if it is judged that the engine rotating speed becomes less than the lower limit value Knfw Lo, the control proceeds to step S23 in which the measuring value n (retry number) of the counter built in the ECU 5 is incremented by 1. When this control is performed at the first time, the retry number is 1 in this step S23.

[0072] Next, the control proceeds to step S24 in which it is judged whether the retry number n is more than a retry number upper limit value Knret inputted into the ECU 5 in advance. The retry number upper limit value Knret defines an upper limit of number of time of the retry control to be performed. When this control is performed at the first time, the retry number n is usually equal to or less than the upper limit value Knret.

[0073] In step S24, if it is judged that the retry number n is equal to or less than the upper limit value Knret, then the control returns to step S4 of Fig. 2 in which a predetermined starting injection quantity of fuel is injected by the injector 3, and the measuring value of the timer is reset to zero.

[0074] This is the retry control above mentioned, and its content is such that after the engine rotating speed is less than the lower limit value Knfw Lo of the resonance rotating speed region of the flywheel F, the fuel injection quantity is increased to try to start the engine E again. In this case, since it is thought that the engine E has warmed up more than the last time at which the starting injection quantity of fuel is injected, it is highly possible that the engine E will be started normally. If the engine E is normally started by this retry control, then the control shifts to the idol control mode via steps S31, A32 and S33 of Fig. 4.

[0075] Thus, in this embodiment, if the engine rotating speed remains in the resonance rotating speed region R of the flywheel F, the engine E is not stopped completely, but the engine rotating speed is once compulsorily diverged from the resonance rotating speed region R of the flywheel F, and thereafter the engine E is started again. Therefore, unlike the first embodiment described above, the driver is not required to carry out an operation for driving the starter motor such as rotation of the injection key, and it is possible to mitigate burden on the driver.

[0076] However, since there is a possibility that an excessive load is imposed on the engine E if the retry control is performed repeatedly, it is desirable to define the maximum number of time of the retry control to be performed.

[0077] This is why the retry number upper limit value Knret as shown in step S24 of Fig. 5 is predetermined.

[0078] In step S24, if it is judged that the retry number n is more than the retry number upper limit value Knret, then the control proceeds to step S25 in which the fuel injection is stopped, or the fuel injection quantity is gradually reduced (to zero eventually). And then, the control proceeds to step S26 in which it is judged whether the engine rotating speed detected by the engine rotating speed sensor 2 is zero, that is, it is judged whether the engine E stops.

[0079] Thus, if the engine E does not start normally even if the predetermined number of time (the retry number upper limit value Knret) of the retry control is performed, the engine E is completely stopped. By this, it can prevent that the excessive load is imposed on the engine E. If the stop of the engine E is judged in step S26, the control returns to step S3 of Fig. 2. And then, if the engine E is rotated again because of the driver's operation for driving the starter motor, the control proceeds to step S4 and the control described above is conducted again.

[0080] An example of transition of the engine rotating speed when the starting control of this embodiment is performed is now described with reference to Fig. 6b.

[0081] As shown, after the engine E starts, the time measurement by the timer starts if the engine rotating speed reaches the lower limit value Knfw Lo of the resonance rotating speed region R of the flywheel F at a time t1. And then, if the engine rotating speed is less than the upper limit value Knfw Hi of the resonance rotating speed region R of the flywheel F although the measuring value t of the timer reaches the comparison value Mt at a time t2 (that is, the engine rotating speed remains in the resonance rotating speed region R of the flywheel F for the predetermined period), the fuel injection quantity is gradually reduced at the time t2. By this, the engine rotating speed decreases, and it becomes less than the lower limit value Knfw Lo of the resonance rotating speed region R of the flywheel F at a time t3. Then, the fuel injection quantity is again increased to the starting injection quantity. By this, the engine rotating speed increases again. In the example shown in Fig. 6b, the engine rotating speed increases relatively rapidly by this first retry control. And then, at a time t4, the engine rotating speed reaches a predetermined rising-up rotating speed Nh being higher than the idol rotating speed Na. Thereafter, the fuel injection quantity is decreased, and the engine rotating speed is kept at the idle rotating speed Na.

[0082] Various modifications of this invention can be considered.

[0083] For example, the divergence control may be such that the fuel injection quantity is increased to make the engine rotating speed diverge from the resonance rotating speed region R to a higher rotating speed region thereof. However, in the case that the fuel injection quantity at the time of starting is an approximately maximum injection quantity like this embodiment, since it is difficult to increase the injection quantity more, it is preferable to decrease the fuel injection quantity.

[0084] Moreover, the "predetermined period" for judging that the engine rotating speed remains in the resonance rotating speed region R of the flywheel F is not limited to time, but may be other values which substitute for time such as a total revolution number of the engine E.

[0085] In addition, according to the engine starting method and system of this invention, even in the case that the driver performs the starter motor drive operation and stops it immediately (in this case, sufficient quantity of fuel may not be injected and the engine rotating speed may remain at a rotating speed which is less than the idle rotating speed), resonance between the crankshaft and the flywheel can be prevented.

[0086] In short, according to this invention, the problems caused by the resonance between the crankshaft and the flywheel at the time of the engine starting can be prevented.

Claims

1. A starting control method for an internal combustion engine in which output of the engine is transmitted to an external component through a flywheel, **characterized in that** if an engine rotating speed remains in a resonance rotating speed region of the flywheel for a predetermined period when the engine starts, a divergence control for controlling a fuel injection to make the engine rotating speed diverge from the resonance rotating speed region is performed.

2. The starting control method as defined in claim 1, **characterized in that** the divergence control com-

prises stopping the fuel injection.

3. The starting control method as defined in claim 1, **characterized in that** the divergence control comprises decreasing a fuel injection quantity, and if the engine rotating speed diverges from the resonance rotating speed region by the divergence control, a retry control for increasing the fuel injection quantity is performed.

4. The starting control method as defined in claim 3, **characterized in that** in case that the engine rotating speed remains in the resonance rotating speed region of the flywheel for a predetermined period even if a predetermined number of times of the retry control is performed, the injection of fuel is stopped.

5. The starting control method as defined in any one of claims 1 to 4, **characterized in that** the resonance rotating speed region is set as a rotating speed region being equal to or less than an idle rotating speed.

6. The starting control method as defined in any one of claims 1 to 5, **characterized in that** the flywheel is a dual mass flywheel.

7. The starting control method as defined in any one of claims 1 to 6, **characterized in that** the predetermined period is set to be longer as an engine temperature is lower.

8. A starting control system for an internal combustion engine in which output of the engine is transmitted to an external component through a flywheel, comprising engine rotating speed detecting means for detecting an engine rotating speed, a fuel injection device for injecting fuel into a combustion chamber of the engine, and control device for controlling a fuel injection conducted by the fuel injection device, **characterized in that** if the engine rotating speed detected by the engine rotating speed detecting means remains in a resonance rotating speed region of the flywheel for a predetermined period when the engine starts, the control device performs a divergence control for controlling the fuel injection by the fuel injection device to make the engine rotating speed diverge from the resonance rotating speed region.

9. The starting control system as defined in claim 8, **characterized in that** the divergence control comprises stopping the fuel injection by the fuel injection device.

10. The starting control system as defined in claim 8, **characterized in that** the divergence control comprises decreasing a quantity of fuel injection by the fuel injection device, and if the engine rotating speed diverges from the resonance rotating speed region by the divergence control, the control device performs a retry control for increasing the quantity of fuel injection by the fuel injection device.

11. The starting control system as defined in claim 10, **characterized in that** in case that the engine rotating speed remains in the resonance rotating speed region of the flywheel for a predetermined period even if a predetermined number of time of the retry control is performed, the control device stops the injection of fuel.

12. The starting control system as defined in any one of claims 8 to 11, **characterized in that** the resonance rotating speed region is set as a rotating speed region being equal to or less than an idle rotating speed.

13. The starting control system as defined in any one of claims 8 to 12, **characterized in that** the flywheel is a dual mass flywheel.

14. The starting control system as defined in any one of claims 8 to 13, **characterized in that** the predetermined period is set to be longer as an engine temperature is lower.

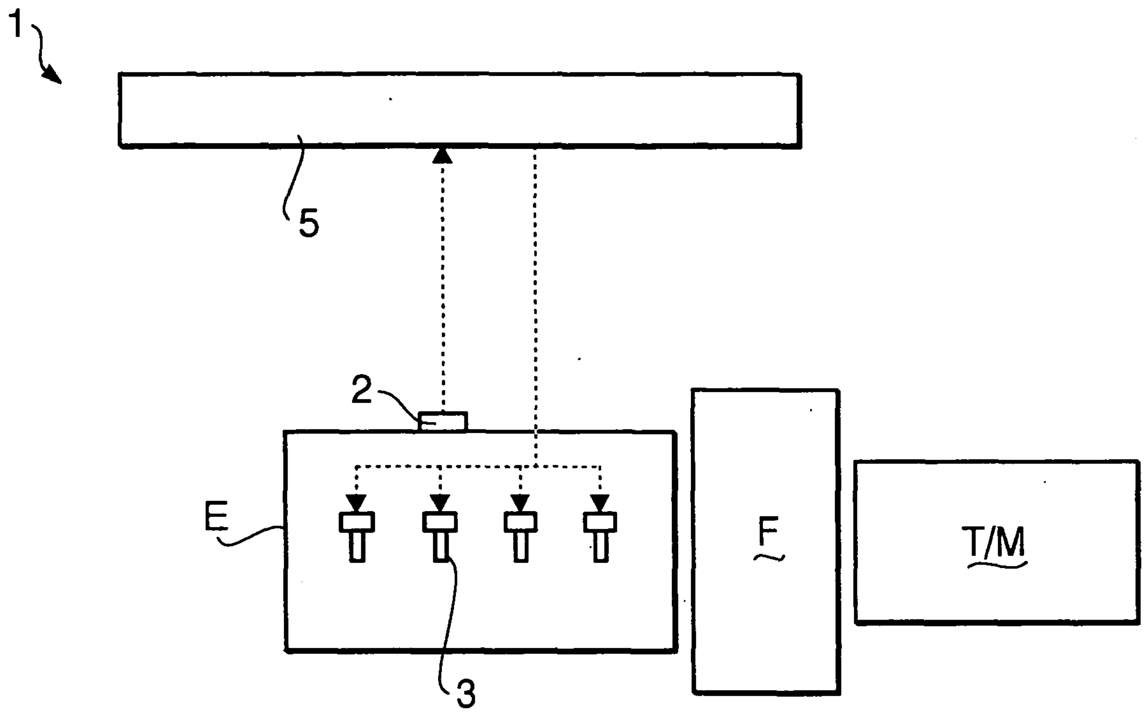
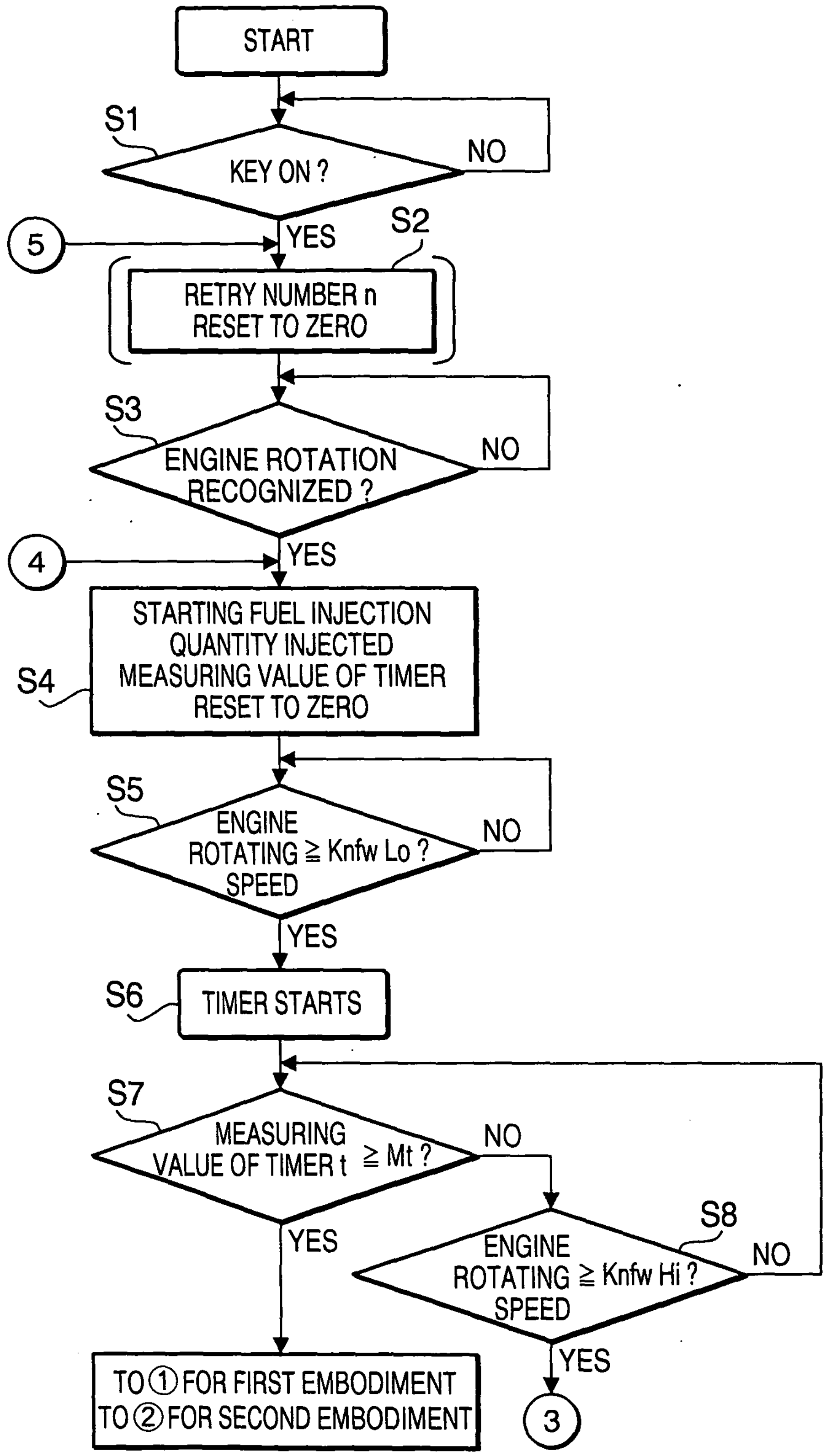


FIG. 1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QUANTITY INJECTED
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ENGINE
ROTATING ≧ Knfw Lo ?
SPEED
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YES
S6
TIMER STARTS
S7
MEASURING
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NO
YES
S8
ENGINE
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TO ① FOR FIRST EMBODIMENT
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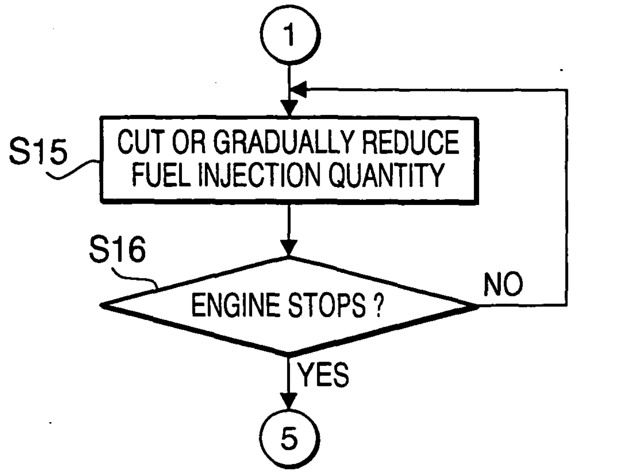
3

FIG. 2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S16
ENGINE STOPS ?
NO
YES
5

FIG. 3

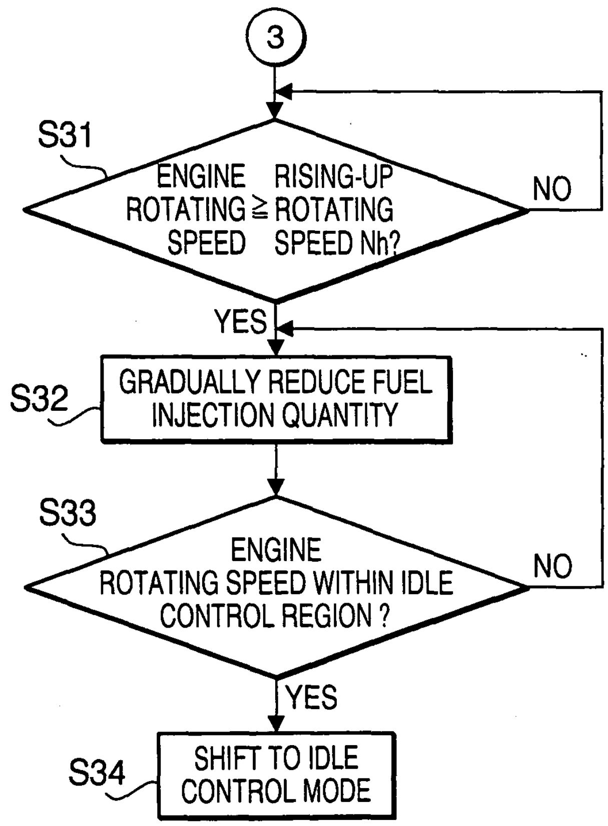
3
S31
ENGINE ROTATING SPEED ≧ RISING-UP ROTATING SPEED Nh?
NO
YES
S32
GRADUALLY REDUCE FUEL INJECTION QUANTITY
S33
ENGINE ROTATING SPEED WITHIN IDLE CONTROL REGION ?
NO
YES
S34
SHIFT TO IDLE CONTROL MODE

FIG. 4

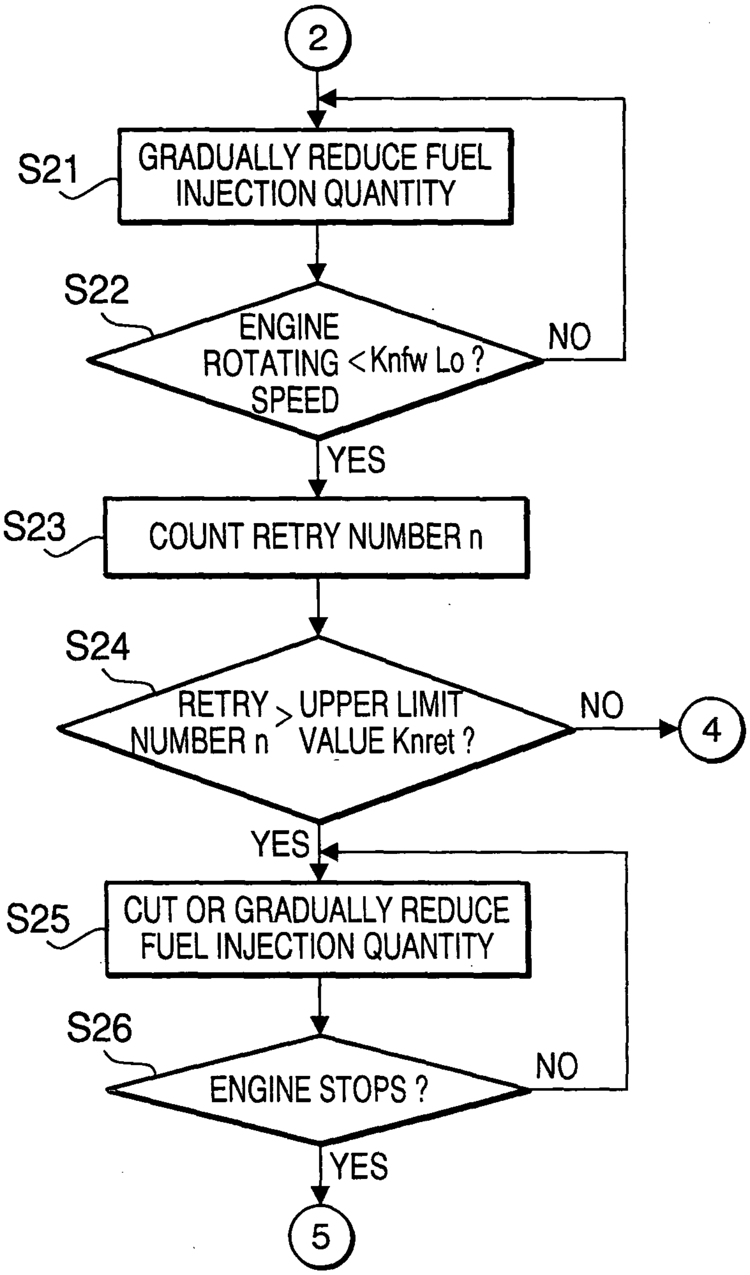
2
S21
GRADUALLY REDUCE FUEL INJECTION QUANTITY
S22
ENGINE ROTATING SPEED < Knfw Lo ?
NO
YES
S23
COUNT RETRY NUMBER n
S24
RETRY NUMBER n > UPPER LIMIT VALUE Knret ?
NO
4
YES
S25
CUT OR GRADUALLY REDUCE FUEL INJECTION QUANTITY
S26
ENGINE STOPS ?
NO
YES
5

FIG. 5

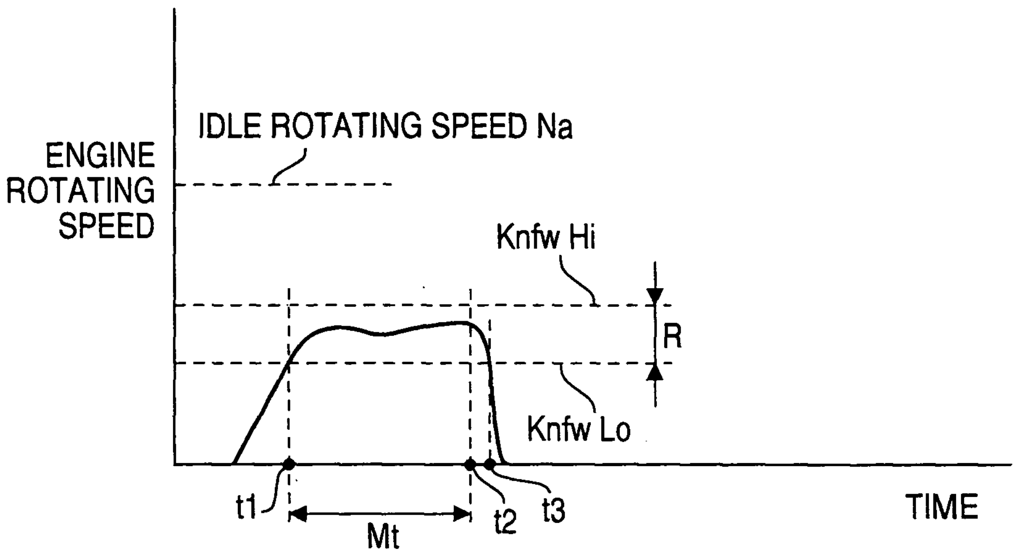
IDLE ROTATING SPEED Na
ENGINE ROTATING SPEED
Knfw Hi
R
Knfw Lo
t1
Mt
t2
t3
TIME

FIG.6a

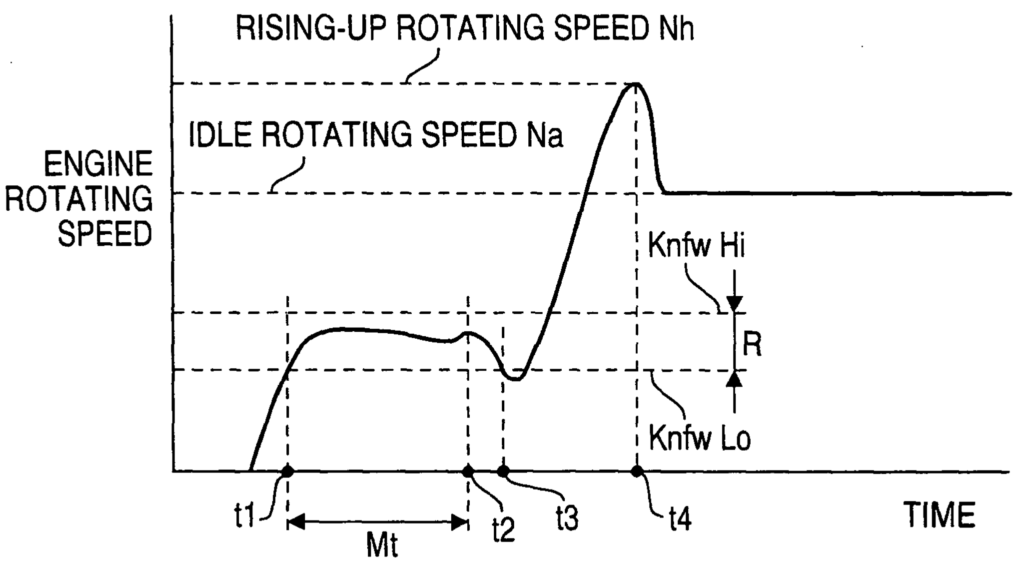
RISING-UP ROTATING SPEED Nh
IDLE ROTATING SPEED Na
ENGINE ROTATING SPEED
Knfw Hi
R
Knfw Lo
t1
Mt
t2
t3
t4
TIME

FIG.6b

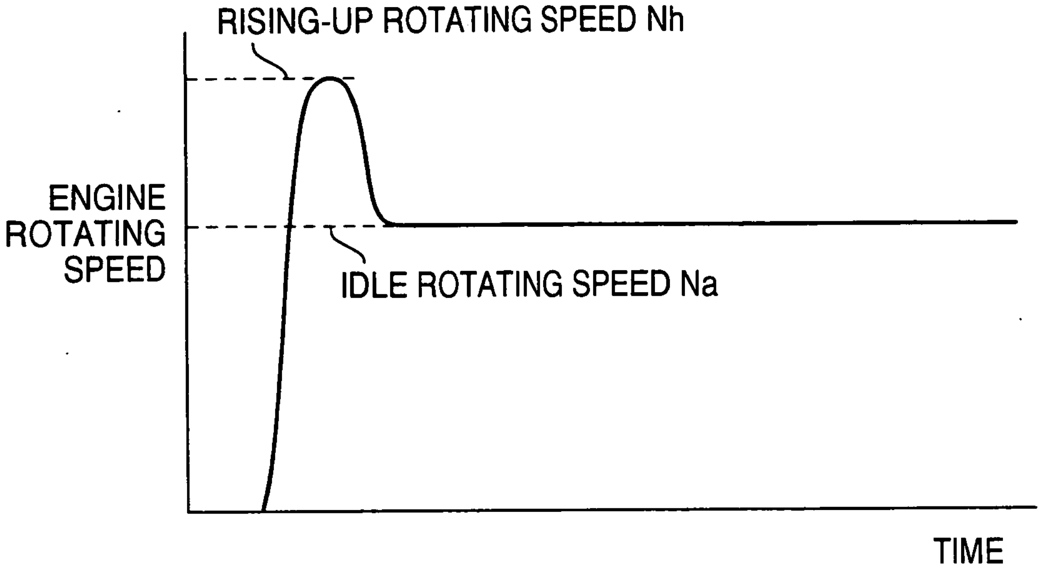
RISING-UP ROTATING SPEED Nh
ENGINE ROTATING SPEED
IDLE ROTATING SPEED Na
TIME

FIG.7a

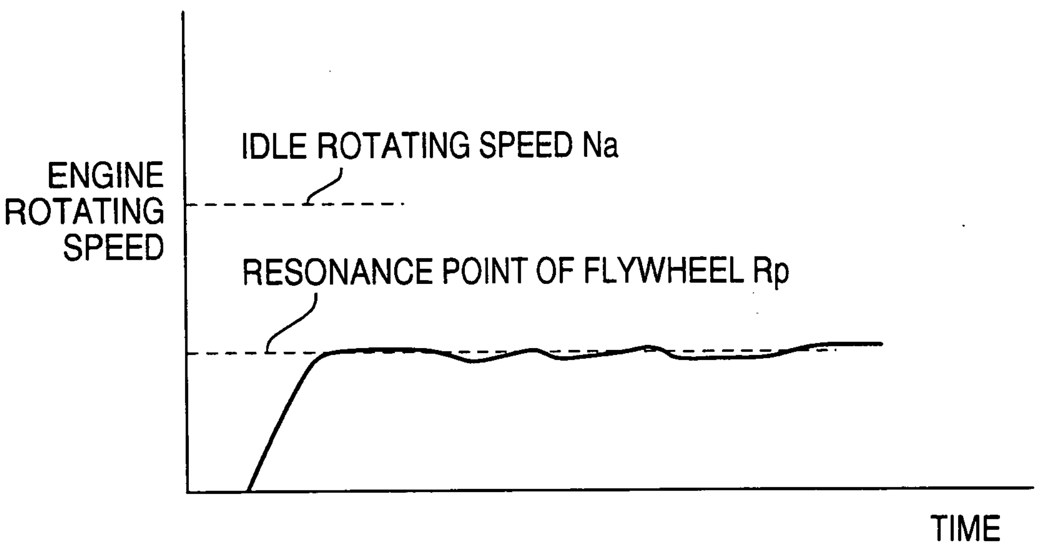
IDLE ROTATING SPEED Na
ENGINE ROTATING SPEED
RESONANCE POINT OF FLYWHEEL Rp
TIME

FIG.7b