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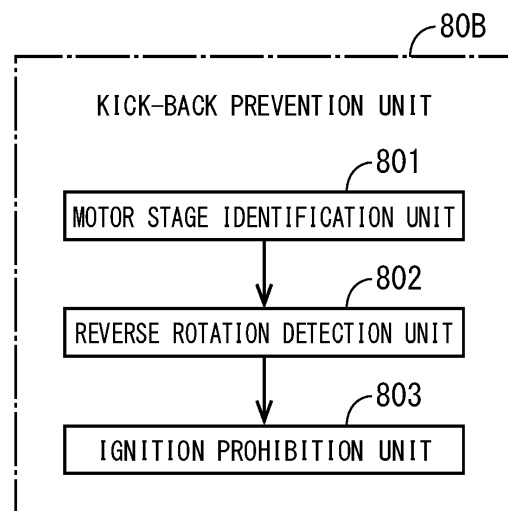
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(54) **ENGINE STARTER DEVICE FOR VEHICLES**

(57) Provided is an engine starter device for vehicles that is capable of preventing kickback with a simple structure without providing a dedicated sensor for detecting the rotational speed of a crankshaft.

A motor stage identification unit (801) identifies an angular range of an ACG starter motor (48) as a motor stage on the basis of the direction of a current flowing through each phase of the ACG starter motor (48). If a three-phase AC motor is adopted as the ACG starter motor (48), the motor stage is identified on the basis of a combination of the directions of the current flowing through each of U, V, and W phases. A reverse rotation detection unit (802) detects that the rotational direction of the crankshaft (40) is changed from forward rotation to reverse rotation on the basis of a change in the motor stage. An ignition prohibition unit (803) ignites the engine at a normal ignition timing as long as the engine rotates forward, and prohibits ignition of the engine when reverse rotation is detected by the reverse rotation detection unit (802).

Fig.8



Description

Technical Field

[0001] The present invention relates to an engine starter device for vehicles suitable for a vehicle equipped with a kick starter for kick-starting an engine, and more particularly to an engine starter device for vehicles that prevents kickback during the cranking sequence while kick-starting.

Background Art

[0002] When an engine is kickstarted in a vehicle (for example, a scooter) with a generator/starter, an instantaneous rotational speed of the engine when a crankshaft reaches a position near the compression top dead center is low, and when ignition is executed at this timing, the crankshaft may rotate reversely. This phenomenon is generally called "kickback" and rarely occurs under various conditions.

[0003] Patent Literature 1 discloses a technique in which, in an ignition control device for engine that inhibits an output of an ignition instruction when a time between a time at which a predetermined crank angle signal for outputting the ignition instruction to an ignition device for an engine is output and a time at which a crank angle signal output just before the predetermined crank angle signal is output is equal to or greater than a predetermined value, a threshold to be compared with the engine speed immediately before the ignition instruction is output is set on the basis of an engine speed near the bottom dead center at which the engine speed starts to decrease.

[0004] According to Patent Literature 1, it is possible to determine whether or not kickback occurs on the basis of the determination which accurately reflects the degree of the decrease in the engine speed, so that it is possible to accurately determine whether or not kickback occurs, and as a result, an occurrence of kickback can be more effectively prevented.

Citation List

Patent Literature

[0005] Patent Literature 1: JP 5148530

Summary of Invention

Technical Problem

[0006] In Patent Literature 1, ignition control is not performed when the rotational speed of the crankshaft in the vicinity of the bottom dead center of the crankshaft is equal to or less than a predetermined value. However, it is necessary to measure the rotational speed of the crankshaft in the vicinity of the compression top dead center to determine whether or not kickback actually oc-

curs, and it is desirable to take necessary measures.

[0007] In addition, Patent Literature 1 employs a structure to measure the rotational speed of the crankshaft using a sensor, and thus, it is necessary to provide a dedicated sensor for detecting the rotational speed of the crankshaft. This may entail a problem that the structure becomes complicated, the number of assembly steps increases, the weight of the vehicle increases, and further, cost increases.

[0008] On the other hand, when a combustion chamber pressure is generated by ignition of a fuel gas of the engine, the generated combustion chamber pressure becomes a drag against a cranking torque of the engine. Therefore, when the combustion chamber pressure is generated before the crank angle exceeds the compression top dead center (TDC), the cranking torque of the engine cannot resist the combustion chamber pressure, and kickback may occur. Therefore, it is desirable to ignite the engine at a timing at which the crank angle exceeds the TDC before the combustion chamber pressure is generated.

[0009] According to the result of experiment conducted by the inventors, it is confirmed that the combustion chamber pressure of the engine does not immediately rise even when the fuel gas is ignited by an ignition coil, and starts to rise after a certain delay time. Further, it is found that such delay time is substantially constant.

[0010] A first object of the present invention is to solve the above technical problem and provide an engine starter device for vehicles that can prevent kickback with a simple structure without providing a dedicated sensor for detecting the rotational speed of a crankshaft.

[0011] A second object of the present invention is to solve the above technical problem and provide an engine starter device for vehicles that sets an ignition timing specific to prevention of kickback, considering that the combustion chamber pressure of an engine starts to rise after a certain delay time from the ignition of the engine.

Solution to Problem

[0012] In order to achieve the above object, the present invention is characterized in that an engine starter device including a generator/starter that is connected to a crankshaft of an engine and rotates synchronously with the crankshaft, a kick starter that kick-starts the engine, and a means for igniting the engine further includes the following means.

(1) The engine starter device is provided with a stage identification means for identifying a stage representing a rotational angle of the generator/starter, a means for detecting reverse rotation of the engine on the basis of a change in the stage, and a means for prohibiting ignition of the engine when reverse rotation of the engine is detected.

(2) The generator/starter is a three-phase brushless motor, and the stage identification means identifies

a stage on the basis of detection values of a U phase, a V phase, and a W phase.

(3) The generator/starter is provided with a rotor sensor, and the direction of a current flowing through each of the phases of the generator/starter is identified according to an output state of the rotor sensor.

(4) The engine starter device includes a means for determining whether or not the crankshaft is within a predetermined angular range near a compression top dead center on the basis of the motor stage, and an ignition prohibition means that prohibits ignition of the engine on the basis of a rotational speed of the generator/starter when the crankshaft is within the predetermined angular range.

(5) The rotational speed is an instantaneous rotational speed.

(6) The predetermined angular range near the compression top dead center is before the compression top dead center.

(7) The predetermined angular range is before an ignition timing, and the ignition prohibition means prohibits the ignition of the engine on the basis of a passage time to pass through the angular range and an ignition delay time from the ignition timing until a pressure increases.

(8) The ignition delay time is a constant.

Advantageous Effects of Invention

[0013] According to the present invention, the following effects are achieved.

(1) The present invention provides an engine starter device provided with a generator/starter that is connected to a crankshaft of an engine and rotates synchronously with the crankshaft, a kick starter that kick-starts the engine, and a means for igniting the engine, the engine starter device including a stage identification means for identifying a stage representing a rotational angle of the generator/starter, a means for detecting reverse rotation of the engine on the basis of a change in the stage, and a means for prohibiting the ignition when reverse rotation of the engine is detected. According to the present invention, it is possible to detect the reverse rotation of the crankshaft without separately providing a dedicated sensor for detecting the angle of the crankshaft, whereby a situation in which there is a high possibility of an occurrence of kickback can be recognized. Thus, kickback can be prevented with a simple and inexpensive configuration.

(2) In the present invention, the generator/starter is a three-phase brushless motor, and the means for detecting reverse rotation of the engine performs identification on the basis of detection values (H/L) of a U phase, a V phase, and a W phase of the rotor sensor. According to the present invention, it is possible to recognize a situation in which there is a high

possibility of an occurrence of kickback only by monitoring the change in the stage without separately providing a dedicated sensor for detecting the angle of the crankshaft.

(3) In the present invention, the generator/starter is provided with a rotor sensor, and the direction of a current flowing through each of the phases of the generator/starter is identified according to an output state of the rotor sensor. According to the present invention, the direction of the current flowing through each phase of the three-phase brushless motor can be easily detected.

(4) In the present invention, the engine starter device includes a means for determining whether or not the crankshaft is within a predetermined angular range near a compression top dead center on the basis of the motor stage, and an ignition prohibition means (803) that prohibits ignition of the engine on the basis of a rotational speed of the generator/starter when the crankshaft is within the predetermined angular range. According to the present invention, permission or prohibition of ignition of the engine can be determined on the basis of the speed of the crankshaft in the vicinity of the compression top dead center, whereby ignition can be performed at an appropriate timing in accordance with the state of the engine. Thus, it is expected to prevent kickback.

(5) In the present invention, the rotational speed of the engine is detected as instantaneous rotational speed. Therefore, it is possible to determine whether to perform ignition on the basis of the instantaneous rotational speed, whereby it is further expected to prevent kickback.

(6) In the present invention, the predetermined angular range near the compression top dead center is before the compression top dead center. Therefore, it is possible to accurately measure the rotational speed in an angular range where kickback may occur by ignition of the engine during forward rotation. Thus, it is expected to effectively prevent an occurrence of kickback caused by ignition of the engine during forward rotation on the basis of the measurement result.

(7) In the present invention, the predetermined angular range is before an ignition timing, and the ignition prohibition means prohibits the ignition of the engine on the basis of a passage time to pass through the angular range and an ignition delay time from the ignition timing until a pressure increases. Therefore, according to the present invention, it becomes easier to recognize the situation in which kickback is more likely to occur.

(8) In the present invention, the ignition delay time is a constant, whereby it is unnecessary to calculate the ignition delay time as required.

Brief Description of Drawings

[0014]

Fig. 1 is a side view of a motorcycle according to an embodiment of the present invention.
 Fig. 2 is a side sectional view of an engine.
 Fig. 3 is a sectional view of the engine.
 Fig. 4 is a schematic block diagram of an idling stop control system of the engine.
 Fig. 5 is a flowchart of an idling stop permission determination control.
 Fig. 6 is a flowchart of an idling stop control.
 Fig. 7 is a front view of a combination meter.
 Fig. 8 is a functional block diagram of a kickback prevention unit (80B).
 Fig. 9 is a diagram showing a method of determining a stage on the basis of a phase current.
 Fig. 10 is a diagram showing a relationship between a combination of phase currents and a stage.
 Fig. 11 is a time chart of ignition control.
 Fig. 12 is a flowchart showing a procedure of the ignition control.

Description of Embodiments

[0015] An embodiment of the present invention will be described below in detail with reference to the accompanying drawings. Fig. 1 is a side view of a motorcycle equipped with a kickback prevention device according to an embodiment of the present invention, and Fig. 2 is a sectional view of an engine mounted on the motorcycle.

[0016] A vehicle body frame includes a single main frame 3 extending rearward and obliquely downward from a head pipe 2, a pair of right and left pivot plates 4, 4 suspending downward at a rear end part of the main frame 3, a pair of right and left rear frames 5, 5 extending rearward and obliquely upward from a rear part of the main frame 3, and sub-frames 6, 6 provided between the main frame 3 and the rear frames 5, 5. A handle 7 is attached to the head pipe 2 so as to freely steer a front fork 8, and a front wheel 9 is rotatably supported at a lower end of the front fork 8.

[0017] A swing arm 11 is connected to the pivot plate 4 with its front end being supported by a pivot shaft 10, by which the swing arm 11 is vertically swingable. A rear wheel 12 is rotatably supported at a rear end of the swing arm 11. A rear cushion 13 is interposed between the swing arm 11 and the rear frame 5 above the swing arm 11. A storage box 14 is attached to front parts of the pair of right and left rear frames 5, 5. A fuel tank 15 is supported from the storage box 14 to rear parts of the rear frames 5, 5, and a seat 16 is attached on the storage box 14 and the fuel tank 15 so as to be freely opened and closed.

[0018] An engine 20 is suspended while being supported by the pivot plates 4 and an engine hanger 17 projecting downward from the main frame 3 at the position

closer to the rear part with respect to the center. The engine 20 is an air-cooled 4-stroke-cycle i-cylinder engine, and includes a centrifugal clutch 51.

[0019] The engine 20 is mounted on the vehicle body frame transversely with a crankshaft 40 oriented in the lateral direction and a cylinder protruding forward substantially horizontally. That is, a cylinder block 22, a cylinder head 23, and a cylinder head cover 24 are sequentially superposed and protrude forward from a crankcase 21.

[0020] A countershaft 73 serving as an output shaft protrudes to the left from a transmission chamber at a rear part of the crankcase 21. A drive sprocket 26 is attached to an end part of the countershaft 73, and a drive chain 28 is stretched between the drive sprocket 26 and a driven sprocket 27 attached to the axle of the rear wheel 12 (see Fig. 1). With this configuration, power of the engine 20 is transmitted to the rear wheel 12.

[0021] An intake pipe 30 extends upward from an upper surface of the cylinder head 23 which is placed substantially horizontally and protrudes forward, and the intake pipe 30 is connected to an air cleaner 32 attached to the main frame 3 through a throttle body 31 integrally provided with a fuel injection valve 95. An exhaust pipe 33 extending downward from the lower surface of the cylinder head 23 bends while extending rearward, and is connected to a muffler 34 disposed on the right side of the vehicle body behind the crankcase 21.

[0022] Referring to Fig. 3, in the engine 20, the crankshaft 40 is rotatably supported by the crankcase 21 via a pair of right and left main bearings 41, 41, and the reciprocating motion of a piston 42 slidably fitted in a cylinder bore of the cylinder block 22 is converted into the rotating motion of the crankshaft 40 via a connecting rod 43. An electrode on the tip of an ignition plug 44 inserted through the ceiling wall of the cylinder head 23 faces a combustion chamber 23a formed between the top surface of the piston 42 and the ceiling surface of the cylinder head 23.

[0023] A left part of the crankshaft 40 extending to the left from the left main bearing 41 is provided with a drive sprocket 45, a driven gear 46, and an ACG starter motor 48 serving as a starter/generator having functions of a starter motor and a generator in this order from the main bearing 41 side to the left. A timing chain 38 is stretched between the drive sprocket 45 connected integrally to the crankshaft 40 and a cam sprocket 36 integrally fitted to a cam shaft 35 of a valve operating system which is rotatably supported by the cylinder head 23, by which the cam shaft 35 is rotationally driven at a rotational speed 1/2 that of the crankshaft 40, and an intake rocker arm 38i and an exhaust rocker arm 38e which swing while in contact with an intake cam 35i and an exhaust cam 35e of the cam shaft 35 open or close an intake valve 39i and an exhaust valve 39e at a predetermined timing, whereby air is sucked into and discharged from the engine 20.

[0024] The driven gear 46 supported to the crankshaft

40 in a rotatable manner via a needle bearing is connected to an outer rotor 48r of the ACG starter motor 48 which is integrally connected to the crankshaft 40 via a one-way clutch 47. An inner stator 48s of the ACG starter motor 48 is fixedly supported by a generator cover 49.

[0025] On the other hand, a right part of the crankshaft 40 extending to the right from the right main bearing 41 has the centrifugal clutch 51 for startup which is provided at the right end and a cylindrical member 56 supported between the centrifugal clutch 51 and the main bearing 41 in a rotatable manner.

[0026] The centrifugal clutch 51 has a drive plate 52 which rotates integrally with the crankshaft 40, and a bowl-shaped clutch outer 53 which is located outside the drive plate 52 and rotates integrally with the cylindrical member 56. Clutch shoes 54 each including three centrifugal weights are supported so as to be swingable by three support shafts 52a fixed to the drive plate 52. Each of the clutch shoes 54 having a lining formed from a friction material on its outer surface is located such that the centroid of the clutch shoe 54 is positioned further toward a retard side than the position of the support shaft 52a in the rotation direction of the crankshaft 40. Each of the clutch shoes 54 rotates with the rotation of the crankshaft 40 and swings outward in the radial direction against a clutch spring (not shown) due to centrifugal force, and when the rotational speed exceeds a predetermined rotational speed, the clutch shoe 54 comes in contact with a clutch outer 53, so that the centrifugal clutch 51 is engaged by frictional force.

[0027] The drive gear 57 is formed integrally with the cylindrical member 56 at the left end of the cylindrical member 56. Therefore, until the rotational speed of the crankshaft 40 exceeds the predetermined rotational speed, the centrifugal clutch 51 is disengaged, and the rotation of the crankshaft 40 is not transmitted to the cylindrical member 56 and the members at the downstream side. However, when it exceeds the predetermined rotational speed, the centrifugal clutch 51 is engaged, so that the rotation of the crankshaft 40 is transmitted to the cylindrical member 56 and the drive gear 57.

[0028] A driven gear 58 meshing with the drive gear 57 is rotatably supported by a main shaft 71 of a constant mesh type multiple speed transmission 70, and the driven gear 58 is connected to a clutch outer 61 of a shift clutch 60 via a damper so as to be driven. The shift clutch 60 is provided at a right end part of the main shaft 71 projecting rightward from the crankcase 21.

[0029] The shift clutch 60 is a frictional multiplate clutch having a large number of clutch plates which are frictionally connected or disconnected by a release mechanism operated by a driver. When the large number of clutch plates are frictionally connected by spring force, the torque of the clutch outer 61 is transmitted to a clutch inner 62 integrally connected to the main shaft 71, so that the shift clutch 60 is engaged. When the large number of clutch plates are disconnected, the transmission of torque to the clutch inner 62 from the clutch outer 61 is

interrupted, so that the shift clutch 60 is disengaged.

[0030] The multiple speed transmission 70 placed behind the crankshaft 40 in the crankcase 21 is a manual transmission, and includes a main shaft 71 on which a main gear group 72 is supported and a countershaft 73 on which a counter gear group 74 is supported. When a shift drum 79 (see Fig. 2) is rotated by a gear shift operation mechanism, shift transmission is performed in such a way that a shift fork (not shown) engaged with a cam groove of the shift drum 79 appropriately moves a shifter gear on the support shaft in the lateral direction, and adjacent gears selected so as to effectively transmit power mesh with each other, the adjacent gears being one of gears of the main gear group 72 and one of gears in the counter gear group 74 which are engaged with each other responsive to the shift operation. The countershaft 73 is an output shaft, and the drive sprocket 26 is fitted to a left end of the countershaft 73 that protrudes to the left beyond the crankcase 21.

[0031] A kick shaft 75 is rotatably supported by the crankcase 21 so as to be parallel to the countershaft 73 in the vicinity of the countershaft 73. The rotation of the kick shaft 75 is transmitted to a gear 78 mounted to the main shaft 71 via an idle gear 77 rotatably supported by the countershaft 73 via a dog clutch 76 of the kick shaft 75, and further transmitted to the crankshaft 40 via the shift clutch 60. Thus, the engine 20 can be kick-started.

[0032] Referring to Figs. 2 and 3, a speed sensor 82 is attached to a rear wall 21b of the crankcase 21 that covers the counter gear group 74 from behind. The speed sensor 82 is mounted at a position behind a shift driven gear 74a that is a gear at the left end among the counter gear group 74 and that integrally rotates with the countershaft 73. The speed sensor 82 projects from the rear wall 21b with a detection unit thereof facing the teeth of the shift driven gear 74a.

[0033] Therefore, as shown in Fig. 2, a gusset 4c (dashed line in Fig. 2) connecting the pair of right and left pivot plates 4, 4 has a recess which is formed in such a manner as to avoid the speed sensor 82, and covers the speed sensor 82 together with an engine mounting part from behind and from diagonally above in a shape of an eave, thereby protecting the speed sensor 82.

[0034] Fig. 4 is a block diagram for describing the functions of idling stop and kickback prevention in the motorcycle substantially constructed as described above, and the engine 20 is controlled by an engine control unit (ECU) 80. The ECU 80 includes an idling stop control unit 80A and a kickback prevention unit 80B.

[0035] The ECU 80 receives detection information indicating a speed V detected by the speed sensor 82, an engine speed NE which is the rotational speed of the crankshaft 40 detected by an engine speed sensor 83, a throttle angle θ which is the opening degree of the throttle valve detected by a throttle angle sensor 84, an oil temperature T of a lubricating oil detected by an oil temperature sensor 85, a shift position SP of the multiple speed transmission 70 detected by a shift position sensor

86, and other operating states of the engine 20.

[0036] Further, the ECU 80 receives information regarding operation of switches such as a start switch 91 and an idling stop switch 92 which are operated by the driver. The start switch 91 is operated for starting the engine 20. The idling stop switch 92 is turned on when the driver intends to execute idling stop, and turned off when the driver does not need idling stop.

[0037] The ECU 80 controls driving of the fuel injection valve 95 provided integrally with the throttle body 31, a throttle valve 96 in the throttle body 31, the ignition plug 44, the ACG starter motor 48, and other devices.

[0038] Next, idling stop control by the idling stop control unit 80A will be described with reference to the flowcharts of Figs. 5 and 6.

[0039] In an idling stop (IS) permission determination routine shown in Fig. 5, it is determined in step S1 whether or not the motorcycle is in an idling stop permission mode for permitting idling stop. In the present embodiment, it is determined whether or not idling stop is permitted on the basis of the idling stop switch 92. If the idling stop switch 92 is off, the process proceeds to step S5 where the idling stop permission is canceled, and an idling stop permission flag F is set to "0". If the idling stop switch 92 is on, the process proceeds to step S2.

[0040] In step S2, it is determined whether or not the oil temperature T is 45°C or higher. If the oil temperature T is less than 45°C, the process proceeds to step S5 to cancel the idling stop permission and set the idling stop permission flag F to "0". If the oil temperature T is 45°C or higher, the process proceeds to step S3.

[0041] In step S3, it is determined whether or not the speed V is equal to or greater than 10 Km/h. If the speed V is less than 10 Km/h, the process proceeds to step S5 to cancel the idling stop permission and set the idling stop permission flag F to "0". If the vehicle speed V is 10 Km/h, the process proceeds to step S4 where the idling stop permission flag F is set to "1" as the idling stop permission mode.

[0042] In the present embodiment, in step S1, it is determined whether or not the driver requests idling stop, and in steps S2 and S3, it is determined whether or not the motorcycle is about to stop. Only when it is determined as a result of the above determination that the driver turns on the idling stop switch 92, requesting idling stop, and the motorcycle is about to stop, idling stop is permitted, and the idling stop permission flag F is set to "1".

[0043] In an idling stop control routine shown in Fig. 6, it is determined based on the idling stop permission flag F whether or not the idling stop permission mode is set in step S11. If the idling stop permission mode is canceled (F = 0), the process exits the present routine without executing idling stop, and returns to step S11 to repeat the above processes. If the idling stop permission mode is set (F = 1), the process proceeds to step S12.

[0044] In step S12, it is determined whether or not the speed V is less than 3 Km/h (including 0 Km/h). If the

speed V is not less than 3 Km/h, the process exits the present routine without executing idling stop. If the speed V is less than 3 Km/h, the process proceeds to step S13 where it is determined whether or not the engine speed NE is at an idling rotational speed. If the engine speed is not at the idling rotational speed, the process exits this routine without executing idling stop. If the engine speed NE is at the idling rotational speed, the process proceeds to step S14.

[0045] In step S14, it is determined whether or not the shift position SP is neutral, that is, whether or not the multiple speed transmission 70 is shifted to a neutral position by gear shift operation. If the multiple speed transmission 70 is not shifted to the neutral position, the process exits the present routine without executing idling stop. If the multiple speed transmission 70 is shifted to the neutral position, the process proceeds to step S15 where it is determined whether or not 0.5 seconds have elapsed after the gear change is performed. If 0.5 seconds have not elapsed, the process exits the present routine, and after 0.5 seconds have elapsed, the process proceeds to step S16. In step S16, idling stop is executed by prohibiting the ignition of the ignition plug 44 or the fuel injection of the fuel injection valve 95, for example.

[0046] The control in steps S11 to S16 is performed, on the assumption that the motorcycle is in the idling stop permission mode, in such a way that, when the speed V is less than 3 Km/h (including 0 Km/h) and the engine speed NE is at the idling rotational speed, it is determined that the motorcycle stops or is about to stop, and if the shift position is changed to the neutral position, idling stop is executed only 0.5 seconds later.

[0047] According to the present embodiment, idling stop is started after a lapse of very short time which is only 0.5 seconds, in response to the driver's intentional operation of changing the shift position to a neutral position, without waiting for a predetermined time that would be taken to check continuation of signal. Thus, the idling time before the idling stop can be decreased as much as possible, and as a result, fuel consumption can be suppressed.

[0048] Since idling stop is executed 0.5 seconds after the multiple speed transmission is changed to the neutral position, the driver can feel more natural shift to the idling stop state without having any discomfort, as compared to a case where idling stop is executed the moment the multiple speed transmission is changed to the neutral position.

[0049] Note that idling stop may be started the moment the multiple speed transmission is changed to the neutral position without waiting for 0.5 seconds, because a sense of discomfort caused by idling stop executed immediately after the multiple speed transmission is shifted to the neutral position is subtle.

[0050] In addition, idling stop is started by the driver's intentional operation for changing the multiple speed transmission to the neutral position, and thus, when the driver intends to start after stopping the motorcycle,

he/she does not need to change the multiple speed transmission to the neutral position. Accordingly, the driver can avoid a situation in which idling stop is accidentally executed and it takes time to restart the motorcycle.

[0051] After idling stop is executed in step S16, the process proceeds to step S17 where it is determined whether or not the shift position SP has been shifted to an in-gear state other than the neutral position. If the shift position SP has not been shifted to the in-gear state and remains in the neutral state, the process exits this routine, so that the idling stop state is maintained.

[0052] If it is determined in step S17 that the shift position SP has been shifted to the in-gear state, the process proceeds to step S18 where it is determined whether or not the throttle angle θ is in a closed state. If the throttle angle θ is in the closed state, the process proceeds to step S19 where the engine 20 is automatically started, and then the process exits this routine.

[0053] When idling stop is started, the centrifugal clutch 51 is already in a disengaged state. Therefore, the vehicle can not start even when the engine 20 is automatically started immediately after the shift position SP of the multiple speed transmission 70 is shifted to the in-gear state other than the neutral state after idling stop. Therefore, automatic start can be performed without any trouble with a simple configuration.

[0054] Idling stop is started by the driver's intentional operation, that is, by gear change, and the engine 20 is automatically started by the intentional operation of gear change, whereby an idling stop control according to the will of the driver can be performed.

[0055] Further, in the present embodiment, when it is determined that the shift position is changed to the in-gear state (step S17), and it is determined in step S18 that the throttle angle θ is not in the closed state but in the open state, the process proceeds to step S20 where the idling stop permission flag F is changed to "0" to cancel the idling stop permission mode. Then, the process proceeds to step S21 where automatic start of the engine 20 is prohibited, and then, the process exits the present routine.

[0056] Accordingly, the start of the motorcycle 1 can be prevented after idling stop, and a normal engine stop state without idling stop can be set by canceling the idling stop permission state.

[0057] In the state where the automatic start of the engine 20 is prohibited, the idling stop permission state is canceled, and the engine 20 is in a normal stop state without having idling stop. Therefore, the engine 20 can be started by a starting operation using the start switch 91 or a kick pedal.

[0058] Unlike the above embodiment, the idling stop control routine may be executed as follows. Specifically, the determination of whether or not the engine speed NE is at the idling rotational speed in step S13 and the determination of whether or not the shift position SP is in the neutral position in step S14 may be changed to the determination of whether or not the throttle angle θ is in

the closed state without the determination regarding the shift position. When the throttle angle θ is in the open state, the process may exit the present routine, and when the throttle angle θ is in the closed state, the process may proceed to step S15.

[0059] In this case, the determination of whether 0.5 seconds have elapsed in step S15 may be changed to a determination of whether or not 3 seconds have elapsed. After the lapse of 3 seconds, idling stop is started regardless of the shift position, and during idling stop, the injection may be cut, a headlight may be dimmed, and an idling stop indicator may be turned on.

[0060] In addition, between step S13 and step S14 in the idling stop control routine of the abovementioned embodiment, determination of whether or not the throttle angle θ is in the closed state may be added. When the throttle angle θ is in the open state, the process may exit the present routine, and when the throttle angle θ is in the closed state, the process may proceed to step S15.

[0061] When the throttle angle θ is opened during idling stop, a starter relay is turned on to automatically start the engine, dimming of the headlight is stopped, and a standby indicator is turned off.

[0062] Further, a side stand switch may be provided, and the motorcycle may be configured as follows. Specifically, when a side stand is pushed down, idling stop may be started, and when the side stand may be pushed up to be brought into a mounted state, the engine may be automatically started. The various idling stop controls described above may be selected by a changeover switch.

[0063] Fig. 7 shows a combination meter 100 provided on a handle cover of the motorcycle.

[0064] The combination meter 100 includes an analog speedometer 101 that is circular and arranged at the center, and various indicators provided around the analog speedometer 101. A neutral indicator 102, a first gear indicator 103, a second gear indicator 104, and the like are arranged on the left half of the combination meter 100 along the outer periphery of the analog speedometer 101, and a third gear indicator 105, a fourth gear indicator 106, an idling stop permission indicator 107 that indicates on/off of the idling stop switch, and the like are arranged on the right half of the combination meter 100 along the outer periphery of the analog speedometer 101.

[0065] During the idling stop control in which idling stop can be started regardless of the shift position, when the idling stop permission indicator 107 of the combination meter 100 in Fig. 7 is on with the idling stop switch being on, and the third gear indicator 105 is on because the multiple speed transmission is in the third position (or fourth position), the first gear indicator 103 and the second gear indicator 104 flicker.

[0066] When the multiple speed transmission is in the third position (or fourth position), it is not appropriate that idling stop is started. Therefore, the first gear indicator 103 and the second gear indicator 104 are flickered to promote the driver to shift down to the first position or the

second position where starting torque can easily be ensured.

[0067] Fig. 8 is a functional block diagram showing the configuration of the kickback prevention unit 80B. The kickback prevention unit 80B mainly includes a motor stage identification unit 801, a reverse rotation detection unit 802, and an ignition prohibition unit 803.

[0068] The motor stage identification unit 801 identifies the angular range of the ACG starter motor 48 as a motor stage (MSTAGE) on the basis of the direction of current flowing through each phase of the ACG starter motor 48. In the present embodiment, a three-phase AC motor is employed as the ACG starter motor 48, and as shown in Figs. 9 and 10, the motor stage is identified as any one of the zeroth stage to the fifth stage on the basis of the combination of the directions of the currents flowing through U, V, and W phases.

[0069] In the present embodiment, for example, a plurality of Hall elements is provided as a rotor sensor for detecting a permanent magnet mounted on an inner rotor of the ACG starter motor 48, and the direction of a current flowing through each phase is detected as an output signal of the Hall elements. If, for example, the U phase is at the Lo level, and both the V phase and the W phase are at the Hi level, the motor stage is identified as "0". Similarly, if, for example, the U phase is at the Hi level, and both the V phase and W phase are at the Lo level, the motor stage is identified as "3".

[0070] The reverse rotation detection unit 802 detects that the rotational direction of the crankshaft 40 is changed from the forward rotation to the reverse rotation on the basis of a change in the motor stage. In the present embodiment, the motor stage changes as $0 \rightarrow 1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 0$ during forward rotation. On the other hand, during reverse rotation, the direction of the current is switched in two of the three phases, so that the motor stage changes as $2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 4 \rightarrow 3 \rightarrow 2$, for example. When the motor stage has such a change specific to the reverse rotation, the reverse rotation detection unit 802 determines that the rotational direction of the ACG starter motor 48, that is, the rotational direction of the engine, has changed from forward rotation to reverse rotation.

[0071] The ignition prohibition unit 803 ignites the engine at a normal ignition timing as long as the engine rotates forward, and prohibits ignition of the engine when reverse rotation is detected by the reverse rotation detection unit 802.

[0072] Fig. 11 is a time chart of ignition control for determining the method and whether to ignite the engine on the basis of the motor stage and the rotational speed of the ACG starter motor 48, and Fig. 12 is a flowchart showing the control procedure.

[0073] In step S31, the output signals of the rotor sensors are acquired. In step S32, the motor stage identification unit 801 identifies the current motor stage of the ACG starter motor 48 on the basis of the combination of the output signals of the rotor sensors. In step S33, it is

determined whether or not the ACG starter motor 48 has reached a motor stage for determining whether to use a computational ignition timing or a fixed ignition timing as the current engine ignition timing.

[0074] In the present embodiment, the motor stage corresponding to 50° before the compression top dead center (TDC) of the engine is an ignition timing determination stage, and when the motor stage reaches the ignition timing determination stage at time t_1 , the procedure proceeds to step S34.

[0075] In step S34, the engine speed NE in the angular range from 50° to 40° before the TDC is measured as an instantaneous engine speed NEa. In the present embodiment, since the 31st motor stage corresponds to the angular range described above, the engine speed in the 31st motor stage is measured as the instantaneous engine speed NEa. In step S35, the instantaneous engine speed NEa is compared with a predetermined reference engine speed NE_{ref} , and if $NEa < NE_{ref}$ is not established, the procedure proceeds to a predetermined computational ignition process.

[0076] On the other hand, if $NEa < NE_{ref}$, the procedure proceeds to step S36 and subsequent steps. If it is determined in step S33 that the current motor stage does not reach the ignition timing determination stage, the procedure similarly proceeds to step S36 and subsequent steps.

[0077] In step S36, it is determined whether or not the current stage reaches a current energization start timing for energizing the ignition coil on the basis of the result of stage identification in step S32. If it is determined that the current stage reaches the current energization start timing at time t_2 in Fig. 11, the procedure proceeds to step S43 where energization of the ignition coil is started/continued.

[0078] On the other hand, if it is determined in step S36 that the motor stage does not reach the current energization start stage, the procedure proceeds to step S37 where it is determined whether or not the motor stage reaches a current ignition stage in which the ignition coil is ignited. In the present embodiment, the ignition timing of the fixed ignition is set to 10° before the TDC, and when the motor stage reaches the 35th stage corresponding to this angle at time t_3 , it is determined that the motor stage reaches the current ignition stage, and the procedure proceeds to step S38.

[0079] In step S38, the reverse rotation detection unit 802 determines whether or not the engine rotates reversely on the basis of the change in the motor stage. If the motor stage has a change specific to the reverse rotation, the procedure proceeds to step S41 where the current engine ignition is stopped. If it is determined that the engine does not rotate reversely, the procedure proceeds to step S39 where a passage time Δt in which the motor passes through the stage closest to the TDC (in the present embodiment, the 34th motor stage from 10° to 20° before the TDC) is measured. In step S40, the passage time Δt in which the motor passes through the

stage closest to the TDC is compared with a kickback determination threshold Δt_{ref} .

[0080] According to an experiment conducted by the present inventors, an ignition delay time Δd from the ignition of the engine until the fuel pressure actually starts to increase is substantially constant, and in order to prevent the occurrence of kickback, it is desirable that the crank angle exceeds the TDC within the ignition delay time Δd before the ignition pressure starts to increase. In view of this, in the present embodiment, the kickback determination threshold Δt_{ref} is set to the ignition delay time Δd . Then, the passage time Δt in which the motor passes through the stage from 10° before the TDC which is the ignition timing to the TDC is compared with the kickback determination threshold Δt_{ref} . If $\Delta t < \Delta t_{ref}$, the possibility of occurrence of kickback is low, so that the procedure proceeds to step S42 where fixed ignition is performed. On the other hand, if $\Delta t \geq \Delta t_{ref}$, the possibility of the occurrence of kickback is not low. Therefore, the procedure proceeds to step S41 where the current engine ignition is prohibited by the ignition prohibition unit 803.

[0081] Note that the determination in step S40 may be performed on the basis of the engine speed. For example, if the ignition timing is at 10° before the TDC, and the ignition delay time Δd is fixed to 2.5 ms, the engine speed by which the motor passes through the angular range of 10° from the ignition timing to the TDC by 2.5 ms is 666.7 rpm. Therefore, it is possible to alternatively perform control in which, when the instantaneous engine speed at 10° before the TDC is less than 670 rpm, the ignition is prohibited, and when it is equal to or greater than 670 rpm, the ignition is permitted.

Reference Signs List

[0082]

1	motorcycle
2	head pipe
3	main frame
4	pivot plate
5	rear frame
8	front fork
20	engine
40	crankshaft
41	main bearing
42	piston
48	ACG starter motor
51	centrifugal clutch
80	ECU
80A	idling stop control unit
80B	kickback prevention unit
82	speed sensor
83	engine speed sensor
84	throttle angle sensor
85	oil temperature sensor
86	shift position sensor

91	start switch
92	idling stop switch
95	fuel injection valve
96	throttle valve

Claims

1. An engine starter device for vehicles including a generator/starter (48) that is connected to a crankshaft of an engine and rotates synchronously with the crankshaft, a kick starter (75) that kick-starts the engine, and a means (44) for igniting the engine, the engine starter device comprising:

a stage identification means (801) for identifying a stage representing a rotational angle of the generator/starter (48);

a means (802) for detecting reverse rotation of the engine on the basis of a change in the stage; and

a means (803) for prohibiting the ignition when reverse rotation of the engine is detected.

2. The engine starter device for vehicles according to claim 1, wherein the generator/starter (48) is a three-phase brushless motor, and the stage identification means (801) identifies a motor stage on the basis of a combination of detection values of a U phase, a V phase, and a W phase.

3. The engine starter device for vehicles according to claim 2, wherein the generator/starter (48) is provided with a rotor sensor, and the stage identification means (801) identifies a direction of a current flowing through each of the phases of the generator/starter (48) according to an output state of the rotor sensor.

4. An engine starter device for vehicles including a generator/starter (48) that is connected to a crankshaft of an engine and rotates synchronously with the crankshaft, a kick starter (75) that kick-starts the engine, and a means (44) for igniting the engine, the engine starter device comprising:

a motor stage identification means (801) for identifying a motor stage representing a rotational angle of the generator/starter (48);

a means for determining whether or not the crankshaft is within a predetermined angular range near a compression top dead center on the basis of the motor stage; and

an ignition prohibition means (803) that prohibits

ignition of the engine on the basis of a rotational speed of the generator/starter (48) when the crankshaft is within the predetermined angular range.

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5. The engine starter device for vehicles according to claim 4, wherein the rotational speed is an instantaneous rotational speed.
6. The engine starter device for vehicles according to claim 4 or 5, wherein the predetermined angular range near the compression top dead center is before the compression top dead center.
7. The engine starter device for vehicles according to any one of claims 4 to 6, wherein the predetermined angular range is before an ignition timing, and the ignition prohibition means (803) prohibits the ignition of the engine on the basis of a passage time to pass through the angular range and an ignition delay time (Δd) from the ignition timing until a pressure increases.
8. The engine starter device for vehicles according to claim 7, wherein the ignition delay time (Δd) is a constant.

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Fig.1

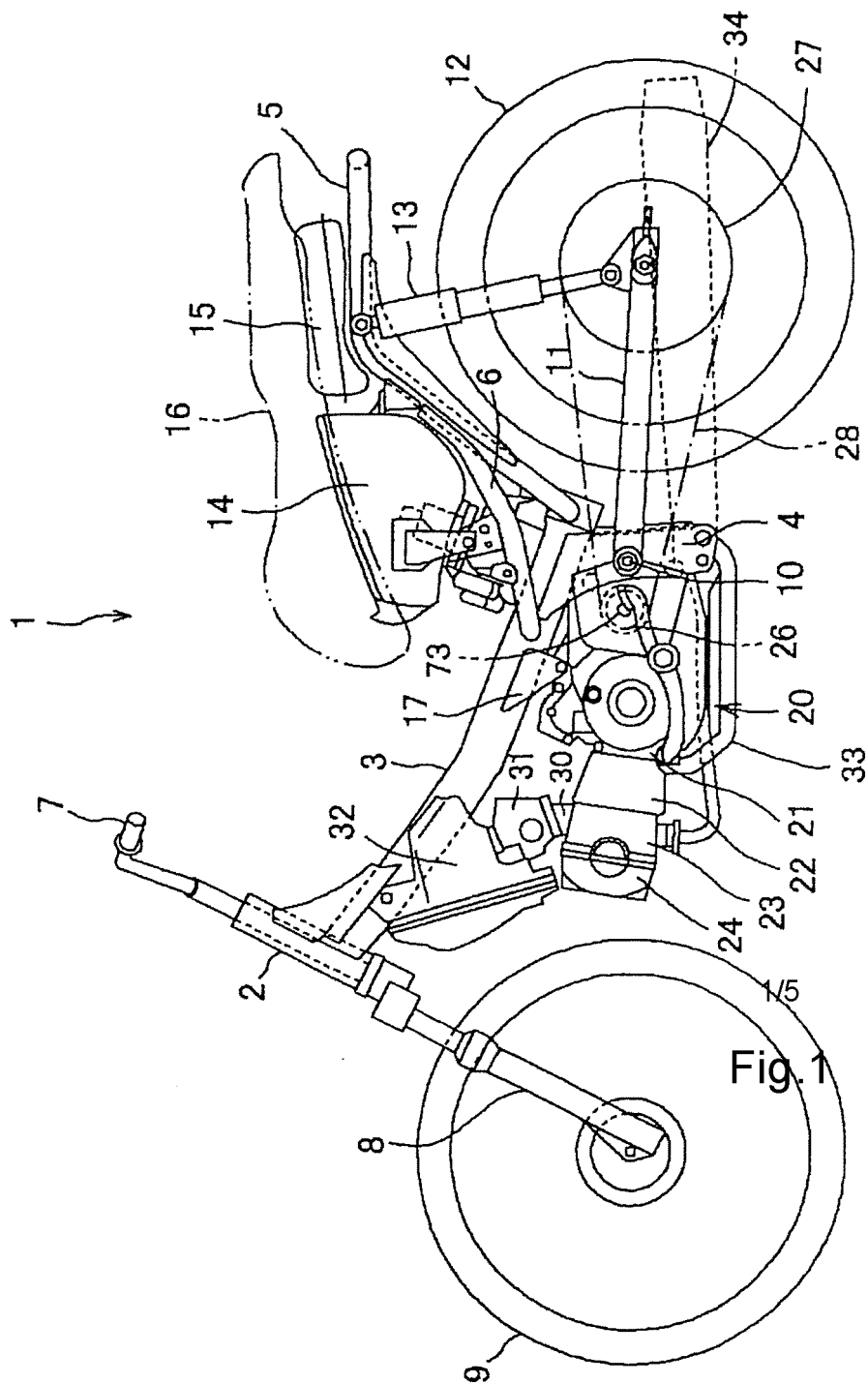


Fig.2

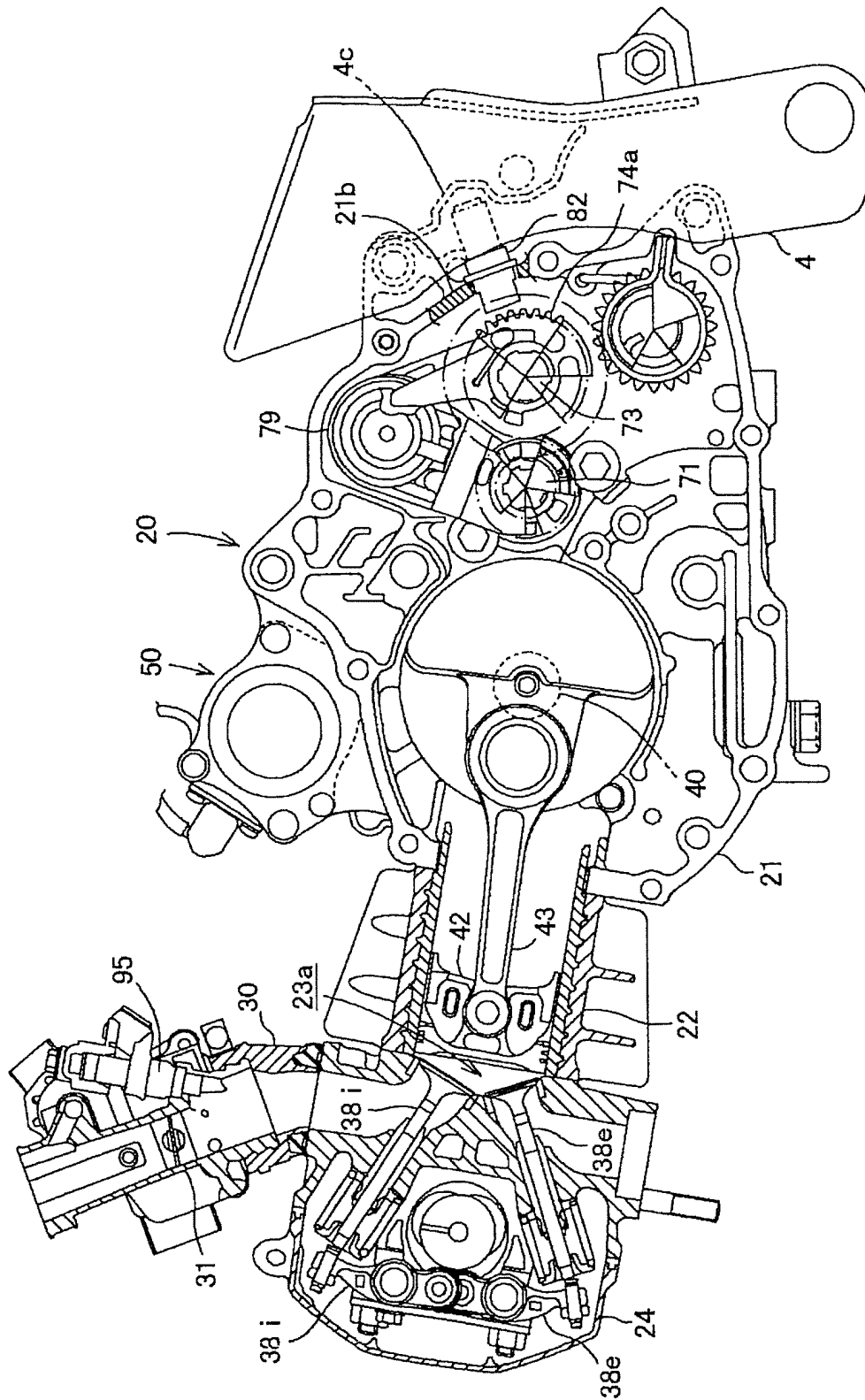


Fig.3

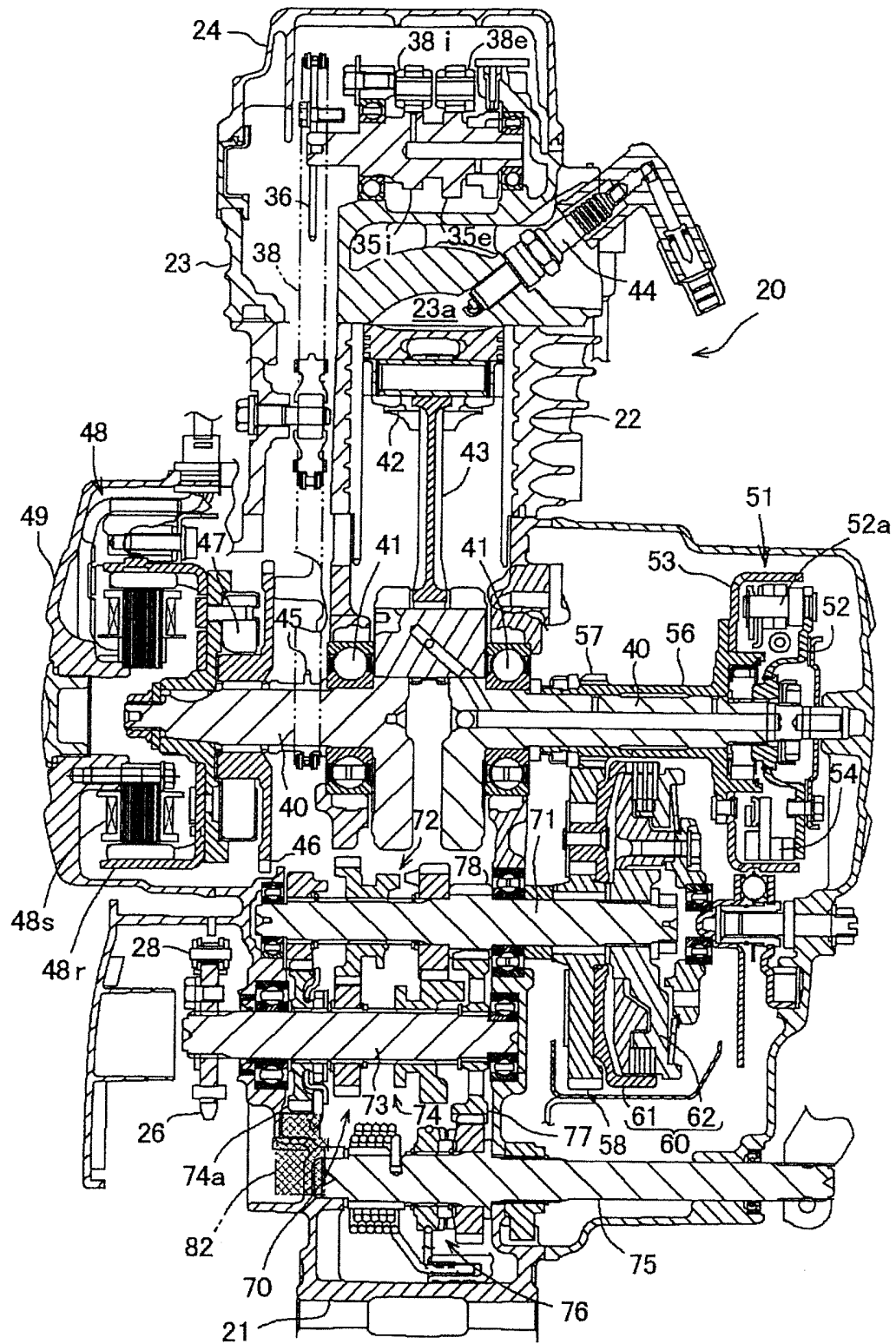


Fig.4

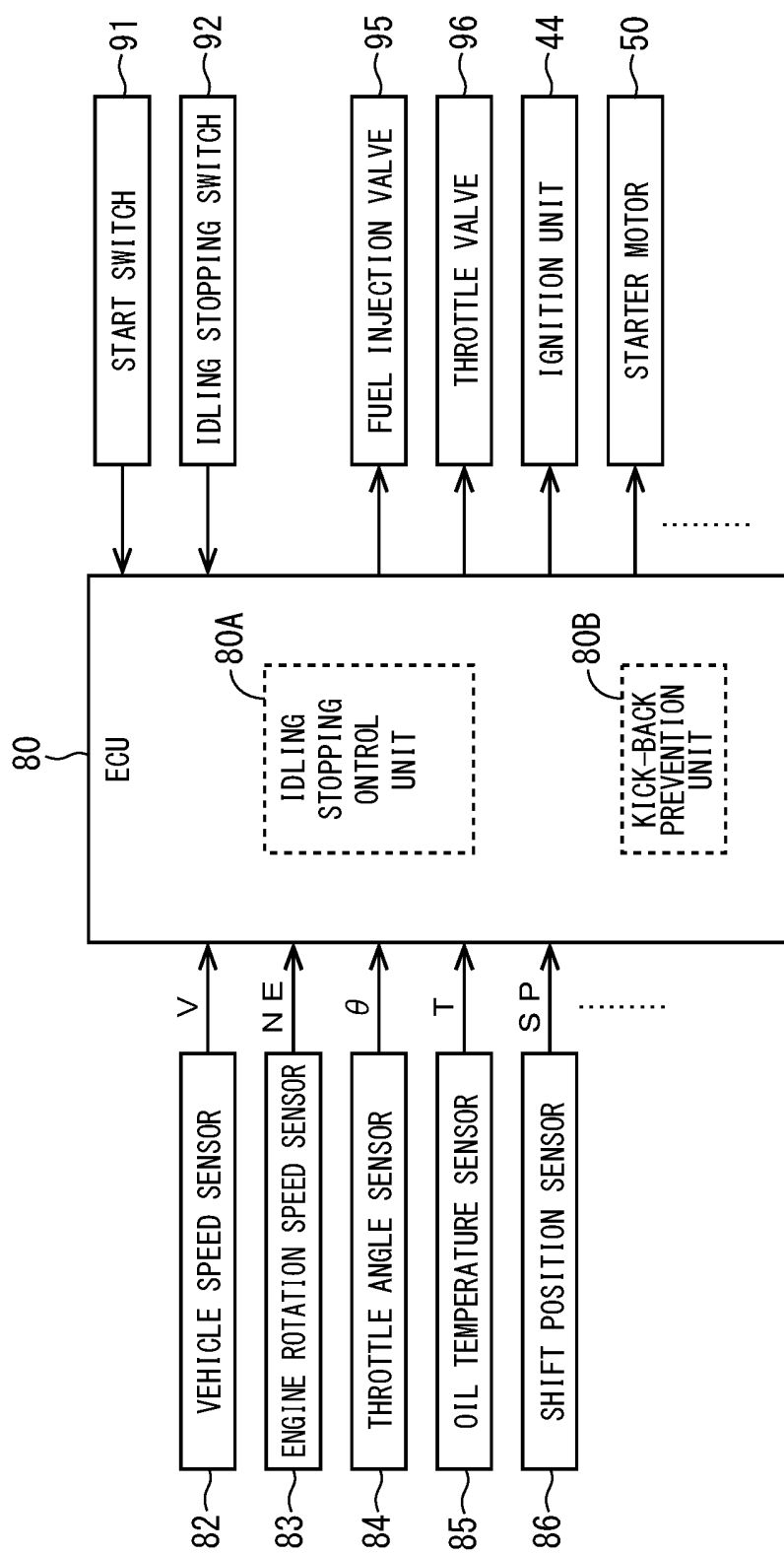


Fig.5

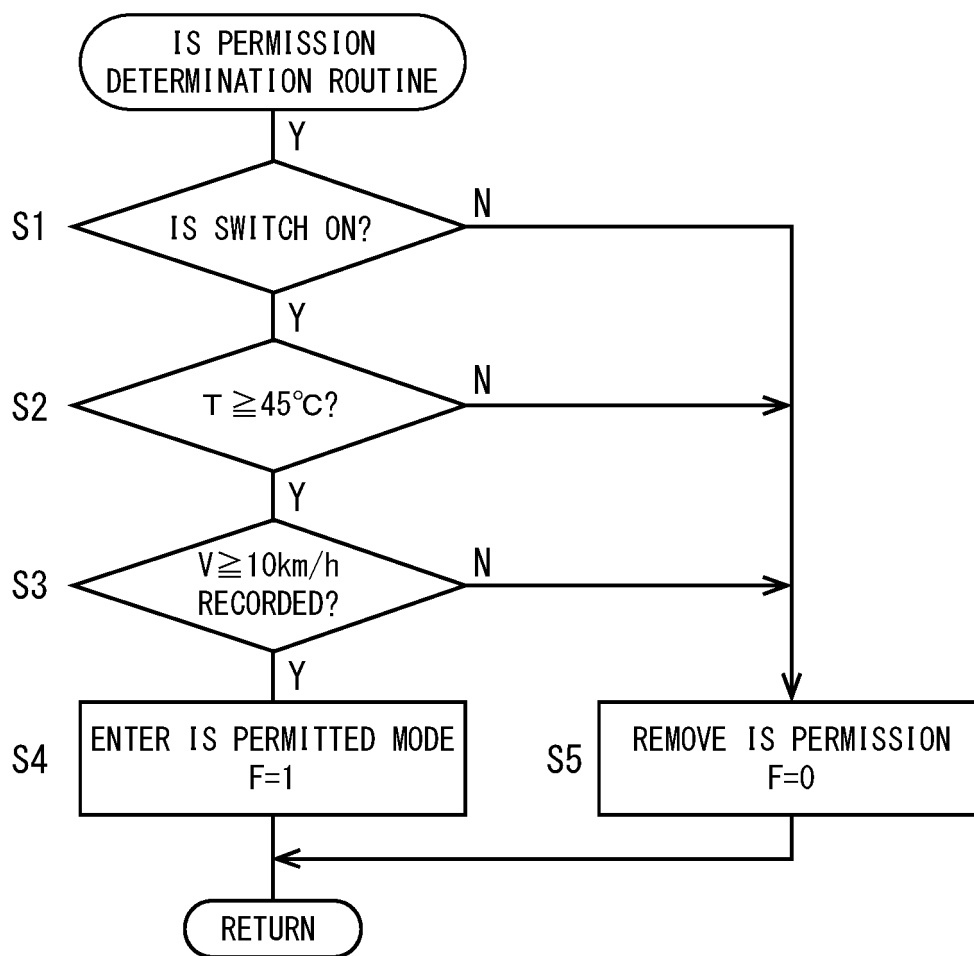


Fig.6

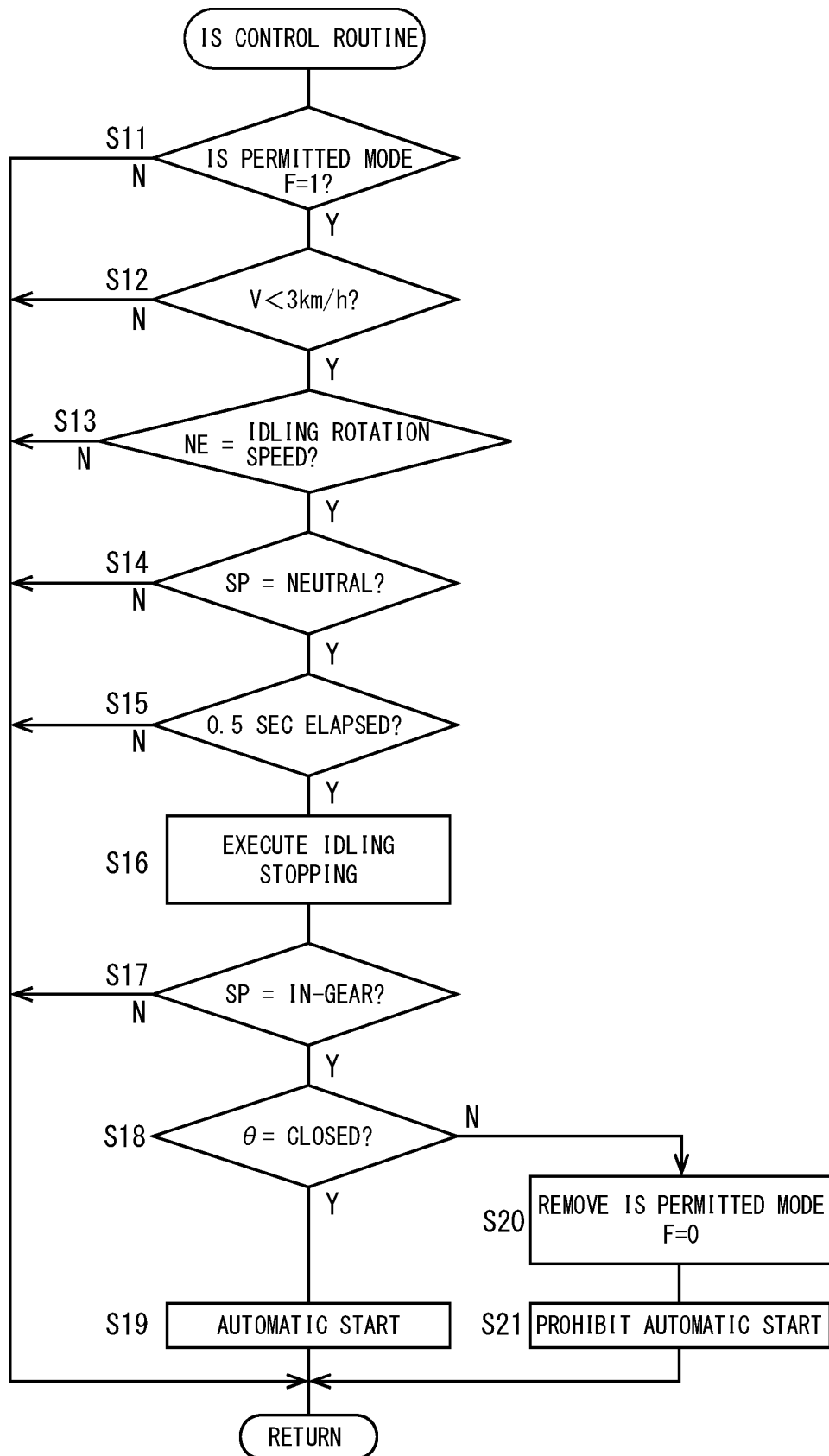


Fig.7

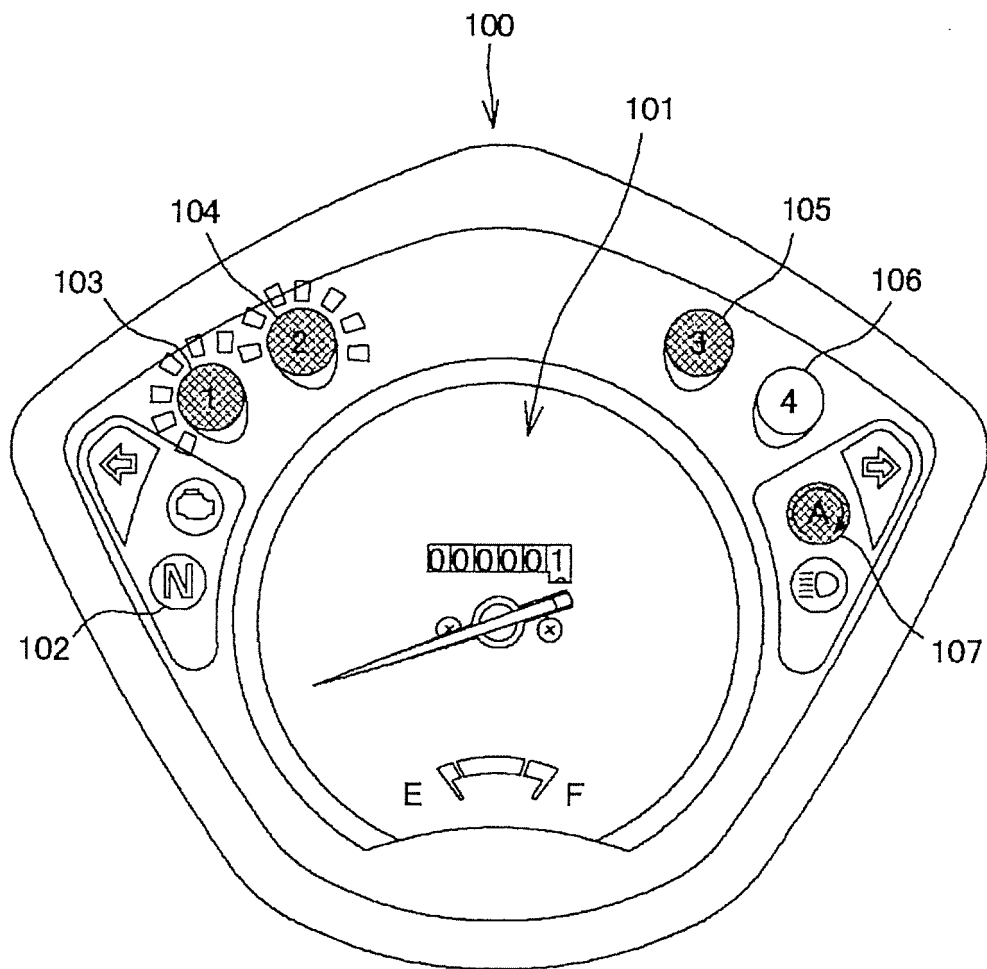


Fig.8

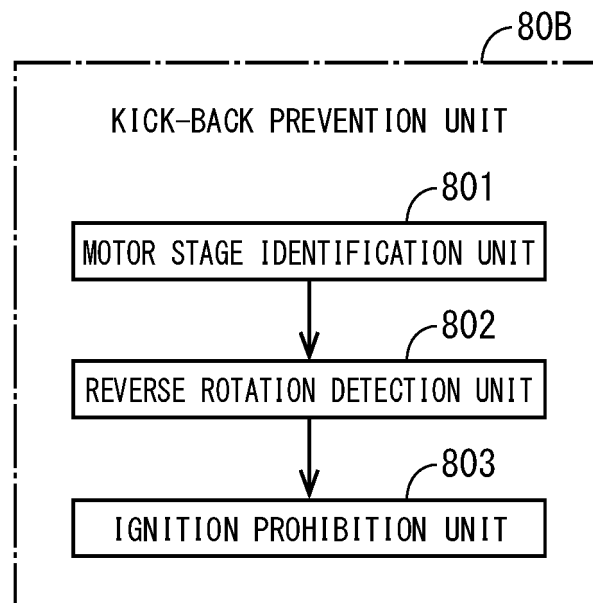


Fig.9

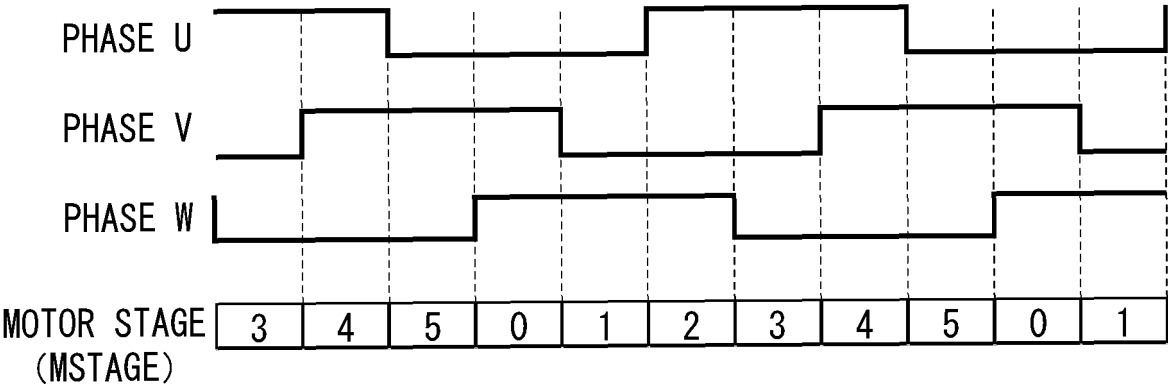


Fig.10

ROTOR SENSOR U	ROTOR SENSOR V	ROTOR SENSOR W	MSTAGE
Lo	Hi	Hi	0
Lo	Lo	Hi	1
Hi	Lo	Hi	2
Hi	Lo	Lo	3
Hi	Hi	Lo	4
Lo	Hi	Lo	5

Fig.11

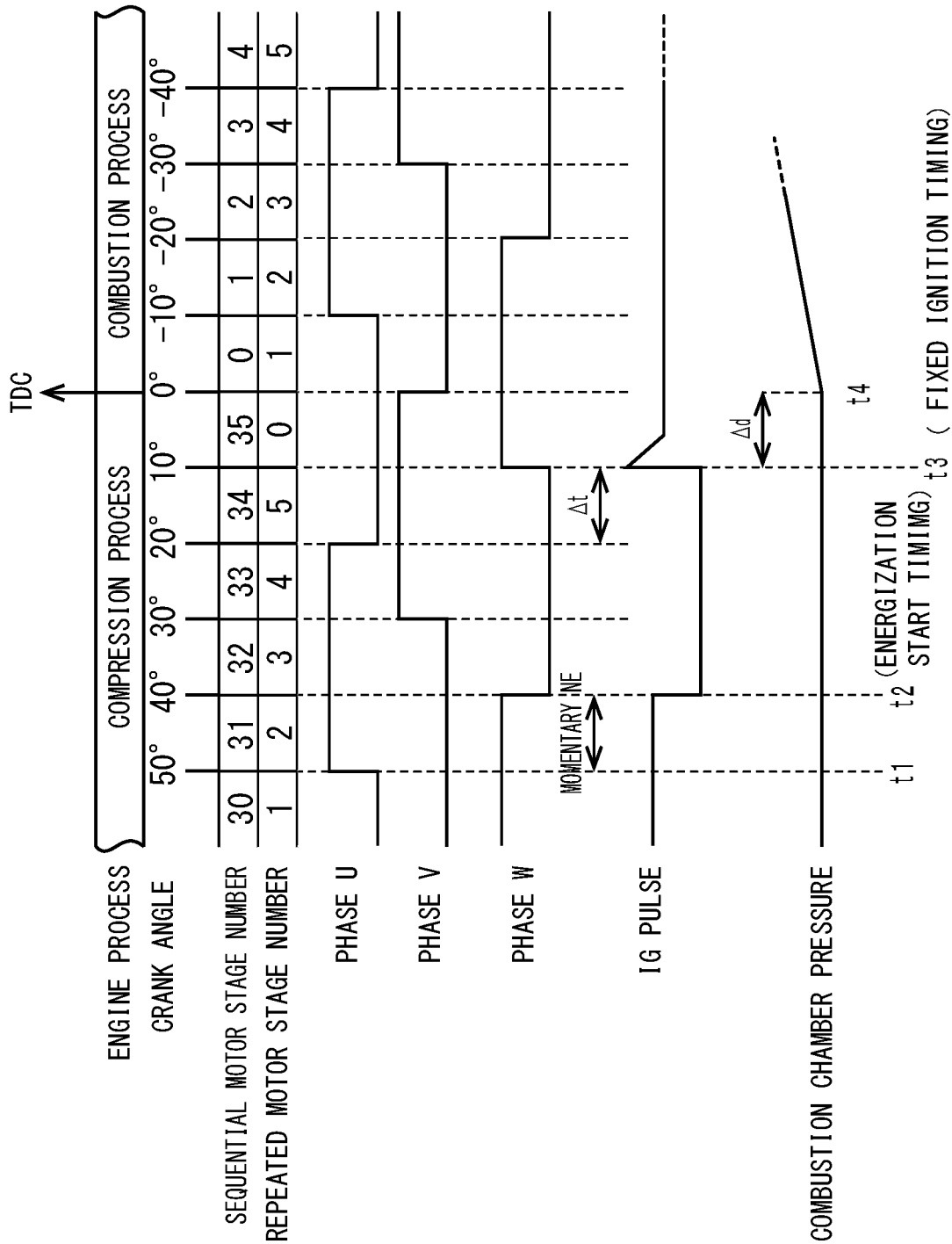
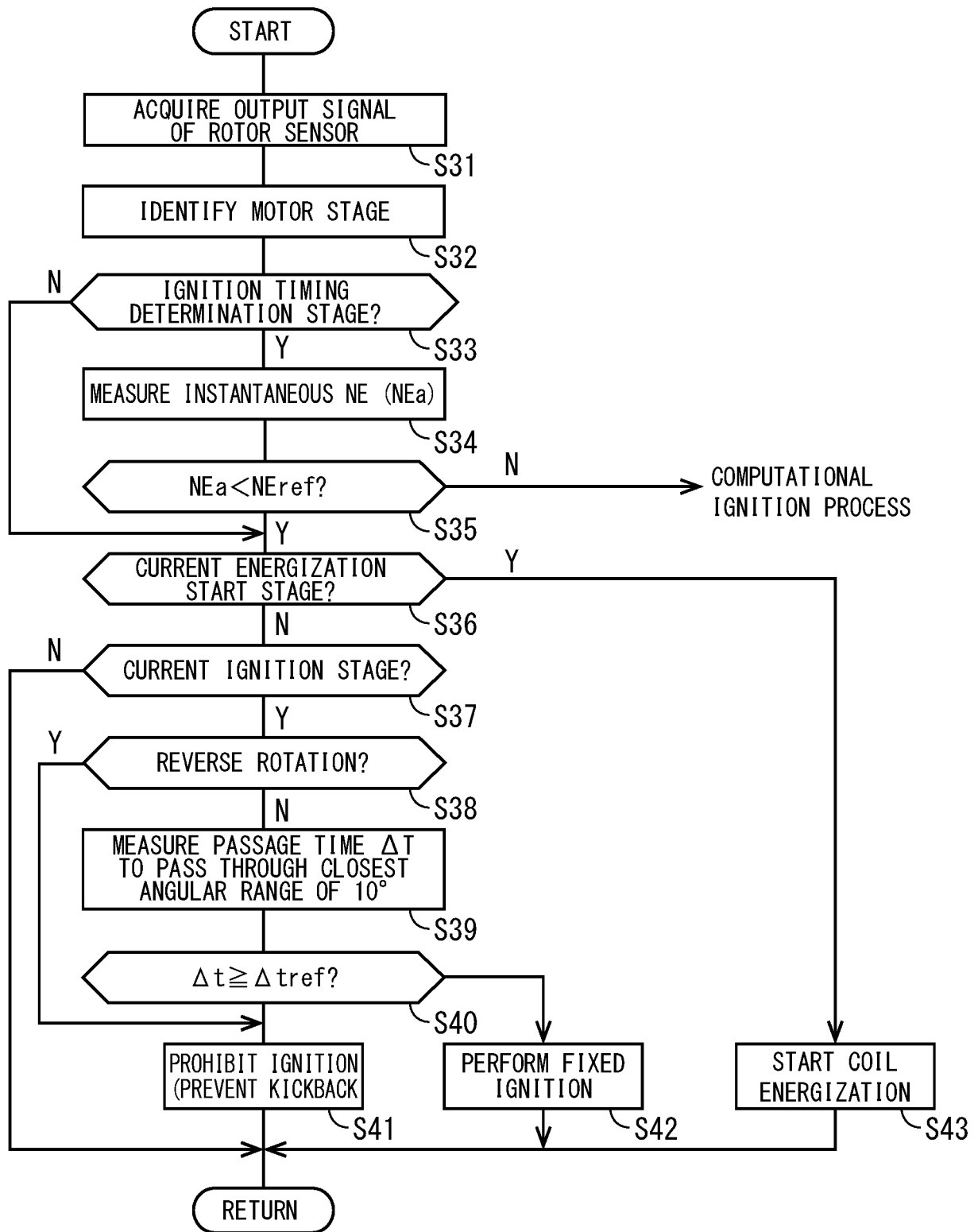


Fig.12



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/022904

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. F02P11/02(2006.01) i, F02N3/04(2006.01) i, F02N11/06(2006.01) i,
F02N11/08(2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl. F02D13/00-29/06, 43/00-45/00, F02N1/00-99/00, F02P1/00-3/12,
7/00-17/12

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2019
Registered utility model specifications of Japan 1996-2019
Published registered utility model applications of Japan 1994-2019

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2005-248921 A (HONDA MOTOR CO., LTD.) 15	1-3
Y	September 2005, paragraphs [0008]-[0034], fig. 1,	4-6
A	5 & EP 1574692 A1, paragraphs [0008]-[0034], fig. 1, 5 & CN 1667253 A & KR 10-2006-0043404 A	7-8
Y	JP 5148530 B2 (KEIHIN CORP.) 20 February 2013,	4-6
A	paragraph [0082] & JP 2010-190171 A	7-8



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search
15.08.2019

Date of mailing of the international search report
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Patent documents cited in the description

- JP 5148530 B [0005]