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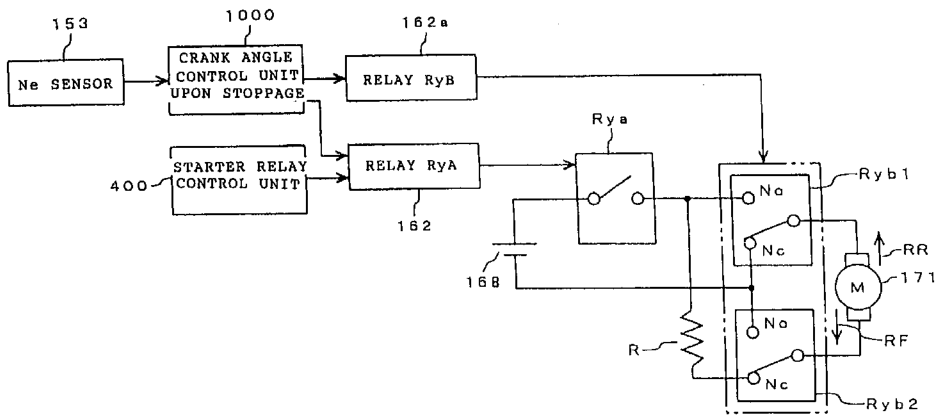
(54) Engine starter

(57) To improve the startability by reducing the effect of a load upon start-up of an engine.

When an Ne sensor (153) detects the stoppage of the engine, a control unit (1000) turns on a relay (RyA). When a starter switch is operated, a starter relay control unit (400) turns on a relay (RyA). The OFF state of the relay (RyB) is kept for a time set on the basis of the water temperature of the engine. When the relay (RyA) is turned on, the starter motor (171) is driven in such a manner as to be reversely rotated when the relay (RyB) is turned off and to be normally rotated when the relay (RyB) is turned on. In this way, the degree of the warming is decided depending on the water temperature, and when the degree of warming is large, the reverse-rotation time of the crank shaft is made short and when the degree of warming is small, the reverse-rotation time of the crank shaft is made long. The crank shaft is reversely rotated for the reverse-rotation time thus set, to be located at a position in a low load region, and is then normally rotated.

FIG. 1



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Description

[0001] The present invention relates to an engine starter, and particularly to an engine starter suitable for improving the startability by reducing the effect of a load torque upon start-up of the engine.

[0002] An engine stoppage/start-up control unit intended to suppress occurrence of exhaust gas and fuel consumption particularly upon idling from the viewpoint of environmental protection and energy saving has been disclosed, for example, in Japanese Patent Laid-open No. Sho 63-75323. The control unit is operated such that when a vehicle is stopped, an engine is automatically stopped, and when a throttle grip is operated to indicate the start-up of the vehicle in the vehicle stoppage state, the engine is automatically restarted to start the vehicle.

[0003] On the other hand, an engine starter has been disclosed, for example, in Japanese Patent Laid-open No. Hei 7-71350, wherein a starter motor (cell motor) is reversely rotated once and then rotated in the normal-rotation direction of the engine in order to reduce the effect of a load torque upon start-up of the engine. In this starter, the frictional resistance is reduced by reversely rotating the cell motor by a specific rotational angle or for a specific time and the rotational speed is increased in a region in which the friction resistance is reduced, to reduce the effect of the load torque at the compression stroke, thereby enhancing the startability.

[0004] The above engine starter for controlling the rotational direction of the cell motor in such a manner as to reversely rotate the crank shaft once and then normally rotate it has the following problem. The rotational friction, that is, the resistance against the rotation of the engine, for example, the viscosity of engine oil differs between in the cool state of the engine and in the warm state of the engine. However, since the above-described engine starter is configured to reversely rotate the crank shaft by a specific angle or for a specific time, the rotational angle position of the crank shaft having been reversely rotated for a specific time differs depending on the value of the above rotational friction of the engine. In other words, there may occur an inconvenience that the specific time has elapsed before the crank shaft is rotated by the specific angle. In this case, the effect of reducing the load torque upon start-up of the engine is insufficient, with a result that the engine cannot be desirably started.

[0005] If the reverse-rotation time is set to value suitable for the cool state of the engine for solving the above inconvenience, there occurs a problem that when the engine is warmed, the crank shaft is reversely rotated for an excessive long time, with a result that it takes a lot of time to start the engine.

[0006] In view of the foregoing, the present invention has been made, and an object of the present invention is to provide an engine starter capable of certainly starting the engine and shortening a time required for starting the vehicle.

[0007] The above object can be achieved by providing engine starters, each being configured to start an engine by reversely rotating a crank shaft for a predetermined reverse-rotation time and then normally rotating the crank shaft, characterized in that

(1) the reverse-rotation time is set on the basis of a rotational friction of the engine in such a manner as to be long when the rotational friction is large and to be short when the rotational friction is small;

(2) the rotational friction is represented by an engine temperature, and the reverse-rotation time is set to be short when the engine temperature is high and the reverse-rotation time is set to be long when the engine temperature is low;

(3) the reverse-rotation time is set to be not less than a time required for the crank shaft to be rotated between a compression top dead center and an exhaust top dead center when the rotational friction of the engine is a predetermined value;

(4) the engine starter includes an engine stoppage/start-up control means for stopping the engine when a vehicle is stopped and restarting the engine in response to vehicle-starting operation performed by a driver; and the reverse-rotation time upon restart-up of the engine is set to be shorter than that upon the initial start-up of the engine;

(5) a ratio of the reverse-rotation time upon initial start-up of the engine to the reverse-rotation time upon restart-up of the engine is set to become larger as the rotational friction becomes smaller; and

(6) a rotational speed and a rotational torque of the crank shaft upon reverse-rotation are set to be smaller than a torque necessary for the crank shaft to overshoot the compression top dead center.

[0008] According to the above features (1) to (6), in the case of starting the engine by reversely rotating the crank shaft once and then normally rotating it, the crank shaft is reversely rotated for a reverse-rotation time previously determined on the basis of the rotational friction of the engine. Accordingly, the reverse-rotation time can be set such that the crank angle position of the crank shaft having been reversely rotated and stopped, that is, the normal-rotation starting position becomes a position allowing the crank shaft to be normally rotated to overshoot the compression top dead center with a small torque.

[0009] Since it is generally considered that the crank shaft is not stopped in the vicinity of the compression top dead center at which a load torque is large, as described in the feature (3), the crank shaft can be stopped in a region between the exhaust top dead center and the compression top dead center in advance of the exhaust top dead center by setting the reverse-rotation time to be equal to or more than a time required for the crank shaft to be rotated between both the top dead centers . According to the research performed by the present inventors, the torque required for the crank shaft to overshoot the compression top dead center is small in such a region, so that the engine can be certainly started by normally rotating the crank shaft from a normal-rotation starting position located in the region.

[0010] In the case of automatically stopping the engine when the vehicle is stopped and then restarting the engine in response to the vehicle-starting operation performed by the driver, the warming of the engine has been finished. In this case, as described in the feature (4), the engine can be started for a short time by shortening the reverse-rotation time upon the restart-up of the engine than that upon the initial start-up of the engine. Further, it may be considered that if the rotational friction is small, the rotated amount of the crankshaft having been reversely rotated for a reverse-rotation time does not differ between in the initial start-up of the engine not warmed and in the restart-up of the engine warmed. In this case, as described in the feature (5), the difference in reverse-rotation time between in the initial start-up and restart-up can be made small.

[0011] According to the feature (6), since the rotational speed and the rotational torque of the motor upon reverse-rotation are made small, the crank shaft doe not overshoot the compression top dead center upon reverse-rotation. Accordingly, even in the case where the crank angle position of the crank shaft upon start of reverse-rotation is near the compression top dead center, the crank shaft can be stopped in advance of the compression top dead center in the normal-rotation direction, and then started to be normally rotated.

[0012] Hereinafter, the present invention will be described in detail with reference to the drawings. It is illustrated in:

Fig. 1
A block diagram showing the function of an essential portion of a starter according to an embodiment of the present invention.

Fig. 2
A side view showing the entire configuration of a scooter type motorcycle on which the engine starter to which the present invention is applied is mounted.

Fig. 3
A plan view off an instrument panel and its neighborhood of the scooter type motorcycle.

Fig. 4
A schematic view showing the outline of a seating state detecting unit.

Fig. 5
A sectional view taken on line A-A of the engine shown in Fig. 2.

Fig. 6
A sectional side view of a cylinder head of the engine and its neighborhood.

Fig. 7
A sectional view of the drive side of an automatic transmission.

Fig. 8
A sectional view of the driven side of the automatic transmission.

Fig. 9
A sectional view showing an oil circulating unit.

Fig. 10
A sectional side view showing the arrangement of a crank sensor.

Fig. 11
A sectional front view showing the arrangement of the crank sensor.

Fig. 12
A block diagram showing the entire configuration of an engine start-up/stoppage control system according to one embodiment of the present invention.

Fig. 13
A block diagram showing the function of a main control unit.

Fig. 14
A block diagram, continued from that shown in Fig. 13, showing the function of the main control unit.

Fig. 15
A list of main operations of the main control unit.

Fig. 16
A diagram showing conditions for switching operational modes and operational patterns from each other.

Fig. 17
A diagram showing a relationship between a crank angle position and an overshoot torque.

Fig. 18
A graph showing a relationship between the reverse-rotation time and the water temperature.

Fig. 19
A flow chart for engine start-up control.

Fig. 20
A flow chart of engine stoppage control.

[0013] Fig. 2 is a side view of the entire configuration of a motorcycle on which an engine starter according to one embodiment of the present invention is mounted. Referring to Fig. 2, a body front 2 is connected to a body rear 3 via a low floor 4. A body frame, which constitutes the skeletal structure of a vehicular body, basically includes a down tube 6 and a main pipe 7. A fuel tank and a luggage box (both not shown) are supported by the main pipe 7, and a seat 8 is disnosed over both the fuel tank and the luggage box. The seat 8 serves as a lid of the luggage box provided on the underside of the seat 8, and is turnably supported by a hinge mechanism (not shown) provided on a front portion FR of the seat 8 for opening/closing the luggage box.

[0014] At the body front 2, a steering head 5 is provided on the down tube 6, and a front fork 12A is rotatably supported by the steering head 5. A handlebar 11A is mounted on a portion upwardly extending from the front fork 12A, and a front wheel 13A is rotatably supported by the downwardly extending leading ends of the front fork 12A. An upper portion of the handlebar 11A is covered with a handle cover 33 serving as an instrument panel.

[0015] A link member (hanger) 37 is turnably supported by an intermediate portion of the main pipe 7, and a swing unit 17 is swingably connected to and supported by the main pipe 7 via the hanger 37. A single-cylinder/four-cycle engine 200 is mounted on a front portion of the swing unit 17. A belt type continuously variable transmission 35 is provided in such a manner as to extend rearwardly from the engine 200. A reduction mechanism 38 is connected to the continuously variable transmission 35 via a centrifugal clutch mechanism to be described later, and a rear wheel 21 is rotatably supported by the reduction mechanism 38. A rear cushion 22 is interposed between the upper end of the reduction mechanism 38 and an upper bend portion of the main pipe 7. An intake pipe 23 extending from a cylinder head 32 of the engine 200 is connected a front portion of the swing unit 17, and a carburetor 24 is connected to the intake pipe 23. An air cleaner 25 is connected to the carburetor 24.

[0016] The base end of a kick arm 28 is fixed to a kick shaft 27 projecting from a transmission case cover 36 of the belt type continuously variable transmission 35. A pivot 18 is provided at a lower portion of a swing unit case 31, and a main stand 26 is pivotably mounted to the pivot 18. Upon parking of the motorcycle, the main stand 26 is raised as shown by a chain line in Fig. 2.

[0017] Fig. 3 is a plan view showing an instrument panel and its neighborhood of the motorcycle. A speed meter 193, a stand-by indicator 256, and a battery indicator 276 are provided in an instrument panel 192 of the handle cover 33. As will be described in detail later, upon stoppage of the engine under engine stoppage/start-up control, the stand-by indicator 256 flashes to warn the driver that the engine is immediately started and the vehicle can be started, if a throttle valve is opened. If the battery voltage is reduced, the battery indicator 276 flashes to warn the driver that the charged amount of power in the battery is deficient.

[0018] The handle cover 33 is provided with an idle switch 253 for permitting or restricting idling, and a starter switch 258 for starting a starter motor (cell motor). The right end portion of the handlebar 11 has a throttle grip 194 and a brake lever 195. In addition, root portions of the right and left throttle grips include a horn switch, a winker switch, and the like as in the conventional motorcycle; however, such components are not shown in Fig. 2.

[0019] The configurations of a hinge portion for opening/closing the seat 8 and a seating switch disposed near the hinge portion will be described below. Fig. 4 is a schematic view showing the structure of the hinge portion for opening/closing the seat 8. Referring to Fig. 4, the seat 8 serving as a lid of the luggage box 9a is provided in such a manner as to be openable/closable in the direction shown by an arrow A relative to the luggage box 9a. To make the seat 8 openable/closable, the luggage box 9a is provided with a hinge shaft 102 and a link member 100 swingable around the hinge shaft 102. The other end, opposed to the end connected to the hinge shaft 102, of the link member 100 is turnably connected to a second hinge shaft 110 provided on a frame 8a of the seat 8. As a result, the seat 8 can be swung around the hinge shaft 102 in the direction shown by the arrow A and can be also swung around the second hinge shaft 110 in the direction shown by an arrow B.

[0020] A spring 103 is interposed between the link member 100 and the frame 8a for biasing the seat 8 clockwise around the second hinge shaft 110. A seating switch 254 is also provided between the link member 100 and the frame 8a. When the driver sits on the seat 8 and the frame 8a is turned by a specific amount counterclockwise around the second hinge shaft 110, the seating switch 156 is turned on for detecting the seating state.

[0021] The engine 200 will be described in detail. Fig. 5 is a sectional view of a starter/generator connected to a crank shaft of the engine, which is equivalent to a sectional view taken on line A-A of Fig. 2. Referring to Fig. 5, a crank shaft 12 is rotatably supported via main bearings 10 and 11 by the swing unit case 31 having the hanger 37 supported by the main pipe 7, and a connecting rod 14 is connected to the crank shaft 12 via crank pin 13. An inner rotor 15 of a starter/generator is provided on one end portion of the crank shaft 12 projecting from a crank chamber 9.

[0022] The inner rotor 15 has a rotor boss 16 and permanent magnets 19 fitted around the outer peripheral surface of the rotor boss 16. In this embodiment, six pieces of the permanent magnets 19 made from neodymium-iron-boron based alloy are spaced at equal angular intervals around the crank shaft 12. The center hole of the rotor boss 16 is fitted around a tip taper portion of the crank shaft 12. A flange member 39 is disposed at one end (on the side opposed to the crank shaft 12) of the rotor boss 16. The rotor boss 16 is fixed, together with the flange member 39, to the crank shaft 12 with a bolt 20.

[0023] The rotor boss 16 has a small-diameter cylindrical portion 40 projecting on the flange member 39 side, and a bush holder 41 is slidably provided on the outer periphery of the cylindrical portion 40. The bush holder 41 is biased in the direction of the flange member 39 by a compression coil spring 42. Brushes 44 biased by the compression coil spring 42 are provided on the bush holder 41. A connecting pin 45 extending in parallel to the center axis of the crank shaft 12 passes through the rotor boss 16. One end of the connecting shaft 45 is fixed to the brush holder 41 and the other end thereof is connected to a plate 46 of a governor to be described in detail later.

[0024] A stator core 48 of an outer stator 47 disposed around the outer periphery of the inner rotor 15 is fixed to the swing unit case 31 with a bolt 49. A power generation coil 50 and a starting coil 51 are wound around a yoke 48a of the stator core 48. A cylindrical portion 48b extends from the stator core 48 in such a manner as to cover the bush holder 41. A commutator holder 52 is connected to the end portion of the cylindrical portion 48b, and commutator pieces 53 are fixed to the commutator holder 52 in such a manner as to be brought into slide-contact with the brushes 44. To be more specific, the commutator pieces 53 are disposed at positions facing to the brushes 44 biased by the compression coil spring 42.

[0025] Although only one brush 44 is shown in Fig. 5, the necessary number of the brushes 44 are actually provided along the rotational direction of the inner rotor 15. One example regarding the numbers and shapes of the brushes and commutator pieces has been described in the specification of the prior application (Japanese Patent Laid-open No. Hei 9-215292) filed by the present applicant. The stroke of the brushes 44 is limited to a specific amount in order that the brushes 44 are separated from the commutator pieces 53 when the brush holder 41 is offset on the crank shaft 12 side by the governor to be described later. A locking means (not shown) for limiting the stroke of the brushes 44 is interposed between the brush holder 41 and the brushes 44.

[0026] A governor 54 for automatically switching an engine-starting mode and a power generation mode from each other is provided at the end portion, fitted to the crank shaft 12, of the rotor boss 16. The governor 54 includes the above-described plate 46 and a roller 55 as a governor weight for offsetting the plate 46 toward the center of the crank shaft 12 in the longitudinal direction. The roller 55 is preferably configured as a metal core covered with a resin cover; however, it may be configured as only a metal core or a resin made core. The rotor boss 16 has a pocket 56 for housing the roller 55. The pocket 56 has a taper in cross-section made narrower on the outer stator 47 side.

[0027] A radiator fan 57 is mounted on the flange member 39, and a radiator 58 is disposed opposite to the radiator fan 57. A sprocket 59 is fixed on the crank shaft 12 at a position between the inner rotor 15 and the main bearing 11. A chain 60 for transmitting a power from the crank shaft 12 for driving a cam shaft (see Fig. 6) is wound around the sprocket 59. The sprocket 59 is integrated with a gear 61 for transmitting a power to a pump for circulating lubricating oil. The gear 61 transmits a power to a gear fixed to a drive shaft of a gear pump to be described later.

[0028] With this configuration, when the starter switch is depressed to apply a voltage to the commutator pieces 53 by a battery (not shown), a current flows in the starting coil 51 through the brushes 44, whereby the inner rotor 15 is rotated. As a result, the crank shaft 12 connected to the inner rotor 15 is rotated, to thereby start the engine 200. As the rotational speed of the engine 200 is increased, a centrifugal force is applied to the governor weight 55, so that the governor weight 55 is moved in the pocket 56 in the outer peripheral direction of the rotor boss 16, to reach a position shown by a chain line in Fig. 5.

[0029] Along with the movement of the governor weight 55, the plate 46 and the connecting pin 45 connected thereto are offset as shown by chain lines in Fig. 5. Since the other end of the connecting pin 45 is engaged with the brush holder 41, the brush holder 41 is also offset. The stroke of the brushes 44 is limited as described above, and therefore, when the brush holder 41 is offset by a distance larger than the critical stroke, the contact between the brushes 44 and the commutator pieces 53 is released. After the brushes 44 are separated from the commutator pieces 53, the crank shaft 12 is rotated by the engine, so that an electric power is generated by the power generation coil 51, to supply a current to the battery.

[0030] The structure of the head and its neighborhood of the engine 200 will be described below. Fig. 6 is a sectional side view of the head and its neighborhood of the engine. A piston 63 disposed in a cylinder 62 is connected to a small-end side of the connecting rod 14 via a piston pin 64. An ignition plug 65 is screwed in the cylinder head 32 in such a manner that an electrode portion thereof faces to a combustion chamber formed between the head of the piston 63 and the cylinder head 32. The cylinder 62 is surrounded by a water jacket 66.

[0031] A cam shaft 69 rotatably supported by bearings 67 and 68 is provided in the cylinder head 32 at a position over the cylinder 62. An attachment 70 is fitted to the cam shaft 69. A cam sprocket 72 is fixed to the attachment 70 with a bolt 71. The chain 60 is wound around the cam sprocket 72. The rotation of the above-described sprocket 59 (see Fig. 5), that is, the rotation of the crank shaft 12 is transmitted to the cam shaft 69 via the chain 60.

[0032] Rocker arms 73, which are provided over the cam shaft 69, are rocked in accordance with the cam shape of the cam shaft 69 when the cam shaft 69 is rotated. The cam shape of the cam shaft 69 is determined such that an intake valve 95 and an exhaust valve 96 are opened/closed in accordance with a specific stroke of the four-cycle engine. The intake pipe 23 is opened/closed by the intake valve 95, and an exhaust pipe 97 is opened/closed by the exhaust valve 96.

[0033] An exhaust cam and an intake cam are integrally formed on the cam shaft 69, and a decompression cam 98 engaged with the cam shaft 69 only in the reverse rotation direction is provided adjacently to these exhaust and intake cams. When the cam shaft 69 is reversely rotated, the decompression cam 98 is turned while following the rotation of the cam shaft 69 in such a manner as to project from the outer peripheral shape of the exhaust cam.

[0034] Accordingly, the exhaust valve 96 can be in the state being slightly lifted upon normal rotation of the cam shaft 69, so that the load at the compression stroke of the engine can be reduced. This makes it possible to make small a torque upon starting the rotation of the crank shaft, and hence to reduce the size of the starter of the four-cycle engine. As a result, it is possible to make compact the crank and its neighborhood and hence to make large the bank angle. In addition, after the cam is normally rotated for a while, the outer shape of the decompression cam 98 is returned within the outer peripheral shape of the exhaust cam.

[0035] A pump chamber 76 surrounded by a water pump base 74 and a water pump housing 75 is formed in the cylinder head 32. A pump shaft 78 having an impeller 77 is disposed in the pump chamber 76. The pump shaft 78 is fitted to the end portion of the cam shaft 69, and is rotatably supported by a bearing 79. A drive force of the pump shaft 78 is obtained by a pin 80 engaged with the center portion of the cam sprocket 72.

[0036] An air reed valve 94, which sucks air when a negative pressure occurs in the exhaust pipe 97 to thereby improve the emission, is provided in a head cover 81. While seal members are provided at locations around the pump chamber 76, the description thereof is omitted.

[0037] An automatic transmission for changing the rotational speed of the engine 200 and transmitting the rotational speed of the engine 200 thus changed to a rear wheel will be described below. Figs. 7 and 8 are sectional views showing a drive side portion and a driven side portion of the automatic transmission of the engine, respectively. Referring to Fig. 7, a pulley 83 around which a V-belt 82 is wounded is provided at the end portion, on the side opposed to the side on which the inner rotor 15 of the starter/generator is provided, of the crank shaft 12. The pulley 83 is composed of a fixed pulley piece 83a and a movable pulley piece 83b. The fixed pulley piece 83a is fixed in its movement relative to the crank shaft 12 in both the rotational and axial directions. The movable pulley piece 83b is slidable relative to the crank shaft 12 in the axial direction. A holder plate 84 is mounted on the back surface, which is not in contact with the V-belt 82, of the movable pulley piece 83b. The holder plate 84 is restricted in its movement relative to the crank shaft 12 in both the rotational and axial directions, that is, rotated together with the crank shaft 12. The space surrounded by the holder plate 84 and the movable pulley piece 83b forms the pocket for housing the roller 85 as the governor weight.

[0038] On the other hand, a clutch mechanism for transmitting a power to the rear wheel 21 is configured as follows. Referring to Fig. 8, a main shaft 125 of the clutch is supported by a bearing 127 fitted in a case 126 and a bearing 129 fitted in a gear box 128. A fixed pulley piece 132a of a pulley 132 is supported by the main shaft 125 via bearings 130 and 131. A cup-shaped clutch plate 134 is fixed to an end portion of the main shaft 125 by means of a nut 133.

[0039] A movable pulley piece 132b of the pulley 132 is provided on a sleeve 135 of the fixed pulley piece 132a in such a manner as to slidable in the longitudinal direction of the main shaft 125. The movable pulley piece 132b is engaged with a disk 136 in such a manner as to be movable around the main shaft 125 integrally with the disk 136. A compression coil spring 137 is provided between the disk 136 and the movable pulley piece 132b for imparting a repulsive force thereto in the direction where a distance therebetween is extended. A shoe 139 swingably supported by a pin 138 is provided on the disk 136. When the rotational speed of the disk 136 is increased, the shoe 139 is swingably moved in the outer peripheral direction by the centrifugal force applied thereto, and is brought into contact with the inner periphery of the clutch plate 134. A spring 140 is provided in order that when the rotational speed of the disk 136 reaches a specific value, the shoe 139 is brought into contact with the clutch plate 134.

[0040] A pinion 141, which is fixed on the main shaft 125, is meshed with a gear 143 fixed to an idle shaft 142. A pinion 144 fixed to the idle shaft 142 is meshed with a gear 146 of an output shaft 145. The rear wheel 21 is composed of a rim 21a and a tire 21b fitted around the periphery of the rim 21a, and the rim 21a is fixed to the output shaft 145.

[0041] With this configuration, in the case where the engine speed is minimized, the roller 85 is located at a position shown by a solid line in Fig. 7, so that the V-belt 82 is wound around the minimum diameter portion of the pulley 83. The movable pulley piece 132b of the pulley 132 is biased by the compression coil spring 137 to be offset to a position shown by a solid line in Fig. 8, so that the V-belt 82 is wound around the maximum diameter portion of the pulley 132. In such a state, since the main shaft 125 of the centrifugal clutch is rotated at the minimum speed, the centrifugal force applied to the disk 136 is minimized, with a result that the shoe 139 is in the state being drawn inwardly by the biasing force of the spring 140 and is thereby not in contact with the clutch plate 134. That is to say, the rotation of the engine is not transmitted to the main shaft 125, so that the axle 21 is not rotated.

[0042] As the engine speed becomes large, the roller 85 is offset in the outer peripheral direction by the centrifugal force applied thereto. The offset position of the roller 85 is shown by the chain line in Fig. 7. When the roller 85 is offset in the outer peripheral direction, the movable pulley piece 83b is pushed to the fixed pulley piece 83a side, so that the V-belt 82 is moved to the maximum diameter side of the pulley 83. On the centrifugal clutch side, the movable pulley piece 132b, which overcomes the biasing force of the compression coil spring 137, is offset in the direction where it is separated from the fixed pulley piece 132a, so that the V-belt 82 is moved to the minimum diameter side of the pulley 132. Accordingly, since the centrifugal force applied to the disk 136 is increased, the shoe 139 overcomes the biasing force of the spring 140 and projects outwardly, to be thus brought into contact with the clutch plate 134. As a result, the engine speed is transmitted to the main shaft 125, and the power is transmitted to the axle 21 via a gear train. In this way, the winding diameter of the V-belt 82 around the pulley 83 on the crank shaft 12 side and the pulley 132 on the centrifugal clutch side is changed in accordance with the engine speed, with a result that the speed change action is thus achieved.

[0043] Upon start-up of the engine, as described above, the engine can be started by applying a current to the starting coil 51; however, in this embodiment, a kick starter for starting the engine 200 by depressing the kick pedal is additionally provided. The kick starter will be described with reference to Fig. 7. A driven dog gear 86 for kick starting is fixed on the back surface of the fixed pulley piece 83a. Meanwhile, a supporting shaft 88 having a helical gear 87 is rotatably supported on the cover 36 side. A cap 89 is fixed to an end portion of the supporting shaft 88, and a drive dog gear 90 meshed with the driven dog gear 86 is formed on an end surface of the can 89.

[0044] The kick shaft 27 is turnably supported on the cover 36, and a sector helical gear 91 to be meshed with the helical gear 87 is welded to the kick shaft 27. The kick arm 28 (see Fig. 8) is spline-connected to an end portion, projecting outwardly from the cover 36, of the kick shaft 27. In Fig. 7, reference numeral 92 and 93 designate return springs.

[0045] With this configuration, when the kick pedal 29 is depressed, the kick shaft 27 and the sector helical gear 91, which overcome the biasing force of the return spring 93, are turned. The mutual twisting direction of the helical gear 87 and the sector helical gear 91 is set such that when the sector helical gear 91 is turned by depressing the kick pedal, the helical gears 87 and 91 generate a force for biasing the supporting shaft 87 on the pulley 83 side. Accordingly, when the kick pedal 29 is depressed, the supporting shaft 87 is offset to the pulley 83 side, so that the drive dog gear 90 formed on the end surface of the cap 89 is meshed with the driven dog gear 86. As a result, the crank shaft 12 is rotated, to start the engine 200. When the engine is started, the depressing force applied to the kick pedal 29 may be weakened. At this time, the sector helical gear 91 is reversed by the return springs 92 and 93, so that the engagement between the drive dog gear 90 and the driven dog gear 86 is released.

[0046] Next, the feed system of lubricating oil will be described with reference to Fig. 9. An oil feeding portion is provided under the crank chamber 9. A pipe line 148 for introducing oil is formed in an oil pan 147, and oil is sucked from the pipe line 148 into a trochoid pump 149 as shown by an arrow D1. The oil thus sucked in the trochoid pump 149 is compressed and discharged into a pipe line 150, passing through the pipe line 150 as shown by arrows D2 and D3, and is discharged into the crank chamber.

[0047] A gear 152 is connected to a pump shaft 151 of the trochoid pump 149, and the gear 61 connected to the crank shaft 12 is meshed with the gear 152. That is to say, the trochoid pump 149 is driven by rotation of the crank shaft 12, to circulate the lubricating oil.

[0048] As described above, in this embodiment, the sprocket 59 for driving the cam shaft 69 and the gear 61 for driving the oil pump are mounted on the crank shaft 12 adjacently to the bearing 11 for supporting the crank shaft 12. And, the inner rotor 15 containing the permanent magnet 19 is disposed at a position near the sprocket 59 and the gear 61, that is, at a position being not apart from the bearing 11. In particular, the governor weight 55 of the governor mechanism for automatically switching the starting and power generating operations from each other is disposed in the vicinity of the bearing 11.

[0049] Next, the arrangement of the sensor for outputting a crank pulse will be described. Figs. 10 and 11 are a sectional side view and a sectional front view of the crank shaft and its neighborhood, showing the arrangement of the sensor (crank pulser) for generating a crank pulse, respectively. Referring to these figures, the crank case is composed of a front crank case 99F and a rear crank case 99R, and a crank pulser 153 is provided on the rear crank case 99R side in such a manner as to be perpendicular to the crank shaft 12. A detecting end 153a of the crank pulser 153 is disposed in such a manner as to face to the outer peripheral edge of a left crank web 12L. A projection, that is, a reluctor 154 is formed on the outer periphery of the left crank web 12L. The crank pulser 153 is magnetically coupled with the reluctor 154, to output a detection signal of a crank angle.

[0050] An engine stoppage/start-up system will be described below. The system includes an idling restricting mode and an idling permitting mode. To be more specific, in the idling restricting mode, when the vehicle is stopped, the engine is automatically stopped, and when the accelerator is operated in the stoppage state, the engine is automatically restarted to start the vehicle (hereinafter, referred also to as "engine-stopping/vehicle-starting mode"). The idling permitting mode includes two modes. One mode is configured to temporarily permit idling after the initial start-up of the engine for performing, typically, warming operation upon start-up of the engine (hereinafter, referred to as "engine-starting mode"); and the other mode is configured to usually permit idling in accordance with the intention of the driver, that is, by turning on the switch (hereinafter, referred to as "idle switch mode").

[0051] Fig. 12 is a block diagram showing the entire configuration of a start-up/stoppage control system of the engine 200. Referring to Fig. 14, a starter/generator 250 provided coaxially with the crank shaft 12 includes a starter motor 171 and an AC generator (ACG) 172. The power generated by the ACG 172 is charged in a battery 168 via a regulator rectifier 167. The regulator rectifier 167 controls the voltage outputted from the starter/generator 250 at a value ranging from 12 V to 14.5 V. The battery 168 is used to supply, when a starter relay 162 is conducted, a drive current to the starter motor 171, and to supply a load current to various kinds of general electrical equipment 174, a main control unit 160, and the like via a main switch 173.

[0052] The main control unit 160 is connected to an Ne sensor (crank pulser) 153, an idle switch 253, a seating switch 254, a vehicular speed sensor 255, a stand-by indicator 256, a throttle sensor 257, a starter switch 258, a stop switch 259, a battery indicator 276, and a water temperature sensor 155. The Ne sensor 153 detects an engine speed Ne. The idle switch 253 manually permits or restricts idling of the engine 200. The seating switch 254 closes the contact and outputs a signal of the "H" level when the driver sits on the seat. The vehicular speed sensor 255 detects the vehicular speed. The stand-by indicator 256 flashes in the engine-stopping/vehicle-starting mode. The throttle sensor 257 detects the throttle opening degree θ. The starter switch 258 drives the starter motor 171 to start the engine 200. The stop switch 259 outputs a signal of the "H" level in response to braking operation. The battery indicator 276 lights up when the voltage of the battery 168 is reduced to a predetermined value (for example, 10 V) or less and warns the driver of the shortage of the charged amount of power in the battery 168. The water temperature sensor 155 detects the temperature of cooling water for the engine, and on the basis of detected result, the warming state of the engine is decided.

[0053] The main control unit 160 is also connected to an ignition controller (including an ignition coil) 161, a control terminal of the starter relay 162, a control terminal of a head lamp relay 163, a control terminal of a by-starter relay 164, and a buzzer 175. The ignition controller 161 ignites the ignition plug 65 in synchronization with rotation of the crank shaft 12. The starter relay 162 supplies a power to the starter motor 171. The head lamp relay 163 supplies a power to the head lamp 169. The by-starter relay 164 supplies a power to a by-starter 165 mounted to a carburetor 166. The buzzer 175 generates a buzzer sound under a specific condition for giving a warning to the driver.

[0054] The control to supply a power to a head lamp 169 is not limited to the turn-on/turn-off control of the head lamp relay 163. For example, switching elements such as FETs may be adopted in place of the head lamp relay 163. In this case, a so-called chopping control is performed such that the voltage applied to the head lamp 169 is substantially reduced by interrupting the switching elements in accordance with a specific cycle and a specific duty ratio in place of turn-off of the supply of the power to the head lamp 169.

[0055] Fig. 13 is a block diagram showing the function of the configuration of the main control unit 160, and Fig. 14 is a block diagram continued from that shown in Fig. 13. In these figures, the same reference numerals as those described in Fig. 12 designate the same or similar parts. Fig. 15 shows a list of control contents of a starter relay control unit 400, a by-starter control unit 900, a stand-by indicator control unit 600, an ignition control unit 700, an operation switching unit 300, a warning buzzer control unit 800, and a charging control unit 500 (which will be described later).

[0056] The operation switching unit 300 shown in Fig. 13 switches, when the state of the idling switch 253, the state of the vehicle, and the like are under specific conditions, the operational mode into either of the "engine-starting mode", the "engine-starting/vehicle-starting mode", and the "idle switch mode". The operation switching unit 300 further switches the "engine-stopping/vehicle-starting mode" into either a first operational pattern (hereinafter, referred to as "first pattern") in which idling is perfectly prohibited or a second operational pattern (hereinafter, referred to as "second pattern") in which idling is exceptionally permitted under a specific condition. The second pattern is desirable as a battery exhaustion preventive mode for preventing battery exhaustion when the engine is stopped for a long period of time in the lighting state of the head lamp 169.

[0057] A signal indicating the state of the idle switch 253 is inputted in an operation switching signal output unit 301 of the operation switching unit 300. If the operational state is in the OFF state (idling restricting state), the signal indicating the state of the idle switch 253 exhibits an "L" level; while if the operational state is in the ON state (idling permitting state), the signal indicating the state of the idle switch 253 exhibits the "H" level. A vehicular speed continuation deciding unit 303 includes a timer 303a. If the vehicular speed sensor 255 detects a predetermined vehicular speed or more for a predetermined time or more, the vehicular speed continuation deciding unit 303 outputs a signal of the "H" level.

[0058] The operation switching signal output unit 301 outputs signals S_{301a}, S_{301b} and S_{301c} for switching the operational mode and the operational pattern of the main control unit 160, in response to the signals outputted from the idle switch 253 and the vehicular speed continuation deciding unit 303 and further to an ignition off signal S_{8021} which becomes the "H" level if the ignition off state of the engine is continued for a specific time (3 min in this embodiment) or more.

[0059] Fig. 16 is a typical diagram showing conditions for switching the operational mode and the operational pattern of the above-described operation switching signal output unit 301. In the operation switching signal output unit 301, if a condition (1) is established in which the main switch 173 is turned on and thereby the control unit 160 is reset or the idle switch 253 is turned off, the "engine-starting mode" is raised by the operational mode switching unit 301a. At this time, the operational mode switching unit 301a outputs the operational mode signal S_{301a} of the "L" level.

[0060] If in the "engine start-up mode", a condition (2) is established in which the predetermined vehicular speed or more is continued for the predetermined time or more, the operational mode is changed from the "engine-starting mode" into the "engine-stopping/vehicle-starting mode" by the operational mode switching unit 301a. At this time, the "L" level of the operational mode signal S_{301a} outputted from the operational mode switching unit 301a is changed into the "H" level. Directly after the "engine-starting mode" is shifted into the "engine-stopping/vehicle-starting mode", the "first pattern" is raised by an operational pattern switching unit 301b. At this time, the operational pattern switching unit 301b outputs the operational pattern signal S_{301b} of the "L" level.

[0061] If in the "first pattern", a condition (3) is established in which an ignition off state continuation deciding unit 802 to be described with reference to Fig. 13 decides that the ignition off state is continued for 3 min or more, the operational pattern of the "engine-stopping/vehicle-starting mode" is changed from the "first pattern" into the "second pattern" by the operational pattern switching unit 301b. At this time, the "L" level of the operational pattern signal S_{301b} outputted from the operational pattern switching unit 301b is changed into the "H" level.

[0062] If the above condition (2) is established in the "second pattern", the operational pattern is changed from the "second pattern" into the "first pattern" by the operational pattern switching unit 301b. At this time, the "H" level of the operational pattern signal S_{301b} outputted from the operational pattern switching unit 301b is changed into the "L" level.

[0063] As a result of research by the inventors, it becomes apparent that it takes a time ranging from about 30 sec to about 2 min for the driver to wait for signal lights to change or wait for a chance of turning to right at a street intersection, and the stoppage of the vehicle for a time over the above waiting time is possibly caused by restriction for one-way traffic due to highway work, traffic jam or the like. Accordingly, in this embodiment, if the vehicle is stopped, that is, the engine is forcibly stopped for a long period of time (3 min or more in this embodiment) while the head lamp is left turned on during operation under the "engine-stopping/vehicle-starting mode", the operational pattern is changed from the "first pattern" into the "second pattern" in which idling is permitted. Accordingly, the engine can be restarted by manually turning on the starter switch 258, to enable the stoppage of the vehicle in the idling state, thereby preventing the battery exhaustion due to lighting of the head lamp 169 continued for a long period of time.

[0064] If a condition (6) is established in which the main switch in the OFF state is turned on and the idle switch is in the ON state, the "L" level of the operational mode signal S_{301c} outputted from an idle switch mode raising unit 301C is changed into the "H" level, to raise the "idle switch mode". It should be noted that in the "engine-stopping/vehicle-starting mode", if the idle switch 253 is turned on and thereby a condition (4) is established, the "idle switch mode" is raised irrespective of the "first pattern" and the "second pattern".

[0065] If in the "idle switch mode", a condition (5) is established in which the idle switch 253 is turned off, the operational mode signal S_{301a} outputted from the operational mode switching unit 301a becomes the "L" level, to raise the "engine-starting mode".

[0066] Referring again to Fig. 13, a signal outputted from the Ne sensor 153 is inputted into an Ne deciding unit 306. If the Ne deciding unit 306 decides that the engine speed is more than the predetermined value, it outputs a signal of the "H" level to a head lamp control unit 305. If the engine speed once exceeds the predetermined value, the Ne deciding unit 306 continuously outputs a signal of the "H" level until the main switch 173 is turned off. The head lamp control unit 305 outputs a control signal of the "H" level or "L" level to the control terminal of the head lamp relay 163 on the basis of the operational mode (pattern) signals S_{301a}, S_{301b} and S_{301c}, the output signal from the Ne deciding unit 306, and the output signal from a running deciding unit 701. If the head lamp relay 163 receives the signal of the "H" level, it allows the head lamp 169 to light up.

[0067] In the case of adopting the switching elements such as FETs in place of the head lamp relay 163, the head lamp control unit 305 outputs a pulse signal having a specific cycle and a specific duty ratio in place of outputting the control signal of the "L" level, to chopping-control the power feed to the head lamp 169.

[0068] As shown in Fig. 15, the head lamp control unit 305 usually outputs the ON signal in any operational mode other than the "engine-starting mode". To be more specific, in the "engine-starting mode", the ON signal is outputted if the Ne deciding unit 306 detects that the engine speed is more than the specific value (1500 rpm in this embodiment) or the running deciding unit 701 decides that the vehicular speed is more than 0 km.

[0069] In the case of adopting the switching elements such as FETs in place of the head lamp relay 163, in the "first pattern" of the "engine-stopping/vehicle-starring mode", the opening/closing of the switching elements is chopping-controlled in accordance with the ignition control to be described in detail later, to thereby minimize the discharge of the battery.

[0070] To be more specific, when the ignition control is interrupted (cut off) in response to the stoppage of the vehicle and the engine is automatically stopped, the head lamp control unit 305 chopping-controls the switching elements with a specific cycle and a specific duty ratio in such a manner that the voltage applied to the head lamp 169 is substantially reduced from a voltage (for example, 13.1 V) in the usual ON state to a specific voltage (for example, 8.6 V) for reduction in light quantity, to thereby reduce the light quantity of the head lamp 169. After that, when the ignition control is restarted in response to vehicle-starting operation and the engine is restarted, the head lamp control unit 305 outputs a DC signal of the "H" level to the switching elements.

[0071] In this way, the discharge of the battery can be suppressed not by switching off the head lamp 169 but reducing the light quantity of the head lamp 169 when the engine is automatically stopped. Accordingly, upon the subsequent vehicle-starting operation, the amount of charges supplied from the generator to the battery can be reduced, so that the electric load of the generator is reduced. As a result, it is possible to improve the acceleration performance upon vehicle-starting operation.

[0072] The ignition control unit 700 permits or prohibits the ignition operation by the ignition controller 161 under a specific condition for each operational mode or each operational pattern. The running deciding unit 701 decides, on the basis of the detection signal inputted from the vehicular speed sensor 255, whether or not the vehicle is in the running state. If the vehicle is in the running state, the running deciding unit 701 outputs a signal of the "H" level.

[0073] An OR circuit 702 outputs a logic sum of the signal outputted from the running deciding unit 701 and the signal indicating the state of the throttle sensor 257. An OR circuit 704 outputs a logic sum of a reversed signal of the operational mode signal S_{301a}, the operational pattern signal S_{301b} and the operational mode signal S_{301c}. An OR circuit 703 outputs a logic sum of signals outputted from the OR circuits 702 and 704 to the ignition controller 161. If the signal inputted in the ignition controller 161 is at the "H" level, the ignition controller 161 executes the ignition operation for each specific timing, and if at the "L" level, the ignition controller 161 interrupts the ignition operation.

[0074] In the ignition control unit 700, as shown in Fig. 15, if the operational mode is either the "engine-starting mode", the "second pattern" of the "engine-stopping/vehicle-starting mode" or the "idle switch mode", the signal outputted from the OR circuit 704 becomes the "H" level, and thereby the signal of the "H" level is usually outputted from the OR circuit 703. That is to say, in the "engine-starting mode", the "second pattern" of the "engine-stopping/vehicle-starting mode" or the "idle switch mode", the ignition controller 161 is usually operated.

[0075] On the contrary, in the "first pattern" of the "engine-stopping/vehicle-starting mode", since the signal outputted from the OR circuit 704 is at the "L" level, the ignition operation is executed under the condition that the running deciding unit 701 decides that the vehicle is in the running state, or the throttle is opened and the output from the OR circuit 702 becomes the "H" level. If the vehicle is in the stoppage state or the throttle is closed, the ignition operation is interrupted.

[0076] The warning buzzer control unit 800 generates a warning, for example, a buzzer for giving a necessary caution to the driver in accordance with the running state of the vehicle and the seating state of the driver for each operational mode or operational pattern. A non-seating state continuation deciding unit 801 receives a signal indicating the state of the seating switch 54. The non-seating state continuation deciding unit 801 includes a timer 8012 for counting a non-seating time of the driver. If the timer 8012 times out, the non-seating state continuation deciding unit 801 outputs a non-seating continuation signal S_{8012} of the "H" level. The timer 8012 in this embodiment is previously set such that it times out after an elapse of 1 sec.

[0077] An ignition off state continuation deciding unit 802 includes a timer 8021 for counting an ignition-off time of the engine. If the ignition off state continuation deciding unit 802 detects the ignition off state, it immediately outputs an ignition off signal S_{8023} of the "H" level and starts the timer 8021. If the timer 8021 times out, the ignition off state continuation deciding unit 802 outputs an ignition off continuation signal S_{8021} of the "H" level. In this embodiment, the timer 8021 is set such that it times out after an elapse of 3 min.

[0078] A buzzer control unit 805 determines the ON/OFF state of the buzzer 175 on the basis of the operational mode (pattern) signals S_{301a}, S_{301b} and S_{301c}, the non-seating continuation signal S_{8012}, the ignition off continuation signal S_{8021}, the ignition off signal S_{8023}, the signal outputted from the running deciding unit 701 and the signal outputted from the throttle sensor 257. If the buzzer control unit 805 decides that the buzzer 175 is to be turned on, it outputs a signal of the "H" level to a buzzer drive unit 814.

[0079] Referring to Fig. 15, in the "engine-starting mode", the buzzer control unit 805 usually turns off the buzzer 175. In the "first pattern" of the "engine-stopping/vehicle-starting mode", if non-seating in the ignition off state is continued for the time (1 sec in this embodiment) required for time-out of the timer 8012 or more or the ignition off state is continued for the time (3 min in this embodiment) required for time-out of the timer 8021 or more, the buzzer control unit 805 turns on the buzzer 175. In the "second pattern" of the "engine-stopping/vehicle-starting mode", if the ignition is in the OFF state; the throttle opening degree becomes "0" on the basis of the input signal from the throttle sensor 257; and the vehicular speed is decided as 0 km by the running deciding unit 701 on the basis of the input signal from the vehicular speed sensor 55, the buzzer control unit 805 turns on the buzzer 175. In the "idle switch mode", if the ignition is in the OFF state and the non-seating state is continued for 1 sec or more, the buzzer control unit 805 turns on the buzzer 175. If the signal outputted from the buzzer control unit 805 becomes the "H" level, the buzzer control unit 814 outputs, to the buzzer 175, a buzzer drive signal for alternately repeating the buzzer ON time of 0.2 sec and the buzzer OFF time of 1.5 sec.

[0080] In this way, according to the buzzer control of this embodiment, during operation under the "engine-stopping/vehicle-starting mode", if the vehicle is stopped and the engine is stopped for a long period of time (3 min or more in this embodiment) with the head lamp left turned on due to restriction for one-way traffic for road construction or the like, the operational pattern of the "engine-stopping/vehicle-starting mode" is changed from the "first pattern" into the "second pattern" and simultaneously a buzzer is generated for informing the driver of permission of idling. Accordingly, only by turning on the starter switch 258 in response to the buzzer, it is possible to prevent battery exhaustion due to continuation of switch-on of the head lamp 169 for a long period of time.

[0081] An accelerating operation detecting unit 502 in the charging control unit 500 detects the vehicular speed and the time elapsed until the throttle is full-opened after it is full-closed on the basis of the input signal from the throttle sensor 257 and the input signal from the vehicular speed sensor 255. If the accelerating operation detecting unit 502 detects that the vehicular speed is more than 0 km and the time elapsed until the throttle is full-opened after it is full-closed is within a specific value, for example, 0.3 sec, it decides that the accelerating operation has been performed, and generates one shot of accelerating operation detecting pulse.

[0082] If the throttle is opened when the vehicular speed is 0 km and the engine speed is a specific value (2500 rpm in this embodiment) or less, a vehicle starting operation detecting unit 503 decides that the vehicle starting operation has been performed and outputs one shot of vehicle starting operation detecting pulse. When a charging restricting unit 504 receives the above accelerating operation detecting pulse signal, it starts a 6 sec timer 504a. The charging restricting unit 504 controls the regulator rectifier 167 to reduce the voltage charged in the battery 168 from the usual value, that is, 14.5 V to 12.0 V until the 6 sec timer 504a times out.

[0083] With this charging control, upon rapid acceleration in which the driver rapidly opens the throttle or upon vehicle movement from the stopping state, the charging voltage is reduced, so that the electrical load of the starter/generator 250 is temporarily reduced. This makes it possible to reduce the mechanical load of the engine 200 caused by the starter/generator 250 and hence to improve the accelerating performance. Further, upon automatic stoppage of the engine, the discharge of the battery can be suppressed at minimum by chopping-controlling the switching elements such as FETs so as to reduce the light quantity of the head lamp 169. This makes it possible to further reduce the load of the starter/generator 250, and hence to further improve the accelerating performance.

[0084] As shown in Fig. 15, if the 6 sec time 504a times out; the engine speed exceeds a specific value (7000 rpm in this embodiment); or the throttle opening degree is reduced, the charging restricting unit 504 stops the charging control and returns the charging voltage to the usual value, that is, 14.5 V.

[0085] Referring to Fig. 14, the starter relay control unit 400 starts the starter relay 162 under a specific condition in accordance with each operational mode or operational pattern. The detection signal from the Ne sensor 153 is supplied to an idling speed-or-less deciding unit 401. If the engine speed is a specific idling speed (for example, 800 rpm) or less, the idling speed-or-less deciding unit 401 outputs a signal of the "H" level. An AND circuit 402 outputs a logic product of the signal outputted from the idling speed-or-less deciding unit 401, the signal indicating the state of the stop switch 259, and the signal indicating the state of the starter switch 258. An AND circuit 404 outputs a logic product of the signal outputted from the idling speed-or-less deciding unit 401, the detection signal from the throttle sensor 257 and the signal indicating the state of the seating switch 254. An OR circuit 408 outputs a logic sum of the signals outputted from the AND circuits 402 and 404.

[0086] An OR circuit 409 outputs a logic sum of the reversed signals of the operational mode signals S_{301c} and S_{301a}. An AND circuit 403 outputs a logic product of the signal outputted from the AND circuit 402 and the signal outputted from the OR circuit 409. An AND circuit 405 outputs a logic product of the signal outputted from the AND circuit 404, the operational mode signal S_{301a}, and the reversed signal of the operational pattern signal S_{301b}. An AND circuit 407 outputs a logic product of the operational mode signal S_{301a}, the operational pattern signal S_{301b}, and the signal outputted from the OR circuit 408. An OR circuit 406 outputs a logic sum of the signals outputted from the AND circuits 403, 405 and 407 to the starter relay 162.

[0087] With this starter relay control, in the "engine-starting mode" and the "idle switch mode", since the signal outputted from the OR circuit 409 exhibits the "H" level, the AND circuit 403 becomes the enable state. As a result, when the engine speed is the idling speed or less and the stop switch 259 is in the ON state (during braking operation), the starter switch 258 is turned on by the driver and thereby the signal outputted from the AND circuit 402 exhibits the "H" level, and then the starter relay 162 is conducted to start the starter motor 171.

[0088] In the "first pattern" of the "engine-stopping/vehicle-starting mode", the AND circuit 405 becomes the enable state. As a result, if the throttle is opened in the state in which the engine speed is the idling speed or less and the seating switch 254 is in the

ON state (during the period in which the driver is sitting on the seat), the signal outputted from the AND circuit 404 becomes the "H" level, so that the starter relay 162 is conducted to start the starter motor 171.

[0089] In the "second pattern" of the "engine-stopping/vehicle-starting mode", the AND circuit 407 becomes the enable state. As a result, if either the AND circuit 402 or 404 becomes the "H" level, the starter relay 162 is conducted to start the starter motor 171.

[0090] A crank angle control unit 1000 for controlling the crank angle upon stoppage of the engine stops, upon stoppage of the engine, the crank shaft at a desired crank angle position by reversely rotating the starter motor 171 for a predetermined time. A stoppage deciding timer 1001 monitors the Ne sensor 153, and outputs a time-out signal of the "H" level when the state in which no signal is outputted from the Ne sensor 153 is continued for a predetermined time Tx. The time-out signal expresses the stoppage of the engine. The time-out signal from the stoppage deciding timer 1001 is inputted in an AND circuit 1002, an AND circuit 1007, and reverserotation permitting timer 1004.

[0091] The reverse-rotation permitting timer 1004 keeps the "H" level of its output signal in response to the time-out signal from the stoppage deciding timer 1001 until an elapse of a predetermined time Ty. The time Ty is determined on the basis of a detection signal from the water temperature sensor 155 for detecting the temperature of cooling water for the engine. To be more specific, the time Ty becomes shorter as the water temperature becomes higher. The relationship between the time Ty and the water temperature will be described later with reference to Fig. 18.

[0092] A comparison unit 1003 compares the engine speed Ne based on the output from the Ne sensor 153 with a reference speed Nref set to be larger than a cranking speed and lower than the idling speed. If the engine speed Ne is the reference speed Nref or more, the comparison unit 1003 outputs a signal of the "L" level indicating that the engine is in the ON state. If the engine speed Ne is less than the reference speed Nref, the comparison unit 1003 outputs a signal of the "H" level indicating that the engine is in the OFF state. The signal from the comparison unit 1003 is inputted in the AND circuit 1002.

[0093] The signals outputted from the AND circuit 1002 and the reverse rotation permitting timer 1004, and detection signal from the cam sensor 155 are inputted in an AND circuit 1005. The AND circuit 1005 outputs a logic sum of these signals. The log sum is inverted by an inverter 1006 and is supplied to the reverse rotation relay 162a.

[0094] The output signal from the reverse rotation permitting timer 1004 is inputted in one input terminal of an AND circuit 1007, and the time-out signal from the stoppage deciding timer 1001 is inputted to the other input terminal of the AND circuit 1007. The signal outputted from the AND circuit 1007 is inputted in the OR circuit 406 of the starter relay control unit 4000. It should be noted that the operation of the crank angle control unit 1000 for controlling the crank angle upon stoppage of the engine will be described in detail later.

[0095] In the by-starter control unit 900, the signal outputted from the Ne sensor 153 is inputted in an Ne deciding unit 901. If the engine speed is a specific value or more, the Ne deciding unit 901 outputs a signal of the "H" level to close the by-starter relay 164. With this configuration, even in any operational mode, the fuel can be made rich when the engine speed is the specific value or more.

[0096] In the indicator control unit 600, the signal outputted from the Ne sensor 153 is inputted in an Ne deciding unit 601. If the engine speed is the specific value or less, the Ne deciding unit 601 outputs a signal of the "H" level. An AND circuit 602 outputs a logic product of the signal indicating the state of the seating switch 254 and the signal outputted from the Ne deciding unit 601. An AND circuit 603 outputs a logic product of the signal outputted from the AND circuit 602, and the reversed signals of the operational mode signal S_{301a} and the operational pattern signal S_{301b} to the stand-by indicator 256. If the signal inputted in the stand-by indicator 256 exhibits the "L" level, the stand-by indicator 256 is switched off, and if the inputted signal exhibits the "H" level, the stand-by indicator 256 flashes.

[0097] To be more specific, since the stand-by indicator 256 flashes during stoppage of the vehicle in the "engine-stopping/vehicle-starting mode", the driver can recognize that if the stand-by indicator 256 flashes, the vehicle can be immediately moved by actuating the accelerator even if the engine is stopped.

[0098] Next, the control of the starter motor 171 upon start-up and stoppage of the engine will be described in detail. The engine in this embodiment is started by reversely driving the starter motor for reversely rotating the crank shaft once to a position at which a load torque of the crank shaft upon normal-rotation becomes small, and then normally driving the starter motor to start the engine. However, since the reverse-rotation of the crank shaft is dependent on the rotational friction of the engine, even if the starter motor is reversely driven for a specific time, the crank shaft cannot be necessary stopped at a desired crank angle position, that is, a desired normal-rotation starting position. To cope with such an inconvenience, as described with reference to Fig. 14, upon stoppage of the vehicle, the starter motor 171 is reversely rotated for a reverse-rotation time determined depending on the output from the water temperature sensor 155. With this configuration, upon restart-up of the engine after temporary stoppage of the vehicle, the engine can be immediately started to start the vehicle without any effect of the load torque.

[0099] Fig. 17 is a diagram showing a relationship between a crank angle position upon start of the starter motor 171 and an overshoot torque, that is, the torque required to overshoot the top dead center. Referring to Fig. 17, the overshoot torque is small in a crank angle region (low load region) from 450° to 630° in advance of a compression top dead center C/T, that is, in a crank angle region from 90° to 270° in advance of an exhaust top dead center O/T. Meanwhile, the overshoot torque is large in a crank angle region (high load region) from 90° to 450° in advance of the compression top dead center C/T, and particularly, it is maximized at 180° in advance of the compression top dead center C/T. In other words, the overshoot torque is large when the crank angle is substantially in advance of the compression top dead center C/T, and is small when the crank angle is substantially in advance of the exhaust top dead center O/T.

[0100] According to this embodiment, the drive time of the starter motor 171 in the reverse-rotation direction of the crank shaft 12 is determined such that the crank shaft 12 is stopped in the above low load region. By reversely driving the starter motor 171 for reversely rotating the crank shaft 12 to a position in the low load region and then driving the starter motor 171 in the normal-rotation direction, the crank shaft 12 can overshoot the compression top dead center C/T with a small overshoot torque.

[0101] When the engine is stopped, the crank shaft is often not stopped at a position in the vicinity of the compression top dead center C/T (in the hatching region of about 140° or less in advance of the compression top dead center C/T in the reverse-rotation direction). In this regard, the starter motor 171 is driven in the reverse-rotation direction for a time required to change the crank angle position from a position of about 140° in advance of the compression top dead center C/T to the front end of the above low load region, that is, to a position of about 90° in advance of the exhaust top dead center O/T.

[0102] In particular, the crank shaft 12 may be reversely rotated for a time equal to or more than a time required for the crank shaft 12 to be rotated between the compression top dead center C/T and the exhaust top dead center O/T, that is, for a time equal to or more than a time required for changing the crank angle position by 360°. That is to say, even if the crank shaft 12 is located at any position upon start of reverse-rotation, the crank angle position is located in advance of the exhaust top dead center O/T, that is, in the low load region by reversely rotating the crank shaft 12 by 360° or more.

[0103] Fig. 18 is a graph showing a relationship between the reverse-rotation time of the starter motor 171 and the temperature of cooling water for the engine. In the figure, the ordinate designates a reverse-rotation time Ty (second) and the abscissa designates the water temperature. In the figure, a solid line designates a first time Ty1 used for start-up by the starter switch 258, and a dotted line designates a second time Ty2 used for restart-up of the engine in response to vehicle-starting operation based on the output from the throttle sensor 257. These first and second times Ty1 and Ty2 are determined by measuring a time required for the crank shaft to be reversely rotated by 360° for each temperature of cooling water for the engine, that is, for each rotational friction. In addition, the rotational speed and the rotational torque of the starter motor 171 upon reverse-rotation are set to be smaller than the overshoot torque against the compression top dead center C/T.

[0104] The reason why the first time Ty1 and the second time Ty2 are different from each other is that the degree of warming differs between in the initial start-up of the engine and in the restart-up of the engine, and even if the temperature of cooling water of the engine is kept constant, the rotational friction differs depending on the degree of the warming. Upon initial start-up by the starter switch 258, the degree of warming is smaller (the rotational friction is larger) than that upon restart-up of the engine in response to vehicle-starting operation based on the output from the throttle sensor 257, and thereby, the reverse-rotation time is set at a larger value (Ty1>Ty2).

[0105] The ratio of the first time Ty1 to the second time Ty2 is set to become smaller as the temperature of cooling water for the engine becomes higher, that is, the rotational friction becomes smaller. The reason for this is that when the water temperature becomes higher and thereby the rotational friction becomes smaller, a difference in rotated amount of the crank shaft having been reversely rotated for a reverse-rotation time becomes smaller between in the initial start-up of the engine not warmed and in the restart-up of the engine sufficiently warmed.

[0106] The control configuration for operating the starter motor 171 upon stoppage of the engine will be described below. Fig. 1 is a circuit for normally/reversely rotating the starter motor 171. Referring to Fig. 1, when it is decided on the basis of the detection signal from the Ne sensor 153 that the engine is stopped, the crank angle control means 1000 turns on the starter relay 162 (hereinafter, referred to as "relay RyA") and turns off the reverse-rotation relay 162a (hereinafter, referred to as "relay RyB"). The relay switching state is kept for the time Ty1 or Ty2 determined on the basis of the detection result of the water temperature sensor 155 as the friction detecting means as described with reference to Fig. 14. The ON/OFF signals from the starter switch 258 and the stop switch 259 are inputted in the starter relay control unit 400, and if the starting condition is satisfied, the relay RyA is turned on.

[0107] The starter motor 171 is connected to a contact Rya of the relay RyA via a first contact Ryb1 of the relay RyB, and is also connected to a contact Rya of the relay RyA via a second contact Ryb2 of the relay RyB and a resistance R. The other terminal of the contact Rya of the relay RyA is connected to a plus terminal of the battery 168, and a minus terminal of the battery 168 is connected to the normally closed (NC) side of the first contact Ryb1 and the normally opened (NO) side of the second contact Ryb2.

[0108] With this configuration, if the relay RyA is turned on and the relay RyB is turned off, a current flows in the starter motor 171 in the direction shown by an arrow RR, and thereby the starter motor 171 is reversely rotated. To be more specific, after the stoppage of the engine, the crank shaft 12 is reversely rotated after an elapse of the time Ty1 or Ty2 corresponding to the temperature of cooling water for the engine. If the relay RyA is turned on and the relay RyB is turned on, the first and second contacts Ryb1 and the Ryb2 are each switched on the side opposed to the side shown in the figure, so that a current flows in the starter motor 171 in the direction shown by an arrow RF and thereby the starter motor 171 is normally rotated. If the relay RyA is turned off, since any current does not flow in the starter motor 171, the crank shaft 12 is not rotated.

[0109] To realize the reduction in weight and miniaturization of the starter motor 171, the starter motor 171 is configured as a low torque motor, and upon normal-rotation, the phase of the starter motor 171 is advanced to increase the torque. Accordingly, upon reverse-rotation, the phase of the starter motor 171 becomes lag, so that the torque becomes about 1/2 to 1/3 of the torque upon normal-rotation. Further, upon reverse-rotation, since a current flows via the resistance R for protecting the relay contact, the current amount is limited as compared with the normal-rotation, so that the rotational speed becomes significantly lower than that upon normal-rotation. With such a combination of the effects, even if the reverse-rotation starting position is close to or enter in the above low load region and the crank shaft is reversely rotated from the reverse-rotation starting position to the compression top dead center C/T, there does not occur any inconvenience that the crank shaft overshoots the compression top dead center C/T to reach an undesirable crank angle position at which a high load torque is required for the crank shaft to overshoot the compression top dead center C/T upon normal-rotation. Accordingly, even if the crank angle position reaches up to the vicinity of the compression top dead center C/T upon termination of the reverse-rotation, when the current-carrying is stopped, the crank shaft is rotated from the compression top dead center C/T in the normal direction and is stopped.

[0110] The above control will be described with reference to a flow chart shown in Fig. 19. The process shown in the flow chart is executed when the main switch 173 is turned on. The engine starting control begins when the starter switch 258 is turned on and the stop switch 259 is turned on. At Step S1, the temperature of cooling water for the engine is detected on the basis of the output from the water temperature sensor 155. At Step S2, the reverse-rotation time Ty1 corresponding to the water temperature thus detected is read from the above-described table (see Fig. 18). At Step S3, the relay RyA is turned on, and a timer T1 for keeping the ON state for the time Ty1 is started. At this time, since the relay RyB is turned off, the crank shaft 12 is reversely rotated.

[0111] At Step S4, it is decided whether or not the timer T1 counts the time Ty1. If YES, the process goes on to Step 35 at which the relay RyB is turned on, to start the normal-rotation of the crank shaft. At the same time, the timer T1 is made clear. At Step S6, it is decided whether or not the starter switch 258 is turned off. If the driver releases the starter switch 258, it is decided that the starter switch 258 is turned off, and the process goes on to Step S7.

[0112] At Step S7, the relay RyA is turned off. At Step S8, the timer Tp is started. At Step S9, it is decided whether or not the timer Tp counts the time t1 for protecting the contact of the relay RyB. If YES, the process goes on to Step S10 at which the relay RyB is turned off. At Step S11, the timer Tp is reset.

[0113] After completion of the starting control, the next control type is decided at Step S12, and respective controls, for example, the ignition control (Step S13), the charging control (Step S14), the head lamp control (Step S15), and the buzzer control (Step S16) are repeated for continuing the running of the vehicle. If a predetermined condition is established during running of the vehicle, the process goes on to Step S1 for the engine starting control or goes on to the engine stopping control to be described later.

[0114] Next, the engine stopping control will be described with reference to the flow chart shown in Fig. 20. At Step 21, the temperature of cooling water for the engine is detected on the basis of the output from the water temperature sensor 155. At Step S22, the reverse-rotation time Ty2 corresponding to the water temperature thus detected is read from the above-described table (see Fig. 18). At Step S23, the relay RyA is turned on, and a timer T2 for keeping the ON state for the time Ty2 is started. At this time, since the relay RyB is turned off, the crank shaft 12 is reversely rotated.

[0115] At Step S24, it is decided whether or not the timer T2 counts the time Ty2. If YES, the process goes on to Step S25 at which the timer T2 is made clear. At Step S26, the relay RyA is turned off, to stop the starter motor 171.

[0116] At Step S27, it is decided that the engine starting condition is established. If the starter switch 258 is turned on and the stop switch 259 is turned on, the engine starting condition is established. If the engine starting condition is established, the process goes on to Step S28 at which the relay RyB is turned on. By the turn-on of the relay RyB, the starter motor 171 is ready for normal-rotation. At Step S29, the timer Tp is started. At Step S30, it is decided whether or not the timer Tp counts the time T1 for protecting the contact of the relay RyB. If YES, the process goes on to Step S31 at which the timer Tp is reset. At Step S32, the relay RyA is turned on, to start the rotation of the crank shaft 12. At this time, since the relay RyB is turned on at Step S28, the crank shaft 12 is normally rotated. At Step S33, it is decided whether or not the engine is started. If YES, the process goes on to Step S7 (see Fig. 19).

[0117] If NO at Step S33, that is, if the engine is not started by the normal-rotation although the crank shaft 12 has been reversely rotated, the process goes on to Step S34 at which the relay RyA is turned off to temporarily stop the starter motor 171 and at Step S35, the relay RyB is turned off for permitting the reverse-rotation. At Step S36, the relay RyA is turned on, and the timer T1 for keeping the ON state for the time Ty1 is started. The crank shaft 12 is reversely rotated for the time Ty1.

[0118] At Step S37, it is decided whether or not the timer T1 counts the time Ty1. If YES, the process goes on to Step S38 at which the relay RyB is turned on, to start the normal-rotation of the crank shaft. At the same time, the timer T1 is made clear. At Step S39, it is decided whether or not the engine is started. If the engine is started, the process goes on to Step S7.

[0119] In this way, when the engine is not started by reversely rotating the starter motor and is then normally rotating it, the crank shaft 12 is immediately, reversely rotated and is normally rotated again irrespective of the crank angle position.

[0120] According to this embodiment, the temperature of cooling water is adopted as a parameter representing the friction, that is, the load of the crank shaft 12; however, the parameter for determining the reverse-rotation time is not limited thereto. For example, the reverse-rotation time may be determined on the basis of the temperature of engine oil detected by an engine oil temperature detecting means additionally provided.

[0121] As described above in detail, according to the inventions described in claims 1 to 6, the crank angle position of the crank shaft having been reversely rotated and stopped can be controlled to be located at a position where the crank shaft can be started to be normally rotated with a small load torque irrespective of the value of the rotational friction. In particular, since the above control can be performed without deciding whether the crank angle is located at an easy-to-start position or a difficult-to-start position, it is not required to provide a member for detecting a crank angle position such as a cam pulser, and therefore, it is possible to reduce the weight and size of the engine and also lower the cost of the engine.

[0122] Since the reverse-rotation time can be set depending on the degree of warming of the engine, it is possible to shorten the reverse-rotation time upon warming operation, and hence to achieve the sharp startability. In particular, in the case of performing the control for restarting the engine in response to vehicle-starting operation by the driver, it is possible to shorten the time elapsed until vehicle-starting, and also to shorten a current-carrying time by optimizing the reverse-rotation time and hence to reduce the power consumption.

[0123] In summary it is an object to improve the startability by reducing the effect of a load upon start-up of an engine.

[0124] When an Ne sensor 153 detects the stoppage of the engine, a control unit 1000 turns on a relay RyA. When a starter switch is operated, a starter relay control unit 400 turns on a relay RyA. The OFF state of the relay RyB is kept for a time set on the basis of the water temperature of the engine. When the relay RyA is turned on, the starter motor 171 is driven in such a manner as to be reversely rotated when the relay RyB is turned off and to be normally rotated when the relay RyB is turned on. In this way, the degree of the warming is decided depending on the water temperature, and when the degree of warming is large, the reverse-rotation time of the crank shaft is made short and when the degree of warming is small, the reverse-rotation time of the crank shaft is made long. The crank shaft is reversely rotated for the reverse-rotation time thus set, to be located at a position in a low load region, and is then normally rotated.

Claims

1. An engine starter for starting an engine (200) by reversely rotating a crank shaft (12) for a predetermined reverse-rotation time (Ty1,Ty2) and then normally rotating said crank shaft (12), characterized in that
said reverse-rotation time (Ty1, Ty2) is set on the basis of a rotational friction of said engine (200) in such a manner as to be long when said rotational friction is large and to be short when said rotational friction is small.

2. An engine starter according to claim 1, wherein said rotational friction is represented by an engine temperature, and said reverse-rotation time (Ty1, Ty2) is set to be short when said engine temperature is high and said reverse-rotation time (Ty1, Ty2) is set to be long when said engine temperature is low.

3. An engine starter according to claim 1 or 2, wherein said reverse-rotation time (Ty1, Ty2) is set to be not less than a time required for said crank shaft (12) to be rotated between a compression top dead center (C/T) and an exhaust top dead center (O/T) when said rotational friction of said engine (200) is a predetermined value.

4. An engine starter according to any one of claims 1 to 3, wherein said engine starter includes an engine stoppage/start-up control means for stopping said engine (200) when a vehicle is stopped and restarting said engine (200) in response to vehicle-starting operation performed by a driver; and
said reverse-rotation time (Ty2) upon restart-up of said engine (200) is set to be shorter than that upon

the initial start-up of said engine (200).

5. An engine starter according to any one of claims 1 to 4, wherein a ratio of said reverse-rotation time (Ty1) upon initial start-up of said engine (200) to said reverse-rotation time (Ty2) upon restart-up of said engine (200) is set to become larger as said rotational friction becomes smaller.

6. An engine starter according to any one of claims 1 to 5, wherein a rotational speed and a rotational torque of said crank shaft (12) upon reverse-rotation are set to be smaller than a torque necessary for said cank shaft (12) to overshoot the compression top dead center (C/T).

FIG. 1

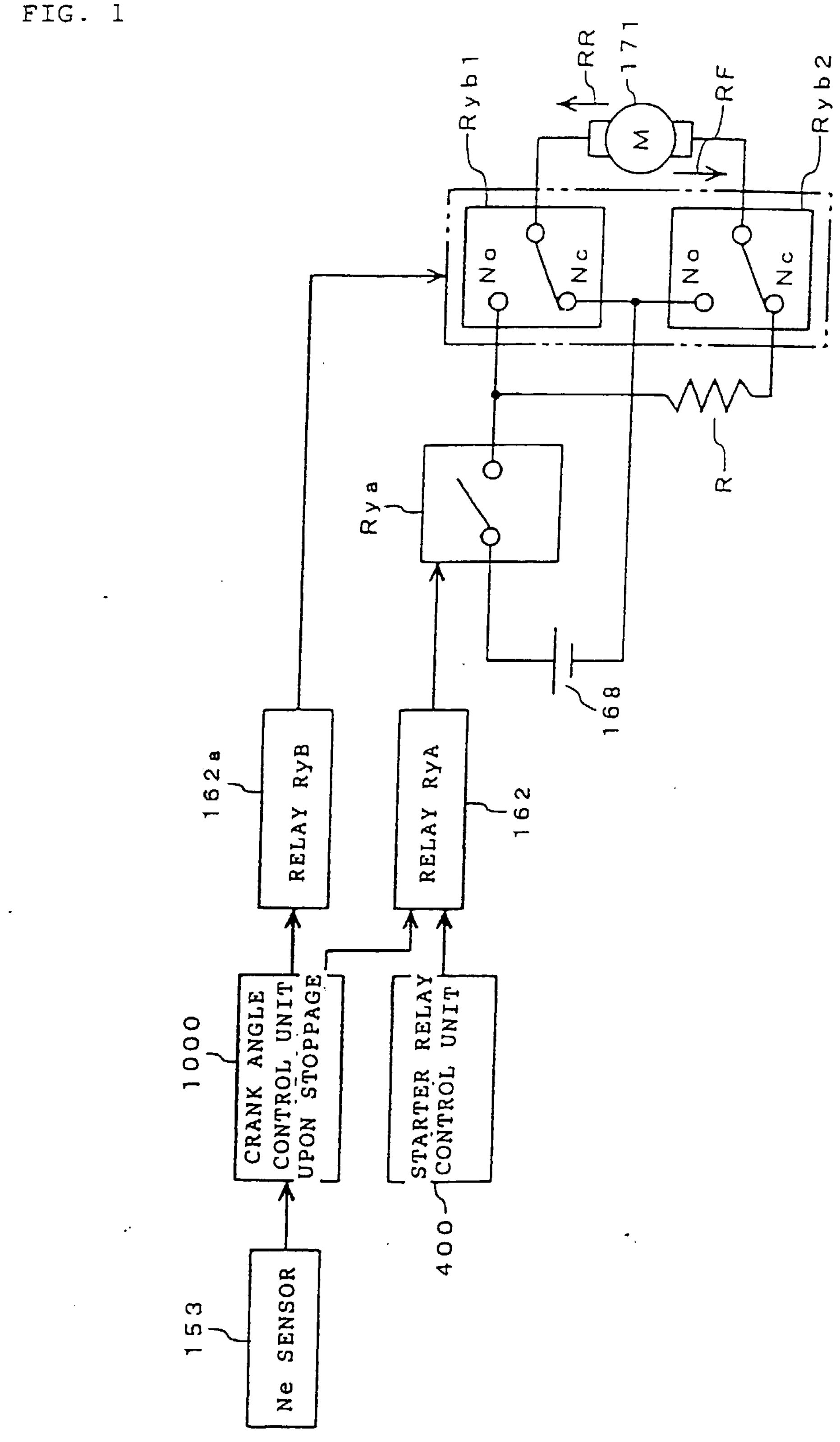

Ne SENSOR
153
CRANK ANGLE CONTROL UNIT UPON STOPPAGE
1000
STARTER RELAY CONTROL UNIT
400
RELAY RyB
162a
RELAY RyA
162
Rya
168
R
Ryb1
Ryb2
No
Nc
No
Nc
M
RR
RF
171

FIG. 2

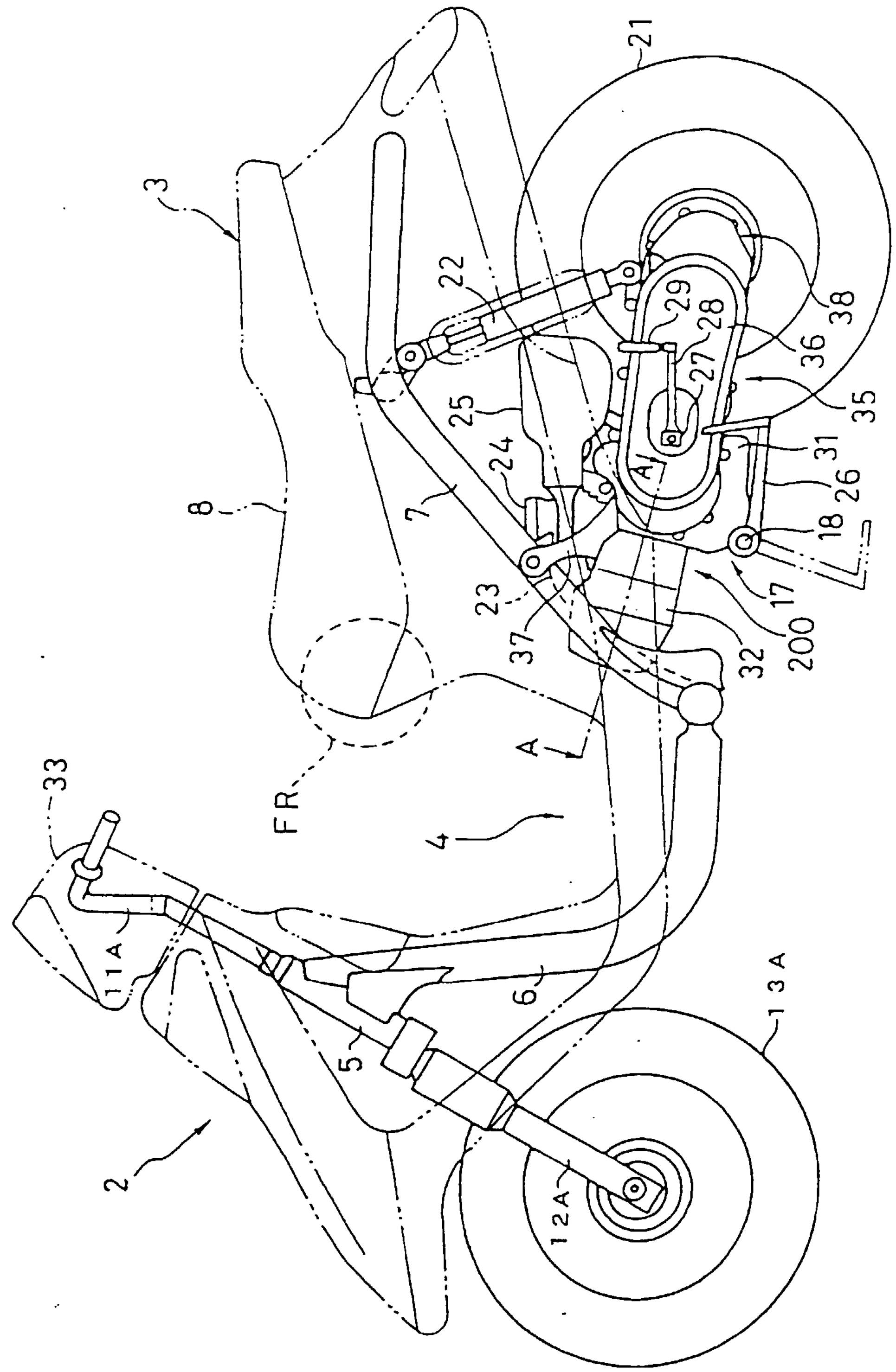

2
3
4
5
6
7
8
11A
12A
13A
17
18
21
22
23
24
25
26
27
28
29
31
32
33
35
36
37
38
200
A
FR

FIG. 3

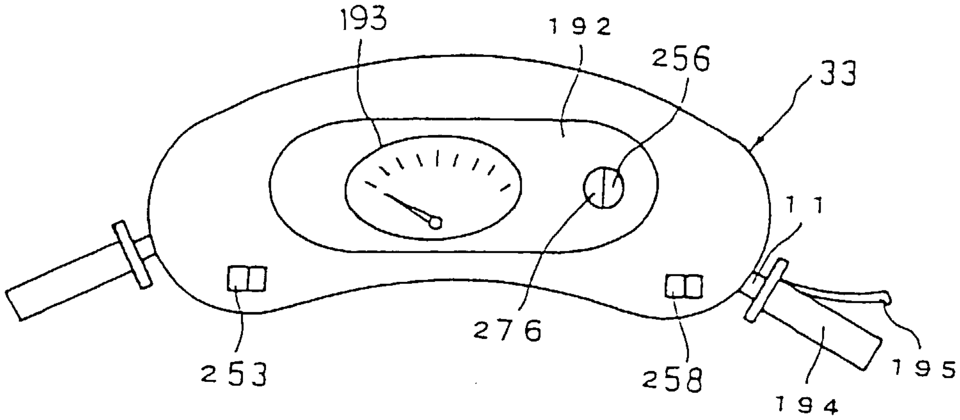

193
192
256
33
11
276
253
258
195
194

FIG. 4

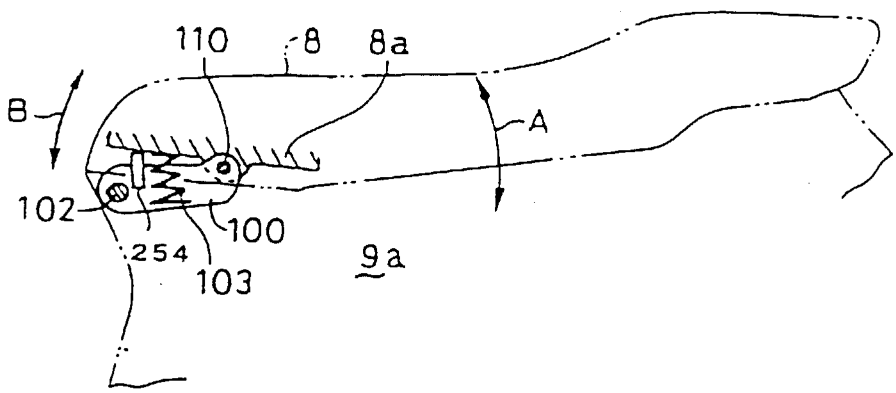

110
8
8a
B
A
102
100
254
103
9a

FIG. 5

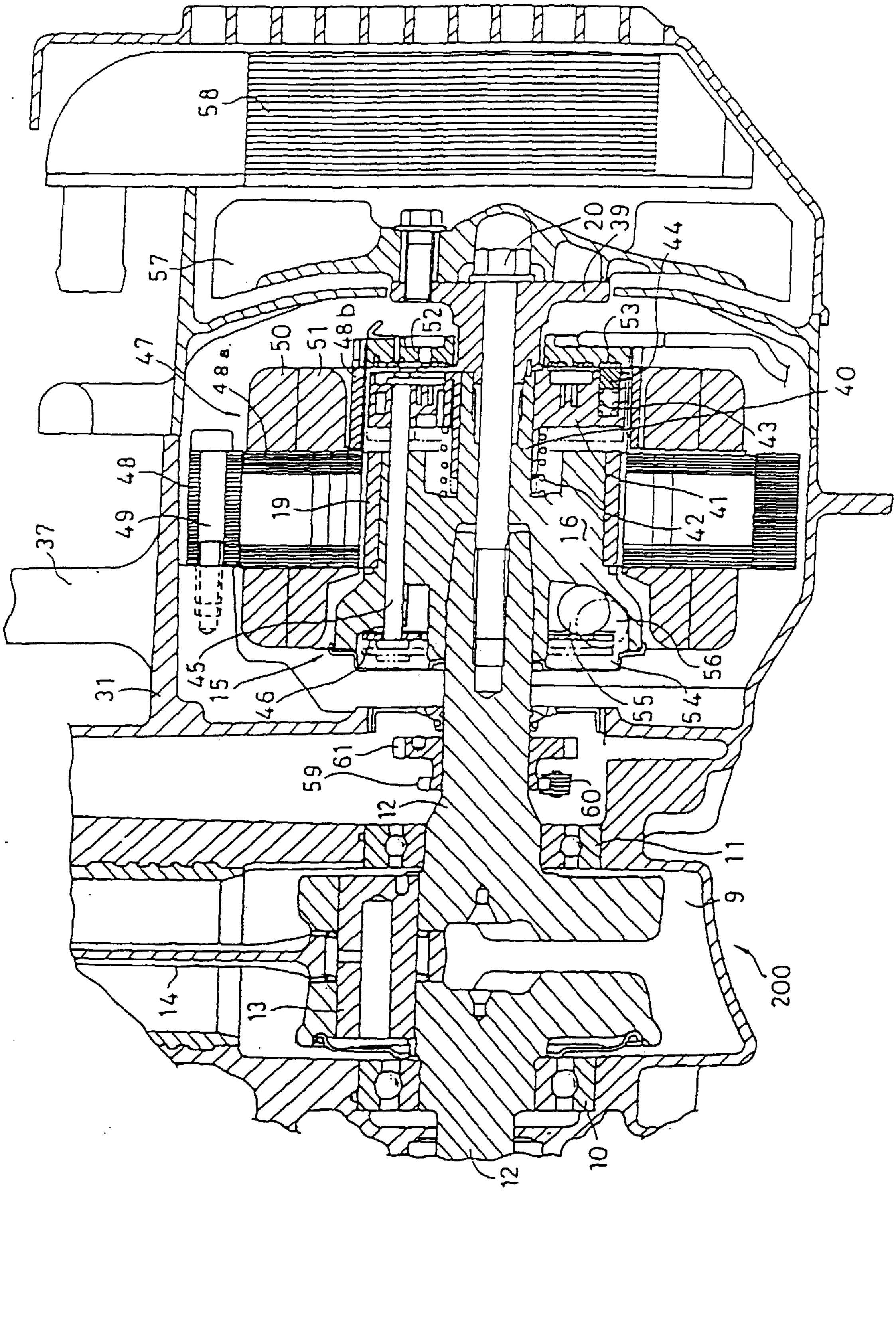

58
57
20
39
44
47
48a
50
51
48b
52
53
40
43
48
49
19
42
41
16
37
45
15
46
56
55
54
31
61
59
60
12
11
9
14
13
200
10
12

FIG. 6

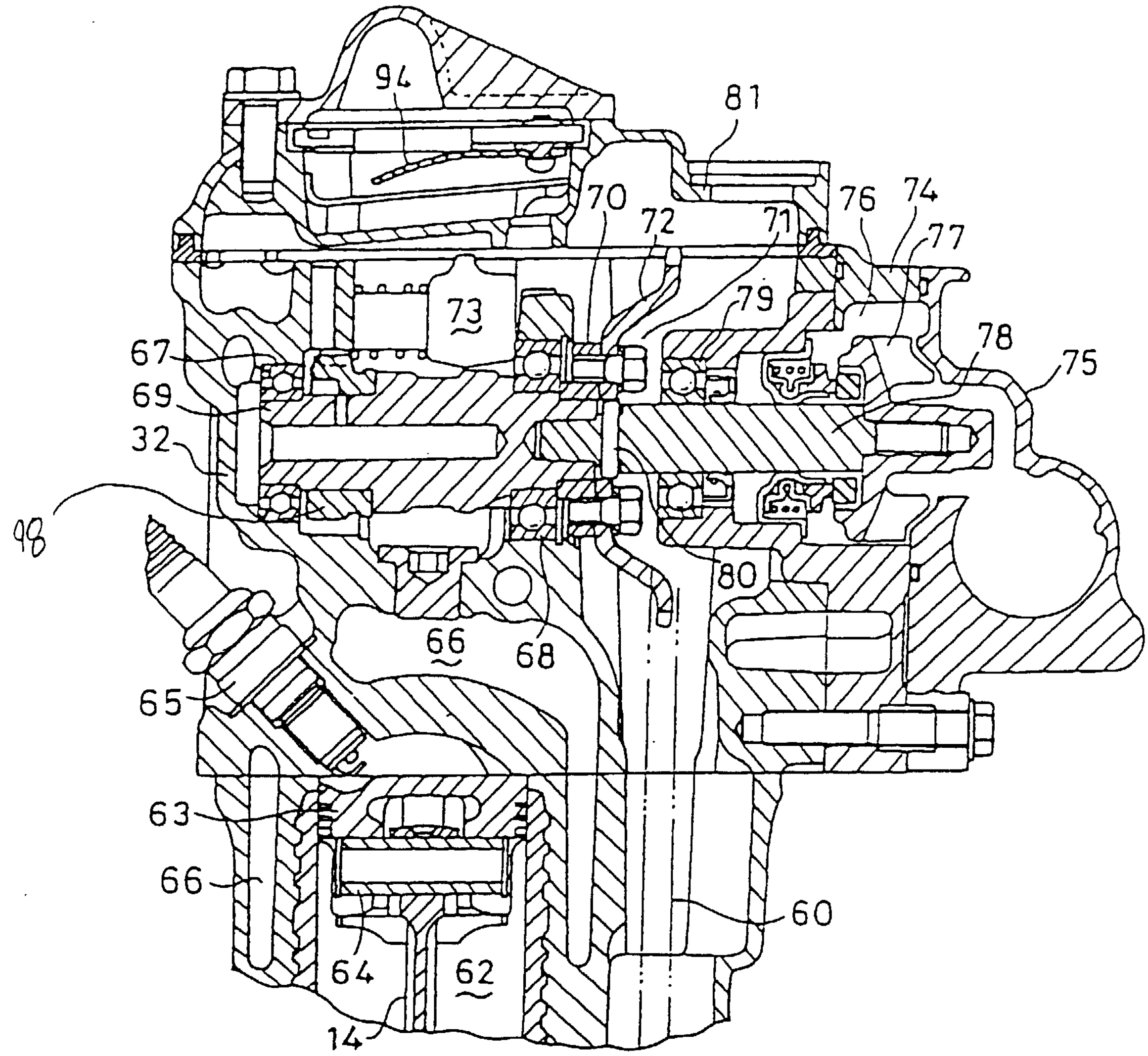

94
81
70
72
71
76
74
77
73
79
78
75
67
69
32
98
80
66
68
65
63
66
60
64
62
14

FIG. 7

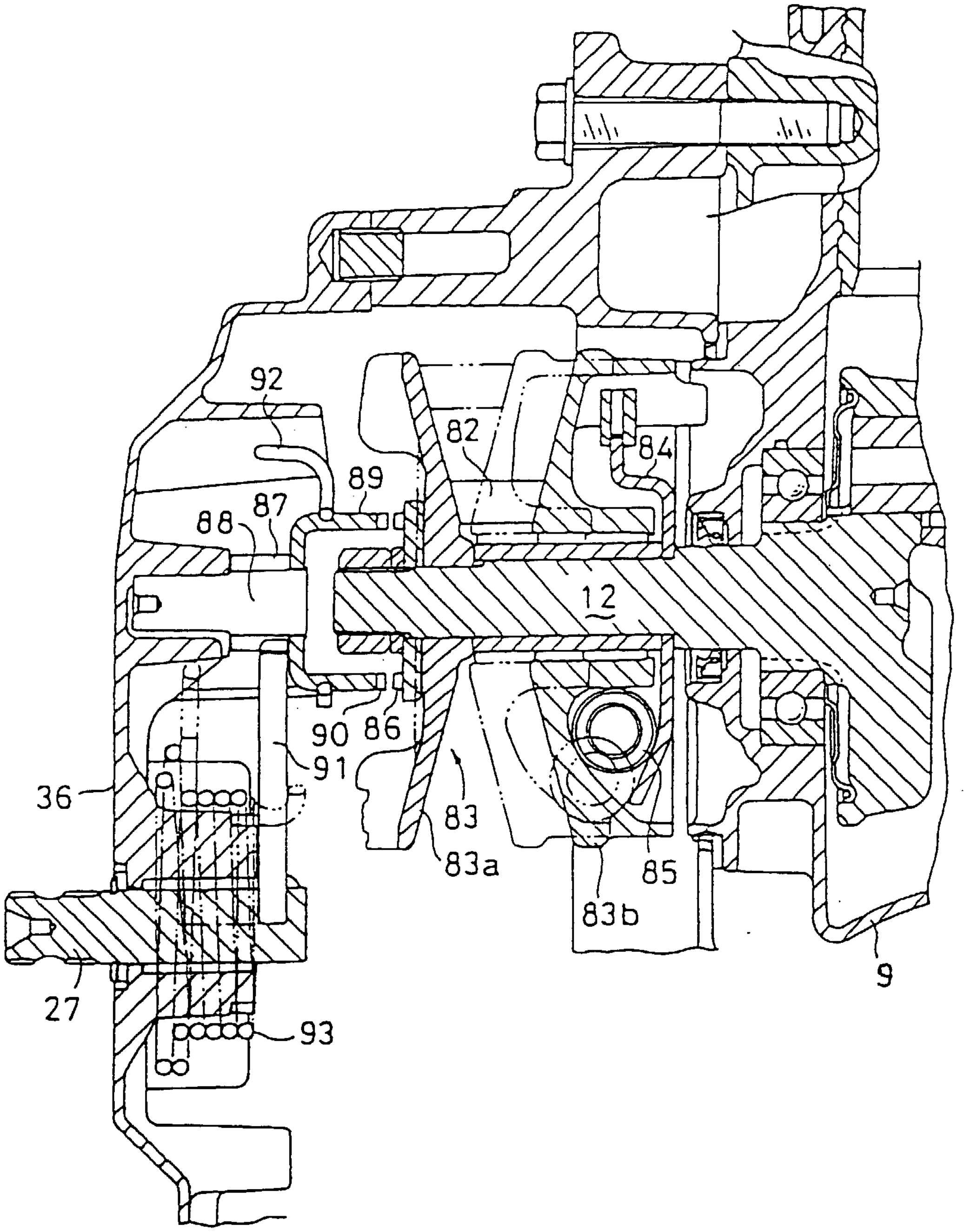


FIG. 8

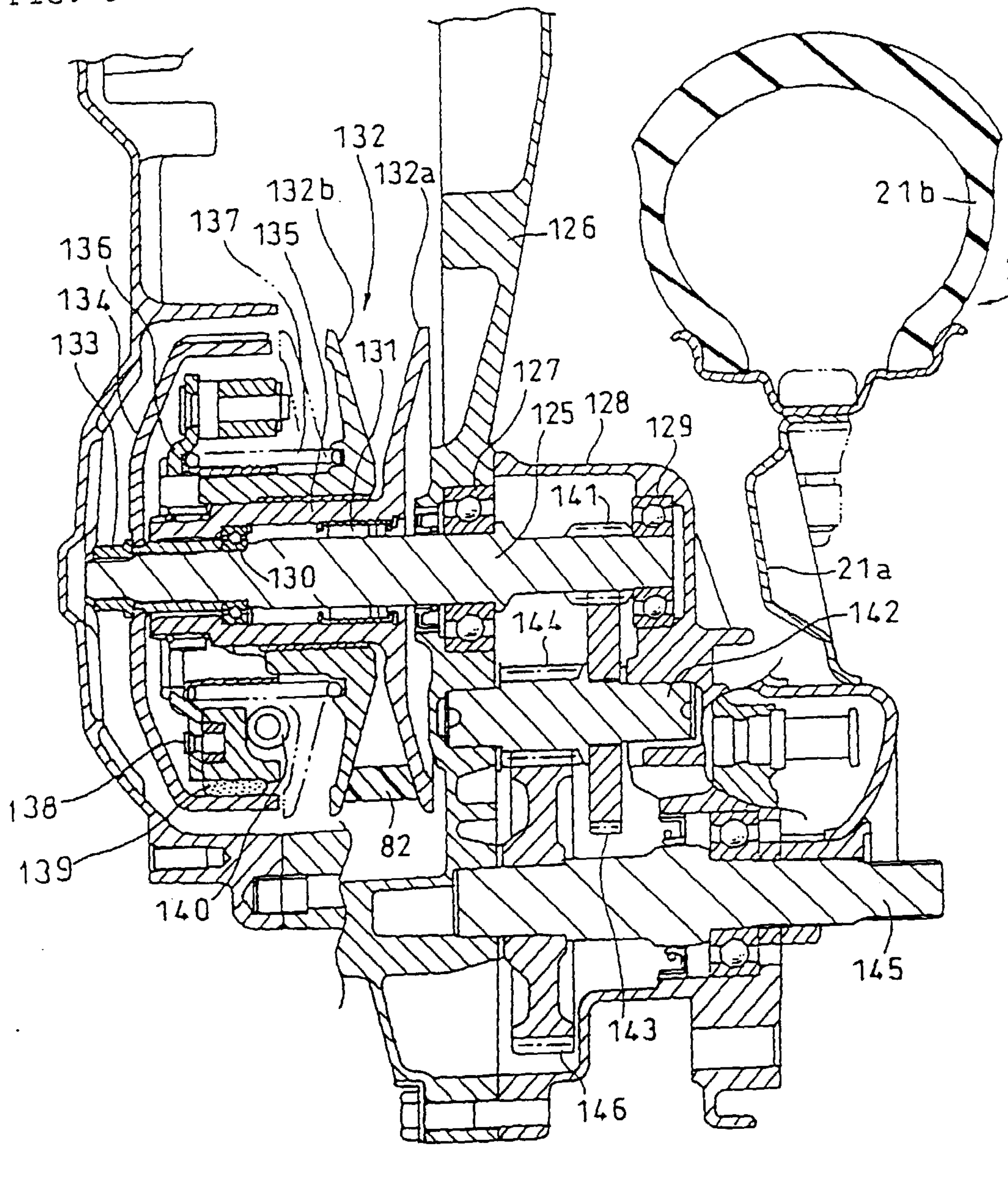

132
132b
132a
126
137
135
136
21b
21
134
133
131
127
125
128
129
141
130
21a
142
144
138
82
139
140
145
143
146

FIG. 9

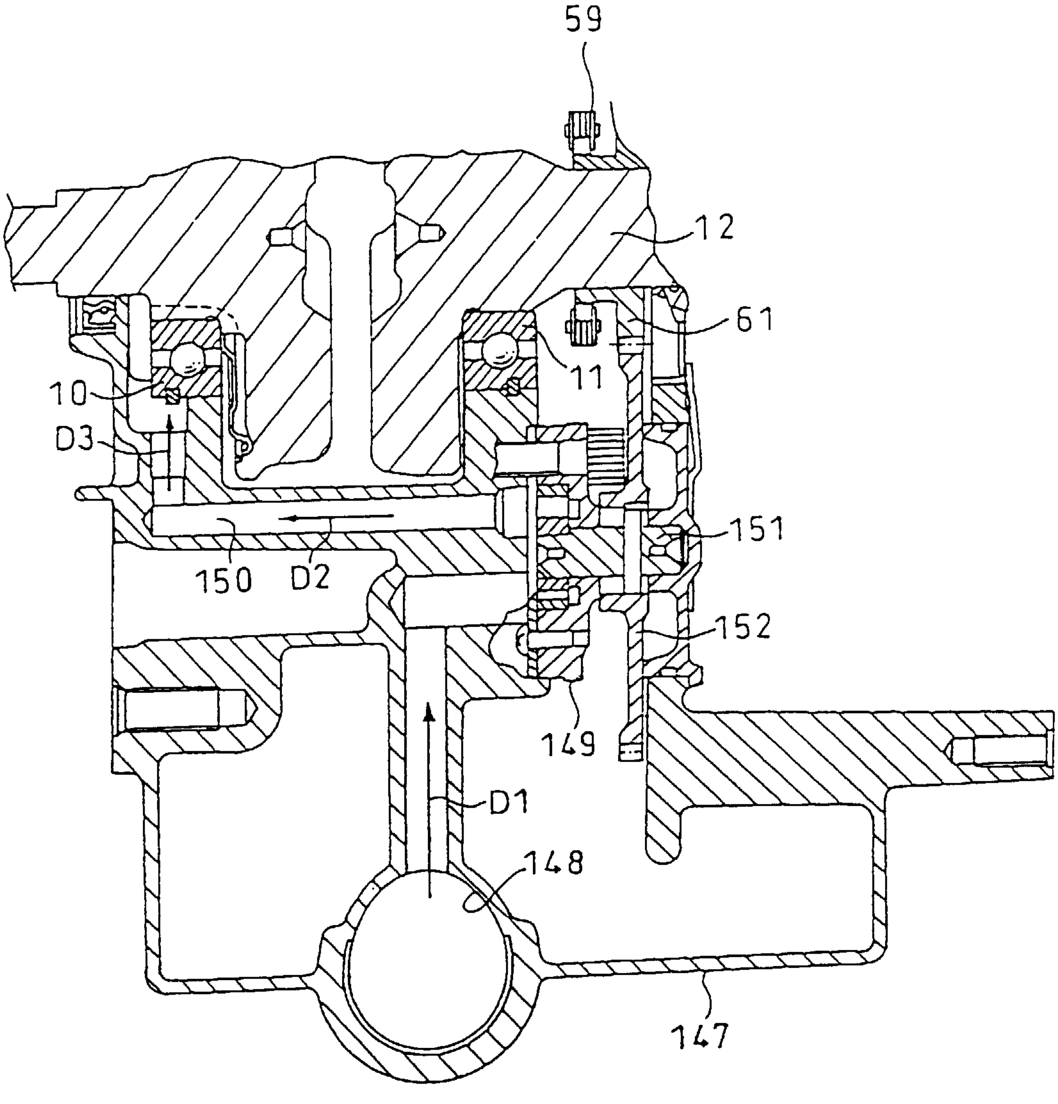


FIG. 10

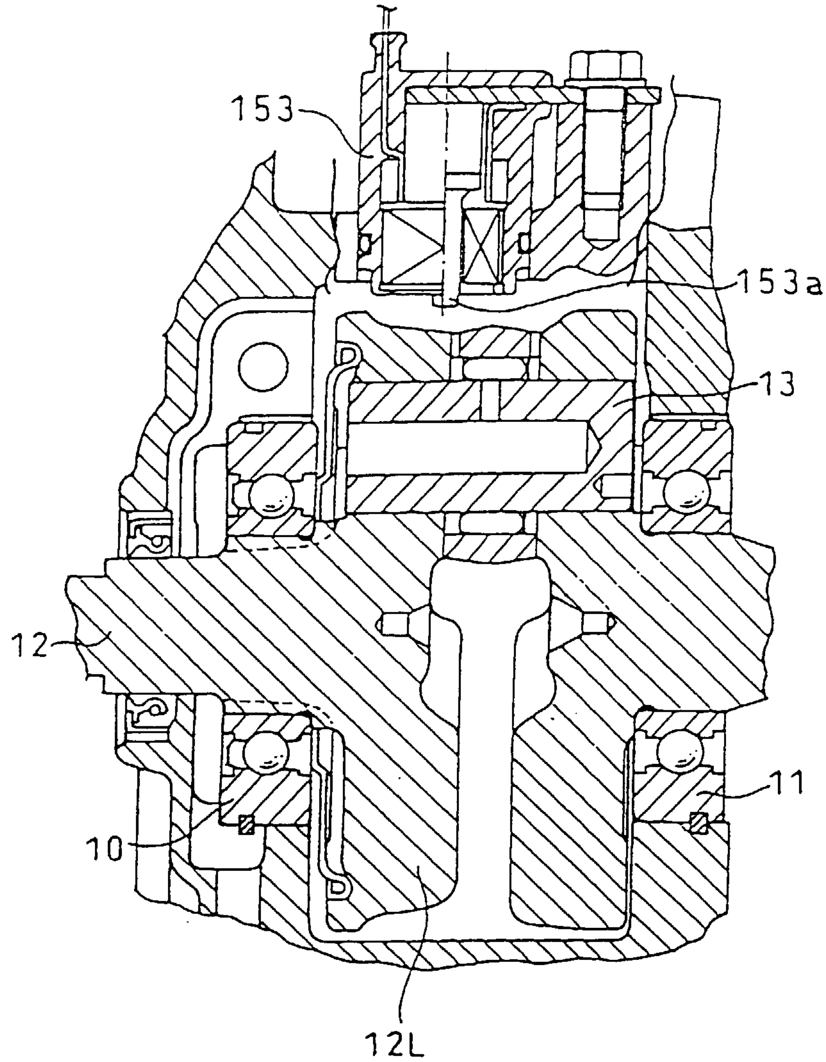


FIG. 11

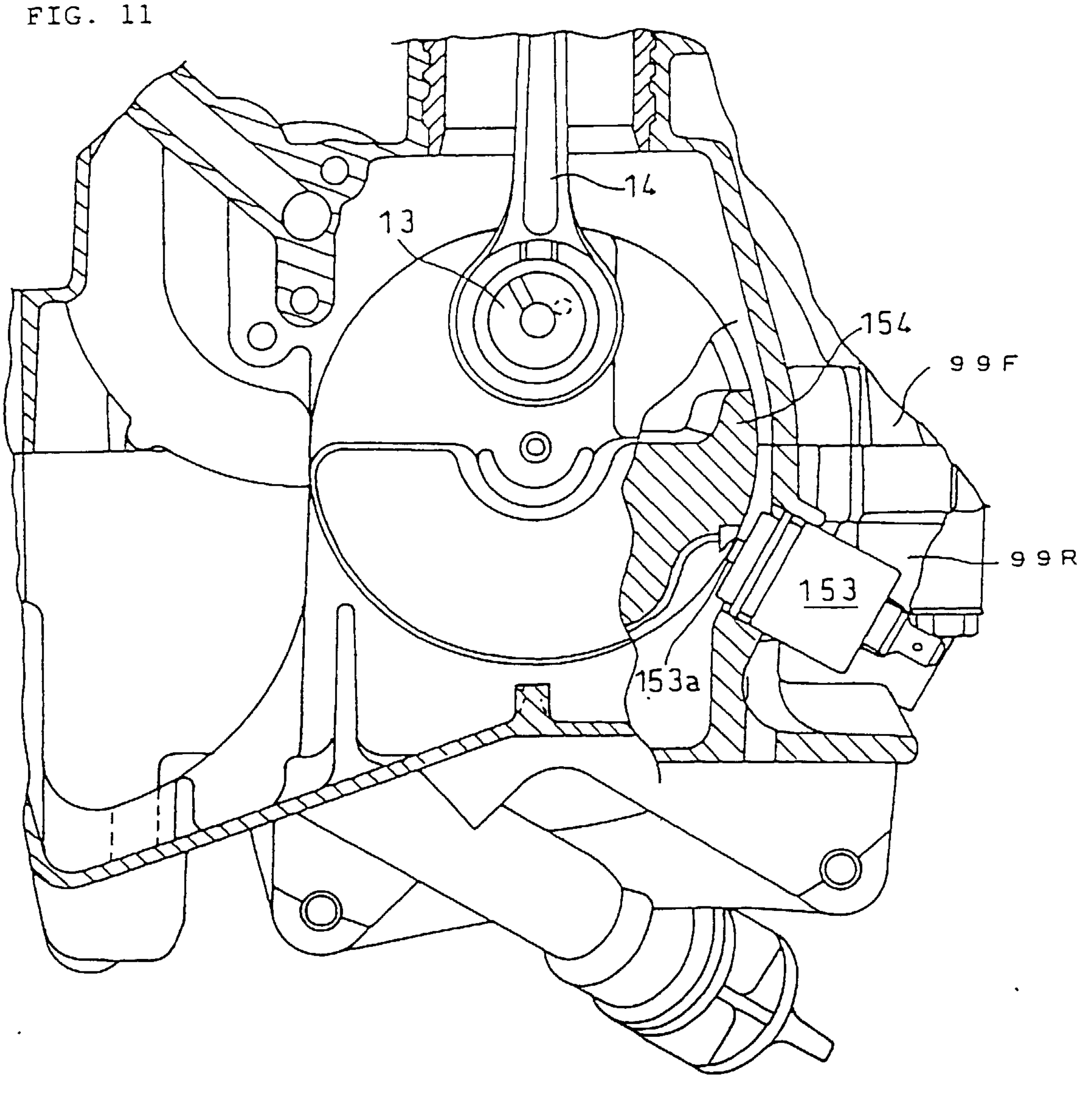
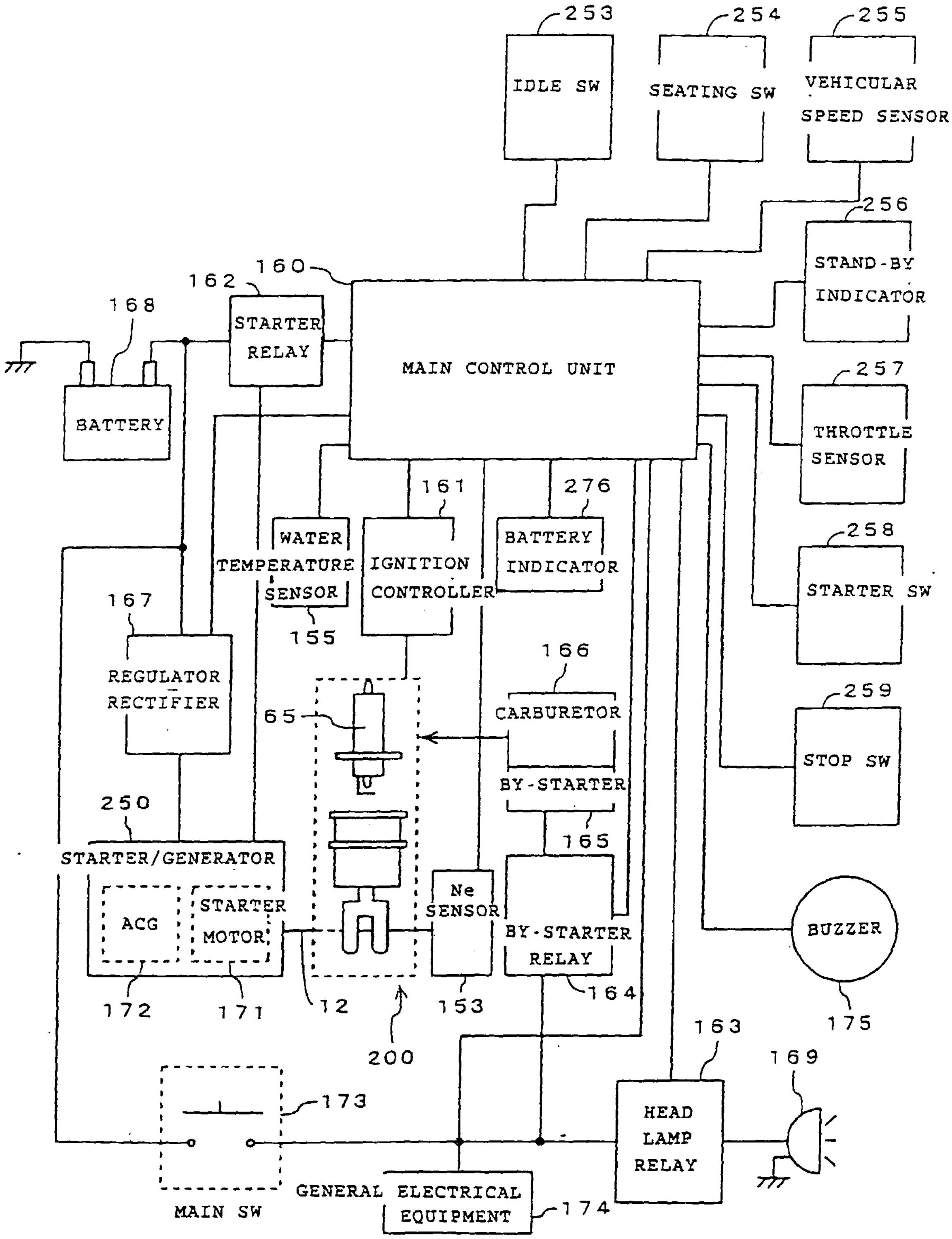


FIG. 12


253
254
255
IDLE SW
SEATING SW
VEHICULAR SPEED SENSOR
256
STAND-BY INDICATOR
160
162
168
STARTER RELAY
MAIN CONTROL UNIT
BATTERY
257
THROTTLE SENSOR
161
276
WATER TEMPERATURE SENSOR
IGNITION CONTROLLER
BATTERY INDICATOR
258
STARTER SW
167
155
166
REGULATOR RECTIFIER
65
CARBURETOR
259
STOP SW
BY-STARTER
250
165
STARTER/GENERATOR
ACG
STARTER MOTOR
Ne SENSOR
BY-STARTER RELAY
BUZZER
172
171
12
153
164
175
200
163
169
173
HEAD LAMP RELAY
MAIN SW
GENERAL ELECTRICAL EQUIPMENT
174

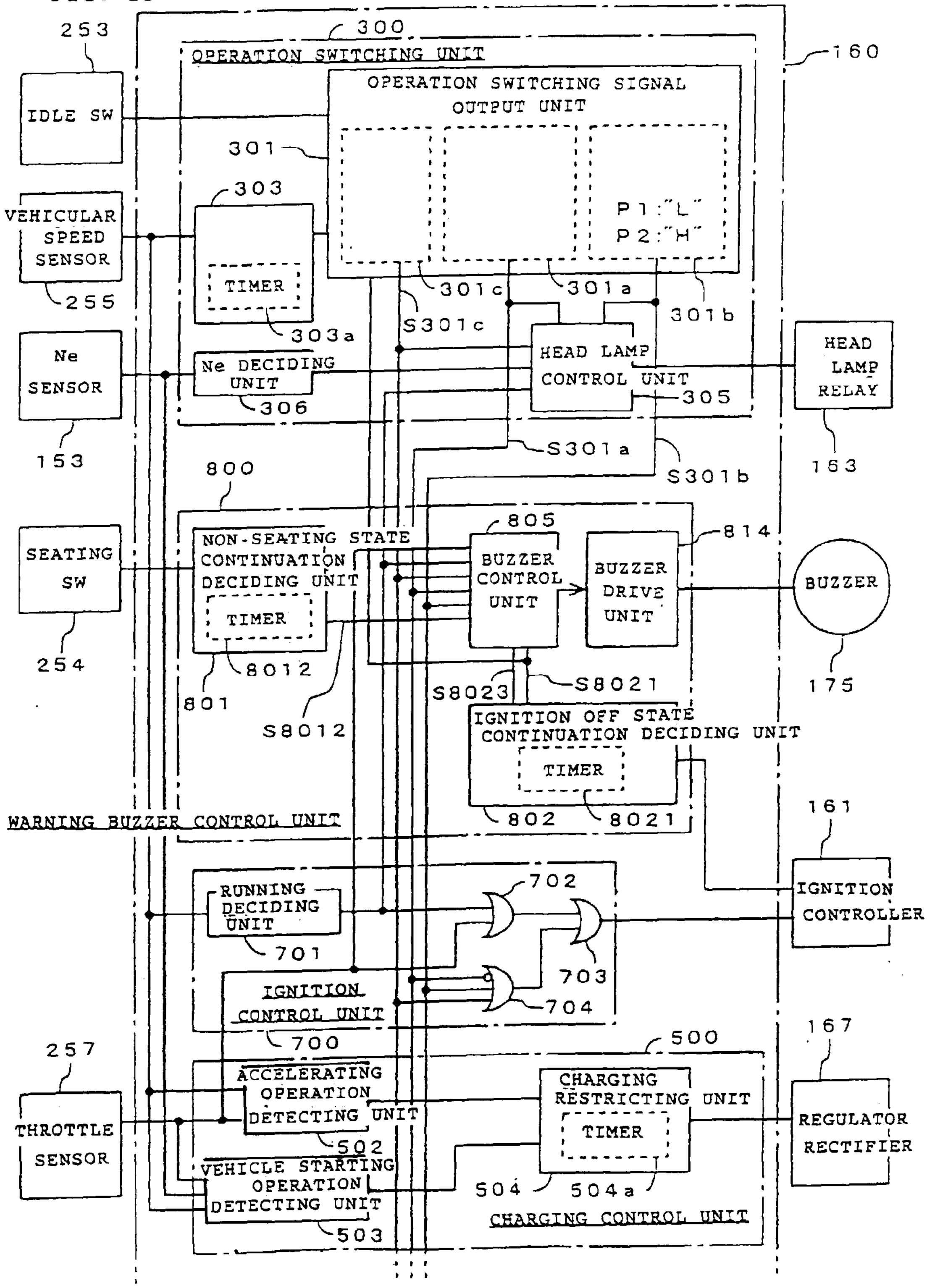
301a: OPERATIONAL MODE SWITCHING UNIT (STARTING MODE: "L", ENGINE-STOPPING/VEHICLE-STARTING MODE: "H")

301b: OPERATIONAL PATTERN SWITCHING UNIT

301c: IDLE SW MODE RAISING UNIT

303: VEHICULAR SPEED CONTINUATION DECIDING UNIT

FIG. 13



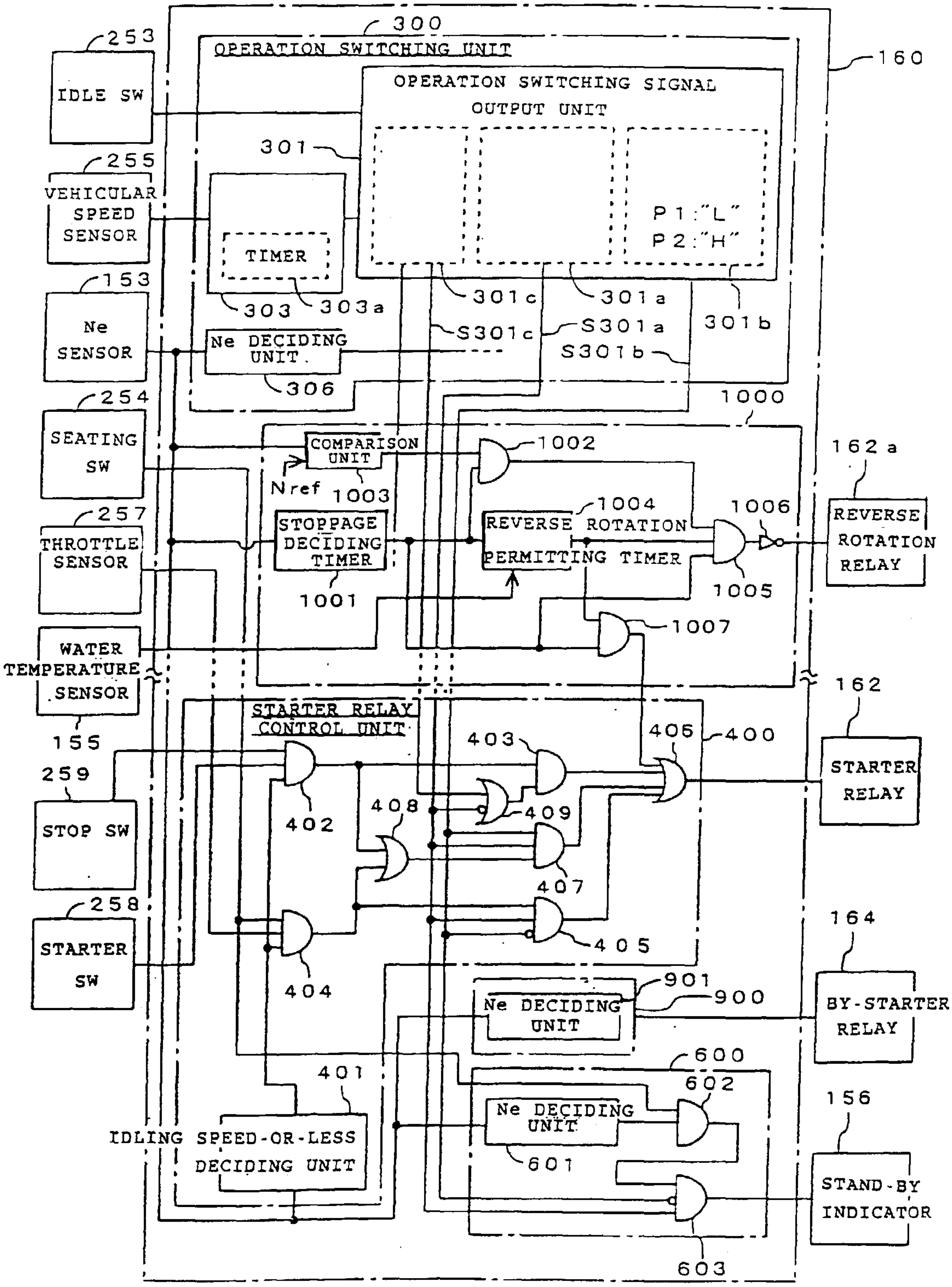
301a: OPERATIONAL MODE SWITCHING UNIT (STARTING MODE: "L", ENGINE-STOPPING/VEHICLE-STARTING MODE: "H")

301b: OPERATIONAL PATTERN SWITCHING UNIT

301c: IDLE SW MODE RAISING UNIT

303: VEHICULAR SPEED CONTINUATION DECIDING UNIT

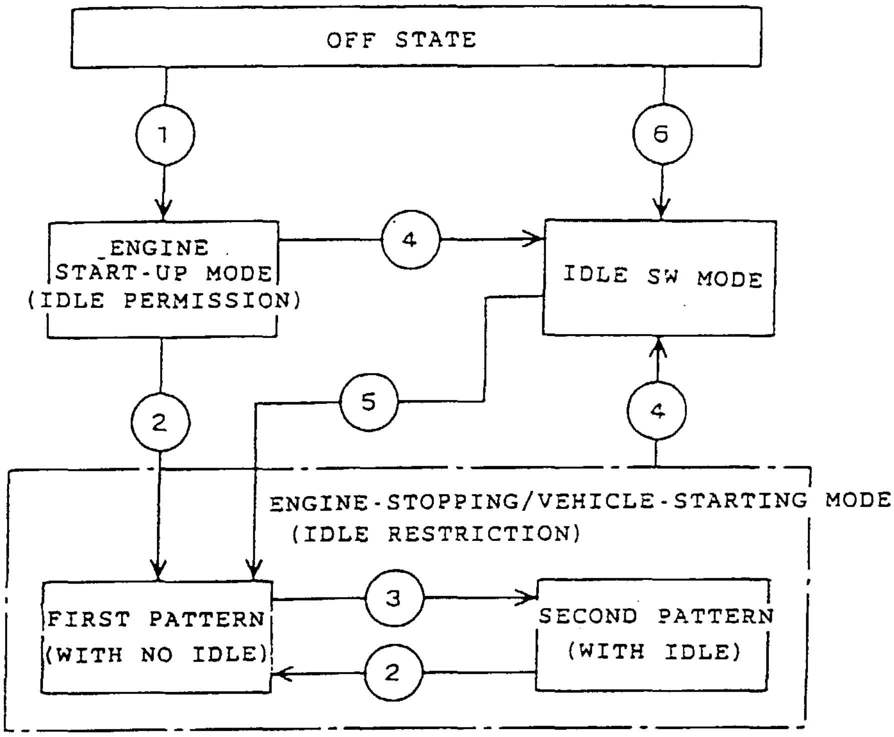
FIG. 14



	STARTING MODE	IDLE SW MODE	ENGINE·STOPPING/VEHICLE·STARTING MODE	
			FIRST PATTERN	SECOND PATTERN
ON/OFF CONTROL OF STARTER RELAY	·STARTER SW IS TURNED ON ·STOP SW IS TURNED ON ·Ne IS IDLE OR LESS AND — ON	DITTO TO THE LEFT	·THROTTLE IS OPENED ·SEATING SW IS TURNED ON ·Ne IS IDLE OR LESS AND — ON	·STARTER SW IS TURNED ON ·STOP SW IS TURNED ON ·Ne IS IDLE OR LESS (AND) ·THROTTLE IS OPENED ·SEATING SW IS TURNED ON ·Ne IS IDLE OR LESS (AND) OR — ON
ON/OFF CONTROL OF BY·STARTER RELAY	Ne IS SPECIFIC ROTATIONAL NUMBER OR MORE ON	DITTO TO THE LEFT	DITTO TO THE LEFT	DITTO TO THE LEFT
CONTROL OF STAND·BY INDICATOR	USUALLY OFF	USUALLY OFF	·SEATING SW IS TURNED ON ·Ne IS SPECIFIC ROTATIONAL NUMBER OR LESS AND — ON	USUALLY OFF
IGNITION CONTROL	USUALLY ON	USUALLY ON	·THROTTLE IS OPENED ·VEHICULAR SPEED IS LARGER THAN 0 KM OR — ON	USUALLY ON
CONTROL OF HEAD LAMP	·Ne IS SPECIFIC ROTATIONAL NUMBER OR MORE (LESS THAN IDLE) ·VEHICULAR SPEED IS LARGER THAN 0 KM OR — ON	USUALLY ON	· TURN ON OF IGNITION CONTROL · TURN OFF OF IGNITION CONTROL ON CHOPPING CONTROL	USUALLY ON
WARNING BUZZER CONTROL	USUALLY OFF	NON·SEATING IS CONTINUED FOR 1 SEC OR MORE IN IGNITION OFF STATE	·OFF STATE OF SEATING SW IS CONTINUED FOR 1 SEC OR MORE IN IGNITION OFF STATE ·IGNITION OFF IS CONTINUED FOR 3 MIN OR MORE OR — ON	·IGNITION IS IN OFF STATE ·THROTTLE OPENED ·VEHICULAR SPEED IS 0 KM AND — ON
CHARGING CONTROL	<STARTING CONDITION> ·VEHICULAR SPEED IS 0 KM ·Ne IS SPECIFIC ROTATIONAL NUMBER OR LESS ·THROTTLE IS OPENED (AND) ·VEHICULAR SPEED IS MORE THAN 0 KM ·THROTTLE IN FULL·CLOSE STATE IS FULL·OPENED WITHIN 0.3 SEC (AND) OR — START		<ENDING CONDITION> ·6 SEC ELAPSES AFTER STARTING ·Ne IS SPECIFIC ROTATIONAL NUMBER OR MORE ·THROTTLE OPENING IS REDUCED OR — END	<CONTROL CONTENT> CHARGING VOLTAGE IS REDUCED FROM 14.5 V TO 12.0 V

FIG. 15

FIG. 16



CONDITION (1): MAIN SW IN OFF STATE IS TURNED ON
AND
IDLE SW IS TURNED OFF

CONDITION (2): SPECIFIC VEHICULAR SPEED OR MORE IS CONTINUED FOR SPECIFIC TIME OR MORE

CONDITION (3): IGNITION OFF IS CONTINUED FOR 3 MIN OR MORE

CONDITION (4): IDLE SW IN OFF STATE IS TURNED ON

CONDITION (5): IDLE SW IN ON STATE IS TURNED OFF

CONDITION (6): IDLE SW IS TURNED ON
AND
MAIN SW IN OFF STATE IS TURNED ON

FIG. 17

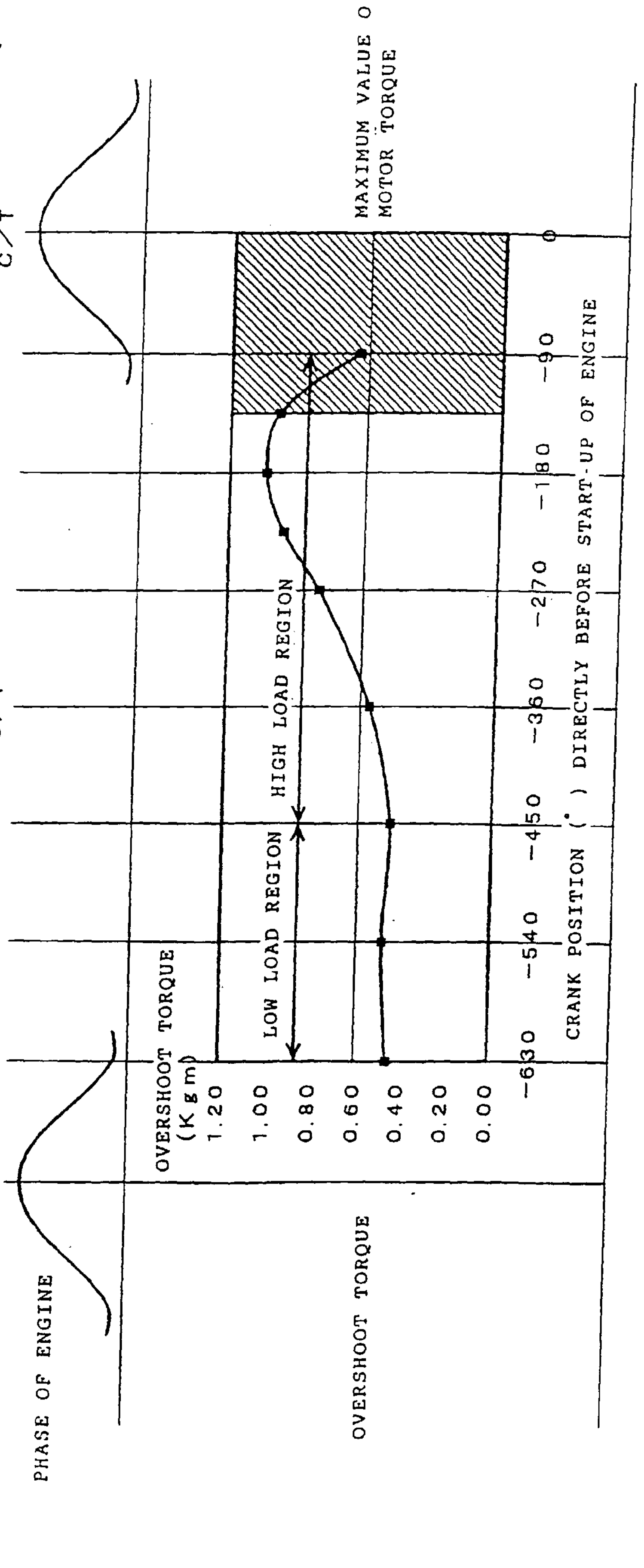

PHASE OF ENGINE
C/T
O/T
C/T
OVERSHOOT TORQUE
OVERSHOOT TORQUE (Kgm)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
LOW LOAD REGION
HIGH LOAD REGION
MAXIMUM VALUE O MOTOR TORQUE
-630
-540
-450
-360
-270
-180
-90
0
CRANK POSITION (°) DIRECTLY BEFORE START-UP OF ENGINE

FIG. 18

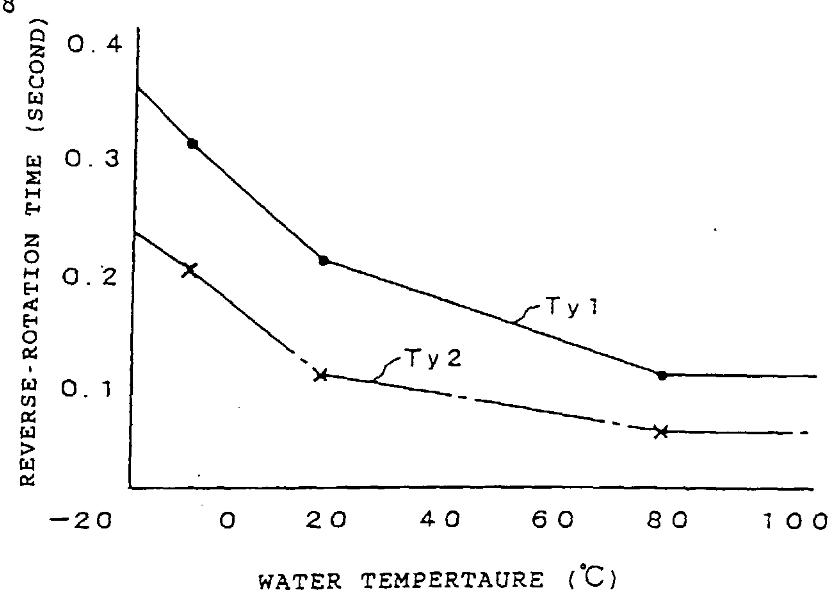

REVERSE-ROTATION TIME (SECOND)
0.4
0.3
0.2
0.1
-20
0
20
40
60
80
100
WATER TEMPERTAURE (℃)
Ty1
Ty2

FIG. 19

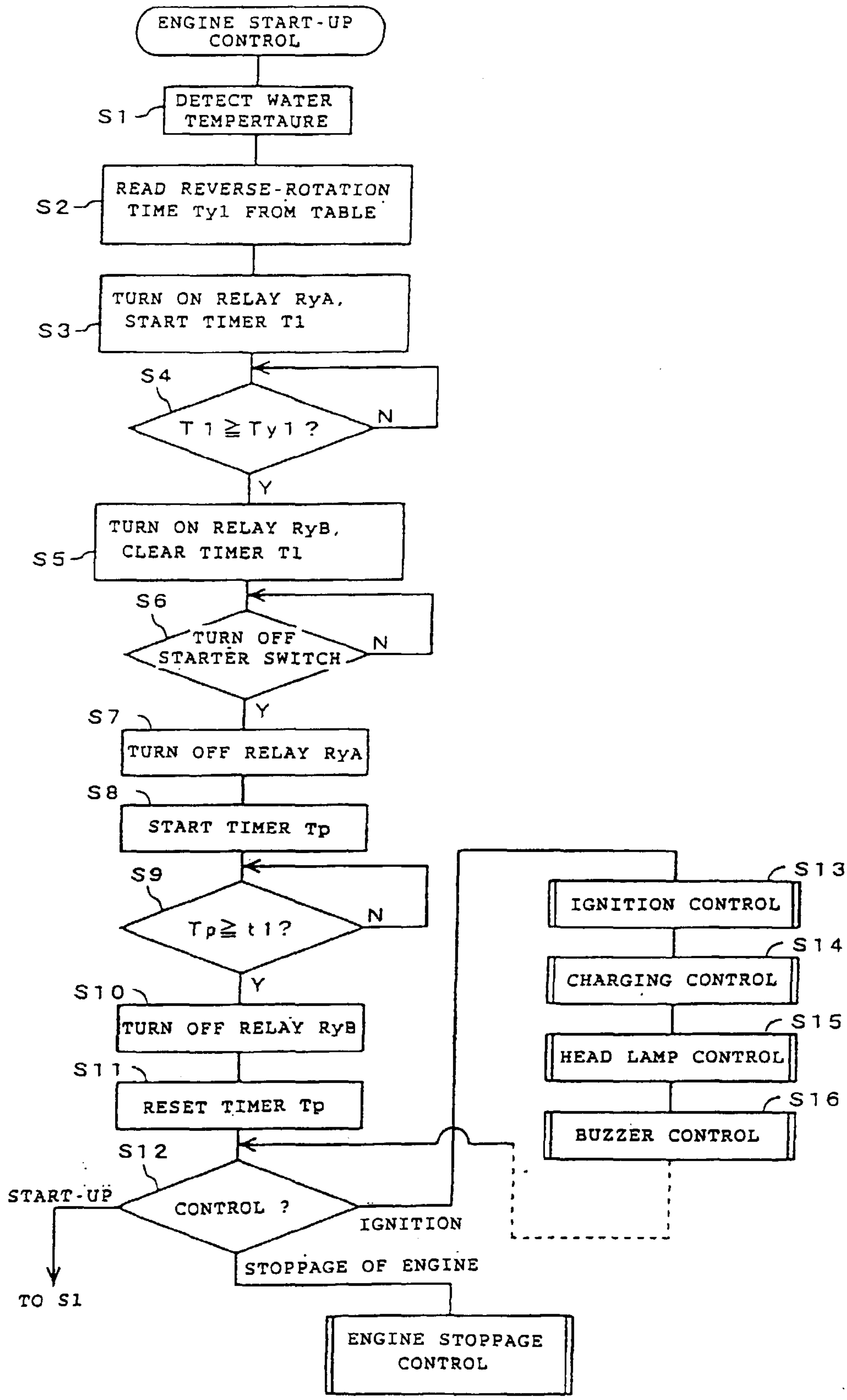
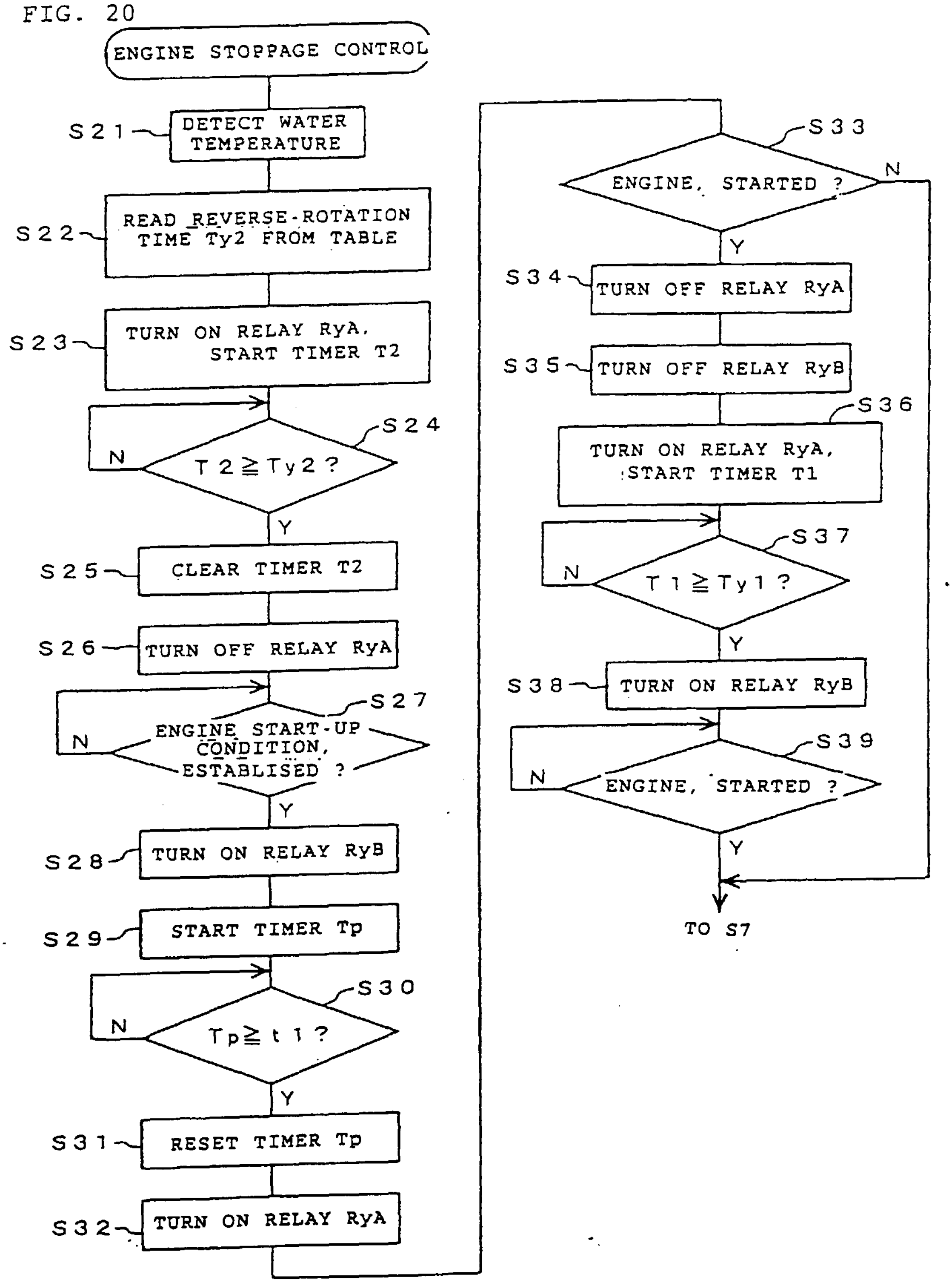

ENGINE START-UP CONTROL
S1
DETECT WATER TEMPERTAURE
S2
READ REVERSE-ROTATION TIME Ty1 FROM TABLE
S3
TURN ON RELAY RyA, START TIMER T1
S4
T1≧Ty1 ?
N
Y
S5
TURN ON RELAY RyB, CLEAR TIMER T1
S6
TURN OFF STARTER SWITCH
N
Y
S7
TURN OFF RELAY RyA
S8
START TIMER Tp
S9
Tp≧t1?
N
Y
S10
TURN OFF RELAY RyB
S11
RESET TIMER Tp
S12
CONTROL ?
START-UP
TO S1
IGNITION
STOPPAGE OF ENGINE
ENGINE STOPPAGE CONTROL
S13
IGNITION CONTROL
S14
CHARGING CONTROL
S15
HEAD LAMP CONTROL
S16
BUZZER CONTROL

FIG. 20


ENGINE STOPPAGE CONTROL
S21 DETECT WATER TEMPERATURE
S22 READ REVERSE-ROTATION TIME Ty2 FROM TABLE
S23 TURN ON RELAY RyA, START TIMER T2
S24 T2≧Ty2 ?
N
Y
S25 CLEAR TIMER T2
S26 TURN OFF RELAY RyA
S27 ENGINE START-UP CONDITION, ESTABLISED ?
N
Y
S28 TURN ON RELAY RyB
S29 START TIMER Tp
S30 Tp≧t1 ?
N
Y
S31 RESET TIMER Tp
S32 TURN ON RELAY RyA
S33 ENGINE, STARTED ?
N
Y
S34 TURN OFF RELAY RyA
S35 TURN OFF RELAY RyB
S36 TURN ON RELAY RyA, START TIMER T1
S37 T1≧Ty1 ?
N
Y
S38 TURN ON RELAY RyB
S39 ENGINE, STARTED ?
N
Y
TO S7

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EUROPEAN SEARCH REPORT

Application Number
EP 00 10 8397

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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A	US 5 713 320 A (PFAFF JOSEPH LAWRENCE ET AL) 3 February 1998 (1998-02-03)		
D,A	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 12, 25 December 1997 (1997-12-25) & JP 09 215292 A (HONDA MOTOR CO LTD), 15 August 1997 (1997-08-15) * abstract *		
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 July 2000	Bijn, E

CATEGORY OF CITED DOCUMENTS

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27-07-2000

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82