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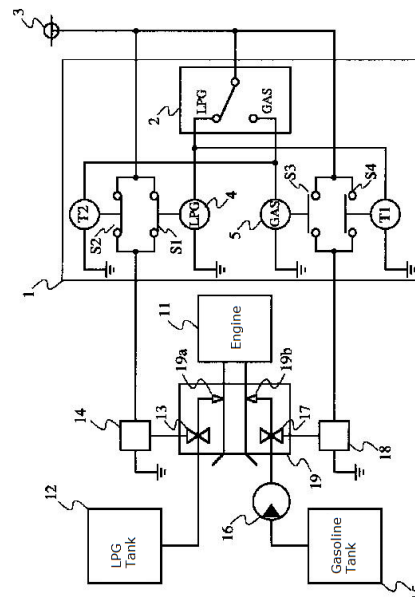
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(54) [Title of the Invention] Fuel Switching Device for Dual Fuel Engine

(57) [Abstract]

[Purpose] When switching the fuel supplied to an engine from a gaseous fuel to a liquid fuel, to continue supplying the gaseous fuel for a certain period of time to ensure that the engine does not stop even during low-speed rotation or under high-load conditions.

[Constitution] When a selection switch 2 is switched from an LPG side to a gasoline side, opening/closing contacts S3 and S4 are closed at the same time, opening/closing contact S1 is opened and, after a timer element T2 has reached a delay time t2, opening/closing contact S2 is opened. During the period from operation of the selection switch 2 to the delay time t2 elapsing, current flows through opening/closing contacts S3 and S4 to a solenoid 18, causing opening/closing valve 17 to open, and current flows through opening/closing contact S2 to another solenoid 14, causing opening/closing valve 13 to open. During the period from opening/closing valve 17 opening to gasoline reaching a nozzle 19b, LPG is continuously supplied to a carburetor 19 so that the supply of fuel to the engine 11 is not interrupted.



[Claims]

[Claim 1] A fuel switching device for a dual-fuel engine that selectively switches between gaseous and liquid fuels and supplies the fuel to the engine, the fuel switching device for a dual-fuel engine characterized in that a control unit is provided to continue supplying gaseous fuel to the engine for a predetermined amount of time set in advance at least when switching from gaseous fuel to liquid fuel.

[Claim 2] The fuel switching device for a dual-fuel engine according to claim 1, further comprising a carburetor having an opening/closing valve for each of the gaseous fuel and the liquid fuel, wherein the control unit opens the opening/closing valves for both the gaseous fuel and the liquid fuel for a predetermined period of time set in advance when switching from gaseous fuel to liquid fuel.

[Claim 3] The fuel switching device for a dual-fuel engine according to claim 2, further comprising a rotation detecting unit for detecting the engine RPM, wherein when the rotation detecting unit detects that the engine is in a low-speed rotation state, the control unit opens the opening/closing valve for the gaseous fuel and the liquid fuel for a predetermined period of time set in advance.

[Claim 4] The fuel switching device for a dual-fuel engine according to claim 2, further comprising a load detecting unit that detects the load state acting on the engine, wherein when the load detecting unit detects a high load condition of the engine, the control unit opens the opening/closing valve for the gaseous fuel and the liquid fuel for a predetermined period of time set in advance.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention] The present invention relates to a dual-fuel engine that selectively switches between supplying a gaseous fuel such as liquefied petroleum gas (LPG) and a liquid fuel such as gasoline, and more specifically to a fuel switching device for a dual-fuel engine that switches between supplying a gaseous fuel and a liquid fuel to the engine in accordance with switching commands.

[0002]

[Prior Art] Work vehicles used both indoors and outdoors, such as aerial work platforms, are equipped with dual-fuel engines that can selectively switch between gaseous and liquid fuels as their power supply. A liquid fuel, which is easy to transport and is safe, should be used as fuel for engines installed in vehicles. However, when working indoors, consideration should be

given to preventing deterioration in the working environment for workers, so a gaseous fuel such as LPG, which emits fewer pollutants in the exhaust gas and produces less noise during combustion than a liquid fuel, is used.

[0003] As in the case of liquid fuels, gaseous fuels must be mixed with air at a specified air-fuel ratio and introduced to the engine cylinders. Therefore, a conventional dual-fuel engine is equipped with a carburetor that has opening/closing valves for both the liquid fuel and the gaseous fuel, which valves are opened and closed by solenoids, etc. When a switch or other device is operated by the driver to input a switching command, one of the opening/closing valves is selectively opened to switch the fuel supplied to the engine.

[0004]

[Problem to Be Solved by the Invention] However, in conventional dual-fuel engines, switching the fuel supplied to the engine while the engine is running could cause the engine to stall. In particular, when switching from a gaseous fuel to a liquid fuel, the engine often stalls when the engine speed is low or when the engine is under heavy load.

[0005] This is because even when using a gaseous fuel, negative pressure acts on the nozzle that discharges the liquid fuel into the carburetor. While a gaseous fuel is being used, liquid fuel in the float chamber located between the liquid fuel opening/closing valve and the nozzle is sucked out by negative pressure. As a result, when the liquid fuel opening/closing valve opens and the gaseous fuel opening/closing valve closes at the same time, fuel is not supplied to the engine during the period it takes for the liquid fuel, which has a slower operating speed than gaseous fuel, to reach the nozzle from the opening/closing valve.

[0006] When the engine is rotating at a relatively high speed or when the load on the engine is relatively small, the engine can continue to rotate due to inertial force even if the fuel supply is temporarily interrupted. However, when the engine speed is low or the engine is under heavy load, the engine load exceeds the inertial force.

[0007] It is an object of the present invention to provide a fuel switching device for a dual-fuel engine that can reliably prevent the engine from stopping even when the engine speed is low or when a large load is applied to the engine, by continuously supplying gaseous fuel to the engine for a certain period of time at least when switching the fuel supplied to the engine from gaseous fuel to liquid fuel.

[0008]

[Means for Solving the Problem] The invention according to claim 1 is a fuel switching device for a dual-fuel engine that selectively switches between gaseous and liquid fuels and supplies the fuel to the engine, the fuel switching device for a dual-fuel engine characterized in that a control unit is provided to continue supplying gaseous fuel to the engine for a predetermined amount of time set in advance at least when switching from gaseous fuel to liquid fuel.

[0009] In the invention according to claim 1, when switching the fuel supplied to the engine from gaseous fuel to liquid fuel, gaseous fuel is continuously supplied to the engine for a predetermined period of time. As a result, the fuel supply to the engine is not interrupted during fuel switching, and even when switching the fuel supplied to the engine to a relatively slow-moving liquid fuel, the engine does not stop rotating even when the engine speed is low or a large load is applied to the engine.

[0010] The invention according to claim 2 is the fuel switching device for a dual-fuel engine described above, further comprising a carburetor having an opening/closing valve for each of the gaseous fuel and the liquid fuel, wherein the control unit opens the opening/closing valves for both the gaseous fuel and the liquid fuel for a predetermined period of time set in advance when switching from gaseous fuel to liquid fuel.

[0011] In the invention according to claim 2, when switching the fuel supplied to the engine from gaseous fuel to liquid fuel, the gaseous fuel and liquid fuel opening/closing valves provided in the carburetor are opened for a predetermined period of time. As a result, during the predetermined time when switching from gaseous fuel to liquid fuel, gaseous fuel is continuously supplied to the carburetor, the supply of fuel from the carburetor to the engine is not interrupted even during the period between the opening of the opening/closing valve and the arrival of liquid fuel in the carburetor, and the engine does not stop rotating even when the engine speed is low or when the engine is under heavy load.

[0012] The invention according to claim 3 is the fuel switching device for a dual-fuel engine described above, further comprising a rotation detecting unit for detecting the engine RPM, wherein when the rotation detecting unit detects that the engine is in a low-speed rotation state, the control unit opens the opening/closing valve for the gaseous fuel and the liquid fuel for a predetermined period of time set in advance.

[0013] In the invention according to claim 3, when switching the fuel supplied to the engine from gaseous fuel to liquid fuel, if the engine is in a low-speed rotation state, the gaseous fuel and liquid fuel opening/closing valves provided in the carburetor are opened for a predetermined time. As a result, during the predetermined time when switching from gaseous fuel to liquid fuel, gaseous fuel is continuously supplied to the carburetor, the supply of fuel from the carburetor to the engine is not interrupted even during the period between the opening of the opening/closing valve and the arrival of liquid fuel in the carburetor, and the engine does not stop rotating during fuel switching even when the engine speed is low and the inertial force generated by the engine is low.

[0014] The invention according to claim 4 is the fuel switching device for a dual-fuel engine described above, further comprising a load detecting unit that detects the load state acting on the engine, wherein when the load detecting unit detects a high load condition of the engine, the control unit opens the opening/closing valve for the gaseous fuel and the liquid fuel for a predetermined period of time set in advance.

[0015] In the invention according to claim 4, when switching the fuel supplied to the engine from gaseous fuel to liquid fuel, if a high load is applied to the engine, the opening/closing valves for gaseous fuel and liquid fuel provided in the carburetor are opened for a predetermined time. As a result, during the predetermined time when switching from gaseous fuel to liquid fuel, gaseous fuel is continuously supplied to the carburetor, the supply of fuel from the carburetor to the engine is not interrupted even during the period between the opening of the opening/closing valve and the arrival of liquid fuel in the carburetor, and the engine does not stop rotating during fuel switching even when the inertial force generated by the engine is low compared to the load acting on the engine.

[0016]

[Embodiment of the Invention] The following is a description of an embodiment of the invention using a dual-fuel engine (simply "the engine" below) that is supplied with LPG as a gaseous fuel and gasoline as a liquid fuel.

[0017] FIG. 1 is a schematic diagram showing the configuration of an engine provided with a fuel switching device according to an embodiment of the invention described in claim 2. The engine 11 is equipped with a carburetor 19. LPG flows into the carburetor 19 from an LPG tank 12 via an opening/closing valve 13, and gasoline flows into the carburetor

19 from a gasoline tank 15 via a fuel pump 16 and opening/closing valve 17. The carburetor 19 mixes the incoming LPG or gasoline with air at a predetermined air-fuel ratio and supplies the mixture to the engine 11. Opening/closing valves 13 and 17 are opened and closed by solenoids 14 and 18, respectively.

[0018] The fuel switching device 1 comprises opening/closing contacts S1 and S2 connected in parallel between the power supply 3 and solenoid 14, opening/closing contacts S3 and S4 connected in parallel between the power supply 3 and solenoid 18, drive mechanisms 4 and 5 for closing opening/closing contacts S1 and S3, a selection switch 2 for receiving selection input to selectively close opening/closing contact S1 or S3, timer element T1 that delays the opening of opening/closing contact S2 by a delay time t1 after the closing of opening/closing contact S1, and a timer element T2 that delays the opening of opening/closing contact S4 by a delay time t2 after the closing of opening/closing contact S3.

[0019] In the fuel switching device 1, when either of the opening/closing contacts S1 or S2 closes, drive current from the power supply 3 flows to solenoid 14, opening/closing valve 13 opens, and LPG flows into carburetor 19. When both opening/closing contacts S1 and S2 are open, drive current from the power supply 3 to solenoid 14 is cut off, the opening/closing valve 13 closes, and LPG can no longer flow into the carburetor 19.

[0020] When either of opening/closing contacts S3 or S4 closes, drive current from the power supply 3 flows to solenoid 18, and opening/closing valve 17 opens to allow gasoline to flow into the carburetor 19. When both opening/closing contacts S3 and S4 are open, the drive current from the power supply 3 to solenoid 18 is cut off, the opening/closing valve 17 closes, and gasoline no longer flows into the carburetor 19.

[0021] Opening/closing contacts S1 and S3 are normally open contacts that open when no drive current is flowing through the drive mechanisms 4, 5, and opening/closing contacts S2 and S4 are normally closed contacts that close when no current is flowing through the timer elements T1, T2. Timer elements T1 and T2 open opening/closing contacts S4 and S2, respectively, after delay times t1 and t2 have elapsed from the moment of activation.

[0022] Therefore, in the fuel switching device 1, when the selection switch 2 is switched to the LPG side, current flows to the drive mechanism 4 and timer element T1, and opening/closing contact S1 is closed via the drive mechanism 4. Then, after delay time t1 has elapsed from the

closing of opening/closing contact S1, opening/closing contact S4 is opened via timer element T1. Current also ceases to flow to the drive mechanism 5 and timer element T2, causing opening/closing contact S3 to open and opening/closing contact S2 to close.

[0023] When the selection switch 2 is switched to the gasoline side, current flows to the drive mechanism 5 and timer element T2, and opening/closing contact S3 is closed via the drive mechanism 5. At the same time, after delay time t2 has elapsed from the closing of opening/closing contact S3, opening/closing contact S2 is opened via timer element T2. Current also ceases to flow to the drive mechanism 4 and timer element T1, causing opening/closing contact S1 to open and opening/closing contact S4 to close.

[0024] Note that delay time t1 kept by timer element T1 is longer than the time required for LPG to flow from opening/closing valve 13 to nozzle 19a in the carburetor 19. Also, delay time t2 kept by timer element T2 is longer than the time required for gasoline to flow from opening/closing valve 17 to nozzle 19b in the carburetor 19.

[0025] In general, gasoline, which is a liquid fuel, has poorer fluidity than LPG, which is a gaseous fuel. Also, a float chamber (not shown) is provided upstream of nozzle 19b inside the carburetor 19. When LPG alone is supplied to the carburetor 19, the predetermined volume of gasoline filling the float chamber is drawn out through nozzle 19b by the negative pressure generated inside the carburetor 19. As a result, once opening/closing valve 17 is opened, gasoline is discharged from nozzle 19b only after the predetermined amount of gasoline fills the float chamber.

[0026] Therefore, the time required for gasoline to flow from opening/closing valve 17 to nozzle 19b in the carburetor 19 is longer than the time required for LPG to flow from opening/closing valve 13 to nozzle 19a in the carburetor 19, and delay time t2 is set to be longer than delay time t1. However, as described later, during delay times t1 and t2, both opening/closing valves 13 and 17 are open, and if delay times t1 and t2 are set too long, the time during which two types of fuel are supplied from the carburetor 19 to the engine 11 becomes longer, which may cause the engine 11 to malfunction. Therefore, delay times t1 and t2 should be set to be as short as possible within the range that satisfies the conditions set forth above.

[0027] In the configuration described above, as shown in the timing chart in FIG. 2, when the selection switch 2 is switched from the gasoline side to the LPG side, opening/closing contacts

S1 and S2 are closed at the same time, opening/closing contact S3 is opened, and after delay time t1 has elapsed, opening/closing contact S4 is opened. Therefore, during the period from the moment the selection switch 2 is switched to the LPG side until delay time t1 has elapsed, current flows through opening/closing contacts S1 and S2 to solenoid 14, causing opening/closing valve 13 to open, and current also flows through opening/closing contact S4 to solenoid 18, keeping opening/closing valve 17 open. As a result, gasoline is continuously supplied to the carburetor 19 during the period from when opening/closing valve 13 is opened until LPG reaches nozzle 19a, and the engine 11 does not stall due to an interruption of fuel supplied to the engine 11 during this time.

[0028] When the selection switch 2 is switched from the LPG side to the gasoline side, opening/closing contacts S3 and S4 are closed at the same time, opening/closing contact S1 is opened, and after delay time t2 has elapsed, opening/closing contact S2 is opened. Therefore, during the period from the time when the selection switch 2 is switched to the gasoline side until delay time t2 has elapsed, current flows through opening/closing contacts S3 and S4 to solenoid 18, causing opening/closing valve 17 to open, and current also flows through opening/closing contact S2 to solenoid 14, keeping opening/closing valve 13 open. As a result, LPG is continuously supplied to the carburetor 19 during the time from when the opening/closing valve 17 is opened until gasoline reaches nozzle 19b, and the engine 11 does not stall due to the interruption of fuel supplied to the engine 11 during this time.

[0029] Note that LPG, which is a gaseous fuel, has a relatively fast operating speed. For this reason, the time required for LPG to reach nozzle 19a from the moment opening/closing valve 13 is opened is relatively short, and if the fuel supplied to the engine 11 is interrupted during this time, the possibility of the engine 11 stalling is low. Therefore, if the rotational speed of the engine 11 is relatively high such that sufficient inertial force is generated, and if an excessive load is not applied to the engine 11, timer element T1 and opening/closing contact S4 can be omitted.

[0030] Also, the fuel switching device 1 is not limited to the configuration shown in FIG. 1 as long as opening/closing valve 13 remains open after the selection switch 2 is switched from the LPG side to the gasoline side and opening/closing valve 17 has opened until at least enough time required for gasoline to reach nozzle 19b in the carburetor 19 from the

opening/closing valve 17 has passed. For example, it may be configured from digital circuits that execute operations specified by software.

[0031] FIG. 3 is a block diagram of the fuel switching device in an embodiment of the invention described in claim 3. The fuel switching device 21 consists of a CPU 22 with ROM 23 and RAM 24, connected to solenoid drive circuits 25, 26, a selection switch 27, and an RPM sensor 28. Solenoid drive circuits 25, 26 drive solenoids 14 and 18, respectively, based on drive data outputted from the CPU 22. The configuration of the engine portion 10 is the same as that shown in FIG. 1.

[0032] The selection switch 27 receives the selection operation for LPG or gasoline as fuel for the engine 11 and inputs operation data to the CPU 22. The RPM sensor 28 corresponds to the rotation detecting unit in the invention according to claim 3. For example, it can be a tach generator that outputs a voltage corresponding to the RPM of the crankshaft of the engine 11, detects the RPM of the engine 11, and inputs the detection result as RPM data to the CPU 22. The CPU 22 controls each input/output device in an integrated manner according to a program stored in advance in the ROM 23, and stores data input/output during this time in a predetermined memory area in the RAM 24. Memory area MA1 in the RAM 24 is allocated to the timers that keep delay times t1 and t2.

[0033] FIG. 4 is a flowchart showing the processing steps performed by the fuel switching device. After the power is turned on, the CPU 22 waits for a switching operation by the selection switch 27 to LPG or gasoline (st1, st2), and when the selection switch 27 is operated from the gasoline side to the LPG side, it drives solenoid 14 (st3), reads RPM data N from the RPM sensor 28 (st4), and compares the read RPM data N with a preset reference RPM K (st5).

In this comparison, if the RPM data N is equal to or less than the reference RPM K, the CPU 22 stops driving the solenoid 18 after a timer allocated in memory area MA1 of the RAM 24 has reached a preset delay time t1 (st6, st7), and if the RPM data N is greater than the reference RPM K, immediately stops driving the solenoid (st8).

[0034] During the processing in st3 to st8, when the engine 11 fuel is switched from gasoline to LPG while the engine 11 is running at a low RPM below the reference RPM K, opening/closing valve 17 can be opened during delay time t1 to continuously supply gasoline to the carburetor 19, which ensures that the engine 11 does not

stall due to interruption of the fuel supply during the period after opening/closing valve 13 is opened and before LPG reaches nozzle 19a. When the engine 11 is running at a high RPM exceeding reference RPM K, the opening/closing valve 17 is closed immediately after opening/closing valve 13 is opened, so that the engine 11 will not malfunction due to the supply of two types of fuel.

[0035] When the selection switch 27 is operated from the LPG side to the gasoline side, the CPU 22 drives solenoid 18 (st9), reads RPM data N from the RPM sensor 28 (st10), and compares the read RPM data N with the preset reference RPM K (st11). In this comparison, if the RPM data N is equal to or less than the reference RPM K, driving of the solenoid 14 is stopped after the timer has reached a preset delay time t2 (st12, st13), and if the RPM data N is greater than the reference RPM K, driving of the solenoid is immediately stopped (st14).

[0036] During the processing performed in st9 to st14, when the engine 11 is running at low RPM below the reference RPM K and the engine 11 fuel is switched from LPG to gasoline, opening/closing valve 13 is opened to continuously supply LPG to the carburetor 19 during delay time t2, and the engine 11 can be reliably kept from stalling due to interruption of the fuel supply during the period between opening the opening/closing valve 17 and the gasoline reaching the nozzle 19b. When the engine 11 is running at a high RPM exceeding the reference RPM K, opening/closing valve 13 is closed immediately after opening/closing valve 17 is opened, so that the engine 11 does not malfunction due to the supply of two types of fuel.

[0037] Given the relatively short time required for LPG, a gaseous fuel with a relatively fast operating speed, to reach the nozzle 19a from the time that opening/closing valve 13 is opened, the processing in steps s4 to s7 can be omitted, provided no excessive load is applied to the engine 11.

[0038] The fuel switching device 21 is not limited to the configuration shown in FIG. 3 as long as opening/closing valve 13 remains open from the period after the selection switch 27 is switched from the LPG side to the gasoline side and opening/closing valve 17 is opened until gasoline reaches nozzle 19b of the carburetor 19 from opening/closing valve 17 at least when the engine 11 is operating at a low RPM. For example, it can be configured using analog circuits.

[0039] FIG. 5 is a block diagram showing the configuration of a fuel switching device

according to an embodiment of the present invention according to claim 4. The fuel switching device 31 consists of a CPU 32 with ROM 33 and RAM 34, connected to solenoid drive circuits 25, 26, a selection switch 27, and a load sensor 38. The solenoid drive circuits 25, 26, selection switch 27, and engine portion 10 are identical to the configuration shown in FIG. 3.

[0040] The load sensor 38 corresponds to the load detecting unit of the invention according to claim 4. For example, it can be a torque sensor that detects mechanical strain generated in the crankshaft by the magnetostrictive effect, detects the load acting on the engine 11, and inputs the detected results as load data to the CPU 32. The CPU 32 controls each input/output device in an integrated manner according to a program stored in advance in the ROM 33, and stores the data input/output during the processing in a predetermined memory area in the RAM 34. Memory area MA1 of the RAM 34 is allocated to timers that keep delay times t1 and t2.

[0041] FIG. 6 is a flowchart showing the processing steps performed by this fuel switching system. After power is turned on, the CPU 32 waits for a switching operation by the selection switch 27 to LPG or gasoline (st21, st22), and when the selection switch 27 is switched from the gasoline side to the LPG side, it drives solenoid 14 (st23), reads the load data L from the load sensor 38 (st24), and compares the read load data L with a preset reference load value M (st25).

In this comparison, if the load data L is greater than a reference load value M, the CPU 32 stops driving the solenoid 18 after a timer allocated in memory area MA1 of the RAM 34 has reached a preset delay time t1 (st26, st27), and if the load data L is equal to or less than the reference load value M, immediately stops driving the solenoid (st28).

[0042] The processing in steps s23 to s28 ensures that when the fuel of the engine 11 is switched from gasoline to LPG under a high load when the load acting on the engine 11 exceeds the reference load value M, gasoline is continuously supplied to the carburetor 19 by opening opening/closing valve 17 during delay time t1, and the engine 11 can be reliably kept from stalling due to interruption of the fuel supply during the period between the opening of opening/closing valve 13 and LPG reaching nozzle 19a. When the load acting on the engine 11 is lower than the reference load value M, opening/closing valve 17 is closed immediately after opening/closing valve 13 opens, so that

the engine 11 does not malfunction due to the supply of two types of fuel.

[0043] When the selection switch 27 is switched from the LPG side to the gasoline side, the CPU 32 drives solenoid 18 (st29), reads the load data L from the load sensor 38 (st30), and compares the read load data L with the preset reference load value M (st31).

In this comparison, if the load data L is greater than a reference load value M, the CPU 32 stops driving the solenoid 18 after the timer has reached a preset delay time t2 (st32, st33), and if the load data L is equal to or less than the reference load value M, immediately stops driving the solenoid (st34).

[0044] During the processing performed in st29 to st34, under high load conditions when the load acting on the engine 11 exceeds the reference load value M and the engine 11 fuel is switched from LPG to gasoline, opening/closing valve 13 is opened to continuously supply LPG to the carburetor 19 during delay time t2, and the engine 11 can be reliably kept from stalling due to interruption of the fuel supply during the period between opening the opening/closing valve 17 and the gasoline reaching the nozzle 19b. Under low load conditions when the load acting on the engine 11 is less than the reference load value M, opening/closing valve 13 is closed immediately after opening/closing valve 17 is opened, so that the engine 11 does not malfunction due to the supply of two types of fuel.

[0045] Given the relatively short time required for LPG, a gaseous fuel with a relatively fast operating speed, to reach the nozzle 19a from the time that opening/closing valve 13 is opened, the processing in steps st24 to st27 can be omitted, provided the engine 11 is running at high speed.

[0046] The fuel switching device 1 is not limited to the configuration shown in FIG. 3 as long as opening/closing valve 13 remains open from the period after the selection switch 27 is switched from the LPG side to the gasoline side and opening/closing valve 17 is opened until gasoline reaches nozzle 19b of the carburetor 19 from opening/closing valve 17 at least when the engine 11 is operating under a high load. For example, it can be configured using analog circuits.

[0047] Also, based on the detection of both the RPM and load of the engine 11, opening/closing valve 13 may remain open only at a low RPM and high load for the engine 11, or at either a low RPM or high load for the engine 11 at least after the selection switch 27 is switched from LPG to gasoline and opening/closing valve 17 is opened until the time required for gasoline to

reach nozzle 19b of the carburetor 19 from the opening/closing valve 17 has been reached.

[0048]

[Effects of the Invention] In the invention according to claim 1, the supply of fuel to the engine is not interrupted during fuel switching, and the engine can be reliably kept from stalling even when the engine speed is low or a large load is acting on the engine by continuing to supply gaseous fuel to the engine for a predetermined time when switching from gaseous fuel to liquid fuel.

[0049] In the invention according to claim 2, gaseous fuel continues to be supplied to the carburetor for a predetermined time during a fuel changeover, the fuel supply from the carburetor to the engine is not interrupted during the period from the opening/closing valve being opened to the liquid fuel reaching the carburetor, and the engine is reliably kept from stalling when the engine speed is low or a large load is acting on the engine by opening the opening/closing valves for the gaseous and liquid fuel valves in the carburetor for a predetermined period of time, at least when switching the fuel supplied to the engine from gaseous fuel to liquid fuel.

[0050] In the invention according to claim 3, gaseous fuel continues to be supplied to the carburetor for a predetermined time during a fuel changeover, the fuel supply from the carburetor to the engine is not interrupted during the period from the opening/closing valve being opened to the liquid fuel reaching the carburetor, and the engine is reliably kept from stalling when the inertial force generated in the engine is low due to a low engine speed by opening the opening/closing valves for the gaseous and liquid fuel valves in the carburetor for a predetermined period of time, at least when switching the fuel supplied to the engine from gaseous fuel to liquid fuel while the engine speed is low.

[0051] In the invention according to claim 4, gaseous fuel continues to be supplied to the carburetor for a predetermined time during a fuel changeover, the fuel supply from the carburetor to the engine is not interrupted during the period from the opening/closing valve being opened to the liquid fuel reaching the carburetor, and the engine is reliably kept from stalling when the inertial force generated by the engine is low compared to the load acting on the engine by opening the opening/closing valves for the gaseous and liquid fuel valves in the carburetor for a predetermined period of time, at least when switching the fuel supplied to the engine from gaseous fuel to liquid fuel while a high load is acting on the engine.

[Brief Description of the Drawings]

[FIG. 1] FIG. 1 is a schematic diagram showing the configuration of an engine provided with a fuel switching device according to an embodiment of the present invention according to claim 2.

[FIG. 2] FIG. 2 is a timing chart for the fuel switching device.

[FIG. 3] FIG. 3 is a block diagram showing the configuration of a fuel switching device according to an embodiment of the present invention according to claim 3.

[FIG. 4] FIG. 4 is a flowchart showing processing steps performed by the fuel switching device.

[FIG. 5] FIG. 5 is a block diagram showing the configuration of a fuel switching device

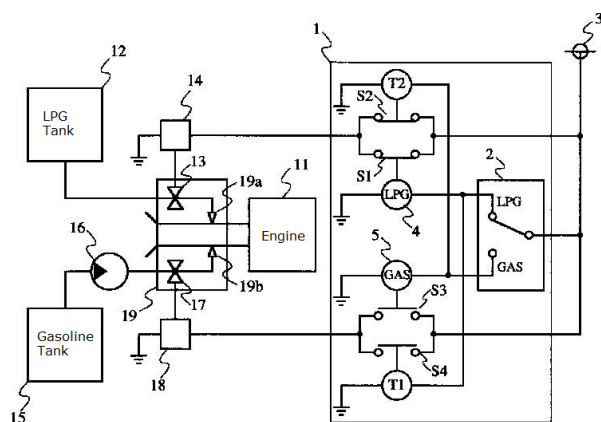
according to an embodiment of the present invention according to claim 4.

[FIG. 6] FIG. 6 is a flowchart showing processing steps performed by the fuel switching device.

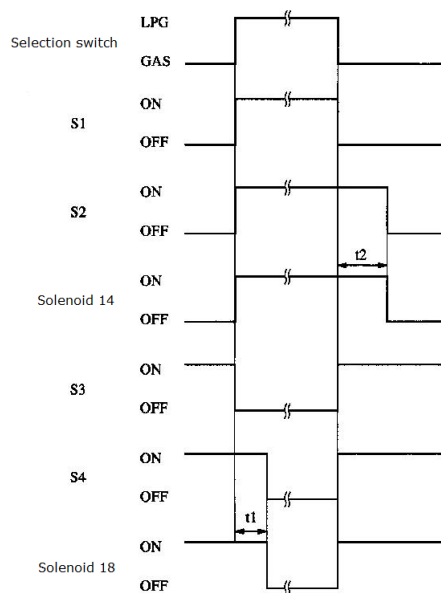
[Reference Numbers]

- 1: Fuel switching device
- 2: Selection switch
- 3: Power supply
- 4, 5: Drive mechanism
- 11: Engine
- 12: LPG tank
- 13, 17: Opening/closing valve
- 14, 18: Solenoid
- 15: Gasoline tank
- 16: Fuel pump
- 19: Carburetor
- 19a, 19b: Nozzle

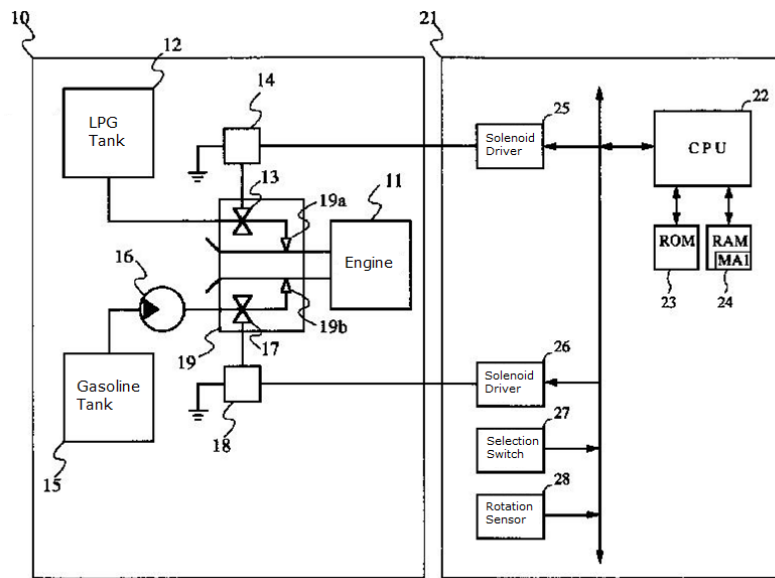
[FIG. 1]



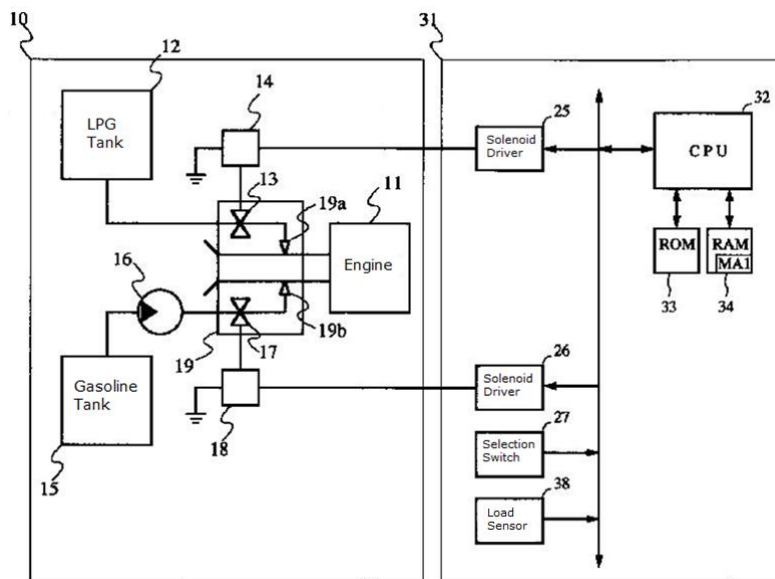
[FIG. 2]



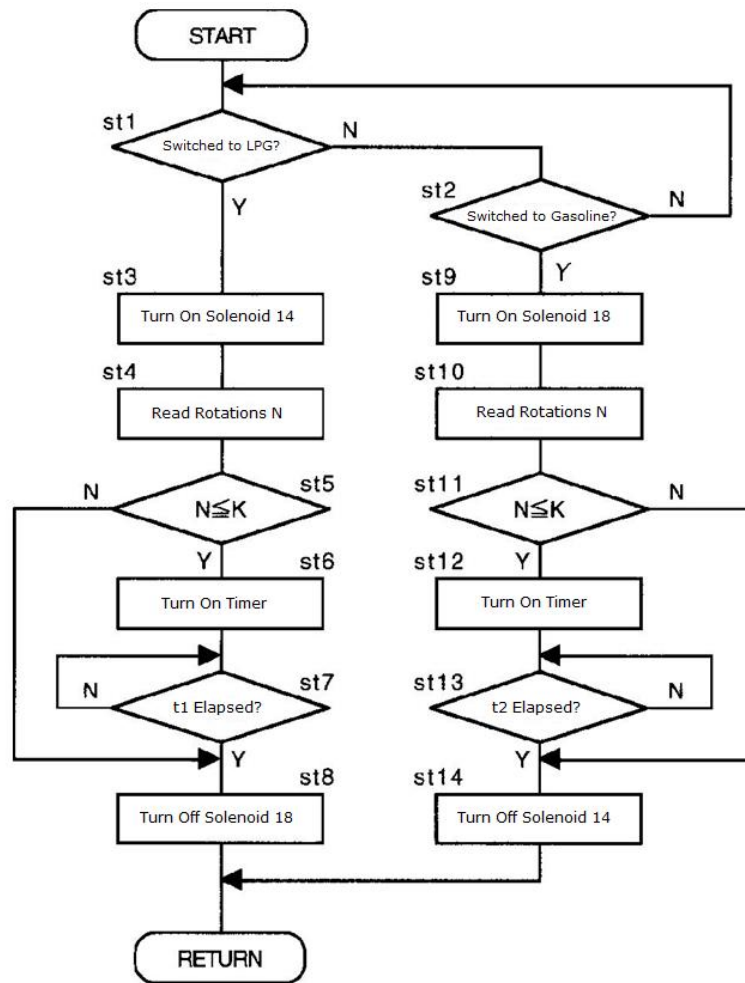
[FIG. 3]



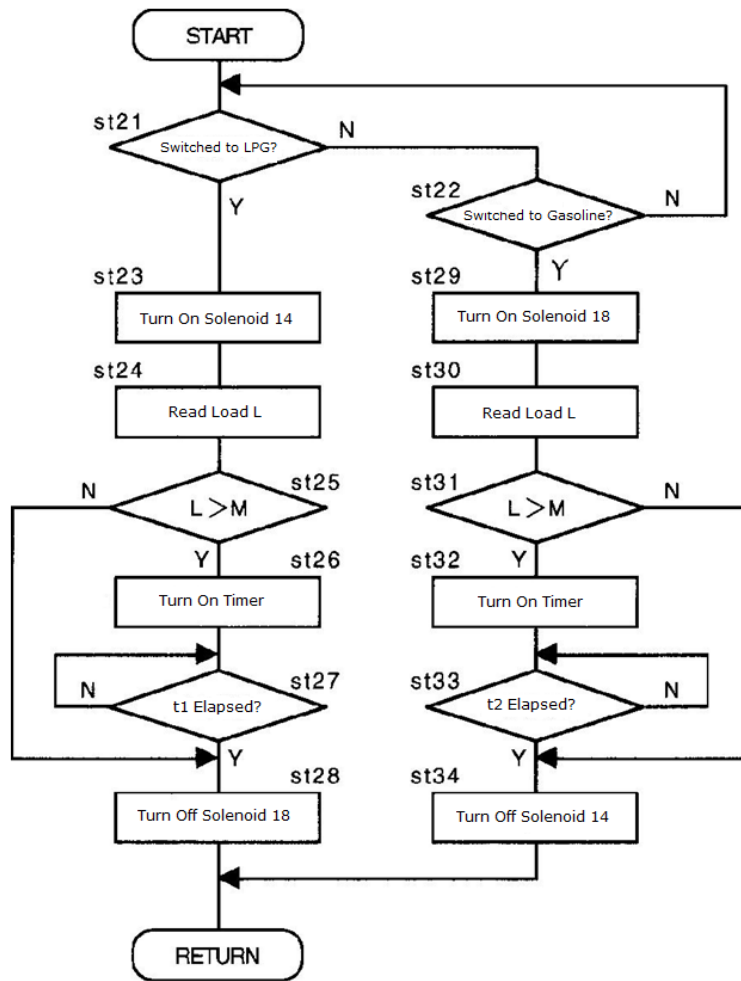
[FIG. 5]



[FIG. 4]



[FIG. 6]



I, Frank McGee, declare that I am a translator fluent in the Japanese and English languages.

I translated the document listed below (a copy of which is attached) from Japanese to English.

The document is designated as:

- JPH1182083A

My translation of the document in English is attached and is, to the best of my knowledge and belief, a true and correct English translation of the document in a form that best reflects the intention and meaning of the original text.

I, the undersigned, declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like are punishable by fine, imprisonment, or both, under 18 U.S.C. § 1001.

I, the undersigned, further declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

A handwritten signature in blue ink, appearing to read 'Frank McGee', is written over a horizontal line.

Frank McGee

Executed on: June 4, 2025