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(71) Applicant: **SANYO Electric Techno Create Co., Ltd.**
Moriguchi-shi
Osaka
570-8677 (JP)

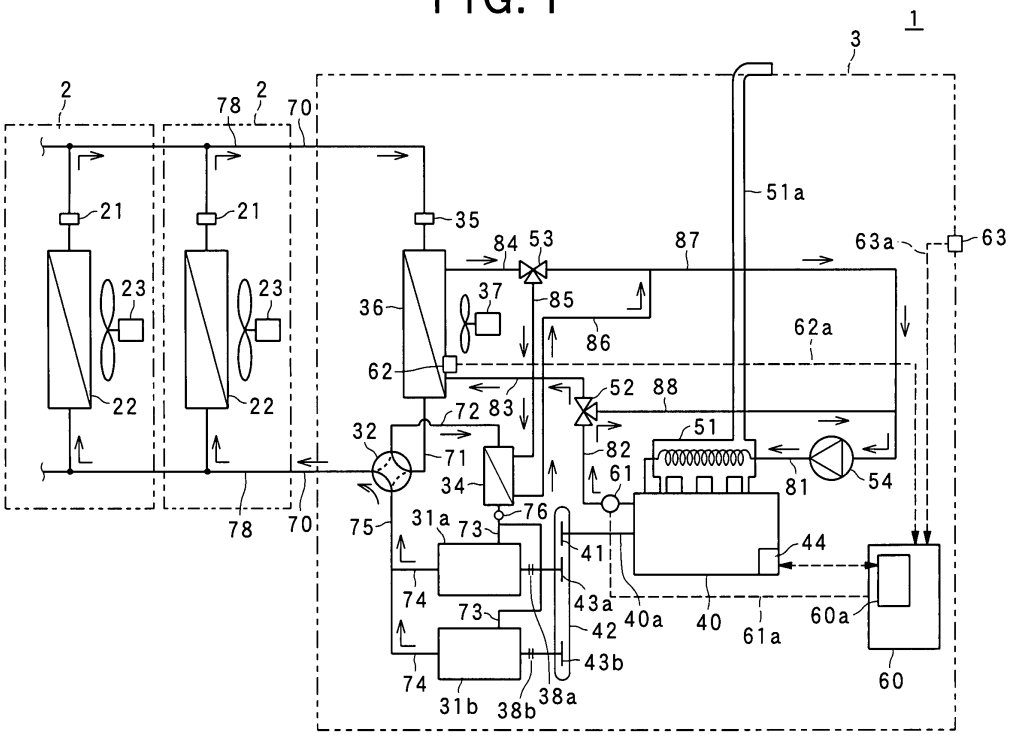
(72) Inventor: **Nakajima, Katsunori**
Ora-gun
Gunma 370-0535 (JP)

(74) Representative: **Glawe, Delfs, Moll**
Patentanwälte
Postfach 26 01 62
80058 München (DE)

(54) **Air conditioner and method of controlling the same**

(57) An air conditioner (1) comprising at least one compressor (31a, 31b) driven by an engine (40)including at least clutch (38a, 38b) which is coupled to the engine so that the clutch can be connected to and disconnected from the engine, a fuel shut-off valve (95) for interrupting fuel supply to the engine, and a controller (60a) for actuating the clutches to disconnect the compressor from the engine under the state that the compressor is driven by the engine when a signal for instructing stop of the engine is input, and then actuating the fuel shut-off valve to interrupt fuel supply to the engine.

FIG. 1



EP 2 000 755 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an air conditioner, and particularly to an air conditioner for driving a compressor by an engine to perform air conditioning operation and a method of controlling the air conditioner.

2. Description of the Related Art

[0002] There is known a gas heat pump type air conditioner for driving fuel such as natural gas or the like by an engine to perform air conditioning operation such as cooling operation, heating operation, etc. An air conditioner in which an engine can be coupled to a compressor through a clutch so as to be connected to and disconnected (separated) from the compressor is known as one of this type of gas heat pump type air conditioners (for example, see JP-A-2001-263765).

[0003] When the engine is stopped in connection with stop of the operation of the air conditioner, fuel supply to the engine is stopped to stop the engine under the state that the engine is kept to be connected to the compressor through the clutch. However, if the engine is stopped by the above method under the state that a load is applied to the compressor, the engine may be suddenly stopped together with the compressor by the load imposed on the compressor, so that large sound or vibration occurs.

SUMMARY OF THE INVENTION

[0004] The present invention has been implemented in view of the foregoing description, and has an object to suppress occurrence of sound and vibration when a compressor and an engine are stopped in an air condition in which the compressor is driven by the engine to perform air conditioning operation.

[0005] In order to attain the above object, according to a first aspect of the present invention, an air conditioner (1) comprising at least one compressor (31a, 31b)) driven by an engine (40) is characterized by comprising at least clutch (38a, 38b) which is coupled to the engine so that the clutch can be connected to and disconnected from the engine, a fuel shut-off valve (95) for interrupting fuel supply to the engine, and a controller (60a) for actuating the clutches to disconnect the compressor from the engine under the state that the compressor is driven by the engine when a signal for instructing stop of the engine is input, and then actuating the fuel shut-off valve to interrupt fuel supply to the engine.

[0006] According to this construction, when the signal for instructing the stop of the compressor is input, the compressor is disconnected from the compressor, and then the fuel supply to the engine is interrupted. Therefore, the engine is stopped under the state that the connection between the engine and the compressor is released. Accordingly, the fuel supply to the engine is interrupted and thus the engine is naturally stopped without being affected by the load of the compressor, and also the compressor is quickly stopped by the compression load of the refrigerant.

[0007] Accordingly, the engine is not suddenly stopped together with the compressor, and thus the sound and vibration at the stop time of the engine can be suppressed. Furthermore, since the sudden stop of the engine is prevented, the lifetime and reliability of the refrigerant pipe and the incidental parts of the engine can be enhanced, and it is unnecessary to provide any part for countermeasure to vibration, so that the number of parts can be reduced.

[0008] In the above construction, it is preferable that the controller detects the load of the engine when a signal for instructing stop of the compressor is input, and changes a time period from the time when the compressor is disconnected from the engine by the clutch till the time when fuel supply to the engine is interrupted by the fuel shut-off valve.

[0009] In this case, the time period from the disconnection of the compressor from the engine till the interruption of the fuel supply to the engine is varied in accordance with the load of the engine when the signal for instructing the stop of the compressor is input, whereby the operation time of the engine from the time when the load of the compressor on the engine is nullified can be adjusted in accordance with the load of the engine.

[0010] In the air conditioner described above, when the compressor and the engine are disconnected from each other by the clutch under the state that a large load is imposed on the compressor, the engine is suddenly released from the large load. When fuel supply to the engine is continued even after the engine is released from the large load, the rotational number of the engine increases rapidly in connection with the sudden decrease of the load, so that so-called blow-up (excessively rising) occurs. When the rotational number of the engine excessively increases due to the blow-up, influence on durability of the engine, occurrence of sound noise, etc. are concerned. According to this construction, the time from the release of the load by the clutch till the fuel shut-off is varied in accordance with the load of the engine, whereby the time period from the disconnection of the compressor from the engine till the fuel shut-off can be shortened to prevent so-called blow-up (excessive rising) when the load of the engine is high is high, for example. Accordingly, the rapid variation of the rotational number of the engine at the stop time of the engine can be avoided, whereby the durability and reliability of the respective parts containing the engine can be secured and also occurrence of excessive noise can be prevented.

[0011] In the above construction, it is preferable that the controller detects the load of the engine on the basis of the rotational number of the engine when the signal for instructing the stop of the compressor is input. Fur-

thermore, in the above construction, it is preferable that the air conditioner is provided with a pressure sensor for detecting the pressure at the suction side of the compressor, and the controller detects the load of the engine on the basis of the detection value of the pressure sensor.

[0012] In the above construction, it is preferable that the controller controls the fuel shut-off valve to interrupt the fuel supply to the engine within a predetermined time after the compressor is disconnected from the engine by the clutch.

[0013] In this case, when the signal for instructing the stop of the compressor is input, the time period from the disconnection between the compressor and the engine till the interruption of the fuel supply to the engine corresponds to the predetermined time or less. Accordingly, by setting as the predetermined time the time which is determined by experiments or the like in advance, the controller is not required to perform the calculation processing, detect the load, etc. when the engine is stopped, and thus the engine can be quickly stopped. Furthermore, it is unnecessary to provide a processor for detect the load, etc.

[0014] Here, the predetermined time is set to such a value that the engine rotational number falls within a predetermined range when the compressor is disconnected from the engine under the state that the load of the engine is highest within a rated operation range, for example. That is, the fuel supply to the engine is interrupted by the fuel shut-off valve within this time, whereby the excessive increase of the rotational number of the engine occurring after the clutch is released can be avoided.

[0015] As described above, the excessive increase of the engine rotational number can be surely avoided by the simplified operation and construction, so that the durability and reliability of the respective parts containing the engine can be enhanced and occurrence of excessive noise can be prevented.

[0016] Furthermore, according to a second aspect of the present invention, a method for controlling an air conditioner including an compressor driven by an engine, a clutch through which the compressor can be connected to and disconnected from the engine, and a fuel shut-off valve for interrupting fuel supply to the engine is characterized in that the clutch is operated to disconnect the compressor from the engine when a signal for instructing stop of the compressor and the engine is input under the state that the compressor is driven by the engine, and then the fuel shut-off valve is operated to interrupt fuel supply to the engine.

[0017] According to this method, when the signal for instructing the stop of the compressor is input, the compressor is disconnected from the engine, and then the fuel supply to the engine is interrupted, whereby the engine is stopped under the state that the connection between the engine and the compressor is released. Accordingly, the fuel supply to the engine is stopped and thus the engine is naturally stopped without being affected by the load of the compressor. Furthermore, the compressor is quickly stopped by the load for compressing the refrigerant. Accordingly, the engine is not suddenly stopped together with the compressor, and thus the sound and vibration at the stop time of the engine are suppressed, so that the lifetime and reliability of the refrigerant pipe and the engine incidental parts can be enhanced. In addition, a part for taking countermeasure to vibration are not required, and thus the number of parts can be reduced.

[0018] According to the present invention, in the air conditioner in which the compressor is driven by the engine to perform the air conditioning operation, sound (noise) and vibration occurring when the compressor and the engine are stopped can be suppressed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 is a diagram showing a refrigerant circuit and a cooling water circuit of an air conditioner according to an embodiment to which the present invention is applied;

Fig. 2 is a diagram showing the construction of the surrounding of an engine provided to the air conditioner according to the embodiment;

Fig. 3 is a flowchart showing the processing when the engine according to the embodiment is stopped; and

Fig. 4 is a flowchart showing the processing when an engine as another example of the embodiment is stopped.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] An embodiment according to the present invention will be described hereunder with reference to the drawings.

[0021] Fig. 1 shows the construction of an air conditioner 1 according to an embodiment.

[0022] The air conditioner 1 shown in Fig. 1 is a gas heat pump type air conditioner in which compressors 31a, 31b are driven by an engine 40 using fuel gas as fuel, and it comprises plural indoor units 2 and one outdoor unit 3.

[0023] The indoor unit 2 is equipped with an indoor heat exchanger 22, an air blower 23 for blowing the indoor heat exchanger 22, etc. to perform cool and heat a room to be air-conditioned.

[0024] The outdoor unit 3 comprises compressors 31a, 31b, an electromagnetic type four-way valve 32, a plate heat exchanger 34, an outdoor heat exchanger 36, an air blower 37 for blowing air to the outdoor heat exchanger 36, etc. The two compressors 31a, 31b equipped to the outdoor unit 3 are coupled to an engine 40 through electromagnetic type clutches 38a, 38b respectively so that the compressors 31a, 31b can be connected to and

disconnected from the engine 40. The compressors 31a and 31b are preferably designed to be different from each other in capacity. In this case, the compressors 31a, 31b which are different in capacity can be independently connected to the engine 40 through the clutches 38a, 38b. Therefore, a compressor having a proper processing capacity can be selected and operated in accordance with an air-conditioning load, so that COP (Coefficient of Performance) of the air conditioner 1 can be enhanced.

[0025] The indoor heat exchanger 22, the compressors 31a, 31b, the four-way valve 32, the plate heat exchanger 34, the outdoor heat exchanger 36, etc. constitute the refrigerant circuit of the air conditioner 1, and the indoor unit 2 and the outdoor unit 3 are connected to each other through a refrigerant pipe 70.

[0026] The outdoor unit 3 is equipped with not only the respective parts constituting the refrigerant circuit described above, but also the engine 40 for driving the compressors 31a, 31b, an exhaust gas heat exchanger 51 for heat-exchanging cooling water of the engine 40 with exhaust gas, a thermostat 52, an electrically-driven three-way valve 53, an electrically-driven cooling water pump 54, etc., and a cooling water circuit is constructed by these parts. An exhaust pipe 51a is connected to an exhaust gas heat exchanger 51 through a drain filter (not shown), and a cooling water tank (not shown) is connected to the cooling water pump 54 through a pipe (not shown).

[0027] The outdoor unit 3 has a central controller 60 for controlling the operation of the four-way valve 32, the three-way valve 53, the air blower 37, etc. through control lines (not shown). The central controller 60 has CPU (not shown), an input/output interface, ROM, RAM, a timer counter, etc., and has an engine controller 60a for controlling the actuation and stop of the engine 40, the connection state between the engine 40 and the compressor 31a, 31b through the clutch 38a, 38b, etc.

[0028] To the input/output interface of the central controller 60 are connected a water temperature sensor 61 which is provided in a cooling water pipe 82 between the engine 40 and the thermostat 52 and detects the temperature of the cooling water of the engine 40, a heat exchange temperature sensor 62 which is secured to the outdoor heat exchanger 36 and detects the surface temperature of a radiation fin (not shown) of the outdoor heat exchanger 36, an outdoor temperature sensor 63 secured to the outer wall surface of the outdoor unit 3, a rotational number sensor 44 for detecting the rotational number of the engine 40, a pressure sensor 76 for detecting the pressure at the suction side of the compressor 31a, 31b, etc.

[0029] Furthermore, the central controller 60 is connected to a control unit (not shown) at the indoor unit 2 side, and mutually transmits/receives signals to/from the control unit to switch the four-way valve 32, the three-way valve 53, etc. so that air conditioning operation set by the control unit, etc. is performed, and also control the respective parts of the air conditioner 1 so that the temperature in each room is set to an air-conditioning set temperature.

[0030] When the central controller 60 judges that it is necessary to drive the compressor 31, for example when the indoor temperature does not reach an air-conditioning set temperature or the like, a thermo-on signal, that is, a compressor driving start signal is input from the central controller 60. Here, the central controller 60 selects any one or both of the compressors 31a and 31b to obtain the proper processing capacity corresponding to the air-conditioning load, and outputs to the engine controller 60a an instruction control signal for driving the selected compressor. The engine controller 60a transmits a control signal to the engine 40 according to an input control signal to drive start STR and start the engine 40. Furthermore, the engine controller 60a supplies a control signal and driving current to a clutch which is selected from the clutches 38a, 38b by the central controller 60 and coupled to the compressor, thereby driving the selected clutch, and switches electromagnet to ON, whereby the driving force of the engine 40 is transmitted to the compressor selected from the compressors 31a, 31b.

[0031] When the central controller 60 judges that it is necessary to stop the driving of the compressor 31, for example, when the indoor temperature exceeds the air-conditioning set temperature or the like, a thermo-off signal, that is, a compressor stop instruction signal is input to the engine controller 60a. When the compressor stop instruction signal is input from the central controller 60, in order to stop the compressor under operation, the engine controller 60a stops supply of driving current to the clutch out of the clutches 38a, 38b which is being connected to the engine 40, thereby separating the clutch from the engine 40. Accordingly, the compressors 31a, 31b are stopped while maintaining the driving of the engine 40. Furthermore, by driving the clutches 38a, 38b, the engine controller 60a can stop only one of the compressors 31a and 31b when both the compressors 31a and 31b are operated.

[0032] Furthermore, the compressor stop instruction signal is also input from the central controller 60 to the engine controller 60a when the air-conditioning operation is stopped. The compressor stop instruction signal output from the central controller 60 is a signal for stopping all the compressor and the engine 40 under operation. When this compressor stop instruction signal is input, the engine controller 60a executes the processing of stopping the engine 40 together with the compressors 31a and 31b under operation. This processing will be described later.

[0033] When heating operation is started in the thus-constructed air conditioner 1, refrigerant flowing from the refrigerant pipe 70 to the outdoor unit 3 side is passed through an expansion valve 35 of the outdoor unit 3 into the outdoor heat exchanger 36. The refrigerant is evaporated in the outdoor heat exchanger 36, and flows through a refrigerant pipe 71, the four-way valve 32 and a refrigerant pipe 72 into the plate heat exchanger 34. In

the plate heat exchanger 34, the refrigerant is heated by cooling water and reaches the suction-side pipes of the compressors 31a, 31b. The plate heat exchanger 34 is a double-pipe heat exchanger in which cooling water passes around the refrigerant pipe, and the outdoor heat exchanger 36 is designed so that the refrigerant pipe and a cooling water pipe are connected to each other through a plate fin. High-temperature refrigerant discharged from the compressors 31a, 31b flows into the indoor heat exchanger 22 at the indoor unit 2 side through the refrigerant pipe 74, the four-way valve 32 and the refrigerant pipe 70 to be heat-exchanged with indoor air blown from the air blower 23 to heat the indoor air, and then flows from the refrigerant pipe 70 to the outdoor unit 3 side again.

[0034] On the other hand, when cooling operation is started in the air conditioner 1, the refrigerant discharged from the compressors 31a, 31b is passed from the refrigerant pipe 74 through the four-way valve 32 to the refrigerant pipe 71, and then flows into the outdoor heat exchanger 36 to be condensed. The condensed liquid refrigerant is passed through the refrigerant pipe 70 and an expansion valve 21 and flows into the indoor heat exchanger 22 at the indoor unit 2 side. The refrigerant which is expanded by the expansion valve 21 is vaporized in the indoor heat exchanger 22 and heat-exchanged with indoor air blown out from the air blower 23 to cool the indoor air, and then flows from the refrigerant pipe 70 to the outdoor unit 3 side again. The refrigerant flowing to the outdoor unit 3 passes through the four-way valve 32, the refrigerant pipe 72 and the refrigerant pipe 73 and reaches the suction side pipes of the compressors 31a and 31b.

[0035] Furthermore, under heating operation, the refrigerant flowing in the refrigerant circuit is heat-exchanged with the cooling water of the engine 40. That is, the cooling water discharged from the cooling water pump 54 passes through the cooling water pipe 81 and flows through the cooling water pipe 81 into the exhaust gas heat exchanger 51 to be heat-exchanged with exhaust gas, and then flows into the cooling water passage of the engine 40. The cooling water which cools the engine 40 and thus increases in temperature passes through the cooling water pipe 82, the thermostat 52,m the cooling water pipe 83 and the outdoor heat-exchanger 36, then passes through the cooling water pipe 84, the three-way valve 53 and the cooling water pipe 85, and then flows into the plate heat exchanger 34. In the plate heat exchanger 34, the cooling water and the refrigerant are heat-exchanged with each other, and the refrigerant is heated by the heat of the cooling water. Thereafter, the cooling water is passed through the cooling water pipe 86 and the cooling water pipe 87, and circulated to the cooling water pump 54 again.

[0036] Furthermore, under the state that the temperature of the cooling water is low, for example, just after the engine 40 is started or the like, the cooling water is fed to a bypass pipe 88 by the thermostat 52, and it is circulated through the bypass pipe 88 until the temperature increases to a proper temperature.

[0037] Subsequently, the construction of the surrounding of the engine 40 will be described with reference to Fig. 2.

[0038] As described above, the engine 40 is coupled to the compressors 31a, 31b through the electromagnetic clutches 38a, 38b so as to be freely connected to and disconnected from the compressors 31a, 31b respectively, and the driving force of the engine 40 is transmitted to the compressors 31a, 31b. The compressors 31a, 31b driven by the engine 40 compress the refrigerant to perform various kinds of air-conditioning operation such as heating operation, cooling operation, etc.

[0039] A pulley 41 is secured to the output shaft 40a of the engine 40, and a belt 42 is suspended among the pulley 41 and pulleys 43a, 43b. The pulleys 43a, 43b are respectively joined to the input shafts 310a, 310b of the compressors 31a, 31b through the clutches 38a, 38b, and the driving force of the engine 40 is transmitted to the input shafts 310a, 310b of the compressors 31a, 31b through the clutches 38a, 38b.

[0040] The engine 40 is a gas engine which is operated by using gas as fuel. High-pressure fuel gas supplied from a gas line is passed through fuel shut-off valves 95 and supplied to a zero governor (pressure governor) 96 The pressure of the high-pressure gas is adjusted to ambient pressure by the zero governor 96, and the thus-adjusted high-pressure gas is supplied to the fuel adjusting valve 93. The fuel adjusting valve 93 adjusts the amount of fuel supplied to the engine 40 under the control of the engine controller 60a. The fuel gas which has been adjusted by the fuel adjusting valve 93 is passed through an air cleaner 97, mixed with air taken from the outside, and then supplied to a throttle adjusting valve 94. The throttle adjusting valve 94 controls the amount of air-fuel mixture (mixing gas of fuel and air (fed into the engine 40. The air-fuel mixture passed through the throttle adjusting valve 94 is passed through the fuel supply pipe 91 and then supplied to the engine 40. The fuel shut-off valves 95 (i.e., the two fuel shut-off valves 95) are arranged in a series-connection style, and these two valves are operated simultaneously with each other. As described later, when a control signal for instructing fuel shut-off is input from the engine controller 60a, fuel from the gas line is immediately shut off.

[0041] In the air conditioner 1, when the engine 40 is stopped, the engine controller 60a drives the clutches 39a, 39b and the fuel shut-off valve 95 upon reception of a compressor stop instruction signal from the central controller 60. Here, both the clutches 38a, 38b are disconnected from the engine 40 at the timing of stopping the engine 40, and when they are not connected to the engine 40, the engine controller 60a transmits a control signal to the fuel shut-off valve 95 so that the fuel supply is interrupted by the fuel shut-off valve 95.

[0042] Furthermore, when at least one of the clutches 38a and 38b is connected to the engine 40 at the timing

of stopping the engine 40, the engine controller 60a drives the clutches 38a and 38b so that the clutches 38a, 38b are disconnected from the engine 40, and then transmits a control signal to the fuel shut-off valve 95 so that the fuel supply is intercepted by the fuel shut-off valve 95.

[0043] Conventionally, the engine 40 is stopped by intercepting the fuel supply to the engine 40 under the state that the loads of the compressors 31a and 31b are imposed on the engine 40 Under this state, the engine 40 is stopped together with the compressors 31a and 31b by the loads of the compressors 31a and 31b. As a result, the engine 40 is suddenly stopped, and sound and vibration occur in connection with the sudden stop.

[0044] However, if the clutches 38a and 38b are driven at the stop time of the engine 40 to disconnect the compressors 31a, 31b from the engine 40 and then the fuel shut-off valve 95 is operated to intercept the fuel supply to the engine 40, both the engine 40 and the compressors 31a, 31b are naturally stopped at the stop time of the engine 40, so that the engine 40 can be prevented from suddenly stopping and thus sound and vibration are greatly suppressed. Furthermore, according to the air conditioner 1 of this embodiment, the time period from the disconnection of the clutches 38a and 38b by the engine controller 60a till the interruption of the fuel supply by the fuel shut-off valve 95 can be varied in accordance with the load of the engine 40. Here, the load of the engine 40 is detected by an engine rotational number sensor 44 and a pressure sensor 76 at the suction side of the compressor.

[0045] The processing at the stop time of the engine will be described hereunder in detail. L

[0046] Fig. 3 is a flowchart showing the processing at the stop time of the engine.

[0047] First, the engine controller 60a waits until a stop instruction signal (thermo-off signal) for the compressors 31a and 31b is input (step S1: No). When the stop instruction signal is input (step s1: Yes), the engine controller 60a checks whether any one or both of the clutches 38a and 38b are connected to the engine 40 (step S2).

[0048] Here, if any one or both of the clutches 38a and 38b is connected to the engine 40 (step S2: Yes), the engine controller 60a refers to the detection values of the engine rotational number sensor 44 and the pressure sensor 76 (step S3).

[0049] Furthermore, the engine controller 60a determines the value corresponding to the load of the engine 40 on the basis of the detection values referred to in step S3, and determines an operation timing A of the fuel shut-off valve 95 on the basis of the value concerned (step S4). This operation timing A is the time from the disconnection of the clutches 38a, 38b till the interruption of fuel by the fuel shut-off valve 95. The engine controller 60a calculates the operation timing A by a predetermined calculation equation as shown in the following equation (1), for example.

[0050] A=2 - (rotational number of engine) X 0.0005 - (refrigerant suction pressure) x 0.4 ... (1)

[0051] Here, the unit of the operation timing A is "second", the unit of the rotational number of the engine is "revolution per minute (rpm)" and the unit of the refrigerant suction pressure is "MPa". The equation (1) is properly changed in accordance with the types and characteristics of the refrigerant and the engine.

[0052] Furthermore, when the value of the operation timing A calculated from the equation (1) is a negative value, the engine controller 60a does not use the value calculated from the equation (1) as the operation timing A, but sets a preset value as the shortest time of the operation timing A to the operation timing A.

[0053] Thereafter, the engine controller 60a disconnects the clutches 38a and 38b from the engine 40 (step S5), and also starts to count the timer simultaneously with the release of the clutches 38a, 38b (step S6).

[0054] The engine controller 60a judges whether the count value B of the timer increases to the operation timing A of the fuel shut-off valve 95 calculated in step S4 (step S7). If the count value B reaches the value of the operation timing A of the fuel shut-off valve 95 (step S7: Yes), the fuel shut-off valve 95 is operated, and interrupts the fuel supply to the engine 40 (step S8). As a result, the engine 40 is stopped.

[0055] Furthermore, if the count value B of the timer is smaller than the value of the operation timing A of the fuel shut-off valve 95 (step S7: No), the engine controller 60a waits until the count value B reaches the value of the operation timing A of the fuel shut-off valve 95.

[0056] On the other hand, if both the clutches 38a and 38b are not connected to the engine 40 in step S2 and the engine 40 is operated (step S2: No), the engine controller 60a operates the fuel shut-off valve 95 to interrupt the fuel supply to the engine 40 (step S8), so that the engine 40 is stopped.

[0057] As described above, according to this embodiment, when the signal for instructing the stop of the compressors 31a, 31b is input, the engine controller 60a of the air conditioner disconnects the compressors 31a, 31b from the engine 40 by the clutches 38a and 38b, and then controls the fuel shut-off valve 95 to interrupt the fuel supply to the engine 40. Therefore, the engine 40 is stopped under the state that the connection between the engine 40 and the compressors 31a, 31b is released, so that the sound and vibration at the stop time of the engine can be suppressed.

[0058] Furthermore, the engine controller 60a detects the load of the engine 40 when the signal for instructing the stop of the compressors 31a, 31b is input, and changes the operation timing A corresponding to the time from the disconnection between the compressors 31a, 31b and the engine 40 till the interruption of the fuel supply to the engine 40 by the fuel shut-off valve 95 in accordance with the detected load after the compressors 31a, 31b are disconnected form the engine 40, so that the time for which the engine 40 continues to operate from the time when the load is nullified can be adjusted in accordance with the load of the engine 40 and thus the

engine can be avoided from blowing up (excessive rising).

[0059] Still furthermore, the engine controller 60a can detect the load of the engine 40 on the basis of the rotational number of the engine 40 when the signal for instructing the stop of the compressors 31a, 31b is input. Furthermore, the engine controller 60a uses a pressure sensor 76 for detecting the pressure at the suction side of the compressor 31a, 31b and can detect the load of the engine 40 on the basis of the detection value of the pressure sensor 76 when the signal for instructing the stop of the compressors 31a, 31b is input.

[0060] Still furthermore, the engine controller 60a can detect the load of the engine 40 by using the detection values of both the rotational number of the engine 40 and the pressure sensor 76.

[0061] In this embodiment, the time period from the time when the clutches 38a, 38b are driven to disconnect the compressors 31a, 31b from the engine 40 till the time when the fuel supply is interrupted by the fuel shut-off valve 95 is varied in accordance with the load of the engine 40. According to this control, a time margin is provided between the operation timing of the clutches 38a, 38b and the stop timing of the engine 40, whereby the operation of the clutches 38a and 38b and the stop of the engine 40 can be surely performed in sequence. Accordingly, the clutches 38a and 38b and the fuel shut-off valve 95 can be surely operated although the precision thereof is low, so that the respective equipment can be surely protected. Furthermore, if the value of the operation timing A is not extremely excessively large, increase of the fuel consumption amount due to delay of the stop timing of the engine 40 is slight.

[0062] However, the present invention is not limited to this style. For example, in order to perform easier controller, the engine 49 may be stopped after a preset fixed time elapses from the time when the clutches 38a and 38b are disconnected (separated) from the engine 40. This case will be described below.

[0063] Fig. 4 is a flowchart showing another example of the processing at the stop time of the engine according to the embodiment to which the present invention is applied. In the processing shown in Fig. 4, the engine controller 60a disconnects the compressors 31a, 31b from the engine 40 by the clutches 38a and 38b, and then interrupts the fuel supply to the engine 40 by the fuel shut-off valve 95 within a predetermined time which is experimentally determined in advance.

[0064] In the processing shown in Fig. 4, the engine controller 60a waits until the stop instruction signal (thermo-off signal) to the compressors 31a, 31b is input (step S11: No). When the stop instruction signal is input (step S11: Yes), the engine controller 60a checks whether any one or both of the clutches 38a, 38b are connected to the engine 40 (step S12).

[0065] Here, if any one or both of the clutches 38a and 38b are connected to the engine 40 (step S12: Yes), the engine controller 60a disconnects the clutches 38a, 38b from the engine 40 (step S13), and starts the count of the timer simultaneously with the release (disconnection) of the clutches 38a, 38b (step S14).

[0066] Furthermore, the engine controller 60a judges whether the count value B of the timer increases to the preset value of the operation timing A of the fuel shut-off valve 95 (step S15). Here, when the count value B reaches the value of the operation timing A (step S15: Yes), the engine controller 60a actuates the fuel shut-off valve 95 to interrupt the fuel supply to the engine 40 (step S16).

[0067] Furthermore, when the count value B is smaller than the value of the operation timing A (step S15: No), the engine controller 60a waits until the count value B reaches the value of the operation timing A of the fuel shut-off valve 95.

[0068] When both the clutches 38a and 38b are not connected to the engine 40 and the engine is operated in step S12 (step S12: No), the engine controller 60a actuates the fuel shut-off valve 95 to interrupt the fuel supply to the engine 40 (step S16), thereby stopping the engine 40.

[0069] According to the processing shown in Fig. 4, the time period from the time when the clutches 38a and 38b are actuated to disconnect the compressors 31a and 31b from the engine 40 till the time when the fuel supply is interrupted is set to a predetermined fixed time. Accordingly, it is unnecessary for the engine controller 60a to perform the calculation processing, the detection of the load, etc. in connection with the stop of the engine 40. Therefore, the engine can be quickly stopped. Furthermore, it is unnecessary to provide a processor for detect the load, etc., and thus the sound and vibration which may occur when the engine 40 and the compressors 31a and 31b are stopped can be suppressed with simplified operation and construction.

[0070] The value of the operation timing A in this case is set to a short time (small value) so as to prevent the blow-up (excessive rising) of the engine when the load of the compressors 31a, 31b is high, that is, when the load of the engine is high. However, it can bring sufficiently practical action and effect insofar as the clutches 38a and 38b and the fuel shut-off valve 95 can be surely operated with high precision.

[0071] The present invention is not limited to the above embodiment, and various modifications may be made to the above embodiment. For example, in the above embodiment, the air conditioner 1 is equipped with plural indoor units 2. However, the number of the indoor units 2 is not limited to a specific value, and one indoor unit 2 may be connected to one outdoor unit 3. Likewise, the number of the clutches and the number of the compressors are not limited to specific values. At least one clutch and at least one compressor may be provided. Furthermore, in the above embodiment, the fuel shut-off valve 95 for interrupting the fuel supply to the engine 40 is provided, and the engine 40 is stopped by operating the fuel shut-off valve 95, however, the present invention is not limited to this style. For example, a fuel adjusting valve

93 for adjusting fuel to be supplied to the engine 40 may interrupt fuel supply. Furthermore, in the above embodiment, the cooling water circuit containing the plate heat exchanger 34 for heat-exchanging the cooling water of the engine 40 with the refrigerant, etc. is provided. The constructions of the respective parts of the cooling water circuit may be freely constructed.

[0072] Furthermore, in the above embodiment, the engine controller 60a implements the function of the timer. However, another microcomputer may be designed to function as a timer. The engine 40 is not limited to an engine using gas such as natural gas or the like as fuel, and it may be an engine which can operate by using diesel oil or heavy fuel oil as fuel. The other detailed constructions may be freely changed.

Claims

1. An air conditioner (1) comprising at least one compressor (31a, 31b)) driven by an engine (40), **characterized by** comprising: at least clutch (38a, 38b) which is coupled to the engine so that the clutch can be connected to and disconnected from the engine; a fuel shut-off valve (95) for interrupting fuel supply to the engine; and a controller (60a) for actuating the clutches to disconnect the compressor from the engine under the state that the compressor is driven by the engine when a signal for instructing stop of the engine is input, and then actuating the fuel shut-off valve to interrupt fuel supply to the engine.

2. The air conditioner according to claim 1, wherein the controller detects the load of the engine when a signal for instructing stop of the compressor is input, and changes a time period from the time when the compressor is disconnected from the engine by the clutch till the time when fuel supply to the engine is interrupted by the fuel shut-off valve.

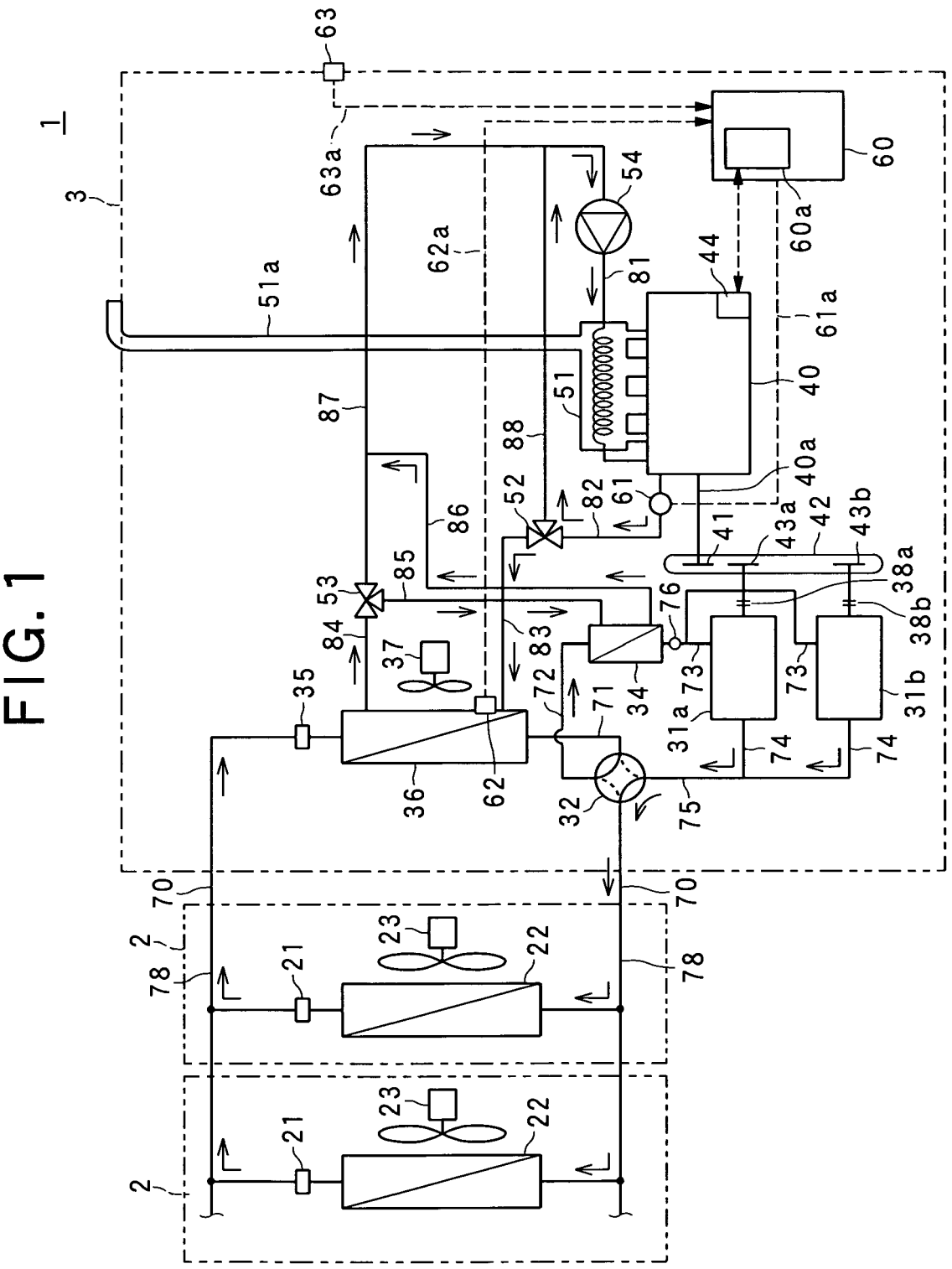
3. The air conditioner according to claim 2, wherein the controller detects the load of the engine on the basis of the rotational number of the engine when the signal for instructing the stop of the compressor is input.

4. The air conditioner according to claim 2, further comprising a pressure sensor for detecting the pressure at the suction side of the compressor, wherein the controller detects the load of the engine on the basis of the detection value of the pressure sensor.

5. The air conditioner according to claim 1, wherein the controller controls the fuel shut-off valve to interrupt the fuel supply to the engine within a predetermined time after the compressor is disconnected from the engine by the clutch.

6. A method for controlling an air conditioner including an compressor driven by an engine, a clutch through which the compressor can be connected to and disconnected from the engine, and a fuel shut-off valve for interrupting fuel supply to the engine, **characterized in that** the clutch is operated to disconnect the compressor from the engine when a signal for instructing stop of the compressor and the engine is input under the state that the compressor is driven by the engine, and then the fuel shut-off valve is operated to interrupt fuel supply to the engine.

FIG. 1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2
3
21
22
23
31a
31b
32
34
35
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37
38a
38b
40
40a
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43b
44
51
51a
52
53
54
60
60a
61
61a
62
62a
63
63a
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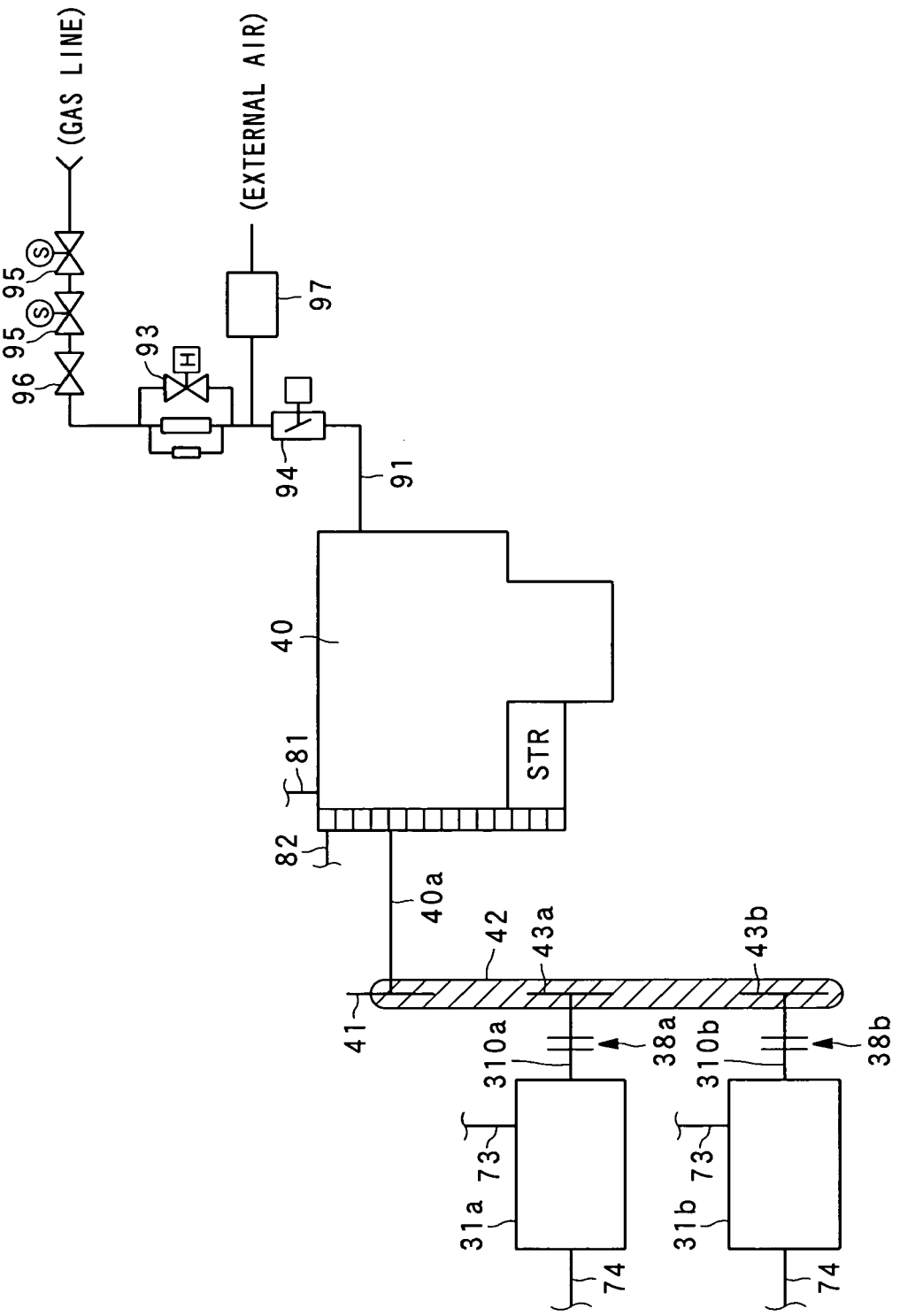
FIG. 2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(EXTERNAL AIR)
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95
96
93
H
97
94
91
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81
STR
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43b
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310a
38a
310b
38b
73
73
31a
31b
74
74

FIG. 3

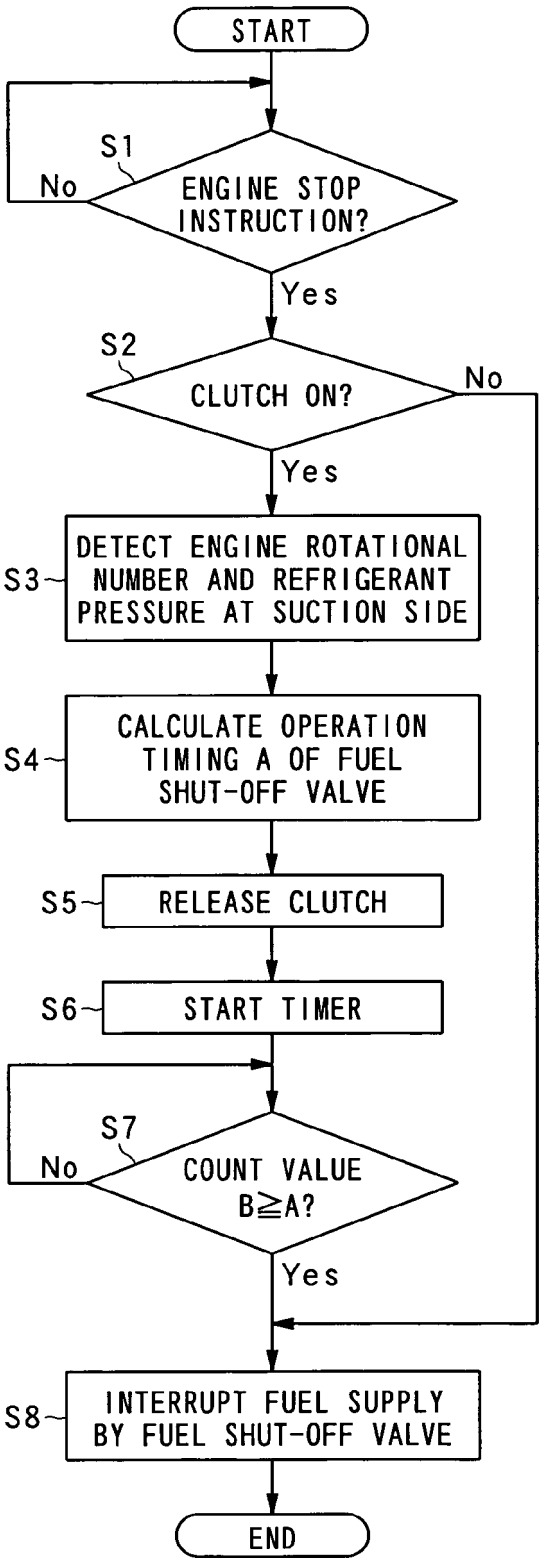
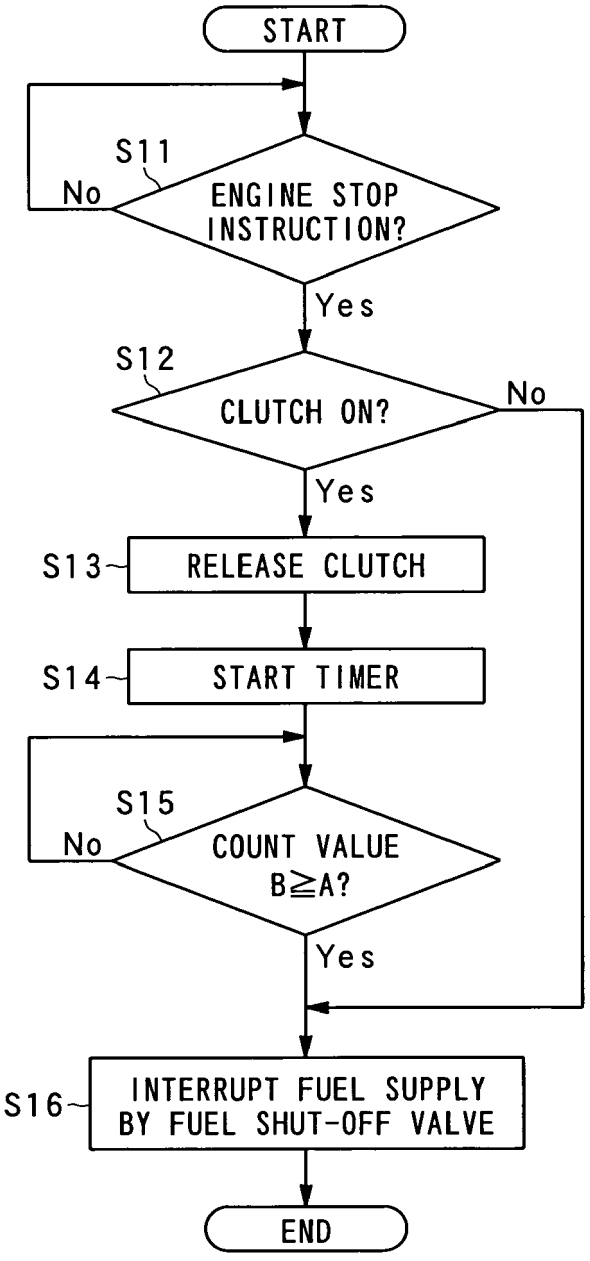

START
S1
No
ENGINE STOP INSTRUCTION?
Yes
S2
CLUTCH ON?
No
Yes
S3
DETECT ENGINE ROTATIONAL NUMBER AND REFRIGERANT PRESSURE AT SUCTION SIDE
S4
CALCULATE OPERATION TIMING A OF FUEL SHUT-OFF VALVE
S5
RELEASE CLUTCH
S6
START TIMER
S7
No
COUNT VALUE B≧A?
Yes
S8
INTERRUPT FUEL SUPPLY BY FUEL SHUT-OFF VALVE
END

FIG. 4


START
S11
No
ENGINE STOP INSTRUCTION?
Yes
S12
CLUTCH ON?
No
Yes
S13
RELEASE CLUTCH
S14
START TIMER
S15
No
COUNT VALUE B≧A?
Yes
S16
INTERRUPT FUEL SUPPLY BY FUEL SHUT-OFF VALVE
END

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2001263765 A **[0002]**