(12) UK Patent Application (19) GB (11) 2 395 988 (13) A

(43) Date of A Publication 09.06.2004

(21) Application No: 0327617.7

(22) Date of Filing: 27.11.2003

(30) Priority Data:
(31) 2002345413 (32) 28.11.2002 (33) JP

(71) Applicant(s):
Denso Corporation
(Incorporated in Japan)
1-1 Showa-cho, Kariya-shi, Aichi 448-8661, Japan

(72) Inventor(s):
Satoshi Izawa
Kazuo Kito
Toshiya Nagasawa

(74) Agent and/or Address for Service:
Withers & Rogers
Goldings House, 2 Hays Lane, LONDON, SE1 2HW, United Kingdom

(51) INT CL[7]:
F04B 27/18

(52) UK CL (Edition W):
F1W WGL W408

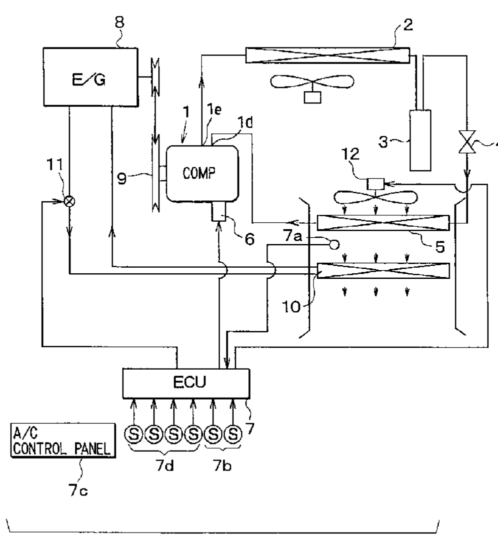
(56) Documents Cited:
JP 110223183 A
US 5059097 A
US 20030291810 A
US 20021445120 A

(58) Field of Search:
UK CL (Edition W) **F1W**
INT CL[7] **F04B**
Other: **ONLINE: WPI; EPODOC; JAPIO**

(54) Abstract Title: **Variable displacement compressor control system**

(57) A compressor system includes a variable displacement compressor 1 having a refrigerant inlet 1d, a refrigerant outlet 1e and a piston to compress the refrigerant. The compressor also has a control pressure chamber 1b connected to the refrigerant inlet and outlet wherein the pressure of the refrigerant in the control pressure chamber regulates the stroke of the piston. The compressor system is characterised by a control valve6, that changes the degree of communication between the control pressure chamber and either of the refrigerant inlet or outlet, and a pressure sensing means 7d which measures either the refrigerant intake pressure or the outlet pressure and a signal outputting means which outputs a signal based upon the refrigerant intake or outlet pressure when the displacement of the compressor apparatus is greater than a pre determined value based on the refrigerant pressure. Also claimed is the use of a temperature sensor 7a in place of the pressure sensor to give an indication of the compressor displacement. The compressor may be of the swash plate type.

FIG. 1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

Original Printed on Recycled Paper

GB 2 395 988 A

FIG. 1

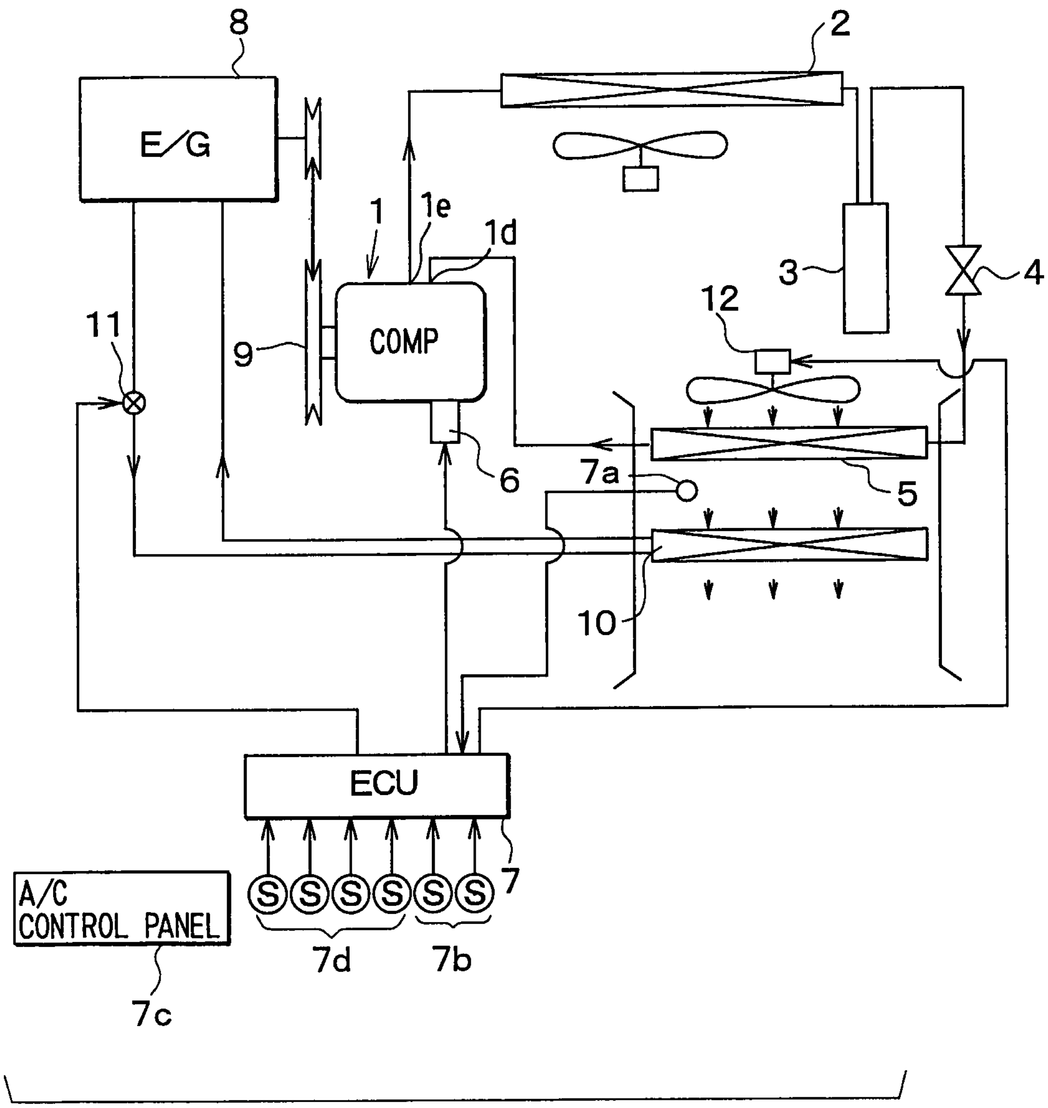

8
E/G
2
1
1e
1d
COMP
3
4
12
11
9
6
7a
5
10
ECU
7
A/C
CONTROL PANEL
S
S
S
S
S
S
7d
7b
7c

FIG. 2

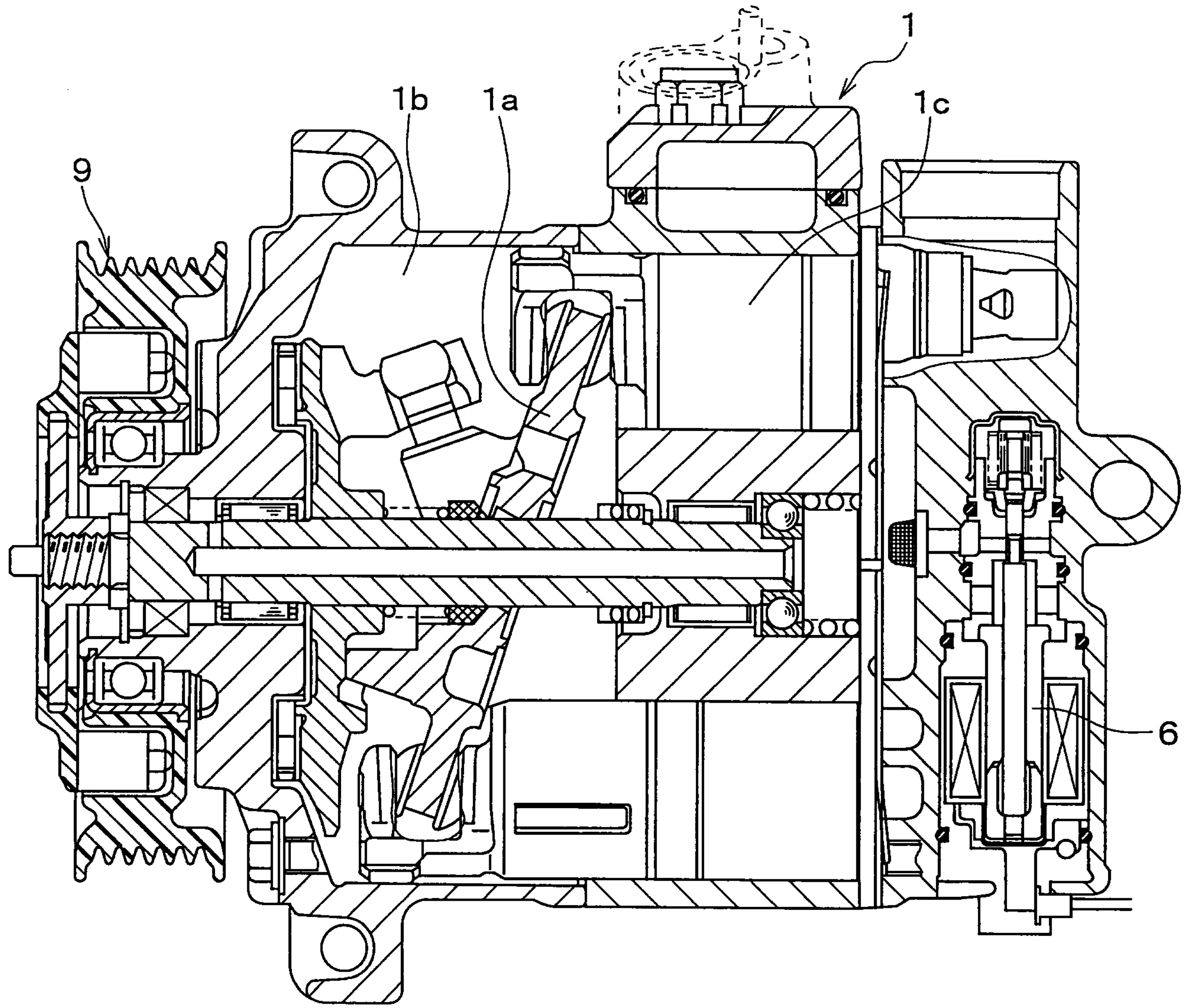


FIG. 3

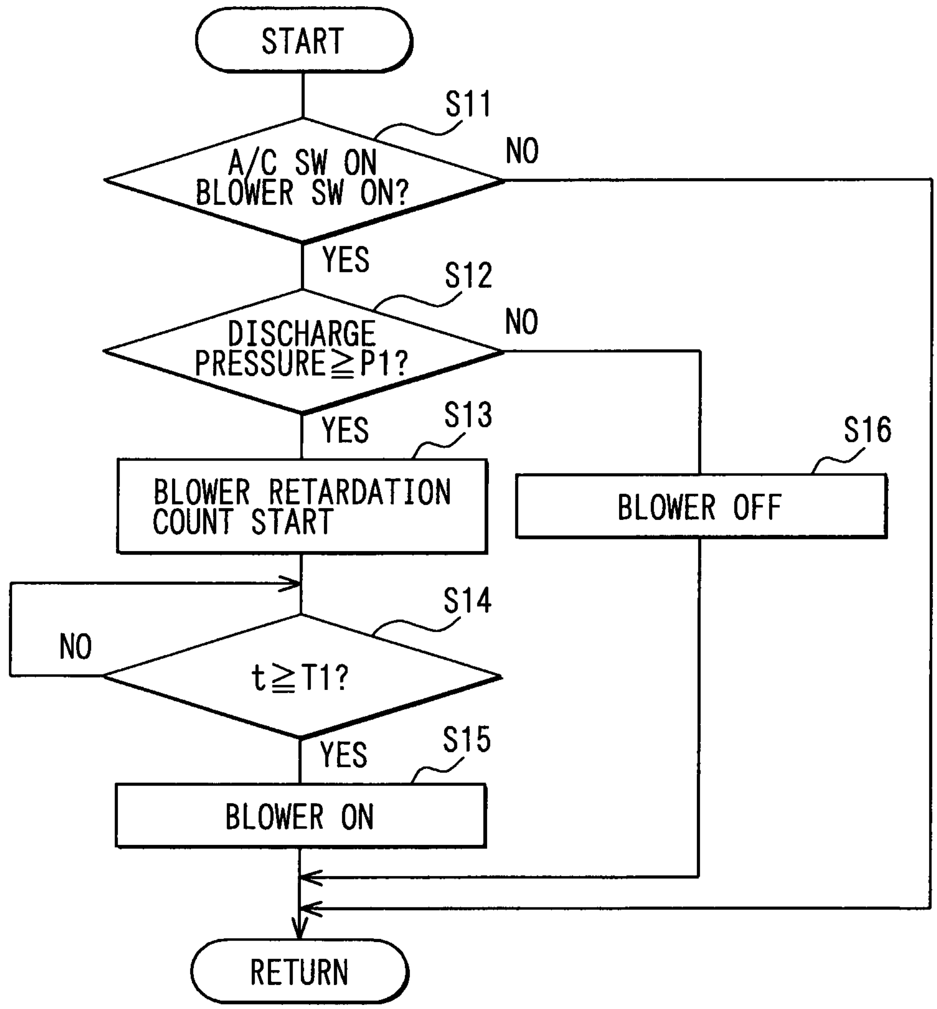

START
S11
A/C SW ON
BLOWER SW ON?
NO
YES
S12
DISCHARGE
PRESSURE≧P1?
NO
YES
S13
BLOWER RETARDATION
COUNT START
S16
BLOWER OFF
S14
NO
t≧T1?
YES
S15
BLOWER ON
RETURN

FIG. 4

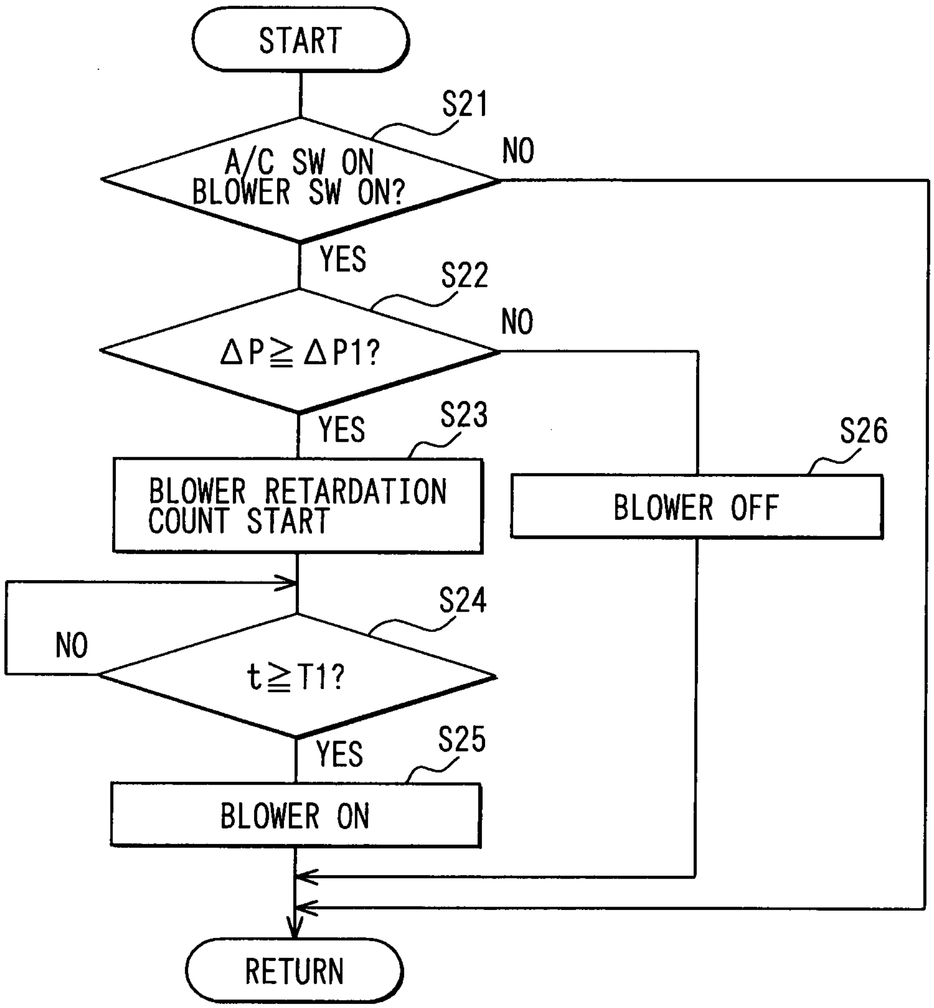
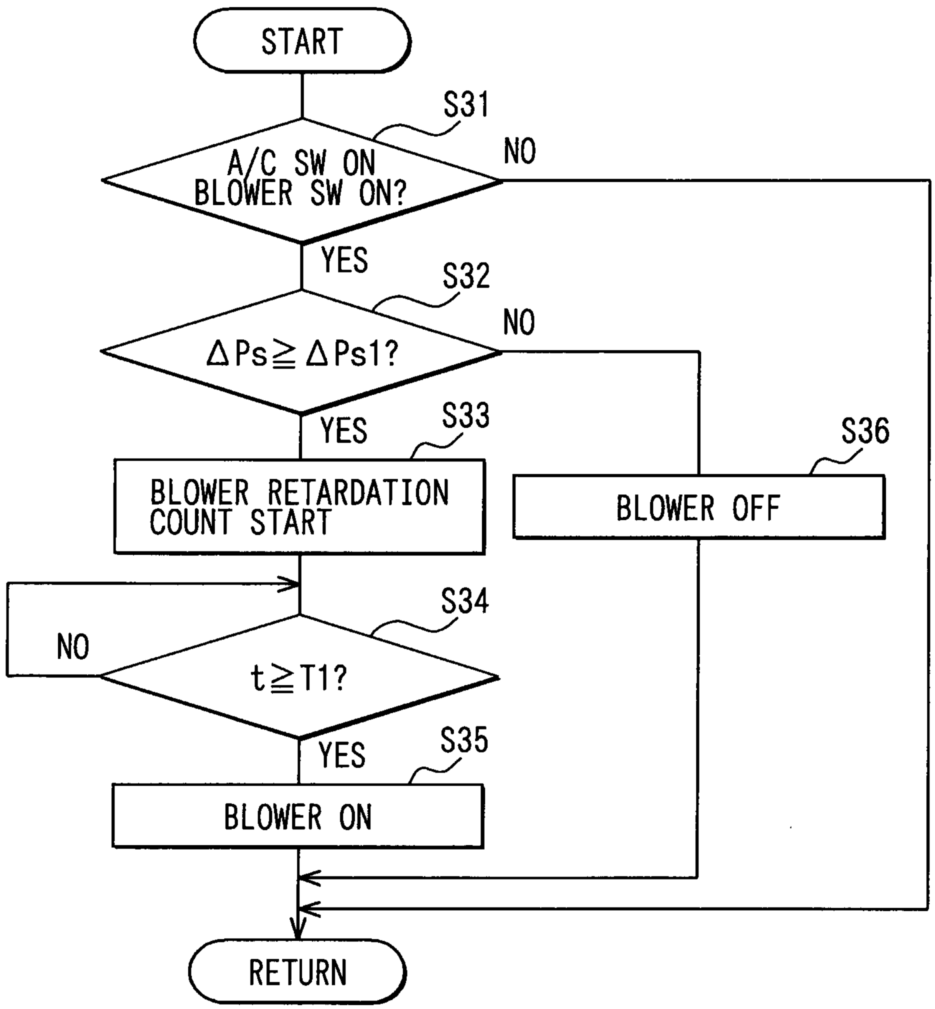
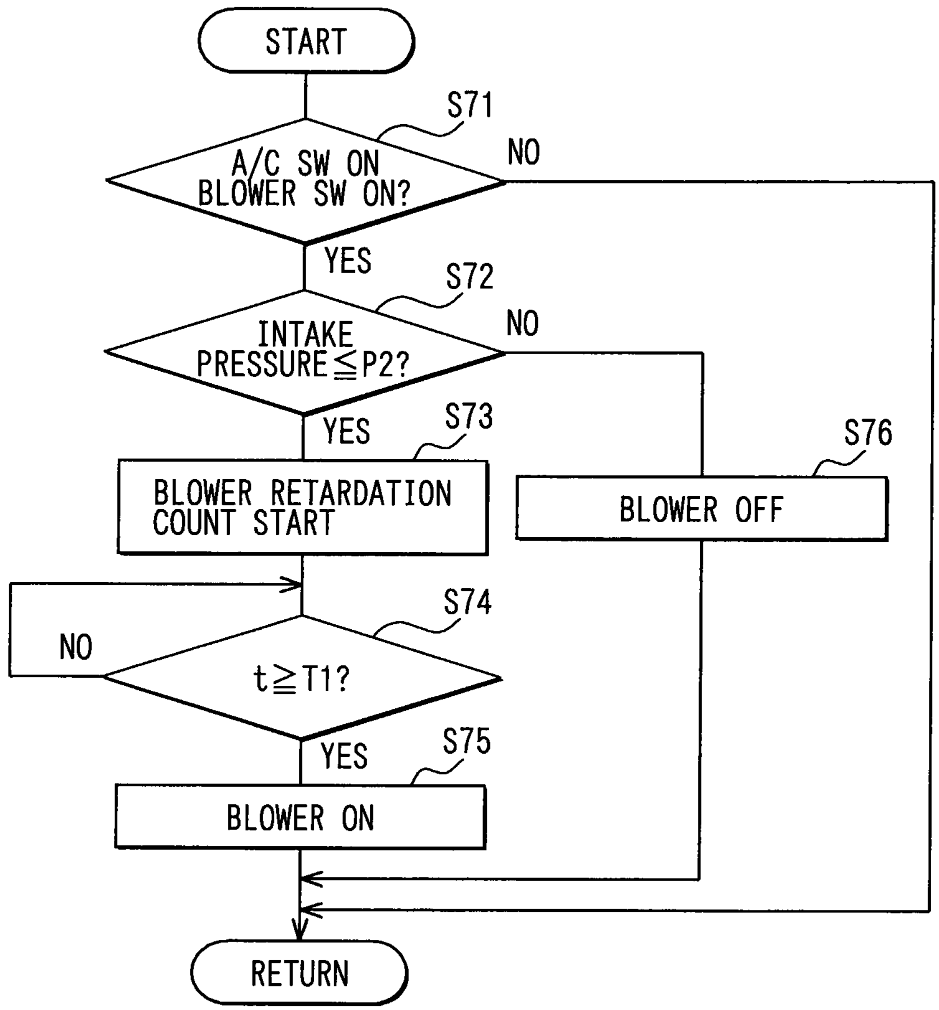

START
S21
A/C SW ON
BLOWER SW ON?
NO
YES
S22
ΔP≧ΔP1?
NO
YES
S23
BLOWER RETARDATION
COUNT START
S26
BLOWER OFF
S24
NO
t≧T1?
YES
S25
BLOWER ON
RETURN

FIG. 5



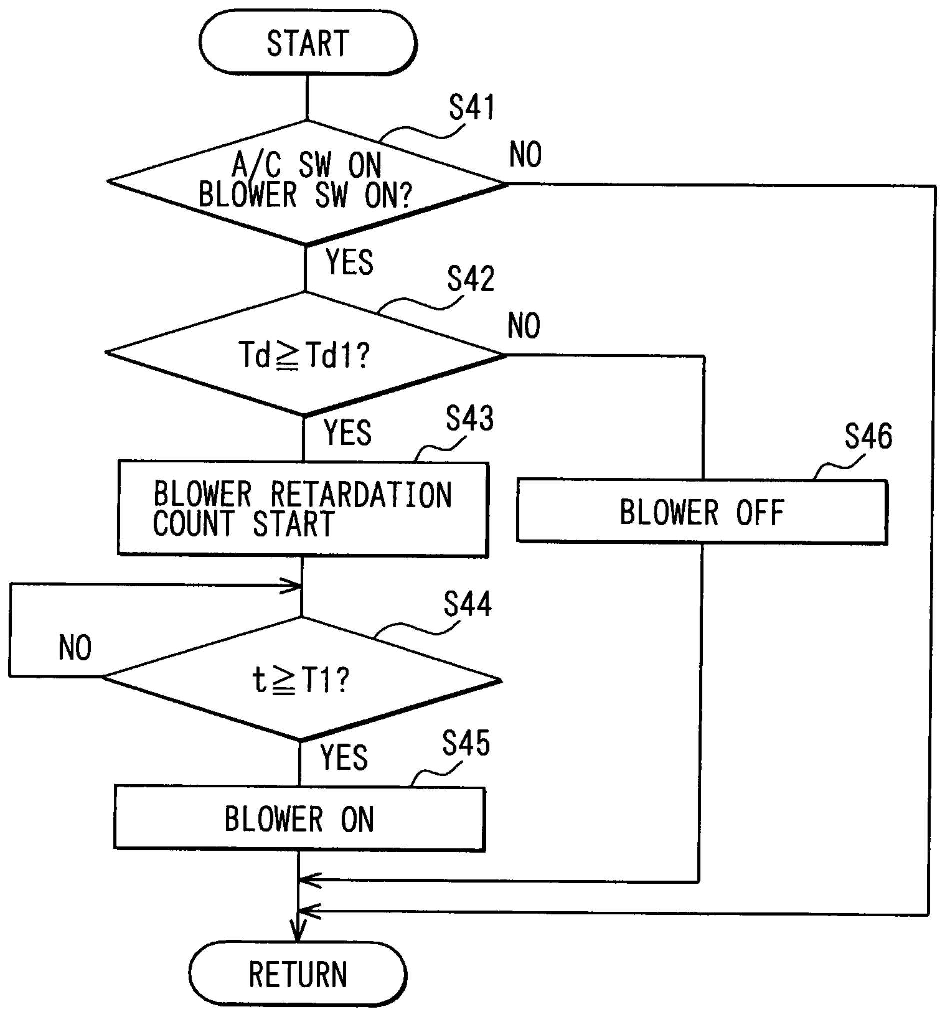
START
S31
A/C SW ON
BLOWER SW ON?
NO
YES
S32
ΔPs≧ΔPs1?
NO
YES
S33
BLOWER RETARDATION
COUNT START
S36
BLOWER OFF
S34
NO
t≧T1?
YES
S35
BLOWER ON
RETURN

FIG. 6


START
S71
A/C SW ON
BLOWER SW ON?
NO
YES
S72
INTAKE
PRESSURE≦P2?
NO
YES
S73
BLOWER RETARDATION
COUNT START
S76
BLOWER OFF
S74
NO
t≧T1?
YES
S75
BLOWER ON
RETURN

7/10

FIG. 7



START
S41
A/C SW ON
BLOWER SW ON?
NO
YES
S42
Td≧Td1?
NO
YES
S43
BLOWER RETARDATION
COUNT START
S46
BLOWER OFF
S44
NO
t≧T1?
YES
S45
BLOWER ON
RETURN

FIG. 8

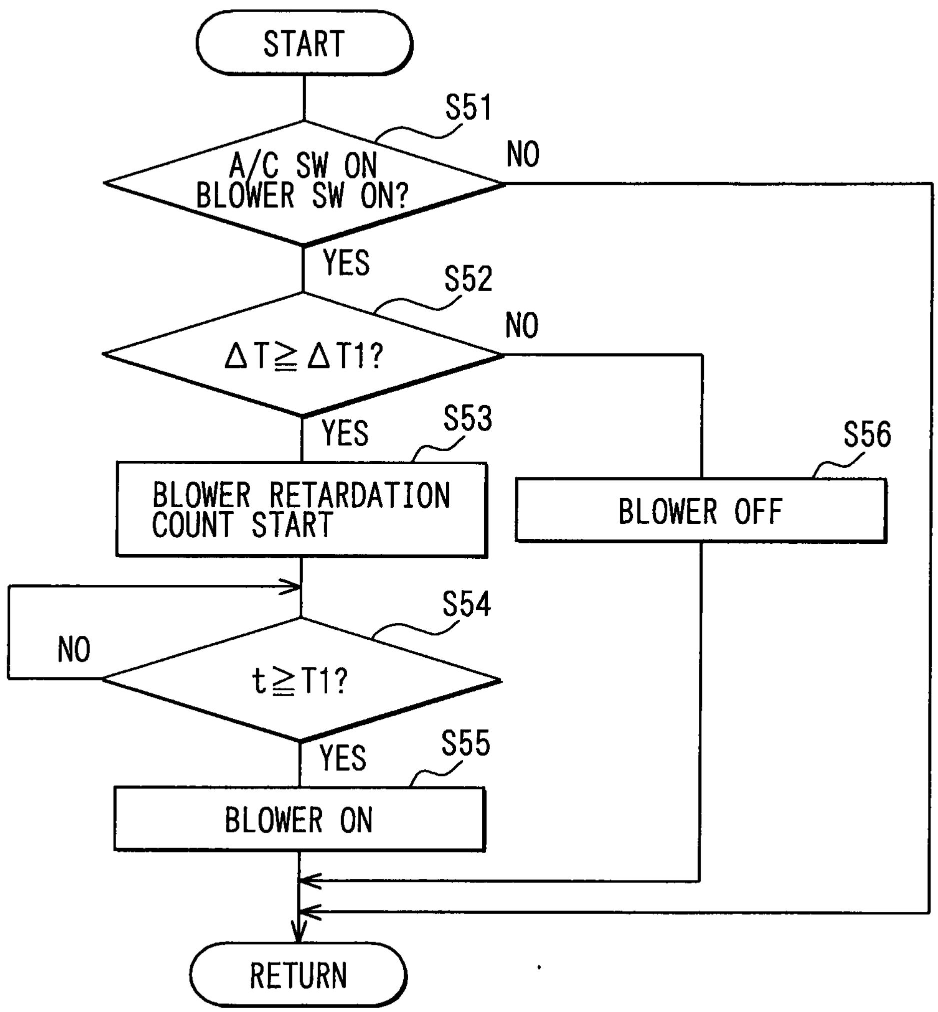

START
S51
A/C SW ON
BLOWER SW ON?
NO
YES
S52
ΔT≧ΔT1?
NO
YES
S53
BLOWER RETARDATION
COUNT START
S56
BLOWER OFF
S54
NO
t≧T1?
YES
S55
BLOWER ON
RETURN

FIG. 9

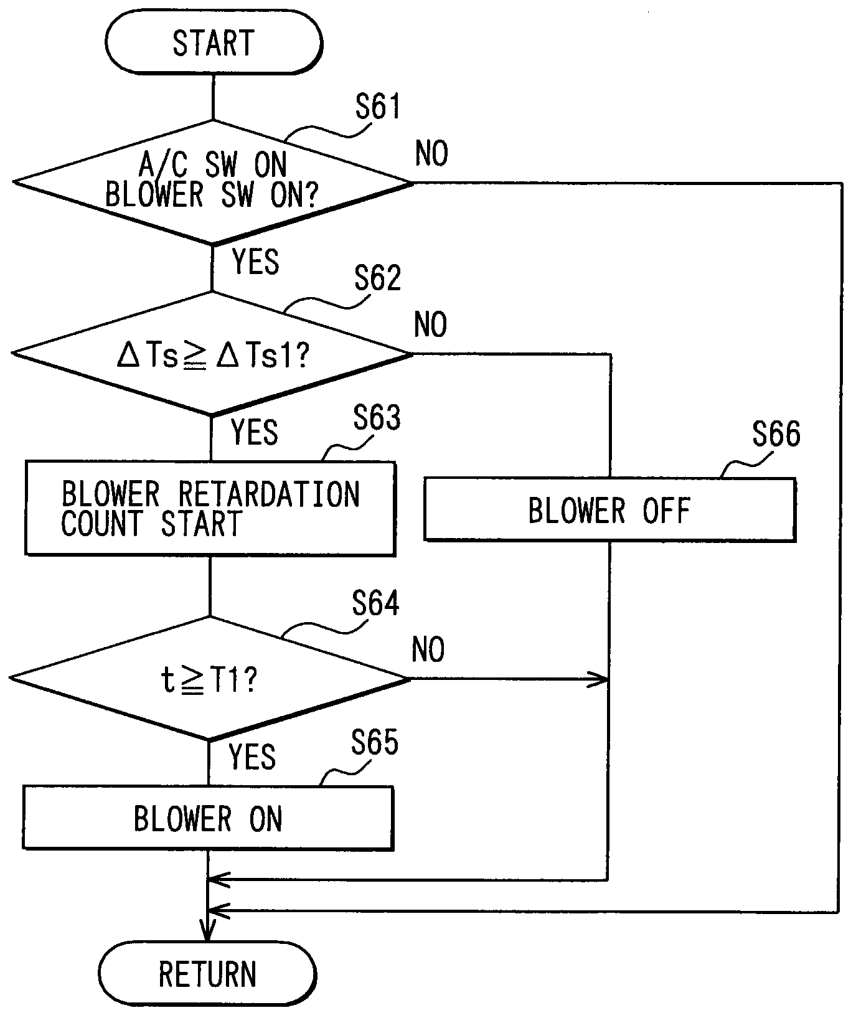
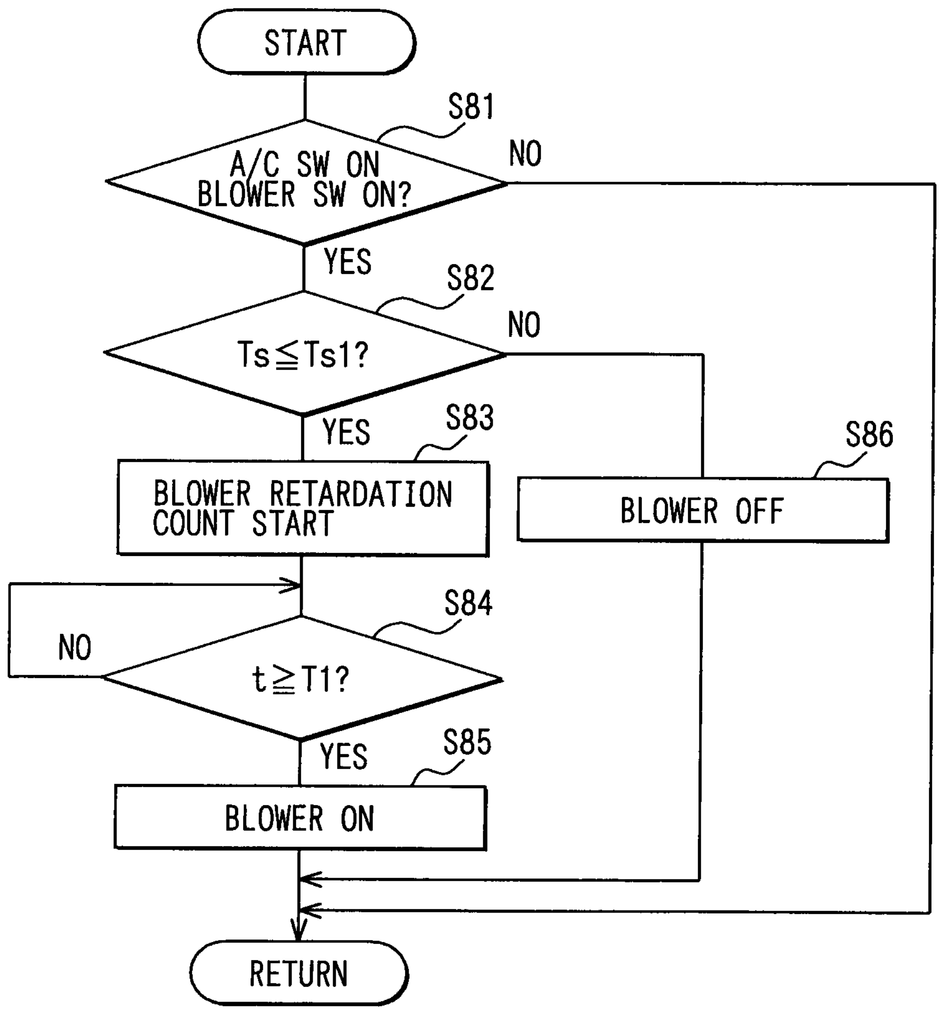

START
S61
A/C SW ON
BLOWER SW ON?
NO
YES
S62
ΔTs≧ΔTs1?
NO
YES
S63
BLOWER RETARDATION
COUNT START
S66
BLOWER OFF
S64
t≧T1?
NO
YES
S65
BLOWER ON
RETURN

FIG. 10


START
S81
A/C SW ON
BLOWER SW ON?
NO
YES
S82
Ts≦Ts1?
NO
YES
S83
BLOWER RETARDATION
COUNT START
S86
BLOWER OFF
S84
NO
t≧T1?
YES
S85
BLOWER ON
RETURN

COMPRESSOR SYSTEM AND AIR CONDITIONING SYSTEM

Description

The present invention relates to a compressor system, which includes a variable displacement compressor apparatus and is effectively applicable to a vehicle air conditioning system.

Right after activation of the air conditioning system, i.e., right after activation of a compressor apparatus, the temperature of a passenger compartment heat exchanger is not sufficiently reduced. Thus, when a blower is activated simultaneously with activation of the compressor, the air, which has not been sufficiently cooled, is blown into a passenger compartment.

Therefore, in a prior art vehicle air conditioning system, the blower is activated to blow air into the passenger compartment only after elapse of a predetermined time period from the time of activating the compressor, i.e., the time of energizing an electromagnetic clutch to transmit drive force to the compressor apparatus. Such an air conditioning system is disclosed in, for example, Japanese Examined Patent Publication No. 5-9285.

The invention disclosed in Japanese Examined Patent Publication No. 5-9285 is an air conditioning system, which uses a fixed displacement compressor apparatus that does not change its displacement. Thus, when the invention disclosed in Japanese Examined Patent Publication No. 5-9285 is applied to an air conditioning system, which has a variable displacement compressor apparatus that can change its displacement, the following problem occurs.

Here, it should be understood that the displacement is a theoretical geometrical displacement of refrigerant discharged from the compressor apparatus per rotation of a shaft of the compressor apparatus.

That is, in a variable displacement compressor apparatus of a swash plate type, which changes a stroke of a piston, balance between force, which is applied to a piston by pressure in a swash plate chamber, and a compressive reaction force, which is applied to the piston, is changed by controlling the pressure in the swash plate chamber. The change in the balance then causes a change in a rotational angular momentum for tilting the swash plate to change the stroke of the piston, thereby changing the displacement of the compressor apparatus.

Furthermore, normally, the swash plate chamber is always communicated with a refrigerant inlet side of the compressor apparatus through a choke means, such as an orifice, and is also communicated with a refrigerant outlet side of the compressor apparatus through a control valve, which can change a degree of opening. The pressure in the swash plate chamber is controlled by controlling the degree of opening of the control valve.

Normally, at the time of maximizing the displacement of the compressor apparatus, the control valve is closed to reduce the pressure of the swash plate chamber to a level that is substantially equal to the intake pressure of the compressor apparatus. On the other hand, at the time of reducing the displacement, the control valve is opened to increase the pressure of the swash plate chamber. Thus, when the displacement of the compressor apparatus is reduced, a large portion of the discharged refrigerant flows into the swash plate chamber.

At this time, when the compressor apparatus is activated in this state where a relatively large amount of refrigerant is accumulated in the swash plate chamber, the swash plate cannot be rotated immediately because of a relatively small pressure difference between the intake pressure and the discharge pressure of the compressor apparatus and a need for rotating the tilted swash plate in the liquid phase refrigerant, which resists rotation of the swash plate. As a result, the displacement of the compressor cannot be increased immediately.

Therefore, even when the blower is activated after elapse of a predetermined time period from the time of activating the compressor apparatus, i.e., the time of outputting a signal for increasing the displacement of the compressor apparatus to the control valve, the displacement is not sufficiently increased, and the air conditioning system is not substantially activated. Thus, the air, which is not cooled, is disadvantageously blown into the passenger compartment.

The present invention addresses the above disadvantage. Thus, it is an objective of the present invention to provide a novel compressor system, which is different from previously proposed compressor systems. It is another objective of the present invention to provide an air conditioning system having such a compressor system. It is a further objective of the present invention to provide a way for addressing the above disadvantage.

To achieve the objectives of the present invention, there is provided a compressor system that includes a variable displacement compressor apparatus, a control valve, a pressure sensing means and a signal outputting means. The compressor apparatus includes a refrigerant inlet, a refrigerant outlet, a piston and a control pressure chamber. The refrigerant is suctioned into the compressor apparatus through the refrigerant inlet. The refrigerant is discharged from the compressor apparatus through the refrigerant outlet. The piston is reciprocably driven upon rotation of the compressor apparatus to compress refrigerant supplied from the refrigerant inlet. The control pressure chamber is connected to the refrigerant inlet and the refrigerant outlet and receives refrigerant pressure from at least one of the refrigerant inlet and the refrigerant outlet. The refrigerant pressure in the control pressure chamber regulates a stroke of the piston to regulate a displacement of the compressor apparatus. The control valve changes at least one of a degree of communication between the refrigerant inlet and the control pressure chamber and a degree of communication between the control pressure chamber and the refrigerant outlet. The pressure sensing means is for measuring at least one of a refrigerant intake pressure of the compressor apparatus and a refrigerant discharge pressure of the compressor apparatus. The signal outputting means is for outputting a signal when it is determined that the displacement of the compressor apparatus is equal to or greater than a predetermined displacement based on the at least one of the refrigerant intake pressure and the refrigerant discharge pressure, which are measured by the pressure sensing means.

In place of the pressure sensing means, a temperature sensing means can be provided. The temperature sensing means is for measuring at least one of a temperature of intake refrigerant, which is suctioned into the compressor apparatus, and a temperature of discharged refrigerant, which is discharged from the compressor apparatus. In such a case, the signal outputting means outputs the signal when it is determined that the displacement of the compressor apparatus is equal to or greater than a predetermined displacement based on the at least one of the temperature of the intake refrigerant and the temperature of the discharged refrigerant, which are measured by the temperature sensing means.

To achieve the objectives of the present invention, there is also provided an air conditioning system that includes a vapor compression refrigeration system, a blower and a blow start control means. In the vapor compression refrigeration system, refrigerant is suctioned and compressed by the above-described compressor system. The blower blows air, which exchanges heat with the refrigerant and is blown into a room. The blower start control means is for activating the blower when the signal is received from the signal outputting means.

The invention, together with additional objectives, features and advantages thereof, will be best understood from the following description, the appended claims and the accompanying drawings in which:

FIG. 1 is a schematic view of a vehicle air conditioning system (vapor compression refrigeration system) according to a first embodiment of the present invention;

FIG. 2 is a cross sectional view of a variable displacement compressor apparatus of a swash plate type according to the first embodiment of the present invention;

FIG. 3 is a flowchart showing control operation of a compressor system according to the first embodiment of the present invention;

FIG. 4 is a flowchart showing control operation of a compressor system according to a second embodiment of the present invention;

FIG. 5 is a flowchart showing control operation of a compressor system according to a third embodiment of the present invention;

FIG. 6 is a flowchart showing control operation of a compressor system according to a fourth embodiment of the present invention;

FIG. 7 is a flowchart showing control operation of a compressor system according to a fifth embodiment of the present invention;

FIG. 8 is a flowchart showing control operation of a compressor system according to a sixth embodiment of the present invention;

FIG. 9 is a flowchart showing control operation of a compressor system according to a seventh embodiment of the present invention; and

FIG. 10 is a flowchart showing control operation of a compressor system according to a eighth embodiment of the present invention.

(First Embodiment)

In the present embodiment, a compressor system of the present invention is embodied in a vehicle air conditioning system, and FIG. 1 is a schematic view of the vehicle air conditioning system.

A vapor compression refrigeration system, which is a major component of the vehicle air conditioning system, includes a compressor apparatus 1, a radiator 2, a receiver 3, a depressurizer 4 and an evaporator 5. The radiator 2 cools refrigerant through heat exchange between the outside air and high temperature and high pressure refrigerant, which is compressed by the compressor apparatus 1. The receiver 3 separates refrigerant, which is outputted from the radiator 2, into liquid phase refrigerant and vapor phase refrigerant and accumulates excessive refrigerant as liquid phase refrigerant. The depressurizer 4 depressurizes the liquid phase refrigerant supplied from the receiver 3. The evaporator 5 serves as a passenger compartment heat exchanger, which evaporates the liquid phase refrigerant through heat exchange between the depressurized low temperature refrigerant and the air to be discharged into a passenger compartment (i.e., a passenger room) of a vehicle.

The compressor apparatus 1 is driven by drive force received from an internal combustion engine (serving as a vehicle drive power source), i.e., an engine 8. The compressor apparatus 1 is mechanically connected to the engine 8 through a V-belt and a pulley 9 and is driven in synchronism with start and stop of the engine 8.

A heater 10 uses coolant of the engine 8 as a heat source and heats the air to be discharged into the passenger compartment. A heating performance of the heater 10 is adjusted by adjusting a flow rate of high temperature coolant supplied to the heater 10 through operation of a flow rate control valve 11. A blower 12 blows air to be discharged into the passenger compartment.

In the present embodiment, a reheating type is adapted. In the reheating type, air, which has passed the evaporator 5, is heated, and heating level of this air is adjusted to adjust the temperature of the air discharged into the passenger compartment. However, the present invention is not limited to this. It should be understood that an air mix type can be adapted in place of the reheating type. In the air mix type, the flow rate of hot air, which passes the heater 10, and the flow rate of cold air, which bypasses the heater 10, are adjusted to adjust the temperature of the air blown into the passenger compartment.

FIG. 2 is a cross sectional view of the variable displacement compressor apparatus 1 of a swash plate type. As is well known in the art, the compressor apparatus 1 can change its displacement by changing a tilt angle of a swash plate 1a, i.e., a stroke of a piston 1c through control of the pressure in a swash plate chamber (crank case) 1b, which serves as a control pressure chamber.

Specifically, an inlet 1d side of the compressor apparatus 1 and the swash plate chamber 1b are always communicated to one another through a choke (not shown), such as an orifice or a capillary tube, which induces a predetermined pressure loss. Furthermore, there is provided a pressure control valve 6, which controls a state of communication in a pressure conducting passage (not shown) that communicates between a refrigerant outlet 1e side of the compressor apparatus 1 and the swash plate chamber 1b. At the time of increasing the displacement of the compressor apparatus 1, the pressure conducting passage is choked or is closed by the pressure control valve 6 to reduce the pressure in the swash plate chamber 1b. On the other hand, at the time of reducing the displacement of the compressor apparatus 1, the pressure control valve 6 is opened to increase the pressure in the swash plate chamber 1b.

Thus, when the displacement is maximized, the pressure in the swash plate chamber 1b is substantially equal to the intake pressure of the compressor apparatus 1 at the inlet 1d. On the other hand, when the displacement of the compressor apparatus 1 is minimized, the pressure in the swash plate chamber 1b is substantially equal to the discharge pressure of the compressor apparatus 1 at the outlet 1e.

As shown in FIG. 1, the pressure control valve 6 is controlled by an electronic control unit (ECU) 7. At the time of normal operation, the pressure control valve 6 is duty controlled by the ECU 7 in such a manner that the pressure (evaporation temperature) in the evaporator 5 is substantially maintained at a corresponding predetermined value.

It is difficult to directly measure the evaporation temperature. Thus, in the present embodiment, the pressure control valve 6 is controlled based on the temperature of the air right after passing the evaporator 5, more specifically, the measured temperature of a temperature sensor 7a.

The ECU 7 receives measured signals from various air conditioning sensors 7b, such as an outside air temperature sensor for measuring the outside air temperature outside the passenger compartment, an inside air temperature sensor for measuring the inside air temperature inside the passenger compartment and a solar radiation sensor besides the temperature sensor 7a. The ECU 7 receives set values of a control panel 7c, which is operated and set by a passenger. The ECU 7 further receives measurements of compressor apparatus control parameter sensors 7d, such as a discharge pressure sensor (serving as a discharge pressure sensing means), a discharged refrigerant temperature sensor (serving as a discharged refrigerant temperature sensing means), an intake pressure sensor (serving as an intake pressure sensing means) and an intake refrigerant temperature sensor (serving as an intake refrigerant temperature sensing means). Here, it should be noted that the discharge pressure sensing means and the intake pressure sensing means can be collectively referred to as a pressure sensing means. Also, the discharged refrigerant temperature sensing means and the intake refrigerant temperature sensing means can be collectively referred to as a temperature sensing means. The discharge pressure sensor measures the refrigerant discharge pressure of the compressor apparatus 1. The discharged refrigerant temperature sensor measures the temperature of the refrigerant discharged from the compressor apparatus 1. The intake pressure sensor measures the refrigerant intake pressure of the compressor apparatus 1. The intake refrigerant temperature sensor measures the temperature of the intake refrigerant, which is drawn into the compressor apparatus 1.

Next, characteristic operation of the present embodiment will be described with reference to a flowchart shown in FIG. 3.

This control flow is executed at the time of cooling operation. At the time of turning on of a start switch (A/C switch) for starting the air conditioning system or at the time of turning on of a blower switch for activating the blower 12, measuring (monitoring) of the refrigerant discharge pressure Pd of the compressor apparatus 1 is simultaneously initiated (S11). When the discharge pressure Pd is equal to or greater than a predetermined pressure P1 (e.g., about 0.7 MPa or +0.1 MPa in the case of saturated pressure at the outside air temperature of 20 degrees Celsius), blower retardation control operation is initiated (S12, S13). On the other hand, when the refrigerant discharge pressure Pd is less than the predetermined pressure P1, the blower is kept turned off (S16).

Here, the blower retardation control operation retards activation of the blower 12 a predetermined time period T1 to prevent blowing of the uncooled air into the passenger compartment. Measurement of the predetermined time T1 is initiated when the discharge pressure Pd becomes equal to or greater than the predetermined pressure P1.

When the A/C switch or the blower switch is disconnected or is turned off, the air conditioning system is held in the stopped state. Thus, normally, when the A/C switch or the blower switch is turned on, a signal for increasing the displacement of the compressor apparatus 1 to the maximum displacement is simultaneously outputted from the ECU 7 to the pressure control valve 6, so that the pressure control valve 6 is operated to change the displacement to the maximum displacement.

Then, when the elapsed measurement time period reaches the predetermined time period T1, the blower 12 is started to initiate blowing of the air into the passenger compartment (S14, S15). When the elapsed measurement time period is less than the predetermined time period T1, the blower 12 is not started (repeating S14). Here, the ECU 7 serves as a blower start control means for activating the blower 12.

Next, advantages of the present embodiment will be described.

In the present embodiment, when the discharge pressure Pd is equal to or greater than the predetermined value P1, it is assumed that the displacement of the compressor apparatus 1 becomes equal to or greater than a predetermined displacement, i.e., becomes the maximum displacement. Then, the blower retardation control operation is initiated. Thus, the blowing of the uncooled air into the passenger compartment can be effectively prevented.

(Second Embodiment)

In the first embodiment, the blower retardation control operation is initiated when the discharge pressure Pd becomes equal to or greater than the predetermined value P1. However, in the present embodiment, as shown in FIG. 4, the blower retardation control operation is initiated when the currently measured refrigerant discharge pressure shows a pressure increase ΔP from the discharge pressure Pd, which is measured at the time of activating the pressure control valve 6 to increasing the displacement of the compressor apparatus 1, i.e., at the time of outputting the signal from the ECU 7 to the pressure control valve 6 to increase the displacement of the compressor apparatus 1 to the maximum displacement, becomes equal to or greater than a predetermined value ΔP1 (e.g., about 0.1 MPa at the outside air temperature of 20 degrees Celsius).

In this way, even in this embodiment, the blowing of uncooled air into the passenger compartment can be effectively prevented.

In the flowchart shown in FIG. 4, steps other than step S22 are the same as those of the first embodiment.

(Third Embodiment)

In the second embodiment, the blower retardation control operation is initiated when the pressure increase ΔP from the discharge pressure Pd, which is measured at the time of activating the pressure control valve 6 to increase the displacement of the compressor apparatus 1, becomes equal to or greater than the predetermined value ΔP1. However, in the present embodiment, as shown in FIG. 5, the blower retardation control operation is initiated when a pressure difference ΔPs between the refrigerant intake pressure Ps and the refrigerant discharge pressure Pd of the compressor apparatus 1 becomes equal to or greater than a predetermined value ΔPs1 (e.g., 0.15 MPa).

In this way, even in the present embodiment, the blowing of uncooled air into the passenger compartment can be effectively prevented.

In the flowchart shown in FIG. 5, steps other than step S32 are the same as those of the first embodiment.

(Fourth Embodiment)

In the first embodiment, the blower retardation control operation is initiated when the discharge pressure Pd becomes equal to or greater than the predetermined value P1. However, in the present embodiment, as shown in FIG. 6, the blower retardation control operation is initiated when the intake pressure Ps becomes equal to or less than a predetermined value P2.

In this way, even in the present embodiment, the blowing of uncooled air into the passenger compartment can be effectively prevented.

In the flowchart shown in FIG. 6, steps other than step S72 are the same as those of the first embodiment.

(Fifth Embodiment)

In the present embodiment, because of existence of a correlation between the discharge pressure Pd and the discharged refrigerant temperature Td of the compressor apparatus 1, the blower retardation control operation is performed while using the discharged refrigerant temperature Td as a parameter. Characteristic control operation of the present embodiment will be described with reference to FIG. 7.

When the A/C switch or the blower switch is turned on, measurement (monitor) of the discharged refrigerant temperature Td of the compressor apparatus 1 is simultaneously initiated (S41). Then, when the discharged refrigerant temperature Td becomes equal to or greater than a predetermined temperature Td1 (e.g., about 30 degrees Celsius at the outside air temperature of 20 degrees Celsius), the blower retardation control operation is initiated (S42, S43).

Thereafter, when the elapsed measurement time period becomes equal to or greater than the predetermined time period T1, the blower 12 is started to initiate the blowing of the air into the passenger compartment (S44, S45). When the elapsed measurement time period is less than the predetermined time period T1, the blower 12 is not operated (repeating S44).

Next, advantages of the present embodiment will be described.

In the present embodiment, when the discharged refrigerant temperature Td is equal to or greater than the predetermined value, it is assumed that the displacement of the compressor apparatus 1 becomes equal to or greater than the predetermined displacement, i.e., becomes the maximum displacement. Then, the blower retardation control operation is initiated. Thus, the blowing of the uncooled air into the passenger compartment can be effectively prevented.

(Sixth Embodiment)

In the fifth embodiment, the blower retardation control operation is initiated when the discharged refrigerant temperature Td is equal to or greater than the predetermined value. However, in the present embodiment, as shown in FIG. 8, the blower retardation control operation is initiated when the currently measured temperature of discharged refrigerant shows a temperature increase ΔT from the discharged refrigerant temperature Td, which is measured at the time of activating the pressure control valve 6 to increase the displacement of the compressor apparatus 1, i.e., at the time of outputting the signal from the ECU 7 to the pressure control valve 6 to increase the displacement of the compressor apparatus 1 to the maximum displacement, becomes equal to or greater than a predetermined value ΔT1 (e.g., about 10 degrees Celsius at the outside air temperature of 20 degrees Celsius).

In this way, even in this embodiment, the blowing of uncooled air into the passenger compartment can be effectively prevented.

In the flowchart shown in FIG. 8, steps other than step S52 are the same as those of the fifth embodiment.

(Seventh Embodiment)

In the sixth embodiment, the blower retardation control operation is initiated when the temperature increase ΔT from the discharged refrigerant temperature Td, which is measured at the time of activating the pressure control valve 6 to increase the displacement of the compressor apparatus 1, becomes equal to or greater than the predetermined value ΔT1. However, in the present embodiment, as shown in FIG. 9, the blower retardation control operation is initiated when a temperature difference ΔTs between the intake refrigerant temperature Ts and the discharged refrigerant temperature Td becomes equal to or greater than a predetermined value ΔTs1 (e.g., about 15 degrees Celsius at the outside air temperature of 20 degrees Celsius).

In this way, even in the present embodiment, the blowing of uncooled air into the passenger compartment can be effectively prevented.

In the flowchart shown in FIG. 9, steps other than step S62 are the same as those of the fifth embodiment.

(Eighth Embodiment)

In the fifth embodiment, the blower retardation control operation is initiated when the discharged refrigerant temperature Td is equal to or greater than the predetermined value. However, in the present embodiment, as shown in FIG. 10, the blower retardation control operation is initiated when the intake refrigerant temperature Ts is equal to or less than a predetermined value Ts1.

In this way, even in this embodiment, the blowing of uncooled air into the passenger compartment can be effectively prevented.

In the flowchart shown in FIG. 10, steps other than step S82 are the same as those of the fifth embodiment.

(Modifications)

In the above embodiments, the control unit for controlling the blower 12 and the control unit for controlling the compressor apparatus 1 are integrated. However, the present invention is not limited to this. For example, the compressor system, which includes the compressor apparatus 1, can be separately provided from the air conditioning control unit, which controls the blower 12. The blower retardation control operation can be initiated when a signal, which indicates that the displacement of the compressor apparatus 1 is equal to or greater than the predetermined displacement, is received by the air conditioning control unit from the compressor system.

In the above embodiments, the ECU 7 corresponds to "a signal outputting means" of the present invention.

In the above embodiments, the pressure control valve 6 is provided in the passage, which connects between the outlet 1e of the compressor apparatus 1 and the swash plate chamber 1b. However, the present invention is not limited to this. For example, the pressure control valve 6 can be provided in a passage, which connects between the inlet 1d of the compressor apparatus 1 and the swash plate chamber 1b.

Additional advantages and modifications will readily occur to those skilled in the art. The invention in its broader terms is therefore not limited to the specific details, representative apparatus, and illustrative examples shown and described.

Claims

1. A compressor system including a variable displacement compressor apparatus , wherein the compressor apparatus (1) includes:

a refrigerant inlet , through which refrigerant is suctioned into the compressor apparatus ;

a refrigerant outlet , through which refrigerant is discharged from the compressor apparatus ;

a piston , which is reciprocably driven upon rotation of the compressor apparatus to compress refrigerant supplied from the refrigerant inlet ; and

a control pressure chamber , which is connected to the refrigerant inlet and the refrigerant outlet and receives refrigerant pressure from at least one of the refrigerant inlet and the refrigerant outlet , wherein the refrigerant pressure in the control pressure chamber (1b) regulates a stroke of the piston to regulate a displacement of the compressor apparatus the compressor system being characterized by:

a control valve that changes at least one of:

a degree of communication between the refrigerant inlet and the control pressure chamber ; and

a degree of communication between the control pressure chamber and the refrigerant outlet ;

a pressure sensing means for measuring at least one of a refrigerant intake pressure of the compressor apparatus and a refrigerant discharge pressure of the compressor apparatus ; and

a signal outputting means for outputting a signal when it is determined that the displacement of the compressor apparatus is equal to or greater than a predetermined displacement based on the at least one of the refrigerant intake pressure and the refrigerant discharge pressure, which are measured by the pressure sensing means .

2. The compressor system according to claim 1, characterized in that:

the pressure sensing means measures the refrigerant discharge pressure of the compressor apparatus ; and

the signal outputting means outputs the signal when the refrigerant discharge pressure, which is measured by the pressure sensing means , becomes equal to or greater than a predetermined value.

3. The compressor system according to claim 1, characterized in that:

the pressure sensing means measures the refrigerant discharge pressure of the compressor apparatus ; and

the signal outputting means outputs the signal when a currently measured refrigerant discharge pressure, which is currently measured by the pressure sensing means , shows a pressure increase, which is equal to or greater than a predetermined value, with respect to a previously measured refrigerant discharge pressure, which is measured by the pressure sensing means at a time of activating the control valve for increasing the displacement of the compressor apparatus .

4. The compressor system according to claim 1, characterized in that:

the pressure sensing means measures both the refrigerant intake pressure of the compressor apparatus and the refrigerant discharge pressure of the compressor apparatus ; and

the signal outputting means outputs the signal when a pressure difference between the refrigerant discharge pressure and the refrigerant intake pressure, which are measured by the pressure sensing means , becomes equal to or greater than a predetermined value.

5. The compressor system according to claim 1, characterized in that:

the pressure sensing means measures the refrigerant intake pressure of the compressor apparatus ; and

the signal outputting means outputs the signal when the refrigerant intake pressure, which is measured by the pressure sensing means , becomes equal to or less than a predetermined value.

6. A compressor system including a variable displacement compressor apparatus , wherein the compressor apparatus

includes:

a refrigerant inlet , through which refrigerant is suctioned into the compressor apparatus ;

a refrigerant outlet , through which refrigerant is discharged from the compressor apparatus ;

a piston , which is reciprocably driven upon rotation of the compressor apparatus to compress refrigerant supplied from the refrigerant inlet ; and

a control pressure chamber , which is connected to the refrigerant inlet and the refrigerant outlet and receives refrigerant pressure from at least one of the refrigerant inlet and the refrigerant outlet , wherein the refrigerant pressure in the control pressure chamber regulates a stroke of the piston to regulate a displacement of the compressor apparatus the compressor system being characterized by:

a control valve that changes at least one of:

a degree of communication between the refrigerant inlet and the control pressure chamber ; and

a degree of communication between the control pressure chamber and the refrigerant outlet ;

a temperature sensing means for measuring at least one of:

a temperature of intake refrigerant, which is suctioned into the compressor apparatus ; and

a temperature of discharged refrigerant, which is discharged from the compressor apparatus ; and a signal outputting means for outputting a signal when it is determined that the displacement of the compressor apparatus is equal to or greater than a predetermined displacement based on the at least one of the temperature of the intake refrigerant and the temperature of the discharged refrigerant, which are measured by the temperature sensing means .

7. The compressor system according to claim 6, characterized in that:

the temperature sensing means measures the temperature of the discharged refrigerant; and

the signal outputting means outputs the signal when the temperature of the discharged refrigerant, which is measured by the temperature sensing means , becomes equal to or greater than a predetermined value.

8. The compressor system according to claim 6, characterized in that:

the temperature sensing means measures the temperature of the discharged refrigerant; and

the signal outputting means outputs the signal when a currently measured temperature of discharged refrigerant, which is currently measured by the temperature sensing means , shows a temperature increase, which is equal to or greater than a predetermined value, with respect to a previously measured temperature of discharged refrigerant, which is measured by the temperature sensing means at a time of activating the control valve for increasing the displacement of the compressor apparatus .

9. The compressor system according to claim 6, characterized in that:

the temperature sensing means measures both the temperature of the intake refrigerant and the temperature of the discharged refrigerant; and

the signal outputting means outputs the signal when a temperature difference between the temperature of the intake refrigerant and the temperature of the discharged refrigerant, which are measured by the temperature sensing means , becomes equal to or greater than a predetermined value.

10. The compressor system according to claim 6, characterized in that:

the temperature sensing means measures the temperature of the intake refrigerant; and

the signal outputting means outputs the signal when the temperature of the intake refrigerant, which is measured by the temperature sensing means , becomes equal to or less than a predetermined value.

11. An air conditioning system characterized by:

a vapor compression refrigeration system, in which refrigerant is suctioned and compressed by the compressor system according to any one of claims 1 to 10;

a blower that blows air, which exchanges heat with the refrigerant and is blown into a room; and

a blower start control means for activating the blower when the signal is received from the signal outputting means.

12. A compressor system substantially as described herein with reference to Figs. 1, 2 and 3, or 4, 5, 6, 7, 8, 9, or 10 of the accompanying drawings.

13. An air conditioning system substantially as described herein with reference to Figs. 1, 2 and 3, or 4, 5, 6, 7, 8, 9, or 10 of the accompanying drawings.

The Patent Office

INVESTOR IN PEOPLE

Application No: GB 0327617.7 **Examiner:** David Hotchkiss
Claims searched: 1 - 5 **Date of search:** 5 April 2004

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1 & 2	US2002144512 A	(TOYOTA JIDOSHA KK) Whole document, discloses a swash plate compressor with a discharge pressure sensor and a control valve which controlls the displacement of the pump.
X	1 & 2	US5059097 A	(DIESEL KIKI CO) Whole document, discloses the maintaining of crank chamber pressure using a pressure sensor, a conrtol unit and a control valve.
X	1 & 2	JP11223183 A	(TOYODA JIDOSHOKKI SEISAKUSHO KK) The controller (33) sets a target refrigerant pressure according to sensor signals including outside and passenger compartment temperatures. Current supplied to the control valve is varied to ensure the desired pressure is reached rapidly. AN - 1999-470732 [40]
XP	1, 2, 5 & 6	US2003029181 A	(SANDEN CORP) Discloses a pressure sensor, a signal comparing device and a control valve, also discloses the use of a temperature sensor

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{W}:

F1W

Worldwide search of patent documents classified in the following areas of the IPC^{7}:

F04B

The following online and other databases have been used in the preparation of this search report:

The Patent Office

INVESTOR IN PEOPLE

Application No: GB 0327617.7
Claims searched: 1 - 5

Examiner: David Hotchkiss
Date of search: 5 April 2004

Online: WPI; EPODOC; JAPIO

An Executive Agency of the Department of Trade and Industry