

DESCRIPTION

Air Conditioner

TECHNICAL FIELD

The present invention relates to an air conditioner
5 which, after an operation stop due to power interruption during
operation, restarts operation when the power supply is
recovered.

BACKGROUND ART

In regions where power interruption often occurs due
10 to poor power supply circumstances, there has been provided an
air conditioner which, after an operation stop due to power
interruption during operation, restarts operation when a
specified delay time is clocked after the power supply is
recovered. In the air conditioner, the delay time is previously
15 set. Therefore, after a plurality of air conditioners A, B, C
as shown in Fig. 5 are all stopped during operation due to power
interruption and then the power supply is recovered by resolving
the power interruption, the individual air conditioners restart
operation by activating compressors simultaneously in the elapse
20 of the delay time since the recovery of the power supply. As
a result, there is a possibility that an overcurrent flows through
a current feeder line, causing a power supply protective breaker
to be operated, so that the feeder line may be interrupted.

DISCLOSURE OF THE INVENTION

An object of the present invention is to provide an air conditioner which is so designed that when a plurality of air conditioners are stopped during operation due to power interruption and then a power supply is recovered, the air
5 conditioners are not restarted simultaneously upon the power recovery so that an overcurrent does not flow through feeder lines, by which a power supply protective breaker can be prevented from being operated.

In order to achieve the above object, the present
10 invention provides an air conditioner which restarts operation when power supply is recovered after an operation stop due to power interruption during operation, comprising: a delay time calculating section for calculating a delay time, which is different from that of another air conditioner, when the power
15 supply is recovered; a delay timer which, upon the power recovery, starts to clock the delay time calculated by the delay time calculating section; and an operation control section for restarting the operation upon completion of the clocking by the delay timer.

20 According to this invention, when a plurality of air conditioners are stopped during operation due to power interruption and then the power supply is recovered, the delay time calculating section of the respective air conditioners calculates the delay time which is different from that of
25 another air conditioner and the delay time is set in the delay

timer. The air conditioners individually restart operation at timing varying among the air conditioners, after the delay time beginning at power recovery is clocked by the delay timer. Accordingly, no air conditioners are restarted simultaneously
5 after power recovery so that an overcurrent does not flow through the feeder line, by which the power supply protective breaker can be prevented from being operated.

In an embodiment of the present invention, the air conditioner further comprises a storage section for storing set
10 values representing operational information therein, wherein the delay time calculating section calculates the delay time from the power recovery until the operation restart based on the set values representing the operational information stored in the storage section.

15 According to the air conditioner of this embodiment, the set values representing operational information such as operational mode, air flow tap and set temperature are stored into the storage section, and the operational information is retained even if the power supply is interrupted. In this case,
20 the set values representing operational information are generally different among the air conditioners and less likely to be equal to one another. Therefore, based on these set values representing operational information, the delay time from power recovery to operation restart are calculated by the delay time
25 calculating section, by which the delay time varying among the

air conditioners can be easily set to the delay timer without setting the intentionally different delay time to every air conditioner.

In another embodiment of the present invention, the
5 air conditioner further comprises temperature sensors for detecting temperatures representing operating state, wherein the delay time calculating section calculates the delay time from the power recovery until the operation restart based on the temperatures representing the operating state detected by the
10 temperature sensors.

According to the air conditioner of this embodiment, temperatures representing operating state such as indoor temperature, outside air temperature, indoor heat exchanger temperature and outdoor heat exchanger temperature are detected
15 by the temperature sensors. In this case, the temperatures representing an operating state of the air conditioner are generally different among the air conditioners and less likely to be equal to one another. Therefore, based on these temperatures representing the operating state, the delay time
20 from power recovery to operation restart are calculated by the delay time calculating section, by which the delay time varying among the air conditioners can be easily set to the delay timer without setting the intentionally different delay time to every air conditioner.

25 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of an air conditioner according to an embodiment of the present invention;

Fig. 2 is a flowchart of a controller of the air conditioner;

5 Fig. 3 is a flowchart relevant to Fig. 2;

Fig. 4 is a timing chart showing restarts of the air conditioners; and

Fig. 5 is a timing chart showing restarts of air conditioners according to the prior art.

10 BEST MODE FOR CARRYING OUT THE INVENTION

Hereinbelow, the air conditioner of the present invention is described in detail by an embodiment thereof illustrated in the accompanying drawings.

Fig. 1 is a block diagram of an air conditioner according to an embodiment of the present invention, where
15 reference numeral 10 denotes an indoor unit and 20 denotes an outdoor unit. The indoor unit 10 has an indoor heat exchanger 1. The outdoor unit 20 has a compressor 2 the suction side of which is connected to one end of the indoor heat exchanger 1 of
20 the indoor unit 10, an outdoor heat exchanger 3 one end of which is connected to the discharge side of the compressor 2, and expansion means 4 one end of which is connected to the other end of the outdoor heat exchanger 3 and the other end of which is connected to the other end of the indoor heat exchanger 1 of the
25 indoor unit 10. The indoor heat exchanger 1, the compressor 2,

the outdoor heat exchanger 3 and the expansion means 4 constitute a refrigerant circuit. Refrigerant discharged from the compressor 2 is condensed as a result of radiating heat outdoors at the outdoor heat exchanger 3, and is expanded by the expansion means 4. Thereafter, the refrigerant evaporates at the indoor heat exchanger 1, absorbing the indoor heat. Thus, the room is cooled.

The indoor unit 10 also includes a relay 5 which turns on and off a drive voltage for the compressor 2, a controller 6 for controlling the relay 5 and the like, and a fan motor 8 which is driven into rotation by a drive signal from the controller 6. The indoor unit 10 further includes, near the fan motor 8, an indoor temperature sensor D1 for detecting indoor temperature and an indoor heat exchanger temperature sensor D2 for detecting temperature of the indoor heat exchanger 1.

Also, the controller 6, which is made up of a microcomputer, I/O circuits and the like, has a receiver section 6a for receiving an operation signal from a remote controller 7, and an EEPROM (Electrically Erasable and Programmable Read Only Memory) 6b as a storage section for storing set values representing operational information set by the remote controller 7. The controller 6 further includes a delay time calculating section 6c for calculating a delay time T based on the set values representing operational information stored in the EEPROM 6b, a delay timer 6d for clocking the delay time T

calculated by the delay time calculating section 6c, and an operation control section 6e for restarting operation upon completion end of the clocking by the delay timer 6d.

Fig. 2 is a flowchart of a main routine showing the process to be performed by the controller 6 after power recovery. Fig. 3 is a flowchart of a subroutine for the calculation process of the compressor-startup delay time T at step S3 of Fig. 2.

Now, operation of the controller 6 is explained below with reference to Figs. 2 and 3.

First, when the process is started after power recovery in Fig. 2, it is decided at step S1 whether or not the microcomputer of the controller 6 has been reset. When it is decided that the microcomputer has been reset, the program goes to step S2. On the other hand, when it is decided that the microcomputer has not been reset, this process is ended. In other words, when the state before power interruption was an operating state, the microcomputer is reset and the program goes to a process of restarting operation shown in steps S2 and the followings. On the other hand, when the state before the power interruption was a stopped state, the microcomputer is not reset and this process is ended.

Then, when the program goes to step S2, data is read from the EEPROM 6b. That is, set values (air flow set value) representing operational information in the state before the operation stop due to the power interruption are read.

Next, the program goes to step S3, where a calculation process of the startup delay time T of the compressor 2 is performed.

5 A subroutine for this calculation process of the startup delay time T of the compressor 2 is explained in detail with reference to Fig. 3. In addition, as the delay time T, a value corresponding to 3 minutes has previously been set.

First, at step S31 shown in Fig. 3, indoor temperature is determined by the indoor temperature sensor D1, and the
10 determined indoor temperature is added to the delay time T.

Next, the program goes to step S32, where temperature of the indoor heat exchanger 1 is determined by the indoor heat exchanger temperature sensor D2, and the determined indoor heat exchanger temperature is added to the delay time T.

15 Next, the program goes to step S33, where the air flow set value is added to the delay time T.

Next, the program goes to step S34, where a count value of a 1-second timer (not shown) is added to the delay time T.

Next, the program goes to step S35, where a count value
20 of a power supply synchronous timer (not shown) is added to the delay time T.

In addition, the 1-second timer and the power supply synchronous timer start clocking at the timing when the microcomputer starts up after power recovery. Because the
25 timing at which the microcomputer starts up varies among the

individual air conditioners, the count values of the 1-second timer and the power supply synchronous timer vary thereamong.

Then, at step S36, the delay time T is set to the delay timer 6d, where the program returns to the main routine of Fig.

5 2.

In the calculation process of the startup delay time T of the compressor 2, with 3 minutes added to the delay time T, a 3-minute standby is ensured so that the refrigerant circuit is equalized in internal pressure. As a result of this, the
10 compressor 2 is reduced in load, thus facilitating the restart of the compressor 2.

Next, the program goes to step S4 shown in Fig. 2, where the delay time T calculated at step S3 is set to the delay timer 6d and the clocking is started, by which the startup of the
15 compressor 2 is delayed until the clocking of the delay timer 6d is ended.

Then, at an end of the clocking of the delay timer 6d, the program goes to step S5, where the compressor 2 is started up by the operation control section 6e, by which the operation
20 is restarted. Thus, this process is ended.

Whereas concrete numerical value computations have been omitted in the description about the calculation process for delay time in Fig. 3 for an easier explanation, an example therefor is described below concretely.

For example, assume that individual parameters can take values of:

Air flow set value: auto=0, L tap=3, ML tap=4,
M tap=5, HM tap=6, H tap=7

5 Count value of 1-second timer: 0 - 59

Count value of power supply synchronous timer:

0 - 99 (for 50 Hz power supply frequency)

0 - 119 (for 60 Hz power supply frequency)

Then, with both indoor temperature and indoor heat exchanger
10 temperature assumed as 18°C, 8-bit operations are performed by
the microcomputer. First, a sum between an indoor temperature
of 12h (in hexadecimal) and an indoor heat exchanger temperature
of 12h (in hexadecimal) is determined, and further 40h (in
hexadecimal) is added to the resulting sum, by which a timer set
15 value TN is determined:

$$TN = 12h + 12h + 40h = 64h.$$

It is noted that adding 40h for determination of the
timer set value TN is a process necessary for operating the delay
timer 6d. Then, after the count value of the 1-second timer and
20 the count value of the power supply synchronous timer are added,
the highest-order 2 bits are set to 0s. Next, if the timer set
value TN is zero, the timer set value TN is made to be 3h; if
the timer set value TN is a value which is divided by 3 with a
remainder of 1, 2 is added to the timer set value TN; and if the
25 timer set value TN is a value which is divided by 3 with a remainder

of 2, 1 is added to the timer set value TN so that the timer set value TN is made to be a multiple of 3. Then, with 40h added to the timer set value TN, the resulting value is set to the delay timer 6d. In this way, the timer set value TN to be set to the
5 delay timer 6d becomes a multiple of 3, where setting a minimum count value of the delay timer 6d to 100 msec makes the timer set value TN set in steps of the delay time T of 300 msec. This value of 300 msec is a minimum time lag that prevents any overlap of peak currents when the compressor is started up at operation
10 restart of the air conditioner in this case. Accordingly, delay times T different in steps of 300 msec are set to the delay timer.

In the case where a plurality of air conditioners having the above constitution are installed, for example, when the plurality of air conditioners A, B, C as shown in Fig. 4
15 are all stopped during operation due to power interruption and then the power supply is recovered, the air conditioners A, B, C are set to delay times TA, TB, TC, which vary among the air conditioners, by their respective controllers 6. Then, the air conditioners A, B, C restart operation at timings varying
20 thereamong after the delay times TA, TB, TC have elapsed since power recovery.

Therefore, the air conditioners are not restarted simultaneously after the power supply is recovered, so that an overcurrent does not flow through the feeder line, by which the

power supply protective breaker can be prevented from being operated.

Also, the set values (air flow set value) representing operational information are stored into the EEPROM 6b, and the operational information is retained even if the power supply is interrupted. Besides, indoor temperature and the temperature of the indoor heat exchanger 1 representing operating state are detected by the indoor temperature sensor D1 and the indoor heat exchanger temperature sensor D2, respectively. In this air conditioner, delay times T from power recovery to operation restart are calculated by the delay time calculating section 6c based on the set values representing the operational information, the indoor temperature and the temperature of the indoor heat exchanger 1 representing the operating state detected after the power recovery, and the count values of the 1-second timer and the power supply synchronous timer. As a result of this, delay times T of different values can be easily set to the delay timer 6d without setting different delay times to the air conditioners.

Further, the delay times T to be set to the delay timer 6d may also be calculated based on the following setting items and various kinds of temperatures representing operating state without being limited to the aforementioned parameters:

Setting items:

Operational mode: auto=1, dry=2, cooling=3,
heating=4, air=5

Air flow set value: auto=0, L tap=3, ML tap=4,
M tap=5, HM tap=6, H tap=7

5 Set temperature

Various temperatures:

Indoor temperature

Outside air temperature

Indoor heat exchanger temperature

10 Outdoor heat exchanger temperature

For example, given

operational mode: cooling=3

air flow tap: M tap=5

indoor temperature: 29°C

15 outside side temperature: 33°C

indoor heat exchanger temperature: 26°C

outdoor heat exchanger temperature: 36°C

set temperature: 26°C,

then the delay time T is

20 $T = 3+5+29+33+26+36+26 = 158$ (sec)

where the initial value of the delay time T is zero.

In the above embodiment, it has been arranged that the delay time T is determined by the delay time calculating section 6c based on set values representing operational information and
25 temperatures representing operating state. However, the delay

time may also be calculated by the delay time calculating section based on either one of the set values representing operational information or the temperatures representing operating state. Also, different delay times T may be set for the individual air
5 conditioners in advance or set after installation, or the delay times may be calculated by random number generation.

Further, in the above embodiment, it has also been arranged that a standby time of 3 minutes is previously set to the delay time T for equalizing the pressure of the refrigerant
10 circuit, and various parameters are added thereto. However, with a 3-minute standby timer additionally provided, the delay time may be clocked upon an expiration of the 3-minute standby timer after power recovery.

Furthermore, the above embodiment has been described
15 with regard to an air conditioner that performs cooling operation only. However, as a matter of course, the present invention may be applied to air conditioners which perform both cooling and heating operations. Also, whereas an air conditioner in which the indoor unit 10 and the outdoor unit 20 are provided separately
20 from each other, the invention may also be applied to air conditioners in which the indoor unit and the outdoor unit are integrated together.

INDUSTRIAL APPLICABILITY

As shown above, the present invention is applicable
25 to a plurality of air conditioners which are simultaneously

operated, and useful for preventing a power supply protective breaker being operated by allowing no overcurrent to flow through a feeder line.



CLAIMS:

1. An air conditioner which restarts operation when power supply is recovered after an operation stop due to power interruption during operation, comprising:

5 a delay time calculating section (6c) for calculating a delay time, which is different from that of another air conditioner, when the power supply is recovered;

a delay timer (6d) which, upon the power recovery, starts to clock the delay time calculated by the delay time
10 calculating section (6c); and

an operation control section (6e) for restarting the operation upon completion of the clocking by the delay timer (6d).

2. The air conditioner as set forth in claim 1, further comprising:

15 a storage section (6b) for storing set values representing operational information therein, wherein

the delay time calculating section (6c) calculates the delay time from the power recovery until the operation restart based on the set values representing the operational information
20 stored in the storage section (6b).

3. The air conditioner as set forth in claim 1, further comprising:

temperature sensors (D1, D2) for detecting temperatures representing operating state, wherein



the delay time calculating section (6c) calculates the delay time from the power recovery until the operation restart based on the temperatures representing the operating state detected by the temperature sensors (D1, D2).