



(11)

EP 3 026 359 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
01.06.2016 Bulletin 2016/22

(51) Int Cl.:
F24F 11/00 (2006.01)

(21) Application number: **15194844.5**

(22) Date of filing: **17.11.2015**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(71) Applicant: **MITSUBISHI HEAVY INDUSTRIES, LTD.**
Tokyo 108-8215 (JP)

(72) Inventor: **ISHIZUKA, Hirofumi**
TOKYO, 108-8215 (JP)

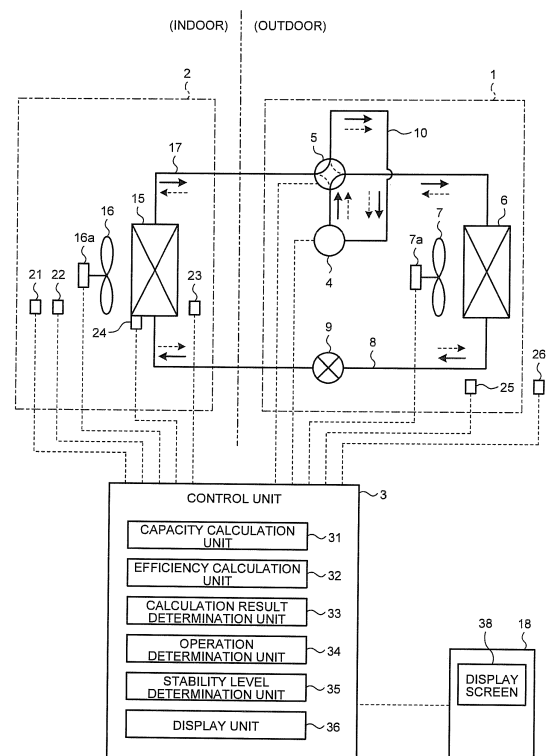
(74) Representative: **Intès, Didier Gérard André et al**
Cabinet Beau de Loménie
158, rue de l'Université
75340 Paris Cedex 07 (FR)

(30) Priority: **20.11.2014 JP 2014235785**

(54) **AIR CONDITIONER**

(57) An air conditioner is provided with an outdoor unit (1) including a compressor (4), an outdoor heat exchanger (6), and a throttle (9), and an indoor unit (2) including an indoor heat exchanger (15) and an indoor blower (16). The air conditioner includes: a capacity calculation unit (31) that calculates capacity of the indoor unit (2) in operation; an efficiency calculation unit (32) that continuously acquires the capacity of the indoor unit (2) calculated by the capacity calculation unit (31) every predetermined period and calculates efficiency of the indoor unit (2) for each of the predetermined period; a calculation result determination unit (33) that determines respective calculation results by comparing the capacity of the indoor unit (2) calculated by the capacity calculation unit (31) and the efficiency of the indoor unit (2) calculated by the efficiency calculation unit (32) with preliminarily set reference capacity and reference efficiency; and a display unit (36) that displays, on a display screen (38), determination by the calculation result determination unit (33).

FIG.1



Description

Field of the invention

5 [0001] The present invention relates to an air conditioner.

Background of the invention

10 [0002] An air conditioner such as for instance disclosed in Patent Literature 1 aims at easily measuring cooling/heating capacity, and includes:

a detection device built inside an air conditioner main body and configured to detect intake air temperature, intake air relative humidity, outlet air temperature, outlet air relative humidity, and a fan rotary speed;
 a calculator configured to calculate cooling/heating capacity from respective data detected by the mentioned detection
 15 device based on a predetermined formula; and
 a display screen configured to display cooling/heating capacity calculated in the calculator.

Citation List

20 Patent Literature

[0003] Patent Literature 1: Japanese Utility Model Application Laid-open No. 61-194138

Summary

25 Technical Problem

[0004] The capacity of an air conditioner varies from moment to moment due to operating conditions. Therefore, it is difficult to determine whether the calculated capacity is normal, and an operation state of an air conditioner is confirmed with low reliability.

[0005] The present invention aims at solving such a problem, and directed to providing an air conditioner that can improve the reliability of confirming the operation state of the air conditioner.

Solution to Problem

35 [0006] According to an aspect of the present invention, an air conditioner is provided that includes an outdoor unit including a compressor, an outdoor heat exchanger and a throttle, and an indoor unit including an indoor heat exchanger and an indoor blower, wherein said air conditioner comprises: a capacity calculation unit configured to calculate capacity of the indoor unit in operation; an efficiency calculation unit configured to continuously acquire the capacity of the indoor unit calculated by the capacity calculation unit every predetermined times and calculate efficiency of the indoor unit for each of the predetermined times; a calculation result determination unit configured to determine respective calculation results by comparing the capacity of the indoor unit calculated by the capacity calculation unit and the efficiency of the indoor unit calculated by the efficiency calculation unit with predetermined reference capacity and reference efficiency; and a display unit configured to display a determination by the calculation result determination unit on a display screen.

40 [0007] This air conditioner enables to determine whether the calculated capacity and efficiency is normal, and reliability of confirming the operation state can be improved.

[0008] Advantageously, the air conditioner further comprises a stability level determination unit configured to determine stability levels of calculated capacity and efficiency. The display unit displays "activating" on the display screen in the case where the stability level is determined as low by the stability level determination unit, displays "determining" on the display screen in the case where the stability level is determined as high by the stability level determination unit, and displays a determination result of an operation state on the display screen in the case where the stability level is determined as high by the stability level determination unit and the high stability level is continuously determined predetermined number of times.

55 [0009] According to an embodiment of the air conditioner, a process until determining the operation state and the determination result of the operation state can be confirmed by the display on the display screen.

[0010] Advantageously, in the air conditioner, the display unit displays a factor causing a low capacity on the display screen.

[0011] According to an embodiment of the air conditioner, a measure to improve a state of low capacity can be taken.

[0012] Advantageously, in the air conditioner, the display unit displays a factor causing a low efficiency on the display screen.

[0013] According to an embodiment of the air conditioner, a measure to improve a state of low efficiency can be taken.

5 **[0014]** Advantageously, in the air conditioner, the stability level determination unit determines a stability level of the indoor unit based on a rotary speed of the compressor, and the display unit displays the stability level determined by the stability level determination unit on the display screen.

[0015] According to an embodiment of the air conditioner, a stability level of the measured value can be confirmed by the display on the display screen.

10 **[0016]** Advantageously, the air conditioner further comprises an outlet temperature detector configured to detect an outlet air temperature at an outlet portion of the indoor unit. The stability level determination unit determines the stability level of the indoor unit based on the rotary speed of the compressor and the outlet air temperature detected by the outlet temperature detector.

[0017] According to an embodiment of the air conditioner, accuracy of determining the stability level can be improved.

15 **[0018]** Advantageously, in the air conditioner, the display unit displays a proposed measure to improve the efficiency of the indoor unit on the display screen.

[0019] According to an embodiment of the air conditioner, a measure to improve the efficiency can be proposed to an operator.

[0020] Advantageously, in the air conditioner, the display unit displays an anticipated effect in the case of improving efficiency on the display screen.

20 **[0021]** According to an embodiment of the air conditioner, in the case of proposing the measure to improve the efficiency to the operator, an effect in the case of improving the efficiency can be presented.

[0022] Advantageously, in the air conditioner, the display screen is disposed at a remote controller configured to control the air conditioner.

25 **[0023]** According to an embodiment of the air conditioner, the remote controller is held by a hand when the operator controls the air conditioner. Therefore, when the display screen is provided at the remote controller, the operator can easily confirm the display thereon.

Advantageous Effects of Invention

30 **[0024]** The air conditioner described in the present application enables to determine whether calculated capacity and efficiency are normal, and reliability of confirming an operation state can be improved.

Brief Description of Drawings

35 **[0025]**

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

FIG. 2 is a table illustrating an efficiency improvement proposed map of the air conditioner according to the embodiment of the present invention.

40 FIG. 3 is a table illustrating an efficiency improvement proposed map of the air conditioner according to the embodiment of the present invention.

FIG. 4 is a table illustrating an efficiency improvement proposed map of the air conditioner according to the embodiment of the present invention.

FIG. 5 is a flowchart illustrating operation of the air conditioner according to the embodiment of the present invention.

45 FIG. 6 is a flowchart illustrating operation of the air conditioner according to the embodiment of the present invention.

Description of Embodiments

50 **[0026]** Embodiments of the present invention will be described below in detail based on the attached drawings. Note that the present invention is not limited by these embodiments. Further, components in the following embodiments may include those easily conceivable by men skilled in the art or those substantially equivalent.

[0027] FIG. 1 is a schematic block diagram of an air conditioner according to an embodiment of the present invention. Further, FIGS. 2 to 4 are tables illustrating efficiency improvement proposed maps of the air conditioner according to the present embodiment.

55 **[0028]** As illustrated in FIG. 1, the air conditioner includes an outdoor unit 1, an indoor unit 2, and a control unit 3.

[0029] The outdoor unit 1 includes, inside a casing, a compressor 4, four-way selector valve 5, an outdoor heat exchanger 6, and an outdoor blower 7. Further, refrigerant piping 8 and a throttle 9 are disposed in the outdoor unit 1, and the four-way selector valve 5, the outdoor heat exchanger 6, and the throttle 9 are disposed on the way of the

refrigerant piping 8. Additionally, refrigerant piping 10 is disposed in the outdoor unit 1, and the compressor 4 and the four-way selector valve 5 are disposed on the way of the refrigerant piping 10.

[0030] The indoor unit 2 includes, inside a casing, an indoor heat exchanger 15 and an indoor blower 16. Further, refrigerant piping 17 is disposed in the indoor unit 2, and the indoor heat exchanger 15 is disposed on the way of the refrigerant piping 17. Additionally, the refrigerant piping 8 of the outdoor unit 1 and the refrigerant piping 17 of the indoor unit 2 are mutually connected to form a circulation circuit.

[0031] The control unit 3 is, for example, a central processing unit (CPU) and controls the outdoor unit 1 and the indoor unit 2 integrally. More specifically, the control unit 3 is: connected to the compressor 4 to control a rotary speed of the compressor 4; connected to the four-way selector valve 5 to control switch of the four-way selector valve 5; connected to a motor 7a of the outdoor blower 7 to control a rotary speed of the outdoor blower 7; and connected to a motor 16a of the indoor blower 16 to control a rotary speed of the indoor blower 16. Further, a remote controller 18 connected wirelessly or by a wire is connected to the control unit 3, and the outdoor unit 1 and the indoor unit 2 are controlled in accordance with control by the remote controller 18.

[0032] More specifically, in the case where control to perform cooling operation is made by the remote controller 18, the control unit 3 switches the four-way selector valve 5. Further, as shown by arrows of solid line illustrated in FIG. 1, gas refrigerant compressed by the compressor 4 passes through the refrigerant piping 8 via the four-way selector valve 5 and enters the outdoor heat exchanger 6, and then radiates heat in the outdoor heat exchanger 6 to outside air fed by the outdoor blower 7. By this, the gas refrigerant is condensed and becomes liquid refrigerant. The liquid refrigerant passes through the refrigerant piping 8 and is adiabatically expanded by being throttled at the throttle 9. After that, the liquid refrigerant passes through the refrigerant piping 17 from the refrigerant piping 8 and enters the indoor heat exchanger 15. In the indoor heat exchanger 15, the liquid refrigerant is evaporated and becomes the gas refrigerant by cooling indoor air fed by the indoor blower 16. As a result, an indoor temperature is decreased. After that, the gas refrigerant passes through the refrigerant piping 8 from the refrigerant piping 17, and passes through the refrigerant piping 10 via the four-way selector valve 5, and then is taken into the compressor 4.

[0033] On the other hand, in the case where control to perform heating operation is made by the remote controller 18, the control unit 3 switches the four-way selector valve 5 to a direction opposite to the cooling operation. Further, as shown by arrows of dotted line illustrated in FIG. 1, the gas refrigerant compressed by the compressor 4 passes through the refrigerant piping 10 and the four-way selector valve 5, passes through the refrigerant piping 17 from the refrigerant piping 8, and then enters the indoor heat exchanger 15. After that, the gas refrigerant passes through the refrigerant piping 8 from the refrigerant piping 17, sequentially passes through the throttle 9, the outdoor heat exchanger 6, and the four-way selector valve 5, and then returns to the compressor 4. Further, in the indoor heat exchanger 15, the indoor air is heated in the process in which the gas refrigerant radiates heat to the indoor air fed by the indoor blower 16 and is condensed. As a result, the indoor temperature is increased.

[0034] According to the present embodiment, the control unit 3 is connected to an intake humidity detector 21, an intake temperature detector 22, an outlet temperature detector 23, and a refrigerant saturation temperature detector 24 which are disposed in the indoor unit 2. Further, the control unit 3 is connected to a current detector 25 disposed in the outdoor unit 1. Additionally, the control unit 3 is connected to an outside air temperature detector 26 disposed outside (outside the casing of the outdoor unit 1).

[0035] The intake humidity detector 21 detects humidity of the indoor air taken into the casing from the indoor blower 16 in the indoor unit 2. The intake temperature detector 22 detects a temperature of the indoor air taken into the casing by the indoor blower 16 in the indoor unit 2. The outlet temperature detector 23 detects a temperature of the air which has been fed by the indoor blower 16 and passed through the indoor heat exchanger 15 in the indoor unit 2. The refrigerant saturation temperature detector 24 is a temperature sensor that detects a saturation temperature of the refrigerant in the indoor heat exchanger 15. The current detector 25 detects current consumed in the outdoor unit 1. The outside air temperature detector 26 detects an outside air temperature. Detection results of these detectors are acquired by the control unit 3.

[0036] Further, the control unit 3 includes a capacity calculation unit 31, an efficiency calculation unit 32, a calculation result determination unit 33, an operation determination unit 34, a stability level determination unit 35, and a display unit 36. These units are, for example, stored as a program in a storage unit which is a hard disk device or a semiconductor storage device not illustrated.

[0037] The capacity calculation unit 31 calculates capacity of the indoor unit 2 in operation (cooling operation capacity and heating operation capacity). More specifically, the capacity calculation unit 31 calculates capacity of the indoor unit 2 by using a following formula (1) from an enthalpy difference calculated based on the detection results of the intake temperature detector 22, the intake humidity detector 21, and the outlet temperature detector 23, and an air flow rate of the indoor unit stored in the control unit 3.

$$Q = G (H_b - H_a) \quad (1)$$

[0038] Here, Q is the capacity of the indoor unit, G is a weight flow rate during blowing operation, H_a is an enthalpy of the intake air, and H_b is an enthalpy of the outlet air.

[0039] The efficiency calculation unit 32 calculates efficiency of the indoor unit 2 in operation (cooling operation efficiency and heating operation efficiency). More specifically, the efficiency calculation unit 32 calculates the efficiency of the indoor unit 2 in operation by dividing the capacity calculated by the capacity calculation unit 31 by power consumption detected by the current detector 25.

[0040] The calculation result determination unit 33 determines the capacity calculated by the capacity calculation unit 31 and the efficiency calculated by the efficiency calculation unit 32. More specifically, reference capacity and reference efficiency are preliminarily set in the calculation result determination unit 33. The reference capacity is an intrinsic capacity under the same conditions as when the capacity is calculated by the capacity calculation unit 31. The reference efficiency is an intrinsic efficiency under the same conditions when the efficiency is calculated by the efficiency calculation unit 32. Further, the calculation result determination unit 33 makes determination by comparing the capacity calculated by the capacity calculation unit 31 with the reference capacity. Also, the calculation result determination unit 33 makes determination by comparing the efficiency calculated by the efficiency calculation unit 32 with the reference efficiency. For example, in the case where the calculated capacity is 80% or more of the reference capacity and the calculated efficiency is 75% or more of the reference efficiency, the calculation results of the capacity and the efficiency are determined as normal. Further, in the case where the calculated capacity is less than 80% of the reference capacity and the calculated efficiency is 75% or more of the reference efficiency, the calculation result of the capacity is determined as short of capacity. Further, in the case where the calculated capacity is 80% or more of the reference capacity and the calculated efficiency is less than 75% of the reference efficiency, the calculation result of the efficiency is determined as short of efficiency.

[0041] The stability level determination unit 35 determines a stability level of the indoor unit 2 based on a rotary speed of the compressor 4, or the rotary speed of the compressor 4 and an outlet air temperature detected by the outlet temperature detector 23. The stability level determination unit 35 determines the stability level of the indoor unit 2. The stability level can be determined based on the rotary speed of the compressor 4 because capacity and efficiency of the indoor unit 2 is largely affected by the rotary speed of the compressor 4. Further, in the case of having the outlet temperature detector 23, the stability level of the indoor unit 2 is determined based on the rotary speed of the compressor 4 and the outlet air temperature detected by the outlet temperature detector 23. More specifically, the stability level determination unit 35 acquires the rotary speed of the compressor 4 every five minutes, and calculates an absolute value of (A₂ - A₁)/A₁ in the case of defining a previous rotary speed as A₁ and a current rotary speed as A₂. Further, for example, when the calculation result is 20% or less, the stability level is determined as "high"; when 21% or more and 50% or less, the stability level is determined as "normal"; and when 51% or more, the stability level is determined as "low". Further, the stability level determination unit 35 acquires the outlet air temperature detected every five minutes by the outlet temperature detector 23, and calculates an absolute value of (B₂ - B₁) in the case of defining the previous outlet air temperature as B₁ and the current outlet air temperature as B₂. Further, when the calculated result is 1°C or less, the stability level is determined as "high"; when 1°C or more and 2°C or less, the stability level is determined as "normal"; and when 3°C or more, the stability level is determined as "low". Additionally, based on the rotary speed of the compressor 4 and the outlet air temperature detected by the outlet temperature detector 23, the stability level determination unit 35 determines that: the stability level is "low" when either one of the stability level is "low"; the stability level is "normal" when either one of the stability levels is "normal" and both of the stability levels are not "low"; and the stability level is "high" when both stability levels are high.

[0042] The operation determination unit 34 determines, based on the determination by the stability level determination unit 35, whether operation of the air conditioner is in a stable state in which the measured values fluctuate within a predetermined range for a predetermined time. More specifically, operation is determined as stable operation when the stability level is determined as high by the stability level determination unit 35 and such determination continues predetermined number of times. For example, determination by the stability level determination unit 35 is made every five minutes, and in the case where the stability level of capacity and efficiency is determined as high three times or more, operation is determined as stable operation.

[0043] The display unit 36 performs various kinds of displays on a display screen 38. In the present embodiment, the display screen 38 is provided at the remote controller 18, but may also be provided at the indoor unit 2, for example, other than remote controller 18.

[0044] The display unit 36 displays a calculation result determined by the calculation result determination unit 33. Further, the display unit 36 displays "activating" on the display screen 38 in the case where the stability levels of the calculated capacity and efficiency are determined as low by the stability level determination unit 35, and displays "de-

termining" on the display screen 38 in the case where the stability levels of the calculated capacity and efficiency are determined as high by the stability level determination unit 35. In the case where the stability levels of the calculated capacity and efficiency are determined as high by the stability level determination unit 35 and such high a stability level continuously determined by the operation determination unit 34 the predetermined number of times, the display unit 36 determines the operation state as "stable operation" and displays a determination result of the operation state on the display screen 38.

[0045] Further, in the case where the operation state is determined as "stable operation" by the operation determination unit 34, the display unit 36 displays, on the display screen 38, the capacity and efficiency of the indoor unit 2 in the stable operation. Meanwhile, the display unit 36 may also display the capacity and the efficiency of the indoor unit 2 on the display screen 38 even in the case where determination of "activating" or "determining" is made by the operation determination unit 34.

[0046] Further, in the case where the capacity of the indoor unit 2 in the stable operation is lower than preset capacity, the display unit 36 displays a matter constituting a factor of low capacity on the display screen 38. For example, the matters constituting the factor of low capacity are: "(1) Is the length of piping between the indoor unit and the outdoor unit long?"; "(2) Is heat insulation of the piping between the indoor unit and the outdoor unit sufficient?"; "(3) Isn't an intake port or an outlet port of the indoor unit or outdoor unit blocked?"; and "(4) Is an amount of refrigerant sufficient?".

[0047] Further, in the case where efficiency of the indoor unit 2 in stable operation is lower than preset efficiency, the display unit 36 displays a matter constituting a factor of low efficiency on the display screen 38. For example, the matters constituting the factor of low efficiency are: "(1) Is the amount of refrigerant appropriate?"; and "(2) Is an operating point appropriate?".

[0048] Further, the display unit 36 displays, on the display screen 38, the stability level determined by the stability level determination unit 35. As described above, the stability levels are displayed as, for example "high", "normal", and "low". Further, in the case where the stability level fluctuates, the stability level is displayed in accordance with a fluctuation level: "high" when stable, "normal" in the case of gradual fluctuation, and "low" in the case of rapid fluctuation.

[0049] Additionally, the display unit 36 displays, on the display screen 38, a proposed measure to improve efficiency of the indoor unit 2 in the stable operation. More specifically, changing an air flow rate of the indoor blower 16 (rotary speed of the motor 16a) may be the proposed improvement measure. In this case, an improvement level is acquired based on a relation map between the air flow rate of the indoor blower 16 and the rotary speed of the compressor 4 illustrated in FIG. 2. Therefore, the display unit 36 can display, on the display screen 38, the proposed measure together with the improvement level. Further, changing a setting temperature may be the proposed improvement measure. When the setting temperature is changed, required capacity is changed and power consumption is reduced, thereby improving the efficiency. In this case, when the outside temperature is 28°C, for example, the load can be made to 5.1 kw from 5.7 kw by changing the setting temperature from 25°C to 26°C based on a relation map between the setting temperature and a load relative to the outside temperature illustrated in FIG. 3. At this point, the rotary speed of the compressor 4 is changed from 59 rps to 51 rps based on a relation map between the setting temperature and the rotary speed of the compressor 4 relative to the outside temperature illustrated in FIG. 4. Further, an improvement level of efficiency in the case where the rotary speed of the compressor 4 is changed can be acquired. The improvement level of efficiency can be acquired from the relation between the rotary speed of the compressor 4 and the efficiency. Based on these results, the capacity and efficiency in the case of changing the setting temperature can be acquired. Therefore, the display unit 36 can display, on the display screen 38, the improvement level, capacity and efficiency together with the proposed measure. Additionally, opening a window may be the proposed improvement measure. In the case where the outside air is sufficiently low during cooling operation, lowering a room temperature by introducing the outside air is recommend. In this case, the display unit 36 displays, on the display screen 38, a power amount (current power consumption amount) that can be reduced by stopping the air conditioner in the case where the room temperature is, for example, 5°C lower than the outside air temperature.

[0050] Further, the display unit 36 displays, on the display screen 38, an effect in the case of improving the efficiency in accordance with the proposed measure. For example, in the case of keeping current efficiency as it is, "current efficiency: 3.0" is displayed. In the case where setting is changed so as to improve the matter constituting the factor of the low efficiency (for example, in the case of selecting energy saving operation 1 not illustrated), "energy saving operation 1: 4.0" is displayed, a decrease rate of the power consumption in the case of changing the setting is displayed as "decrease rate of power consumption 75%", and a reduction rate of an electric bill in the case of performing 10-hour operation after the setting change is displayed as "reduction rate of electric bill: about 230 yen".

[0051] In the following, operation of the above-described air conditioner will be described. FIGS. 5 and 6 are flowcharts illustrating the operation of the air conditioner according to the present embodiment.

[0052] As illustrated in FIG. 5, the air conditioner is made to perform cooling operation or heating operation as desired (Step S1). After Step S1, capacity of the indoor unit 2 for a predetermined period (e.g., 5 minutes) is calculated (Step S2), and efficiency of the indoor unit 2 for the same period is calculated (Step S3). Here, in the case of having an outlet air temperature sensor instead of calculating the capacity of the indoor unit, a change rate of the outlet air temperature

may be calculated in Step S2, and a change rate of the rotary speed of the compressor may be calculated in Step S3.

[0053] After Step S3, the stability levels of the calculated capacity and efficiency (or the outlet air temperature and the rotary speed of the compressor) are determined by the stability level determination unit 35

[0054] (Step S4). Note that the stability level determined in Step S4, such as "high", "normal", or "low" is displayed on the display screen 38. In the case where the stability level is low in this stability level determination (Step S5: No), "activating" is displayed on the display screen 38 (Step S6), and operation returns to Step S2. On the other hand, in the case where the stability level is high in the stability level determination in Step S4 (Step S5: Yes), when the stability level is not continuously determined by the operation determination unit 34 the predetermined number of times (Step S7: No), 1 is added to current number of times n (Step S8), and "determining" is displayed on the display screen 38 (Step S9), and then operation returns to Step S2. Further, in Step S8, when the high stability level is continuously determined by the operation determination unit 34 the predetermined number of times (Step S7: Yes), the operation state is determined as stable operation (Step S10). Then, operation is shifted to a calculation result determination flow for capacity and efficiency illustrated in FIG. 6.

[0055] In the stable operation, the capacity of the indoor unit 2 is calculated in the same manner as above-described Steps S2, S3 as illustrated in the calculation result determination flow in FIG. 6 (Step S21), and the efficiency of the indoor unit 2 is calculated (Step S22). Meanwhile, in the case where the capacity of the indoor unit and the efficiency of the indoor unit are calculated in Steps S2, S3 when determination of the stable operation is made in above-described Step S10, the capacity and the efficiency here may be those calculated here or may be newly calculated after determination of the operation is made in above-described Step S10.

[0056] Subsequently, the calculation result is determined by the calculation result determination unit 33 (Step S23). In the case where the determination result in Step S23 is normal (Step S24: Yes), "stable operation" and "normal" are displayed on the display screen 38 as a determination result of the operation state (Step S25), and further the calculated capacity and efficiency are displayed (Step S26). Further, ratios of measured values of the capacity and the efficiency relative to the reference efficiency, which are calculated by the calculation result determination unit 33 half way for determination, may be displayed on the display screen 38. After that, a proposed measure to improve the capacity and efficiency and an effect of improvement are displayed (Step S27). On the other hand, in the case where the determination result is not normal and short of capacity or short of efficiency are determined in Step S23 (Step S24: No), "stable operation", and "short of capacity" or "short of efficiency" are displayed on the display screen 38 (Step S28). Further, a factor causing the short of capacity or the short of efficiency are displayed (Step S29) and also the calculated capacity and efficiency are displayed (Step S30).

[0057] Thus, the air conditioner according to the present embodiment is provided with: the outdoor unit 1 including the compressor 4, outdoor heat exchanger 6, and throttle 9; and the indoor unit 2 including the indoor heat exchanger 15 and the indoor blower 16. The air conditioner includes: the capacity calculation unit 31 that calculates capacity of the indoor unit 2 in operation; the efficiency calculation unit 32 that continuously acquires the capacity of the indoor unit 2 calculated by the capacity calculation unit 31 every predetermined period and calculates efficiency of the indoor unit 2 for each of the predetermined period; the calculation result determination unit 33 that determines respective calculation results by comparing the capacity of the indoor unit 2 calculated by the capacity calculation unit 31 and the efficiency of the indoor unit 2 calculated by the efficiency calculation unit 32 with the preliminarily set reference capacity and reference efficiency; and the display unit 36 that displays, on the display screen 28, determination by the calculation result determination unit 33.

[0058] According to the air conditioner disclosed in the present application, it is possible to determine whether the calculated capacity and efficiency is normal, and reliability of confirming the operation state can be improved. Note that operation (operation illustrated in FIG. 5) may be performed in test run of the air conditioner, and capacity and efficiency can be concretely confirmed at the time of the test run.

[0059] Further, the air conditioner according to the present embodiment further includes the stability level determination unit 35 that determines stability levels of the calculated capacity and efficiency. The display unit 36 displays activating on the display screen 38 in the case where the stability level is determined as low by the stability level determination unit 35, displays determining on the display screen 38 in the case where the stability level is determined as high by the stability level determination unit 35, and displays a determination result of the stable operation state on the display screen 38 in the case where the stability level is determined as high by the stability level determination unit 35 and such high stability level is continuously determined the predetermined number of times.

[0060] According to such an air conditioner, it is possible to confirm, by the display on the display screen 38, a process until the operation state is determined and a determination result of the operation state.

[0061] Further, in the air conditioner of the present embodiment, the display unit 36 displays the matter constituting a factor of low capacity is displayed on the display screen 38.

[0062] According to an embodiment of the air conditioner, a measure to improve the state of low capacity can be taken.

[0063] Further, in the air conditioner of the present embodiment, the display unit 36 displays the matter constituting a factor of low efficiency is displayed on the display screen 38.

[0064] According to an embodiment of the air conditioner, a measure to improve a state of low efficiency can be taken.

[0065] Further, the air conditioner of the present embodiment further includes the stability level determination unit 35 that determines the stability level of the indoor unit 2 based on the rotary speed of the compressor 4. The display unit 36 displays the stability level determined by the stability level determination unit 35 on the display screen 38 in the case where the operation state is determined as stable operation by the operation determination unit 34.

[0066] According to such an air conditioner, the stability level of the measure values can be confirmed by the display on the display screen 38.

[0067] Further, in the air conditioner of the present embodiment, the outlet temperature detector 23 that detects an outlet air temperature at the outlet portion of the indoor unit 2, and the stability level determination unit 35 determines the stability level of the indoor unit 2 based on the rotary speed of the compressor 4 and the outlet air temperature detected by the outlet temperature detector 23.

[0068] According to such an air conditioner, accuracy of determining the stability level can be improved.

[0069] Further, in the air conditioner of the present embodiment, the display unit 36 displays, on the display screen 38, a proposed measure to improve the efficiency of the indoor unit 2 in the stable operation.

[0070] According to such an air conditioner, a measure to improve the efficiency can be proposed to an operator.

[0071] Further, in the air conditioner of the present embodiment, the display unit 36 displays an effect in the case of improving the efficiency on the display screen 38.

[0072] According to such an air conditioner, in the case of proposing the measure to improve the efficiency to the operator, an effect in the case of improving the efficiency can be presented.

[0073] Further, in the air conditioner of the present embodiment, the display screen 38 is provided at the remote controller 18 to control the air conditioner.

[0074] According to an embodiment of the air conditioner, the remote controller 18 is held by a hand when the operator controls the air conditioner. Therefore, the operator can easily confirm the display when the display screen 38 is provided at the remote controller 18.

Reference Signs List

[0075]

- 1 OUTDOOR UNIT
- 2 INDOOR UNIT
- 4 COMPRESSOR
- 6 OUTDOOR HEAT EXCHANGER
- 9 THROTTLE
- 15 INDOOR HEAT EXCHANGER
- 16 INDOOR BLOWER
- 18 REMOTE CONTROLLER
- 23 OUTLET TEMPERATURE DETECTOR
- 31 CAPACITY CALCULATION UNIT
- 32 EFFICIENCY CALCULATION UNIT
- 33 CALCULATION RESULT DETERMINATION UNIT
- 34 OPERATION DETERMINATION UNIT
- 35 STABILITY LEVEL DETERMINATION UNIT
- 36 DISPLAY UNIT
- 38 DISPLAY SCREEN

Claims

1. An air conditioner including an outdoor unit (1) including a compressor (4), an outdoor heat exchanger (6) and a throttle (9), and an indoor unit (2) including an indoor heat exchanger (15) and an indoor blower (16), said air conditioner comprising:

a capacity calculation unit (31) configured to calculate capacity of the indoor unit (2) in operation;
an efficiency calculation unit (32) configured to continuously acquire the capacity of the indoor unit (2) calculated by the capacity calculation unit (31) every predetermined times and calculate efficiency of the indoor unit (2) for each of the predetermined times;

a calculation result determination unit (33) configured to determine respective calculation results by comparing the capacity of the indoor unit (2) calculated by the capacity calculation unit (31) and the efficiency of the indoor unit (2) calculated by the efficiency calculation unit (32) with predetermined reference capacity and reference efficiency; and

a display unit (36) configured to display a determination by the calculation result determination unit (33) on a display screen (38).

2. The air conditioner according to claim 1, further comprising a stability level determination unit (35) configured to determine stability levels of calculated capacity and efficiency,

wherein the display unit (36) is configured to display "activating" on the display screen (38) in the case where the stability level is determined as low by the stability level determination unit (35), to display "determining" on the display screen (38) in the case where the stability level is determined as high by the stability level determination unit (35), and to display a determination result of an operation state on the display screen (38) in the case where the stability level is determined as high by the stability level determination unit (35) and the high stability level is continuously determined predetermined number of times.

3. The air conditioner according to claim 1 or 2, wherein the display unit (36) is configured to display a factor causing a low capacity on the display screen (38).

4. The air conditioner according to any one of claims 1 to 3, wherein the display unit (36) is configured to display a factor causing a low efficiency on the display screen (38).

5. The air conditioner according to any one of claims 1 to 4, wherein the stability level determination unit (35) is configured to determine the stability level of the indoor unit (2) based on a rotary speed of the compressor (4), and the display unit (36) is configured to display the stability level determined by the stability level determination unit (35) on the display screen (38).

6. The air conditioner according to claim 5, further comprising an outlet temperature detector (23) configured to detect an outlet air temperature at an outlet portion of the indoor unit (2), wherein the stability level determination unit (35) is configured to determine the stability level of the indoor unit (2) based on the rotary speed of the compressor (4) and the outlet air temperature detected by the outlet temperature detector (23).

7. The air conditioner according to any one of claims 1 to 6, wherein the display unit (36) is configured to display a proposed measure to improve the efficiency of the indoor unit (2) on the display screen (38).

8. The air conditioner according to claim 7, wherein the display unit (36) is configured to display an anticipated effect in the case of improving efficiency on the display screen (38).

9. The air conditioner according to any one of claims 1 to 8, wherein the display screen (38) is disposed at a remote controller (18) configured to control the air conditioner.

FIG. 1

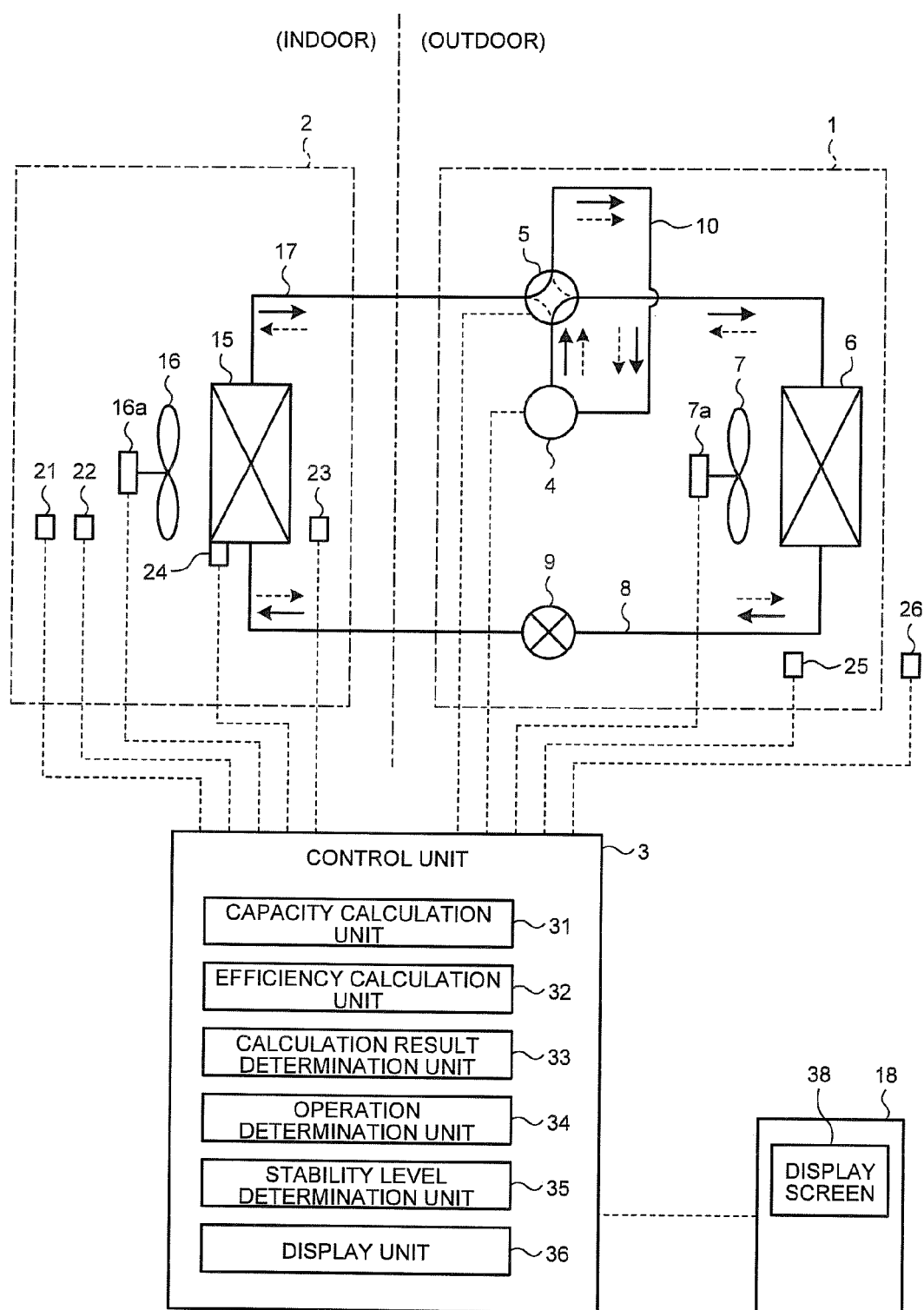


FIG.2

		AIR FLOW RATE				
		60%	80%	100%	120%	140%
ROTARY SPEED OF COMPRES- SOR	20	204%	230%	255%	268%	281%
	40	120%	135%	150%	158%	165%
	60	80%	90%	100%	105%	110%
	80	64%	72%	75%	84%	88%
	100	45%	50%	58%	59%	62%

FIG.3

	OUTSIDE TEMPERA- TURE	°C	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
LOAD	SETTING TEMP.: 20°C	kW	2.9	3.4	4.0	4.6	5.1	5.7	6.3	6.9	7.4	8.0	8.6	9.1	9.7	10.3	10.9	11.4	12.0	12.6
	SETTING TEMP.: 25°C	kW	0.0	0.6	1.1	1.7	2.3	2.9	3.4	4.0	4.6	5.1	5.7	6.3	6.9	7.4	8.0	8.6	9.1	9.7
	SETTING TEMP.: 26°C	kW	0.0	0.0	0.6	1.1	1.7	2.3	2.9	3.4	4.0	4.6	5.1	5.7	6.3	6.9	7.4	8.0	8.6	9.1
	SETTING TEMP.: 30°C	kW	-2.9	-2.3	-1.7	-1.1	-0.6	0.0	0.6	1.1	1.7	2.3	2.9	3.4	4.0	4.6	5.1	5.7	6.3	6.9

FIG.4

	OUTSIDE TEMPERA- TURE	°C	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
ROTARY SPEED OF COMPRES- SOR	SETTING TEMP.: 20°C	rps	29	35	41	47	53	59	65	71	76	82	88	94	100	106	112	118	124	129
	SETTING TEMP.: 25°C	rps	0	6	12	18	24	29	35	41	47	53	59	65	71	76	82	88	94	100
	SETTING TEMP.: 26°C	rps	0	0	6	12	18	24	29	35	41	47	53	59	65	71	76	82	88	94
	SETTING TEMP.: 30°C	rps	0	0	0	0	0	0	6	12	18	24	29	35	41	47	53	59	65	71

FIG.5

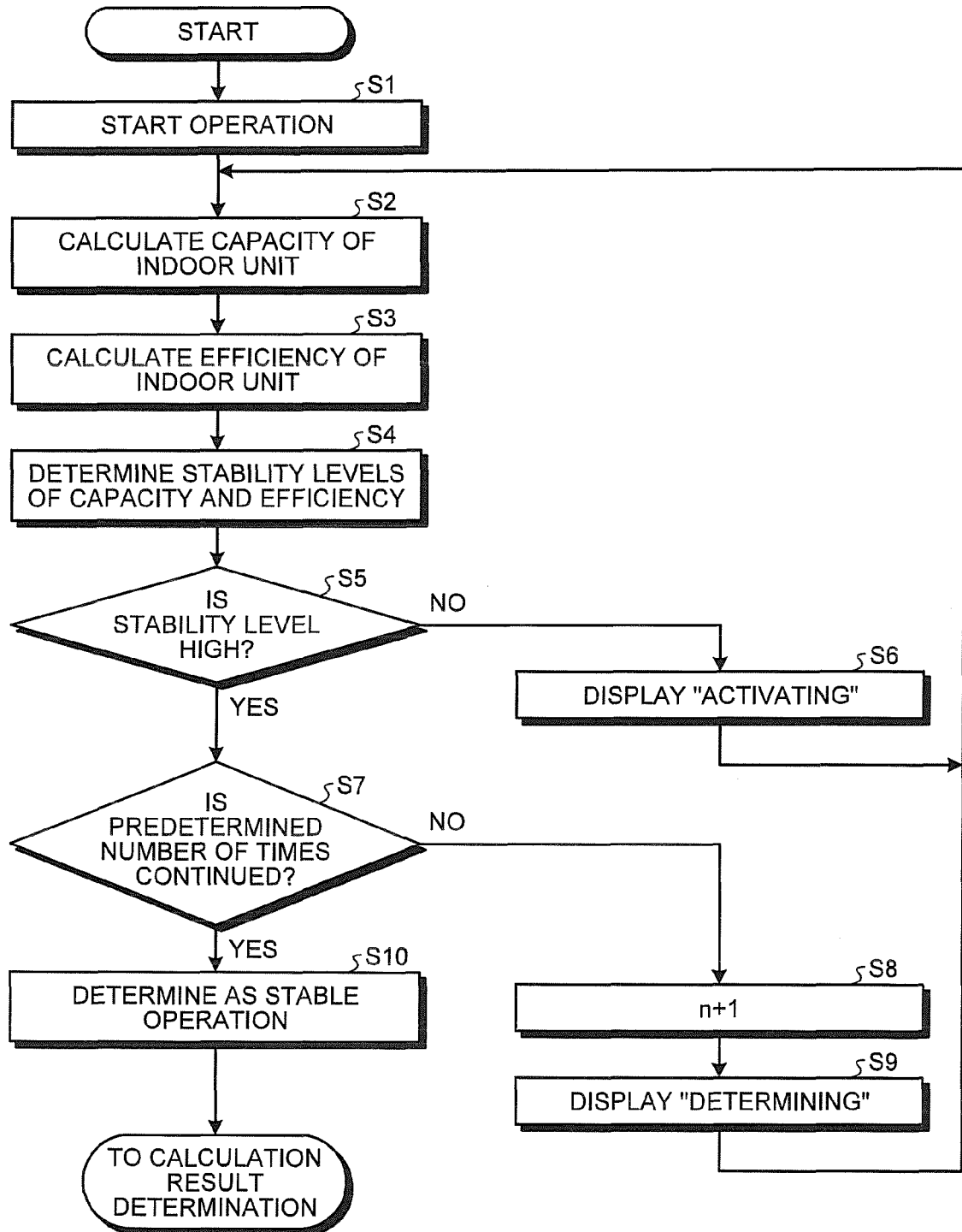
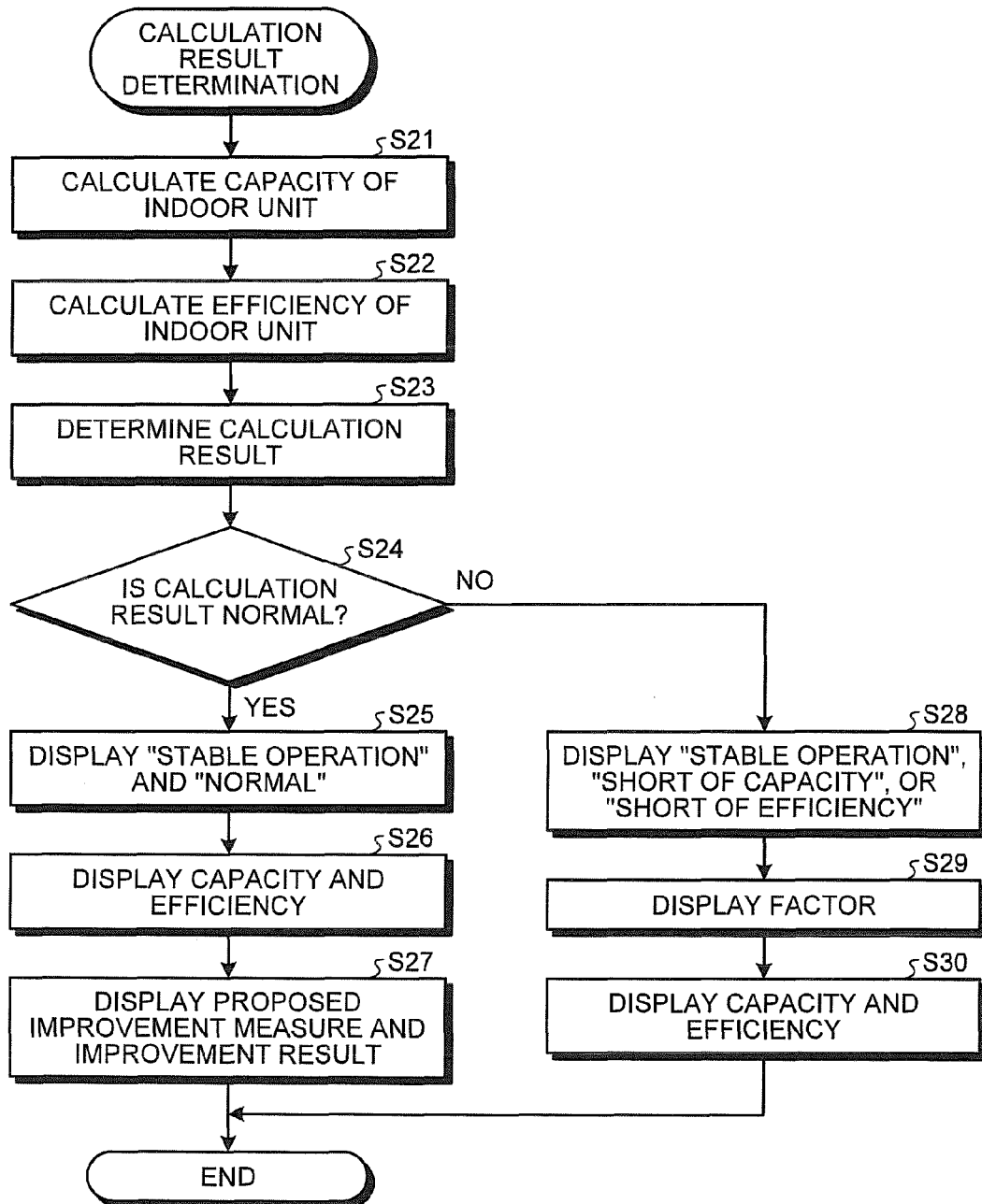


FIG.6





EUROPEAN SEARCH REPORT

Application Number
EP 15 19 4844

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	TW 201 346 190 A (CHUNGHWA TELECOM CO LTD [TW]) 16 November 2013 (2013-11-16)	1-7,9	INV. F24F11/00
A	* paragraph [0057] - paragraph [0062]; figure 1 *	8	
Y	EP 2 166 294 A2 (MITSUBISHI ELECTRIC CORP [JP]) 24 March 2010 (2010-03-24)	1-7,9	
A	* paragraph [0047] - paragraph [0054]; figure 2 *	8	
Y	US 2013/253707 A1 (ROSA ALEXIS [US] ET AL) 26 September 2013 (2013-09-26)	7	
A	* paragraph [0045] - paragraph [0054]; figures 2-4 *	1-6,8,9	
A	US 2012/046909 A1 (DAZAI RYOUTA [JP]) 23 February 2012 (2012-02-23)	1-9	TECHNICAL FIELDS SEARCHED (IPC) F24F
A	* paragraph [0047] - paragraph [0061]; figures 2-4 *	1-9	
A	JP 2012 137246 A (MITSUBISHI ELECTRIC CORP) 19 July 2012 (2012-07-19)	1-9	
A	* abstract; figures 2-3 *	1-9	
A	US 2014/180483 A1 (CHENG YEN-TING [TW] ET AL) 26 June 2014 (2014-06-26)	1	
A	* paragraph [0007] - paragraph [0018]; figures 5A, 5B *	1	
A	EP 2 327 937 A1 (DAIKIN IND LTD [JP]) 1 June 2011 (2011-06-01)		
A	* abstract; figures 2,4-5 *		
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		26 April 2016	Anconetani, Mirco
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 15 19 4844

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

26-04-2016

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
TW 201346190 A	16-11-2013	CN 102865643 A	09-01-2013
		TW 201346190 A	16-11-2013
EP 2166294 A2	24-03-2010	CN 101676639 A	24-03-2010
		EP 2166294 A2	24-03-2010
		JP 4680287 B2	11-05-2011
		JP 2010071505 A	02-04-2010
		US 2010064708 A1	18-03-2010
US 2013253707 A1	26-09-2013	CA 2809855 A1	20-09-2013
		US 2013253707 A1	26-09-2013
		US 2015330653 A1	19-11-2015
US 2012046909 A1	23-02-2012	JP 2012042129 A	01-03-2012
		US 2012046909 A1	23-02-2012
JP 2012137246 A	19-07-2012	JP 5404595 B2	05-02-2014
		JP 2012137246 A	19-07-2012
US 2014180483 A1	26-06-2014	NONE	
EP 2327937 A1	01-06-2011	AU 2009283752 A1	25-02-2010
		BR PI0917291 A2	10-11-2015
		CN 102124277 A	13-07-2011
		EP 2327937 A1	01-06-2011
		JP 5146533 B2	20-02-2013
		KR 20110046504 A	04-05-2011
		US 2011144948 A1	16-06-2011
		WO 2010021101 A1	25-02-2010

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 61194138 U [0003]