(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 491 973 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
15.01.2025 Bulletin 2025/03

(21) Application number: **24186959.3**

(22) Date of filing: **05.07.2024**

(51) International Patent Classification (IPC):
F25B 49/00 *(2006.01)* ***F24F 11/38*** *(2018.01)*
F24F 11/77 *(2018.01)* ***F25B 13/00*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F25B 49/005; F24F 11/36; F24F 11/38; F24F 11/77; F25B 13/00; F24F 2110/10; F24F 2110/12; F25B 2313/0294; F25B 2500/06; F25B 2500/08; F25B 2500/19; F25B 2500/24; F25B 2600/0251; F25B 2600/112; F25B 2600/23; (Cont.)

(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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(30) Priority: **07.07.2023 CN 202310837086**

(71) Applicant: **Guangdong Carrier Heating, Ventilation And Air Conditioning Co., Ltd.**
Foshan Guangdong 528244 (CN)

(72) Inventors:
- **YE, Jianwei**
  Foshan, 528244 (CN)
- **HE, Changjing**
  Foshan, 528244 (CN)

(74) Representative: **Dehns**
10 Old Bailey
London EC4M 7NG (GB)

(54) PROTECTION METHOD AND DEVICE FOR HIGH-TEMPERATURE PREVENTION DURING HEATING AND REFRIGERANT SHORTAGE DURING HEATING, AND AIR CONDITIONING SYSTEM

(57) A protection method and device for high-temperature prevention during heating and refrigerant shortage during heating, and an air conditioning system. The method includes the following steps: in a heating mode, starting an outdoor fan, and detecting an outdoor ambient temperature, an exhaust temperature of a compressor (11), a fan current of the outdoor fan and an operating duration of the outdoor fan in real time; when the operating duration is greater than a first preset duration, comparing whether the sum of the exhaust temperature and a compensation temperature is greater than a first preset temperature and whether the fan current is greater than a preset current value, where the compensation temperature is associated with the outdoor ambient temperature; if yes, controlling the outdoor fan to stop operating and an indoor unit to operate normally; after the outdoor fan stops operating, determining whether the sum of the exhaust temperature and the compensation temperature is greater than a second preset temperature for a second duration; and if yes, controlling the compressor (11) to stop and reporting a fault. The method, device and system can avoid accidentally entering a high-temperature prevention mode due to refrigerant shortage, and improve the operation stability and reliability of the air conditioning system.

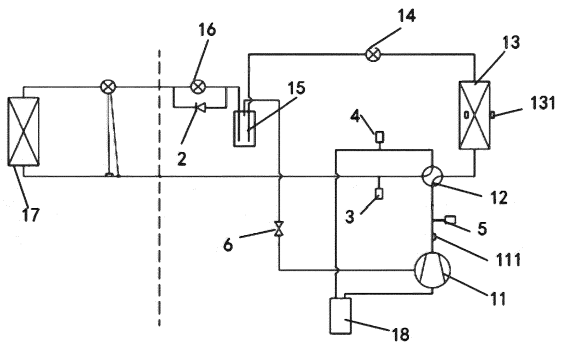

FIG. 1

EP 4 491 973 A1

(Cont. next page)

(52) Cooperative Patent Classification (CPC): (Cont.)
F25B 2700/15; F25B 2700/2106; F25B 2700/21152

Description

TECHNICAL FIELD

[0001] The present invention relates to the field of air conditioners, and in particular to a protection method and device for high-temperature prevention during heating and refrigerant shortage during heating, and an air conditioning system.

BACKGROUND

[0002] An air conditioner provides heating in a high-temperature environment, and due to a high temperature of an indoor-unit heat exchanger, in order to avoid damage to a compressor due to excessive pressure, an outdoor fan needs to be stopped intermittently to actively unload during heating.

[0003] The existing means for preventing high temperature during heating includes: collecting the temperature of the indoor heat exchanger, comparing the temperature with a preset parameter, and performing high-temperature prevention and stopping the outdoor fan if the temperature of the indoor heat exchanger is higher than the preset parameter. The temperature of the indoor heat exchanger is controlled by an indoor-unit mainboard of an air conditioner, and thus, indoor unit and outdoor unit communication is required to control the start and stop of an outdoor compressor. For some fixed-frequency air conditioning systems without indoor unit and outdoor unit communication, the high-temperature prevention control cannot be realized. In addition, the temperature of the indoor heat exchanger serves as the main or only control factor. When the temperature of the indoor heat exchanger is abnormal, the temperature drop time of the indoor heat exchanger is too long and the design of protection temperature parameters is unreasonable, the high-temperature prevention control will fail, thereby affecting the service life of the compressor.

SUMMARY

[0004] In view of the above problems, there is provided a protection method and device for high-temperature prevention during heating and refrigerant shortage during heating, and an air conditioning system. The indoor-unit temperature can be replaced to determine whether to enter high-temperature prevention without the need for indoor unit and outdoor unit communication, and the accuracy of high-temperature prevention determination is ensured, allowing the air conditioning system to enter a high-temperature prevention mode in time, and thus improving the operation reliability of the air conditioner. Furthermore, the excessively high exhaust temperature caused by refrigerant shortage can be excluded, to avoid accidentally entering the high-temperature prevention mode due to refrigerant shortage and improve the operation stability and reliability of the air conditioning system.

[0005] According to a first aspect of the invention there is provided a protection method for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system. The air conditioning system includes an indoor unit and an outdoor unit, and the outdoor unit at least includes a compressor and an outdoor fan. The protection method includes the following steps:

a detection step: in a heating mode, starting the outdoor fan, and detecting an outdoor ambient temperature, an exhaust temperature of the compressor, a fan current of the outdoor fan and an operating duration of the outdoor fan in real time;

a high-temperature prevention determination step: when the operating duration is greater than a first preset duration, comparing whether the sum of the exhaust temperature and a compensation temperature is greater than a first preset temperature and whether the fan current is greater than a preset current value; where the compensation temperature is associated with the outdoor ambient temperature;

a high-temperature prevention protection entry step: when the sum of the exhaust temperature and the compensation temperature is greater than the first preset temperature and the fan current is greater than the preset current value, controlling the outdoor fan to stop operating and the indoor unit to operate normally;

a refrigerant shortage determination step: after the outdoor fan stops operating, determining whether the sum of the exhaust temperature and the compensation temperature is greater than a second preset temperature for a second duration; and

a refrigerant shortage protection entry step: when the sum of the exhaust temperature and the compensation temperature is greater than the second preset temperature for the second duration, controlling the compressor to stop and reporting a fault.

[0006] According to the technical solution, corresponding compensation temperatures are preset respectively according to different outdoor ambient temperatures to compensate the exhaust temperature, so that the compensated exhaust temperature can reflect the temperature state of the indoor unit. In this way, the indoor-unit temperature can be replaced to determine whether to enter high-temperature prevention without the need for indoor unit and outdoor unit communication, and the accuracy of high-temperature prevention determination is ensured, allowing the air conditioning system to enter a high-temperature prevention mode in time, and thus improving the operation reliability of the air conditioner. In addition, whether there is refrigerant shortage is determined according to a comparison result of the compensated exhaust temperature and the preset temperature, and the excessively high exhaust temperature caused by refrigerant shortage is excluded, so that the

misoperation of entering high-temperature prevention as determined only by means of the exhaust temperature can be avoided, improving the accuracy of entry of high-temperature prevention. Furthermore, a fault is reported in time in a case of refrigerant shortage, improving the operation stability and reliability of the air conditioning system.

[0007] Optionally, the air conditioning system is a fixed-frequency air conditioning system without indoor unit and outdoor unit communication.

[0008] Optionally, in the high-temperature prevention determination step, the association of the compensation temperature with the outdoor ambient temperature includes:

when the outdoor ambient temperature is greater than a first temperature threshold, the compensation temperature is a first compensation temperature;

when the outdoor ambient temperature is greater than a second temperature threshold and less than or equal to the first temperature threshold, the compensation temperature is a second compensation temperature; and

when the outdoor ambient temperature is less than or equal to the second temperature threshold, the compensation temperature is a third compensation temperature, and the first temperature threshold is greater than the second temperature threshold.

[0009] According to the technical solution, a plurality of temperature intervals and a plurality of compensation temperatures are set, which is beneficial for improving the accuracy of determination of high-temperature prevention and refrigerant shortage.

[0010] Optionally, in the refrigerant shortage determination step, the second preset temperature ranges from 90° C to 110°C.

[0011] According to the technical solution, after the outdoor fan stops operating in the high-temperature prevention mode, normally, the exhaust temperature will decrease due to the deterioration of evaporation, thereby achieving the purpose of high-temperature prevention. However, in the case of serious refrigerant shortage in the system, the exhaust temperature is not sufficiently cooled through refrigerant circulation, and the exhaust temperature will continue to rise due to the heating of the compressor. Therefore, whether the outdoor fan operates has little influence on the exhaust temperature. When the exhaust temperature is excessively high, it can be determined that the increase of the exhaust temperature is caused by refrigerant shortage.

[0012] Optionally, the outdoor unit further includes an outdoor heat exchanger; and the protection method further includes:

an outdoor fan start control step: determining whether the outdoor fan meets an outdoor fan starting condition; if yes, starting the outdoor fan, and if no, returning to the high-temperature prevention protection entry step; where the outdoor fan starting condition includes:

the shutdown duration of the outdoor fan is greater than a third preset duration;

the sum of the exhaust temperature and the compensation temperature is less than a third preset temperature, and the third preset temperature is less than the first preset temperature;

or the difference between the outdoor ambient temperature and an outlet temperature of the outdoor heat exchanger is greater than a first temperature difference threshold.

[0013] According to the technical solution, when the outdoor fan stops in the high-temperature prevention mode, the deterioration of the evaporation effect of the outdoor unit and the decrease of the exhaust temperature will be caused usually, thereby achieving the purpose of high-temperature prevention. When the shutdown duration is greater than the third preset duration, the outdoor fan is forced to start, which can avoid the slow decrease in exhaust temperature under high-temperature conditions or due to thermal inertia of the temperature of the outdoor heat exchanger and dirty blockage of the outdoor heat exchanger, causing the air conditioning system to be in the high-temperature prevention mode for a long time and the evaporation effect of the outdoor unit to deteriorate, resulting in freezing, and the air conditioner performs frosting and defrosting actions, improving user experience. Or, when the sum of the exhaust temperature and the compensation temperature is less than the third preset temperature, that is, when the exhaust temperature drops significantly, the high-temperature prevention is exited to allow the outdoor fan to operate normally and ensure the evaporation effect of the outdoor unit; or, when the outlet temperature of the outdoor heat exchanger is lower than the outdoor ambient temperature to a certain extent, that is, it means that the evaporation effect has deteriorated, the exhaust temperature will decrease, high-temperature prevention can be thus achieved. Further, when the difference between the outdoor ambient temperature and the outlet temperature of the outdoor heat exchanger is greater than the first temperature difference threshold, the outdoor fan is started in time to improve the evaporation effect and prevent the outdoor unit from being frosted. Any of the conditions can be chosen according to the actual situation to exit the high-temperature prevention protection, which is highly flexible and is conducive to the reliable operation of the air conditioning system and improves user experience.

[0014] Optionally, the third preset duration ranges from 3 to 10 min.

[0015] According to the technical solution, an appropriate duration is selected, which can avoid the deterioration of the evaporation effect and the influence on the heating effect due to the long-time operation of the high-temperature prevention mode.

[0016] Optionally, the third preset temperature ranges from 70°C to 90°C.

[0017] According to the technical solution, an appropriate exhaust temperature range is selected, which enables the high-temperature prevention protection mode to be exited in time when the exhaust temperature is reduced to a certain extent, thereby ensuring the reliable operation of the air conditioning system and improving the user experience.

[0018] Optionally, the first temperature difference threshold ranges from 10°C to 40°C.

[0019] According to the technical solution, an appropriate first temperature difference threshold is selected, which can avoid the frequent entry of the high-temperature prevention protection caused by the excessively high outlet temperature of the outdoor heat exchanger or the frosting of the outdoor heat exchanger caused by the excessively low outlet temperature of the outdoor heat exchanger, thereby prolonging the service life of the air conditioner and improving the user experience.

[0020] According to a second aspect of the invention there is provided a protection device for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system, including:

a detection module, configured to: in a heating mode and under the condition that an outdoor fan is started, detect an outdoor ambient temperature, an exhaust temperature of the compressor, a fan current of the outdoor fan and an operating duration of the outdoor fan in real time;

a high-temperature prevention determination module, configured to: when the operating duration is greater than a first preset duration, compare whether the sum of the exhaust temperature and a compensation temperature is greater than a first preset temperature and whether the fan current is greater than a preset current value, where the compensation temperature is associated with the outdoor ambient temperature;

a high-temperature prevention protection entry module, configured to: when the sum of the exhaust temperature and the compensation temperature is greater than the first preset temperature and the fan current is greater than the preset current value, control the outdoor fan to stop operating and the indoor unit to operate normally;

a refrigerant shortage determination module, configured to: after the outdoor fan stops operating, determine whether the sum of the exhaust temperature and the compensation temperature is greater than a second preset temperature for a second duration; and

a refrigerant shortage protection entry module, configured to: when the sum of the exhaust temperature and the compensation temperature is greater than the second preset temperature for the second duration, control the compressor to stop and report a fault.

[0021] Another aspect of the present invention provides an air conditioning system, including the protection device for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system as described above.

BRIEF DESCRIPTION OF DRAWINGS

[0022] Certain exemplary embodiments will now be described in greater detail by way of example only and with reference to the accompanying drawings in which:

FIG. 1 is a schematic diagram of the structure of an air conditioning system;

FIG. 2 is a schematic flowchart of a protection method for high-temperature prevention during heating and refrigerant shortage during heating of the air conditioning system; and

FIG. 3 is a schematic diagram of the modular structure of a protection device for high-temperature prevention during heating and refrigerant shortage during heating of the air conditioning system.

Reference numerals:

[0023] compressor 11; first temperature detector 111; four-way valve 12; outdoor heat exchanger 13; second temperature detector 131; first throttling element 14; liquid storage tank 15; second throttling element 16; indoor heat exchanger 17; gas-liquid separator 18; one-way valve 2; pressure sensor 3; low-pressure pressure switch 4; high-pressure pressure switch 5; detection module 61; high-temperature protection determination module 62; high-temperature prevention protection entry module 63; refrigerant shortage determination module 64; refrigerant shortage protection entry module 65; and outdoor fan start control module 66.

DETAILED DESCRIPTION

[0024] The technical solutions in embodiments of the present invention are described clearly and completely below with reference to the accompanying drawings The described embodiments are merely a part rather than all of the embodiments of the present invention. All other embodiments shall fall within the protection scope of the present invention as set out in the appended claims.

[0025] As shown in FIG. 1, an embodiment of the present invention provides an air conditioning system, including a compressor 11, a four-way valve 12, an outdoor heat exchanger 13, an outdoor fan (not shown in the figure), a first throttling element 14, a liquid storage tank 15, a second throttling element 16, an indoor heat exchanger 17 and a gas-liquid separator 18 which are connected sequentially to form a refrigerant circulation flow path, and further includes a first temperature detector 111 (a temperature-sensitive package arranged on an exhaust pipe) for detecting the exhaust temperature of

the compressor and a second temperature detector 131 for detecting the outdoor ambient temperature. Further, a one-way valve 2 is arranged across the second throttling element 16 in parallel, and the one-way valve 2 controls a unidirectional flow of the refrigerant from the liquid storage tank 15 to the indoor heat exchanger 17; a pressure sensor 3 is arranged on a pipeline between the indoor heat exchanger 17 and the four-way valve 12; a low-pressure pressure switch 4 is arranged between the four-way valve 12 and the gas-liquid separator 18; and a high-pressure pressure switch 5 is arranged between the compressor 11 and the four-way valve 12. The function of the liquid storage tank 15 is similar to that of the liquid-gas separator 18, a gaseous refrigerant generated by separation enters the compressor 11 through a branch pipeline to supplement the refrigerant quantity, a liquid refrigerant generated by separation enters a main refrigerant path, and the high-pressure pressure switch 5 and the low-pressure pressure switch 4 are used to monitor the pressure of the refrigerant in an air conditioning pipeline and provide a feedback to an air conditioning controller (not shown in the figure). When the refrigerant pressure is excessively low, the low-pressure pressure switch 4 is switched off, and the controller knows that the refrigerant quantity of the system is insufficient after receiving the signal and controls the compressor 11 not to work; and when the refrigerant pressure is excessively high, the high-pressure pressure switch 5 is switched off, and the controller controls the compressor 11 to stop working after receiving the signal, to prevent pipe explosion caused by the excessively high pressure. Preferably, the air conditioning system in this embodiment is a fixed-frequency air conditioning system without indoor unit and outdoor unit communication, and the compressor 11 is a fixed-frequency compressor. It should be noted that although the embodiment of the present invention shows the structure of the air conditioning system above, it should not constitute a limitation to the air conditioning system. Air conditioning systems with other structural forms are also applicable to a protection method for high-temperature prevention during heating and refrigerant shortage during heating provided below.

[0026] As shown in FIG. 2, an embodiment of the present invention provides a protection method for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system, including the following steps:

a detection step: in a heating mode, starting the outdoor fan, and detecting an outdoor ambient temperature, an exhaust temperature of the compressor, a fan current of the outdoor fan and an operating duration of the outdoor fan in real time;

a high-temperature prevention determination step: when the operating duration is greater than a first preset duration (for example, the operating duration is greater than 3 min, to avoid some situations, when the outdoor fan starts to operate for a short time, the exhaust temperature rapidly reaches to a set value (referring to a first preset temperature) and the outdoor fan is stopped again, the accumulated shutdown time of the outdoor fan is excessively long, and the outdoor heat exchanger is frosted due to the lack of effective heat exchange), comparing whether the sum of the exhaust temperature and a compensation temperature is greater than a first preset temperature and whether the fan current is greater than a preset current value, where the compensation temperature is associated with the outdoor ambient temperature;

a high-temperature prevention protection entry step: when the sum of the exhaust temperature and the compensation temperature is greater than the first preset temperature and the fan current is greater than the preset current value, controlling the outdoor fan to stop operating and the indoor unit to operate normally;

a refrigerant shortage determination step: after the outdoor fan stops operating, determining whether the exhaust temperature is greater than a second preset temperature for a second duration (e.g., 2 min); and

a refrigerant shortage protection entry step: when the exhaust temperature is greater than the second preset temperature for the second duration, controlling the compressor to stop and reporting a fault.

[0027] In the above manner, corresponding compensation temperatures are preset respectively according to different outdoor ambient temperatures to compensate the exhaust temperature, so that the compensated exhaust temperature can reflect the temperature state of the indoor unit. In this way, the indoor-unit temperature can be replaced to determine whether to enter high-temperature prevention without the need for indoor unit and outdoor unit communication, and the accuracy of high-temperature prevention determination is ensured, allowing the air conditioning system to enter a high-temperature prevention mode in time, and thus improving the operation reliability of the air conditioner, and saving the cost of the communication line between the indoor and outdoor units. The temperature detector is a part of the system itself, so there is no additional cost. In addition, whether there is refrigerant shortage is determined according to a comparison result of the compensated exhaust temperature and the preset temperature, and the excessively high exhaust temperature caused by refrigerant shortage can be excluded, to avoid accidentally entering the high-temperature prevention mode due to refrigerant shortage. Furthermore, a fault is reported in time in a case of refrigerant shortage, improving the operation stability of the air conditioning system.

[0028] In a preferred embodiment of the present invention, in the high-temperature prevention determination step, the association of the compensation temperature with the outdoor ambient temperature includes:

when the outdoor ambient temperature is greater than a first temperature threshold (e.g., 24°C), the compensation temperature is a first compensation temperature (e.g., 0°C);

when the outdoor ambient temperature is greater than a second temperature threshold and less than or equal to the first temperature threshold, the compensation temperature is a second compensation temperature (e.g., 4°C); and

when the outdoor ambient temperature is less than or equal to the second temperature threshold (e.g., 14°C), the compensation temperature is a third compensation temperature (e.g., 7°C), and the first temperature threshold is greater than the second temperature threshold.

[0029] In the above manner, a plurality of temperature intervals and a plurality of compensation temperatures are set, which is beneficial for improving the accuracy of determination of high-temperature prevention and refrigerant shortage. The technician can adjust the temperature threshold and compensation temperature value according to actual conditions. Preferably, the first compensation temperature ranges from-5°C to 5°C, the second compensation temperature ranges from-5°C to 5°C, and the third compensation temperature ranges from -5°C to 5°C.

[0030] In a preferred embodiment of the present invention, in the high-temperature prevention determination step, the first preset temperature ranges from 70°C to 100°C, preferably 82°C (the first preset temperature is the exhaust temperature corresponding to the indoor heat exchanger temperature of 55°C. According to different types of the compressor, the exhaust temperature corresponding to the indoor heat exchanger temperature of 55°C may be different. The technician can adaptively adjust the first preset temperature).

[0031] In a preferred embodiment of the present invention, in the refrigerant shortage determination step, the second preset temperature ranges from 90°C to 110°C, preferably 105°C. In the above manner, after the outdoor fan stops operating in the high-temperature prevention mode, normally, the exhaust temperature will decrease due to the deterioration of evaporation, thereby achieving the purpose of high-temperature prevention. However, in the case of serious refrigerant shortage in the system, the exhaust temperature is not sufficiently cooled through refrigerant circulation, and the exhaust temperature will continue to rise due to the heating of the compressor. Therefore, whether the outdoor fan operates has little influence on the exhaust temperature. When the exhaust temperature is excessively high, it can be determined that the increase of the exhaust temperature is caused by refrigerant shortage. Furthermore, the second preset temperature is lower than the normal exhaust protection temperature of the compressor (generally 115°C), so that the compressor 11 can be protected in time in case of refrigerant shortage, thereby prolonging the service life of the compressor 11.

[0032] In a preferred embodiment of the present invention, the protection method further includes:

an outdoor fan start control step: determining whether the outdoor fan meets an outdoor fan starting condition; if yes, starting the outdoor fan, and if no, returning to the high-temperature prevention protection entry step; where the outdoor fan starting condition includes:

the shutdown duration of the outdoor fan is greater than a third preset duration;

the sum of the exhaust temperature and the compensation temperature is less than a third preset temperature, and the third preset temperature is less than the first preset temperature;

or the difference between the outdoor ambient temperature and an outlet temperature of the outdoor heat exchanger is greater than a first temperature difference threshold.

[0033] In the above manner, when the outdoor fan stops in the high-temperature prevention mode, the deterioration of the evaporation effect of the outdoor unit and the decrease of the exhaust temperature will be caused usually, thereby achieving the purpose of high-temperature prevention. When the shutdown duration is greater than the third preset duration, the outdoor fan is forced to start, which can avoid the slow decrease in exhaust temperature under high-temperature conditions or due to thermal inertia of the temperature of the outdoor heat exchanger and dirty blockage of the outdoor heat exchanger, causing the air conditioning system to be in the high-temperature prevention mode for a long time and the evaporation effect of the outdoor unit to deteriorate, and the air conditioner performs frosting and defrosting actions. Or, when the sum of the exhaust temperature and the compensation temperature is less than the third preset temperature, that is, when the exhaust temperature drops significantly, the high-temperature prevention is exited to allow the outdoor fan to operate normally and ensure the evaporation effect of the outdoor unit; or, when the outlet temperature of the outdoor heat exchanger is lower than the outdoor ambient temperature to a certain extent, that is, it means that the evaporation effect has deteriorated, the exhaust temperature will decrease, high-temperature prevention can be thus achieved. Further, when the difference between the outdoor ambient temperature and the outlet temperature of the outdoor heat exchanger is greater than the first temperature difference threshold, the outdoor fan is started in time to improve the evaporation effect and prevent the outdoor unit from being frosted. Any of the conditions can be chosen according to the actual situation to exit the high-temperature prevention protection, which is highly flexible and is conducive to the reliable operation of the air conditioning system and improves user experience.

[0034] In a preferred embodiment of the present inven-

tion, the third preset duration ranges from 3 to 10 min, preferably 6 min. An appropriate duration is selected, which can avoid the deterioration of the evaporation effect and the influence on the heating effect due to the long-time operation of the high-temperature prevention mode.

[0035] In a preferred embodiment of the present invention, the third preset temperature ranges from 70°C to 90°C, preferably 76°C (the third preset temperature is the exhaust temperature corresponding to the indoor heat exchanger temperature of 48°C. According to different types of the compressor, the exhaust temperature corresponding to the indoor heat exchanger temperature of 48°C may be different. The technician can adaptively adjust the third preset temperature).

[0036] An appropriate exhaust temperature range is selected, which enables the high-temperature prevention protection mode to be exited in time when the exhaust temperature is reduced to a certain extent, thereby ensuring the reliable operation of the air conditioning system and improving the user experience.

[0037] In a preferred embodiment of the present invention, the first temperature difference threshold ranges from 10°C to 40°C, preferably 30°C.

[0038] In the above manner, an appropriate first temperature difference threshold is selected, which can avoid the frequent entry of the high-temperature prevention protection caused by the excessively high outlet temperature of the outdoor heat exchanger or the frosting of the outdoor heat exchanger caused by the excessively low outlet temperature of the outdoor heat exchanger, thereby prolonging the service life of the air conditioner and improving the user experience.

[0039] It should be noted that although this embodiment describes the above protection method that is applied to a fixed-frequency machine system under the non-communication condition, it is conceivable that it can also be applied to a fixed-frequency machine system.

[0040] As shown in FIG. 3, another embodiment of the present invention provides a protection device for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system, including:

a detection module 61, configured to: in a heating mode and under the condition that an outdoor fan is started, detect an outdoor ambient temperature, an exhaust temperature of the compressor 11, a fan current of the outdoor fan and an operating duration of the outdoor fan in real time;

a high-temperature prevention determination module 62, configured to: when the operating duration is greater than a first preset duration, compare whether the sum of the exhaust temperature and a compensation temperature is greater than a first preset temperature and whether the fan current is greater than a preset current value, where the compensation temperature is associated with the outdoor ambient temperature;

a high-temperature prevention protection entry module 63, configured to: when the sum of the exhaust temperature and the compensation temperature is greater than the first preset temperature and the fan current is greater than the preset current value, control the outdoor fan to stop operating and the indoor unit (indoor heat exchanger 17) to operate normally;

a refrigerant shortage determination module 64, configured to: after the outdoor fan stops operating, determine whether the exhaust temperature is greater than a second preset temperature for a second duration; and

a refrigerant shortage protection entry module 65, configured to: when the exhaust temperature is greater than the second preset temperature for the second duration, control the compressor to stop and report a fault.

[0041] Specifically, in this embodiment, the detection module may include a temperature detection module such as a temperature-sensitive package and a temperature sensor, a current meter for detecting the fan current, and a timer for detecting the shutdown duration. The high-temperature prevention determination module and the refrigerant shortage determination module may also be integrated into the controller of the air conditioner. The controller is used to determine whether the air conditioner enters high-temperature prevention and refrigerant shortage protection according to the above operational logics. The high-temperature prevention protection entry module and the refrigerant shortage protection entry module may be integrated into the controller of the air conditioner. The controller is used to control the air conditioner to enter the refrigerant shortage protection according to the comparison result of the exhaust temperature and the second preset temperature, and to control the air conditioner to enter the high-temperature prevention protection according to the comparison result of the sum of the exhaust temperature and the compensation temperature and the first preset temperature, and the comparison result of the fan current and the preset current value. Specifically, the controller may be an integrated circuit chip having a signal processing capability. The controller may be a general-purpose processor, including a central processing unit (CPU), or a single-chip microcomputer, a microcontroller unit (MCU), a complex programmable logic device (CPLD), a field-programmable gate array (FPGA), an application specific integrated circuit (ASIC), an embedded ARM and other chips. The controller may implement or perform each of the methods, steps and logic block diagrams disclosed in the embodiments of the present invention.

[0042] In a preferred embodiment of the present invention, the protection device further includes an outdoor fan start control module 66, configured to: determine whether the outdoor fan meets an outdoor fan starting condition; if

yes, start the outdoor fan, and if no, operate the high-temperature prevention protection entry module, where the outdoor fan starting condition includes:
the shutdown duration of the outdoor fan is greater than a third preset time; the sum of the exhaust temperature and the compensation temperature is less than a third preset temperature, and the third preset temperature is less than the first preset temperature; or the difference between the outdoor ambient temperature and the outlet temperature of the outdoor heat exchanger is greater than the first temperature difference threshold.

[0043] It should be noted that the detection module 61, the high-temperature prevention determination module 62, the high-temperature prevention protection entry module 63, the refrigerant shortage determination module 64, the refrigerant shortage protection entry module 65, and the outdoor fan start control module 66 correspond to the detection step, the high-temperature prevention determination step, the high-temperature prevention protection entry step, the refrigerant shortage determination step, the refrigerant shortage protection entry step and the outdoor fan start control step in the above protection method. The implementation examples and application scenarios of the respective modules are the same as those of the corresponding steps, but are not limited to the contents disclosed in the above embodiment.

[0044] In a preferred embodiment of the present invention, the association of the compensation temperature with the outdoor ambient temperature includes:

when the outdoor ambient temperature is greater than a first temperature threshold (e.g., 24°C), the compensation temperature is a first compensation temperature (e.g., 0°C);
when the outdoor ambient temperature is greater than a second temperature threshold and less than or equal to the first temperature threshold, the compensation temperature is a second compensation temperature (e.g., 4°C); and
when the outdoor ambient temperature is less than or equal to the second temperature threshold (e.g., 14°C), the compensation temperature is a third compensation temperature (e.g., 7°C), and the first temperature threshold is greater than the second temperature threshold.

[0045] In the above manner, a plurality of temperature intervals and a plurality of compensation temperatures are set, which is beneficial for improving the accuracy of determination of high-temperature prevention and refrigerant shortage. The technician can adjust the temperature threshold and compensation temperature value according to actual conditions. Preferably, the first compensation temperature ranges from-5°C to 5°C, the second compensation temperature ranges from-5°C to 5°C, and the third compensation temperature ranges from -5°C to 5°C.

[0046] In a preferred embodiment of the present invention, the first preset temperature ranges from 70°C to 100°C, preferably 82°C. The second preset temperature ranges from 90°C to 110°C, preferably 105°C. The first preset duration is 3 min, the second preset duration is 2 min, and the third preset duration ranges from 3 to 10 min.

[0047] Another embodiment of the present invention provides an air conditioning system, including the protection device for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system as described above.

[0048] The present invention further provides a computer-readable storage medium, storing a computer program, which is configured to, when executed, implement the protection method for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system as described above. The storage medium includes: a USB flash disk, a read-only memory (ROM), a random-access memory (RAM), a mobile hard disk, a magnetic disk, an optical disk or other media that can store program codes.

[0049] The above are merely preferred embodiments of the present invention, and are not used to limit the present invention. Any modifications, improvements, and the like shall be included within the scope of the invention as set out in the appended claims.

Claims

1. A protection method for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system, wherein the air conditioning system comprises an indoor unit and an outdoor unit and the outdoor unit at least comprises a compressor (11) and an outdoor fan, the protection method comprising the following steps:

   a detection step: in a heating mode, starting the outdoor fan, and detecting an outdoor ambient temperature, an exhaust temperature of the compressor, a fan current of the outdoor fan and an operating duration of the outdoor fan in real time;
   a high-temperature prevention determination step: when the operating duration is greater than a first preset duration, comparing whether the sum of the exhaust temperature and a compensation temperature is greater than a first preset temperature and whether the fan current is greater than a preset current value; wherein the compensation temperature is associated with the outdoor ambient temperature;
   a high-temperature prevention protection entry step: when the sum of the exhaust temperature and the compensation temperature is greater than the first preset temperature and the fan current is greater than the preset current value,

controlling the outdoor fan to stop operating and the indoor unit to operate normally;

a refrigerant shortage determination step: after the outdoor fan stops operating, determining whether the sum of the exhaust temperature and the compensation temperature is greater than a second preset temperature for a second duration; and

a refrigerant shortage protection entry step: when the sum of the exhaust temperature and the compensation temperature is greater than the second preset temperature for the second duration, controlling the compressor to stop and reporting a fault.

2. The protection method for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system according to claim 1, wherein the air conditioning system is a fixed-frequency air conditioning system without indoor unit and outdoor unit communication.

3. The protection method for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system according to claim 1 or 2, wherein in the high-temperature prevention determination step, the association of the compensation temperature with the outdoor ambient temperature comprises:

when the outdoor ambient temperature is greater than a first temperature threshold, the compensation temperature is a first compensation temperature;

when the outdoor ambient temperature is greater than a second temperature threshold and less than or equal to the first temperature threshold, the compensation temperature is a second compensation temperature; and

when the outdoor ambient temperature is less than or equal to the second temperature threshold, the compensation temperature is a third compensation temperature, and the first temperature threshold is greater than the second temperature threshold.

4. The protection method for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system according to any preceding claim, wherein in the refrigerant shortage determination step, the second preset temperature ranges from 90°C to 110°C.

5. The protection method for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system according to any preceding claim, wherein the outdoor unit further comprises an outdoor heat exchanger (13); and the protection method further comprises:

an outdoor fan start control step: determining whether the outdoor fan meets an outdoor fan starting condition; if yes, starting the outdoor fan, and if no, returning to the high-temperature prevention protection entry step; wherein the outdoor fan starting condition comprises:

the shutdown duration of the outdoor fan is greater than a third preset duration;

the sum of the exhaust temperature and the compensation temperature is less than a third preset temperature, and the third preset temperature is less than the first preset temperature;

or the difference between the outdoor ambient temperature and an outlet temperature of the outdoor heat exchanger is greater than a first temperature difference threshold.

6. The protection method for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system according to claim 5, wherein the third preset duration ranges from 3 to 10 min.

7. The protection method for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system according to claim 5 or 6, wherein the third preset temperature ranges from 70°C to 90°C.

8. The protection method for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system according to claim 5, 6 or 7, wherein the first temperature difference threshold ranges from 10°C to 40°C.

9. A protection device for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system, comprising:

a detection module (61), configured to: in a heating mode and under the condition that an outdoor fan is started, detect an outdoor ambient temperature, an exhaust temperature of the compressor, a fan current of the outdoor fan and an operating duration of the outdoor fan in real time;

a high-temperature prevention determination module (62), configured to: when the operating duration is greater than a first preset duration, compare whether the sum of the exhaust temperature and a compensation temperature is greater than a first preset temperature and whether the fan current is greater than a preset current value; wherein the compensation temperature is associated with the outdoor ambient temperature;

a high-temperature prevention protection entry module (63), configured to: when the sum of the exhaust temperature and the compensation temperature is greater than the first preset temperature and the fan current is greater than the preset current value, control the outdoor fan to stop operating and the indoor unit to operate normally;

a refrigerant shortage determination module (64), configured to: after the outdoor fan stops operating, determine whether the sum of the exhaust temperature and the compensation temperature is greater than a second preset temperature for a second duration; and

a refrigerant shortage protection entry module (65), configured to: when the sum of the exhaust temperature and the compensation temperature is greater than the second preset temperature for the second duration, control the compressor to stop and report a fault.

10. An air conditioning system, comprising the protection device for high-temperature prevention during heating and refrigerant shortage during heating of an air conditioning system according to claim 9.

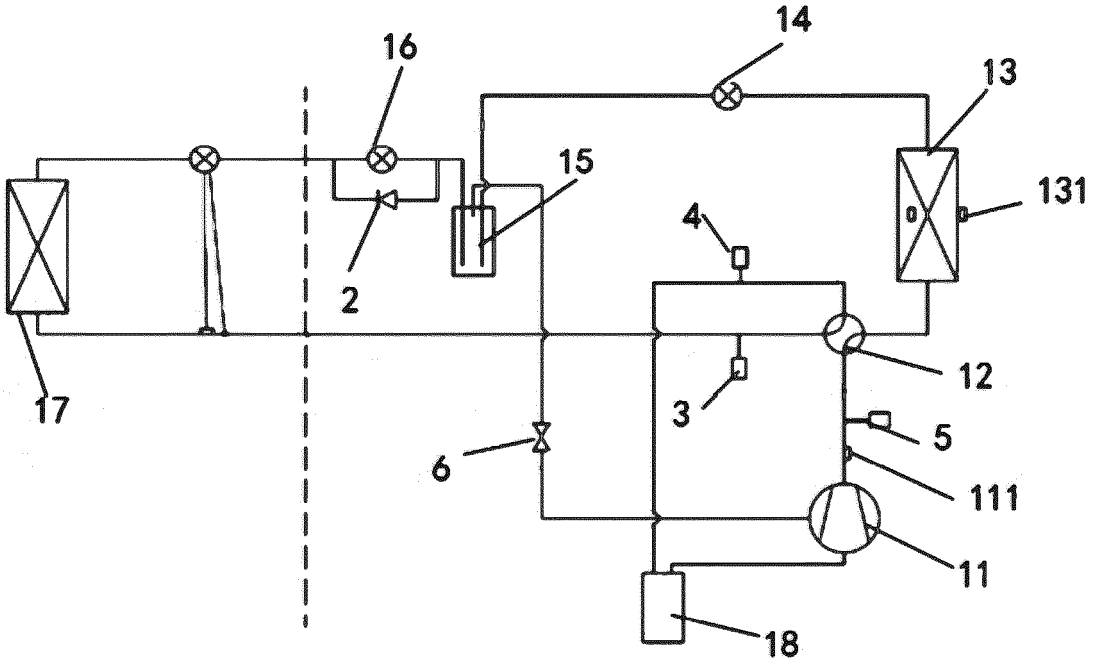

FIG. 1

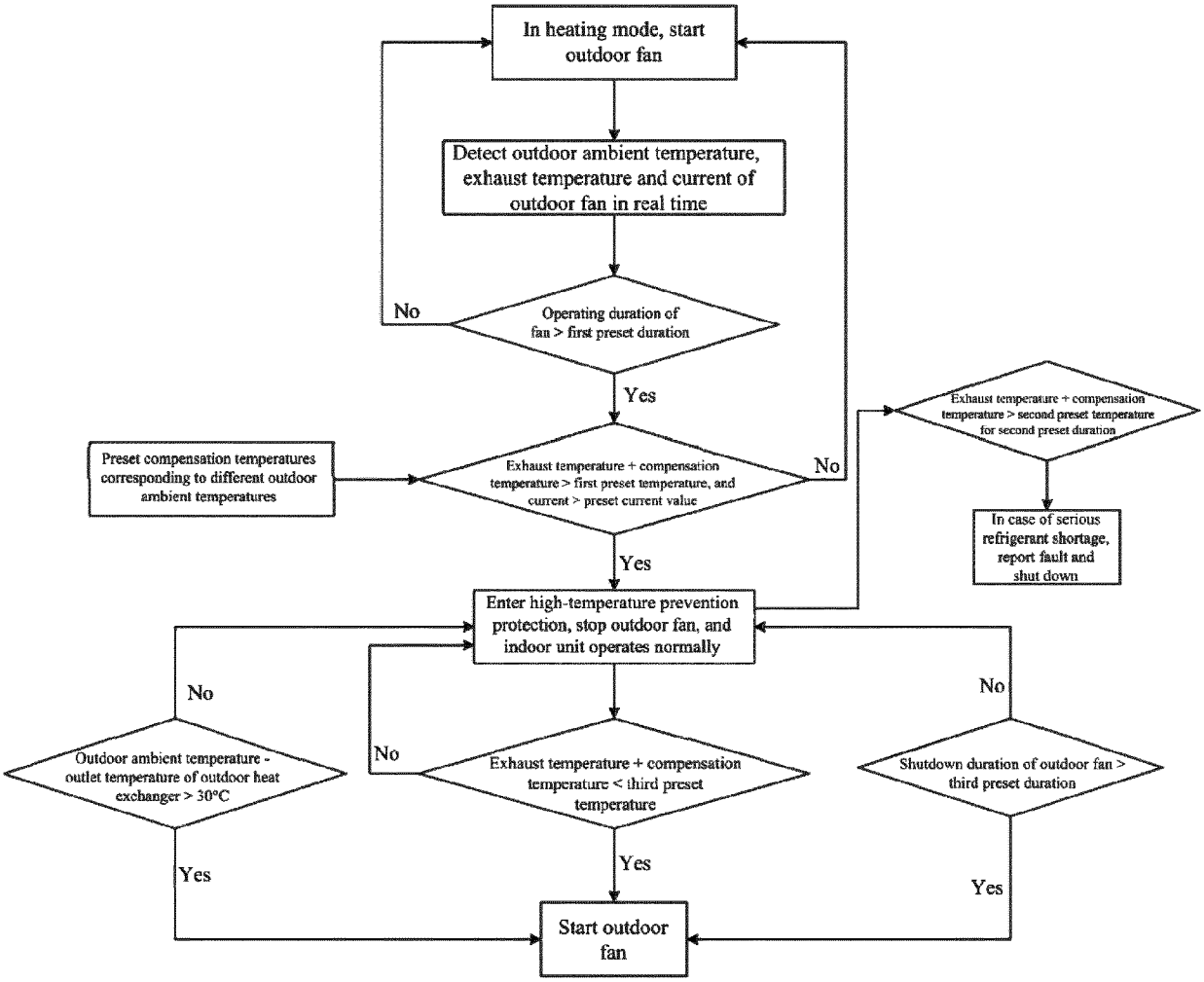
In heating mode, start outdoor fan
Detect outdoor ambient temperature, exhaust temperature and current of outdoor fan in real time
Operating duration of fan > first preset duration
No
Yes
Preset compensation temperatures corresponding to different outdoor ambient temperatures
Exhaust temperature + compensation temperature > first preset temperature, and current > preset current value
No
Yes
Exhaust temperature + compensation temperature > second preset temperature for second preset duration
In case of serious refrigerant shortage, report fault and shut down
Enter high-temperature prevention protection, stop outdoor fan, and indoor unit operates normally
No
Outdoor ambient temperature - outlet temperature of outdoor heat exchanger > 30°C
Yes
No
Exhaust temperature + compensation temperature < third preset temperature
Yes
No
Shutdown duration of outdoor fan > third preset duration
Yes
Start outdoor fan

FIG. 2

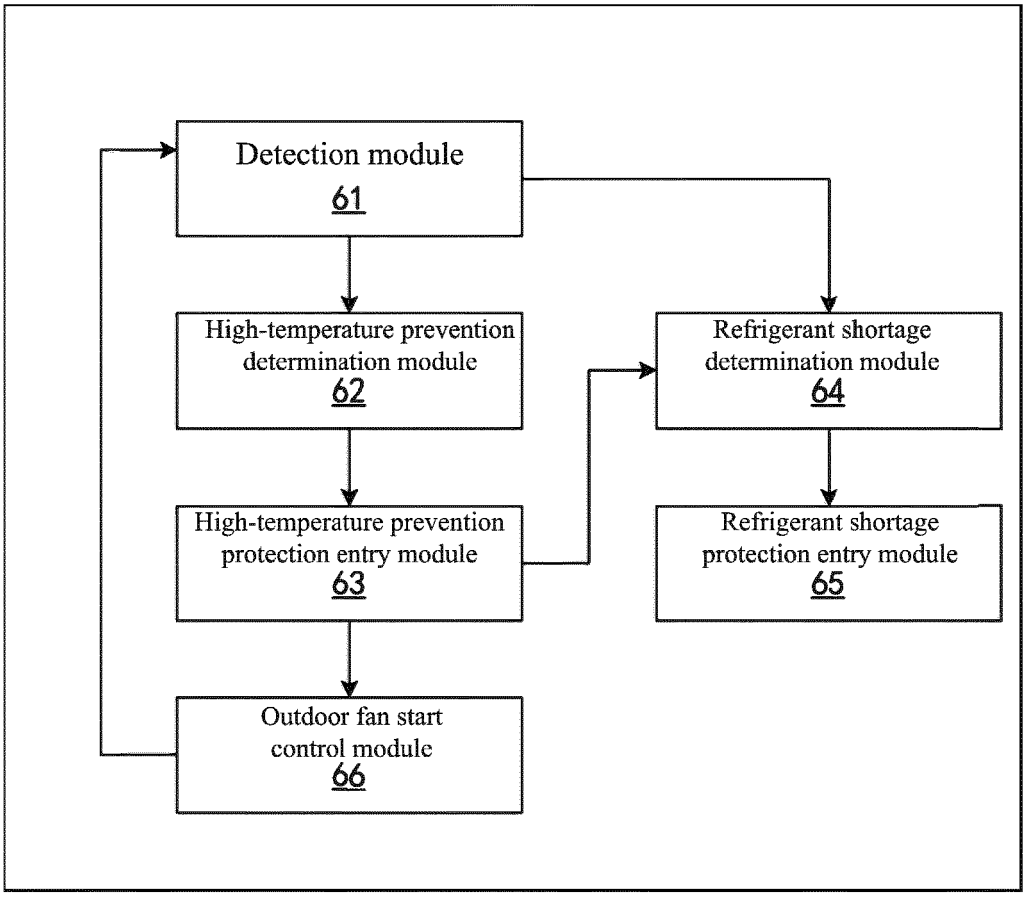
Detection module
61
High-temperature prevention determination module
62
High-temperature prevention protection entry module
63
Outdoor fan start control module
66
Refrigerant shortage determination module
64
Refrigerant shortage protection entry module
65

FIG. 3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 24 18 6959

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	CN 107 367 012 B (GREE ELECTRIC APPLIANCES INC ZHUHAI) 11 February 2020 (2020-02-11) * paragraph [0004] - paragraph [0039]; claim 1; figures 1, 2 *	1-10	INV. F25B49/00 F24F11/38 F24F11/77 F25B13/00
A	CN 110 131 833 A (NINGBO AUX ELECTRIC CO LTD) 16 August 2019 (2019-08-16) * paragraph [0024] - paragraph [0048]; figures 1,2 *	1-10	
A	CN 111 189 104 A (HISENSE GUANGDONG AIR CONDITIONING CO LTD) 22 May 2020 (2020-05-22) * paragraph [0003] - paragraph [0130]; figures 1-5 *	1-10	

TECHNICAL FIELDS SEARCHED (IPC)

F25B
F24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 December 2024	Lucic, Anita

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 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 24 18 6959

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.

02-12-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 107367012 B	11-02-2020	NONE	
CN 110131833 A	16-08-2019	NONE	
CN 111189104 A	22-05-2020	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82