



(11)

EP 1 666 805 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
07.06.2006 Bulletin 2006/23

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

(21) Application number: **05257338.3**

(22) Date of filing: **29.11.2005**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI
SK TR**
Designated Extension States:
AL BA HR MK YU

- **Kim, Ki-bum**
Seoul (KR)
- **Sung, Si-kyong,**
105-703 Samsung Raemian Apt.
Seoul (KR)
- **Ha, Do-yong**
Anyang-si
Gyeonggi-do (KR)
- **Yoon, Pil-hyun**
Yangcheon-gu,
Seoul (KR)

(30) Priority: **29.11.2004 KR 2004098756**

(71) Applicant: **LG Electronics Inc.**
Yeongdeungpo-Gu
Seoul (KR)

(72) Inventors:
• **Choi, Sung-oh**
Gwangmyeong-si
Gyeonggi-do (KR)

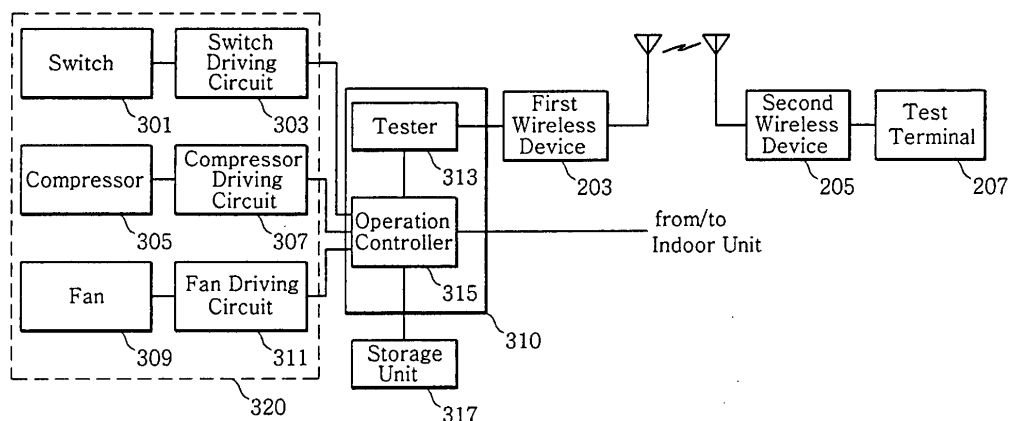
(74) Representative: **Camp, Ronald et al**
Kilburn & Strode
20 Red Lion Street
London WC1R 4PJ (GB)

(54) Apparatus for testing an air conditioner

(57) An apparatus for testing an air conditioner includes a first wireless device (203) connected to the air conditioner, and a second wireless device (205) connected to a test terminal (207). The first wireless device (203) transmits and receives test result information and test-related information based on a testing program installed in the test terminal in a local-area wireless communication manner, and the second wireless device transmits

and receives the test-related information and test result information based on the testing program in the local-area wireless communication manner. Therefore, local-area wireless communication can be carried out between the air conditioner and the test terminal, thereby making it possible to significantly save trouble for installation of testing instruments, such as cables and a converter, and to significantly curtail costs and manpower for test work.

Fig.3



Description

[0001] The present invention relates to an air conditioner. It more particularly to a technique for testing an air conditioner.

[0002] An air conditioner generally refers to an appliance that cools or heats an indoor space such as a residential area, restaurant or office. Recently, in order to more efficiently cool or heat an indoor space partitioned into a plurality of rooms, a technique has been developed which cools or heats the rooms individually using one air conditioner.

[0003] In general terms, air conditioners may be classified into a separated type wherein indoor and outdoor units are separated from each other, and an integrated type wherein indoor and outdoor units are integrated. Air conditioners may also be classified into a single type wherein one indoor unit is connected to one outdoor unit, and a multi-type wherein a plurality of indoor units installed in respective rooms are connected in common to one outdoor unit via a network.

[0004] Meanwhile, misconnection of pipes and wires is liable to occur due to complex piping and wiring when an air conditioner is installed. In this regard, it is common that an air conditioner is tested upon being installed. For example, in the case of a separated type air conditioner in which indoor and outdoor units are separated from each other, separate wiring, followed by separate piping, is required to interconnect the indoor and outdoor units for installation of the air conditioner. In the case of a multi-type air conditioner in which a plurality of indoor units are connected to one outdoor unit, the indoor units must be accurately connected to the outdoor unit through respective wire connectors and respective service valves of the outdoor unit for installation of the air conditioner. Further, a separate piping process must be additionally performed. If an air conditioner is installed in this manner, then it is tested. That is, the entire operation of an air conditioner is tested.

[0005] A description will hereinafter be given of a problem with a conventional system for testing an air conditioner with reference to FIG. 1. It is assumed here that the air conditioner is of the separated type and the multi-type for the purpose of a better understanding of the conventional problem.

[0006] The installer installs an outdoor unit of the air conditioner outside of a building and an indoor unit of the air conditioner inside of the building, respectively, and then tests the air conditioner. In order to test the air conditioner, for example, the installer must operate the indoor unit indoors to check the operation state of the indoor unit, and then go outdoors to check the operation state of the outdoor unit.

[0007] In order to address this problem, a testing program has been proposed which is installed and run in a test terminal outside of the air conditioner. For example, the installer interconnects the outdoor unit and the test terminal in such a way that they can communicate with

each other, and then runs the testing program in the test terminal to check the cooling/heating operation states of the outdoor and indoor units and the states of wiring and piping therebetween.

[0008] However, in the conventional test system, in order to test the outdoor and indoor units of the air conditioner, the installer dismantles the front panel of the outdoor unit, denoted by reference numeral 101, from the body thereof and then the cover of a circuit box in the outdoor unit 101 from the body of the circuit box. Subsequently, the installer connects one plug of a jig cable 103 to an operation/test control unit in the circuit box (not shown). The jig cable 103 connected to the outdoor unit 101 is generally 15 to 20M long.

[0009] The air conditioner may support any communication protocols. For example, the air conditioner may support RS-485 communication protocol. In this case, an RS-485 communication port may be provided in the operation/test control unit or separately from the control unit.

[0010] A test terminal 109 may be a general PC terminal which can be carried by the installer, such as a notebook computer. The test terminal 109 is connected with a tester of the operation/test control unit in the outdoor unit 101 to communicate therewith. That is, the test terminal 109 runs a testing program to communicate with the tester to transmit test-related information to the tester and receive test result information from the tester.

[0011] Similarly, the test terminal 109 may support any communication protocols for communications with other external devices. For example, such communication protocols may be a serial communication protocol and universal serial bus (USB) protocol. Communication protocols supported by the air conditioner and the test terminal 109 may often be different from each other.

[0012] A converter 105 is connected with the other plug of the jig cable 103 and in turn with one plug of a cable 107 (e.g., a serial cable or USB to serial conversion cable) for the test terminal 109. The converter 105 is adapted to convert test result information of the air conditioner into that of a communication protocol of the test terminal, and test-related information of the test terminal into that of a communication protocol of the air conditioner, respectively.

[0013] The above-mentioned conventional test system is disadvantageous in that, in order to test the air conditioner, the installer has the inconvenience of having to carry the jig cable 103 to a place where the outdoor unit 101 is present, dismantle the front panel of the outdoor unit 101 from the body thereof and then the cover of the circuit box from the body thereof, and then connect the jig cable 103 to the operation/test control unit. Further, a plurality of instruments which are too heavy and complex to install, such as the cables 103 and 107 and the converter 105, must be provided in the conventional test system, and much trouble is required to install those instruments.

[0014] In addition, the conventional test system en-

counters restrictions in the lengths of the jig cable 103 and serial cable 107. For this reason, for example, in the case where the outdoor unit and the indoor units are far away from each other, test result information may become unstable due to a limitation in communication distances between the outdoor unit and the indoor units. To solve this problem, the installer has to go outdoors to perform testing, which leads to inconvenience of use.

[0015] One aspect of the present invention seeks to provide an improved technique for testing an air conditioner.

[0016] Embodiments of the present invention can provide an apparatus for testing an air conditioner, wherein costs and manpower for installation of testing instruments can be curtailed.

[0017] Embodiments of the present invention can provide an apparatus for testing an air conditioner, wherein outdoor and indoor units can be tested indoors.

[0018] Embodiments of the present invention can provide an apparatus for testing an air conditioner, wherein reliability of test result information being transmitted can be secured.

[0019] An aspect of the present invention provides an apparatus for testing an air conditioner, comprising: a first wireless device connected to the air conditioner, the first wireless device transmitting and receiving test result information and test-related information based on a testing program installed in a test terminal in a local-area wireless communication manner; and a second wireless device connected to the test terminal, the second wireless device transmitting and receiving the test-related information and test result information based on the testing program in the local-area wireless communication manner.

[0020] The first wireless device may include: a connector connected to a connector of an operation/test control unit provided in the air conditioner; and a local-area wireless communication unit for receiving the test result information from the operation/test control unit through the connector of the first wireless device, transmitting the received test result information to the second wireless device in the local-area wireless communication manner, receiving the test-related information from the second wireless device in the local-area wireless communication manner, and delivering the received test-related information to the operation/test control unit through the connector of the first wireless device.

[0021] The second wireless device may include: a connector connected to a connector of the test terminal; and a local-area wireless communication unit for receiving the test result information transmitted from the first wireless device in the local-area wireless communication manner, delivering the received test result information to the test terminal through the connector of the second wireless device, receiving the test-related information from the test terminal through the connector of the second wireless device, and transmitting the received test-related information to the first wireless device in the local-

area wireless communication manner.

[0022] The first wireless device may further include a converter for converting the test result information from the operation/test control unit, received through the connector of the first wireless device, into that of a communication protocol of the test terminal, and the test-related information from the second wireless device, received in the local-area wireless communication manner, into that of a communication protocol of the air conditioner, respectively.

[0023] In a feature of an embodiment of the present invention, local-area wireless communication can be carried out between an air conditioner and a test terminal using a pair of wireless devices that can be simply and conveniently carried and installed. Therefore, it is possible to significantly save trouble for installation of testing instruments, such as cables and a converter, and to significantly curtail costs and manpower for monitoring work.

[0024] Embodiments of the invention will now be described by way of non-limiting example only, with reference to the drawings, in which:

FIG. 1 is a schematic view of a conventional system for testing an air conditioner;

FIG. 2 is a schematic view of a system for testing an air conditioner according to the present invention;

FIG. 3 is a block diagram showing the configuration of an apparatus for testing an air conditioner according to an exemplary embodiment of the present invention; and

FIG. 4 is a block diagram of wireless devices according to an exemplary embodiment of the present invention.

[0025] Embodiments of the present invention will hereinafter be described with reference to these figures.

[0026] With reference to FIG. 3, an operation/test control unit 310 is provided in an outdoor unit 201 of the air conditioner. The operation/test control unit 310 includes an operation controller 315 for controlling the operation of a driving part 320 of the air conditioner according to an operating program stored in a storage unit 317. For example, the operation controller 315 controls the flow of refrigerant according to a cooling mode or heating mode. As well known to those skilled in the art, the air conditioner is operated in the cooling mode or heating mode depending on which one of outdoor and indoor heat exchangers (not shown) into which high-temperature, high-pressure refrigerant discharged from a compressor 305 is introduced earlier.

[0027] The control operation of the operation controller 315 and the operation of the driving part 320 of the air conditioner are well known in the art. For reference, the operation of the operation controller 315 will hereinafter be described in conjunction with a few examples. A compressor driving circuit 307 drives the compressor 305 under the control of the operation controller 315 such that the compressor 305 discharges high-temperature, high-

pressure refrigerant. At this time, the operation controller 315 computes an appropriate operating frequency of the compressor 305 on the basis of a set target temperature and a room temperature.

[0028] A switch 301 is provided in a pipe arrangement (not shown and may be positioned at the side of the outdoor unit) to switch the flow of the refrigerant. At this time, the operation controller 315 outputs an associated control signal to a switch driving circuit 303 such that the switch driving circuit 303 drives the switch 301. A fan 309 blows air to raise heat exchange efficiency. To this end, the operation controller 315 controls a fan driving circuit 311 to drive the fan 309.

[0029] The operation/test control unit 310 further includes a tester 313 for testing the air conditioner according to a testing program and transmitting test result information (for example, wiring state information, piping state information, cooling operation information, heating operation information, etc.) to a test terminal 207. The tester 313 checks whether each unit of the air conditioner is normally operated. For example, in the case where the air conditioner is of a multi-type, the tester 313 sequentially operates indoor units and then receives cooling operation information, heating operation information, piping state information and wiring state information from each of the indoor units.

[0030] In one embodiment, error sensors (not shown), such as a temperature sensor, are provided in the air conditioner, and the tester 313 inspects data sensed by the error sensors and checks, on the basis of the inspected data, whether the respective units of the air conditioner are normally operated. Also, the tester 313 compares the temperature of piping at an operation start point with the temperature of the piping at a predetermined time after the operation start point and, if the difference between those temperatures does not exceed a predetermined value, regards the connection of the piping as misconnection. The operation of this tester 313 is well known in the art. Those skilled in the art will readily embody the tester 313 from this specification.

[0031] In one embodiment, in response to a test command signal of the testing program, the tester 313 identifies and operates the respective elements of the driving part 320 and then checks whether the respective elements are normally operated. The tester 313 also stores information regarding the operation states of the respective elements of the driving part 320 in the storage unit 317 and transmits it to the test terminal 207.

[0032] In this embodiment, for the testing of the air conditioner, a first wireless device 203 is connected to the outdoor unit 201 of the air conditioner and a second wireless device 205 is connected to the test terminal 207, as shown in FIGS. 2 and 3.

[0033] With reference to FIG. 4, the first wireless device 203, connected to the outdoor unit 201 of the air conditioner, includes a first connector 401 connected to an associated connector (not shown) of the operation/test control unit 310 in the outdoor unit 201, and a first

local-area wireless communication unit 405 for receiving test result information based on the testing program from the tester 313 of the operation/test control unit 310 through the first connector 401, transmitting the received test result information to the test terminal 207 in a local-area wireless communication manner, receiving test-related information based on the testing program from the test terminal 207 in the local-area wireless communication manner, and delivering the received test-related information to the tester 313 through the first connector 401. The second wireless device 205, connected to the test terminal 207 in which the testing program is run, includes a second connector 409 inserted into a connection terminal of the test terminal 207, and a second local-area wireless communication unit 407 for receiving the test result information transmitted from the first local-area wireless communication unit 405 in the local-area wireless communication manner, delivering the received test result information to the test terminal 207 through the second connector 409, receiving the test-related information based on the testing program from the test terminal 207 through the second connector 409, and transmitting the received test-related information to the first local-area wireless communication unit 405 in the local-area wireless communication manner.

[0034] As stated above, the first wireless device 203 is connected to the outdoor unit 201 of the air conditioner. The first connector 401 is provided in the first wireless device 203 and connected to an associated connector of the operation/test control unit 310 in the outdoor unit 201. The air conditioner may support any communication protocols. Preferably, the air conditioner supports RS-485 communication protocol.

[0035] In this case, an RS-485 communication port may be provided in the operation/test control unit 310 or separately from the control unit 310. Once a communication port is provided separately from the operation/test control unit 310, the first connector 401 is connected to the control unit 310 via the provided communication port.

[0036] A protocol conversion operation must be additionally performed with respect to data to be transmitted through a communication port, for example, an RS-485 communication port. It will be understood herein that the first connector 401 is connected to the operation/test control unit 310 through a communication port which is provided in the operation/test control unit 310 or separately from the control unit 310.

[0037] For example, the first connector 401 may be fitted in an associated connector (not shown), for example, a card slot, receptacle or the like, of the operation/test control unit 310. Namely, the first wireless device 203 may be made in the form of a card or module, so that it can be mounted to the associated connector of the control unit 310. As a result, the first connector 401 may be made in the form of a terminal fittable in a card slot or in the form of a plug insertable into a receptacle.

[0038] A technology that mounts a computer peripheral product in card or module form on a main printed

circuit board of a computer or a housing of a main device of the computer is well known in a computer system manufacturing field. Those skilled in the art will readily embody the first connector 401 and the associated connector of the control unit 310 from this specification.

[0039] The second wireless device 205 is connected to the test terminal 207. In the present embodiment, the second connector 409 of the second wireless device 205 is a USB connector, which may be a USB plug or USB receptacle. The USB connector is connected to the test terminal 207, such as a computer, directly or via a USB cable. The skilled person will appreciate that other types of connector may be employed.

[0040] The first local-area wireless communication unit 405 of the first wireless device 203 and the second local-area wireless communication unit 407 of the second wireless device 205 perform local-area wireless communication with each other.

[0041] In one embodiment, each of the first and second local-area wireless communication units 405 and 407 is implemented with a USB Bluetooth module. The USB Bluetooth module is a device that is connected to a USB host (through a USB connector) to support USB communication, and wirelessly transmits and receives data in a Bluetooth communication manner. Those skilled in the art will readily embody such a USB Bluetooth module from this specification.

[0042] The USB Bluetooth module generally includes a USB Bluetooth module controller, and a Bluetooth wireless processor. The Bluetooth module controller includes a highspeed processing module, an interface module for the Bluetooth wireless processor, a Bluetooth baseband processing module, and a universal input/output unit. The Bluetooth module controller provides a USB device communication function to perform the USB communication with the USB host. It also processes a local-area wireless data communication function with other USB Bluetooth modules.

[0043] In the present embodiment, the first wireless device 203 further includes a converter 403 for converting the test result information from the tester 313 of the operation/test control unit 310, received through the first connector 401, into that of a communication protocol of the test terminal 207, and the test-related information from the test terminal 207, delivered by the first local-area wireless communication unit 405, into that of a communication protocol of the air conditioner, respectively.

[0044] Communication protocols supported by the air conditioner and the test terminal 207 may often be different from each other. In this connection, the converter 403 is arranged to convert the test result information of the air conditioner into that of the communication protocol of the test terminal 207, and the test-related information of the test terminal 207 into that of the communication protocol of the air conditioner, respectively. In one embodiment, the communication protocol of the air conditioner is RS-485 communication protocol and the communication protocol of the test terminal 207 is RS-232

communication protocol or USB protocol. As an alternative (not shown), the converter 403 may be provided in the air conditioner.

[0045] As stated above, the operation/test control unit 310 of the air conditioner has a connector to which the first wireless device 203 is connectable. In one embodiment, the first wireless device 203 is installed in the air conditioner only during testing work. In some cases, the wireless device 203 may be installed in the air conditioner even at normal times.

[0046] The present invention is also applicable to the case where the air conditioner is of a multi-type wherein a plurality of indoor units installed respectively in rooms are connected in common to one outdoor unit via a network. In one embodiment, the operation/test control unit 310 is connected to one or more indoor units via the network. In this case, the control unit 310 can communicate with an associated indoor unit via an RS-485 communication port (not shown) provided therein or separately therefrom, as described above.

[0047] In one embodiment, the test terminal 207 is a portable terminal (e.g., a notebook computer), so that testing instruments can be installed more simply and conveniently. However this is not essential.

[0048] In one embodiment, the use of the testing program enables the testing operation to be controlled in a software manner, with no need for a conventional test controller provided between the outdoor unit and the test terminal.

[0049] As apparent from the above description, by using embodiments of the present invention, local-area wireless communication can be carried out between an air conditioner and a test terminal, thereby making it possible to significantly save trouble for installation of testing instruments, such as cables and a converter, and to significantly curtail costs and manpower for testing work.

[0050] Further, the installer can conveniently perform testing even indoors. In addition, because information is transmitted in a local-area wireless communication manner, it is possible to prevent the information from being lost due to a voltage drop of a jig cable, and thus to secure reliability of the information.

[0051] Although the embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope of the invention as disclosed in the claims.

Claims

1. An apparatus for testing an air conditioner, comprising:

a first wireless device (203) connected to the air conditioner, the first wireless device (203) comprising means for transmitting and receiving test

result information and test-related information based on a testing program installed in a test terminal (207) in a local-area wireless communication manner; and

a second wireless device (205) connected to the test terminal (207), the second wireless device (205) comprising means for transmitting and receiving the test-related information and test result information based on the testing program in the local-area wireless communication manner.

2. The apparatus as set forth in claim 1, wherein the first wireless device (203) includes:

a connector (401) connected to a connector of an operation/test control unit (310) provided in the air conditioner; and

a local-area wireless communication unit comprising means for receiving the test result information from the operation/test control unit (310) through the connector (401) of the first wireless device (203), transmitting the received test result information to the second wireless device (205) in the local-area wireless communication manner, receiving the test-related information from the second wireless device (205) in the local-area wireless communication manner, and delivering the received test-related information to the operation/test control unit (310) through the connector (401) of the first wireless device (203).

3. The apparatus as set forth in claim 2, wherein the first wireless device (203) further includes a converter (403) comprising means for converting the test result information from the operation/test control unit (310), received through the connector (401) of the first wireless device (203), into that of a communication protocol of the test terminal (207), and the test-related information from the second wireless device (205), received in the local-area wireless communication manner, into that of a communication protocol of the air conditioner, respectively.

4. The apparatus as set forth in claim 1, wherein the second wireless device (205) includes:

a connector (409) connected to a connector of the test terminal (207); and

a local-area wireless communication unit comprising means for receiving the test result information transmitted from the first wireless device (203) in the local-area wireless communication manner, delivering the received test result information to the test terminal (207) through the connector (409) of the second wireless device (205), receiving the test-related information from the test terminal (207) through the connector (409)

of the second wireless device (205), and transmitting the received test-related information to the first wireless device (203) in the local-area wireless communication manner.

5. The apparatus as set forth in claim 2 or 4, wherein the local-area wireless communication unit is a USB Bluetooth module.

6. The apparatus as set forth in claim 4, wherein the connector (409) of the second wireless device (205) is a USB connector.

7. The apparatus as set forth in claim 2, wherein:

the air conditioner is of a separated type wherein indoor and outdoor units are separated from each other; and
the operation/test control unit (310) is provided in the outdoor unit.

8. An apparatus for testing an air conditioner, comprising:

an operation/test control unit (310) comprising means for controlling driving of the air conditioner and testing the air conditioner;
a first wireless device (203) connected to the operation/test control unit (310);
a test terminal (207) equipped with a testing program for testing the air conditioner; and
a second wireless device (205) connected to the test terminal (207),
wherein the first wireless device (203) comprises means to transmit and receive test result information and test-related information based on the testing program in a local-area wireless communication manner, and the second wireless device (205) comprises means to transmit and receive the test-related information and test result information based on the testing program in the local-area wireless communication manner.

9. The apparatus as set forth in claim 8, wherein:

the air conditioner is of a separated type wherein indoor and outdoor units are separated from each other; and
the operation/test control unit (310) is provided in the outdoor unit.

10. The apparatus as set forth in claim 8, wherein each of the first and second wireless devices (203 and 205) includes a local-area wireless communication unit for performing local-area wireless communication, wherein the local-area wireless communication unit is a USB Bluetooth module.

11. The apparatus as set forth in claim 8, wherein the first wireless device (203) includes a converter (403) comprising means for converting the test result information, delivered from the operation/test control unit (310), into that of a communication protocol of the test terminal (207), and the test-related information, received from the second wireless device (205) in the local-area wireless communication manner, into that of a communication protocol of the air conditioner, respectively.

5

10

15

20

25

30

35

40

45

50

Fig.1

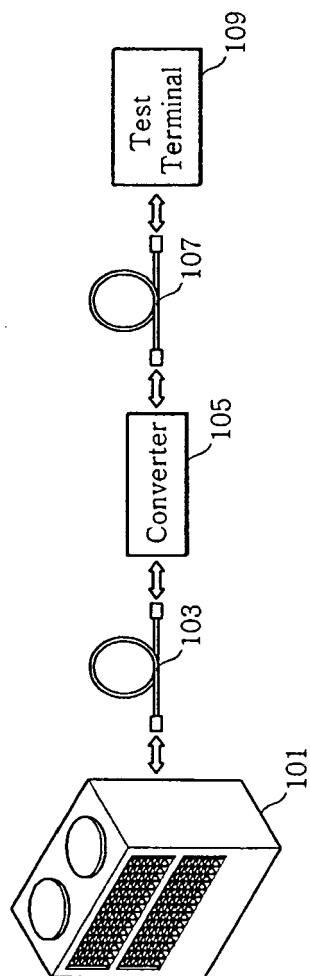


Fig.2

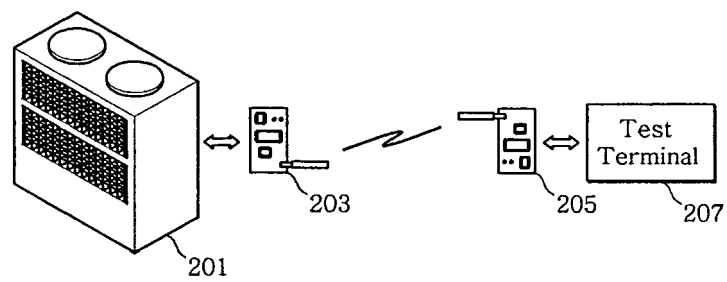


Fig.3

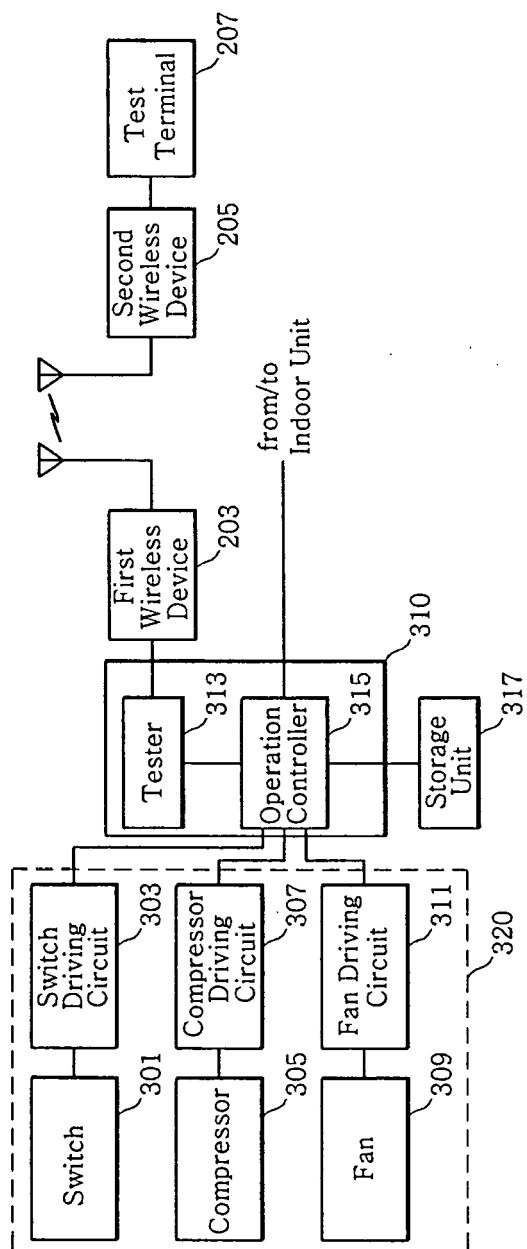
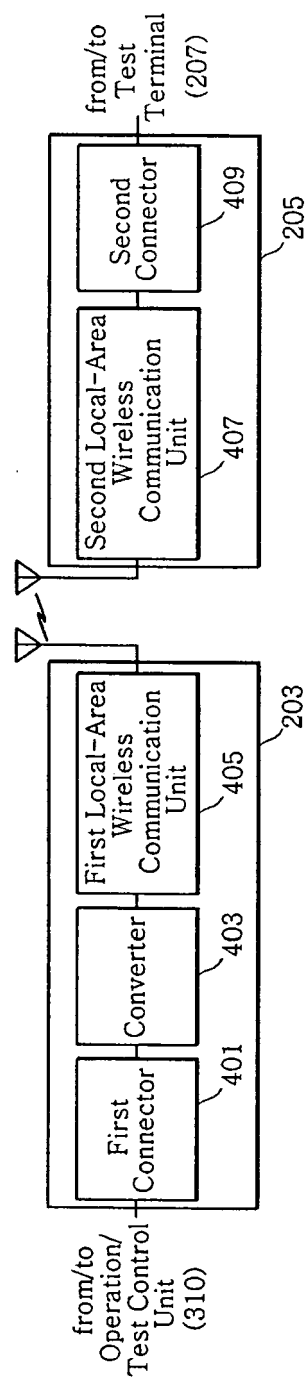


Fig.4





DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 03/064933 A (SIEMENS BUILDING TECHNOLOGIES, INC) 7 August 2003 (2003-08-07) * the whole document *	1-11	F24F11/00
X	US 5 495 722 A (MANSON ET AL) 5 March 1996 (1996-03-05) * column 2, line 65 - column 5, line 42; figure 1 *	1	
X	US 5 454 510 A (MANSON ET AL) 3 October 1995 (1995-10-03) * abstract; figure 1 *	1	
P,X	US 2005/103874 A1 (ERDMAN CLAIR E.JR ET AL) 19 May 2005 (2005-05-19) * paragraph [0024]; figures 1,2 *	1-11	
			TECHNICAL FIELDS SEARCHED (IPC)
			F24F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 7 March 2006	Examiner Valenza, D
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			

2

EPO FORM 1503 03-82 (P04C01)

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

EP 05 25 7338

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.

07-03-2006

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 03064933	A	07-08-2003	EP 1470456 A1	27-10-2004
			EP 1470457 A2	27-10-2004
			WO 03065136 A1	07-08-2003

US 5495722	A	05-03-1996	NONE	

US 5454510	A	03-10-1995	NONE	

US 2005103874	A1	19-05-2005	NONE	
