IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

CARRIER CORPORATION, Plaintiff, v. GOODMAN GLOBAL, INC., GOODMAN MANUFACTURING COMPANY, L.P., GOODMAN GLOBAL HOLDINGS, INC., GOODMAN DISTRIBUTION, INC., and GOODMAN SALES COMPANY Defendants.	)	C.A. No. 12-930 (SLR) **JURY TRIAL DEMANDED**
GOODMAN MANUFACTURING COMPANY, L.P. and GOODMAN DISTRIBUTION, INC., Counterclaim Plaintiffs, v. CARRIER CORPORATION, Counterclaim Defendant.	)	

FIRST AMENDED COMPLAINT

Plaintiff Carrier Corporation ("Carrier"), for its first amended complaint against Defendants Goodman Global, Inc., Goodman Manufacturing Company, L.P., Goodman Global Holdings, Inc., Goodman Distribution, Inc., and Goodman Sales Company (collectively, "Goodman" or "Defendants"), hereby demands a jury trial and alleges as follows:

THE PARTIES

1. Carrier is a corporation organized under the laws of Delaware with a principal place of business at One Carrier Place, Farmington, CT 06032.

2. On information and belief, Defendant Goodman Global, Inc. is a corporation organized under the laws of Delaware with a principal place of business at 5151 San Felipe Street, Suite 500, Houston, TX 77056.

3. On information and belief, Defendant Goodman Manufacturing Company, L.P. is a partnership organized under the laws of Texas with a principal place of business at 5151 San Felipe Street, Suite 500, Houston, TX 77056.

4. On information and belief, Defendant Goodman Global Holdings, Inc. is a corporation organized under the laws of Delaware with a principal place of business at 5151 San Felipe Street, Suite 500, Houston, TX 77056.

5. On information and belief, Defendant Goodman Distribution, Inc. is a corporation organized under the laws of Texas with a principal place of business at 5151 San Felipe Street, Suite 500, Houston, TX 77056. Defendant Goodman Distribution, Inc. is qualified with the Delaware Secretary of State to do business in Delaware, and its registered agent in Delaware is The Corporation Trust Company, located at 1209 Orange Street, Wilmington, DE 19801.

6. On information and belief, Defendant Goodman Sales Company is a corporation organized under the laws of Texas with a principal place of business at 5151 San Felipe Street, Suite 500, Houston, TX 77056.

JURISDICTION AND VENUE

7. This Court has subject matter jurisdiction pursuant to 28 U.S.C. §§ 1331 and 1338 because this action arises under the patent laws of the United States, including 35 U.S.C. § 271 et seq.

8. The Court has personal jurisdiction over Defendants Goodman Global, Inc. and Goodman Global Holdings, Inc. at least because Defendants Goodman Global, Inc. and Goodman Global Holdings, Inc. are Delaware corporations. Personal jurisdiction (1) exists generally over all Defendants because they (directly and/or through their subsidiaries, divisions, groups or distributors) have sufficient minimum contacts with the District of Delaware as a result of business conducted within the State of Delaware; and/or (2) exists specifically over all Defendants because, on information and belief, Defendants have committed acts of infringement in the District of Delaware, including at least because they each (directly and/or through their subsidiaries, divisions, groups, or distributors) advertise, market, offer for sale, or sell the infringing products at issue in this case in the District of Delaware.

9. Venue is proper in this district under 28 U.S.C. §§ 1391(b) and 1400(b), at least because Defendants Goodman Global, Inc. and Goodman Global Holdings, Inc. are Delaware corporations and all Defendants are subject to personal jurisdiction in the District of Delaware and have committed acts of infringement in Delaware.

COUNT ONE — INFRINGEMENT OF THE '004 PATENT

10. On July 10, 2007, the United States Patent & Trademark Office issued United States Patent No. 7,243,004 ("the '004 Patent"), entitled "Self-Configuring Controls for Heating, Ventilating and Air Conditioning Systems." A copy of the '004 Patent is attached hereto as Exhibit A.

11. Carrier has owned the '004 Patent throughout the period of Defendants' infringing acts and still owns the '004 Patent.

12. Defendants have been and are infringing the '004 Patent by making, using, offering to sell, and/or selling in the United States their ComfortNet family of products,

including at least thermostats, air conditioners, heat pumps, furnaces, and air handlers under the trade names "Goodman" and/or "Amana" that incorporate the "ComfortNet Communicating System."

13. Defendants have actual knowledge of the '004 Patent and Carrier's claims of infringement based at least on the filing of the original complaint in this action. Defendants further have knowledge of Carrier's infringement allegations from Carrier's Initial Claim Charts, which were served on January 16, 2013. Despite that knowledge, Defendants have continued making, advertising, marketing, selling, offering to sell, supporting, and distributing the accused products in the ComfortNet family of products.

14. Defendants have been and are indirectly infringing the '004 Patent by inducing infringement and/or contributing to the infringement of the '004 Patent by others (*e.g.*, distributors, installers, and end users).

15. On information and belief, Defendants have been and are encouraging others (*e.g.*, distributors, installers, and end users) to directly infringe the '004 Patent with knowledge of that infringement, such as by making, advertising, marketing, selling, offering to sell, supporting, and distributing their ComfortNet family of products, including ComfortNet thermostats, air conditioners, furnaces, heat pumps, and air handlers, for ComfortNet Communicating Systems that are covered by at least claim 1 of the '004 Patent, and that are used to infringe claim 18 of the '004 Patent. Defendants' customers directly infringe the '004 Patent.

16. Defendants' ComfortNet family of products are especially made for or adapted for use in infringing the '004 Patent.

17. Defendants' ComfortNet family of products are not staple articles or commodities of commerce suitable for substantial non-infringing use.

18. Defendants know that the HVAC systems for which its ComfortNet family of products are especially designed are patented by the '004 Patent and infringing the '004 Patent.

19. Carrier has complied with 35 U.S.C. § 287 by placing a notice of the '004 Patent on Carrier products made, offered for sale, and/or sold under the '004 Patent.

20. Carrier has been damaged by Defendants' infringement of the '004 Patent and is suffering and will continue to suffer damage and irreparable harm unless the Court enjoins Defendants from their activities.

COUNT TWO — INFRINGEMENT OF THE '452 PATENT

21. On August 17, 2010, the United States Patent & Trademark Office issued United States Patent No. 7,775,452 ("the '452 Patent"), entitled "Serial Communicating HVAC System." A copy of the '452 Patent is attached hereto as Exhibit B.

22. Carrier has owned the '452 Patent throughout the period of Defendants' infringing acts and still owns the '452 Patent.

23. Defendants have been and are infringing the '452 Patent by making, using, offering to sell, and/or selling in the United States their ComfortNet family of products, including at least thermostats, air conditioners, heat pumps, furnaces, and air handlers under the trade names "Goodman" and/or "Amana" that incorporate the "ComfortNet Communicating System."

24. Defendants have actual knowledge of the '452 Patent and Carrier's claims of infringement based at least on the filing of the original complaint in this action. Defendants further have knowledge of Carrier's infringement allegations from Carrier's Initial Claim Charts, which were served on January 16, 2013. Despite that knowledge, Defendants have continued

making, advertising, marketing, selling, offering to sell, supporting, and distributing the accused products in the ComfortNet family of products.

25. Defendants have been and are indirectly infringing the '452 Patent by inducing infringement and/or contributing to the infringement of the '452 Patent by others (*e.g.*, distributors, installers, and end users).

26. On information and belief, Defendants have been and are encouraging others (*e.g.*, distributors, installers, and end users) to directly infringe the '452 Patent with knowledge of that infringement, such as by making, advertising, marketing, selling, offering to sell, supporting, and distributing their ComfortNet family of products, including ComfortNet thermostats, air conditioners, furnaces, heat pumps, and air handlers, for ComfortNet Communicating Systems that are covered by at least claim 1 of the '452 Patent.

27. Defendants' ComfortNet family of products are especially made for or adapted for use in infringing the '452 Patent.

28. Defendants' ComfortNet family of products are not staple articles or commodities of commerce suitable for substantial non-infringing use.

29. Defendants know that the HVAC systems for which its ComfortNet family of products are especially designed are patented by the '452 Patent and infringing the '452 Patent.

30. Carrier has complied with 35 U.S.C. § 287 by placing a notice of the '452 Patent on Carrier products made, offered for sale, and/or sold under the '452 Patent.

31. Carrier has been damaged by Defendants' infringement of the '452 Patent and is suffering and will continue to suffer damage and irreparable harm unless the Court enjoins Defendants from their activities.

PRAYER FOR RELIEF

WHEREFORE, Carrier prays for relief and judgment against Defendants as follows:

A. That Defendants have infringed one or more claims of the '004 and '452 patents;

B. An injunction against Defendants, their officers, agents, servants, employees, all parent and subsidiary entities, all assignees and successors in interest, and those persons or entities acting in concert or participation with Defendants, including distributors and customers, enjoining them from further infringement of the '004 and '452 patents;

C. An award of damages under 35 U.S.C. § 284, including an accounting and pre- and post-judgment interest, and an award of costs;

D. That this case is exceptional under 35 U.S.C. § 285, and an award of Carrier's reasonable attorneys' fees and expenses;

E. Such other relief that this Court deems just and proper.

DEMAND FOR JURY TRIAL

Carrier hereby demands a trial by jury for all claims and issues so triable.

MORRIS, NICHOLS, ARSHT & TUNNELL LLP

Jack B. Blumenfeld (#1014)
Maryellen Noreika (#3208)
1201 North Market Street
P.O. Box 1347
Wilmington, DE 19899
(302) 658-9200
jblumenfeld@mnat.com
mnoreika@mnat.com

Attorneys for Plaintiff Carrier Corporation

OF COUNSEL:

Gregg F. LoCascio, P.C.
Sean M. McEldowney
Katharine M. Burke
Anders P. Fjellstedt
Joseph Edell
KIRKLAND & ELLIS LLP
655 15th St. N.W., Suite 1200
Washington, D.C. 20005
(202) 879-5000

January 31, 2013

EXHIBIT A

(12) **United States Patent**
Shah et al.

(10) **Patent No.: US 7,243,004 B2**
(45) **Date of Patent: Jul. 10, 2007**

(54) **SELF-CONFIGURING CONTROLS FOR HEATING, VENTILATING AND AIR CONDITIONING SYSTEMS**

(75) Inventors: **Rajendra K. Shah**, Indianapolis, IN (US); **Jerry D. Ryan**, Indianapolis, IN (US)

(73) Assignee: **Carrier Corporation**, Syracuse, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 319 days.

(21) Appl. No.: **10/752,628**

(22) Filed: **Jan. 7, 2004**

(65) **Prior Publication Data**

US 2005/0149232 A1 Jul. 7, 2005

(51) **Int. Cl.**
G01M 1/38 (2006.01)

(52) **U.S. Cl.** ..... **700/276**; 700/277; 700/299; 700/300; 236/91 D; 236/91 E

(58) **Field of Classification Search** ..... 700/276, 700/277, 278, 299, 300; 236/47, 91 D, 91 E; 165/253, 254, 257
See application file for complete search history.

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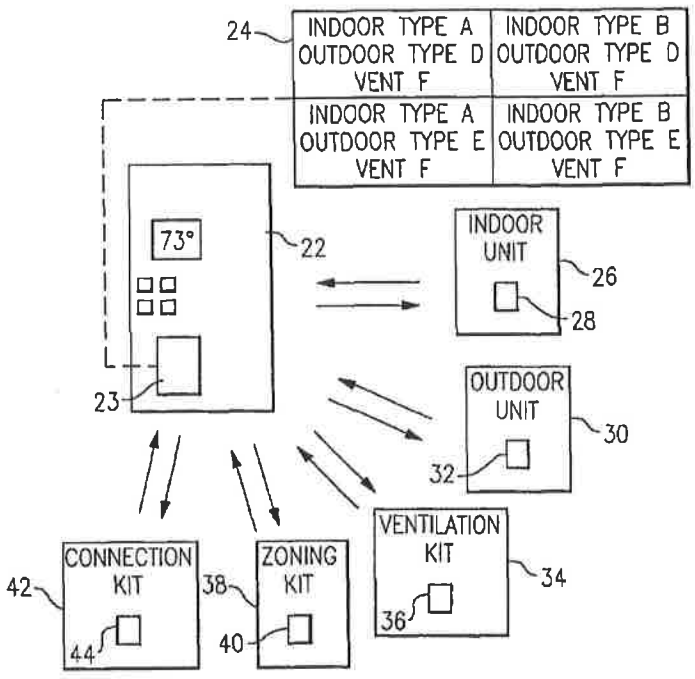
Primary Examiner—Zoila Cabrera
Assistant Examiner—Charles Kasenge
(74) *Attorney, Agent, or Firm*—Carlson, Gaskey & Olds

(57) **ABSTRACT**

A system for self-configuring complex HVAC systems has each of several units provided with a microprocessor control. The several units are each available in various optional styles, sizes, etc. The microprocessors provide information to a central control of the particular characteristic of the particular unit. Thus, when the HVAC system is initially assembled, the microprocessors associated with the individual units report these characteristics to the control. The control then determines the characteristics of each of the individual units, and accesses control strategies for the combination of individual units that are being utilized in the particular HVAC system.

19 Claims, 3 Drawing Sheets



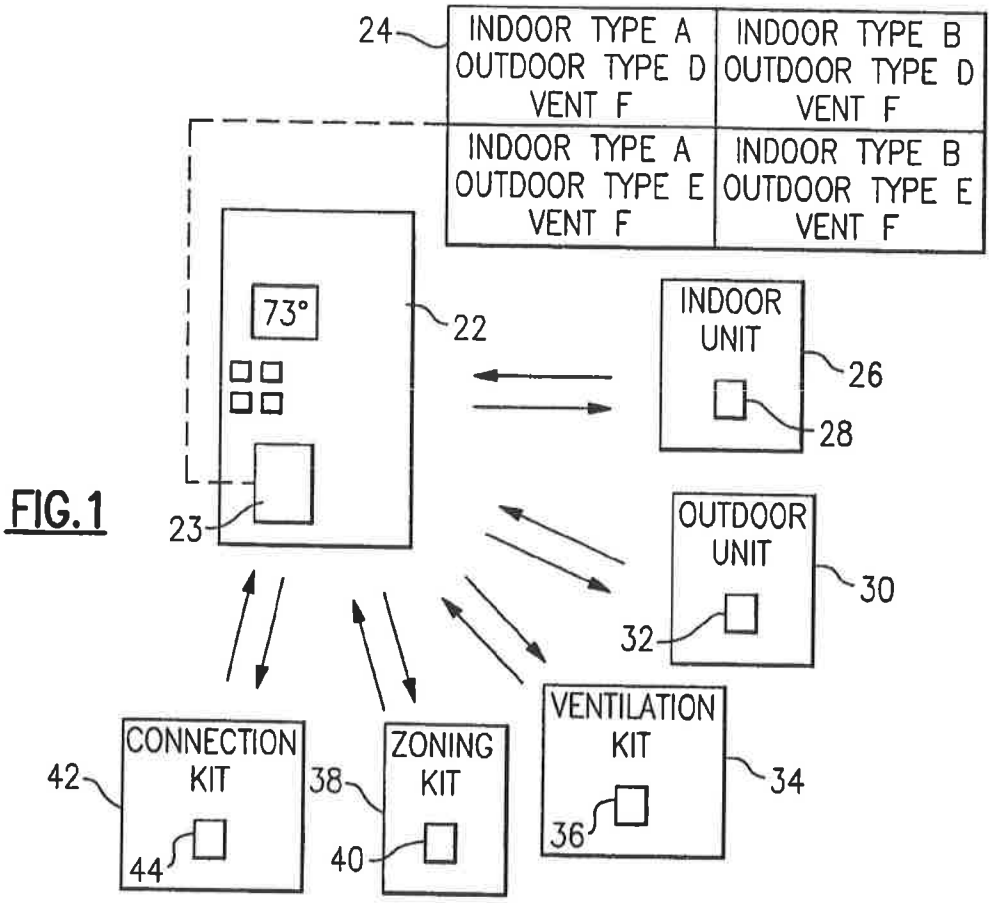


FIG.1

FIG.2

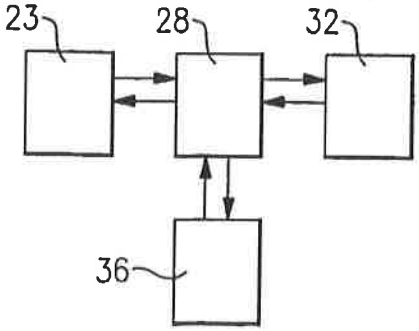


FIG.3

	EQUIPMENT UNIT EXAMPLES	FACTORY PROGRAMMED UNIT CONFIGURATION INFORMATION	IDENTIFIED FIELD INSTALLED ACCESSORIES
1	THERMOSTAT/USER INTERFACE (SYSTEM CONTROL)	MODEL NUMBER SERIAL NUMBER	• REMOTE ROOM SENSOR
2	VARIABLE SPEED FAN COIL	MODEL NUMBER SERIAL NUMBER FAN COIL SIZE AIR FLOW RANGE PRESSURE CONSTANTS	•ELECTRIC HEATER W/ CAPACITY •OUTDOOR TEMPERATURE SENSOR
3	VARIABLE SPEED HI-EFF FURNACE VARIABLE SPEED MID-EFF FURNACE	MODEL NUMBER SERIAL NUMBER FURNACE SIZE AIR FLOW RANGE PRESSURE CONSTANTS	•OUTDOOR TEMPERATURE SENSOR •TWINNED FURNACE
4	TWO SPEED AIR CONDITIONER (AC) TWO SPEED HEAT PUMP (HP)	MODEL NUMBER SERIAL NUMBER TYPE (AC OR HP) CAPACITY LOW/HIGH CAPACITY RATIO REFRIGERANT (R-22 OR R-410A)	
5	FOUR ZONE CONTROL	MODEL NUMBER SERIAL NUMBER ZONE RANGE (FIELD ADJUSTABLE)	•REMOTE ZONE SENSOR(S) •VENTILATOR •LEAVING AIR TEMPERATURE SENSOR •HEAT PUMP TEMPERATURE SENSOR
6	ZONE SMART SENSOR	MODEL NUMBER SERIAL NUMBER ZONE NUMBER (FIELD ADJUSTABLE)	
7	INTERFACE MODULE	MODEL NUMBER SERIAL NUMBER	•VENTILATOR •SINGLE SPEED HP •LEGACY TWO SPEED AC/HP
8	REMOTE ACCESS MODULE	MODEL NUMBER SERIAL NUMBER	•WATER LEVEL SENSOR

FIG.1B

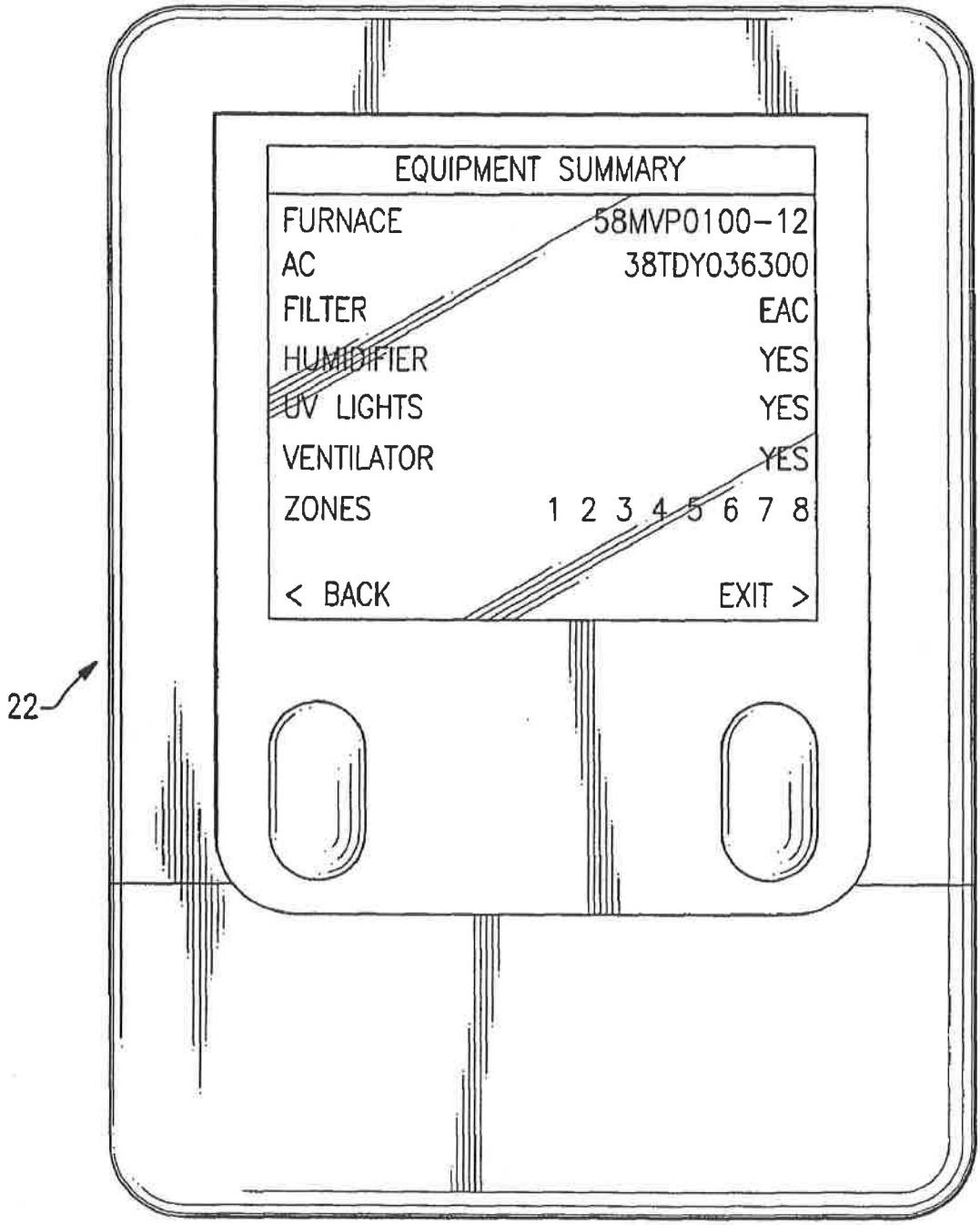

EQUIPMENT SUMMARY
FURNACE 58MVP0100-12
AC 38TDY036300
FILTER EAC
HUMIDIFIER YES
UV LIGHTS YES
VENTILATOR YES
ZONES 1 2 3 4 5 6 7 8
< BACK EXIT >
22

FIG. 1C

SELF-CONFIGURING CONTROLS FOR HEATING, VENTILATING AND AIR CONDITIONING SYSTEMS

BACKGROUND OF THE INVENTION

This application relates to a heating, ventilation and air conditioning system wherein the various units report to a central control about characteristics of the units. In this way, the control is provided with information on each of the several units, and can identify a control strategy to encompass the individual characteristics of the several units, and to ensure they cooperate efficiently.

Heating, ventilation and air conditioning (HVAC) systems are becoming increasingly complex. As an example, such systems typically include an indoor unit, which may be a furnace or heater/fan coil. Also, an outdoor unit that may be an air conditioner or heat pump is provided. Most units include a thermostat. More sophisticated systems may include separate zone controls for several zones, a ventilator, a humidifier, an air cleaner, etc.

Each of the several distinct units may have several available sizes (capacities, airflow, ranges, zone ranges, etc.) As examples, furnaces typically come in several capacity ranges, as do air conditioners. Within a size, there may also be types, such as high efficiency, mid-efficiency, etc. There are several options for each of the other units such as the zone control, ventilator, humidifier, air cleaner, etc.

To provide efficient system control, an installer must configure a control to know the characteristics of the other units installed in the particular system. As an example, the particular size or capacity of the furnace may impact the control of the ventilator, humidifier, etc. This is but one example of interaction, and a worker of ordinary skill in this art would recognize that each of the units would have several levels of interaction with other units.

The method an installer uses for configuration can take several different forms. As an example, the installer may need to set switches, jumpers or software flags in a central control. Typically, such configuration must be done for several distinct units in the system. This configuration can require the installer to be highly trained in all aspects of the systems. Errors in proper configuration can result in inefficient control, including customer dissatisfaction, malfunction, inefficient operation, and even equipment failure.

As HVAC systems become even more sophisticated, and perform more advanced functions, the complexity of configuration will only increase.

SUMMARY OF THE INVENTION

A disclosed system is self-configuring, in that plural units are provided with an electronic control that reports the unit's particular characteristics to a central control. The central control takes in the characteristics of each of the several units, and has available to it optimum operational strategies based upon the combination of several units that have reported.

In disclosed embodiments of this invention, each of the main units are provided with microprocessor controls that communicate with the central control. The central control is preferably located within the thermostat.

The central control is preferably provided with control algorithms to control the inter-related operation of the several units based upon the characteristics of each unit. Thus, once the system is initially assembled, each of the several units communicates its individual characteristics to the central control. The central control is then able to control each of the units in an efficient manner based upon how the several units would be best operated in combination with the other units. The controls that are utilized once the characteristics of the units have been determined, are known. This invention extends to the way the size, type, etc. information is supplied to the central control. Problems with regard to configuration are eliminated, as the "configuration" is done at set-up.

These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view of a building HVAC system.

FIG. **1**B shows examples of the types of information that might be provided.

FIG. **1**C shows an example display.

FIG. **2** is a flowchart of a method according to the present invention.

FIG. **3** shows a most preferred schematic arrangement.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** schematically shows an HVAC system **20** incorporating a thermostat **22**. As shown, thermostat **22** incorporates a microprocessor **23** which is a central control for system **20**. The microprocessor **23** has available access to a memory **24**. An indoor heating unit **26** may be a furnace, or a heater and fan, and is also provided with a microprocessor **28**. An outdoor unit **30** which may be an air conditioner or heat pump, is also provided with a microprocessor **32**.

An auxiliary device, shown as a ventilation device **34**, has its own microprocessor **36**. Various zone controls **38** have microprocessors **40** shown schematically also. A connectivity kit, such as a remote access module **42** has a microprocessor **44**. A remote access module is typically a wireless link to an internet connection that allows a user to monitor or change temperature conditions from a remote location. This is an example system, and this invention does extend to systems with fewer units and systems with more units.

As shown, each of the units **26**, **30**, **34**, **38** and **42** communicate with the microprocessor **23**. The microprocessors **28**, **32**, **36**, **40** and **44** associated with the several units control operation of each individual unit. The microprocessors **28**, **32**, **36**, **40** and **44** receive instructions from the microprocessor **23**. Microprocessor **23** sends instruction to achieve temperature, etc. as requested by a user through the thermostat.

Moreover, and in accordance with this invention, the microprocessors **28**, **32**, **36**, **40** and **44** are operable to provide characteristic information to the microprocessor **23**. In particular, each of the units **26**, **30**, **34**, **38** and **42** come in optional sizes, capacities, etc. Their individual microprocessors are able to communicate information to the microprocessor **23** at the thermostat **22** to report on the particular characteristic of the particular installed unit **26**, **30**, **34**, **38** and **42**.

Each of the microprocessors (**28**, **32**, **36**, **40** and **44**) associated with the particular reporting units have stored information that is associated with a particular characteristic of the units (**26**, **30**, **34**, **38** and **42**), and can distinguish between the available types of reporting units. As an example, if there are several available indoor units, the characteristic information stored in the microprocessor **28** of

the indoor unit **26** would carry some code indicative of the particular characteristic. The microprocessor **23** is provided information such that the reporting information from the indoor unit **26** would let the microprocessor **23** know what the particular characteristics are.

The characteristic information is preferably programmed into each unit's microprocessor in the factory at the time the equipment is manufactured. One preferred method of factory programming the configuration information is by a factory run test computer, which can recognize the exact model being tested. The factory run test computer can then digitally download the model specific information, or the characteristic information, into the electronic control of the unit. Alternatively, some configuration information may be factory set by means of jumpers, switches, or model plugs.

When the system is initially installed, the microprocessor **23** is provided with this characteristic information on each of the units **26**, **30**, **34**, **38** and **42**. If a unit is ever changed, the replacement unit will need to report its characteristic information. Thus, the reports preferably occur at least periodically.

As shown in FIG. **2**, an initial step in this invention, is to connect the units together. The units will then all report to the microprocessor **23**. Microprocessor **23** can then access a memory **24** to determine how the several units are best controlled in combination with each other to achieve optimal results. The information in the memory **24** may be determined experimentally, or in other ways known to a worker of ordinary skill in the art. A worker of ordinary skill in the art would recognize how each of the several units are best utilized in combination with each other dependent upon the characteristic of each of the units, or how such optimal operation algorithms can be determined.

As shown for example in FIG. **1**, within the memory **24** are a plurality of available options for the indoor unit, the outdoor unit, and the ventilator. Various combinations of types, shown here indicated by letters of the alphabet, are stored, and are associated with algorithms for operation of that preferred combination of type units. Once the microprocessor **23** is provided with information of the types of indoor unit, outdoor unit, and ventilation device, it can identify and utilize appropriate controls for the particular combination. The illustrated memory is an oversimplification, in that there are other units such as shown in FIG. **1** that would also have options within the memory. Examples of the types of information, and some of the example types of units are shown in FIG. **1**B. Thus, and as an example, the furnace may be programmed to report information on its characteristics such as model number, serial number, furnace size, airflow range, and pressure constants. Again, while the chart does show numerous other units and types of characteristic information, the listing is meant to be exemplary and not limiting.

At the time of installation, the identified characteristics are displayed in some manner to the installer. One example display is shown in FIG. **1**C. Preferably, a display on thermostat **22** would report to the installer that reporting information has been successfully received from each of the units that should have reported. The installer can then ensure proper installation, and that the characteristic information has been properly reported.

While the various units are shown reporting directly to the microprocessor **23**, in practice, it will be most preferred that they would communicate through a serial bus connection such as is disclosed in co-pending U.S. patent application Ser. No. 10/752,626, entitled "Communicating HVAC System" filed on even date herewith, and naming the same inventors as this application.

As shown in FIG. **3**, the preferred arrangement includes control wires providing a control communication bus between microprocessor **23** and **28**. The microprocessor **32** in the outdoor unit **30** preferably communicates through indoor unit microprocessor **28** to microprocessor **23**. Further, the auxiliary microprocessors such as the microprocessor **36** in the ventilation unit may also communicate to the microprocessor **23** through the indoor unit microprocessor **28**. Again, this aspect of the invention is disclosed in greater detail in the above-referenced co-pending patent application, and the details of the connection are incorporated herein by reference.

As also shown in FIG. **1**B, each of the reporting units may carry information from various accessing units to report to microprocessor **23**. Examples are identified under "Identified Field Installed Accessories" column. One example is the capacity of an electric heater may be reported by the microprocessor **28** associated with the fan coil. The electric heater may report its capacity to microprocessor **28** such as disclosed in U.S. patent application Ser. No. 10/707,524, entitled "Identification of Electric Heater Capacity," filed on Dec. 12, 2003. The capacity of the electric heater will then be included in the characteristics communicated by microprocessor **28** to microprocessor **23**. Again, other examples of accessory information are illustrated in FIG. **1**B, but are not intended to be limiting.

The stored control algorithms may be as known in the art. As mentioned above, in the prior art, when the system was initially configured, an installer set flags, switches, etc. which instructed the control on which algorithm to pick. The present invention is directed to providing the information to the control without any need for the installer to perform such steps.

While microprocessor controls have been disclosed, other types of appropriate controls can be utilized to perform this invention.

Although a preferred embodiment of this invention has been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.

What is claimed is:

1. A control for an HVAC system comprising:

a central control for receiving information from each of a plurality of HVAC units, said central control being operable to receive information about characteristics of the plurality of HVAC units, and to access a memory of control algorithms, at least one of said plurality of HVAC units being of the type that there are several available models, and at least one of the characteristics of said one of the plurality of HVAC units is an identification of the particular model which has been incorporated into a system receiving said central control, said memory including a plurality of control algorithms, with each of said control algorithms being associated with a particular set of combination of characteristics of the plurality of HVAC units that may report to the control, and the particular model being included in said particular set of combination of characteristics of the plurality of the HVAC units, said control selecting one of said plurality of control algorithms associated with the particular combination of characteristics of the plurality of HVAC units that

report to the control, and said central control being operable to control the plurality of HVAC units using said selected one of said plurality of control algorithms.

2. The control as set forth in claim 1, wherein said central control includes a microprocessor control.

3. The control as set forth in claim 1, wherein said central control is in a thermostat.

4. The control as set forth in claim 1, wherein said information about characteristics of said plurality of reporting HVAC units comes to said central control over a single data bus.

5. The control as set forth in claim 1, wherein said characteristic information includes information on the size of said plurality of HVAC units.

6. An HVAC system comprising;

an indoor unit having a control operable to communicate characteristic information of said indoor unit to a central control, an outdoor unit having a control operable to communicate characteristic information of said outdoor unit to said central control; and

said central control communicating with said indoor unit and said outdoor unit, and said central control receiving said characteristic information from said indoor unit and said outdoor unit, and determining an optimal control strategy for said indoor unit and said outdoor unit based upon said reported characteristic information, said central control storing a plurality of optimal control strategies, and selecting a particular one of said optimal control strategies to utilize based upon the particular characteristic information reported from said indoor unit and said outdoor unit; and

wherein said indoor unit is one of a furnace and a heater/fan combination, and said outdoor unit is done of an air conditioner and a heat pump.

7. The system as set forth in claim 6, wherein said central control is mounted on a unit other than said indoor and outdoor units.

8. The system as set forth in claim 7, wherein said central control is mounted in a thermostat.

9. The system as set forth in claim 6, wherein said central control also receives characteristic information from auxiliary equipment.

10. The system as set forth in claim 9, wherein said central control receives characteristic information from a ventilation device.

11. The system as set forth in claim 9, wherein zoning controls provide characteristic information to said central control.

12. The system as set forth in claim 9, wherein said control receives characteristic information from a connectivity kit.

13. The system as set forth in claim 6, wherein said characteristic information from said indoor and said outdoor units comes to said central control over a single data bus.

14. The system as set forth in claim 6, wherein said characteristic information includes information on the size of a plurality of HVAC units.

15. The system as set forth in claim 6, wherein at least one auxiliary component is mounted to at least one of said indoor and outdoor units, with said control for one of said indoor and outdoor units identifying characteristics of said auxiliary component, and reports said identified characteristic of said auxiliary component to said central control.

16. The system as set forth in claim 6, wherein said particular one of said optimal control strategies is selected based upon the combination of received characteristic information from both said indoor unit and said outdoor unit.

17. An HVAC system comprising:

an indoor unit having a control operable to communicate characteristic information of said indoor unit to a central control, an outdoor unit having a control operable to communicate characteristic information of said outdoor unit to said central control;

said central control communication with said indoor unit and said outdoor unit, and said central control receiving said characteristic information from said indoor unit and said outdoor unit, and determining an optimal control strategy for said indoor unit and said outdoor unit based upon said reported characteristic information, said central control storing a plurality of optimal control strategies, and selecting a particular one of said optimal control strategies to utilize based upon the particular characteristic information reported from said indoor unit and said outdoor unit; and

said central control receiving said characteristic information, and accessing a stored memory wherein various control algorithms are stored based upon particular combinations of indoor and outdoor units, and said central control utilizing said associated optimum control algorithms based upon the communicated characteristic information of said indoor and outdoor units.

18. A method of operating an HVAC system comprising the steps of:

(1) providing a plurality of units in an HVAC system including at least an indoor unit and an outdoor unit and a central control, said indoor and outdoor units having a particular set of characteristics from a plurality of available types of indoor and outdoor units;

(2) communicating stored characteristic information from said indoor and outdoor units to said central control; and

(3) associating said reporting characteristic information at said central control, to identify a particular combination of said reporting indoor and outdoor units, and accessing optimum control algorithms, said memory including a plurality of control algorithms, with each of said control algorithms being associated with a particular set of combination of characteristics of the plurality of HVAC units that may report to the control, said control selecting one of said plurality of control algorithms based upon said particular combination of said indoor and outdoor units, and utilizing said selected one of said plurality of control algorithms to control the plurality of units.

19. The method as set forth in claim 18, wherein auxiliary units further provide characteristic information to said central control, and are utilized to determine optimum control algorithms at said central control.

* * * * *

EXHIBIT B

(12) **United States Patent**
Shah et al.

(10) **Patent No.: US 7,775,452 B2**
(45) **Date of Patent: Aug. 17, 2010**

(54) **SERIAL COMMUNICATING HVAC SYSTEM**

(75) Inventors: **Rajendra K. Shah**, Indianapolis, IN (US); **Jerry D. Ryan**, Indianapolis, IN (US)

(73) Assignee: **Carrier Corporation**, Syracuse, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1060 days.

(21) Appl. No.: **10/752,626**

(22) Filed: **Jan. 7, 2004**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
G05D 23/00 (2006.01)

(52) **U.S. Cl.** **236/51**; 62/129; 700/276

(58) **Field of Classification Search** 62/175, 62/298, 126, 127, 129, 130; 236/51, 94; 165/11.1; 700/276
See application file for complete search history.

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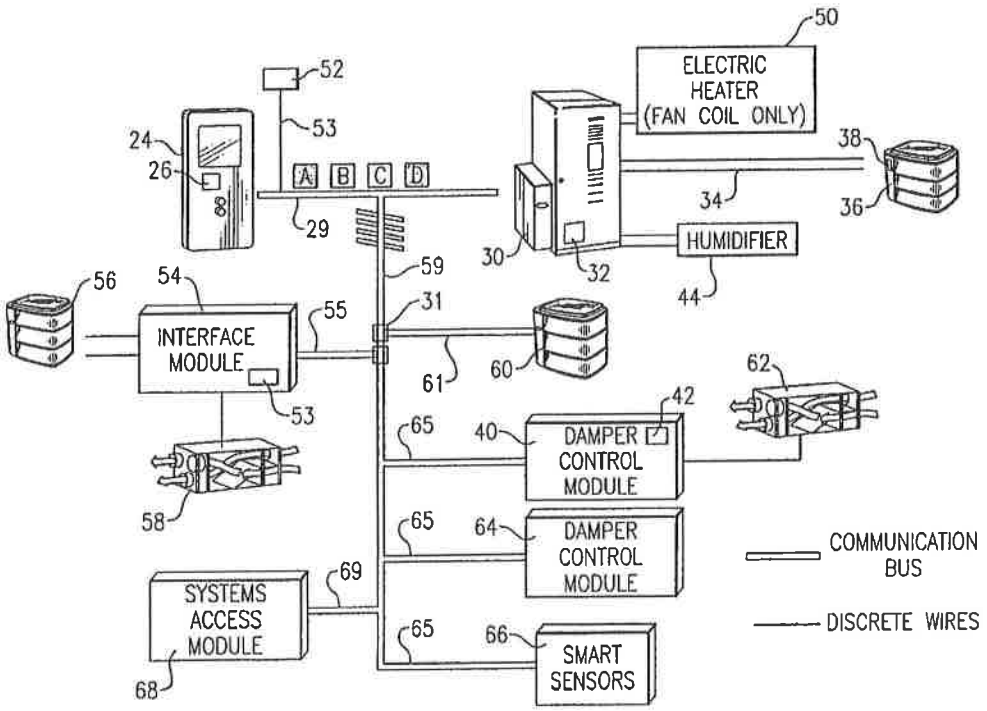
Primary Examiner—Marc E Norman
(74) *Attorney, Agent, or Firm*—Carlson, Gaskey & Olds

(57) **ABSTRACT**

An HVAC system is provided with control communication over a serial data bus. In this manner, the hard wired controls of the prior art are eliminated. A thermostat includes a central control microprocessor that communicates control signals to and from a microprocessor at an indoor unit. The indoor unit may be a furnace or a fan/heater combination. The microprocessor on the indoor unit is operable to receive signals from the central control microprocessor and control the indoor unit accordingly. Moreover, the microprocessor at the indoor unit is operable to pass control signals on to an outdoor unit such as an air conditioner or heat pump. Most preferably, this outdoor unit is provided with its own microprocessor. Further, other peripheral units may be incorporated to be controlled over the same data bus from the thermostat. Installation and updating of HVAC systems is greatly simplified by this control arrangement.

29 Claims, 2 Drawing Sheets



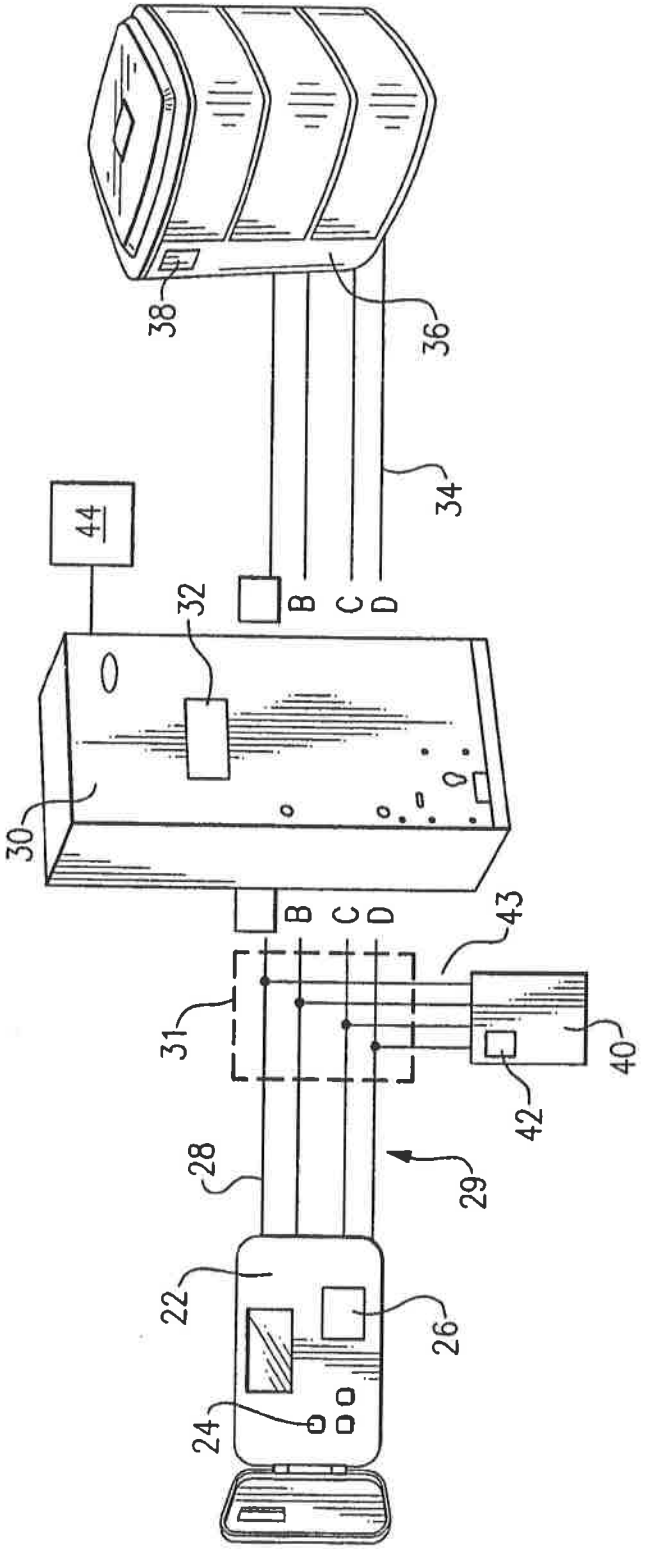
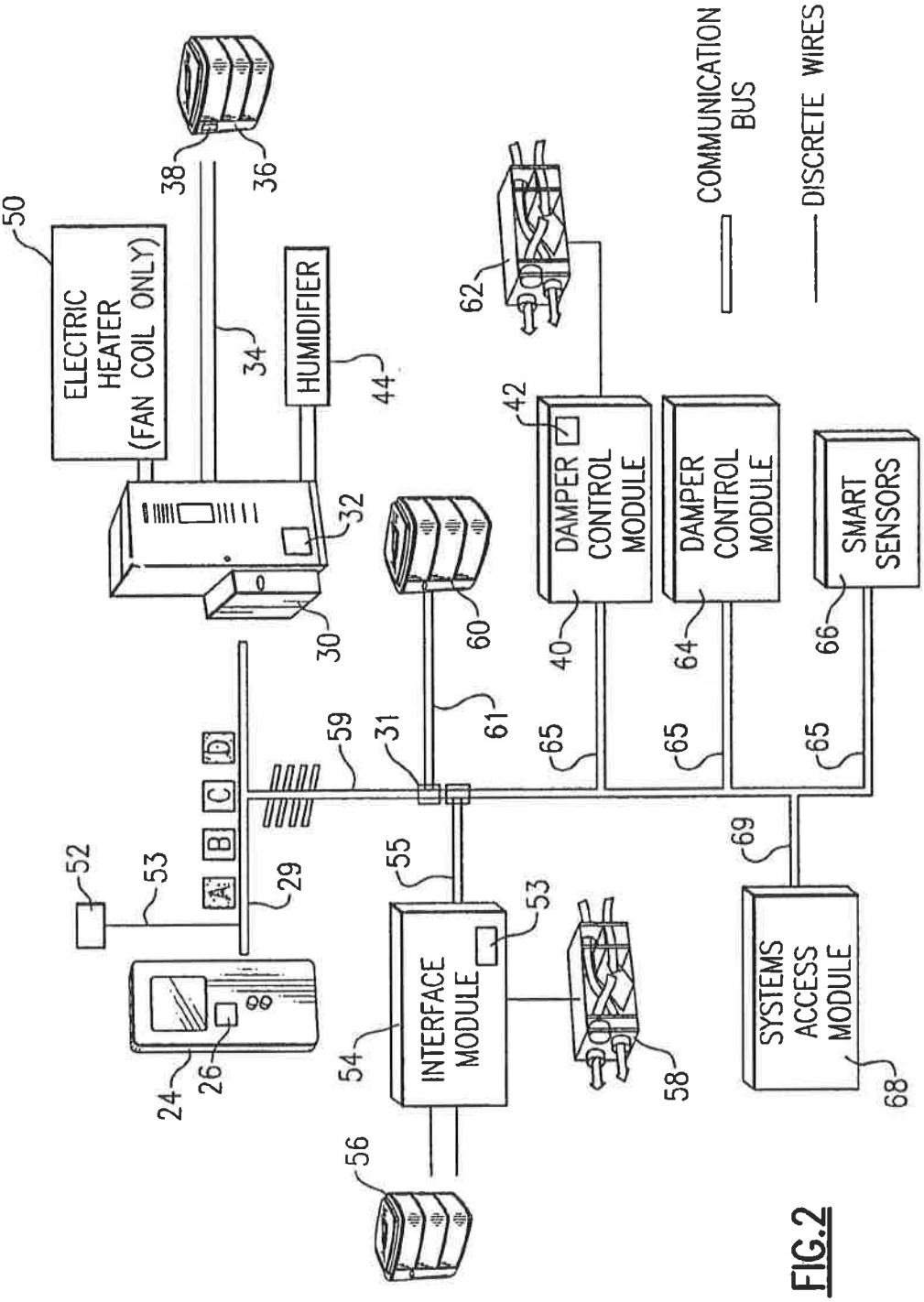


FIG. 1


COMMUNICATION BUS
DISCRETE WIRES
ELECTRIC HEATER (FAN COIL ONLY)
HUMIDIFIER
DAMPER CONTROL MODULE
DAMPER CONTROL MODULE
SMART SENSORS
INTERFACE MODULE
SYSTEMS ACCESS MODULE
A
B
C
D
50
38
36
34
44
42
62
32
30
60
40
64
66
59
31
61
65
65
65
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69
24
26
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68
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FIG.2

SERIAL COMMUNICATING HVAC SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to a heating, ventilating and air conditioning (IVAC) system wherein several interconnected units communicate control signals to and from each other over a communication bus.

HVAC systems are becoming increasingly complicated. As these systems increase in complexity, and sophistication of control, the number of wires that are hard-wired between the system components and controls increase. As an example, traditional residential HVAC systems have a thermostat on the wall of the home that allows a user to set a desired operating mode and temperature. There is also typically an indoor unit (a gas furnace or a heater/fan) and an outdoor unit (air conditioner or heat pump). Even this simple system illustrates the problem mentioned above.

HVAC systems operate on a simple control protocol. Based upon user-desired settings at the thermostat, and actual room temperature, command signals are sent to the indoor and/or outdoor equipment to perform heating, cooling, or fan functions. In the majority of the present systems, each of these functions requires a dedicated wire to run between the thermostat and the respective piece of equipment. The thermostat switches on a 24 volt AC signal over the wires to command the equipment to turn on a desired function, and removes the 24 volt AC signal to turn off the function.

Some systems have extended this protocol to include an additional wire for carrying fault information from one piece of equipment back to the thermostat, and displaying fault information to the user of the HVAC system. As residential systems become more sophisticated, multiple stages of heating and cooling are becoming common. Here again, the traditional protocol has been extended to include an additional wire for each equipment stage. New functions, such as controlling humidity, are also being integrated into thermostats. Again, each function has typically required its own wire.

As an example, one thermostat currently manufactured by the assignee of this application includes the ability to connect up to 11 wires. Two of the wires provide the 24 volt power, and two of the wires extend to an outdoor air temperature sensor. Seven other wires control various functions at the indoor and outdoor HVAC units. As an example, separate wires are required to turn on the indoor unit and to move it between various speeds or stages. These 11 wires do not include any of the "feedback" or status information as mentioned above. To provide this feedback would require even more wires. As can be appreciated, this results in a very complex installation, as each of the 11 wires must be attached at the correct location on the thermostat. Each of the seven control wires provide a single control function. As the number of wires grows, so does the installation complexity and possibility of mis-wiring. Compounding this problem, each combination of equipment (fan or furnace, AC or heat pump, one-stage or multi-stage, humidifier or not, etc.) has a different wiring arrangement. All of this can be challenging for a less experienced residential HVAC installer. This can lead to poor installation, resulting in degraded performance, malfunction, or service calls.

In many existing homes, the above challenges are complicated in that there are only four wires run through the wall to the thermostat at set-up. It may be difficult or impossible to run extra wires to upgrade functionality.

Some systems have included somewhat more sophisticated controls. As an example, the assignee of the present application developed a thermostat control which communicates

multiple control signals over two control wires to a main control panel. However, the main control panel is still hard-wired to the indoor and/or outdoor units. As such, there is still the problem mentioned above with regard to an undue number of wires.

Thus, a simplified system would be desirable that addresses the above-referenced problems and allows for easy system upgrade.

SUMMARY OF THE INVENTION

In the disclosed embodiment of this invention, at least a thermostat, and an indoor unit have electronic controls. The controls from these units communicate over four wires, with control signals being sent on two of the wires, and power being provided on the other two wires. An unlimited number of different control signals can be sent over the two control wires. Further, peripheral controls such as zone dampers, remote access modules, etc. also may have controls that communicate over the four-wire bus as mentioned above. The disclosed systems use microprocessors for the controls.

The disclosed communication of control signals is serial in nature, and enables virtually unlimited flow of information through the system. As disclosed, the thermostat provides a central control and initiates all communication, and sends all system commands to the respective equipment controls.

The indoor unit may be provided with controls that can provide information to existing outdoor units, and peripherals such as humidifiers that operate on the traditional hardwire protocol, and do not have built-in communicating capability (i.e., a dedicated microprocessor). Peripheral units with a dedicated control may also have the ability to interface with other hardwired peripheral units. As such, in its broadest scope, the present invention includes a central control in a thermostat, wherein the thermostat can receive user-desired settings, and communicate several distinct control signals to an indoor unit over two wires. The control signals are communicated over a communication bus, directly to a microprocessor that controls the indoor unit.

These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** schematically shows a system according to the present invention.

FIG. **2** schematically shows a system according to this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** is a simplified illustration of a basic IFVAC system **20** including the inventive serial communication, and incorporating a thermostat **22** having user input settings **24**, as known. A microprocessor **26** is incorporated into the thermostat **22**. The microprocessor **26** is both a bus master and a system master, in that the thermostat microprocessor **26** initiates all communication between the various units as will be described below. Further, the microprocessor **26** issues all commands to the respective units, again as will be explained below. Microprocessor **26** makes these command decisions based upon user settings, as well as other information it receives back from the respective units. In general, the control decisions made by the microprocessor **26** are as known in the

art. The present invention is directed to how these signals are communicated between the microprocessor **26** and the associated units.

Four wires **28**A-**28**D provide a data bus **29** to communicate microprocessor **26** to a microprocessor **32** at an indoor unit, such as a furnace control, or a fan/heater control. As shown, other peripheral units may communicate through the microprocessor **32** at indoor unit **30** and back to the microprocessor **26** at thermostat **22**. An example of a peripheral unit would be a humidifier **44**, which may not have its own microprocessor control.

A peripheral unit **40**, such as a damper control module having a microprocessor **42** is shown communicating with the data bus **29**, and then to microprocessor **26** through four wires **43**A-D. Wires **43**A-D are connected to wires **28**A-D, as known, such as at a routing or junction box **31**.

The humidifier **44** is shown as an existing type peripheral that will be hard-wired to communicate with the microprocessor **32**, and then to microprocessor **26**, over data bus **29** (wires **28**A-**28**D). Microprocessor **26** will in turn send control signals back for the humidifier **44**. The microprocessor **32** is provided with control function that allows it to control a hard-wired humidifier, based upon signals received from microprocessor **26**. Alternatively, and with further development in HVAC systems generally, humidifiers that are controlled over the same four wire data bus **29** may be developed and incorporated into the system. Again, the microprocessor **26** would then be fully functional to control that new microprocessor at the humidifier **44**.

The data bus (**29**, **31**) is wired such that two of the wires, e.g., C and D, carry 24 volt AC power originating from the indoor unit **30** to power all other controls in the system. The other two wires, A and B, are used for system-wide communication and control.

Also, as known, the thermostat is provided with a room temperature sensor, and optionally may be provided with a humidity sensor, and a digital display. Also, among the information communicated could be identity codes such that microprocessor **26** can identify a reporting unit, status and fault information, as well as the standard feedback normally provided by such units to a system control. As can be appreciated, the signals communicated over the system are provided with codes or identifiers such that they are properly routed and identified. Protocols to achieve this goal are known.

Since the units are all connected by the same simple wiring scheme, wires A-D, it is relatively easy for the installer to properly install the various units. Moreover, since only four wires are required, the problem mentioned above with regard to incorporating more sophisticated HVAC systems into existing structures having only four wires leading to the thermostat is eliminated.

Another set of wires **34**A-**34**D communicates microprocessor **32** to an outdoor unit **36**, and its microprocessor **38**. As mentioned above, the microprocessor **32** at the indoor unit **30** is also capable of controlling a hard-wired outdoor unit.

When a user inputs desired environmental conditions into the controls **24** at the thermostat **22**, the microprocessor **26** sends appropriate control signals over the data bus **29** to the indoor unit **30**, and "peripherals" (i.e., damper control **40**). From indoor unit **30**, the signal may be sent serially to outdoor unit **36**, and "peripheral" **44**.

While FIG. **1** shows a basic arrangement that may come within this invention. FIG. **2** shows the power of the invention to provide various options.

As shown in FIG. **2**, thermostat **24** communicates with the indoor unit **30** over the data bus **29**. An electric heater **50** may

be hard wired to the indoor unit **30** that if the indoor unit **30** is a fan coil and control. The fan coil control is operable to control the electric heater. As one example of an interface between a fan coil control and an electric heater, see co-pending U.S. patent application Ser. No. 10/707,524, entitled "Identification of Electric Heater Capacity," filed Dec. 19, 2003. The entire disclosure of this application is incorporated herein by reference. As known, a fan coil and heater can also providing cooling.

Data bus **34** may communicate the microprocessor **32** at the indoor unit **30** to a control **38** on outdoor unit **36**. Further, a hard-wired "dumb" humidifier that is controlled by the microprocessor **32** at the indoor unit **30** may be connected to the microprocessor **32**. As disclosed above, the outdoor unit **36** could also be controlled by the microprocessor **32**.

As shown also in FIG. **2**, a remote sensor **52** may communicate directly with the thermostat **24**. The data bus **53** connecting this remote sensor **52** to the thermostat **24** may be connected to the data bus **29** such as at a junction box, etc. Such a remote sensor may be utilized in the same room as the thermostat, when it is desired to have a temperature sensor in the room, but the thermostat concealed, such as in a closet, etc. As further shown, the outdoor unit **60** may be directly connected to a data bus **59**, branched from data bus **29** through data bus **61**. Appropriate junction or attachments **31** connect bus **59** to data bus **29**, and bus **61** to bus **59**. Such a connection may be utilized when the outdoor unit has its own microprocessor control, but for any number of reasons, it is desirable to wire the outdoor unit directly into the bus **59**, rather than through the indoor unit **30** (such as if the indoor and outdoor units are remote from each other within the building).

As shown, damper control module **40** has a microprocessor **42** and may provide a control function for a "dumb" ventilator **62**. Here again, the microprocessor **42** at the damper control module **40** is provided with control instructions for controlling the "dumb" ventilator. As shown, it is preferably a hard-wired connection between the ventilator and microprocessor **42** within the damper control module **40**. As is known, a damper control module takes in control signals and opens or closes dampers to control the flow of air into various rooms within a building.

Of course, other damper control modules such as **64** may be simply directly connected via a data bus **65** to the data bus **59**.

Smart sensors **66** may include a microprocessor **67**, and be connected over a data bus **65** to the data bus **59**. Again, with each of the data busses **65**, some junction **31** may be utilized to communicate the two.

An access module **68** may also be connected into the data bus **59**, through its own data bus **69**. As known, an access module allows remote access to the HVAC system. Of course, as would be understood by a worker of ordinary skill in this art, any data bus **61**, **65**, **69** could also be connected directly to the data bus **29**, rather than through a branch data bus **59**.

One other feature provides additional freedom of design. An interface module **54** can basically incorporate a microprocessor control **53** to communicate with "dumb" outdoor units, ventilators, etc. Essentially, the interface module **54** microprocessor **53** is provided with controls for one or more of the "dumb" units (**56**, **58**). Interface module **54** communicates over a data bus **55** with data bus **59**.

The microprocessors associated with each of the units are provided with built-in software to communicate back to the thermostat microprocessor **26**, and to interpret and act upon instructions from microprocessor **26**. Again, all of this control may be as known in the art. It is how the control signals are communicated that is novel. Also, although microprocessors

are disclosed, other type controls capable of performing the disclosed functions may be used.

While four wires A-D are illustrated, it should be understood that the invention could be provided by other arrangements. As an example, the control function could be provided by a co-ax wiring having an inner and outer wire to provide the control communication. For purposes of this application, such a co-ax wire would provide two of the four wires. Also, while the central control is disclosed in the thermostat, it could also be a separate control, or at some other component, such as on the indoor unit.

Although a preferred embodiment of this invention has been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.

What is claimed is:

1. An HVAC system comprising:

a thermostat incorporating a central control, and operator input switches;

a data bus communicating control signals from said central control to an indoor HVAC unit, said indoor HVAC unit being operable to provide a heating function to air within an environment, said indoor HVAC unit being provided with a control that directly controls said indoor HVAC unit, and which receives control signals on said data bus from said central control.

2. The HVAC system as set forth in claim **1**, wherein an outdoor HVAC unit is provided with its own control, and said outdoor HVAC unit control communicating with said central control over said data bus.

3. The HVAC system as set forth in claim **2**, wherein said outdoor HVAC unit is one of an air conditioner and a heat pump.

4. The HVAC system as set forth in claim **1**, wherein at least one peripheral HVAC unit includes its own control, and communicates through said indoor HVAC unit control to provide control signals to and from said central control.

5. The HVAC system as set forth in claim **1**, wherein four wires communicate said indoor HVAC unit control to said central control, with two of said wires carrying power, and two of said wires carrying said control signals with a plurality of distinct signals being sent over said two wires carrying control signals.

6. The HVAC system as set forth in claim **1**, wherein at least one peripheral unit is hard-wired to said indoor HVAC unit control, and said indoor HVAC unit control being designed to include control information for said at least one peripheral unit.

7. The HVAC system as set forth in claim **1**, wherein an interface module is provided with a control to communicate with said data bus from an associated HVAC unit that does not have a control capable of receiving control signals over said data bus, said interface module being hard-wired to said associated HVAC unit, and said interface module being provided with control information for controlling said associated HVAC unit.

8. The HVAC system as set forth in claim **1**, wherein a remote sensor generally communicates with said central control over said data bus.

9. The HVAC system as set forth in claim **1**, wherein said central control and said indoor HVAC unit control are both microprocessors.

10. The HVAC system as set forth in claim 1, wherein said control signals include an identifier for routing information for said data bus.

11. The HVAC system as set forth in claim **1**, wherein said indoor HVAC unit is one of a furnace and a fan/heater unit.

12. An HVAC system comprising:

a data bus including four wires communicating signals from a central control to a control for an indoor HVAC unit, said data bus including two control wires carrying a plurality of distinct control signals and two power wires carrying power, said indoor HVAC unit providing a power source for providing power over said two power wires, said central control being a system control for generating and sending controls signals to said indoor HVAC unit control, said indoor HVAC unit being operable to provide heating and a fan function to move air within an environment; and

an outdoor HVAC unit provided with four wires, with two power wires carrying power signals, and two control wires carrying a plurality of distinct control signals from said outdoor HVAC unit to said central control, said central control providing control signals to said outdoor HVAC unit control to operate said outdoor HVAC unit.

13. The HVAC system as set forth in claim **12**, wherein at least one peripheral unit is hard-wired to said indoor unit control, said indoor HVAC unit control being designed to include control information for said at least one peripheral unit.

14. The HVAC system as set forth in claim **13**, wherein said at least one peripheral unit is a humidifier.

15. The HVAC system as set forth in claim **12**, wherein at least one peripheral unit incorporating a control controlling its functions, said at least one peripheral unit control communicating with said central control over four wires, with two power wires and two control wires carrying controls signals from said central control to said at least one peripheral unit control.

16. The HVAC system as set forth in claim **15**, wherein said at least one peripheral unit is a damper control module.

17. The HVAC system as set forth in claim **15**, wherein said at least one peripheral unit is a sensor for sensing a condition in a room, said sensor providing signals to said central control over said two control wires.

18. The HVAC system as set forth in claim **12**, wherein said outdoor HVAC unit control communicates with said central control serially through said indoor HVAC unit control.

19. The HVAC system as set forth in claim **12**, wherein said outdoor HVAC unit control and said indoor HVAC unit control separately connect into said data bus to communicate to said central control.

20. The HVAC system as set forth in claim **12**, wherein an interface module is provided with a control to communicate with said data bus from an associated HVAC unit that does not have a control capable of receiving control signals over said data bus, said interface module being hard-wired to said associated HVAC unit, and said interface module being provided with control information for controlling said associated HVAC unit.

21. The HVAC system as set forth in claim **12**, wherein said central control, said indoor HVAC unit control and said outdoor HVAC unit control are all microprocessors.

22. The HVAC system as set forth in claim **12**, wherein said control signals include an identifier for routing information for said data bus.

23. The HVAC system as set forth in claim **12**, wherein said four wires are provided by four distinct and separate wires.

24. The HVAC system as set forth in claim **12**, wherein said indoor HVAC unit is one of a furnace and a fan/heater unit.

25. The HVAC system as set forth in claim **12**, wherein said outdoor HVAC unit is one of an air conditioner and a heat pump.

26. An HVAC system comprising:

a central control;

a thermostat having operator input switches;

an indoor HVAC unit being operable to provide a heating function to air within an environment, said indoor HVAC unit being provided with a control that directly controls said HVAC unit; and

a data bus communicating control signals from said central control to and from said thermostat and at least to said indoor HVAC unit, said indoor HVAC unit receiving control signals on said data bus from said central control and signals from said operator input switch being passed to said central control to generate control for said indoor HVAC unit over said data bus.

27. The HVAC system as set forth in claim **26**, wherein said indoor HVAC unit is one of a furnace and a fan/heater unit.

28. The HVAC system as set forth in claim **26**, wherein an outdoor HVAC unit is provided with its own control and said outdoor HVAC unit control communicating with said central control over said data bus.

29. The HVAC system as set forth in claim **28**, wherein said outdoor HVAC unit is one of an air conditioner and a heat pump.

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