

Description

The present invention relates to electronic thermostats for heating/cooling systems and, more particularly, to thermostats employing a user-interactive microprocessor controlled by unique software to facilitate installation and user interaction.

The specific embodiment of the present invention described herein is disclosed in the context of the heating/cooling system that is the subject of our U.S. Patent No. 4,725,001, issued February 16, 1988. In fact, a portion of the present invention was initially disclosed in that patent. It is to be understood, however, that the inventive concepts utilized in the specific disclosed embodiment of the present invention have application in a wide variety of types of heating, ventilating and air-conditioning (HVAC) systems and are not limited to the particular system disclosed in the aforementioned patent.

There are numerous electronic thermostats known in the prior art, some of which are disclosed in U. S. Patents Nos. 4,172,555 (Levine '555); 4,199,023 (Phillips); 4,206,872 (Levine '872); 4,356,962 (Levine '962); 4,408,711 (Levine '711); 4,460,123 (Beverly); 4,469,274 (Levine '274); and 4,473,183 (Kensinger et al). Some of these electronic thermostats include microprocessors controlled by specifically formulated software designed to effect intended heating/cooling system operation. Specifically, the aforementioned Beverly patent discloses a thermostat utilizing a microprocessor. All prior art electronic thermostats have been difficult for the average homeowner to install, particularly when replacing a thermostat in a pre-existing HVAC system. In particular, the wires of an existing system are not labelled as to function (i.e. burner, fan, air conditioner, voltage supply, etc.) and it is quite likely that the wires can be improperly connected, possibly causing damage to the system equipment. Consequently, the installation of prior art electronic thermostats has required trained personnel to avoid damage to the system.

Patent specification US-A-4725001 discloses an electronic thermostat for controlling the operation of a temperature-modifying apparatus of a type having a plurality of wires to which the thermostat must be connected, the thermostat comprising: data-entry means for permitting manual entry of data into the thermostat; means for providing individual messages in a speakable language; and means for providing a sequence of prompts to instruct an installer to perform corresponding steps in a procedure for providing electrical connections from the wires of said apparatus to points in the thermostat and for requesting manual entry of response data via said data entry means to indicate the effect on the apparatus as certain of the steps are performed. In a specific arrangement described in US-A-4725001, in response to such response data, the thermostat instructs the installer to remove the power, to exchange certain wires to re-apply the power and then to respond to further prompts.

One aspect of the present invention is characterised by control means responsive to entry of said response data for automatically structuring the thermostat for proper operation with the connections of the wires made by the user, the controls means comprising means responsive to entered response data indicative of connections other than the proper connections between the wires of the temperature-modifying apparatus and the points in the thermostat for automatically switching the connections to provide proper connections. Thus, it is not necessary for the installer to remove the power, exchange wires and then re-apply the power, possibly more than once, in order to obtain the proper connections between the wires and the thermostat.

In accordance with another aspect of the invention, there is provided a method for interacting between an electronic thermostat and an installer for the purpose of effecting proper electrical connections required at the thermostat for a plurality of wires of a temperature-modifying apparatus controlled by the thermostat. The method comprises the steps of: requesting and receiving entry of installer-initiated indications into the thermostat; and providing a plurality of sequential instructional prompts in a common speakable language to instruct the installer to follow respective steps for electrically connecting the plurality of wires of the apparatus to points in the thermostat, the prompts also including instructions to the installer to enter installer-observed responses of the apparatus. The method is characterised in that: it is for use with a thermostat including control means for automatically structuring the thermostat for proper operation of the temperature-modifying apparatus with connections of the wires made by the installer, the control means including means for switching connections between the wires and the points in the thermostat; and the method includes the step of causing the control means to structure the thermostat for proper operation with connections of the wires made by the installer in response to entered installer-observed apparatus responses, and, if entered installer-observed responses indicate connections made by the installer between the wires and the points are not the proper connections required at the thermostat, causing the switching means automatically to change connections made between the wires and the points.

Specific embodiments of the present invention will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a schematic diagram of an interactive electronic thermostat including the inter-connections be-

tween a microprocessor and a temperature sensor, and between the microprocessor and an HVAC system; Fig. 2 is a schematic diagram of a conventional four-wire forced air HVAC system to which the circuit of Fig. 1 can be connected in accordance with the present invention;

Fig. 3 is a schematic diagram of a conventional five-wired forced air HVAC system to which the circuit of Fig. 1 can be connected in accordance with the present invention;

Fig. 4 is a schematic diagram of a lamp circuit employed in the process of connecting the circuit of Fig. 1 to the circuit of Fig. 3;

Fig. 5 illustrates the program routine for interaction with the system user to instruct proper connection of the thermostat to a four-wire HVAC system such as illustrated in Fig. 3;

Fig. 6 illustrates the program routine for interaction with the system user to instruct proper connection of the thermostat to a five-wire HVAC system such as illustrated in Fig. 4;

Fig. 7 illustrates the program routine for determining whether or not a pre-existing HVAC system is compatible with the thermostat being installed;

Fig. 8 is a schematic circuit diagram of an embodiment of an interactive electronic thermostat according to the present invention wherein thermostat control circuits are automatically assigned to the proper wires from the HVAC system irrespective of the thermostat terminals to which the wires are connected; and

Fig. 9 illustrates the program for use with the circuit of Fig. 8 to automatically assign the thermostat control circuits to the HVAC system wires.

The electronic thermostat of the present invention is illustrated schematically in Fig. 1 of the accompanying drawings to which specific reference is now made. The thermostat includes a microprocessor 10, a display unit 11, a keypad 12, circuitry 13 for providing a measured temperature-indicative signal to the microprocessor, and solid state relays 14, 15 and 16 for connecting the microprocessor to the HVAC system. Microprocessor 10 may be any commercially available microprocessor or the equivalent (e.g., programmable logic array, application-specific integrated chip, etc.) capable of functioning in a manner consistent with the description set forth herein. In a prototype version of the invention which has been constructed and tested, a Commodore Model 64 computer was utilized for microprocessor 10; a Hewlett Packard Model HP-871 is also suitable. Display unit 11 may be any cathode ray tube (CRT) display unit compatible with the particular microprocessor employed. Alternatively, a light emitting diode or liquid crystal display unit may be employed. Keypad 12 may also be any input keypad (or keyboard) device compatible with the microprocessor. It will also be appreciated that the various prompts described below may be audible, rather than visual prompts such as might be effected by voice simulation. Likewise, voice input may be employed in place of a keypad if the thermostat is equipped with a voice recognition capability.

The temperature indication circuit 13 is the Fahrenheit Thermometer Application Circuit illustrated in the National Semi-Conductor Linear Databook, 1982 edition, at page 9 - 29. That circuit provides an accurately calibrated analog signal representative of the ambient temperature, in degrees Fahrenheit, to which the precision temperature sensor LM 335 (National Semi-Conductor Corporation) is exposed. Typically, the precision temperature sensor is disposed in a room, home, or other space to be heated and/or cooled by the system controlled by the thermostat of the present invention. Circuit 13 includes a voltage reference diode LM 336 (National Semiconductor Corporation) connected as a 2.5 volt reference having a temperature coefficient that is independent of its breakdown voltage. The temperature indicative output signal from circuit 13 is connected to the analog-to-digital converter input port of computer 10. Power for the circuit is provided from the +5 volt supply terminal of the computer. It will be understood that the particular circuit 13 illustrated in Fig. 1 is only one example of many temperature responsive circuits that may be employed with the present invention.

The solid state relays 14, 15 and 16 are respective control circuits serving to connect the computer 10 to the HVAC system via system wires at terminals T1, T2, T3 and T4, in the case of a four-wire system, or at terminals T1, T2, T3, T4 and T5, in the case of a five-wire system. Solid state relays 14, 15 and 16 are preferably opto-isolators, such as Opto 22 Model MP 120 D2, and are selectively energizable by computer 10, under software control, to close circuit contacts connected to the system wires. Any other control circuits capable of providing the functions described herein may be used in place of the preferred opto-isolators. In the illustrated embodiment the energizing input circuit for each solid state relay is referenced to ground, relay 14 is energized via computer output port P1, relay 15 is energized via computer output port P2, and relay 16 is energized via computer output port P3.

The solid state relays are employed as part of the feature of the present invention which permits foolproof proper connection of the thermostat terminals to the wires of the HVAC system during installation. To this end, one side of the contact for each of relays 14 and 15 is connected to terminal T1; the same side of the contact for relay 16 is connected through a switch 17 to terminal T1 when switch 17 is in its illustrated position. Switch 17 is placed in the illustrated position by the installer when the heating/cooling system is a four-wire system; the switch is placed in its other position when a five-wire system configuration is being served by the thermo-

stat. Five-wire systems are typically used when the air conditioner has a voltage supply transformer that is separate and apart from the heating system supply transformer. The other side of the contacts for relays 14, 15 and 16 are connected to terminal T2, T3 and T4, respectively. Switch 17 connects terminal T5 to the first-mentioned side of the contact of relay 16 for the five-wire system.

FOUR-WIRE INSTALLATION

A typical and conventional four-wire HVAC system is illustrated schematically in Fig. 2 to which specific reference is now made. Primary power, typically 110 volts, 60 Hz, is applied across the primary winding 21 of a transformer 20 and is stepped down to 24 volts across secondary winding 22. A 24V AC line is one of the four-wires of the system to be connected to the thermostat and is derived from one side of secondary winding 22. The other side of the secondary winding is connected to one side of each of three relay coils for the fan control relay 23, the furnace control relay 24 and the air conditioner control relay 25, respectively. The opposite sides of these three relay coils are the Fan, Furnace, and A/C wires constituting the other three wires of the four system wires. It will be appreciated that when the 24V AC line is connected to any or all of the other three wires via solid state relays 14, 15, 16 (Fig. 1), the relays associated with those wires are energized thereby to close the contacts associated with the energized relay and turn on the appropriate function (i.e., fan, furnace, air conditioner).

In order for the thermostat to operate, it is important that the 24V AC line be connected at terminal T1 (Fig. 1) which contacts one side of each of the solid state relays 14, 15 and 16. The Fan, Furnace and A/C lines are connected to the other sides of respective relays so that energization of each relay effects the appropriate furnace function. Connection of any two lines other than the 24V AC line to a relay precludes operation of the functions associated with those lines. Since the wires from the furnace are not labeled by function and are, more often than not, uncoded, it is unlikely that the 24V AC line will be connected to the T1 terminal by mere chance. Consequently, the software stored in computer 10 is provided with an interactive installation program or routine for a four-wire system. The flow chart for that program is illustrated in Fig. 5 to which specific reference is made in the following discussion.

Entry into the four-wire installation routine maybe initiated by the entry of a particular combination of digits from keypad 12 (Fig. 1) that is recognized by the computer as a request to begin a four-wire installation procedure. The particular combination of numbers to be entered would typically be described in the installation instructions provided with the thermostat. (A different number combination code would be required for entry into a five-wire installation procedure under the control of the software routine illustrated in Fig. 6 or a boiler installation procedure under the control of the software routine illustrated in Fig. 7). For the four-wire installation, a parameter designated "Optocount" is established and represents, at any time, one of the solid state relays 14, 15, 16, or none of these relays. At the start of the procedure the Optocount is reset and the installer is instructed, at display 11, to turn the HVAC system off. This, and all other displayed instructions, appear or are audibly rendered in the English language or other national language of the country in which the system is installed. After the system has been turned off, as would typically be signified by the actuation of a key at the keypad 12, the installer is instructed to connect all four wires from the heating/cooling system to respective terminals T1 through T4. The instruction indicates that the red wire, if any, should be connected to T1 since red is often used to code the hot or power wire and may, therefore, be the 24V AC line. In any event, after all four wires are connected, irrespective of whether or not they are correctly connected by function, the installer is instructed to depress the 0 key at keypad 12. When this has been done the Optocount is incremented by one count to a count of one to represent port P1 and solid state relay 14. Since at this time the Optocount is less than four, the installer is instructed to turn the system on. In addition, the output port (in this case P1) of computer 10 corresponding to the Optocount delivers a signal to energize the solid state relay associated with that Optocount. In other words, solid state relay 14 is energized. The installer is then asked to indicate, by depression of an appropriate key at keypad 12, what occurred by virtue of the system having been turned on and solid state relay 14 having been energized. With relay 14 energized, terminals T1 and T2 are shorted together. If one of the four lines connected to T1 or T2 is the 24V AC line, either the fan, the furnace or the air conditioner will be activated by the energization of relay 14 since the other connected line will be the FAN, FURNACE, or A/C line. If the installer depresses a "0", signifying that neither the fan, the furnace nor the air conditioner was activated, the Optocount is examined to determine whether or not it exceeds a value of one. Since, under the assumed conditions, the Opto-count is equal to one, the result of the examination is negative. The program then instructs the installer to exchange the wires connected at T1 and T2 with the wires connected at T3 and T4; the installer is also instructed to turn the system off. Following this the software then loops back to repeat the previous steps beginning with a determination as to whether or not the Opto-count is less than four. This time, however, one of the two leads connected to T1 and T2 will be the 24V AC lead so that the in-

staller, after turning the system back on, enters either "1" (signifying that the furnace or furnace and fan have been energized), "2" (signifying that the fan only has been energized), or "3" (signifying that the air conditioner has been energized). The software then makes one or more inquiries to determine which of the keys has been pressed by the installer. Assuming that the installer presses the "1" key, the computer output port corresponding to the Optocount is de-activated to de-energize the corresponding solid state relay (in this case relay 14). Since the "1" key indicated that the furnace had been energized, the computer port corresponding to the Optocount (namely P1) is designated as the furnace port; accordingly, relay 14 is assigned the function of controlling operation of the furnace. The next output port P2, corresponding to Optocount plus one, is then activated to energize solid state relay 15. The software then loops back to the point in the loop where the Optocount is incremented.

With the Optocount now at a value of two, the procedure repeats so that the installer is once again requested to enter a numeral corresponding to what is observed when the system is turned on. At this time, since the 24V AC and FURNACE lines are connected at T1, T2, the only possibilities when the system is turned on are that nothing happened, or the fan was energized, or the air conditioner was energized. The possibility of nothing happening occurs only when the 24V AC line is connected to T2 rather than T1, the latter being tied to one side of each of the relays 14, 15 and 16. Assuming this to be the case, a "0" is entered by the installer and, since the Optocount is greater than one, the installer is prompted by the display to exchange the two wires at T1 and T2. At this point in time the 24V AC line is properly connected to T1 and the FURNACE line is connected to T2. Further, the FAN and A/C lines are connected at T3 and T4, although not necessarily in that order. The software now loops back to the point where the determination is made as to whether or not the Optocount is less than four.

Once again the installer is prompted to turn the system on and the computer output port (P2) corresponding to the current Optocount is activated, thereby energizing solid state relay 15. Only two possibilities now remain, depending on whether the FAN or A/C line is connected to T3. If the FAN line is so connected, a "2" will be pressed by the installer and detected by the system. As a result the P2 output port of computer 10, corresponding to the current Optocount, is deactivated and designated as the fan port, thereby assigning to relay 15 the function of controlling fan operation. The P3 port, corresponding to a value of the Optocount plus one, is activated to energize relay 16. The software then loops back to the point at which the Optocount is incremented to a value of three and output port P3 is activated.

After the system is turned on, the only remaining possibility is that the air conditioner is energized, in response to which the installer enters the numeral "3" via keypad 12. Relay 16, therefore, must be assigned the task of controlling air conditioner operation. Accordingly, the software deactivates the P3 port, designates that port as the air conditioner port and activates the computer port corresponding to output port plus one. This port is not connected to the system so that no effect is observed. The software loops back to the point at which the Optocount is incremented and a determination is now made that the Optocount is not less than four; in fact, the Optocount is equal to four. Under these circumstances the system recognizes completion of the installation procedure and directs the program to the Main Program described in our aforementioned U.S. Patent No. 4,725,001 or to an appropriate point in other programs utilized in any other electronic set back or set forward thermostat.

From the foregoing it will be appreciated that the concept behind the four-wire installation procedure is that the first relay 14 is energized and the installer is required to inform the system as to which of the fan, furnace or air conditioner has been energized. If one of these is energized, the activated port is designated by the system as the port dedicated to the energized component, and the corresponding relay is assigned to control that component. If nothing is energized the system recognizes that the 24V AC line has not been connected at T1 or T2 and therefore requires that the pair of wires at T1 and T2 be exchanged with the pair of wires at T3 and T4. Under such circumstances one of the fan, furnace and air conditioner will be energized and the appropriate computer port and relay are assigned to the energized component. Assurance that the 24V AC line is connected to T1 is provided at the time the P2 port is to be assigned (after the P1 port has been assigned). If none of the components are energized after the P1 port has been assigned, the system recognizes that the 24V AC line has been connected to T2 rather than T1 and requires the installer to exchange these two wires. The system then proceeds to determine which components are connected to T3 and T4, in response to the installer's key entry, and assigns the computer output ports appropriately.

FIVE-WIRE INSTALLATION

A typical five-wire heating/cooling system is illustrated schematically in Fig. 3 to which specific reference is now made. Primary power is applied across primary winding 31 of transformer 30 and is stepped down to 24 volts at each of two separate and isolated secondary windings 32 and 33. Secondary winding 32 is asso-

ciated with the furnace and fan and has one side thereof designated 24V AC(FAN/FURNACE). The other side of winding 32 is connected to one side of the relay coils in each of the fan control relay 34 and furnace control relay 35. The other side of the fan control relay coil is the system FAN line; the other side of the furnace control relay coil is the system FURNACE line.

5 Secondary winding 33 is dedicated to the air conditioner and has one side thereof dedicated 24V AC(A/C) and the other side thereof connected to the relay coil in the air conditioner control relay 36. The other side of the air conditioner control relay coil is designated A/C.

For installation of the thermostat in a five-wire system, switch 17 (Fig. 1) is switched to connect T5 to one side of the contact for solid state relay 16, thereby isolating that relay contact from the others. This is consistent with the isolation provided between the air conditioner relay 36 and the other two relays 34, 35 by virtue of the separate secondary windings 33 and 32. It will be appreciated that installation of the thermostat in a five-wire system faces one problem which is not present in the four-wire system. Specifically, it is possible that the 24V AC(FAN/FURNACE) line might be short-circuited to the separate 24V AC(A/C) line if these two lines are connected to the same relay 14, 15 or 16 and if that relay is energized. Since the wires are not labeled, the possibility of this improper connection is not remote. Moreover, other undesirable connection combinations may be made, resulting in improper indications and operations of the system. Consequentially, a special lamp circuit, illustrated in Fig. 4, is employed for the five-wire system installation procedure. This lamp circuit includes a resistor 40 and an indicator lamp 41 connected in series between two terminals X and Y. Lamp 41 is typically a 12 volt (AC) lamp, and resistor 40 has a typical resistance of about three hundred fifty ohms. This lamp circuit permits connections to be checked before the relays 14, 15 and 16 are energized, thereby preventing improper and potentially dangerous connections.

The five-wire installation procedure is controlled by software represented by the flowchart illustrated in Fig. 6 to which specific reference is now made. After the Attempt Count parameter (to be described in detail below) is reset, the installer is instructed, in English at display 11, to connect any two of the five system wires (from Fig. 3) across the lamp circuit at terminals X and Y. If lamp 41 lights, it is an indication that one of the connected wires is either the 24V AC fan/furnace line or the 24V AC(A/C) line, while the other connected wire is the FAN, FURNACE or A/C line. More particularly, if both connected wires are 24V AC lines from the two transformers, there is no voltage drop across or current path through the lamp and it will not light. Two connected control lines (FAN, FURNACE and A/C) yield the same result. When there is a voltage drop across the lamp, the lamp lights in spite of the fact that none of relays 34, 35 or 36 is energized because the drop across the lamp acts as a voltage divider preventing the entire twenty-four volts from energizing these relays. Assuming for the present that lamp 41 is not lighted by the two connected wires, the installer is instructed to enter a "0" character via keypad 12. This is detected by the system which then proceeds to increment the Attempt Count parameter and, if the Attempt Count is not greater than three, the system displays a further prompt for the installer. The Attempt Count is used to keep track of the number of times that the installer connects a different pair of the five system wires across the lamp circuit. If more than three connection attempts are made without lighting lamp 41, the system directs the installer to replace the lamp which is assumed to be defective.

Assuming that the Attempt Count parameter is not greater than three, the display prompt instructs the installer to replace the wire connected at terminal X of the lamp circuit with one of the yet unconnected wires. A further prompt instructs the installer to enter a "1", if the lamp lights, or a "0", if it does not light. This procedure continues until the lamp 41 is lighted by the two wires connected to terminals X and Y.

Upon sensing that the key pressed by the installer is not "0", a check is made to be sure that the pressed key is a "1". If any other character was entered, an entry error exists and the system starts the installation procedure over again from the beginning. (Note - although not necessarily described and illustrated in conjunction with other software routines described herein, this return to the beginning of a routine may be incorporated after each character entry if an unacceptable character has been entered by the installer/operator).

If the entered character is a "1", the Attempt Count is reset and the system proceeds with a determination of which lines are connected across the lamp circuit. As part of this procedure the installer is instructed to remove the wires from terminals X and Y and place them at T2 and T1 and, when this is done, to turn the system on. The entry of any character by the installer from keypad 12 signifies that the installer has followed the instructions. (Note - although not necessarily specified in other software routines described herein, this technique of requiring entry of any character to acknowledge completion of a required task may be utilized throughout the system).

Computer output port P1 is actuated after the system has been turned on and an operative pair of wires have been connected to T1, T2. The installer is then prompted to enter a "1" if only the furnace is energized, a "2" if the furnace and fan are both energized, a "3" if only the fan is energized, or a "4" if the air conditioner is energized. A system parameter Z is assigned the value of the pressed key. Once the key is pressed and the value of Z assigned, the installer is instructed to connect any of the two remaining unconnected wires across

the lamp circuit at terminals X and Y. If the two wires connected across the lamp circuit do not cause the lamp to light, the installer is instructed to replace one of these wires and then the other with unconnected wires until the lamp is lit. When two of the remaining three wires cause the lamp to light, the installer is instructed to so indicate by pressing any key. At this point the system determines whether or not the parameter Z, as entered by the installer when the system is turned on, is equal to one, two or three. If this is in fact the case, then the pair of wires presently connected across the lamp circuit must be the 24V AC (A/C) and A/C lines. This is true, because if Z is equal to one, two or three, either the furnace only, the furnace and fan, or the fan only were energized when the system was turned on; the air conditioner was not energized by the two wires connected at T1 and T2. In order for the two wires connected across the lamp circuit at X and Y to cause lamp 41 to light, therefore, these two wires must be the two wires associated with the air conditioner control. Consequently, the air conditioner control lines connected across the lamp circuit should be connected to solid state relay 16 at T4 and T5, and the installer is so instructed if it is determined that the parameter Z is equal to one, two or three. The computer then assigns port P3 as the air conditioner port and relay 16 as the air conditioner control relay. On the other hand, if the parameter Z is equal to four, the installer is instructed to remove the two wires connected at T1, T2 and place them at T4, T5. The reason for this is that if the installer entered the character "4" signifying that the air conditioner was energized when the system was turned on, then the two wires connected at T1, T2 are the 24V AC(A/C) and A/C lines. The installer is also instructed to move the wires across the lamp circuit at terminals X and Y to T1, T2. Port P3 is assigned as the air conditioner port.

After assignment of port P3 as the air conditioner port, the installer is prompted to connect the remaining unconnected wire to T3, and to turn the system on. After this has been done the computer output port P2 is activated and the installer is requested to enter a character indicating which, if any, of the components became energized by energization of relay 15. This entered character, the value of which is assigned as the new value of the parameter Z, is a "1" if nothing was energized, a "2" if the furnace only or furnace and fan are energized, and a "3" if the fan only is energized. The installer is also instructed to turn the system off at this point in time. If a "1" is entered, signifying that nothing was energized by relay 15, the installer is instructed to interchange the wires connected to T1 and T2 and to turn the system on. The software then loops back to the point where port P2 is activated and the installer is once again requested to enter a character indicating which component was energized. If a "2" is entered, the system recognizes that the FURNACE line is connected at T3 and acts accordingly by assigning computer port P2 as the furnace port and relay 15 as the furnace control relay. This leaves port P1 as the only unassigned port which must, under the circumstances, be the fan port. Accordingly, the fan port function is assigned to P1 and relay 14 is assigned to function of controlling the fan.

If the installer enters a "3", indicating that only the fan has been energized in response to activation of port P2, this port is then assigned as the fan port and P1 is assigned the furnace function. In either case, after all of the three computer ports have been assigned a function, the software switches to the Main Program routine such as described in our aforementioned U.S. Patent No. 4,725,001, or to an appropriate point in the program of any other set back or set forward electronic thermostat.

The foregoing installation procedures for the thermostat in either a four-wire or five-wire system are virtually foolproof in that they prompt the installer, who need not be particularly trained, to make appropriate connections until the correct connection for the system wiring is completed. The correct connection is readily achieved in a short period of time in spite of the fact that the four or five system wires are not labeled as to function.

BOILER INSTALLATION

A boiler typically is a two-wire system; that is, temperature control is effected from the thermostat by two wires to turn the boiler on and off. The cycling system disclosed in our U.S. Patent No. 4,725,001 cannot efficiently operate with all commercially available boiler systems. For example, in a boiler system in which the liquid is continuously maintained at or near the normal system heating temperature (e.g., in order to have hot water available for fast response to heating demands), cycling below any temperature lower than that normal temperature is not possible; that is, the constant water temperature will control the boiler, not the space heating demand sensed by the thermostat. Under such circumstances it is desirable for the interactive thermostat to inform the homeowner/operator that the pre-existing system is not compatible with the thermostat being installed. Accordingly, the boiler installation procedure described below incorporates the incompatibility indication feature. It will be appreciated, of course, that this feature is not limited to the cycling control thermostat described in our aforesaid patent; rather, it is applicable to any thermostat that may not be compatible or operationally advantageous when used with particular heating/cooling systems.

Referring now to the program routine flowchart illustrated in Fig. 7, the routine begins by the computer asking the homeowner, via display 11 (Fig. 1) whether or not the heating/cooling system includes a heat pump. If so, the operator enters a "1" at keypad 12 and the microprocessor 10 responds by providing a message at

display 11 indicating that the heating/cooling system is incompatible and instructing the homeowner to rewire the system or return the thermostat for a refund. If the homeowner enters a "0", the microprocessor responds by asking whether or not a steam radiator system is present. If the homeowner answers in the positive (i.e., with a "1" entered at keypad 12), the system incompatible message is displayed. If the system is not of the steam radiator type, the homeowner's negative answer causes the software to inquire as to whether or not a hot water heater is employed separate from the furnace. If not, the system incompatibility message is displayed. If the system incompatibility message is displayed at any time, the program is terminated.

If the hot water heater is separate from the furnace, the positive response from the homeowner causes the microprocessor to instruct the homeowner to remove power from the furnace if such power has not been previously removed, and the homeowner is required to indicate that this has been done by depressing an appropriate key at keypad 12. Thereafter the microprocessor displays an instruction requiring that the water in the boiler be allowed to cool for a minimum of two hours. The response to this may either be an entry at the keypad by the homeowner after the appropriate amount of time has elapsed, or an automatic timed sequence initiated by the microprocessor to assure that the minimum two hour interval has elapsed. In either case, the operator is then instructed to set the thermostat to a temperature below room temperature and then to apply power to the furnace; the operator is required to acknowledge completion of each of these tasks by depression of an appropriate key at the keypad 12. At this point in the program the operator is requested to indicate whether or not the burner is on by depressing a "1" for a positive response and a "0" for a negative response. The purpose of these last few steps in the program is to determine if the circuitry controlling the heating/cooling system are compatible with the thermostat control system described in our aforementioned U.S. Patent No. 4,725,001. In particular, the test determines whether or not the thermostat in the system controls both the burner and circulator pump, or only the circulator pump. If there is internal temperature control (e.g., an immersion control, etc.), the automatic thermostat described in our aforementioned patent cannot cycle the water temperature in the system. If the thermostat does not control the burner, the operator may return the unit for a refund or rewire the system to render it compatible (i.e., so that the thermostat controls both the burner and the circulator pump). Thus, if the burner becomes energized when power is applied to the furnace, it is clear that something other than the thermostat is in control. If the burner is not on, the thermostat controls the burner and the system is compatible.

Assuming the system to be compatible, the operator is instructed to remove power from the furnace and then remove the old thermostat from the system. After this has been done, as indicated by appropriate entry from keypad 12, the wire connection portion of the program begins. Since the thermostat in a boiler system has only two wires connected thereto, the user is instructed to connect the two thermostat wires to terminals T1 and T2, in any order, at microprocessor 10. Under such circumstances the solid state relay 14 is assigned to control boiler operation in accordance with the temperature sensed by the thermostat. The operator is then instructed to attach the new thermostat to the wall, apply power to the furnace and then press the reset button at the keypad to initiate the main program operation.

AUTOMATIC CONNECTION

According to the present invention the interactive thermostat is arranged such that it automatically adapts itself to any connections, made by the installer, of the HVAC system wires to the thermostat. In this regard reference is made to Fig. 8 of the accompanying drawings. The circuitry is similar to that illustrated in Fig. 1 in that microprocessor 10 functions in the same manner with display 11, keypad 12, temperature sensor 13 and solid state relays 14, 15 and 16 connected to microprocessor output ports P1, P2 and P3, respectively. An additional solid state relay 18 is provided in the circuit of Fig. 8 and is driven by the microprocessor output port P4. When the contacts of relay 18 are closed, solenoid 15 is energized and changes the position of each of the four-poles of the four-position solenoid-driven switch, the poles of which are designated 51, 52, 53 and 54.

Solid state relays 14, 15 and 16 have their contacts connected to four lines A, B, C and D such that line A is connected to one contact of each of the relays while lines B, C and D are connected to the other contact at respective relays 14, 15 and 16. The four positions of the switch poles 51, 52, 53 and 54 are connected, via lines A, B, C and D, to different contacts of relays 14, 15 and 16, depending upon the position of the solenoid-driven switch. The common terminal at each switch pole 51, 52, 53 and 54 is connected to a respective thermostat terminal T1, T2, T3 and T4. Thus, the thermostat terminals are controllably connected to different contacts of relays 14, 15 and 16 via lines A, B, C and D in accordance with the position of the solenoid-driven switch. Table I is a chart showing the line (i.e., A, B, C and D) to which each thermostat terminal (T1, T2, T3, T4) is connected for each switch position.

TABLE I

Switch Position	T1	T2	T3	T4
1	A	B	C	D
2	B	C	D	A
3	C	D	A	B
4	D	A	B	C

In use, when the thermostat of Fig. 8 is installed, the installer may connect the four HVAC system lines (see Fig. 2) to any of the thermostat terminals T1, T2, T3 and T4. Depending upon the installer's response to certain prompts and queries originating at microprocessor 10 and displayed at display 11, the microprocessor drives solenoid 50 to different sequential positions until certain conditions are satisfied. The solenoid driven switch, therefore, permits the installer to connect each HVAC system wire only once; the computer automatically actuates the switch to achieve the proper connections. This operation is illustrated in the software flow-chart of Fig. 9 to which specific reference is now made.

After entry into the four-wire installation routine illustrated in Fig. 9, the installer is instructed to connect all four wires to respective thermostat terminals T1, T2, T3 and T4 with the red wire being connected to terminal T1 if at all possible. Although not illustrated in Fig. 9, the installer is also instructed to press the zero key at the keypad after the wires have been connected. Thereafter the installer is instructed to turn the system on (i.e., apply power to the HVAC system). When this has been done, as signified by the 0 or other key being depressed at keypad 12, output port P1 of microprocessor 10 provides a signal to energize solid state relay 14. The installer is then requested to indicate, by depression of an appropriate key at keypad 12, whether or not any component (i.e., the fan, the furnace or the air conditioner) of the HVAC system was activated. It should be noted that, for the initial position of the solenoid-driven switch, thermostat terminals T1 and T2 are connected to lines A and B and therefore to the contacts of solid state relay 14. If the 24V AC system line is connected to either of terminals T1 and T2, then one of the HVAC system components (i.e., the component for which the line is connected to the other of terminals T1 and T2) is energized at this time. The installer indicates by depression of an appropriate key whether or not a component is, in fact energized. If nothing is energized, the microprocessor provides an actuation signal at output port P4 to energize solid state relay 18 and thereby drive solenoid 50 to rotate the switch one position (i.e., position 2 wherein the movable contact at each of poles 51, 52, 53 and 54 is at twelve o'clock in the drawing). This routine repeats until such time as a system component is energized by the actuation of solid state relay 14, thereby indicating that one of lines A and B is connected to the 24V AC system line. Once this has occurred the microprocessor 10 turns off output port P1 to de-energize solid state relay 14, and energizes output port P2 to actuate solid state relay 15. The installer is once again requested to indicate whether or not any of the system components has been energized. If a system component is energized at this time, then the 24V AC line is properly connected to the A line and therefore to one contact of each of solid state relays 14, 15 and 16. On the other hand, if none of the system components are energized at this time, then the 24V AC line is connected to the B line and, hence, only to solid state relay 14. Assuming the latter to be the case, the installer enters an indication, via keypad 12, that no component of the system has been energized. The microprocessor responds at output port P4 by causing solid state relay 18 to advance the solenoid-driven switch three positions. In this regard, it will be noted that each of the switch poles 51, 52, 53 and 54 is wired such that the position of the pole in which its assigned thermostat terminal is connected to line A is actually three clockwise positions removed from the position in which the pole interconnects its thermostat terminal with line B. Thus, for example, assume that the solenoid-driven switch is initially in position 3, its three-o'clock position, wherein thermostat terminal T4 is connected by switch pole 54 to line B and hence solid state relay 14. From the previous description we have determined that line B is connected to the 24V AC system line which must, therefore, be connected to thermostat terminal T4. In order to properly apply the 24V AC system line to all three of solid state relays 14, 15 and 16, then switch pole 54 must connect thermostat terminal T4 to the A line. This is achieved, as described, by causing the solenoid-driven switch to be rotated three clockwise positions, namely to position 2, the twelve o'clock position, wherein switch pole 54 connects thermostat terminal T4 to line A. On the other hand, if, upon actuation of solid state relay 15, one of the HVAC system components is energized, the microprocessor determines, from the installer response, that the 24V AC line is properly connected to line A at each of the solid state relays 14, 15, 16.

Once the 24V AC line is properly connected to line A, the microprocessor causes the display 11 to request the installer to actuate an appropriate key at keypad 12 in accordance with which of the system components has been energized. Thus, if only the fan has been energized, the installer is instructed to depress key 1; if the fan and the burner have been energized, the installer is requested to depress key 2; and if the fan and air conditioner have been energized, the installer is instructed to depress key 3. The thusly indicated energized system component is then assigned to solid state relay 15 and to microprocessor output port P2. The microprocessor then de-actuates solid state relay 15 at output port P2 and energizes solid state relay 16 at output port P3. The installer is once again requested to actuate an appropriate key at keypad 12 to indicate which of the system components has been energized. The appropriate function is assigned to solid state relay 16 and output port P3, and the remaining unassigned function is assigned to output port P1 and solid state relay 14. The program routine then ends with all of the HVAC system wires properly connected and identified at the computer ports.

It will be appreciated that the solenoid-driven four-pole switch may be replaced by a switching matrix. Alternatively, a manual thumbwheel switch, or the like, may be employed whereby the installer advances the switch positions, under computer instruction, until the HVAC system lines are properly connected. The manually-actuated switch is less expensive than a solenoid-driven switch and still permits a one-time only connection of the four system wires to thermostat terminals. This same approach described above for permitting one-time only connections in a four-wire system may also be employed for a five-wire system.

The preferred embodiment of the interactive thermostat of the present invention, as disclosed herein, takes the form of a general purpose microprocessor operating under the control of unique software to achieve the stated objectives. It is to be understood, of course, that the invention also encompasses within its scope embodiments comprised of special purpose analog and/or digital hardware alone as well as such special purpose hardware used in combination with appropriate software.

From the foregoing description it will be appreciated that the present invention makes available a novel interactive electronic thermostat and a unique method for permitting a homeowner or other user of the electronic thermostat to properly install the thermostat without fear of improper electrical connections.

Claims

1. An electronic thermostat for controlling the operation of a temperature-modifying apparatus of a type having a plurality of wires to which the thermostat must be connected, the thermostat comprising:
 - data-entry means for permitting manual entry of data into the thermostat;
 - means for providing individual messages in a speakable language; and
 - means for providing a sequence of prompts to instruct an installer to perform corresponding steps in a procedure for providing electrical connections from the wires of said apparatus to points in the thermostat and for requesting manual entry of response data via said data entry means to indicate the effect on the apparatus as certain of the steps are performed;
 - characterised by:
 - control means responsive to entry of said response data for automatically structuring the thermostat for proper operation with the connections of the wires made by the user, the controls means comprising means responsive to entered response data indicative of connections other than the proper connections between the wires of the temperature-modifying apparatus and the points in the thermostat for automatically switching the connections to provide proper connections.
2. A thermostat as claimed in claim 1, for controlling such a temperature-modifying apparatus having at least two individually-actuable temperature-modifying devices, wherein the control means comprises first and second control circuits, and means for assigning control over actuation of each of the temperature-modifying devices to a respective one of the control circuits in response to the response data.
3. A thermostat as claimed in claim 1, for controlling such a temperature-modifying apparatus in the form of an HVAC system having a furnace, an air conditioner, a ventilation fan and at least four wires to which the thermostat is to be connected, at least one of the wires being a power supply wire common to the furnace, air conditioner and ventilation fan, wherein:
 - the thermostat includes at least four terminals;
 - the control means comprises:
 - first, second, third and fourth control lines;
 - a first selectively actuable control circuit for providing a connection between the first and



Once the 24V AC line is properly connected to line A, the microprocessor causes the display 11 to request the installer to actuate an appropriate key at keypad 12 in accordance with which of the system components has been energized. Thus, if only the fan has been energized, the installer is instructed to depress key 1; if the fan and the burner have been energized, the installer is requested to depress key 2; and if the fan and air conditioner have been energized, the installer is instructed to depress key 3. The thusly indicated energized system component is then assigned to solid state relay 15 and to microprocessor output port P2. The microprocessor then de-actuates solid state relay 15 at output port P2 and energizes solid state relay 16 at output port P3. The installer is once again requested to actuate an appropriate key at keypad 12 to indicate which of the system components has been energized. The appropriate function is assigned to solid state relay 16 and output port P3, and the remaining unassigned function is assigned to output port P1 and solid state relay 14. The program routine then ends with all of the HVAC system wires properly connected and identified at the computer ports.

It will be appreciated that the solenoid-driven four-pole switch may be replaced by a switching matrix. Alternatively, a manual thumbwheel switch, or the like, may be employed whereby the installer advances the switch positions, under computer instruction, until the HVAC system lines are properly connected. The manually-actuated switch is less expensive than a solenoid-driven switch and still permits a one-time only connection of the four system wires to thermostat terminals. This same approach described above for permitting one-time only connections in a four-wire system may also be employed for a five-wire system.

The preferred embodiment of the interactive thermostat of the present invention, as disclosed herein, takes the form of a general purpose microprocessor operating under the control of unique software to achieve the stated objectives. It is to be understood, of course, that the invention also encompasses within its scope embodiments comprised of special purpose analog and/or digital hardware alone as well as such special purpose hardware used in combination with appropriate software.

From the foregoing description it will be appreciated that the present invention makes available a novel interactive electronic thermostat and a unique method for permitting a homeowner or other user of the electronic thermostat to properly install the thermostat without fear of improper electrical connections.

Claims

1. An electronic thermostat for controlling the operation of a temperature-modifying apparatus of a type having a plurality of wires to which the thermostat must be connected, the thermostat comprising:
 - data-entry means for permitting manual entry of data into the thermostat;
 - means for providing individual messages in a speakable language; and
 - means for providing a sequence of prompts to instruct an installer to perform corresponding steps in a procedure for providing electrical connections from the wires of said apparatus to points in the thermostat and for requesting manual entry of response data via said data entry means to indicate the effect on the apparatus as certain of the steps are performed;
 - characterised by:
 - control means responsive to entry of said response data for automatically structuring the thermostat for proper operation with the connections of the wires made by the user, the controls means comprising means responsive to entered response data indicative of connections other than the proper connections between the wires of the temperature-modifying apparatus and the points in the thermostat for automatically switching the connections to provide proper connections.
2. A thermostat as claimed in claim 1, for controlling such a temperature-modifying apparatus having at least two individually-actuable temperature-modifying devices, wherein the control means comprises first and second control circuits, and means for assigning control over actuation of each of the temperature-modifying devices to a respective one of the control circuits in response to the response data.
3. A thermostat as claimed in claim 1, for controlling such a temperature-modifying apparatus in the form of an HVAC system having a furnace, an air conditioner, a ventilation fan and at least four wires to which the thermostat is to be connected, at least one of the wires being a power supply wire common to the furnace, air conditioner and ventilation fan, wherein:
 - the thermostat includes at least four terminals;
 - the control means comprises:
 - first, second, third and fourth control lines;
 - a first selectively actuable control circuit for providing a connection between the first and



second control lines;

a second selectively actuatable control circuit for providing a connection between the first and third control lines;

a third selectively actuatable control circuit for providing a connection between the first and fourth control lines; and

switching means for connecting each of the terminals to a respective one of the control lines and being selectively actuatable to change which terminal is connected to which control line;

the prompting means is operable to instruct the installer to remove power from the HVAC system, then to connect the four wires to the four terminals without necessarily identifying which wires are to be connected to which terminals, then to apply power to the HVAC system, and then to provide an indication that the power has been so applied;

responsive to the first indication, the control means is operable to actuate the first control circuit, and the prompting means is operable to instruct the installer to provide an indication as to whether (1) the furnace is energised, (2) the air conditioner is energised, (3) only the fan is energised, or (4) none of the furnace, air conditioner and fan is energised; and

responsive to the indication (1), (2), (3) or (4), the control means is operable to actuate the switching means to change automatically which of said terminals are connected to which of said control lines until the terminal to which said supply wire is connected is connected to said first control line.

4. A thermostat as claimed in any preceding claim, further comprising line test means for testing said wires two at a time and providing an indication when only one of the tested wires is a supply line.

5. A method for interacting between an electronic thermostat and an installer for the purpose of effecting proper electrical connections required at the thermostat for a plurality of wires of a temperature-modifying apparatus controlled by the thermostat, the method comprising the steps of:

requesting and receiving entry of installer-initiated indications into the thermostat; and

providing a plurality of sequential instructional prompts in a common speakable language to instruct the installer to follow respective steps for electrically connecting the plurality of wires of the apparatus to points in the thermostat, the prompts also including instructions to the installer to enter installer-observed responses of the apparatus;

characterised in that:

the method is for use with a thermostat including control means for automatically structuring the thermostat for proper operation of the temperature-modifying apparatus with connections of the wires made by the installer, the control means including means for switching connections between the wires and the points in the thermostat; and

the method includes the step of causing the control means to structure the thermostat for proper operation with connections of the wires made by the installer in response to entered installer-observed apparatus responses, and, if entered installer-observed responses indicate connections made by the installer between the wires and the points are not the proper connections required at the thermostat, causing the switching means automatically to change connections made between the wires and the points.

6. The method according to claim 5 wherein said installer-observed apparatus responses are manually entered into said thermostat as coded indicia for those responses.

7. The method according to claim 5 wherein said instructional prompts are displayed at a visual display.

8. The method according to claim 5 wherein said instructional prompts are audible.

9. The method according to claim 5 wherein the temperature-modifying apparatus is a forced air heating and air conditioning system having three controlled units, namely a furnace, an air conditioner and a fan; wherein said thermostat includes three control circuits each capable of controlling operation of any of said units; and

wherein the method further includes the step of assigning each of said control circuits the function of controlling a respective one of said units on the basis of said installer-observed apparatus responses.

10. The method according to claim 5 wherein said temperature-modifying apparatus is a forced air heating and air conditioning system, wherein the thermostat includes four thermostat terminals T1, T2, T3 and T4, four control lines A, B, C and D, and said means for changing connections comprises actuatable switching means for connecting said terminals to said control lines individually and in any combination, wherein



said plurality of wires includes four wires, namely a supply wire, a fan wire, a furnace wire and an air conditioner wire, wherein said method includes the following steps:

- (a) instructing the installer to connect said four wires to the four thermostat terminals without necessarily identifying which wires are to be connected to which thermostat terminals;
- (b) instructing the installer to apply power to the apparatus;
- (c) activating a first control circuit between control lines A and B at said thermostat;
- (d) instructing the installer to indicate whether or not any part of the apparatus was actuated in response to step (c);
- (e) in response to a negative indication by the installer at step (d), actuating said switching means to change which thermostat terminals are connected to which control lines, and repeating step (d);
- (f) in response to a positive indication by the installer at step (d), de-activating the first control circuit and activating a second control circuit between control lines A and C;
- (g) instructing the installer to indicate whether or not any part of the apparatus was actuated in response to step (f) ;
- (h) in response to a negative indication by the installer at step (g), actuating said switching means such that the thermostat terminal to which the supply wire is connected is electrically connected to control line A;
- (i) in response to either a positive indication by the installer at step (g) or to completion of step (h), instructing the installer to indicate which of the following conditions is in effect at the apparatus: (1) fan unit on; (2) air conditioner unit on; and (3) furnace unit on;
- (j) in response to entry of conditions (1), (2) or (3), at step (i), assigning to said second control circuit the function of controlling the unit designated by that entered condition; and
- (k) deactivating the second control circuit and activating a third control circuit between control lines A and C.

11. The method according to claim 10 further comprising the steps of:

- (l) instructing the installer to indicate which of the following conditions is in effect at the apparatus: (1) fan unit on; (2) air conditioner unit on; and (3) furnace unit on;
- (m) in response to entry of conditions (1), (2) or (3) at step (1), assigning to said third control circuit the function of controlling the unit designated by that entered condition; and
- (n) assigning to said first control circuit the function of controlling the unit not previously assigned.

12. The method according to claim 5 wherein said temperature-modifying apparatus includes n independently-actuable and electrically-energizable devices, wherein n is an integer equal to at least two, wherein the number of said wires is an integer equal to at least n+1 and at least one of said wires serves as a power supply line for each of at least two of said devices, wherein said control means of said thermostat includes n actuatable controllers to be assigned the function of controlling said n devices, respectively, and wherein said method includes the steps of:

- (a) instructing the installer to connect said wires to respective terminals at said thermostat without necessarily specifying which wires are to be connected to which terminals;
- (b) instructing the installer to apply power to said apparatus and to enter an indication of which, if any, of said electrically-energizable devices is energized;
- (c) in response to the indication entered in step (b):
 - (c.1) if the entered indication is that none of said devices is energized, causing said connection changing means to automatically change internal connections in said thermostat between said terminals and said controllers, and repeating steps (b) and (c);
 - (c.2) if the entered indication is that any of said devices is energized, assigning to a first of said controllers the function of controlling that energized device.

13. The method according to claim 12 where n is equal to three and further including the steps of:

- (d) in response to completion of step (c.2), automatically actuating a second of said controllers and instructing the installer to enter an indication of which of the electrically-energizable devices is energized;
- (e) in response to the indication entered in step (d), assigning to said second controller the function of controlling the device indicated as being energized in step (d); and
- (f) assigning to a third of said controllers the function of controlling the electrically-energizable device for which the control function has not previously been energized.



14. The method according to claim 12 further comprising of steps of:

(d) in response to completion of step (c.2), automatically actuating, in sequence, n-2 of the remaining n-1 of said controllers and instructing the installer after each such actuation to enter an indication of which of the electrically-energizable devices is energized; and

(e) in response to the indication entered after each actuation in step (d), assigning to the actuated controller the function of controlling the device so indicated as being energized.

15. The method according to claim 12 further comprising the step of:

(f) when only one of said controllers is left unassigned the function of controlling the device, and only one device remains with its control unassigned to a controller, automatically assigning to said only one controller the function of controlling said only one device.

Patentansprüche

1. Elektronischer Thermostat für die Steuerung des Betriebes einer die Temperatur modifizierenden Vorrichtung, die eine Mehrzahl von Leitungen hat, mit welchen der Thermostat verbunden werden muß, wobei der Thermostat aufweist:

Dateneingangsmittel für die Ermöglichung der manuellen Eingabe von Daten in den Thermostaten;

Mittel zur Schaffung einzelner Nachrichten in einer sprechbaren Sprache; und Mittel zur Schaffung einer Folge von Führungstexten, um einen Installateur anzuweisen, entsprechende Schritte in einem Verfahren zur Schaffung elektrischer Verbindungen von den Leitungen der Vorrichtung zu Stellen in dem Thermostat und für die Anforderung der manuellen Eingabe von Antwortedaten über die Dateneingabemittel durchzuführen, um die Wirkung auf die Vorrichtung anzuzeigen, wenn gewisse Schritte durchgeführt werden;

gekennzeichnet durch:

Steuermittel, die auf die Eingabe der Antwortedaten für den automatischen Aufbau des Thermostaten für den geeigneten Betrieb mit den Leitungsverbindungen ansprechen, die vom Benutzer gemacht sind, wobei die Steuermittel Mittel aufweisen, welche auf eingegebene Antwortedaten ansprechen, die andere als die richtigen Verbindungen anzeigen zwischen den Leitungen der die Temperatur modifizierenden Vorrichtung und den Stellen in dem Thermostat für ein automatisches Schalten der Verbindungen, um richtige Verbindungen vorzusehen.

2. Thermostat nach Anspruch 1 zur Steuerung solch einer die Temperatur modifizierenden Vorrichtung mit mindestens zwei einzeln betätigbaren, die Temperatur modifizierenden Vorrichtungen, wobei das Steuermittel erste und zweite Steuerschaltkreise und Mittel aufweist für die Zuordnung der Steuerung über die Betätigung jeder der die Temperatur modifizierenden Vorrichtungen zu einem entsprechenden Steuerschaltkreis in Abhängigkeit von den Antwortedaten.

3. Thermostat nach Anspruch 1 zur Steuerung bzw. Überwachung einer solchen die Temperatur modifizierenden Vorrichtung in der Form eines HVAC-Systems mit einem Ofen, einem Luftkonditionierer, einem Ventilationsgebläse und mindestens vier Leitungen, mit denen der Thermostat zu verbinden ist, wobei mindestens eine Leitung, die eine Netzanschlußleitung ist, dem Ofen, dem Luftkonditionierer und dem Ventilationsgebläse gemeinsam ist, wobei:

der Thermostat mindestens vier Anschlüsse aufweist;

das Steuermittel aufweist:

erste, zweite, dritte und vierte Steuerleitungen;

einen ersten selektiv betätigbaren Steuerschaltkreis zur Schaffung einer Verbindung zwischen der ersten und zweiten Steuerleitung;

eine zweite selektiv betätigbare Steuerschaltung zur Schaffung einer Verbindung zwischen der ersten und dritten Steuerleitung;

einen dritten selektiv betätigbaren Steuerschaltkreis zur Schaffung einer Verbindung zwischen der ersten und vierten Steuerleitung; und

Schaltmittel zur Verbindung jedes der Anschlüsse mit einem entsprechenden Anschluß der Steuerleitungen, die auch selektiv betätigbar sind, um auszutauschen, welcher Anschluß mit welcher Steuerleitung verbunden ist;

wobei das Führungsmittel betreibbar ist, um dem Installateur die Weisung zu geben, das Netz von dem HVAC-System abzunehmen, dann die vier Leitungen mit den vier Anschlüssen zu verbinden, ohne not-



wendigerweise zu identifizieren, welche Leitungen mit den Anschlüssen zu verbinden sind, dann das Netz an das HVAC-System anzulegen und dann eine Anzeige vorzusehen, daß die Netzspannung angelegt worden ist;

wobei in Abhängigkeit von der ersten Anzeige das Steuermittel betreibbar ist, um die erste Steuerschaltung zu betätigen, und das Führungsmittel betreibbar ist, um dem Installateur die Weisung zu geben, eine Anzeige dafür vorzusehen, ob (1) der Ofen eingeschaltet ist, (2) der Luftkonditionierer eingeschaltet ist, (3) nur das Gebläse eingeschaltet ist oder (4) weder der Ofen noch der Luftkonditionierer noch das Gebläse eingeschaltet ist; und

in Abhängigkeit von der Anzeige (1), (2), (3) oder (4) das Steuermittel betreibbar ist, um die Schalteinrichtung zu betätigen und automatisch zu wechseln bzw. auszutauschen, welcher Anschluß mit welcher Steuerleitung verbunden ist, bis der Anschluß, mit welchem die Zuführleitung verbunden ist, mit der ersten Steuerleitung verbunden ist.

4. Thermostat nach einem vorhergehenden Anspruch, ferner mit Leitungstestmitteln, um zwei Leitungen gleichzeitig zu testen und eine Anzeige vorzusehen, wenn nur eine der geprüften Leitungen eine Speiseleitung ist.

5. Verfahren zur gegenseitigen Beeinflussung zwischen einem elektronischen Thermostaten und einem Installateur zwecks Bewirkung richtiger elektrischer Verbindungen, die an dem Thermostat für eine Vielzahl von Leitungen einer die Temperatur modifizierenden Vorrichtung angefordert sind, welche von dem Thermostat gesteuert wird, wobei das Verfahren folgende Schritte aufweist: Abrufen und Aufnehmen der Eingabe von vom Installateur initiierten Anzeigen in den Thermostat; und

Schaffung einer Vielzahl von aufeinanderfolgenden Weisungsführungstexten in einer gemeinsamen, sprechbaren Sprache, um dem Installateur die Weisung zu geben, den entsprechenden Stufen zu folgen für das elektrische Verbinden der Vielzahl von Leitungen der Vorrichtung zu Stellen in dem Thermostat, wobei die Führungstexte auch Weisungen für den Installateur aufweisen, vom Installateur überwachte Antworten der Vorrichtung einzugeben;

dadurch gekennzeichnet, daß:

das Verfahren verwendbar ist bei einem Thermostat mit Steuermitteln für den automatischen Aufbau des Thermostaten für geeigneten Betrieb der die Temperatur modifizierenden Vorrichtung mit Leitungsverbindungen, die von dem Installateur vorgenommen wurden, wobei das Steuermittel Mittel aufweist zum Schalten von Verbindungen zwischen den Leitungen und den Stellen in dem Thermostat; und das Verfahren den Schritt aufweist, das Steuermittel zu veranlassen, den Thermostat für den richtigen Betrieb aufzubauen mit Leitungsanschlüssen, die vom Installateur hergestellt sind in Abhängigkeit von eingegebenen, vom Installateur wahrgenommenen Vorrichtungsantworten, und wenn eingegebene, vom Installateur beobachtete Antworten anzeigen, daß Verbindungen, die von dem Installateur zwischen den Leitungen und den Punkten hergestellt wurden, nicht die richtigen Verbindungen sind, die am Thermostat erforderlich sind, Veranlassen der Schaltmittel, um automatisch Verbindungen auszuwechseln, die zwischen den Leitungen und den Punkten hergestellt worden sind.

6. Verfahren nach Anspruch 5, wobei die von dem Installateur beobachteten Vorrichtungsantworten von Hand in den Thermostat als codierte Richtzahlen für diese Antworten eingegeben werden.

7. Verfahren nach Anspruch 5, wobei die Weisungsführungstexte an einem Sichtschirm dargestellt werden.

8. Verfahren nach Anspruch 5, wobei die Weisungsführungstexte hörbar sind.

9. Verfahren nach Anspruch 5, wobei die die Temperatur modifizierende Vorrichtung ein Zwangsluftheiz- und Luftkonditioniersystem ist mit drei gesteuerten Einheiten, nämlich einem Ofen, einem Luftkonditionierer und einem Gebläse;

wobei der Thermostat drei Steuerschaltkreise aufweist, deren jeder in der Lage ist, den Betrieb einer beliebigen der Einheiten zu steuern; und

wobei das Verfahren ferner den Schritt aufweist, jedem der Steuerschaltkreise die Funktion der Steuerung einer entsprechenden Einheit auf der Basis der vom Installateur beobachteten Vorrichtungsantworten zuzuordnen.

10. Verfahren nach Anspruch 5, wobei die die Temperatur modifizierende Vorrichtung ein Zwangsluftheizungs- und Luftkonditioniersystem ist, wobei der Thermostat vier Thermostatanschlüsse T1, T2, T3 und T4 aufweist, vier Steuerleitungen A, B, C und D aufweist und das Mittel zum Wechseln



der Anschlüsse betätigbare Schaltmittel aufweist zum Verbinden der Anschlüsse mit einzelnen Steuerleitungen und in beliebiger Kombination, wobei die Vielzahl von Leitungen vier Leitungen aufweist, nämlich eine Speiseleitung, eine Gebläseleitung, eine Ofenleitung und eine Luftkonditionierleitung, wobei das Verfahren folgende Schritte aufweist:

- 5 (a) Anweisen des Installateurs zum Verbinden der vier Leitungen mit den vier Thermostatanschlüssen, ohne notwendigerweise zu identifizieren, welche Leitung mit welchem der Thermostatanschlüsse zu verbinden ist;
- (b) Anweisen des Installateurs, um Netzspannung an die Vorrichtung zu geben;
- (c) Betätigen der ersten Steuerschaltung zwischen Steuerleitungen A und B an dem Thermostat;
- 10 (d) Anweisen des Installateurs zur Anzeige, ob ein beliebiger Teil der Vorrichtung in Abhängigkeit von Schritt (c) betätigt war oder nicht;
- (e) in Abhängigkeit von einer negativen Anzeige von dem Installateur bei Schritt (d), Betätigen der Schaltmittel zum Austauschen, welche Thermostatanschlüsse mit welchen Steuerleitungen verbunden werden, und Wiederholen des Schrittes (d);
- 15 (f) in Abhängigkeit von einer positiven Anzeige von dem Installateur bei Schritt (d), Deaktivieren der ersten Steuerschaltung und Aktivieren einer zweiten Steuerschaltung zwischen den Steuerleitungen A und C;
- (g) Anweisen des Installateurs, um anzuzeigen, ob ein beliebiger Teil der Vorrichtung in Abhängigkeit von Schritt (f) betätigt war oder nicht;
- 20 (h) in Abhängigkeit von einer negativen Anzeige von dem Installateur bei Schritt (g), Betätigen des Schaltmittels derart, daß der Thermostatanschluß, mit welchem die Netzleitung verbunden ist, elektrisch mit Steuerleitung A verbunden wird;
- (i) in Abhängigkeit entweder von einer positiven Anzeige durch den Installateur bei Schritt (g) oder zur Vervollständigung des Schrittes (h), Anweisung an den Installateur, um anzuzeigen, welche der folgenden Bedingungen an der Vorrichtung wirksam ist: (1) Gebläseeinheit ein; (2) Luftkonditioniereinheit ein; und (3) Ofeneinheit ein;
- 25 (j) in Abhängigkeit vom Eingeben der Bedingungen (1), (2) oder (3), beim Schritt (i), Zuordnen der Steuerungsfunktion der durch die eingegebene Bedingung bestimmten Einheit an den zweiten Steuerschaltkreis; und
- 30 (k) Deaktivieren des zweiten Steuerschaltkreises und Aktivieren eines dritten Steuerschaltkreises zwischen Steuerleitungen A und C.

11. Verfahren nach Anspruch 10, ferner mit folgenden Schritten:

- 35 (l) Anweisen des Installateurs, um anzuzeigen, welche der folgenden Bedingungen bei der Vorrichtung gilt: (1) Gebläseeinheit ein; (2) Luftkonditioniereinheit ein; und (3) Ofeneinheit ein;
- (m) in Abhängigkeit von der Eingabe der Bedingungen (1), (2) oder (3) beim Schritt (l), Zuordnen der Funktion des Steuerns der Einheit, die durch die eingegebene Bedingung bestimmt ist, an den dritten Steuerschaltkreis; und
- 40 (n) Zuordnen der Funktion des Steuerns der Einheit, die zuvor nicht zugeordnet ist, an den ersten Steuerschaltkreis.

12. Verfahren nach Anspruch 5, wobei die die Temperatur modifizierende Vorrichtung n unabhängig betätigbare und elektrisch mit Energie versorgbare Vorrichtungen aufweist, wobei n eine Ganzzahl gleich mindestens 2 ist, wobei die Zahl der Leitungen eine Ganzzahl gleich mindestens $n + 1$ ist und mindestens eine der Leitungen als eine Netzspeiseleitung dient für jede der mindestens zwei Vorrichtungen, wobei das Steuermittel des Thermostaten n betätigbare Steuereinrichtungen aufweist, denen die Funktion der Steuerung von n Vorrichtungen zuzuordnen ist, bzw. wobei das Verfahren folgende Schritte aufweist:

- 45 (a) Anweisen des Installateurs, um die Leitungen mit entsprechenden Anschlüssen am Thermostat zu verbinden, ohne notwendigerweise zu spezifizieren, welche Leitungen mit welchen Anschlüssen zu verbinden sind;
- 50 (b) Anweisen des Installateurs, um Netzspannung an die Vorrichtung anzulegen und eine Anzeige einzugeben, welche der elektrisch einschaltbaren Vorrichtungen, wenn überhaupt, eingeschaltet ist;
- (c) in Abhängigkeit von der in Schritt (b) eingegebenen Anzeige:
 - 55 (c.1) wenn die eingegebene Anzeige besagt, daß keine der Vorrichtungen eingeschaltet ist, Veranlassen des Verbindungsaustauschmittels, um automatisch innere Anschlüsse in dem Thermostat zwischen den Anschlüssen und den Steuereinrichtungen auszutauschen, und Wiederholen der Schritte (b) und (c);
 - (c.2) wenn die eingegebene Anzeige die ist, daß eine beliebige der Vorrichtungen eingeschaltet ist,



Zuordnen der Funktion der Steuerung jener eingeschalteten Vorrichtung zu einer ersten der Steuereinrichtungen.

13. Verfahren nach Anspruch 12, wobei n gleich 3 ist und ferner folgende Schritte vorgesehen sind:

(d) in Abhängigkeit von der Vervollständigung des Schrittes (c.2), automatisches Betätigen einer zweiten Steuereinrichtung und Anweisen des installateurs, um eine Anzeige einzugeben, welche der elektrisch einschaltbaren Vorrichtungen eingeschaltet ist;

(e) in Abhängigkeit von der Anzeige, die in Schritt (d) eingegeben ist, Zuordnen der Funktion der Steuerung der Vorrichtung, die im Schritt (d) als eingeschaltet angezeigt ist, an die zweite Steuereinrichtung; und

(f) Zuordnen der Funktion des Steuerns der elektrisch einschaltbaren Vorrichtung, für welche die Steuerfunktion nicht zuvor eingeschaltet worden ist, an eine dritte Steuereinrichtung.

14. Verfahren nach Anspruch 12, welches ferner folgende Schritte aufweist:

(d) in Abhängigkeit von der Vervollständigung des Schrittes (c.2), automatisches Betätigen, in Folge, von n - 2 der verbleibenden n - 1 der Kontrolleinrichtungen und Anweisen des installateurs nach jeder solcher Betätigung, um eine Anzeige einzugeben, welche der elektrisch einschaltbaren Vorrichtungen eingeschaltet ist; und

(e) in Abhängigkeit von der Anzeige, die nach jeder Betätigung im Schritt (d) eingegeben ist, Zuordnen der Funktion des Steuerns der Vorrichtung, die so als eingeschaltet angezeigt ist, zu der betätigten Steuereinrichtung.

15. Verfahren nach Anspruch 12, wobei ferner folgender Schritt vorgesehen ist:

(f) wenn nur eine der Steuereinrichtungen ohne Zuordnung mit der Steuerfunktion der Vorrichtung geblieben ist und nur eine Vorrichtung verbleibt, bei der die Steuerung einer Steuereinrichtung zugeordnet ist, automatisches Zuordnen der Steuerfunktion nur einer Vorrichtung zu nur einer Steuereinrichtung.

Revendications

1. Thermostat électronique pour commander le fonctionnement d'un appareil modifiant la température, d'un type comprenant une pluralité de fils auxquels le thermostat doit être connecté, le thermostat comprenant :

des moyens d'introduction des données pour permettre l'introduction manuelle de données dans le thermostat ;

des moyens pour émettre des messages individuels dans un langage parlé ; et

des moyens pour délivrer une suite de sollicitations donnant à un installateur des instructions pour qu'il exécute des étapes correspondantes dans une procédure d'établissement de connexion électrique entre les fils dudit appareil et certains points du thermostat et pour demander l'introduction manuelle de données de réponse grâce auxdits moyens d'introduction afin d'indiquer l'effet sur l'appareil de l'exécution de certaines des étapes ;

caractérisé par :

des moyens de commande répondant à l'introduction desdites données de réponse pour structurer automatiquement le thermostat en vue d'un fonctionnement correct pour les connexions de fils effectuées par l'utilisateur, les moyens de commande comprenant des moyens conçus pour répondre aux données de réponse introduites et indiquant des connexions différentes des connexions appropriées entre les fils de l'appareil modifiant la température et les points du thermostat afin de commuter automatiquement les connexions vers des connexions correctes.

2. Thermostat selon la revendication 1, pour commander un appareil modifiant la température du type ci-dessus comprenant au moins deux dispositifs de modification de la température, susceptibles d'être déclenchés individuellement, dans lequel les moyens de commande comprennent un premier et un second circuits de commande, et des moyens pour donner la commande au moment de la manoeuvre de chacun des dispositifs modifiant la température à l'un des circuits de commande respectifs en réponse aux données de réponse.

3. Thermostat selon la revendication 1, pour commander un appareil modifiant la température du type ci-dessus prenant la forme d'un système HVAC (Chauffage Ventilation Conditionnement d'Air) comprenant



une chaudière, un climatiseur, un ventilateur et au moins quatre fils auxquels le thermostat doit être connecté, un au moins des fils étant un fil d'alimentation commun à la chaudière, au climatiseur et au ventilateur, dans lequel :

le thermostat comprend au moins quatre bornes :

les moyens de commande comprennent :

une première, une seconde, une troisième et une quatrième lignes de commande ;

un premier circuit de commande pouvant être manoeuvré sélectivement pour établir une connexion entre la première et la seconde des lignes de commande ;

un second circuit de commande susceptible d'être manoeuvré sélectivement pour établir une connexion entre la première et la troisième des lignes de commande ;

un troisième circuit de commande susceptible d'être manoeuvré sélectivement pour établir une connexion entre la première et la quatrième des lignes de commande ; et

des moyens de commutation pour connecter chacune des bornes à l'une des lignes de commande respectives et pouvant être manoeuvrés de manière sélective pour modifier quelle borne est reliée à quelle ligne de commande ;

les moyens de sollicitation ont pour fonction d'instruire l'installateur en lui demandant de mettre le système HVAC hors tension, puis de connecter les quatre fils aux quatre bornes sans nécessairement identifier quels fils doivent être connectés à quelles bornes, puis de mettre sous tension le système HVAC, et ensuite de donner une indication quand le système a été mis sous tension ;

en répondant à la première indication, les moyens de commande sont susceptibles de commander le premier circuit de commande et les moyens de sollicitation peuvent agir en donnant à l'installateur l'instruction d'indiquer si (1) la chaudière est sous tension, (2) le climatiseur est sous tension, (3) le ventilateur est seul sous tension ou (4) si aucun des appareils parmi la chaudière, le climatiseur et le ventilateur n'est sous tension ; et

en répondant à l'indication (1), (2), (3) ou (4) les moyens de commande peuvent agir en manoeuvrant les moyens de commutation pour modifier automatiquement quelles bornes sont connectées à quelles lignes de commande jusqu'à ce que la borne à laquelle le fil d'alimentation est relié soit connectée à ladite première ligne de commande.

4. Thermostat selon l'une quelconque des revendications précédentes, comprenant encore des moyens de test des lignes pour tester lesdits fils deux par deux et donner une indication lorsqu'un seul des fils testés est un fil d'alimentation.

5. Procédé pour assurer les interactions entre un thermostat électronique et un installateur dans le but d'effectuer les connexions électriques convenables sur le thermostat pour une pluralité de fils d'un appareil de modification de température commandé par le thermostat, le procédé comprenant les étapes suivantes :

demander et recevoir des indications introduites par l'installateur dans le thermostat ; et

établir une pluralité de sollicitations séquentielles d'instructions en un langage parlé commun pour donner à l'installateur des instructions sur les étapes respectives à suivre afin de connecter électriquement la pluralité des fils de l'appareil aux points du thermostat, les sollicitations comprenant également des instructions demandant à l'installateur d'introduire dans l'appareil, en réponse, ce qu'il a observé ; caractérisé en ce que :

le procédé est destiné à être utilisé avec un thermostat comprenant des moyens de commande pour structurer automatiquement le thermostat en vue d'un fonctionnement correct de l'appareil de modification de température avec les connexions de fil effectuées par l'installateur, les moyens de commande comprenant des moyens pour commuter des connexions entre les fils et les points du thermostat ; et

le procédé comprend l'étape qui consiste à solliciter les moyens de commande pour qu'ils structurent le thermostat en vue d'un fonctionnement correct avec des connexions de fils faites par l'installateur en réponse aux indications observées et introduites par l'installateur, et, si les réponses observées et introduites par l'installateur signalent que les connexions faites par l'installateur entre les fils et les points ne sont pas les connexions correctes nécessaires au thermostat, en sollicitant automatiquement les moyens de commutation pour modifier les connexions effectuées entre les fils et les points.

6. Procédé selon la revendication 5, dans lequel lesdites réponses observées par l'opérateur sont introduites manuellement dans ledit thermostat sous forme d'indices codés de ces réponses.

7. Procédé selon la revendication 5, dans lequel lesdites sollicitations d'instructions sont affichées sur un



écran visuel.

8. Procédé selon la revendication 5, dans lequel lesdites sollicitations d'instructions sont audibles.
- 5 9. Procédé selon la revendication 5, dans lequel l'appareil modifiant la température est un système de chauffage et de conditionnement d'air à air forcé comprenant trois unités commandées, à savoir une chaudière, un climatiseur et un ventilateur ;
 dans lequel ledit thermostat comprend trois circuits de commande capables chacun de commander le fonctionnement de l'une desdites trois unités ; et
 10 dans lequel le procédé comprend encore l'étape consistant à attribuer à chacun desdits circuits de commande la fonction de commande d'une respective desdites unités en fonction des réponses observées sur l'appareil par l'installateur.
10. Procédé selon la revendication 5, dans lequel ledit appareil modifiant la température est un système de chauffage et de conditionnement d'air à air forcé, dans lequel le thermostat comprend quatre bornes de thermostat T1, T2, T3 et T4, quatre lignes de commande A, B, C et D, et lesdits moyens pour modifier les connexions comprennent des moyens de commutation manoeuvrables pour relier lesdites bornes auxdites lignes de commande individuellement ou selon une combinaison quelconque, dans lequel ladite pluralité de fils comprend quatre fils, à savoir un fil d'alimentation, un fil de ventilateur, un fil de chaudière et un fil de climatiseur, dans lequel ledit procédé comprend les étapes suivantes :
 15 (a) donner à l'installateur l'instruction de connecter les quatre fils à quatre bornes du thermostat sans nécessairement identifier quels fils doivent être connectés à quelles bornes du thermostat ;
 (b) donner à l'installateur l'instruction de mettre l'appareil sous tension ;
 (c) activer un premier circuit de commande entre les lignes de commande A et B audit thermostat ;
 20 (d) donner à l'installateur l'instruction d'indiquer si oui ou non une partie quelconque de l'appareil a été déclenchée en réponse à l'étape (c) ;
 (e) en réponse à une indication négative de l'installateur à l'étape (d), manoeuvrer ledit moyen de commutation pour modifier quelles bornes du thermostat sont connectées à quelles lignes de commande, et répéter l'opération (d) ;
 25 (f) en réponse à une indication positive de l'installateur à l'étape (d), désactiver le premier circuit de commande et activer un second circuit de commande entre les lignes de commande A et C ;
 (g) donner à l'installateur l'instruction d'indiquer si oui ou non une partie quelconque de l'appareil a été déclenchée en réponse à l'étape (f) ;
 (h) en réponse à une indication négative de l'installateur à l'étape (g), manoeuvrer lesdits moyens de commutation de manière que la borne du thermostat à laquelle le fil d'alimentation est relié soit électriquement connectée à la ligne de commande A ;
 30 (i) en réponse soit à une indication positive de l'installateur à l'étape (g), soit à la fin de l'étape (h), donner à l'installateur l'instruction d'indiquer si les conditions suivantes sont réalisées sur l'appareil : (1) ventilateur en marche ; (2) conditionneur air en marche ; et (3) chaudière en marche ;
 (j) en réponse à l'introduction des conditions (1), (2) ou (3), à l'étape (i), affecter audit second circuit de commande la fonction qui consiste à commander l'unité désignée par ladite condition introduite ; et
 35 (k) désactiver le second circuit de commande et activer un troisième circuit de commande entre les lignes de commande A et C.
- 45 11. Procédé selon la revendication 10, comprenant encore les étapes suivantes :
 (l) donner à l'installateur l'instruction d'indiquer laquelle des conditions suivantes est en vigueur sur l'appareil : (1) ventilateur en marche ; (2) climatiseur en marche ; et (3) chaudière en marche ;
 (m) en réponse à l'introduction des conditions (1), (2) ou (3), à l'étape (l), affecter audit troisième circuit de commande la fonction qui consiste à commander l'unité désignée par ladite condition introduite ; et
 50 (n) affecter audit premier circuit de commande la fonction qui consiste à commander l'unité qui n'a pas été affectée au préalable.
- 55 12. Procédé selon la revendication 5, dans lequel ledit appareil modifiant la température comprend n dispositifs pouvant être actionnés indépendamment et excités électriquement, dans lequel n est un nombre entier égal à au moins deux, dans lequel le nombre desdits fils est un entier égal à au moins $n+1$ et un au moins desdits fils sert de ligne d'alimentation pour chacun desdits deux dispositifs au moins, dans lequel lesdits moyens de commande dudit thermostat comprennent n contrôleurs susceptibles d'être déclenchés pour être affectés au rôle de commande desdits n dispositifs, respectivement, et dans lequel



ledit procédé comprend les étapes suivantes :

(a) donner à l'installateur l'instruction de connecter lesdits fils auxdites bornes respectives dudit thermostat sans nécessairement spécifier quels fils doivent être connectés à quelles bornes ;

(b) donner à l'installateur l'instruction de mettre sous tension ledit appareil et d'introduire une indication mentionnant si l'un quelconque desdits dispositifs susceptibles d'être excités électriquement est effectivement excité ;

(c) en réponse à l'indication introduite à l'étape (b) :

(c.1) si l'indication introduite mentionne qu'aucun desdits dispositifs n'est excité, solliciter lesdits moyens de modification des connexions pour modifier automatiquement les connexions internes dudit thermostat entre lesdites bornes et lesdits contrôleurs, et répéter les étapes (b) et (c) ;

(c.2) si l'indication introduite précise qu'un quelconque desdits dispositifs est excité, affecter à un premier desdits contrôleurs la fonction consistant à commander ledit dispositif excité.

13. Procédé selon la revendication 12, dans lequel n est égal à trois et qui comprend en outre les étapes suivantes :

(d) en réponse à l'exécution de l'étape (c.2), actionner automatiquement un second desdits contrôleurs et donner à l'installateur l'instruction d'introduire une indication mentionnant lequel desdits dispositifs électriquement excitable est effectivement excité ;

(e) en réponse à l'indication introduite à l'étape (d), affecter audit second contrôleur la fonction consistant à commander le dispositif signalé comme étant excité à l'étape (d) ; et

(f) affecter à un troisième desdits contrôleurs la fonction consistant à commander le dispositif susceptible d'être excité électriquement et auquel une fonction de commande n'a pas encore été affectée.

14. Procédé selon la revendication 12, comprenant encore les étapes suivantes :

(d) en réponse à l'exécution de l'étape (c.2), actionner automatiquement, successivement, $n-2$ des $n-1$ restants desdits contrôleurs et donner à l'installation l'instruction après la commande de chacun desdits contrôleurs d'introduire une indication mentionnant lequel des dispositifs susceptibles d'être excités électriquement est effectivement excité ; et

(e) en réponse à l'indication introduite après chaque action de l'étape (d), affecter au contrôleur effectivement actionné la fonction consistant à commander le dispositif ainsi signalé comme étant excité.

15. Procédé selon la revendication 12, comprenant en outre l'étape suivante :

(f) lorsqu'un seul desdits contrôleurs est laissé sans affectation de fonction de commande du dispositif, et lorsqu'il reste un seul dispositif dont la commande n'est pas affectée à un contrôleur, affecter automatiquement audit dernier contrôleur la fonction consistant à commander ledit dernier dispositif.