



(51) International Patent Classification:
F24F 11/00 (2006.01)

(21) International Application Number:
PCT/US2014/015136

(22) International Filing Date:
6 February 2014 (06.02.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/762,761 8 February 2013 (08.02.2013) US
14/169,014 30 January 2014 (30.01.2014) US

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(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM,
ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished
upon receipt of that report (Rule 48.2(g))

(54) Title: HVAC CUSTOMER SUPPORT SYSTEM

(57) Abstract: An HVAC thermostat has a processor configured to control at least one component of an HVAC system in response to temperature and at least one of (1) receive voice over internet protocol (VOIP) data and (2) transmit VOIP data.



HVAC Customer Support System

BACKGROUND

[0001] Heating, ventilation, and/or air conditioning (HVAC) systems with programmable system controllers may be used to control the indoor temperature of buildings. HVAC systems may be controlled by settings for heating, ventilation, cooling, humidity, and air quality. In some cases, a user may enter the settings at a thermostat or other user interface via a keypad, touchscreen, or the like. HVAC systems may comprise a multitude of components. The components may need maintenance and repair, and/or a user may need instructions in operating the HVAC systems. In some cases, the owner may request a repair technician to travel to the location of the HVAC system to diagnose and/or repair the HVAC system.

SUMMARY

[0002] In some embodiments of the disclosure, a heating, ventilation, and/or air conditioning (HVAC) thermostat is disclosed as comprising a processor configured to control at least one component of an HVAC system in response to temperature and at least one of (1) receive voice over internet protocol (VOIP) data and (2) transmit VOIP data.

[0003] In other embodiments of the disclosure, a method of operating a thermostat is disclosed as comprising controlling, in response to a signal from at least one climate sensor attached to a thermostat, a heating, ventilation, and/or air conditioning (HVAC) component, transmitting voice information from the thermostat using voice over internet protocol (VOIP), and receiving voice information using VOIP, and outputting the received voice information via a speaker.

[0004] In yet other embodiments of the disclosure, a device is disclosed as comprising a microphone, a speaker, an input, a network interface, and a processor system. The processor system may be configured to store product information regarding the device as a whole, receive a customer service command from the input to initiate a customer service call regarding the device, transmit the service information via the network interface in response to the customer service command, transmit, in response to the customer service command, first voice information input by the microphone to a remote service center via the network interface using voice over internet protocol (VOIP), and receive second voice information from the remote service center via the network interface using VOIP, and output the second voice information via the speaker.

[0005] In still other embodiments of the disclosure, a method of operating a customer service center is disclosed as comprising receiving diagnostic data generated by a heating, ventilation, and/or air conditioning (HVAC) controller associated with a first HVAC system component, and receiving voice over internet protocol (VOIP) data from the HVAC controller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Figure 1 is a schematic diagram of an HVAC system according to an embodiment of the disclosure;

[0007] Figure 2 is a simplified schematic diagram of the air circulation paths of the HVAC system of Figure 1;

[0008] Figure 3 is a simplified diagram of a system controller of an HVAC system according to an embodiment of the disclosure;

[0009] Figure 4 is a simplified representation of a method suitable for implementing the embodiments of the disclosure;

[0010] Figure 5 illustrates a menu-driven user interface that may be used on a thermostat according to embodiments of the disclosure; and

[0011] Figure 6 illustrates a menu-driven user interface that may be used to initiate a VOIP session using a thermostat according to embodiments of the disclosure.

DETAILED DESCRIPTION

[0012] Customer or technician support for devices may be facilitated by a customer support call-in number. Some devices owned by homeowners are large and technically advanced, such as major appliances, thermostats, and/or a heating, ventilation, and/or air conditioning (HVAC) systems. These devices may be connected to each other for various reasons. Obtaining customer support for the devices may require a customer or technician to find the related product documentation to find the call-in number, or otherwise search for the information. The customer may then need to call customer support using a telephone to get the support they need. In some cases, the customer may provide information about the device over the telephone, and/or otherwise assist in identifying the problem they are experiencing.

[0013] Some embodiments disclosed herein relate to the combination of built-in voice communication with diagnostic data to improve the customer support experience and reduce costs for providing the support. For many technically advanced devices, such as HVAC systems and major appliances, it may be desirable for reasons unrelated to customer service to connect the

device to an Internet Protocol (IP) system, such as a wireless router connected to the Internet. In some embodiments disclosed herein, a microphone and speaker may be provided to enable voice input and output to a thermostat or other devices. When a homeowner or technician experiences a problem with the connected device, they may easily reach customer support by, in some embodiments, pressing a button located on the device. Pressing the button may activate a voice over internet protocol (VOIP) software application and directly call the customer support location. The call may be initiated, for example, with a stored telephone number and/or IP address. The person located locally to the device may talk to a person remote from the device and the device may send diagnostic information directly to the support center. Remote control of the device for diagnostic purposes may be enabled and a maintenance visit may be scheduled if needed.

[0014] In Figures 1 and 2, a technically advanced HVAC system is described, suitable for use with other embodiments disclosed herein.

[0015] Referring now to Figure 1, a schematic diagram of an HVAC system 100 according to an embodiment of this disclosure is shown. HVAC system 100 comprises an indoor unit 102, an outdoor unit 104, and a system controller 106. In some embodiments, the system controller 106 may operate to control operation of the indoor unit 102 and/or the outdoor unit 104. As shown, the HVAC system 100 is a so-called heat pump system that may be selectively operated to implement one or more substantially closed thermodynamic refrigeration cycles to provide a cooling functionality and/or a heating functionality.

[0016] Indoor unit 102 comprises an indoor heat exchanger 108, an indoor fan 110, and an indoor metering device 112. Indoor heat exchanger 108 is a plate fin heat exchanger configured to allow heat exchange between refrigerant carried within internal tubing of the indoor heat exchanger 108 and fluids that contact the indoor heat exchanger 108 but that are kept segregated from the refrigerant. In other embodiments, indoor heat exchanger 108 may comprise a spine fin heat exchanger, a microchannel heat exchanger, or any other suitable type of heat exchanger.

[0017] The indoor fan 110 is a centrifugal blower comprising a blower housing, a blower impeller at least partially disposed within the blower housing, and a blower motor configured to selectively rotate the blower impeller. In other embodiments, the indoor fan 110 may comprise a mixed-flow fan and/or any other suitable type of fan. The indoor fan 110 is configured as a modulating and/or variable speed fan capable of being operated at many speeds over one or more ranges of speeds. In other embodiments, the indoor fan 110 may be configured as a multiple speed

fan capable of being operated at a plurality of operating speeds by selectively electrically powering different ones of multiple electromagnetic windings of a motor of the indoor fan 110. In yet other embodiments, the indoor fan 110 may be a single speed fan.

[0018] The indoor metering device 112 is an electronically controlled motor driven electronic expansion valve (EEV). In alternative embodiments, the indoor metering device 112 may comprise a thermostatic expansion valve, a capillary tube assembly, and/or any other suitable metering device. The indoor metering device 112 may comprise and/or be associated with a refrigerant check valve and/or refrigerant bypass for use when a direction of refrigerant flow through the indoor metering device 112 is such that the indoor metering device 112 is not intended to meter or otherwise substantially restrict flow of the refrigerant through the indoor metering device 112.

[0019] Outdoor unit 104 comprises an outdoor heat exchanger 114, a compressor 116, an outdoor fan 118, an outdoor metering device 120, a reversing valve 122. Outdoor heat exchanger 114 is a spine fin heat exchanger configured to allow heat exchange between refrigerant carried within internal passages of the outdoor heat exchanger 114 and fluids that contact the outdoor heat exchanger 114 but that are kept segregated from the refrigerant. In other embodiments, outdoor heat exchanger 114 may comprise a plate fin heat exchanger, a microchannel heat exchanger, or any other suitable type of heat exchanger.

[0020] The compressor 116 is a multiple speed scroll type compressor configured to selectively pump refrigerant at a plurality of mass flow rates. In alternative embodiments, the compressor 116 may comprise a modulating compressor capable of operation over one or more speed ranges, the compressor 116 may comprise a reciprocating type compressor, the compressor 116 may be a single speed compressor, and/or the compressor 116 may comprise any other suitable refrigerant compressor and/or refrigerant pump.

[0021] The outdoor fan 118 is an axial fan comprising a fan blade assembly and fan motor configured to selectively rotate the fan blade assembly. In other embodiments, the outdoor fan 118 may comprise a mixed-flow fan, a centrifugal blower, and/or any other suitable type of fan and/or blower. The outdoor fan 118 is configured as a modulating and/or variable speed fan capable of being operated at many speeds over one or more ranges of speeds. In other embodiments, the outdoor fan 118 may be configured as a multiple speed fan capable of being operated at a plurality of operating speeds by selectively electrically powering different ones of multiple electromagnetic

windings of a motor of the outdoor fan 118. In yet other embodiments, the outdoor fan 118 may be a single speed fan.

[0022] The outdoor metering device 120 is a thermostatic expansion valve. In alternative embodiments, the outdoor metering device 120 may comprise an electronically controlled motor driven EEV, a capillary tube assembly, and/or any other suitable metering device. The outdoor metering device 120 may comprise and/or be associated with a refrigerant check valve and/or refrigerant bypass for use when a direction of refrigerant flow through the outdoor metering device 120 is such that the outdoor metering device 120 is not intended to meter or otherwise substantially restrict flow of the refrigerant through the outdoor metering device 120.

[0023] The reversing valve 122 is a so-called four-way reversing valve. The reversing valve 122 may be selectively controlled to alter a flow path of refrigerant in the HVAC system 100 as described in greater detail below. The reversing valve 122 may comprise an electrical solenoid or other device configured to selectively move a component of the reversing valve 122 between operational positions. The system controller 106 may comprise a touchscreen interface for displaying information and for receiving user inputs. The system controller 106 may display information related to the operation of the HVAC system 100 and may receive user inputs related to operation of the HVAC system 100. However, the system controller 106 may further be operable to display information and receive user inputs tangentially and/or unrelated to operation of the HVAC system 100. In some embodiments, the system controller 106 may comprise a temperature sensor and may further be configured to control heating and/or cooling of zones associated with the HVAC system 100. In some embodiments, the system controller 106 may be configured as a thermostat for controlling supply of conditioned air to zones associated with the HVAC system 100.

[0024] In some embodiments, the system controller 106 may selectively communicate with an indoor controller 124 of the indoor unit 102, with an outdoor controller 126 of the outdoor unit 104, and/or with other components of the HVAC system 100. In some embodiments, the system controller 106 may be configured for selective bidirectional communication over a communication bus 128. In some embodiments, portions of the communication bus 128 may comprise a three-wire connection suitable for communicating messages between the system controller 106 and one or more of the HVAC system 100 components configured for interfacing with the communication bus 128.

[0025] Still further, the system controller 106 may be configured to selectively communicate with HVAC system 100 components and/or other devices 130 via a communication network 132. In some embodiments, the communication network 132 may comprise a telephone network and the other device 130 may comprise a telephone. In some embodiments, the communication network 132 may comprise the Internet and the other device 130 may comprise a computer, a so-called smartphone, and/or other Internet enabled mobile telecommunication device.

[0026] In some embodiments, the other device 130 may be a computer located in a customer service center or other remote service location. System controller 106 may be specifically configured to contact a limited list of other devices 130 identified by IP addresses or telephone numbers which correspond to a customer service center where a customer may speak with a customer service representative, HVAC technician, operator, distributor, or other person with knowledge or authority related to the HVAC system 100. System controller 106 may be configured to communicate with other device 130 using various internet protocols, including VOIP(s).

[0027] The indoor controller 124 may be carried by the indoor unit 102 and may be configured to receive information inputs, transmit information outputs, and otherwise communicate with the system controller 106, the outdoor controller 126, and/or any other device via the communication bus 128 and/or any other suitable medium of communication. In some embodiments, the indoor controller 124 may be configured to communicate with an indoor personality module 134, receive information related to a speed of the indoor fan 110, transmit a control output to an electric heat relay, transmit information regarding an indoor fan 110 volumetric flow-rate, communicate with and/or otherwise affect control over an air cleaner 136, and communicate with an indoor EEV controller 138. In some embodiments, the indoor controller 124 may be configured to communicate with an indoor fan controller 142 and/or otherwise affect control over operation of the indoor fan 110. In some embodiments, the indoor personality module 134 may comprise information related to the identification and/or operation of the indoor unit 102 and/or a position of the outdoor metering device 120.

[0028] In some embodiments, the indoor EEV controller 138 may be configured to receive information regarding temperatures and pressures of the refrigerant in the indoor unit 102. More specifically, the indoor EEV controller 138 may be configured to receive information regarding temperatures and pressures of refrigerant entering, exiting, and/or within the indoor heat exchanger

108. Further, the indoor EEV controller 138 may be configured to communicate with the indoor metering device 112 and/or otherwise affect control over the indoor metering device 112.

[0029] The outdoor controller 126 may be carried by the outdoor unit 104 and may be configured to receive information inputs, transmit information outputs, and otherwise communicate with the system controller 106, the indoor controller 124, and/or any other device via the communication bus 128 and/or any other suitable medium of communication. In some embodiments, the outdoor controller 126 may be configured to communicate with an outdoor personality module 140 that may comprise information related to the identification and/or operation of the outdoor unit 104.

[0030] In some embodiments, the outdoor controller 126 may be configured to receive information related to an ambient temperature associated with the outdoor unit 104, information related to a temperature of the outdoor heat exchanger 114, and/or information related to refrigerant temperatures and/or pressures of refrigerant entering, exiting, and/or within the outdoor heat exchanger 114 and/or the compressor 116. In some embodiments, the outdoor controller 126 may be configured to transmit information related to monitoring, communicating with, and/or otherwise affecting control over the outdoor fan 118, a compressor sump heater, a solenoid of the reversing valve 122, a relay associated with adjusting and/or monitoring a refrigerant charge of the HVAC system 100, a position of the indoor metering device 112, and/or a position of the outdoor metering device 120. The outdoor controller 126 may further be configured to communicate with a compressor drive controller 144 that is configured to electrically power and/or control the compressor 116.

[0031] The HVAC system 100 is shown configured for operating in a so-called cooling mode in which heat is absorbed by refrigerant at the indoor heat exchanger 108 and heat is rejected from the refrigerant at the outdoor heat exchanger 114. In some embodiments, the compressor 116 may be operated to compress refrigerant and pump the relatively high temperature and high pressure compressed refrigerant from the compressor 116 to the outdoor heat exchanger 114 through the reversing valve 122 and to the outdoor heat exchanger 114. As the refrigerant is passed through the outdoor heat exchanger 114, the outdoor fan 118 may be operated to move air into contact with the outdoor heat exchanger 114, thereby transferring heat from the refrigerant to the air surrounding the outdoor heat exchanger 114. The refrigerant may primarily comprise liquid phase refrigerant and the refrigerant may be pumped from the outdoor heat exchanger 114 to the indoor

metering device 112 through and/or around the outdoor metering device 120 which does not substantially impede flow of the refrigerant in the cooling mode. The indoor metering device 112 may meter passage of the refrigerant through the indoor metering device 112 so that the refrigerant downstream of the indoor metering device 112 is at a lower pressure than the refrigerant upstream of the indoor metering device 112. The pressure differential across the indoor metering device 112 allows the refrigerant downstream of the indoor metering device 112 to expand and/or at least partially convert to gaseous phase. The gaseous phase refrigerant may enter the indoor heat exchanger 108. As the refrigerant is passed through the indoor heat exchanger 108, the indoor fan 110 may be operated to move air into contact with the indoor heat exchanger 108, thereby transferring heat to the refrigerant from the air surrounding the indoor heat exchanger 108. The refrigerant may thereafter reenter the compressor 116 after passing through the reversing valve 122.

[0032] To operate the HVAC system 100 in the so-called heating mode, the reversing valve 122 may be controlled to alter the flow path of the refrigerant, the indoor metering device 112 may be disabled and/or bypassed, and the outdoor metering device 120 may be enabled. In the heating mode, refrigerant may flow from the compressor 116 to the indoor heat exchanger 108 through the reversing valve 122, the refrigerant may be substantially unaffected by the indoor metering device 112, the refrigerant may experience a pressure differential across the outdoor metering device 120, the refrigerant may pass through the outdoor heat exchanger 114, and the refrigerant may reenter the compressor 116 after passing through the reversing valve 122. Most generally, operation of the HVAC system 100 in the heating mode reverses the roles of the indoor heat exchanger 108 and the outdoor heat exchanger 114 as compared to their operation in the cooling mode.

[0033] Still further, the system controller 106 may be configured to selectively communicate with other systems via the communication network 132. In some embodiments, the system controller 106 may communicate with other devices 130, such as, telephones, smart phones, and/or personal computers.

[0034] Communication bus 128 may take the form of a three wire connection, as mentioned above. For example, the three wire connection may be implemented using standards such as ClimateTalk and BACnet. Communication bus 128 may alternatively comprise a CT-485 interface, an RS-485 interface, and/or an Ethernet 10BASE-T or 100BASE-TX interface, and/or any other suitable communication interface.

[0035] Referring now to Figure 2, a simplified schematic diagram of the air circulation paths for a structure 200 conditioned by two HVAC systems 100 is shown. In this embodiment, the structure 200 is conceptualized as comprising a lower floor 202 and an upper floor 204. The lower floor 202 comprises zones 206, 208, and 210 while the upper floor 204 comprises zones 212, 214, and 216. The HVAC system 100 associated with the lower floor 202 is configured to circulate and/or condition air of lower zones 206, 208, and 210 while the HVAC system 100 associated with the upper floor 204 is configured to circulate and/or condition air of upper zones 212, 214, and 216.

[0036] In addition to the components of HVAC system 100 described above, in this embodiment, each HVAC system 100 further comprises a ventilator 146, a prefilter 148, a humidifier 150, and a bypass duct 152. The ventilator 146 may be operated to selectively exhaust circulating air to the environment and/or introduce environmental air into the circulating air. The prefilter 148 may generally comprise a filter media selected to catch and/or retain relatively large particulate matter prior to air exiting the prefilter 148 and entering the air cleaner 136. The humidifier 150 may be operated to adjust a humidity of the circulating air. The bypass duct 152 may be utilized to regulate air pressures within the ducts that form the circulating air flow paths. In some embodiments, air flow through the bypass duct 152 may be regulated by a bypass damper 154 while air flow delivered to the zones 206, 208, 210, 212, 214, and 216 may be regulated by zone dampers 156.

[0037] Still further, each HVAC system 100 may further comprise a zone thermostat 158 and a zone sensor 160. In some embodiments, a zone thermostat 158 may communicate with the system controller 106 and may allow a user to control a temperature, humidity, and/or other environmental setting for the zone in which the zone thermostat 158 is located. Further, the zone thermostat 158 may communicate with the system controller 106 to provide temperature, humidity, and/or other environmental feedback regarding the zone in which the zone thermostat 158 is located. In some embodiments, a zone sensor 160 may communicate with the system controller 106 to provide temperature, humidity, and/or other environmental feedback regarding the zone in which the zone sensor 160 is located.

[0038] While HVAC systems 100 are shown as a so-called split system comprising an indoor unit 102 located separately from the outdoor unit 104, alternative embodiments of an HVAC system 100 may comprise a so-called package system in which one or more of the components of

the indoor unit 102 and one or more of the components of the outdoor unit 104 are carried together in a common housing or package. The HVAC system 100 is shown as a so-called ducted system where the indoor unit 102 is located remote from the conditioned zones, thereby requiring air ducts to route the circulating air. However, in alternative embodiments, an HVAC system 100 may be configured as a non-ducted system in which the indoor unit 102 and/or multiple indoor units 102 associated with an outdoor unit 104 is located substantially in the space and/or zone to be conditioned by the respective indoor units 102, thereby not requiring air ducts to route the air conditioned by the indoor units 102.

[0039] Still referring to Figure 2, the system controllers 106 may be configured for bidirectional communication with each other and may further be configured so that a user may, using any of the system controllers 106, monitor and/or control any of the HVAC system 100 components regardless of which zones the components may be associated. Further, each system controller 106, each zone thermostat 158, and each zone sensor 160 may comprise a humidity sensor. As such, it will be appreciated that structure 200 is equipped with a plurality of humidity sensors in a plurality of different locations. In some embodiments, a user may effectively select which of the plurality of humidity sensors is used to control operation of one or more of the HVAC systems 100.

[0040] Figure 3 illustrates a processor (e.g., electronic controller or computer) system 300 that comprises a processing component 310 suitable for implementing one or more embodiments disclosed herein. For example, the processor system 300 may serve as any of controllers 106, 124, 126, 134, 140, 158, or 160 in Figure 1 or Figure 2. Processor system 300 may further be installed on any HVAC component that may be installed in an HVAC system. In addition to the processor component 310 (which may be referred to as a central processor unit or CPU), the processor system 300 might comprise network connectivity devices 320, random access memory (RAM) 330, read only memory (ROM) 340, secondary storage 350, and input/output (I/O) devices 360. The processor system 300 may further comprise transceivers 325 as part of network connectivity device 320. The processor system 300 may further comprise HVAC Communication Bus Interface 370, display 372, speaker 374, microphone 376, and sensors 378. In some cases, some of these components may not be present or may be combined in various combinations with one another or with other components not shown. These components might be located in a single physical entity or in more than one physical entity. Any actions described herein as being taken by the processor

component 310 might be taken by the processor component 310 alone or by the processor component 310 in conjunction with one or more components shown or not shown in the drawing.

[0041] The processor component 310 executes instructions, codes, computer programs, or scripts that it might access from the network connectivity devices 320, RAM 330, ROM 340, or secondary storage 350 (which might comprise various disk-based systems such as hard disk, floppy disk, optical disk, or other drive). While only one processor component 310 is shown, multiple processors may be present. Thus, while instructions may be discussed as being executed by a processor, the instructions may be executed simultaneously, serially, or otherwise by one or multiple processors. The processor component 310 may be implemented as one or more CPU chips.

[0042] The network connectivity devices 320 may take the form of modems, modem banks, Ethernet devices, universal serial bus (USB) interface devices, serial interfaces, token ring devices, fiber distributed data interface (FDDI) devices, wireless local area network (WLAN) devices, radio transceiver devices such as code division multiple access (CDMA) devices, global system for mobile communications (GSM) radio transceiver devices, worldwide interoperability for microwave access (WiMAX) devices, and/or other well-known devices for connecting to networks. These network connectivity devices 320 may enable the processor component 310 to communicate with the Internet or one or more telecommunications networks or other networks from which the processor component 310 might receive information or to which the processor component 310 might output information.

[0043] The network connectivity devices 320 might also comprise one or more transceiver 325 capable of transmitting and/or receiving data wirelessly in the form of electromagnetic waves, such as radio frequency signals or microwave frequency signals. Alternatively, the data may propagate in or on the surface of electrical conductors, in coaxial cables, in waveguides, in optical media such as optical fiber, or in other media. The transceiver 325 might comprise separate receiving and transmitting units or a single transceiver. Information transmitted or received by the transceiver 325 may comprise data that has been processed by the processor component 310 or instructions that are to be executed by processor component 310. Such information may be received from and outputted to a network in the form, for example, of a computer data baseband signal or signal embodied in a carrier wave. The data may be ordered according to different sequences as may be desirable for either processing or generating the data or transmitting or receiving the data. The

baseband signal, the signal embedded in the carrier wave, or other types of signals currently used or hereafter developed may be referred to as the transmission medium and may be generated according to several methods well known to one skilled in the art.

[0044] The RAM 330 might be used to store volatile data and perhaps to store instructions that are executed by the processor component 310. The ROM 340 is a non-volatile memory device that typically has a smaller memory capacity than the memory capacity of the secondary storage 350. ROM 340 might be used to store instructions and perhaps data that are read during execution of the instructions. Access to both RAM 330 and ROM 340 is typically faster than to secondary storage 350. The secondary storage 350 is typically comprised of one or more disk drives or tape drives and might be used for non-volatile storage of data or as an over-flow data storage device if RAM 330 is not large enough to hold all working data. Secondary storage 350 may be used to store programs or instructions that are loaded into RAM 330 when such programs are selected for execution or information is needed.

[0045] The I/O devices 360 may comprise keyboards, keypads, switches, dials, mice, track balls, voice recognizers, card readers, paper tape readers, printers, transducers, sensors, and/or any other suitable input or output devices. Also, the transceiver 325 might be considered to be a component of the I/O devices 360 instead of or in addition to being a component of the network connectivity devices 320. Some or all of the I/O devices 360 may be substantially similar to various components disclosed herein.

[0046] HVAC communication bus interface 370 may take the form of a three wire connection, as mentioned above. For example, the three wire connection may be implemented using standards such as ClimateTalk and BACnet. HVAC communication bus interface 370 may alternatively comprise a CT-485 interface, an RS-485 interface, and/or an Ethernet 10BASE-T or 100BASE-TX interface, and/or any other suitable communication interface.

[0047] Display 372 may comprise liquid crystal displays (LCDs), touch screen displays, video monitors, plasma screens, digital ink, or other known display technology. Speaker 374 may be a conventional speaker, piezo electric element, or other sound producing element. Microphone 376 may be any known sound sensing device used to input sound data. Sensors 378 may be any type of HVAC sensor typically used to operate HVAC systems, such as temperature sensors, barometric pressure sensors, humidity sensors, air quality sensors, etc.

[0048] Processing component 310 may receive, store, retrieve, and/or transmit HVAC configuration information in any of the RAM 330, ROM 340, and secondary storage 350. HVAC configuration information may comprise information about the manufacturer, model number, serial number, and system specifications of any and/or all components in the system. processor component 310 may also store and retrieve information about customer service locations, addresses, and other contact information such as web addresses, IP addresses, telephone support numbers, and other relevant contact information. Processor component 310 may also store and retrieve information about a particular installation, such as customer name and location, installation date, installer identification, distributor identification, routine maintenance already performed, repairs already performed, and information about service technicians. Processor component 310 may store and retrieve diagnostic information about the system, comprising error codes, failure codes, anticipated failure times, needed maintenance, needed repairs, normal function status, malfunction status, and functional history. For example, the processor may store and retrieve fan run times, compressor run times, fan speed, compressor status, air-flow switch status, sensor status, power failure, fuel supply information, or any other information relevant to the function and/or malfunction of the device.

[0049] I/O devices 360 may comprise a dedicated switch 380 on the front of the device. Alternatively, the switch may be a soft switch, for example a programmed region of a touch screen interface in a particular context, as shown in Figure 5. For example, the dedicated switch 380 may be a simple momentary mechanical push-button switch on a front panel of the housing of a processor system 300 labeled "Press for customer service". The processor component 310 may be configured to check for actuation dedicated switch 380 through I/O device 360. When actuation of the dedicated switch 380 is detected, the processor system 300 may be configured to initiate a VOIP software application to pass voice inputs from microphone 376 through network connectivity device 320 to a customer service center, and to pass voice inputs received through network connectivity device 320 from the customer service center to speaker 374.

[0050] The processor component 310 may be configured to retrieve customer service contact information from secondary storage 350 from a limited number of possible contacts. For example, the processor component 310 may be configured to only contact a particular manufacturer, which may then handle the request as appropriate. The customer service call may be forwarded to local service technicians, or handled in any other way as appropriate. Limiting the possible contacts

using the VOIP applications may help to constrain costs associated with this service, depending on local regulations and telecommunication laws. For example, the customer may be able to use the processor system 300 to get customer service from the manufacturer, but not to make personal calls to friends in other countries. Limiting contacts may also limit security risks, if the processor is configured to execute instructions received from network connectivity device 320.

[0051] The processor component 310 may be configured to send HVAC configuration information, diagnostic information, service history, customer name, customer preferences, technician information, installation information, local repair and service company information, status information, error codes, malfunction information, and any information that may be relevant to customer service, and handling a customer service call about the product. The processor component 310 may be configured to send some or all of this information when the VOIP call is established. This may make the customer service call proceed more rapidly. Automated data analysis at the customer service center may automatically present a solution for the problem based on received diagnostic information. For example, if a fan motor is bad, the customer service center automated data analysis may recognize this problem immediately, based on the diagnostic information received and previous customer service calls, and send a proposed solution to a display screen seen by the customer service representative speaking with the customer. The solution may be to inform the customer what is wrong, inform the customer of available options, suggest a course of action, recommend a local technician, and estimate a cost of the repair. This may happen without the customer having to even describe the problem.

[0052] The customer service representative may also ask the customer to observe various conditions, or take various actions related to the diagnosis of the problem. The processor component 310 may be configured to execute instructions sent by the customer service representative. For example, the processor component 310 may be configured to run diagnostic tests or send particular data back to the customer service representative. This may allow the customer service representative to directly perform diagnostic tests, rather than request that the customer perform these tests. Further, the diagnostic tests may be initiated by automated diagnostic software maintained by the customer service center. This may allow diagnostic tests to be performed based on data received from many similar systems. Thus, if a particular fan motor fails frequently after a certain number of hours of operation, the diagnostic software at the customer service center may be aware of this trend, whereas software located on the local HVAC system

may not comprise access to data about other similar installations in other customers' houses. In addition, the customer service center may be able to diagnose ambiguous data better. For example, if a particular set of data is ambiguous, and may indicate that either a sensor or a motor is malfunctioning, the customer service center may be able to make an educated guess at which is likely, based on experiences from many customer service calls. A repair technician may be sent to the location with both parts, or only the most likely part, based on information received from the customer service call. This may reduce the costs of the repair, while also reducing delays due to diagnosis and availability of parts.

[0053] The synergy available when the VOIP application is built into the processor system 300 is not available when the customer uses their own general purpose phone to call a customer service center, and report a problem. When the customer makes a traditional call, the customer service representative is not automatically connected to the device, and not automatically given the customer information, comprising device status and diagnostic information. The customer service representative is also not automatically connected to the processor component 310 to run diagnostic tests. The whole process may take much longer using the traditional approach, and not arrive at the same optimal solution due to inherent and typical limitations in the abilities of customers. Some burdens that customers traditionally experience may be lifted.

[0054] Adding speaker 374 and/or microphone 376 may allow a processor component 310 to be configured to communicate using VOIP instructions through network connectivity device 320.

[0055] Figure 4 illustrates a method 400 of operating a thermostat, which may begin at block 410 by controlling an HVAC component in response to HVAC settings. The HVAC settings may relate to a climate sensor attached to a thermostat or other HVAC component.

[0056] The method 400 may continue at block 420 by receiving voice information from a microphone on the thermostat. This information may be digitized data representing the user's voice, whether the user is a home owner, installer, technician, repairman, maintenance worker, or other individual. The reception of the voice data may commence in response to receiving a customer service command to initiate a customer service call to a remote service center. The customer service command may be input by voice, dedicated button, or a menu-driven user interface.

[0057] The method may continue at block 430 by transmitting the voice information through a network communication interface to a particular destination, for example an IP address or

telephone number directing the information to a customer service center using VOIP. The IP address or telephone number may be stored in a controller in the thermostat. In addition to the voice data, the method may comprise sending information stored by the thermostat such as product information. The product information may comprise system identification information, diagnostic information relating to the configuration and operation of the thermostat, information about the installation operation, status, and history of any HVAC components connected to the thermostat, and other information.

[0058] The method may continue at block 440 by receiving VOIP information using the thermostat. This may be the digitized voice information coming from the customer service center in response to sending the user voice information. The method may comprise instances where the customer service center may identify a malfunction of the HVAC component, identify a part required for repair of the malfunction of the HVAC component, and transmit information identifying the part to at least one of the thermostat, an HVAC parts dealer, and a HVAC service center. The voice data may comprise instructions to the user to perform certain diagnostic observations or actions, and report the results. In addition, the voice data may be accompanied by diagnostic data and instructions from the customer service center. The instructions may be machine instructions directed at a controller in the thermostat.

[0059] The method 400 may continue at block 450 by outputting the received VOIP information through a speaker on the thermostat.

[0060] Figure 5 shows a menu-driven user interface 500 that may be used on a thermostat. The thermostat menu may comprise several levels, and multiple selections 510 on each level, as shown. One particular selection, service 520, may lead to a dedicated customer service VOIP connection. This may be illustrated in Figure 6. Figure 6 illustrates a touch screen display interface 600 which may be used to establish a VOIP call to a manufacturer by selecting a particular choice, such as 610. The VOIP call may also be established with a local technician using selection 620. The service menu may provide a selection for running diagnostics, such as 630. The service menu may further provide a system information selection 640 for reviewing system information, or inputting system information. As an alternative, a call to a customer service center may be initiated by a hardwired button on the front of the thermostat, connected to a dedicated switch.

[0061] As used herein, the terms "customer service center" and "remote service center" are used interchangeably. Either of these terms can refer to a call center run by a manufacturer,

distributor, or dealer. On or more people may work in the call center to answer customer questions and help with customer concerns. The call center may accept voice data whether it arrives over the internet, through a wired telephone interface, or over cellular communication services.

[0062] At least one embodiment is disclosed and variations, combinations, and/or modifications of the embodiment(s) and/or features of the embodiment(s) made by a person having ordinary skill in the art are within the scope of the disclosure. Alternative embodiments that result from combining, integrating, and/or omitting features of the embodiment(s) are also within the scope of the disclosure. Where numerical ranges or limitations are expressly stated, such express ranges or limitations should be understood to comprise iterative ranges or limitations of like magnitude falling within the expressly stated ranges or limitations (e.g., from about 1 to about 10 comprises, 2, 3, 4, etc.; greater than 0.10 comprises 0.11, 0.12, 0.13, etc.). For example, whenever a numerical range with a lower limit, R_l , and an upper limit, R_u , is disclosed, any number falling within the range is specifically disclosed. In particular, the following numbers within the range are specifically disclosed: $R = R_l + k * (R_u - R_l)$, wherein k is a variable ranging from 1 percent to 100 percent with a 1 percent increment, i.e., k is 1 percent, 2 percent, 3 percent, 4 percent, 5 percent, ..., 50 percent, 51 percent, 52 percent, ..., 95 percent, 96 percent, 97 percent, 98 percent, 99 percent, or 100 percent. Moreover, any numerical range defined by two R numbers as defined in the above is also specifically disclosed. Use of the term "optionally" with respect to any element of a claim means that the element is required, or alternatively, the element is not required, both alternatives being within the scope of the claim. Use of broader terms such as comprises, comprises, and having should be understood to provide support for narrower terms such as consisting of, consisting essentially of, and comprised substantially of. Accordingly, the scope of protection is not limited by the description set out above but is defined by the claims that follow, that scope comprising all equivalents of the subject matter of the claims. Each and every claim is incorporated as further disclosure into the specification and the claims are embodiment(s) of the present invention.

CLAIMS

What Is Claimed Is:

1. A heating, ventilation, and/or air conditioning (HVAC) thermostat, comprising:
a processor configured to:
control at least one component of an HVAC system in response to temperature;
and
at least one of (1) receive voice over internet protocol (VOIP) data and (2) transmit VOIP data.
2. The HVAC thermostat of claim 1, further comprising:
a microphone configured to selectively receive sound inputs for conversion into the VOIP data.
3. The HVAC thermostat of claim 1, further comprising:
a speaker configured to selectively output sound converted from the VOIP data.
4. The thermostat of claim 1, wherein the processor system is configured to store product information further comprising HVAC component information related to the at least one HVAC component connected to the thermostat.
5. The thermostat of claim 4, wherein the processor is configured to store product information which further comprises at least information identifying the thermostat, information identifying the HVAC component, diagnostic information related to the operation of the thermostat, and diagnostic information related to the operation of the HVAC component, and wherein the processor is configured to transmit product information comprising the at least information identifying the thermostat, information identifying the HVAC component, diagnostic information relating to the operation of the thermostat, and diagnostic information related to the operation of the HVAC component to a remote service center.

6. The thermostat according to claim 5, wherein the processor is further configured to receive additional diagnostic information from the remote service center, and to display the additional diagnostic information on a display.
7. The thermostat according to claim 6, wherein the processor is further configured to:
store diagnostic instructions relating to the functions of the HVAC component and the thermostat;
receive a command from the remote service center invoking the diagnostic instructions;
and
execute the invoked diagnostic instructions.
8. The thermostat according to claim 7, wherein the processor is further configured to limit communications to a predetermined list of allowed numbers, the numbers being one of Internet Protocol addresses and customer service telephone numbers.
9. A method of operating a thermostat, comprising:
controlling, in response to a signal from at least one climate sensor attached to a thermostat, a heating, ventilation, and air/or conditioning (HVAC) component;
transmitting voice information from the thermostat using voice over internet protocol (VOIP); and
receiving voice information using VOIP, and outputting the received voice information via a speaker.
10. The method of claim 9, further comprising:
storing product information, the product information comprising system identification information and diagnostic information relating to at least the configuration and operation of the thermostat and HVAC component;
receiving by the thermostat a customer service command to initiate a customer service call to a remote service center;
transmitting the product information to the remote service center via a network interface attached to the thermostat in response to the customer service command.

11. The method of claim 9, further comprising:
 - performing diagnostic actions on one of the thermostat and the HVAC component in response to receiving voice information, and
 - reporting the results of the diagnostic actions using VOIP.
12. The method of claim 10, further comprising:
 - generating HVAC diagnostic information by the HVAC component relating to the operation of the HVAC component;
 - transmitting the HVAC diagnostic information to the thermostat; and
 - comprising the HVAC diagnostic information in said storing product information and said transmitting the product information.
13. The method of claim 10, wherein the customer service command is a voice command received by the thermostat through a microphone.
14. The method of claim 10, further comprising:
 - identifying, at the remote service center, a malfunction of the HVAC component;
 - identifying, at the remote service center, a part required for repair of the malfunction of the HVAC component; and
 - transmitting, by the remote service center, information identifying the part to at least one of the thermostat, an HVAC parts dealer, and a HVAC service center.
15. A device, comprising:
 - a microphone;
 - a speaker;
 - an input;
 - a network interface; and
 - a processor system configured to:
 - store product information regarding the device as a whole;

receive a customer service command from the input to initiate a customer service call regarding the device;

transmit the service information via the network interface in response to the customer service command;

transmit, in response to the customer service command, first voice information input by the microphone to a remote service center via the network interface using voice over internet protocol (VOIP); and

receive second voice information from the remote service center via the network interface using VOIP, and output the second voice information via the speaker.

16. The device according to claim 15, further comprising a display, wherein the processor system is further configured to receive diagnostic information from the remote service center and to display the diagnostic information on the display.

17. The device according to claim 16, wherein the processor system is further configured to store predetermined customer service information regarding at least one of a customer service telephone number and a customer service Internet Protocol address, and to retrieve the customer service information in response to a customer service command.

18. The device according to claim 15, further comprising a display, and wherein the processor system is further configured to:

store diagnostic instructions relating to diagnosis of the functions of the device;

receive a command from the remote service center invoking the diagnostic instructions and to execute the invoked diagnostic instructions; and

display data retrieved as a result of the execution of the diagnostic instructions on the display and at the remote service center.

19. The device according to claim 15, wherein the processor system is further configured to limit communications to a predetermined list of allowed numbers, the numbers being one of Internet Protocol addresses and customer service telephone numbers.

20. The device according to claim 15, wherein the input is limited to a predetermined list of allowed choices for establishing a communication via VOIP.
21. A method of operating a customer service center, comprising:
receiving diagnostic data generated by a heating, ventilation, and air/or conditioning (HVAC) controller associated with a first HVAC system component; and
receiving voice over internet protocol (VOIP) data from the HVAC controller.
22. The method according to claim 21, further comprising:
controlling, by the customer service center, a function of the HVAC system component;
and
transmitting voice information using VOIP from the customer service center to the HVAC controller.

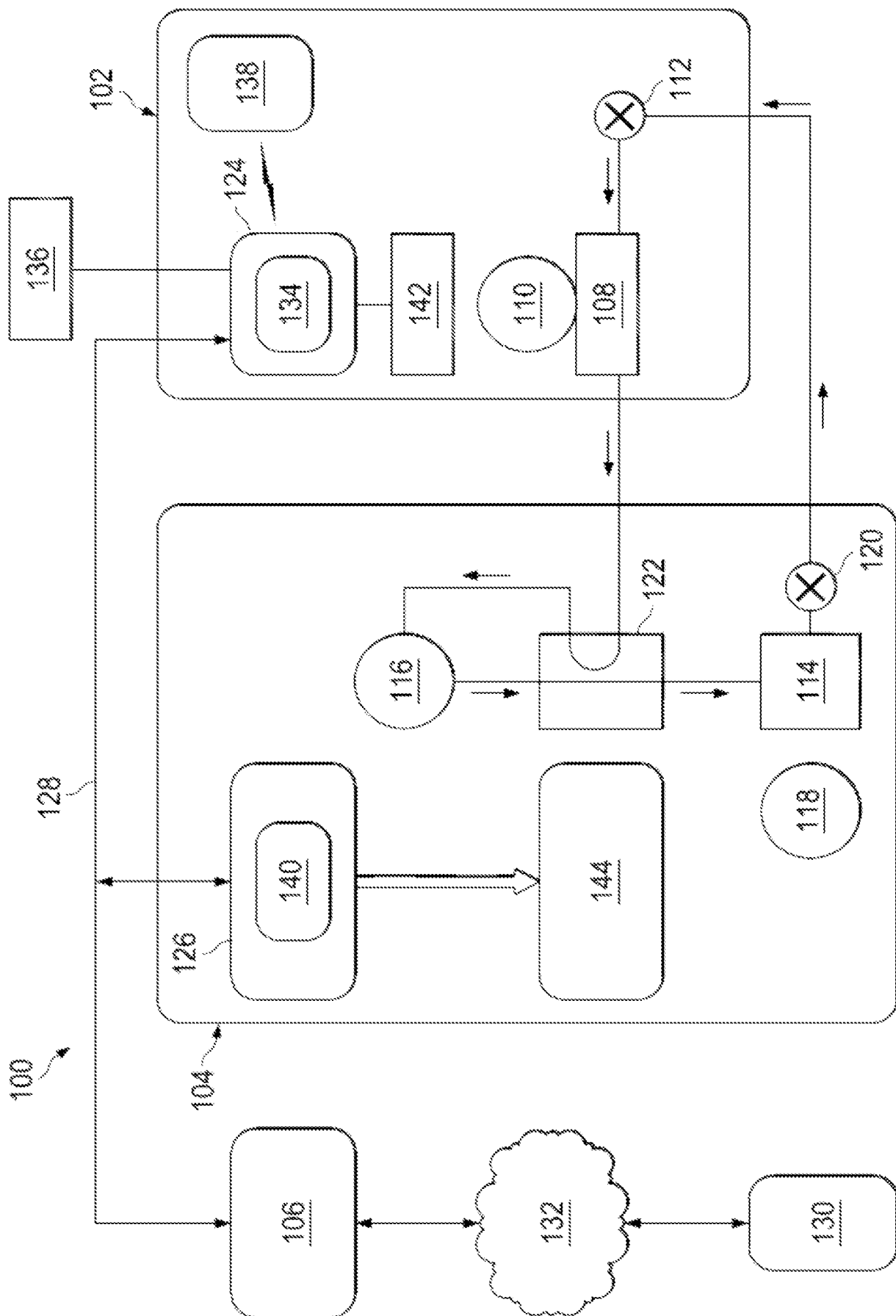
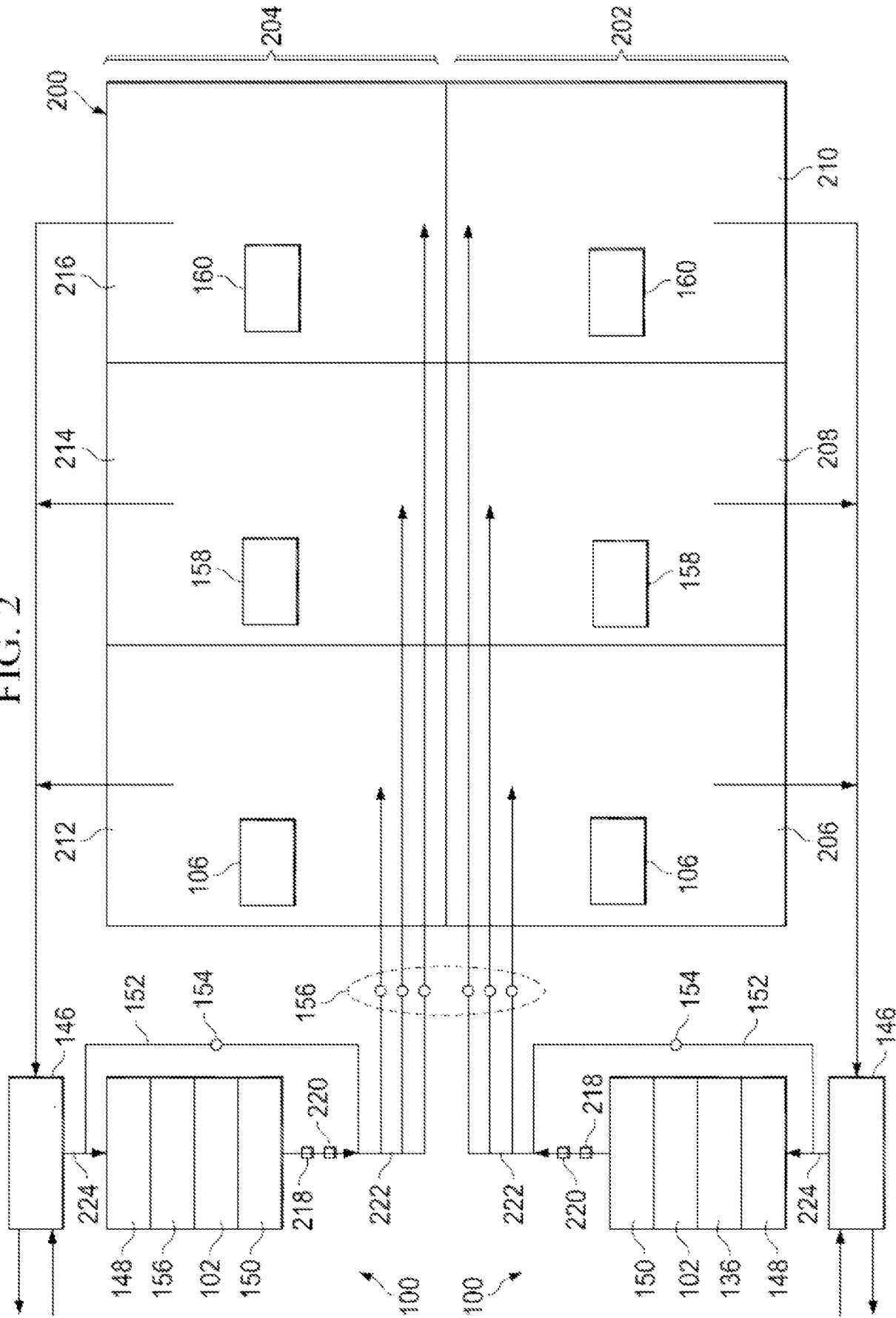


FIG. 1

FIG. 2



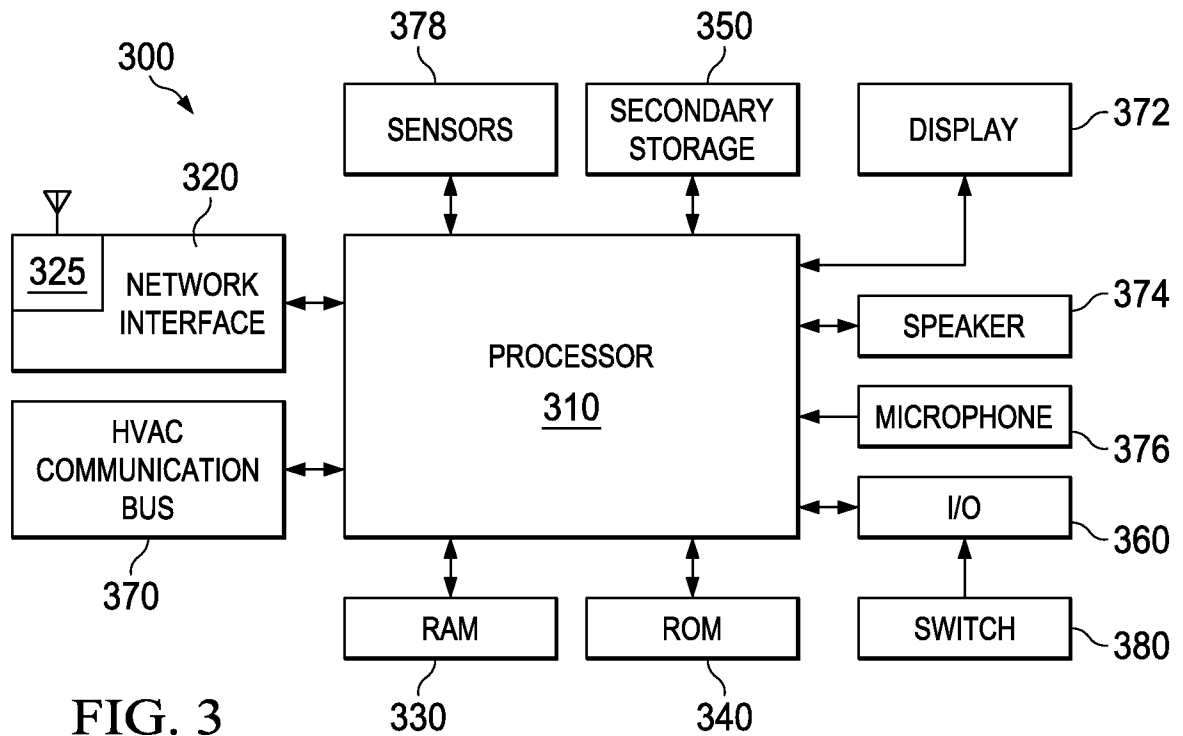


FIG. 3

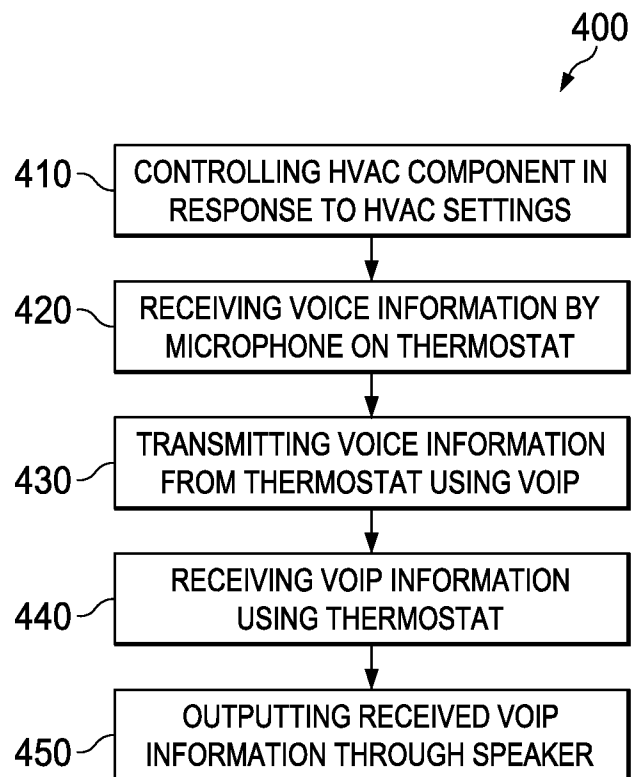


FIG. 4

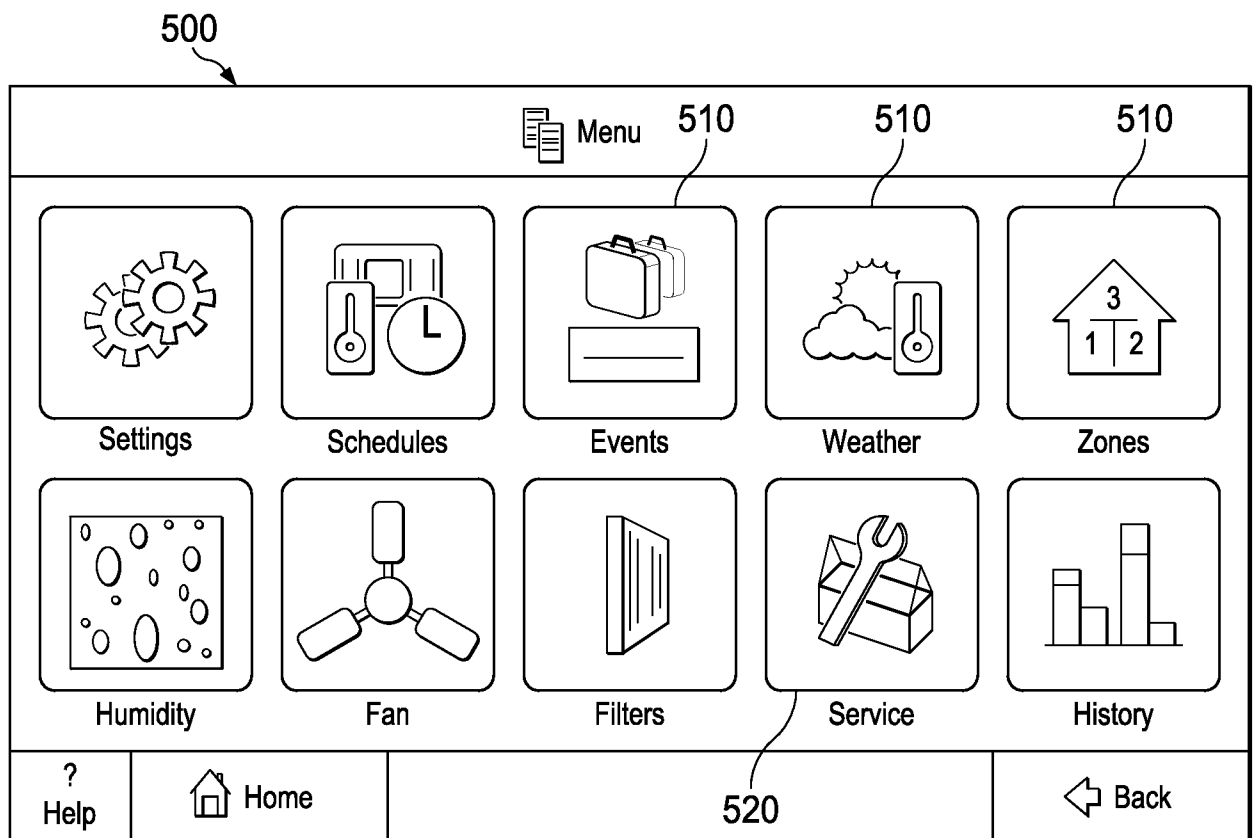


FIG. 5

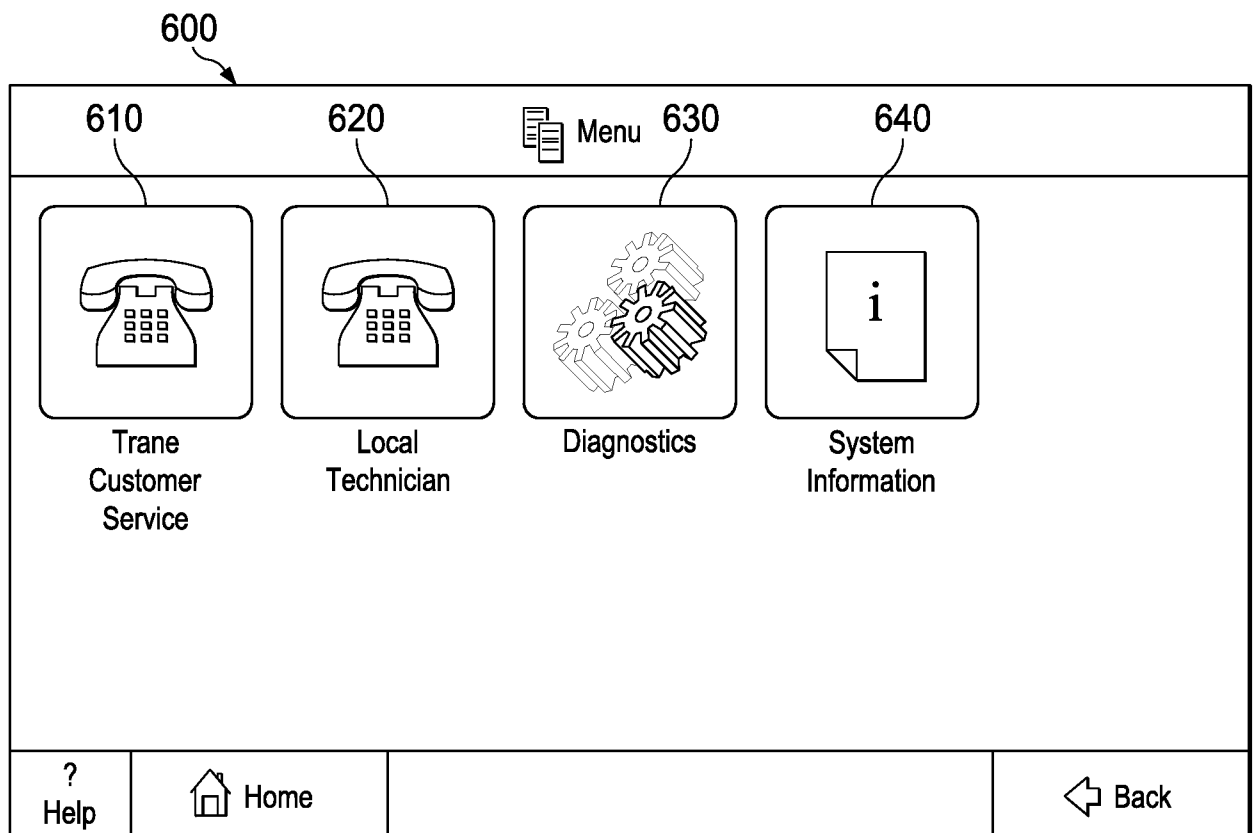


FIG. 6