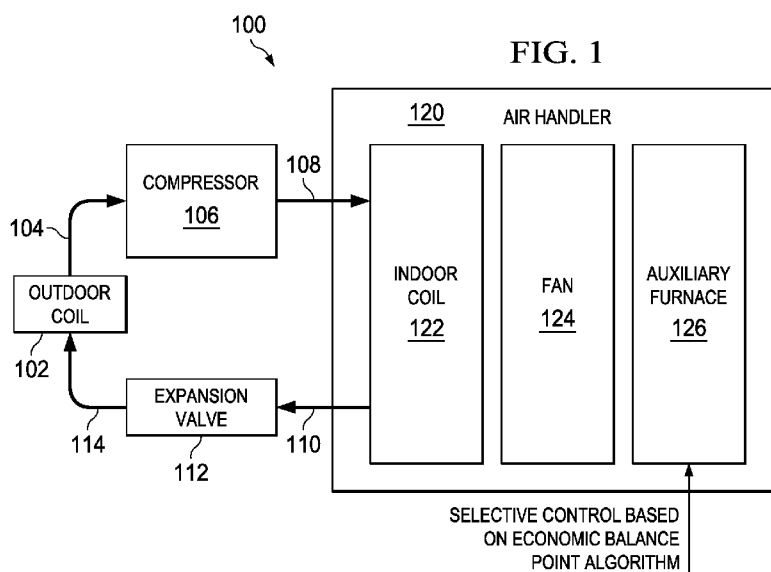




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[Continued on next page]

(54) **Title:** SYSTEMS AND METHODS FOR CONTROLLING A HYBRID HEATING SYSTEM

(57) **Abstract:** In at least some embodiments, a hybrid heating system includes a heat pump and an auxiliary furnace. The system also includes a controller coupled to the heat pump and the auxiliary furnace. The controller, in response to receiving a heat request, selects either the heat pump or the auxiliary furnace based on an economic balance point algorithm.



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- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*
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SYSTEMS AND METHODS FOR CONTROLLING A HYBRID HEATING SYSTEM

BACKGROUND

[0001] In a heat pump and refrigeration cycle, refrigerant alternately absorbs and rejects thermal energy as it circulates through the system and is compressed, condensed, expanded, and evaporated. In particular, a liquid refrigerant flows from a condenser, through an expansion device (e.g., expansion valve) and into an evaporator. As the refrigerant flows through the expansion device and evaporator, the pressure of the refrigerant decreases, the refrigerant phase changes into a gas, and the refrigerant absorbs thermal energy. From the evaporator, the gaseous refrigerant proceeds to a compressor, and then back to the condenser. As the refrigerant flows through the compressor and condenser, the pressure of the refrigerant is increased, the refrigerant phase changes back into a liquid, and the refrigerant gives up thermal energy. The process is implemented to emit thermal energy into a space (e.g., to heat a house) or to remove thermal energy from a space (e.g., to air condition a house).

[0002] In a heating cycle, the efficiency of a heat pump system is reduced as the outdoor temperature drops. In other words, for every heat pump system, there is an outdoor temperature threshold (referred to herein as “the thermal balance point”) below which the heat pump system is no longer effective. Accordingly, some heating, ventilation, and air conditioning (HVAC) systems implement a hybrid (or dual) fuel system for heating, which comprises a heat pump system and an auxiliary furnace. The auxiliary furnace may burn gas, oil, propane or other combustibles. With the auxiliary furnace, the hybrid fuel system is capable of heating an indoor environment even if the outdoor temperature drops below the thermal balance point of the heat pump system.

SUMMARY OF THE DISCLOSURE

[0003] In at least some embodiments, a hybrid heating system includes a heat pump and an auxiliary furnace. The hybrid heating system also includes a controller coupled to the heat pump and the auxiliary furnace. The controller, in response to receiving a heat request, selects either the heat pump or the auxiliary furnace based on an economic balance point algorithm.

[0004] In at least some embodiments, a control system for a hybrid heating system includes economic balance point logic configured to determine an outdoor temperature threshold at which operating an auxiliary furnace is less expensive than operating a heat pump. The control system also includes selection logic configured to select, in response to a heat request, either the auxiliary furnace or the heat pump based on the outdoor temperature threshold.

[0005] In at least some embodiments, a method for controlling a hybrid heating system includes determining, by a controller, an outdoor temperature threshold at which operating an auxiliary furnace is less expensive than operating a heat pump. The method also includes receiving, by the controller, a heat request. The method also includes selecting, by the controller, either the auxiliary furnace or the heat pump based on the determined outdoor temperature threshold.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIGURE 1 illustrates an HVAC system with hybrid heating in accordance with an embodiment of the disclosure;

[0007] FIGURE 2 illustrates a control system configuration for the HVAC system of FIGURE 1 in accordance with an embodiment of the disclosure;

[0008] FIGURE 3 illustrates a block diagram of a system in accordance with an embodiment of the disclosure;

[0009] FIGURES 4A-4J show windows of a user interface program for controlling hybrid heating in accordance with an embodiment of the disclosure; and

[0010] FIGURE 5 shows a method in accordance with an embodiment of the disclosure.

DETAILED DESCRIPTION

[0011] FIGURE 1 illustrates an HVAC system 100 with hybrid heating in accordance with an embodiment of the disclosure. In the HVAC system 100, refrigerant cycles through a heat pump comprising outdoor coil 102, compressor 106, indoor coil 122, and expansion valve 112. The arrows 104, 108, 110 and 114 show the direction of flow for refrigerant in a heating cycle. For a cooling cycle, the direction of flow for refrigerant in HVAC system 100 would be reversed.

[0012] In a heating cycle, the outdoor coil 102 causes refrigerant to evaporate. As the liquid refrigerant evaporates it pulls heat from the outside air. The gaseous refrigerant flows (arrow 104) from the outdoor coil 102 to compressor 106, where the gaseous refrigerant is compressed to produce a high-pressure, superheated refrigerant vapor. The vapor leaves compressor 106 and flows (arrow 108) to the indoor coil 122. At the indoor coil 122, air from fan (blower) 124 removes heat from the vapor (warming the indoor air) and, when enough heat is removed, the vapor condenses into a high-pressure liquid. This high-pressure liquid flows (arrow 110) from the indoor coil 122 to the expansion valve 112, which meters the flow (arrow 114) of the high-pressure liquid to the outdoor coil 102. The heating cycle process described herein can be repeated as needed. For example, the heating cycle of HVAC system 100 may be activated and/or maintained in response to a thermostat control signal.

[0013] As shown in FIGURE 1, the indoor coil 122 and the fan 124 may be components of an air handler 120. The air handler 120 may also comprise an auxiliary furnace 126, which is selectively activated as part of a hybrid heating scheme as disclosed herein. Alternatively, the auxiliary furnace 126 may be separate from the air handler 120. In either case, the auxiliary furnace 126 may be selectively activated (e.g., instead of the heat pump components) based on an economic balance point algorithm. In operation, the economic balance point algorithm determines when operating the heat pump of HVAC system 100 is more expensive to run than the auxiliary furnace 126. In such case, the economic balance point algorithm causes the auxiliary furnace 126 to run instead of the heat pump. The economic balance point algorithm also may account for user inputs to adjust or override the determined economic balance point as described herein.

[0014] FIGURE 2 illustrates a control system configuration 200 for the HVAC system 100 of FIGURE 1 in accordance with an embodiment of the disclosure. The control system configuration 200 illustrates a hierarchical control for HVAC systems, including those with hybrid heating as disclosed herein. As shown, the thermostat 202 operates as the overall system controller of configuration 200 and is configured to communicate with an indoor subsystem controller 222 of indoor subsystem 220 and an outdoor subsystem controller 212 of outdoor subsystem 210. The indoor subsystem 220 may

comprise, for example, indoor heat pump components 224 (e.g., indoor coil 122 and fan 124) and auxiliary furnace components 226 (e.g., auxiliary furnace 126) such as those described for FIGURE 1. Meanwhile, the outdoor subsystem 210 comprises outdoor heat pump components 214 such as the compressor 106 and the outdoor coil 102 described for FIGURE 1. In at least some embodiments, the indoor subsystem controller 222 implements some or all of the economic balance point algorithm features described herein.

[0015] FIGURE 3 illustrates a block diagram of a system 300 in accordance with an embodiment of the disclosure. As shown, the system 300 comprises a controller 310 coupled to a hybrid heating system 320 having a heat pump 322 and an auxiliary furnace 324. In at least some embodiments, the controller 310 and the user interface 302 corresponds to the indoor subsystem controller 222 of FIGURE 2. In various embodiments, the user interface 302 corresponds to an interface on a thermostat or other control unit that enables user interaction to control operations of the hybrid heating system 320. Alternatively, the user interface 302 may correspond to a computer program or web portal accessible via a handheld computing device (e.g., a smart phone), a laptop and/or a desktop computer.

[0016] As shown, the controller 310 comprises economic balance point logic 312 configured to select whether to operate the heat pump 322 or the auxiliary furnace 324 in response to a heat request. In accordance with at least some embodiments, the economic balance point logic 312 employs control parameters 314 to determine when operating heat pump 322 is more expensive than operating auxiliary furnace 324. Values for the control parameters 314 may be based on previously stored default values and/or dynamic values received via a user interface 302 coupled to the controller 310. As an example, the control parameters 314 may correspond to an auxiliary furnace fuel cost parameter, a heat pump electricity cost parameter, a heat pump efficiency parameter, and an auxiliary furnace efficiency parameter. Using such control parameters 314, the economic balance point logic 312 determines an outdoor temperature balance point at which operating the heat pump 322 is more expensive than operating the auxiliary furnace 324.

[0017] The outdoor temperature balance point may be determined before or after a heat request is received. In either case, the economic balance point logic 312 may respond to a heat request by comparing a current outdoor temperature with the determined outdoor temperature balance point, and then selecting either the heat pump or the auxiliary furnace based on the comparison.

[0018] More specifically, in FIGURE 3, the selection logic 316 coupled to the economic balance point logic 312 may receive a recommendation or control signal from the economic balance point logic 312. In response to a control signal from the economic balance point logic 312, the selection logic 316 asserts a control signal to activate either the heat pump 322 or the auxiliary furnace 324. In accordance with at least some embodiments, the heat pump 322 and the auxiliary furnace 324 are independently activated, but are not typically operated together.

[0019] The selection logic 316 is also configured to receive a manually selected control scheme for the hybrid heating system 320 from the user interface 302. The manually selected control scheme may correspond to adjusting or overriding the determined outdoor temperature balance point discussed previously. In other words, the user interface 302 enables a user to selectively disable and enable the economic balance point algorithm performed by the economic balance point logic 312. Additionally or alternatively, the user interface 302 enables a user to manually set an outdoor temperature at which the auxiliary furnace 324 operates in response to a heat request instead of the heat pump 322. Additionally or alternatively, the user interface 302 enables a user to manually select a thermostat control algorithm instead of the economic balance point algorithm for control of the hybrid heating system 320. The thermostat control algorithm (e.g., implemented by thermostat 302) may, for each heating cycle, initialize a first heating stage in which the heat pump 322 is active without the auxiliary furnace 324 and, if needed, initialize a second heating stage in which the auxiliary furnace 324 is active without the heat pump 322.

[0020] FIGURES 4A-4J show windows of a user interface program for controlling hybrid heating in accordance with an embodiment of the disclosure. The user interface program may be part of the user interface 302 described for FIGURE 3. In FIGURE 4A, window 400A shows a “settings” menu including a dual fuel icon 402 that can be

selected by clicking on it. Selection of the dual fuel icon 402 enables a user to adjust control features for a hybrid heating system (e.g., the hybrid heating system 320 of FIGURE 3). The other icons of FIGURE 4A correspond to other control features or utilities accessible via the user interface program.

[0021] In FIGURE 4B, window 400B shows a dual fuel menu that appears in response to clicking the dual fuel icon 402 of FIGURE 4A. The dual fuel menu of window 400B enables a user to manually adjust control features and/or control parameter values for a hybrid heating system. For example, clicking on the comfort box 408 and then clicking the “next” button 410A enables a user to pass control of the hybrid heating system to a thermostat (e.g., thermostat 202 of FIGURE 2). When the thermostat controls the hybrid heating system, use of the economic balance point algorithm is temporarily disabled or is otherwise ignored. The thermostat may implement a thermostat control algorithm that, for each heating cycle, initializes a first heating stage in which the heat pump 322 is active without the auxiliary furnace 324. If needed (e.g., when the heat pump 322 is insufficient), the thermostat control algorithm initializes a second heating stage in which the auxiliary furnace is active without the heat pump.

[0022] Clicking on the operating cost box 404 and then clicking on the “next” button 410A enables a user to input values for control parameters (e.g., control parameters 314 of FIGURE 3) of an economic balance point algorithm. In other words, selection of the operating cost box 404 causes implementation of the economic cost balance algorithm for the hybrid heating system 320. The control parameter values for the economic balance point algorithm are input by a user via the user interface program as shown in the windows of FIGURES 4C-4F. Additionally or alternatively, one or more default values may be provided in the user interface program for the economic balance point algorithm as shown in the windows of FIGURES 4G-4H.

[0023] FIGURES 4C-4H show various windows that enable selection of control parameter values for an economic balance point algorithm. The windows of FIGURES 4C-4H may be displayed in series, for example, after clicking on the operating cost box 404 and the “next” box 410A. In FIGURE 4C, the window 400C enables a user to select a gas furnace box 412 or an oil furnace box 414. In other words, the economic balance

point algorithm accounts for the type of fuel used with the auxiliary furnace 324. Upon clicking the gas furnace box 412 and the “next” button 410B, the window 400E of FIGURE 4E is displayed by the user interface program. Alternatively, upon clicking the oil furnace box 414 and the “next” button 410B, the window 400F is displayed by the user interface program. In window 400C, selection of the “back” button 416A causes the dual fuel menu window 400B to be displayed again.

[0024] In FIGURE 4D, a window 400D with an electricity cost utility 418 is shown. The electricity cost utility 418 enables a user to enter an electricity cost (dollars/kwh). After entering the electricity cost, a user selects the “next” button 410C to use the entered electricity cost with the economic balance point algorithm. More specifically, the electricity cost is used to determine a cost of operating the heat pump 322. In screenshot 400D, selection of the “back” button 416B causes window 400C to be displayed again.

[0025] In FIGURE 4E, a window 400E with a gas cost utility 422 is shown. The window 400E is displayed if the gas furnace box 412 is selected in window 400C. The gas cost utility 422 enables a user to enter a natural gas cost in dollars/therm by clicking the “natural gas \$/therm” button 420. Alternatively, the gas cost utility 422 enables a user to enter a natural gas cost in dollars/MCF by clicking the “natural gas \$/MFC” button 424. Alternatively, the gas cost utility 422 enables a user to enter a propane gas cost in dollars/gallon by clicking the “propane gas \$/gal” button 426. After entering a gas cost, a user selects the “next” button 410D to use the entered gas cost with the economic balance point algorithm. More specifically, the gas cost is used to determine a cost of operating the auxiliary furnace 324. In window 400E, selection of the “back” button 416C causes window 400D to be displayed again.

[0026] In FIGURE 4F, a window 400F with an oil cost utility 430 is shown. The window 400F is displayed if the oil furnace box 414 is selected in window 400C. The oil cost utility 430 enables a user to enter a fuel oil cost in dollars/gallon by clicking the “fuel oil \$/gal” button 428. Alternatively, the “fuel oil \$/gal” button 428 need not be clicked since only one fuel oil cost option is provided. After entering a fuel oil cost, a user selects the “next” button 410E to use the entered fuel oil cost with the economic balance point algorithm. More specifically, the fuel oil cost is used to determine a cost of

operating the auxiliary furnace 324. In window 400F, selection of the “back” button 416D causes screenshot 400D to be displayed again.

[0027] In FIGURE 4G, a window 400G with an Annual Fuel Utilization Efficiency (AFUE) rating utility 432 is shown. The AFUE rating utility 432 enables a user to adjust an AFUE rating corresponding to the auxiliary furnace 324. The AFUE rating for the AFUE rating utility 432 may be initially set to a default value (e.g., 78) and may be adjusted within a predetermined range (e.g., 78-98). After entering an AFUE rating, a user selects the “next” button 410F to use the entered AFUE rating with the economic balance point algorithm. More specifically, the AFUE rating is used to determine a cost of operating the auxiliary furnace 324. In window 400G, selection of the “back” button 416E causes either window 400E or window 400F to be displayed again.

[0028] In FIGURE 4H, a window 400H with a Heating Season Performance Factor (HSPF) rating utility 434 is shown. The HSPF rating utility 434 enables a user to adjust an HSPF rating corresponding to the heat pump 322. The HSPF rating for the HSPF rating utility 434 may be initially set to a default value (e.g., 7.7) and may be adjusted within a predetermined range (e.g., 7.7-12). After entering an HSPF rating, a user selects the “next” button 410G to use the entered HSPF rating with the economic balance point algorithm. More specifically, the HSPF rating is used to determine a cost of operating the heat pump 322. In window 400H, selection of the “back” button 416F causes the window 400G to be displayed again.

[0029] In FIGURE 4I, a window 400I with a determined outdoor temperature balance point utility 436 is shown. The determined outdoor temperature balance point utility 436 shows results of an outdoor temperature balance point determined by the economic balance point algorithm (referred to as the “furnace heating outdoor temperature” in utility 436) based on control parameter values entered via the user interface program (e.g., via the utilities of window 400D-400H). The determined outdoor balance point utility 436 also enables a user to adjust the determined outdoor temperature balance point up or down. To accept the determined outdoor temperature balance point or an adjusted outdoor temperature balance point, the user selects the “accept” button 438A. The user may alternatively click the “cancel” button 440A to cancel use of the

determined outdoor temperature balance point or adjusted outdoor temperature balance point to control a hybrid heating system 320.

[0030] Returning to FIGURE 4B, clicking on the outdoor temperature box 406 and then clicking on the “next” button 410A enables a user to manually set an outdoor temperature balance point. When the outdoor temperature is at or above the outdoor temperature balance point, the heat pump 322 is selected in response to a heat request. When the outdoor temperature is below the outdoor temperature balance point, the auxiliary furnace 324 is selected in response to a heat request. FIGURE 4J shows a window 400J with a custom outdoor temperature balance point utility 437. The custom outdoor temperature balance point utility 437 enables a user to select a custom outdoor temperature balance point (referred to as the “furnace heating outdoor temperature” in utility 437) between 0 – 70 degrees Fahrenheit. Other temperature ranges could or selection means could alternatively be used. Once a custom outdoor temperature balance point is selected in utility 437, a user clicks the “accept” button 438B to implement use of the custom outdoor temperature balance point. The user may alternatively click the “cancel” button 440B to cancel use of a custom temperature balance point.

[0031] Although windows 400C-400J describe various features and utilities in a particular order, the windows presented herein are not intended to limit other user interface embodiments that may implement an economic balance point algorithm as described herein. In other words, user interface embodiments may vary with regard to how information is presented to a user and how a user enters information.

[0032] FIGURE 5 shows a method 500 in accordance with an embodiment of the disclosure. The method 500 may be performed by a controller (e.g., controller 310) or control system for hybrid fuel heating of an HVAC system as described herein. As shown, the method 500 comprises determining an outdoor temperature balance point at which operating an auxiliary furnace is less expensive than operating a heat pump (block 502). The determined outdoor temperature balance point may be based on control parameters such as an auxiliary furnace fuel cost parameter, a heat pump electricity cost parameter, a heat pump efficiency parameter and an auxiliary furnace efficiency parameter. At block 504, a heat request is received. Finally, an auxiliary furnace or

heat pump is selected (responsive to the heat request) based on the determined outdoor temperature balance point (block 506).

[0033] In at least some embodiments, the method 500 may enable determination of the outdoor temperature balance point to be disabled or overridden by a user. For example, a user may enter a custom outdoor temperature balance point. Further, a user may select to implement a thermostat control scheme instead of an economic balance point algorithm. The thermostat control scheme comprises, for example, initializing a first heating stage in which the heat pump is active without the auxiliary furnace. If needed, thermostat control scheme initializes a second heating stage in which the auxiliary furnace is active without the heat pump.

[0034] Preferred embodiments have been described herein in sufficient detail, it is believed, to enable one skilled in the art to practice the disclosed embodiments. Although preferred embodiments have been described in detail, those skilled in the art will also recognize that various substitutions and modifications may be made without departing from the scope and spirit of the appended claims.

[0035] 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 include iterative ranges or limitations of like magnitude falling within the expressly stated ranges or limitations (e.g., from about 1 to about 10 includes, 2, 3, 4, etc.; greater than 0.10 includes 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, includes, 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 including 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 hybrid heating system, comprising:
a heat pump;
an auxiliary furnace; and
a controller coupled to the heat pump and the auxiliary furnace,
wherein the controller, in response to receiving a heat request, selects either the heat pump or the auxiliary furnace based on an economic balance point algorithm.
2. The hybrid heating system of claim 1 wherein the economic balance point algorithm comprises an auxiliary furnace fuel cost parameter, a heat pump electricity cost parameter, a heat pump efficiency parameter, and an auxiliary furnace efficiency parameter.
3. The hybrid heating system of claim 2 wherein the economic balance point algorithm implements default values for at least one of the auxiliary furnace fuel cost parameter, the heat pump electricity cost parameter, the heat pump efficiency parameter, and the auxiliary furnace efficiency parameter.
4. The hybrid heating system of claim 2 wherein the controller comprises a user interface and wherein values for at least one of the auxiliary furnace fuel cost parameter, the heat pump electricity cost parameter, the heat pump efficiency parameter, and the auxiliary furnace efficiency parameter are based on user input via the user interface.
5. The hybrid heating system of claim 1 wherein the economic balance point algorithm determines an outdoor temperature balance point at which operating the auxiliary furnace is less expensive than operating the heat pump.
6. The hybrid heating system of claim 5 wherein the controller, in response to receiving a heat request, compares a current outdoor temperature with a previously

determined outdoor temperature balance point and selects either the heat pump or the auxiliary furnace based on the comparison.

7. The hybrid heating system of claim 1 wherein the controller comprises a user interface that enables a user to selectively disable and enable the economic balance point algorithm.

8. The hybrid heating system of claim 1 wherein the controller couples to a user interface that enables a user to manually set an outdoor temperature at which the auxiliary furnace operates in response to a heat request instead of the heat pump.

9. The hybrid heating system of claim 1 wherein the controller selectively implements a thermostat control algorithm instead of the economic balance point algorithm based on user input.

10. The hybrid heating system of claim 9 wherein the thermostat control algorithm, for each heating cycle, initializes a first heating stage in which the heat pump is active without the auxiliary furnace and, if needed, initializes a second heating stage in which the auxiliary furnace is active without the heat pump.

11. A control system for a hybrid heating system, the control system comprising:
economic balance point logic configured to determine an outdoor temperature threshold at which operating an auxiliary furnace is less expensive than operating a heat pump;

selection logic configured to select, in response to a heat request, either the auxiliary furnace or the heat pump based on the outdoor temperature threshold.

12. The control system of claim 11 wherein the economic balance point logic determines the output temperature threshold based on an auxiliary furnace fuel cost parameter, a heat pump electricity cost parameter, a heat pump efficiency parameter, and an auxiliary furnace efficiency parameter.

13. The control system of claim 12 wherein the economic balance point logic implements default values for at least one of the auxiliary furnace fuel cost parameter, the heat pump electricity cost parameter, the heat pump efficiency parameter, and the auxiliary furnace efficiency parameter.

14. The control system of claim 11 further comprising a user interface in communication with the economic balance point logic, wherein values for at least one of the auxiliary furnace fuel cost parameter, the heat pump electricity cost parameter, the heat pump efficiency parameter, and the auxiliary furnace efficiency parameter are based on user input via the user interface.

15. The control system of claim 12 further comprising a user interface in communication with the selection logic, wherein the selection logic is configured to select either the auxiliary furnace or the heat pump for a heat cycle based on an outdoor temperature value or a thermostat control scheme selected manually by a user via the user interface.

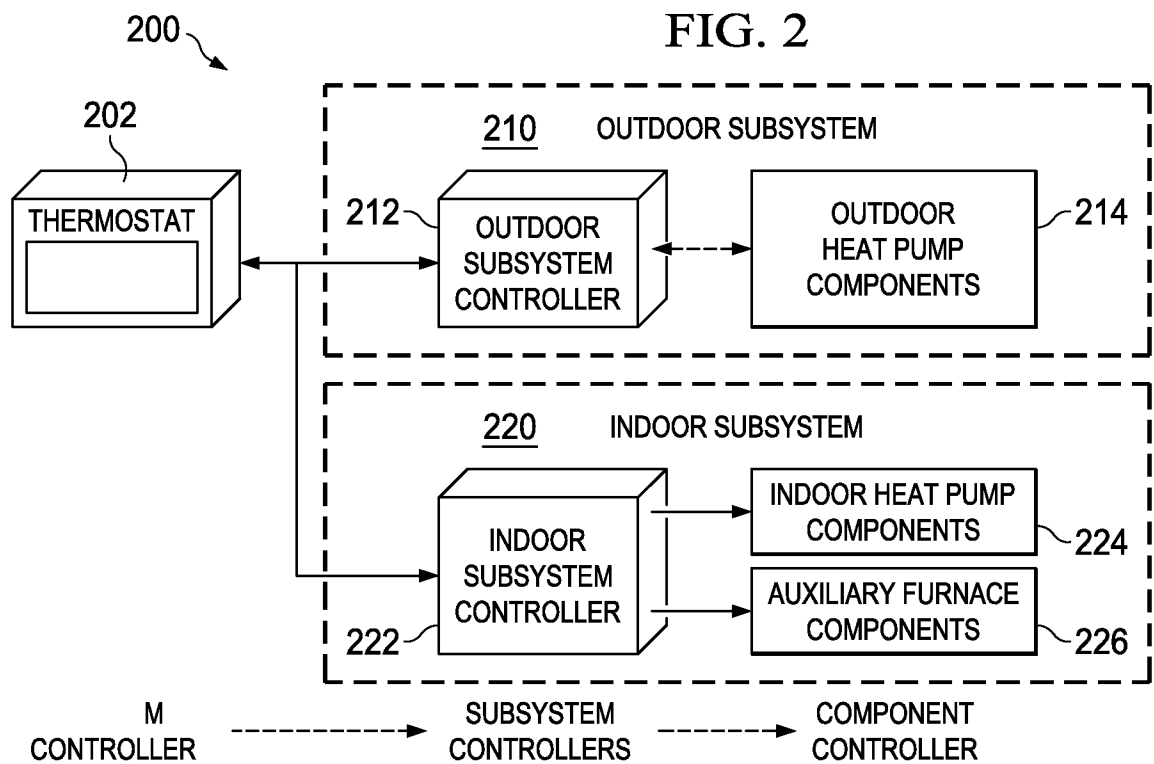
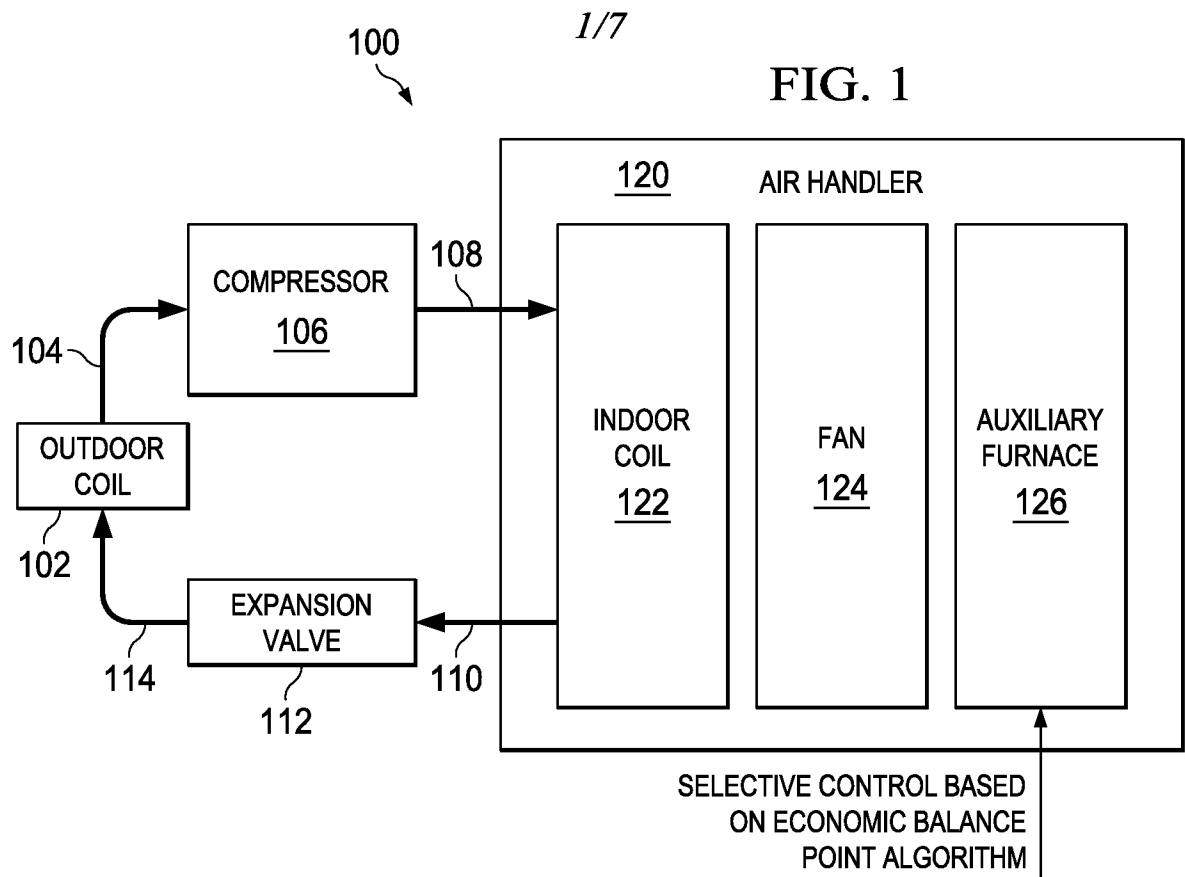
16. A method for controlling a hybrid heating system, comprising:
determining, by a controller, an outdoor temperature threshold at which operating an auxiliary furnace is less expensive than operating a heat pump;
receiving, by the controller, a heat request; and
selecting, by the controller, either the auxiliary furnace or the heat pump based on the determined outdoor temperature threshold.

17. The method of claim 16 wherein said determining the outdoor temperature threshold is based on an auxiliary furnace fuel cost parameter, a heat pump electricity cost parameter, a heat pump efficiency parameter, and an auxiliary furnace efficiency parameter.

18. The method of claim 16 further comprising overriding the determined outdoor temperature threshold with an outdoor temperature provided by a user.

19. The method of claim 16 further comprising disabling use of the determined outdoor temperature threshold for said selection and enabling use of a thermostat control scheme to select either the auxiliary furnace or the heat pump based on the determined outdoor temperature threshold .

20. The method of claim 19 wherein the thermostat control scheme comprises initializing a first heating stage in which the heat pump is active without the auxiliary furnace and, if needed, initializing a second heating stage in which the auxiliary furnace is active without the heat pump.



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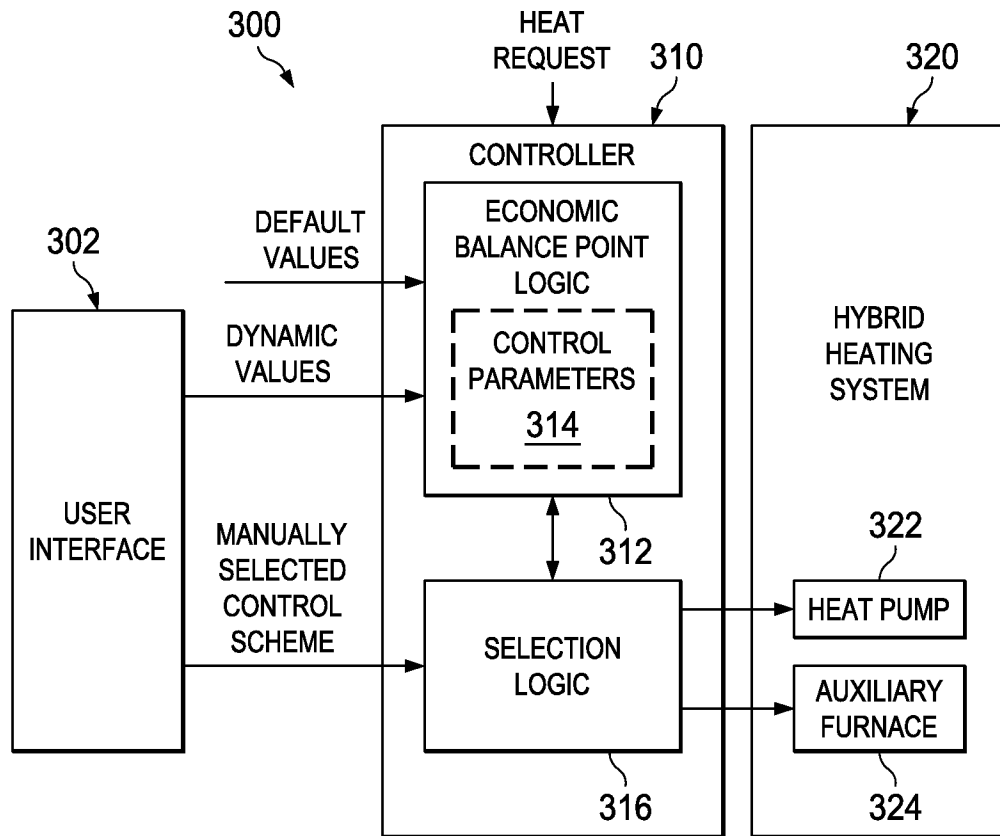


FIG. 3

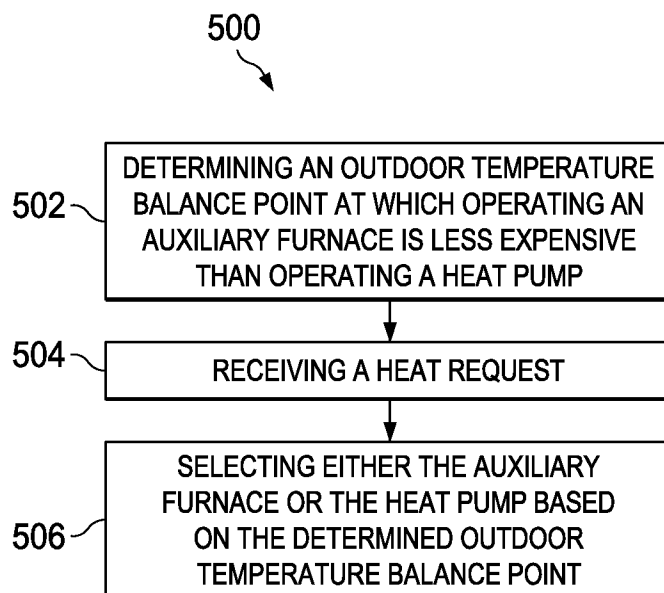


FIG. 5

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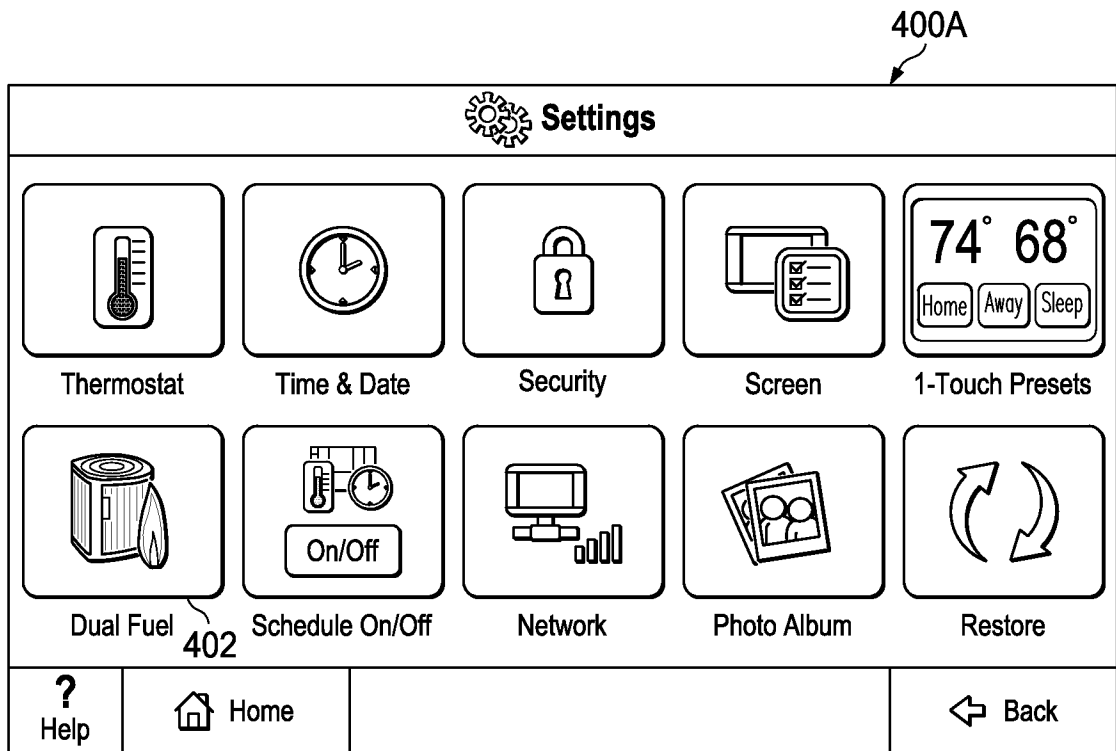


FIG. 4A

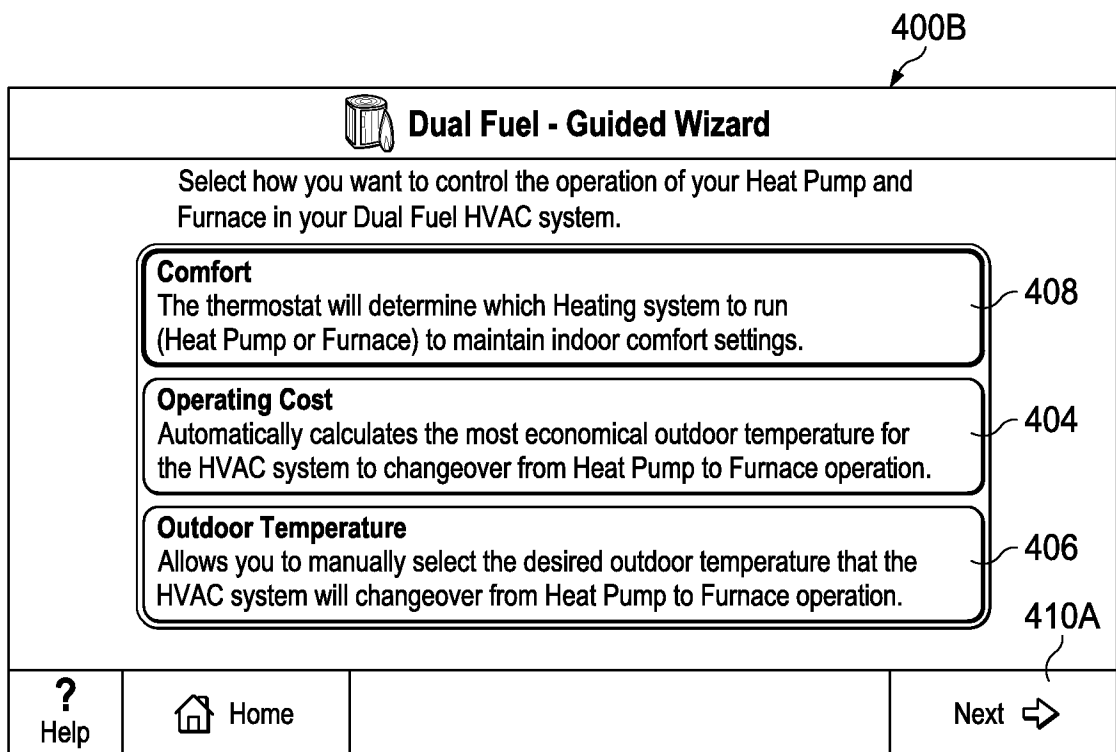


FIG. 4B

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400C

 **Dual Fuel - Guided Wizard**

Select the type of Auxiliary (Back-up) Heat installed

Gas Furnace	<u>412</u>
Oil Furnace	<u>414</u>

416A

410B

? Help

Home

Back

Next

FIG. 4C

400D

 **Dual Fuel - Guided Wizard**

Enter Electricity cost in \$/kwh

418

416B

410C

1

2

3

4

5

6

7

8

9

.

0

? Help

Home

Back

Next

FIG. 4D

5/7

400E

 **Dual Fuel - Guided Wizard**

Enter Natural Gas cost in \$/therm

422

1

2

3

4

5

6

7

8

9

.

0

<

420

Natural Gas
\$/therm

424

Natural Gas
\$/MCF

426

Propane
\$/Gal

416C

410D

? Help

Home

< Back

Next >

FIG. 4E

400F

 **Dual Fuel - Guided Wizard**

Enter Fuel Oil cost in \$/gal

430

1

2

3

4

5

6

7

8

9

.

0

<

428

Fuel Oil
\$/Gal

416D

410E

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FIG. 4F

6/7

400G

 **Dual Fuel - Guided Wizard**

Choose the furnace AFUE rating

AFUE Rating

78

78 - 98

432

416E

410F

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FIG. 4G

400H

 **Dual Fuel - Guided Wizard**

Choose the Heat Pump HSPF rating

HSPF Rating

7.7

7.7 - 12

434

416F

410G

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FIG. 4H

7/7

400I

**Dual Fuel - Guided Wizard**

Furnace heating is more economical below -36 degrees.
Press Accept to use this setting or edit the furnace changeover temperature and then press Accept.

Furnace Heating
Outdoor Temperature

6

0 - 70 F

436

Press Accept to select this temperature 440A

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Cancel

Accept 438A

FIG. 4I

400J

**Dual Fuel - Guided Wizard**

Select the desired Outdoor Temperature that the Heat Pump will Changeover to Furnace operation.
Note: Heat Pump will be restricted from operating at or below this temperature.

Furnace Heating
Outdoor Temperature

40

0 - 70 F

437

Press Accept to select this temperature 440B

?
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Cancel

Accept 438B

FIG. 4J