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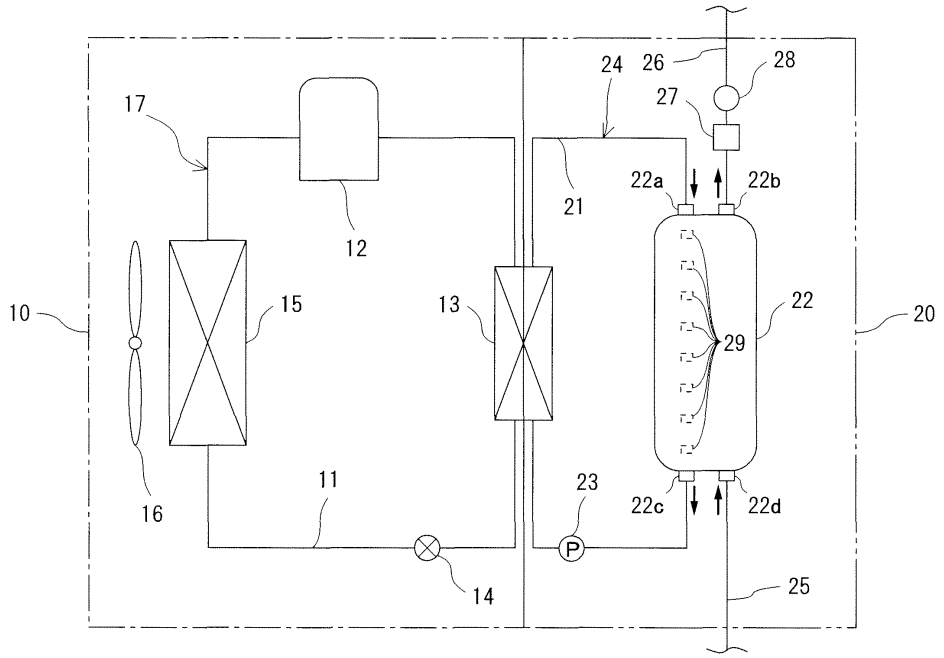
(54) Heat pump type hot water supply apparatus

(57) This heat pump type hot water supply apparatus has a hot water storage tank (22) capable of supplying stored hot water to outside of the tank (22), and a heat pump unit (10) for heating hot water in the hot water storage tank (22) to a set-up temperature (31a) set up beforehand. The hot water supply apparatus newly calculates a set-up temperature so that the energy of hot water in the hot water storage tank (22) becomes equal to a unit period consumption energy calculated based on the energy of hot water supplied to outside of the tank (22) for a past predetermined term. Furthermore, the hot water supply apparatus has the display (46) and speaker (47) for outputting newly calculated set-up temperature based on difference between newly calculated temperature and current set-up temperature (31a).

FIG. 1



EP 2 009 360 A2

Description

[0001] The present invention relates to, for example, an heat pump type hot water supply apparatus which heats hot water in a hot water storage tank to a set-up temperature by a heat pump.

[0002] A generally known electrical hot water device comprises a remote control having a supply start switch for supplying a predetermined amount of hot water in a bath tab. When the supply start switch is operated, if the amount of remaining hot water is less than a predetermined amount and a predetermined period passed from a notice of remaining hot water in the past, this electrical hot water device notice by a sound such as "remaining hot water became short".

[0003] On the other hand, a heat pump type hot water supply apparatus heats hot water stored in a hot water storage tank to a temperature set up beforehand, and said heating is performed during midnight when the cost of electric is cheap. Thus, the heat pump type hot water supply apparatus uses low cost energy. However, for example, since the temperature is too high, when large amount of hot water in the tank remains, energy is not used efficiently. Conversely, since the temperature is too low, when hot water in the tank runs short, it become necessary to heat hot water in the tank again using high cost energy at the time other than midnight. In this case, low cost energy is not used efficiently.

[0004] An object of the present invention is to provide a heat pump type hot water supply apparatus capable of using low cost energy efficiently.

[0005] In order to achieve the above object, in the present invention, a heat pump type hot water supply apparatus is provided with a hot water storage tank capable of supplying stored hot water to outside of the tank, a heat pump unit for heating hot water in the hot water storage tank according to a set-up condition set up beforehand, a calculation means for newly calculating a set-up condition so that an energy of hot water in the hot water storage tank becomes equal to a unit period consumption energy calculated based on an energy of hot water supplied to outside of the tank for a past predetermined term, an output means for outputting said newly calculated set-up condition based on a difference between the newly calculated set-up condition and said set-up condition which is set up beforehand.

[0006] Thus, this heat pump type hot water supply apparatus newly calculates the set-up condition so that the energy of hot water in the hot water storage tank becomes equal to the unit period consumption energy calculated based on the energy of hot water supplied to outside of the tank for a past predetermined term. Also, this heat pump type hot water supply apparatus outputs the newly calculated set-up condition based on the difference between the newly calculated set-up condition and the set-up condition which is set up beforehand. By this, for example, new set up condition is calculated so that the newly calculated energy becomes equal to one day consumption energy calculated based on hot water supplied to outside of the tank for one month. Also, when a difference between newly calculated condition and the condition set up beforehand is not within -5°C to 0°C , newly calculated condition is outputted. By this, in the case in which large amount of hot water remains in the hot water storage tank when hot water in the hot water storage tank is heated to the present set-up temperature, ore in the case in which hot water in the hot water storage tank runs short when hot water in the hot water storage tank is heated to present set-up temperature, the set-up condition, which enable that supplying whole hot water in the hot water storage tank in one day, is informed to users.

[0007] Therefore, users pay attention about whether or not users set up calculated set-up condition as new set-up condition. Also, hot water in the hot water storage tank is heated while midnight when the cost of electric energy is cheap based on calculated set-up condition. By this, low price energy is used efficiently.

[0008] The above and other objects, features, and advantages of the present invention will become more apparent from the following description and the accompanying drawings.

FIG. 1 is a schematic configuration view of a heat pump type hot water supply apparatus in accordance with an embodiment of the present invention;
FIG. 2 is a block diagram showing a control system configuration for the heat pump type hot water supply apparatus shown in FIG. 1;
FIG. 3 is a front view of a remote control shown in FIG. 2; and
FIG. 4 is a flowchart showing an operation for outputting a calculated temperature.

[0009] FIGS. 1 to 4 show an embodiment of the present invention. FIG. 1 is a schematic configuration view of a heat pump type hot water supply apparatus, FIG. 2 is a block diagram showing a control system configuration for the heat pump type hot water supply apparatus shown in FIG. 1, FIG. 3 is a front view of a remote control shown in FIG. 2, and FIG. 4 is a flowchart showing an operation for outputting a calculated temperature.

[0010] First, the configuration of a heat pump type hot water supply apparatus in accordance with one embodiment of the present invention is explained with reference to FIG. 1.

[0011] This heat pump type hot water supply apparatus includes a heat pump unit 10 and a hot water storage unit 20. Also, this heat pump type hot water supply apparatus has a refrigerant circuit 17 formed by connecting a compressor 12, a water heat exchanger 13, a pressure reducing valve 14, and a heat exchanger 15 via a refrigerant pipe 11, and the refrigerant circuit 17 is filled with a refrigerant such as CO_2.

[0012] The compressor 12 having a motor (not shown) as a power source is configured as publicly known so that the number of revolutions thereof is controlled vari-

ably. The compressor 12 pressurizes the refrigerant to circulate the refrigerant in the refrigerant circuit 17.

[0013] The water heat exchanger 13 conducts heat-exchange between the high temperature and pressure refrigerant that is discharged from the compressor 12 and flows in the refrigerant pipe 11 with the hot water flowing in a circulation pipe 21, described later. By this, the water heat exchanger 13 functions as a condenser, so that the hot water flowing in the later-described circulation pipe 21 is heated.

[0014] The pressure reducing valve 14 is a commonly known motor-operated valve, and depressurizes the refrigerant from which heat is absorbed by the water heat exchanger 13 to change the refrigerant into a low-temperature and pressure one.

[0015] The heat exchanger 15 conducts heat-exchange between the refrigerant flowing in from the pressure reducing valve 14 and the outside air introduced by a fan 16. The heat-exchanged refrigerant is sent to the compressor 12 via the refrigerant pipe 11. By this, the heat exchanger 15 functions as an evaporator, so that the refrigerant is heated.

[0016] The hot water storage unit 20 has a circulation circuit 24 formed by connecting a hot water storage tank 22, a circulating pump 23, and the above-described water heat exchanger 13 via the circulation pipe 21. Also, the hot water storage unit 20 includes a water supply pipe 25, a hot water supply pipe 26, a flowmeter 27, a thermometer 28, and temperature sensors 29.

[0017] In the upper part of the hot water storage tank 22, a circulation inlet 22a and a hot water outlet 22b are provided, and in the lower part of the hot water storage tank 22, a circulation outlet 22c and a water inlet 22d are provided. The hot water storage tank 22 is supplied with ordinary-temperature water as necessary from an outside water source (not shown) via the water supply pipe 25 and the water inlet 22d.

[0018] The circulating pump 23 pressurizes the hot water flowing out of the circulation outlet 22c to circulate the hot water in the circulation circuit 24 and allow it to flow into the hot water storage tank 22 through the circulation inlet 22a. By this, the hot water flowing out of the lower part of the hot water storage tank 22 is heated by the water heat exchanger 13 of the heat pump unit 10, and the hot water having a set-up temperature, described later, is stored in the hot water storage tank 22.

[0019] The hot water having the set-up temperature stored in the hot water storage tank 22 is supplied upon request to the outside via the hot water outlet 22b and the hot water supply pipe 26. The flowmeter 27 and the thermometer 28 provided in the hot water supply pipe 26 detect the flow rate and temperature of the hot water flowing out of the hot water outlet 22b, respectively.

[0020] The temperature sensors 29 are installed at equal intervals in the up and down direction in the hot water storage tank 22 to detect the temperatures of hot water in the hot water storage tank 22 at the installation positions thereof. The temperature sensors 29 can detect the amount of hot water having a predetermined temperature and the amount of hot water having the ordinary temperature in the hot water storage tank 22.

[0021] Next, a control system configuration for the heat pump type hot water supply apparatus shown in FIG. 1 is explained with reference to FIGS. 2 and 3.

[0022] As shown in FIG. 2, a control section 30 and a remote control 40 each are formed by a publicly known computer, and this computer has memory such as a CPU, RAM, and ROM. Also, the control section 30 and the remote control 40 exchange control signals and data between the two. In this embodiment, the control section 30 and the remote control 40 each are formed by a computer. However, the present invention is not limited to this configuration. The control section 30 and the remote control 40 can be formed by one computer.

[0023] The control section 30 heats the water in the hot water storage tank 22 to a set-up temperature 31a, described later, that is set up beforehand. The control section 30 is connected with the flowmeter 27, the thermometer 28, the temperature sensors 29, a storage device 31, the compressor 12, the pressure reducing valve 14, the fan 16, and the circulating pump 23. Also, the control section 30 outputs a control signal based on the data inputted from the flowmeter 27, the thermometer 28, and the temperature sensors 29, the later-described set-up temperature 31a stored in the storage device 31, and the program stored in the memory of the control section 30 itself. Also, the control section 30 drives the compressor 12, the pressure reducing valve 14, the fan 16, and the circulating pump 23.

[0024] The storage device 31 is formed by a publicly known mass storage device for storing files, programs, and the like required by the control section 30. As necessary, the control section 30 stores data in the storage device 31, and reads the data stored in the storage device 31.

[0025] The remote control 40 is operated when a user sets up various conditions of the heat pump type hot water supply apparatus. The remote control 40 is connected with an output button 41 for outputting a calculated temperature, selection buttons 42 and 43, a decision button 44, a cancel button 45, a display 46, and a speaker 47.

[0026] As shown in FIG. 3, on a surface panel 40a of the remote control 40, the output button 41, the selection buttons 42 and 43, the decision button 44, and the cancel button 45 are provided in the central lower part thereof, the display 46 is provided in the central upper part thereof, and the speaker 47 is provided on the right-hand side.

[0027] The user operates the selection buttons 42 and 43, the decision button 44, and the cancel button 45 based on the information outputted by the display 46 and the speaker 47, by which a set-up condition, for example, the set-up temperature of hot water in the hot water storage tank 22, which is heated by the heat pump unit 10, can be set up. The remote control 40 sends the set-up temperature data to the control section 30, and the control section 30 stores the sent set-up temperature data in the

storage device 31 as the set-up temperature 31a.

[0028] In this embodiment, the set-up temperature is set up as a set-up condition. However, the present invention is not limited to this configuration. The amount of hot water heated by the heat pump unit 10 or the time for heating can also be set up, or a plurality of set-up conditions can also be set up.

[0029] In this heat pump type hot water supply apparatus, when the amount of hot water having the predetermined temperature in the hot water storage tank 22 becomes a predetermined amount according to the temperature data of the temperature sensors 29 or when the time becomes predetermined time according to the date of calendar function and the time of clock function of the control section 30 itself, the control section 30 reads the set-up temperature 31a stored in the storage device 31, and also starts the compressor 12, the pressure reducing valve 14, the fan 16, and the circulating pump 23, by which the heating of hot water in the hot water storage tank 22 is started. One example of the predetermined time is midnight time when the cost of electric energy is cheap. Thereafter, when the hot water storage tank 22 is filled with the hot water having the set-up temperature 31a stored in the storage device 31 according to the temperature data of the temperature sensors 29, the control section 30 stops the compressor 12, the pressure reducing valve 14, the fan 16, and the circulating pump 23, by which the heating of hot water in the hot water storage tank 22 is finished. By this, the hot water in the hot water storage tank 22 is heated to the set-up temperature 31a by the heat pump unit 10.

[0030] Also, each time the hot water stored in the hot water storage tank 22 is supplied to the outside via the hot water supply pipe 26, the control section 30 calculates the energy, for example, the calorie of hot water supplied to the outside based on the flow rate data of the flowmeter 27, the temperature data of the thermometer 28, and the time of clock function of the control section 30 itself. In a calorie history 31b stored in the storage device 31, the calorie of hot water supplied per one day is stored for the past one week. The control section 30 reads the calorie history 31b from the storage device 31. Also, the control section 30 stores the calculated calorie in the calorie history 31b in the storage device 31 based on the date of calendar function of the control section 30 itself.

[0031] Next, the operation for calculating and outputting the calculated temperature in this embodiment is explained with reference to FIG. 4.

[0032] When the user presses the output button 41 provided on the surface panel 40a of the remote control 40, the remote control 40 sends a control signal to the control section 30, and the control section 30 starts output processing of calculated temperature to output the calculated temperature. Since the calculated temperature is outputted by the user's pressing operation of the output button 41 provided on the surface panel 40a of the remote control 40 as described above, the user can optionally output the calculated set-up condition.

[0033] As shown in FIG. 4, the control section 30 reads the calorie history 31b from the storage device 31, and determines the consumed calorie per one day based on the calorie history 31b (Step S11) .

[0034] In this embodiment, for example, for the past one week, the mean value of the calorie of hot water supplied per one day is calculated based on the calorie history 31b, and this mean value is made a consumed calorie per one day. The present invention is not limited to the case in which the consumed calorie per one day is calculated based on the calorie history 31b. The control section 30 can determine the consumed calorie per one day based on, for example, the outside air temperature data of an outside air thermometer (not shown) and the season data having the transition of air temperature, which is received from an external network (not shown), in addition to the calorie history 31b.

[0035] Next, the control section 30 calculates a set-up temperature (hereinafter referred to as a calculated temperature) based on the capacity of the hot water storage tank 22, which is stored in the memory of the control section 30 itself, so that the calorie of hot water in the hot water storage tank 22 is equal to the consumed calorie per one day, which has been calculated in Step S11 (Step S12). By this, the calculated temperature corresponding to the consumed calorie per one day, which is calculated based on the calorie of hot water supplied from the hot water storage tank 22 to the outside for the past one week, is calculated.

[0036] Next, it is judged whether or not the difference between the calculated temperature and the present set-up temperature 31a stored in the storage device 31 is within a predetermined range (Step S13). The predetermined range is, for example, a temperature range of -5°C to 0°C.

[0037] If the judgment result is that the difference between the calculated temperature and the present set-up temperature 31a is within the temperature range of minus 5°C to 0°C, the control section 30 sends a control signal and data to the remote control 40, and the remote control 40 outputs a massage saying that the present set-up temperature is proper by using an image and a sound using the display 46 and the speaker 47 (Step S14). Thereafter, the control section 30 finishes the output processing of calculated temperature.

[0038] If the judgment result is that the difference between the calculated temperature and the present set-up temperature 31a is not within the temperature range of minus 5°C to 0°C, the control section 30 sends a control signal and calculated temperature data to the remote control 40, and the remote control 40 outputs the calculated temperature by using an image and a sound using the display 46 and the speaker 47 (Step S15). By this, in the case in which much hot water remains in the hot water storage tank 22 when the hot water in the hot water storage tank 22 is heated to the present set-up temperature 31a or in the case in which the hot water in the hot water storage tank 22 runs short when the hot water in the hot

water storage tank 22 is heated to the present set-up temperature 31a, the user is informed of the set-up temperature such that the whole of hot water in the hot water storage tank 22 is supplied in one day.

[0039] In this embodiment, the calculated temperature is outputted by using both of an image and a sound. However, the calculated temperature can also be outputted by using either one of an image and a sound.

[0040] At the same time, the remote control 40 outputs a message for asking whether or not the calculated temperature is set up as a new set-up temperature by using an image and a sound using the display 46 and the speaker 47 (Step S16).

[0041] Next, when the user operates the selection buttons 42 and 43, the decision button 44, and the cancel button 45, the remote control 40 judges whether or not the user sets up the calculated temperature as a new set-up temperature (Step S17).

[0042] If the judgment result is that the user sets up the calculated temperature as a new set-up temperature, the remote control 40 sends a control signal to the control section 30, and the control section 30 sets up a new set-up temperature 31a in the storage device 31 (Step S18). Since the calculated temperature is set up as the new set-up temperature 31a by the user's operation of the selection buttons 42 and 43, the decision button 44, and the cancel button 45 as described above, the user can optionally set up a calculated set-up condition as a new set-up temperature.

[0043] If the judgment result is that the user does not set up the calculated temperature as a new set-up temperature, the control section 30 does nothing and finishes the output processing of calculated temperature.

[0044] In this embodiment, the set-up temperature is used as a set-up condition, and the calculated temperature corresponding to the consumed calorie per one day is calculated, so that the calculated temperature can be set up as the new set-up temperature 31a. However, in the case in which the set-up temperature 31a set up newly is close to the upper limit of temperature capable of being set up, the heating efficiency of the heat pump unit 10 goes down. In this case, therefore, for example, the set-up amount of hot water and the set-up time are used as set-up conditions, and the hot water in the hot water storage tank 22 is heated a plurality of times per one day, by which the restriction of capacity of the hot water storage tank 22 can also be avoided. In this case, the amount of hot water in the hot water storage tank 22 and the time for heating are calculated.

[0045] As described above, according to the present invention, the calculated temperature corresponding to the consumed calorie per one day, which is calculated based on the calorie of hot water supplied from the hot water storage tank 22 to the outside for the past one week, is calculated. Also, in the case in which the difference between the calculated temperature and the present set-up temperature 31a is not within the range of -5°C to 0°C, the calculated temperature is outputted. Therefore, in the case where much hot water remains in the hot water storage tank 22 when the hot water in the hot water storage tank 22 is heated to the present set-up temperature 31a or in the case where the hot water in the hot water storage tank 22 runs short when the hot water in the hot water storage tank 22 is heated to the present set-up temperature 31a, the user is informed of the set-up temperature such that the whole of hot water in the hot water storage tank 22 is supplied in one day. Therefore, the user pays attention to whether or not the user sets up the calculated set-up condition as a new set-up condition. Also, the hot water in the hot water storage tank 22 is heated during midnight when the cost of electric energy is cheap based on the calculated set-up condition, so that a low-price energy is used efficiently.

[0046] When the user presses the output button 41 on the surface panel 40a of the remote control 40, the calculated temperature is outputted. By this, the user can optionally output the calculated set-up condition.

[0047] Further, when the user operates the selection buttons 42 and 43, the decision button 44, and the cancel button 45, the calculated temperature is set up as the new set-up temperature 31a. Since the user can optionally set up the calculated set-up condition as the new set-up condition, the user can set up a proper set-up temperature easily, so that the user can use low-price energy more easily.

[0048] Further, since the calculated temperature is outputted by at least one of an image and a sound, the user can recognize the calculated set-up condition easily, so that the user's attention can be excited easily.

[0049] The preferred embodiments described in this specification are illustrative and not restrictive. The scope of invention is given by the appended claims, and all changes and modifications included in the meaning of claims are embraced in the present invention.

Claims

1. A heat pump type hot water supply apparatus comprising:

a hot water storage tank (22) capable of supplying stored hot water to outside of the tank;
a heat pump unit (10) for heating hot water in the hot water storage tank (22) according to a set-up condition (31a) set up beforehand;
a calculation means for newly calculating a set-up condition so that an energy of hot water in the hot water storage tank (22) becomes equal to a unit period consumption energy calculated based on an energy of hot water supplied to outside of the tank (22) for a past predetermined term;
an output means for outputting said newly calculated set-up condition based on a difference between the newly calculated set-up condition

and said set-up condition (31a) which is set up beforehand.

2. The heat pump type hot water supply apparatus according to claim 1, further comprising:

a remote control (40) comprises an output control part (41) which is provided for outputting said newly calculated set-up condition.

3. The heat pump type hot water supply apparatus according to claim 2, wherein
the remote control (40) has a set-up means which sets up the newly calculated condition as a new set-up condition.

4. The heat pump type hot water supply apparatus according to any one of claims 1 to 3, wherein
the output means outputs said newly calculated set-up condition by using at least one of a image and a sound.

5. The heat pump type hot water supply apparatus according to any one of claims 1 to 4, wherein
the set-up condition includes at least one of temperature of hot water, time for heating, and the amount of hot water.

FIG. 1

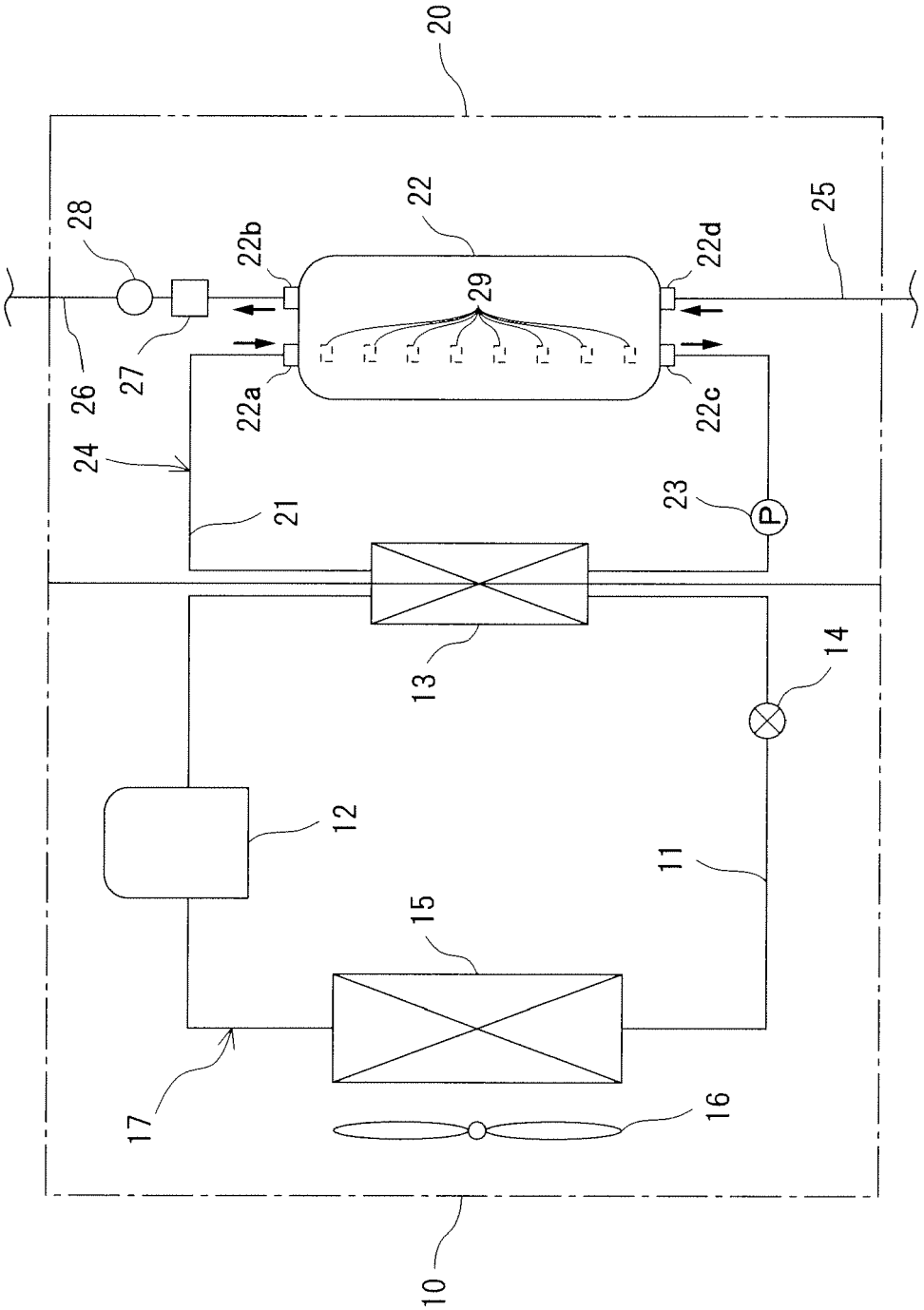


FIG. 2

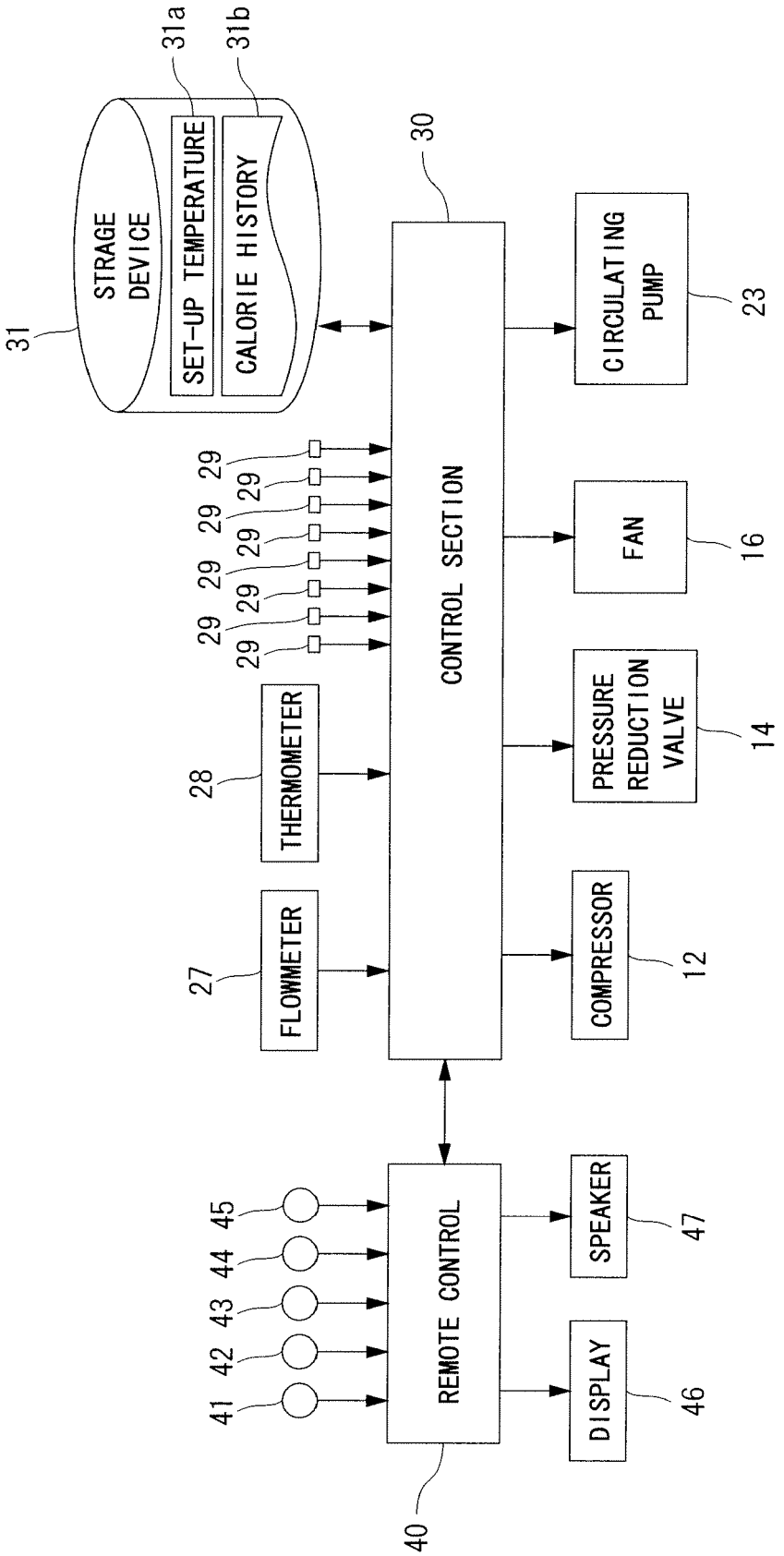

STRAGE DEVICE
SET-UP TEMPERATURE
CALORIE HISTORY
31
31a
31b
30
CONTROL SECTION
CIRCULATING PUMP
23
FAN
16
PRESSURE REDUCTION VALVE
14
COMPRESSOR
12
THERMOMETER
28
FLOWMETER
27
29
REMOTE CONTROL
40
41
42
43
44
45
SPEAKER
47
DISPLAY
46

FIG. 3

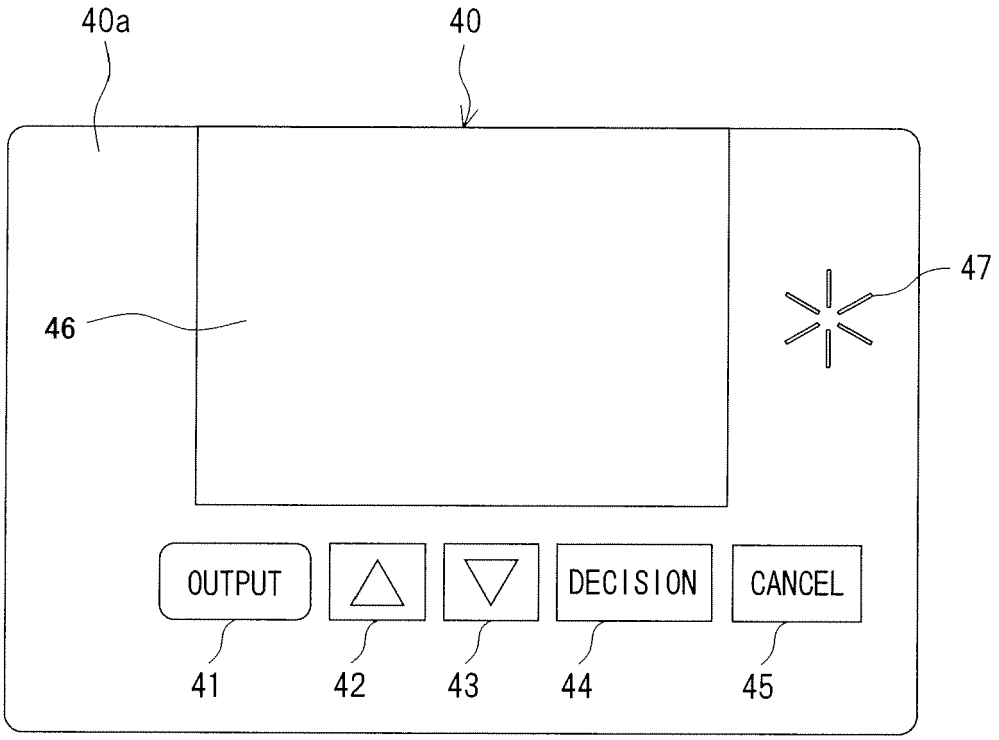
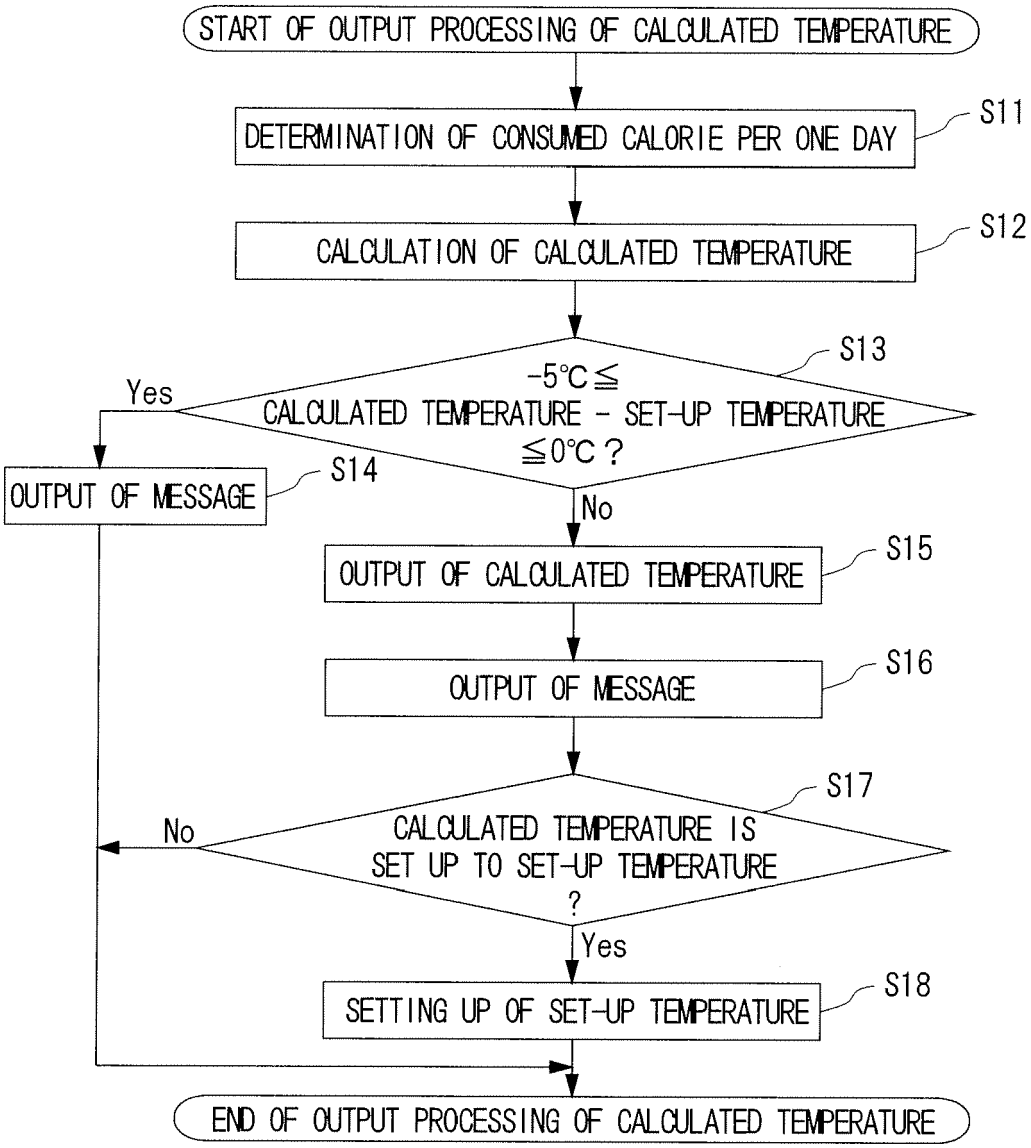


FIG. 4


START OF OUTPUT PROCESSING OF CALCULATED TEMPERATURE
DETERMINATION OF CONSUMED CALORIE PER ONE DAY
S11
CALCULATION OF CALCULATED TEMPERATURE
S12
-5℃≦
CALCULATED TEMPERATURE - SET-UP TEMPERATURE
≦0℃?
S13
Yes
No
OUTPUT OF MESSAGE
S14
OUTPUT OF CALCULATED TEMPERATURE
S15
OUTPUT OF MESSAGE
S16
CALCULATED TEMPERATURE IS
SET UP TO SET-UP TEMPERATURE
?
S17
No
Yes
SETTING UP OF SET-UP TEMPERATURE
S18
END OF OUTPUT PROCESSING OF CALCULATED TEMPERATURE