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(54) Title: CENTRAL-HEATING SYSTEM

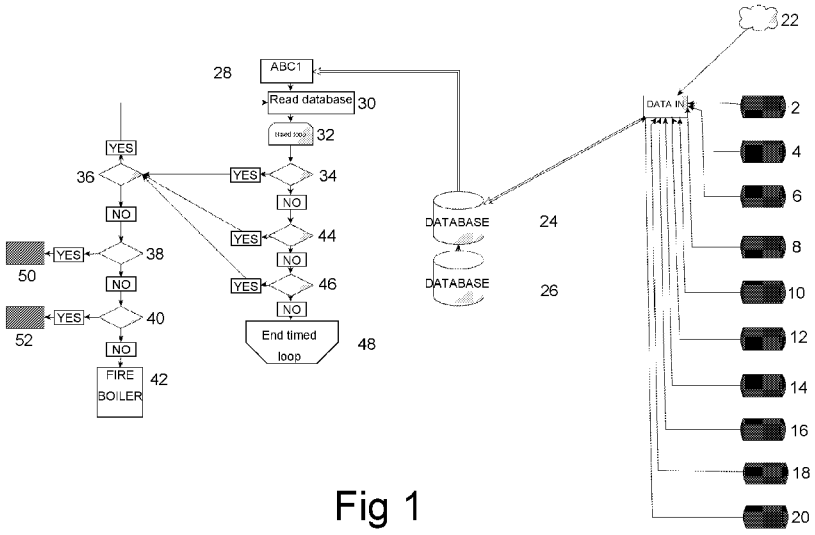


Fig 1

(57) Abstract: A central-heating system offers a budget mode, in which the user can set a heating budget and the system determines from the temperatures and heating periods chosen whether the budget can be met, and an eco mode which seeks to shut off the heat source in advance of the target temperature being met, to allow for residual heat in the system continuing to increase the temperature.

WO 2016/005745 A1

CENTRAL-HEATING SYSTEM

Field of the Invention

This invention relates to a central-heating system providing one or more of an eco mode and a budget mode.

Background to the Invention

A typical central-heating system has a water heater, commonly referred to in the UK as the boiler, supplying hot water through a pumped circuit to a plurality of space-heating radiators (heat exchangers) and to a coil heating a hot water storage cylinder. It has a controller which is configured to control the periods of time for which the boiler is operable, and to monitor temperature via a pre-set thermostat and control the operation of the pump so that when the desired room temperature is attained, the pump is stopped, thereby reducing demand on the boiler. A separate thermostat monitors the stored water temperature in the cylinder to control separately the supply of hot-water from the boiler to the coil, for example by means of a controllable valve selectively diverting the pump flow to the cylinder coil and/or to the radiators. Additional features may be provided, for example a setting shutting down the system for holidays, but with an over-ride to re-start the system if an interior temperature low enough to risk freezing of water is detected. On return to the building after a period away, the user has to switch to the normal operating mode, which means that there can be a delay while the temperature returns to the desired value.

With fuel prices ever increasing, the need for maximum efficiency of operation becomes increasingly important. One problem with conventional central-heating systems of the type described is that the thermostatic control achieved is very imprecise; when the set temperature is detected by the thermostat, the pump is stopped, but the body of hot water in the system means that heat continues to be emitted by the radiators, so that the room temperature can continue to rise to a peak above the set temperature. With modern condensing boilers, for maximum efficiency the water returning to the boiler after circulation through the radiators or the cylinder coil needs to be at or below the dew point of water (55°C). This is typically achieved by trial and error

adjustment of the outgoing water temperature, and it is thus difficult to ensure that the boiler does achieve maximum efficiency consistently.

It is also difficult for a user to predict the likely cost implications of any heat settings, and thus budgeting is typically a matter of trial and error, with error potentially having a damaging effect on a family budget.

Summary of the Invention

According to the invention, there is provided a central-heating system for heating an enclosed space, comprising:

a fuel-burning heat source;

means for distributing heat from the heat source to the enclosed space;

a programmable controller having data inputs connected to:

at least one air-temperature sensor within the enclosed space;

at least one air-temperature sensor externally of the enclosed space;

means for measuring the consumption of fuel by the heat source;

the programmable controller also being connected to a data storage device, a display means and a data input device, and being programmed to store in the data storage data relating to fuel consumption measurements in relation to external and internal temperature measurements for a period of normal operation of the system prior to operation of a budget mode, and then to be operable in the budget mode to:

receive via the data input device data relating to predicted external temperatures for a predetermined period, fuel unit costs, desired internal temperature and a user cost budget for said predetermined period; and

operate the system for the predetermined period in such a manner as to keep actual fuel costs within said cost budget.

The invention also provides a central-heating system for heating an enclosed space, comprising:

a fuel-burning heat source;

means for distributing heat from the heat source to the enclosed space;

a programmable controller having data inputs connected to:

at least one air-temperature sensor within the enclosed space;

at least one air-temperature sensor externally of the enclosed space;

the programmable controller also being connected to a data storage device, a display means and a data input device, and being programmed to receive from the data input device a target temperature set by a user for the enclosed space to be achieved in one or more pre-set operating periods and then to store in the data storage data relating to operation of the heat source in relation to temperature within and external to the enclosed space, and then to be operable in an eco mode to:

a) monitor the temperature sensed by the or each air-temperature sensor, stop operation of the heat source when the monitored temperature within the enclosed space exceeds a pre-programmed offset below the target temperature and re-start operation of the heat source when the monitored temperature falls below the offset; and

b) determine from the stored data and the temperatures measured by the temperature sensors whether the heat source is likely to achieve the target temperature within the current operating period and if not to cease operation of the eco mode.

The programmable controller is preferably further programmed to receive via the data input device data relating to predicted external temperatures for a predetermined period, and to employ these data in determining whether the heat source is likely to achieve the target temperature within the current operating period.

The programmable controller is more preferably further programmed to apply pre-determined adjustments to the target temperature and/or the operating periods if the budget is not likely to be met and to determine whether these adjustments will enable the budget to be met if applied.

Other features of the invention are set out in the claims.

Brief Description of the Drawings

In the drawings, which are operational flow diagrams illustrating one exemplary embodiment of the invention:

Figure 1 shows the main system;

Figure 2 shows the eco mode of the system; and

Figure 3 shows the budget mode of the system.

Detailed Description of the Illustrated Embodiment

Referring first to Figure 1, the system, which includes a gas-fired water heater or boiler, has a plurality of data inputs, illustrated diagrammatically on the right-hand side of the Figure, as follows:

Gas Flow Sensor Data 2;

Boiler return water temperature 4;

Boiler flow temperature 6;

Hot water storage cylinder top temperature 8;

Hot water storage cylinder middle temperature 10;

Hot water storage cylinder lower temperature 12;

Outside air temperature 14;

Inside air temperature 16;

Outside relative humidity 18;

Inside relative humidity 20.

It is also provided with weather forecast data via an internet connection 22. The data is stored in database area 24, while operating periods and target or demand temperatures, entered by the user through a user interface (Figure 3), are stored in database area 26. The database storage areas are linked to a programmable controller 28.

The basic main control steps are shown in the left-hand side of Figure 1. The programmable controller 28 reads the operating periods and demand temperatures from the database at 30 and starts a timed loop at 32. The first step 34 in the loop is to determine whether there is a programmed operating period current for the current time. If there is, step 36 is to determine whether the demand temperature is met, i.e. whether the internal temperature sensor input at 14 is at or greater than the demand temperature. If it is, the control returns to step 30. If it is not, it passes to step 38, which determines whether eco mode is enabled. If it is set, then control passes to the eco module as described hereinafter with reference to Figure 2. If eco mode is not enabled, it

passes to step 40, which determines whether budget mode is set. If it is, control is passed to the budget module as described hereinafter with reference to Figure 3. If budget mode is not set, a signal is passed to enable the boiler 42 to operate.

Returning to the timed loop, additional conventional settings are provided for by step 44 which determines whether a boost setting has been selected to give a short-term boost of temperature. If this has been set, the control passes back to step 36, but if not, step 46 operates to determine whether an override has been set, in effect switching off the normal control cycle. If this has been set, control passes back to step 36. If not, the timed loop ends at step 48.

Referring now to Figure 2, the eco module, entered at step 50, first retrieves at step 200 the operating period and demand temperature data from area 26 of the database and then at step 202 weather and temperature data from area 24 of the database. The database also includes an area 204 which stores the boiler firing data, i.e. duration and timing of gas flow from the gas flow sensor input 2 (Figure 1) as well as related boiler data from inputs 4-12. These data are retrieved by the programmable controller at step 206. The first programming step 208 determines whether the outside temperature is greater than the demand temperature. If it is, a command is sent to turn off the boiler 42. If not, step 210 determines from the weather data whether the outside temperature is increasing. If it is, step 212 determines whether the outside temperature is within 4 degrees of the demand temperature. If it is, again a command is sent to the boiler 42 to turn it off. If it is not, the program passes to step 214, which determines whether the internal temperature is within 2.5 degrees of the demand temperature. If it is, a command is sent to turn off the boiler 42. If it is not processing step 216 calculates from the boiler firing history related to external and internal recorded temperatures whether the boiler is likely to achieve the demand temperature in the enclosed space during the remaining part of the current operating period. If the prediction is that it will, control is looped back to step 214, whereas if the prediction is that it will not, the eco mode is exited at step 218, returning control to the normal mode described with reference to Figure 1.

The budget module is illustrated by Figure 30 and is entered at step 52. At step 302, the demand temperatures and weather forecast are retrieved from database areas 24 and 26 and the daily heat requirements are calculated from them. The user has previously entered a heating budget into the system via the interface 304, for example a touch pad display or display and keyboard or keypad. This is stored in database area 306, and is retrieved at step 308,, to enable the controller to calculate a daily spend available based on the daily heat requirements calculated in step 302. In step 310 the gas flow history is retrieved from database area 204 to calculate the gas flow per degree rise in internal temperature, and this is used in step 312 to calculate the expected daily cost. Step 314 tests whether the budget entered by the user will succeed, by comparing the daily spend with the budgeted daily spend. If it is not in excess, step 316 displays a message on the display 304 that the budget is acceptable and a signal to the operate controller 318 to permit normal operation of the system in accordance with the pre-set temperatures and operating periods.

If the result of step 314 is that the cost is greater than the budget, step 320 tests whether the shortfall is greater than a pre-programmed margin. If it is, step 322 displays a message on the display 304 that it is not possible to provide adequate heating on that budget, inviting the user to amend the entries. If the result of step 322 is that the shortfall is within the margin, step 324 applies a predetermined reduction of the selected operating periods and step 326 determines whether this would enable the budget to be met. If the budget could be met by the time period reductions, step 328 sends a message to display 304 to this effect and instructs the operate controller 318 accordingly. If the time adjustments do not permit the budget to be met, step 330 then applies a predetermined reduction to the target or demand temperature or temperatures during the pre-set operating periods and step 332 determines whether this change will enable the budget to be met. If it will, step 334 instructs the operate controller 318 and displays a message showing the reduced times and temperatures on the display 304. If it will not, then step 336 applies greater time and temperature reductions to pre-set values chosen by the user, step 338 then testing whether these will enable the budget to be met. If it will, the

operate controller 318 is instructed accordingly and a message is displayed to the user on display 304. If it will not, a message is displayed on the display 304 informing the user that the budget cannot be met and inviting the user to make further adjustments to the budget or the settings.

5

CLAIMS

1. A central-heating system for heating an enclosed space, comprising:

a fuel-burning heat source;

means for distributing heat from the heat source to the enclosed space;

a programmable controller having data inputs connected to:

at least one air-temperature sensor within the enclosed space;

at least one air-temperature sensor externally of the enclosed space;

the programmable controller also being connected to a data storage device, a display means and a data input device, and being programmed to receive from the data input device a target temperature set by a user for the enclosed space to be achieved in one or more pre-set operating periods and then to store in the data storage data relating to operation of the heat source in relation to temperature within and external to the enclosed space, and then to be operable in an eco mode to:

a) monitor the temperature sensed by the or each air-temperature sensor, stop operation of the heat source when the monitored temperature within the enclosed space exceeds a pre-programmed offset below the target temperature and re-start operation of the heat source when the monitored temperature falls below the offset; and

b) determine from the stored data and the temperatures measured by the temperature sensors whether the heat source is likely to achieve the target temperature within the current operating period and if not to cease operation of the eco mode.

2. A central-heating system according to Claim 1, wherein the programmable controller is further programmed to receive via the data input device data relating to predicted external temperatures for a predetermined period, and to employ these data in determining whether the heat source is likely to achieve the target temperature within the current operating period.

3. A central-heating system according to Claim 1 or 2, wherein the programmable controller is further programmed to apply pre-determined adjustments to the target temperature and/or the operating periods if the budget is not likely to be met and to determine whether these adjustments will enable the budget to be met if applied.

4. A central-heating system according to Claim 1, 2 or 3, further comprising means for measuring the consumption of fuel by the heat source;

the programmable controller also being programmed to store in the data storage data relating to fuel consumption measurements in relation to external and internal temperature measurements for a period of normal operation of the system prior to operation of a budget mode, and then to be operable in the budget mode to:

receive via the data input device data relating to predicted external temperatures for a predetermined period, fuel unit costs, desired internal temperature and a user cost budget for said predetermined period; and

operate the system for the predetermined period in such a manner as to keep actual fuel costs within said cost budget.

5. A central-heating system for heating an enclosed space, comprising:

a fuel-burning heat source;

means for distributing heat from the heat source to the enclosed space;

a programmable controller having data inputs connected to:

at least one air-temperature sensor within the enclosed space;

at least one air-temperature sensor externally of the enclosed space;

means for measuring the consumption of fuel by the heat source;

the programmable controller also being connected to a data storage device, a display means and a data input device, and being programmed to store in the data storage data relating to fuel consumption measurements in relation to external and internal temperature measurements for a period of normal operation of the system prior to operation of a budget mode, and then to be operable in the budget mode to:

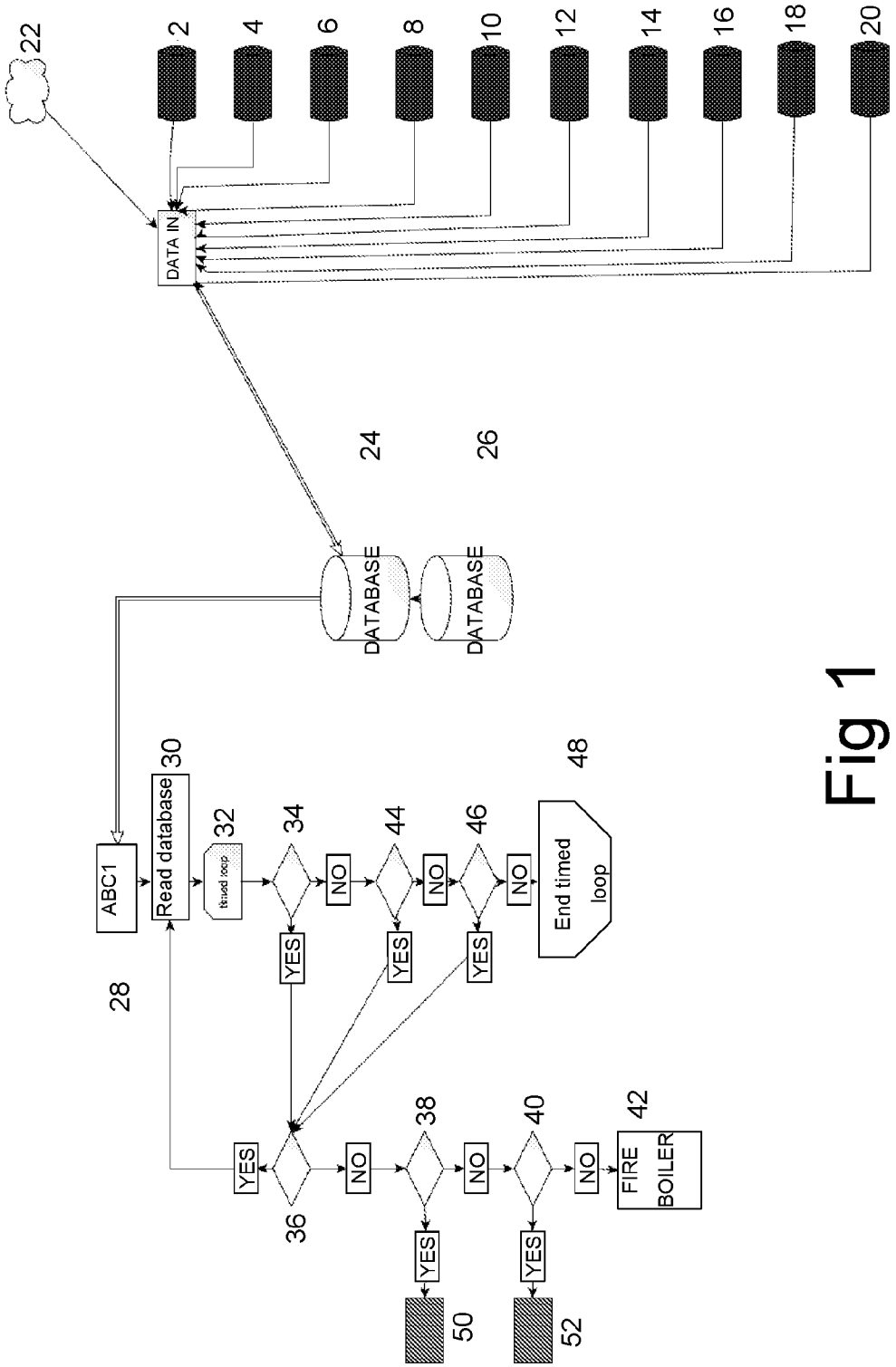
receive via the data input device data relating to predicted external temperatures for a predetermined period, fuel unit costs, desired internal temperature and a user cost budget for said predetermined period; and

operate the system for the predetermined period in such a manner as to keep actual fuel costs within said cost budget.

6. A central-heating system according to any preceding claim, wherein the heat source is a water heater and the means for distributing heat comprises a pump for circulating water heated by the heater through a plurality of heat exchangers distributed around an enclosed space to be heated.

7. A central-heating system according to any preceding claim, wherein the heat source is configured to burn gas.

8. A central-heating system, substantially as described with reference to the drawings.


22
2
4
6
8
10
12
14
16
18
20
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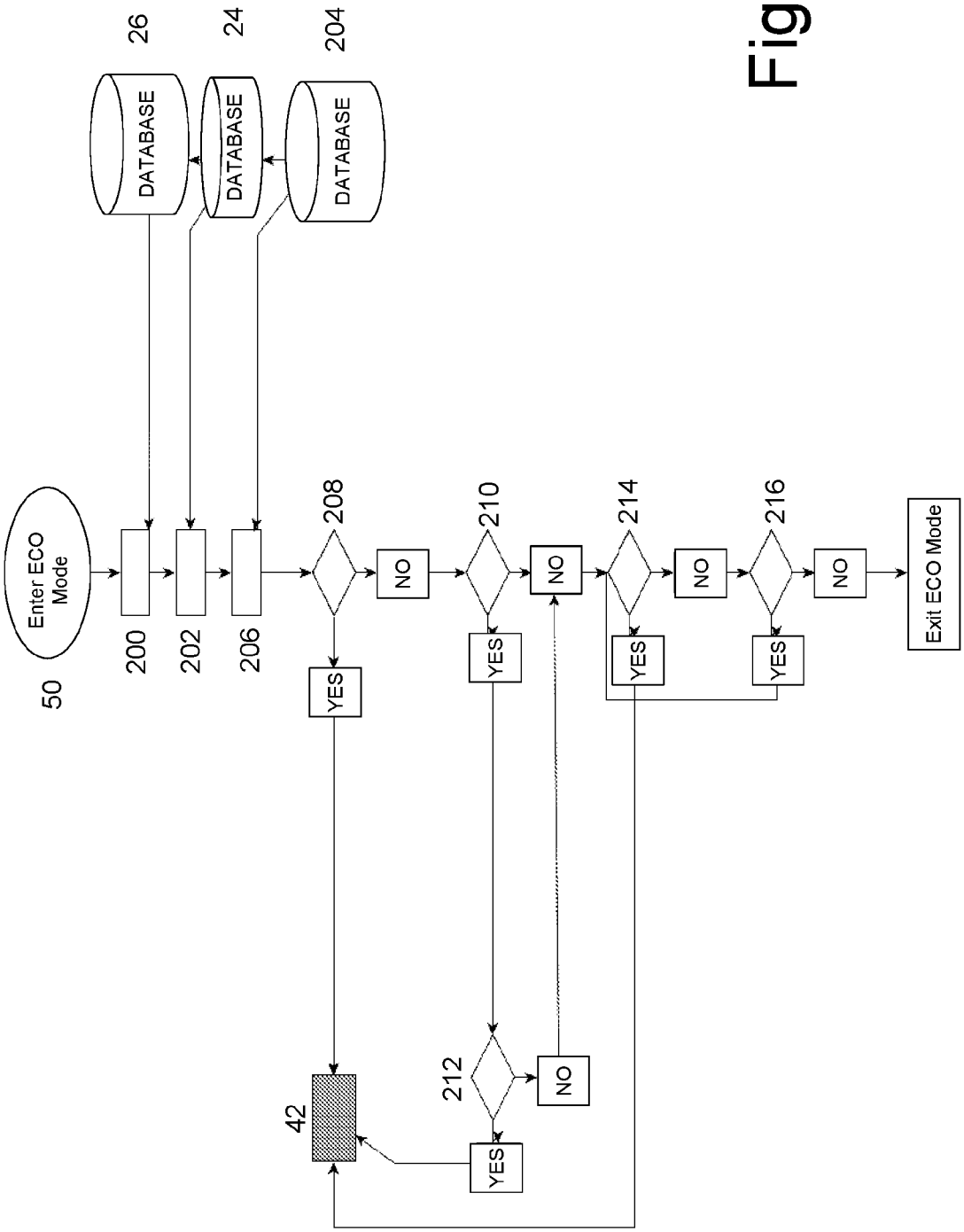
24
26
DATABASE
DATABASE
28
ABC1
30
Read database
32
timed loop
34
NO
44
NO
46
NO
48
End timed loop
YES
YES
YES
36
YES
NO
38
NO
40
NO
42
FIRE BOILER
YES
YES
50
52

Fig 1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206
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42
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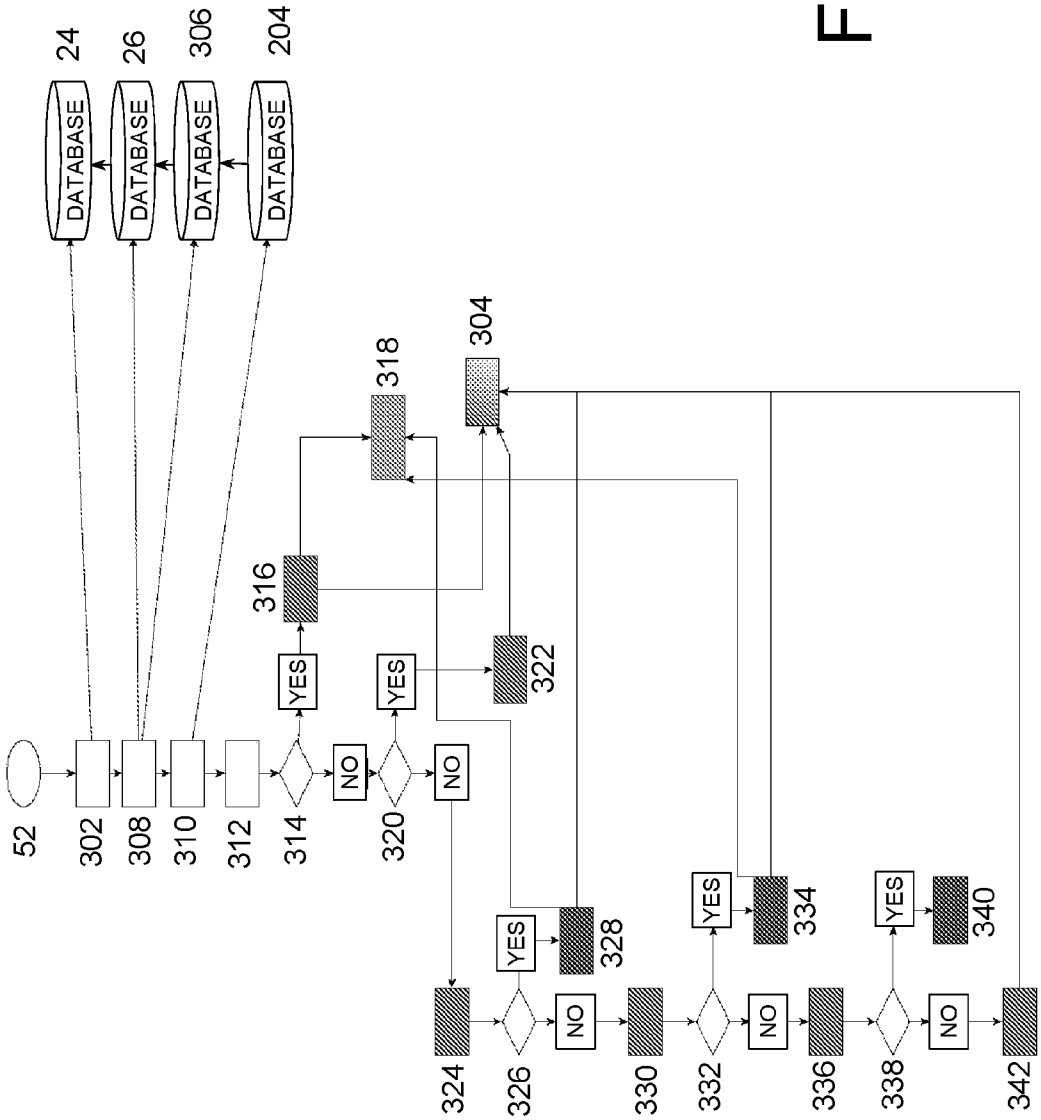
YES

Fig 2

Fig 3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314
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320
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328
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334
YES
340
YES
324
326
NO
330
332
NO
336
338
NO
342

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2015/051976

A. CLASSIFICATION OF SUBJECT MATTER
INV. F24D19/10 G05D23/19
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F24D G05D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013/338835 A1 (PEPE CHRISTOPHER MARK [US]) 19 December 2013 (2013-12-19)	1,3-8
Y	paragraph [0095]; figures 11a,4 paragraph [0122] - paragraph [0154]; figure 15b	2

Y	JP 2011 247513 A (MITSUBISHI ELECTRIC CORP) 8 December 2011 (2011-12-08) abstract	2

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
1 October 2015	14/10/2015

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013338835 A1	19-12-2013	US 2013338835 A1	19-12-2013
		WO 2013188440 A1	19-12-2013
JP 2011247513 A	08-12-2011	JP 5121882 B2	16-01-2013
		JP 2011247513 A	08-12-2011