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(54) **Arrangement in heat-accumulating fireplace**

(57) The invention relates to an arrangement in a heat-accumulating fireplace, the arrangement comprising a measuring device (1) adapted to react to temperature changes, arranged into the heat-accumulating structure of the fireplace, and intended to control the use of the fireplace. For the purpose of facilitating an efficient use of the fireplace, the arrangement comprises an elec-

tric calculation unit (2) coupled to a display unit (3) arranged to provide data showing the heat accumulation status of the fireplace in response to temperature changes detected by the measuring device (1) and to inform the user of the fireplace that the fireplace has reached maximum and correct heat accumulation and that there is a risk of overheating the fireplace if fuel is added.

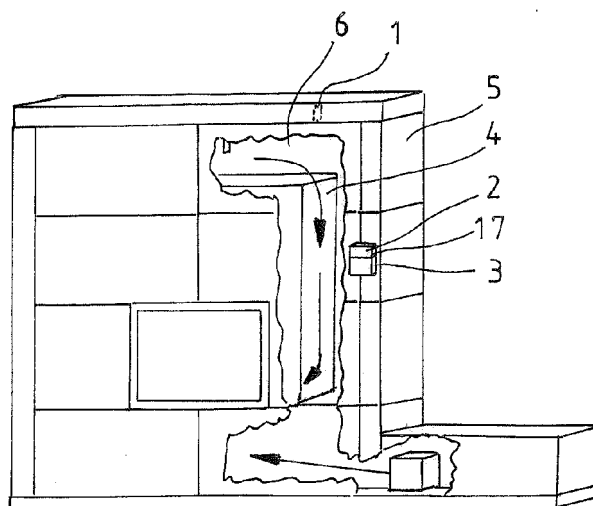


FIG. 1

Description

Background of the invention

[0001] The invention relates to an arrangement in a heat-accumulating fireplace, the arrangement comprising a measuring device adapted to react to temperature changes, arranged into the heat-accumulating wall structure of the fireplace, and intended to control the use of the fireplace.

[0002] Publication AT 390832 discloses an arrangement of this type comprising a temperature sensor adapted to adjust the amount of combustion air entering the fireplace. The purpose of the arrangement is to close air supply automatically when a predetermined temperature has been reached in the fireplace. Air supply is closed on the presumption that said predetermined temperature is only reached after a predetermined amount of fuel has nearly burned out. A problem with this prior-art arrangement is that when adding fuel more than said predetermined amount, air supply needs to be opened either manually or by other means. Thus, overheating the fireplace is possible in this arrangement. If air supply is not opened, there is a risk of carbon monoxide poisoning.

Brief description of the invention

[0003] The object of the invention is to provide a novel arrangement for the use of a heat-accumulating fireplace, which arrangement facilitates the use of the fireplace and makes the use of the fireplace more energy efficient. With the arrangement, it is also possible to avoid overheating the fireplace and the thus caused early damaging of the fireplace.

[0004] To achieve this, the invention is characterised in that the arrangement comprises an electric calculation unit coupled to a display unit arranged to provide data showing the heat accumulation status of the fireplace in response to temperature changes detected by a measuring device and to inform the user of the fireplace, when the fireplace has reached maximum and correct heat accumulation, that there is a risk of overheating the fireplace if fuel is added.

[0005] The heat-accumulating structure preferably comprises a massive heat-accumulating inner structure and a separate outer shell structure, to which the measuring device is arranged. Mounting the measuring device in said location is easy. Even though the measuring device is mounted in the outer shell structure, it reacts quite quickly to temperature changes of the inner structure. The solution indicates the risk of overheating of the inner structures of the fireplace even if temperature changes are monitored in a location of the fireplace not subject to high heat loads. Since the measuring device is mounted in the outer shell structure, it reacts to the temperature surrounding the fireplace - especially if the outer shell structure is separate and at a distance from the inner structure - and the system can be used to show a rec-

ommended re-heating time. Between the outer shell structure and inner structure, there is preferably an air gap, whereby the measuring device mounted in the outer shell is quite quickly able to react to temperature changes in the inner structure. Preferably, the air gap does not have any insulating material, because this would greatly slow down and hamper the ability of the measuring device to react to the temperature changes in the inner structure.

[0006] Preferred embodiments of the invention are disclosed in the attached claims 2 to 15.

[0007] The arrangement of the invention provides the advantage that it greatly facilitates the use of the fireplace, which is why no experience is required of a user to achieve maximum accumulation to the fireplace without the risk of overheating it in such a manner that its durability would suffer.

Brief description of the figures

[0008] In the following, the invention will be described in more detail with reference to a preferred embodiment and attached drawing, in which

Figure 1 shows an arrangement of the invention, Figure 2 shows an enlarged detail of Figure 1, Figure 3 shows a temperature curve of a heat-accumulating structure of a fireplace as a function of time, Figure 4 shows a component of the arrangement of Figure 1, Figure 5 illustrates the operation of the arrangement of Figure 1, and Figure 6 shows a way of defining the temperature set value T1sv mentioned in Figure 5.

Detailed description of the invention

[0009] Figure 1 shows an arrangement according to the invention, comprising a heat-accumulating fireplace having a measuring device 1 and calculation unit 2 coupled to a display unit 3 arranged thereto, the display unit being arranged to display the heat accumulation status of the fireplace. The term measuring device does not in itself include the calculation unit and/or display unit.

[0010] The fireplace comprises a massive stone structure that forms a heat-accumulating mass. The stone structure comprises a massive inner stone structure 4 and a surrounding outer shell structure 5. The outer shell structure 5 is separate and at a distance from the inner stone structure 4. The double-layer structure of the fireplace is presented in Figure 1 that shows a partly open fireplace and in Figure 2 that shows a detail of the opened fireplace.

[0011] The measuring device 1 is a temperature sensor that is arranged in the outer shell structure 5 and measures the temperature Tmv of the outer shell structure 5. Because the temperature of the outer shell of the fireplace varies depending on which part of the outer shell

is monitored, the measuring device 1 provides information on the outer shell temperature only in the location where the measuring device is installed. Due to the fact that at the location of the measuring device 1, between the outer shell structure 5 and inner stone structure 4, there is no insulation material, such as wool which is usually installed between the outer and inner shells of fireplaces having an double-layer structure, the measuring device easily reacts to temperature changes in the inner stone structure 4. This makes it possible that by measuring and monitoring the temperature Tmv of the outer stone structure 5, quite reliable information is also obtained of the amount of heat in the inner stone structure 4. Thus, by measuring the temperature of the outer stone structure 5, fairly reliable information is obtained of the heat accumulation status of the fireplace, that is, of the amount of heat therein. In the arrangement of Figure 1, there is a smoke flue 6 between the inner stone structure 4 and outer stone structure 5. The outer shell structure 5 is at a distance D from the inner stone structure 4. The distance D is preferably 10 to 100 mm.

[0012] Figure 3 shows a temperature curve of a successfully accumulated fireplace, that is, of a heat-accumulating structure of a correctly heated and almost fully accumulated fireplace, as a function of time. The temperature curve has been obtained by measuring the temperature Tmv of the outer stone structure 5 as a function of time. The temperature curve drawn with a uniform line has been obtained by heating the fireplace according to the instructions from the display unit 3.

[0013] Figure 4 shows the display unit 3 of Figure 1 in more detail. The display unit 3 indicates with graphical data the heat accumulation status of the fireplace, that is, the amount of heat therein. The display unit 3 is controlled by the calculation unit 2 that in turn is arranged to obtain data on the measuring results of the measuring device 1.

[0014] The graphical data is implemented by means of eight symbols 7 that may alternatively be light or dark depending on the temperature measured by the measuring device 1, which thus correlates with the heat accumulation status of the fireplace. If the temperature Tmv measured by the measuring device 1 is 20°C, all symbols 7 are light. If the temperature Tmv measured by the measuring device 1 is 30°C, one symbol 7 is dark; if the measured temperature Tmv is 40°C, two symbols are dark, etc. In the case of Figure 4, four symbols are dark, so the temperature Tmv measured from the fireplace is at least 60°C, but below 70°C, because the fifth symbol is not dark. If all eight symbols 7 are dark, a temperature of at least 100°C has been measured from the fireplace.

[0015] Figure 5 shows the operation of the arrangement. In the arrangement of Figure 5, temperature is measured continuously in each stage. The calculation unit 2 of Figure 1 is programmed to display in a field 9, or instruction field, of the display unit 3 "DO NOT ADD WOOD," if the measuring device 1 measures a temperature Tmv that exceeds 70°C (see Figure 5, step 54). At

70°C, five symbols 7 are dark. When the person heating the fireplace receives this notice, s/he does not add wood, but allows the wood in the fireplace to burn out, after which s/he may close the damper (not shown) of the fireplace. Because the temperature of the inner structure 4 of the fireplace is higher than that of the outer stone structure 5, temperature measured from the fireplace rises even if no wood is added. The figure shows that in the example, the temperature rises to the maximum value Tmvmax of 100°C. After about five hours from starting the heating, the fireplace is allowed to cool (see Figure 3). Cooling is slow, because the heat-accumulating mass of the fireplace is great.

[0016] A field 8 of the display unit 3 indicates the measured temperature Tmv as a numerical value and in °C.

[0017] The calculation unit 2, which is a data processor and display unit 3, is programmed to display on the instruction field 9 of the display unit "HEATING CAN BE RESTARTED," when the temperature Tmv measured from the fireplace has decreased to approximately 40°C (see Figure 5, step 57). In the case of Figure 3, this takes place approximately 22 hours after starting the heating. The display unit 3 is adapted to provide said notification at a time and temperature, at which the fireplace is able to receive lots of heat, i.e., it has cooled down substantially, however, before the fireplace has cooled so much that it cannot in practice emit much heat into the environment. When the fireplace is not fully cooled, it is also very easy to light it up again. The temperature, at which it is recommended to start heating again, may be referred to as a second temperature set value T2sv. Its size is selected to be 30 to 50°C depending on how even a heat emission is required of the fireplace. A high value (e.g. 50°C) provides a more even heat emission than a low value (e.g. 30°C). The higher the value T2sv, the more often the fireplace must be re-heated.

[0018] If the measured temperature $Tmv \geq T1sv - \Delta T1$, wherein T1 sv is a temperature set value and $\Delta T1$ is a so-called first safety margin, the display unit 3 displays "DO NOT ADD WOOD" (see Figure 5, step 54). The temperature set value T1sv and safety margin $\Delta T1$ must be defined and set in the arrangement (see Figure 5, step 51) so that the arrangement knows at which temperature Tmv to warn about adding wood. The sizes of the temperature set value T1 sv and safety margin $\Delta T1$ depend mainly on the structure, mass and material of the fireplace. A suitable temperature set value T1sv for a soapstone fireplace is 70°C to 90°C, and a suitable safety margin $\Delta T1$ value is 0.15 to 0.25 x T1sv. If 90°C is selected as the T1sv set value and 0.2 x T1sv as the safety margin $\Delta T1$, this calculates into $Tmv = 90^\circ\text{C} - 0.2 \times 90^\circ\text{C} = 72^\circ\text{C}$, that is, the arrangement warns against adding wood when $Tmv \geq 72^\circ\text{C}$ (see Figure 5, steps 53 and 54). Defining the temperature set value T1sv will be discussed in more detail later.

[0019] The first safety margin $\Delta T1$ may be defined by monitoring the rate of temperature increase. The increase rate may easily be defined by comparing the pre-

vailing temperature with a value measured earlier and by checking the temperature curve of Figure 3. The rate of temperature increase is fireplace-specific and depends mainly on the type, manufacturing material and mass of the fireplace. Temperature increase may be foreseen by multiplying the rate of temperature increase (degrees / time unit) by a fireplace-specific coefficient (time). The coefficient(s) may be determined by experimentation. The system could also be self-learning in such a manner, for instance, that during the learning stage, as a specific temperature is exceeded, the processor provides a signal not to add more wood (see the above "DO NOT ADD WOOD"), after which the processor 1) defines a gradient, 2) observes how much the temperature will rise from this, and 3) stores the data into a memory. During future heating times, the processor may 1) monitor the gradient, 2) on the basis of the gradient, fetch from the stored history data information on how much the temperature will rise from the present, and 3) subtract the temperature increase prediction from a "safe" maximum temperature. When it is estimated on the basis of the gradient and history that a safe maximum temperature will be reached, a signal is provided not to add more wood ("DO NOT ADD WOOD").

[0020] If the fireplace is repeatedly heated by adding a furnace-full or more wood against the instructions of the display unit 3, the fireplace will overheat repeatedly and its service life will shorten. During overheating, the temperature of the inner stone structure 4 increases above its long-term durability. A seldom occurring slight overheating is not very dangerous. The dashed line in Figure 3 shows a situation, in which a furnace-full of wood has been added into the fireplace - against the instructions of the display unit 3 - when the temperature of the outer shell structure is 90°C. Adding wood increases the temperature of the outer shell structure 5 to Tmvmax 120°C. This is 20°C above the temperature that the fireplace can endure for certain, because the curve marked by a uniform line in Figure 3 represents the correct maximum heat accumulation that indicates 100°C as the maximum temperature Tmvmax.

[0021] The condition of the fireplace should be checked and necessary maintenance work done to it, if it has been overheated repeatedly. For the purpose of indicating that the fireplace possibly requires maintenance and should be checked, the arrangement calculates cumulatively the overheating time, tl, that is, how long the fireplace has been overheated (see Figure 5, step 59). A field 10 in the display unit 3 shows the overheating time in hours. Calculating the overheating time tl will be started when the measured temperature Tmv is higher by a second safety margin ΔT2 than the temperature set value T1sv (see Figure 5, steps 55, 58). The size of the second safety margin is preferably selected to be $\Delta T2 = 0.1 \dots 0.2 \times \text{temperature set value } T1sv$. Accordingly, if the temperature set value T1 sv is selected to be 90°C and the second safety margin ΔT2 is selected to be 0.15 x 90°C = 13.5°C, the calculation of the over-

heating time tc will be started when the measured temperature is $90 + 13.5 = 103.5^\circ\text{C}$. When the overheating time tc exceeds a limit value tl of 50 hours, the display unit 3 of the arrangement displays in a field 11 "CHECK" and/or the arrangement emits an audio signal (see Figure 5, steps 59, 60). The value of the safety margin ΔT2 and especially the temperature set value T1sv depend on the location of the measuring device 1 and must be selected accordingly. The location where the measuring device is mounted represents the fireplace only when the shape of the heating curve is examined; the location does not represent absolute temperature values. Depending on the mounting location and fireplace, it is possible that in one case a certain temperature indicates a general overheating, even though in another case a temperature higher than this does not necessarily indicate overheating.

[0022] The arrangement is switched on and off using a button 12 in the display unit 3; the required temperature set values T1sv and T2sv may be programmed with buttons 13 and 15 (reset button). The programming is not described in detail herein, because it does not require any special expertise.

[0023] The arrangement goes into learning state by pressing a button 14 of the display unit (see Figure 4, and Figure 6, step 61). The purpose of the learning state is to define a suitable temperature set value T1sv. This is done according to Figure 6, step 62, in such a manner that the person heating the fireplace attempts to heat it correctly to accumulate as high an amount of heat as possible. Correct heating means that the fireplace is heated in a conventional manner with wood containing a conventional heat value without overheating it in such a manner that its strength suffers. Preferably, the instructions for use of the manufacturer assist in correct heating. A person skilled in the art is familiar with correct heating. The success of the heating is evaluated by measuring the temperature and comparing the measured temperatures with those allowed that do not overheat the fireplace (see Figure 6, step 63). The temperatures are stored into a memory 17 of the arrangement that is arranged to the calculation unit 2. If heating is not successful, the temperatures/heat curves are deleted from the memory 17 of the arrangement (see Figure 6, step 66); if heating is successful, the temperature set value T1 sv is defined by selecting as its value the maximum temperature Tmvmax measured from the outer shell 5 minus the safety margin = 10°C to 20°C, and this is stored into the memory 17 of the arrangement (see Figure 6, step 64). If during correct and successful heating it is noted that the temperature of the outer shell increases to the maximum value of 90°C, for instance, the temperature set value T1 sv is selected to be 90°C minus the safety margin. If the safety margin is selected to be 15°C, the temperature set value becomes 75°C. When the temperature set value T1sv has been defined, and the actions according to Figure 5 need to be performed, the temperature set value T1sv is fetched from the memory 17 of the arrangement (see Figure 6, step 65). A person skilled in the art is ca-

pable of evaluating the success of the heating.

[0024] The button 15 in the display unit is a reset button that is used when programming the arrangement.

[0025] A few temperature set values and safety margins that form different programs may be stored into the arrangement. One program provides a very even heat emission, whereas another program provides a more uneven heat emission. The former program requires that the re-heating of the fireplace be done relatively often. The required program may be selected by pressing a menu button 16 of the display unit 3.

[0026] In the above, the invention is described by means of examples, wherefore it is noted that the details of the invention may be implemented in various ways within the scope of the attached claims. The temperature set values, safety margins sizes, and counter limit value may also be selected specifically for each fireplace. Instead of firewood, it is possible to use some other fuel, such as pellets, to heat the fireplace. In the example, the calculation unit is described as a programmed data processor, but it may also be implemented by dedicated logic. The amount of information provided by the display unit 3 may vary, as may the presentation of the information (graphical, numeric, audio, or light information, etc.). The fireplace does not necessarily need to comprise an outer shell separate from the inner stone structure, even though this is highly recommended. The manufacturing material of the fireplace does not need to be stone, but may be some other material.

Claims

1. An arrangement in a heat-accumulating fireplace, the arrangement comprising a measuring device (1) that is arranged to react to temperature changes and that is arranged to the heat-accumulating structure of the fireplace and intended to control the use of the fireplace, **characterised in that** the arrangement comprises an electric calculation unit (2) coupled to a display unit (3) and arranged to display data representing the heat accumulation status of the fireplace in response to temperature changes detected by the measuring device (1) and to inform the user of the fireplace, when the fireplace has reached its maximum and correct heat accumulation, that there is a danger of overheating the fireplace, if fuel is added.
2. An arrangement as claimed in claim 1, **characterised in that** the heat-accumulating structure comprises a massive heat-accumulating inner structure (4) and an outer shell structure (5) and that the measuring device (1) is arranged in the outer shell structure (5).
3. An arrangement as claimed in claim 2, **characterised in that** there is an air gap (6) between the outer

shell structure (5) and inner structure (4).

4. An arrangement as claimed in claim 3, **characterised in that** a smoke flue forms the air gap (6).
5. An arrangement as claimed in any one of preceding claims 1 to 4, **characterised in that** the display unit (3) is arranged to show the heat accumulation status of the fireplace by using graphical data.
6. An arrangement as claimed in any one of the preceding claims, **characterised in that** the calculation unit (2) is arranged to
 - retain in a memory (51) a temperature set value T1 sv,
 - monitor (53) a temperature Tmv of the heat-accumulating structure (5) of the fireplace by means of the measuring device (1),
 - compare (53) the temperature Tmv of the structure with the temperature set value T1sv, and
 - produce (54), in response to the temperature Tmv of the structure being higher than the temperature set value T1sv minus a first safety margin $\Delta T1$, through the display unit a signal to stop adding fuel, which shows that the fireplace has accumulated heat to the extent that more fuel shall not be added.
7. An arrangement as claimed in claim 6, **characterised in that** the first safety margin $\Delta T1$ is selected to be 0.15 to 0.25 x the temperature set value T1 sv in °C.
8. An arrangement as claimed in claim 6 or 7, **characterised in that** the temperature set value T1 sv is selected to be 50 to 100°C.
9. An arrangement as claimed in any one of preceding claims 6 to 8, **characterised in that** the calculation unit (2) is arranged to compare (55) the temperature Tmv of the structure with the temperature set value T1 sv, and in response to the temperature Tmv of the structure being higher than the temperature set value T1sv plus a second safety margin $\Delta T2$ to produce (58) through the display unit (3) a signal indicating the overheating of the fireplace.
10. An arrangement as claimed in claim 9, **characterised in that** the calculation unit (2) is arranged to calculate (58) cumulatively the time when the fireplace has been overheated, to compare (59) the cumulatively calculated time tc with a time limit tl and, in response to the cumulatively calculated time tc exceeding the time limit tl, to produce (60) through the display unit (3) a signal indicating a need to check the fireplace.

11. An arrangement as claimed in claim 10, **characterised in that** the display unit (3) is arranged to display the cumulatively calculated time t_c the fireplace has been overheated.

12. An arrangement as claimed in any one of preceding claims 9 to 11, **characterised in that** the second safety margin ΔT_2 is selected to be 0.10 to 0.20 x the temperature set value T_1 sv in °C.

13. An arrangement as claimed in any one of preceding claims 6 to 12, **characterised in that** the calculation unit (2) is further arranged to

- retain in the memory (51) a second temperature set value T_{2sv} ,
- monitor the temperature T_{mv} of the heat-accumulating structure (5) of the fireplace by means of the measuring device (1),
- compare (56) the temperature T_{mv} of the structure with the second temperature set value T_{2sv} , and
- in response to the temperature T_{mv} of the structure being lower than the second temperature set value T_{2sv} to produce (57) through the display unit (3) a signal indicating the start of reheating the fireplace.

14. An arrangement as claimed in claim 13, **characterised in that** the second temperature set value T_{2sv} is selected to be 30 to 50°C.

15. An arrangement as claimed in any one of preceding claims 6 to 14, **characterised in that** it comprises definition means for defining a temperature set value T_{sv} specifically for each fireplace, the definition means comprising a memory (17) for storing the heating result of the fireplace that is obtained by heating the fireplace in batches with solid fuel having a conventional heat value by using conventional and correct heating with the aim of obtaining maximum heat accumulation of the fireplace, the definition means comprising

- means for monitoring the heating result by measuring the temperature T_{mv} of the heat-accumulating structure (5) of the fireplace by means of the measuring device (1) and for storing (62) the highest measured temperature T_{mvmax} into the memory (17) of the arrangement,
- means for evaluating (63) the heating result and, in response to the heating not corresponding to said aim, for deleting the stored value (66) from the memory (17) of the arrangement and, if the heating corresponds to said aim, for defining (64) on the basis of the stored highest measured temperature T_{mvmax} a temperature set value T_{1sv} by selecting (64) as its value a tem-

perature that is 10°C to 20°C below the highest measured temperature T_{mvmax} and for storing (64) it into the memory (17) of the arrangement.

16. An arrangement as claimed in claim 6, **characterised in that** the calculation unit (2) is arranged to

- monitor the increase rate of the temperature T_{mv} of the structure,
- and
- use the increase rate of the temperature T_{mv} of the structure in defining the first safety margin ΔT_1 .

17. An arrangement as claimed in claim 16, **characterised in that** for defining the first safety margin ΔT_1 , the calculation unit (2) comprises means for multiplying the temperature increase rate by a fireplace-specific coefficient.

18. An arrangement as claimed in claim 16, **characterised in that** for defining the first safety margin ΔT_1 the calculation unit (2) comprises

- means for storing into the memory (17) several values for the temperature increase rate at the time of providing the signal to stop adding fuel,
- means for storing into the memory (17) for each stored temperature increase rate value, how long the temperature will continue to increase after the time the signal to stop adding fuel is given, and
- means for defining the first safety margin ΔT_1 on the basis of the temperature increase rate and said data stored into the memory (17).

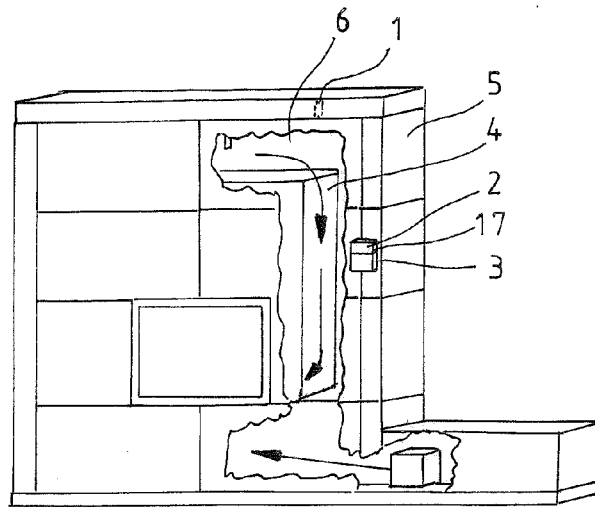


FIG. 1

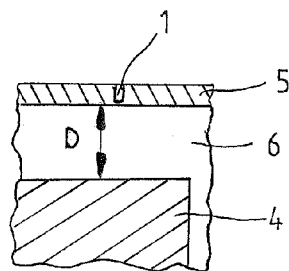


FIG. 2

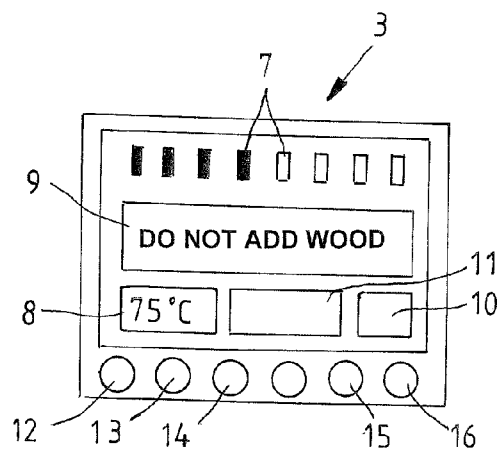


FIG. 4

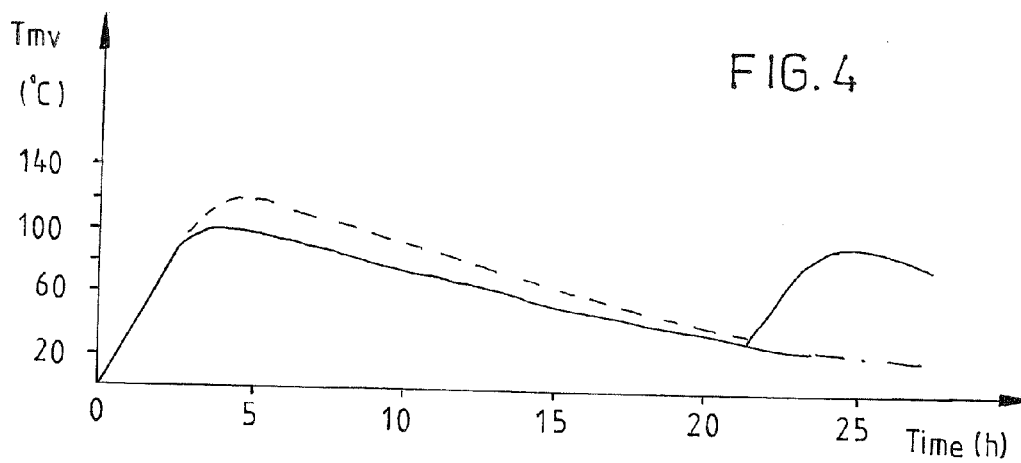


FIG. 3

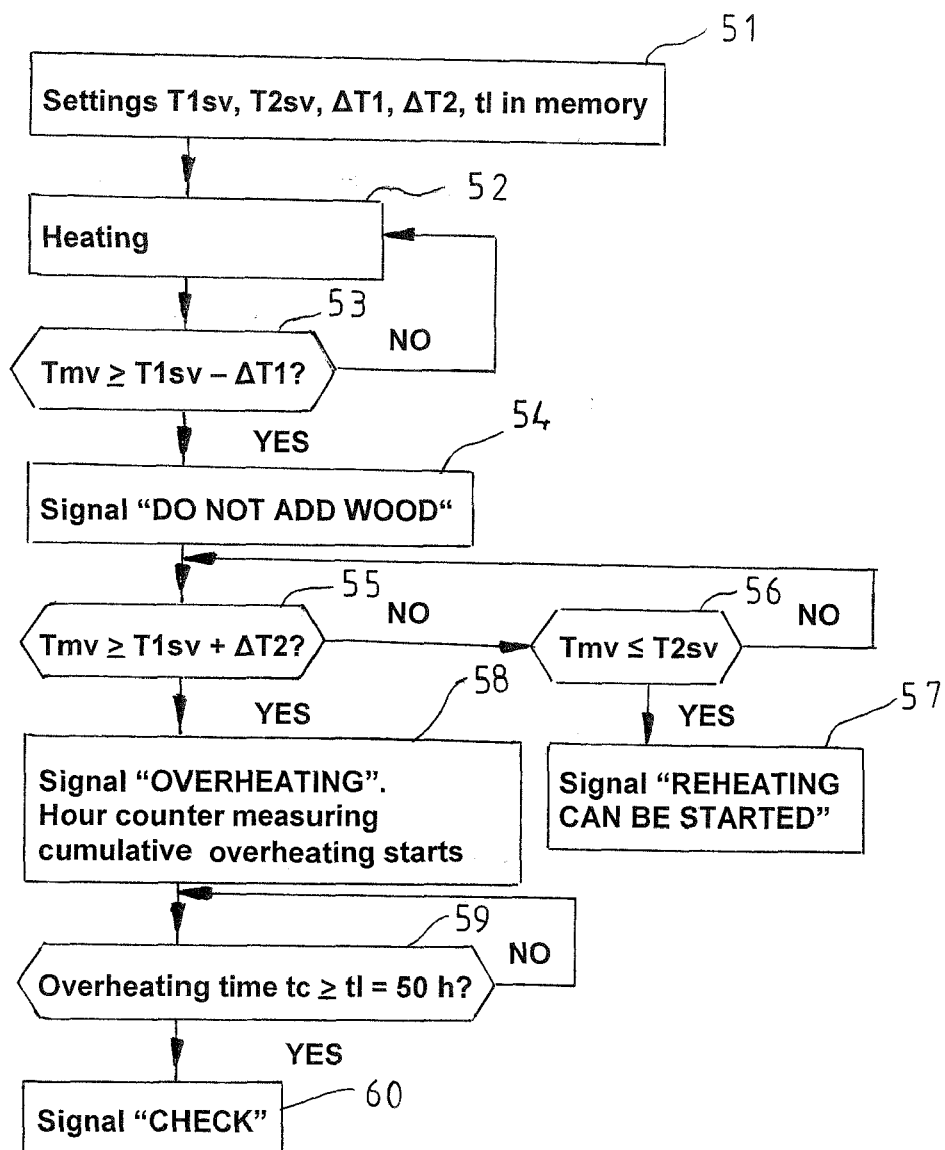


FIG. 5

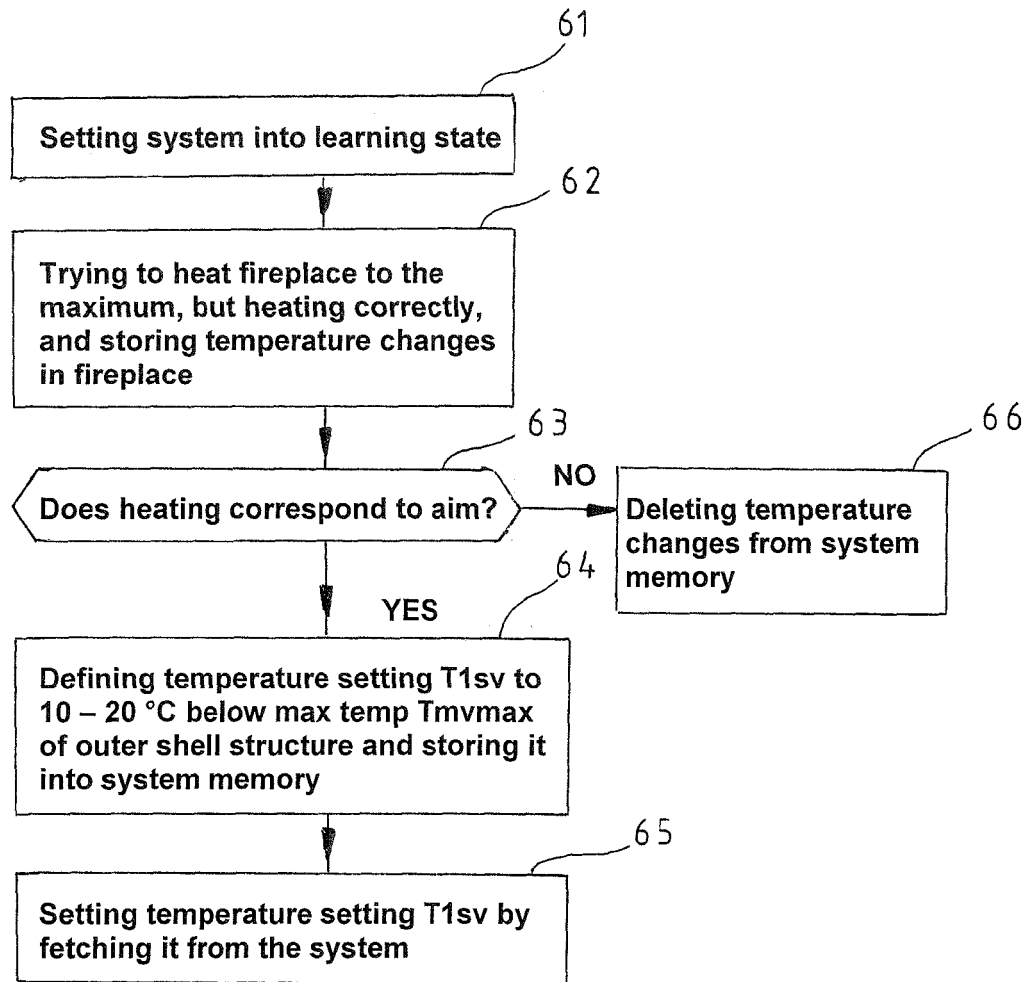


FIG. 6



EUROPEAN SEARCH REPORT

Application Number
EP 11 15 0911

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 4 901 059 A (AMANN MATTHEW J [US]) 13 February 1990 (1990-02-13) * abstract; figure 1 * * column 1, lines 5-9 * * column 2, lines 19-53 * * claims 1-4 *	1-18	INV. F24B1/24 F24B1/187
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A	US 2007/289589 A1 (MCFARLAND DANIEL T [US]) 20 December 2007 (2007-12-20) * abstract; figure 1 *	1	TECHNICAL FIELDS SEARCHED (IPC) F24B F24C F23N F24H
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 12 May 2011	Examiner Moreno Rey, Marcos
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 15 0911

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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12-05-2011

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REFERENCES CITED IN THE DESCRIPTION

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