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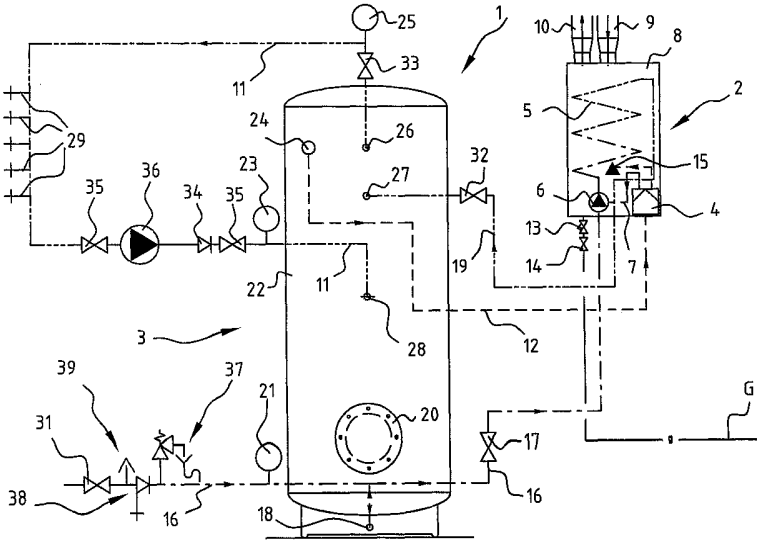
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(54) Title: SYSTEM AND METHOD FOR HEATING TAP WATER



(57) Abstract: The present invention relates to a hot tap water system, comprising: - a storage tánk for storing tap water heated by means of the heating device, - a water transporting system comprising conduits for transporting water between the storage tank and a hea ting device, and at least one pump for pumping the water through the conduits, - the heating device for heating the tap water is provided with a heat exchanger in the heating device, wherein: - the tap water is heated in the heat exchanger in the heating device directly by the combustion gases.

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SYSTEM AND METHOD FOR HEATING TAP WATER

The invention relates to a system and method for heating tap water. There are numerous hot tap water systems available on the market.

The invention relates more specifically to a method and system for a hot tap water system for buildings with a variable hot water requirement, such as a residential building for a large group of people such as a multi-family building or a residential home for the elderly or a nursing home. In such buildings it is recommended that a number of people can use hot water independently of each other, wherein the different people are not inconvenienced by the hot water usage of others. It is therefore important that either a very large hot water generating capacity is available or a system with a buffer by means of for instance a storage tank. These systems are however of complex structure and therefore costly and inefficient in terms of energy consumption.

In order to obviate these drawbacks the present invention provides a hot tap water system, comprising:

- a storage tank for storing tap water heated by means of the heating device,
- a water transporting system comprising conduits for transporting water between the storage tank and a heating device, and at least one pump for pumping the water through the conduits,
- the heating device for heating the tap water is provided with a heat exchanger in the heating device, wherein:
- the tap water is heated in the heat exchanger in the heating device directly by the combustion gases.

Such a system has the advantage that water of a very low relative temperature can be fed to the heat exchanger in the heating device. The energy efficiency of the heating device is hereby very high because there is a relatively great temperature difference (ΔT). The conden-

sation heat of the combustion gases is also utilized here to heat the water.

In known systems water from a closed water circuit flows through the heat exchanger in the heating device. This water in the closed water circuit flows through a second heat exchanger, whereby the tap water is heated. The lowest temperature of the water in the closed system is hereby always above the lowest temperature of the tap water.

A system according to the invention also suffers less heat loss because no use is made of a second heat exchanger. A known system with a second heat exchanger further requires at least one extra pump, thus increasing cost.

According to a first preferred embodiment, the system comprises a direct connection between the water mains and the heat exchanger in the heating device. Water with the lowest possible temperature is hereby fed to the system. The heat exchanger is spiral-shaped, whereby the temperature difference (ΔT) of the water for heating in the heat exchanger can be maximal.

The system preferably comprises a direct cold water connection between the storage tank and the heat exchanger in the heating device. If hot water from the storage tank is used, the storage tank will be replenished with cold water from the underside. In order to heat this cold water as efficiently as possible, it is fed directly in this embodiment to the heat exchanger in the heating device.

The coupling of the cold water connection can preferably be coupled to substantially the underside of the storage tank. This is advantageous since the water in the storage tank will be coldest at the bottom. This is the case, among other reasons, because fresh cold mains water is fed to the underside of the storage tank.

In a further preferred embodiment, the system comprises a direct hot water connection between the heat exchanger in the heating device and the storage tank. In addition to the above described advantages, this has the advantage that the water which has the highest possible temperature after being heated as efficiently as possible is fed directly to the storage tank. Cold water drained from the storage tank on the underside is fed back to the storage tank on the top side after being directly heated in the heating device.

The hot water connection can preferably be coupled for this purpose to the upper half of the storage tank. In addition, the hot water connection is preferably situated substantially up to a quarter way along the height of the storage tank. The hot water is hereby fed to the storage tank in the region where the hot water is present in the storage tank.

The system preferably further comprises a hot water feed system in the direction of the draw-off points with a return conduit to the storage tank. This provides the hot water users with a high degree of comfort since the hot water is also supplied in the direction of the draw-off points even if it is not being used, so that when water is drawn off it will be immediately hot. The return conduit is arranged substantially close to the centre of the storage tank. The return water, which cools partially while it flows through the feed system and the return conduit, is hereby fed back into a part of the storage tank where the water temperature is likewise lower, or the water is located in the storage tank closer to the draw-off point for optional reheating by means of the heating device.

In a further embodiment, the system comprises temperature sensors and/or one or more water flow sensors for measuring the water temperature at least at one position in the system, and an electronic control system for controlling the pump and the heating device on the basis of

signals from the sensors. It hereby becomes possible to carry the water through the heat exchanger at a speed such that the final temperature is optimal relative to the starting temperature.

The amount of combustion energy produced in the heating device can likewise be varied. This has the advantage that, if a small difference in the temperature of the water has to be made up, or if a small quantity of water has to be heated, the heating device can burn for a relatively long time at a relatively low power, thereby increasing the efficiency of the heating device. A heating device also functions more efficiently when there are small variations in power. In one embodiment the heating device is fired for as long as possible at maximum power in order to hold the temperature in the storage tank as close as possible to a preset temperature. Only when there is a small difference from this temperature, for instance 1-5 degrees, is the heating device modulated downward. A high comfort level of the system can be achieved with this method at a relatively low heating device power, and therefore a more advantageously embodied heating device. The comfort level is defined here in that there is a high reserve capacity of hot water because the storage tank contains as much hot water as possible.

In further embodiments thereof, the system comprises control means for controlling the rotation speed of the pump. The pump is preferably further manufactured from or preferably comprises an oxidation-free material such as bronze or stainless steel. This makes it possible to apply relatively oxygen-rich water. Fresh tap water or fresh mains water is generally relatively oxygen-rich, which would cause relatively rapid ageing of a standard iron pump.

The heat exchanger is preferably manufactured from or comprises an oxidation-free metal such as stainless steel. It is also the case with this component of the system that a heat exchanger which is sensitive to oxygen-

rich water would age or need replacement relatively quickly in a system according to the present invention, since the mains water is fed directly to the heat exchanger. This heat exchanger is preferably embodied in SS 316. This provides the advantages for instance that it is not susceptible to corrosion on the inside by oxygen-rich tap water or corrosion on the outside due to corrosion by condensation from the combustion gases.

The heat exchanger takes a spiral-shaped form, whereby it can absorb relatively high temperature differences. The heat exchanger can herein make resilient movements during heating and cooling (of parts) thereof.

The storage tank preferably comprises an oxidation-free material, such as stainless steel, in the inner wall.

A further aspect of the present invention relates to a method for heating water in a hot tap water system, comprising a heating device with a heat exchanger which is situated in the heating device and which is directly heated, comprising steps for:

- feeding relatively cold water to the heat exchanger,
- heating the water in the heat exchanger by means of combustion gases inside the heating device, and
- storing the heated water in a storage tank. This method provides the advantages such as making use of condensation energy from the combustion gases and advantages as specified in the foregoing.

In one embodiment the method comprises steps for heating water on the basis of sensor signals, wherein water from the underside of the storage tank is supplied to the heat exchanger. The coldest water is hereby fed to the heat exchanger for optimum use of the energy of the combustion gases. All the water in the storage tank will eventually be replaced from above by hot water until there are no longer any cold zones present in the tank.

The method preferably comprises steps for holding the water in the storage tank substantially within a first temperature range for a period such as a day, wherein the water is brought substantially to a second temperature for a short sub-period during the period. Infection by for instance legionella bacteria is hereby prevented or suppressed. The prevention of cold zones according to this method in this system prevents ineradicable sources of infection being created in the system (at the bottom of the storage tank).

Further advantages, features and details of the present invention will be described on the basis of specific embodiments and with reference to the annexed figures, in which:

- Fig. 1 shows a schematic view of a preferred embodiment according to the present invention;
- Fig. 2 shows a flow diagram of a further preferred embodiment according to the present invention.

Fig. 1 shows a first embodiment according to the present invention. The hot tap water system 1 comprises a heating device 2 and a storage tank 3, also referred to as boiler. The system is provided with fresh mains water via mains water feed conduit 16. The fresh mains water is supplied on the underside of the boiler at feed point 18. This draw-off point 18 also serves for the supply of cold water from the boiler to heating device 2 by means of conduit 16. The water is always fed in practice to the boiler and then fed through to the heating device. It is however equally possible for mains water to be supplied directly to heating device 2.

Heating device 2 comprises a gas feed G which supplies gas to the heating device by means of a closing valve 14 and a filter 13.

The heating device is arranged in a housing 8 and further comprises a circulation pump 6 and control electronics 4 in this housing. Control electronics 4 control

the pump 6 in respect of switching on and off and the rotation speed to be used. The control electronics further control gas block 15 comprising a fan. This gas block comprising a fan determines the amount of fuel, air and oxygen supplied to the burner of the heating device.

The heating device further comprises a spiral-shaped, stainless steel heat exchanger 5 to which the water for heating is directly fed. Pump 6 serves in this case to transport the water from boiler 3 to heat exchanger 5 and back again to boiler 3 by means of conduit 19 and inlet 27. Heating device 2 is further provided with air feed 9 and flue gas discharge or combustion gas discharge 10. For control of the gas block with the fan and the pump, the electronics make use of data from temperature sensors 21,23,24 or 25, which can all be connected to the electronics in similar manner to sensor 24 by means of connection 19. Control electronics 4 control the heating device in modulating manner, the temperature of the water in the boiler, the heating device pump and the rotation speed thereof, the operating times of the installation and a legionella prevention control (this is described in detail hereinbelow). The control is preferably regulated such that the boiler temperature remains as close as possible to a predetermined temperature irrespective of the draw-off or take-off flow rate. This is achieved in that: the heating device continues to burn as long as possible at maximum load at water temperatures which vary more than 2K from the predetermined temperature (ΔT); the burner is preferably modulated downward in the case of a lower ΔT so that the heating device continues to burn for a longer time at lower power, and will hereby not begin to switch on and off frequently, and/or the pump rotation speed is preferably controlled such that the water temperature from the heating device to the boiler remains between a minimum of 55 and a maximum of 75 degrees Celsius, subject to the entry temperature.

The control electronics are further provided with a legionella infection prevention program which functions by a periodic daily increase in the boiler temperature up to or above 65 degrees so as to eliminate a possible legionella infection, whereby it is not necessary to operate continuously at a high temperature within the system. An advantage hereof is that limescale deposits are prevented. Limescale deposition normally occurs at higher temperatures. A short daily increase in the temperature also prevents seals in the conduits drying out due to the long-term effect of high temperatures, whereby the lifespan of the installation and conduits is greatly increased.

On the basis of information from temperature sensor 21,22,23,24,25, or on the basis of predetermined program data, the electronics determine in step 40 whether heating of the water is necessary because of a legionella instruction. If this is the case, the water is heated in step 47 to the preset legionella destruction temperature. If it is determined in step 40 that there is no legionella instruction, it is determined in step 41 whether there is a boiler instruction. If this is the case (y), there is determined in step 44 whether there is still a legionella instruction here. If this is not the case, the boiler water is (re)heated to the preset normal temperature. If the answer is no in step 41, there is determined whether an additional pumping operation is necessary in step 42. If this is not necessary, the procedure begins again at step 40. If the additional pumping operation is important, there is determined in step 43 whether there is now a boiler instruction. If this is so, the method continues in the above mentioned step 44. If it is determined in step 43 that there is no boiler instruction, it continues in step 45, in which a check is once again made as to whether a boiler instruction is necessary. Should this be the case, the procedure continues in step 46. If it is determined in step 45 that there is no legionella instruction, an additional pumping operation follows in step 48.

In the heating device the best result is obtained if the difference in temperature between the supplied water and the drained water is as great as possible. To this end the water from the boiler is fed from the coldest point to the heating device. This is the underside of the boiler at draw-off point 18. As already stated, the heated water is fed to feed point 27 which is situated about a quarter way along the boiler from the top. It is important that the supplied water is fed at a relatively high point into the boiler. The hot water for the draw-off points 29 is drained from the boiler at connecting point 26. Take-off point 26 is preferably located one sixth of the way along the boiler from the top, but in any case close to the top of the boiler well above the middle of the boiler, whereby the still relatively hot water will not mix with the cold water at the bottom of the boiler. When a recirculation system is applied, water is circulated continuously from the boiler in the direction of the draw-off points and back again to the boiler via conduit 11. This takes place with driving of pump 36. Closing valves 35 and non-return valve 34 are situated in the conduits. The supplied water is fed to the boiler substantially halfway along the boiler by means of a connecting point 28.

For the purpose of cleaning the system a hatch 20 is provided close to the underside of the boiler. Possible limescale occurring in the heat exchanger will be dislodged by the resilient movement of the heat exchanger (due to the large ΔT) and be carried by the water flow to the tank. The limescale will in this way collect at the bottom of the boiler, since there is a low water speed here.

An overflow valve 37, an adjustable non-return valve 38 and a venting means 39 are arranged in the feed conduit 16 to the main tap 31.

In order to optimize the use of the heating device, the control electronics 4 can on the one hand vary the throughfeed speed of pump 6 and on the other regulate the amount of fuel and the amount of air supplied by means

of the fan of gas block 15. The heating device can hereby burn at low power for a longer period of time, which also produces a more efficient result than a heating device burning at high power which burns for a short period or which begins to switch on and off frequently. This is particularly important when the boiler must reheat water regularly through a small temperature difference due to the use of the recirculation system. In such a situation an optimum heat transfer is realized in heat exchanger 5 by regulating the combustion rate and pump 6. A further large gain in efficiency of a device according to this embodiment is that relatively cold water can be fed from the underside of the boiler or the water mains directly to the heating device, whereby very high heat utilization in heat exchanger 5 is realized from the combustion energy released by the combustion gases.

The invention is described on the basis of a preferred embodiment. The rights sought are however defined by the appended claims.

CLAIMS

1. Hot tap water system, comprising:

- a storage tank for storing tap water heated by means of the heating device,

- a water transporting system comprising conduits for transporting water between the storage tank and a heating device, and at least one pump for pumping the water through the conduits,

- the heating device for heating the tap water is provided with a heat exchanger in the heating device, wherein:

- the tap water is heated in the heat exchanger in the heating device directly by the combustion gases.

2. System as claimed in claim 1, comprising a direct connection between the water mains and the heat exchanger in the heating device.

3. System as claimed in claim 1 or 2, comprising a direct cold water connection between the storage tank and the heat exchanger in the heating device.

4. System as claimed in claim 3, wherein the coupling of the cold water connection can be coupled to substantially the underside of the storage tank.

5. System as claimed in one or more of the foregoing claims, comprising a direct hot water connection between the heat exchanger in the heating device and the storage tank.

6. System as claimed in claim 5, the hot water connection can be coupled in the upper half of the storage tank.

7. System as claimed in claim 5 or 6, wherein the hot water connection is substantially a quarter way along the height of the storage tank as seen from the top of the storage tank.

8. System as claimed in one or more of the foregoing claims, comprising a hot water feed system in the direction of the draw-off points with a return conduit to the storage tank.

9. System as claimed in claim 8, wherein the return conduit is arranged substantially close to the centre of the storage tank.

10. System as claimed in one or more of the foregoing claims, comprising temperature sensors and/or water flow sensors for measuring the water temperature at least at one position in the system, and an electronic control system for controlling the pump and the heating device on the basis of signals from the sensor.

11. System as claimed in one or more of the foregoing claims, comprising control means for controlling the rotation speed of the pump.

12. System as claimed in one or more of the foregoing claims, wherein the pump comprises an oxidation-free material such as stainless steel or bronze.

13. System as claimed in one or more of the foregoing claims, wherein the heat exchanger comprises an oxidation-free metal such as stainless steel.

14. System as claimed in one or more of the foregoing claims, wherein the storage tank comprises an inner

wall with an oxidation-free material such as stainless steel.

15. Method for heating water in a hot water tap system, comprising a heating device with a heat exchanger which is situated in the heating device and which is directly heated, comprising steps for:

- feeding relatively cold water to the heat exchanger,
- heating the water in the heat exchanger by means of combustion gases inside the heating device, and
- storing the heated water in a storage tank.

16. Method as claimed in claim 15, comprising steps for heating water on the basis of sensor signals, wherein water from the underside of the storage tank is supplied to the heat exchanger.

17. Method as claimed in claim 15 or 16, wherein the water in the storage tank is held substantially within a first temperature range for a period such as a day, and wherein the water is brought substantially to a second temperature for a short sub-period during the period.

18. Method as claimed in one or more of the claims 15-17, comprising steps for controlling the water speed through the heat exchanger, so that the water is heated to a predetermined temperature.

19. Method as claimed in one or more of the claims 15-18, comprising steps for adjusting down the power of the heating device relative to the maximum power so that the firing time of the heating device is lengthened.

20. Method as claimed in one or more of the claims 15-18 performed using a system according to one or more of the claims 1-14.

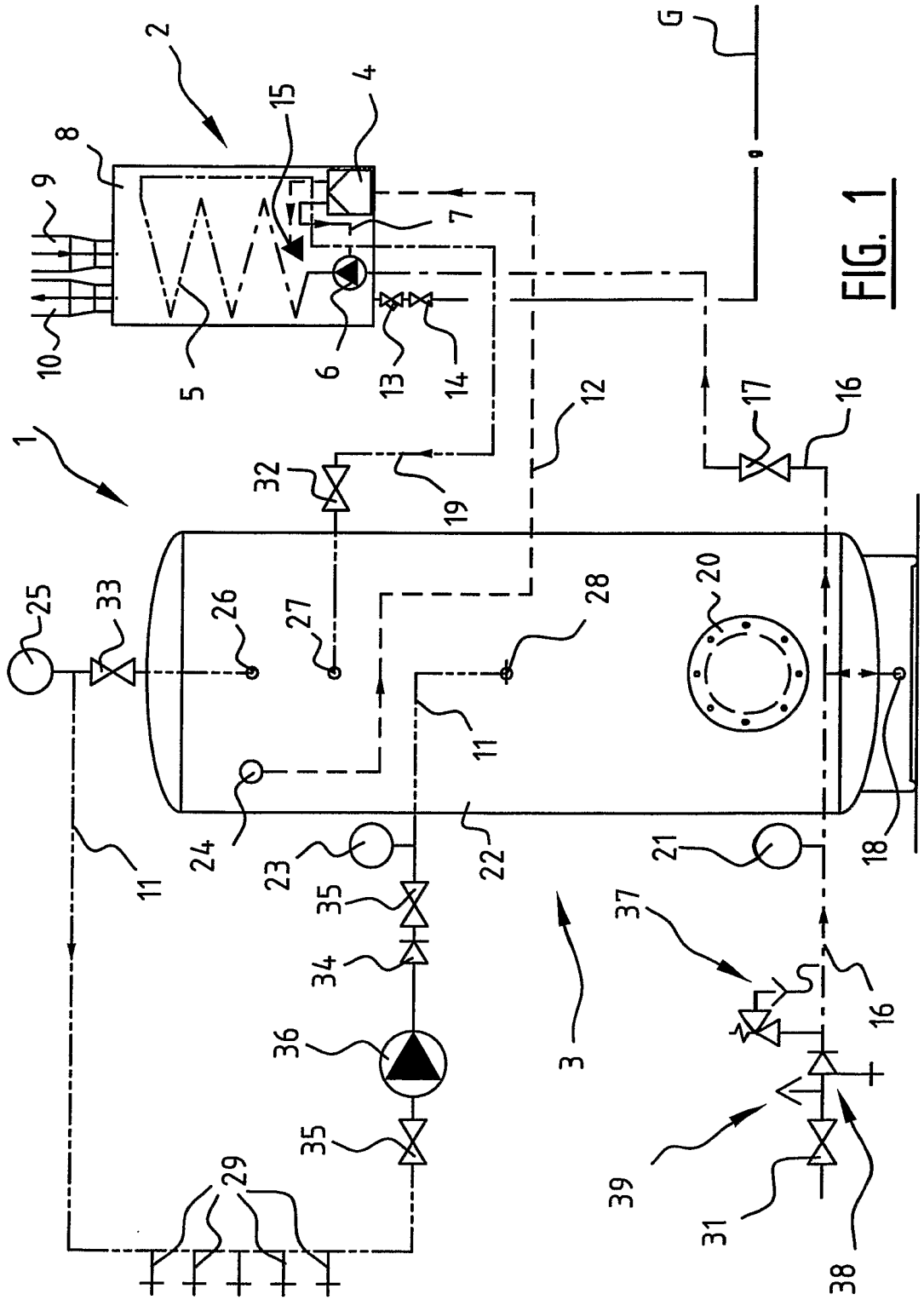

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FIG. 1

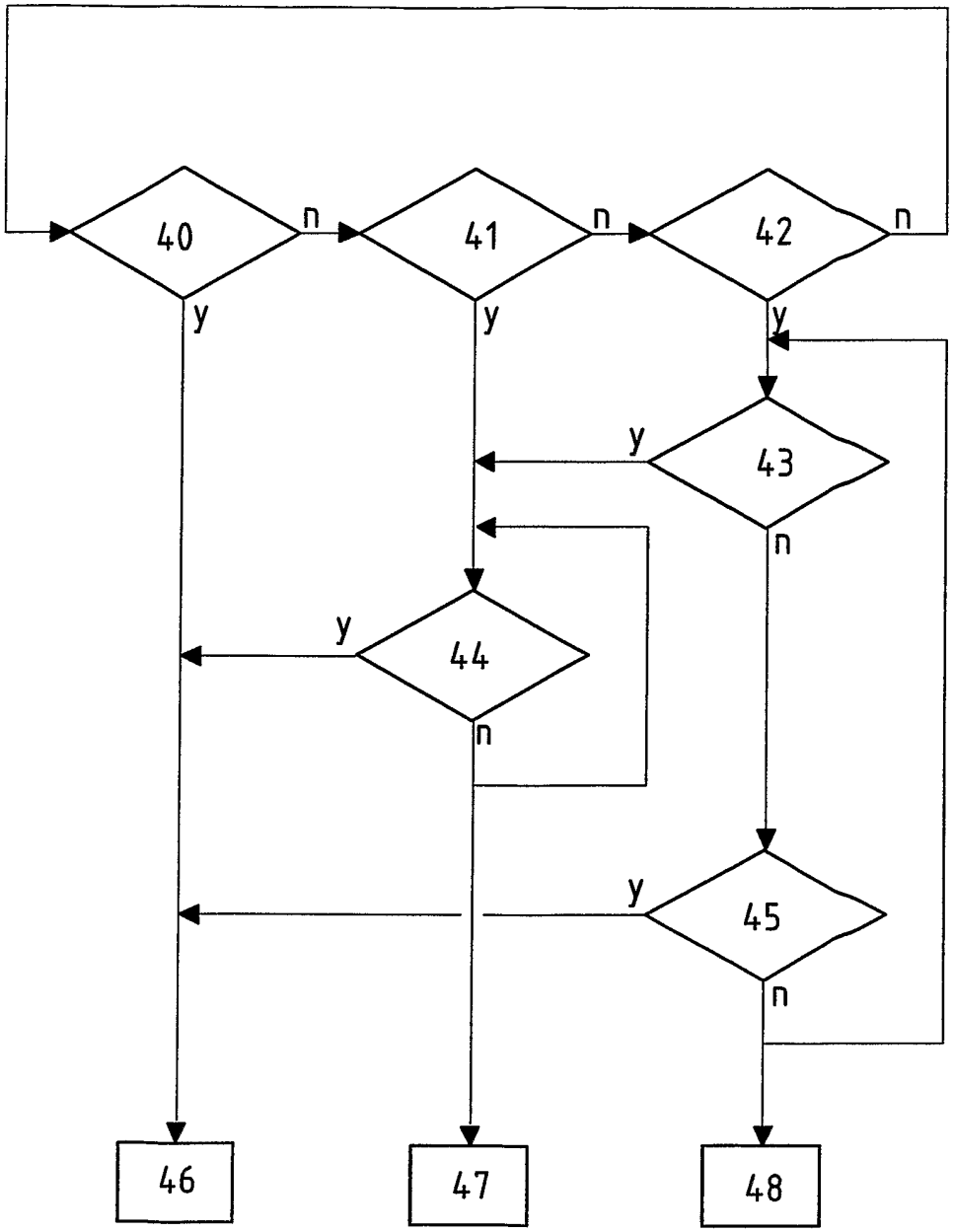


FIG. 2

INTERNATIONAL SEARCH REPORT

Interi al Application No
PCT/NL2005/000051

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F24D17/00 F24D19/10

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)
IPC 7 F24D

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 626 287 A (KRAUSE TIMOTHY D ET AL) 6 May 1997 (1997-05-06) the whole document	1-11,15, 16,20
X	US 5 056 712 A (ENCK HARRY J) 15 October 1991 (1991-10-15) the whole document	1-5, 8-11,15, 16
A	US 6 453 938 B1 (EBSTER WILFRIED) 24 September 2002 (2002-09-24) abstract	1,8,9

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

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
25 May 2005	02/06/2005

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Interr al Application No
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