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(54) Method and device for controlling a liquid temperature.

(57) The invention relates to a method for controlling the temperature of a liquid supplied to a take-off point by a non-controllable heating appliance (2) by measuring the temperature of the liquid prior to the take-off point, admixing to the liquid flow from the heating appliance a second, colder liquid flow when the measured temperature exceeds a determined target value, wherein the quantity for admixing is continuously adapted.

The liquid flows can be brought into mutual heat-transferring contact prior to mixing.

The invention also relates to a device for performing the method provided with a first inlet conduit (3) for connecting to the heating appliance, a second inlet conduit (4) for connecting to a source (7) of colder liquid and having controllable shut-off means, a mixing chamber connected to the first and second inlet conduit, an outlet conduit connected to the mixing chamber and provided with means for measuring the temperature of the liquid flowing therethrough, and control means connected for transmitting signals to the shut-off means, wherein the temperature measuring means are connected for transmitting signals to the control means.

The first (3) and second (4) inlet conduit of the control device can be mutually connected for heat transfer over a part of their length, in that a storage container (10) is arranged in one of the inlet conduits, the content of which container is greater than that of the associated inlet conduit, and the other inlet conduit is carried through the storage container.

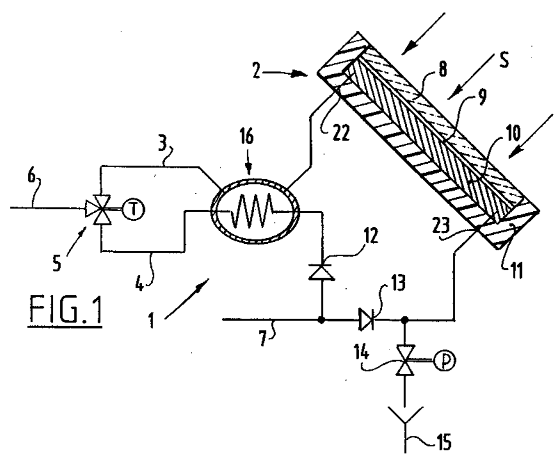

FIG.1

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The invention relates to a method for controlling the temperature of a liquid which is supplied by a non-controllable heating appliance to a take-off point. The invention relates particularly to such a method for use with water coming from a heating appliance powered by natural, for instance solar, energy.

Appliances which are powered by natural energy such as solar energy can generally not be controlled, or hardly so, as their performance is related to a quantity which cannot be influenced by the user, such as for instance the number of hours of solar radiation, the number of hours that the wind exceeds a determined strength or the like. In the use of such appliances it is however important that a form of control is nevertheless applied. This applies in particular to hot water appliances operated on solar energy, since when solar radiation is strong the temperature of the water in such appliances can rise so high that this forms a danger to the user. For auxiliary heating apparatus which will generally be used in combination with such a hot water appliance operated on solar energy to provide additional heating when the solar radiation is insufficient, it is also the case that this may not be exposed to water with too high a temperature. A water temperature of 90 °C at the inlet is generally considered a safe limit for such auxiliary heating apparatus, while for a user the water temperature may preferably not be higher than 80 °C.

There therefore exists a need for a method of controlling the temperature of the water coming from a hot water appliance operated by solar energy. Since the object of the application of solar energy is to limit as far as possible the consumption of other types of energy, particularly that obtained through burning fossil fuels, the sought after control method must also result in a low consumption of energy (and water). What must be particularly prevented is that water heated by the heating appliance is drained without being used in order to limit the temperature of the water supplied to the user or to the auxiliary heating apparatus.

According to the invention this is achieved by a method of the above described type which comprises the steps of measuring the temperature of a liquid supplied to at least one take-off point by a non-controllable, in particular a natural energy powered heating appliance, by measuring the temperature of the liquid prior to the take-off point, admixing to the liquid flow from the heating appliance a second liquid flow with a determined lower temperature when the measured temperature exceeds a determined target value, and continuously adapting the quantity of the second liquid flow for admixing such that in each case the measured temperature approaches as closely as possible the determined target value.

Because the temperature of the liquid coming from the heating appliance is controlled by admixing a second liquid at lower temperature, no wastage of heated liquid occurs.

The liquid flows are preferably brought into mutual heat-transferring contact prior to mixing. The temperature of the liquid coming from the heating appliance is hereby already slightly decreased, whereby the device where mixing takes place will be exposed to lower temperatures.

When one of the liquid flows is collected and stored for a short time prior to mixing, excessive fluctuations in the temperature of the liquid coming from the heating appliance are already damped somewhat, whereby temperature control is further simplified.

The invention also relates to a device for performing the above described method. Such a device is provided according to the invention with a first inlet conduit for connecting to the heating appliance, a second inlet conduit for connecting to a source of liquid with a determined lower temperature and provided with controllable shut-off means, a mixing chamber connected to the first and second inlet conduit, an outlet conduit connected to the mixing chamber and provided with means for measuring the temperature of the liquid flowing therethrough, and control means connected for transmitting signals to the shut-off means, wherein the temperature measuring means are connected for transmitting signals to the control means.

Preferred embodiments of this device are described in the dependent claims 7-12.

Finally, the invention relates further to a heating system equipped with a control device of the above described type.

The invention is elucidated on the basis of a number of embodiments, wherein reference is made to the annexed drawing in which corresponding parts are designated with the same reference numerals, and wherein:

fig. 1 shows a schematic view of a heating system with a control device according to the invention;

fig. 2 is a partly cut away perspective view of the control device shown in fig. 1;

fig. 3 is a partly cut away perspective view of an alternative embodiment of the heat exchanger shown in fig. 2; and

fig. 4 is a partly sectional perspective view of a second alternative embodiment of the heat exchanger.

A device 1 (fig. 1) for controlling the temperature of a liquid supplied to at least one take-off point by a non-controllable, in particular a natural energy heating appliance 2 powered is provided with an inlet conduit 3 joined to a connection 22 of the heating appliance and a second inlet conduit 4 connected to a source 7 of liquid with a determined lower temperature. The regular water supply system can for instance function as source of liquid at low temperature. The first and second inlet conduits 3,4 come together in a mixing chamber which in the embodiment shown forms part of a thermostatic mixing valve 5. An outlet conduit 6 is connected to the mixing valve 5. The thermostatic mixing valve comprises means for measuring the temperature of the liquid delivered to the outlet conduit 6 and means for opening and closing at choice the second inlet conduit 4. The shut-off means are controlled by control means which receive control signals from the temperature measuring means.

The non-controllable heating appliance 2 is formed in the shown embodiment by a solar boiler which consists of a transparent plate 8 which is arranged in the outside wall or the roof of a building and behind which a water reservoir 10 is arranged with interposing of an air cavity 9. Water reservoir 10 is enclosed on all sides by an insulation layer 11. Under the influence of the incident solar radiation S the water present in reservoir 10 is heated, wherein it flows slowly from the lower connection 23 in the direction of the upper connection 22. The water for heating is transported via water conduit 7 and a non-return valve 13 to the connection 23 of solar boiler 2. An adjustable pressure-sensitive valve 14 serves to prevent the pressure in reservoir 10 becoming too high, for instance when the water present therein begins to boil. In that case a part of the water present is drained via valve 14 to a sewer connection 15.

When a user needs water and opens a tap somewhere in the building, a flow of water begins from reservoir 10 to the take-off point where the user is located. In order to protect the user against excessive temperature of the water from heating appliance 2, this water is mixed if necessary with cold water from water conduit 7, which water is guided via a non-return valve 12 to the second inlet conduit 4. In the thermostatic mixing valve 5 this mains water, the temperature of which in general only varies a little from for instance 5 to 15 ° C, is mixed with the hot water from the heating appliance which can reach temperatures of a maximum of 135 ° C.

The mixing is preferably performed such that the water which flows via the outlet conduit 6 to the take-off point is not hotter than 80 ° C, which is the maximum safe temperature for human users. There will however often be an auxiliary heating apparatus present between the outlet conduit 6 and the take-off point, for instance an electrical or gas-fired boiler, for additional heating of the water when the solar radiation contains too little energy (for example during the winter or on cloudy days). Such an auxiliary heating apparatus may not generally be exposed to a supply flow with a temperature of more than 90 ° C, so that interposing of the control device 1 is also necessary in this case.

In order to protect the mixing valve 5 itself against excessive inlet temperatures and also to prevent possible larger temperature fluctuations as far as possible, the flow of hot water from heating appliance 2 is placed in heat-transferring contact with the flow of cold water from the water supply system 7 before reaching mixing valve 5. This takes place in a heat exchanger 16.

The non-return valves 12, 13 otherwise serve to prevent that, when the water in the heating appliance 2 reaches a determined very high temperature of for instance 135 ° C, hot water flows back into the mains supply system 7 as a result of the associated pressure.

Together with the so-called inlet combination (consisting of non-return valve 13 and pressure valve 14) the control device 1 can be assembled into a single cabinet 17 (fig. 2) for simple connection. This cabinet 17 can be placed by a fitter in the vicinity of heating appliance 2 and be connected up rapidly by interconnecting the conduits 3,4,6,7 and 15. Cabinet 17 will generally be placed in an attic as the solar boiler 2 has to be placed obliquely for optimum performance, and the only sloping surfaces in a building are generally to be found on the roof. When the attic area is heated this moreover ensures that the connections 22,23 of solar boiler 2 remain frost-free, whereby frost damage to the solar boiler is prevented.

In the embodiment shown the heat exchanger 16 is formed by a storage container 19 which is arranged in the first inlet conduit and the content of which is greater than that of the first inlet conduit 3 and through which the second inlet conduit 4 is guided. In order to obtain the greatest possible heat exchanging surface area, the cold water inlet conduit 4 is wound to a spiral 20. Large temperature fluctuations are damped by the thermal mass of the water situated in storage container 19. This is important since the thermostatic mixing valve 5 generally requires a certain response time before it admixes sufficient cold water to the hot water from the first inlet conduit 3. Sudden temperature increases of the hot water supplied to mixing valve 5 could thus result in water of too high a temperature being passed through mixing valve 5 before sufficient cold water is admixed.

The cold water from water supply system 7 is fed as according to arrow CI to the control device 1 and fed for the greater part through non-return valve 13 in the direction of arrow CO to the lower connection 23 of solar boiler 2. The hot water coming from the solar boiler is fed as according to arrow H from the upper connection 22 to control device 1 and flows through an inflow opening 21 in storage container 19 which also functions as heat exchanger 16. When a user needs water at a take-off point this is supplied via the first inlet conduit 3 to mixing valve 5 where as much cold water is then admixed from the second inlet conduit 4 that the water exiting as according to arrow M has a temperature such as is chosen by the user by means of the adjustment knob 18. This target temperature can for instance be set to any desired value between 30 and 70 ° C. As a result of interposing the heat exchanger 16 the inlet temperature of the water supplied to mixing valve 5 via the first inlet conduit 3 is limited, whereby a comparatively inexpensive mixing valve can be used.

A better heat transfer can be achieved in heat exchanger 16 when the hot water is supplied not axially but tangentially to the storage container 19. For this purpose the injection aperture 21 can be arranged close to the cylindrical side wall of the storage container, practically parallel to a tangent to the cylindrical surface (fig. 3).

In an embodiment which is simpler and which can thereby be manufactured at lower cost, the heat exchanger 16 is formed by a double-walled tube. An optimum heat transfer is herein obtained when the inner tube forms part of the first inlet conduit 3 for the hot water and the outer tube forms part of the second inlet conduit 4 for the cold water. In order to embody the heat exchanger 16 as compactly as possible it can be wound to a spiral (fig. 4).

Claims

1. Method for controlling the temperature of a liquid which is supplied to at least one take-off point by a non-controllable, in particular a natural energy powered heating appliance, by measuring the temperature of the liquid prior to the take-off point, admixing to the liquid flow from the heating appliance a second liquid flow with a determined lower temperature when the measured temperature exceeds a determined target value, and continuously adapting the quantity of the second liquid flow for admixing such that the measured temperature of the mixture approaches as closely as possible the determined target value.

2. Method as claimed in claim 1, **characterized in that** prior to mixing the liquid flows are brought into mutual heat-transferring contact.

3. Method as claimed in claim 1 or 2, **characterized in that** one of the liquid flows is collected and stored for a short time prior to mixing.

4. Method as claimed in claims 2 and 3, **characterized in that** the other liquid flow is brought into heat-transferring contact with the stored liquid flow.

5. Method as claimed in any of the foregoing claims, **characterized in that** the target value of the temperature is adjusted prior to delivery of liquid from the heating appliance.

6. Device for controlling the temperature of a liquid which is supplied to at least one take-off point by a non-controllable, in particular a natural energy powered heating appliance, provided with a first inlet conduit for connecting to the heating appliance, a second inlet conduit for connecting to a source of liquid with a determined lower temperature and provided with controllable shut-off means, a mixing chamber connected to the first and second inlet conduit, an outlet conduit connected to the mixing chamber and provided with means for measuring the temperature of the liquid flowing therethrough, and control means connected for transmitting signals to the shut-off means, wherein the temperature measuring means are connected for transmitting signals to the control means.

7. Control device as claimed in claim 6, **characterized in that** the first and second inlet conduit are mutually connected for heat transfer over at least a part of their length.

8. Control device as claimed in claim 6 or 7, **characterized by** a storage container which is arranged in one of the inlet conduits and the content of which is greater than that of the associated inlet conduit.

9. Control device as claimed in claims 7 and 8, **characterized in that** the other inlet conduit is carried through the storage container.

10. Control device as claimed in claim 7, **characterized in that** one of the inlet conduits is enclosed over at least a part of its length by the other inlet conduit.

11. Control device as claimed in claim 10, **characterized in that** the inlet conduits are wound spirally over at least a part of their mutually enclosing length.

12. Control device as claimed in one or more of the claims 6-11, **characterized in that** the control means are adjustable.

13. Heating system provided with a non-controllable, in particular a natural energy powered heating appliance, at least one take-off point for heated liquid connected to the heating appliance, and a control device as claimed in one or more of the claims 6-12 interposed between the heating appliance and the at least one take-off point.

14. Heating system as claimed in claim 13, **characterized in that** the heating appliance is a so-called solar boiler.

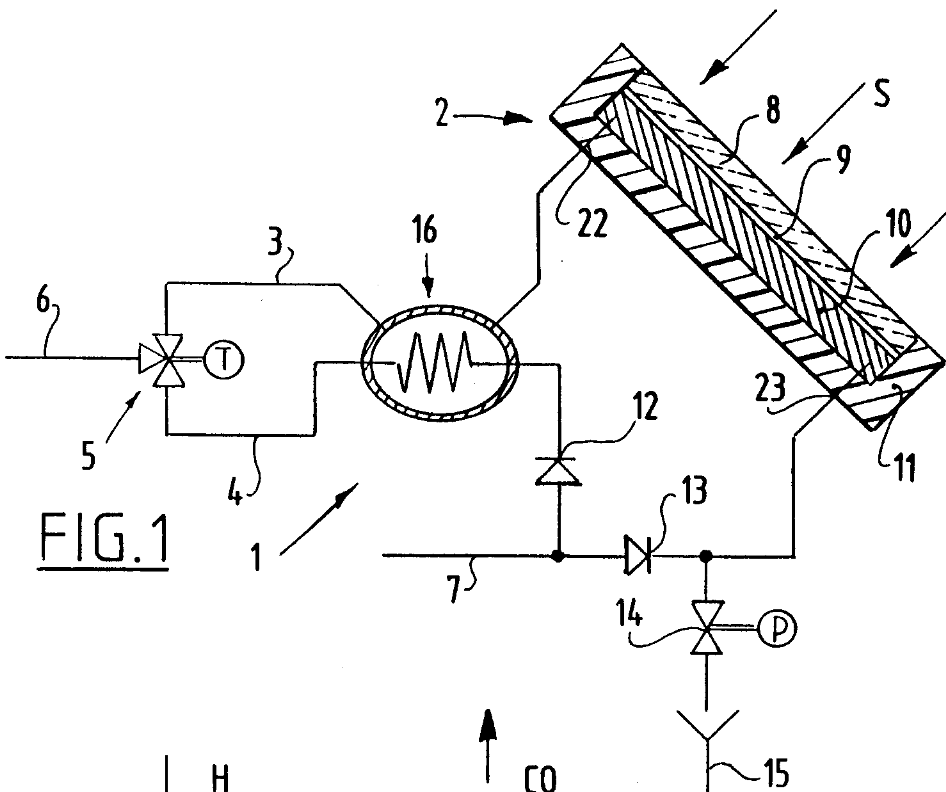
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FIG.1

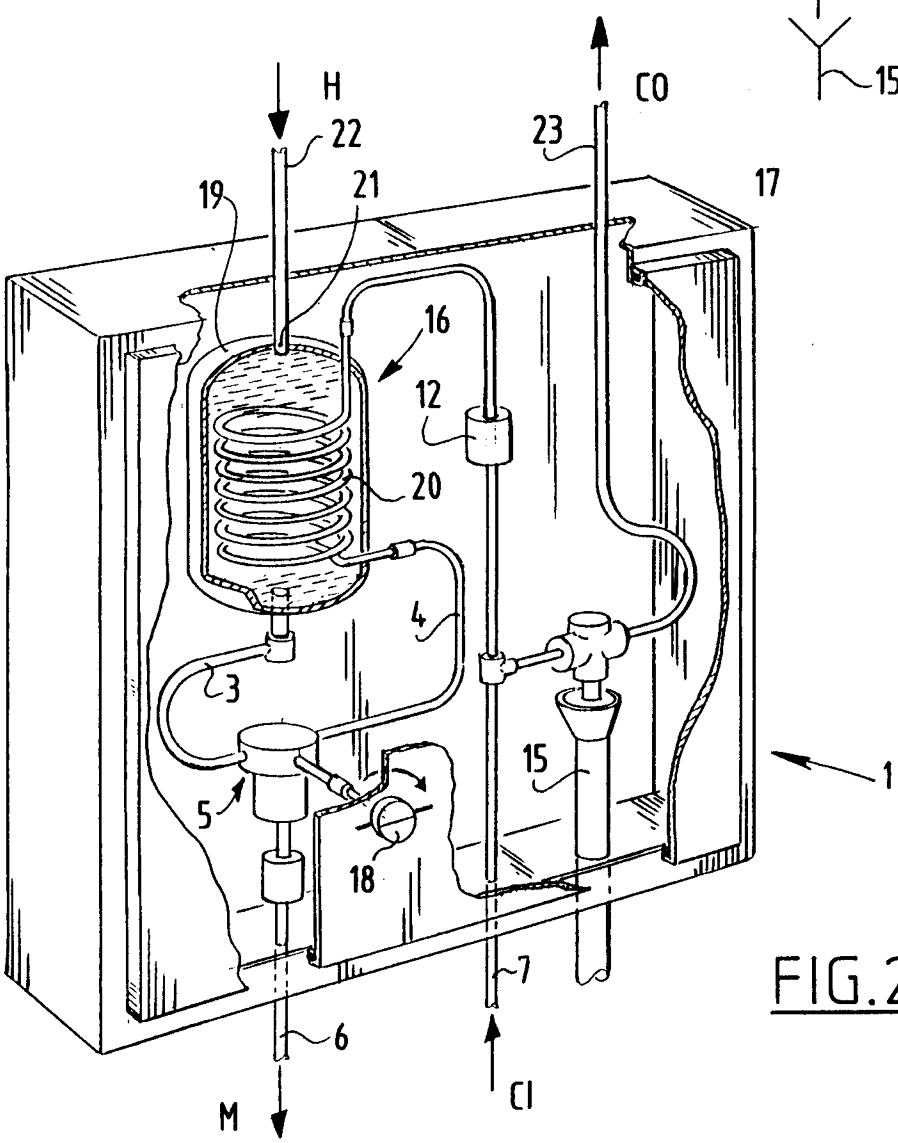
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FIG.2

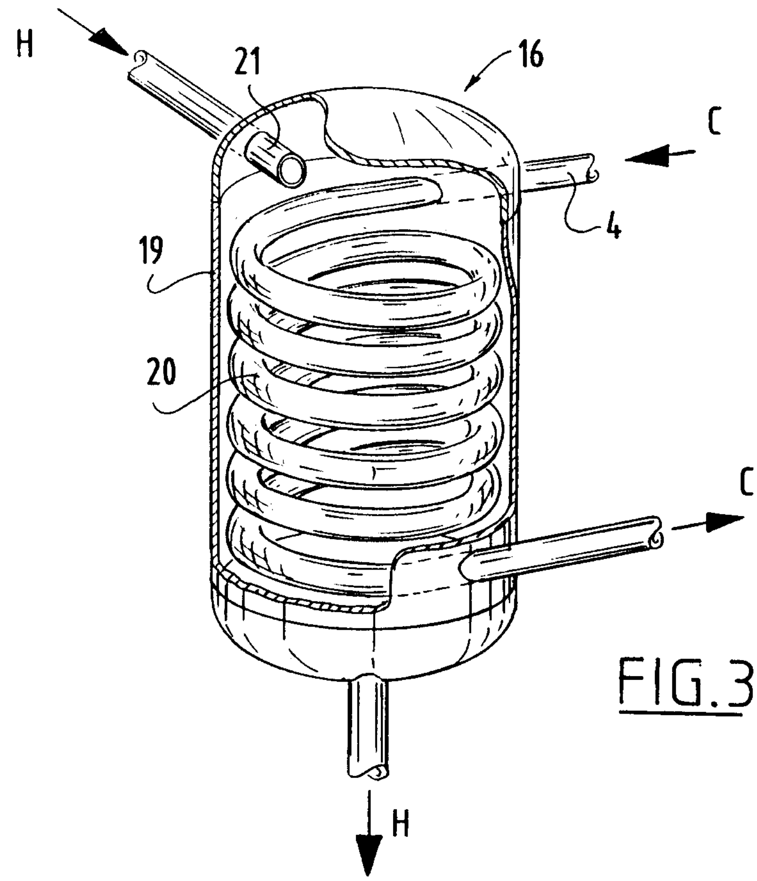

FIG.3

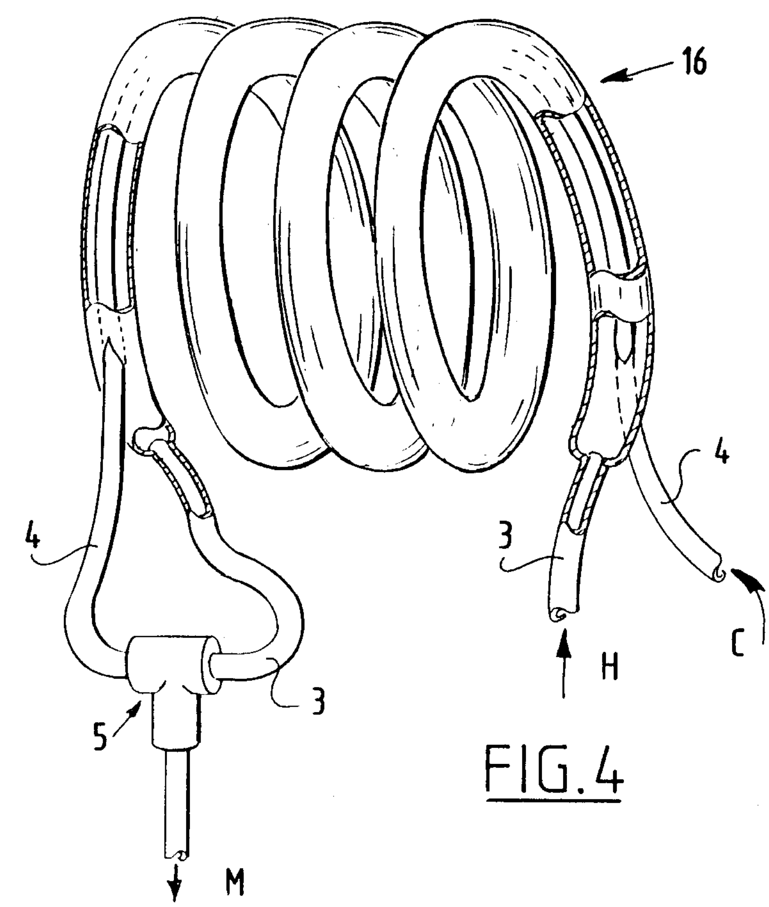

FIG.4

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EUROPEAN SEARCH REPORT

Application Number
EP 94 20 3768

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	FR-A-2 329 951 (GRAS) * the whole document *	1,6,13,14	F24D19/10 F24D17/00 F24J2/40
A	DE-U-90 14 688 (JOH. VAILLANT GMBH U. CO) * claims; figures *	1,6	
A	EP-A-0 491 460 (PERLMAN) * abstract *	1,2,6	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
F24D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 April 1995	Van Gestel, H

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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