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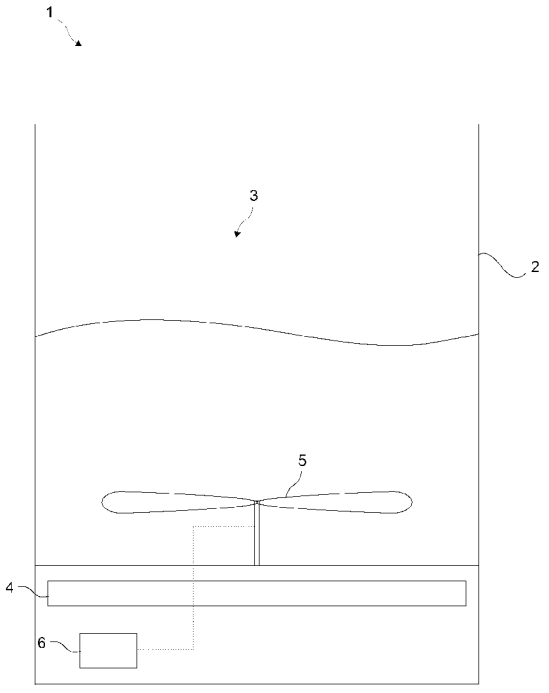
[Continued on next page]

(54) Title: A SILENTLY OPERATING LIQUID HEATING DEVICE

Figure1



(57) Abstract: The present invention relates to a liquid heating device (1) comprising a body (2), a container (3) that is disposed in the body (2) and wherein the water to be heated is filled, a heater (4) that provides the heating of the container (3), and a stirring means (5) that provides the stirring of the water inside the container (3).

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Description

A SILENTLY OPERATING LIQUID HEATING DEVICE

[0001] The present invention relates to a liquid heating device wherein the liquid is stirred.

[0002] In liquid heating devices, especially in water heaters used for boiling water, the heating process generally takes place at the base of the container containing the liquid. In this case, the liquid in the vicinity of the base of the container is heated faster and the temperature decreases gradually from the base upward and a temperature difference occurs in the vertical direction within the liquid. For the reason that the base of the container is heated up excessively before the liquid contained in the container has not yet boiled throughout, regional evaporations are observed on the base. The liquid evaporating on the base rises upward in tiny bubbles because the density of the gas phase is lower. As the liquid bubbles in the gas phase rise, they come into contact with the colder liquid and burst, making noise. In the state of the art stirring of the liquid by stirrers disposed inside the container as a solution to this problem is known. By stirring the liquid, the temperature difference throughout the liquid decreases and it is tried to prevent the bursting of the liquid bubbles and reduce the noise level. However, the liquid heating devices with the said stirrers cannot still operate completely silently.

[0003] In the state of the art British Patent Application No. GB2445070, a water heater having a stirrer is disclosed.

[0004] In the state of the art Chinese Patent Application No. CN103815785, a water heater having a stirrer is disclosed.

[0005] The aim of the present invention is the realization of a liquid heating device that can be operated silently.

[0006] The liquid heating device realized in order to attain the aim of the present invention, explicated in the claims, comprises a control unit that enables the liquid therein to be stirred at a maximum first limit rotational speed until the temperature of the liquid reaches a first limit temperature predetermined by the producer and at a higher speed than the first limit rotational speed until the liquid increases from the first limit temperature to

a second limit temperature predetermined by the producer. In the liquid heating device of the present invention, the liquid rising in bubbles upon changing to the gas phase in the vicinity of the base of the container containing the liquid is prevented from meeting lower temperatures within the liquid and bursting, thus providing the silent operation of the liquid heating device.

[0007] In an embodiment of the present invention, it has been found as a result of the experiments carried out by the producer that the first limit temperature is inversely proportional to the power of the heater used in the heating of the liquid, and it is calculated as such and saved in the memory of the control unit.

[0008] In an embodiment of the present invention, it has been found as a result of the experiments carried out by the producer that the second limit temperature is directly proportional to the power of the heater used in the heating of the liquid, and it is calculated as such and saved in the memory of the control unit.

[0009] In another embodiment of the present invention, when the temperature of the liquid in the container is between the first limit temperature and the second limit temperature, the liquid is stirred at a constant second limit rotational speed predetermined by the producer. By stirring the liquid in the container at a constant speed, the temperature difference is eliminated and thereby total noise level is reduced by providing that the bubbles reach the surface without bursting, in other words, by providing that the bubbles are mixed into the liquid and disposed of before they burst.

[0010] In another embodiment of the present invention, when the temperature of the liquid in the container is between the first limit temperature and the second limit temperature, the liquid is stirred at variable speeds that are higher than the first limit rotational speed. In this embodiment, the stirring speed is changed depending on the parameters that have an effect on the total noise level.

[0011] In a version of this embodiment, the liquid is stirred in the said temperature range at speeds starting with the first limit rotational speed and accelerating speeds toward a third limit rotational speed predetermined by

the producer. By means of the rotational speed increased in parallel with the increasing amount of the liquid changing to the gas phase, the total noise level is reduced.

[0012] In another version of this embodiment, the liquid is stirred in the said temperature range first by accelerating from the first limit rotational speed to the third limit rotational speed and then stirred by slowing down the rotational speed from the third limit rotational speed and reducing the same to the first limit rotational speed. When the liquid's boiling point is approached, in other words, when the temperature difference within the liquid decreases and the temperature across the liquid comes to the same level, the bubbles formed by the liquid changing to the gas phase can reach the surface without bursting. In this case, by reducing the rotational speed over the time, the stirring means that performs the stirring process is prevented from increasing the total noise level.

[0013] In another embodiment of the present invention, the first limit rotational speed is a speed between zero and two hundred and fifty revolutions per minute. As a result of the experiments carried out by the producer, the producer has obtained the said rotational speeds as the speeds that do not increase the total noise level and the determined rotational speeds are saved in the memory of the control unit. In another embodiment of the present invention, the second limit rotational speed is a speed between two hundred fifty and five hundred revolutions per minute. In another embodiment of the present invention, the third limit rotational speed is a speed between two hundred fifty and five hundred revolutions per minute.

[0014] In another embodiment of the present invention, the first limit temperature is a temperature between 30 and 60 °C, in another embodiment of the present invention, the second limit temperature is a temperature between 80 and 100 °C. The said temperatures are the beginning and ending points of the temperature ranges obtained by the producer as a result of experiments, within which the liquid heating device emits noise which is different from the levels of noise that can be considered silent.

[0015] In the liquid heating device of the present invention, a more silent liquid heating process compared with such samples that do not perform stirring

or that continuously perform stirring at a constant speed in the state of the art is realized. The silent stirring process is realized by preventing bursting of the bubbles due to the temperature difference across the liquid before they reach the surface and by preventing the stirring means from making extra noise by stirring at low speeds at low temperatures where there is no bubble formation and at high temperatures where the bubbles reach the surface.

[0016] The liquid heating device realized in order to attain the aim of the present invention is illustrated in the attached figures where

[0017] Figure 1 - is the schematic view of a liquid heating device.

[0018] The elements illustrated in the figures and the steps are numbered as follows:

1. Liquid heating device
2. Body
3. Container
4. Heater
5. Stirring means
6. Control unit

[0019] T1. First limit temperature

[0020] T2. Second limit temperature

[0021] R1. First limit rotational speed

[0022] R2. Second limit rotational speed

[0023] R3. Third limit rotational speed

[0024] The liquid heating device (1) comprises a body (2), a container (3) that is disposed in the body (2) and wherein the water to be heated is filled, a heater (4) that provides the heating of the container (3), and a stirring means (5) that provides the stirring of the water inside the container (3).

[0025] The liquid heating device (1) of the present invention comprises a control unit (6) that by controlling the stirring means (5) enables the liquid in the container (3) to be stirred at a first limit rotational speed (R1) at most until the liquid reaches a predetermined first limit temperature (T1) and at a speed which is greater than the first limit rotational speed (R1) when the temperature of the liquid is between the first limit temperature (T1) and a

second limit temperature (T2) which is greater than the first limit temperature (T1).

[0026] In the liquid heating device (1) of the present invention, changing to the gas phase does not occur in the vicinity of the base of the container (3) until the liquid inside the container (3) reaches the first limit temperature (T1) and the total noise level of the liquid heating device (1) is low. Within this period, the stirring means (5) is not operated or is operated at low speed, in other words, by stirring the liquid at the first limit rotational speed (R1) at most, the stirring means (5) is prevented from making extra noise. With the temperature of the liquid in the container (3) increasing, in other words, with the temperature exceeding the first limit temperature (T1), the liquid in the vicinity of the base of the container (3) begins to change to the gas phase and the liquid changing to the gas phase begins to rise in bubbles. From the temperature where bubbles are forming on, in other words, from the first limit temperature (T1) on, with the stirring means (5) being stirred by increasing the rotational speed, in other words, at a speed higher than the first limit rotational speed (R1), the temperature difference across the liquid is decreased and the bubbles are enabled to reach the surface without bursting. Thus, the total noise level of the liquid heating device (1) is reduced. What is meant by the expression of the temperature of the liquid inside the container (3) is the mean temperature of the liquid, and the temperature of the liquid in the vicinity of the base of the container (3) is higher than the temperature of the liquid and the temperature of the liquid in the vicinity of the surface is lower than the temperature of the liquid. The temperature of the liquid can be measured by any temperature sensor as well as calculated by means of the data received from a thermostat under the base of the container (3).

[0027] In an embodiment of the present invention, the first limit temperatures (T1) determined as inversely proportional to the power of the heater (4) are saved in the memory of the control unit (6). When the power of the heater (4) is high, the base of the container (3) heats up faster and bursting of the liquid bubbles occurs at lower liquid temperatures. Therefore, the value of the first limit temperature (T1) is kept low in the liquid heating devices (1)

having a high power heater (4). For example, in a liquid heating device (1) having a 1500W heater (4), the first limit temperature (T1) is 55°C, while in a liquid heating device (1) having a 1800W heater (4), the first limit temperature (T1) is 35°C. By means of this embodiment, the same control unit (6) can be used in liquid heating devices (1) having different heaters (4). Thus, cost advantage is provided in the production of the liquid heating devices (1) in different types.

[0028] In another embodiment of the present invention, the second limit temperatures (T2) determined as directly proportional to the power of the heater (4) are saved in the memory of the control unit (6). When a high power heater (4) is used, the temperature difference in the vertical direction across the liquid in the container (3) is higher when compared with the case with the low power heater (4). In other words, with the low power heaters (4), the liquid inside the container (3) is heated more homogenously. Therefore, when low power heaters (4) are used, stirring of the liquid when it is close to boiling is no longer necessary. For example, in a liquid heating device (1) having a 1500W heater (4), the second limit temperature (T2) is 80°C, while in a liquid heating device (1) having a 1800W heater (4), the second limit temperature (T2) is 95°C. By means of this embodiment, the same control unit (6) can be used in liquid heating devices (1) having different heaters (4). Consequently, cost advantage is provided in the production of the liquid heating devices (1) in different types.

[0029] In another embodiment of the present invention, when the temperature of the liquid inside the container (3) is between the first limit temperature (T1) and the second limit temperature (T2), the control unit (6) enables the liquid to be stirred at a predetermined constant second limit rotational speed (R2) which is greater than the first limit rotational speed (R1). In this embodiment, the liquid is stirred at higher speeds such that the temperature difference is reduced and it is provided that the liquid bubbles in gas phase which multiply with the increasing of the temperature of the liquid inside the container (3) reach the surface of the liquid without bursting.

[0030] In another embodiment of the present invention, when the temperature of the liquid inside the container (3) is between the first limit temperature (T1) and the second limit temperature (T2), the control unit (6) enables the liquid to be stirred at variable speeds which are higher than the predetermined first limit rotational speed (R1). For example, the rotational speed rises by increasing in proportion to the temperature of the liquid inside the container (3).

[0031] In another embodiment of the present invention, when the temperature of the liquid inside the container (3) is between the first limit temperature (T1) and the second limit temperature (T2), the control unit (6) enables the liquid to be stirred at such speeds increasing from the first limit rotational speed (R1) toward a predetermined third limit rotational speed (R3) which is higher than the first limit rotational speed (R1). As the liquid inside the container (3) heats up, the temperature difference between the liquid in the vicinity of the base of the container (3) and the liquid in upper parts increases as well. By means of this embodiment, as the temperature of the liquid increases, the rotational speed of the stirring means (5) is increased and thereby bursting of the liquid bubbles in gas phase is prevented.

[0032] In another embodiment of the present invention, when the temperature of the liquid inside the container (3) is between the first limit temperature (T1) and the second limit temperature (T2), the control unit (6) enables the liquid to be stirred first at speeds increasing from the first limit rotational speed (R1) toward the third limit rotational speed (R3) and then at speeds decreasing from the third limit rotational speed (R3) toward the first limit rotational speed (R1). When the liquid inside the container (3) is close to boiling, most of the liquid in the vicinity of the base of the container (3) changes to gas phase. In this case, as the liquid comes close the boiling point, the level of noise produced by the liquid heating device (1) decreases. In parallel with the level of noise produced by the liquid heating device (1), the rotational speed of the stirring means (5) is first increased and then as the liquid comes close to boiling, the rotational speed is reduced. By changing the rotational speed of the stirring means (5) in parallel with the noise produced by the liquid heating device (1) in the state

where the liquid is not stirred, the noise produced by the stirring means (5) itself is prevented from increasing the total noise level.

[0033] In another embodiment of the present invention, the first limit rotational speed (R1) is a speed between zero and two hundred fifty revolutions per minute (rpm). At the beginning of the liquid heating process, in other words, before the liquid in the vicinity of the base of the container (3) has not yet begun to change to gas phase, the liquid is stirred at low speeds. Thus, the noise produced by the stirring means (5) itself is prevented from increasing the total noise level.

[0034] In another embodiment of the present invention, the second limit rotational speed (R2) is a speed between two hundred fifty and five hundred revolutions per minute (rpm). The rotational speeds required to suppress the noise produced by the bubbles that changed to gas phase and burst are determined as a result of the experiments carried out by the producer. In order to provide effective noise elimination, the liquid is required to be stirred between the first limit temperature (T1) and the second limit temperature (T2) at a speed of 250 to 500 revolutions per minute. At speeds higher than 500 revolutions per minute, the stirring means (5) produces a noise at a level greater than the noise emitted by the bursting bubbles.

[0035] In another embodiment of the present invention, the third limit rotational speed (R3) is a speed between two hundred fifty and five hundred revolutions per minute (rpm). Also in the embodiments where the liquid is stirred at varying speeds, the liquid must be stirred at the speeds mentioned in the above embodiment.

[0036] In another embodiment of the present invention, the first limit temperature (T1) is a temperature between 30 and 60°C. Depending on the power of the heater (4), the temperature where the bursting bubbles emit noise at a noticeable level varies. The values determined by the producer as a result of the experiments are between 30 and 60°C.

[0037] In another embodiment of the present invention, the second limit temperature (T2) is a temperature between 80 and 100°C. Depending on the power of the heater (4), the temperature at which the noise comes

out/occurs at a noticeable level due to the temperature difference during heating of the liquid varies. The values determined by the producer as a result of the experiments for the second limit temperature (T2) are between 80 and 100°C.

[0038] In another embodiment of the present invention, the stirring means (5) comprises a blade rotating as attached to a shaft. The shaft can be disposed at the base of the container (3) as well as on the lid (not shown in the figures) that closes the container (3).

[0039] In another embodiment of the present invention, the stirring means (5) comprises a motor (not shown in the figures) disposed under the base of the container (3) that can create a rotating magnetic field and a magnetic element (not shown in the figures) that is placed inside the container (3) and that rotates by means of the rotating magnetic field applied by the motor, thus providing stirring of the liquid inside the container (3).

[0040] In another embodiment of the present invention, the container (3) is coated with a hydrophobic material. Thus, the liquid in the vicinity of the base of the container (3) is enabled to change to gas phase easily and the noise level is reduced.

[0041] In another embodiment of the present invention, the container (3) is coated with polytetrafluoroethylene. By providing that the liquid in the vicinity of the base of the container (3) changes in greater volumes to gas phase by reducing the friction of the base of the container (3), the bubbles are prevented from bursting and the noise level is reduced.

[0042] In the liquid heating device (1) of the present invention, by not stirring or stirring at low speeds the liquid before the occurrence of changing to gas phase in the liquid heating process, the stirring means (5) is prevented from contributing to the total noise level and by stirring the liquid at higher speeds as the liquid begins to change to gas phase, homogenous heating of the liquid is provided and by thus the bubbles changing to gas phase are prevented from making noise by bursting. In sum, by stirring the liquid at varying speeds, the stirring means (5) is prevented from raising the total noise level.

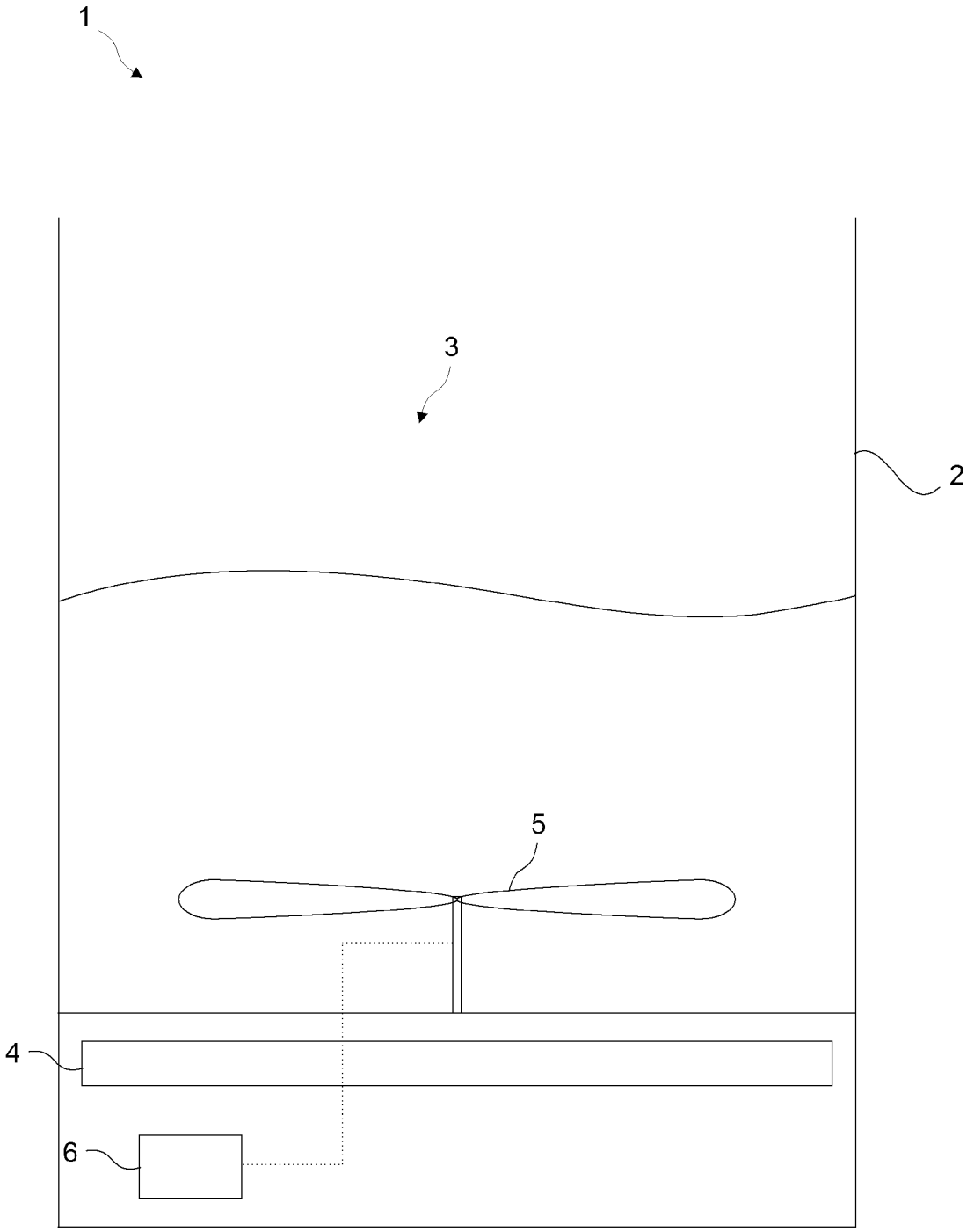
Claims

1. A liquid heating device (1) **comprising** a body (2), a container (3) that is disposed in the body (2) and wherein the liquid to be heated is filled, a heater (4) that provides the heating of the container (3), and a stirring means (5) that provides the stirring of the water inside the container (3), **characterized by** a control unit (6) that by controlling the stirring means (5) enables the liquid in the container (3) to be stirred at a first limit rotational speed (R1) at most until the liquid reaches a predetermined first limit temperature (T1) and at a speed which is greater than the first limit rotational speed (R1) when the temperature of the liquid is between the first limit temperature (T1) and a second limit temperature (T2) which is greater than the first limit temperature (T1).
2. A liquid heating device (1) as in Claim 1, **characterized by** the control unit (6) in the memory of which the first limit temperatures (T1) determined as inversely proportional to the power of the heater (4) are saved.
3. A liquid heating device (1) as in any one of the above claims, **characterized by** the control unit (6) in the memory of which the second limit temperatures (T2) determined as directly proportional to the power of the heater (4) are saved.
4. A liquid heating device (1) as in any of the claims 1 to 3, **characterized by** the control unit (6) that enables the liquid inside the container (3) to be stirred at a predetermined constant second limit rotational speed (R2) when the temperature of the liquid is between the first limit temperature (T1) and the second limit temperature (T2).
5. A liquid heating device (1) as in any of the claims 1 to 3, **characterized by** the control unit (6) that enables the liquid inside the container (3) to be stirred at predetermined varying speeds when the temperature of the liquid is between the first limit temperature (T1) and the second limit temperature (T2).
6. A liquid heating device (1) as in Claim 5, **characterized by** the control unit (7) that enables the liquid inside the container (3) to be stirred at speeds increasing from the first limit rotational speed (R1) to a predetermined third limit rotational speed (R3) when the temperature of the liquid is between the first limit temperature (T1) and the second limit temperature (T2).
7. A liquid heating device (1) as in Claim 5, **characterized by** the control unit (6) that enables the liquid inside the container (3) to be stirred first at speeds

increasing from the first limit rotational speed (R1) toward the third limit rotational speed (R3) and then at speeds decreasing from the third limit rotational speed (R3) toward the first limit rotational speed (R1).

8. A liquid heating device (1) as in any one of the above claims, **characterized by** the first rotational speed (R1) which is between 0 and 250 revolutions per minute.
9. A liquid heating device (1) as in Claim 4, **characterized by** the second rotational speed (R2) which is between 250 and 500 revolutions per minute.
10. A liquid heating device (1) as in Claim 6 or 7, **characterized by** the third rotational speed (R3) which is between 250 and 500 revolutions per minute.
11. A liquid heating device (1) as in any one of the above claims, **characterized by** the first limit temperature (T1) which is between 30 and 60°C.
12. A liquid heating device (1) as in any of the above claims, **characterized by** the second limit temperature (T2) which is between 80 and 100°C.

Figure1



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/079193

A. CLASSIFICATION OF SUBJECT MATTER
INV. A47J43/07
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)
A47J

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	CN 202 891 694 U (TOP ELECTRIC APPLIANCES IND) 24 April 2013 (2013-04-24)	1
A	claim 1	2-12

☐ 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
9 January 2017	23/01/2017

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1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/079193

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 202891694 U	24-04-2013	NONE	