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(71) Applicant: **BREVILLE PTY LIMITED** [AU/AU];
Ground Floor, Suite 2, 170-180 Bourke Road, Alexandria,
New South Wales 2015 (AU).

(72) Inventors: **FRYER, Scott**; c/o Breville Pty Limited,
Ground Floor, Suite 2, 170-180 Bourke Road, Alexandria,
New South Wales 2015 (AU). **TOFAILI, Alex**; c/o Breville
Pty Limited, Ground Floor, Suite 2, 170-180 Bourke Road,
Alexandria, New South Wales 2015 (AU). **PSAROLOGOS, Con**; c/o Breville Pty Limited, Ground Floor, Suite
2, 170-180 Bourke Road, Alexandria, New South Wales
2015 (AU). **REN, Xiang**; c/o Breville Pty Limited, Ground

Floor, Suite 2, 170-180 Bourke Road, Alexandria, New
South Wales 2015 (AU).

(74) Agent: **SPRUSON & FERGUSON**; GPO BOX 3898,
SYDNEY, New South Wales 2001 (AU).

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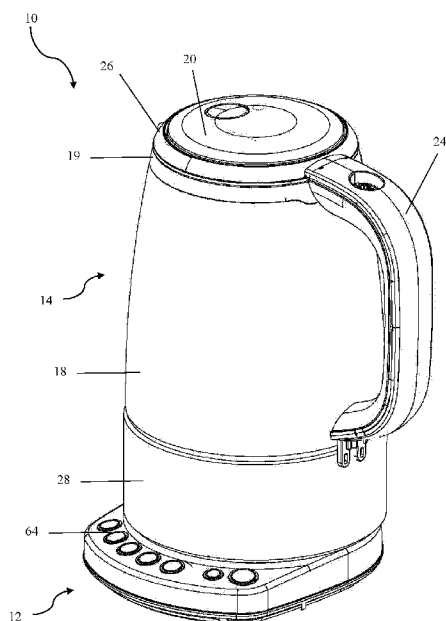


Fig. 1

(57) Abstract: A kettle (10) comprising: a hollow body (14) having a bottom wall (16) and a side wall (18) extending upwardly from the bottom wall (16) to a rim (19), with the side wall (18) surrounding a cavity (22) to receive water to be heated, the bottom wall (16) having an inner surface (17) facing the cavity (22), the inner surface (17) having an area; and a heating element (32) in thermal communication with the bottom wall (16) to thereby heat the water, the heating element (32) occupying a horizontal area that is at least 30% of the inner surface area (17).

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KETTLE

Field

[0001] This invention relates to a kettle.

Background

[0002] Kettles are well-known devices to rapidly boil water for, for example, making tea, cooking, or the like. A disadvantage of presently known kettles is that as water is heated by a heating element, a small quantity of water close to the heating element is heated to above its boiling point. The quantity of water changes phase to steam and collects as a steam bubble at a steam bubble initiation site, usually a surface imperfection. As the steam bubble has a lower density than water the steam bubble rises due to buoyancy. As the steam bubble rises, the temperature of the surrounding water is below boiling temperature, causing the steam bubble to also cool down below boiling temperature. As the steam bubble cavitates, significant sound waves are created. The noise caused by the cavitation is undesirable in a home environment. It is very difficult to spread the heat over a kettle surface of a tube heating element of the kind used in a variety of kettles. Therefore, water adjacent the tube heating element tends to heat up faster as opposed to water away from it creating an imbalance in temperature and magnifying the cavitation.

[0003] Attempts have been made to design a kettle to avoid the formation of steam bubbles by subjecting the interior surface of the kettle to a surface treatment such that minimal, or no, surface imperfections exist. This approach eliminates the initiation sites for steam bubbles, which reduces the amount of bubbles formed, the amount of bubbles that cavitate and therefore the noise level. However, the surface finish is vulnerable to damage such as scratching etc. Yet further, following successive boiling cycles, water will leave behind a residue, which will then act as steam bubble initiation sites.

Summary of Invention

[0004] It is an object of the present invention to address the above discussed problem, or at least provide a useful alternative to the above-mentioned kettles.

[0005] In a first aspect the present invention provides a kettle comprising:

a hollow body having a bottom wall and a side wall extending upwardly from the bottom wall to a rim, with the side wall surrounding a cavity to receive water to be heated, the bottom wall having an inner surface facing the cavity, the inner surface having an area; and

a heating element in thermal communication with the bottom wall to thereby heat the water; the heating element occupying a horizontal area that is at least 30% of the inner surface area.

[0006] Preferably, the horizontal area is in a plane below the bottom wall.

[0007] Preferably, the inner surface is generally planar and the plane is parallel to the inner surface.

[0008] Preferably, the plane is horizontal when the kettle is resting on a surface.

[0009] Preferably, the inner surface is horizontal when the kettle is resting on a surface.

[0010] Preferably, the kettle further comprises a housing fixed to the hollow body, the housing comprising a sound-isolating layer.

[0011] Preferably, the housing is fixed to the hollow body by an adhesive located between the hollow body and the housing.

[0012] Preferably, the adhesive bonded to the sound-isolating layer.

[0013] Preferably, the heating element is retained by the sound-isolating layer such that a gap exists between the heating element and the bottom wall.

[0014] Preferably, the sound-isolating layer is formed from rubber silicone

[0015] Preferably, the housing further comprises a sound-absorbing layer.

[0016] Preferably, the sound-absorbing layer is located below the sound-isolating layer.

[0017] Preferably, the sound-absorbing layer is a foam.

[0018] Preferably, the kettle further comprises:

- a base to receive the hollow body and the housing;
- a controller located in the base;
- a magnetic power supply located in the base; and
- a receiving power module located in the housing and connected to the heating element,

wherein the magnetic power supply is configured to supply power to the receiving power module to supply power to the heating element.

[0019] Preferably, the controller is operatively connected to the heating element using a power cable to supply power to the heating element, and a communication cable to receive sensor data from the heating element.

[0020] Preferably, the base has a projection and the housing has a recess, the projection being locatable in the recess such that, when the projection is located in the recess, the magnetic power supply is aligned with receiving power module to supply power.

[0021] Preferably, the heating element occupies a horizontal area that is at least 50% of the inner surface area.

[0022] More preferably, the heating element occupies a horizontal area that is at least 70% of the inner surface area.

[0023] Even more preferably, the heating element occupies a horizontal area that is at least 90% of the inner surface area.

[0024] Preferably, the heat density provided by the heating element is between 0.1 to 0.4 W/mm² in a 100 mm² region.

Brief Description of Drawings

[0025] Preferred embodiments of the present invention will now be described, by way of examples only, with reference to the accompanying drawings:

[0026] Fig. 1 is a perspective view of a kettle according to an embodiment of the present invention.

[0027] Fig. 2 is a top plan view of the kettle of Fig. 1.

[0028] Fig. 3 is a front elevation view of the kettle of Fig. 1.

[0029] Fig. 4 is a section view along the axis D-D indicated on Fig. 3 of the kettle of Fig. 1.

[0030] Fig. 5 is a partial section view of the kettle of Fig. 1 showing a TFT heating element used in the kettle of Fig. 1.

Description of Embodiments

[0031] As shown in Fig. 1, a kettle 10 according to an embodiment of the present invention includes a base 12 and a hollow body 14. The hollow body 14 has a bottom wall 16 and a side wall 18 extending upwardly from the bottom wall 16 to a rim 19. The hollow body 14 also has a lid 20 to engage the rim 19. As best seen in Fig. 3, the hollow body 14 also includes a handle 24 attached to the side wall 18, and a spout 26 also attached to the side wall 18.

[0032] As shown in Fig. 4, the bottom wall 16, the side wall 18 and the lid 20 surround a cavity 22 to receive water to be heated. Further, the bottom wall 16 has a generally planar inner surface 17 facing the cavity 22. The inner surface 17 has an area that is substantially horizontal when the kettle 10 is resting on a surface.

[0033] As further shown in Fig. 4, the hollow body 14 also includes a housing 28 fixed to the hollow body 14. The housing 28 is separated from the hollow body 14 by a sound-isolating layer or rubber mount 30, preferably made of a silicone rubber.

[0034] The bottom wall 16 includes a heating element 32 that occupies a horizontal area as projected, for example, onto the inner surface 17 of the bottom wall 16. For example, if the heating element 32 were a tube of 10 mm diameter and a horizontal length of 50 mm, it would occupy a horizontal area of 500 mm². In the preferred embodiment the heating element 32 is a resistive thin film transistor (TFT) element that forms substantially all of the bottom wall 16.

The heating element 32 occupies a horizontal area as defined by the width and length of a trace 33, as shown in Fig. 5.

[0035] The rubber mount 30 extends below the heating element 32. The rubber mount 30 also wraps around an edge 34 of the heating element 32 such that the heating element 32 does not contact the housing 28. Yet further, the rubber mount 30 extends a short distance above the heating element 32, inwardly from the edge 34 such that the heating element 32 also does not contact the side wall 18. That is, the rubber mount 30 has a shorter horizontal extent above the heating element 32 than below the heating element 34 to ensure efficient thermal communication between the heating element 32 and water contained in the cavity 22. The rubber mount 30 also extends parallel to the side wall 18 between the side wall 18 and the housing 28, such that the housing 28 does not contact the side wall 18. The housing 28 and the rubber mount 30 are adhesively fixed to the hollow body 14, for example at lower rounded corner 21 of the side wall 18.

[0036] The housing 28 includes a first retainer 36 located below the rubber mount 30. The retainer 36 is attached to the housing 28 by a set of fasteners 38. A first sound-absorbing layer 40 is held between the rubber mount 30 and the retainer 36. The first sound-absorbing layer 40 is preferably a foam. The first sound-absorbing layer 40 includes an aperture 42 to allow access to the heating element 32. Located in the aperture 42 is a connector 44, the connector 44 includes a power cable (not shown) connected to the heating element 32.

[0037] The housing further includes a floor 46 located below the retainer 36. The floor 46 is attached to the housing 28 by a set of fasteners 48. A second sound-absorbing layer 50 is held between the retainer 36 and the floor 46. The second sound-absorbing layer 50 is preferably a foam. The floor 46 includes a recess 52 above and around which is located a chamber 54. The chamber 54 houses an electrical power receiving module 56. The power receiving module 56 is adapted to receive a sensor signal from a sensor (not shown) via the connector and is also adapted to supply power to the heating element 32 via the power cable.

[0038] The base 12 is adapted to receive the hollow body 14 and includes an upper surface 58. The upper surface 58 includes a location projection 60 adapted to be received in the recess 52, the projection 60 is a rotating electrical connector. Located in the base 12 is a power supply module 62 adapted to supply power to the power receiving module 56 using the rotating electrical

connector. The base 12 further includes, in this embodiment, seven buttons 64, though any number could be used, to receive instructions from a user and a controller (not shown). The buttons 64 are adapted to send a button signal to the controller. The first controller is adapted to operate the power supply module 62 in response to the button signal. The controller may also receive a sensor signal from the power receiving module 56. In response to that indication the controller is also adapted to control the supply of power to the power receiving module 56.

[0039] Finally, the base 12 includes a set of rubber feet 66 upon which the kettle 10 rests when placed on a surface (not shown).

[0040] Use of the kettle 10 will now be discussed.

[0041] The base 12 is connected to a power source (not shown), such as an outlet and the hollow body 14 is placed on the base 12. When placing the hollow body 14 on the base 12, the projection 60 is located in the recess 52. The power supply module 62 is now able to supply power to the power receiving module 56.

[0042] When the buttons 64 are operated by a user to indicate that water in the cavity 22 should be heated, the controller operates the power supply module 62 to supply power to the receiving power module 56. The receiving power module 56 subsequently supplies power to the heating element 32.

[0043] The heating element 32 is resistively heated and increases the temperature of the bottom wall 16 of the hollow body 14. The heat transfer density of the heating element 32, referring to the inner surface 17 of the bottom wall 16 is preferably between $0.1\text{--}0.4\text{ W/mm}^2$ averaged in a, for example, 100 mm^2 region. The bottom wall 16 transfers hHeat is transferred from the heating element 32 to water contained in the cavity 22. As the water in the cavity 22 reaches its boiling point it starts to agitate.

[0044] The sensor, for example, provides the sensor signal to the controller indicating a water temperature. Once the water temperature reaches a pre-determined water temperature the controller ceases to supply power to the receiving power module 56.

[0045] Advantages of the kettle 10 will now be discussed.

[0046] The horizontal area occupied by the heating element 32 is a substantial portion of the inner surface area 17. Therefore, the heat transfer from the heating element 32 to the water contained in the cavity 22 occurs over a large surface area, compared with tube heating elements that were previously discussed operating on the same household wattage. By distributing the heat over a larger surface area the kettle 10 substantially reduces the likelihood that water will be heated above its boiling point, thereby reducing the likelihood that a steam bubble will form. As fewer, or no, steam bubbles are formed, no steam bubbles exist that can cavitate, which reduces, or eliminates, the noise created by steam bubble cavitation.

[0047] The hollow body 14 rests substantially on the sound-isolating rubber mount 30. As the water agitates close to its boiling point, the sound-isolating rubber mount 30 absorbs a portion of and reduces transmission of the vibration to the housing 28 and the base 12. This arrangement reduces noise created by vibrations caused by the agitation of the water.

[0048] The rubber mount 30 also retains the heating element 32. The heating element 32 may vibrate when heated, due to the use of alternating current (AC). The retention of the heating element 32 by the rubber mount 30 absorbs a portion of and reduces the transmission of these vibrations to both the cavity 22, as well as the housing 28.

[0049] The sound-absorbing foam layers 40, 50 absorb a portion of and reduce the vibrations and noise that may yet transfer through the rubber mount 30.

[0050] Together, the heating element 32, the sound-isolating rubber mount 30, and the sound-absorbing foam layers 40, 50 substantially reduce the noise produced by the kettle 10.

[0051] Although the embodiments of the invention have been discussed above, it will be appreciated by a person skilled in the art that the above description merely relates to a preferred embodiment and the claimed invention may include alternative embodiments not yet discussed.

[0052] For example, the cross section of the heater element 32 may only overlap the cross section of the lower surface 16 by more than 70%, more than 50%, or even more than 30%.

[0053] Yet further, the heating element 32 could be a heating coil having a path and a width in the horizontal plane.

[0054] Yet further, the heating element 32 may be separate and extending in a parallel horizontal plane below, but adjacent and/or attached to the bottom wall 16.

[0055] Yet further, the heating element 32 may be separate and extending in a parallel horizontal plane below, and distanced by a gap from the bottom wall 16.

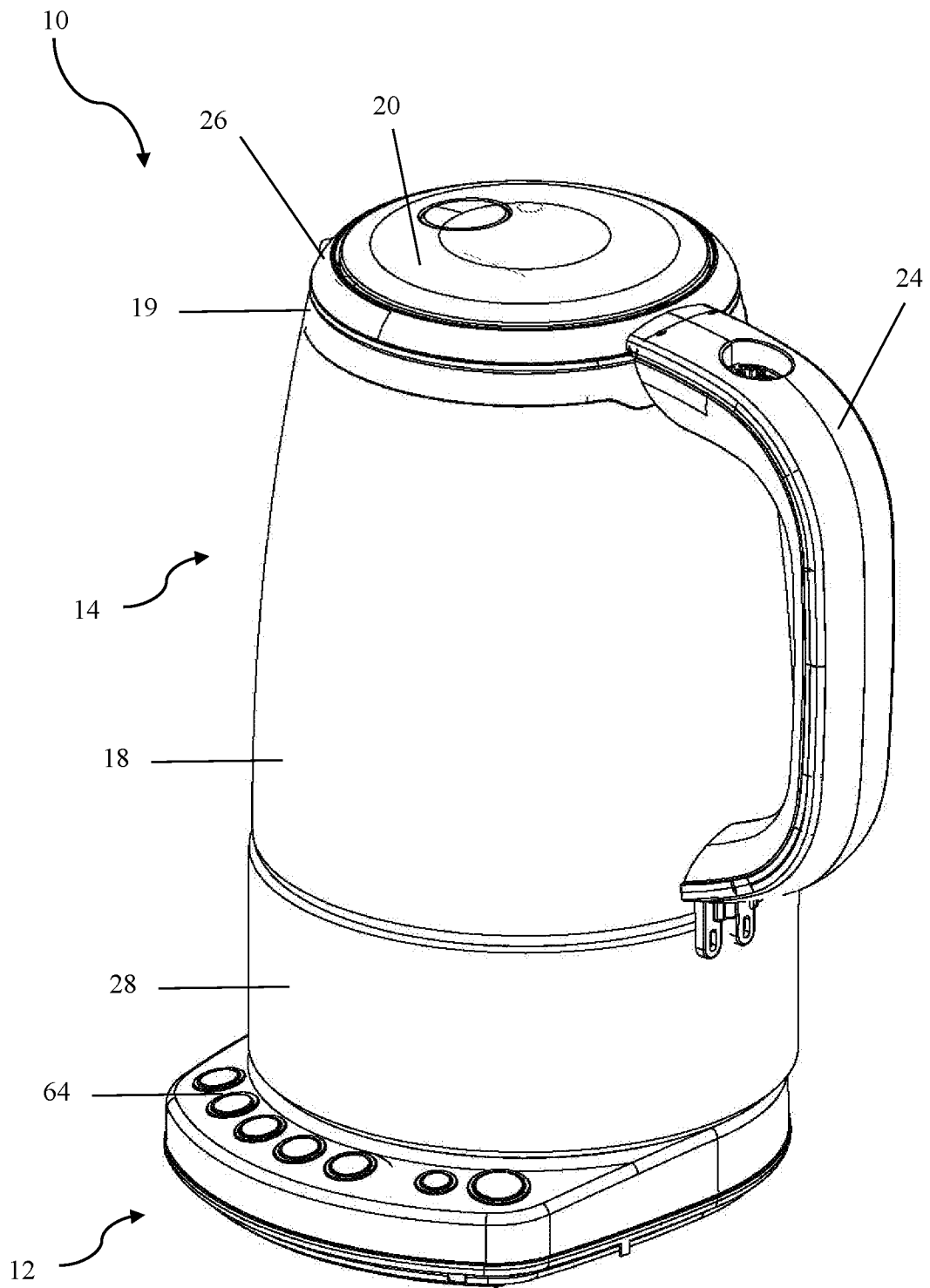
CLAIMS

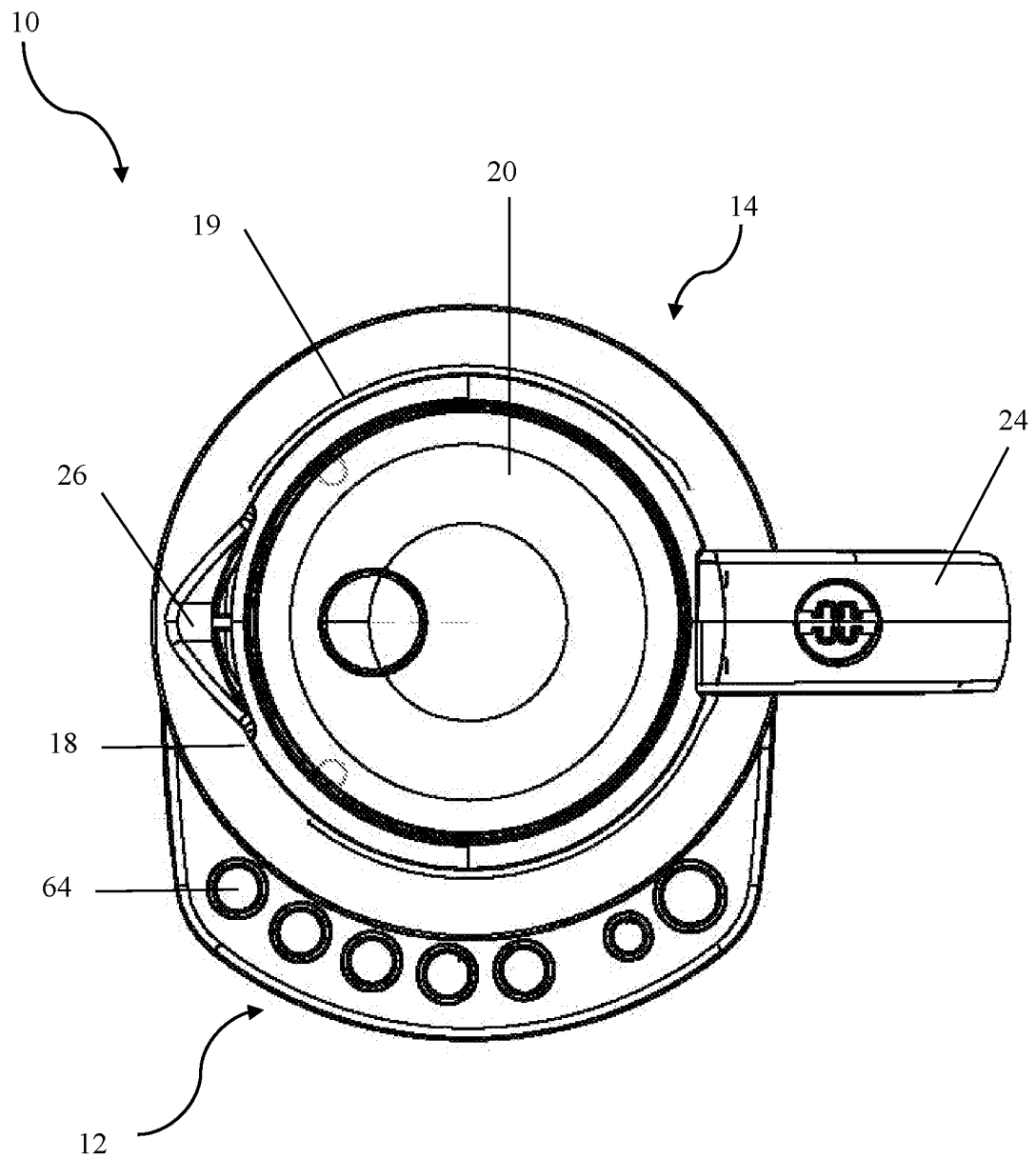
1. A kettle comprising:
a hollow body having a bottom wall and a side wall extending upwardly from the bottom wall to a rim, with the side wall surrounding a cavity to receive water to be heated, the bottom wall having an inner surface facing the cavity, the inner surface having an area; and
a heating element in thermal communication with the bottom wall to thereby heat the water, the heating element occupying a horizontal area that is at least 30% of the inner surface area.
2. The kettle of claim 1, wherein the horizontal area is in a plane below the bottom wall.
3. The kettle of claim 2, wherein the inner surface is generally planar and the plane is parallel to the inner surface.
4. The kettle of claim 2 or 3, wherein the plane is horizontal when the kettle is resting on a surface.
5. The kettle of any one of the preceding claims, wherein the inner surface is horizontal when the kettle is resting on a surface.
6. The kettle of any one of the preceding claims, wherein the kettle further comprises a housing fixed to the hollow body, the housing comprising a sound-isolating layer.
7. The kettle of claim 6, wherein the housing is fixed to the hollow body by an adhesive located between the hollow body and the housing.
8. The kettle of claim 7, wherein the adhesive bonded to the sound-isolating layer.
9. The kettle of any one of claims 6 to 8, wherein the heating element is retained by the sound-isolating layer such that a gap exists between the heating element and the bottom wall.
10. The kettle of any one of claims 6 to 9, wherein the sound-isolating layer is formed from rubber silicone

11. The kettle of any one of claims 6 to 10, wherein the housing further comprises a sound-absorbing layer.
12. The kettle of claim 11, wherein the sound-absorbing layer is located below the sound-isolating layer.
13. The kettle of claim 11 or 12, wherein the sound-absorbing layer is a foam.
14. The kettle of any one of claims 6 to 13, wherein the kettle further comprises:
 - a base to receive the hollow body and the housing;
 - a controller located in the base;
 - a magnetic power supply located in the base; and
 - a receiving power module located in the housing and connected to the heating element, wherein the magnetic power supply is configured to supply power to the receiving power module to supply power to the heating element.
15. The kettle of claim 14, wherein the controller is operatively connected to the heating element using a power cable to supply power to the heating element, and a communication cable to receive sensor data from the heating element.
16. The kettle of claim 15, wherein:
 - the base has a projection and the housing has a recess, the projection being locatable in the recess such that, when the projection is located in the recess, the magnetic power supply is aligned with receiving power module to supply power.
17. The kettle of any one of the preceding claims, wherein the heating element occupies a horizontal area that is at least 50% of the inner surface area.
18. The kettle of any one of the preceding claims, wherein the heating element occupies a horizontal area that is at least 70% of the inner surface area.
19. The kettle of any one of the preceding claims, wherein the heating element occupies a horizontal area that is at least 90% of the inner surface area.

20. The kettle of any one of the preceding claims, wherein the heat density provided by the heating element is between 0.1 to 0.4 W/mm² in a 100 mm² region.

Breville Pty Limited
Patent Attorneys for the Applicant/Nominated Person
SPRUSON & FERGUSON

**Fig. 1**

**Fig. 2**

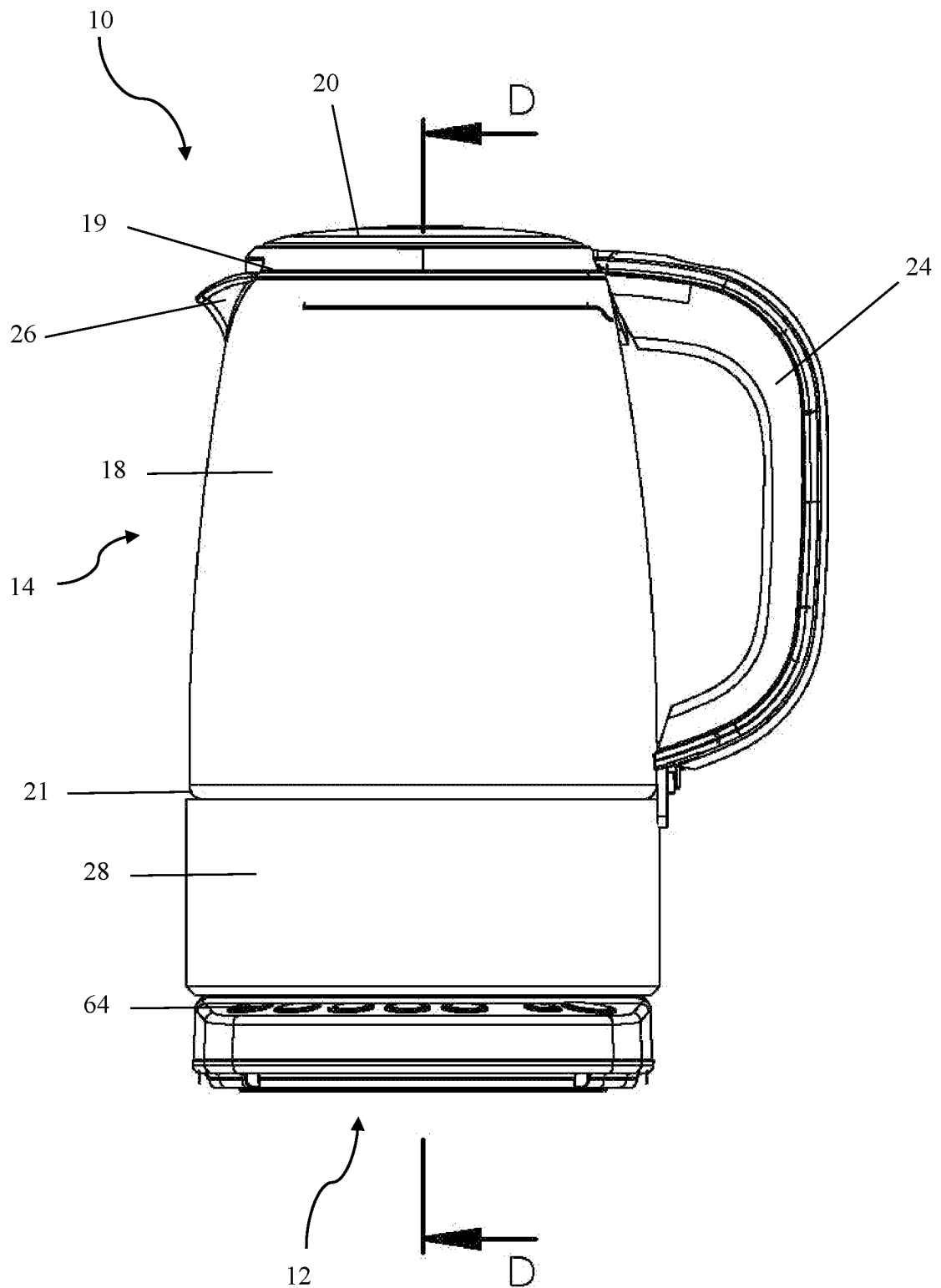
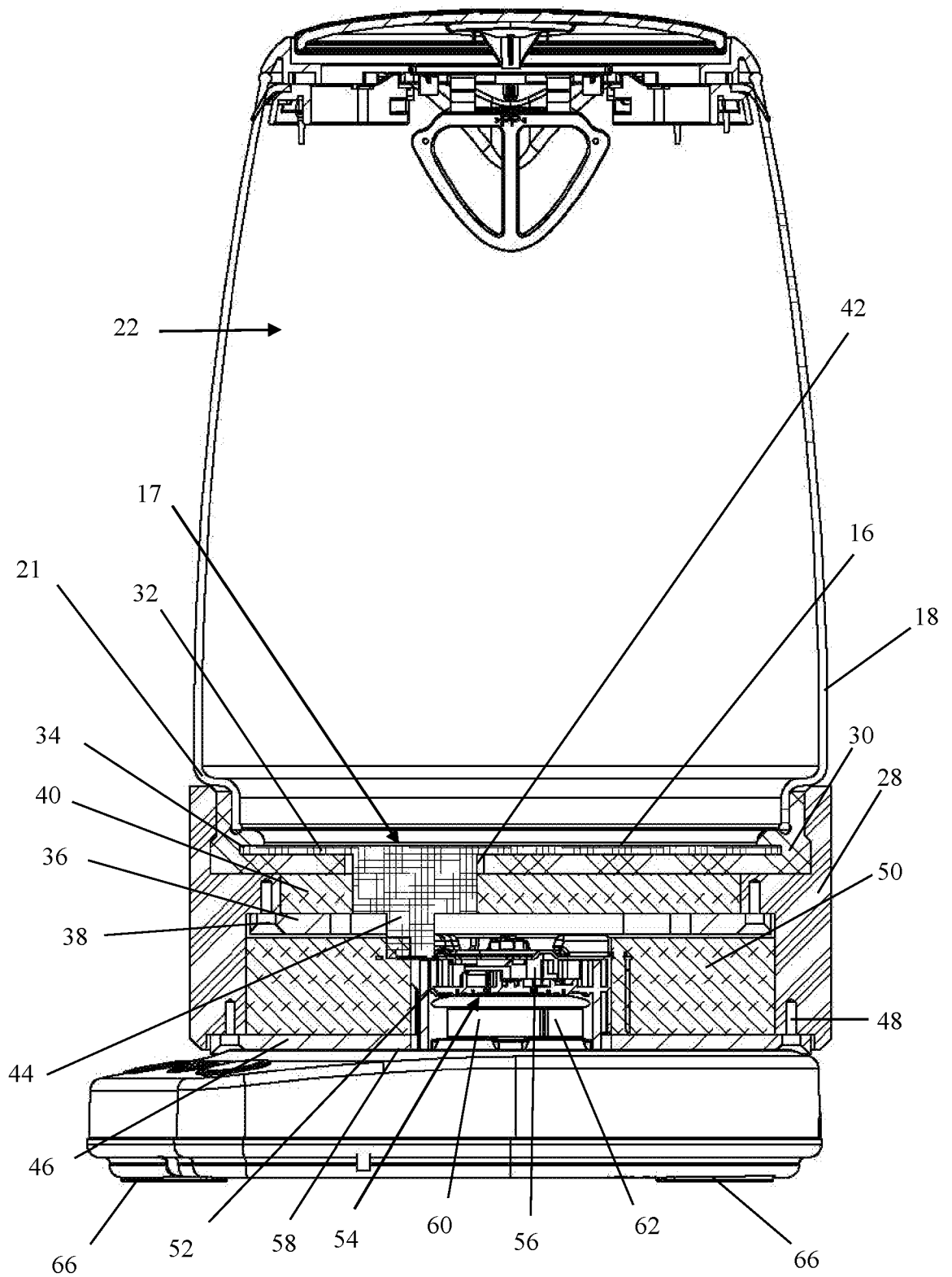


Fig. 3

**Fig. 4**

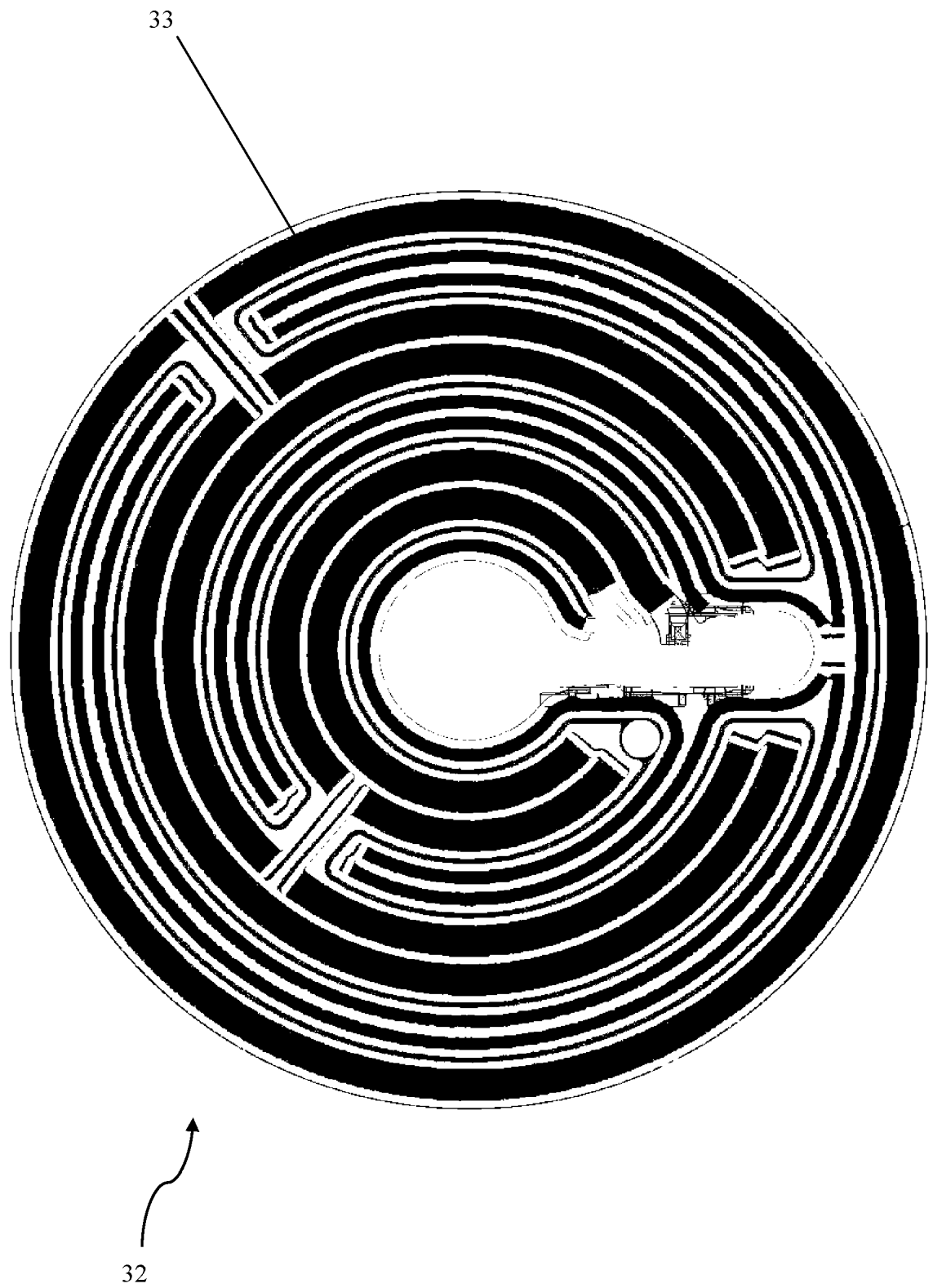


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2019/051111

A. CLASSIFICATION OF SUBJECT MATTER

A47J 27/21 (2006.01)

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)

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)

Databases: Epoque database PATENW, WPI, EPODOC; Google Patents, Auspat, Espacenet

IPC/CPC: A47J27/2105, A47J27/21008, A47G19/22, A47J27/21

Keywords: increase, max, large, area, surface, contact, size, distribute, fraction, ratio, percentage, heat, thermal, element, sound, vibration, noise, isolate, absorb, buffer, muffle, insulate, magnet, induction, power, supply, wireless, and synonyms, see SIS for details.

Applicant/inventor name searched in external databases (Auspat, Espacenet) and internal databases provided by IP Australia.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

☒ Further documents are listed in the continuation of Box C☒ See patent family annex

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"D" document cited by the applicant in the international application	"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
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
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"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

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Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
Email address: pct@ipaustalia.gov.au

Authorised officer

Andrew Burgess
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No. +61262832636

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/AU2019/051111
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/AU2019/051111	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
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		JP 6403314 B2	10 Oct 2018
End of Annex			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001. Form PCT/ISA/210 (Family Annex)(July 2019)			