(12) UK Patent (19) GB (11) 2595630 (13) B

(45) Date of B Publication 15.06.2022

(54) Title of the Invention: Flow through heaters

(51) INT CL: ***F24H 1/10*** (2022.01) ***H05B 3/20*** (2006.01)

(21) Application No: **2004273.5**

(22) Date of Filing: **24.03.2020**

(60) Parent of Application No(s)
2206049.5, 2206047.9 under section 15(9) of the Patents Act 1977

(43) Date of A Publication **08.12.2021**

(56) Documents Cited:

GB 2391611 A	**EP 0485211 A1**
WO 2001/056440 A2	**CN 206310710 U**
CN 202269905 U	**CN 201779861 U**
CN 110131880 A	**CN 103104984 A**
DE 202017101338 U1	**US 4888465 A2**
US 20070228032 A1	

(58) Field of Search:
As for published application 2595630 A viz:
INT CL **A47J, F24D, F24H, H05B**
Other: **WPI, EPODOC**
updated as appropriate

Additional Fields
Other: **None**

(72) Inventor(s):
Rob Maatkamp
Arjan Wilhelmus Maria Koster
Mario Janice Poelstra
Willem Antoon Bernard Nijman
Hendrik Johan Arnout Nieuwenhuis
Reinardus Hermanus Bernardus Deenen
Alex Reinier Nijhoff
Gradus johannes Kloppers

(73) Proprietor(s):
Ferro Techniek B.V.
(Incorporated in the Netherlands)
Bremstraat 1, NL-7011 AT Gaanderen, Netherlands

(74) Agent and/or Address for Service:
Maucher Jenkins
Seventh Floor Offices, Artillery House,
11-19 Artillery Row, London, SW1P 1RT,
United Kingdom

GB 2595630 B

Fig. 1

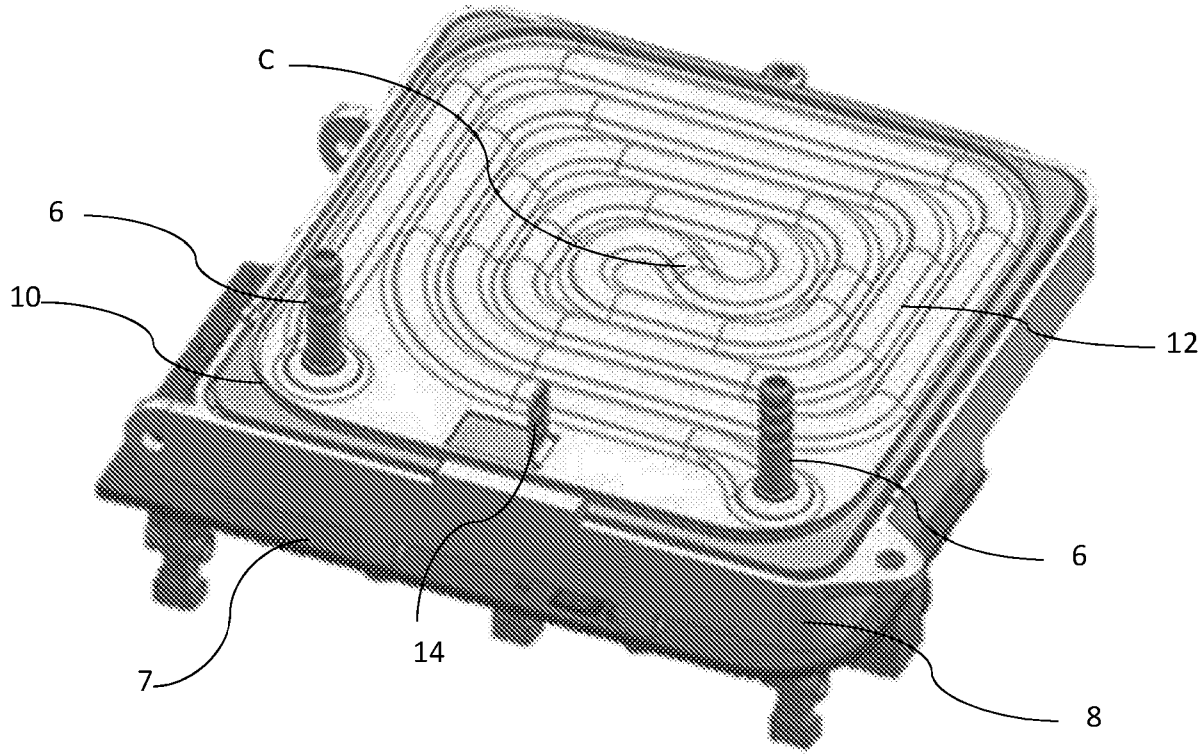


Fig. 2

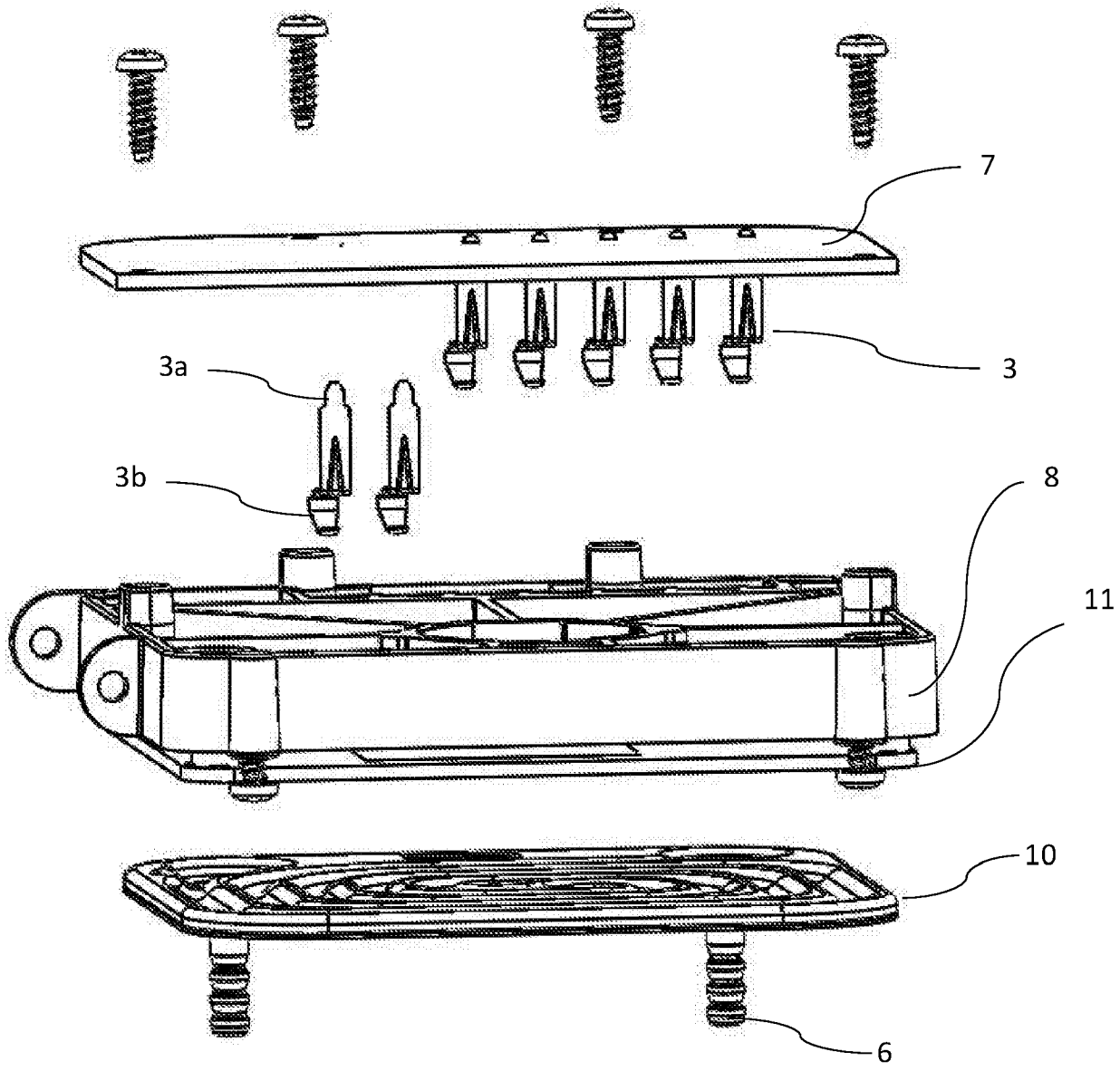


Fig. 3

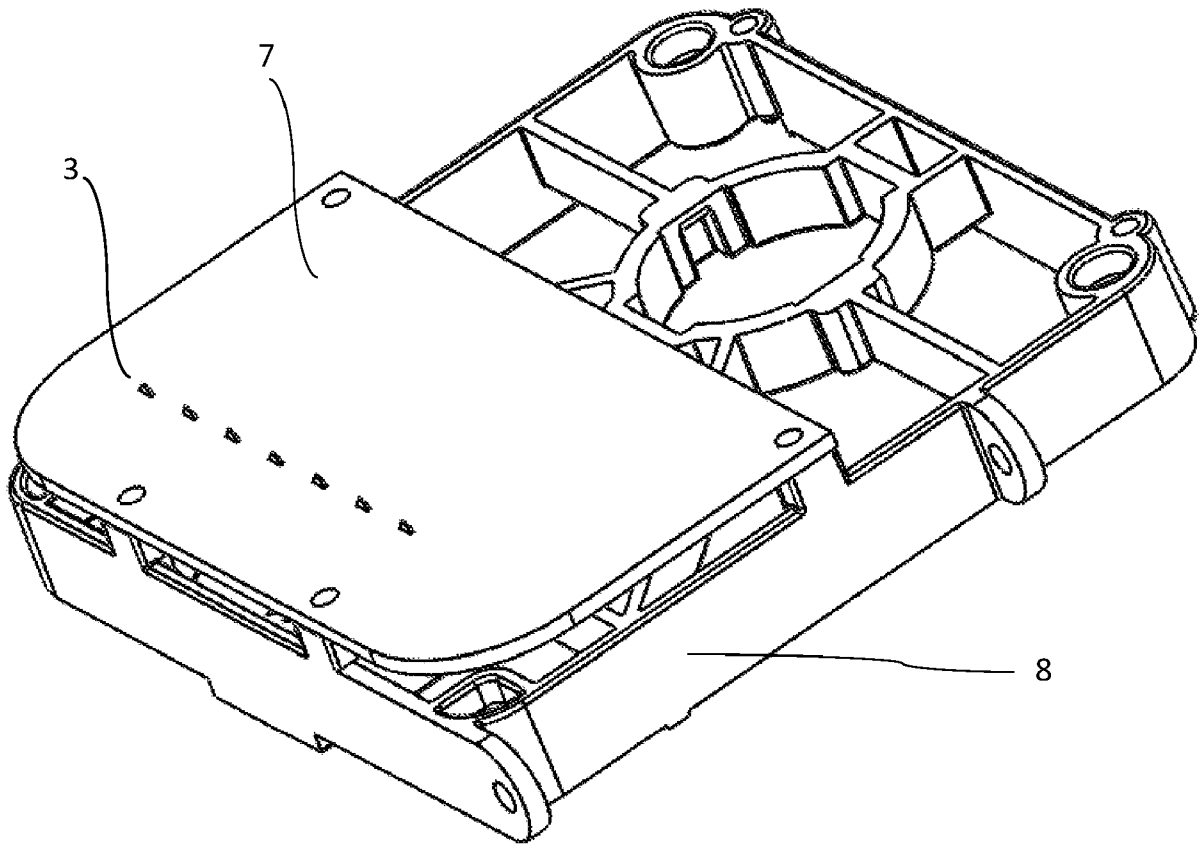


Fig. 4

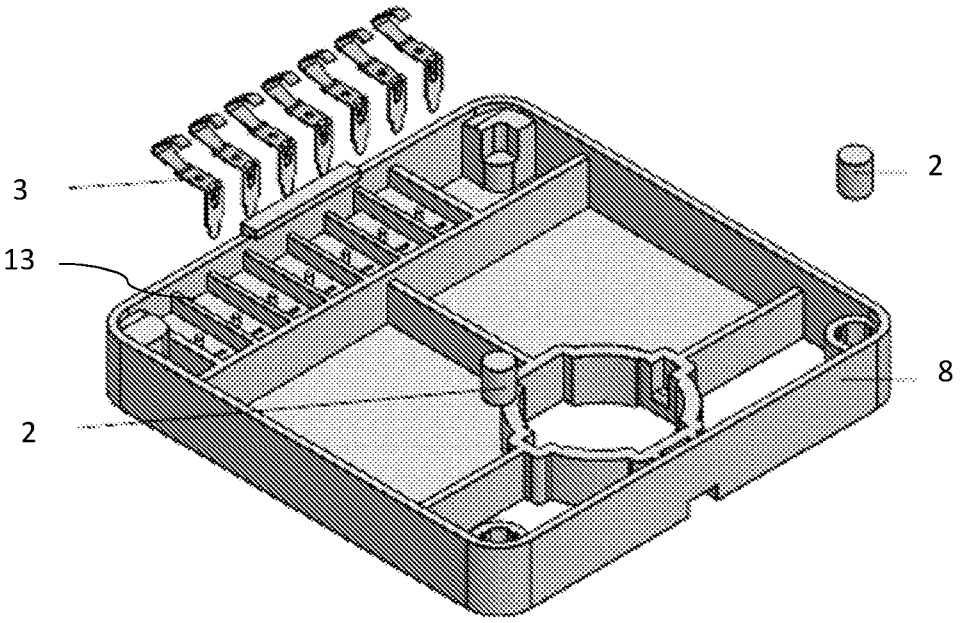


Fig. 5

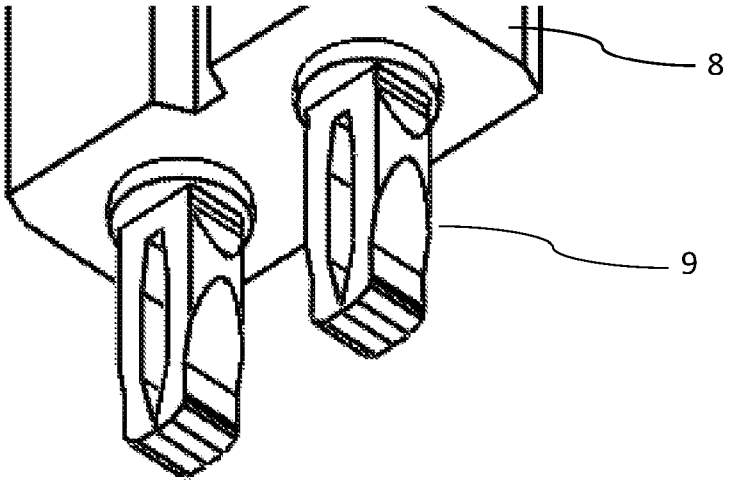


Fig. 6a

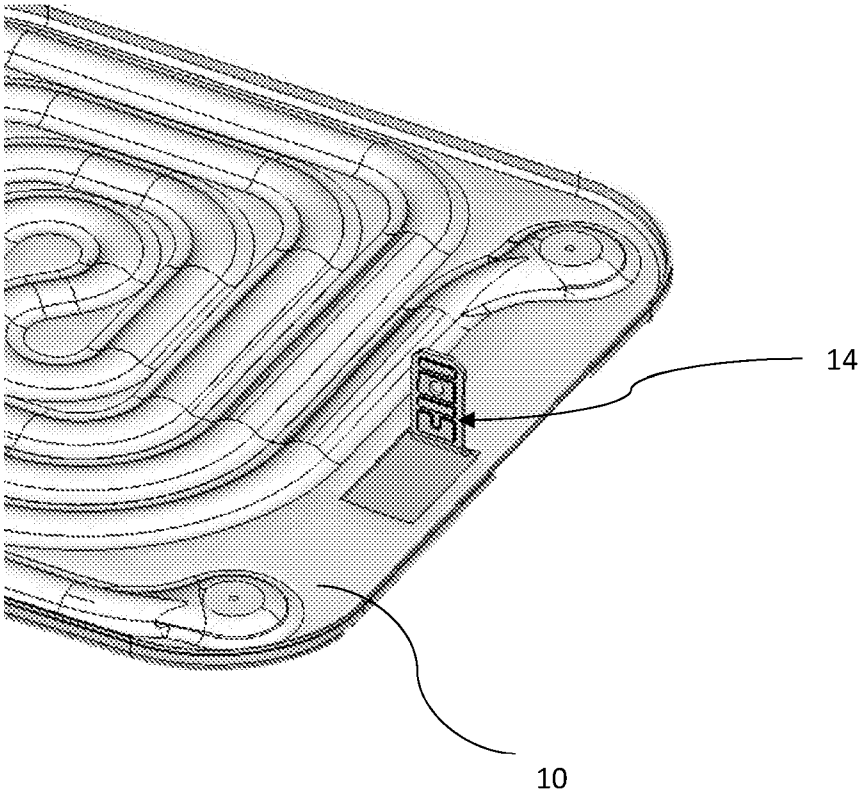
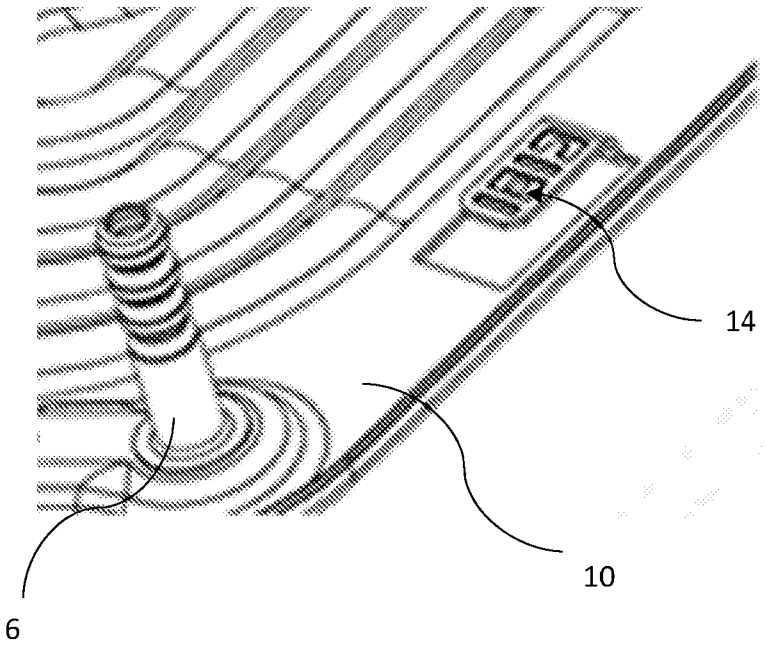


Fig. 6b



Flow Through Heaters

Field of the Invention

[0001] This present invention relates to flow through heaters, and particularly thick film flow-through heaters.

Background of the Invention

[0002] Flow through heaters heat a fluid as it flows through the heater. These may be used for example for continuous or near-instantaneous dispensing of hot or boiling water, for use for example in hot water dispensers or coffee makers.

[0003] A flow through heater described in patent publication GB-A-2481265 comprises a channel plate brazed to a planar thick film heating element. The thick film heating element comprises a substrate of material with good thermal conductive properties such as a metal, an electrically insulating layer, such as vitreous enamel, and at least one resistor track applied by a thick film technique. A channel, formed between the channel plate and the planar heating element, guides the fluid to be heated in a path corresponding to the layout of the heating track on the thick film heater. The low thermal mass of this type of flow through heater (FTH) provides a fast response and a very controllable heater.

[0004] The channel plate of the heater disclosed in GB-A-2481265 is round, and the channel has a circular spiral form to maximise the radius of the bends in the channel and reduce pressure drops along the channel. A heater track aligned with the channel also has a circular spiral form, which reduces problems associated with tight bends in heater tracks.

[0005] The flow-through heater may include associated electronic components, for example to provide temperature sensing and/or control. The electronic components may control an E-Fast (RTM) sensor as disclosed in EP-A-1828068. In a conventional arrangement, electrical connections between electronic components and the thick film heating element are made using springs, which may include silver contacts, that press against contact pads on the heating element. The spring has a terminal which may be connected to a printed circuit board (PCB) using a wire fitted with a receptacle for receiving the terminal.

[0006] Flow-through heaters are relatively high-powered devices, and many applications of such heaters require the temperature of the heater to be controlled within specific limits. This is typically achieved using an NTC thermistor to measure the temperature of the fluid output

and switching the supply of current to the heating track in response to the measured temperature, for example using a Triac, thyristor or similar electronic device. These devices should be maintained below a critical temperature and are often mounted on a heatsink to promote cooling. The heatsink adds to the weight and cost of the heater.

[0007] High-powered flow-through heaters typically require an earth connection in order to meet safety standards. In a conventional FTH provided by Ferro Techniek BV, the earth connection is made to a conductive substrate of the heater by means of an eyelet connector, screw and locking washer.

Statements of the Invention

[0008] According to the present invention, there is provided a flow through heater comprises a thick film heating element and a channel plate attached to the thick film heating element to form a fluid channel that has a planar square or rectangular spiral form. Advantageously, this allows the dimensions of the heating element to be reduced for a given heating area, thus also reducing the materials required. Any pressure drop caused by right-angled bends in the spiral may be insignificant in application of the heater, such as espresso coffee makers. In an embodiment of the invention, there is provided a flow through heater comprising a thick film heating element having a PCB connected thereto by one or more connectors, each having a first end connected directly to the PCB, and a second end comprising a spring making electrical contact with the thick film heating element.

[0009] In an embodiment of the invention, there is provided a flow through heater comprising a thick film heating element and a fluid channel, wherein a power switching or control component is mounted adjacent an inlet of the fluid channel, so as to cool the component. Advantageously, this may obviate the need for a heatsink, and may provide more efficient cooling.

[0010] In an embodiment of the invention, there is provided a flow through heater comprising a thick film heating element and a fluid channel, wherein an electronic component is mounted directly on the thick film heating element, for example by printing or surface mounting.

[0011] In an embodiment of the invention, there is provided a flow through heater comprising a thick film heating element and a channel plate attached to the heating element to form a channel for fluid heated by the heating element, wherein the channel plate includes

an integral terminal which may be bent out of the plane of the channel plate for making an earth connection.

Brief Description of the Drawings

[0012] There now follows, by way of example only, a detailed description of preferred embodiments of the present invention, with reference to the figures identified below.

[0013] Fig. 1 is a perspective view of a thick film flow-through heater in an embodiment of the invention, viewed from above the channel plate.

[0014] Fig. 2 is an exploded view of the embodiment, viewed from below the channel plate.

[0015] Fig. 3 shows a PCB connected to a bracket of the heater in the embodiment.

[0016] Fig. 4 shows the bracket with terminals for connection to the PCB.

[0017] Fig. 5 shows a part of the bracket in an alternative embodiment, with push fit pins for connection to the PCB.

[0018] Fig. 6a shows a channel plate for use in a heater in embodiments of the invention, including a terminal.

[0019] Fig. 6b shows a detail of the terminal at a later stage in the manufacturing process.

Detailed Description of the Embodiments

FTH with square spiral channel

[0020] Figure 1 shows a thick film heater in an embodiment of the invention, comprising a channel plate 10 attached (e.g. by brazing or welding) to a thick film heating element 11 to form a fluid channel 12 therebetween. Tubes 6 are attached to corresponding apertures in the channel plate 10, which act as the inlet and outlet for the fluid channel 12. Preferably either tube 6 can be used as the inlet with the other acting as the outlet.

[0021] The thick film heating element 11 comprises a substrate, which may be substantially planar, and one or more electrical heating (e.g. resistor) tracks deposited on the substrate using a thick film printing or deposition process. The substrate may be of thermally conducting material, such as a metal. Where the substrate is electrically conductive, an electrically insulating layer may be applied to a surface of the substrate before the electrical

heating track(s) is deposited, to electrically insulate the tracks from the substrate. This electrically insulating layer should have reasonable or good thermal conducting properties and may for example comprise vitreous enamel. Alternatively, the substrate may be of an electrically insulating material, such as ceramic. Preferably, a further electrically insulating layer is applied over the heating track, to electrically insulate and protect the track.

[0022] The channel plate 10 is preferably attached to the opposite face of the substrate to the one on which the heating track(s) is deposited. Hence, the heating track(s) and the electrically insulating layers may be deposited either before or after the channel plate 10 is attached to the substrate. The face of the substrate on which the channel plate 10 is attached may be referred to as the wet side of the substrate, and the face on which the heating track(s) are deposited may be referred to as the dry side.

[0023] The fluid channel 12 has a planar spiral form, extending from one aperture towards the centre C of the channel plate 10 in one direction (for example, clockwise), and thence from the centre C to the other aperture in an opposite direction (for example, anti-clockwise). In this embodiment, the spirals are square or rectangular, comprising linear sections each connected at right angles to the next linear section by a bend which extends through a right angle in the direction of the spiral i.e. clockwise or anticlockwise. The channel plate 10 is also preferably square or rectangular, corresponding to the shape of the fluid channel 12. The thick film heating element 11 is also preferably square or rectangular, corresponding to the shape of the channel plate 10.

[0024] The inventors have discovered that the pressure drop through the fluid channel 12 is relatively insignificant in certain applications. For example, in an espresso-type coffee machine there is a large pressure drop through the coffee grounds, so that a relatively small increase in the pressure drop through the flow-through heater is of little consequence. On the other hand, the use of a square or rectangular shape significantly reduces the space and material requirements of the flow through heater. For example, for a given heating area of the thick film heating element 11, the side of an overall square shape will be reduced by over 10% compared to the diameter of a round shape and the area of the material used will be reduced by the square of this reduction e.g. 21.5%.

Connection of components to thick film heating element

[0025] The flow-through heater in at least some embodiments of the invention may include associated electronic components, for example to provide temperature sensing and/or control. In one example, the electronic components may work in conjunction with an E-Fast (RTM) sensor as disclosed in EP-A-1828068. The electronic components may be mounted on a printed circuit board (PCB) 7 which is mounted on one side of a bracket 8, on the other side of which is mounted the thick film heating element 11. The bracket 8 may be made of moulded plastic or other suitable material. The bracket 8 may be used to mount the flow-through heater in an appliance.

[0026] Electrical connections between the PCB 7 and the thick film heating element 11 may be made by connector springs 3, each having a termination end 3a that is connected directly to the PCB 7, for example by soldering into a hole in the PCB 7, and a spring end 3b that makes electrical contact with a surface pad on the thick film heating element 11. As shown in Figure 4, each of the connector springs 3 may be mounted in a respective partition 13 in the bracket 8, with the termination end 3a passing through a corresponding slot in the bracket 8 to make contact with the PCB 7. The connector springs 3 may be secured within their respective partitions 13, for example by a pin extending into an aperture in the connector spring 3.

[0027] Alternatively, the termination ends 3a may comprise push fit pins 9 as shown for example in Figure 5, which make a push fit connection into a corresponding connector aperture in the PCB 7. Examples of this push fit technology are available under the Elopin (RTM) and Isfit (TM) brands.

[0028] Instead of using the bracket 8, the PCB 7 may be mounted directly onto the thick film heating element 11, preferably spaced apart therefrom using spacers or lugs which may form part of the thick film heating element 11.

Mounting electronic devices

[0029] In at least some embodiments of the invention, the thick film heater includes one or more electronic device(s) 2 for switching or controlling the current supplied to the thick film heating track(s), such as a Triac, thyristor or similar device. The electronic device(s) 2 may be controlled in response to a temperature sensor, such as a thermistor. The electronic device(s) 2 may be mounted directly on the dry side of the substrate of the thick film heating

element 11, preferably in a position opposite the fluid channel 12 so that the fluid cools the electronic device through the substrate, and most preferably opposite a portion of the fluid channel where the fluid is cool, such as an inlet of the fluid channel 12. The electronic device(s) 2 may then be connected directly to the heater track(s), for example by soldering. Alternatively, the electronic device(s) may be mounted on the channel plate 10 in a position adjacent the inlet, so that the fluid cools the device through the channel plate 10.

[0030] Other types of electronic device or component, such as an NTC thermistor, may additionally or alternatively be mounted directly on the dry side of the substrate. The electronic device or component may have a surface mount configuration allowing direct connection to track(s) on the substrate. Alternatively or additionally, an electronic device or component, such as an NTC resistor, a thermal fuse or a thermal protector such as disclosed in WO-A-2008/150171, may be printed onto the dry side of the substrate. The tracks may additionally be connected to the PCB 7, as described above.

Terminal for earth connection

[0031] In at least some embodiments of the invention, the channel plate 10 may include a terminal 14 for making an earth connection. In one embodiment as shown in Figures 6a and 6b, the terminal 14 is formed as part of the sheet material of the channel plate 10, with a partial cut-out so that the terminal may be bent out of the plane of the channel plate 10, for example in the form of a tab, so as to allow connection to an earth connector. The terminal 14 may be bent substantially perpendicular to the channel plate 10 as shown in Figure 6a, and optionally bent back to be substantially parallel to, but raised above the channel plate 10 as shown in Figure 6b.

[0032] The terminal 14 may be bent after the channel plate 10 has been attached to the element substrate, for example by brazing, to avoid interfering with the machinery used to perform the attachment.

[0033] Alternatively, the terminal 14 could be formed as part of the thick film heating element, although this may be less advantageous as it may not be possible to bend the terminal out of the plane of the substrate after manufacture of the heater.

Alternative embodiments

[0034] In some embodiments, individual features as described above may be combined or omitted. On reading the above description, the skilled person may contemplate alternative embodiments which nevertheless fall within the scope of the accompanying claims.

Claims

1. Flow-through heater apparatus, comprising:
    a. a thick film heating element; and
    b. a channel plate attached to the heating element to form a fluid channel therebetween;
    wherein the fluid channel has a planar rectangular spiral form or a square spiral form.

2. Apparatus of claim 1, wherein the fluid channel comprises a first section extending in one spiral direction inwards towards a central part of the element and a second section extending in an opposite spiral direction outwards from the central part.

3. Apparatus of any preceding claim, wherein the fluid channel comprises a series of linear sections each connected the next one of the series by a right-angle turn in the direction of the spiral.

4. Apparatus of any preceding claim, wherein the thick film heating element has a square or rectangular form conforming to the fluid channel.

5. Apparatus of any preceding claim, wherein the channel plate has a square or rectangular form conforming to the fluid channel.

6. Apparatus of any preceding claim, wherein the thick film heating element comprises a substrate having one or more heating tracks on a first face thereof, wherein the channel plate is attached to a second face of the substrate opposite to the first face.

7. Flow-through heater apparatus of any preceding claim, further comprising:
    a printed circuit board, PCB;
    wherein the PCB is connected to the thick film heating element by one or more connectors, each having a first end connected directly to the PCB, and a second end comprising a spring making electrical contact with the thick film heating element.

8. Apparatus of claim 7, wherein the first end extends into a corresponding aperture within the PCB.

9. Apparatus of claim 7 or claim 8, including a bracket mounted between the heating element and the PCB such that the one or more connectors pass through the bracket.

10. Apparatus of claim 9, wherein the one or more connectors are supported within the bracket.

11. Apparatus of claim 7 or claim 8, wherein the PCB is mounted directly to the heating element.

12. Flow-through heater apparatus of any preceding claim, further comprising:
at least one electronic device or component for switching or controlling supply of current to the heating element, mounted adjacent the fluid channel.

13. Apparatus of claim 12, wherein the at least one electronic device or component is mounted adjacent an inlet of the fluid channel.

14. Apparatus of claim 12 or claim 13, wherein the at least one electronic device or component is mounted on the heating element.

15. Apparatus of claim 12 or claim 13, wherein the at least one electronic device or component is mounted on the channel plate.

16. Apparatus of any one of claims 12 to 15, wherein the at least one electronic device or component comprises a Triac, thyristor or similar device.

17. Flow-through heater apparatus of any one of claims 1 to 11, further comprising:
at least one electronic device or component mounted on the thick film heating element.

18. Apparatus of claim 17, wherein the at least one electronic device or component is mounted on a dry side of the heating element opposite the channel plate.

19. Apparatus of claim 17 or 18, wherein the at least one electronic device or component is printed on the heating element.

20. Apparatus of claim 19, wherein the at least one electronic device or component comprises an NTC resistor.

21. Apparatus of claim 19, wherein the at least one electronic device or component comprises a thermal fuse.

22. Apparatus of claim 17 or 18, wherein the at least one electronic device or component is surface mounted on the heating element.

23. Flow-through heater apparatus of any preceding claim, further comprising:
a terminal integrally formed with the channel plate.

24. Apparatus of claim 23, wherein the terminal is bent out of the plane of the channel plate.

25. A method of manufacturing the apparatus of claim 24, wherein the terminal is bent out of the plane of the channel plate after the channel plate is attached to the thick film heating element.