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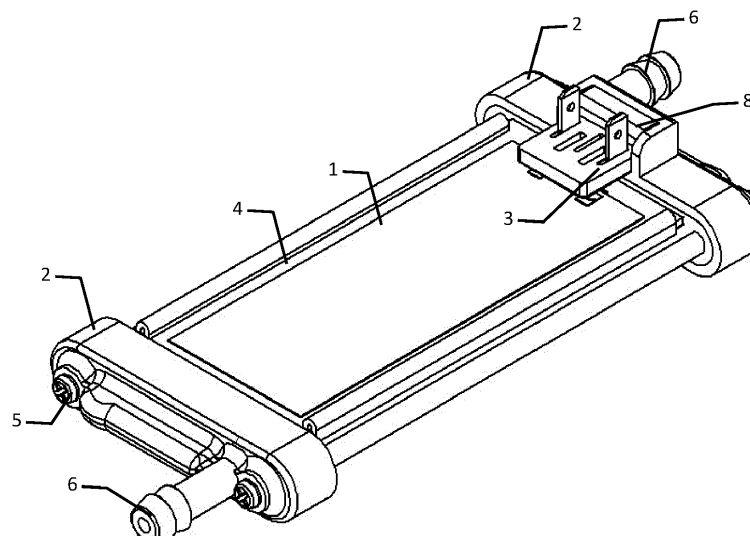
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(54) **FLOW THROUGH HEATER AND METHOD OF MANUFACTURE THEREOF**

(57) Flow through heater comprises an integral body including a plurality of flow channels and a thick film heater in thermal contact with the integral body, such that fluid flowing through the flow channels is heated by the thick film heater. The integral body may be formed of aluminium, for example by extrusion, or of ceramic. The

thick film heater may comprise a substrate that is attached to the integral body, or may comprise one or more thick film tracks deposited directly on the integral body. Where the integral body is made of aluminium, the surface may be anodised to form an insulating layer on which the tracks may be deposited.

Fig. 1



Description

Technical Field

[0001] The present invention relates to flow through heaters, particularly thick film flow through heaters, and their methods of manufacture.

Background Art

[0002] Flow through heaters heat a fluid as it passes through the heater. These can be used in but not limited to hot water dispensers or coffee machines to provide continuous or near-instantaneous dispensing of hot or boiling water.

[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] Corrosion can be an issue with stainless steel flow through heaters. Stainless steel is susceptible to a variety of corrosion mechanisms, notably pitting corrosion, crevice corrosion, and, to a lesser extent, stress corrosion cracking. In some flow through heaters, there may be a risk of stagnation in sites such as cracks or fissures at the joints between the constituent parts, such as between the channel plate and the planar heating element.

[0005] The channel plate and heating element may be joined together by brazing, soldering or welding. However, these joining techniques may add cost and increase scrap rate and/or production lead time. Additionally or alternatively, there is a risk of water leaking through the join between the channel plate and the thick film heater.

[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. A Triac is usually used in this case to control the current flow. Typically, a heatsink would be used in conjunction to promote cooling on the Triac, but heatsinks add to the weight and cost of the appliance.

Summary of Invention

[0007] According to one aspect of the invention, there is provided a flow through heater comprising an integral body having a plurality of flow channels integrally formed therein, and a thick film heater in thermal contact with the integral body for heating fluid passing through the

flow channels.

[0008] The integral body may be integral in that it is formed as a single, homogenous component with the flow channels passing therethrough. In this way, the sides of the flow channels are defined by the form of the integral body rather than being defined by different components that are fixed together. Advantageously, the use of an integral body may avoid the need to connect components together in order to form the flow channels, thus avoiding the risk of stagnation, corrosion and/or leakage along the flow channels. Additionally or alternatively, the problems involved in joining processes, such as brazing, soldering or welding, may be avoided.

[0009] The integral body may be formed of aluminium. Aluminium is resistant to corrosion, and may be anodised to further increase its corrosion resistance. Aluminium also has a high thermal conductivity, which improves heat transfer to the flow channels. The use of aluminium instead of steel may reduce the cost of manufacture. The aluminium integral body may be formed by extrusion, die-casting or metal injection moulding. Alternatively, the integral body may be formed of ceramic material, for example by extrusion, ceramic injection moulding or isostatic pressing.

[0010] The thick film heater may comprise a substrate which is attached to the body, for example by crimping a portion of the body onto the substrate, or using fixings such as bolts or screws; these may be thermally conductive so as to assist thermal conduction from the thick film heater to the body. Alternatively, one or more thick film heating tracks may be deposited directly onto the body. Where the body is made of aluminium, the thick film heating track(s) may be deposited on an anodised surface of the body, so that there is no need to deposit a separate insulating layer on the body before depositing the track(s).

[0011] A flow path through the flow channels may be defined by one or more manifolds, which may be arranged at either end of the flow channels. The manifolds may be configured to define a serial and/or parallel flow paths through the flow channels. The number of channels through which the fluid flows in parallel may increase or decrease as the fluid flows through the flow through heater.

[0012] A thick film heater as described above may be provided on each of two or more faces of the integral body, thus increasing the heating power.

[0013] According to another aspect of the invention, there is provided a method of manufacture of the flow through heater in which the body is integrally formed and the thick film heater is provided in thermal contact with the body, either by attaching a thick film heater substrate or by depositing one or more thick film heating tracks onto the body with electrical insulation where necessary, such as an anodised aluminium surface.

Brief Description of Drawings

[0014] Specific embodiments of the present invention will now be described with reference to the accompanying drawings as listed below.

Fig. 1 is a perspective view of a flow through heater in a first embodiment.

Fig. 1a is a longitudinal cross-section in a plane of the flow-through heater of the first embodiment.

Fig. 2 is an exploded view of a flow through heater in a second embodiment.

Fig. 2a is a longitudinal cross-section in a plane of the flow through heater in the second embodiment.

Fig. 2b is an exploded view of one end of the flow through heater in the second embodiment.

Fig. 3 is a flow chart of a method of manufacture in an embodiment.

Description of Embodiments

[0015] Fig. 1 and Fig. 1a show a first embodiment, in which a thick film heating element or heater 1 is mounted in thermal contact with an integral body 4 comprising a plurality of flow channels 4a-4e, such that fluid flowing through the flow channels 4a-4e is heated by the element 1. The body 4 is formed as an integral component with the flow channels 4a-4e formed therein, rather than being formed of separate parts as in the prior art.

[0016] The body 4 may be formed of aluminium, for example by extrusion, diecasting or metal injection moulding. Alternatively, the body 4 may be formed from a ceramic material, which may be formed by extrusion, ceramic injection moulding or isostatic pressing.

[0017] In this embodiment, the body 4 is formed in a generally cuboid shape, with fluid channels 4a-4e extending from one end of the body to the other along a central plane of the body. In alternative embodiments, the body 4 may be formed in other shapes to suit the required application. The use of extrusion or moulding techniques to form the body 4 allows flexibility in the design of the body 4.

[0018] The thick film heating element 1 may be provided on one or both major faces of the body 4, parallel to the central plane. This provides good thermal transfer between the thick film heating element 1 and the fluid channels 4a-4e. The thick film heating element 1 may be formed on a substrate, which may be of stainless steel or ceramic. If required, an insulating layer is printed or sprayed on the substrate and then fired. Resistor tracks, connection pads and connection features for electronic components may then be added by printing and firing. The thick film heating element 1 may be fixed to the body,

for example by crimps, screws or bolts. The fixing material may be selected for thermal conductivity.

[0019] Alternatively, the thick film heater 1 may comprise thick film track(s) formed directly onto the body 4, for example by printing. In this case an electrically insulating layer may be deposited onto the body 4 before the thick film track(s) are deposited. Alternatively, where the body 4 is formed of aluminium, a layer of aluminium oxide can be formed on the surface of the body 4, for example by an anodising process.

[0020] In any of the above alternatives, a protective overglaze may be applied over the thick film track(s).

[0021] At each end of the body 4 is mounted a manifold 2, comprising a fluid port 6 and a manifold channel 10 that interconnects the flow channels 4a-4e. The manifold 2 is attached to the end of the body 4 by fixing screws 5, bolts or other fixing components, which may be fixed within a fixing channel formed within the body 4.

[0022] The manifold channels 10 may be configured to provide a series and/or parallel flow path through the flow channels 4a-4e. In the first embodiment, the manifold channels are configured so that fluid flows through a first outer flow channel 4a and then in parallel through a plurality of (in this case three) middle flow channels 4b-4d before passing through a second outer flow channel 4e. This arrangement may be particularly suitable for steam generation, because water is quickly heated in the parallel middle flow channels 4b to 4d before passing through the second outer flow channel 4e, with a pressure drop sufficient to allow the water to remain liquid within the second outer flow channel 4e but emerge from the outlet as steam. More generally, the manifold channels 10 may be configured so that the number of flow channels increases or decreases as the fluid flows through a first number of channels (in parallel if there are more than one) in series with a second number of channels (also in parallel if there are more than one). The advantage of a smaller number of channels may be that the flow resistance increases, allowing for a greater pressure drop. The advantage of a larger number of channels may be more rapid heating of the fluid.

[0023] As the manifolds 2 are provided as separate or separable components from the body 4, the flow path through the flow channels 4a-4e may be configured by the arrangement of the manifold channels 10, such that different flow path configurations may be provided by selection of manifolds 2. As shown in Fig. 2, the or each manifold 2 may comprise an outer housing 2a and an inner moulding 2b which together define the manifold channels 10.

[0024] The fluid ports 6 provided respectively a fluid inlet and a fluid outlet to the flow through heater. The fluid ports 6 may be provided at opposite ends of the body 4, as shown, or may both be provided at one end, depending on the intended application of the flow-through heater.

[0025] Electrical terminals 8 are connected to the thick film heating track(s) of the element 1, for example by contact springs 7. The electrical terminals 8 may be lo-

cated in a terminal housing 3, which may be supported by or integrated with one or both of the manifolds 2. The location of the electrical terminals 8 is dependent on the layout of the thick film heating tracks, and may be at one or both ends of the body 4.

[0026] One or more sensors, such as an NTC (negative temperature coefficient) thermistor, may be arranged so as to sense the temperature of fluid within the flow path and/or at the outlet of the flow path. The sensor(s) may be mounted directly onto the body 4 and may be supported by the terminal housing 3. Alternatively, the one or more sensors may be mounted within one or more of the manifolds 2.

[0027] Additionally a Triac, which is used in the control circuit to modulate the current flow to the heater, can be mounted on the body 4, preferably near the inlet of the flow path in order to cool the Triac. A thermal fuse and/or bimetallic cut out may be mounted on the body 4.

[0028] Fig. 2, Fig. 2a and Fig. 2b show a second embodiment which is similar to the first embodiment except for the following variants, each of which may be applied independently of the other variants.

[0029] In a first variant, the body 4 comprises three flow channels 4a-4c rather than the five flow channels 4a-4e in the first embodiment. The number of flow channels, as well as the width of the flow channels, may be selected according to the desired application.

[0030] In a second variant, the manifold channel 10 is arranged so that flow channels 4a-4c are connected together in series rather than in parallel.

[0031] In a third variant, the body 4 includes crimping portions 9 formed as longitudinal walls that project away from a plane of the body 4. The element 1 is attached to the body 4 by placing the element 1 between the crimping portions 9 and then crimping the crimping portions 9 around the longitudinal edges of the element 1.

[0032] In a fourth variant, shown in Fig. 2b, there are provided a pair of heating elements 1, contacting opposite main faces of the body 4. Each of the heating elements 1 has associated electrical terminals 8, connected to the thick film heating track(s) by contact springs 7.

[0033] As shown in Fig. 3, a method of manufacture of an embodiment (such as the first or second embodiments and variants described above) may comprise the following steps:

S1: form the integral body 4. In the case of an aluminium body 4, this may be by extruding, diecasting or metal injection moulding. In the case of a ceramic body 4, this may be extrusion, injection moulding or isostatic pressing.

S2: provide the thick film heater 1 in thermal contact with the integral body 4. Where the thick film heater is a thick film heating element comprising thick film heating tracks deposited on a separate substrate, this may comprise attaching the substrate to the body 4. Alternatively, the thick film heating tracks

may be deposited on the body 4.

S3: Attach manifolds 2 to body 4.

S4: Connect terminals 8 to thick film heater 1.

[0034] The order of the above steps may be varied, except where one step is dependent on a previous step. For example, the order of steps S3 and S4 may be reversed. Step S4 may be performed before step S3, except where the mounting of the terminals 8 is dependent on the manifold(s) 2 being present.

[0035] The above embodiments are described by way of example and are not limiting on the scope of the invention. Alternative embodiments, which may become apparent to the skilled person on reading the above description, may nevertheless fall within the scope of the present invention.

Claims

1. Flow through heater comprising an integral body (4) having a plurality of flow channels (4a-4e) formed therein, and a thick film heater (1) in thermal contact with the integral body (4), such that fluid flowing through the flow channels (4a-4e) is heated by the thick film heater (1).
2. Flow through heater of claim 1, wherein the integral body (4) comprises aluminium.
3. Flow through heater of claim 1 or claim 2, wherein the integral body (4) is formed by extrusion, diecasting or metal injection moulding.
4. Flow through heater of claim 1, wherein the integral body (4) comprises ceramic material, formed for example by extrusion, ceramic injection moulding or isostatic pressing.
5. Flow through heater of any preceding claim, wherein the thick film heater (1) comprises one or more thick film heating tracks deposited on a substrate, which is attached to the integral body (4) for example by crimping and/or by one or more thermally conductive fixings.
6. Flow through heater of any one of claims 1 to 5, wherein the thick film heater (1) comprises one or more thick film heating tracks deposited on the integral body (4).
7. Flow through heater of claim 6 when dependent on claim 2, wherein the one or more thick film heating tracks are deposited on an anodised surface of the integral aluminium body (4).

8. Flow through heater of any preceding claim, further including an electronic component, for example a sensor, mounted on the integral body (4).
9. Flow through heater of any preceding claim, including one or more manifolds (2) interconnecting the flow channels (4a-4e) in series and/or in parallel. 5
10. Flow through heater of claim 9, wherein the one or more manifolds (2) are configured so that fluid flows through a first number of flow channels and then through a second number of channels, wherein the first number of flow channels may be greater than or less than the second number of flow channels. 10
11. Flow through heater of claim 9 or 10, wherein the flow channels (4a-4e) extend from a first end to a second end of the integral body (4), and the or each manifold (2) is connected to a corresponding one of the first and second ends. 15
12. Flow through heater of any one of claims 9-11, including electrical terminals (8) connected to the thick film heater, the electrical terminals being provided in a housing supported by, or integral with one or more said manifolds (2). 20
13. A method of manufacture of the flow through heater of any preceding claim, comprising: 25

forming the integral body (4) with the flow channels (4a-4e) therein; and
 providing the thick film heater (1) in thermal contact with the integral body (4). 30
14. The method of claim 13 when dependent directly or indirectly on claim 2, including forming the aluminium integral body (4) by extrusion, diecasting or metal injection moulding. 35
15. The method of claim 13 when dependent directly or indirectly on claim 4, including forming the ceramic integral body (4) by extrusion, ceramic injection moulding or isostatic pressing. 40

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Fig. 1

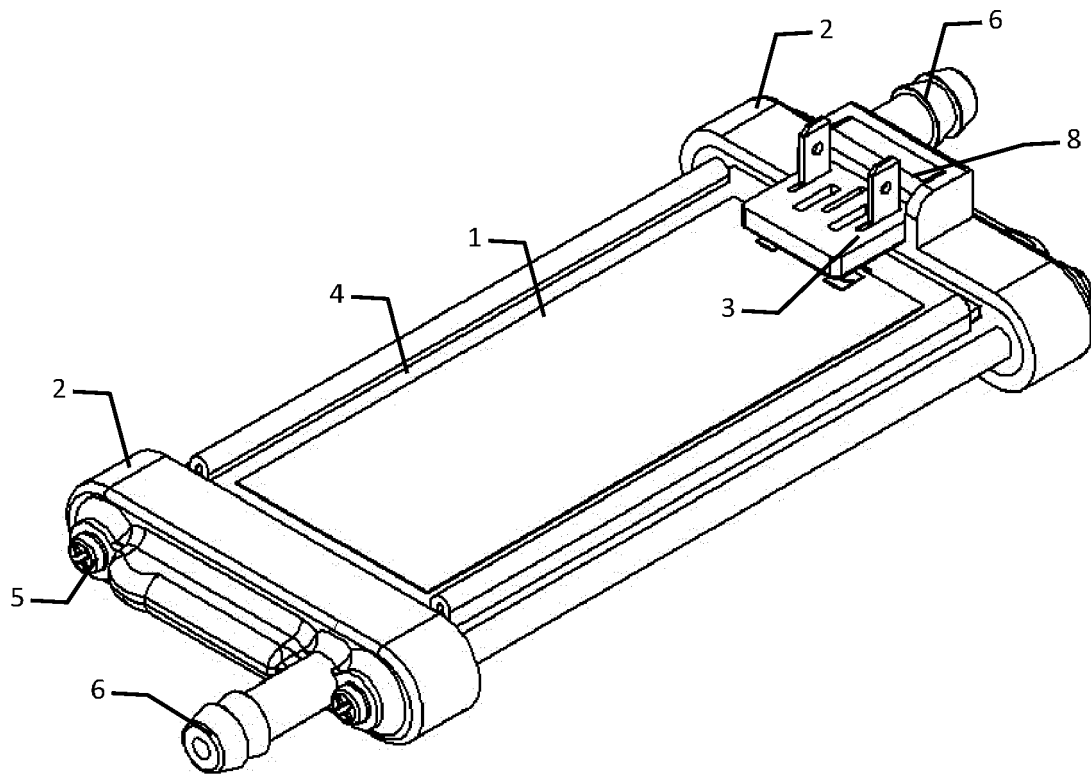


Fig. 1a

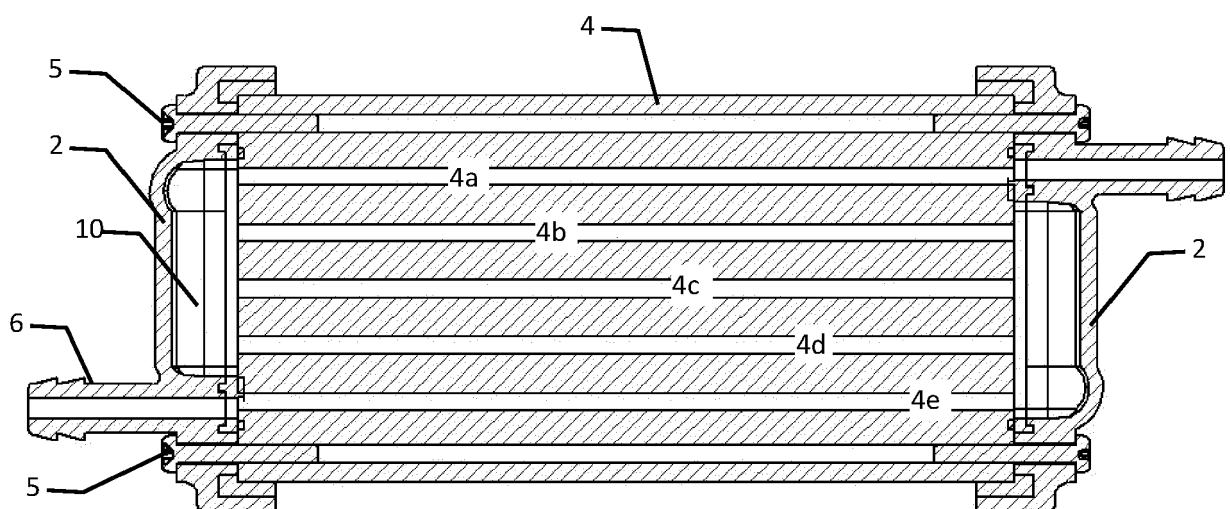


Fig. 2

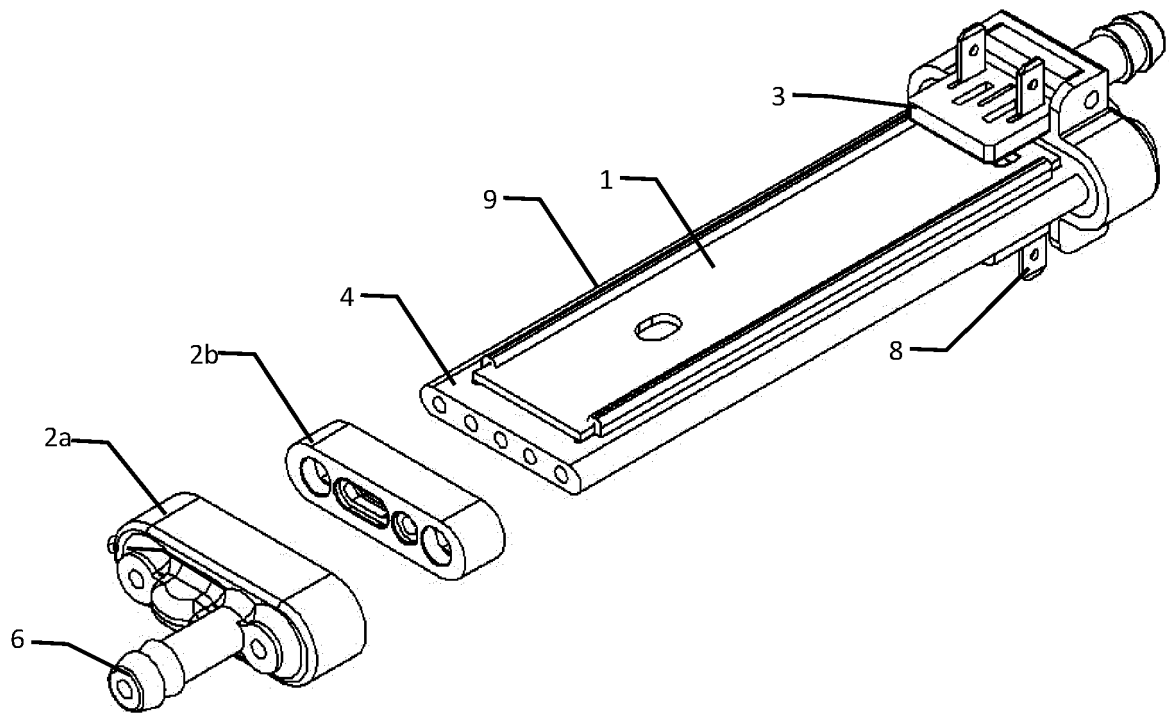


Fig. 2a

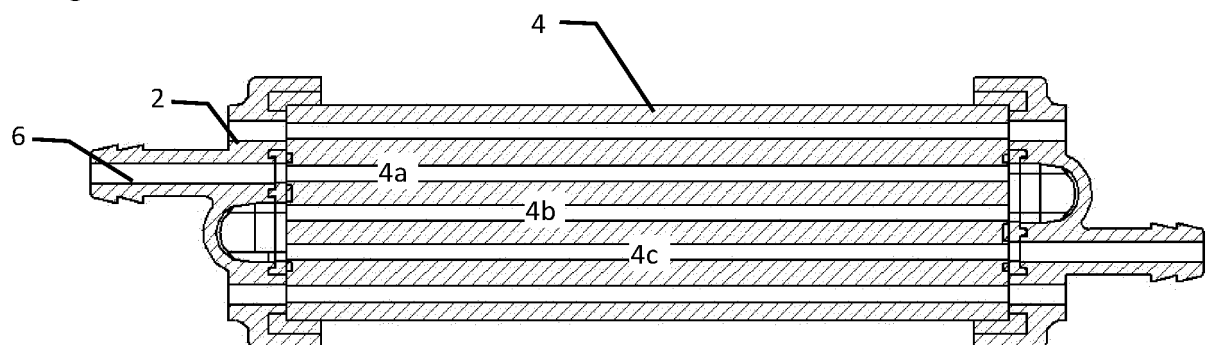


Fig. 2b

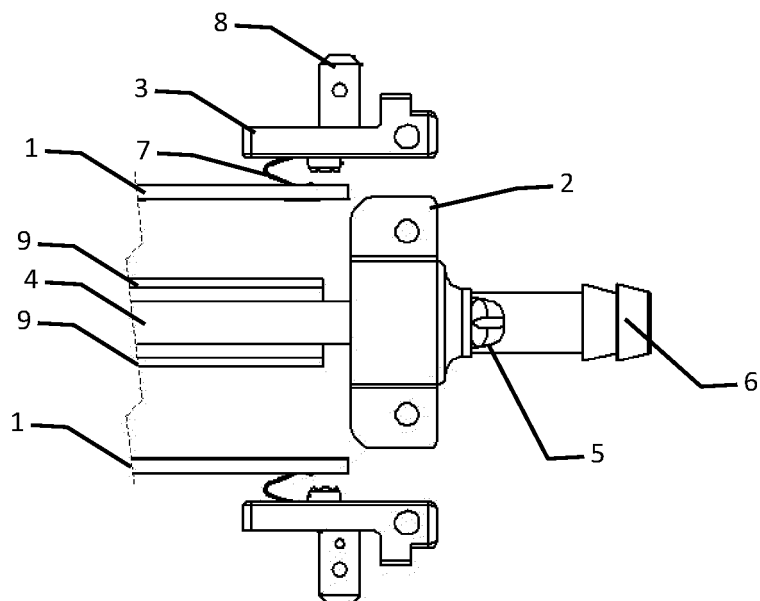
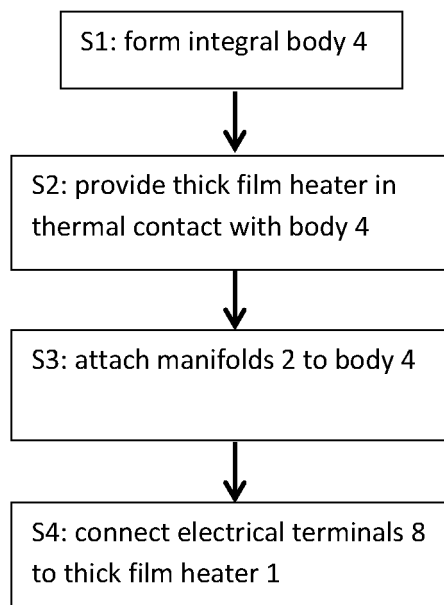


Fig. 3





EUROPEAN SEARCH REPORT

Application Number

EP 23 21 5025

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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X	DE 44 36 013 A1 (KURZ WOLFGANG [DE]; RIEKER HEINZ [DE]) 18 April 1996 (1996-04-18) * column 1, line 3 - line 6 * * column 3, line 57 - column 4, line 50; figure 1 * * claim 7 *	1-4, 8-13,15	
X	US 4 920 868 A (GEHRMANN ALFRED [DE]) 1 May 1990 (1990-05-01) * column 7, line 62 - column 8, line 12; figure 4 *	1, 6, 7, 13	TECHNICAL FIELDS SEARCHED (IPC) H05B
The present search report has been drawn up for all claims			

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EPO FORM 1503 03:82 (P04C01)

Place of search Munich	Date of completion of the search 24 April 2024	Examiner Barzic, Florent
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ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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