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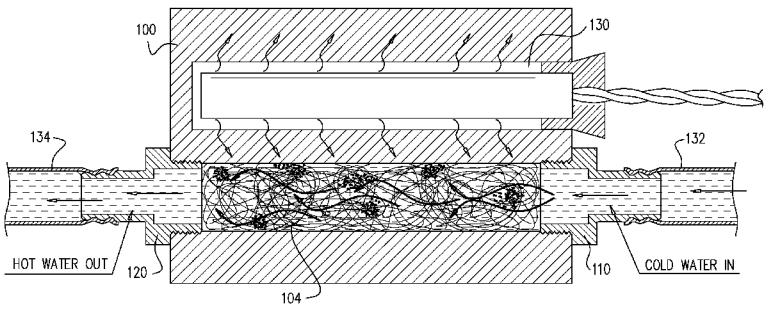
(54) Title: APPARATUS FOR RAPID HEATING OF LIQUIDS

FIG. 3



(57) Abstract: Apparatus for rapid heating of a liquid including a heat source, a liquid flowpath defining element defining a liquid heating flowpath therein having a liquid inlet and a liquid outlet, a collection of flexible elongate thermal conductors located within the flowpath, the collection of flexible elongate thermal conductor portions being thermally coupled to the heat source and defining multiple liquid heating passageways through the flowpath whose configurations and cross-sectional dimensions change over time, thereby being resistant to clogging.

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APPARATUS FOR RAPID HEATING OF LIQUIDS

FIELD OF THE INVENTION

The present invention relates generally to heating of liquids and more particularly to devices for rapid heating of water.

BACKGROUND OF THE INVENTION

Various types of devices for heating of liquids are known.

SUMMARY OF THE INVENTION

The present invention seeks to provide an improved device for heating of liquids. There is thus provided in accordance with a preferred embodiment of the present invention apparatus for rapid heating of a liquid including a heat source, a liquid flowpath defining element defining a liquid heating flowpath therein having a liquid inlet and a liquid outlet, a collection of flexible elongate thermal conductors located within the flowpath, the collection of flexible elongate thermal conductor portions being thermally coupled to the heat source and defining multiple liquid heating passageways through the flowpath whose configurations and cross-sectional dimensions change over time, thereby being resistant to clogging.

Preferably, the collection of flexible elongate thermal conductors is fixed to the liquid flowpath defining element. Additionally or alternatively, the collection of flexible elongate thermal conductors includes multiple separate conductors mutually arranged in an irregular and mutually displaceable arrangement, which changes in response to liquid flow therepast. Additionally or alternatively, the liquid flowpath defining element is a thermal conductor and is coupled to the heat source and the multiplicity of flexible elongate thermal conductors.

In accordance with a preferred embodiment of the present invention the liquid flowpath defining element includes a bore defining the liquid flowpath and a recess, spaced from the bore, for receiving the heating element. Additionally, the collection of flexible elongate thermal connectors is packed within the bore and in thermal contact with the heating element via the liquid flowpath defining element.

In accordance with a preferred embodiment of the present invention the collection of flexible elongate thermal connectors has a dynamic arrangement of interstices in response to liquid flow therepast.

There is also provided in accordance with another preferred embodiment of the present invention a method for rapid heating of a liquid including directing liquid along a liquid heating flowpath in which are located a collection of flexible thermal conductors which define interstices therebetween and conducting heat from a heat source to the liquid via the flexible thermal conductors.

In accordance with a preferred embodiment of the present invention the liquid heating flowpath is defined by a liquid flowpath defining element having a liquid inlet and a liquid outlet and the collection of flexible elongate thermal conductors located within the flowpath defines multiple liquid heating passageways through the flowpath whose configurations and cross-sectional dimensions change over time, thereby being resistant to clogging. Additionally, the collection flexible elongate thermal conductors includes multiple separate conductors mutually arranged in an irregular and mutually displaceable arrangement, which changes in response to liquid flow therepast.

Preferably, the liquid flowpath defining element operates as a thermal conductor and transmits heat from the heat source to the flexible elongate thermal conductors. Additionally or alternatively, the liquid flowpath defining element is a thermal conductor and is coupled to the heat source and the multiplicity of flexible elongate thermal conductors.

In accordance with a preferred embodiment of the present invention the collection of flexible elongate thermal conductors includes multiple separate conductors mutually arranged in an irregular and mutually displaceable arrangement, which changes in response to liquid flow therepast. Preferably, the liquid flowpath defining element transmits heat from heat source to the flexible elongate thermal conductors.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings, in which:

Figs. 1A & 1B are a simplified assembled view illustration and a simplified exploded view illustration, respectively, of apparatus for rapid heating of liquids, constructed and operative in accordance with a preferred embodiment of the present invention;

Figs. 2A, 2B, 2C and 2D are simplified sectional illustrations of a liquid heating pathway, taken along lines IIA – IIA in Fig. 1A at four different points in time and showing variability in the configuration thereof; and

Fig. 3 is a simplified illustration of the apparatus for rapid heating of liquids, taken along lines III – III in Fig. 1A.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Reference is now made to Figs. 1A - 3, which illustrate apparatus for rapid heating of liquids, constructed and operative in accordance with a preferred embodiment of the present invention. As seen in Figs. 1A - 3, the apparatus comprises a heat conducting and liquid conveying element 100, preferably formed of a highly heat conductive metal, such as aluminum, and including a liquid flow and heating bore 102, extending therethrough, in which are located a collection 104 of mutually displaceable thermal conductors, typically formed of stainless steel, which are preferably intertwined in a manner which changes over time in response to liquid flow therepast. The collection 104 may be defined by multiple separate conductors or alternatively by a single conductor. The thermal conductors are typically in the form of narrow strips or fibers.

Liquid inflow and outflow fixtures 110 and 120 are typically formed of aluminum or another suitable heat-conducting metal and coupled to respective inflow and outflow ends of bore 102. A heating element 130 is located in a heating element recess 131 formed in element 100. An example of a suitable heating element 130 is an electromagnetic heating element manufactured by Shenzhen Hanke Instrument Co., Ltd, headquartered at #2 Shangxue City 1st Road, Bantian, Longgang District, P.C. Heating element 130 preferably reaches a peak temperature of approximately 180° Celsius.

Inlet and outlet liquid conduits 132 and 134, typically formed of metal, rubber or plastic, are attached, respectively, to liquid inflow and outflow fixtures 110 and 120 and connect bore 102 to a source of liquid to be heated (not shown) and to a heated liquid utilization device (not shown).

Reference is now made to Figs. 2A, 2B, 2C, 2D which illustrate a particular feature of an embodiment of the present invention wherein, as the result of liquid flow thereby the arrangement of the thermal conductors in collection 104 changes over time, preferably in a random or unpredictable manner, preferably such that the interstices therebetween change in configuration over time in a random or unpredictable manner. This has a particular advantage in that clogging of the collection 104 by solid or semisolid impurities in the liquid flowing through bore 102 is largely obviated.

In this way, as can be seen by comparing Figs. 2A, 2B, 2C and 2D, clogging of a given region between adjacent thermal conductors leads to mutual displacement of the thermal conductors defining that region, thereby changing the configuration of the interstices and allowing the impurities to pass. This is in distinction to a fixed mesh in which the configuration of the interstices between adjacent conductors is fixed, often leading to incremental clogging of the entire mesh.

In a preferred embodiment, the collection 104 of thermal conductors is lightly packed into bore 102 in good thermal contact with element 100 such that heat produced by heating element 130 is efficiently conducted via element 100 to the thermal conductors in collection 104 and to the liquid flowing therepast in bore 102. The conductors in collection 104 may or may not be fixed to element 100. Preferably, the flow of water through bore 102 past the collection 104 of thermal conductors is turbulent flow and this turbulent flow enhances the mutual displacement of the conductors and the realignment of the interstices thereof over time.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of features described hereinabove and variations and modifications thereof which are not in the prior art.

CLAIMS

1. Apparatus for rapid heating of a liquid comprising:

a heat source;

a liquid flowpath defining element defining a liquid heating flowpath therein having a liquid inlet and a liquid outlet;

a collection of flexible elongate thermal conductors located within said flowpath, said collection of flexible elongate thermal conductor portions being thermally coupled to said heat source and defining multiple liquid heating passageways through said flowpath whose configurations and cross-sectional dimensions change over time, thereby being resistant to clogging.

2. Apparatus for rapid heating of a liquid according to claim 1 wherein said collection of flexible elongate thermal conductors is fixed to said liquid flowpath defining element.

3. Apparatus for rapid heating of a liquid according to claim 1 wherein said collection of flexible elongate thermal conductors comprises multiple separate conductors mutually arranged in an irregular and mutually displaceable arrangement, which changes in response to liquid flow therepast.

4. A device for rapid heating of a liquid according to claim 2 wherein said liquid flowpath defining element is a thermal conductor and is coupled to said heat source and said multiplicity of flexible elongate thermal conductors.

5. A device for rapid heating of a liquid according to claim 3 wherein said liquid flowpath defining element is a thermal conductor and is coupled to said heat source and said multiplicity of flexible elongate thermal conductors.

6. Apparatus for rapid heating of a liquid according to claim 2 wherein said collection of flexible elongate thermal conductors comprises multiple separate

conductors mutually arranged in an irregular and mutually displaceable arrangement, which changes in response to liquid flow therepast.

7. Apparatus for rapid heating of a liquid according to claim 6 wherein said liquid flowpath defining element is a thermal conductor and is coupled to said heat source and said multiplicity of flexible elongate thermal conductors.

8. Apparatus for rapid heating of a liquid according to claim 1 wherein said liquid flowpath defining element includes a bore defining said liquid flowpath and a recess, spaced from said bore, for receiving said heating element.

9. Apparatus for rapid heating of a liquid according to claim 8 wherein said collection of flexible elongate thermal connectors is packed within said bore and in thermal contact with said heating element via said liquid flowpath defining element.

10. Apparatus for rapid heating of a liquid according to claim 9 wherein said collection of flexible elongate thermal connectors has a dynamic arrangement of interstices in response to liquid flow therepast.

11. A method for rapid heating of a liquid comprising:

directing liquid along a liquid heating flowpath in which are located a collection of flexible thermal conductors which define interstices therebetween; and

conducting heat from a heat source to said liquid via said flexible thermal conductors.

12. A method for rapid heating of a liquid according to claim 11 wherein said liquid heating flowpath is defined by a liquid flowpath defining element having a liquid inlet and a liquid outlet and said collection of flexible elongate thermal conductors located within said flowpath defines multiple liquid heating passageways through said flowpath whose configurations and cross-sectional dimensions change over time, thereby being resistant to clogging.

13. A method for rapid heating of a liquid according to claim 12 wherein said collection flexible elongate thermal conductors comprises multiple separate conductors mutually arranged in an irregular and mutually displaceable arrangement, which changes in response to liquid flow therepast.

14. A method for rapid heating of a liquid according to claim 12 wherein said liquid flowpath defining element operates as a thermal conductor and transmits heat from said heat source to said flexible elongate thermal conductors.

15. A method for rapid heating of a liquid according to claim 13 wherein said liquid flowpath defining element is a thermal conductor and is coupled to said heat source and said multiplicity of flexible elongate thermal conductors.

16. A method for rapid heating of a liquid according to claim 11 wherein said collection of flexible elongate thermal conductors comprises multiple separate conductors mutually arranged in an irregular and mutually displaceable arrangement, which changes in response to liquid flow therepast.

17. A method for rapid heating of a liquid according to claim 12 wherein said liquid flowpath defining element transmits heat from heat source to said flexible elongate thermal conductors.

FIG. 1A

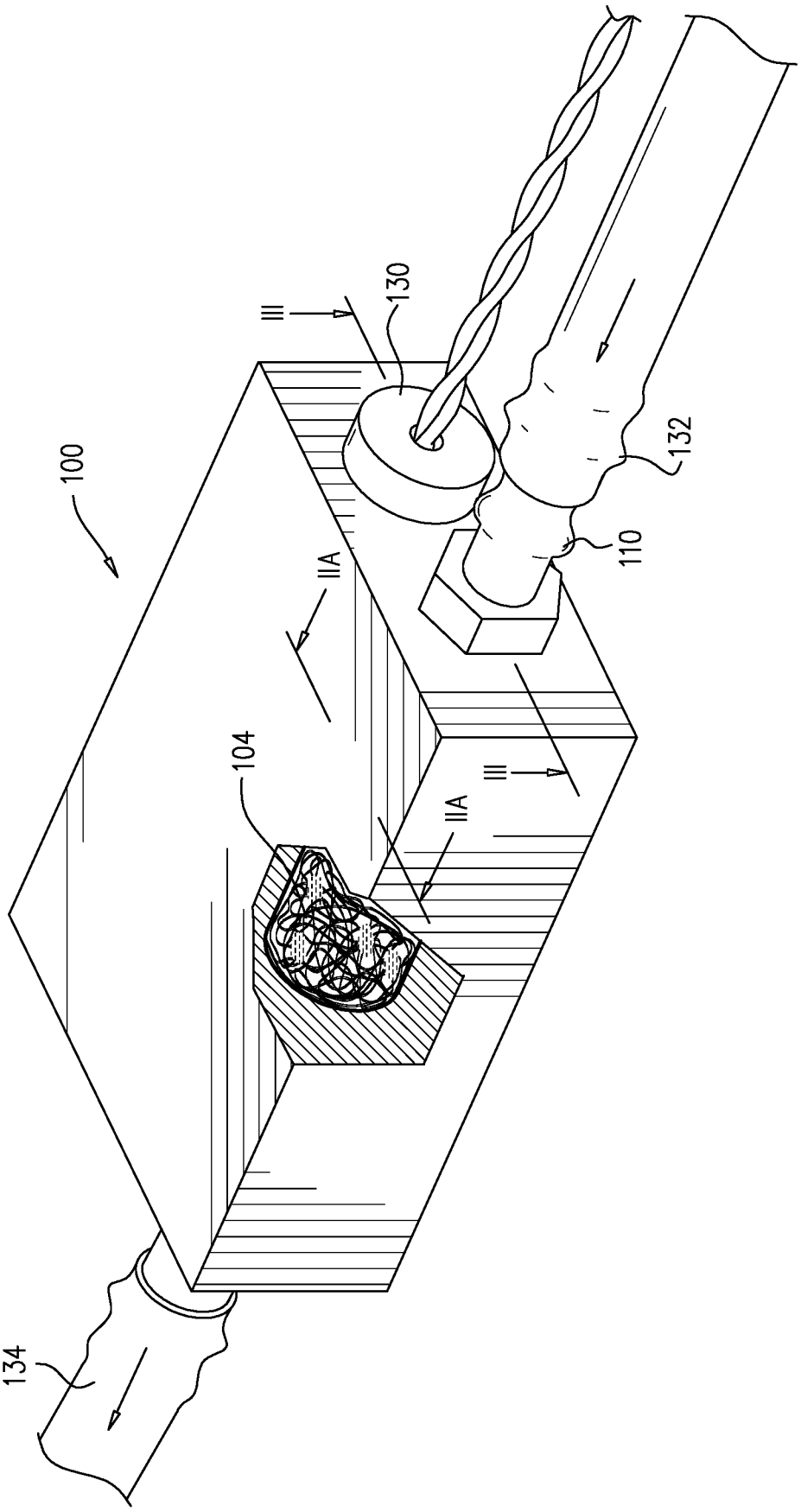


FIG. 1B

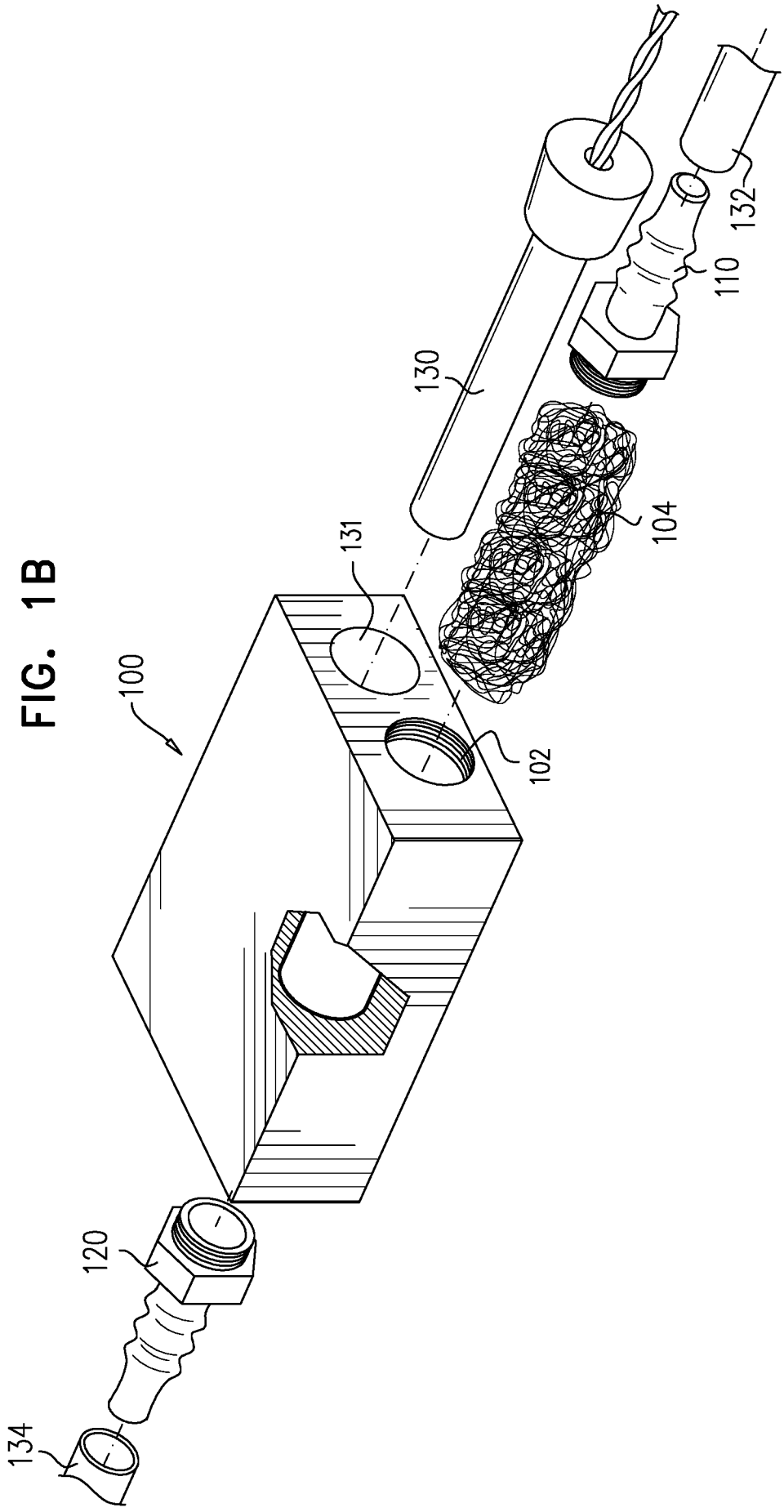


FIG. 2A

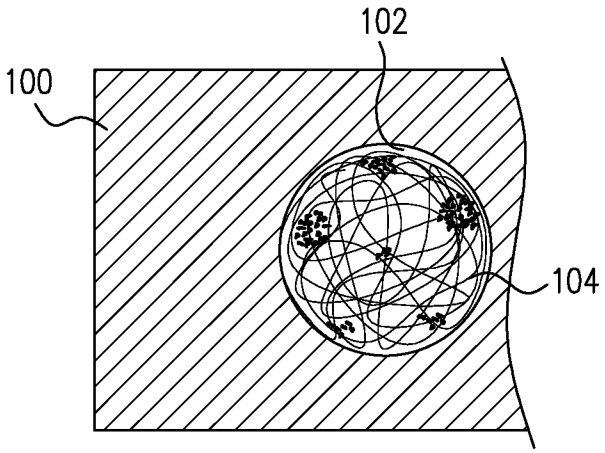


FIG. 2B

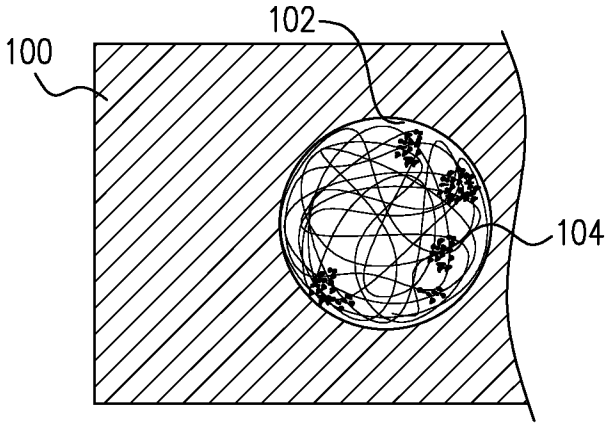


FIG. 2C

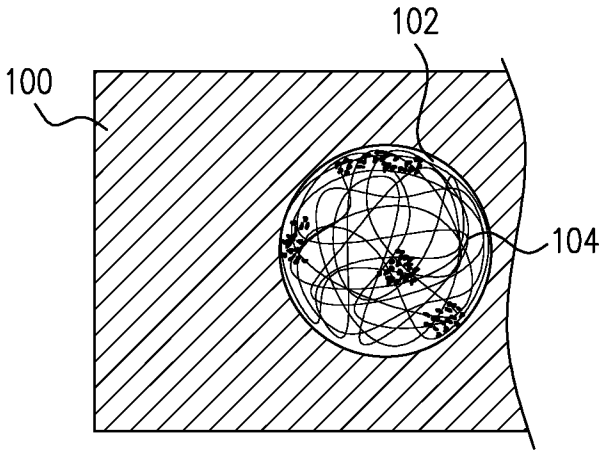


FIG. 2D

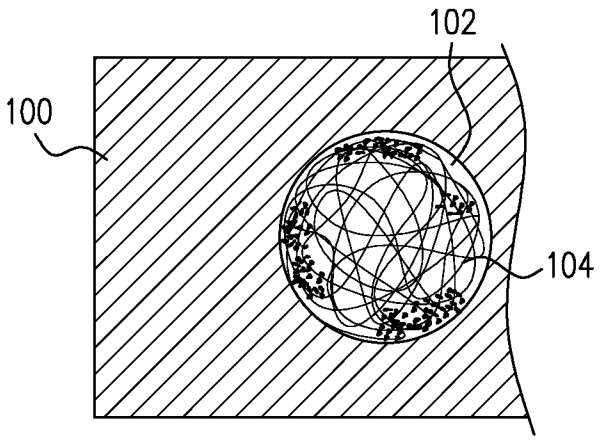
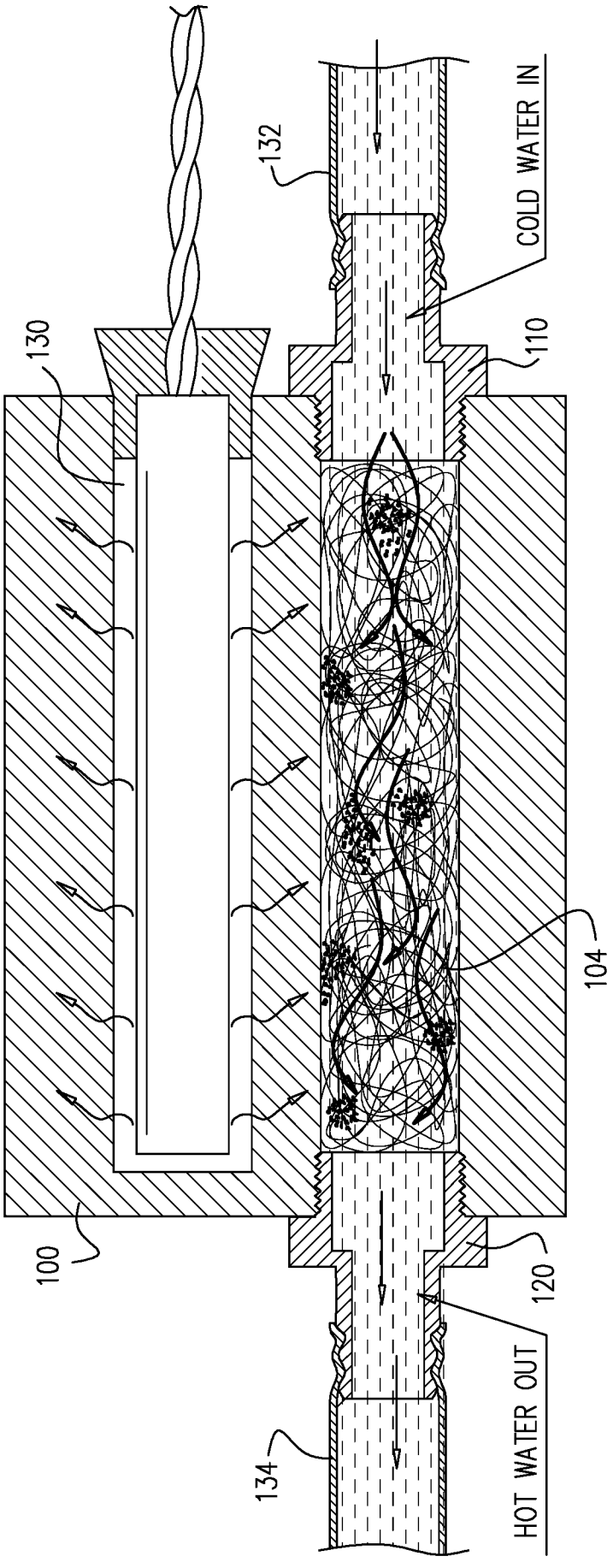


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F28F 13/12; B01J 19/24; B01J 19/32; F02G 1/055; F22B 1/00; F22B 1/28; F24H 1/00 (2017.01)

CPC - F28F 13/12; F02G 1/055; F22B 1/28; F24H 1/10; F24H 1/18; F24H 1/20; F24H 9/18; F28D 15/04; F28F 13/06 (2017.02)

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)

See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

USPC - 122/18.1; 219/601; 219/618; 219/628; 219/629; 219/687; 392/465; 392/485; 392/486 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,818,842 A (WALTY) 04 April 1989 (04.04.1989) entire document	1, 2, 4, 8-12, 14, 17
Y	US 6,008,482 A (TAKAHASHI et al) 28 December 1999 (28.12.1999) entire document	1, 2, 4, 8-12, 14, 17
A	WO 01/94006 A2 (ABB LUMMUS GLOBAL, INC.) 13 December 2001 (13.12.2001) entire document	1-17
A	US 4,310,747 A (RICE et al) 12 January 1982 (12.01.1982) entire document	1-17
A	US 2005/0281864 A1 (YAMADA) 29 December 2005 (29.12.2005) entire document	1-17

☐ 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

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"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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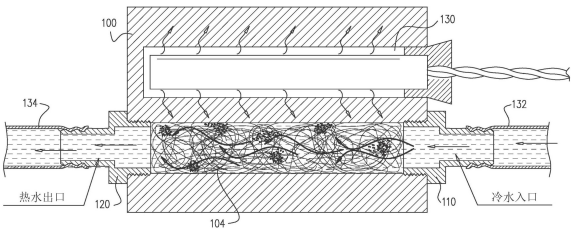
权利要求书2页 说明书3页 附图5页

(54)发明名称

快速加热液体的装置

(57)摘要

一种快速加热液体的装置，包括：一热源；一液体流路定义元件，定义一液体加热流路在其中，并具有一液体入口和一液体出口；多个柔性细长热导体的一集合，位于所述液体加热流路内，所述多个柔性细长热导体的部分被热耦合到所述热源并且定义出通过所述液体加热流路的多个液体加热通道，所述多个柔性细长热导体的结构和横截面尺寸随时间而变化，从而防止堵塞。



CN 108291787 A

1.一种快速加热液体的装置,其特征在于,所述快速加热液体的装置包括:一热源;

一液体流路定义元件,定义一液体加热流路在其中,并具有一液体入口和一液体出口;及

多个柔性细长热导体的一集合,位于所述液体加热流路内,所述多个柔性细长热导体的所述集合的部分被热耦合到所述热源并且定义出通过所述液体加热流路的多个液体加热通道,所述多个柔性细长热导体的结构和横截面尺寸随时间而变化,从而防止堵塞。

2.根据权利要求1所述的快速加热液体的装置,其特征在于,所述多个柔性细长热导体的所述集合被固定到所述液体流路定义元件。

3.根据权利要求1所述的快速加热液体的装置,其特征在于,所述多个柔性细长热导体的所述集合包括相互地以一不规则的及互相可移位的排列方式排列成的多个分开的导体,所述多个导体响应于流经的液体流动而变化。

4.根据权利要求2所述的快速加热液体的装置,其特征在于,所述液体流路定义元件是一热导体,并且耦合到所述热源和所述多个柔性细长热导体。

5.根据权利要求3所述的快速加热液体的装置,其特征在于,所述液体流路定义元件是一热导体,并且耦合到所述热源和所述多个柔性细长热导体。

6.根据权利要求2所述的快速加热液体的装置,其特征在于,所述多个柔性细长热导体的所述集合包括相互地以一不规则的及互相可移位的排列方式排列成的多个分开的导体,所述多个导体响应于流经的液体流动而变化。

7.根据权利要求6所述的快速加热液体的装置,其特征在于,所述液体流路定义元件是一热导体,并且耦合到所述热源和所述多个柔性细长热导体。

8.根据权利要求1所述的快速加热液体的装置,其特征在于,所述液体流路定义元件包括定义出所述液体加热流路的一通孔及与所述通孔间隔开的用于收纳所述加热元件的一凹穴。

9.根据权利要求8所述的快速加热液体的装置,其特征在于,所述多个柔性细长热导体的所述集合塞入所述通孔内,并且通过所述液体流路定义元件与所述加热元件热接触。

10.根据权利要求9所述的快速加热液体的装置,其特征在于,所述多个柔性细长热导体的所述集合响应于流经的液体流动而具有一动态的空隙排列。

11.一种快速加热液体的方法,其特征在于,所述快速加热液体的方法包括:沿着一液体加热流路引导一液体,所述液体加热流路中设置有多个柔性细长热导体的一集合,所述多个柔性细长热导体之间定义有多个空隙;及

通过所述多个柔性细长热导体将热能从一热源传导到所述液体。

12.根据权利要求11所述的快速加热液体的方法,其特征在于,所述液体加热流路由具有一液体入口和一液体出口的一液体流路定义元件所定义,并且位于所述液体加热流路内的所述多个柔性细长热导体的所述集合定义出通过所述液体加热流路的多个液体加热通道,且所述多个柔性细长热导体的结构和横截面尺寸随时间变化,从而防止堵塞。

13.根据权利要求12所述的快速加热液体的方法,其特征在于,所述多个柔性细长热导体的所述集合包含多个分开的导体,所述多个导体相互地以一不规则的及互相可移位的排列方式排列,所述多个导体响应于流经的液体流动而变化。

14.根据权利要求12所述的快速加热液体的方法,其特征在于,所述液体流路定义元件

运作作为一热导体并将热能从所述热源传递到所述多个柔性细长热导体。

15.根据权利要求13所述的快速加热液体的方法，其特征在于，所述液体流路定义元件是一热导体，并且耦合到所述热源和所述多个柔性细长热导体。

16.根据权利要求11所述的快速加热液体的方法，其特征在于，所述多个柔性细长热导体的所述集合包括相互地以一不规则的及互相可移位的排列方式排列成的多个分开的导体，所述多个导体随着流经的液体流动而变化。

17.根据权利要求12所述的快速加热液体的方法，其特征在于，所述液体流路定义元件将热能从所述热源传递到所述多个柔性细长热导体。

快速加热液体的装置

技术领域

[0001] 本发明涉及液体的加热，特别是涉及一种快速加热水的装置。

背景技术

[0002] 许多类型的加热液体的装置是已知的。

发明内容

[0003] 本发明寻求提供一种加热液体的改进装置。因此，根据本发明的优选实施例，提供一种快速加热的液体的装置，包括一热源；一液体流路定义元件，其定义一液体加热流路在其中，并具有一液体入口和一液体出口；一具有多个柔性细长热导体的集合，位于所述液体加热流路内，所述多个柔性细长热导体的所述集合的部分被热耦合到所述热源并且定义出通过所述液体加热流路的多个液体加热通道，所述多个柔性细长热导体的结构和横截面尺寸随时间而变化，从而防止堵塞。

[0004] 优选地，所述多个柔性细长热导体的所述集合被固定到所述液体流路定义元件。附加地或可替代地，所述多个柔性细长热导体的所述集合包括相互地以一不规则的及互相可移位的排列方式排列成的多个分开的导体，所述多个导体响应于流经的液体流动而变化。附加地或可替代地，所述液体流路定义元件是一热导体并且耦合到所述热源和所述多个柔性细长热导体。

[0005] 根据本发明的优选实施例，所述液体流路定义元件包括定义所述液体加热流路的一通孔及与所述通孔隔开的用于收纳所述加热元件的一凹穴。此外，所述多个柔性细长热导体的所述集合被塞入所述通孔内并通过所述液体流路定义元件与所述加热元件热接触。

[0006] 根据本发明的一优选实施例，所述多个柔性细长热导体的所述集合响应于流经的液体流动而具有一动态的空隙排列。

[0007] 根据本发明的另一优选实施例，还提供了一种快速加热液体的方法，包括沿着一液体加热流路引导液体，所述液体加热流路中设置有一具有多个柔性细长热导体的集合，所述多个柔性细长热导体之间形成多个间隙，以及通过所述多个柔性细长热导体将热能由一热源传导至所述液体。

[0008] 根据本发明的一优选实施例，所述液体加热流路由具有一液体入口和一液体出口的一液体流路定义元件所定义，并且位于所述液体加热流路内的具有多个柔性细长热导体的一集合定义通过所述液体加热流路的多个液体加热通道，且所述多个柔性细长热导体的结构和横截面尺寸随时间而变化，从而防止堵塞。此外，所述多个柔性细长热导体的所述集合包括多个分开的导体，它们相互地以一不规则的及互相可移位的排列方式排列，所述多个导体响应于流经它们的液体流动而变化。

[0009] 优选地，所述液体流路定义元件运作作为一热导体并将热能从所述热源传递到所述多个柔性细长热导体。附加地或替代地，所述液体流路定义元件是一热导体并且耦合到所述热源和所述多个柔性细长热导体。

[0010] 根据本发明的一优选实施例，所述柔性细长热导体的所述集合包括相互地以一不规则的及互相可移位的排列方式排列成的多个分开的导体，所述多个导体响应于流经的液体流动而变化。优选地，所述液体流路定义元件将热能从所述热源传递到所述多个柔性细长热导体。

附图说明

[0011] 通过以下结合附图的详细描述将更全面地理解和认识本发明，其中：

[0012] 图1A和1B：分别是根据本发明的一优选实施例的一快速加热液体的装置的构造和操作的一简化组装视图和一简化分解视图。

[0013] 图2A、2B、2C和2D：沿着第1A图中的线IIA-IIA截取的一液体加热通道的在四个不同的时间点显示其结构变化的简化截面图。

[0014] 图3：沿第1A图中的III-III线的所述快速加热液体的装置的一简化图。

具体实施方式

[0015] 请参考图1A至3，其显示根据本发明的一优选实施例的一快速加热液体的装置的构造和操作。如图1A至3所示，所述装置包括一导热和液体输送元件100，其优选地由例如铝的一高导热金属所形成，并且包括延伸穿过其中的一液体流动和加热通孔102，所述通孔102内设置多个可相互移位的热导体的一集合104，通常由不锈钢形成，其优选地是以一种随时间变化响应液体流动的方式相互缠绕。所述集合104可由多个分开的导体或一个单一的导体所定义。所述多个热导体通常为多个窄条或纤维的形式。

[0016] 一液体流入配件110和一液体流出配件120通常由铝或其它合适的导热金属形成，并分别耦合到所述通孔102的一流入端和一流出端。一加热元件130设置形成在所述元件100的一加热元件凹穴131之中。一合适的加热元件130的例子是由总部位于深圳市龙岗区阪田上雪科技城一路2号的深圳市汉科仪器有限公司所制造的一种电磁加热元件，所述加热元件130优选地可达到摄氏约180度的最高温度。

[0017] 通常由金属、橡胶或塑料形成的一入口液体导管132和一出口液体导管134分别被连接到所述液体流入配件110和所述液体流出配件120，以将所述通孔102连接到一个待加热的液体源(未绘示)及一个利用加热液体的装置(未绘示)。

[0018] 请参考图2A、2B、2C、2D，其显示本发明一实施例的一特定特征，其中由于液体流动的结果，所述集合104中的多个热导体的排列随时间而改变，优选地是以随机或不可预测的方式改变，使得它们之间的间隙以随机或不可预测的方式随时间改变结构。这具有特别的优点，大量消除了由流过所述通孔102的液体中的固体或半固体杂质所造成的所述集合104的堵塞。

[0019] 以这种方式，通过比较图2A、2B、2C和2D，相邻多个热导体之间的一给定区域的堵塞导致定义所述区域的所述多个热导体的相互移位，从而改变所述间隙的结构并允许杂质通过。这与一固定的网格不同，在所述固定的网格中，相邻导体之间的间隙的结构是固定的，通常这导致整个网格递增的堵塞。

[0020] 在一优选实施例中，所述多个热导体的所述集合104被轻轻地塞入与所述元件100有良好热接触的通孔102之中，使得由所述加热元件130产生的热能有效地通过所述元件

100传导到所述集合104中的多个热导体，然后传到流动在所述通孔102的液体。所述集合104中的多个导体可以是固定或不固定到所述元件100。优选地，通过具有热导体的集合104的所述通孔102的水的流动是湍急，并且所述湍急的流动增强了所述多个导体的相互移位并随着时间的推移重新调整其彼此之间的间隙。

[0021] 本领域中的普通技术人员将会理解，本发明并不限于上面具体示出和描述的内容。相反，本发明的范围包括上述各种特征的组合和子组合以及它们的变型和修正形式，并且所述变型和修正形式并未在现有技术中。

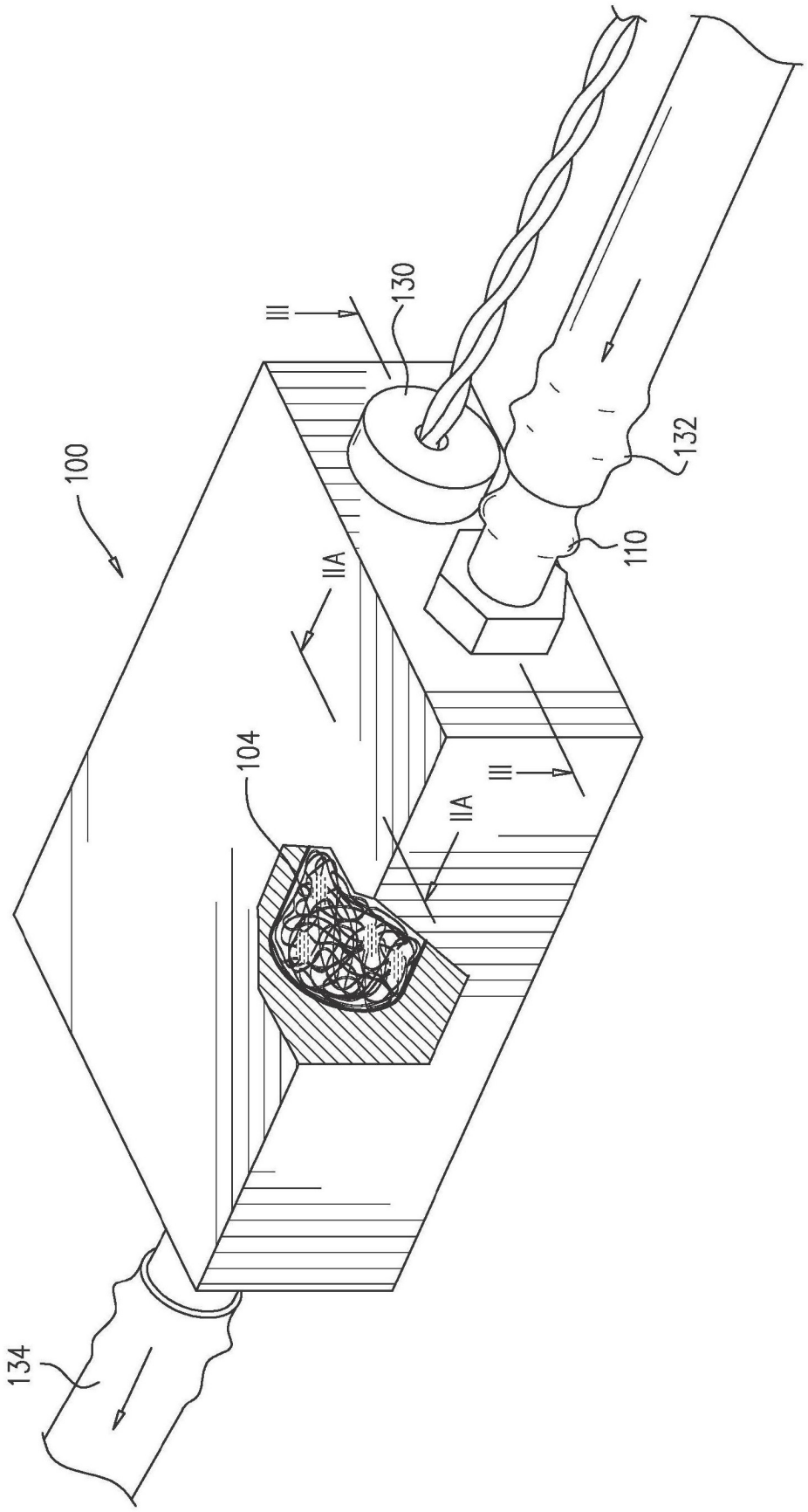


图1A

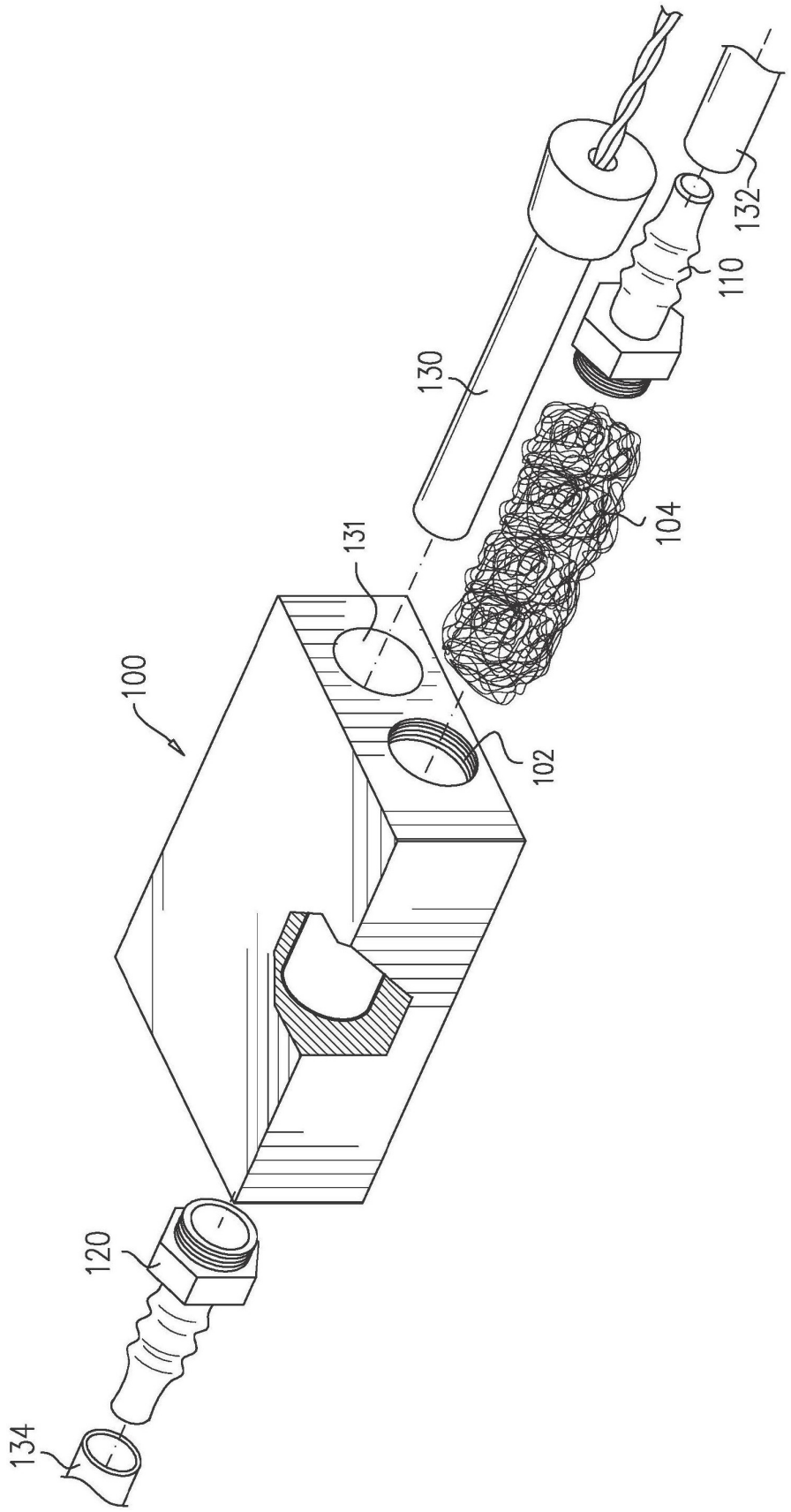


图1B

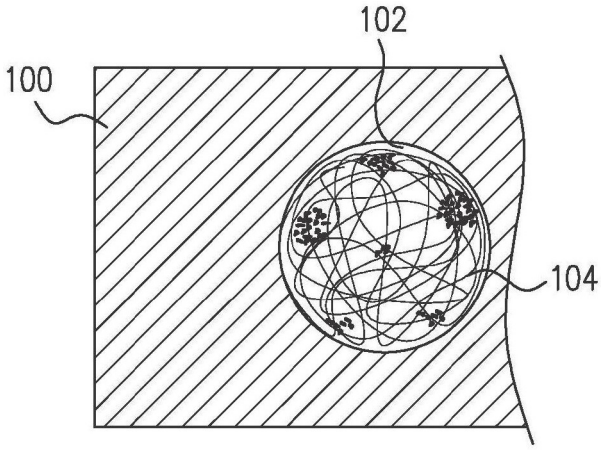


图2A

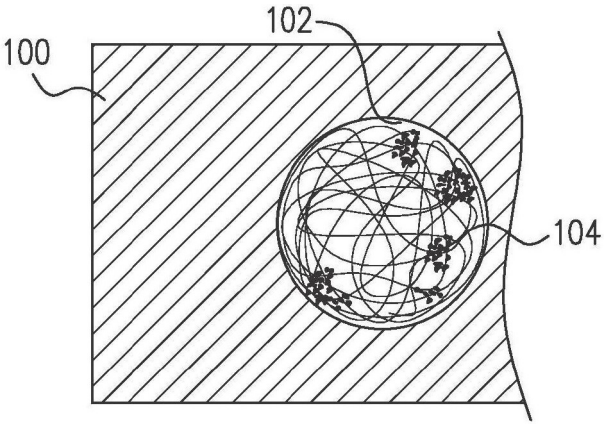


图2B

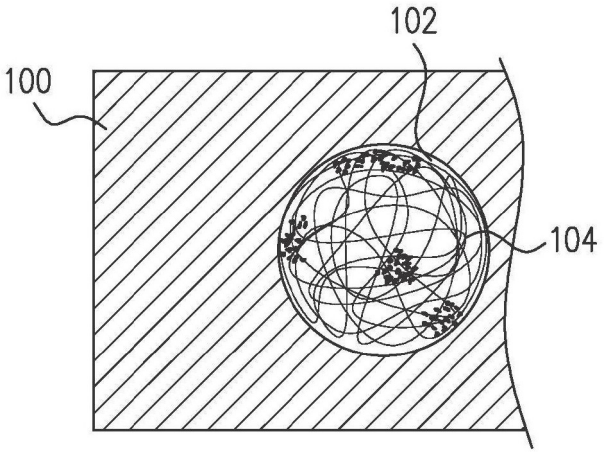


图2C

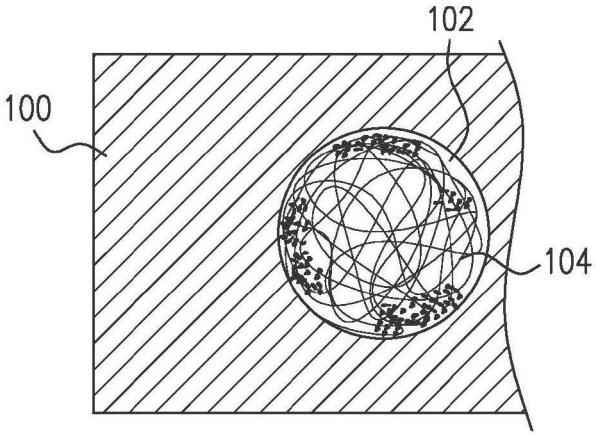


图2D

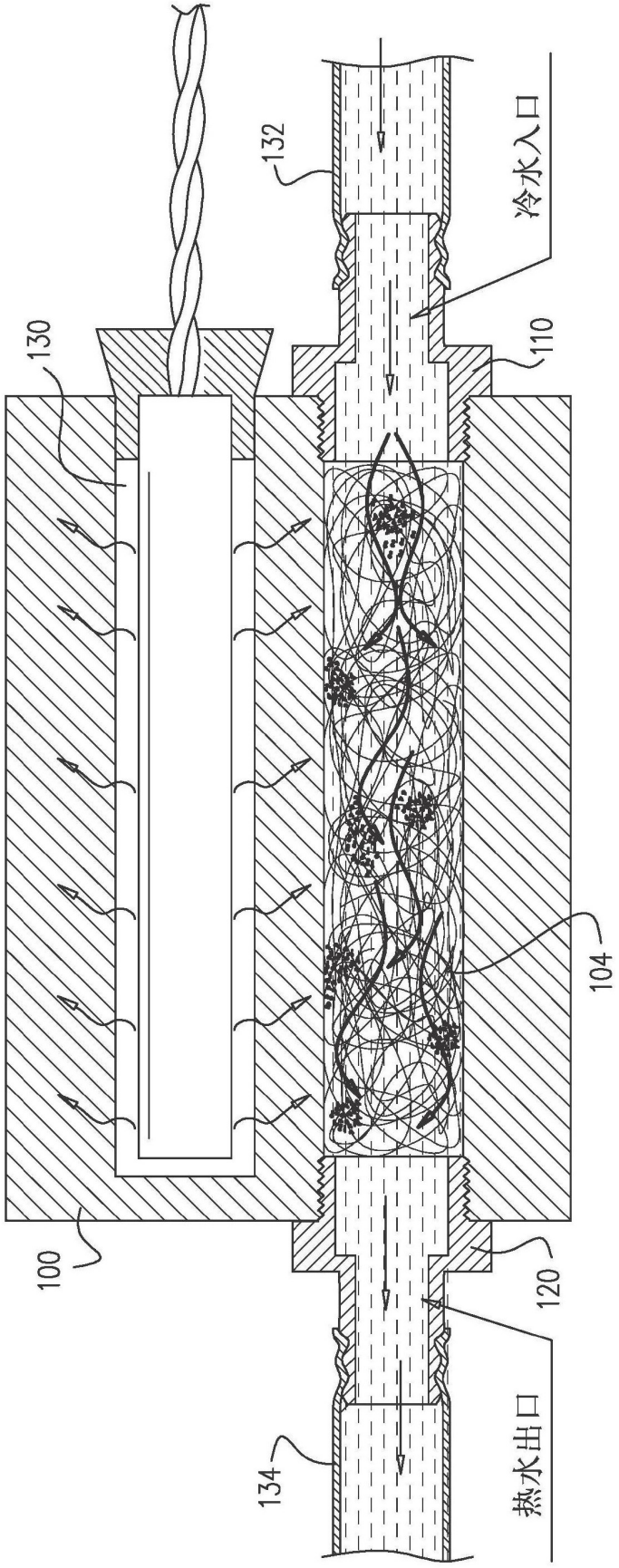


图3