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(54) HEAT EXCHANGER

(57) Disclosed in the present invention is a heat exchanger, comprising: a first manifold and a second manifold disposed on the same side of the heat exchanger; and a plurality of heat exchange tubes, each heat exchange tube having: a first heat exchange part and a second heat exchange part which are substantially parallel; and a first end and a second end connected to the first heat exchange part and the second heat exchange part respectively, with the first end deviating from a center line of the first heat exchange part by curving, such that the first end and the second end are connected to, and in fluid communication with, the first manifold and the second manifold respectively. In the heat exchanger, the manifolds are arranged on the same side, so connecting pipelines are saved, and costs are lower.

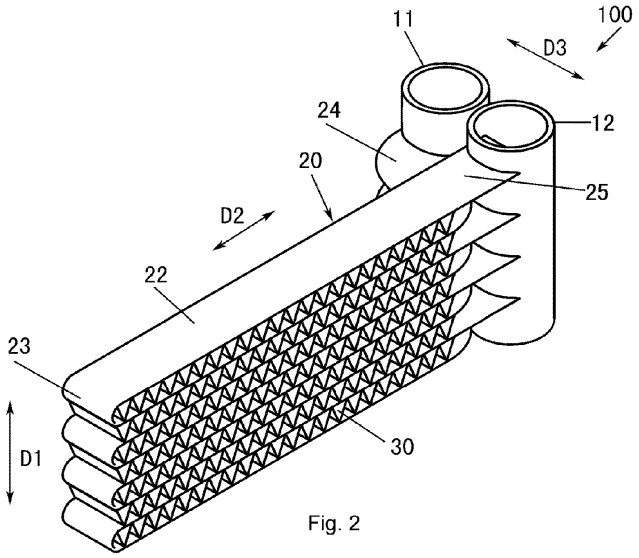

Fig. 2

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Description

Technical field

[0001] The present invention relates to a heat exchanger.

Background

[0002] In general, a heat exchanger such as a microchannel heat exchanger comprises two manifolds disposed on two sides of the heat exchanger, heat exchange tubes such as flat tubes connected between the two manifolds, and fins disposed between the heat exchange tubes.

Summary

[0003] An object of an embodiment of the present invention is to provide a heat exchanger, such that manifolds are arranged on the same side, to save connecting pipelines.

[0004] An embodiment of the present invention provides a heat exchanger, comprising: a first manifold and a second manifold disposed on the same side of the heat exchanger; and a plurality of heat exchange tubes, each heat exchange tube having: a first heat exchange part and a second heat exchange part which are substantially parallel; and a first end and a second end connected to the first heat exchange part and the second heat exchange part respectively, with the first end deviating from a center line of the first heat exchange part by curving, such that the first end and the second end are connected to, and in fluid communication with, the first manifold and the second manifold respectively.

[0005] According to an embodiment of the present invention, each heat exchange tube also has a connecting part connecting the first heat exchange part and the second heat exchange part; at least one of the connecting parts is a U-shaped tube, or at least one heat exchange tube is an integral whole and the connecting part of the at least one heat exchange tube is formed by bending.

[0006] According to an embodiment of the present invention, the second end deviates from a center line of the second heat exchange part by curving, and the first end and the second end deviate in opposite directions.

[0007] According to an embodiment of the present invention, the first heat exchange part and the second heat exchange part are arranged in a first direction, and extend in a second direction which is substantially perpendicular to the first direction, and the first end deviates from the center line of the first heat exchange part in a third direction which is substantially perpendicular to the first direction and the second direction.

[0008] According to an embodiment of the present invention, the first heat exchange part and the second heat exchange part are arranged in a first direction, and extend in a second direction which is substantially perpendicular to the first direction, the first end deviates from the center line of the first heat exchange part in a third direction which is substantially perpendicular to the first direction and the second direction, and the second end deviates from the center line of the second heat exchange part in a third direction which is substantially perpendicular to the first direction and the second direction.

[0009] According to an embodiment of the present invention, a direction of extension of a part, connected to the first manifold, of the first end of each heat exchange tube is substantially the same as a direction of extension of the first heat exchange part.

[0010] According to an embodiment of the present invention, a direction of extension of a part, connected to the first manifold, of the first end of each heat exchange tube is substantially the same as a direction of extension of the first heat exchange part, and a direction of extension of a part, connected to the second manifold, of the second end of each heat exchange tube is substantially the same as a direction of extension of the second heat exchange part.

[0011] According to an embodiment of the present invention, a part, connected to the first manifold, of the first end of each heat exchange tube extends substantially in a second direction.

[0012] According to an embodiment of the present invention, a part, connected to the first manifold, of the first end of each heat exchange tube extends substantially in a second direction, and a part, connected to the second manifold, of the second end of each heat exchange tube extends substantially in the second direction.

[0013] According to an embodiment of the present invention, each heat exchange tube also has a plurality of third heat exchange parts disposed between the first heat exchange part and the second heat exchange part, and the first heat exchange part, the second heat exchange part and the third heat exchange parts are substantially parallel.

[0014] According to an embodiment of the present invention, each heat exchange tube also has a plurality of connecting parts connecting adjacent heat exchange parts amongst the first heat exchange part, the third heat exchange parts and the second heat exchange part, with at least one of the connecting parts being formed by bending, or being a U-shaped tube.

[0015] According to an embodiment of the present invention, the heat exchanger further comprises: a fin, disposed between the first heat exchange part and the second heat exchange part.

[0016] According to an embodiment of the present invention, the heat exchanger further comprises: a fin, disposed between adjacent heat exchange parts amongst the first heat exchange part, the third heat exchange parts and the second heat exchange part.

[0017] According to an embodiment of the present invention, the first end of each heat exchange tube is inclined relative to the first heat exchange part.

[0018] According to an embodiment of the present in-

vention, the first end of each heat exchange tube is inclined relative to the first heat exchange part, and the second end of each heat exchange tube is inclined relative to the second heat exchange part.

[0019] According to an embodiment of the present invention, the first end deviates from the center line of the first heat exchange part by curving substantially in a plane defined by the second direction and the third direction.

[0020] According to an embodiment of the present invention, the first end deviates from the center line of the first heat exchange part by curving substantially in a plane defined by the second direction and the third direction, and the second end deviates from the center line of the second heat exchange part by curving substantially in the plane defined by the second direction and the third direction.

[0021] According to an embodiment of the present invention, the first end and the first heat exchange part of each heat exchange tube lie substantially in a plane defined by the second direction and the third direction.

[0022] According to an embodiment of the present invention, the first end and the first heat exchange part of each heat exchange tube lie substantially in a plane defined by the second direction and the third direction, and the second end and the second heat exchange part of each heat exchange tube lie substantially in the plane defined by the second direction and the third direction.

[0023] According to an embodiment of the present invention, the first heat exchange part and the second heat exchange part are arranged in a first direction, and extend in a second direction which is substantially perpendicular to the first direction, and said same side of the heat exchanger is the same side in the second direction, in a plane defined by the first direction and the second direction.

[0024] According to an embodiment of the present invention, the first end and the second end are opposite the connecting part.

[0025] According to an embodiment of the present invention, the first manifold and the second manifold are disposed side by side.

[0026] According to an embodiment of the present invention, the first manifold and the second manifold are manifolds with D-shaped cross sections, and substantially flat surfaces of the manifolds with the D-shaped cross sections face each other.

[0027] According to an embodiment of the present invention, the heat exchanger further comprises: a heat insulating element disposed between the first manifold and the second manifold.

[0028] According to an embodiment of the present invention, each of the heat exchange tubes is an integral whole.

[0029] In the heat exchanger according to an embodiment of the present invention, the manifolds are arranged on the same side, so connecting pipelines are saved, and costs are lower.

Brief Description of the Drawings

[0030]

Fig. 1 is a schematic diagram of a heat exchange tube of a heat exchanger according to a first embodiment of the present invention;

fig. 2 is a three-dimensional schematic diagram of the heat exchanger according to the first embodiment of the present invention;

fig. 3 is a view of the heat exchanger according to the first embodiment of the present invention from the right;

fig. 4 is a main view of the heat exchanger according to the first embodiment of the present invention;

fig. 5 is a schematic diagram of a heat exchange tube of a heat exchanger according to a second embodiment of the present invention;

fig. 6 is a three-dimensional schematic diagram of the heat exchanger according to the second embodiment of the present invention;

fig. 7 is a view of the heat exchanger according to the second embodiment of the present invention from the right;

fig. 8 is a main view of the heat exchanger according to the second embodiment of the present invention;

fig. 9 is a schematic diagram of a heat exchange tube of a heat exchanger according to a third embodiment of the present invention;

fig. 10 is a three-dimensional schematic diagram of the heat exchanger according to the third embodiment of the present invention;

fig. 11 is a view of the heat exchanger according to the third embodiment of the present invention from the right;

fig. 12 is a main view of the heat exchanger according to the third embodiment of the present invention;

fig. 13 is a schematic diagram of a heat exchange tube of a heat exchanger according to a fourth embodiment of the present invention;

fig. 14 is a three-dimensional schematic diagram of the heat exchanger according to the fourth embodiment of the present invention;

fig. 15 is a view of the heat exchanger according to the fourth embodiment of the present invention from the right; and

fig. 16 is a main view of the heat exchanger according to the fourth embodiment of the present invention.

Detailed Description

[0031] Figs. 1, 5, 9 and 13 show heat exchange tubes according to embodiments of the present invention; figs. 2 to 4, 6 to 8, 10 to 12 and 14 to 16 show heat exchangers according to embodiments of the present invention, wherein an end cap for an end of a manifold of the heat exchanger has been omitted, hence that end of the heat exchange tube which is inserted into the manifold can be

seen.

[0032] As shown in figs. 1 to 16, a heat exchanger 100, such as a micro-channel heat exchanger according to an embodiment of the present invention comprises: a first manifold 11 and a second manifold 12 disposed on the same side of the heat exchanger 100 (e.g. a first manifold 11 and a second manifold 12 disposed substantially in parallel, at an angle or side by side, or a first manifold 11 and a second manifold 12 formed from one tube by means of a longitudinal partition plate); and a plurality of heat exchange tubes 20 such as flat tubes, each heat exchange tube 20 having: a first heat exchange part 21 and a second heat exchange part 22 which are substantially parallel; and a first end 24 and a second end 25 connected to the first heat exchange part 21 and the second heat exchange part 22 respectively, with the first end 24 deviating from a center line (i.e. an axis, axial center line or longitudinal center line of a tube section forming the heat exchange part) of the first heat exchange part 21 by curving, such that the first end 24 and the second end 25 are connected to, and in fluid communication with, the first manifold 11 and the second manifold 12 respectively. Each heat exchange tube 20 also has a connecting part 23 connecting the first heat exchange part 21 and the second heat exchange part 22. At least one heat exchange tube 20 is an integral whole, and the connecting part 23 of the at least one heat exchange tube 20 may be formed by bending. Optionally, each heat exchange tube 20 also has a connecting part 23 connecting the first heat exchange part 21 and the second heat exchange part 22, with at least one of the connecting parts 23 being a U-shaped tube, e.g. a single U-shaped tube is connected to the first heat exchange part 21 and the second heat exchange part 22 by welding. According to one example of the present invention, each of the heat exchange tubes 21 is an integral whole.

[0033] A refrigerant can flow into the heat exchanger through the first manifold 11 and flow out of the heat exchanger through the second manifold 12. In the embodiment shown in the figure, the first end 24 and the second end 25 are opposite the connecting part 23. The heat exchanger 100 also comprises: fins 30, disposed between the first heat exchange part 21 and the second heat exchange part 22. In the embodiment shown in figs. 1 to 4, the first end 24 deviates from the center line of the first heat exchange part 21 by bending twice, and each heat exchange tube 20 comprises two heat exchange parts.

[0034] Referring to figs. 1 to 16, according to some embodiments of the present invention, each heat exchange tube 20 also has a plurality of third heat exchange parts disposed between the first heat exchange part 21 and the second heat exchange part 22, and the first heat exchange part 21, the second heat exchange part 22 and the third heat exchange parts are substantially parallel. Each heat exchange tube 20 also has a plurality of connecting parts 23 connecting adjacent heat exchange parts amongst the first heat exchange part 21, the third heat exchange parts and the second heat exchange part 22, with at least one of the connecting parts 23 being formed by bending, or being a U-shaped tube. The heat exchanger 100 also comprises: fins 30, disposed between adjacent heat exchange parts amongst the first heat exchange part 21, the third heat exchange parts and the second heat exchange part 22. By forming a plurality of connecting parts 23, each heat exchange tube 20 may comprise four or more heat exchange parts.

[0035] Referring to figs. 2 to 4, 6 to 8 and 10 to 12, the first heat exchange part 21 and the second heat exchange part 22 are arranged in a first direction D1, and extend in a second direction D2 which is substantially perpendicular to the first direction D1, and said same side of the heat exchanger 100 is the same side in the second direction D2, in a plane defined by the first direction D1 and the second direction D2.

[0036] As shown in figs. 5 to 12, the second end 25 deviates from a center line (i.e. an axis, axial center line or longitudinal center line of a tube section forming the heat exchange part) of the second heat exchange part 22 by curving, and the first end 24 and the second end 25 deviate in opposite directions.

[0037] In the embodiment shown in figs. 5 to 8, the first end 24 and the second end 25 deviate from the center line of the first heat exchange part 21 and the center line of the second heat exchange part 22 respectively by bending twice, and each heat exchange tube 20 comprises two heat exchange parts; by forming a plurality of connecting parts 23, each heat exchange tube 20 may comprise four or more heat exchange parts.

[0038] As shown in figs. 2 to 4, the first heat exchange part 21 and the second heat exchange part 22 are arranged in the first direction D1 (i.e. an axial direction of the first manifold 11 and the second manifold 12), and extend in the second direction D2 which is substantially perpendicular to the first direction D1; and the first end 24 deviates from the center line of the first heat exchange part 21 in a third direction D3 which is substantially perpendicular to the first direction D1 and the second direction D2. The first manifold 11 and the second manifold 12 are disposed in the third direction D3. For example, the first end 24 deviates from the center line of the first heat exchange part 21 by curving substantially in a plane defined by the second direction D2 and the third direction D3. According to some embodiments of the present invention, the first end 24 and the first heat exchange part 21 of each heat exchange tube 20 may lie substantially in the plane defined by the second direction D2 and the third direction D3.

[0039] As shown in figs. 6 to 8 and 10 to 12, the first heat exchange part 21 and the second heat exchange part 22 are arranged in the first direction D1 (i.e. the axial direction of the first manifold 11 and the second manifold 12), and extend in the second direction D2 which is substantially perpendicular to the first direction D1; the first end 24 deviates from the center line of the first heat exchange part 21 in the third direction D3 which is substan-

tially perpendicular to the first direction D1 and the second direction D2, and the second end 25 deviates from the center line of the second heat exchange part 22 in the third direction D3 which is substantially perpendicular to the first direction D1 and the second direction D2. For example, the first end 24 deviates from the center line of the first heat exchange part 21 by curving substantially in the plane defined by the second direction D2 and the third direction D3, and the second end 25 deviates from the center line of the second heat exchange part 22 by curving substantially in the plane defined by the second direction D2 and the third direction D3. According to some embodiments of the present invention, the first end 24 and the first heat exchange part 21 of each heat exchange tube 20 lie substantially in the plane defined by the second direction D2 and the third direction D3, and the second end 25 and the second heat exchange part 22 of each heat exchange tube 20 lie substantially in the plane defined by the second direction D2 and the third direction D3.

[0040] In the embodiment shown in figs. 1 to 4, a direction of extension of a part 241, connected to the first manifold 11, of the first end 24 of each heat exchange tube 20 is substantially the same as the direction of extension of the first heat exchange part 21. For example, the part 241, connected to the first manifold 11, of the first end 24 of each heat exchange tube 20 extends substantially in the second direction D2.

[0041] In the embodiment shown in figs. 5 to 8, the direction of extension of the part 241, connected to the first manifold 11, of the first end 24 of each heat exchange tube 20 is substantially the same as the direction of extension of the first heat exchange part 21, and a direction of extension of a part 251, connected to the second manifold 12, of the second end 25 of each heat exchange tube 20 is substantially the same as the direction of extension of the second heat exchange part 22. For example, the part 241, connected to the first manifold 11, of the first end 24 of each heat exchange tube 20 extends substantially in the second direction D2, and the part 251, connected to the second manifold 12, of the second end 25 of each heat exchange tube 20 extends substantially in the second direction D2.

[0042] Referring to figs. 9 to 12, the first end 24 (e.g. a center line of the first end 24 (i.e. an axis, axial center line or longitudinal center line of a tube section forming the end)) of each heat exchange tube 20 is inclined relative to the first heat exchange part 21 (e.g. the center line of the first heat exchange part 21 (i.e. the axis, axial center line or longitudinal center line of the tube section forming the first heat exchange part 21)). In the embodiment shown in figs. 9 to 12, the first end 24 and the second end 25 deviate from the center line of the first heat exchange part 21 and the center line of the second heat exchange part 22 respectively by bending once, and each heat exchange tube 20 comprises two heat exchange parts; by forming a plurality of connecting parts 23, each heat exchange tube 20 may comprise four or more heat exchange parts.

[0043] In the embodiment shown in figs. 9 to 12, the first end 24 of each heat exchange tube 20 is inclined relative to the first heat exchange part 21, and the second end 25 (e.g. a center line of the second end 25 (i.e. an axis, axial center line or longitudinal center line of a tube section forming the end)) of each heat exchange tube 20 is inclined relative to the second heat exchange part 22 (e.g. the center line of the second heat exchange part 22 (i.e. the axis, axial center line or longitudinal center line of the tube section forming the second heat exchange part 22)).

[0044] A heat insulating space 40 or heat insulating element may be disposed between the first manifold 11 and the second manifold 12, and may prevent heat exchange between the two manifolds and the formation of a heat bridge, which would affect the heat exchange effect of the heat exchanger. The first manifold 11 and the second manifold 12 may be two separate manifolds, but could also be a first manifold 11 and a second manifold 12 formed from one tube by means of a longitudinal partition plate. The longitudinal partition plate may be two partition plates; the two partition plates may be integral with pipe walls of the pipes, but could also be separate.

[0045] As shown in figs. 14 to 16, the first manifold 11 and the second manifold 12 are manifolds with D-shaped cross sections, and substantially flat surfaces of the two manifolds with the D-shaped cross sections face each other. A gap is provided between the first manifold 11 and the second manifold 12. The heat insulating element may be disposed in the gap.

[0046] The heat exchanger according to an embodiment of the present invention may be used in the fields of heating, ventilating and air conditioning, motor vehicles, refrigeration and transport, and may be a micro-channel heat exchanger or a parallel-flow heat exchanger, etc. The heat exchanger according to an embodiment of the present invention can reduce costs, increase the wind field uniformity and output wind temperature uniformity of a micro-channel heat pump evaporator, and increase the utilization rate of the heat exchange area.

[0047] Moreover, in the heat exchanger according to the present invention, a partition plate may be disposed in the manifold, so as to form different circuits. In addition, in the heat exchanger according to the present invention, the circuit length may be adjusted as required (with the heat exchange tube being bent a number of times). When the heat exchanger is used in an evaporator, the difference between the condensate water produced by the top portion and condensate water of the bottom-half portion is not large, the wind field of the heat exchanger is more uniform, and the output wind temperatures of various parts of the heat exchanger are more uniform.

[0048] Furthermore, in the heat exchanger according to the present invention, the manifolds are arranged at a single side, so connecting pipelines and manifolds are saved, and costs are lower. In addition, a single row of flat tubes may be employed, so that wind resistance is

low.

Claims

1. A heat exchanger, comprising:

   a first manifold and a second manifold disposed on the same side of the heat exchanger; and
   a plurality of heat exchange tubes, each heat exchange tube having:

   a first heat exchange part and a second heat exchange part which are substantially parallel; and
   a first end and a second end connected to the first heat exchange part and the second heat exchange part respectively, with the first end deviating from a center line of the first heat exchange part by curving, such that the first end and the second end are connected to, and in fluid communication with, the first manifold and the second manifold respectively.

2. The heat exchanger as claimed in claim 1, wherein: each heat exchange tube further has a connecting part connecting the first heat exchange part and the second heat exchange part; at least one of the connecting parts is a U-shaped tube, or at least one heat exchange tube is an integral whole and the connecting part of the at least one heat exchange tube is formed by bending.

3. The heat exchanger as claimed in claim 1, wherein: the second end deviates from a center line of the second heat exchange part by curving, and the first end and the second end deviate in opposite directions.

4. The heat exchanger as claimed in claim 1, wherein:

   the first heat exchange part and the second heat exchange part are arranged in a first direction, and extend in a second direction which is substantially perpendicular to the first direction, and
   the first end deviates from the center line of the first heat exchange part in a third direction which is substantially perpendicular to the first direction and the second direction.

5. The heat exchanger as claimed in claim 3, wherein:

   the first heat exchange part and the second heat exchange part are arranged in a first direction, and extend in a second direction which is substantially perpendicular to the first direction,
   the first end deviates from the center line of the first heat exchange part in a third direction which is substantially perpendicular to the first direction and the second direction, and
   the second end deviates from the center line of the second heat exchange part in a third direction which is substantially perpendicular to the first direction and the second direction.

6. The heat exchanger as claimed in claim 1, wherein: each heat exchange tube further has a plurality of third heat exchange parts disposed between the first heat exchange part and the second heat exchange part, and the first heat exchange part, the second heat exchange part and the third heat exchange parts are substantially parallel.

7. The heat exchanger as claimed in claim 6, wherein: each heat exchange tube further has a plurality of connecting parts connecting adjacent heat exchange parts amongst the first heat exchange part, the third heat exchange parts and the second heat exchange part, with at least one of the connecting parts being formed by bending, or being a U-shaped tube.

8. The heat exchanger as claimed in claim 1, further comprising:
   a fin, disposed between the first heat exchange part and the second heat exchange part.

9. The heat exchanger as claimed in claim 6, further comprising:
   a fin, disposed between adjacent heat exchange parts amongst the first heat exchange part, the third heat exchange parts and the second heat exchange part.

10. The heat exchanger as claimed in claim 1, wherein: the first end of each heat exchange tube is inclined relative to the first heat exchange part.

11. The heat exchanger as claimed in claim 3, wherein:

    the first end of each heat exchange tube is inclined relative to the first heat exchange part, and
    the second end of each heat exchange tube is inclined relative to the second heat exchange part.

12. The heat exchanger as claimed in claim 4, wherein: the first end deviates from the center line of the first heat exchange part by curving substantially in a plane defined by the second direction and the third direction.

13. The heat exchanger as claimed in claim 5, wherein:

the first end deviates from the center line of the first heat exchange part by curving substantially in a plane defined by the second direction and the third direction, and
the second end deviates from the center line of the second heat exchange part by curving substantially in the plane defined by the second direction and the third direction.

14. The heat exchanger as claimed in claim 4, wherein:
the first end and the first heat exchange part of each heat exchange tube lie substantially in a plane defined by the second direction and the third direction.

15. The heat exchanger as claimed in claim 5, wherein:

the first end and the first heat exchange part of each heat exchange tube lie substantially in a plane defined by the second direction and the third direction, and
the second end and the second heat exchange part of each heat exchange tube lie substantially in the plane defined by the second direction and the third direction.

16. The heat exchanger as claimed in claim 1, wherein:

the first heat exchange part and the second heat exchange part are arranged in a first direction, and extend in a second direction which is substantially perpendicular to the first direction, and said same side of the heat exchanger is the same side in the second direction, in a plane defined by the first direction and the second direction.

17. The heat exchanger as claimed in claim 1, wherein:
the first manifold and the second manifold are manifolds with D-shaped cross sections, and substantially flat surfaces of the manifolds with the D-shaped cross sections face each other.

18. The heat exchanger as claimed in claim 1 or 17, further comprising:
a heat insulating element disposed between the first manifold and the second manifold.

19. The heat exchanger as claimed in claim 1, wherein:
each of the heat exchange tubes is an integral whole.

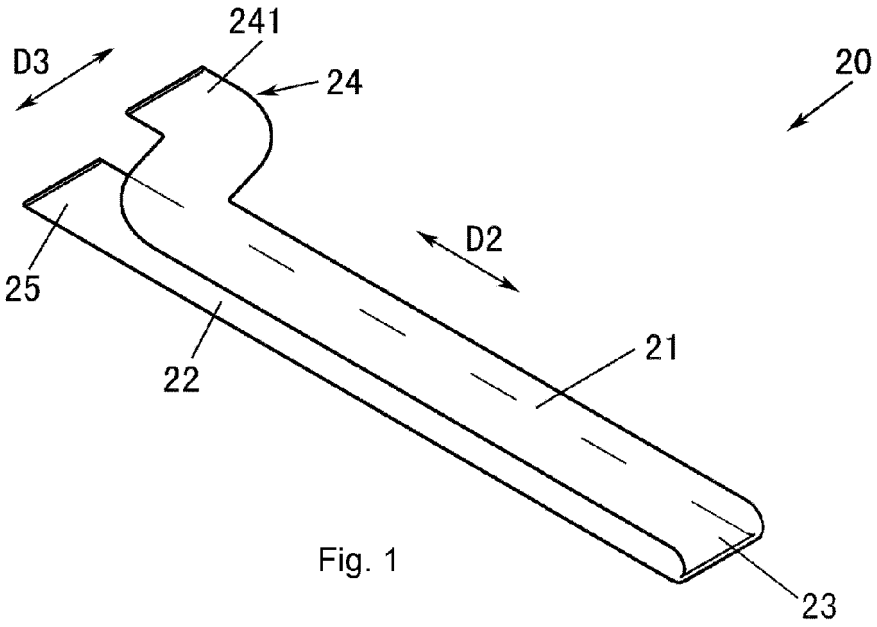

Fig. 1

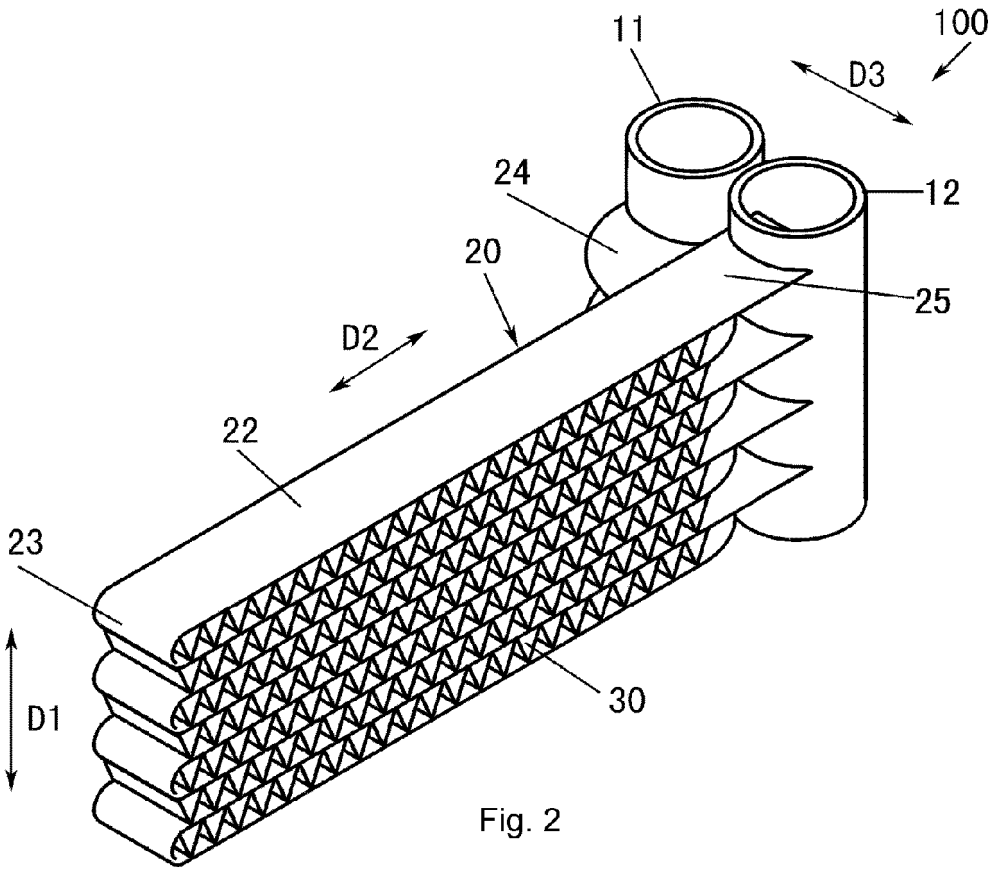

Fig. 2

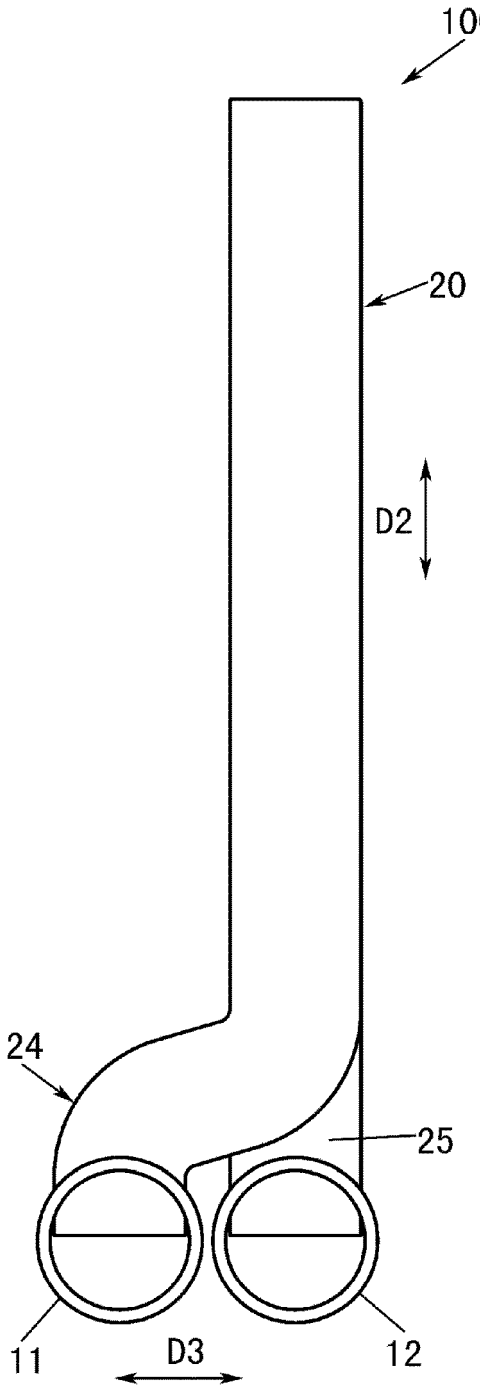

Fig. 3

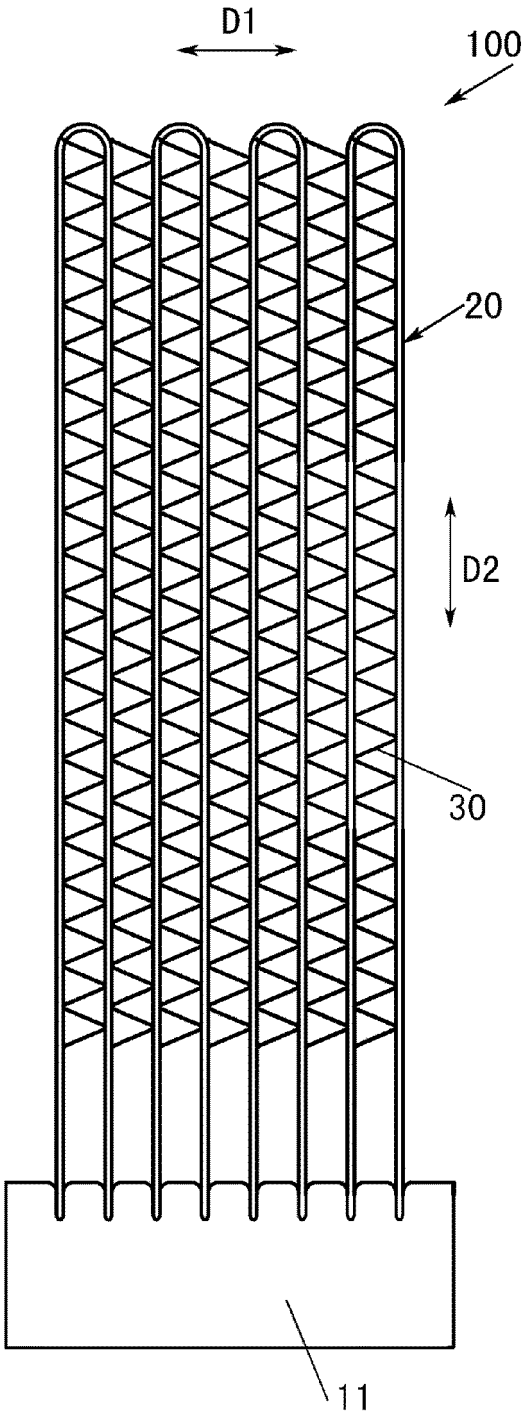

Fig. 4

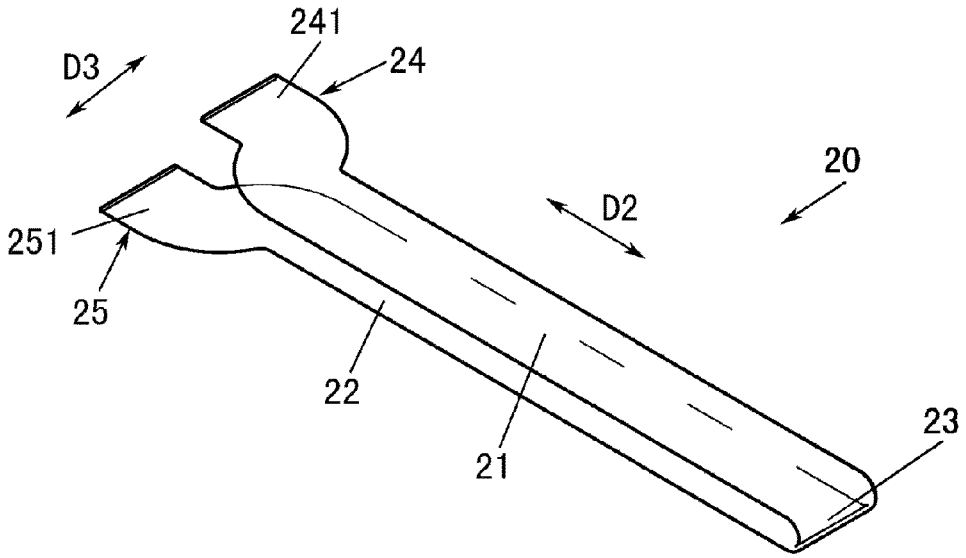

Fig. 5

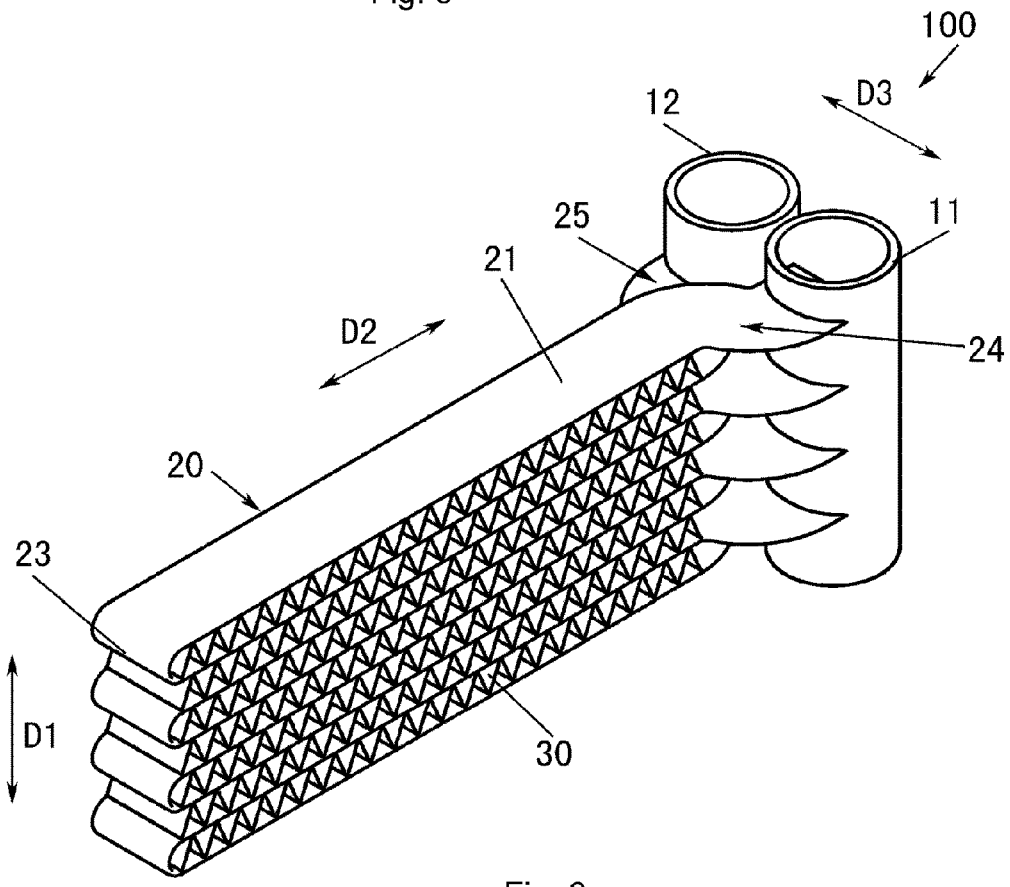

Fig. 6

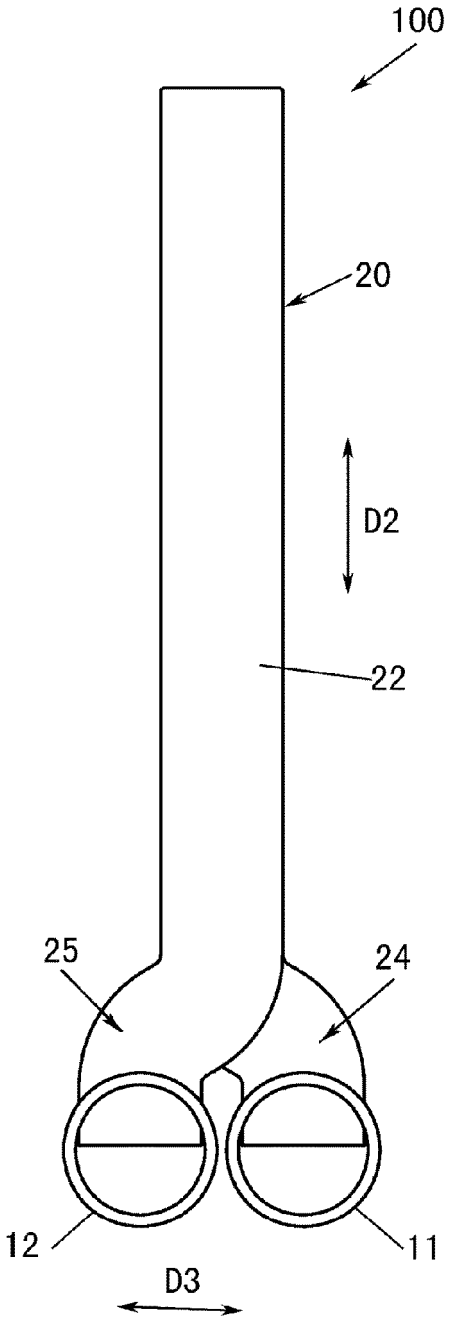

Fig. 7

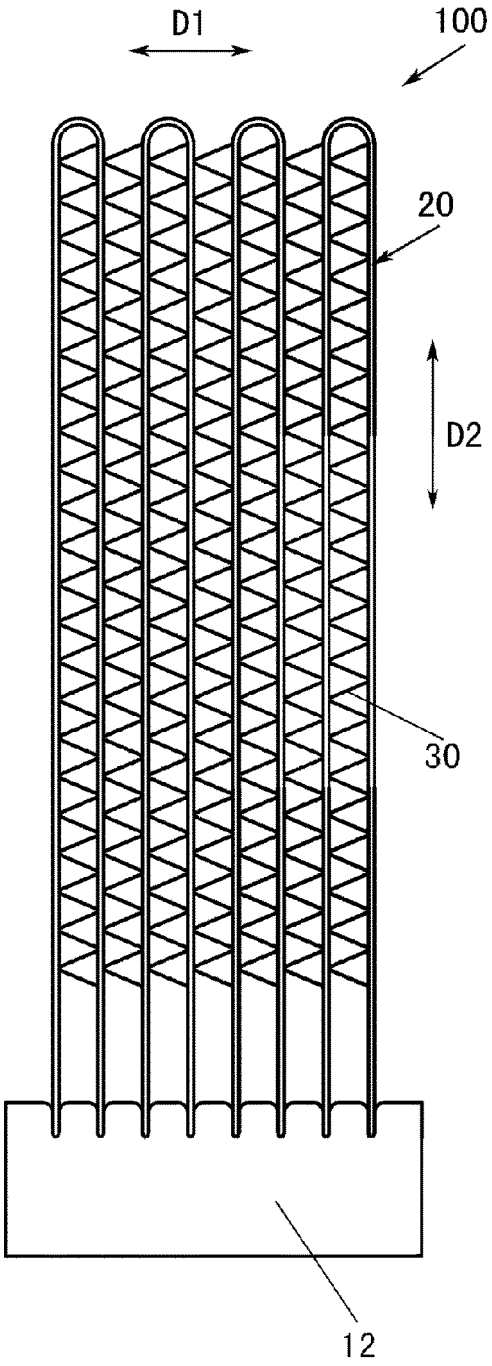

Fig. 8

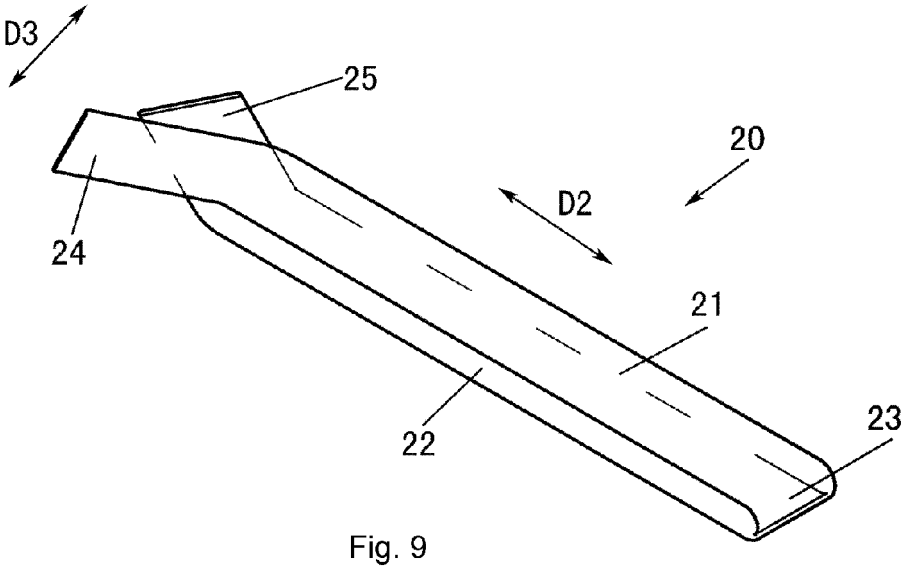

Fig. 9

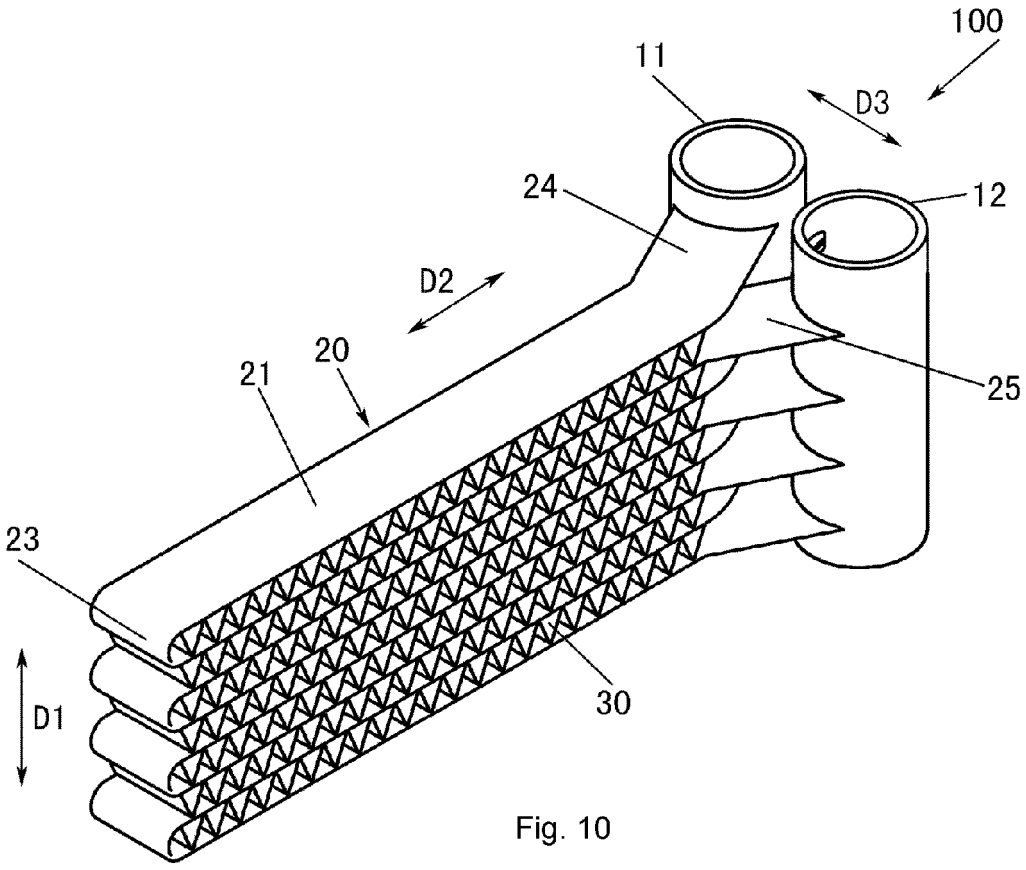

Fig. 10

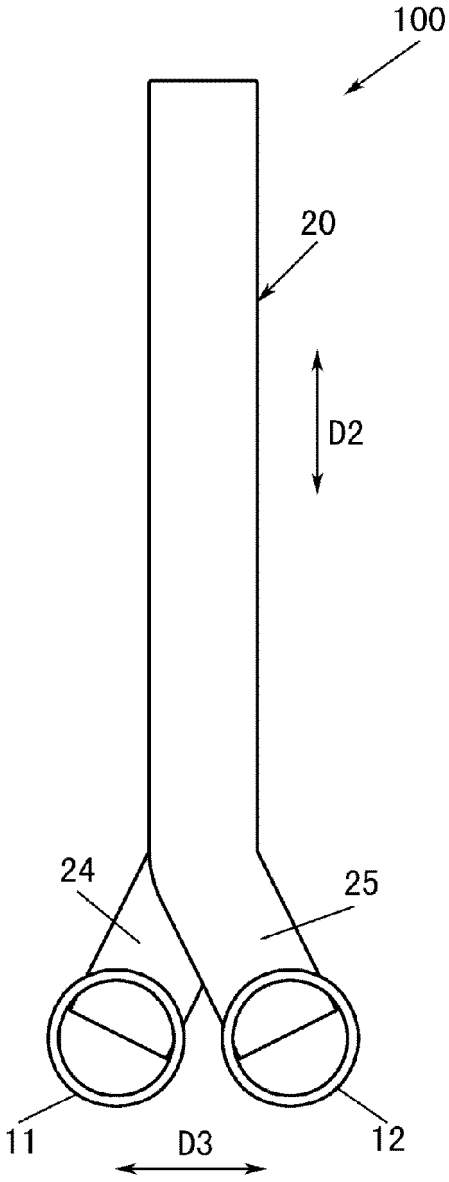

Fig. 11

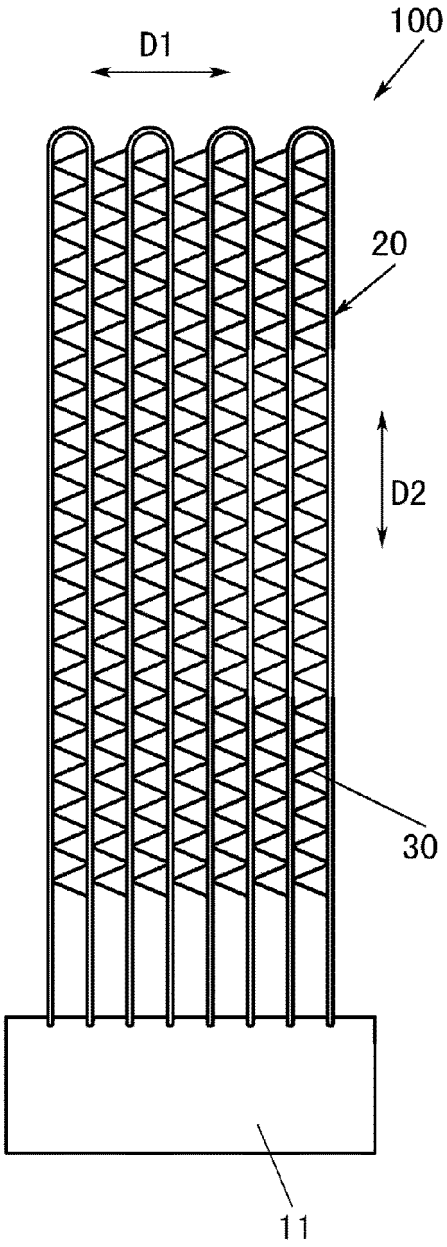

Fig. 12

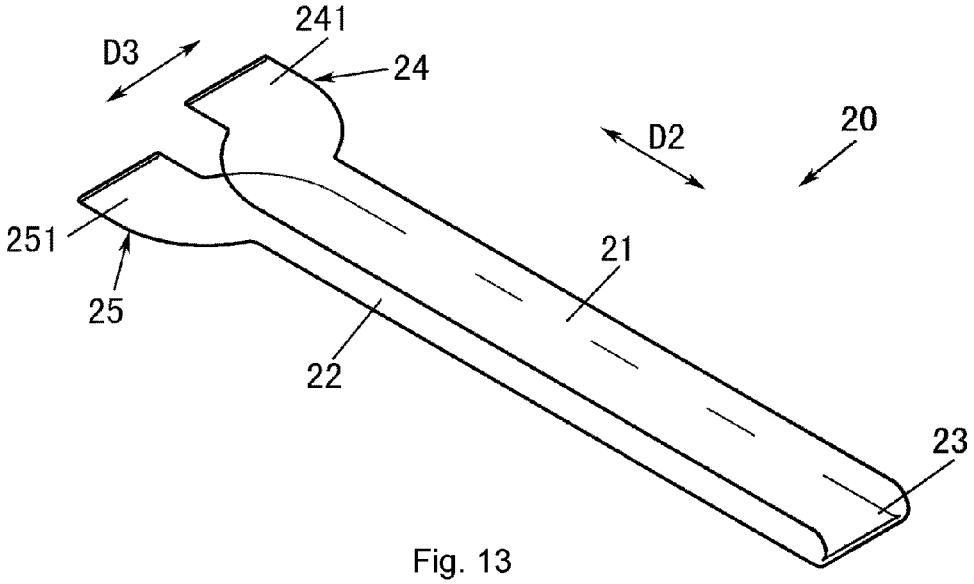

Fig. 13

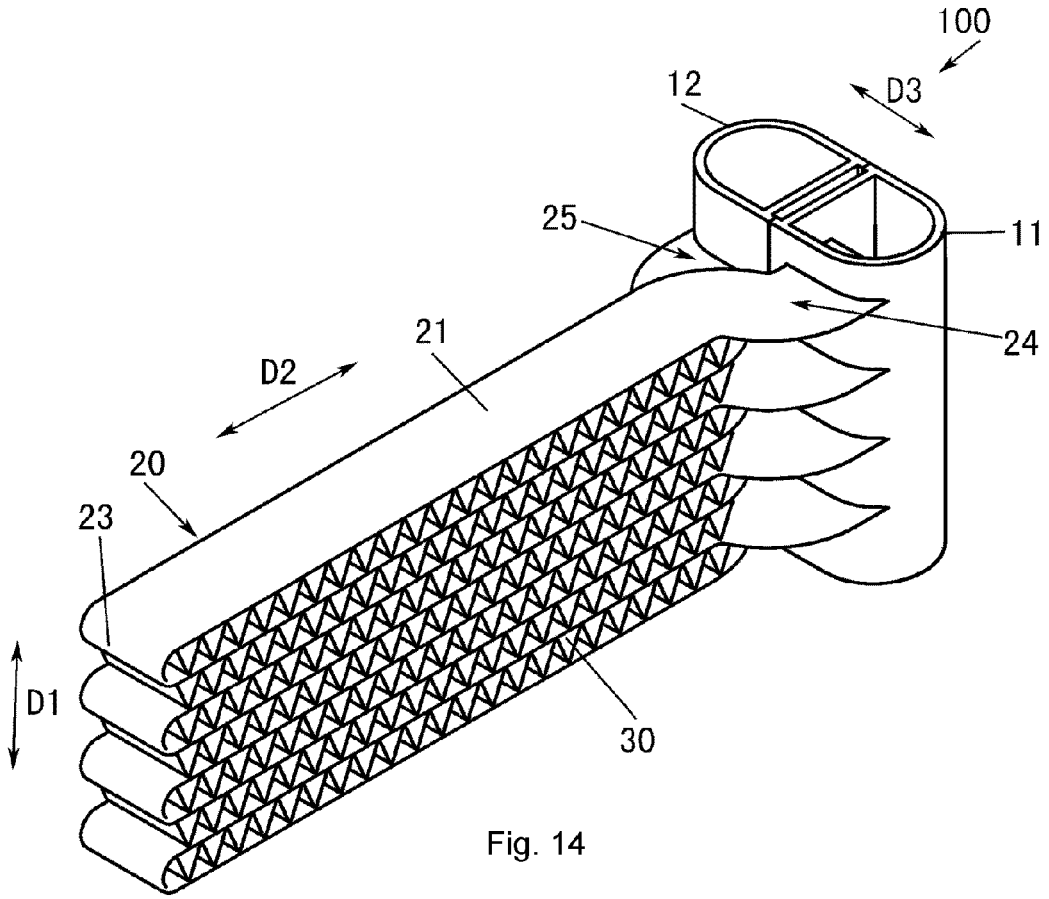

Fig. 14

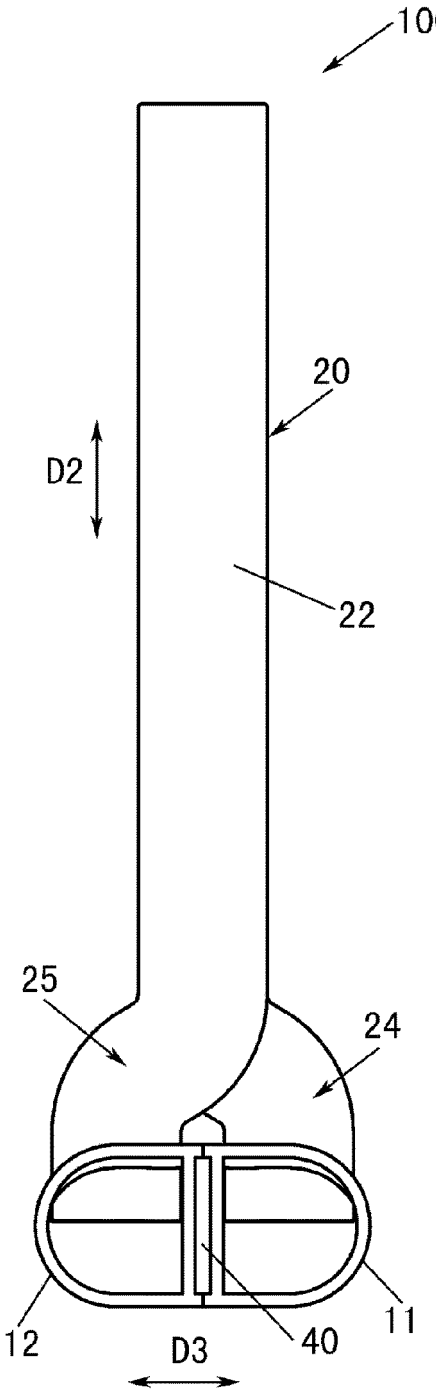

Fig. 15

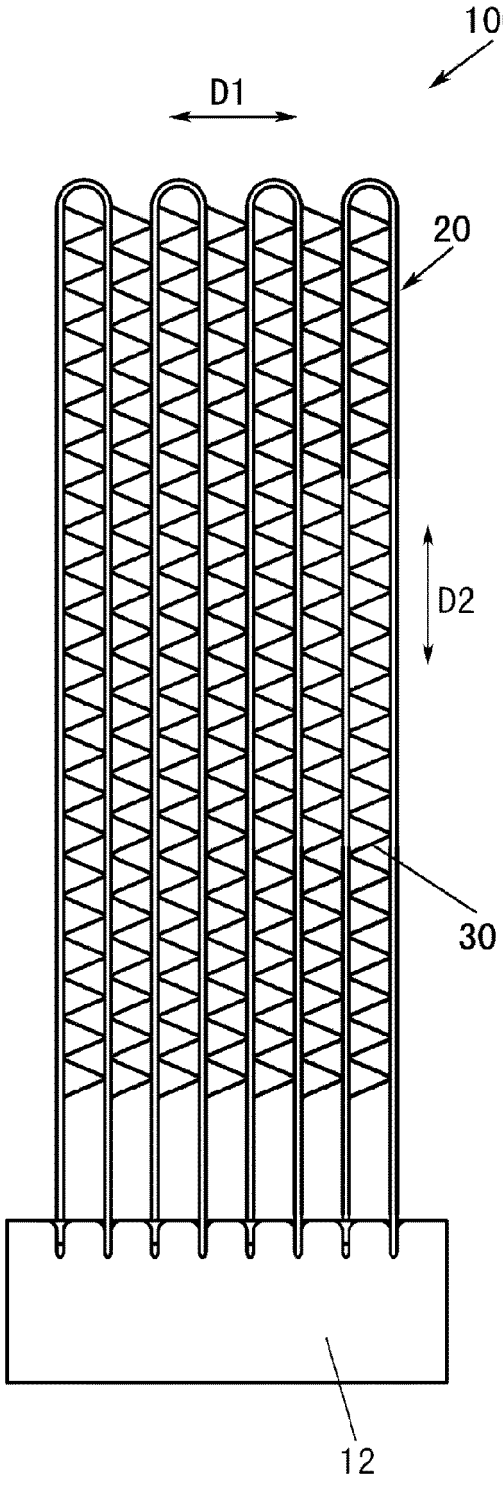

Fig. 16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/093023

A. CLASSIFICATION OF SUBJECT MATTER

F25B 39/00 (2006.01) i

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)

F25B 39/-; F28F 9/-; F28D 1/-

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)

CNTXT, CNKI, CNABS, VEN: DANFOSS MICRO CHANNEL HEAT EXCHANGER, concurrent flow, afflux, same side, heat-exchange tube, heat exchanger; microchannel, flat, header?, collect+, same, side?, pipe?, heat+, exchanger?

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 103245132 A (SHANGHAI JIAOTONG UNIVERSITY), 14 August 2013 (14.08.2013), description, page 3, paragraphs [0024]-[0033], and figures 1-4	1-19
X	CN 103277942 A (GUANGDONG MIDEA AIR-CONDITIONING EQUIPMENT CO., LTD.), 04 September 2013 (04.09.2013), description, page 3, paragraph [0041] to page 6, paragraph [0067], and figures 3-10	1-19
X	CN 203310165 U (GUANGDONG MIDEA AIR-CONDITIONING EQUIPMENT CO., LTD.), 27 November 2013 (27.11.2013), description, page 3, paragraph [0041] to page 6, paragraph [0067], and figures 3-10	1-19
A	CN 104596153 A (SANHUA (HANGZHOU) MICRO CHANNEL HEAT EXCHANGER CO., LTD.), 06 May 2015 (06.05.2015), the whole document	1-19
A	CN 103697745 A (DANFOSS MICRO CHANNEL HEAT EXCHANGER JIAXING CO., LTD.), 02 April 2014 (02.04.2014), the whole document	1-19
A	EP 1881288 A1 (MODINE MFG. CO.), 23 January 2008 (23.01.2008), the whole document	1-19

☐ 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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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

"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
18 October 2016 (18.10.2016)	**03 November 2016 (03.11.2016)**
Name and mailing address of the ISA/CN: State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No.: (86-10) 62019451	Authorized officer **TANG, Yu** Telephone No.: (86-10) **62414211**

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2016/093023

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 103245132 A	14 August 2013	CN 103245132 B	23 September 2015
CN 103277942 A	04 September 2013	CN 103277942 B	03 June 2015
CN 203310165 U	27 November 2013	None	
CN 104596153 A	06 May 2015	None	
CN 103697745 A	02 April 2014	WO 2015106726 A1	23 July 2015
EP 1881288 A1	23 January 2008	CN 101109609 A	23 January 2008
		US 8091617 B2	10 January 2012
		US 2008023187 A1	31 January 2008
		DE 102006033771 A1	24 January 2008

Form PCT/ISA/210 (patent family annex) (July 2009)