(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 562 506 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
27.02.2013 Bulletin 2013/09

(51) Int Cl.:
F28D 7/16 *(2006.01)* ***F28F 27/00*** *(2006.01)*

(21) Application number: **11178395.7**

(22) Date of filing: **23.08.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(71) Applicant: **Yu Shen Machinery Co., Ltd.**
New Taipei City (TW)

(72) Inventor: **YANG, Yung-Sho**
New Taipei City, Taiwan (TW)

(74) Representative: **Horak, Michael et al**
Horak Rechtsanwälte
Georgstrasse 48
30159 Hannover (DE)

(54) Shell-and-tube heat exchanger

(57) A shell-and-tube heat exchanger has a tubular shell (10), two tube panels (11) mounted in the shell (10), multiple heat transfer tubes (13) axially mounted between the tube panels (11), an inlet tube (14) mounted in the shell (10) and connected to a shell side inlet (101) of the shell (10), a spurting tube (15) axially mounted in the shell (10) and connected to the inlet tube (14), and a front cover (20) and a rear cover (30) respectively mounted on a front opening and a rear opening of the shell (10). Shell side fluid spurts into the shell (10) from the spurting tube (15). The shell side fluid does not become turbulent, no air film occurs in the shell (10) and lower surfaces of the heat transfer tubes (15) act as heating surfaces so the heat exchanger has high heat transfer efficiency.

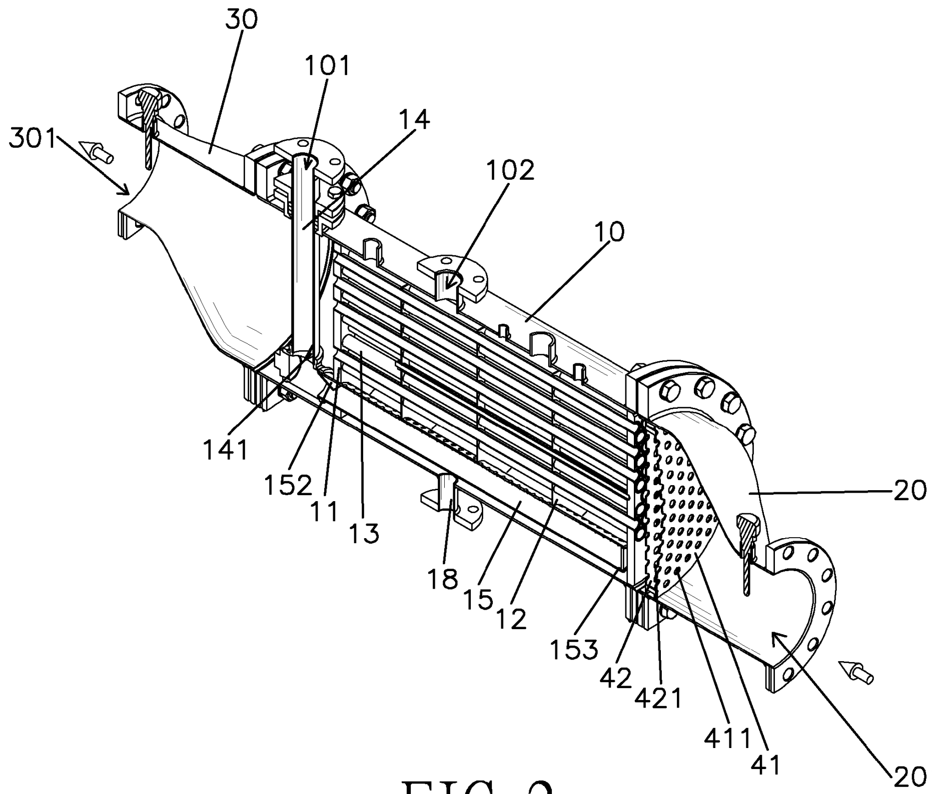

FIG.2

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Description

1. Field of the Invention

[0001] The present invention relates to a shell-and-tube heat exchanger, especially to a shell-and-tube heat exchanger that has good heat exchange efficiency.

2. Description of the Prior Art(s)

[0002] With reference to Figs. 6 and 7, a conventional shell-and-tube heat exchanger 90 comprises a shell assembly, a front cover 92, a rear cover 93 and a safety valve 95.

[0003] The shell assembly has a shell 91, two tube panels 913, multiple upper baffles 914, multiple lower baffles 915 and multiple heat transfer tubes 916. The shell 91 is tubular and has a front opening, a rear opening, a shell side inlet 911, a shell side outlet 912 and a condensate outlet 917. The condensate outlet 917 is connected to and communicates with a steam trap 94. The tube panels 913 are respectively mounted at and cover the front opening and the rear opening of the shell 91. Each tube panel 913 has multiple through holes. The upper baffles 914 are semilunar, are mounted on an inner top wall of the shell 91 and are separately arranged in the shell 91 and between the front and rear openings of the shell 91. The lower baffles 915 are semilunar, are mounted on an inner bottom wall of the shell 91 and are separately arranged in the shell 91 and between the front and rear openings of the shell 91. Each lower baffle 915 is disposed between two adjacent upper baffles 914. Thus, a curved channel is formed between the upper and lower baffles 914, 915. The heat transfer tubes 916 are axially mounted in the shell 91 and are mounted through the tube panels 913 and the upper and/or lower baffles 914, 915.

[0004] The front cover 92 is securely mounted on the front opening of the shell 91 and has a tube side inlet 921. The rear cover 93 is securely mounted on the rear opening of the shell 91 and has a tube side outlet 931. The safety valve 95 is mounted on the shell 91, protrudes into the shell 91, and detects and controls fluid pressure in the shell 91.

[0005] Tube side fluid that needs to be heated or cooled flows into the conventional shell-and-tube heat exchanger 90 from the tube side inlet 921 of the front cover 92 and through the heat transfer tubes 916, and then flows out of the conventional shell-and-tube heat exchanger 90 from the tube side outlet 931 of the rear cover 93. Shell side fluid such as steam or cooling water flows into the conventional shell-and-tube heat exchanger 90 from the shell side inlet 911 of the shell 91 and along the curved channel formed between the upper and lower baffles 914, 915, and then flows out of the conventional shell-and-tube heat exchanger 90 from the shell side outlet 912 of the shell 91. Thus, the tube side fluid and the shell side fluid exchange heat. Condensate formed in the shell 91 is drained to the seam trap 94 through the condensate outlet 917 of the shell 91.

[0006] However, for example, when shell side fluid in the shell 91 is steam to transfer heat to the tube side fluid in the heat transfer tubes 916, where the shell side fluid flows downwardly, top surfaces of the heat transfer tubes 916 act as heating surfaces; where the shell side fluid flows upwardly, lower surfaces of the heat transfer tubes 916 act as the heating surfaces. Thus, the heating surfaces on one heat transfer tube 916 differ with positions. Furthermore, since the shell side fluid also transversely flows toward the shell side outlet 912 of the shell 91, the shell side fluid bumps against the upper and lower baffles 914, 915, becomes turbulent and air films occur at nooks in the shell 91. Therefore, heat transfer efficiency between the shell side fluid and the heat transfer tubes 916 is affected.

[0007] With further reference to Fig. 8, also, because the shell side fluid has to flow downwardly and upwardly and the heat transfer tubes 916 hinder the shell side fluid, the shell side fluid tends to flow along a side channel 918 defined around an inner surface of the shell 91. Therefore, the conventional shell-and-tube heat exchanger 90 has low heat transfer efficiency.

[0008] Moreover, according to the principle of inertia force, when the tube side fluid flows through the tube side inlet 921 of the front cover 92, most of the tube side fluid flows into the heat transfer tubes 916 that directly correspond to the tube side inlet 921 of the front cover 92 and only few of the tube side fluid flows into the heat transfer tubes 916 that do not directly correspond to the tube side inlet 921 of the front cover 92. Therefore, the heat transfer tubes 916 have different quantities of tube side fluid flowing therein, and the tube side fluid in different heat transfer tubes 916 have different flow rates. Consequently, heat transfer efficiencies in different heat transfer tubes 916 differ.

[0009] The main objective of the present invention is to provide a shell-and-tube heat exchanger. The shell-and-tube heat exchanger has a tubular shell, two tube panels mounted in the shell, multiple heat transfer tubes axially mounted on and between the tube panels, an inlet tube mounted in the shell and connected to a shell side inlet of the shell, a spurting tube axially mounted in the shell and connected to the inlet tube, and a front cover and a rear cover respectively mounted on a front opening and a rear opening of the shell.

[0010] Shell side fluid spurts into the shell from the spurting tube toward a specific direction. The shell side fluid does not become turbulent, no air film occurs in the shell and lower surfaces of the heat transfer tubes act as heating surfaces so the shell-and-tube heat exchanger has high heat transfer efficiency.

<u>IN THE DRAWINGS</u>

[0011]

Fig. 1 is an operational perspective view of a shell-and-tube heat exchanger in accordance with the present invention;

Fig. 2 is cross-sectional perspective view of the shell-and-tube heat exchanger in Fig. 1;

Fig. 3 is an enlarged side view of a shell assembly of the shell-and-tube heat exchanger in Fig. 1;

Fig. 4 is an enlarged side view of a first guiding panel and a second guiding panel of the shell-and-tube heat exchanger in Fig. 1;

Fig. 5 is a cross-sectional end view of the shell-and-tube heat exchanger in Fig. 1;

Fig. 6 is an enlarged schematic side view of a conventional shell-and-tube heat exchanger in accordance with the prior art;

Fig. 7 is an operational and cross-sectional perspective view of the conventional shell-and-tube heat exchanger in Fig. 6; and

Fig. 8 is a cross-sectional end view of the conventional shell-and-tube heat exchanger in Fig. 6.

[0012] With reference to Figs. 1 and 2, a shell-and-tube heat exchanger in accordance with the present invention comprises a shell assembly, a front cover 20, a rear cover 30, a first guiding panel 41 and a second guiding panel 42.

[0013] The shell assembly has a shell 10, two tube panels 11, multiple partition panels 12, multiple supporting rods 16, multiple heat transfer tubes 13, an inlet tube 14, an upper guiding panel 141, a spurting tube 15, a lower guiding panel 152 and a drain tube 18.

[0014] The shell 10 is tubular and has a front opening, a rear opening, a shell side inlet 101 and a shell side outlet 102. The shell side inlet 101 is formed through the shell 10 and is disposed adjacent to the rear opening of the shell 10. The shell side outlet 102 is formed through the shell 10 and is disposed adjacent to the front opening of the shell 10.

[0015] The tube panels 11 are respectively mounted at and cover the front opening and the rear opening of the shell 10. Each tube panel 11 has multiple through holes separately formed through the tube panel 11. The partition panels 12 are separately arranged in the shell 10 and between the tube panels 11. Each partition panel 12 has multiple through holes separately formed through the partition panel 12. The supporting rods 16 are axially mounted in the shell 10 and through the through holes of the partition panels 12 to support and hold the partition panels 12. The heat transfer tubes 13 are axially mounted in the shell 10 and through the through holes of the partition panels 12. Each heat transfer tube 13 has two ends respectively mounted through the through holes of the tube panels 11 and corresponding to the front opening and the rear opening of the shell 10. The inlet tube 14 is mounted in the shell 10, may be disposed between the rear opening of the shell 10 and the tube panel 11 that is mounted at the rear opening of the shell 10, and has an inner end and an outer end. The outer end of the inlet tube 14 is connected to and communicates with the shell side inlet 101 of the shell 10. The upper guiding panel 141 is mounted on an inner wall of the inlet tube 14, is disposed adjacent to the inner end of the inlet tube 14 and protrudes inwardly and downwardly.

[0016] With further reference to Fig. 3, the spurting tube 15 is axially mounted in the shell 10, may be disposed at a bottom of the shell 10, is mounted through the tube panels 11 and the partition panels 12 and has a first end, a second end, multiple spurting holes 151 and a drain hole 153. The first end of the spurting tube 15 is connected to and communicates with the inner end of the inlet tube 14. The spurting holes 151 are separately formed through the spurting tube 15. Preferably, the closer the spurting holes 151 are to the first end of the spurting tube 15, with the higher density the spurting holes 151 are distributed. The drain hole 153 is formed through the spurting tube 15 and is disposed adjacent to the second end of the spurting tube 15. The lower guiding panel 152 is mounted on an inner wall of the spurting tube 15, is disposed adjacent to the first end of the spurting tube 15 and protrudes inwardly and downwardly.

[0017] The drain tube 18 is mounted on and through a bottom of the shell 10.

[0018] The front cover 20 is securely mounted on the front opening of the shell 10 and has a tube side inlet 201 formed through the front cover 20 and communicating with the heat transfer tubes 13.

[0019] The rear cover 30 is securely mounted on the rear opening of the shell 10 and has a tube side outlet 301 formed through the rear cover 30 and communicating with the heat transfer tubes 13. Preferably, the tube side outlet 301 of the rear cover 30 is disposed higher than the tube side inlet 201 of the front cover 20.

[0020] With further reference to Fig. 4, the first guiding panel 41 is mounted in the front cover 20, curves outward toward the tube side inlet 201 of the front cover 20 and has multiple guide holes 411 separately formed through the first guiding panel 41.

[0021] The second guiding panel 42 is flat, is mounted between the first guiding panel 41 and the tube panel 11 that is mounted at the front opening of the shell 10, is connected to the first guiding panel 41 via multiple fasteners 43, and has multiple guide holes 421 separately formed through the second guiding panel 42.

[0022] With reference to Fig. 1, the shell-and-tube heat exchanger may further comprise a steam inlet valve 511, a cooling water inlet valve 512, a pressure release valve 513, a cooling water outlet valve 52, a pressure gauge 53, a vacuum breaker 54, a safety valve 55, a steam trap 56 and multiple temperature sensors 571, 572, 573, 574. The steam inlet valve 511 and the cooling water inlet valve 512 are connected to the shell side inlet 101 of the shell 10. The pressure release valve 513 is connected to the steam inlet valve 511 to control the shell side fluid. The cooling water outlet valve 52 is connected to the shell side outlet 102. The pressure gauge 53, the vacuum breaker 54 and the safety valve 55 are mounted on the shell 10 to detect and control pressure of the shell side fluid in the shell 10. The steam trap 56 is connected to the drain tube 18 of the shell 10 via a pipeline so condensate formed in the shell 10 can be drained via the steam trap 56. The temperature sensors 571, 572, 573, 574 are respectively mounted on the front cover 20, the rear cover 30, the pipeline that connects the steam trap 56 to the drain tube 18 of the shell 10 and the cooling water outlet valve 52 to detect temperatures of the tube side fluid, the condensate and the shell side fluid.

[0023] Tube side fluid flows into the shell-and-tube heat exchanger from the tube side inlet 201 of the front cover 20 and flows along the curved first guiding panel 41 to distribute to the guide holes 411 of the first guiding panel 41. Then the tube side fluid flows through the guide holes 411, 421 of the first guiding panel 41 and the second guiding panel 42, into the heat transfer tubes 13 and through the tube side outlet 301 of the rear cover 30 to flow out of the shell-and-tube heat exchanger. Shell side fluid flows through the shell side inlet 101 of the shell 10 to flow into the inlet tube 14 and the spurting tube 15. Then the shell side fluid flows through the spurting holes 151 of the spurting tube 15 to spurt into the shell 10 and exchanges heat with the tube side fluid in the heat transfer tubes 13.

[0024] When the shell side fluid is steam, the steam flows through the inlet tube 14 and the spurting tube 15, and bumps against the upper guiding panel 141 and the lower guiding panel 152, and condensate is formed on the upper and lower guiding panels 141, 152. Then the condensate accumulated in the spurting tube 15 is drained out of the spurting tube 15 via the drain hole 153. Thus, humidity of the shell side fluid is lowered so less condensate is formed in the shell 10.

[0025] With further reference to Fig. 5, the shell-and-tube heat exchanger as described has the following advantages. For example, when shell side fluid in the shell 10 is steam, since the spurting tube 15 is disposed at the bottom of the shell 10, the shell side fluid always flows upwardly toward a top of the shell 10. Thus, the shell side fluid does not become turbulent, no air film occurs in the shell 10 and lower surfaces of the heat transfer tubes 13 act as heating surfaces. Consequently, the shell-and-tube heat exchanger has high heat transfer efficiency. Moreover, with the first and second guiding panels 41, 42 mounted in the front cover 20, the tube side fluid flows equally into each heat transfer tubes 13. Therefore, the tube side fluid in different heat transfer tubes 13 has equal heat transfer efficiencies.

Claims

1. A shell-and-tube heat exchanger comprising a shell assembly having a shell (10) being tubular and having a front opening, a rear opening, a shell side inlet (101) and a shell side outlet (102), two tube panels (11) respectively mounted at and covering the front opening and the rear opening of the shell (10) and multiple heat transfer tubes (13) axially mounted in the shell (10), and each heat transfer tube (13) having two ends respectively mounted through the tube panels (11) and corresponding to the front opening and the rear opening of the shell (10), a front cover (20) securely mounted on the front opening of the shell (10) and having a tube side inlet (201) formed through the front cover (20) and communicating with the heat transfer tubes (13), and a rear cover (30) securely mounted on the rear opening of the shell (10) and having a tube side outlet (301) formed through the rear cover (30) and communicating with the heat transfer tubes (13), and the shell-and-tube heat exchanger **characterized in that**:

the shell assembly further has
an inlet tube (14) mounted in the shell (10) and having an inner end and an outer end connected to and communicating with the shell side inlet (101) of the shell (10); and
a spurting tube (15) axially mounted in the shell (10) and having
a first end connected to and communicating with the inner end of the inlet tube (14);
a second end; and
multiple spurting holes (151) separately formed through the spurting tube (15).

2. The heat exchanger as claimed in claim 1 further comprising a first guiding panel (41) mounted in the front cover (20), curving toward the tube side inlet (201) of the front cover (20) and having multiple guide holes (411) separately formed through the first guiding panel (41).

3. The heat exchanger as claimed in claim 2 further comprising a second guiding panel (42) being flat, mounted between the first guiding panel (41) and the tube panel (11) that is mounted at the front opening of the shell (10), and having multiple guide holes (421) separately formed through the second guiding panel (42).

4. The heat exchanger as claimed in claims 1, 2 or 3, wherein the spurting tube (15) is disposed at a bottom of the shell (10).

5. The heat exchanger as claimed in claim 4, wherein the closer the spurting holes (151) are to the first end of the spurting tube (15), with the higher density the spurting holes (151) are distributed.

6. The heat exchanger as claimed in claim 5, wherein the shell assembly further has
multiple partition panels (12) separately arranged in the shell (10) and between the tube panels (11); and
multiple supporting rods (16) axially mounted in the shell (10) and through the partition panels (12); and

the heat transfer tubes (13) and the spurting tube (15) are mounted through the partition panels (12).

7. The heat exchanger as claimed in claim 6, wherein the shell assembly further has
an upper guiding panel (141) mounted on an inner wall of the inlet tube (14), disposed adjacent to the inner end of the inlet tube (14) and protruding inwardly and downwardly; and
a lower guiding panel (152) mounted on an inner wall of the spurting tube (15), disposed adjacent to the first end of the spurting tube (15) and protruding inwardly and downwardly.

8. The heat exchanger as claimed in claim 7, wherein the spurting tube (15) further has a drain hole (153) formed through the spurting tube (15) and disposed adjacent to the second end of the spurting tube (15).

9. The heat exchanger as claimed in claim 8, wherein the tube side outlet (301) of the rear cover (30) is disposed higher than the tube side inlet (201) of the front cover (20).

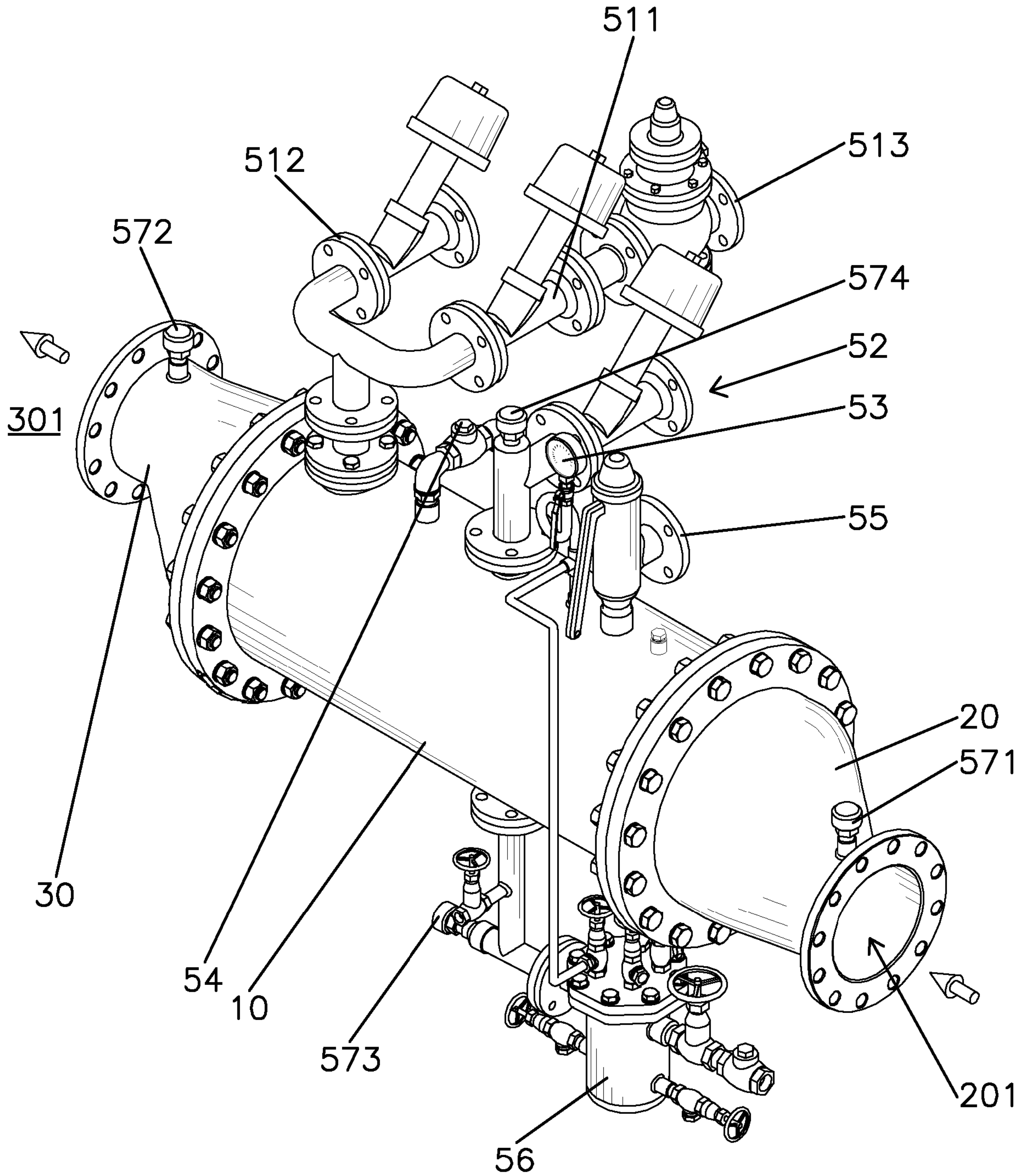

FIG.1

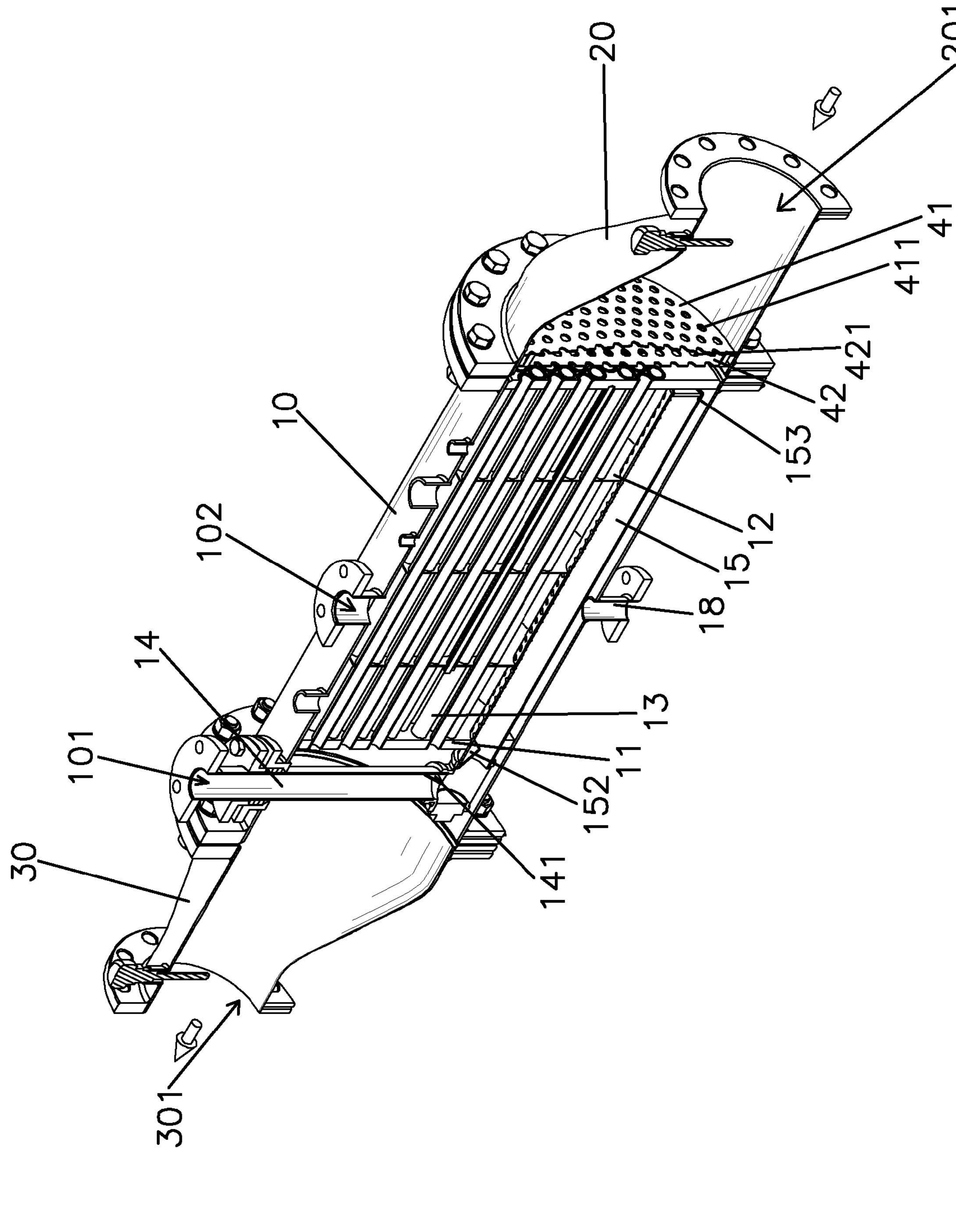

FIG. 2

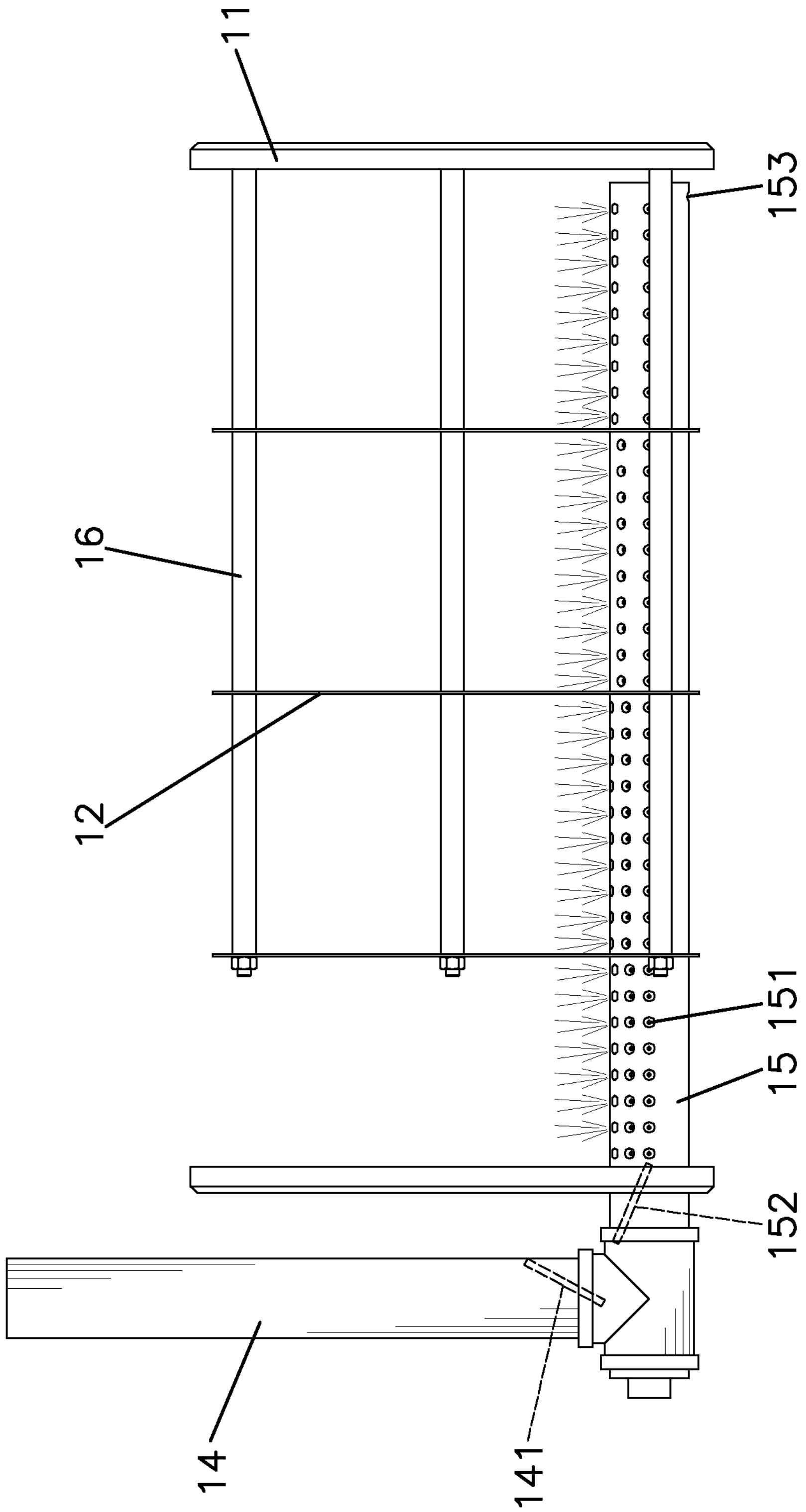

FIG. 3

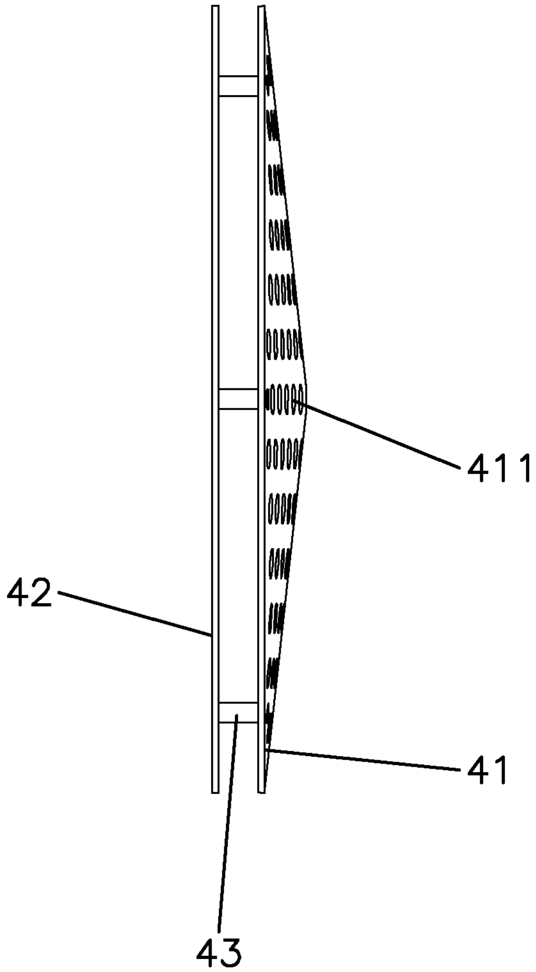

FIG.4

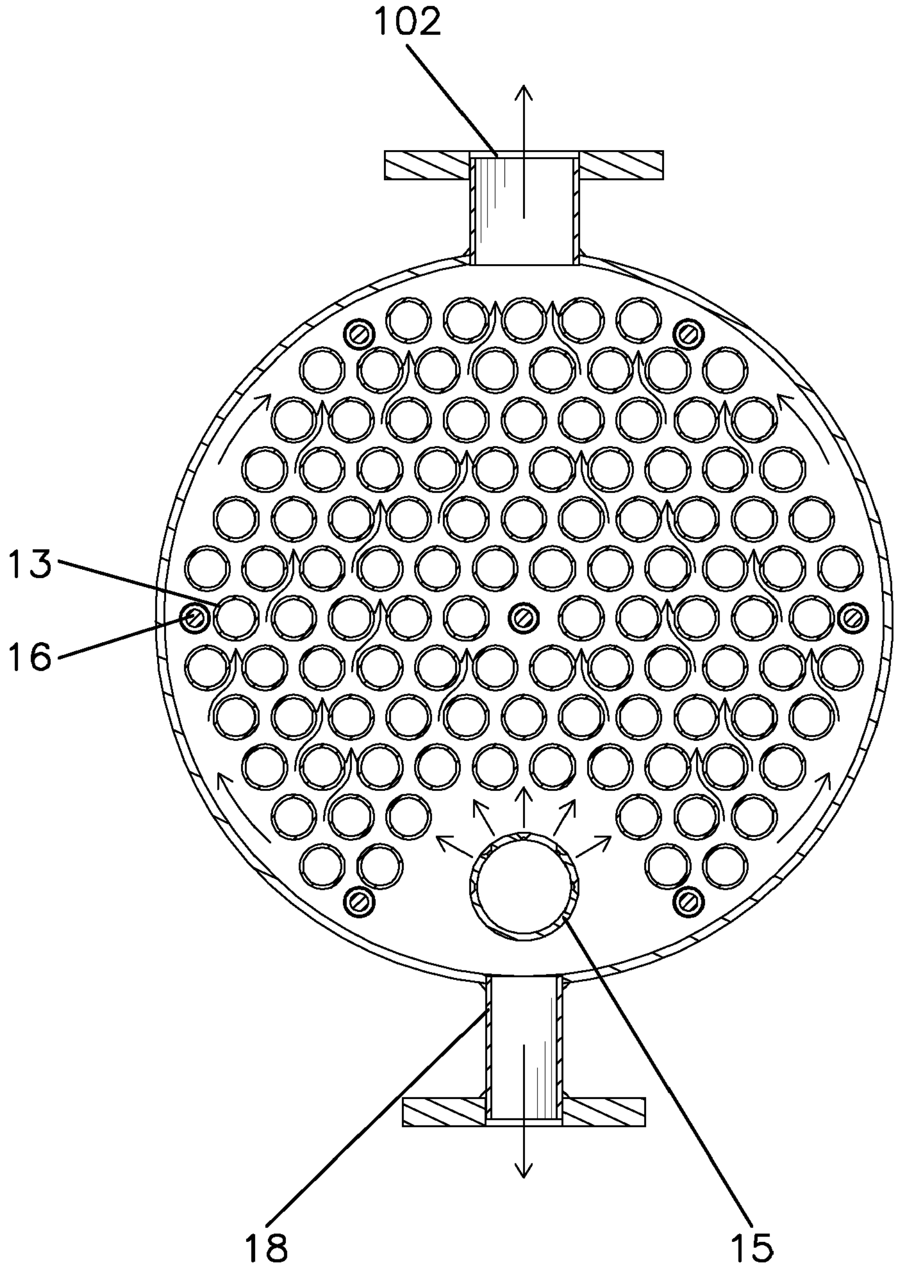

FIG.5

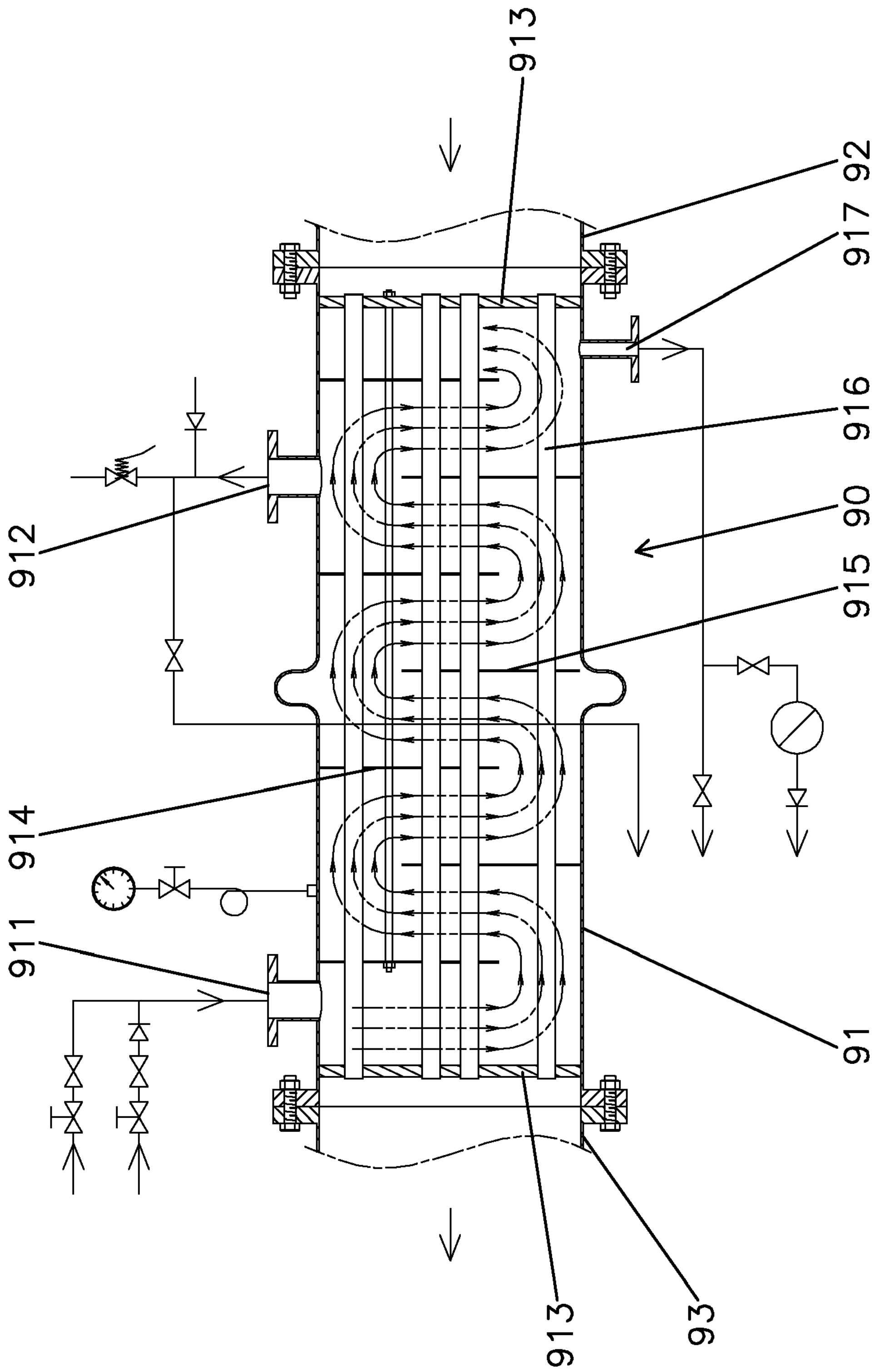

FIG. 6
PRIOR ART

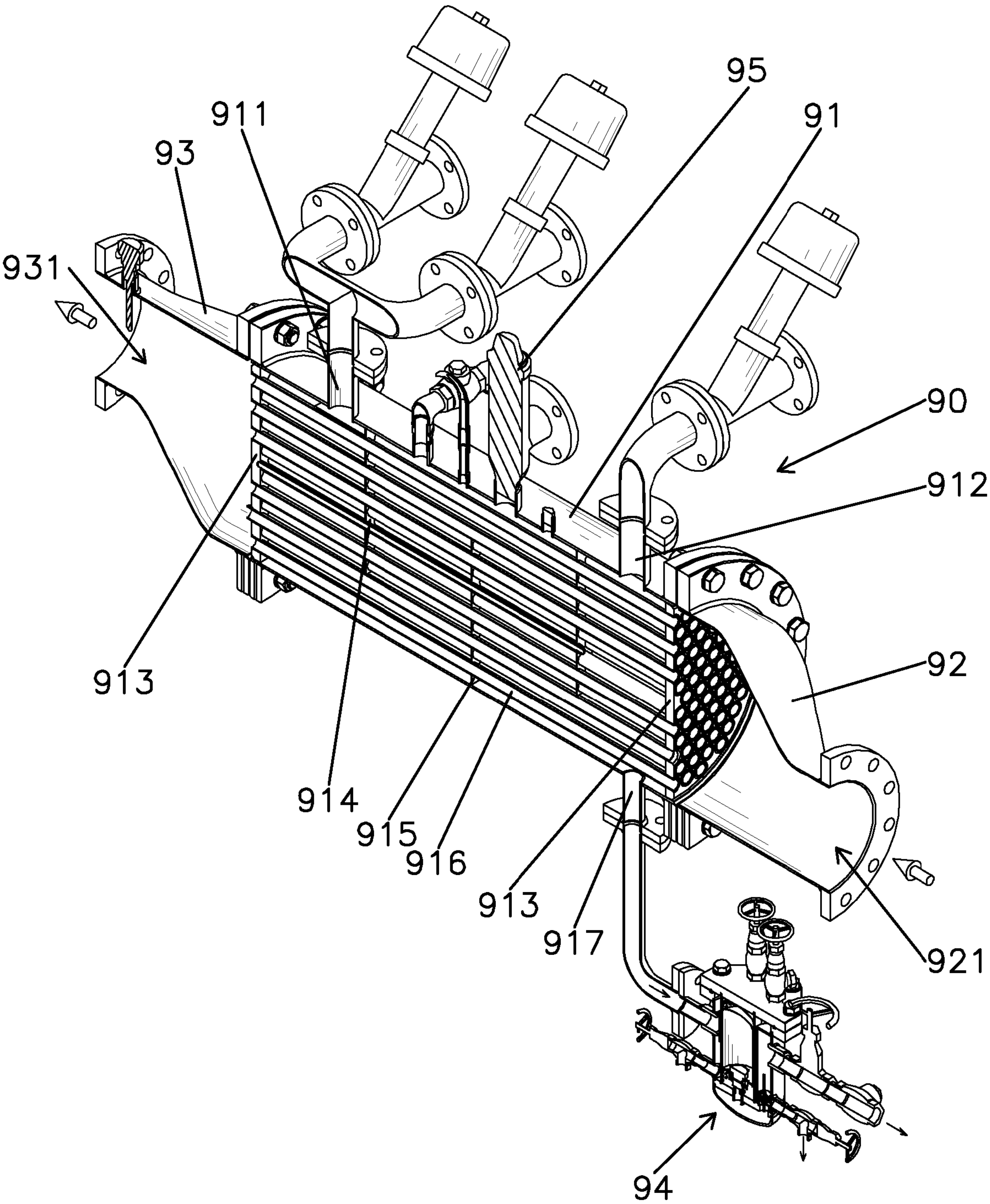

FIG.7
PRIOR ART

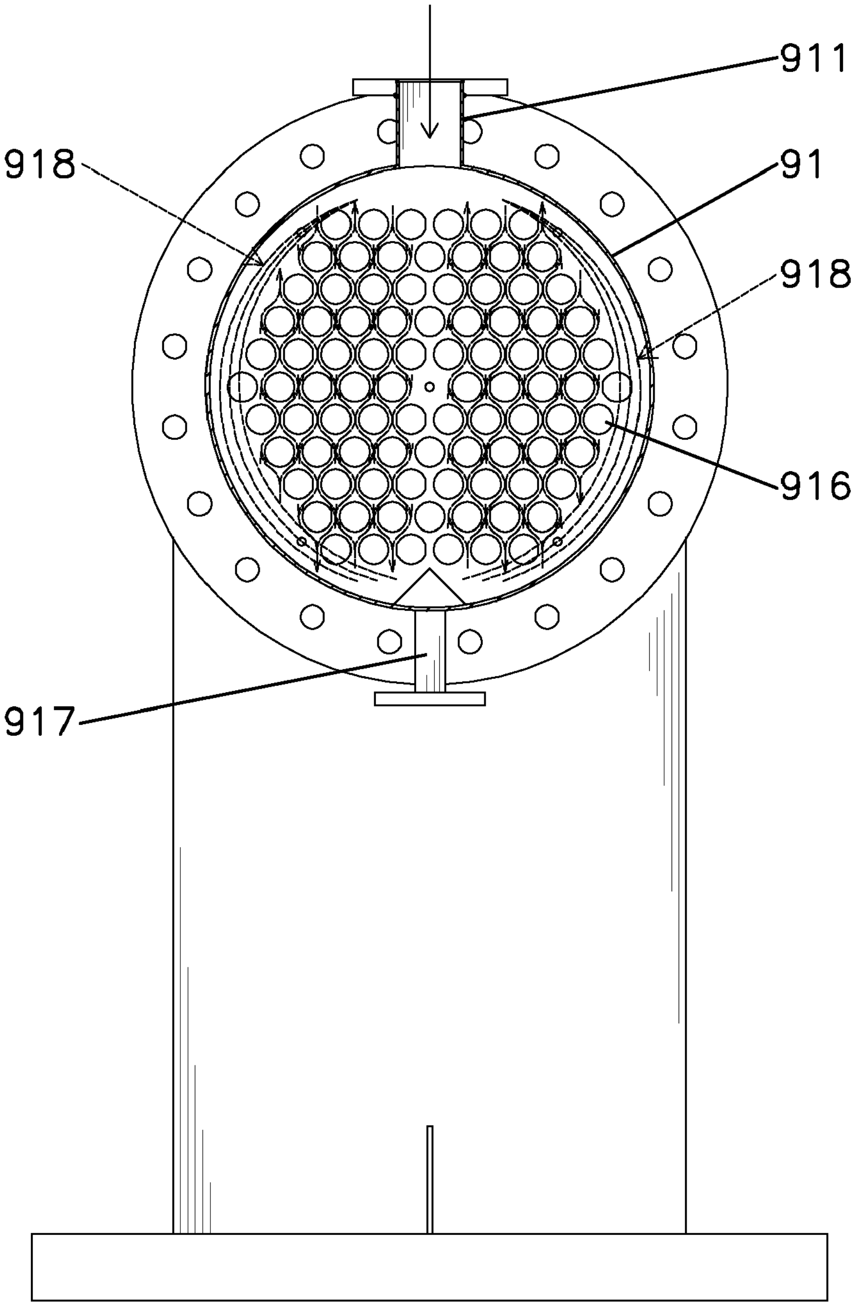

FIG.8
PRIOR ART

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EUROPEAN SEARCH REPORT

Application Number
EP 11 17 8395

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 1 498 678 A1 (BORSIG GMBH [DE]) 19 January 2005 (2005-01-19) * figures * -----	1-9	INV. F28D7/16 F28F27/00
A	DE 273 452 C (SIEGFRIED MERTENS) 21 November 1913 (1913-11-21) * figures * -----	1-9	
A	US 3 173 480 A (PARKER KENNETH O ET AL) 16 March 1965 (1965-03-16) * figures * -----	1-9	

TECHNICAL FIELDS SEARCHED (IPC)
F28D
F28F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	18 January 2012	Mellado Ramirez, J

CATEGORY OF CITED DOCUMENTS

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18-01-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1498678 A1	19-01-2005	AT 338931 T	15-09-2006
		DK 1498678 T3	22-01-2007
		EP 1498678 A1	19-01-2005
		ES 2271434 T3	16-04-2007
DE 273452 C	21-11-1913	NONE	
US 3173480 A	16-03-1965	NONE	

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