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(54) **HEAT EXCHANGER TUBE**

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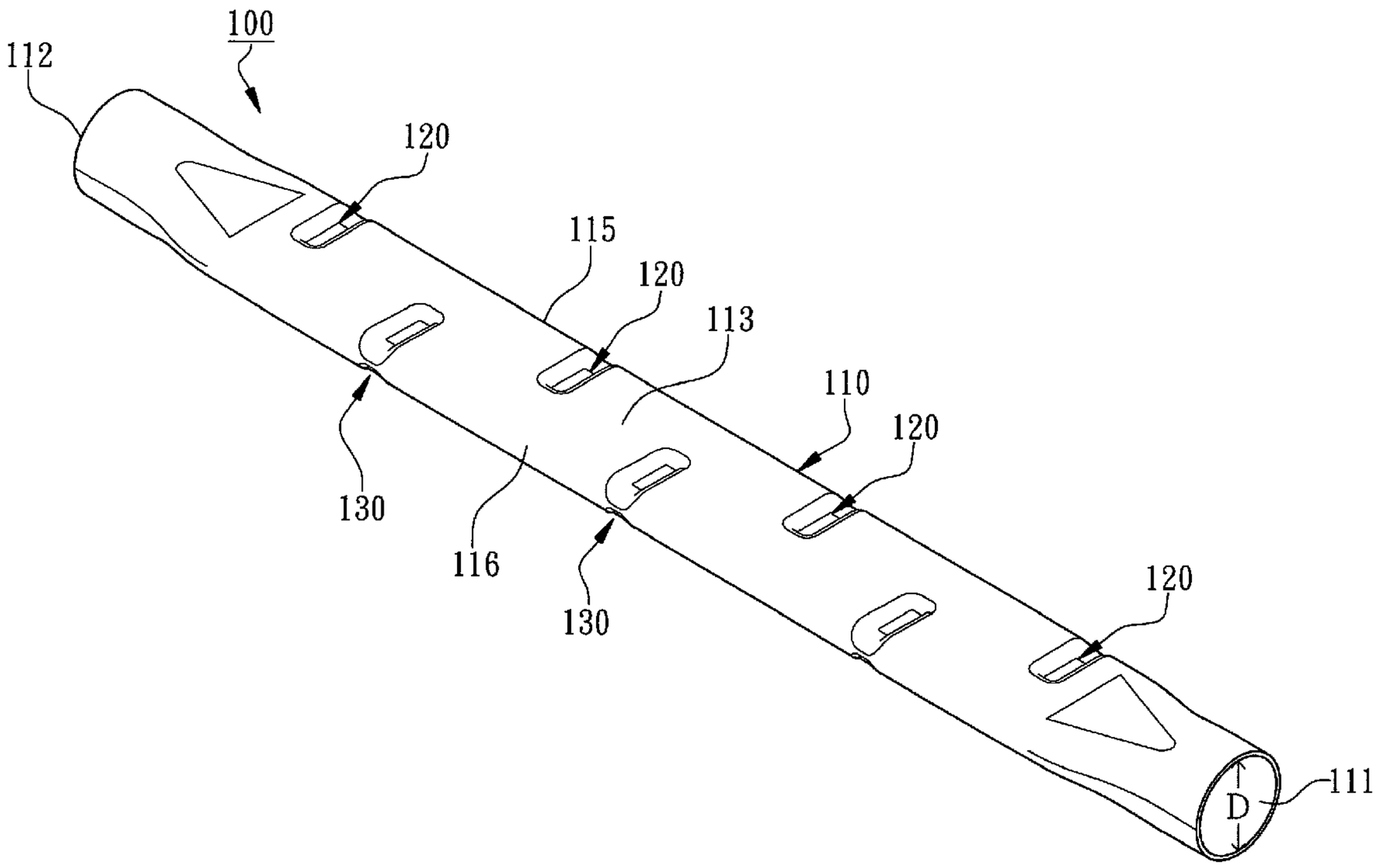
(57) **ABSTRACT**

Disclosed is a heat exchanger tube having a flattened pipe having two non-flattened ends connected with a first opening and a second opening. A plurality of first half-slacking narrows and a plurality of second half-slacking narrows are arranged in an interlaced zigzag pattern such that a winding flow channel is formed inside the flattened pipe to increase heat exchange efficiency. In a preferred embodiment, each of the first half-slacking narrow and the second half-slacking narrow consists of a pair of adjacent indentations formed on the two opposing flattened surfaces of the flattened pipe respectively to achieve a unit body structure of the flattened pipe.



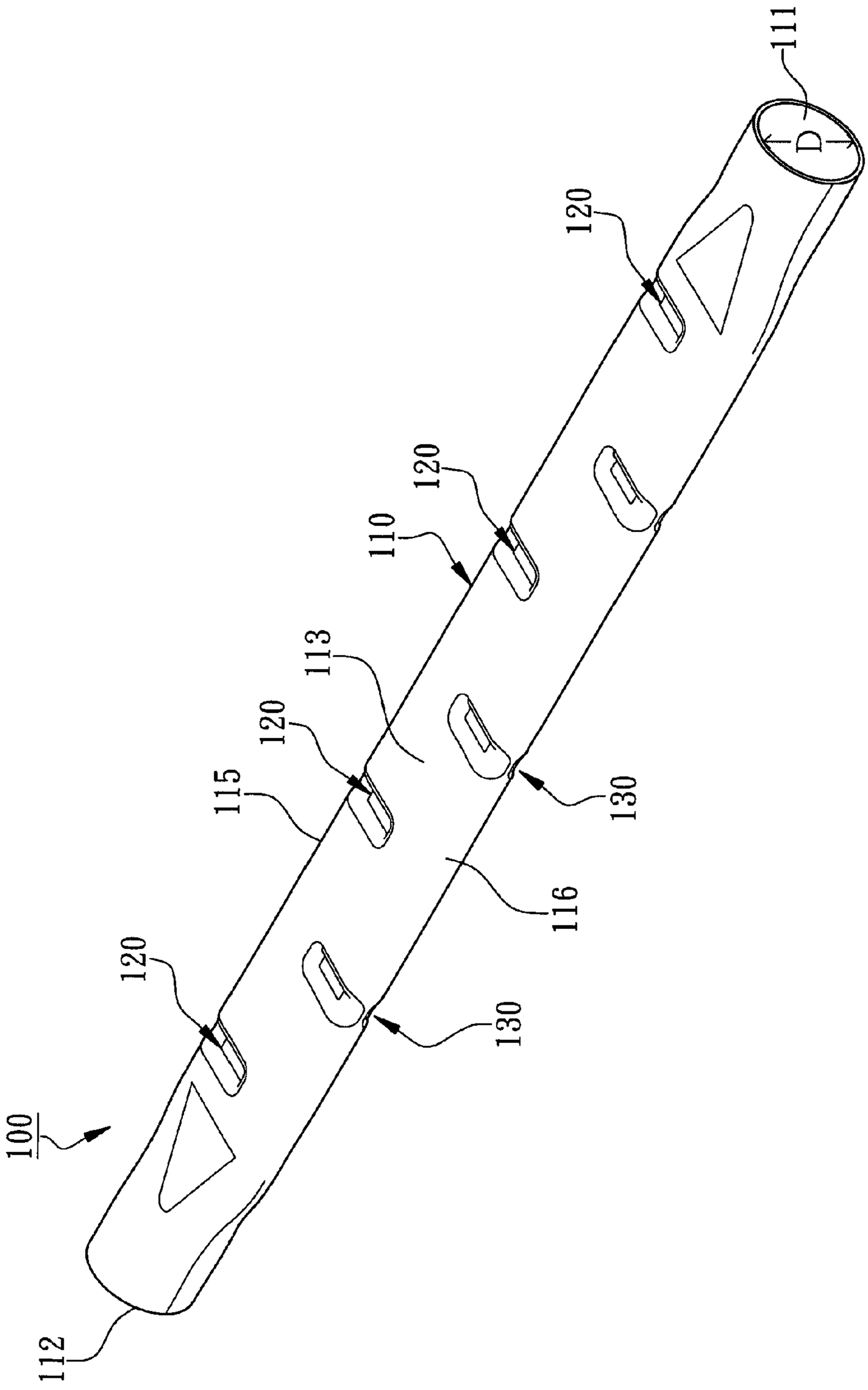


FIG. 1

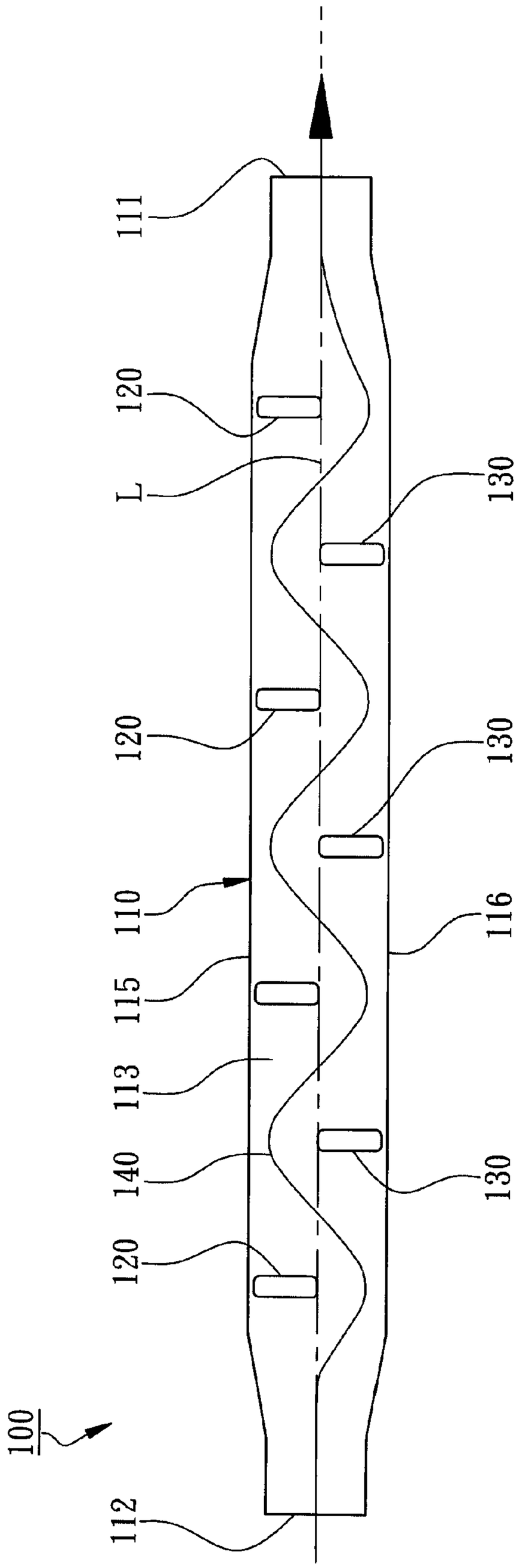
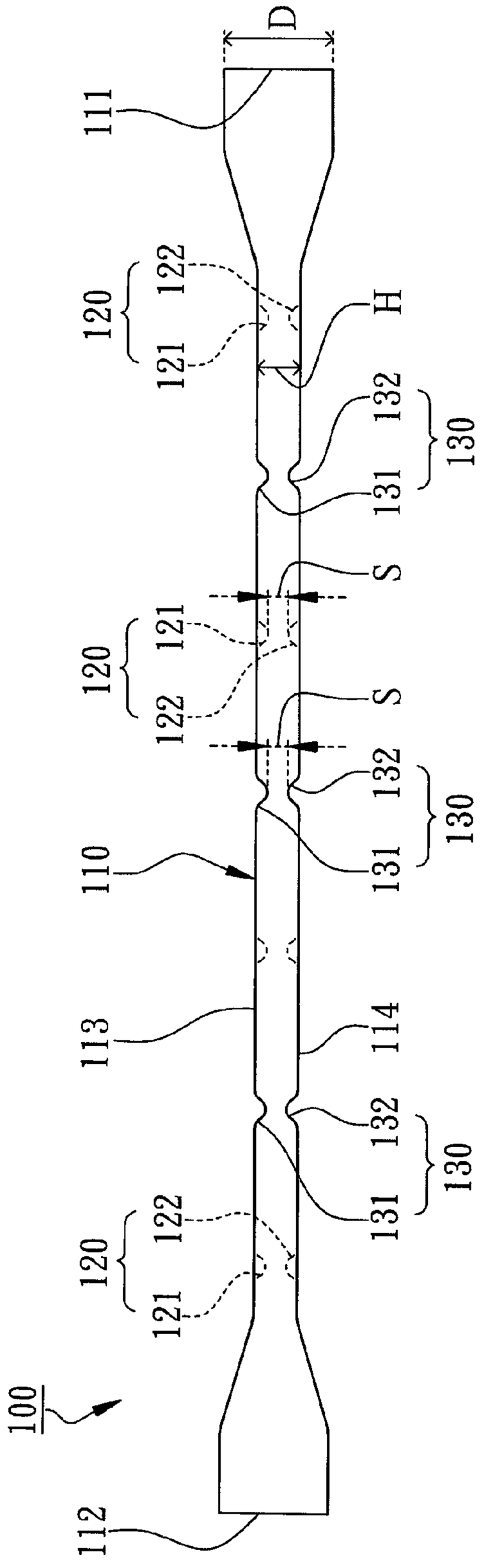


FIG. 2


D
111
120
122
121
H
32
132
130
131
S
S
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100
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132
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131
100
112

FIG. 3

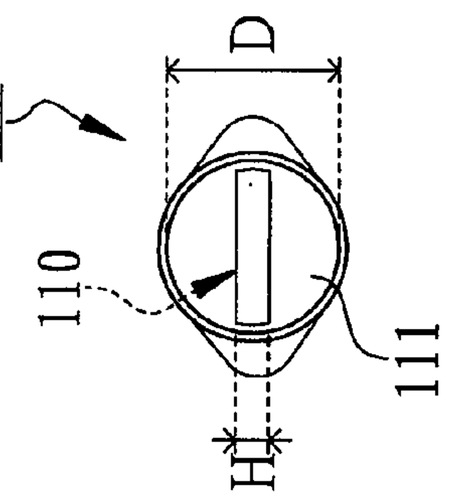
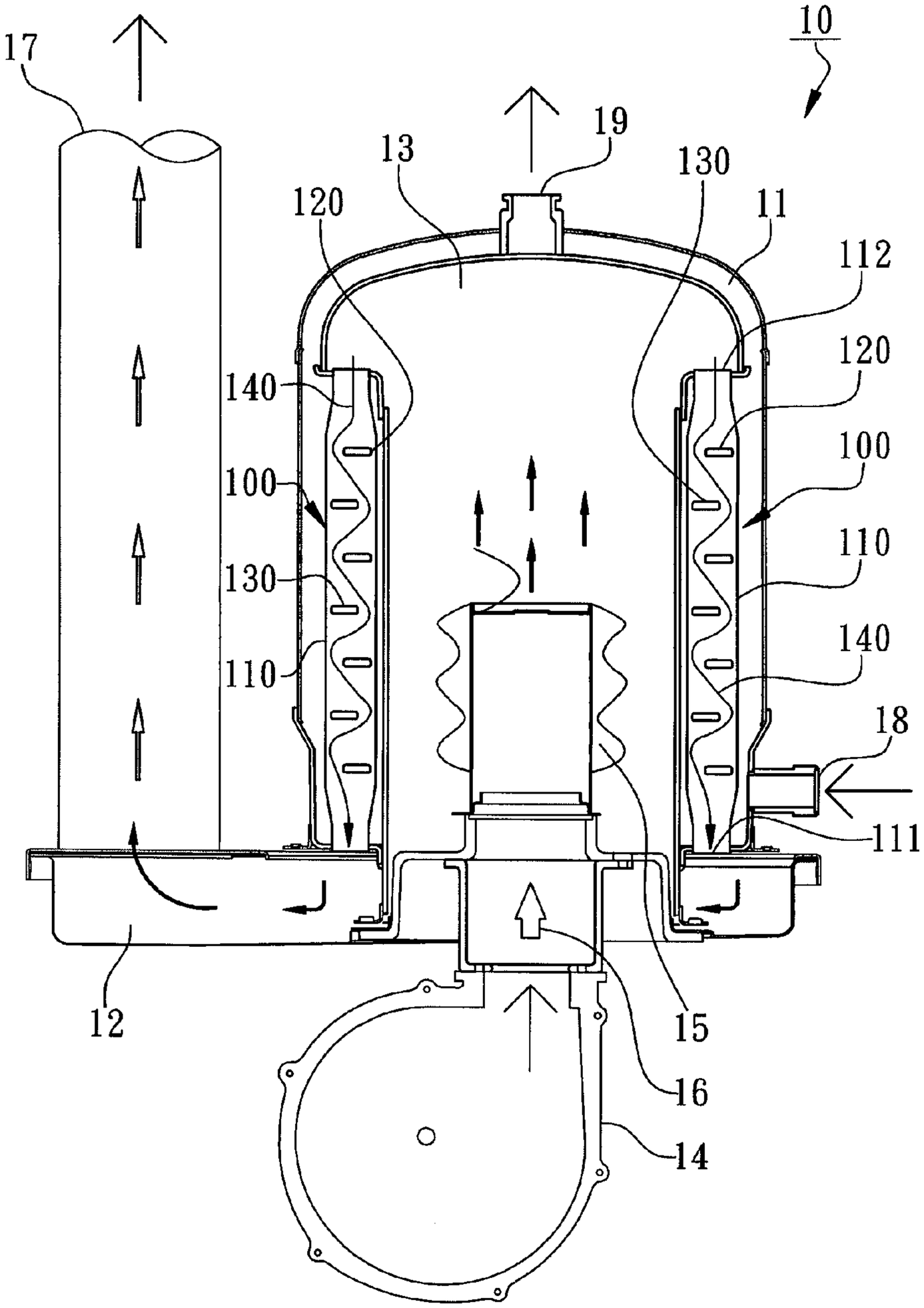

100
D
110
111
H

FIG. 4


17
10
19
13
130
120
11
112
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140
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16
14

FIG. 5

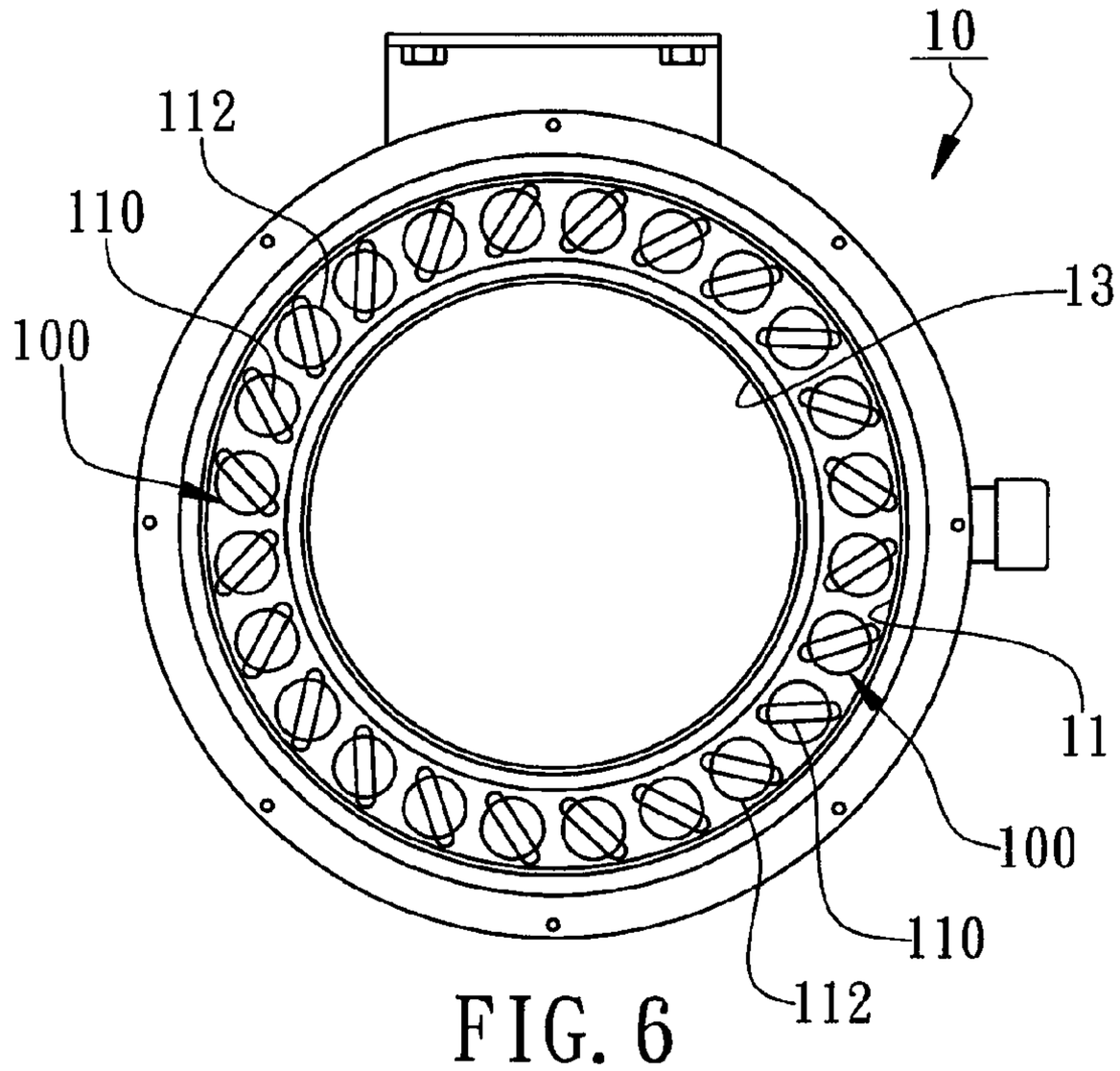

FIG. 6

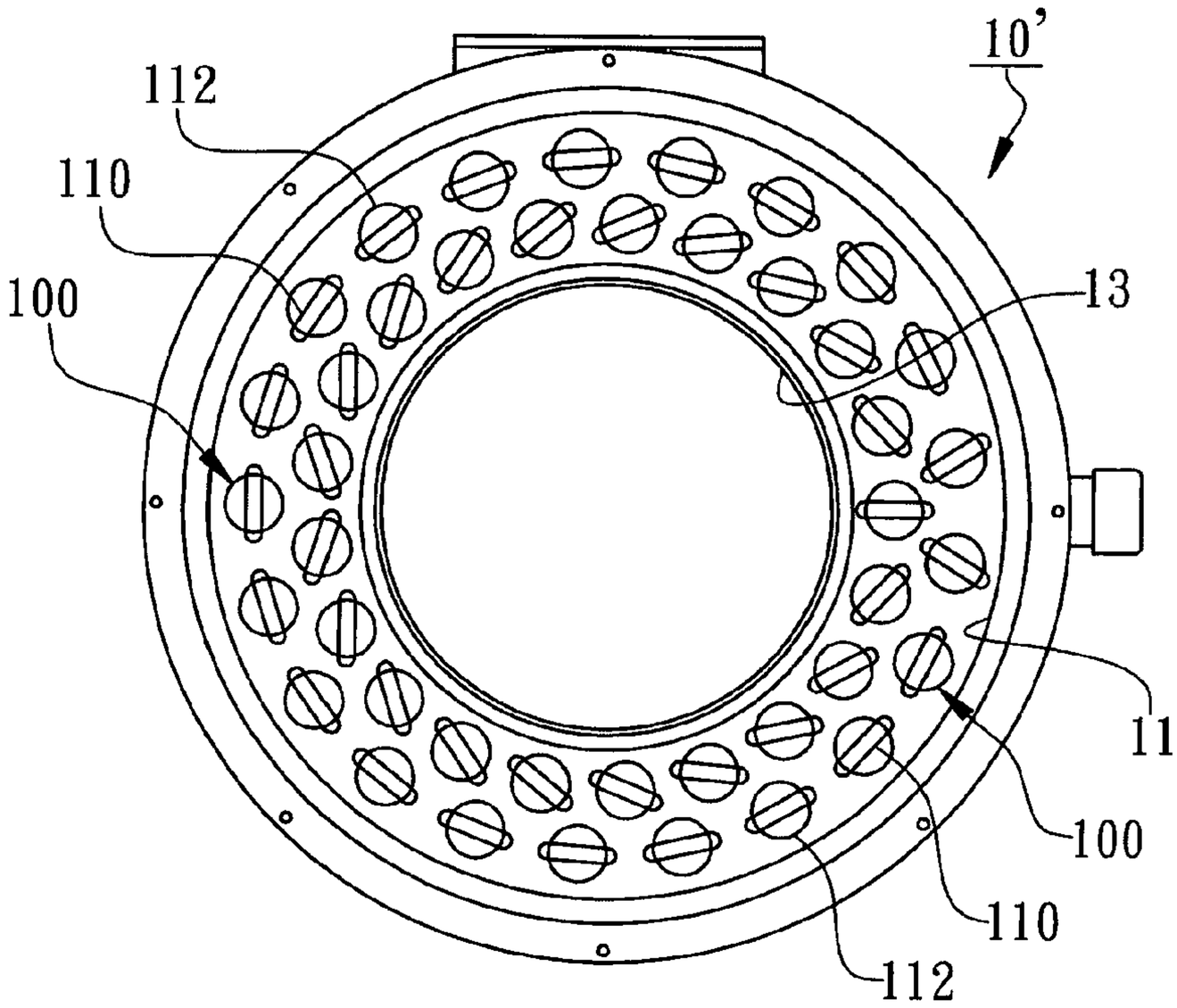

FIG. 7

HEAT EXCHANGER TUBE

FIELD OF THE INVENTION

[0001] The present invention relates to a component and parts in a heating device, and more specifically to a heat exchanger tube.

BACKGROUND OF THE INVENTION

[0002] Generally speaking, a plurality of heat exchange tubes are always installed inside a heating device or a pre-heating device to heat up liquids or gases. Conventional heat exchanger tubes are circular straight tubes where heat exchange efficiency depends on tube lengths and tube materials. In order to increase heat exchanger efficiency, turbulent fins are disposed inside heat exchanger tubes, however, the installation of turbulent fins will increase manufacture cost and assembling time.

[0003] Nakado et al. had disclosed a heat exchanger tube as revealed in US Patent publication No. 2002/0125002 A1 having a heat exchanger tube has a tube body whose interior is defined as a passage of a fluid and whose inner and outer surfaces are defined as heat entrance and exit surfaces of the fluid. It is characterized in that a bowl-shaped bulging wall portion bulging toward the direction of the opposite wall portions is formed on one or both of the opposite wall portions of said tube body, the bulging leading ends of said bowl-shaped bulging wall portions are defined as connecting portions linearly protruding and linearly brought into contact with the opposite wall portions and are fixed thereto. However, the extruded portions of the bowl-shaped bulging wall portions are flow blocking points which can not effectively slow down the fluid but cause fluid turbulent leading to poor heat exchanger efficiency.

SUMMARY OF THE INVENTION

[0004] The main purpose of the present invention is to provide a heat exchanger tube to offer a winding flow channel longer than the length of the heat exchanger pipe without disposing turbulent fins to increase heat exchanger efficiency.

[0005] The second purpose of the present invention is to provide a heat exchanger tube to offer a better heat exchanger configuration by rotating the orientation of two opposing flattened surfaces of its flattened pipe.

[0006] According to the present invention, a heat exchanger tube is revealed comprising a flattened pipe having two non-flattened ends connected with a first opening and a second opening. A plurality of first half-slacking narrows and a plurality of second half-slacking narrows are arranged in an interlaced zigzag pattern such that a winding flow channel is formed inside the flattened pipe to increase heat exchange efficiency. In a preferred embodiment, each of the first half-slacking narrows and the second half-slacking narrows consists of a pair of adjacent indentations disposed on one flattened surface of a flattened pipe to achieve a unit body structure of a flattened pipe.

DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** is a three-dimensional view of a heat exchanger tube according to the preferred embodiment of the present invention.

[0008] FIG. **2** is a top view illustrating one of two opposing flattened surfaces of the heat exchanger tube according to the preferred embodiment of the present invention.

[0009] FIG. **3** is a sidewall view of the heat exchanger tube according to the preferred embodiment of the present invention.

[0010] FIG. **4** is an opening side view of the heat exchanger tube illustrating the orientation of the first opening of the heat exchanger tube according to the preferred embodiment of the present invention.

[0011] FIG. **5** is a cross-sectional view illustrating a plurality of heat exchanger tubes installed inside a hot-water heater according to the preferred embodiment of the present invention.

[0012] FIG. **6** is a top view illustrating the heat exchanger tubes installed inside a hot-water heater according to the preferred embodiment of the present invention.

[0013] FIG. **7** is a top view illustrating a plurality of heat exchanger tubes installed inside another hot-water heater according to the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0014] With reference to the attached drawings, the present invention is described by means of the embodiment(s) below where the attached drawings are simplified for illustration purposes only to illustrate the structures or methods of the present invention by describing the relationships between the components and assembly in the present invention. Therefore, the components shown in the figures are not expressed with the actual numbers, actual shapes, actual dimensions, nor with the actual ratio. Some of the dimensions or dimension ratios have been enlarged or simplified to provide a better illustration. The actual numbers, actual shapes, or actual dimension ratios can be selectively designed and disposed and the detail component layouts may be more complicated.

[0015] According to the preferred embodiment of the present invention, a heat exchanger tube is illustrating in FIG. **1** for a three-dimensional view, in FIG. **2** for a top view, in FIG. **3** for a side view, and in FIG. **4** to illustrate the orientation of an opening.

[0016] The heat exchanger tube **100** comprises a flattened pipe **110** having two non-flattened ends connected with a first opening **111** and a second opening **112**, i.e., the diameter or length of the first opening **111** and the second opening **112** is smaller than a flattened width of the flattened pipe **111** but greater than a flattened height of the flattened pipe **111**. In the present embodiment, the first opening **111** and the second opening **112** are circular where the diameter D of the first opening ranges from 19 mm to 26 mm and the flattened width of the flattened pipe **110** ranges from 26 mm to 35 mm.

[0017] Besides, a plurality of first half-slacking narrows **120** and a plurality of second half-slacking narrows **130** are formed in the flattened pipe **110** where the first half-slacking narrows **120** and the second half-slacking narrows **130** are arranged in an interlaced zigzag pattern such that a winding flow channel **140** is formed inside the flattened pipe **110** to increase heat exchange efficiency as shown in FIG. **2** and FIG. **5**. That is to say, one of the first half-slacking narrows **120** is located between two adjacent second half-slacking narrows **130** but not arranged on a straight line, and one of the second half-slacking narrows **130** is located between two adjacent first half-slacking narrows **120** but not arranged on a straight line. Preferably, each one of the second half-slacking narrows **130** is located at a center line between two adjacent first half-slacking narrows **120** and disposed on the opposing sidewall of the flattened pipe **110** away from the first half-slacking

narrows **120** to create a winding flow channel **140** having a regular wave flow inside the flattened pipe **110** to eliminate turbulent. The purposes of the first half-slacking narrows **120** and the second half-slacking narrows **130** are to slow down the flowing speed without blocking the fluid in the flattened pipe **110**. Each of the first half-slacking narrows **120** and the second half-slacking narrows **130** offers a gap S inside the flattened pipe **110** where the gap S is smaller than half of a flow channel height H of the flattened pipe **110** between the two opposing flattened surfaces. The gap S ranges 0.01 mm to 2 mm where the flow channel height H of the flattened pipe **110** ranges from 6 mm to 9 mm. The lengths of the first half-slacking narrows **120** and the second half-slacking narrows **130** perpendicular to the length of the flattened pipe **110** are smaller than the flattened width of the flattened pipe **110** and not smaller than half of the flattened width of the flattened pipe **110**. Moreover, as shown in FIG. **3** and FIG. **4**, the flow channel height H of the flattened pipe **110** is smaller than half of the diameter D of the first opening **111**.

[0018] In a more specific structure, the flattened pipe **110** has a first sidewall **115** and a second sidewall **116** disposed between the edges of the two flattened surfaces **113** and **114** where the first half-slacking narrows **120** are formed on a first line on the flattened surfaces **113**, **114** adjacent to the first sidewall **115** and the second half-slacking narrows **130** are formed on a second line on the flattened surfaces **113**, **114** adjacent to the second sidewall **116**, as shown in FIGS. **1** and **2**.

[0019] As shown in FIG. **3**, in a preferred structure, each of the first half-slacking narrows **120** consists of a pair of corresponding adjacent indentations **121** and **122** disposed on two flattened surfaces **113** and **114** respectively and each of the second half-slacking narrows **130** consists of a pair of corresponding adjacent indentations **131** and **132** disposed on two flattened surfaces **113** and **114** respectively to achieve a unit body structure of the flattened pipe **110** where, as shown in FIG. **2**, the lengths of the first half-slacking narrows **120** formed by the corresponding indentations **121** and **122** and the lengths of the second half-slacking narrows **130** formed by the corresponding indentations **131** and **132** are preferably at least reaching a central line L of the flattened pipe **110**. Each pair of the indentations **121**, **122**, and **131**, **132** have a shape of "I" and perpendicular to the central line L of the flattened pipe **110** where the indentations **121**, **122**, **131**, and **132** can be formed at the same time during flattening the flattened pipe **110** by mold pressing.

[0020] To be more specific, preferably there is no physical contact between each pair of the indentations **121** and **122** and between each pair of the indentations **131** and **132** so that the curve of the winding flow channel **140** can become changeable. When the flowing speed inside the flattened pipe **110** becomes faster, the curve of the winding flow channel **140** has less amplitude to enable faster exhausting of the gases inside the flattened pipe **110**. When the flowing speed inside the flattened pipe **110** becomes slower, the curve of the winding flow channel **140** has larger amplitude to enable longer heat exchanging time of the gases inside the flattened pipe **110**.

[0021] It is different from the conventional heat exchanger tubes where liquid fluid flows through the conventional heat exchanger tubes, however, the heat exchanger tube **100** can specifically flow high-temperature gas more than 120 centigrade degree. A plurality of heat exchanger tubes **100** as mentioned above can be installed inside a hot-water heater **10** where the flattened pipes **110** are installed inside a water tank **11** of the hot-water heater **10** where the first opening **111** is connected to an exhaust pipe **12** of the hot-water heater **10** and the second opening **112** is connected to a combustion chamber **13** of the hot-water heater **10**. The blower **14** of the hot-water heater **10** provides combustion-supporting gases entering through a gas inlet **16** to mix with fuel then burn inside a burner **15** to generate high-temperature gases inside the combustion chamber **12** of the hot-water heater **10** where the high-temperature gases are introduced into the flattened pipe **110** of the heat exchanger pipe **110** through the second openings **112**. Moreover, the flowing of the high-temperature gases is affected by the first half-slacking narrows **120** and the second half-slacking narrows **130** to form the winding flow channel **140**, therefore, the high-temperature gases have sufficient heat exchanged with the water stored inside the water tank **11**. The high-temperature gases are then exhausted from the first opening **111** and flowed to the air-exhaust channel **12** where the temperature of the high-temperature gases will dramatically be reduced and exhausted from the exhaust **17** of the hot-water heater **10**. On the other hand, the stored water in the water tank **11** will be supplied by a cold water inlet **18** and heated through the combustion chamber **13** and the high-efficient heat exchanger pipe **110** and flowed out from the hot-water outlet **19** at the central opening of the water tank **11**. Furthermore, without any limitation, the heat exchanger tubes **100** also can be installed in any known heating devices or preheating devices such as boiler.

[0022] Through the implementation of circular design of the first opening **111** and the second opening **112**, the orientation of the flattened pipes **110** of a plurality of heat exchanger tubes **100** can be adjusted before installed inside a hot-water heater **10** or other heating devices or preheating devices. As shown in FIG. **6**, a plurality of heat exchanger tubes **100** can be installed in a single circle inside the water tank **11** of a hot-water heater **10** where the orientation of the flattened pipes **110** can be adjusted such a way that one of the flattened surfaces of the flattened pipes **110** can be perpendicularly facing to or tilting with an angle facing to the combustion chamber **13** of the hot-water heater **10** to achieve the maximum heat exchanging efficiency. Besides, as shown in FIG. **7**, a plurality of heat exchanger tubes **100** can be installed in multiple circles inside a water tank **11** of another hot-water heater **10'** where the maximum heat exchanging efficiency can be achieved by adjusting the orientation of the flattened pipes **110**.

[0023] The above description of embodiments of this invention is intended to be illustrative but not limited. Other embodiments of this invention will be obvious to those skilled in the art in view of the above disclosure which still will be covered by and within the scope of the present invention even with any modifications, equivalent variations, and adaptations.

What is claimed is:

1. A heat exchanger tube comprising a flattened pipe having two non-flattened ends connected with a first opening and a second opening respectively, wherein there are a plurality of first half-slacking narrows and a plurality of second half-slacking narrows formed in the flattened pipe which are arranged in an interlaced zigzag pattern such that a winding flow channel is formed inside the flattened pipe.

2. The heat exchanger tube as claimed in claim **1**, wherein the flattened pipe has a first sidewall and a second sidewall at two opposing flattened surfaces of the flattened pipe, wherein the first half-slacking narrows are formed on a first line on the

flattened surfaces adjacent to the first sidewall and the second half-slacking narrows are formed on a second line on the flattened surfaces adjacent to the second sidewall.

3. The heat exchanger tube as claimed in claim **2**, wherein each of the first half-slacking narrows and the second half-slacking narrows consists of a pair of adjacent indentations formed on the two opposing flattened surfaces of the flattened pipe respectively.

4. The heat exchanger tube as claimed in claim **3**, wherein the lengths of the indentations at least reach a central line of the flattened pipe.

5. The heat exchanger tube as claimed in claim **3**, wherein the adjacent indentations in pairs are not in a physical contact with each other.

6. The heat exchanger tube as claimed in claim **3**, wherein each pair of the adjacent indentations have a "I" shape and are perpendicular to a central line of the flattened pipe.

7. The heat exchanger tube as claimed in claim **1**, wherein each of the first half-slacking narrows and the second half-slacking narrows offers a gap smaller than half of a flow channel height of the flattened pipe between the two opposing flattened surfaces.

8. The heat exchanger tube as claimed in claim **1**, wherein each of the second half-slacking narrows is located at the center between two adjacent first half-slacking narrows.

9. The heat exchanger tube as claimed in claim **1**, wherein the first opening and the second opening are circular.

10. The heat exchanger tube as claimed in claim **9**, wherein the flow channel height of the flattened pipe is smaller than half of the diameter of the first opening.

11. The heat exchanger tube as claimed in claim **1**, wherein the flattened pipe is installed inside a water tank of a hot-water heater, wherein the first opening is connected to an air-exhaust channel of the hot-water heater and the second opening is connected to a combustion chamber of the hot-water heater.

12. The heat exchanger tube as claimed in claim **1**, wherein a high-temperature gas flows in the flattened pipe.

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