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(54) **HEAT EXCHANGER STRUCTURE**

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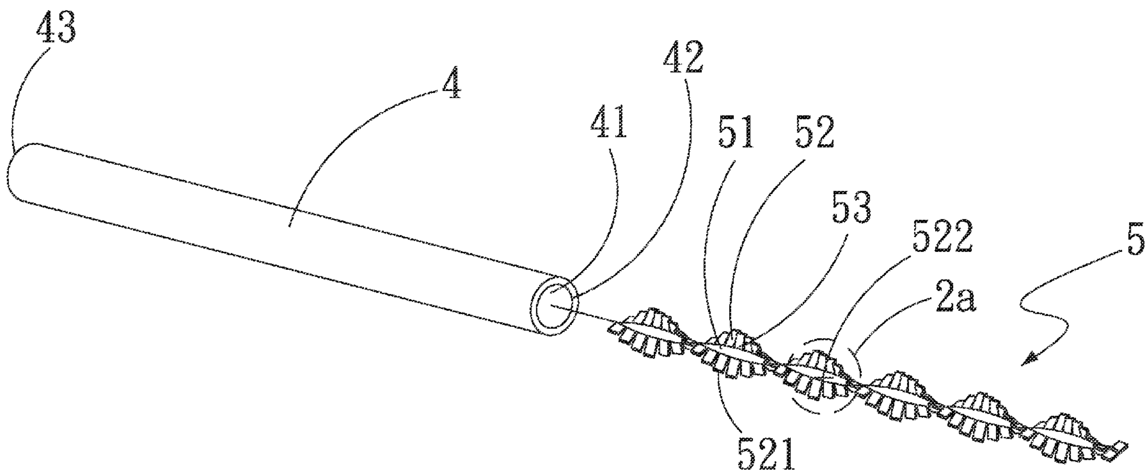
(57) **ABSTRACT**

A heat exchanger structure includes a pipe and a flow-guiding element. The pipe internally defines a chamber, in which the flow-guiding element is disposed. The flow-guiding element includes a helical main body and a plurality of turbulence promoters radially outward extended from two opposite lateral sides of the helical main body. The turbulence promoters are independently arranged on the helical main body with free ends of the turbulence promoters contacting with an inner wall surface of the chamber, so that a fin cooling effect is produced. The turbulence promoters and the helical main body together define at least one flow-guiding section. With the helically distributed turbulence promoters of the flow-guiding element, the heat transfer ability and the thermal performance factor of both laminar and turbulent flows in the pipe can be increased to provide excellent heat transfer effect.



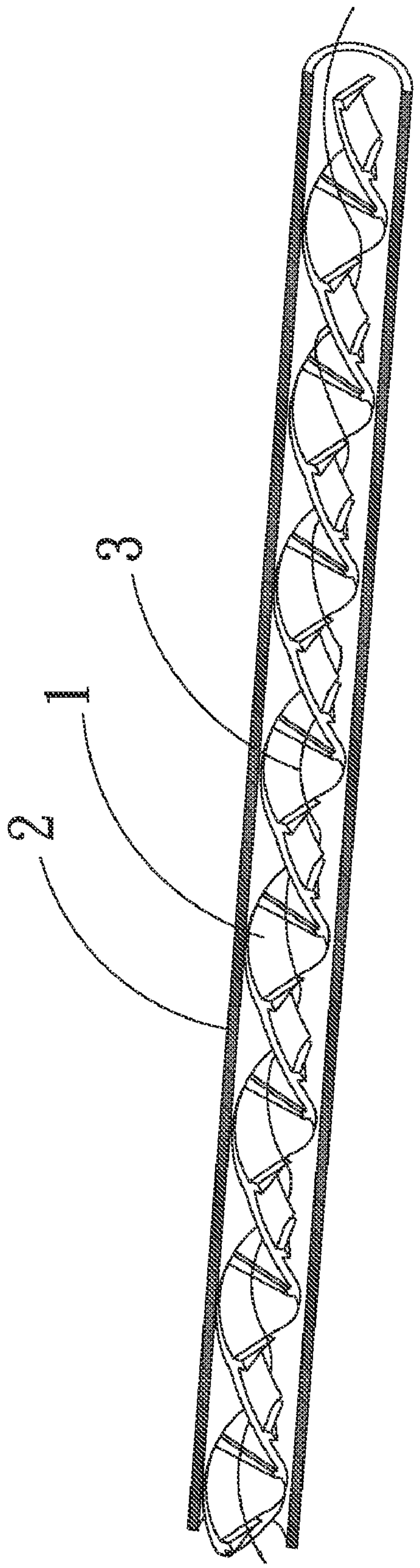


Fig. 1(Prior Art)

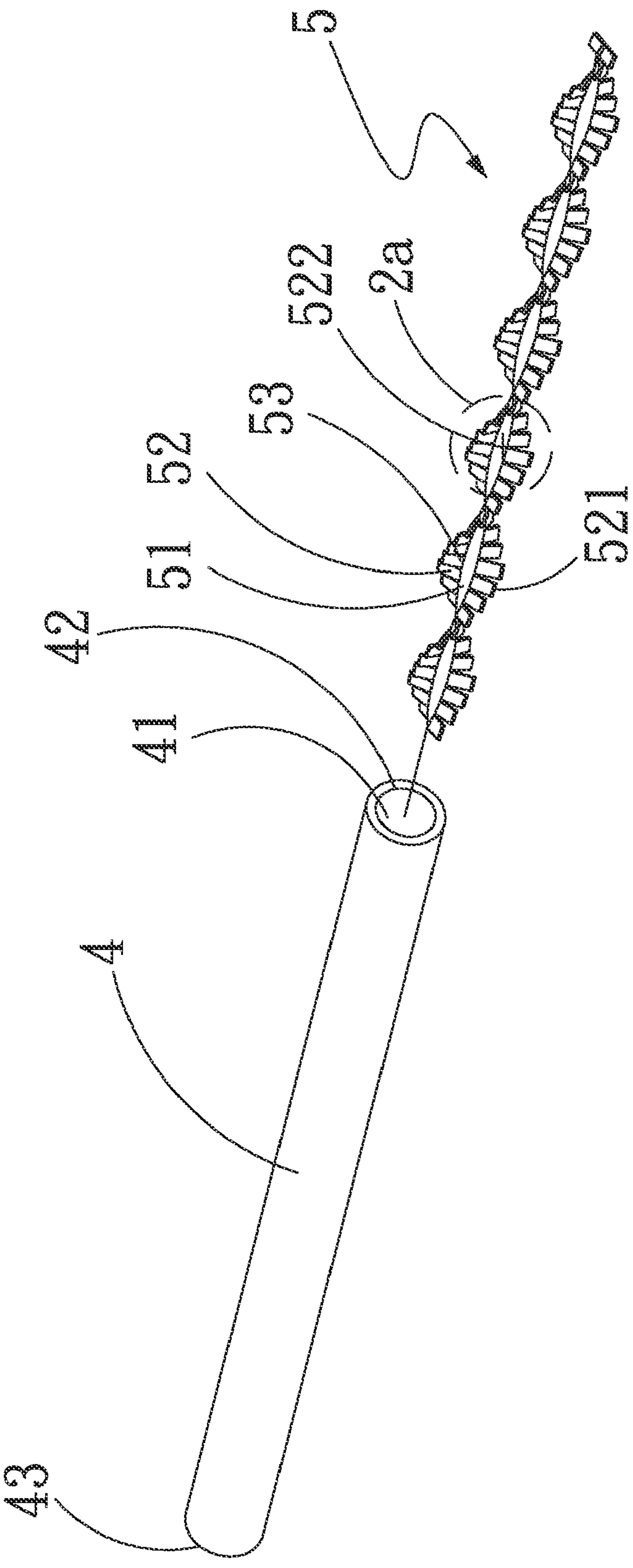


Fig.2

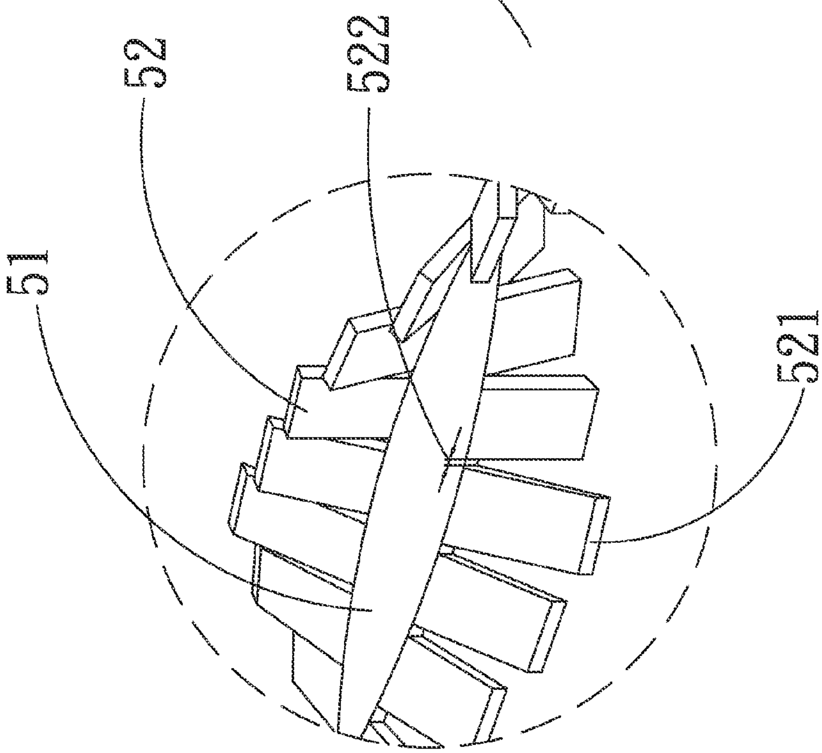


Fig. 2a

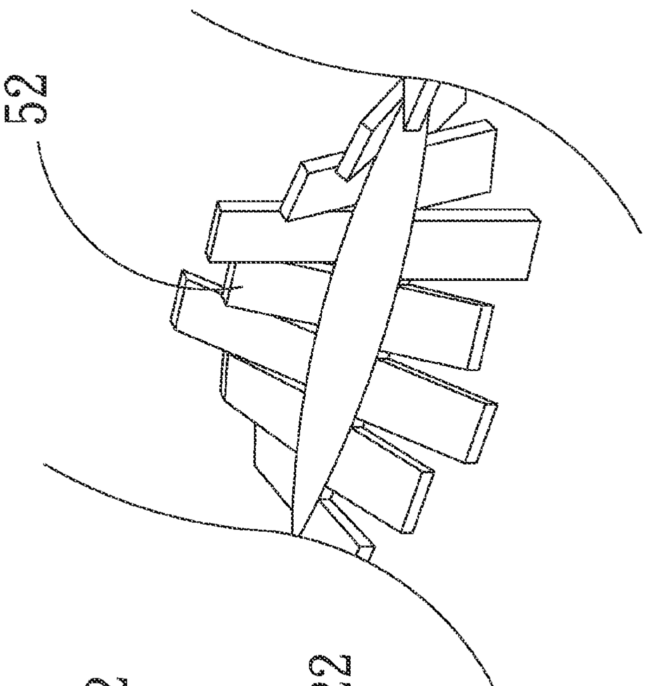


Fig. 2b

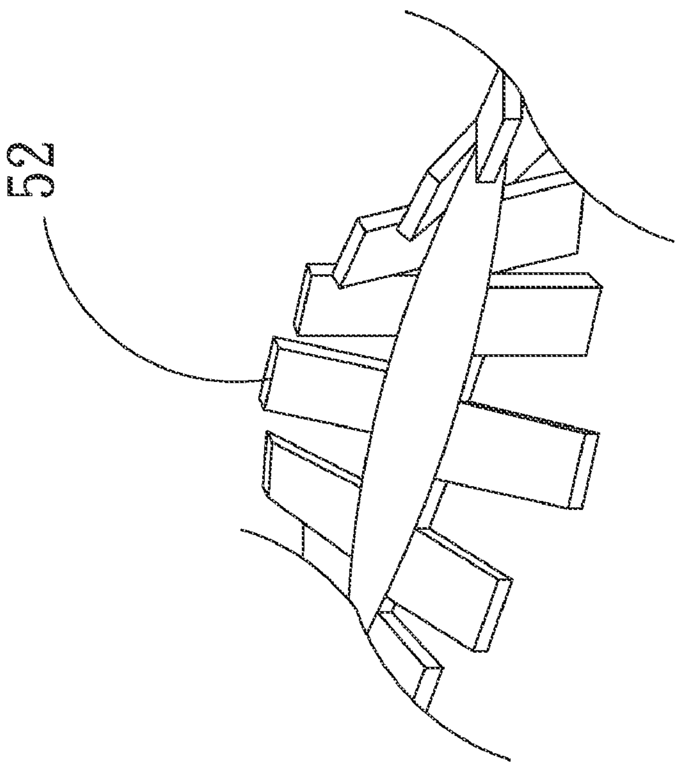


Fig. 2c

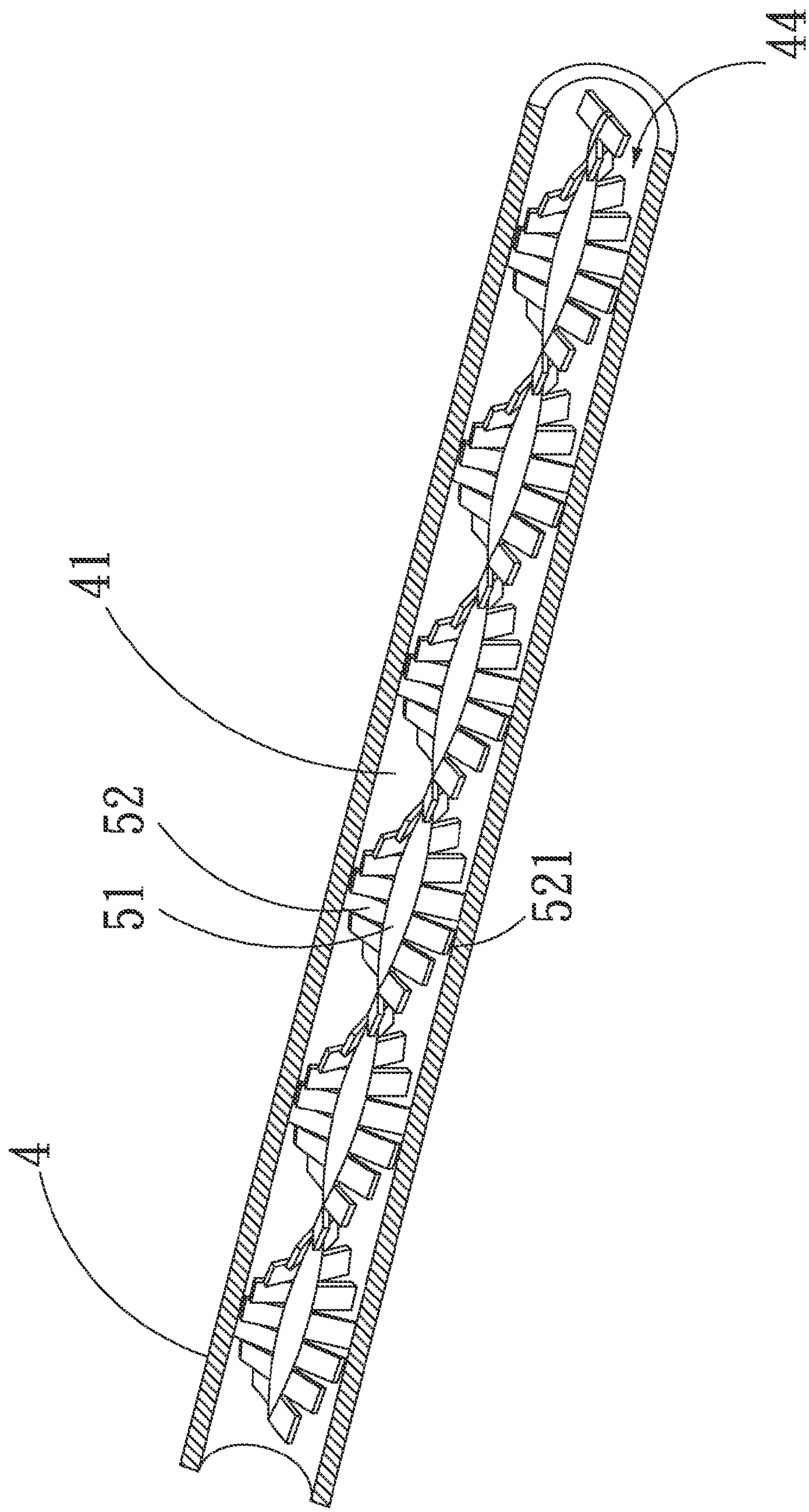


Fig.3

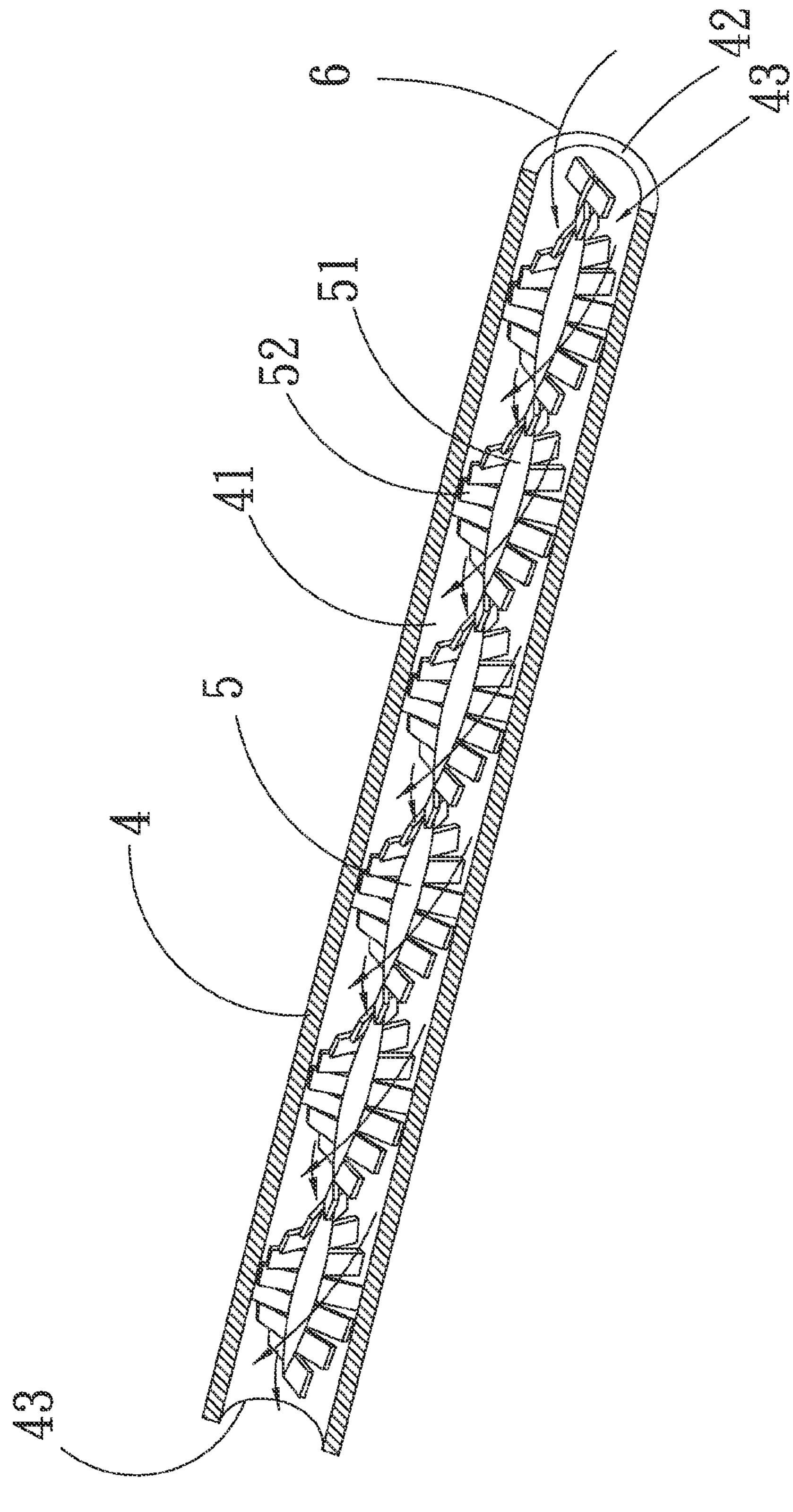


Fig.4

HEAT EXCHANGER STRUCTURE

[0001] This application claims the priority benefit of Taiwan patent application number 098219888 filed on Oct. 28, 2009.

FIELD OF THE INVENTION

[0002] The present invention relates to a heat exchanger structure, and more particularly to a heat exchanger structure that is able to induce swirling flow, increase turbulent intensity, and expand the range of effective Reynolds number enabling enhanced pipe flow heat transfer ability of the conventional heat exchanger internally provided with a twisted tape, so as to further upgrade the conventional smooth-surface twisted tape's ability in enhancing the heat transfer.

BACKGROUND OF THE INVENTION

[0003] To further upgrade the heat transfer enhancing ability and the thermal performance factor of pipe flow, and to expand the range of Reynolds number that enables effectively increased heat transfer coefficient, many ways have been developed and tried, such as dispose a twisted tape in the pipe of the heat exchanger, dispose a continuous twisted tape in a helical undulated pipe, or dispose a twisted tape in a polygonal pipe, or dispose multiple twisted tapes in one conduit.

[0004] It is found the conventional smooth-surface twisted tape is not able to increase the heat transfer ability through increasing turbulent intensity, and the conventional smooth-surface twisted tape has a relatively small range of Reynolds number.

[0005] The Reynolds number gives a measure of the ratio of inertial force to viscous force in flowing fluid. When the Reynolds number is small, the influence of the viscous force on the flow field is larger than that of the inertial force on the flow field, the turbulence in the flow field due to flowing speed reduces with high viscous force, and the stable laminar flow occurs. On the other hand, when the Reynolds number is large, the influence of the inertial force on the flow field is larger than that of the viscous force on the flow field, the unstable turbulent flow occurs, and any minor change in flowing speed tends to develop and intensify to form a turbulent and irregular turbulent flow field.

[0006] FIG. **1** shows a heat exchanger pipe **2** that has a conventional smooth-surface twisted tape **1** disposed therein for the purpose of inducing a swirling flow **3** in the pipe **2** to thereby provide heat transfer coefficient to the flow field in the pipe.

[0007] The swirling flow **3** induced by the conventional smooth-surface twisted tape **1** provides a fluid momentum perpendicular to an inner wall surface of the pipe **2**, and can therefore better enhance the heat transfer in the laminar region in the flow field. However, in the turbulent region, since the fluid has oscillation phenomenon, it already has a fluid momentum perpendicular to the inner wall surface of the pipe **2**. Thus, the conventional smooth-surface twisted tape **1** has relatively weak effect on enhancing the heat transfer in the turbulent flow.

[0008] It is therefore tried by the inventor to develop an improved heat exchanger structure to solve the problems and drawbacks in the conventional heat exchanger with the smooth-surface twisted tape.

SUMMARY OF THE INVENTION

[0009] A primary object of the present invention is to provide a heat exchanger structure that is able to increase the heat transfer ability and the thermal performance factor of both the laminar flow and turbulent flow in the heat exchanger pipe.

[0010] To achieve the above and other objects, the heat exchanger structure according to the present invention includes a pipe and a flow-guiding element. The pipe internally defines a chamber, in which the flow-guiding element is disposed. The flow-guiding element includes a helical main body and a plurality of turbulence promoters radially outward extended from two opposite lateral sides of the helical main body. The turbulence promoters are independently arranged on the helical main body with free ends of the turbulence promoters contacting with an inner wall surface of the chamber, so that a fin cooling effect can be produced. The turbulence promoters and the helical main body together define at least one flow-guiding section in the chamber of the pipe. With the helically distributed turbulence promoters of the flow-guiding element, the heat transfer ability and the thermal performance factor of both laminar and turbulent flows in the pipe can be increased to provide excellent heat transfer effect. Therefore, the present invention provides the following advantages:

[0011] 1. Increases the heat transfer ability and the thermal performance factor of both the laminar and turbulent flows in the pipe.

[0012] 2. Expands the range of effective Reynolds number that enables enhanced heat transfer effect.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The structure and the technical means adopted by the present invention to achieve the above and other objects can be best understood by referring to the following detailed description of the preferred embodiments and the accompanying drawings, wherein

[0014] FIG. **1** is a cutaway view of a conventional heat exchanger;

[0015] FIG. **2** is an exploded perspective view of a heat exchanger structure according to an embodiment of the present invention;

[0016] FIG. **2***a* is an enlarged view of the circled area **2***a* of FIG. **2** showing a first embodiment of the flow-guiding element included in the present invention;

[0017] FIG. **2***b* is a fragmentary perspective view showing a second embodiment of the flow-guiding element included in the present invention;

[0018] FIG. **2***c* is a fragmentary perspective view showing a third embodiment of the flow-guiding element included in the present invention;

[0019] FIG. **3** is a cutaway view of the heat exchanger structure of the present invention; and

[0020] FIG. **4** is a cutaway view showing the flow direction of the fluid in the heat exchanger pipe of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] Please refer to FIGS. **2**, **2***a*-*c*, **3** and **4**. As shown, the heat exchanger structure according to the present invention includes a pipe **4** and a flow-guiding element **5**.

[0022] The pipe **4** internally defines a chamber **41**.

[0023] The flow-guiding element **5** is disposed in the chamber **41**, and includes a helical main body **51**. A plurality of turbulence promoters **52** is radially outward extended from two opposite lateral sides of the helical main body **51**. The turbulence promoters **52** are arranged independently. Each of the turbulence promoters **52** has a free end **521** facing toward an inner wall surface of the chamber **41**. The turbulence promoters **52** and the helical main body **51** together define at least one flow-guiding section **53**.

[0024] The pipe **4** has at least one inlet end **42** and at least one outlet end **43**. A fluid **6** enters the chamber **41** of the pipe **4** via the inlet end **42**.

[0025] The flow-guiding element **5** is disposed in the chamber **41** of the pipe **4** with the free ends of the turbulence promoters **52** of the flow-guiding element **5** in contact with the inner wall surface of the chamber **41**, such that the turbulence promoters **52** and the chamber **41** together define a helical flow path **44** in the pipe **4**. The fluid **6** flows through the helical flow path **44** to induce a swirling flow, which provides heat transfer coefficient to the flow field in the pipe **4**.

[0026] Due to an increased torsion of the main body **51** and the turbulence promoters **52** of the flow-guiding element **5**, the range of effective Reynolds number enabling upgraded heat conduction is increased.

[0027] The turbulence promoters **52** each can be in the form of a plate, a needle (not shown), a bar, or a strip (not shown). In the illustrated embodiment of the present invention, the turbulence promoters **52** are in the form of plates, as can be seen from FIG. **2***a*. However, it is understood the turbulence promoters **52** are not limited to the form of plates, but can be in other forms.

[0028] The turbulence promoters **52** are spaced from one another by a clearance **522**. The turbulence promoters **52** can have the same length, as shown in FIG. **2***a*, or have different lengths, as shown in FIG. **2***b*. Further, the turbulence promoters **52** can be spaced from one another by a uniform clearance **522**, as shown in FIG. **2***a*, or by different clearances **522**, as shown in FIG. **2***c*.

[0029] Please refer to FIG. **4**. The flow-guiding element **5** is disposed in the chamber **41** of the pipe **4**; the fluid **6** flows into the pipe **4** via the inlet end **42** and out of the pipe **4** via the outlet end **43** to conduct heat exchange. When the fluid **6** enters the chamber **41** of the pipe **4** via the inlet end **42**, the helically distributed turbulence promoters **52** of the flow-guiding element **5** enable a shear stress layer formed behind the turbulence promoters **52** to interact with the swirling flow in the main flow field, so that the fluid **6** has increased fluid mixing property and turbulent intensity, which leads to enhanced heat transfer ability and increased pressure loss coefficient. Compared to the average Nusselt number of the conventional smooth-surface twisted-tape tube that is about 1.28-2.4 times as high as the smooth-surface round pipe, the turbulence promoters **52** of the flow-guiding element **5** of the present invention has increased average Nusselt number and heat transfer coefficient in laminar region that is 6.3-9.5 times as high as that of the smooth-surface round pipe.

[0030] Further, with the flow-guiding element **5** of the present invention, the range of effective Reynolds number enabling upgraded heat transfer is wider than that of the conventional continuous smooth-surface twisted tape. Meanwhile, the flow-guiding element **5** has increased torsion to thereby lead to an increased range of effective Reynolds number enabling enhanced heat transfer.

[0031] Moreover, from the analysis result that Fanning pressure loss coefficient changes with the Reynolds number, it is concluded that the flow-guiding element **5** of the present invention is able to suppress the conversion of the flow field from the laminar flow into the turbulent flow in the transition region.

[0032] The turbulence promoters **52** of the flow-guiding element **5** are so designed that they not only provide higher heat transfer enhancing value than the conventional continuous smooth-surface twisted tape, but also enable improved thermal performance factor.

[0033] In the illustrated embodiment of the present invention, the heat transfer ability and the thermal performance factor of the smooth-surface round pipe is increased while only one single flow-guiding element **5** is provided. It is trusted the heat transfer ability and the thermal performance factor of the smooth-surface round pipe can be further increased when more flow-guiding elements **5** are provided (not shown). Moreover, when the torsion for the flow-guiding element **5** is properly selected, it would be able to simultaneously increase the heat transfer ability and the thermal performance factor of both the laminar and turbulent pipe flows.

[0034] The present invention has been described with some preferred embodiments thereof and it is understood that many changes and modifications in the described embodiments, such as any change in the configuration or arrangement of the pipe or the flow-guiding element, can be carried out without departing from the scope and the spirit of the invention that is intended to be limited only by the appended claims.

What is claimed is:

1. A heat exchanger structure, comprising:

a pipe internally defining a chamber; and

a flow-guiding element being disposed in the chamber; the flow-guiding element including a helical main body and a plurality of turbulence promoters radially outward extended from two opposite lateral sides of the helical main body; the turbulence promoters being independently arranged, and each having a free end facing toward and contacting with an inner wall surface of the chamber; and the turbulence promoters and the helical main body together defining at least one flow-guiding section.

2. The heat exchanger structure as claimed in claim **1**, wherein the turbulence promoters are selected from the group consisting of plate-shaped, needle-shaped, bar-shaped, and strip-shaped turbulence promoters.

3. The heat exchanger structure as claimed in claim **1**, wherein the flow-guiding element and the chamber together define a helical flow path in the pipe.

4. The heat exchanger structure as claimed in claim **1**, wherein the turbulence promoters are spaced from one another by a clearance.

5. The heat exchanger structure as claimed in claim **1**, wherein the turbulence promoters are the same in length.

6. The heat exchanger structure as claimed in claim **1**, wherein the turbulence promoters are different in length.

7. The heat exchanger structure as claimed in claim **1**, wherein the turbulence promoters are spaced from one another by a uniform clearance.

8. The heat exchanger structure as claimed in claim **1**, wherein the turbulence promoters are spaced from one another by different clearances.

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