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(54) **REFRIGERANT TUBE FOR HEAT EXCHANGERS**

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(57) **ABSTRACT**

A refrigerant tube for heat exchangers is disclosed. The refrigerant tube has an outer diameter of not larger than 5.3 mm, with a plurality of internal spiral fins formed on the inner surface of the refrigerant tube. The refrigerant tube has a thickness of 0.16 mm~0.2 mm. The internal spiral fins are set in their number to 40~50, and each have a height of 0.15 mm~0.18 mm, a projection angle of 38°~42°, and a spiral angle of 6°~20°. Due to the internal spiral fins in addition to the reduced outer diameter of the refrigerant tube, the tube reduces the production cost of heat exchangers and accomplishes the recent trend of compactness of the heat exchangers. The tube also has several advantages expected from small-diameter refrigerant tubes, such as a reduction in air-side pressure loss, and improves heat transfer efficiency of the heat exchangers. This refrigerant tube thus enhances the heat exchange operational performance of the heat exchangers.

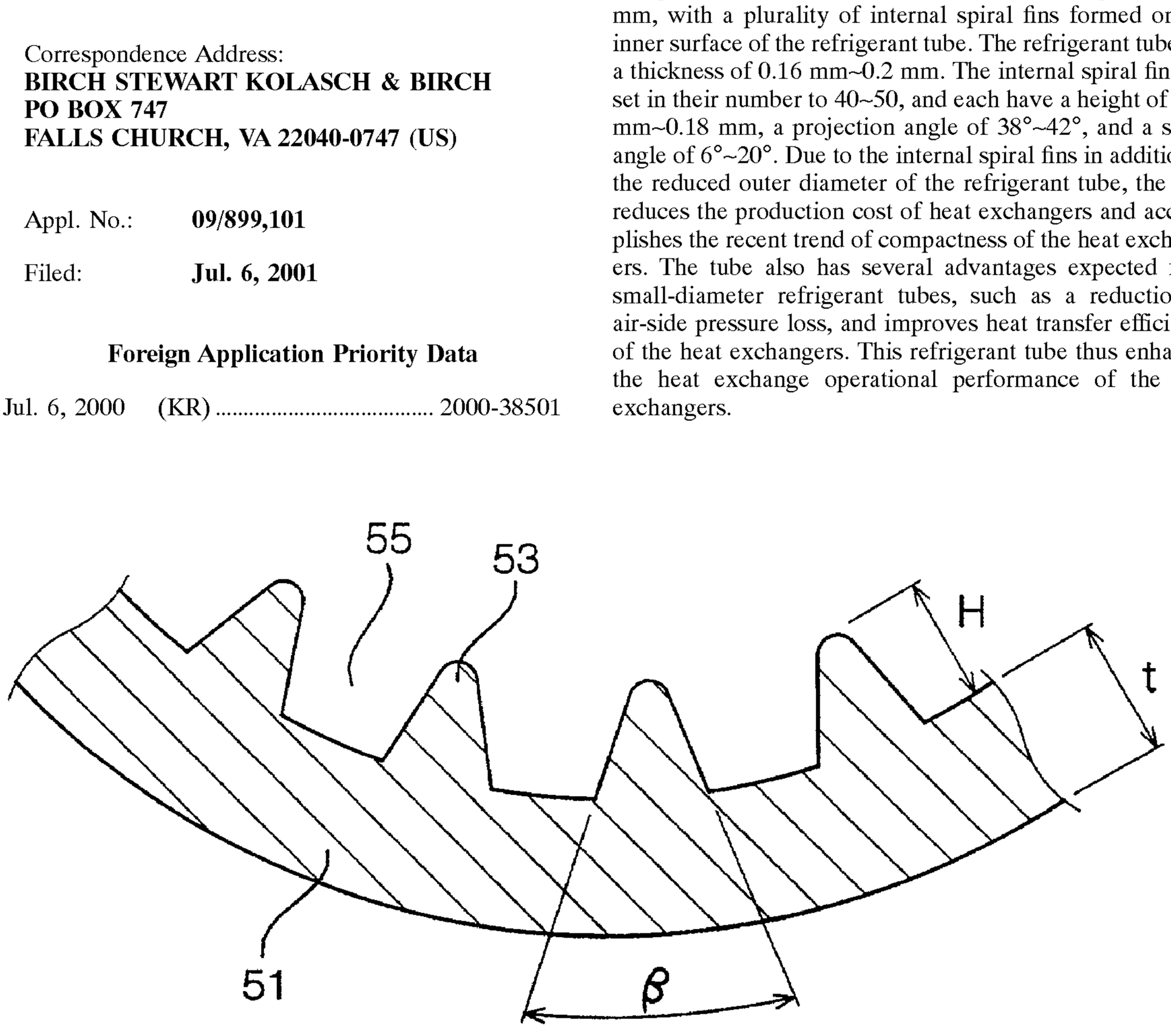


FIG.1(Prior Art)

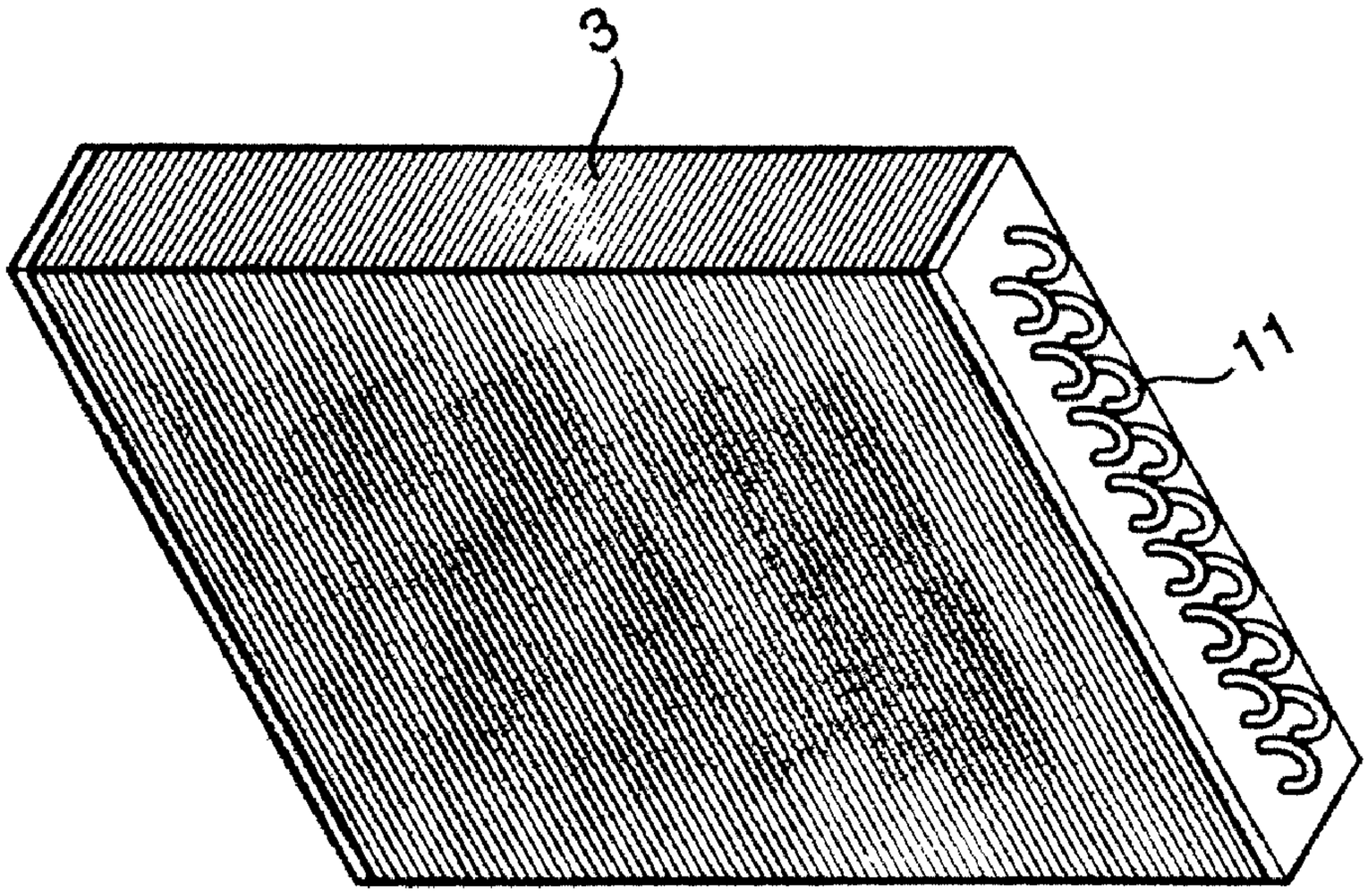


FIG.2(Prior Art)

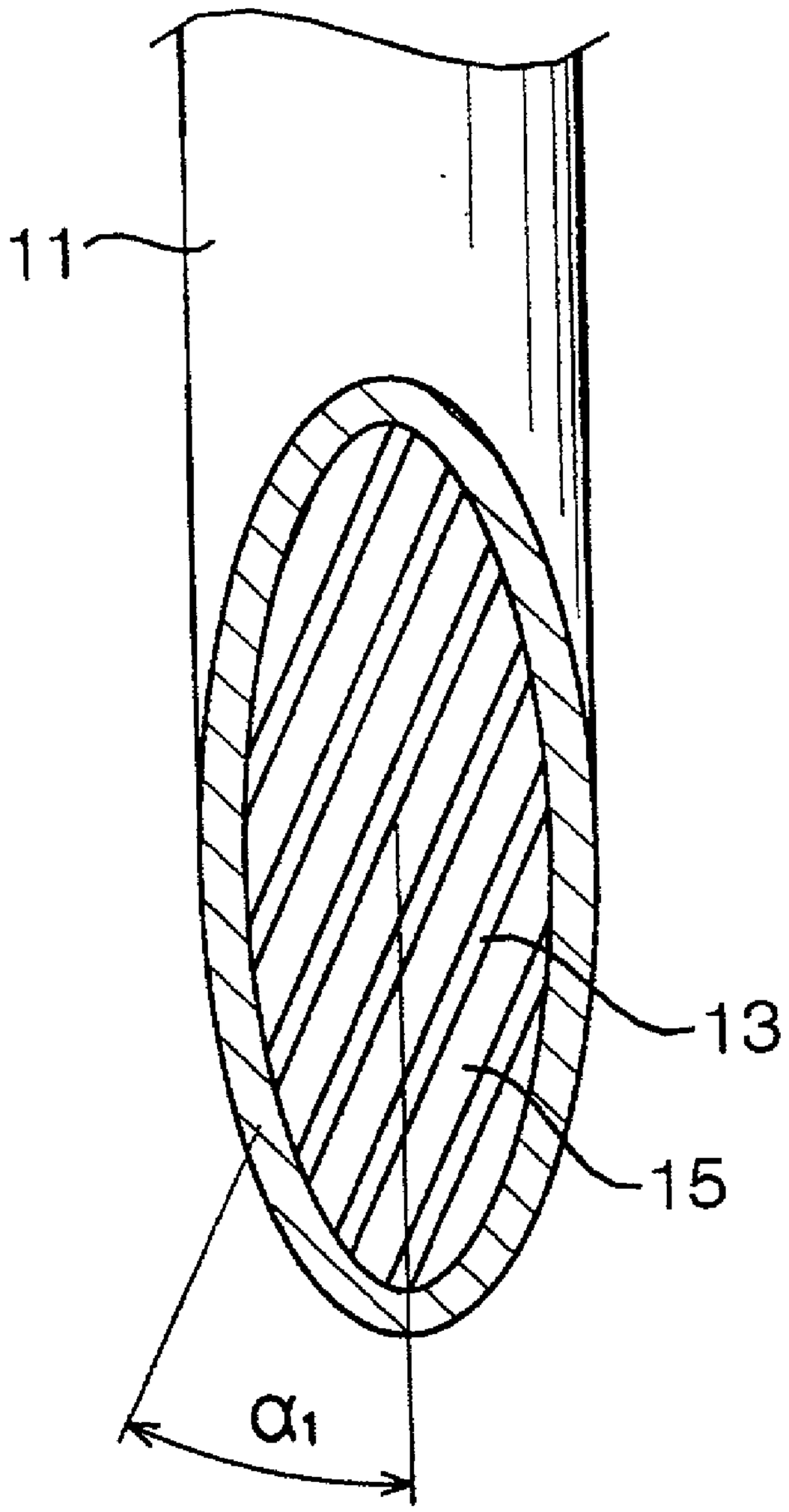


FIG.3(Prior Art)

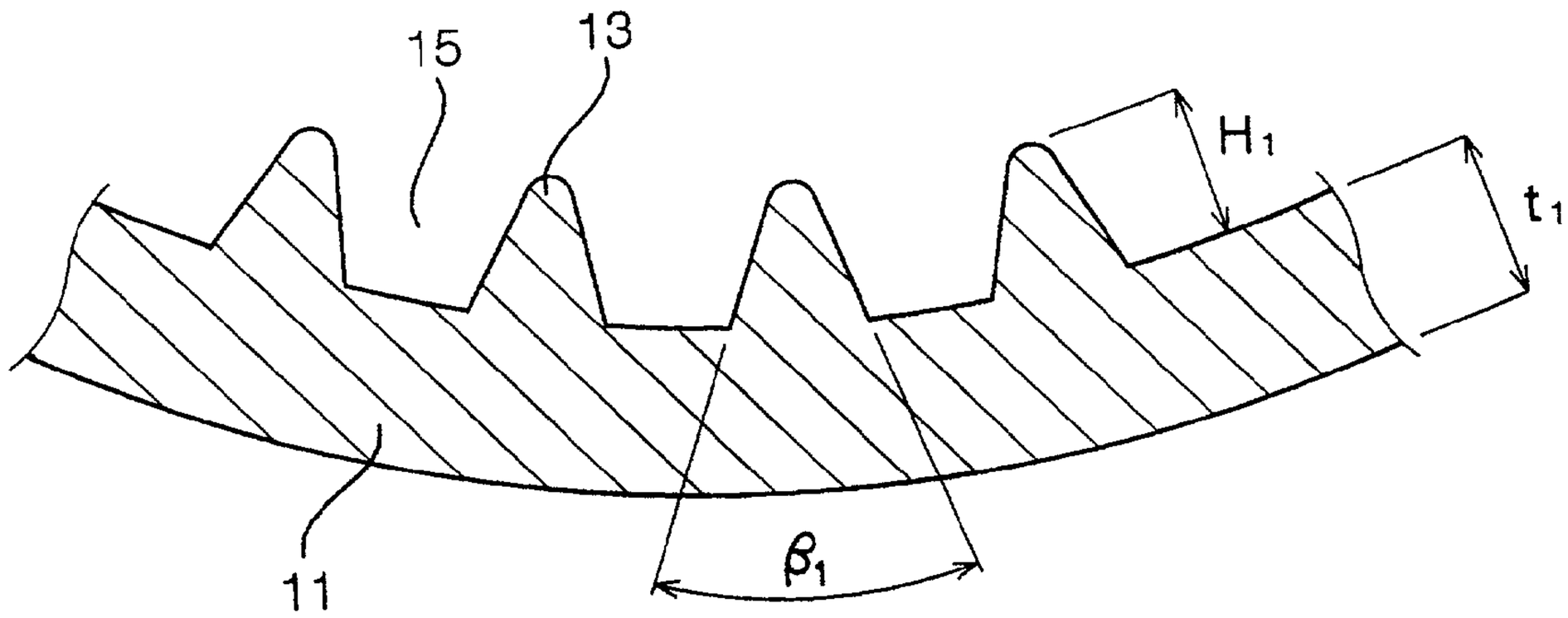


FIG. 4

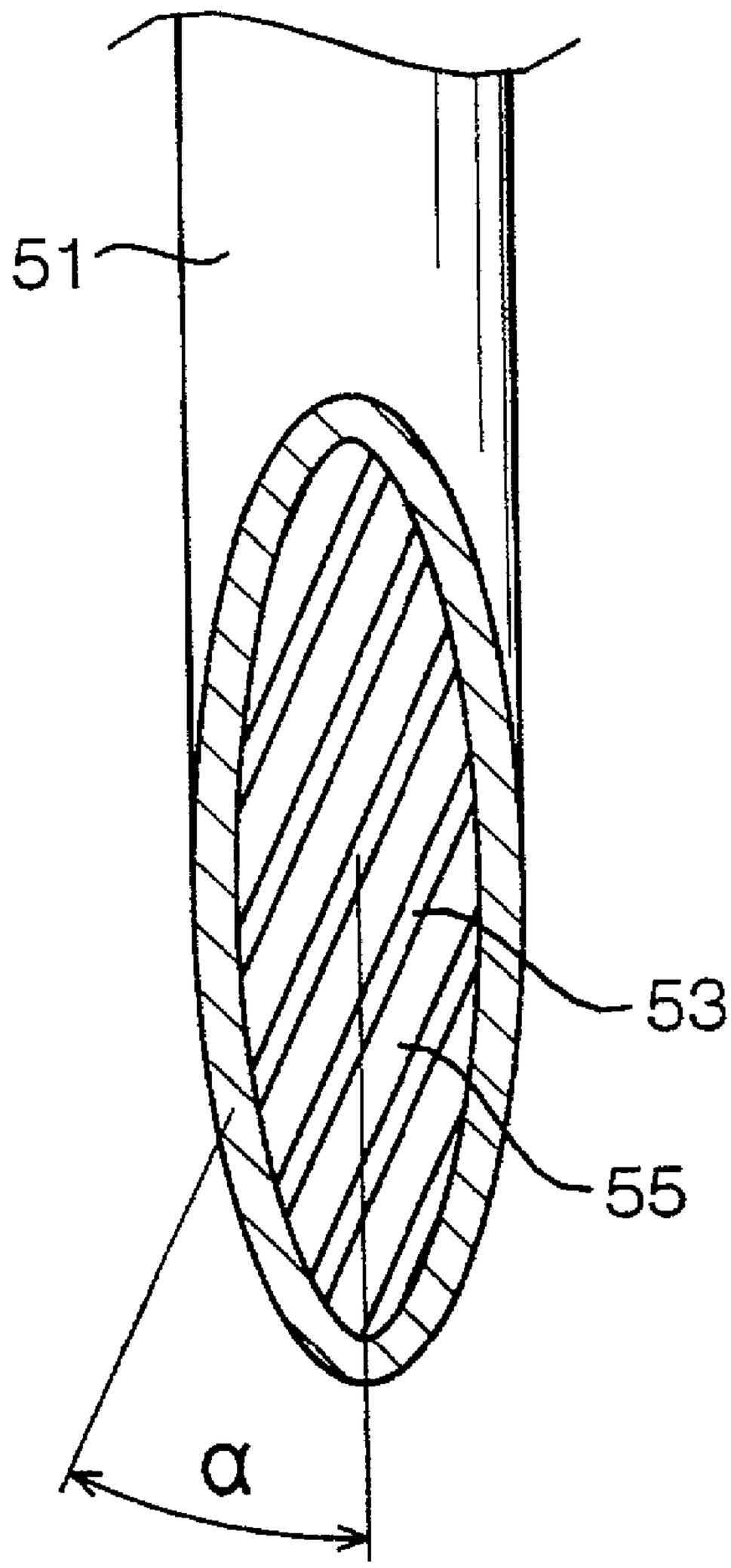
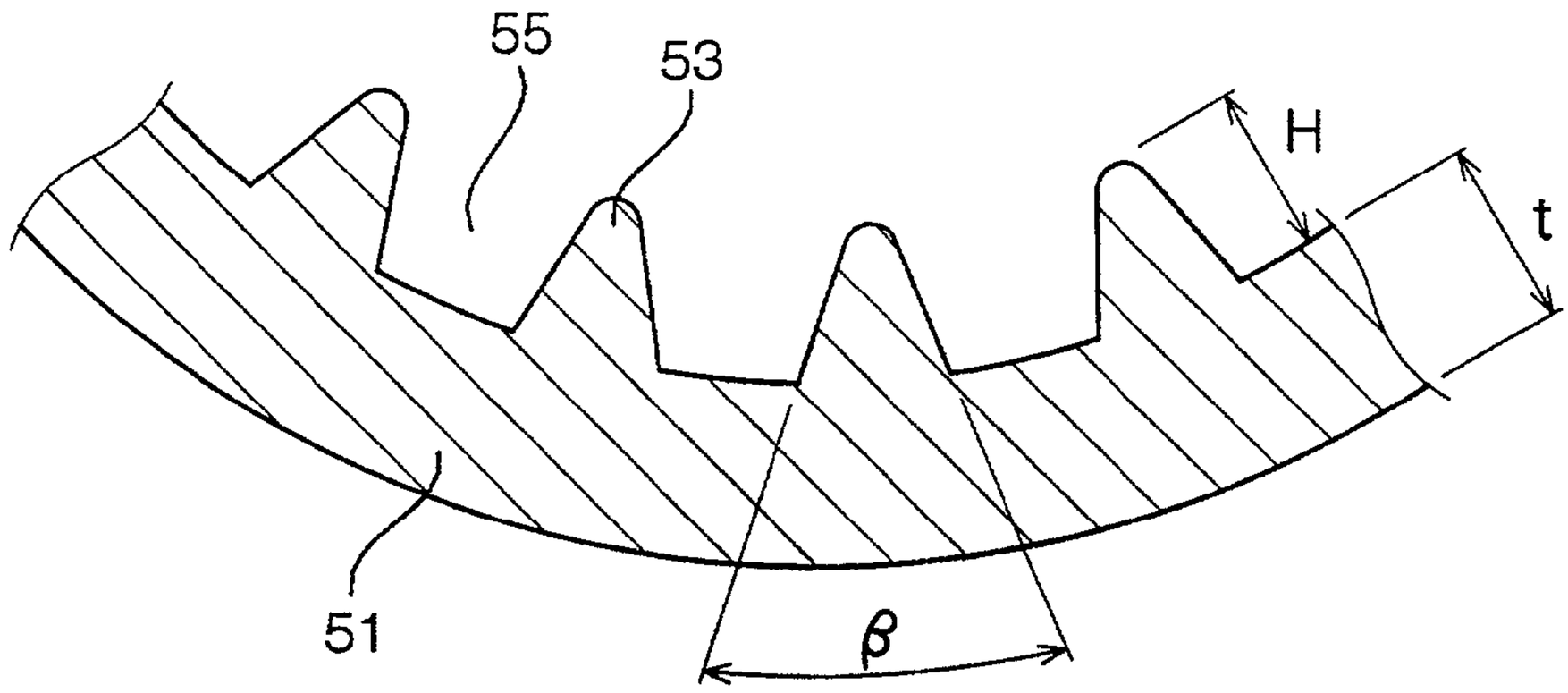


FIG.5



REFRIGERANT TUBE FOR HEAT EXCHANGERS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a refrigerant tube for heat exchangers and, more particularly, to a refrigerant tube for heat exchangers of air conditioning systems, provided with a plurality of internal spiral fins on its inner surface for improving its heat exchange effect.

[0003] 2. Description of the Prior Art

[0004] **FIG. 1** is a perspective view of a conventional heat exchanger for air conditioning systems. As shown in the drawing, the conventional heat exchanger comprises a refrigerant tube **11** and a plurality of air guide fins **3**. The refrigerant tube **11** is regularly bent to form a zigzag-shaped tube assembly. This tube **11** forms a refrigerant passage of the heat exchanger. The air guide fins **3** are vertically arranged at regular intervals, with the linear parts of the zigzagged refrigerant tube **11** passing through the fins **3**. During an operation of the heat exchanger, refrigerant flowing in the refrigerant tube **11** absorbs or dissipates heat from or to air currents flowing around the tube **11**.

[0005] As shown in **FIGS. 2 and 3**, the conventional refrigerant tube **11** for such heat exchangers has an outer diameter of 7 mm or 9 mm, with a plurality of internal spiral fins **13** regularly formed on the inner surface of the tube **11** while defining a plurality of grooves **15** between them. The internal fins **13** and grooves **15** enlarge the heat transferring surface area of the tube **11**, in addition to agitating the thermal boundary layer inside the refrigerant flowing in the tube **11**. Therefore, the fins **13** and grooves **15** promote heat transfer between the refrigerant inside the tube **11** and air currents outside the tube **11**, thus improving the heat exchange effect of the heat exchanger.

[0006] In a detailed description, the fins **13** and grooves **15** enlarge the internal surface area of the tube **11**, at which the tube **11** comes into contact with liquid or gas refrigerant. The fins **13** and grooves **15** also produce capillary effect and shear flow in refrigerant flowing in the tube **11** at a low flow rate, thus increasing the turbulent intensity of the liquid layer in the tube **11**. In such a case, the internal surface area of the tube **11**, and the turbulent intensity and thickness of the liquid layer in the tube **11** vary in accordance with the number and shape of the fins **13**.

[0007] While designing such refrigerant tubes **11** for heat exchangers, it is necessary to predetermine the optimal design factors of the internal fins **13**, such as the number, height, projecting angle and spiral angle of the fins **13**.

[0008] In the prior art, a standard method of predetermining the design factors of such internal fins of refrigerant tubes has not been proposed, but the internal fins have been designed in accordance with an optimal combination of design factors obtained from repeated tests.

[0009] That is, the tests are performed while changing the design factors of the internal fins under a variety of expected conditions, such as the quantity and kind of refrigerant and environmental conditions, so as to produce an optimal combination of the design factors.

[0010] The conventional refrigerant tube **11** for heat exchangers designed through the above-mentioned process has an outer diameter of 7 mm or 9 mm and a thickness (t_1) of 0.27 mm, with sixty internal fins **13** each having a height (H_1) of 0.15 mm, a projection angle (β_1) of 56°, and a spiral angle (α_1) of 18°.

[0011] In recent years, it is desired to reduce the outer diameter of the refrigerant tube **11** in an effort to reduce the production cost and air-side pressure loss of the tube **11**.

[0012] When the above-mentioned design factors of the fins **13** are applied to a refrigerant tube **11**, having such a reduced outer diameter, without changing the design factors of the fins **13**, the refrigerant-side pressure loss of the tube **11** is undesirably increased, thus reducing the heat exchange efficiency of the tube **11**. In addition, the above-mentioned design factors of the internal fins **13** exceed design limits of fins that can be practically formed on the tube **11** having such a reduced outer diameter, and so it is almost impossible to produce a desired refrigerant tube, having such a reduced outer diameter and provided with fins **13** having such design factors.

[0013] The conventional refrigerant tube **11** is designed without considering the use of newly proposed alternative refrigerant in place of typical refrigerant, and so the tube **11** used with such alternative refrigerant cannot perform its designed operational function due to pressure loss and heat transfer coefficient of the alternative refrigerant which are different from those of the typical refrigerant.

[0014] Therefore, it is necessary to propose a refrigerant tube, which has a reduced outer diameter and internal fins having optimally designed number and shape, thus reducing the pressure loss of refrigerant and improving the heat transfer characteristics of the refrigerant, such as heat transfer coefficient.

SUMMARY OF THE INVENTION

[0015] Accordingly, the present invention has been made keeping in mind the above problems occurring in the prior art, and an object of the present invention is to provide a refrigerant tube for heat exchangers, which has a desirably reduced outer diameter, in addition to internal fins having optimal design factors preferably compatible with the reduced outer diameter of the tube, and which thus reduces the production cost of the heat exchangers and accomplishes the recent trend of compactness of the heat exchangers, and which has several advantages expected from small-diameter refrigerant tubes, such as a reduction in air-side pressure loss, and which improves heat transfer efficiency of the heat exchangers, and enhances the heat exchange operational performance of the heat exchangers.

[0016] In order to accomplish the above object, the present invention provides a refrigerant tube assembled with a plurality of air guide fins in a heat exchanger, wherein the refrigerant tube has an outer diameter of not larger than 5.3 mm, with a plurality of internal spiral fins formed on the inner surface of the refrigerant tube.

[0017] The refrigerant tube has a thickness of 0.16 mm~0.2 mm.

[0018] In addition, the internal spiral fins are set in their number to 40~50, and each have a height of 0.15 mm~0.18 mm, a projection angle of 38°~42°, and a spiral angle of 6°~20°.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

[0020] **FIG. 1** is a perspective view of a conventional heat exchanger;

[0021] **FIG. 2** is a broken view of a conventional refrigerant tube for heat exchangers, showing the interior of the tube;

[0022] **FIG. 3** is a sectional view of a part of the conventional refrigerant tube for heat exchangers;

[0023] **FIG. 4** is a broken view of a refrigerant tube for heat exchangers in accordance with the preferred embodiment of the present invention, showing the interior of the tube; and

[0024] **FIG. 5** is a sectional view of a part of the refrigerant tube of this invention.

DETAILED DESCRIPTION OF THE INVENTION

[0025] Reference now should be made to the drawings, in which the same reference numerals are used throughout the different drawings to designate the same or similar components.

[0026] **FIG. 4** is a broken view of a refrigerant tube for heat exchangers in accordance with the preferred embodiment of the present invention, showing the interior of the tube. **FIG. 5** is a sectional view of a part of the refrigerant tube.

[0027] As shown in the drawings, the refrigerant tube **51** according to the present invention is used in a heat exchanger for air conditioning systems, which consists of a plurality of air guide fins (not shown) vertically arranged at regular intervals, with the linear parts of the refrigerant tube **51** passing through the air guide fins. The refrigerant tube **51** of this invention has an outer diameter of not larger than 5.3 mm, with a plurality of internal spiral fins **53** formed on the inner surface of the tube **51** while defining a plurality of grooves **55** between them.

[0028] The tube **51** has a thickness (t) of 0.16 mm~0.2 mm, while the number of the internal fins **53** is set to 40~50. In addition, the internal fins **53** each have a spiral angle (α) of 6°~20°, a height (H) of 0.15 mm~0.18 mm, and a projection angle (β) of 38°42°.

[0029] In the present invention, the spiral angle (α) of the internal fins **53** is preferably set to 6°~10° or 16°~20°.

[0030] In comparison with a heat exchanger using a conventional refrigerant tube **11** having an outer diameter of 7 mm or 9 mm, a heat exchanger using the refrigerant tube **51** of this invention having a reduced outer diameter of 5.3 mm is increased in its refrigerant-side pressure loss at the same flow rate of refrigerant, but is reduced in the thickness (t) of its refrigerant tube **51**. The internal fins **53** of the tube **51** according to this invention are designed such that they are optimally compatible with the reduced outer diameter of the tube **51**, while considering both the increased refrigerant-side pressure loss and the reduced tube thickness (t). It is noted that the refrigerant-side pressure loss of the refrigerant tube **51** according to this invention is preferably reduced to improve the heat exchange operational performance of the heat exchanger. In addition, it is possible for manufacturers of such heat exchangers to easily manage the allowance of the internal fins **53** during a process of producing the refrigerant tubes **51**.

[0031] In addition, the refrigerant tube **51** having the internal fins **53** of this invention can easily use alternative refrigerant in place of typical refrigerant without changing the dimension of the tube **51** or the internal fins **53** since the fins **53** are designed in consideration of a change in the pressure loss and heat transfer coefficient in the case of replacing typical refrigerant with alternative refrigerant.

[0032] As described above, the present invention provides a refrigerant tube for heat exchangers. The tube of this invention has a desirably reduced outer diameter, in addition to internal fins having optimal design factors preferably compatible with the reduced outer diameter of the tube. This tube thus reduces the production cost of heat exchangers and accomplishes the recent trend of compactness of the heat exchangers, in addition to having several advantages expected from small-diameter refrigerant tubes, such as a reduction in air-side pressure loss. The refrigerant tube of this invention also improves heat transfer efficiency of the heat exchangers, and enhances the heat exchange operational performance of the heat exchangers.

[0033] In addition, since the internal fins of this invention are designed such that they are compatible with a small-diameter refrigerant tube, the tube optimally reduces refrigerant-side pressure loss. It is also possible for manufacturers of the heat exchangers for air conditioning systems to easily manage the allowance of the internal fins during a process of producing the refrigerant tubes.

[0034] Although a preferred embodiment of the present invention has been described for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

What is claimed is:

1. A refrigerant tube assembled with a plurality of air guide fins in a heat exchanger, wherein said refrigerant tube has an outer diameter of not larger than 5.3 mm, with a plurality of internal spiral fins formed on an inner surface of said refrigerant tube.

2. The refrigerant tube according to claim 1, wherein a thickness of said refrigerant tube is set to 0.16 mm~0.2 mm.

3. The refrigerant tube according to claim 1, wherein said internal spiral fins are set in their number to 40~50, and each have a height of 0.15 mm~0.18 mm, a projection angle of 38°~42°, and a spiral angle of 6°~20°.

4. The refrigerant tube according to claim 3, wherein said spiral angle of the internal spiral fins is set to 6°~10°.

5. The refrigerant tube according to claim 3, wherein said spiral angle of the internal spiral fins is set to 16°~20°.

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