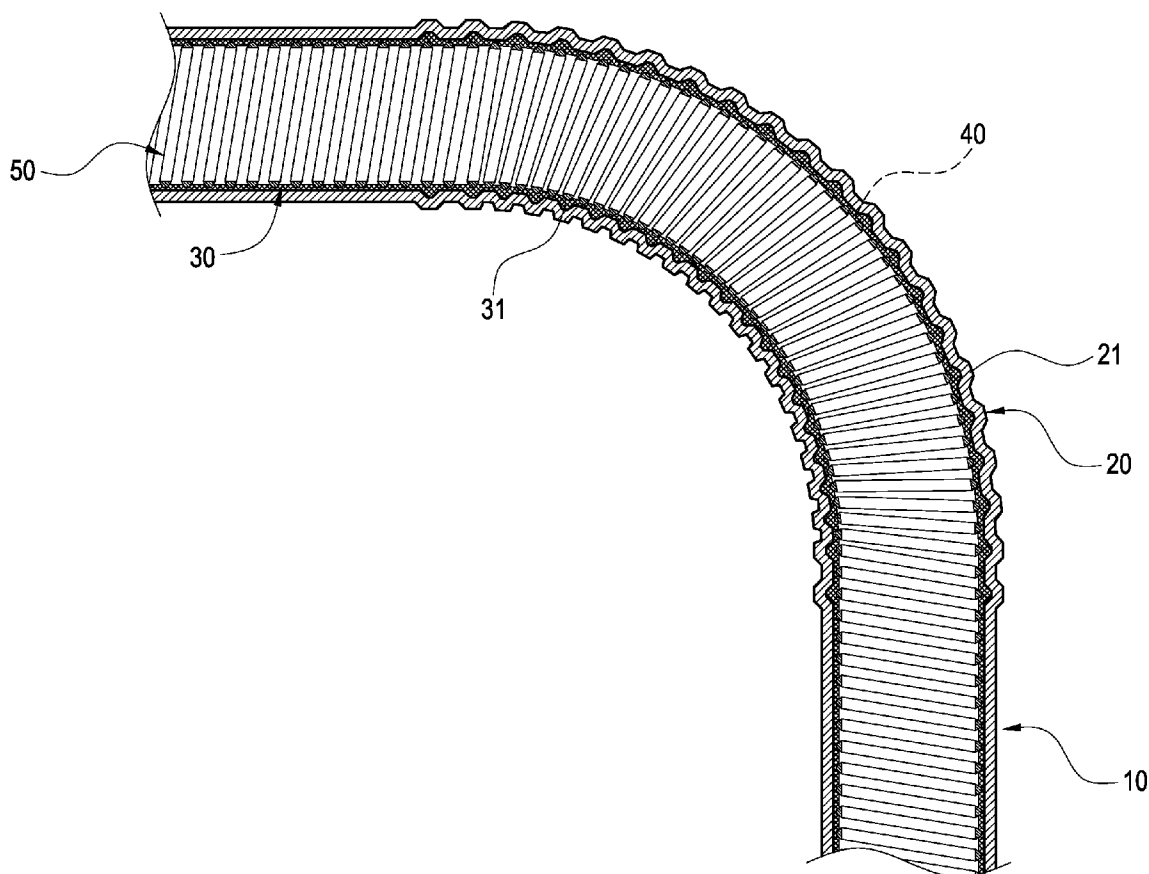




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(19) **United States**(12) **Patent Application Publication**
Meyer, IV et al.(10) **Pub. No.: US 2011/0088874 A1**(43) **Pub. Date: Apr. 21, 2011**(54) **HEAT PIPE WITH A FLEXIBLE STRUCTURE**(52) **U.S. Cl. 165/104.26**(76) **Inventors:** **George Anthony. Meyer, IV**, San Jose, CA (US); **Chien-Hung Sun**, Zhongli City (TW); **Chieh-Ping Chen**, Zhongli City (TW)(21) **Appl. No.: 12/582,328**(22) **Filed: Oct. 20, 2009****Publication Classification**(51) **Int. Cl.**
F28D 15/04 (2006.01)(57) **ABSTRACT**

A heat pipe includes a metal pipe, a flexible structure, a woven mesh, a working fluid, and a support element. The flexible structure is formed on the metal pipe, and the woven mesh is disposed inside the metal pipe, and the working fluid is filled into the metal pipe and attached onto the woven mesh, and the support element is passed into the woven mesh, such that the heat pipe can be bent into a desired shape manually by an easy way according to actual using requirements.



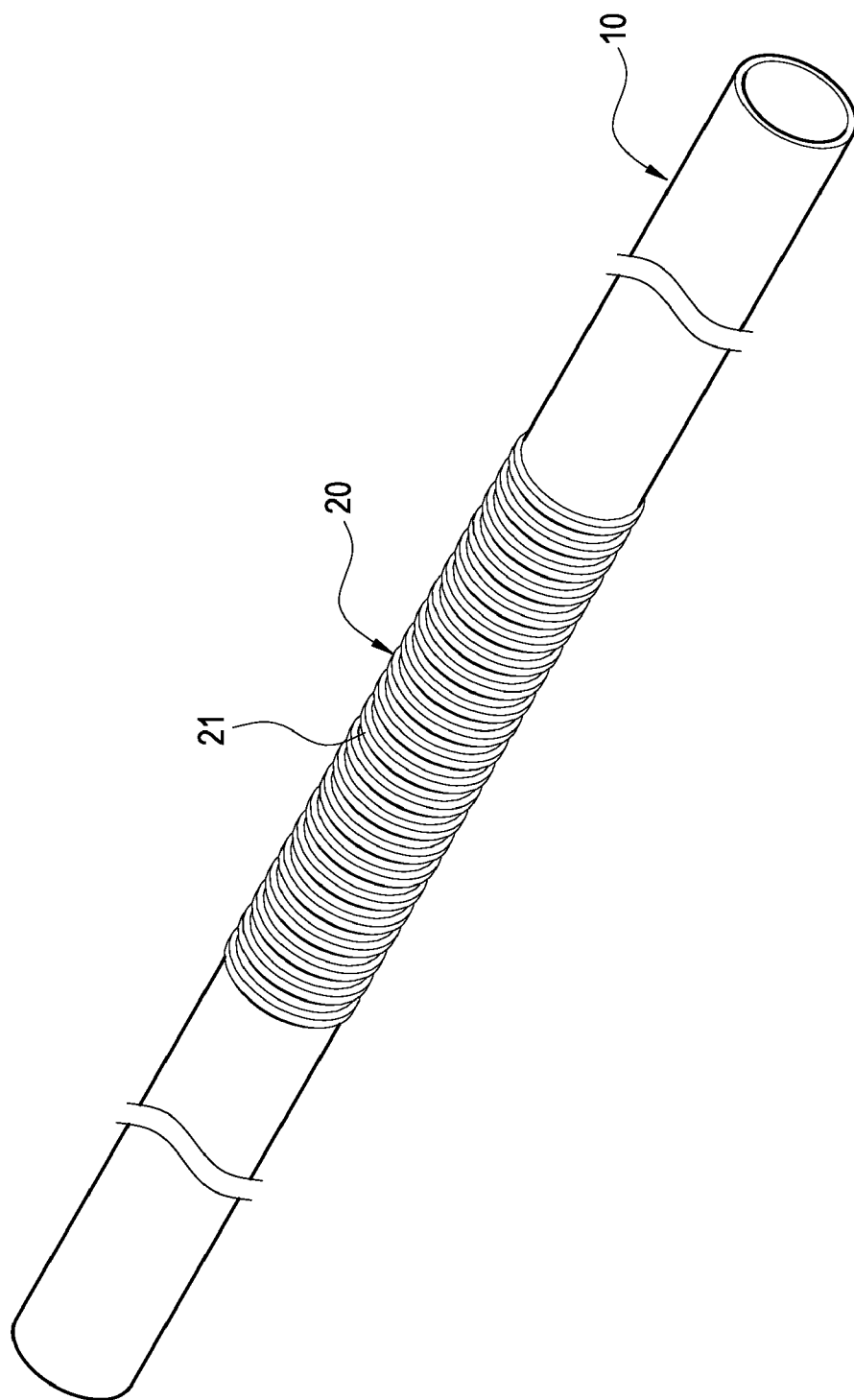


FIG. 1

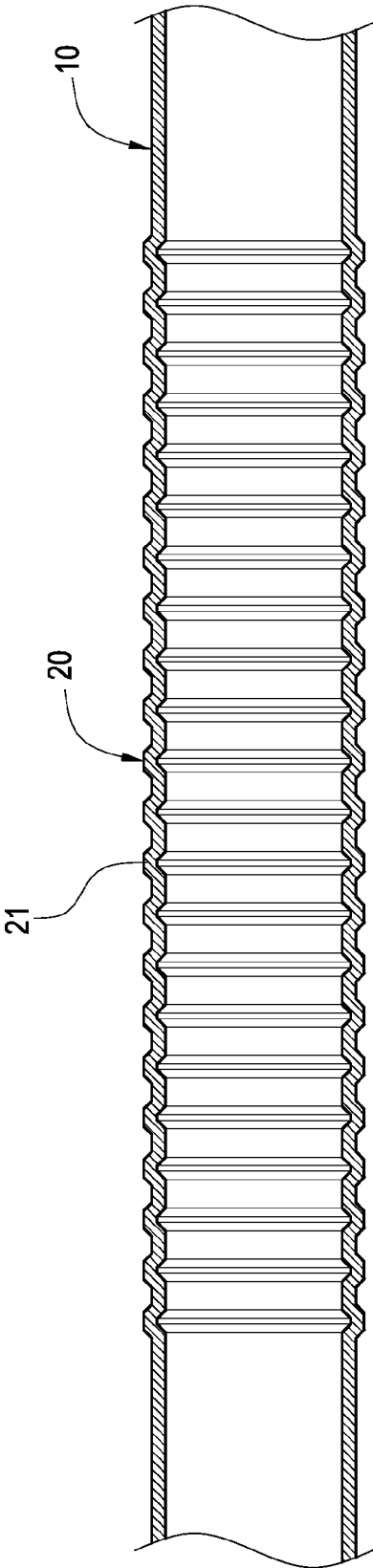


FIG.2

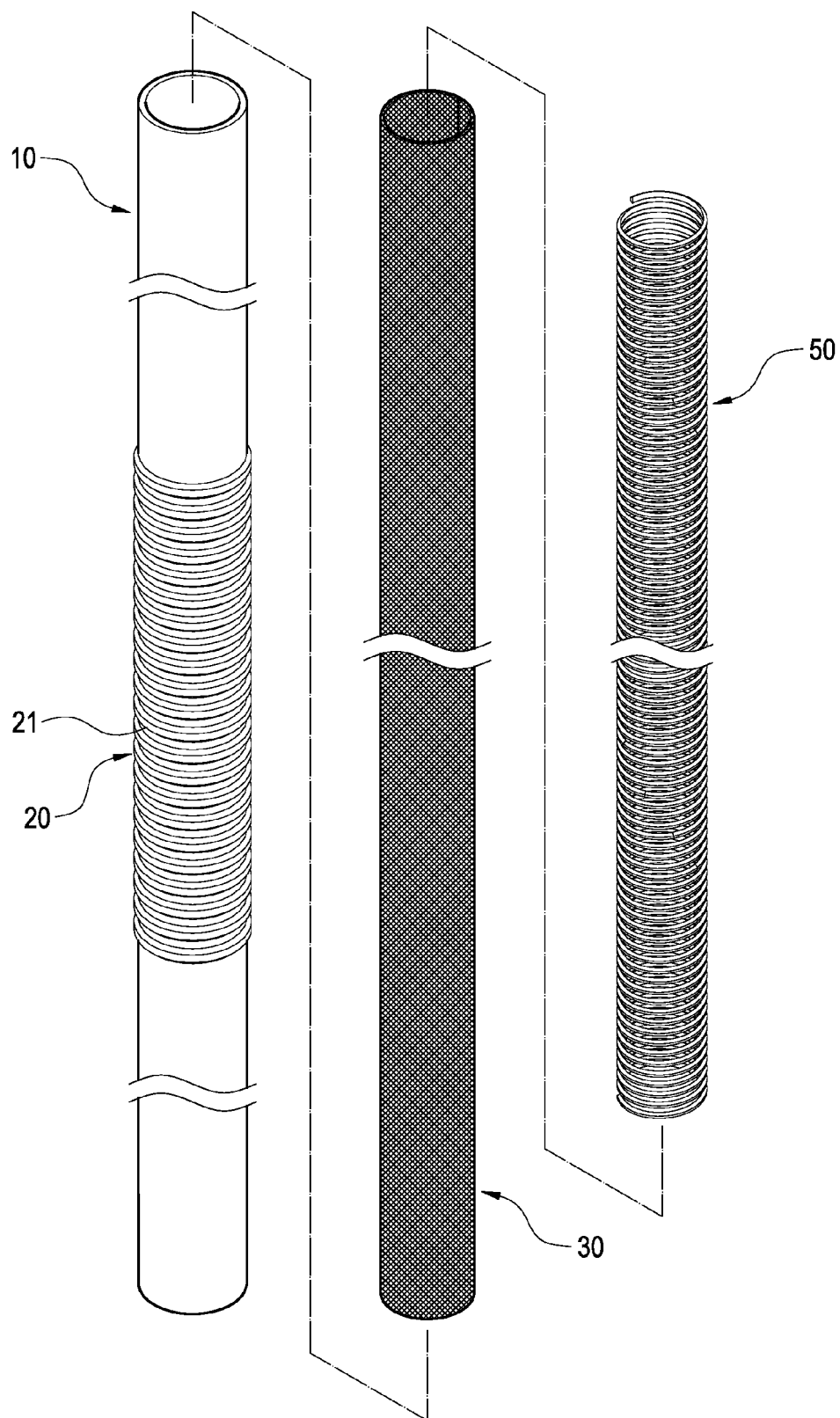


FIG.3

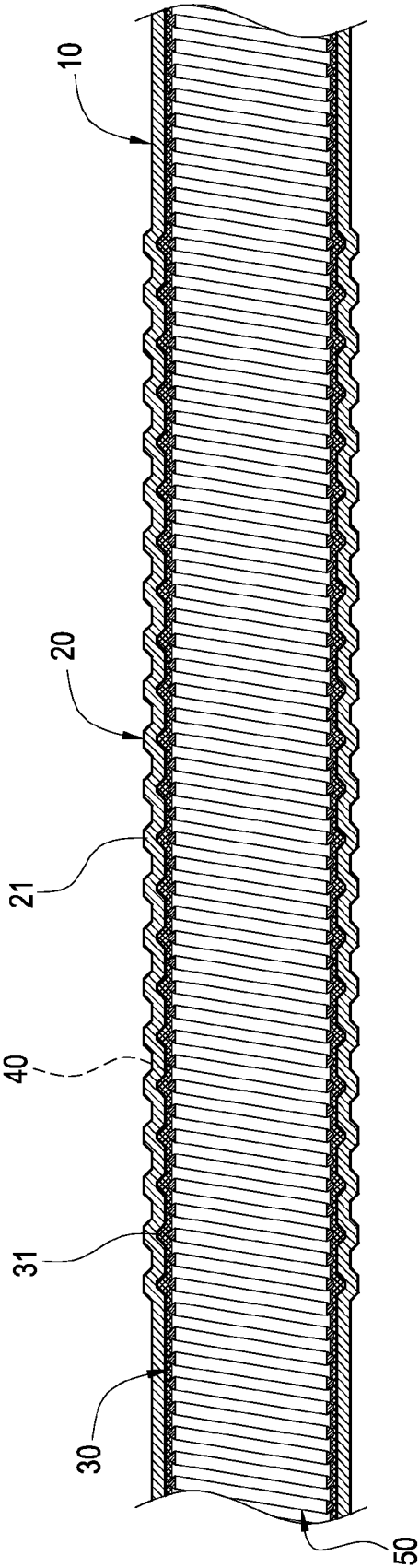


FIG.4

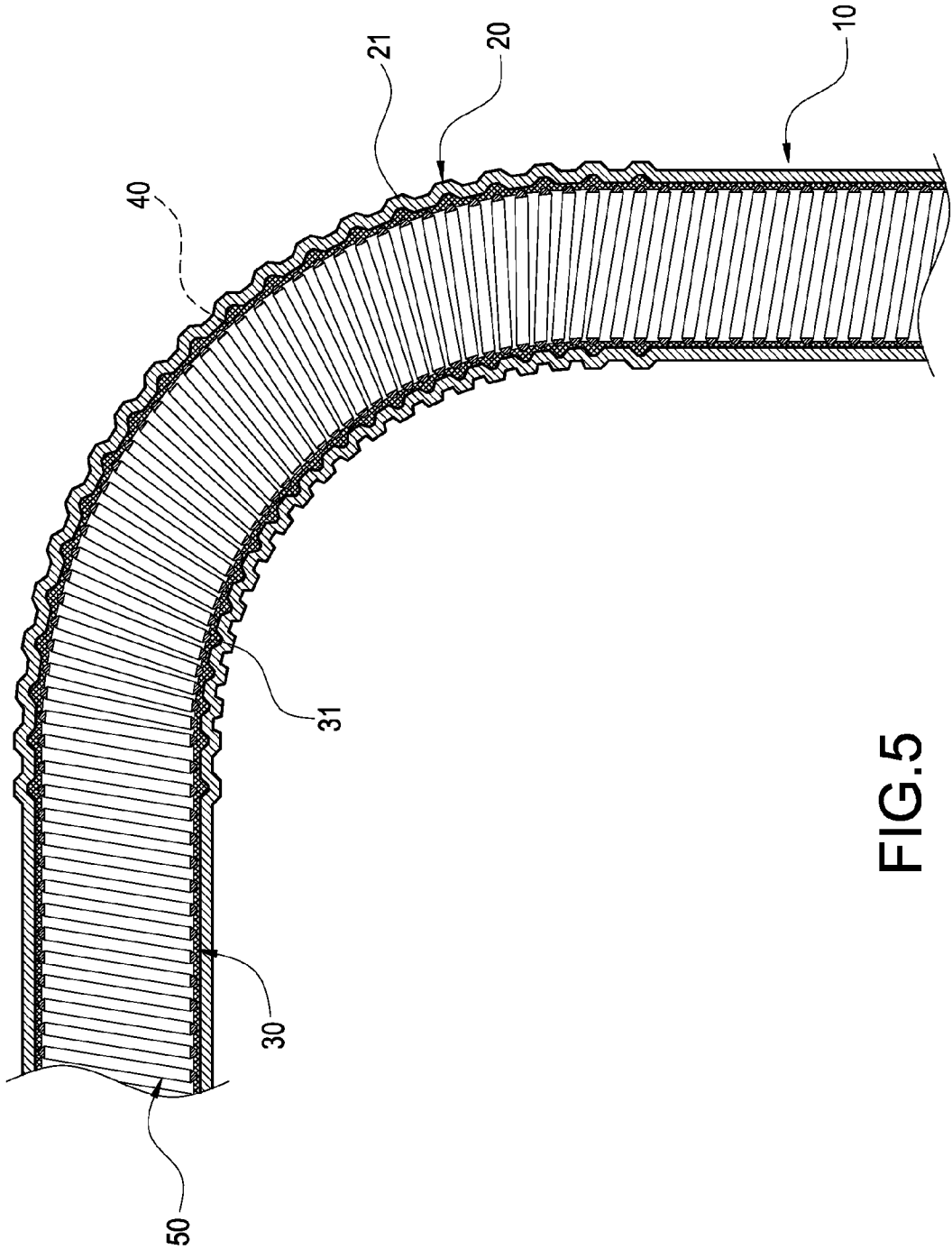


FIG.5

HEAT PIPE WITH A FLEXIBLE STRUCTURE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a heat dissipating device, and more particularly to a flexible heat pipe.

[0003] 2. Description of Prior Art

[0004] As information industry develops rapidly, computer devices usually come with an increasingly higher data processing speed, and produce more heats from the electric resistance of electronic components such as CPUs, IC components, power transistors, power supply devices installed in the computer devices during the operation of these electronic components, and thus the temperature of components rises. In addition, as the integrated circuit technology advances and becomes widely used, the electronic devices tend to be developed with a light, thin, compact and high-frequency high-speed design, so that the heat produced per unit area of the densely installed components is increased. If the heat produced by the electronic components is not dissipated properly and timely, a high temperature will result and slow down the execution speed and affect the system safety and performance adversely, and even worse, the heat may damage hardware equipments. To suppress the rise of temperature caused by an excessively large quantity of heat produced during the operation of the electronic components, it is necessary to dissipate the heat by a heat dissipating device. Among various different heat dissipating devices, heat pipe with the features of super silence, high-speed heat conduction, high thermal conductivity, lightweight, compact size, free-of-mechanical parts, and simple structure, is used extensively in the area of dissipating heat of electronic devices.

[0005] The structure of a conventional heat pipe is a sealed vacuum pipe including a capillary tissue on an internal wall of the pipe, a vapor channel in the middle of the pipe, and a working fluid filled into the vacuum pipe and having a volume equal to the total volume of crevices of the capillary tissue, wherein the working liquid is water, ethanol, acetone or any liquid with the features of a high heat of vaporization, a good mobility, stable chemical properties and a low boiling point. The heat pipe can be divided into an evaporating section and a condensing section according to its functions of absorbing and dispersing heat. If the evaporating section is heated, the working liquid in the capillary tissue will absorb heat and thus the temperature will rise. When the temperature rises to an evaporation point, the temperature will remain at the evaporation point, and the evaporating section will still continue absorbing a large quantity of heat to vaporize the liquid. The vapor under a slight pressure different passes through the channel in the pipe quickly, until the vapor is cooled to a condensation point when it reaches the condensing section. Now, the temperature remains at the condensation point, and a large quantity of heat is discharged, and the heat is conducted through the heat pipe and dissipated to the outside, such that the vapor can be condensed into a liquid to be entered into the capillary tissues, and the liquid in the capillary tissues flows back to the evaporating section by the capillary action to continue transmitting heat by a heat circulation caused by a phase change of the working liquid.

[0006] The conventional heat pipe is generally manufactured into a cylindrical shape for thermally coupling a heat generating source and a heat dissipating body in order to transmit the heat produced by the heat generating source to the heat dissipating body for heat dissipation. Since the heat

generating source and the heat dissipating body are disposed at different positions, and there are other devices installed in a path between the heat generating source and the heat dissipating, therefore the heat pipe must be bent into a required curvature to fit different using conditions in order to avoid other devices or to achieve a connection. However, a mechanical tool is required for bending the heat pipe into the cylindrical shape, and it is common to have discrepancy or even error of the curvature of the heat pipe. As a result, it is necessary to adjust the curvature of the heat pipe by the mechanical tool in an installation. Obviously, the conventional heat pipe wastes time and labor cost for its installation and requires further improvements.

[0007] In view of the shortcomings of the prior art, the inventor of the present invention based on years of experience in the related field to conduct extensive researches and experiments, and finally developed a flexible heat pipe in accordance with the present invention and provide a feasible effective solution to overcome the shortcomings of the prior art.

SUMMARY OF THE INVENTION

[0008] Therefore, it is a primary objective of the present invention to provide a flexible heat pipe that can be bent into a desired shape manually in an easy way according to actual using requirements,

[0009] To achieve the foregoing objective, the present invention provides a heat pipe having a flexible structure and capable of being bent into a desired shape manually in an easy way according to actual using requirements.

[0010] To achieve the foregoing objective, the present invention provides a heat pipe comprising:

[0011] a metal pipe;

[0012] a flexible structure, formed on the metal pipe, and comprised of a plurality of coils with an interval apart from one another, and the center of the coils being limited by the axis of the metal pipe;

[0013] a woven mesh, disposed inside the metal pipe, and having a plurality of protruding rings formed at a position of the woven mesh corresponding to the flexible structure and coupled to the coils;

[0014] a working fluid, filled inside the metal pipe and attached onto the woven mesh; and

[0015] a support element, passed into the interior of the woven mesh, abutted against the woven mesh, and attached onto an internal wall of the metal pipe.

[0016] The present invention is characterized in that the flexible structure is formed on the metal pipe, such that the heat pipe can be bent directly and manually according to the actual installation conditions without requiring any tool, and thus facilitating the installation and saving time. In addition, the woven mesh and the support element can be bent together with the heat pipe without a risk of being broken, such that the woven mesh can be maintained in contact with the internal wall of the metal pipe to allow the working fluid to flow smoothly in the woven mesh and to maintain a good heat dissipating effect.

BRIEF DESCRIPTION OF DRAWINGS

[0017] FIG. 1 is a perspective view of the present invention;

[0018] FIG. 2 is an axial cross-sectional view of a metal pipe of the present invention;

[0019] FIG. 3 is an exploded view of the present invention;

[0020] FIG. 4 is an axial cross-sectional view of the present invention; and

[0021] FIG. 5 is a cross-sectional view of an operating status of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0022] The technical characteristics, features and advantages of the present invention will become apparent in the following detailed description of the preferred embodiments with reference to the accompanying drawings. The drawings are provided for reference and illustration only, but not intended for limiting the present invention.

[0023] With reference to FIGS. 1 to 4 for a perspective view of the present invention, an axial cross-sectional view of a metal pipe of the present invention, an exploded view of the present invention, and an axial cross-sectional view of a heat pipe having a flexible structure in accordance with the present invention respectively, the heat pipe comprises a metal pipe 10, a flexible structure 20, a woven mesh 30, a working fluid 40, and a support element 50.

[0024] The metal pipe 10 is in a cylindrical shape, but the invention is not limited to such shape only. The metal pipe 10 is made of a good conducting material such as copper and silver, but the invention is not limited to such metals only. The interior of the metal pipe 10 is hollow for accommodating other devices to enhance the thermal conductive effect.

[0025] The flexible structure 20 is formed on the metal pipe 10 and comprised of a plurality of coils 21 installed alternately with one another, and the center of the coils 21 is limited by the axis of the metal pipe 10. The coil 21 is made of a good thermal conductive material and formed on the metal pipe 10, and the center of the coil 21 is limited by the axis of the metal pipe 10, and the external peripheral wall of the external the coil 21 is protruded with respect to the external peripheral wall of the metal pipe 10, and the internal peripheral wall of the coil 21 is sunken with respect to the internal peripheral wall of the metal pipe 10.

[0026] The woven mesh 30 is disposed inside the metal pipe 10 and attached onto the internal wall of the metal pipe 10, and the woven mesh 30 is made of a material having a good thermal conductivity such as a metal, but the invention is not limited to such material only. The woven mesh 30 includes a plurality of crevices for producing a capillary effect. The woven mesh 30 is in a cylindrical shape, but the invention is not limited to such shape only, and any shape matched with the shape of the internal wall of the metal pipe 10 can be used for the invention, and the woven mesh 30 includes a plurality of protruding rings 31 formed at positions corresponding to the flexible structure 20 and attached to the coils 21 respectively, wherein the external peripheral wall of the protruding ring 31 has a shape corresponding to the shape of the internal peripheral wall of the coil 21, such that the protruding rings 31 of the woven mesh 30 can be attached to the coils 21 of the flexible structure 20.

[0027] The working fluid 40 is filled into the metal pipe 10 and attached onto the woven mesh 30, wherein the working fluid 40 is a liquid with features of a high heat of vaporization, a good mobility, stable chemical properties and a low boiling point such as water, ethanol or acetone, etc, but the invention is not limited to these liquids only. The working fluid 40 is permeated into a plurality of crevices of the woven mesh 30. By the capillary action, the working fluid 40 can flow to achieve the transmission of heat by means of a phase change of the working fluid 40.

[0028] The support element 50 is passed into the woven mesh 30, abutted against the woven mesh 30 and attached onto an internal wall of the metal pipe 10, and the support element 50 is made of a material with a strong structural strength, a high flexibility and bendable elasticity, and the shape of the support element 50 is matched with the shape of the interior of the woven mesh 30, and the external peripheral wall of the support element 50 is attached onto the internal peripheral wall of the woven mesh 30 for supporting the woven mesh 30, and the support element 50 does not occupy the whole internal space of the metal pipe 10, and the external peripheral wall of the support element 50 is not covered completely by the internal peripheral wall of the woven mesh 30, wherein the support element 50 of this preferred embodiment is a spiral spring, but the present invention is not limited to such device only.

[0029] With reference to FIG. 5 for a cross-sectional view of an operating status of the present invention, the heat pipe can be bent manually in an easy way without requiring a tool, when it is necessary to bend the heat pipe to facilitate the installation. The coils 21 of the flexible structure 20 are put together with each other on one side and apart from each other on the other side, such that the heat pipe having a flexible structure can be bent easily. The pipe wall will not be sunken due to an excessive bending on any part of heat pipe. The woven mesh 30 can be attached onto the internal peripheral wall of the metal pipe 10 and the heat pipe having a flexible structure can be bent together with the woven mesh 30 to fit different bending angles, and will not break due to the bending, so as to prevent the flow of the working fluid 40 from being interrupted or blocked, and the protruding rings 31 remain attached with the coils 21 anytime to maintain the good heat dissipating effect. Further, when the heat pipe having a flexible structure is bent, the support element 50 is bent accordingly to maintain the status of supporting the woven mesh 30, since the support element 50 is a spiral spring. The vapor formed by the vaporization of the working fluid 40 escapes from the crevices of the woven mesh 30 and passes through the gaps between the spring into the metal pipe 10, and the vapor can flow in the spring without being blocked.

[0030] The present invention is illustrated with reference to the preferred embodiment and not intended to limit the patent scope of the present invention. Various substitutions and modifications have suggested in the foregoing description, and other will occur to those of ordinary skill in the art. Therefore, all such substitutions and modifications are intended to be embraced within the scope of the invention as defined in the appended claims.

What is claimed is:

1. A heat pipe, comprising:
 - a metal pipe;
 - a flexible structure, formed on the metal pipe, and comprised of a plurality of coils having an interval apart from one another, and the center of the coils being limited by the axis of the metal pipe;
 - a woven mesh, disposed inside the metal pipe, and having a plurality of protruding rings formed at a position of the woven mesh corresponding to the flexible structure and coupled to the coils;
 - a working fluid, filled into the interior of the metal pipe and attached to the woven mesh; and

a support element, passed into the interior of the woven mesh, and abutted against the woven mesh, and attached onto an internal wall of the metal pipe.

2. The heat pipe of claim 1, wherein the support element is a spiral spring.

3. The heat pipe of claim 1, wherein the metal pipe is in a circular shape.

4. The heat pipe of claim 1, wherein the metal pipe is made of copper.

5. The heat pipe of claim 1, wherein the woven mesh is in a cylindrical shape.

6. The heat pipe of claim 1, wherein the woven mesh is made of a metal.

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