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(54) **HEAT DISSIPATION DEVICE WITH HEAT PIPE**

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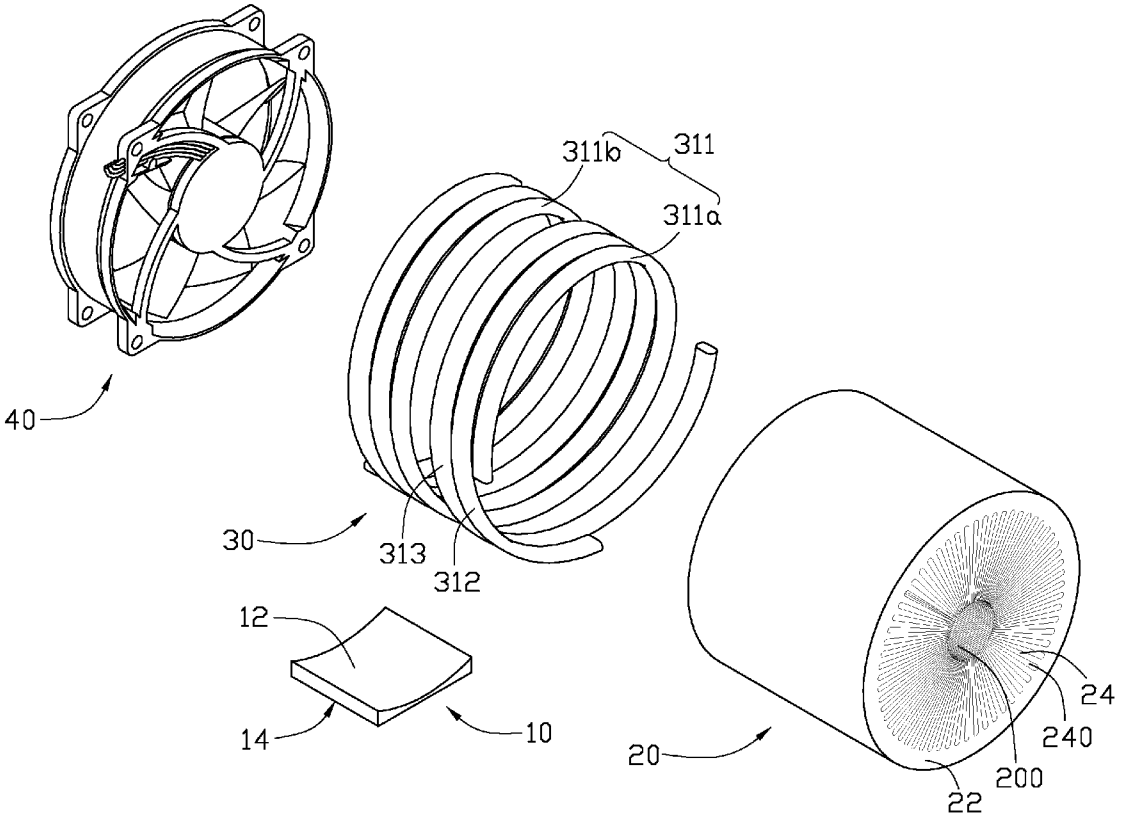
(57) **ABSTRACT**

A heat dissipation device includes a heat sink and a helical heat pipe assembly. The heat sink includes a hollow cylindrical body and a number of fins extending inwardly from an inner surface of the body to an axis of the body. The helical heat pipe assembly is wrapped on an outer surface of the body and helically extends along an axial direction of the body.



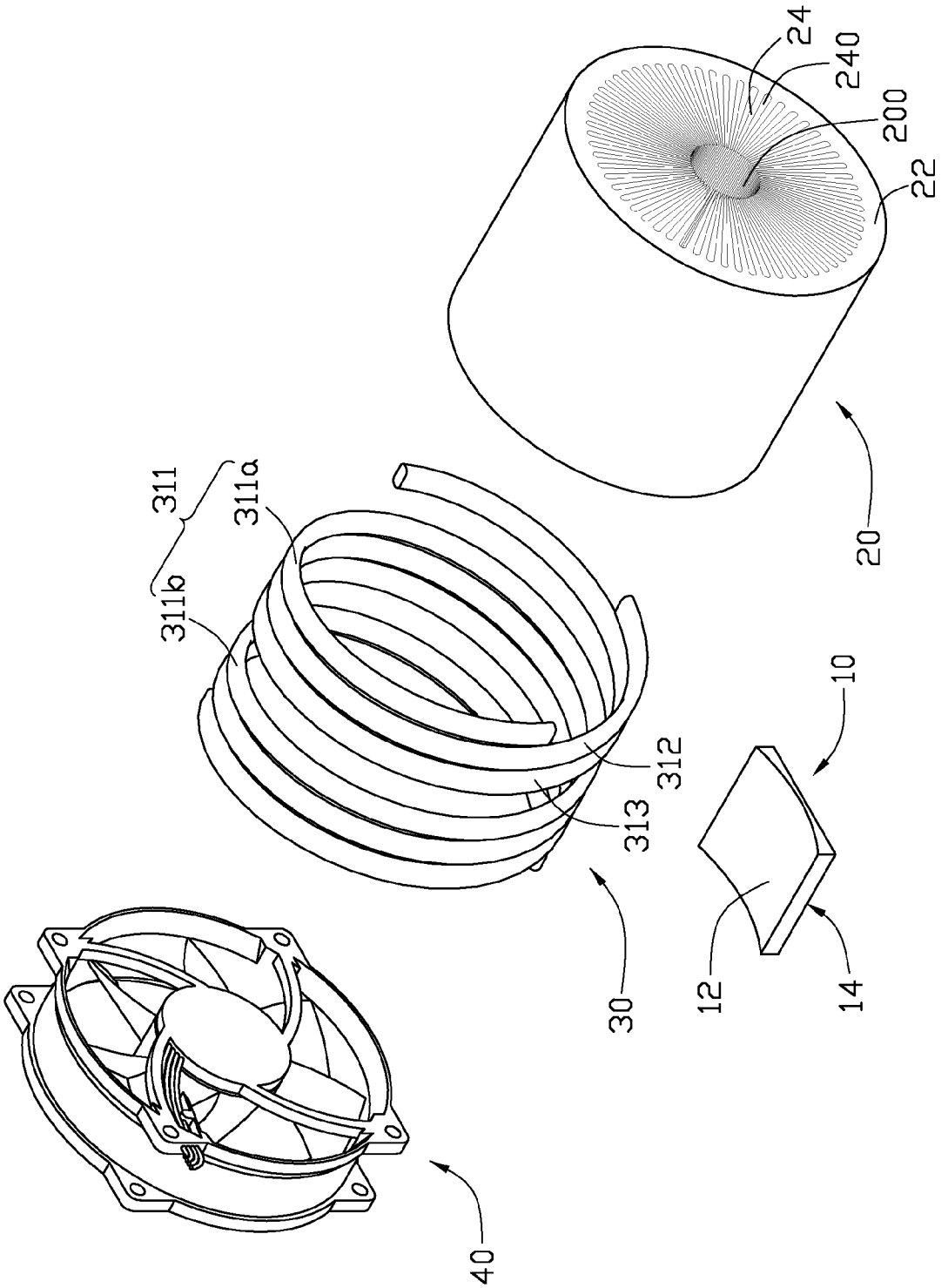


FIG. 1

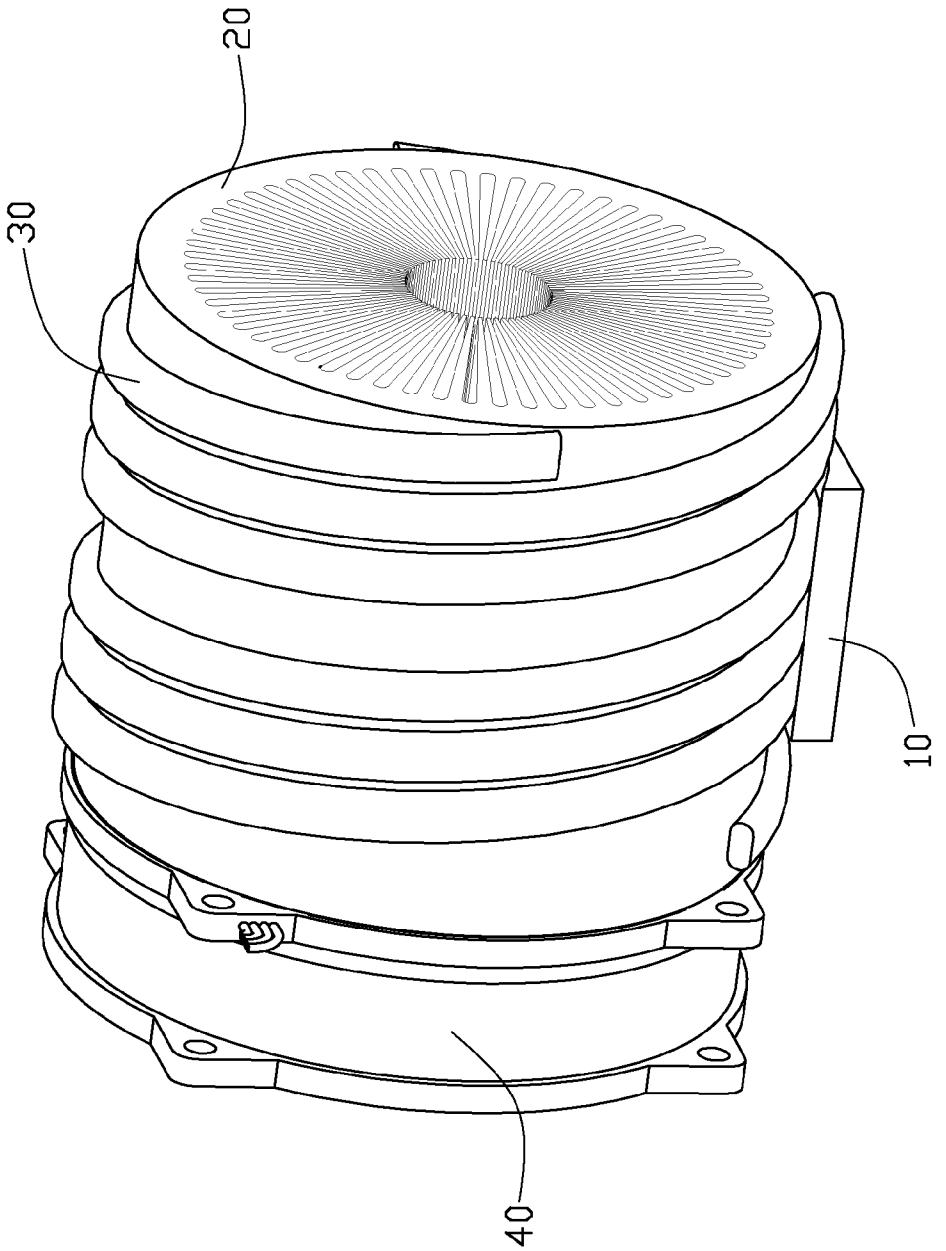


FIG. 2

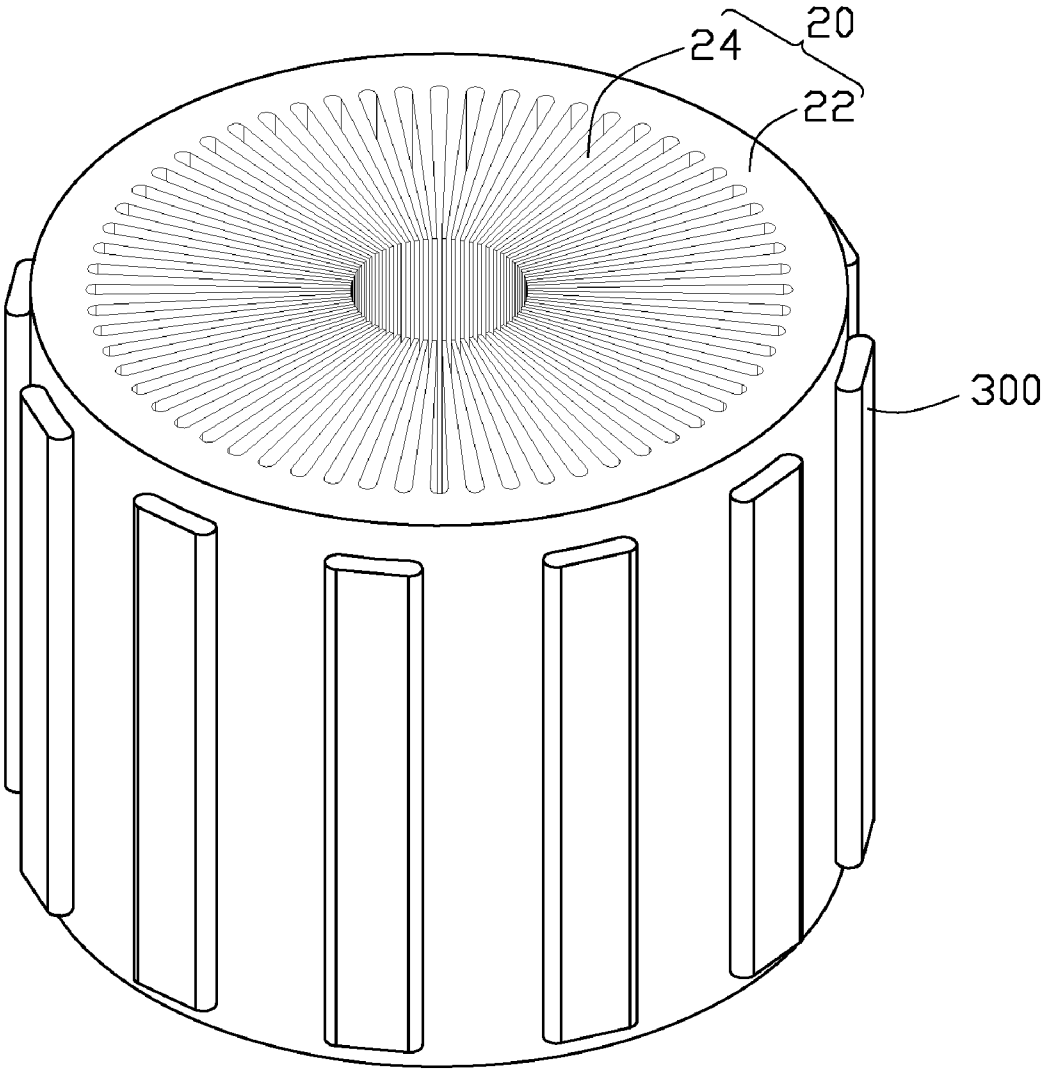


FIG. 3

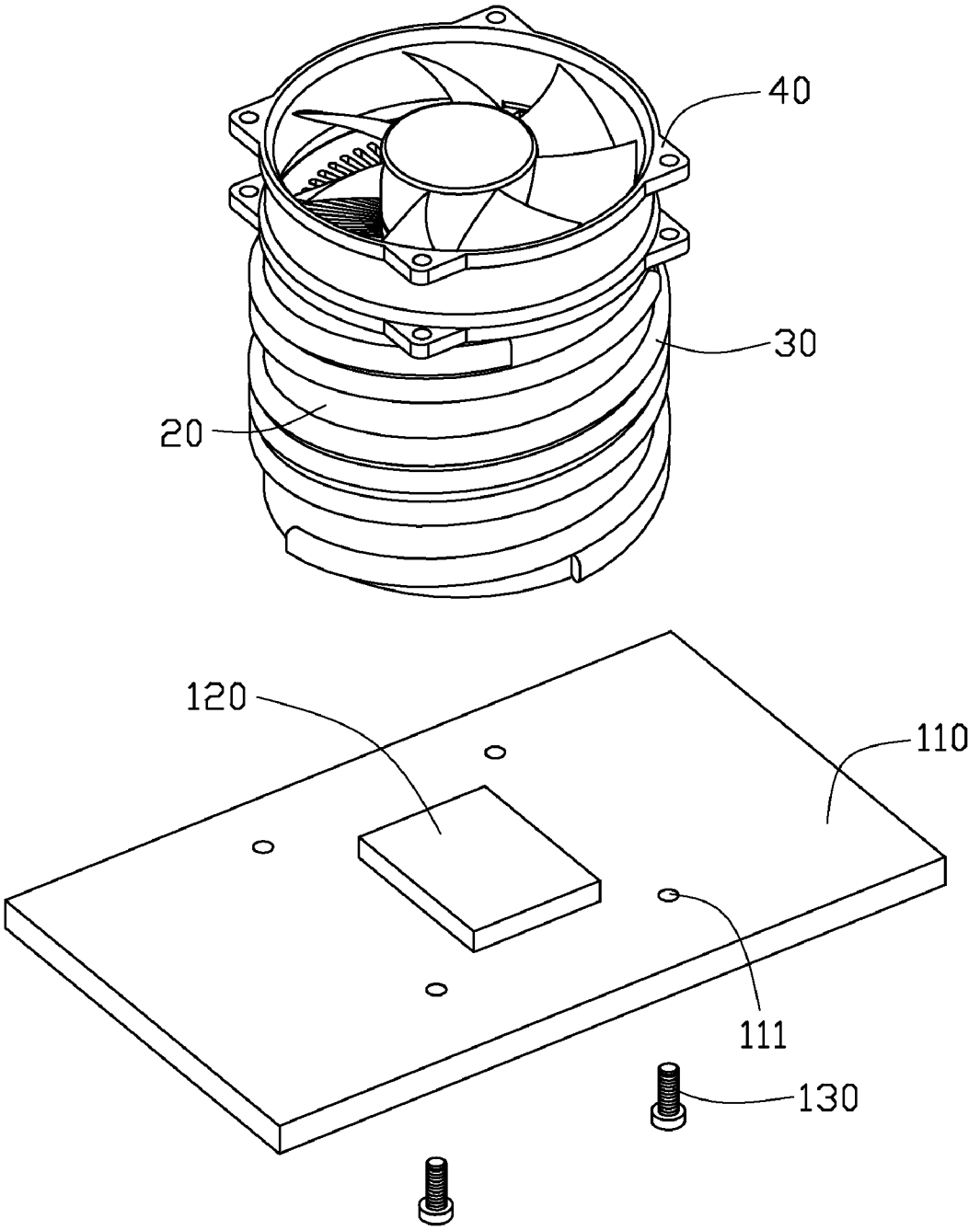


FIG. 4

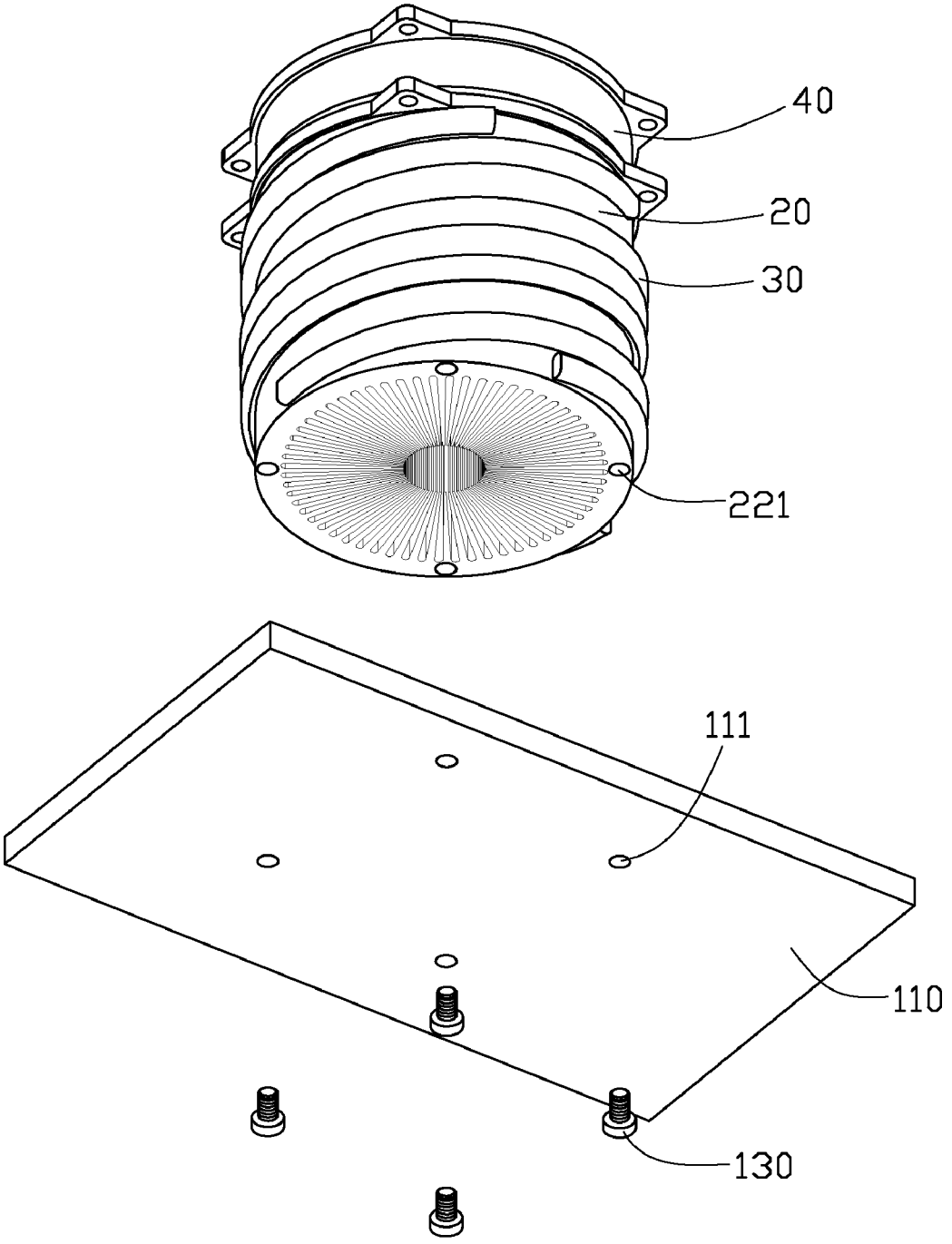


FIG. 5

HEAT DISSIPATION DEVICE WITH HEAT PIPE

BACKGROUND

[0001] 1. Technical Field

[0002] The disclosure relates to heat dissipation devices and, particularly, to a heat dissipation device with a heat pipe.

[0003] 2. Description of Related Art

[0004] Heat dissipation devices are increasingly used in electronic products. A conventional heat dissipation device includes a base contacting a heat generating device, a plurality of parallel fins protruding from a top surface of the base and a heat pipe. In operation, the heat generated from the heat generating device is absorbed by the base and transferred by the fins. However, this conventional heat dissipation device has low heat dissipation efficiency.

[0005] In order to improve the heat dissipation efficiency of the heat dissipation device mentioned above, a heat pipe is applied to transfer the heat from the heat generating device to the fins. In detail, an evaporator section of the heat pipe is disposed between the bottom surface of the base and the heat generating device, and a condenser end of the heat pipe extends through the fins. In operation, the heat is quickly transferred by the heat pipe from the heat generating device to the fins, whereby the heat is dissipated out rapidly. Thus, the heat pipe plays a critical role during heat dissipation process. However, once the heat pipe is invalid or damaged, a heat dissipation efficiency of the whole heat dissipation device will be greatly degraded.

[0006] What is needed, therefore, is a heat dissipation device with a heat pipe overcoming the described limitations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Many aspects of the present apparatus can be better understood with reference to the following drawings. The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the present apparatus. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the several views.

[0008] FIG. **1** is an isometric, exploded view of a heat dissipation device in accordance with a first embodiment of the disclosure.

[0009] FIG. **2** is an assembled view of the heat dissipation device of FIG. **1**.

[0010] FIG. **3** is an isometric, exploded view of a heat dissipation device in accordance with a second embodiment of the disclosure, showing an assembly of a heat sink and a plurality of heat pipes.

[0011] FIG. **4** is an isometric, exploded view of a heat dissipation device in accordance with a third embodiment of the disclosure, showing the heat dissipation device assembled on a printed circuit board.

[0012] FIG. **5** is the exploded view of the heat dissipation device of FIG. **4**, viewed from a different angle.

DETAILED DESCRIPTION

[0013] Referring to FIG. **1** and FIG. **2**, a heat dissipation device in accordance with a first embodiment includes a heat conducting base **10**, a heat sink **20**, a heat pipe assembly **30** and a fan **40**. The heat conducting base **10** is made of heat conducting material, such as copper, aluminum, or the like. The heat conducting base **10** includes a top surface **12** thermally connecting with the heat pipe assembly **30**, and a bottom surface **14** thermally contacting a heat generating device (not shown). The top surface **12** is curved corresponding to a curve of the heat pipe assembly **30**.

[0014] The heat sink **20** is a unitary structure made from a metal block and includes a hollow cylindrical body **22**, and a plurality of fins **24** extending inwardly from an inner surface of the body **22** toward an axis of the body **22**. The fins **24** each have a first end connected to the inner surface of the body **22** and a terminal second end opposite to the first end. Each of the fins **24** is a wedge-shaped plate, and has a thickness gradually decreasing from the first end to the second end thereof. The first ends of the fins **24** are evenly arranged on a circumference of the inner surface of the body **22**, and the second ends of the fins **24** cooperatively define an aperture **200**. The second ends of the fins **24** may be free and spaced from each other or be connected to each other. A plurality of air flow paths **240** is defined by adjacent fins **24**. In the illustrated embodiment, the second ends of the fins **24** are spaced from each other, and the air flow paths **240** extend inwardly from the inner surface of the body **22** and communicate with the aperture **200**. Each air flow path **240** has a width gradually decreasing along a corresponding radial direction from the inner surface of the body **22** to the aperture **200**.

[0015] Being arranged on the circumference of the inner surface of the body **22** and extending inwardly from the inner surface of the body **22**, the fins **24** simultaneously transfer heat of the whole annular inner surface of the body **22** from the first end to the second end thereof along various directions. Then the heat at the second ends of the fins **24** can be quickly dissipated by air flowing through the air flow paths **240**. Therefore, the illustrated structure of the heat sink **20** can dissipate the heat absorbed thereby quickly and efficiently.

[0016] Alternatively, the heat sink **20** can be an assembled structure of the body **22** and the fins **24**. For example, the fins **24** are included in a unitary fin structure. In detail, a metallic sheet is bent in sequence to form a zigzag or wave configuration including a number of wedge-shaped protrusions. Each protrusion constructs one fin **24**. Thus, the desired unitary fin structure is obtained. Then the unitary fin structure is assembled on the inner surface of the body **22** by a bolt or a soldering manner, thereby obtaining the assembled heat sink **20** consisting of the body **22** and the fins **24**.

[0017] Alternatively, the outer surface of the body **22** can protrude or be soldered with a number of fins to increase a heat dissipating area of the body **22**. For example, a number of fins are formed on the outer surface of the body **22** and located between the turn **311***b* of the heat pipe **311** and the heat pipe **313**.

[0018] One or more heat pipe assembly **30** wraps the outer surface of the body **22** of the heat sink **20** to remove the heat from the annular outer surface of the body **22**. The heat pipe assembly **30** has a helical structure obtained by curving one or more elongated flat-type heat pipe. A curvature radius of the helical heat pipe assembly **30** is equal to that of the outer surface of the body **22** to assure that the helical heat pipe can tightly combine with the outer surface of the body **22**. In this embodiment, the helical heat pipe assembly **30** is soldered on the outer surface of the body **22**. In order to improve heat exchange efficiency between the heat sink **20** and the helical heat pipe assembly **30**, a thermal interface material is applied between the outer surface of the body **22** and the helical heat pipe assembly **30**. In operation, the whole annular outer surface of the body **22** exchanges heat with the heat pipe assem-

bly **30** and therefore the heat of the body **22** of the heat sink **20** can be quickly removed by the heat pipe assembly **30**.

[0019] Alternatively, the outer surface of the body **22** of the heat sink **20** defines a groove to receive the heat pipe assembly **30** therein. The heat pipe assembly **30** can be partially or wholly embedded in the groove of the body **22**. The groove facilitates the heat pipe assembly **30** being easily soldered on the body **22** and tightly combining with the body **22**. The outer surface of the body **22** can define a helical groove to receive the helical heat pipe assembly **30** therein, or define a number of parallel grooves to receive a number of straight heat pipes therein.

[0020] It is understood that shapes, structures of the heat pipe assembly **30** and the outer surface of the body **22** can be varied, so long as the heat pipe assembly **30** surrounds the outer surface of the body **22**.

[0021] In the illustrated embodiment, the helical heat pipe assembly **30** is formed by three elongated flat-type heat pipes **311**, **312**, **313**. The pipe **311** includes multi-turns wrapping the body **22** of the heat sink **20**. Adjacent turns of one of the three heat pipes **311**, **312**, **313** are spaced by the other two of the three heat pipes **311**, **312**, **313**. In this embodiment, two adjacent turns **311***a*, **311***b* of the heat pipe **311** are spaced by the heat pipe **312** and the heat pipe **313**. That is, the heat pipe **312** and the heat pipe **313** are sandwiched between the two adjacent turns **311***a*, **311***b* of the heat pipe **311**. In this structure, a distance between the adjacent turns **311***a*, **311***b* of the heat pipe **311** is relatively long. That is, a section the heat pipe **311** between the adjacent turns **311***a*, **311***b* can have a relatively low curving degree, thereby avoiding capillary structures therein to be damaged during forming the heat pipe **311**. In order to obtain a relatively high heat exchange efficiency, a length of the helical heat pipe assembly **30** is equal to that of the body **22** of the heat sink **20**, whereby the heat pipe assembly **30** substantially contacts the whole outer surface of the body **22**.

[0022] The fan **40** is mounted on the another side surface of the body **22** to generate an air flow in the axial direction of the body **22**. The fan **40** includes a cylindrical frame **41** and a blade module **42** fixed to the frame **41**. The blade module **42** includes a shaft **421** and several blades **422** extending outwardly from the shaft **421**. The frame **41** is mounted to the body **22** with the shaft **421** of the blade module **42** corresponding to the aperture **200** and the blades **422** corresponding to the air flow paths **240**. In heat exchanging process, a portion of air flows generated by the blades **422** flow in the air flow paths **240** along a lengthwise direction of the body **22**, simultaneously, another portion of air flow congregates and flows in the aperture **200** along the axial direction of the body **22**. By the two approaches, the air flow exchanges heat with the fins **24** and the inner surface of the body **22** of the heat sink **20** to take away the heat.

[0023] In assembly, the heat pipe assembly **30** is soldered to the outer surface of the body **22** of the heat sink **20**. An assembly of the heat sink **20** and the heat pipe assembly **30** is mounted on the base **10** by soldering the heat pipe assembly **30** to the top surface **12** of the base **10**. The fan **40** is mounted to the side of the body **22** of the heat sink **20** by a number of bolts.

[0024] Referring to FIG. **3**, a heat dissipation device in accordance with a second embodiment is illustrated. The heat dissipation device of the second embodiment has a structure similar to the heat dissipation device of the first embodiment, differing only in that configuration of a heat pipe is different from that of the heat pipe assembly **30**. The heat pipe includes a number of parallel straight heat pipes **300** disposed on the outer surface of the body **22** and surround the body **22**. The straight heat pipes **300** are parallel to the axis of the body **22**. Adjacent heat pipes **300** can be spaced from or adjoin each other.

[0025] Referring to FIG. **4** and FIG. **5**, a heat dissipation device in accordance with a third embodiment is illustrated. The heat dissipation device has a structure similar to the heat dissipation device of the first embodiment, differing only in that the heat conducting base **10** is omitted. The body **22** (shown in FIG. **1**) of the heat sink **20** includes a first side surface thermally contacting a heat generating device **120** and a second side surface opposite to the first side surface. Each of the fins **24** (shown in FIG. **1**) has a flat surface coplanar with the second side surface of the body **22**. The body **22** is directly mounted to a printed circuit board **110** supporting a heat generating device **120** thereon by a plurality of blots **130**. The body **22** defines a plurality of threaded holes **221**, and the printed circuit board **110** defines a plurality of through holes **111** corresponding to the threaded holes **221**. The blots **130** extend through the second threaded holes **111** of the printed circuit board **110** and are threaded in the first threaded holes **221** of the body **22** to fasten the body **22** to the printed circuit board **110**, thereby the flat surface of the fins **24** thermally contacting the heat generating device **120**. It is understood that the flat surface cooperatively formed by all of the fins **24** can be concave or convex relative to the first side surface of the body **22**, so long as the flat surface of the fins **24** easily and tightly thermally combines with the heat generating device **120**. The fan **40** is fixed to the second first side surface of the body **22**.

[0026] Regarding the heat dissipation device of the illustrated embodiment, the helical heat pipe assembly **30** surrounds the outer surface of the body **22** of the heat sink **20** and thermally contact the heat conducting base **10**. Thus a large contacting area is obtained between the helical heat pipe assembly **30** and the body **22** of the heat sink **20**, thereby a large heat exchange area between the heat pipe assembly **30** and the body **22** of the heat sink **20** being obtained. The fins **24** positioned in side of the body **22** define a number of air flow paths **240** to allow the air flow generated by the fan **40** flowing therethrough and takes away the heat of the heat sink **20**.

[0027] It is to be understood, however, that even though numerous characteristics and advantages of the present embodiments have been set forth in the foregoing description, together with details of the apparatus and function of the embodiments, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the embodiments to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

1. A heat dissipation device comprising:

a heat sink comprising a hollow cylindrical body and a plurality of fins extending inwardly from an inner surface of the body to an axis of the body; and

a helical heat pipe assembly wrapped on an outer surface of the body and helically extending along the axial direction of the body.

2. The heat dissipation device of claim **1**, wherein the fins each have a first end connected to the inner surface of the body and a terminal second end opposite to the first end, and wherein the second ends of the fins cooperatively define an aperture.

3. The heat dissipation device of claim **2**, wherein the second ends of the fins are spaced from each other.

4. The heat dissipation device of claim **3**, wherein the fins define a plurality of air flow path communicating with the aperture.

5. The heat dissipation device of claim **4**, wherein the helical heat pipe assembly is obtained by curving at least one heat pipe.

6. The heat dissipation device of claim **5**, wherein the helical heat pipe assembly comprises multi-turns wrapping the outer surface of the body of the heat sink, and wherein the multi-turns are spaced from each other.

7. The heat dissipation device of claim **6**, wherein the helical heat pipe assembly is formed by curving a first, second and third heat pipes, and adjacent turns of the first heat pipe are spaced by the second heat pipe and the third heat pipe.

8. The heat dissipation device of claim **7**, wherein the outer surface of the body of the heat sink defines a helical groove to receive the helical heat pipe assembly therein.

9. The heat dissipation device of claim **8**, wherein the helical heat pipe assembly is partially or wholly embedded in the groove of the body of the heat sink.

10. The heat dissipation device of claim **4**, wherein the heat dissipation device further comprises a fan comprising a frame and a blade module fixed to the frame, the blade module comprises a shaft and several blades extending outwardly from the shaft, the frame is mounted to a first side surface of the body with the shaft corresponding to the aperture and the blades corresponding to the air flow paths.

11. The heat dissipation device of claim **10**, wherein the body of the heat sink comprises a second side surface opposite to the first side surface, the second side surface is configured for thermally contacting a heat generating device.

12. The heat dissipation device of claim **10**, wherein the heat dissipation device further comprises a heat conducting base having a bottom surface for thermally contacting a heat generating device and a top surface thermally connecting with the helical heat pipe assembly.

13. A heat dissipation device comprising:

a heat sink comprising a tubular, cylindrical body and a plurality of fins extending inwardly from an inner surface of the body to an axis of the body, the fins each having a free end unconnected to the inner surface of the body, the free ends of the fins cooperatively defining an aperture communicating with two side surfaces of the body;

a plurality heat pipes disposed on an outer surface of the body and surrounding the outer surface of the body;

a fan mounted to one of the two side surfaces of the body.

14. The heat dissipation device of claim **13**, wherein the fins define a plurality of air flow paths communicating with the aperture.

15. The heat dissipation device of claim **14**, wherein the plurality heat pipes constructs a helical structure wrapping the outer surface of the body and helically extending a long an axial direction of the body.

16. The heat dissipation device of claim **15**, wherein the helical structure is formed by curving a first, second and third heat pipes and comprises a plurality of spaced turns wrapping the outer surface of the body, and wherein adjacent turns of the first heat pipe are spaced by the second heat pipe and the third heat pipe.

17. The heat dissipation device of claim **14**, wherein the heat pipes are parallel straight heat pipes disposed on a circumference of the outer surface of the body and extend along an axial direction of the body.

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