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(54) HEAT EXCHANGER

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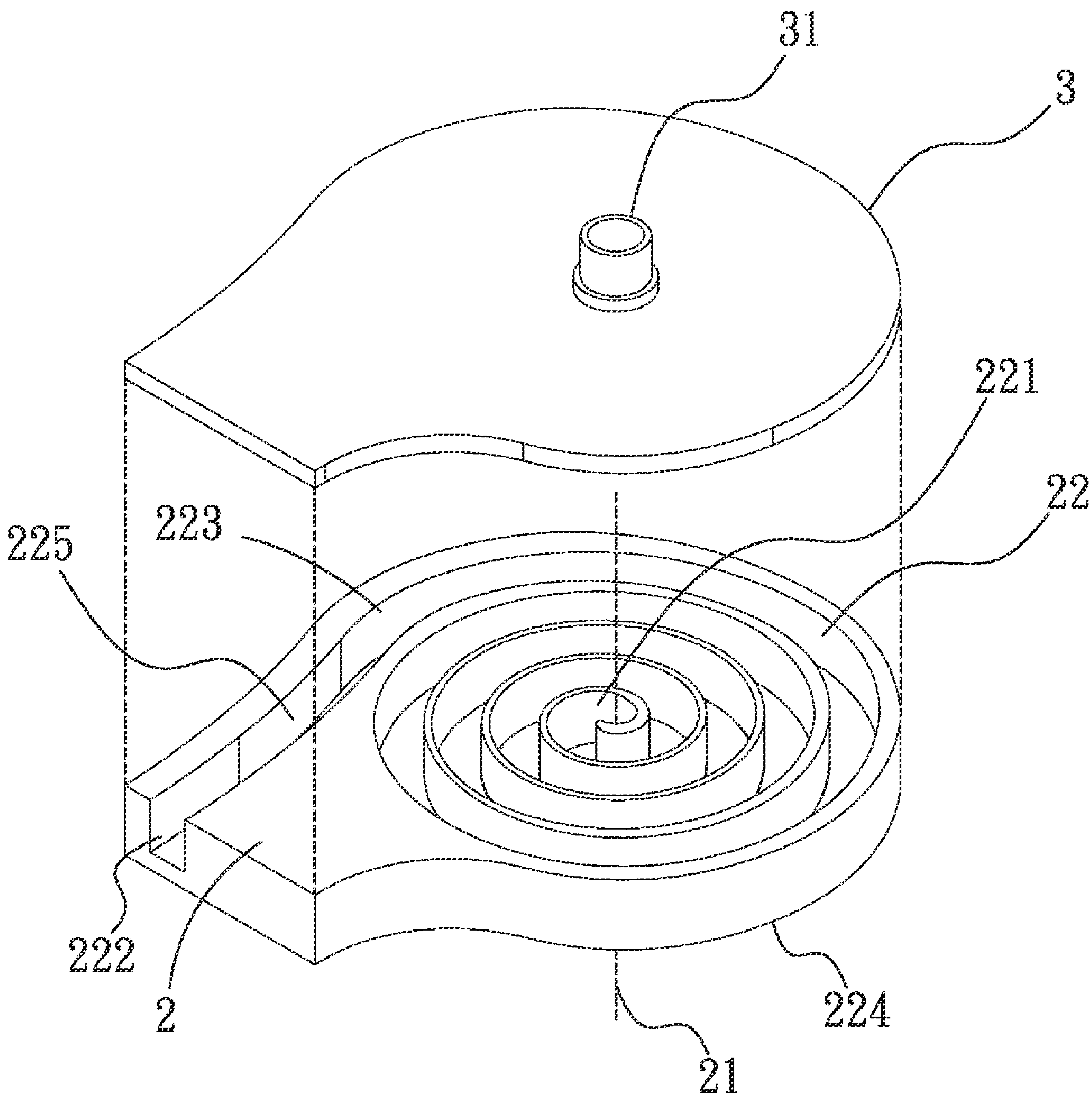
(57) **ABSTRACT**

A heat exchanger includes a body having a center and a spiral guiding trough extending spirally and outwardly from the center toward an outside of the center. The radius of the spiral guiding trough increases gradually from the center toward the outside of the center. A first port and a second port are in communication with the spiral guiding trough respectively. With the combination of the spiral guiding trough and the body, the fluid can be sufficiently mixed in the spiral guiding trough, thereby achieving an excellent thermal-conducting effect.



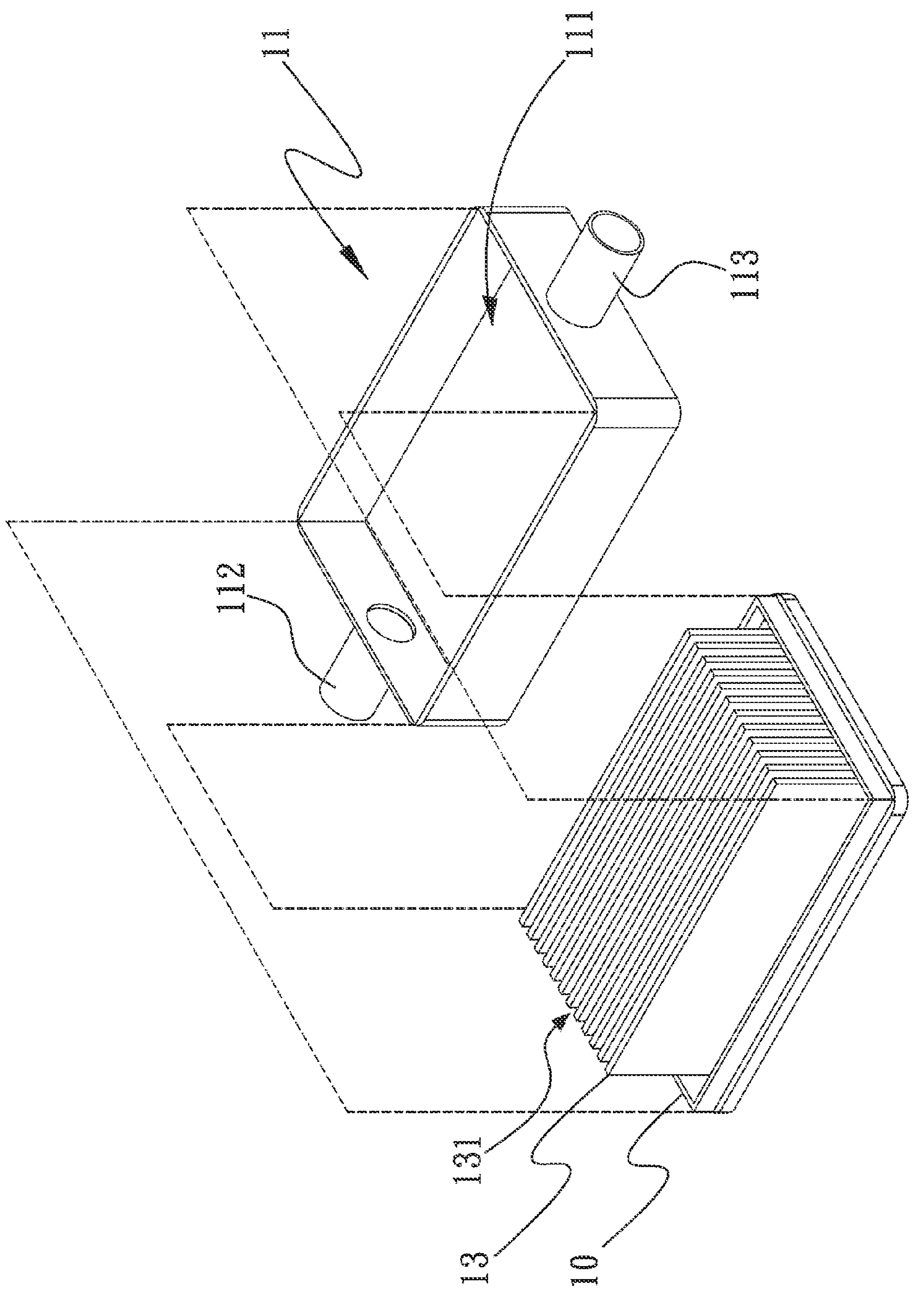


Fig. 1 (PRIOR ART)

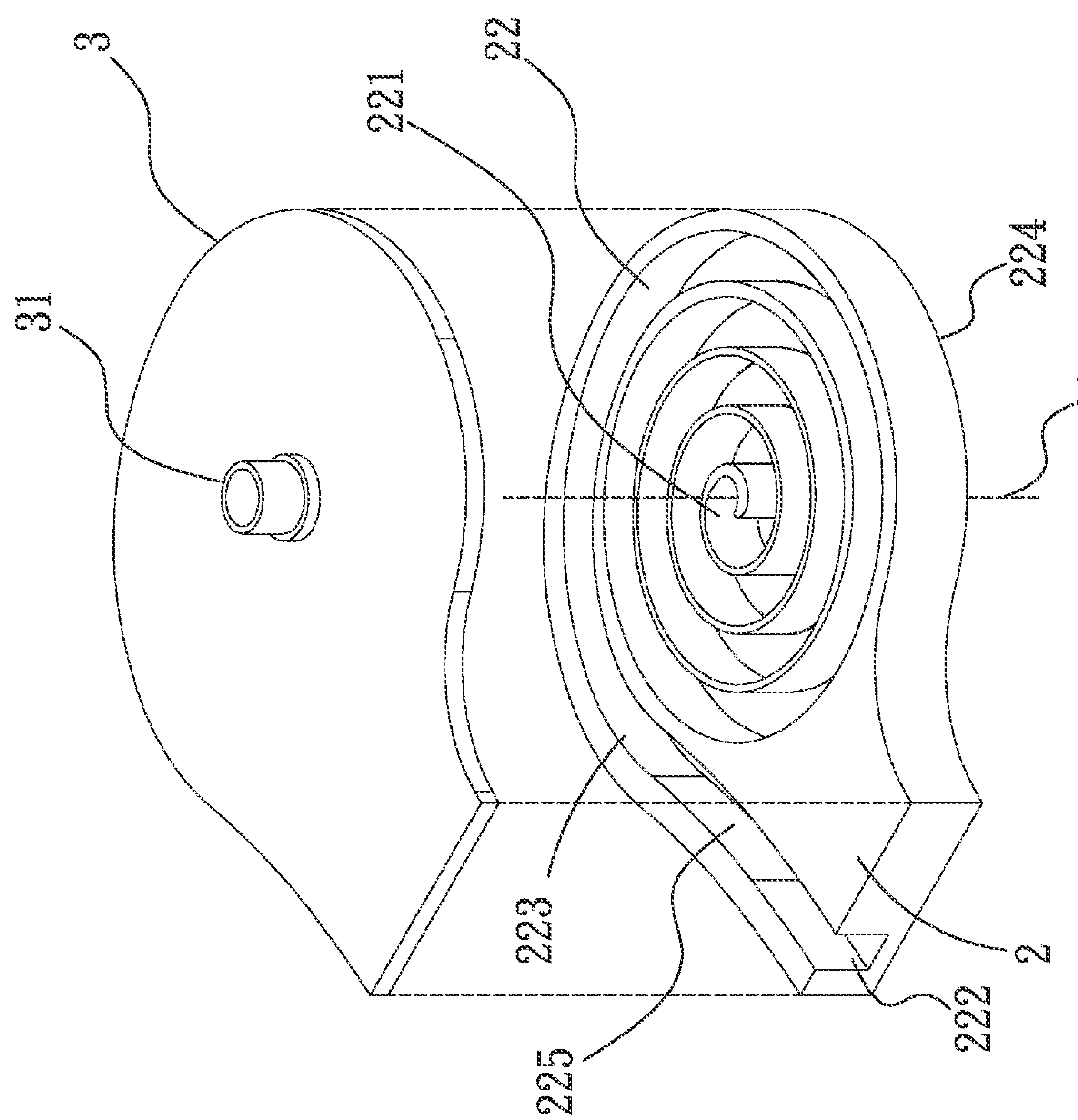


Fig. 2

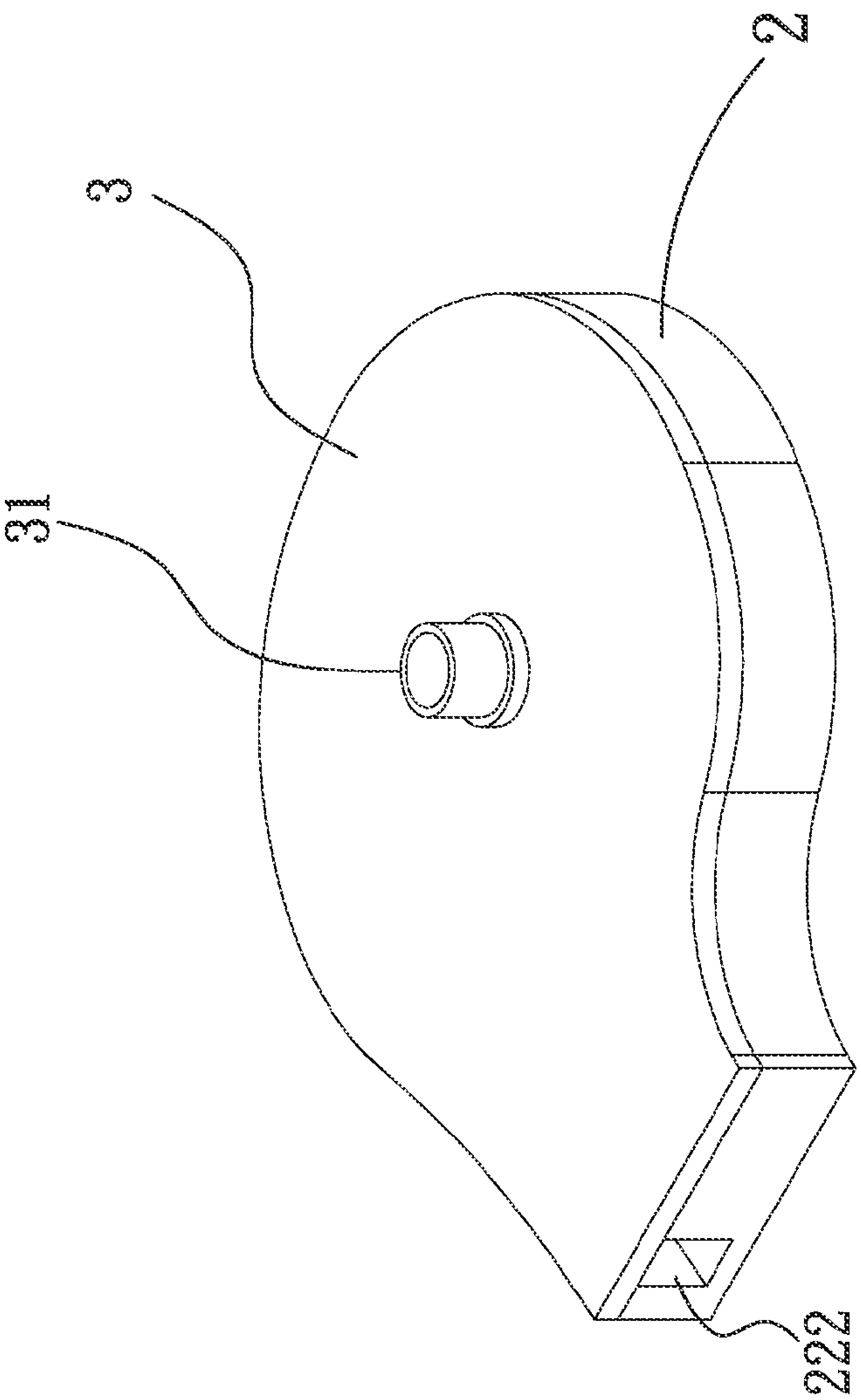


Fig. 3

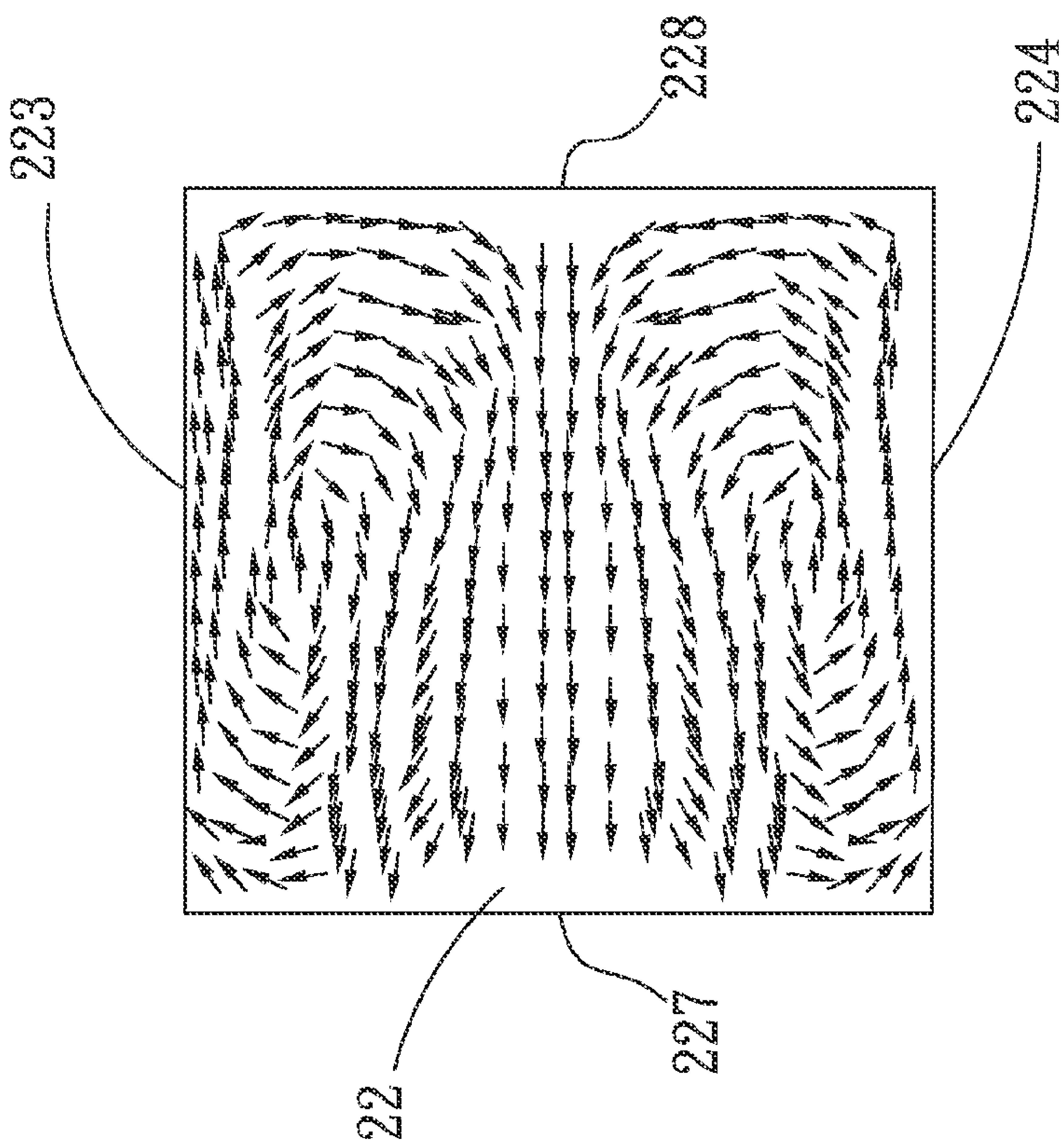


Fig. 5

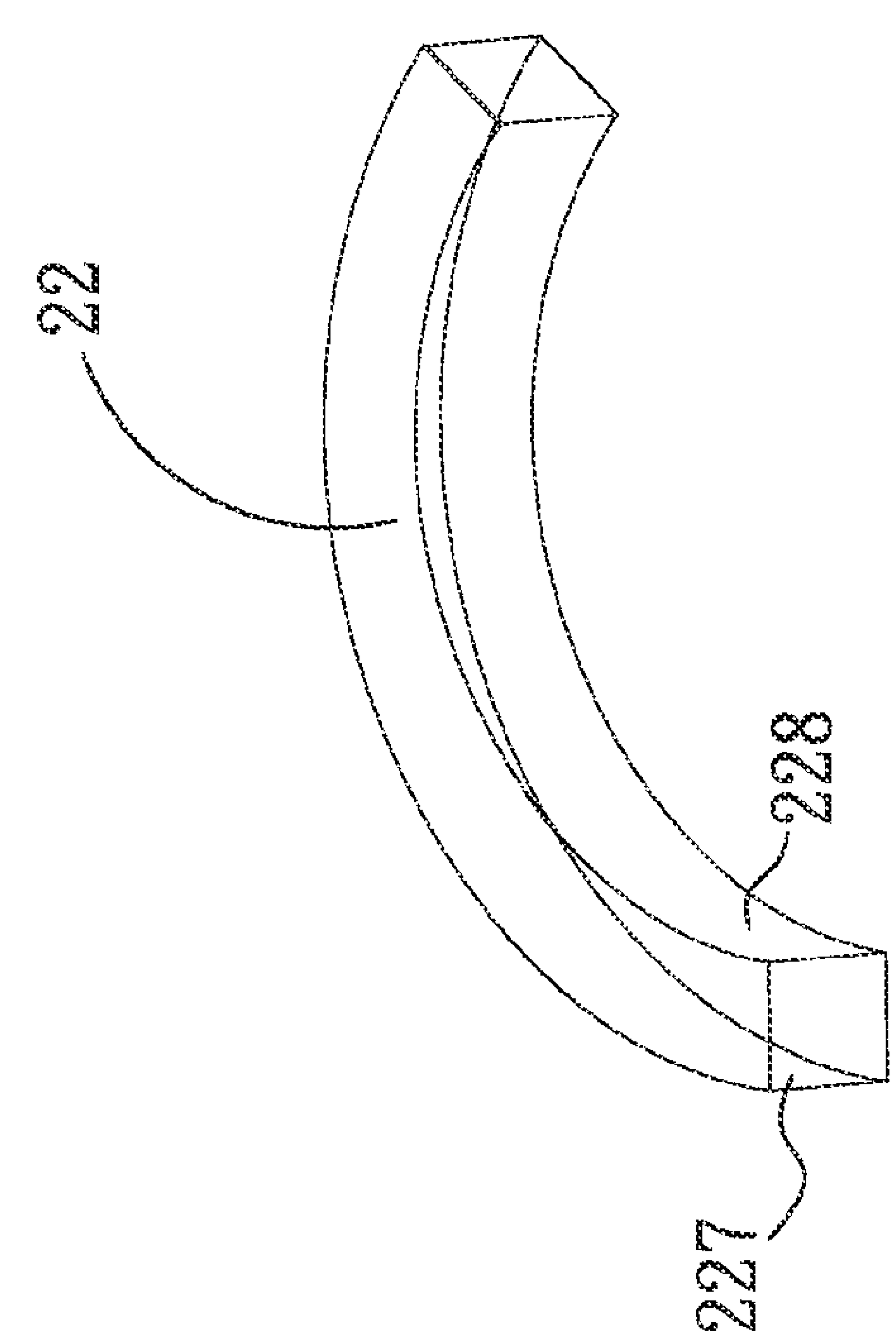


Fig. 4

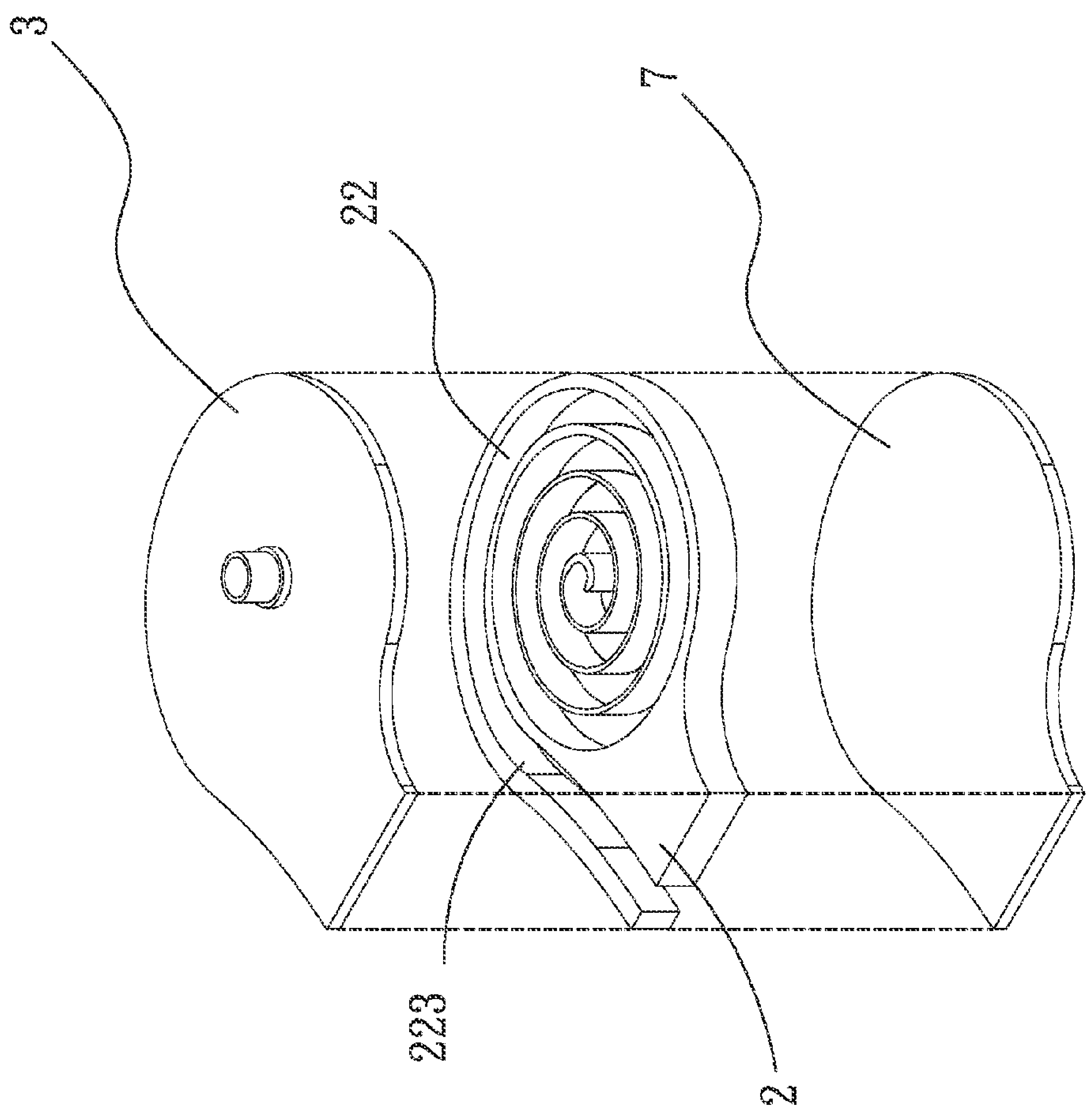


Fig. 6

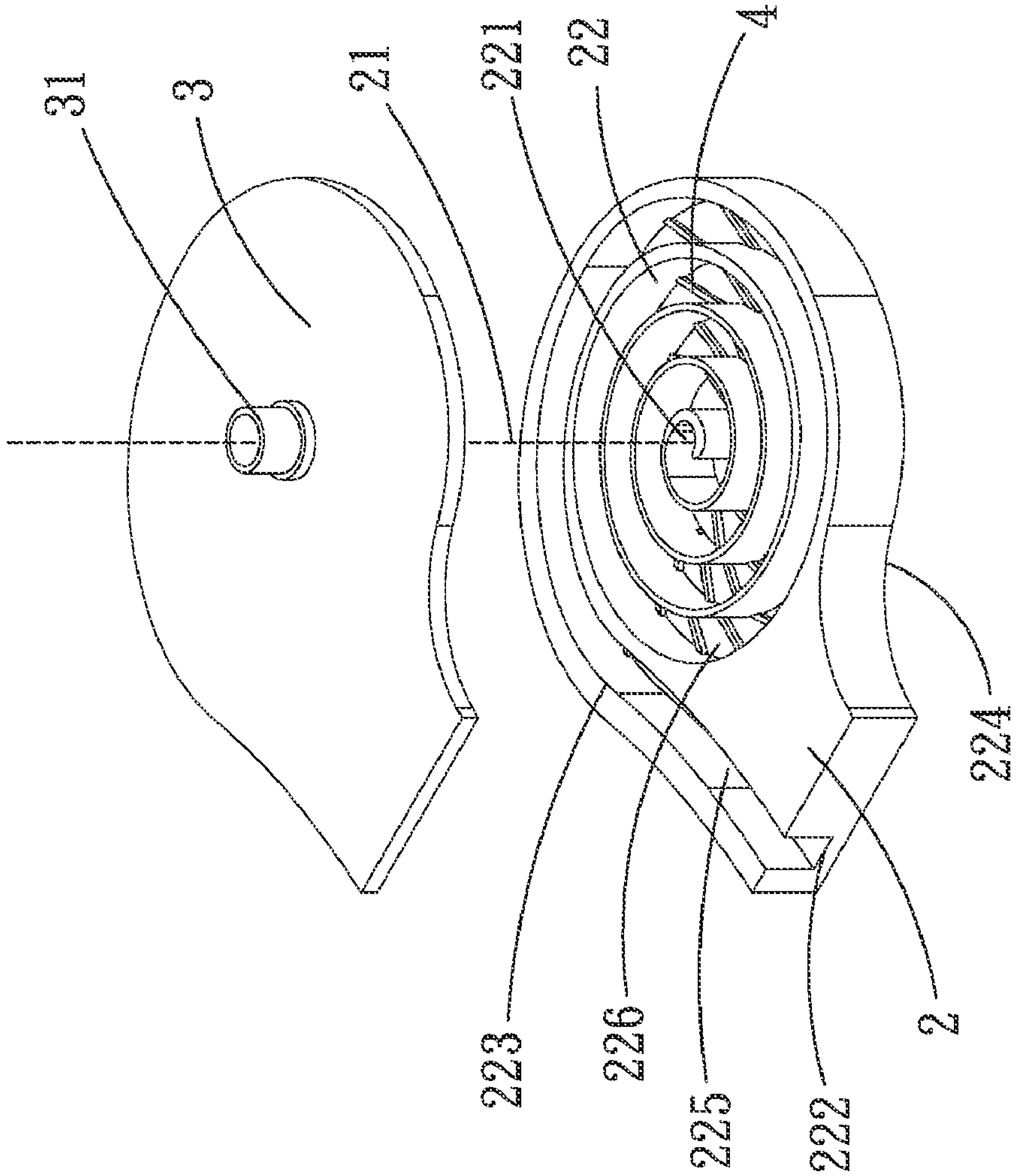


Fig. 7

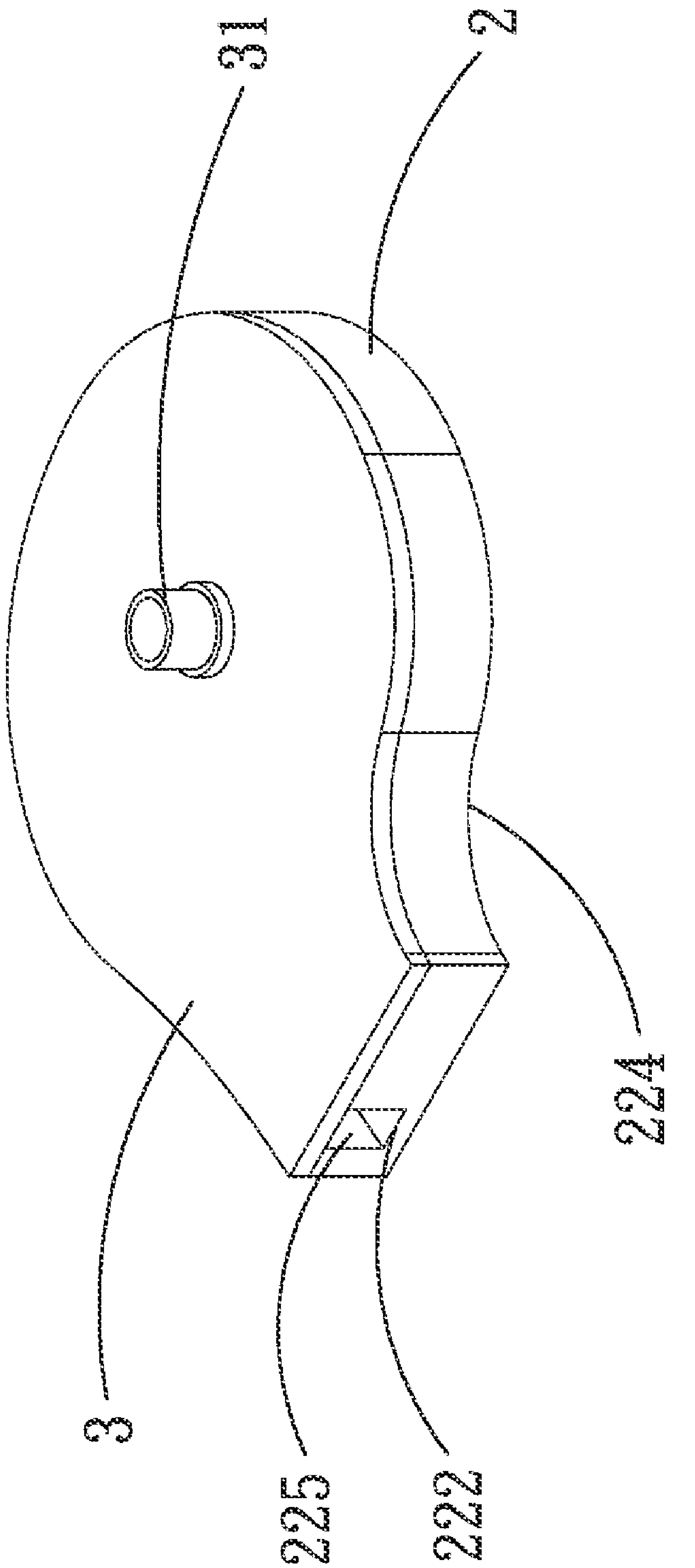


Fig. 8

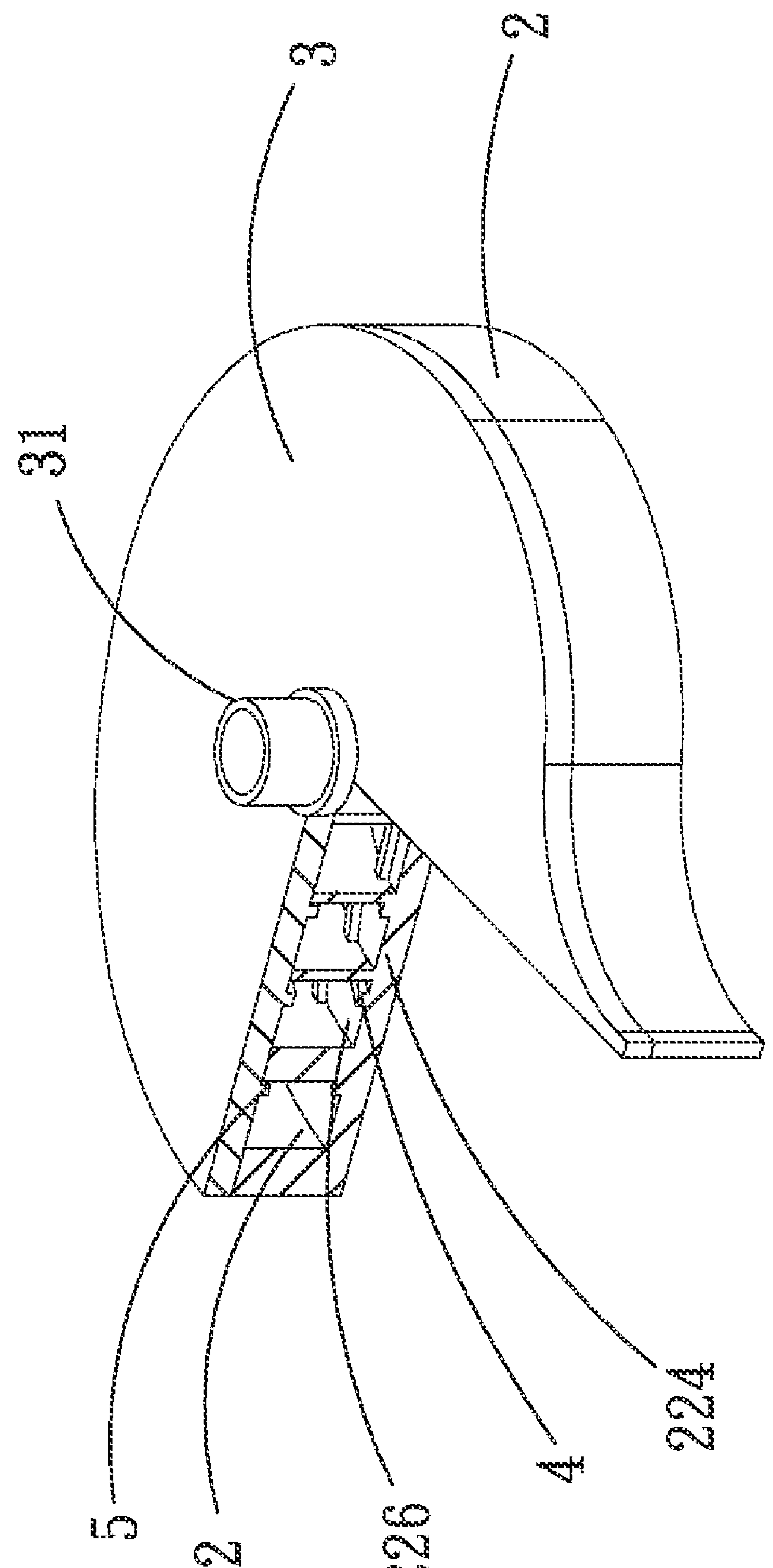


Fig. 9

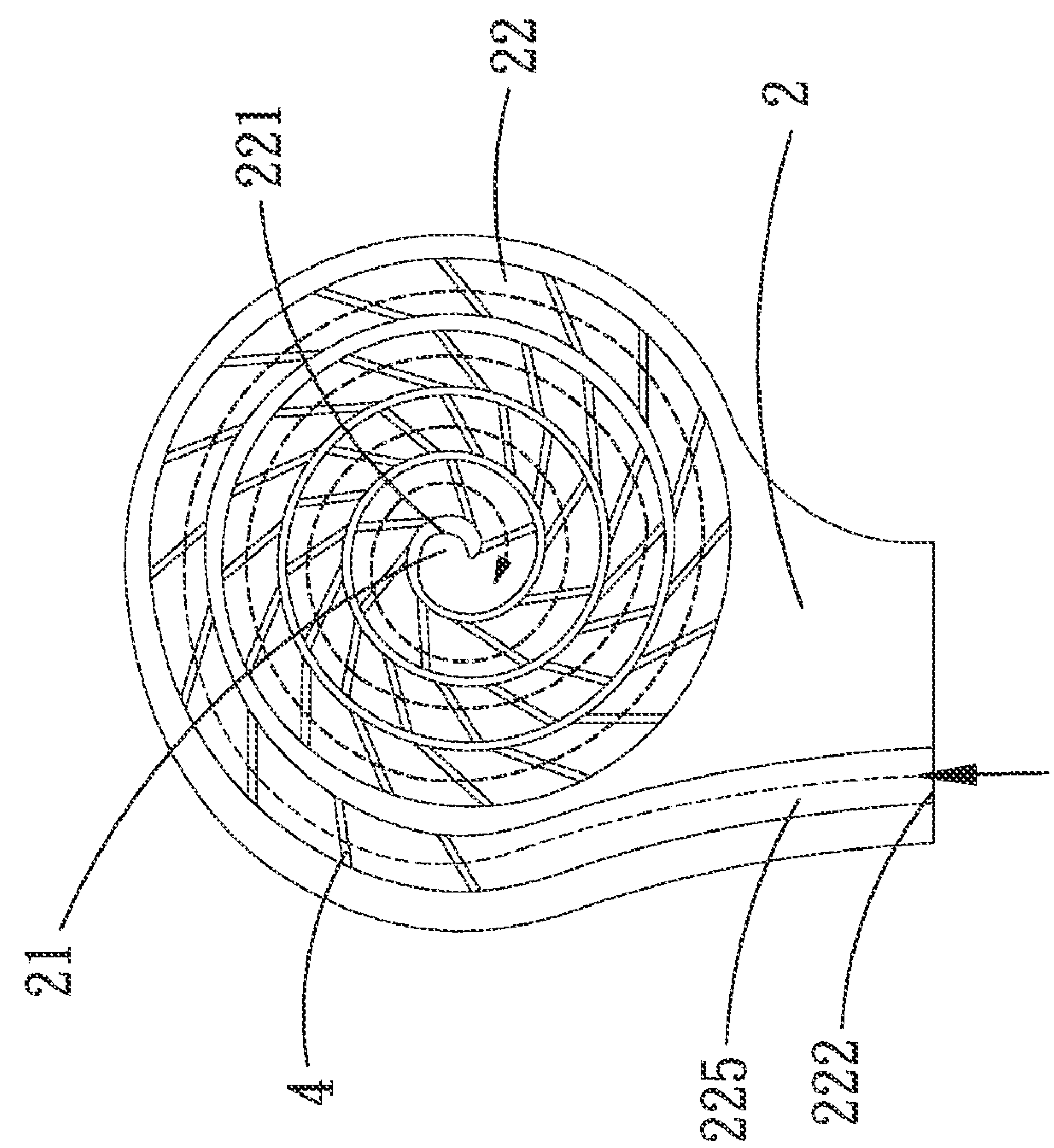


Fig. 10

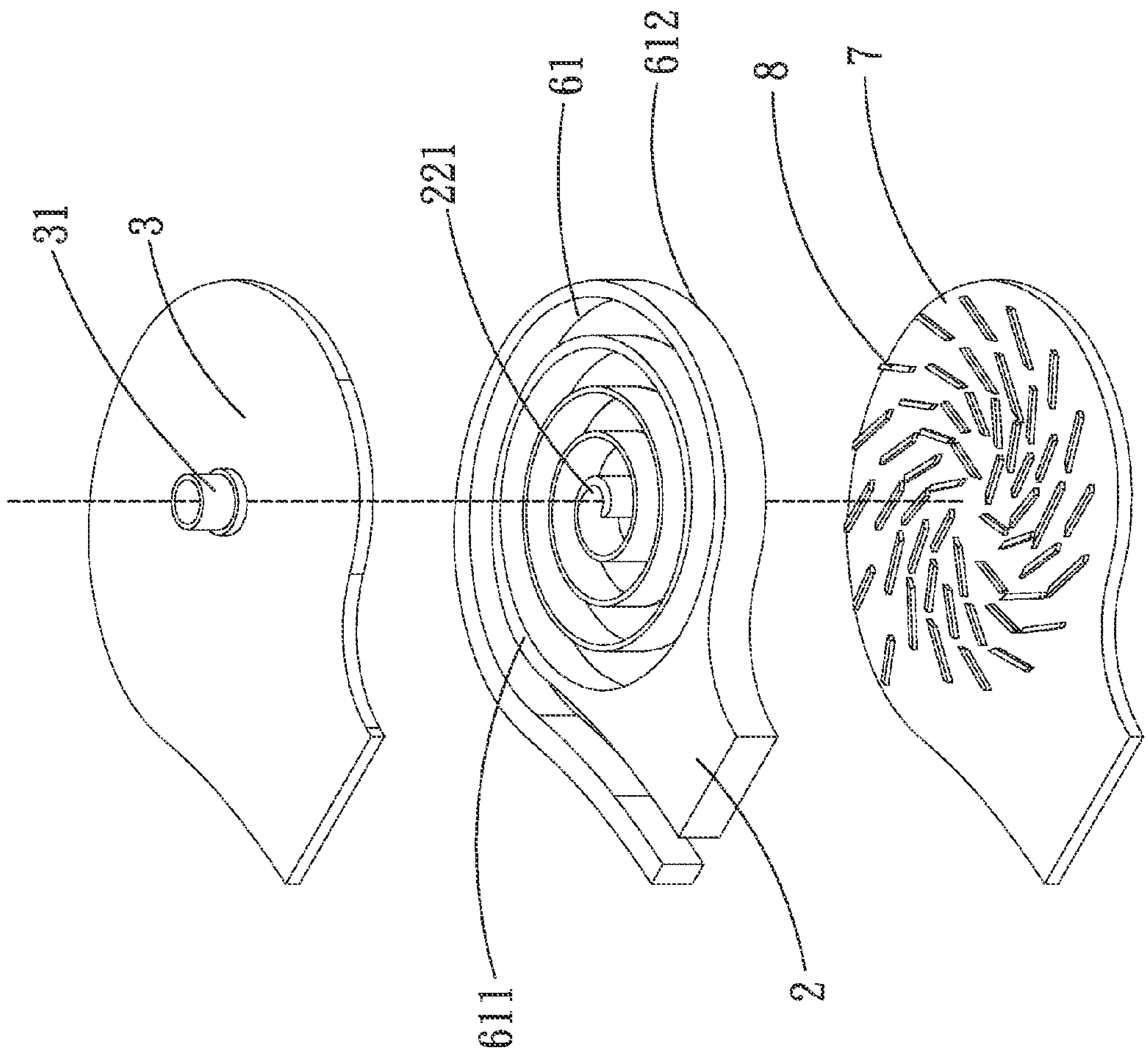


Fig. 11

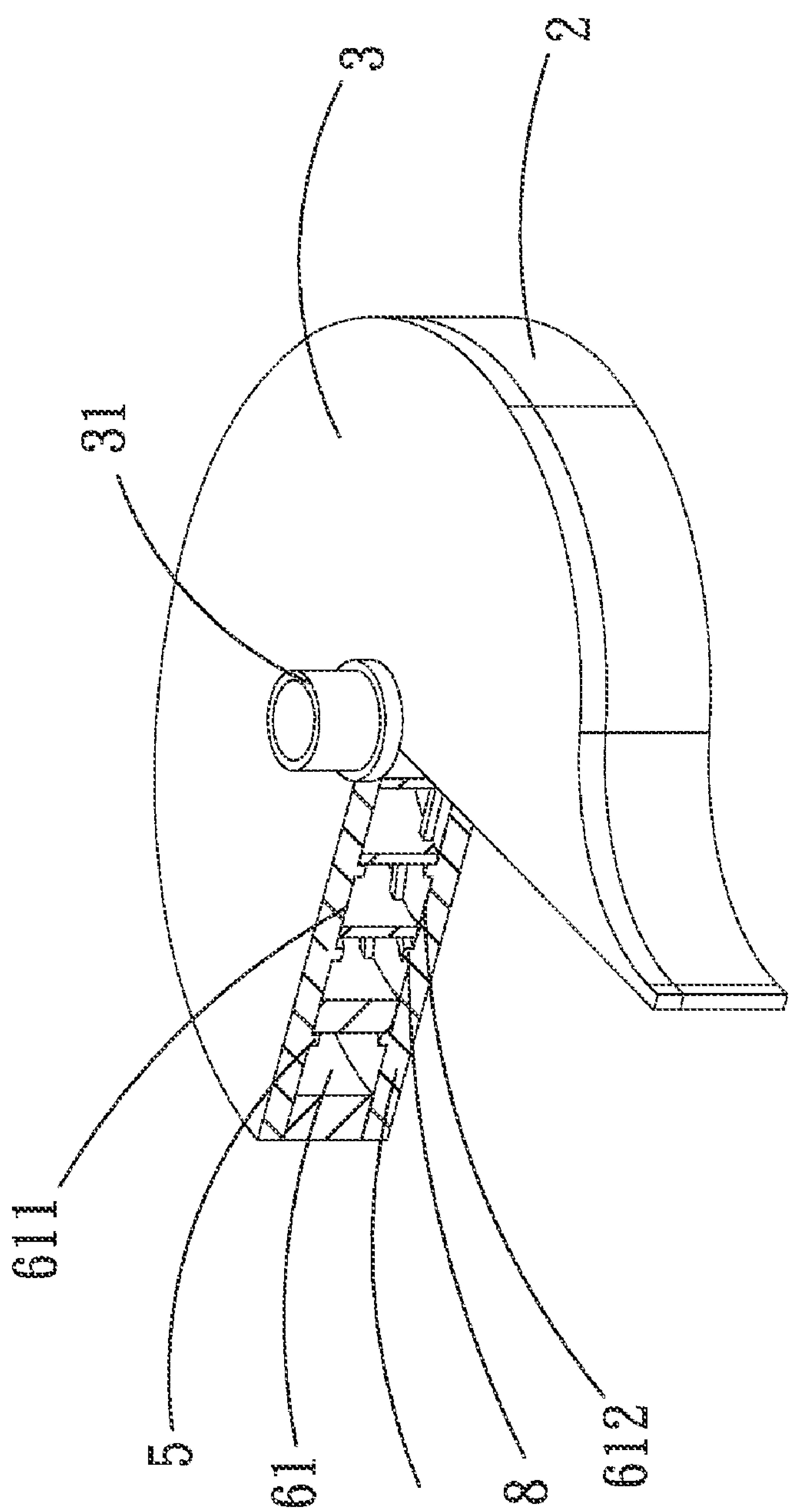


Fig. 12

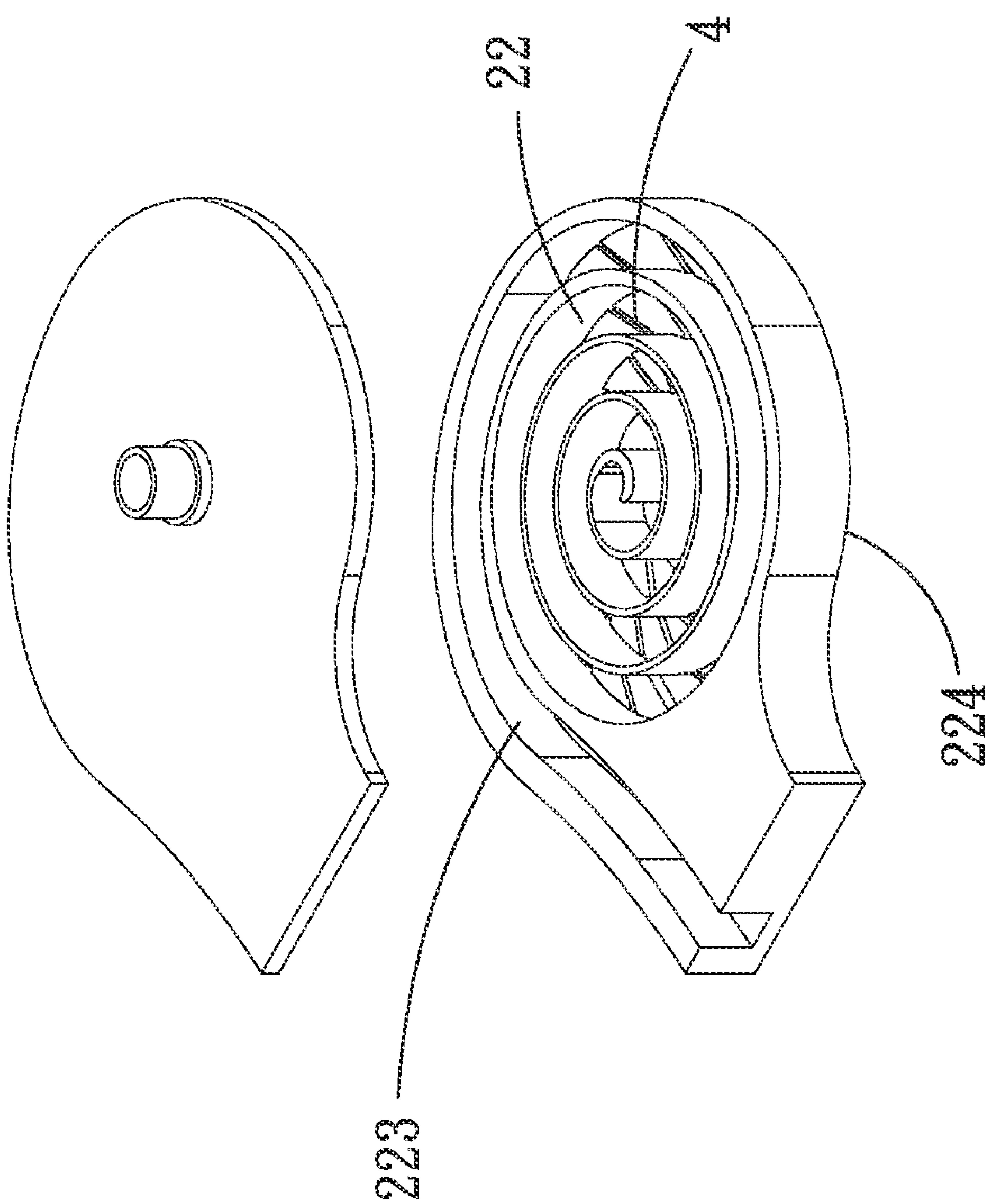


Fig. 13

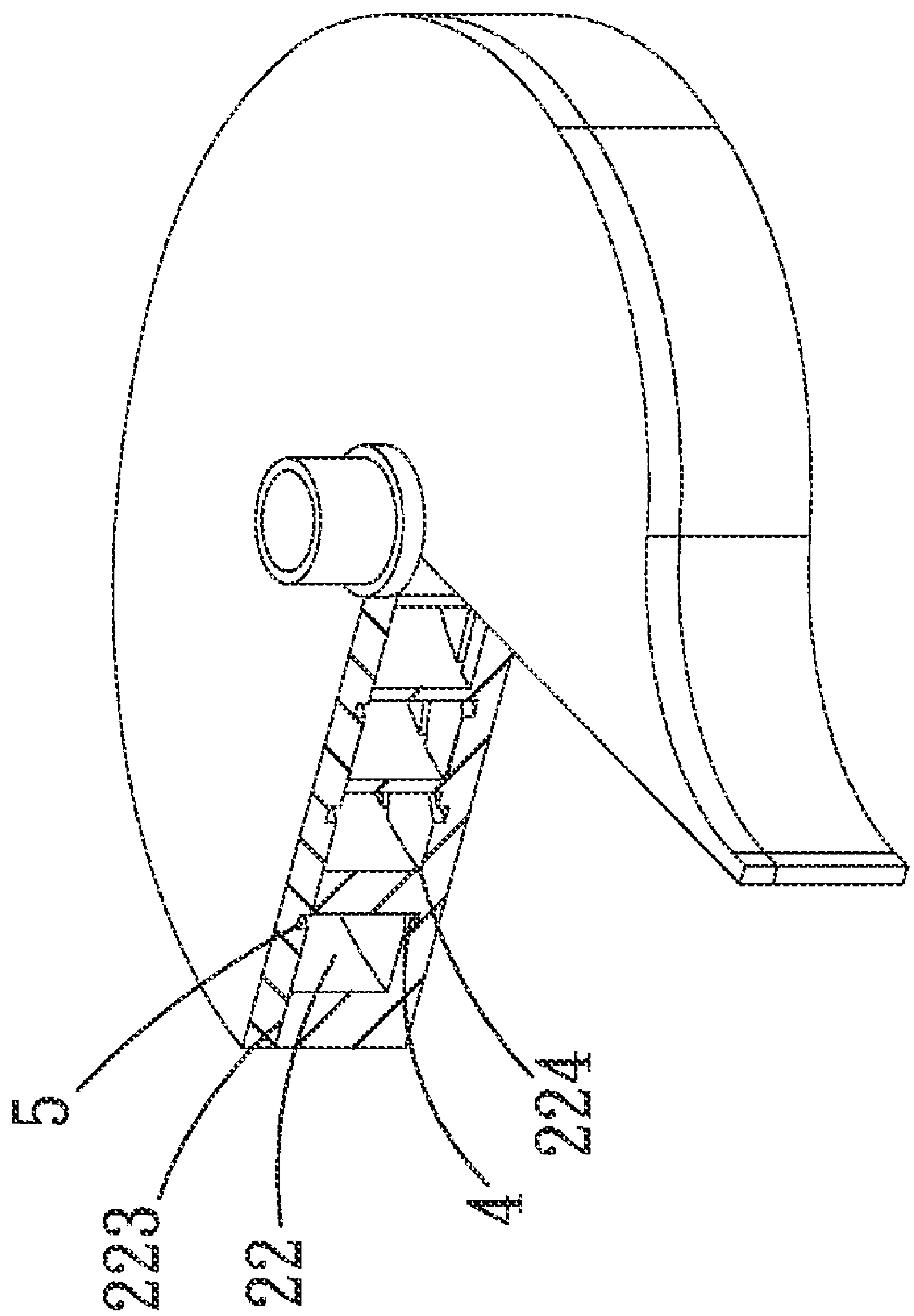


Fig. 14

HEAT EXCHANGER

[0001] This application claims the priority benefit of Taiwan patent application number 099100907 filed on Jan. 14, 2010.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a heat exchanger, and in particular to a heat exchanger with an increased thermal-conducting efficiency.

[0004] 2. Description of Prior Art

[0005] With the continuous advancement of electronic information technology, electronic apparatuses (such as computers, notebook computer, communication housings, or the like) are getting more popular and widely used in our daily life. However, since electronic elements in the electronic apparatuses generate waste heat during their operation at high speed, the waste heat ma be accumulated in the electronic apparatuses if the waste heat cannot be dissipated to the outside of the electronic apparatuses. As a result, the temperature of the electronic elements inside the electronic apparatus increases continuously, which causes the electronic elements to suffer damage or deteriorate the efficiency in operation due to its high temperature.

[0006] In order to improve the heat dissipation of the above-mentioned electronic apparatus, a common solution is to install a heat-dissipating fan in the electronic apparatus to generate a compulsive airflow for heat dissipation. However, the amount of airflow generated by the heat-dissipating fan is so limited that the heat-dissipating effect and the degree of lowering the temperature are restricted. Therefore, another solution is proposed, in which a water-cooling heat-dissipating device is directly adhered on a heat-generating element (such as a central processing unit, MPU, south bridge chip, north bridge chip or the like). A pump introduces a cooling liquid from a reservoir into the water-cooling heat-dissipating device, so that the cooling liquid and the water-cooling heat-dissipating device absorb the heat generated by the heat-generating element. Then, the cooling liquid is exhausted from an outlet port of the water-cooling heat-dissipating device to a heat-dissipating module. After the cooling liquid is cooled in the heat-dissipating module, the cooling liquid is transferred to the reservoir again for circulation. With the circulation of the cooling liquid, the temperature of the heat-generating element can be reduced, thereby maintaining the normal operation of the heat-generating element.

[0007] Although the aforesaid water-cooling heat-dissipating device can generate a better heat-dissipating effect than that of air cooling, another problem is generated. That is, since the water-cooling heat-dissipating device abuts one surface of the heat-generating element (i.e. heat-absorbing surface), only the lowest layer of the cooling liquid in the water-cooling device is effective in exchanging the heat with the heat-absorbing surface. Further, the cooling liquid stayed in the water-cooling heat-dissipating device is so short that the cooling liquid is rapidly exhausted from the outlet port even not absorbing enough heat. As a result, the water-cooling effect is insufficient, which also affects the thermal-conducting effect and the heat-dissipating effect.

[0008] Please refer to FIG. **1** showing a conventional water-cooling heat-dissipating structure, which includes a base **10** and a cover **11**. The cover **11** has an accommodating space **111**, an inlet pipe **112** and an outlet pipe **113**. The inlet pipe **112** and the outlet pipe **113** are formed on two opposite sides of the cover **11** in communication with the accommodating space **111**. The base **10** is covered by the cover **11**. The base **10** is provided with a plurality of heat-dissipating fins **13** protruding the accommodating space **111** of the cover **11**. A plurality of one-way channels **131** is formed between the heat-dissipating fins **13** and corresponds to the inlet pipe **112** and the outlet pipe **113** respectively. Thus, when a cooling liquid is introduced into the accommodating space **111** from the inlet pipe **112**, the plurality of one-way channels **131** guides the cooling liquid to pass through the heat-dissipating fins **13**, thereby exchanging the heat with the heat-dissipating fins **13** and achieving a better heat-dissipating effect.

[0009] In the aforesaid heat-dissipating structure, the heat-dissipating fins **13** increases the total heat-dissipating area, so that the cooling fluid can flow through and stay in the plurality of one-way channels **131** for a longer period of time, thereby generating a better heat-exchanging effect. However, since the one-way channels **131** are formed between the fins, a larger frictional resistance is generated between the fins and the cooling liquid. Thus, with the same pump of a certain power, the cooling liquid can be driven at a smaller flowing rate. As a result, the coefficient of thermal convection is low while the coefficient of pressure loss is high, which affects the amount of thermal convection and thermal conduction between the cooling liquid and the heat-dissipating fins **13**. Therefore, the whole heat-exchanging efficiency, the thermal-conducting effect and in turn the heat-dissipating effect of the whole structure are insufficient.

[0010] According to the above, the conventional heat-dissipating structure has problems as follows;

[0011] (1) the amount of the cooling liquid in the base is so small that the thermal-conducting effect is poor;

[0012] (2) only a lower layer of the cooling liquid is brought into thermal contact with a heat source, so that the thermal-conducting effect is poor;

[0013] (3) poor heat-exchanging efficiency; and

[0014] (4) poor heat-dissipating effect.

[0015] In view of the above, the present inventor proposes a novel heat exchanger based on his expert experience and delicate researches.

SUMMARY OF THE INVENTION

[0016] In order to solve the above problems, an objective of the present invention is to provide a heat exchanger having a spiral guiding trough, whereby the thermal-conducting capacity and the coefficient of thermal performance can be increased.

[0017] In order to achieve the above objective, the present invention is to provide a heat exchanger, which includes: a body having a center and a spiral guiding trough extending spirally and outwardly from the center to an outside of the center, a radius of the spiral guiding trough increasing gradually from the center to the outside of the center; and a first port and a second port in communication with the spiral guiding trough respectively. With the spiral guiding trough, a fluid can be mixed sufficiently in the spiral guiding trough, thereby achieving an excellent thermal-conducting effect.

[0018] The present invention further provides a heat exchanger, which includes: a body having a center and a spiral guiding trough extending spirally and outwardly from the center to an outside of the center, a radius of the spiral guiding trough increasing gradually from the center to the outside of the center; a first port and a second port in communication with the spiral guiding trough respectively; and at least one first turbulent unit provided on a wall surface of the spiral guiding trough.

[0019] According to the present invention, the spiral guiding trough is formed with an open side on one side of the body and a closed end on the other side. At least one first cover is provided on the open side for covering the body to seal the open side. The first cover has at least one second turbulent unit to correspond to the open side of the spiral guiding trough. The first cover has a tube in communication with the first port.

[0020] According to the present invention, the spiral guiding trough is formed with an open side respectively on both sides of the body. A first cover and a second cover are provided to correspond to two open sides and cover the body to seal the open sides. The first cover and the second cover have at least one second turbulent unit and at least one third turbulent unit to correspond to the open sides of the spiral guiding trough respectively.

[0021] According to the present invention, the spiral guiding trough has a first channel in communication with the second port. The first channel is in communication with the spiral guiding trough and the second port by means of the first channel.

[0022] The above objectives and structural and functional features of the present invention will be described in more detail with reference to preferred embodiment thereof shown in the accompanying drawings

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. **1** is an exploded view showing a conventional water-cooling heat-dissipating assembly;

[0024] FIG. **2** is an exploded view showing a first embodiment of the present invention;

[0025] FIG. **3** is an assembled view showing the first embodiment of the present invention;

[0026] FIG. **4** is an partially perspective view showing the spiral guiding trough of the first embodiment of the present invention;

[0027] FIG. **5** is a schematic view showing Dean vortices generated by a fluid in the cross section of the spiral guiding trough in FIG. **4**;

[0028] FIG. **6** is an exploded view showing a second embodiment of the present invention;

[0029] FIG. **7** is an exploded perspective view showing a third embodiment of the present invention;

[0030] FIG. **8** is an assembled perspective view showing the third embodiment of the present invention;

[0031] FIG. **9** is a cross-sectional perspective view showing the third embodiment of the present invention;

[0032] FIG. **10** is a schematic view showing the operating state of the third embodiment of the present invention;

[0033] FIG. **11** is an exploded perspective view showing a fourth embodiment of the present invention;

[0034] FIG. **12** is a cross-sectional perspective view showing the fourth embodiment of the present invention;

[0035] FIG. **13** is an exploded perspective view showing a fifth embodiment of the present invention; and

[0036] FIG. **14** is a cross-sectional perspective view showing the fifth embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0037] The present invention is directed to a heat exchanger. The drawings show several preferred embodiments of the present invention. Please refer to FIGS. **2** to **5**. The heat exchanger of a first embodiment of the present invention includes a body **2** having a center **21** as shown by a dotted axis. A spiral guiding trough **22** extends spirally and outwardly from the center **21** to the outside of the center **21**. The radius of the spiral guiding trough **22** increases gradually from the center **21** to the outside of the center **21**. In other words, the spiral guiding trough **22** extends spirally toward the inner wall of the body **2**, thereby forming a spiral channel (i.e. the spiral guiding trough **22**). FIG. **2** shows the spiral guiding trough **22**.

[0038] The body **2** further has a first port **221** and a second port **222**. The first port **221** is provided in the center **21**, and the second port **222** is provided at the outside of the center **21**. The first port **221** and the second port **222** are in communication with the spiral guiding trough **22**.

[0039] The spiral guiding trough **22** has a first channel **225** between the spiral guiding trough **22** and the second port **222**. The first channel **225** is in communication with the second port **222**, so that a fluid (such as cooling liquid or water) can be introduced into the second port **222** of the spiral guiding trough **22**. When the fluid flows through the spiral guiding trough **22**, a centrifugal force generated by the spiral guiding trough can be used to enhance the mixing of the fluid. Then, the fluid flows through the first port **221** to exit a tube **31**.

[0040] That is, after the fluid flows through the first channel **225** via the second port **222**, the fluid will flow toward the first port **221** along the spiral guiding trough **22**. At this time, since the radius of the spiral guiding trough **22** decreases gradually toward the center **21**, the fluid in the spiral guiding trough **22** will generate a secondary flow (i.e. Dean vortices) due to a centrifugal force and an inertia force exerted by the inner walls of the spiral guiding trough **22**. That is, the fluid field in the spiral guiding trough **22** will generate two vortices that are symmetrical to each other with opposite rotating directions (as shown in FIGS. **4** and **5**). The vortices indicated by the arrows in FIG. **5** flow between an outer side **227** (the side away from the center **21**) and an inner side **228** (the side close to the center **21**) of the spiral guiding trough **22**.

[0041] After the fluid flows through the first port **221**, the fluid flows to a pump (not shown) via the tube **31**. Then, the fluid is driven by the pump to return to the second port **222**. Thus, the fluid continuously circulates in the spiral guiding trough **22** and the pump, thereby achieving an excellent heat-dissipating effect.

[0042] By means of the spiral guiding trough **22**, the fluid flowing therein will be sufficiently mixed due to the secondary flow, thereby increasing the heat-exchanging efficiency and the thermal-conducting effect.

[0043] Please refer to FIGS. **2** and **3**. The heat exchanger further includes at least one first cover **3**. The first cover **3** covers the body **2**. The first cover **3** has the tube **31** in communication with the first port **221**. The tube **31**, the first port **221**, the spiral guiding trough **22** and the second port **222** are in communication with each other. The spiral guiding trough **22** is formed on one side of the body **2** with an open side **223**. A closed side **224** is formed opposite to the open side **223**. The spiral guiding trough **22** penetrates one side of the body **2** and thus the open side **223** is formed on the penetrating side. The other side of the body **2** is not penetrated by the spiral guiding trough **22**. With this arrangement, the closed side **224** is formed opposite to the open side **223**.

[0044] The first cover **3** closes the open side **223**. That is, the first cover **3** moves toward the open side **223**, so that the first cover **3** can cover the body **2** to close the open side **223**, thereby forming the heat exchanger.

[0045] The present invention can be applied to the heat dissipation of a heat-generating source (such as a computer, notebook computer, communication housing or other industrial electronic apparatus). The electronic elements in the heat-generating source convert electricity into heat energy. One side of the body **2** (i.e. the surface of the body **2** opposite to the open side **223**) is positioned to face the heat-generating source. After the fluid in the spiral guiding trough **22** exchanges the heat with the heat-generating source, the portion of the fluid in the spiral guiding trough **22** close to the heat-generating source (with a higher temperature) and the portion of the fluid in the spiral guiding trough **22** (with a lower temperature) can be mixed sufficiently, thereby achieving an excellent heat-exchanging effect of the heat exchanger (or enhancing the thermal-conducting efficiency of the fluid).

[0046] Please refer to FIG. **6**, which shows a second embodiment of the present invention. The second embodiment is substantially the same as the first embodiment, and thus the redundant description is omitted thereto. The only difference between the second embodiment and the first embodiment lies in that the heat exchanger further includes a second cover **7**. The second cover **7** and the first cover **3** cover both sides of the body **2** respectively. The spiral guiding trough **22** are formed on both sides of the body **2** with an open side **223** respectively. The first cover **3** and the second cover **7** are used to close the open sides **223** respectively.

[0047] Please refer to FIGS. **7** to **9**, which show a third embodiment of the present invention. The third embodiment is substantially the same as the first embodiment, and thus the redundant description is omitted thereto. The only difference between the third embodiment and the first embodiment lies in that the heat exchanger further includes at least one first turbulent unit **4** provided on a wall surface **226** of the spiral guiding trough **22**. In the present embodiment, the first turbulent unit **4** is provided on the closed side **224** of the spiral guiding trough **22**. The first cover **3** has at least one second turbulent unit **5** facing the open side **223** of the spiral guiding trough **22**. Thus, in the present embodiment, the first turbulent unit **4** and the second turbulent unit **5** are provided on the closed side **224** and the open side **223** of the spiral guiding trough **22** respectively. The first turbulent unit **4** and the second turbulent unit **5** are protrusions provided on the closed side **224** and the open side **223** of the spiral guiding trough **22** respectively.

[0048] Please refer to FIGS. **5**, **9**, and **10**, the fluid can enter the heat exchanger via the second port **222** and exit via the first port **221**. Alternatively, the fluid can enter the heat exchanger via the first port **222** and exit via the second port **221**. In the present embodiment, the fluid enters the heat exchanger via the second port **222**, flows toward the first port **221** and exits the heat exchanger via the tube **31** (as indicated by the arrows of FIG. **10**). That is to say, the fluid flows into the heat exchanger via the second port **222** and into the first channel **225** of the spiral guiding trough **22**. After the fluid flows through the first channel **225**, it enters the spiral guiding trough **22** and flows toward the center **21** of the body **2** along the spiral guiding trough **22**. Since the fluid generates a three-dimensional secondary flow (i.e. dean vortices) due to the inertia force and the centrifugal force, the fluid field in the spiral guiding trough **22** generates two vortices that are symmetrical to each other with two opposite rotating directions. The vortices (indicated by the arrows in FIG. **5**) flow between the outer side **227** (the side away from the center **21**) and the inner side **228** (the side close to the center **21**).

[0049] At the same time, the fluid in the spiral guiding trough **22** flows along the first turbulent unit **4** and the second turbulent unit **5** of the first cover **3**, thereby generating a swirling flow in the spiral guiding trough **22** to increase the coefficient of thermal convection therein. The first turbulent unit **4** and the second turbulent unit **5** also generate two vortices that are symmetrical to each other with opposite rotating directions in the spiral guiding trough **22**. The vortices (as indicated by the arrows in FIG. **5**) flow between the outer side **227** (the side away from the center **21**) and the inside side **227** (the side close to the center **21**) in the spiral guiding trough **22**, thereby enhancing the strength of turbulence and thermal-conducting effect. The vortices caused by the first turbulent unit **4** and the second turbulent unit **5** are of the same directions as that of Dean vortices. Thus, the secondary flow caused by the first turbulent unit **4** and the second turbulent unit **5** also increases strength of turbulence in the spiral guiding trough **22** and the thermal-conducting effect of the heat exchanger.

[0050] According to the above, in comparison with prior art, the present invention allows the fluid to flow along the first turbulent unit **4** and the second turbulent unit **5** of the spiral guiding trough **22**, thereby increasing the strength of Dean vortices, swirling flow, turbulent flow, and laminar flow. Not only the fluid can be mixed in the spiral guiding trough **22** fore more times, but also the thermal-conducting capacity and the coefficient of thermal performance of the fluid can be increased.

[0051] Please refer to FIGS. **11** and **12**, which show the fourth embodiment of the present invention. The most components of the fourth embodiment are the same as those of the third embodiment, and thus the redundant description is omitted for clarity. The only difference between the fourth embodiment and the third embodiment lies in that a spiral guiding trough **61** is formed on both sides of the body **2** with an open side **611**, **612** respectively. A first cover **3** (the same as that of the third embodiment) and a second cover **7** face the open sides **611** and **612** respectively to cover the body **2** and close the open sides **611**, **612**. The first cover **3** has a tube **31** in communication with the first port **221**. The first cover **3** and the second cover **7** have the second turbulent unit **5** and the third turbulent unit **8** respectively, thereby increasing the strength of turbulent flow in the spiral guiding trough and the thermal-conducting effect of the heat exchanger.

[0052] Please refer to FIGS. **13** and **14**, which show the fifth embodiment of the present invention. The most components of the fifth embodiment are the same as those of the third embodiment, and thus the redundant description is omitted for clarity. The only difference between the fifth embodiment and the third embodiment lies in that the first turbulent unit **4** and the second turbulent unit **5** are formed into troughs provided on the closed side **224** and the open side **223** of the spiral guiding trough **22** respectively. Thus, the secondary flow caused by the first turbulent unit **4** and the second turbulent unit **5** can increase the strength of turbulent flow in the spiral guiding trough and the thermal-conducting effect in the heat exchanger.

[0053] Although the present invention has been described with reference to the foregoing preferred embodiments, it will be understood that the invention is not limited to the details thereof. Various equivalent variations and modifications can still occur to those skilled in this art in view of the teachings of the present invention. Thus, all such variations and equivalent modifications are also embraced within the scope of the invention as defined in the appended claims.

What is claimed is:

1. A heat exchanger, including:

a body having a center and a spiral guiding trough extending spirally and outwardly from the center toward an outside of the center, a radius of the spiral guiding trough increasing gradually from the center toward the outside of the center, and

a first port and a second port being in communication with the spiral guiding trough respectively.

2. The heat exchanger according to claim **1**, wherein the first port is positioned in the center, and the second port is positioned in the outside of the center.

3. The heat exchanger according to claim **2**, wherein the spiral guiding trough has a first channel provided between the spiral guiding trough and the second channel in communication with the second port.

4. The heat exchanger according to claim **1**, further including at least one first cover for covering the body, the first cover having a tube in communication with the first port.

5. The heat exchanger according to claim **2**, further including at least one first cover for covering the body, the first cover having a tube in communication with the first port.

6. The heat exchanger according to claim **4**, wherein the spiral guiding trough is formed on one side of the body with an open side, the first cover seals the open side.

7. The heat exchanger according to claim **1**, further including a first cover and a second cover for covering both sides the body, the spiral guiding trough is formed on both sides of the body with an open side respectively, the first cover and the second cover seal the open side respectively.

8. A heat exchanger, including:

a body having a center and a spiral guiding trough extending spirally and outwardly from the center toward an outside of the center, a radius of the spiral guiding trough increasing gradually from the center toward the outside of the center, a first port and a second port being in communication with the spiral guiding trough respectively; and

at least one first turbulent unit provided on a wall surface of the spiral guiding trough.

9. The heat exchanger according to claim **8**, wherein the first turbulent unit is a protrusion.

10. The heat exchanger according to claim **8**, wherein the first turbulent unit is a trough.

11. The heat exchanger according to claim **8**, wherein the spiral guiding trough is formed with an open side on one side of the body, and a closed side on the other side.

12. The heat exchanger according to claim **8**, wherein the spiral guiding trough has a first channel in communication with the second port.

13. The heat exchanger according to claim **11**, further including at least one first cover facing the open side for covering the body to seal the open side, the first cover having a tube in communication with the first port.

14. The heat exchanger according to claim **13**, wherein the first cover has at least one second turbulent unit corresponding to the open side of the spiral guiding trough.

15. The heat exchanger according to claim **14**, wherein the second turbulent unit is a protrusion.

16. The heat exchanger according to claim **14**, wherein the second turbulent unit is a trough.

17. The heat exchanger according to claim **8**, wherein the spiral guiding trough is formed on both sides of the body with an open side respectively.

18. The heat exchanger according to claim **17**, further including a first cover and a second cover facing the two open sides for covering the body to seal the open sides.

19. The heat exchanger according to claim **18**, wherein the first cover and the second cover have at least one second turbulent unit and at least one third turbulent unit corresponding to the open sides of the spiral guiding trough respectively.

20. The heat exchanger according to claim **19**, wherein the second turbulent unit and the third turbulent unit are protrusions.

21. The heat exchanger according to claim **19**, wherein the second turbulent unit and the third turbulent unit are troughs.

22. The heat exchanger according to claim **19**, wherein the first turbulent unit is a protrusion, and the third turbulent unit is a trough.

23. The heat exchanger according to claim **19**, wherein the first turbulent unit is a trough, and the third turbulent unit is a protrusion.

* * * * *