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(54) **MAGNETIC COMPONENT COMPILING STRUCTURE AND MAGNETIC REFRIGERATOR ADAPTING MAGNETIC COMPONENT COMPILING STRUCTURE THEREOF**

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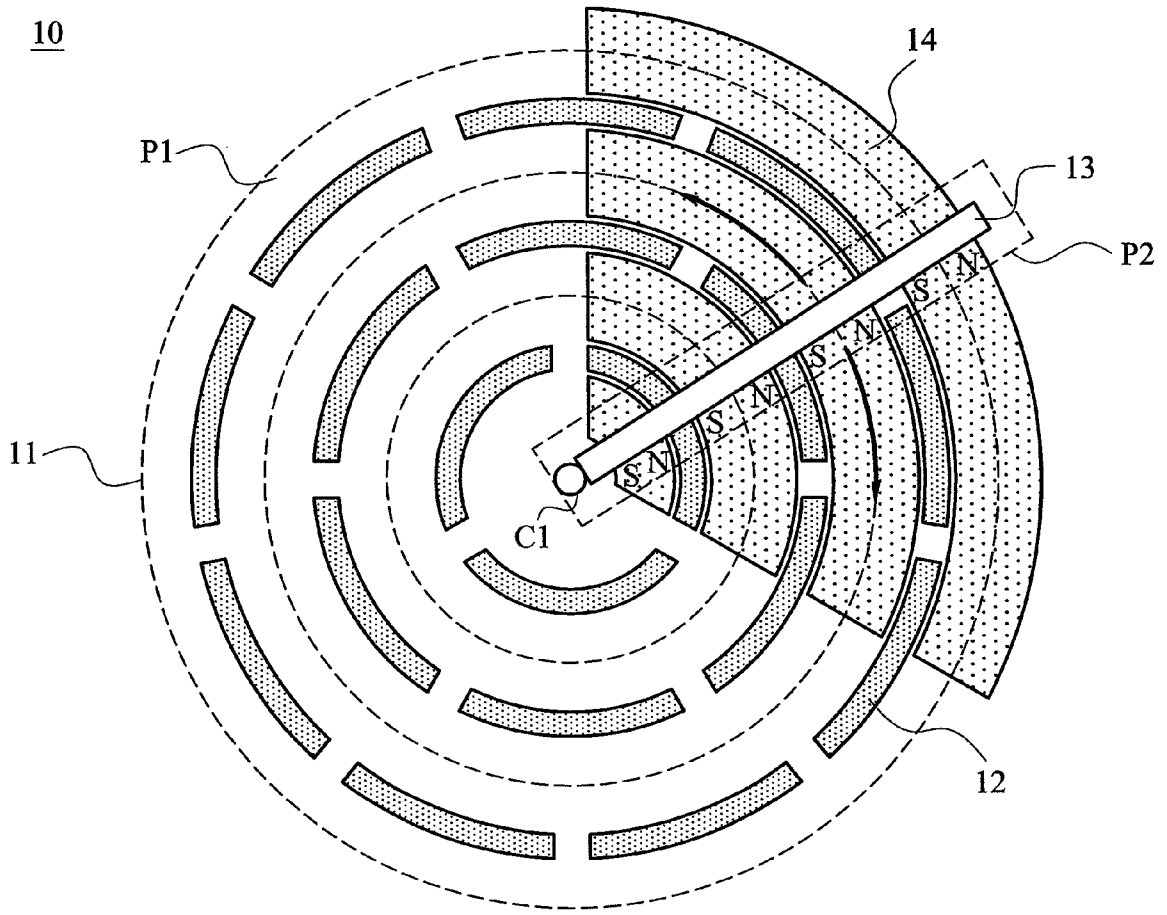
(57) **ABSTRACT**

A magnetic component compiling structure and a magnetic refrigerator adapts the magnetic component compiling structure thereof. The magnetic component compiling structure has more refrigerating beds and less permanent magnet per volume. Hence, the magnetic refrigerator saves more costs during manufacturing, and achieves higher cooling efficiency.



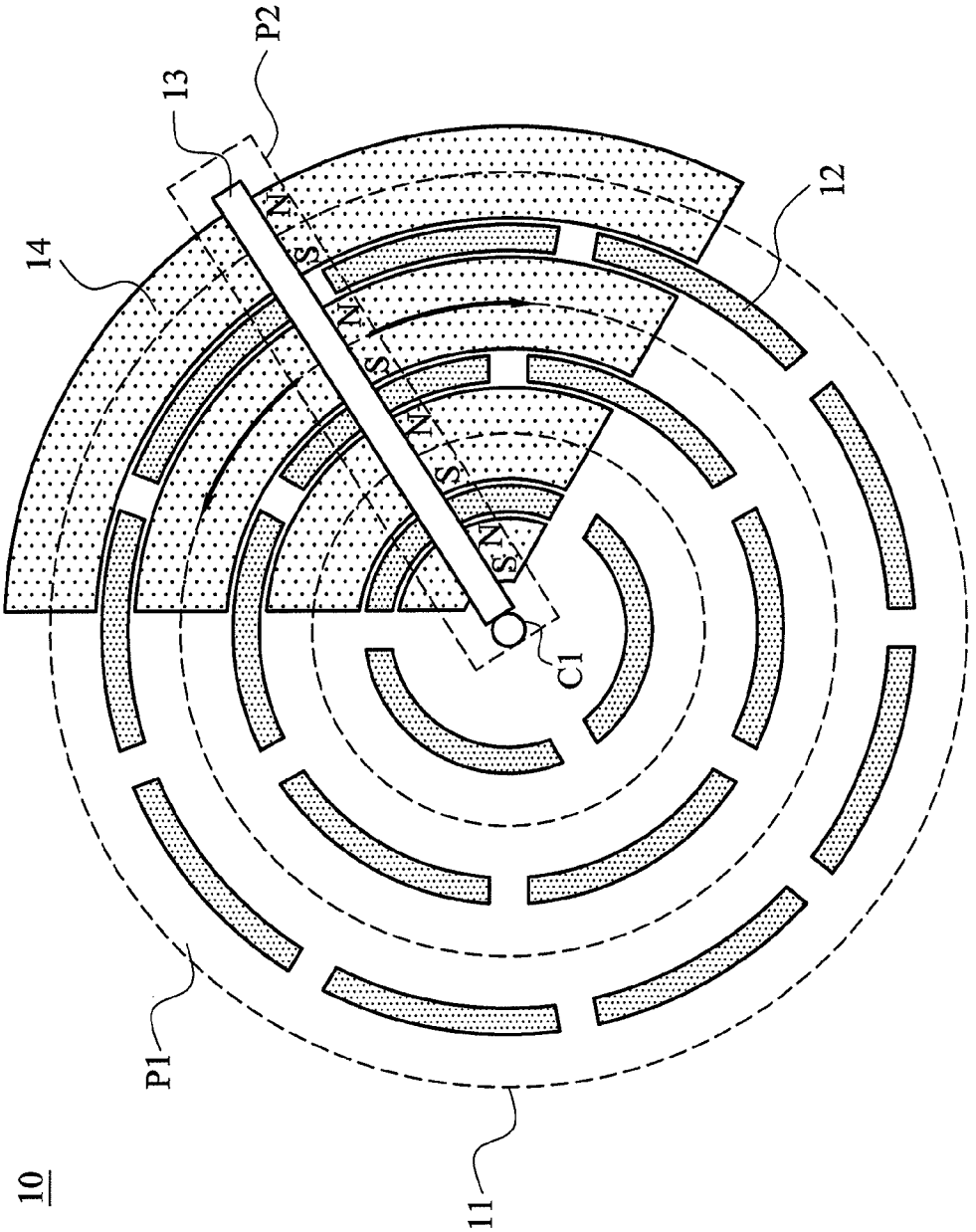


FIG. 1

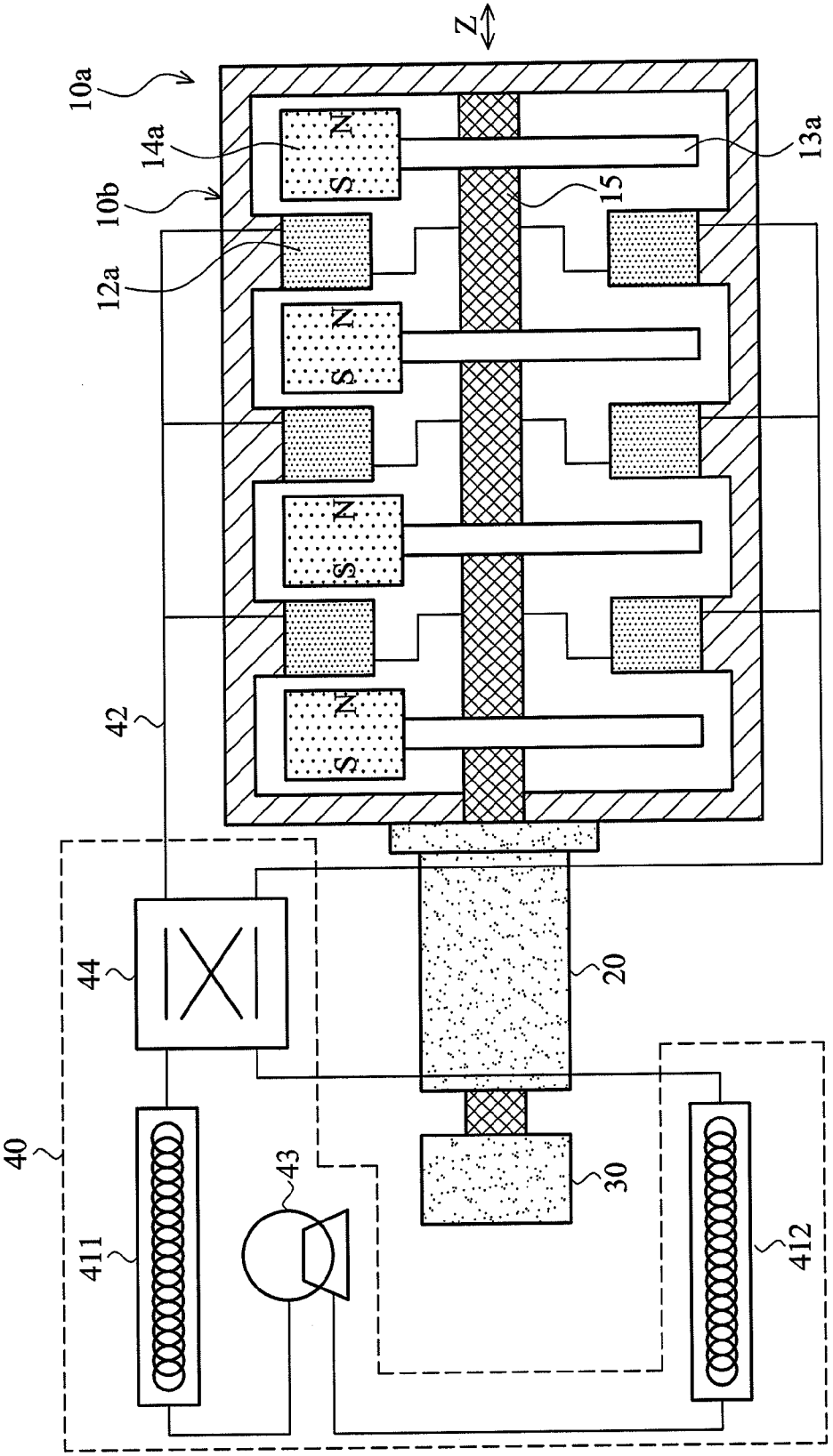


FIG. 2

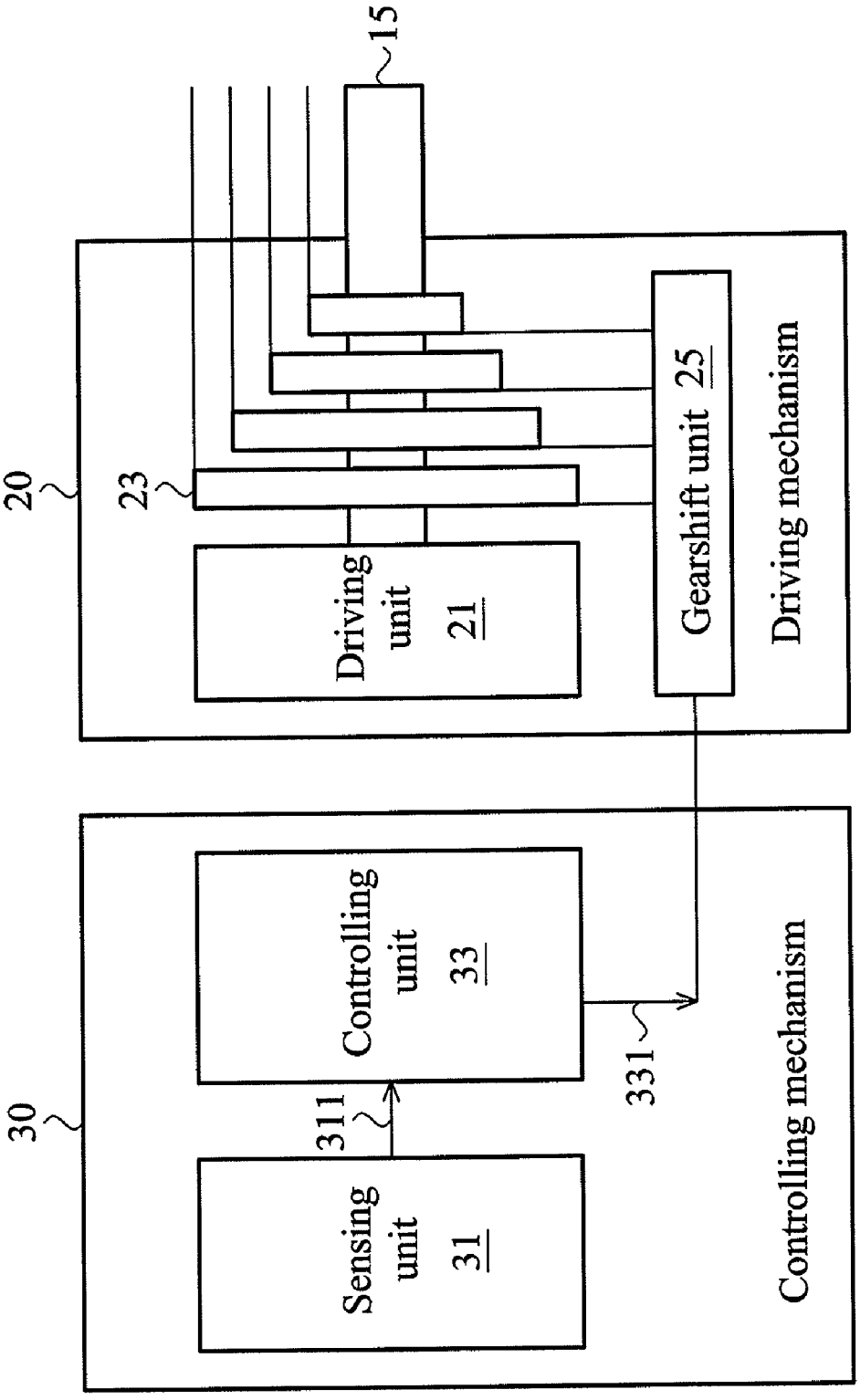

15
20
23
Driving unit 21
Gearshift unit 25
Driving mechanism
30
Controlling unit 33
311
331
Sensing unit 31
Controlling mechanism

FIG. 3

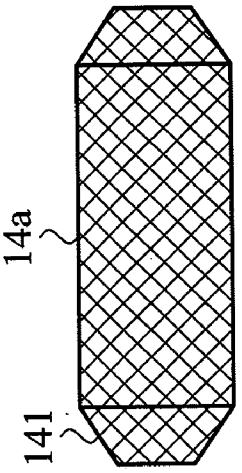


FIG. 4b

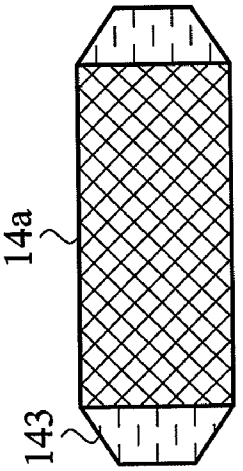


FIG. 4d

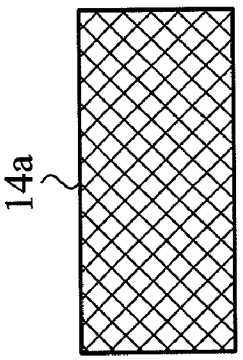


FIG. 4a

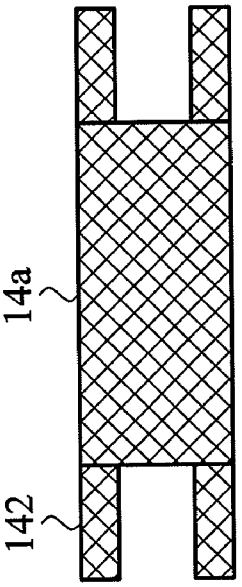


FIG. 4c

MAGNETIC COMPONENT COMPILING STRUCTURE AND MAGNETIC REFRIGERATOR ADAPTING MAGNETIC COMPONENT COMPILING STRUCTURE THEREOF

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 61,245,455 , filed Sep. 24, 2009.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to a magnetic component compiling structure and a magnetic refrigerator adapting the magnetic component compiling structure.

[0004] 2. Description of the Related Art

[0005] Magneto-caloric effect, MCE, is a characteristic of a magnetic material. Hence changing magnetic flux of an outer magnetic field will change entropy of material itself and follow the processes of absorbing or exhausting heat. Therefore, so called magneto-caloric material, MCM, means a material which has remarkable MCE manner. Further, so called magnetic refrigerating technology means adapting MCM to replace traditional refrigerant, such as CFC, HCFC, HFC, etc., to achieve a more environment friendly refrigerator, thus amount of MCM used in a magnetic refrigerator is an important concern while estimating cooling efficiency. However, when the amount of MCM is increasing, the amount of permanent magnets needs is accordingly increasing so as to keep constant MCE.

[0006] A traditional rotating magnetic refrigerator, refer to Japanese publication number 2008-51409, US publication number 2006/0218936, usually comprises motor driving a permanent magnet rotating in 360 degrees so as to magnetize or demagnetize MCM contained in refrigerating beds disposed on a periphery wherein the permanent magnet passes by. The drawbacks of above-mentioned rotating magnetic refrigerator are utilization rate of volume is low and utilization rate of material is low, that is if a user thicken the refrigerating bed to increase overall amount of MCM contained, the magnetic field casted by the permanent magnets were weaken relatively.

[0007] Therefore, how to contain the most amount of refrigerating beds in a finite space so as to achieve the highest utilization rate of material per unit volume is an important concern. Besides, how to cast less extra magnetic field and which shape is more suitable for the extra magnetic field are also important concerns.

BRIEF SUMMARY OF THE INVENTION

[0008] It is an object of the present invention to provide a magnetic component compiling structure containing the most magnetic components per unit volume.

[0009] It is an other object of the present invention to provide a magnetic refrigerator containing the most refrigerating beds per unit volume.

[0010] To achieve the above or other objects, the present invention discloses a single layer magnetic component compiling structure, comprising a plurality of first magnetic components, a shaft, and a plurality of second magnetic components. The first magnetic components are disposed on peripheries of a plurality of concentric circles with different radius defined by a center on a first plane. The shaft fixed at an end to a center on a second plane, wherein the centers of the first plane and the second plane are disposed in a line with a finite distance. The second magnetic components are disposed to the shaft and driven by the shaft when the shaft rotates, wherein each second magnetic component partly penetrates into the first plane and passes through intervals of the first magnetic components.

[0011] Besides, the present invention discloses a multiple layers magnetic component compiling structure, comprising a central axis, a plurality of magnetic component compiling sets. The axis extends along a direction, and each magnetic component compiling set comprises a plurality of first magnetic components, a shaft, and a plurality of second magnetic components. The arrangement of above-mentioned first magnetic components, shaft, and second magnetic components is nearly the same as the arrangement of the single layer magnetic component compiling structure, and it seems no need being further described here.

[0012] In addition, the invention also discloses a magnetic refrigerator adopting a magnetic component compiling structure, the magnetic refrigerator comprises a magnetic component compiling structure, a driving mechanism, a controlling mechanism, and a heat exchanging mechanism. The magnetic component compiling is adapted to the multiple layers magnetic component compiling structure as mentioned before. The driving mechanism drives the central axis of the magnetic component compiling structure rotating, the controlling mechanism controls the driving mechanism, and the heat exchanging mechanism connects the first magnetic components and exchanges heat with MCM contained in the first magnetic components to achieving a cooling outcome.

[0013] It is necessary to perform some improvements in order to enhance working efficiency of magnetic refrigerator of the present invention. For example, a user in the art may change a shape of the first magnetic component so as to contain as most MCM as possible. For example, a user in the art may change a shape of the second magnetic component so as to generate a larger or more homogeneous magnetic field. For example, a user in the art may change a shape of a permanent magnet structure of the present invention, wherein the permanent magnet structure comprises a smaller surface area, a C-shaped magnetic structure, and an auxiliary soft iron so as to cast the magnetic field more concentrating and homogenizing to a refrigerating bed and enhance cooling efficiency.

[0014] As mentioned above, because the magnetic components are compiled along an axis direction, while disposing refrigerating beds on a plurality concentric circles with different radius, a larger amount of refrigerating beds per unit volume and a less amount of permanent magnets needed are both achieved. Meanwhile, the driving mechanism drives the magnetic component compiling sets respectively so as to let a user in the art choosing freely according to necessary, and the overall working efficiency will be enhanced too.

[0015] A detailed description is given in the following embodiments with reference to the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0016] The invention will become more fully understood from the detailed description given herein below illustration only, and thus is not limitative of the present invention, and wherein:

[0017] FIG. **1** is a schematic view of a single layer magnetic component compiling structure according to an embodiment of the present invention;

[0018] FIG. **2** is a schematic view of a magnetic refrigerator according to an embodiment of the present invention;

[0019] FIG. **3** is a block diagram shows a driving mechanism and a controlling mechanism of the magnetic refrigerator according to an embodiment of the invention; and

[0020] FIGS. **4***a*, **4***b*, **4***c* and **4**D are schematic views of variations of second magnetic components of the according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0021] The present invention will be apparent from the following detailed description, which proceeds with reference to the accompanying drawings, wherein the same references relate to the same elements.

[0022] In a first embodiment of the present invention, there discloses a single layer magnetic component compiling structure, please refer to FIG. **1**, wherein the magnetic component compiling structure **10** comprises at least a plurality of first magnetic components **12**, a shaft **13**, and a plurality of second magnetic component **14**. The first magnetic components **12** are separately disposed with intervals along peripheries of a plurality of concentric circles **11**, wherein the concentric circles **11** are defined by a center C**1** on a first plane P**1** with different radius, and wherein the first magnetic components **12** are adapted to be disposed in different phases.

[0023] The shaft **13** is fixed at and end to a center on a second plane P**2**, wherein the second plane P**2** is slightly far away from the first plane P**1**, that is, the center of the second plane P**2** and the center of the first plane P**1** are adapted to be disposed, for example, in line vertically with a finite distance. The second magnetic components **14** are adapted to be separately disposed on the shaft **13** with intervals to each other, and thus the second magnetic components **14** are driven by the shaft **13** synchronously when the shaft **13** rotates. Each of the second magnetic components **14** is partly penetrating from the second plane P**2** into the first plane P**1** and passing through intervals between the first magnetic components **12** nearby.

[0024] Hence when the shaft **13** rotates and drives the second magnetic components **14**, the second magnetic components **14** and the first magnetic components **12** will not collide with each other and will make a relative motion to each other toward the center C**1**, i.e., center of the concentric circles **11** of the first plane where the first magnetic components **12** are disposed on. Besides, since the first magnetic components **12** are disposed in different phases, the above-mentioned relative motion is expected to be intermittent, that is, for example, two second magnetic components **14** will not be driven passing through two (or three) first magnetic components **12** disposed on an inner and an outer circles at the same time.

[0025] The first magnetic component **12** as mentioned can generate MCE, and the first magnetic components **12** may contain MCM inside thereof. Besides, shape of the first magnetic component **12** is adapted to the peripheral arc of the concentric circles **11**, such that the second magnetic components **14** can pass by the first magnetic components **12** more smoothly. Besides, each interval between the first magnetic components **12** is adapted to be disposed an auxiliary soft iron. The second magnetic component **14** as mentioned can generate magnetic flux, and the second magnetic component **14** is, for example, a permanent magnet or electromagnet, as FIG. **4***a* shows.

[0026] In an embodiment of the present invention, a plurality of shafts **13** are adapted to be disposed on the second plane P**2**, and wherein the shafts **13** are separately disposed with different phases, for example, two shafts **13** with 180 degrees away from each other, or three shafts **13** with 120 degrees away from each other, or four shafts **13** with 90 degrees away from each other, and so on. The above-mentioned multiple shafts arrangement is an easy solution for enhancing frequency of the relative motion as mentioned so as to enhance overall working efficiency or so called cooling efficiency.

[0027] In a second embodiment of the present invention, there discloses a multiple layers magnetic component compiling structure, please further refer to FIG. **2**, a schematic view of a magnetic refrigerator according to an embodiment of the present invention, wherein the magnetic component compiling structure **10***a* comprises at least a central axis **15** and a plurality of magnetic component compiling sets **10***b*. The central axis **15** extends, for example, along a direction Z, wherein the direction Z can be defined as a vertical or horizontal direction in this specification hereafter in other embodiment.

[0028] The magnetic component compiling sets **10***b* are adapted to the central axis **15** along the direction Z with different heights, wherein each magnetic component compiling set **10***b* comprises a plurality of first magnetic components **12***a*, a shaft **13***a*, and a plurality of second magnetic components **14***a* as mentioned, such that the arrangement of each magnetic component compiling set **10***b* is substantially the same as what the single layer magnetic component compiling structure **10** is. For example, please further refer to FIG. **1**, the magnetic components **12***a* are separately disposed along a plurality of concentric circles **11** with different radius defined by a center on an plane vertical to the direction Z.

[0029] Each end of the shafts **13***a* is connected to the central axis **15** with different heights according to the magnetic component compiling set **10***b* which the end belongs. The shafts **13***a* move on a plurality of peripheral routes defined by the ends thereof as mentioned. This embodiment expands a single layer application as mentioned to a multiple layers application, and the detailed arrangement is assumed as the same as the above-mentioned embodiment, thus this specification will not describe too much and people in the art are confirmed that they will also adapt this embodiment easily.

[0030] In a third embodiment of the present invention, please refer to FIG. **2**, the magnetic component compiling sets are adapted to a magnetic refrigerator, wherein the magnetic refrigerator comprises at least a magnetic component compiling structure **10***a*, a driving mechanism **20**, a controlling mechanism **30**, and a heat exchanging mechanism **40**. The magnetic component compiling structure **10***a* comprises a central axis **15** and a plurality of magnetic component compiling sets **10***b* as mentioned. The driving mechanism **20** drives the central axis **15** and the shafts **13***a* so as to make the first magnetic components **12***a* and the second magnetic components **14***a* moving relatively, while the controlling mechanism **30** controls the driving mechanism **20** to drive the central axis **15** and the shafts **13***a*. The heat exchanging mechanism **40** is connected to the first magnetic components **12***a* and thus exchanging heat with the first magnetic components **12***a*, wherein the first magnetic component **12***a* is adapted to generate MCE as mentioned.

[0031] Please refer to FIGS. **2** and **3**, a block diagram shows a driving mechanism and a controlling mechanism of the magnetic refrigerator according to an embodiment of the invention. The driving mechanism **20** comprises at least a driving unit **21**, a plurality of transmission units **23**, and a gearshift unit **25**. The driving unit **21** is, for example, a motor and is able generating a finite torque. The transmission unit **23** comprises, for example, a set of gear wheels and chains. The transmission units **23** are according to and drive the magnetic component compiling sets **10***b* respectively. The gearshift unit **25** is, for example, a gearbox and is able connecting to the transmission unit **23**.

[0032] The controlling mechanism **30** comprises at least a sensing unit **31**, and a controlling unit **33**. The sensing unit **31** senses temperature nearby and then generates at least a set of sensing signals **311**, while the controlling unit **33** receives the sensing signals **311** and inputs at least a set of controlling signals **331** accordingly, wherein the controlling signals **331** is adapted to be transferred into, for example, the gearshift unit **25** of the driving mechanism **20** and thus controls the driving mechanism **20**.

[0033] In an embodiment of the present invention, wherein the set of controlling signals **331**, for example, commands the gearshift unit **25** to generate different gear shifting effects as demand, wherein shafts disposed on different heights along the extending direction Z of the central axis **15** may be driven separately due to different controlling signals **331**. Besides, each shaft **13***a* may have its own rotating speed, say zero or a proper angular speed. In the other words, the shafts **13***a* of different magnetic component compiling sets **10***b* can rotate independently.

[0034] The heat exchanging mechanism **40** at least comprises, for example, a heat exchanger, a heat sink, a set of heat dissipating fins, or a set of heat dissipating manifolds. Please refer to FIG. **2**, the heat exchanging mechanism **40** of an embodiment of the invention comprises at least a hot heat exchanger **411**, a cold heat exchanger **412**, a set of heat pipes **42**, a pump **43**, and a switch **44**. The heat pipes **42** are connected to the first magnetic components **12***a*, the hot heat exchanger **411**, and the cold heat exchanger **412** so as to exchange heat therebetween. The heat pipe **42** is, for example, contains heat conducting fluid, and the heat conducting fluid is pressured by the pump **43** to finish a flowing cycle. The switch **44** is adapted to be disposed within the set of heat pipes **42** so as to control a various of heat exchanging loops for various demands.

[0035] Please further refer to FIGS. **4***a*, **4***b*, **4***c*, and **4***d*, schematic views of variations of second magnetic components of the according to an embodiment of the present invention. In order to enhance refrigerating efficiency, a larger magnetic flux is needed. Hence, a series of variation on second magnetic component **14***a* is brought to practice. For example, a simple embodiment of second magnetic component **14***a* is shown as FIG. **4***a*. Further, a pair of auxiliary soft irons **141** are attached on the second magnetic component **14***a* as FIG. **4***b* shows. On the other way, there may be a plurality of smaller permanent magnets **142** are attached on the second magnetic component **14***a* as FIG. **4***c* shows. Still further, there may be a pair of yokes **143** are attached on the second magnetic component **14***a* as FIG. **4***d* shows. It is noted that people in the art may figure out their own ways to enhance magnetic flux, and the invention will not limit all possible variations or substitutions.

[0036] The present invention discloses a magnetic component compiling structure referred to single layer or multiple layers embodiments. As designed, more first magnetic components and less second magnetic components per area or per volume in the present invention will be obtained. Taking a single layer and a single shaft condition as an example, it can be disposed one refrigerating bed for two permanent magnets, or two refrigerating beds for three permanent magnets, or three refrigerating beds for four permanent magnets, and so on. Hence, comparing to conventional magnetic component compiling structure, when the quantity of first magnetic components in the present invention increasing, the quantity of second magnetic components needed in the present invention is decreasing accordingly.

[0037] Besides, when the quantity of first magnetic components in the present invention increasing to a large amount, the ratio between the first magnetic components and the second magnetic components needed is gradually becoming 1:1, and thus the most efficient magnetic component compiling structure is obtained, too. The permanent magnets is in, for example, a rectangular shape, a rectangular shape but shrunk from both sides, or a C-character shape. Besides, the above-mentioned auxiliary soft iron is adapted to the variant shape of permanent magnets as mentioned.

[0038] In summary, the present invention discloses a single layer magnetic component compiling structure, a multiple layers magnetic component compiling structure, and a magnetic refrigerator comprising the compiling structure. Ideally, most refrigerating beds and least permanent magnets needed per area or per volume by the magnetic refrigerator of the present invention is obtained, thus the cooling efficiency is enhanced while the cost of MCM is reduced.

[0039] Although the invention has been described with reference to specific embodiments, this description is not meant to be construed in a limiting sense. Various modifications of the disclosed embodiments, as well as alternative embodiments, will be apparent to persons skilled in the art. It is, therefore, contemplated that the appended claims will cover all modifications that fall within the true scope of the invention.

What is claimed is:

1. A magnetic component compiling structure, comprising:

a plurality of first magnetic components separately disposed on peripheries of a plurality of concentric circles with different radius defined by a center on a first plane;

a shaft fixed at an end to a center on a second plane, wherein the centers on the first plane and on the second plane are disposed in line vertically with a finite distance; and

a plurality of second magnetic components separately disposed on the shaft and driven by the shaft synchronously when the shaft rotates, wherein each second magnetic component partly penetrates into the first plane and passes through intervals of the first magnetic components.

2. The magnetic component compiling structure according to claim **1**, wherein the first magnetic component is adapted to generate magneto-caloric effect.

3. The magnetic component compiling structure according to claim **2**, wherein the first magnetic component further comprises an auxiliary soft iron.

4. The magnetic component compiling structure according to claim **1**, wherein the second plane is adapted to a plurality

of shafts of different phases disposed with a plurality of second magnetic components.

5. The magnetic component compiling structure according to claim **4**, wherein the second magnetic component generates a magnetic flux.

6. A magnetic component compiling structure, comprising:

a central axis extended along a direction; and

a plurality of magnetic component compiling sets adapted to the central axis with different heights, wherein each magnetic component compiling set comprises:

a plurality of first magnetic components separately disposed on peripheries of a plurality of concentric circles with different radius defined by a center on an plane vertical to the direction;

a shaft fixed at ends to the central axis and disposed separately from the plane; and

a plurality of second magnetic components adapted to be separately disposed on the shaft and driven by the shaft synchronously when the shaft rotates, wherein each second magnetic component partly penetrates into the plane and passes through intervals of the first magnetic components.

7. The magnetic component compiling structure according to claim **6**, wherein the first magnetic component is adapted to generate magneto-caloric effect.

8. The magnetic component compiling structure according to claim **7**, wherein the first magnetic component further comprises an auxiliary soft iron.

9. The magnetic component compiling structure according to claim **6**, wherein each magnetic component compiling set further comprises a plurality of shafts disposed at the same heights but in different phases, wherein each shaft is disposed with a plurality of second magnetic components.

10. The magnetic component compiling structure according to claim **9**, wherein the second magnetic component generates a magnetic flux.

11. A magnetic refrigerator, comprising:

a magnetic component compiling structure, comprising:

a central axis extended along a direction; and

a plurality of magnetic component compiling sets adapted to the central axis with different heights, wherein each magnetic component compiling set comprising:

a plurality of first magnetic components separately disposed on peripheries of a plurality of concentric circles with different radius defined by a center on an plane vertical to the direction;

a shaft fixed at ends to the central axis and disposed separately from the plane; and

a plurality of second magnetic components adapted to be separately disposed on the shaft and driven by the shaft synchronously when the shaft rotates, wherein each second magnetic component partly penetrates into the plane and passes through intervals of the first magnetic components;

a driving mechanism driving the central axis and the shafts to make the first magnetic components and the second magnetic components moving relatively;

a controlling mechanism controlling the driving mechanism; and

a heat exchanging mechanism connecting to the first magnetic components and exchanging heat with the first magnetic components, wherein the first magnetic component adapted to generate magneto-caloric effect.

12. The magnetic refrigerator according to claim **11**, wherein the first magnetic component further comprises an auxiliary soft iron.

13. The magnetic refrigerator according to claim **11**, wherein the shafts of different magnetic component compiling sets rotate independently.

14. The magnetic refrigerator according to claim **13**, wherein each magnetic component compiling set further comprises a plurality of shafts disposed at the same heights but in different phases, wherein each shaft is disposed with a plurality of second magnetic components.

15. The magnetic refrigerator according to claim **13**, wherein the driving mechanism comprises:

a driving unit generating a torque;

a plurality of transmission units driving the magnetic component compiling sets respectively; and

a gearshift unit connecting to the driving unit and the transmission units.

16. The magnetic refrigerator according to claim **15**, wherein the driving unit is a motor.

17. The magnetic refrigerator according to claim **15**, wherein the transmission unit comprises a set of gear wheels and chains.

18. The magnetic refrigerator according to claim **15**, wherein the gearshift unit is a gearbox.

19. The magnetic refrigerator according to claim **15**, wherein the controlling mechanism comprises:

a sensing unit sensing temperature nearby and generating a set of sensing signals; and

a controlling unit receiving the set of sensing signals and inputting a set of controlling signals into the gearshift unit of the driving mechanism.

20. The magnetic refrigerator according to claim **11**, wherein the heat exchanging mechanism comprises a heat exchanger, a heat sink, a heat dissipating fin or a set of heat dissipating manifolds.

* * * * *