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(54) **CYLINDER HEAD OF PISTON TYPE COMPRESSOR AND PISTON TYPE COMPRESSOR**

(57) A cylinder head for a piston compressor and a piston compressor are disclosed. The cylinder head includes a metal outer cover and an isolation inner cover. The metal outer cover covers the isolation inner cover, and the isolation inner cover is made of a heat insulation material.

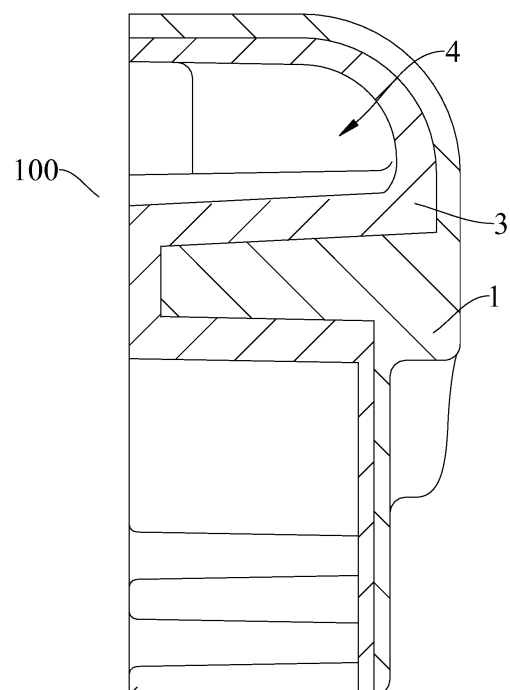


Fig. 3

Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Chinese Patent Application No. 201810714128.2, filed by ANHUI MEIZHI COMPRESSOR CO., LTD. on June 29, 2018, the entire content of which is incorporated herein by reference.

FIELD

[0002] The present disclosure relates to a field of compressor manufacturing technology, and more particularly to a cylinder head for a piston compressor and a piston compressor having the cylinder head.

BACKGROUND

[0003] In the related art, cylinder heads are used to close crankcases of compressors, and are entirely die-cast from metallic aluminum. During operation of compressors, gas exhausted from and gas sucked into cylinder heads perform heat conduction through walls of the cylinder heads. If the temperature sucked into cylinders during suction of compressors is relatively high, resulting in overheating of the suction, the cooling capacity of compressors and the energy efficiency ratio of refrigeration systems will be seriously affected and have room for improvement.

SUMMARY

[0004] The present disclosure aims to solve at least one of the technical problems in the related art. To this end, an objective of the present disclosure is to propose a cylinder head for a piston compressor, and the cylinder head has a composite structure made of closed-cell foamed aluminum and solid aluminum, which results in good heat insulation effect and vibration attenuation performance.

[0005] The cylinder head according to embodiments of the present disclosure includes a metal outer cover and an isolation inner cover, the metal outer cover covering the isolation inner cover, and the isolation inner cover being made of a heat insulation material.

[0006] For the cylinder head according to the embodiments of the present disclosure, since the isolation inner cover has good heat insulation performance, so that the temperature of the gas sucked by the compressor having the cylinder head during operation will not be too high, thereby ensuring a stable cooling capacity and a high energy efficiency ratio.

[0007] For the cylinder head according to the embodiments of the present disclosure, the isolation inner cover is made of a porous material.

[0008] For the cylinder head according to the embodiments of the present disclosure, the isolation inner cover

is made of a closed-cell foamed aluminum material.

[0009] For the cylinder head according to the embodiments of the present disclosure, the metal outer cover has a groove, and the isolation inner cover is disposed to an inner wall surface of the groove to define an accommodating chamber.

[0010] For the cylinder head according to the embodiments of the present disclosure, the metal outer cover is made of a solid aluminum material.

[0011] For the cylinder head according to the embodiments of the present disclosure, the metal outer cover has a mounting table configured to mount the cylinder head.

[0012] For the cylinder head according to the embodiments of the present disclosure, the isolation inner cover has a thickness of N, and the metal outer cover has a thickness of M, which satisfy $0 < N \leq M$.

[0013] For the cylinder head according to the embodiments of the present disclosure, a closed cell of the isolation inner cover has a wall thickness of L which satisfies $0.2\text{mm} \leq L \leq 0.5\text{mm}$.

[0014] For the cylinder head according to the embodiments of the present disclosure, the isolation inner cover has an internal aperture of D which satisfies $1\text{mm} \leq D \leq 6\text{mm}$.

[0015] For the cylinder head according to the embodiments of the present disclosure, the isolation inner cover has an internal porosity of A which satisfies $30\% \leq A \leq 75\%$.

[0016] For the cylinder head according to the embodiments of the present disclosure, the isolation inner cover has an elasticity modulus of E which satisfies $1.4\text{GPa} \leq E \leq 8.0\text{GPa}$.

[0017] For the cylinder head according to the embodiments of the present disclosure, the isolation inner cover has a silicon carbide additive, and the contained silicon carbide has a mass fraction of B which satisfies $0.1\% \leq B \leq 1.1\%$.

[0018] The present disclosure further proposes a piston compressor.

[0019] The piston compressor according to embodiments of the present disclosure is provided with the cylinder head according to any one of the above embodiments.

[0020] The piston compressor has the same advantages as the above cylinder head, compared with the related art, which will not be elaborated herein.

[0021] Additional aspects and advantages of embodiments of present disclosure will be given in part in the following descriptions, become apparent in part from the following descriptions, or be learned from the practice of the embodiments of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] These and/or other aspects and advantages of embodiments of the present disclosure will become apparent and more readily appreciated from the following descriptions made with reference the accompanying

drawings, in which:

Fig. 1 illustrates a schematic view of a cylinder head according to embodiments of the present disclosure.
 Fig. 2 illustrates a front view of a cylinder head according to embodiments of the present disclosure.
 Fig. 3 illustrates a sectional view of a cylinder head according to embodiments of the present disclosure.
 Fig. 4 illustrates a top view of a piston compressor according to embodiments of the present disclosure.
 Fig. 5 illustrates an exploded view of a cylinder head and a valve assembly according to embodiments of the present disclosure.
 Fig. 6 illustrates a sectional view of a piston compressor according to embodiments of the present disclosure.

Reference numerals:

[0023]

cylinder head 100,
 metal outer cover 1, mounting table 2, isolation inner cover 3, accommodating chamber 4,
 cylinder block 101, piston 102, connecting rod 103, crankshaft 104, housing assembly 105, motor stator 106, motor rotor 107,
 lift limiter 200, exhaust valve sheet 300, valve plate 400, suction valve sheet 500.

DETAILED DESCRIPTION

[0024] Embodiments of the present disclosure will be described in detail and examples of the embodiments will be illustrated in the accompanying drawings, where same or similar reference numerals are used to indicate same or similar members or members with same or similar functions. The embodiments described herein with reference to the drawings are explanatory, which aim to illustrate the present disclosure, but shall not be construed to limit the present disclosure.

[0025] A cylinder head 100 for a piston compressor according to embodiments of the present disclosure will be described with reference to Figs. 1 to 6.

[0026] As illustrated in Figs. 1-6, the cylinder head 100 according to the embodiments of the present disclosure includes a metal outer cover 1 and an isolation inner cover 3.

[0027] The metal outer cover 1 covers the isolation inner cover 3, and the isolation inner cover 3 is made of a heat insulation material, that is, the isolation inner cover 3 has good heat insulation performance, such that the temperature of gas sucked by the compressor having the cylinder head 100 during operation will not be too high, and hence have a stable cooling capacity and a high energy efficiency ratio.

[0028] As illustrated in Fig. 3, the metal outer cover 1 has a groove, and the isolation inner cover 3 is disposed

to an inner wall surface of the groove to define an accommodating chamber 4, that is, an outer surface of the isolation inner cover 3 is fitted with the inner wall surface of the groove. In some embodiments, the isolation inner cover 3 is made of porous materials, so as to possess heat insulation, sound insulation, and vibration absorption effects. Thus, not only can the compressor have the stable cooling capacity and the high energy efficiency ratio, but also the isolation inner cover 3 can reduce the vibration impact on the cylinder head generated by the gas entering the accommodating chamber, attenuate the impact noise, and improve the vibration attenuation effect. In a specific embodiment shown in Fig. 3, the isolation inner cover 3 is made of a closed-cell foamed aluminum material, wherein the isolation inner cover 3 can be foamed and formed on the inner wall surface of the groove by a powder metallurgy foaming method in solid metal sintering methods. The isolation inner cover 3 can be foamed and formed into complex structures by the powder metallurgy foaming method to allow the isolation inner cover 3 to be closely fitted with the metal outer cover 1.

[0029] It should be noted that the closed-cell foamed aluminum material is a novel light functional material, and has characteristics of low density, high strength, high stiffness ratio, sound absorption, high damping and vibration attenuation performance, and high impact energy absorption rate. The density of the closed-cell foamed aluminum material is usually 0.1-0.4 times the density of metallic aluminum, such that the isolation inner cover 3 has an obvious lightweight effect. Meanwhile, when the acoustic wave frequency is between 800 Hz and 4000 Hz, the sound insulation coefficient of the closed-cell foamed aluminum material is 0.9 or higher. The damping performance is 5-10 times that of metallic aluminum. Therefore, the isolation inner cover 3 made of the closed-cell foamed aluminum material has the advantages of light weight, excellent vibration absorption effect, good sound insulation effect, and good heat insulation performance.

[0030] As illustrated in Figs. 4 and 6, the cylinder head 100 is mounted on the piston compressor, and the accommodating chamber 4 of the isolation inner cover 3 can be used to store the gas temporarily. The cylinder head 100 is connected to a cylinder end of a crankcase by threaded fasteners, and at the same time the isolation inner cover 3 is partially in contact with a suction silencer. During the operation of the compressor, a refrigerant gas sucked through the suction silencer performs heat conduction with the refrigerant gas discharged from a cylinder bore into the cylinder head 100, and the refrigerant gas discharged into the cylinder head 100 may impact the cylinder head 100, thereby resulting in vibration and impact noise. However, the isolation inner cover 3 has good heat insulation performance, so that there is no excessive heat exchange between the discharged gas and the sucked gas. In such a way, the temperature of the sucked gas is not excessively high, thereby ensuring

the stable cooling capacity of the compressor, and a refrigeration system with such a compressor has a relatively high energy efficiency ratio, improving the practicality and economy of the compressor, and avoiding suction overheating. Moreover, the isolation inner cover 3 has sound absorption and high damping characteristics, which will greatly reduce the impact noise and improve the vibration attenuation effect, so that the compressor has a stable working state during operation.

[0031] For the cylinder head 100 according to the embodiments of the present disclosure, since the isolation inner cover 3 has good heat insulation and sound insulation performance, so that the temperature of the gas sucked by the compressor having the cylinder head 100 during operation is not too high, thereby ensuring a stable cooling capacity and a high energy efficiency ratio. The isolation inner cover 3 can reduce the vibration impact on the cylinder head 100 generated by the gas entering the accommodating chamber 4, weaken the impact noise, and improve the vibration attenuation effect.

[0032] For the cylinder head 100 according to the embodiments of the present disclosure, as illustrated in Figs. 1 and 2, the metal outer cover 1 has a mounting table 2 configured to mount the cylinder head 100, and the cylinder head 100 can be fixedly connected to the cylinder end of the crankcase by threaded fasteners at the mounting table 2, whereby the cylinder head 100 can close the crankcase to facilitate the gas suction and discharge of the compressor.

[0033] In an embodiment, the metal outer cover 1 has four mounting tables 2 spaced apart along an axial direction. As shown in Figs. 1 and 2, the four mounting tables 2 are located at four corners of the metal outer cover 1, such that four corners of the cylinder head 100 are fixedly connected with the cylinder end of the crankcase. A valve assembly is connected between the cylinder head 100 and the cylinder end of the crankcase, and includes a lift limiter 200, an exhaust valve sheet 300, a valve plate 400, and a suction valve sheet 500. In this way, the cylinder head 100, the lift limiter 200, the exhaust valve sheet 300, the valve plate 400, the suction valve sheet 500, and the cylinder end of the crankcase are sequentially connected and fixed by multiple sets of threaded fasteners, thereby ensuring the normal gas suction and discharge of the compressor and improving the stability of the overall structure of the compressor.

[0034] In some embodiments, the isolation inner cover 3 has a thickness of N, the metal outer cover 1 has a thickness of M, and the total thickness of the cylinder head 100 is H, which satisfy $H=M+N$, $0<N\leq M$. That is, the total thickness of the cylinder head 100 is equal to the sum of the thickness of the isolation inner cover 3 and the thickness of the metal outer cover 1, and the thickness of the metal outer cover 1 is not less than that of the isolation inner cover 3. Thus, the metal outer cover 1 of the thickness can ensure the high structural rigidity and strength of the cylinder head 100, and make the overall structure of the cylinder head 100 stable. At the same

time, the isolation inner cover 3 of the corresponding thickness can avoid excessive heat conduction between the discharged gas and the sucked gas in the cylinder head 100, thereby ensuring that the suction temperature of the compressor is relatively low, and with the sound insulation and high damping characteristics of the isolation inner cover 3, the noise reduction and silencing effect can be obtained, upgrading the performance of the compressor.

[0035] In some embodiments, the closed cells of the isolation inner cover 3 have a wall thickness of L, which satisfies $0.2\text{mm} \leq L \leq 0.5\text{mm}$. For example, $L=0.3\text{mm}$, and $L=0.4\text{mm}$. It could be understood that the isolation inner cover 3 is made of the closed-cell foamed aluminum material, that is, the isolation inner cover 3 has a plurality of closed cells, and a suitable wall thickness of the closed cells can ensure the rigidity and strength of the overall structure of the isolation inner cover 3, and guarantee that the isolation inner cover 3 has good sound insulation and heat insulation performance. The greater the wall thickness of the closed cells is, the poorer the heat insulation performance of the isolation inner cover 3 is, and materials are wasted. The smaller the wall thickness of the closed cells is, the lower the structural rigidity and strength of the isolation inner cover 3 is, and the isolation inner cover 3 is easily deformed. Thus, the isolation inner cover 3 of a suitable thickness can improve the overall performance efficiently and have excellent practicability and economy.

[0036] The isolation inner cover 3 has an internal aperture of D which satisfies $1\text{mm} \leq D \leq 6\text{mm}$. For example, $D=2\text{mm}$, $D=3\text{mm}$, $D=5\text{mm}$. The internal aperture with suitable thickness can ensure that the isolation inner cover 3 has stable structural rigidity and good sound insulation and sound absorption performance. If the internal aperture is too large, the rigidity of the isolation inner cover 3 is poor and the stability will be reduced. If the internal aperture is too small, the sound insulation performance of the isolation inner cover 3 will become poor. Hence, the internal aperture is set to an appropriate size, which can effectively improve the overall performance.

[0037] The isolation inner cover 3 has an internal porosity of A which satisfies $30\% \leq A \leq 75\%$. For example, $A=40\%$, $A=50\%$, $A=60\%$. By setting a suitable internal porosity, it can be ensured that the isolation inner cover 3 has good sound insulation and heat insulation performance, and stable structural rigidity and strength, so that the isolation inner cover 3 can achieve the heat insulation effect on the gas suction and discharge, and lower the noise inside the cylinder head 100 effectively.

[0038] The isolation inner cover 3 has an elasticity modulus of E which satisfies $1.4\text{GPa} \leq E \leq 8.0\text{GPa}$. For example, $E=2.3\text{GPa}$, $E=4.2\text{GPa}$, $E=5.8\text{GPa}$. By setting a suitable elasticity modulus, it can be ensured that the internal performance of the isolation inner cover 3 is stable, so that the overall structure of the isolation inner cover 3 is stable, avoiding excessive deformation of the isolation inner cover 3 under external forces, and improving

the stability of the overall structure of the cylinder head 100. Moreover, the isolation inner cover 3 with a higher elasticity modulus can have better vibration damping performance, absorb the impact energy of the gas on the cylinder head 100, and reduce noise.

[0039] The isolation inner cover 3 has a silicon carbide additive, and the mass fraction of silicon carbide contained therein is B, which satisfies $0.1\% \leq B \leq 1.1\%$. For example, $B=0.4\%$, $B=0.7\%$, $B=1.0\%$. By adding silicon carbide to the isolation inner cover 3, the rigidity and strength of the isolation inner cover 3 can be improved to ensure excellent stability of the isolation inner cover 3.

[0040] The present disclosure further proposes a piston compressor.

[0041] The piston compressor according to embodiments of the present disclosure is provided with the cylinder head 100 according to any one of the above embodiments. The isolation inner cover 3 has good heat insulation and sound insulation performance, so that the temperature of the gas sucked by the piston compressor during operation will not be too high, thereby ensuring a stable cooling capacity and higher energy efficiency ratio. Moreover, the isolation inner cover 3 can reduce the vibration impact on the cylinder head 100, generated by the gas entering the accommodating chamber 4, weaken the impact noise, and improve the vibration attenuation effect.

[0042] As illustrated in Fig. 6, the piston compressor further includes a cylinder block 101, a piston 102, a connecting rod 103, a crankshaft 104, a housing assembly 105, a motor stator 106, and a motor rotor 107. A driving motor drives the crankshaft 104 to move, the crankshaft 104 drives the connecting rod 103 to move, the connecting rod 103 drives, by a piston pin, the piston 102 to reciprocate, thereby realizing the gas suction and discharge of the compressor. The cylinder block 101, the piston 102, the connecting rod 103, the crankshaft 104, the motor stator 106, and the motor rotor 107 are all mounted in the housing assembly 105 to make various components of the piston compressor relatively fixed, and create a stable working environment.

[0043] It should be noted that the piston compressor according to the embodiments of the present disclosure can be applied to any refrigeration device such as a refrigerator, a freezer, an air conditioner, a dehumidifier and so on, and the piston compressor is connected to an evaporator, a condenser, a throttle device and the like to constitute a complete refrigeration system. The refrigeration system has good cooling performance and low noise in use.

[0044] Reference throughout this specification to "an embodiment," "some embodiments," "an exemplary embodiment," "an example," "a specific example," or "some examples," means that a particular feature, structure, material, or characteristic described in connection with the embodiment or example is included in at least one embodiment or example of the present disclosure. The appearances of the above phrases throughout this spec-

ification are not necessarily referring to the same embodiment or example of the present disclosure. Furthermore, the particular features, structures, materials, or characteristics may be combined in any suitable manner in one or more embodiments or examples.

[0045] Although embodiments of the present disclosure have been shown and described, it would be appreciated by those skilled in the art that any changes, modifications, alternatives and variations can be made in the embodiments without departing from the principle and purpose of the present disclosure. The scope of the present disclosure is defined by claims and the like.

15 Claims

1. A cylinder head for a piston compressor, comprising: a metal outer cover and an isolation inner cover, the metal outer cover covering the isolation inner cover, and the isolation inner cover being made of a heat insulation material.
2. The cylinder head according to claim 1, wherein the isolation inner cover is made of a porous material.
3. The cylinder head according to claim 1 or 2, wherein the isolation inner cover is made of a closed-cell foamed aluminum material.
4. The cylinder head according to any one of claims 1 to 3, wherein the metal outer cover has a groove, and the isolation inner cover is disposed to an inner wall surface of the groove to define an accommodating chamber.
5. The cylinder head according to any one of claims 1 to 4, wherein the metal outer cover is made of a solid aluminum material.
6. The cylinder head according to any one of claims 1 to 5, wherein the metal outer cover has a mounting table configured to mount the cylinder head.
7. The cylinder head according to any one of claims 1 to 6, wherein the isolation inner cover has a thickness of N, and the metal outer cover has a thickness of M, which satisfy $0 < N \leq M$.
8. The cylinder head according to claim 3, wherein a closed cell of the isolation inner cover has a wall thickness of L which satisfies $0.2\text{mm} \leq L \leq 0.5\text{mm}$.
9. The cylinder head according to claim 3, wherein the isolation inner cover has an internal aperture of D which satisfies $1\text{mm} \leq D \leq 6\text{mm}$.
10. The cylinder head according to claim 3, wherein the isolation inner cover has an internal porosity of A

which satisfies $30\% \leq A \leq 75\%$.

11. The cylinder head according to claim 7, wherein the isolation inner cover has an elasticity modulus of E which satisfies $1.4\text{GPa} \leq E \leq 8.0\text{GPa}$. 5
12. The cylinder head according to claim 3, wherein the isolation inner cover has a silicon carbide additive, and the contained silicon carbide has a mass fraction of B which satisfies $0.1\% \leq B \leq 1.1\%$. 10
13. A piston compressor provided with a cylinder head for a piston compressor according to any one of claims 1 to 12. 15

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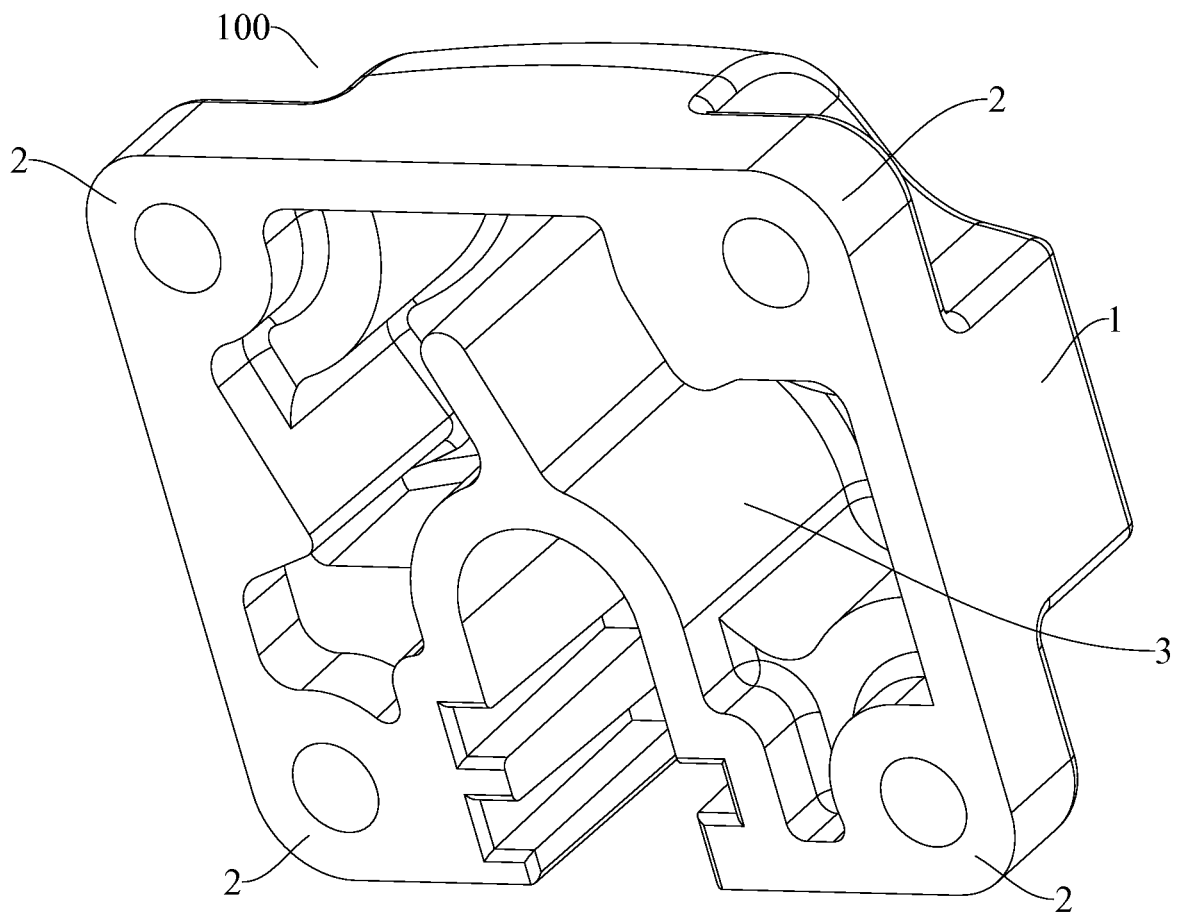


Fig. 1

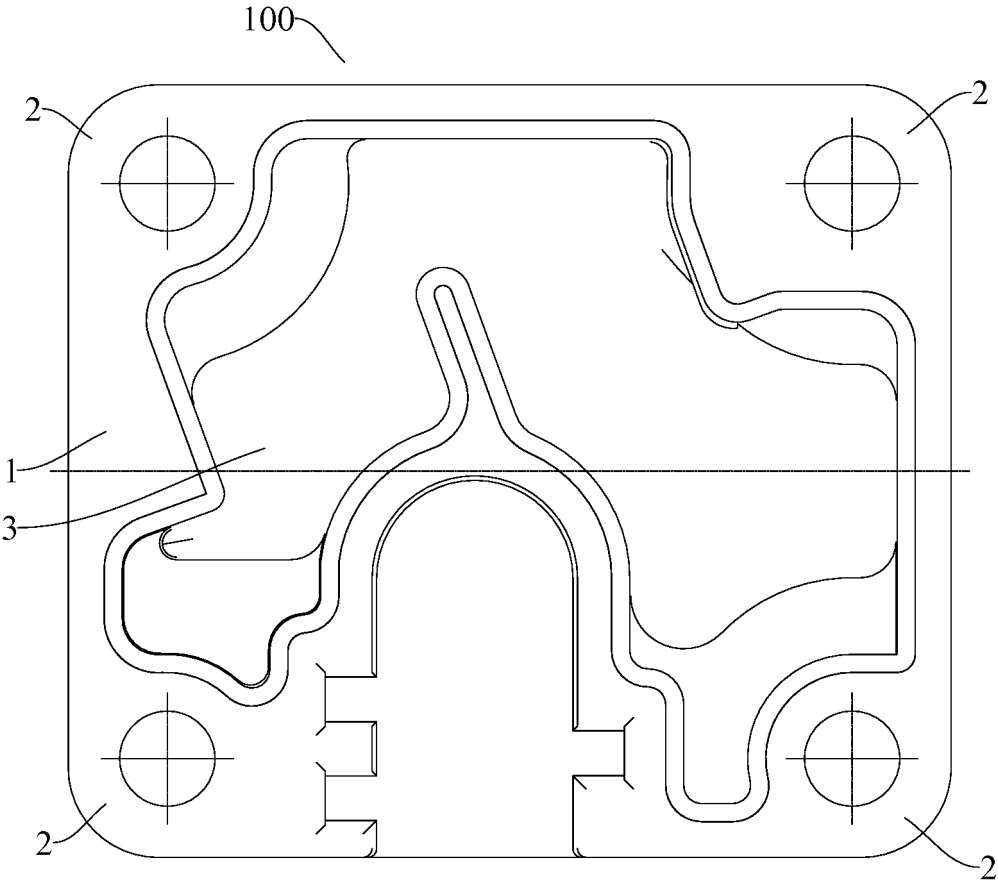


Fig. 2

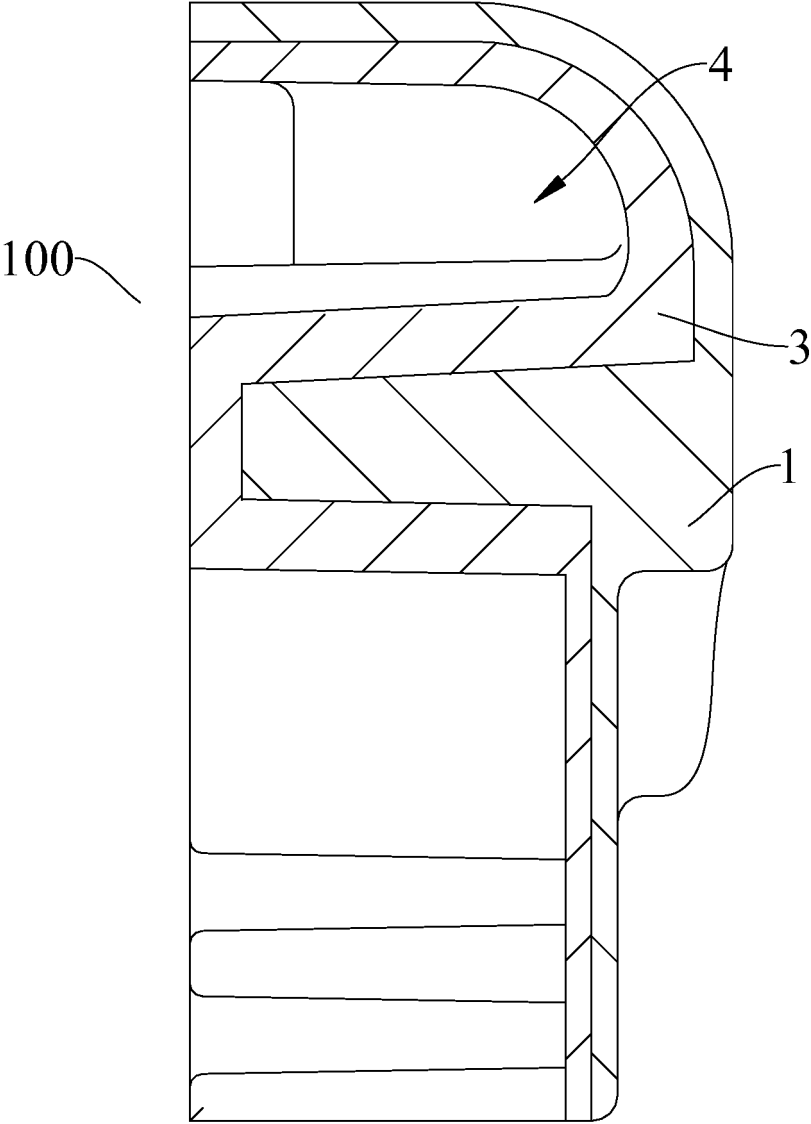


Fig. 3

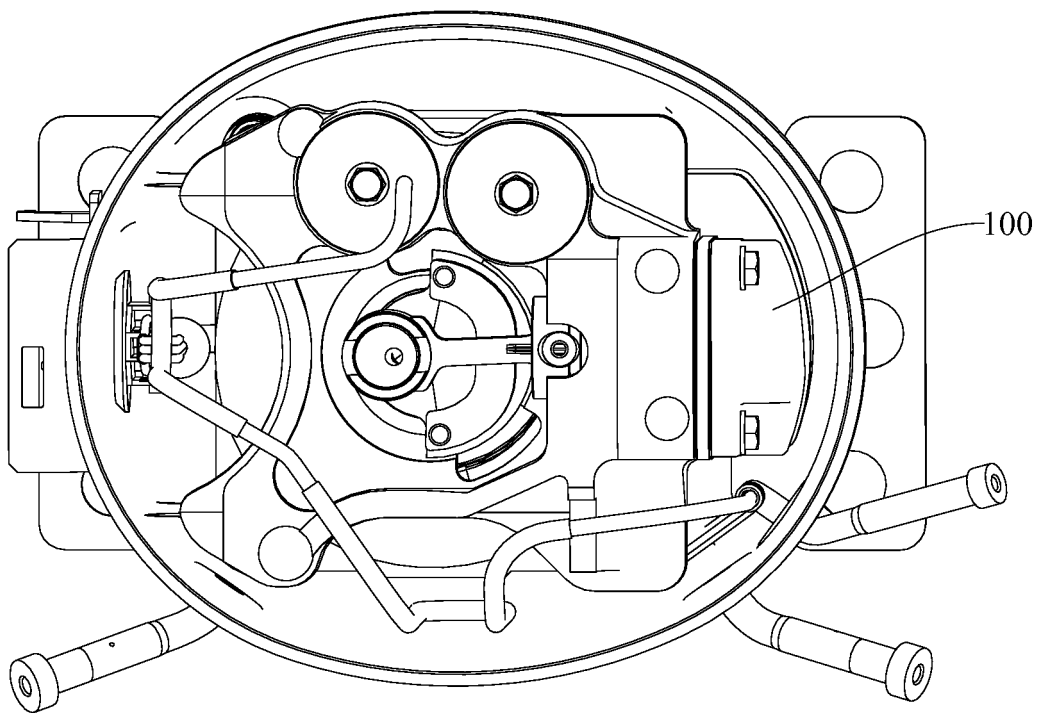


Fig. 4

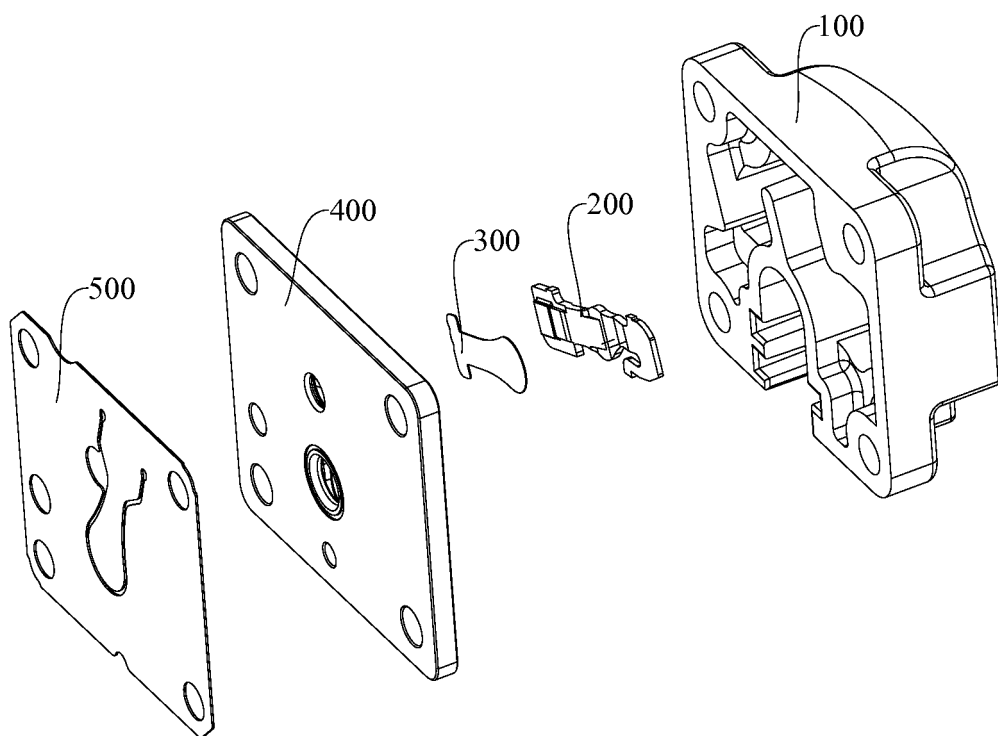


Fig. 5

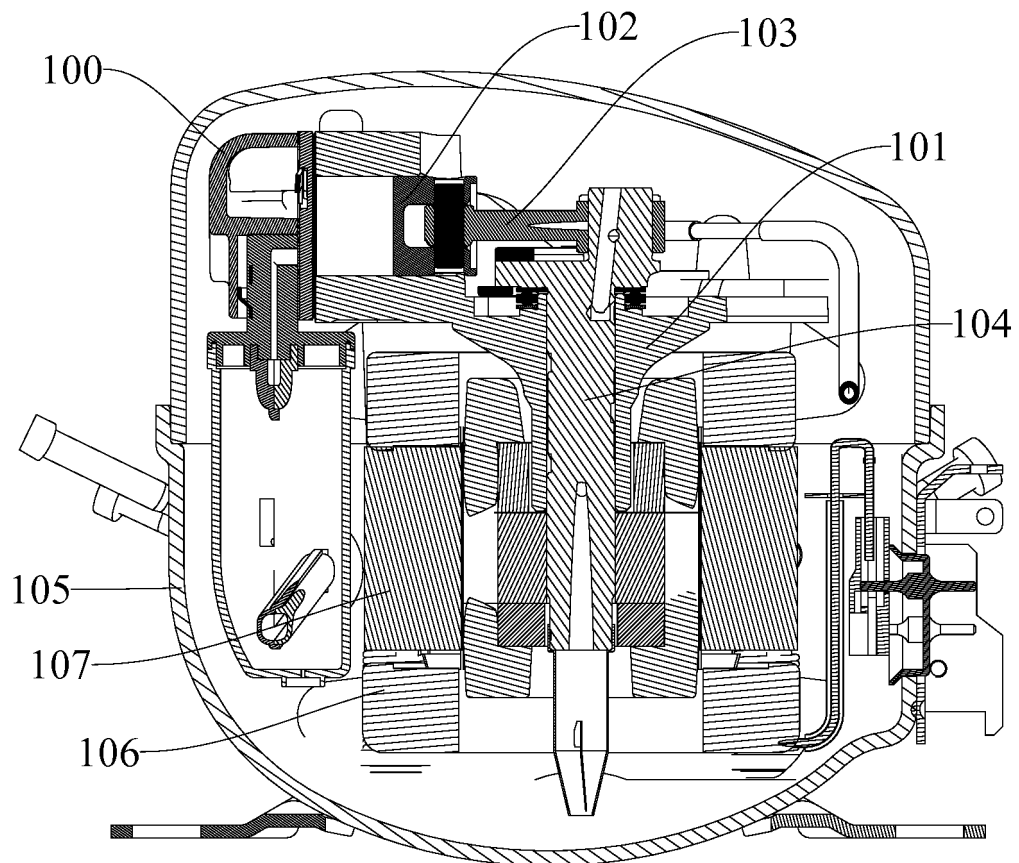


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2018/098940

A. CLASSIFICATION OF SUBJECT MATTER F04C 29/06(2006.01)i; F04B 39/12(2006.01)i According to International Patent Classification (IPC) or to both national classification and IPC																								
B. FIELDS SEARCHED																								
Minimum documentation searched (classification system followed by classification symbols) F04B, F04C Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched																								
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) VEN; CNKI; CNABS: 气缸, 发动机, 热, 壳, 噪, 盖, 泡沫铝, 压缩机, 保温, 隔热, 消音, cylinder, engine, heat, housing, noise, cover, foam s aluminum, compressor, heat s preservation, heat s insulation, muffle																								
C. DOCUMENTS CONSIDERED TO BE RELEVANT																								
<table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>CN 203301294 U (WANG, QIANG ET AL.) 20 November 2013 (2013-11-20) see description, paragraphs 24-31, and figures 1-5</td> <td>1-13</td> </tr> <tr> <td>A</td> <td>CN 106351843 A (XI'AN JIAOTONG UNIVERSITY) 25 January 2017 (2017-01-25) see entire document</td> <td>1-13</td> </tr> <tr> <td>A</td> <td>WO 2008033096 A1 (MATSUSHITA ELECTRIC IND. CO., LTD. ET AL.) 20 March 2008 (2008-03-20) see entire document</td> <td>1-13</td> </tr> <tr> <td>A</td> <td>CN 203822465 U (WEICHAI POWER CO., LTD.) 10 September 2014 (2014-09-10) see entire document</td> <td>1-13</td> </tr> <tr> <td>A</td> <td>CN 105017957 A (HYUNDAI MOTOR COMPANY) 04 November 2015 (2015-11-04) see entire document</td> <td>1-13</td> </tr> <tr> <td>A</td> <td>CN 102562298 A (CHEN, MINGHUI) 11 July 2012 (2012-07-11) see entire document</td> <td>1-13</td> </tr> <tr> <td>A</td> <td>WO 2013006931 A1 (WHIRLPOOL SA ET AL.) 17 January 2013 (2013-01-17) see entire document</td> <td>1-13</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	CN 203301294 U (WANG, QIANG ET AL.) 20 November 2013 (2013-11-20) see description, paragraphs 24-31, and figures 1-5	1-13	A	CN 106351843 A (XI'AN JIAOTONG UNIVERSITY) 25 January 2017 (2017-01-25) see entire document	1-13	A	WO 2008033096 A1 (MATSUSHITA ELECTRIC IND. CO., LTD. ET AL.) 20 March 2008 (2008-03-20) see entire document	1-13	A	CN 203822465 U (WEICHAI POWER CO., LTD.) 10 September 2014 (2014-09-10) see entire document	1-13	A	CN 105017957 A (HYUNDAI MOTOR COMPANY) 04 November 2015 (2015-11-04) see entire document	1-13	A	CN 102562298 A (CHEN, MINGHUI) 11 July 2012 (2012-07-11) see entire document	1-13	A	WO 2013006931 A1 (WHIRLPOOL SA ET AL.) 17 January 2013 (2013-01-17) see entire document	1-13
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Date of the actual completion of the international search 07 March 2019	Date of mailing of the international search report 28 March 2019																							
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2018/098940

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2018/098940

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