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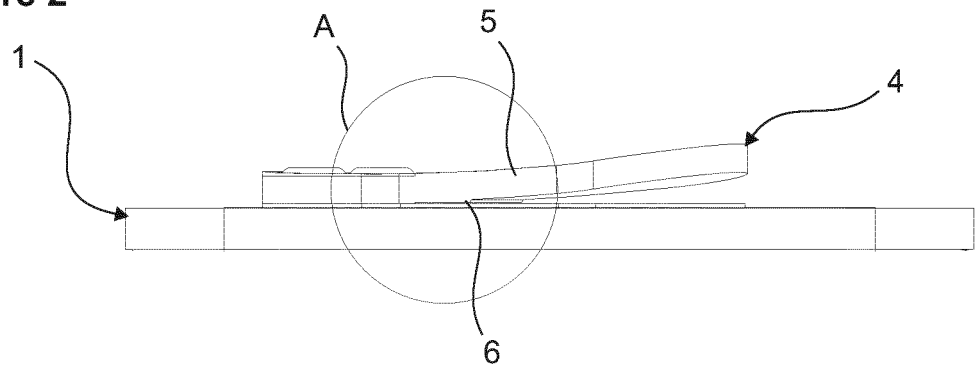
(54) **A COMPRESSOR**

(57) The present invention relates to a compressor comprising a casing which supports the components therein; a cylinder which enables allows the refrigerant fluid to be sucked and compressed; a piston which is operated in the cylinder; a cylinder head which directs the compressed refrigerant fluid sucked into the cylinder by the movement of the piston; a valve table (1) which is disposed between the cylinder and the cylinder head; a suction port (2) which is arranged on the valve table (1) and which enables the refrigerant fluid to enter the cylinder during the suction movement of the piston; an exhaust port (3) which enables the refrigerant fluid to be discharged from the cylinder during the compression movement of the piston; an exhaust valve (4) which opens and closes the exhaust port (3); and a limiting member (5) which is positioned so as to align with the top of the exhaust valve (4) in the opening direction thereof and which limits the opening of the exhaust valve (4).

Figure 2



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Description

[0001] The present invention relates to a compressor wherein the operational performance of the exhaust valve is improved.

[0002] In hermetic compressors, exhaust valves which open and close according to the pressure difference are used. In order to limit the opening distance of said exhaust valves, a limiting member is used so as to align with the top of the exhaust valve. The operational aim of the exhaust valve is to open the leaf easily and to prevent too much compression in the cylinder, and to close immediately when the flow of the refrigerant fluid in the cylinder is completely finished so as to prevent the high-pressure refrigerant fluid from returning to the cylinder volume. The limiting member is used to attain this aim. The limiting member enables the exhaust valve to remain fixed at a point when opened so as not to move too far from the closing point. Thus, a rapid closing occurs as soon as the exhaust process is completed.

[0003] By means of the opening/closing movement of the exhaust valves, the flow of the refrigerant fluid in the compressor is ensured. Therefore, the parameters related to the exhaust valves have a very significant effect on the performance of the compressor. The most important among the parameters of the exhaust valve is the stiffness coefficient of the exhaust valve. In variable-speed compressors, the optimization of said parameter varies for each speed. When the compressor operates at high speeds, the compressor exhaust time is short due to the flow rate of the refrigerant fluid. Therefore, the time required for the exhaust valve to close is also short. Otherwise, backflows occur and the capacity decreases.

[0004] The decrease in the stiffness coefficient of the exhaust valve causes the stiffness on the exhaust valve to decrease. Since the exhaust valve travels the distance required to be closed with a lower force, the acceleration of the exhaust valve during the closing decreases. This causes the exhaust valve to close later than normal.

[0005] When the compressor operates at low speeds, the forces acting on the exhaust valve during the opening are less due to the flow rate of the refrigerant fluid.

[0006] When the opening force is less than the force required to keep the exhaust valve fully open, the exhaust valve tends to close. Since the exhaust process continues in the meantime, the flow narrows down and push the exhaust valve with greater force in the direction of opening, which causes the exhaust valve to tend to open again. This oscillatory movement on said exhaust valve adversely affects the performance of the compressor. Since the force required to keep the exhaust valve open increases when the stiffness coefficient of the exhaust valve is increased, the oscillatory movements also increase, which adversely affects the efficiency of the compressor.

[0007] The value of the stiffness coefficient of the exhaust valve creates different results at different speeds, and the value of the stiffness coefficient of the exhaust valve also has different adverse effects, regardless of the speed. Since the use of an exhaust valve with a high stiffness coefficient increases the force required to open the exhaust valve, this causes the refrigerant fluid in the cylinder to be compressed more than desired, increasing the power consumption of the compressor. When open, the exhaust valve is in contact with the limiting member. This contact creates an adhesion effect for the exhaust valve onto the limiting member due to the lubricant on the surface. Since, when an exhaust valve with a low stiffness coefficient is used, there is low stress when said exhaust valve is open, the adhesion effect caused by lubricant prevails and delays the closing of the exhaust valve.

[0008] In the state of the art United States Patent Application No. US2009291007, a compressor is disclosed, comprising a limiting member which gains a second stiffness coefficient by means of the higher section than the free end at the middle section after fully opened up to the free end so as to prevent late closing and increase thermal efficiency.

[0009] In the state of the art South Korean Patent Application No. KR20070102846, a compressor is disclosed, comprising an exhaust valve which creates free movement space by creating space beyond the stopping point on the limiting member and which thus increases thermal efficiency by reducing flow losses.

[0010] The aim of the present invention is the realization of a compressor wherein the operational performance of the exhaust valve is improved.

[0011] The compressor realized in order to attain the aim of the present invention, explicated in the first claim and the respective claims thereof, comprises a casing which supports the components therein; a cylinder which enables allows the refrigerant fluid to be sucked and compressed; a piston which is operated in the cylinder; a cylinder head which directs the compressed refrigerant fluid sucked into the cylinder by the movement of the piston; a valve table which is disposed between the cylinder and the cylinder head; a suction port which is arranged on the valve table and which enables the refrigerant fluid to enter the cylinder during the suction movement of the piston; an exhaust port which enables the refrigerant fluid to be discharged from the cylinder during the compression movement of the piston; an exhaust valve which opens and closes the exhaust port; a limiting member which is positioned so as to align with the top of the exhaust valve in the opening direction thereof and which limits the opening of the exhaust valve; and at least one step which is provided on the surface of the limiting member facing the valve table, on the closed side of the limiting member. By means of the step, the operational performance of the exhaust valve is increased at different rotational speeds of the compressor. Moreover, by means of the present invention, when an exhaust valve having a low stiffness coefficient is used to solve the problem of extra compression in the cylinder, the adhesion effect from the lubricant is minimized by means of the

step.

[0012] The step provided on the closed end side of the limiting member ensures that the exhaust valve operates at full length when the exhaust valve is opened, and during the continuation of the opening moment, the working length of the exhaust valve becomes shorter. The exhaust valve operating at full length, in other words with a low stiffness coefficient, at the moment of opening reduces the force required to open, preventing extra compression. Thus, the power consumption is reduced. After the opening moment, the operational point of the exhaust valve is shortened by means of the step on the limiting member, the tension on the exhaust valve increases and the problem of late closing is eliminated. Moreover, since, by means of the step, the contact surface between the exhaust valve and the limiting member is reduced due to the bending caused by the step, the lubricant-induced adhesion effect is also reduced.

[0013] The step is a protrusion on the surface of the limiting member facing the valve table, which extends towards the valve table. Thus, the step ensures that the force required to open the exhaust valve and the power consumption are decreased.

[0014] In another embodiment of the present invention, the step is provided on the surface of the valve table facing the limiting member.

[0015] By means of the present invention, the adverse effects caused by the low or high stiffness coefficient of the exhaust valve, independent of the rotational speed, are eliminated. Loss of capacity at high speeds occurring when an exhaust valve with a low stiffness coefficient is used to prevent oscillation at low speeds is prevented. Since the contact surface with the limiting member is reduced by means of the step when the exhaust valve is fully open, the adhesion effect of the lubricant is also decreased.

[0016] A compressor realized in order to attain the aim of the present invention is illustrated in the attached figures, where:

Figure 1 - is the top view of a valve table.

Figure 2 - is the sideways view of the valve table.

Figure 3 - is the view of detail A in Figure 2.

[0017] The elements illustrated in the figures are numbered as follows.

1. Valve table

2. Suction port

3. Exhaust port

4. Exhaust valve

5. Limiting member

6. Step

[0018] The compressor comprises a casing which supports the components therein; a cylinder which enables allows the refrigerant fluid to be sucked and compressed; a piston which is operated in the cylinder; a cylinder head which directs the compressed refrigerant fluid sucked into the cylinder by the movement of the piston; a valve table (1) which is disposed between the cylinder and the cylinder head; a suction port (2) which is arranged on the valve table (1) and which enables the refrigerant fluid to enter the cylinder during the suction movement of the piston; an exhaust port (3) which enables the refrigerant fluid to be discharged from the cylinder during the compression movement of the piston; an exhaust valve (4) which opens and closes the exhaust port (3); a limiting member (5) which is positioned so as to align with the top of the exhaust valve (4) in the opening direction thereof and which limits the opening of the exhaust valve (4); and at least one step (6) which is provided between the surface of the limiting member (5) facing the valve table (1) and the valve table (1) and which remains on the closed side of the limiting member (5) (Figure 1).

[0019] In the preferred embodiment of the present invention, the step (6) is provided on the surface of the limiting member (5) facing the valve table (1). By means of the step (6), the operational performance of the exhaust valve (4) is increased at different rotational speeds of the compressor. Moreover, by means of the present invention, when an exhaust valve (4) having a low stiffness coefficient is used to solve the problem of extra compression in the cylinder, the adhesion effect from the lubricant is minimized by means of the step (6) (Figure 2).

[0020] The step (6) provided on the closed end side of the limiting member (5) ensures that the exhaust valve (4) operates at full length when the exhaust valve (4) is opened, and during the continuation of the opening moment, the working length of the exhaust valve (4) becomes shorter. The exhaust valve (4) operating at full length, in other words with a low stiffness coefficient, at the moment of opening reduces the force required to open, preventing extra compression. Thus, the power consumption is reduced. After the opening moment, the operational point of the exhaust valve (4) is shortened by means of the step (6) on the limiting member (5), the tension on the exhaust valve (4) increases and the problem of late closing is eliminated. Moreover, since, by means of the step (6), the contact surface between the exhaust valve (4) and the limiting member (5) is reduced due to the bending caused by the step (6), the lubricant-induced adhesion effect is also reduced.

[0021] The step (6) is a protrusion on the surface of the limiting member (5) facing the valve table (1), which extends towards the valve table (1). Thus, the step (6) ensures that the force required to open the exhaust valve (4) and the power consumption are decreased (Figure 3).

[0022] In another embodiment of the present invention, the step (6) is provided on the surface of the valve table

(1) facing the limiting member (5).

[0023] By means of the present invention, the adverse effects caused by the low or high stiffness coefficient of the exhaust valve (4), independent of the rotational speed, are eliminated. Loss of capacity at high speeds occurring when an exhaust valve (4) with a low stiffness coefficient is used to prevent oscillation at low speeds is prevented. Since the contact surface with the limiting member (5) is reduced by means of the step (6) when the exhaust valve (4) is fully open, the adhesion effect of the lubricant is also decreased.

Claims

1. A compressor **comprising** a casing which supports the components therein; a cylinder which enables allows the refrigerant fluid to be sucked and compressed; a piston which is operated in the cylinder; a cylinder head which directs the compressed refrigerant fluid sucked into the cylinder by the movement of the piston; a valve table (1) which is disposed between the cylinder and the cylinder head; a suction port (2) which is arranged on the valve table (1) and which enables the refrigerant fluid to enter the cylinder during the suction movement of the piston; an exhaust port (3) which enables the refrigerant fluid to be discharged from the cylinder during the compression movement of the piston; an exhaust valve (4) which opens and closes the exhaust port (3); and a limiting member (5) which is positioned so as to align with the top of the exhaust valve (4) in the opening direction thereof and which limits the opening of the exhaust valve (4), **characterized by** at least one step (6) which is provided between the surface of the limiting member (5) facing the valve table (1) and the valve table (1) and which remains on the closed side of the limiting member (5).

2. A compressor as in Claim 1, **characterized by** at least one step (6) which is provided on the surface of the limiting member (5) facing the valve table (1).

3. A compressor as in Claim 1, **characterized by** the step (6) which is provided on the closed end side of the limiting member (5) and which ensures that the exhaust valve (4) operates at full length during the opening of the exhaust valve (4), and that, during the continuation of the opening moment, the working length of the exhaust valve (4) becomes shorter.

4. A compressor as in Claim 1, **characterized by** the step (6) which is a protrusion on the surface of the limiting member (5) facing the valve table (1), which extends towards the valve table (1).

5. A compressor as in Claim 1, **characterized by** the step (6) which is provided on the surface of the valve table (1) facing the limiting member (5).

Figure 1

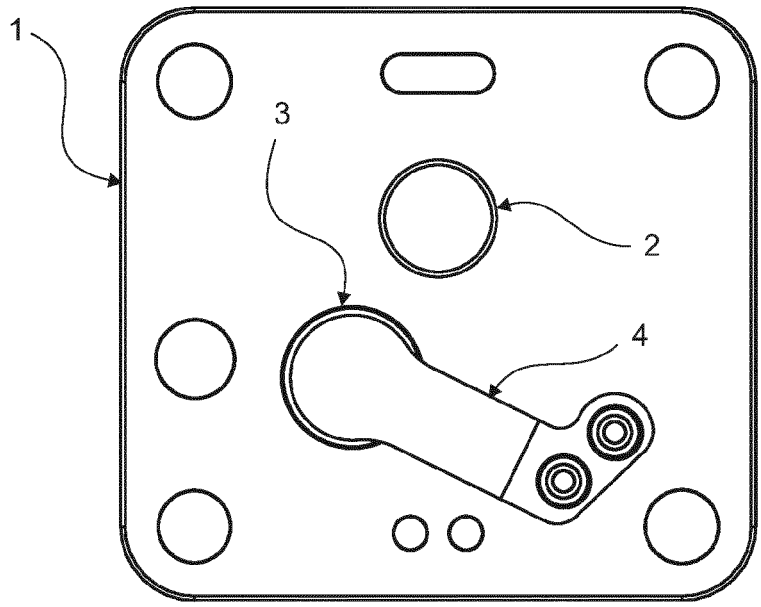


Figure 2

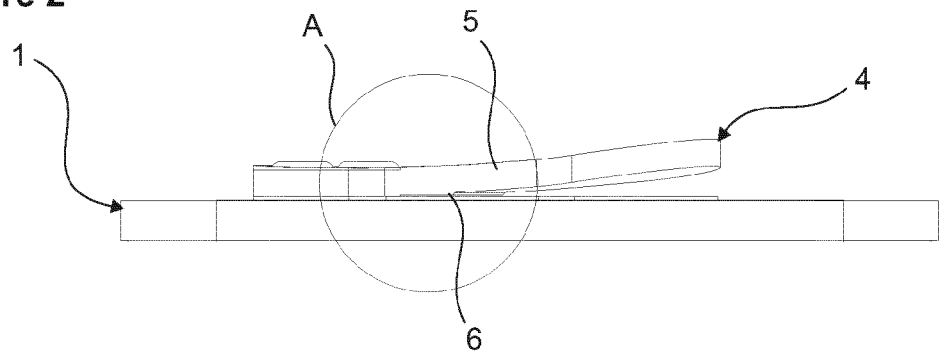
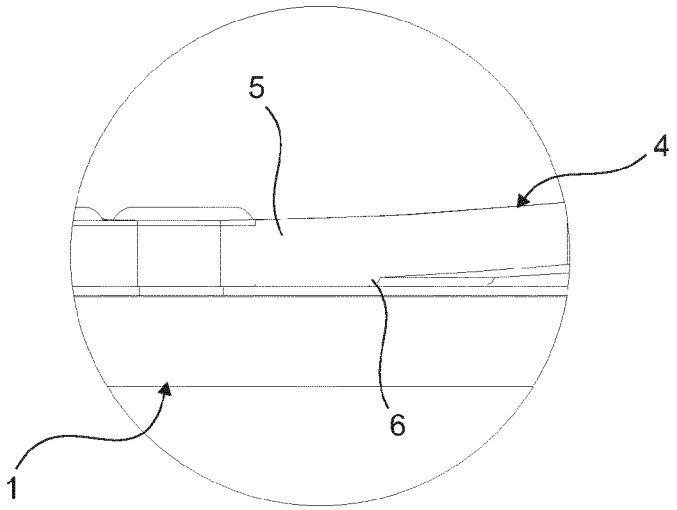


Figure 3



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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 7221

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	KR 2022 0106501 A (LG ELECTRONICS INC [KR]) 29 July 2022 (2022-07-29)	1,3,5	INV. F04B53/10
A	* figures 1, 4-8, 10, 12, 14 *	2,4	F04B39/10
X	US 2020/032797 A1 (LEE JAEHA [KR] ET AL) 30 January 2020 (2020-01-30)	1,3	
A	* figures 1, 2, 3A, 3B *	2,4,5	
X	JP 2002 115656 A (HITACHI LTD) 19 April 2002 (2002-04-19) * figures 1, 2, 4, 5 *	1-5	
X	JP H09 250461 A (SANDEN CORP) 22 September 1997 (1997-09-22)	1,3,5	
A	* paragraph [0001]; figures 1-3, 6 *	2,4	
X	KR 2007 0021995 A (MATSUSHITA TENKI SANGYO CO., LTD.) 23 February 2007 (2007-02-23)	2-5	
A	* figures 1, 3, 5 *	1	
X	US 5 601 118 A (JANG GEUN-SIK [KR]) 11 February 1997 (1997-02-11)	2-5	TECHNICAL FIELDS SEARCHED (IPC)
A	* figures 1, 6B, 9A-9D *	1	F04B F04C
X	DE 24 51 207 A1 (BOSCH SIEMENS HAUSGERAETE) 6 May 1976 (1976-05-06)	2-4	
A	* page 1, paragraph 1; figure 1 *	1,5	
X	KR 2018 0103368 A (LG ELECTRONICS INC [KR]) 19 September 2018 (2018-09-19)	2-4	
A	* figures 2-8 *	1,5	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 March 2024	Homan, Peter

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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18-03-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
KR 20220106501 A	29-07-2022	EP 4283126 A1	29-11-2023
		KR 20220106501 A	29-07-2022
		US 2024052839 A1	15-02-2024
		WO 2022158680 A1	28-07-2022
US 2020032797 A1	30-01-2020	CN 211449025 U	08-09-2020
		KR 20200013344 A	07-02-2020
		US 2020032797 A1	30-01-2020
JP 2002115656 A	19-04-2002	NONE	
JP H09250461 A	22-09-1997	NONE	
KR 20070021995 A	23-02-2007	NONE	
US 5601118 A	11-02-1997	JP 2795625 B2	10-09-1998
		JP H08326939 A	10-12-1996
		KR 970002212 U	24-01-1997
		US 5601118 A	11-02-1997
DE 2451207 A1	06-05-1976	DE 2451207 A1	06-05-1976
		DK 484875 A	30-04-1976
		FR 2290132 A7	28-05-1976
		IT 1043661 B	29-02-1980
KR 20180103368 A	19-09-2018	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2009291007 A **[0008]**
- KR 20070102846 **[0009]**