(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 171 025 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
24.05.2017 Bulletin 2017/21

(51) Int Cl.:
F04B 39/10 *(2006.01)*

(21) Application number: **16199499.1**

(22) Date of filing: **18.11.2016**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **19.11.2015 BR 202015029126 U**

(71) Applicant: **Whirlpool S.A.**
04578-000 São Paulo - SP (BR)

(72) Inventors:
- **Arceno, Eduardo**
  89219-330 Joinville (BR)
- **Pereira, Evandro Luiz Lange**
  89218-040 Joinville (BR)

(74) Representative: **Soldatini, Andrea et al**
Società Italiana Brevetti S.p.A.
Corso dei Tintori, 25
50122 Firenze (IT)

(54) **CONSTRUCTIVE DISPOSITION IN RECIPROCATING COMPRESSOR SUCTION VALVE**

(57) Constructive disposition introduced in reciprocating compressor suction valve, whose moving parameters of elastic flexion area and, therefore, sealing end are mainly defined by specific geometries and dimensions of the own flexible segment of suction valve. Furthermore, the stiffness coefficient and natural frequency of flexible segment of suction valve are also defined from specific geometries and dimensions of the own flexible segment of suction valve, without being necessary to alter the material or thickness of metallic blade where the suction valve is defined.

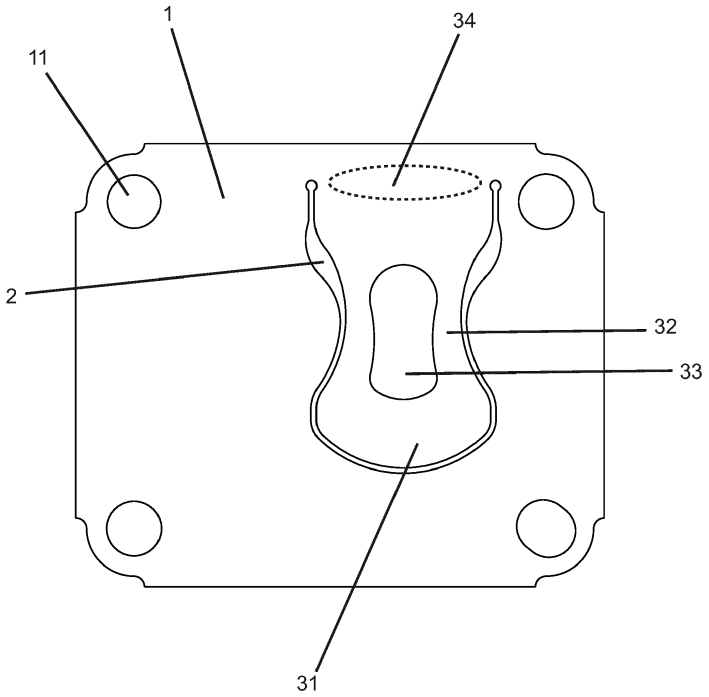


FIG. 2

EP 3 171 025 A1

Description

Field of the Invention

[0001] The present invention refers to a new constructive disposition in reciprocating compressor suction valve and, specially, high performance reed valve used in reciprocating compressors which integrate cooling systems.

[0002] In general lines, the suction valve here revealed comprises several constructive-dimensional features that makes possible its adequacy to reduced dimensions reciprocating compressors.

Background of the Invention

[0003] As it is known by experts on the art, the current state of the art comprises a wide range of constructive arrangements introduced in suction valves for reciprocating compressors. In this context, it stands out reed valves, which comprises at least one mobile segment defined by a metallic foil.

[0004] According to the scope of the current invention suction valves like reed are highlighted which are defined by a metallic foil whose general outline is analogous to the geometry of plate-valve that composes the reciprocating compressor head.

[0005] The figure 1 shows a suction valve like reed that, defined in a metallic foil of analogous general outline to plate-valve (not showed), integrates the current state of the art. As it possible to observe, said metallic foil comprises a fundamentally continuous and regular area and a semi-outlining hollow slot whose form defines the flexible segment of suction valve. Said suction valve showed on figure 1 is cooperating, at least, with a plate-valve described and shown on document US7083400.

[0006] Specially, the suction valve shown on figure 1 includes at least one sealing end (related to the suction port on the plate-valve), at least one elastic flexion area and at least one passing port disposed between said sealing end and the elastic flexion area, port which is sized to be aligned with the exhaust port existing on the plate-valve.

[0007] As it is known by experts on the art, the main objective of this constructive arrangement type of suction valve is optimizing the assembly process and suction valve alignment (in this case, the sealing end, the suction port and the passing port) with the plate-valve.

[0008] Among different technical aspects related to this constructive arrangement, it is known that the moving parameters of the elastic flexion area and, accordingly, sealing end are intimately related with the thickness and the confection material of metallic foil. This means that the valve flexion capability (or still, the operation capability of the valve during the suction cycles of the reciprocating compressor) can be better defined based on appropriate choices of material and metallic foil thickness. It occurs, however, that this type of adequacy usually increases both project cost and manufacturing costs (specially, costs related to feedstock) of reciprocating compressor as a hole, which can make this type of action essentially prohibitive.

[0009] It is also possible alter the moving parameters of the elastic flexion area and, consequently, the sealing end based on the shape and/or arrangement and/or design of the semi-outlying hollowed slot whose format defines the second flexible segment of suction valve. It occurs, however, that this type of actuation is especially interesting in reciprocating compressors not miniaturized, where there is space (the plate-valve is used to have large dimensions, allowing the over-sizing of metallic foil where the suction valve like reed is defined) to more than sufficient to adequate the size and/or arrangement and/or design of the semi-outlying hollowed slot whose format defines the flexible segment of suction valve to the project needs, without being necessary alter the manufacturing material. This means that such actuation is not trivially applied in reciprocating compressors of smaller dimensions, or still, in miniaturized reciprocating compressors.

[0010] It is based on this scenario that arises the present invention.

Objectives of the Invention

[0011] Thus, it is an objective of the present invention to reveal a new constructive arrangement introduced in suction valve for reciprocating compressor whose moving parameters of elastic flexion area and, consequently, the sealing end to be mainly defined from specific geometries and dimensions of the own flexible segment of suction valve.

[0012] Consequently, it is an objective of the invention in question to define the rigidity coefficient and natural frequency of the flexible segment of the suction valve without the need to change the material or the thickness of metallic foil where the suction valve is defined.

[0013] Last, it is a general objective of the invention in question that the new constructive arrangement introduced on the suction valve for the reciprocating compressor is specially suitable to reciprocating compressors of positive displacement being capable of using both in variable speed compressors and conventional compressors (On-Off or fixed speed).

Brief Description of the Drawings

[0014] The present invention will be detailed based on the figures related below, in which:

Figure 1 shows a suction valve belonging to the current state of the art;

Figure 2 shows the suction valve according to the present invention; and

Figures 3A, 3B, 3C and 3D shows specific differentials of the suction valve according to the present

invention.

Detailed Description of the invention

[0015] As shown on figure 2, the new constructive arrangement introduced in suction valve of reciprocating compressor comprises a rigid foil 1, preferably made with a metallic alloy, in which it is observed a semi-outlying hollowed slot 2 that defines the flexible segment 3, which includes at least one sealing end 31, at least one elastic flexion area 32, at least one passing port 33, and at least one crimping area 34.

[0016] Said rigid foil 1 comprises still at least four passing ports 11 that, disposed in disconnection with the semi-outlying hollowed slot 2 and the flexible segment 3, define just mounting orientation guides for the fixing means (not shown) used to fix the reciprocating compressor head.

[0017] In general lines, the inventive character of the invention in question is mainly focused on the dimensional relations of flexible segment 3. In this sense, and as shown on figures 3A, 3B, 3C and 3D, are indicated the most relevant dimensions "H", "L", "C", "R1", "R2", "B1", B"2" and where.

[0018] The "H" dimension comprises the general longitudinal length of the flexible segment 3, this is, the straight length measured between the distal points of the sealing end 31 and the crimping area 34 of flexible segment 3. The "L" dimension comprises the general latitudinal length of the flexible segment 3, this is, the straight length measured between the distal points of the sealing end 31 of flexible segment 3. The "H" and "L" dimensions, as well as the relation between them, is better shown on figure 3A.

[0019] The "C" dimension comprises the general longitudinal length of the passing port 33 of flexible segment 3, this is, the straight length measured between the oppose distal points of passing port 33 of flexible segment 3. The "C" dimension, including the relation of this with the "H" dimension is better shown on figure 3B.

[0020] The "R1" dimension comprises the upper internal outline radius of passing port 33 of flexible segment 3, and the dimension "R2" comprises the lower internal outline radius of passing port 33 of the flexible segment 3. Clearly, said passing port 33 of flexible segment 3 comprises an essentially oblong format. The dimensions "R1" and "R2", as well as the imaginary circles "CR1" and "CR2" respectively related to "R1" and "R2" radius are better shown on figure 3C.

[0021] The "B1" dimension comprises the latitudinal straight distance between two points, to know: point I (insertion point between the imaginary circle "CR1" and the most prominently portion of the upper internal outline radius of passing port 33 of flexible segment 3), and point II (external outline point of flexible segment 3 closer to point I). The dimension "B2" comprises the latitudinal straight distance between two points, to know: point I (insertion point between the imaginary circle "CR2" and the most prominently portion of the lower internal outline radius of passing port 33 of flexible segment 3), and point II (external outline point of flexible segment 3 closer to point I). The dimensions "B1" and "B2", as well as the relation between them, is better shown on figure 3D.

[0022] According to the present invention, there are observed the following dimensional relations:

The "H" dimension is larger than the dimension "L" in a ratio that can range from 1,3:1 to 1,9:1. Preferably, the "H" dimension is larger than the "L" dimension in a ratio of 1,6:1.

The "H" dimension is larger than the dimension "C" in a ratio that can range from 1,6:1 to 2,5:1. Preferably, the "H" dimension is larger than the "C" dimension in a ratio of 2,1:1.

The "R2" dimension is larger than the dimension "R1" in a ratio that can range from 1,1:1 to 1,7:1. Preferably, the "R2" dimension is larger than the "R1" dimension in a ratio of 1,45:1.

The "B2" dimension is larger than the dimension "B1" in a ratio that can range from 1,2:1 to 1,8:1. Preferably, the "B2" dimension is larger than the "B1" dimension in a ratio of 1,5:1.

[0023] The ratio between the above mentioned dimensions enables the rigidity increase and of natural frequency of flexible segment 3 without being necessary any change on material or thickness of rigid foil 1.

[0024] This rigidity and natural frequency reached are totally favorable to reciprocating compressors since this two answer parameters of suction valve are essential for defining efficiency of compressor and the operation noise.

[0025] Additionally, it is noteworthy that the operation frequency point of flexible segment, according to the present invention, is different from the natural frequency of internal resonant cavity of compressor (the internal cavity of compressor comprises the region composed by cooling gas located between the compressor body and the internal pieces of the compressor). The objective of changing the natural frequency of the valve is leaving the excitation region of natural frequency of compressor cavity, further to guarantee cooling capability parameters and energetic performance desired of the product.

Claims

1. Constructive disposition introduced in reciprocating compressor suction valve, comprising:

a rigid blade (1) having at least one semi-surrounding hollow slot (2) which defines at least one flexible segment (3); said flexible segment (3) comprising at least one sealing end (31), at least one elastic flexion area (32), at least one passing port (33), and at least one crimping area (34);aid flexible segment (3) further comprising

the following dimensions:

"H" dimension, which comprises a general longitudinal extension of flexible segment (3);
"L" dimension, which comprises a general latitudinal extension of flexible segment (3); dimension, in which "C" comprises the general longitudinal extension of passing port (33) of flexible segment (3);
"R1" dimension, which comprises the upper internal surrounding radius of passing port (33) of flexible segment (3);
"R2" dimension, which comprises the lower internal outline radius of passing port (33) of flexible segment (3);
"B1" dimension, which comprises the latitudinal straight distance between the insertion point between the imaginary circle "CR1" and the most outstanding portion of the superior internal outline radius of passing port 33 of flexible segment (3) and the external outline point of flexible segment (3) closer to the interception point between the imaginary circle "CR1" and the most outstanding portion of upper internal outline radius of passing port (33) of flexible segment (3);
"B2" dimension, which comprises the latitudinal straight distance between the interception point between the imaginary circle "CR2" and the most outstanding portion of lower internal outline radius of passing port (33) of flexible segment (3) and the external outline point of flexible segment (3) closer to the interception point between the imaginary circle "CR2" and the most outstanding portion of lower internal outline radius of passing port (33) of flexible segment;
said constructive disposal introduced on a reciprocating compressor suction valve being specially **characterized by**:

the "H" dimension is larger than "L" dimension in a ratio which can vary between 1,31:1 to 1,9:1;
the "H" dimension is larger than "C" dimension in a ratio which can vary between 1,61:1 to 2,5:1;
the "R2" dimension is larger than "R1" dimension in a ratio which can vary between 1,1:1 to 1,7:1; and
the "B2" dimension is larger than "B1" dimension in a ratio which can vary between 1,2:1 to 1,8:1..

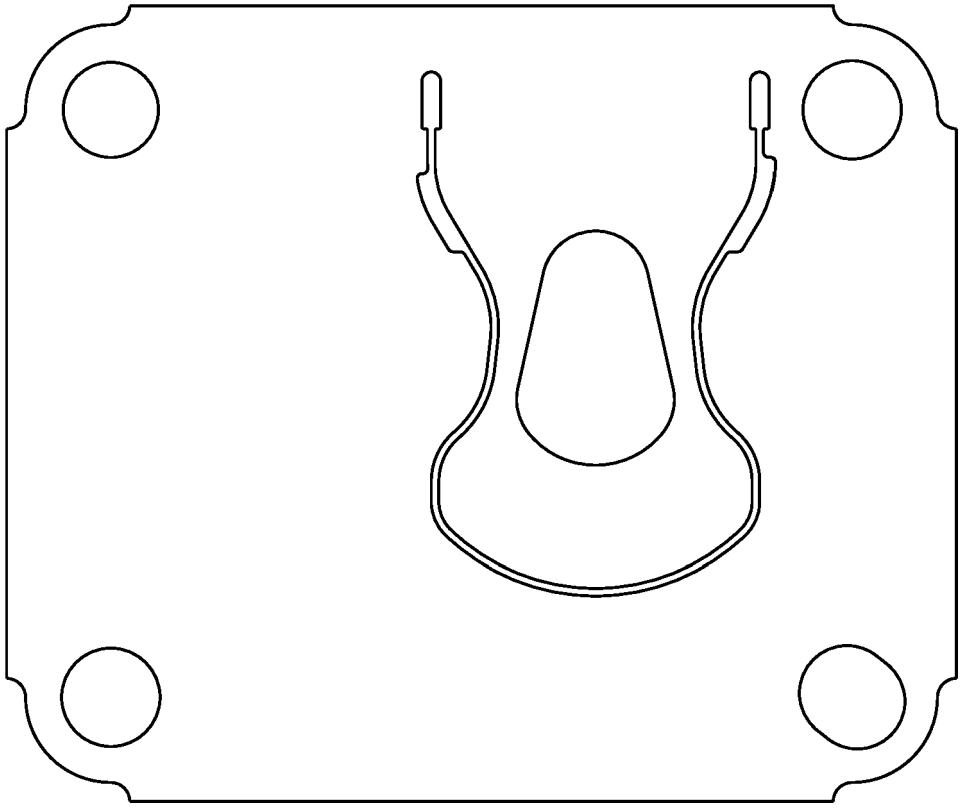


FIG. 1
PRIOR ART

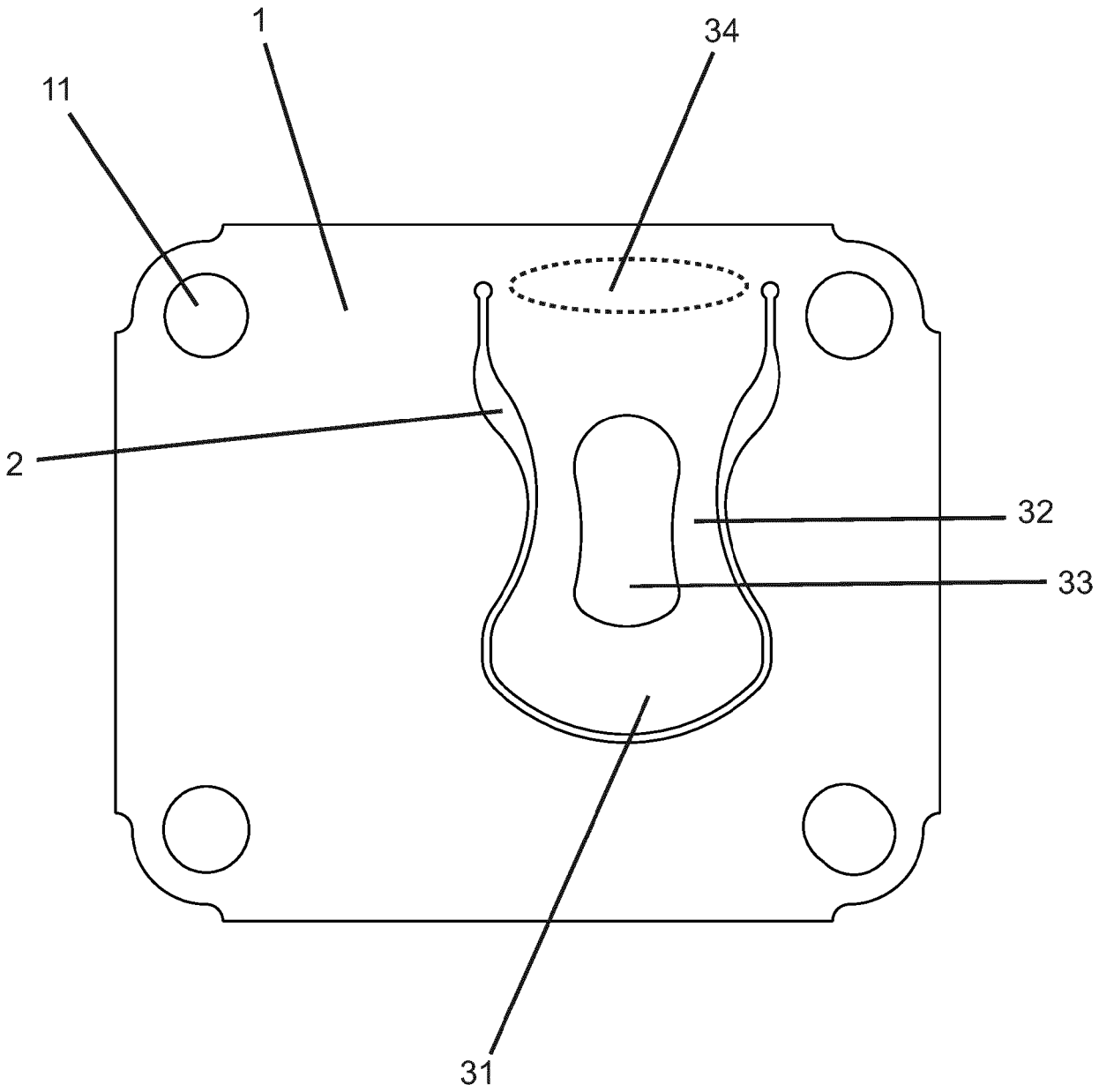


FIG. 2

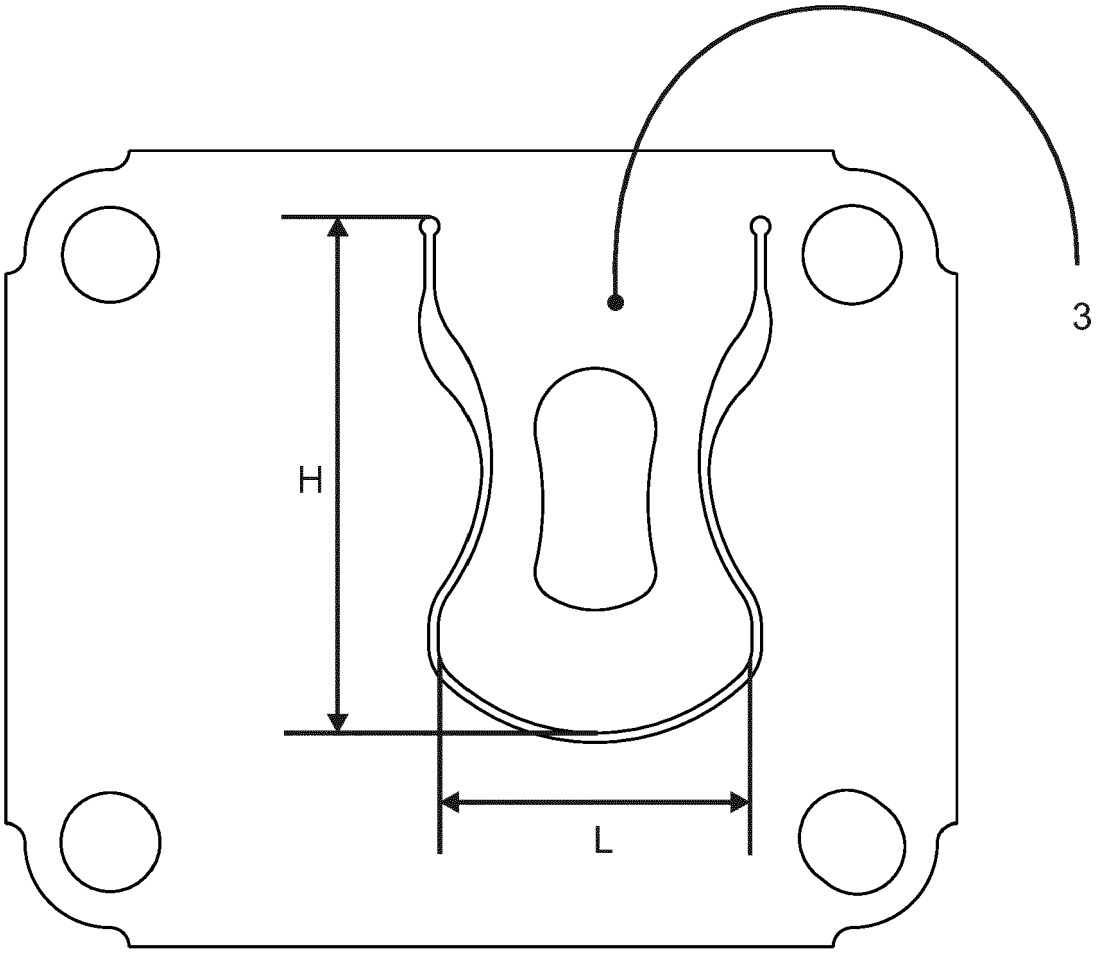


FIG. 3A

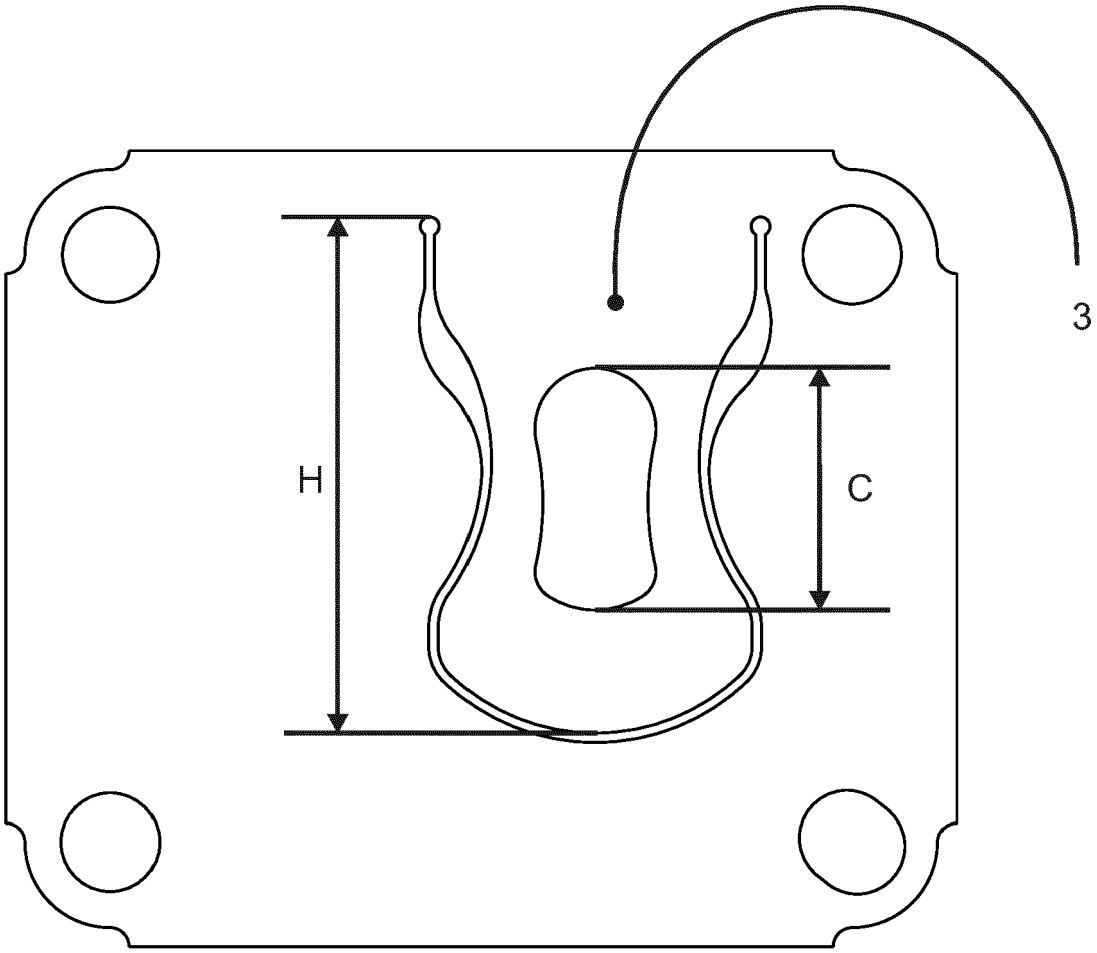


FIG. 3B

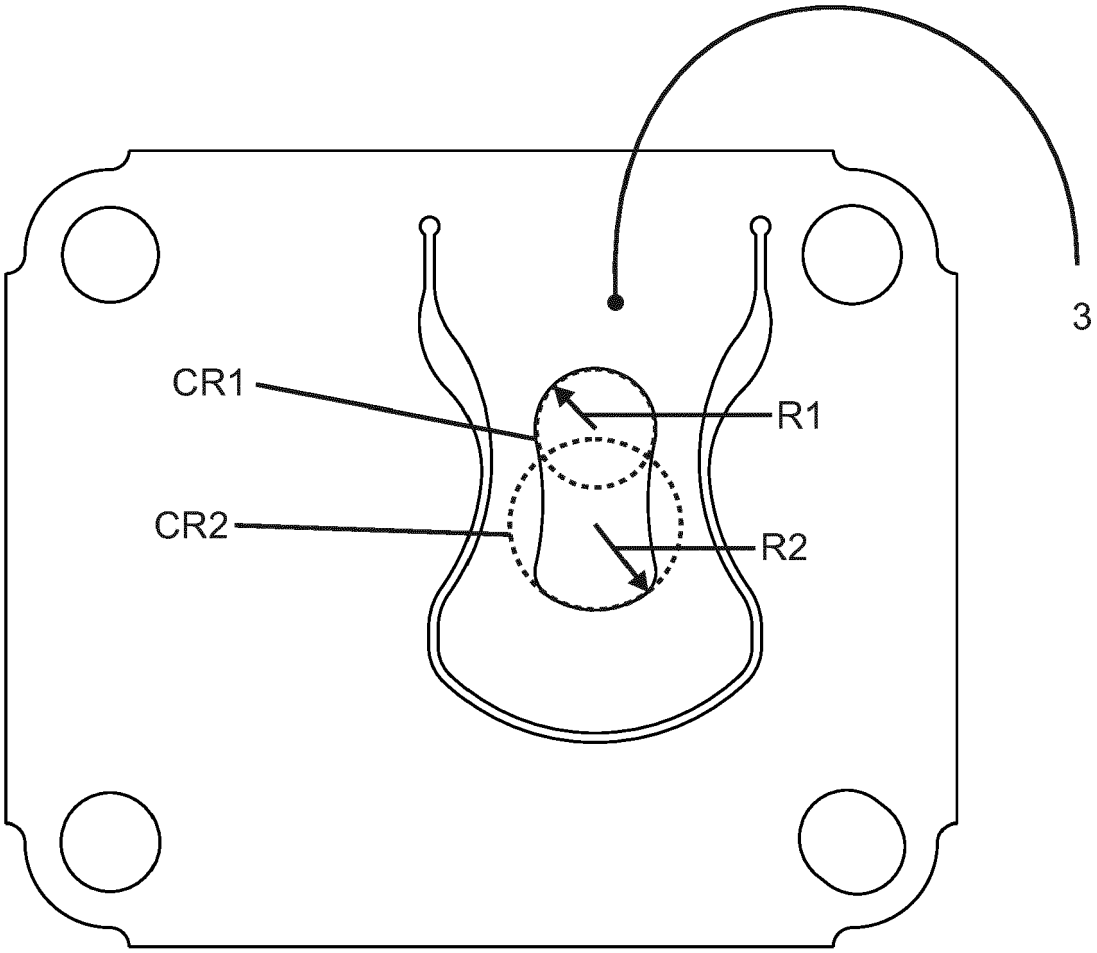


FIG. 3C

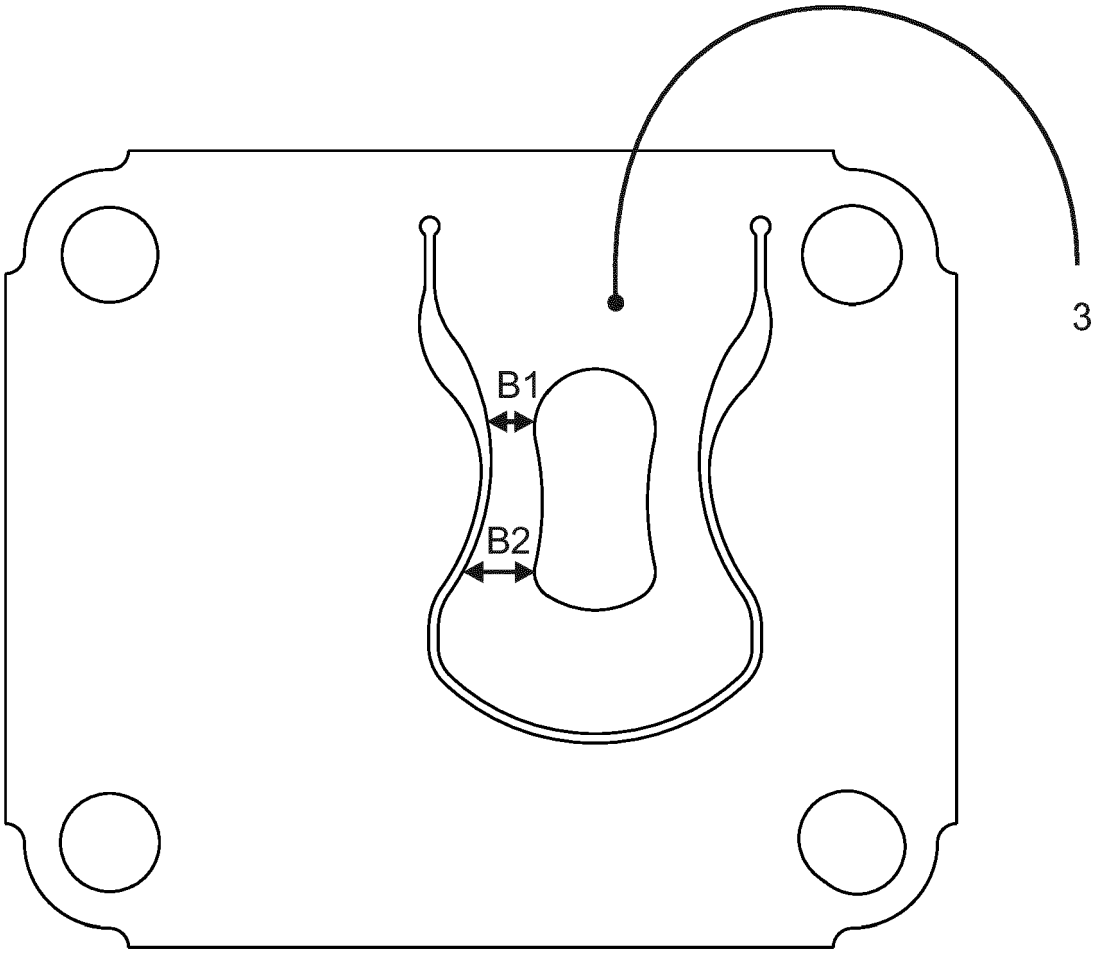


FIG. 3D

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 16 19 9499

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	US 2006/096647 A1 (BORTOLI MARCOS GIOVANI D [BR] ET AL) 11 May 2006 (2006-05-11) * abstract *; claims; figures 1,4 * * paragraphs [0028] - [0037] *	1	INV. F04B39/10
A	WO 2009/135281 A1 (WHIRLPOOL SA [BR]; UNIV FED DE SANTA CATARINA UFS [BR]; RIBAS JUNIOR F) 12 November 2009 (2009-11-12) * abstract *; claims; figures 1-8 *	1	
A	WO 2012/145812 A2 (WHIRLPOOL SA [BR]; FAGOTTI FABIAN [BR]) 1 November 2012 (2012-11-01) * abstract *; figures 2,4 *	1	
			TECHNICAL FIELDS SEARCHED (IPC) F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 March 2017	Pinna, Stefano

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 19 9499

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

30-03-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006096647 A1	11-05-2006	AT 430261 T	15-05-2009
		AU 2003269614 A1	04-05-2004
		BR 0204413 A	01-06-2004
		CN 1688813 A	26-10-2005
		EP 1561033 A1	10-08-2005
		ES 2324164 T3	31-07-2009
		JP 4570956 B2	27-10-2010
		JP 2006502337 A	19-01-2006
		KR 20050053740 A	08-06-2005
		US 2006096647 A1	11-05-2006
		WO 2004033907 A1	22-04-2004
WO 2009135281 A1	12-11-2009	BR PI0801970 A2	12-01-2010
		CN 102119275 A	06-07-2011
		EP 2304236 A1	06-04-2011
		JP 2011520059 A	14-07-2011
		KR 20110013444 A	09-02-2011
		US 2011103937 A1	05-05-2011
		WO 2009135281 A1	12-11-2009
WO 2012145812 A2	01-11-2012	BR PI1101993 A2	11-02-2014
		CN 103608588 A	26-02-2014
		EP 2702274 A2	05-03-2014
		ES 2572331 T3	31-05-2016
		JP 2014512483 A	22-05-2014
		KR 20140024913 A	03-03-2014
		SG 194672 A1	30-12-2013
		US 2014134026 A1	15-05-2014
		WO 2012145812 A2	01-11-2012

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

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 7083400 B **[0005]**