(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 September 2007 (27.09.2007)

PCT

(10) International Publication Number
WO 2007/107510 A1

(51) International Patent Classification:
F25B 31/00 (2006.01)

(21) International Application Number:
PCT/EP2007/052498

(22) International Filing Date: 16 March 2007 (16.03.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
TR2006/01256 17 March 2006 (17.03.2006) TR

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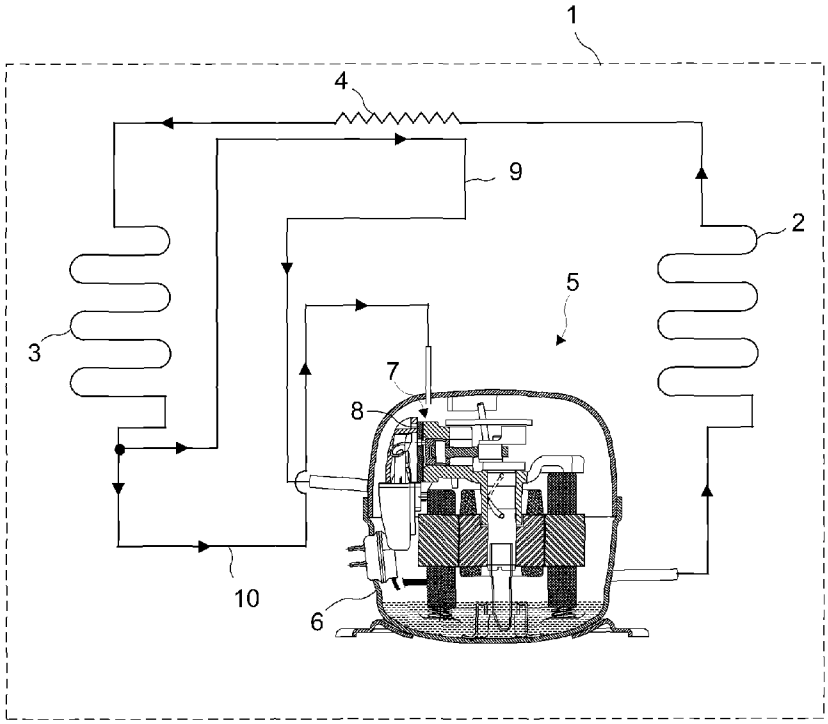
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) **Title:** A COOLING DEVICE



(57) **Abstract:** The cooling device (1) of the present invention comprises a compressor (5) having a cylinder (7) that provides the circulating fluid to be sucked and pumped, a cylinder head (8) situated above the cylinder (7), directing the sucked and pumped circulating fluid and a casing (6) protecting the motor and the other elements.

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Description

A COOLING DEVICE

[0001] The present invention relates to the cooling of the compressor cylinder.

[0002] In cooling devices, the refrigerant fluid circulating in the cooling cycle is in the superheated vapor phase when leaving the compressor. The refrigerant fluid leaving the compressor in the vapor phase changes to the liquid-vapor phase in the condenser and to the liquid phase at the vicinity of the entrance to the capillary tubes. The fluid starts to change again into the liquid-vapor phase from the liquid phase with decrease of pressure along the capillary tube and reaches the evaporator in the liquid-vapor phase at a low dryness rate. The refrigerant fluid changes into the vapor phase at the exit of the evaporator due to the absorption of heat from the surroundings, again reaching the compressor.

[0003]

[0004] Particularly in the domestic type refrigerators, the low temperature refrigerant vapor at the exit of the evaporator is used in decreasing the dryness rate at the entrance of the evaporator and in increasing the cooling capacity of the system by wrapping the suction line over the capillary tube or by forming a heat exchanger with telescopic ducts within each other. After the refrigerant vapor at low pressure and temperature is received into the compressor, the refrigerant fluid passes through the suction muffler and the plenum and enters the cylinder wherein it is compressed. In the conventional compressors, the efficiency of the compression process is decreased and as a result while the compressor performance decreases, the energy consumption of the refrigerator increases since the heat generated during the compression process cannot be removed from the cylinder.

[0005] In the state of the art European Patent Application no. EP0976993, an external cooling circuit is set up for cooling the cylinder and after the coolant fluid circulates in the channels formed in the cylinder wall to cool the cylinder, goes out of the compressor casing releasing the absorbed heat to the environment in a separate heat exchanger. Furthermore in the said document, the coolant fluid that is condensed and passes into the liquid phase in the condenser in the cooling circuit is sent to the cylinder by a circuit connected in series to the system and the cylinder is cooled.

[0006] In the state of the art United States of America Patent no. US4006602, the cylinder is cooled by taking advantage of the high pressure refrigerant at the outlet of the condenser by using two parallel conduits at the outlet of the condenser.

[0007] In the state of the art documents and applications, the ducts that deliver the high pressure refrigerant coming from the condenser to the compressor casing for cooling the cylinder should be entirely leak-proof. Furthermore, in the case that the refrigerant received from the high pressure line is used for cooling the cylinder, the ducts should be rigidly connected to the casing and around the perimeter of the cylinder, since this refrigerant will circulate in the ducts within the casing and in the cylinder walls and this connection creates new pathways that transmit the vibrations of the body to the casing.

[0008] The objective of the present invention is to design a cooling device comprising a compressor wherein the temperature of the cylinder is effectively reduced.

[0009] The cooling device designed to fulfill the objective of the present invention, explicated in the first claim and the respective claims thereof, comprises an additional cylinder cooling circuit that provides to use the low pressure refrigerant leaving the evaporator in cooling the cylinder, with one end extending into the evaporator exit and the other end extending towards the cylinder thus directing the refrigerant over the cylinder, parallel to the suction line, delivering the refrigerant from the evaporator exit to the compressor.

[0010] By means of the present invention, some portion of the refrigerant vapor leaving the evaporator and which is at a relatively lower temperature, is sent directly to the compressor casing by means of a line parallel to the suction line and is blown on the upper part of the cylinder providing to cool the cylinder. Since this process is realized by a parallel line, no modification is done in the section that extends to the capillary tube and cools the fluid in the capillary tube; however a certain amount of the flow passing through this line is directly delivered to the compressor casing with a well insulated parallel line.

[0011] Through using the low pressure line, the necessity for connecting the casing to the cylinder cooling circuit in the casing by means of rigid ducts is eliminated. Since gas at low pressure is used, connection of the cylinder cooling circuit to the casing can be realized by even elastic ducts and hereby the problems of vibration are prevented.

[0012] Furthermore, the temperature difference between the low temperature refrigerant at the exit of the evaporator and the cylinder is higher compared to other applications. When the cylinder temperature is 85 °C, while the temperature difference is 50° C if the low temperature refrigerant is received from the exit of the condenser, but the temperature difference is 80 °C – 90 °C if the low temperature refrigerant is received from the exit of the evaporator. Consequently the effectiveness of heat transfer is increased

in cooling the cylinder.

[0013] In another embodiment of the present invention, in order to cool the compressor cylinder effectively, fins are used that correspond to the top portion of the cylinder, effectuating heat transfer on the cylinder head.

[0014] In yet another embodiment of the present invention, the cooling device comprises a solenoid valve that directs the refrigerant to the cylinder cooling circuit in a controlled manner. Consequently, the solenoid valve provides the cylinder cooling circuit to participate in the cooling cycle by opening at certain times during the cooling cycle.

[0015] By cooling the cylinder, the system performance is increased and energy consumption of the cooling device is reduced.

[0016] The cooling device designed to fulfill the objective of the present invention is illustrated in the attached figures, where:

[0017] Figure 1 – is the schematic view of a cooling device.

[0018] Figure 2 – is the detailed view of a compressor.

[0019] Figure 3 – is the view of a cylinder head.

[0020] Figure 4 – is the view of the fins mounted on the cylinder.

[0021] The elements illustrated in the figures are numbered as follows:

1. Cooling device
2. Condenser
3. Evaporator
4. Capillary tube
5. Compressor
6. Casing
7. Cylinder
8. Cylinder head
9. Suction line
10. Cylinder cooling circuit
11. Fin

[0022] The cooling device (1) of the present invention comprises a compressor (5) having a cylinder (7) that provides the circulating fluid to be sucked and pumped, a cylinder head (8) situated above the cylinder (7), directing the sucked and pumped circulating fluid and a casing (6) protecting the motor and the other elements; a condenser (2) providing the refrigerant leaving the compressor (5) as superheated vapor to be condensed to first the liquid-vapor phase then entirely to liquid phase; one or more evaporators (3) providing the refrigerant circulating within to absorb heat, cooling the

surroundings therein; one or more capillary tubes (4) situated between the condenser (2) and the evaporator (3) providing the refrigerant to be constricted and to enter the liquid-vapor phase with a lower pressure; a suction line (9) with one end extending to the evaporator (3) exit and the other end to the compressor (5) and a cylinder cooling circuit (10) positioned parallel to the suction line (9), providing to direct some amount of the low temperature refrigerant leaving the evaporator (3) directly towards the cylinder (7) or the cylinder head (8) (Figure 1 and Figure 2).

[0023] One end of the cylinder cooling circuit (10) is connected to the exit of the evaporator (3), and the other end extends directly over the cylinder (7) in the compressor (5) providing some portion of the refrigerant leaving the evaporator (3) to be blown towards the cylinder (7) thereby cooling the cylinder (7).

[0024] The suction line (9) wraps around the capillary tube (4) and extends into the compressor (5) casing (6). Consequently, the still low temperature of the refrigerant leaving the evaporator (3) is transferred to the refrigerant flowing in the capillary tube (4) providing to keep the temperature of the refrigerant entering into the evaporator (3) at a low value. The cylinder cooling circuit (10) is linked to the cooling cycle by being parallel to this suction line (9).

[0025] The low pressure refrigerant reaching the compressor (5) casing (6) is compressed by the compressor (5) and delivered to the condenser (2). The high pressure refrigerant passing through the condenser (2) enters the capillary tube and the pressure is lowered to that of evaporation pressure. The refrigerant entering the evaporator (3) and evaporating by absorbing heat from the surroundings leaves the evaporator (3) and is dispersed into the suction line (9) and the cylinder cooling circuit (10). The low temperature refrigerant vapor leaving the evaporator (3), absorbs heat from the fluid in the capillary tube (4) by the help of the suction line (9) thus lowering the dryness level of the refrigerant entering the evaporator (3) and from there is directed to the compressor (5). This embodiment affects the cooling capacity of the system favorably.

[0026] The cylinder cooling circuit (10), arranged between the evaporator (3) exit and the compressor (5) such that it is parallel to the suction line (9), is connected to the compressor (5) casing (6) such that it delivers the refrigerant directly from the evaporator (3) exit to the vicinity of the cylinder (7). In this embodiment of the present invention, the refrigerant is delivered into the casing (6) from an opening that directly extends to the area facing the upper portion of the cylinder (7). Since the temperature of the gas leaving the evaporator (3) is substantially lower than the temperature of the cylinder (7), the cylinder (7) can be effectively cooled. The refrigerant that cools the

cylinder (7) heads towards the muffler entrance is mixed with the refrigerant coming from the suction line (9) and is received into the muffler.

[0027] The refrigerant temperature, which can be in the interval of –15°C - +5° C at the exit of the evaporator (3) ,depending on the type of the cooling device (1), is delivered to the compressor (5) casing (6) such that there is as small a temperature rise as possible by this parallel line (10) installed between the evaporator (3) exit and the compressor (5) casing (6). Since there are two parallel lines (9 and 10) between the evaporator (3) and the compressor (5), the refrigerant circulation between the capillary tubes (4) – suction line (9) is not disturbed; this circulation is realized with only a lower flow rate.

[0028] In another embodiment of the present invention, the suction line (9) and the cylinder cooling circuit (10) of the cooling device (1) each has different diameters so that the distribution of the refrigerant flow in both of the lines (9 and 10) can be adjusted.

[0029] In yet another embodiment of the present invention, the cooling device (1) comprises a solenoid valve that provides to direct the refrigerant towards the cylinder cooling circuit (10) in a controlled manner. Consequently, the solenoid valve opens at certain times of the cooling cycle providing the cylinder cooling circuit (10) to participate in the cooling cycle. The solenoid valve preferably opens as the compressor (5) is energized thereby allowing the refrigerant to pass and provides the refrigerant passing through the cylinder cooling circuit (10) to be blown over the cylinder (7).

[0030] In another embodiment of the present invention, the cooling device (1) comprises one or more fins (11) that increase the heat transfer surface area on the cylinder head (8), corresponding to the upper portion of the cylinder (7) in order to effectively cool the cylinder (7) of the compressor (5). The fins (11) can be produced from copper or aluminum material as separate pieces or can also be produced in one piece with the cylinder head (8) (Figure 3 and Figure 4).

[0031] In the cooling device (1) of the present invention, the refrigerant circulation is preferably provided by a hermetical and reciprocating compressor (5).

[0032] By means of the present invention, the utilization of the low pressure refrigerant at the evaporator (3) exit for cooling the cylinder (7) has provided for the increase in the system performance by cooling the cylinder (7) in this manner and hence resulted in the decrease of energy consumption in the cooling device (1).

Claims

[0001] A cooling device (1) comprising a compressor (5) having a cylinder (7) that provides the circulating fluid to be sucked and pumped, a cylinder head (8) situated above the cylinder (7), directing the sucked and pumped circulating fluid and a casing (6) protecting the motor and the other elements; a condenser (2) providing the refrigerant leaving the compressor (5) as superheated vapor to be condensed changing to first the liquid-vapor phase then entirely to the liquid phase; one or more evaporators (3) providing the refrigerant circulating within to absorb heat, cooling its surroundings; one or more capillary tubes (4) situated between the condenser (2) and the evaporator (3), providing the refrigerant to be constricted and to enter the liquid-vapor phase with a lower pressure; a suction line (9) with one end extending to the evaporator (3) exit and the other end to the compressor (5) **and characterized by** a cylinder cooling circuit (10) positioned parallel to the suction line (9), providing to direct a certain amount of the low temperature refrigerant leaving the evaporator (3) directly to the cylinder (7) or the cylinder head (8).

[0002] A cooling device (1) as in Claim 1, **characterized by** a cylinder cooling circuit (10) with one end connected to the evaporator (3) exit and the other end extending directly over the cylinder (7) in the compressor (5), providing to blow some of the refrigerant leaving the evaporator (3) towards the cylinder (7).

[0003] A cooling device (1) as in Claim 1 or 2, characterized by a suction line (9) and a cylinder cooling circuit (10) having different diameters so that the refrigerant flow rate dispersion can be adjusted.

[0004] A cooling device (1) as in any one of the above claims, **characterized by** a solenoid valve providing to controllably direct the refrigerant to the cylinder cooling circuit (10).

[0005] A cooling device (1) as in any one of the above claims, **characterized by** one or more fins (11) that increase the heat transfer surface area on the cylinder head (8), corresponding to the upper portion of the cylinder (7) in order to effectively cool the cylinder (7).

Figure 1

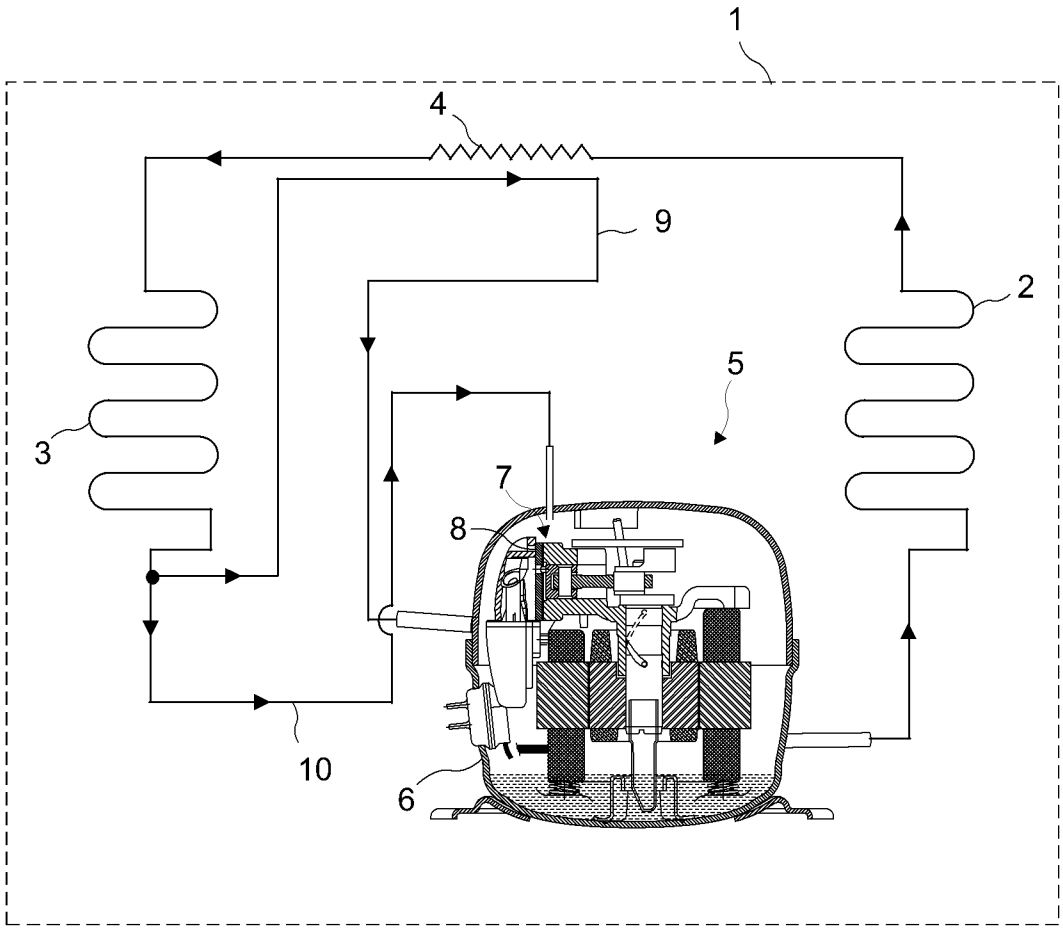


Figure 2

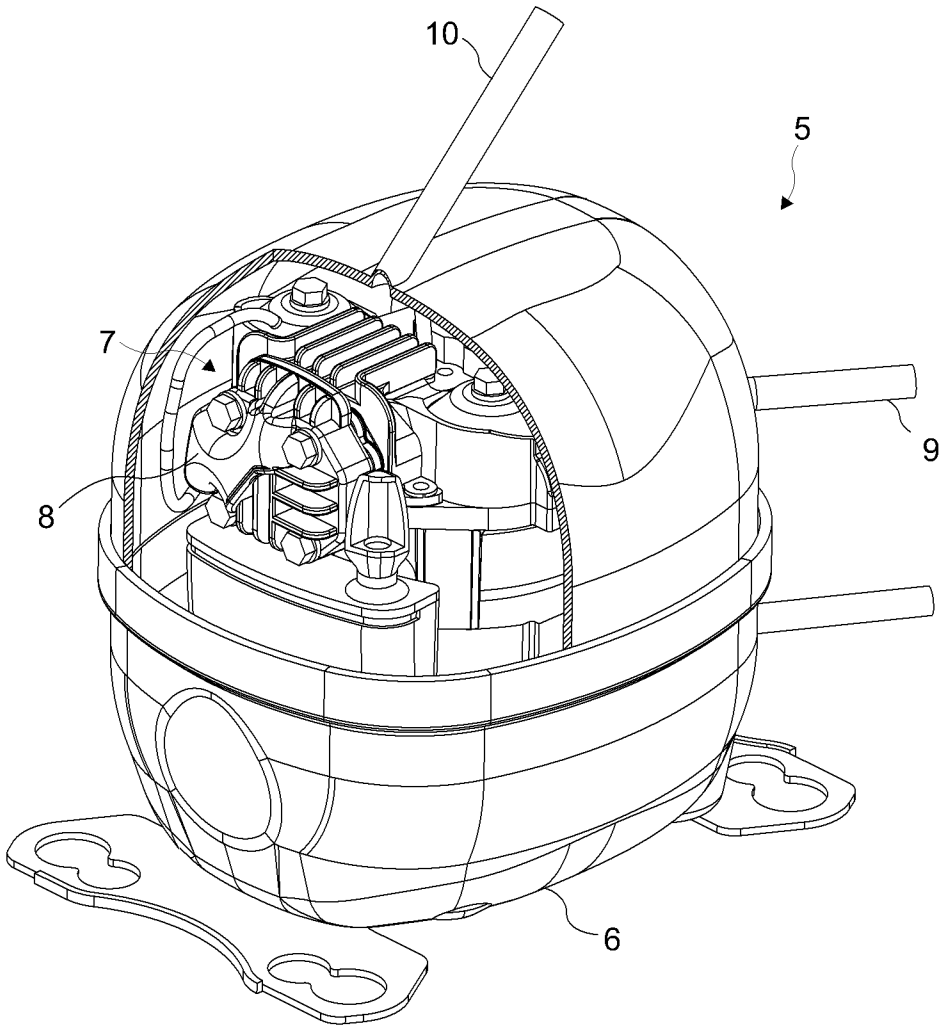


Figure 3

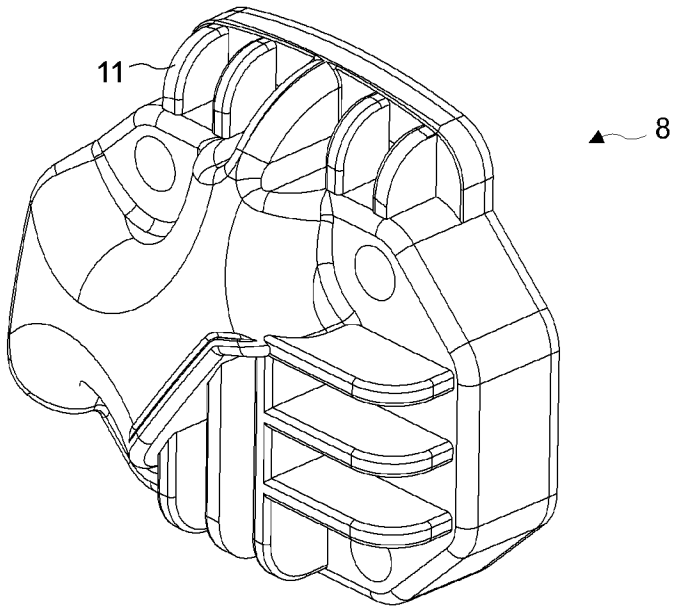
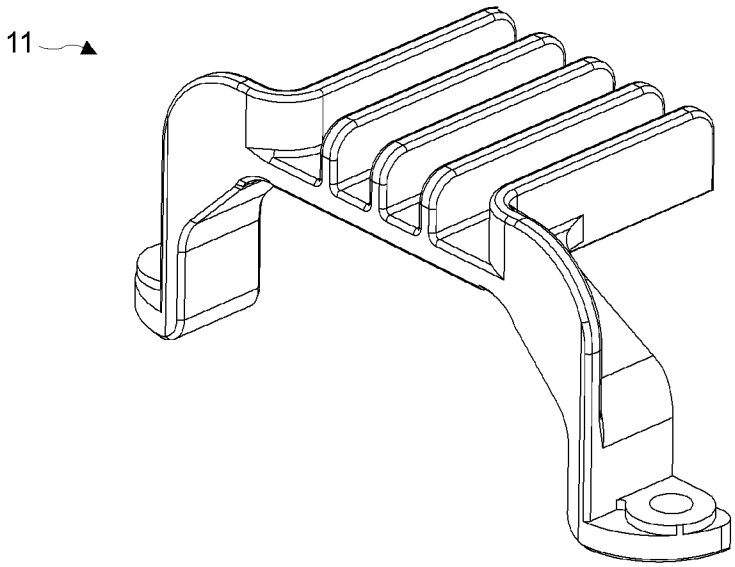


Figure 4



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/052498

A. CLASSIFICATION OF SUBJECT MATTER
INV. F25B31/00

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)
F25B

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/024262 A1 (MOSEMANN DIETER [DE] ET AL) 6 February 2003 (2003-02-06) paragraph [0008] - paragraph [0013]; claim 3; figures 1-4	1,2,4,5
X	DE 31 19 436 A1 (HAASE WAERME GMBH [DE]) 2 December 1982 (1982-12-02) page 7 - page 8; figure 1	1,3-5
A	WO 2005/057095 A (MODINE MFG CO [US]) 23 June 2005 (2005-06-23) figure 1	
A	US 5 408 836 A (SJOHOLM LARS I [US] ET AL) 25 April 1995 (1995-04-25) column 4, line 27 - column 13, line 36; figures 1,5	

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
20 June 2007	04/07/2007

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/052498

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 006 602 A (FANBERG RALPH Z) 8 February 1977 (1977-02-08) cited in the application the whole document	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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