



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
18.10.2017 Bulletin 2017/42

(51) Int Cl.:
F04C 23/00 (2006.01)

(21) Application number: **17163466.0**

(22) Date of filing: **29.03.2017**

(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

(72) Inventors:
• **LI, Hsun-An**
Taipei City 104 (TW)
• **HUNG, Ming-Chung**
New Taipei City 241 (TW)
• **LIN, Wei-Hsu**
New Taipei City 241 (TW)
• **YEH, Chung-Hung**
Keelung City 204 (TW)

(30) Priority: **13.04.2016 TW 105111428**

(71) Applicant: **Fu Sheng Industrial Co., Ltd.**
Taipei City 104 (TW)

(74) Representative: **Chamberlain, Alan James**
Haseltine Lake LLP
Redcliff Quay
120 Redcliff Street
Bristol BS1 6HU (GB)

(54) **COMPRESSION APPARATUS**

(57) A compression apparatus including a first compression unit and a second compression unit is provided. The first compression unit is adapted to compress a fluid. The second compression unit is connected to the first compression unit. After the fluid is compressed by the

first compression unit, the second compression unit is adapted to compress the fluid. The volumetric efficiency of the second compression unit is greater than the volumetric efficiency of the first compression unit.

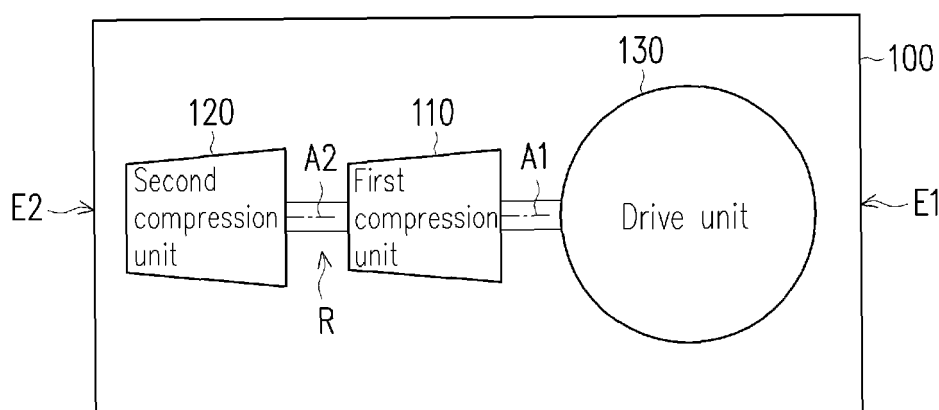


FIG. 1

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The invention relates to a compression apparatus, and more particularly, to a compound two-stage compression apparatus.

Description of Related Art

[0002] The compressor is an apparatus compressing a fluid and increasing fluid pressure, and has a wide application range. Common applications include, for instance, heating, ventilation and air conditioning, refrigeration cycle, providing industrial driving power, silicon chemical engineering, petrochemical engineering, and natural gas transportation. Based on operating principle, the compressor can be divided into a positive-displacement compressor and an aerodynamic compressor.

[0003] The positive-displacement compressor introduces a fluid inside an enclosed space and increases fluid pressure via compression of space volume. Based on different compression methods, the positive-displacement compressor can be divided into the types of reciprocating, rotary, scroll, and screw. The current compound two-stage compressor is mostly formed by two compressors of the same type, such as a double reciprocating compressor or a twin screw compressor. However, the properties of the same type of compressors are the same, and advantages of different types of compressors are difficult to be combined to effectively increase compression efficiency.

SUMMARY OF THE INVENTION

[0004] The invention provides a compression apparatus combining the advantages of different types of compressors to increase compression efficiency.

[0005] A compression apparatus of the invention includes a first compression unit and a second compression unit. The first compression unit is adapted to compress a fluid. The second compression unit is connected to the first compression unit. After the fluid is compressed by the first compression unit, the second compression unit is adapted to compress the fluid. The volumetric efficiency of the second compression unit is greater than the volumetric efficiency of the first compression unit.

[0006] In an embodiment of the invention, the first compression unit is a screw compression unit and the second compression unit is a scroll compression unit.

[0007] A compression apparatus of the invention includes a first compression unit and a second compression unit. The first compression unit is adapted to compress a fluid. The second compression unit is connected to the first compression unit. After the fluid is compressed by the first compression unit, the second compression

unit is adapted to compress the fluid. The first compression unit is a screw compression unit and the second compression unit is a scroll compression unit.

[0008] In an embodiment of the invention, the volumetric efficiency of the second compression unit is greater than the volumetric efficiency of the first compression unit.

[0009] In an embodiment of the invention, the exhaust amount of the first compression unit is greater than the exhaust amount of the second compression unit.

[0010] In an embodiment of the invention, the compression apparatus has an inlet end and an outlet end, wherein the first compression unit is located between the inlet end and the second compression unit, the second compression unit is located between the first compression unit and the outlet end, and the fluid is adapted to enter the first compression unit via the inlet end and adapted to leave the second compression unit via the outlet end.

[0011] In an embodiment of the invention, the first compression unit is adapted to compress the fluid such that the fluid has a first pressure, the second compression unit is adapted to compress the fluid having the first pressure such that the fluid has a second pressure, and the second pressure is greater than the first pressure.

[0012] In an embodiment of the invention, the compression apparatus includes a drive unit, wherein the drive unit is adapted to drive the first compression unit and the second compression unit at the same time.

[0013] In an embodiment of the invention, the first compression unit is connected between the drive unit and the second compression unit.

[0014] In an embodiment of the invention, the drive unit is connected between the first compression unit and the second compression unit.

[0015] In an embodiment of the invention, the first compression unit is adapted to operate along a first rotation axis, the second compression unit is adapted to operate along a second rotation axis, and the first rotation axis and the second rotation axis are coaxial.

[0016] In an embodiment of the invention, the compression apparatus includes a coupling, wherein the first compression unit has a first axle, the second compression unit has a second axle, and the first axle and the second axle are connected to each other via the coupling.

[0017] In an embodiment of the invention, the first compression unit has a first axle, the second compression unit has a second axle, and the first axle and the second axle are the same axle.

[0018] Based on the above, in the invention, different types of compression units are integrated in a single compression apparatus to combine the advantages of different types of compressors. Specifically, the first compression unit can be a screw compression unit having higher structural strength and the second compression unit can be a scroll compression unit having better resistance to internal leakage and higher volumetric efficiency. When the first compression unit is used to perform a first stage

compression, if a portion of the fluid (such as refrigerant) entering the first compression unit is undesirably liquid and is gasified and expanded instantly inside the first compression unit, then damage to the first compression unit due to the instant expansion of the fluid can be prevented by the high structural strength thereof. Moreover, when the second compression unit is used to perform a second stage compression, the fluid entering the second compression unit has a greater pressure from the first stage compression, and internal leakage to the second compression unit generated by greater pressure of the fluid can be prevented due to the feature of better resistance to internal leakage thereof. Accordingly, the compression apparatus can have good compression efficiency, and the durability of the compression apparatus is increased.

[0019] In order to make the aforementioned features and advantages of the disclosure more comprehensible, embodiments accompanied with figures are described in detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

FIG. 1 is a schematic of a compression apparatus of an embodiment of the invention.

FIG. 2 is a diagram comparing the power consumption of the compression apparatus of FIG. 1 and a conventional two-stage compressor.

FIG. 3 is a diagram comparing the coefficient of performance (COP) of the compression apparatus of FIG. 1 and conventional two-stage compressors.

FIG. 4 shows a specific structure of the compression apparatus of FIG. 1 in region R.

FIG. 5 is a schematic of a compression apparatus of another embodiment of the invention.

DESCRIPTION OF THE EMBODIMENTS

[0021] FIG. 1 is a schematic of a compression apparatus of an embodiment of the invention. Referring to FIG. 1, a compression apparatus 100 of the present embodiment includes a first compression unit 110, a second compression unit 120, and a drive unit 130. The second compression unit 120 is connected to the first compression unit 110, and the drive unit 130 is, for instance, a motor and is adapted to drive the first compression unit 110 and the second compression unit 120 to operate at the same time. The compression apparatus 100 of the present embodiment is, for instance, applied in refrigeration and air conditioning systems or other fields, and the invention is not limited thereto.

[0022] The first compression unit 110 is adapted to compress a fluid (such as refrigerant) such that the fluid has a first pressure. After the fluid is compressed by the first compression unit 110, the fluid flows from the first compression unit 110 to the second compression unit 120, and the second compression unit 120 is adapted to further compress the fluid such that the fluid has a second pressure greater than the first pressure. That is, the compression apparatus 100 of the present embodiment is a compound two-stage compressor containing the first compression unit 110 and the second compression unit 120, and the first compression unit 110 and the second compression unit 120 perform a first stage compression and a second stage compression on the fluid in order.

[0023] In the present embodiment, the first compression unit 110 is, for instance, a screw compression unit, and the second compression unit 120 is, for instance, a scroll compression unit. Therefore, the volumetric efficiency of the second compression unit 120 is greater than the volumetric efficiency of the first compression unit 110, the exhaust amount of the first compression unit 110 is greater than the exhaust amount of the second compression unit 120, and the structural strength of the first compression unit 110 is greater than the structural strength of the second compression unit 120. In other embodiments, the first compression unit 110 and the second compression unit 120 can respectively be other types of compression units, and the invention is not limited thereto.

[0024] In the above configuration of the present embodiment, the compression apparatus 100 can display advantages of the first compression unit 110 (screw compression unit) such as high structural strength, liquid compression resistance, capacity control, and large exhaust amount, and can also display advantages of the second compression unit 120 (scroll compression unit) such as greater resistance to internal leakage and large volumetric efficiency. For instance, when the first compression unit 110 is used to perform the first stage compression, if a portion of the fluid (such as refrigerant) entering the first compression unit 110 is undesirably liquid and is gasified and expanded instantly inside the first compression unit 110, then damage to the first compression unit 110 due to the instant expansion of the fluid can be prevented by the high structural strength thereof. Moreover, when the second compression unit 120 is used to perform the second stage compression, the fluid entering the second compression unit 120 has a greater pressure from the first stage compression, and internal leakage to the second compression unit 120 generated by greater pressure of the fluid can be prevented due to the feature of better resistance to internal leakage thereof. Accordingly, the compression apparatus 100 has good compression efficiency, and the durability of the compression apparatus 100 is increased.

[0025] FIG. 2 is a diagram comparing the power consumption of the compression apparatus of FIG. 1 and a conventional two-stage compressor. FIG. 3 is a diagram

comparing the coefficient of performance (COP) of the compression apparatus of FIG. 1 and conventional two-stage compressors. Curve A in FIG. 2 and FIG. 3 corresponds to the compression apparatus 100 of the present embodiment, curve B corresponds to the two-stage compressor of a conventional dual reciprocating compression unit, and curve C corresponds to the two-stage compressor of a conventional twin screw compression unit. As shown in FIG. 2 and FIG. 3, at an evaporation temperature of -25°C to -60°C , the power consumption of the compression apparatus 100 of the present embodiment is significantly lower than the power consumptions of the two conventional two-stage compressors, and the coefficient of performance of the compression apparatus 100 of the present embodiment is significantly higher than the coefficient of performance of the conventional two-stage compressors. The definition of coefficient of performance is the ratio of cold room capacity (kW) and power consumption (kW).

[0026] In the following, the specific configuration of the compression apparatus 100 of the present embodiment is further described. In the present embodiment, the compression apparatus 100 has an inlet end E1 and an outlet end E2, the first compression unit 110 is located between the inlet end E1 and the second compression unit 120, and the second compression unit 120 is located between the first compression unit 110 and the outlet end E2. The fluid is adapted to enter the first compression unit 110 via the inlet end E1 and adapted to leave the second compression unit 120 via the outlet end E2. It should be mentioned that, the structural shapes of the first compression unit 110, the second compression unit 120, and the drive unit 130 shown in FIG. 1 are only exemplary and are not intended to limit the invention. Moreover, the fluid is, for instance, transferred via the flow path of the inlet end E1, the first compression unit 110, the second compression unit 120, and the outlet end E2 in order, and the specific structure of the flow path can be configured based on the actual structural design of the compression apparatus 100, and is not repeated herein.

[0027] In the present embodiment, the first compression unit 110 is adapted to operate along a first rotation axis A1 via the driving of the drive unit 130, and the second compression unit 120 is adapted to operate along a second rotation axis A2 via the driving of the drive unit 130. The first rotation axis A1 and the second rotation axis A2 are coaxial, such that the drive unit 130 can drive the first compression unit 110 and the second compression unit 120 to operate at the same time. Moreover, since the first compression unit 110 and the second compression unit 120 are disposed in a coaxial manner as described above, the fluid can be transferred from the first compression unit 110 to the second compression unit 120 in a straight line and does not need to be transferred in a winding manner, and therefore better work efficiency is achieved.

[0028] FIG. 4 shows a specific structure of the compression apparatus of FIG. 1 in region R. Referring to

FIG. 4, the first compression unit 110 of the present embodiment has a first axle 112, the second compression unit 120 has a second axle 122, the compression apparatus 100 further includes a coupling 140, and the first axle 112 and the second axle 122 are connected to each other via the coupling 140. Accordingly, when the drive unit 130 shown in FIG. 1 drives the first compression unit 110 to operate, the second compression unit 120 can be driven via the connection of the first axle 112 and the second axle 122 at the same time. That is, the compression apparatus 100 of the present embodiment connects the axes of different types of compression units using the coupling 140 to integrate different types of compression units. In other embodiments, the first axle 112 and the second axle 122 can also be changed to be connected to the same axle of the first compression unit 110 and the second compression unit 120, and therefore the coupling can be omitted, and the invention is not limited thereto.

[0029] Referring to FIG. 1, the first compression unit 110 of the present embodiment is connected between the drive unit 130 and the second compression unit 120. However, the invention is not limited thereto, and description is provided below with reference to figures. FIG. 5 is a schematic of a compression apparatus of another embodiment of the invention. In a compression apparatus 200 of FIG. 5, the operating methods of a first compression unit 210, a second compression unit 220, a drive unit 230, an inlet end E1', and an outlet end E2' are similar to the operating methods of the first compression unit 110, the second compression unit 120, the drive unit 130, the inlet end E1, and the outlet end E2 of FIG. 1 and are not repeated herein. The difference between the compression apparatus 200 and the compression apparatus 100 is that, the drive unit 230 is connected between the first compression unit 210 and the second compression unit 220.

[0030] Based on the above, in the invention, different types of compression units are integrated in a single compression apparatus to combine the advantages of different types of compressors. Specifically, the first compression unit can be a screw compression unit having higher structural strength and the second compression unit can be a scroll compression unit having better resistance to internal leakage and higher volumetric efficiency. When the first compression unit is used to perform the first stage compression, if a portion of the fluid (such as refrigerant) entering the first compression unit is undesirably liquid and is gasified and expanded instantly inside the first compression unit, then damage to the first compression unit due to the instant expansion of the fluid can be prevented by the high structural strength thereof. Moreover, when the second compression unit is used to perform the second stage compression, the fluid entering the second compression unit has a greater pressure from the first stage compression, and internal leakage to the second compression unit generated by greater pressure of the fluid can be prevented due to the feature of better

resistance to internal leakage thereof. Accordingly, the compression apparatus can have good compression efficiency, and the durability of the compression apparatus is increased.

Claims

1. A compression apparatus (100, 200), comprising:

a first compression unit (110, 210) adapted to compress a fluid; and
a second compression unit (120, 220) connected to the first compression unit (110, 210), wherein after the fluid is compressed by the first compression unit (110, 210), the second compression unit (120, 220) is adapted to compress the fluid,
wherein a volumetric efficiency of the second compression unit (120, 220) is greater than a volumetric efficiency of the first compression unit (110, 210).

2. The compression apparatus (100, 200) of claim 1, wherein the first compression unit (110, 210) is a screw compression unit and the second compression unit (120, 220) is a scroll compression unit.

3. The compression apparatus (100, 200) of claim 1, wherein an exhaust amount of the first compression unit (110, 210) is greater than an exhaust amount of the second compression unit (120, 220).

4. The compression apparatus (100, 200) of claim 1, having an inlet end (E1, E1') and an outlet end (E2, E2'), wherein the first compression unit (110, 210) is located between the inlet end (E1, E1') and the second compression unit (120, 220), the second compression unit (120, 220) is located between the first compression unit (110, 210) and the outlet end (E2, E2'), and the fluid is adapted to enter the first compression unit (110, 210) via the inlet end (E1, E1') and adapted to leave the second compression unit (120, 220) via the outlet end (E2, E2').

5. The compression apparatus (100, 200) of claim 1, wherein the first compression unit (110, 210) is adapted to compress the fluid such that the fluid has a first pressure, the second compression unit (120, 220) is adapted to compress the fluid having the first pressure such that the fluid has a second pressure, and the second pressure is greater than the first pressure.

6. The compression apparatus (100) of claim 1, wherein the first compression unit (110) is connected between a drive unit (130) and the second compression unit (120).

7. The compression apparatus (200) of claim 1, wherein a drive unit (230) is connected between the first compression unit (210) and the second compression unit (220).

8. The compression apparatus (100) of claim 1, wherein the first compression unit (110) is adapted to operate along a first rotation axis (A1), the second compression unit (120) is adapted to operate along a second rotation axis (A2), and the first rotation axis (A1) and the second rotation axis (A2) are coaxial.

9. The compression apparatus (100) of claim 1, comprising a coupling (140), wherein the first compression unit (110) has a first axle (112), the second compression unit (120) has a second axle (122), and the first axle (112) and the second axle (122) are connected to each other via the coupling (140).

10. The compression apparatus (100) of claim 1, wherein the first compression unit (110) has a first axle (112), the second compression unit (120) has a second axle (122), and the first axle (112) and the second axle (122) are the same axle.

11. A compression apparatus (100, 200), comprising:

a first compression unit (110, 210) adapted to compress a fluid; and
a second compression unit (120, 220) connected to the first compression unit (110, 210), wherein after the fluid is compressed by the first compression unit (110, 210), the second compression unit (120, 220) is adapted to compress the fluid,
wherein the first compression unit (110, 210) is a screw compression unit and the second compression unit (120, 220) is a scroll compression unit,
wherein a volumetric efficiency of the second compression unit (120, 220) is greater than a volumetric efficiency of the first compression unit (110, 210).

12. The compression apparatus (100, 200) of claim 11, wherein an exhaust amount of the first compression unit (110, 210) is greater than an exhaust amount of the second compression unit (120, 220).

13. The compression apparatus (100, 200) of claim 11, having an inlet end (E1, E1') and an outlet end (E2, E2'), wherein the first compression unit (110, 210) is located between the inlet end (E1, E1') and the second compression unit (120, 220), the second compression unit (120, 220) is located between the first compression unit (110, 210) and the outlet end (E2, E2'), and the fluid is adapted to enter the first compression unit (110, 210) via the inlet end (E1,

E1') and adapted to leave the second compression unit (120, 220) via the outlet end (E2, E2').

14. The compression apparatus (100, 200) of claim 11, wherein the first compression unit (110, 210) is adapted to compress the fluid such that the fluid has a first pressure, the second compression unit (120, 220) is adapted to compress the fluid having the first pressure such that the fluid has a second pressure, and the second pressure is greater than the first pressure. 5 10
15. The compression apparatus (100) of claim 11, wherein the first compression unit (110) is connected between a drive unit (130) and the second compression unit (120). 15
16. The compression apparatus (200) of claim 11, wherein a drive unit (230) is connected between the first compression unit (210) and the second compression unit (220). 20
17. The compression apparatus (100) of claim 11, wherein the first compression unit (110) is adapted to operate along a first rotation axis (A1), the second compression unit (120) is adapted to operate along a second rotation axis (A2), and the first rotation axis (A1) and the second rotation axis (A2) are coaxial. 25
18. The compression apparatus (100) of claim 11, comprising a coupling (140), wherein the first compression unit (110) has a first axle (112), the second compression unit (120) has a second axle (122), and the first axle (112) and the second axle (122) are connected to each other via the coupling (140). 30 35
19. The compression apparatus (100) of claim 11, wherein the first compression unit (110) has a first axle (112), the second compression unit (120) has a second axle (122), and the first axle (112) and the second axle (122) are the same axle. 40

45

50

55

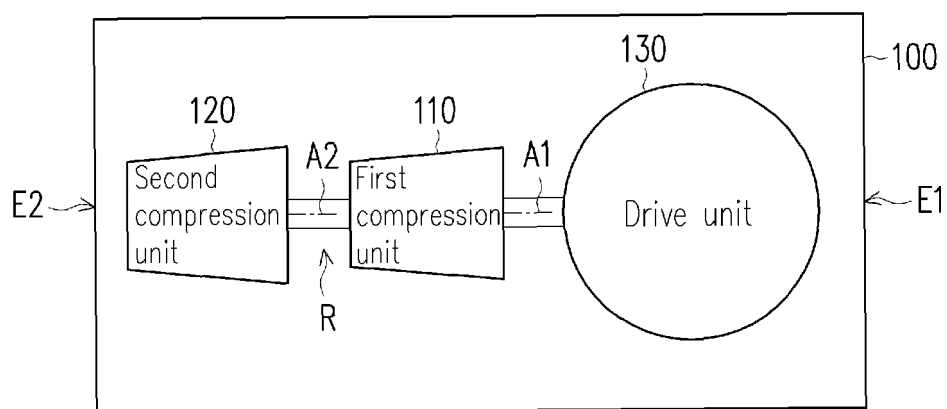


FIG. 1

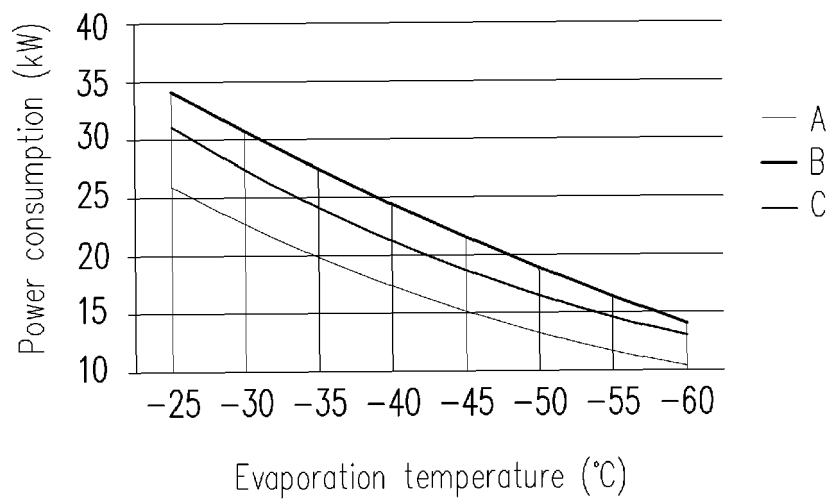


FIG. 2

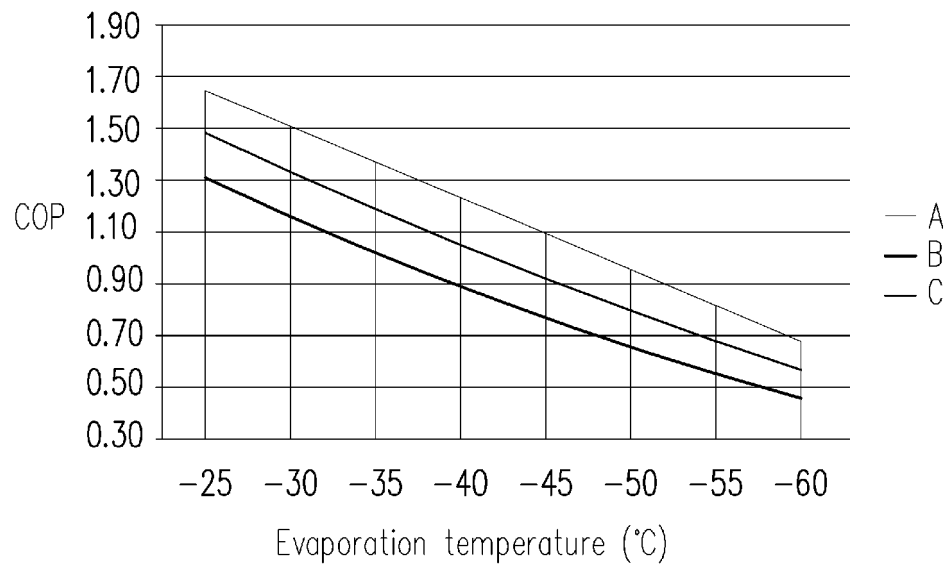


FIG. 3

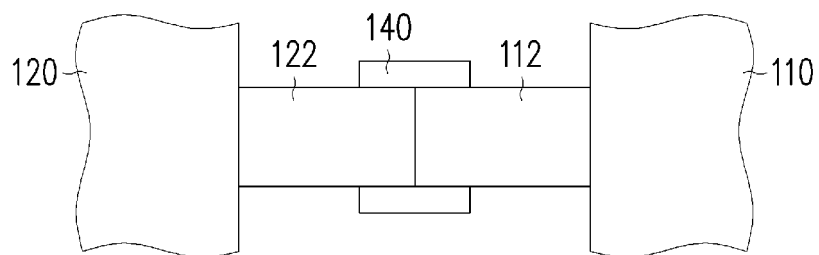


FIG. 4

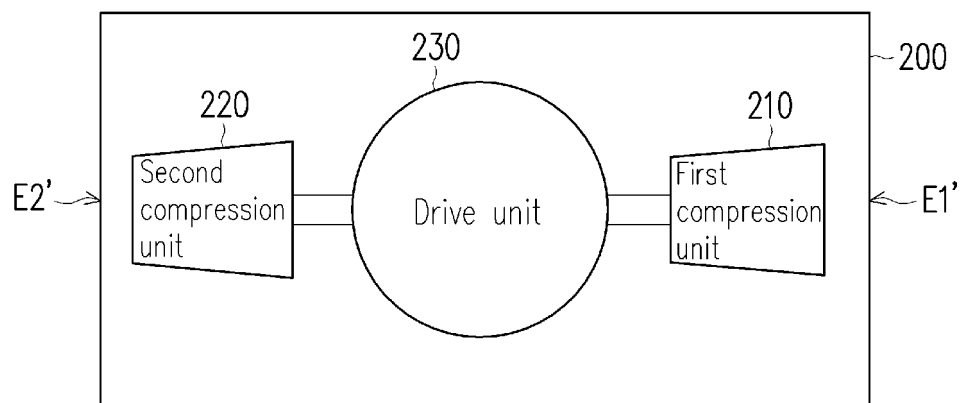


FIG. 5



EUROPEAN SEARCH REPORT

Application Number
EP 17 16 3466

5

10

15

20

25

30

35

40

45

50

55

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	EP 1 101 942 A2 (TEIJIN SEIKI CO LTD [JP]) 23 May 2001 (2001-05-23) * paragraph [0055]; figure 4 * * paragraph [0101] * -----	1-19	INV. F04C23/00
A	WO 97/16647 A1 (AAF MCQUAY INC [US]; YOUNG TERENCE WILLIAM THOMAS [GB]; ROLL JOHN MICH) 9 May 1997 (1997-05-09) * page 6, line 1 - line 9; claim 7; figures 2,6 * -----	1-19	
			TECHNICAL FIELDS SEARCHED (IPC)
			F04C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 14 June 2017	Examiner Grilli, Muzio
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			

 1
EPO FORM 1503 03/02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 17 16 3466

5 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.

14-06-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1101942	A2	23-05-2001	AT 357598 T 15-04-2007
			DE 60034006 T2 12-07-2007
			EP 1101942 A2 23-05-2001
			EP 1813818 A2 01-08-2007
			JP 2001207984 A 03-08-2001
			KR 20010051783 A 25-06-2001
			KR 20070012282 A 25-01-2007
			TW 468003 B 11-12-2001
			US 6375431 B1 23-04-2002

WO 9716647	A1	09-05-1997	AU 7322596 A 22-05-1997
			AU 7501096 A 22-05-1997
			WO 9716647 A1 09-05-1997

ORM P0459