



- (51) International Patent Classification:
F24F 3/044 (2006.01) F25B 29/00 (2006.01)
F25B 25/00 (2006.01)
- (21) International Application Number:
PCT/US2012/035127
- (22) International Filing Date:
26 April 2012 (26.04.2012)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/480,511 29 April 2011 (29.04.2011) US
- (71) Applicant (for all designated States except US): CARRIER CORPORATION [US/US]; 1 Carrier Place, Farmington, Connecticut 06034 (US).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): LUO, Dong [CN/US]; 52 Sally Dr., South Windsor, Connecticut 06074 (US).

- (74) Agent: FOX, David A.; Cantor Colburn LLP, 20 Church Street, 22nd Floor, Hartford, Connecticut 06103 (US).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, 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, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, 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, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

[Continued on next page]

(54) Title: AIR CONDITIONER EXHAUST RECYCLING

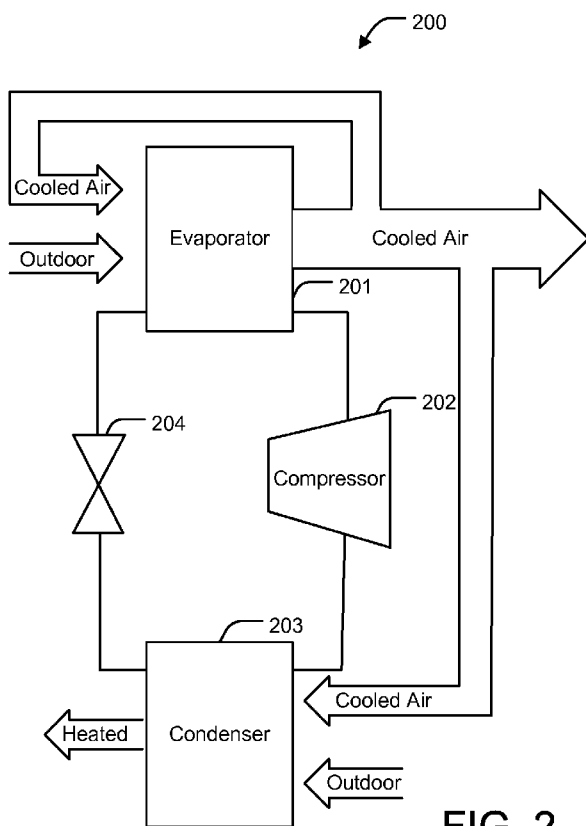


FIG. 2

(57) Abstract: An air conditioning system includes an air conditioning portion configured to condition a volume of air flowing there-through and an exhaust portion configured to exchange heat with the air conditioning portion through a working fluid. A portion of the volume of air exiting the air conditioning portion is mechanically diverted into the exhaust portion.

WO 2012/149112 A1

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, — *of inventorship (Rule 4.17(iv))*
ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

- *with international search report (Art. 21(3))*

AIR CONDITIONER EXHAUST RECYCLING

BACKGROUND OF THE INVENTION

[0001] The present invention is directed to air-conditioning systems, and more particularly, example embodiments of the present invention are directed to exhaust recycling in air-conditioning systems.

[0002] Conventional air conditioning systems suffer from energy inefficiencies during cooling or heating cycles responsive to an ambient temperature of air / fluid flowing over a condenser or evaporator of the air conditioning system, respectively. For example, during operation of a heating-cycle of an air conditioner, the cooler the ambient temperature of air / fluid flowing over the evaporator, the more inefficient a heat pump becomes. Further, during operation of a cooling-cycle of an air conditioner, the hotter the ambient temperature of air / fluid flowing over the condenser, the more inefficient the air conditioner becomes.

BRIEF DESCRIPTION OF THE INVENTION

[0003] According to an example embodiment of the present invention, an air conditioning system includes an air conditioning portion configured to condition a volume of air flowing there-through and an exhaust portion configured to exchange heat with the air conditioning portion through a working fluid. A portion of the volume of air exiting the air conditioning portion is mechanically diverted into the exhaust portion.

[0004] According to another example embodiment of the present invention, an air conditioning system includes a housing which defines an air conditioning portion configured to condition air entering and flowing there-through, an exhaust portion configured to exchange heat with the air conditioning portion through a working fluid, and a diversion channel proximate the air conditioning portion and the exhaust portion. The diversion channel is arranged to divert a portion of air entering the air conditioning portion to the exhaust portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The subject matter which is regarded as the invention is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

- [0006] FIG. 1 depicts a conventional air conditioning system in cooling mode;
- [0007] FIG. 2 depicts an air conditioning system in cooling mode, according to an example embodiment;
- [0008] FIG. 3 depicts a conventional air conditioning system in heating mode;
- [0009] FIG. 4 depicts an air conditioning system in heating mode, according to an example embodiment; and
- [0010] FIG. 5 depicts a diagram of an example roof-top air conditioning system, according to an example embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0011] According to example embodiments, air conditioning systems with exhaust recycling are provided, which redirect exhaust to either an evaporator or condenser of the air conditioning systems. The technical effects include increased energy efficiency during operation of the air conditioning system in either a heat-pump or cooling mode.

[0012] Turning to FIG. 1, a conventional air conditioning system is depicted. The system 100 includes an evaporator 101. The system 100 further includes compressor 102 in fluid communication with the evaporator 101. The system 100 further includes condenser 103 in fluid communication with the compressor 102. The system 100 further includes expansion valve 104 in fluid communication with the condenser 103 and the evaporator 101. As illustrated, a conventional refrigeration cycle is produced where refrigerant is exchanged between the evaporator 101 and condenser 103 in a manner which allows heat to be exchanged with air flowing over the evaporator 101 and condenser 103.

[0013] For example, condenser 103 exchanges heat with outdoor air flowing there-through. Further, outdoor air exchanges heat with the evaporator 101 as it flows there-through. Moreover, a portion of the cooled air exiting the evaporator 101 is diverted after flowing through a conditioned space and mixed with outdoor air which flows through the evaporator 101. In this manner, heat is removed from the cooled-air / outdoor air mix entering the evaporator 101 and is exchanged with outdoor air flowing through the condenser 103.

[0014] It is apparent that as the ambient temperature of outdoor air entering the condenser 103 increases, the flow of heat from the condenser 103 to the outdoor air decreases. More clearly, there is a net decrease in temperature differential, thereby reducing the availability of a heat sink produced by the outdoor air. However, example embodiments provide for a decrease in the temperature of air entering a condenser, thereby increasing the

temperature differential and decreasing energy consumption of an exemplary air conditioning system.

[0015] For example, FIG. 2 depicts an air conditioning system, according to an example embodiment. The system 200 includes an evaporator 201. The system 200 further includes compressor 202 in fluid communication with the evaporator 201. The system 200 further includes condenser 203 in fluid communication with the compressor 202. The system 200 further includes expansion valve 204 in fluid communication with the condenser 203 and the evaporator 201. It is noted that although system 200 is illustrated with a particular number and type of components, example embodiments do not preclude the addition of any suitable components and/or omission of components according to any desired implementation.

[0016] As illustrated, a refrigeration cycle is produced where refrigerant is exchanged between the evaporator 201 and condenser 203 in a manner which allows heat to be exchanged with air flowing over the evaporator 201 and condenser 203. For example, condenser 203 exchanges heat with outdoor air flowing there-through. Further, outdoor air exchanges heat with the evaporator 201 as it flows there-through. Moreover, a portion of the cooled air exiting the evaporator 201 is diverted after flowing through a conditioned space and mixed with outdoor air which flows through the evaporator 201 and the condenser 203. In this manner, heat is removed from the recirculated air / outdoor air mix entering the evaporator 201 and is exchanged with a mixture of both outdoor air and recirculated air flowing through the condenser 203.

[0017] It is apparent that as the ambient temperature of outdoor air entering the condenser 203 increases, the recirculated air mixing with the outdoor air serves to mitigate a net temperature increase. More clearly, the temperature differential between refrigerant of the condenser 203 and the entering air is stabilized through diversion of the recirculated air, thereby maintaining the availability of a heat sink for heat exchange. Thus energy consumption of an air conditioning system is decreased compared to conventional systems.

[0018] In addition to increased efficiency of air conditioning systems during cooling-cycles described above, example embodiments provide increased efficiency during heating-cycles as well. For example, FIG. 3 depicts a conventional heat pump system. The system 300 includes a condenser 301. The system 300 further includes compressor 302 in fluid communication with the condenser 301. The system 300 further includes evaporator 303 in fluid communication with the compressor 302. The system 300 further includes expansion valve 304 in fluid communication with the condenser 301 and the evaporator 303. As illustrated, a conventional heating-cycle is produced where a working fluid is exchanged

between the evaporator 303 and condenser 301 in a manner which allows heat to be exchanged with air flowing over the evaporator 303 and condenser 301.

[0019] For example, evaporator 303 removes heat from outdoor air flowing there-through. Further, outdoor air exchanges heat with the condenser 301 as it flows there-through. Moreover, a portion of the heated air exiting the condenser 301 is diverted after flowing through a conditioned space and mixed with outdoor air which flows through the condenser 301. In this manner, heat is removed from outdoor air flowing through the evaporator 303, which is added to the recirculated air / outdoor air mix entering the condenser 301.

[0020] It is apparent that as the ambient temperature of outdoor air entering the evaporator 303 decreases, the flow of heat to the evaporator 303 from the outdoor air decreases. More clearly, there is a net decrease in temperature differential, thereby reducing the availability of a heat source produced by the evaporator. However, example embodiments provide for an increase in the temperature of air entering an evaporator in a heat pump, thereby increasing the temperature differential and decreasing energy consumption of an exemplary heat pump system.

[0021] For example, FIG. 4 depicts a heat pump system, according to an example embodiment. The system 400 includes a condenser 401. The system 400 further includes compressor 402 in fluid communication with the condenser 401. The system 400 further includes evaporator 403 in fluid communication with the compressor 402. The system 400 further includes expansion valve 404 in fluid communication with the condenser 401 and the evaporator 403. As illustrated, a conventional heating-cycle is produced where a working fluid is exchanged between the evaporator 403 and condenser 401 in a manner which allows heat to be exchanged with air flowing over the evaporator 403 and condenser 401.

[0022] For example, evaporator 403 removes heat from outdoor air flowing there-through. Further, outdoor air exchanges heat with the condenser 401 as it flows there-through. Moreover, a portion of the heated air exiting the condenser 401 is diverted after flowing through a conditioned space and mixed with outdoor air which flows through the condenser 401 and the evaporator 403. In this manner, heat is removed from the mixture of outdoor air and recirculated air flowing through the evaporator 403, which is added to the recirculated air / outdoor air mix entering the condenser 401.

[0023] It is apparent that as the ambient temperature of outdoor air entering the evaporator 403 decreases, the recirculated air mixing with the outdoor air serves to mitigate a net temperature decrease. More clearly, the temperature differential between refrigerant of the

evaporator 403 and the outdoor air is stabilized through diversion of the recirculated air, thereby maintaining the availability of a heat source for heat exchange. Thus energy consumption of a heat pump system is decreased. It should also be noted that an added benefit of exemplary heat pump systems is the reduced possibility of heat pump failure due to an evaporator freezing out. Therefore, overall energy efficiency is further increased due to reduced necessity of running cyclic defrost cycles on the heat pump.

[0024] Although described as separate, it should be appreciated that the diversion of conditioned air, whether it is cooled or heated, in exemplary systems may be facilitated through at least one diversion channel due to the reversible nature of air conditioning systems. For example, as the operation of an evaporator in a system may be reversed, a single diversion channel serving to divert the conditioned air to the evaporator also serves to divert the conditioned air to the condenser when the system is operating in reverse. It should be appreciated that the opposite is also true. For example, an air conditioning system may be arranged to include an air conditioning portion and an exhaust portion, where conditioned air is diverted to the exhaust portion. In this example, if the system is run in reverse, the benefits of both FIGS. 2 and 4 are realized. Therefore, example embodiments should not be construed as limited to separate and distinct air conditioning and heat pump systems, but are extensible to any suitable combination.

[0025] As a non-limiting example, a roof-top air conditioning system is illustrated in FIG. 5 which incorporates the benefits and features of example embodiments. Turning to FIG. 5, the system 500 may include a housing 501 configured to house components of the system 500. The housing 501 may include an air conditioning portion 510, a conditioned air diversion channel / duct 520, and an exhaust portion 530. The diversion channel 520 is configured to divert recirculated air entering the air conditioning portion 510 to the exhaust portion 530. For example, conditioned air leaves the air conditioning portion 510 to circulate in a conditioned environment, such as a building, refrigerator, freezer, transport container, etc. Upon circulating, the air reenters the air conditioning portion 510 to be mixed with outdoor air. Before mixing, a portion of the air flows through the diversion channel into the exhaust portion 530.

[0026] The flow of circulated conditioned air through the diversion channel 520 is facilitated by dampers D4 and D5. The damper D4 is proximate a first longitudinal end of the diversion channel 520, and the damper D5 is proximate a second longitudinal end of the diversion channel 520. Upon flowing through the diversion channel 520, the circulated conditioned air is forced through condenser 507 by fan(s) 511 in the exhaust portion 530. It is

noted that at least one wall of the exhaust portion 520 may be finned or include apertures such that outdoor air is also forced through the condenser 507 by the fan(s) 511.

[0027] As further illustrated, the housing 501 further includes inlet port 502 configured to allow outdoor air to enter the air conditioning portion 510. The housing 501 further includes outlet port 503 configured to allow a portion of conditioned air to exit the system 500. In this manner, both outdoor air and conditioned air is mixed before being reconditioned. This aids in resupplying fresh air to the conditioned environment. Flow of outdoor air is facilitated and controlled with damper D1 which is proximate inlet port 502. The exit flow of circulated conditioned air is facilitated and controlled through damper D2 which is proximate the outlet port 503. Upon entering the air conditioning portion 510, the mixed outdoor / conditioned air is forced through filter 504 and evaporator 506 by fan(s) 505. Thereafter, the newly conditioned air mix flows to the conditioned environment.

[0028] As described above, conditioned air is recycled to stabilize a temperature within an exhaust portion of an air conditioning system. Although particularly illustrated as including an evaporator arranged in a conditioning portion and a condenser in the exhaust portion, it should be understood that upon operating in reverse, the roles of the evaporator and condenser change while still including all benefits outlined above.

[0029] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

CLAIMS:

1. An air conditioning system, comprising:
an air conditioning portion configured to condition a volume of air flowing there-through; and
an exhaust portion configured to exchange heat with the air conditioning portion through a working fluid;
wherein a portion of the volume of air exiting the air conditioning portion is mechanically diverted into the exhaust portion.
2. The system of claim 1, further comprising:
a diversion channel proximate the air conditioning portion and the exhaust portion, and configured to divert the portion of the volume of air.
3. The system of claim 1, further comprising:
an evaporator in cooling mode or a condenser in heating mode arranged within the air conditioning portion; and
a condenser in cooling mode or an evaporator in heating mode arranged within the exhaust portion.
4. The system of claim 3, wherein the portion of the volume of air stabilizes a temperature of air flowing through the condenser in cooling mode or the evaporator in heating mode.
5. The system of claim 4, wherein a second portion of the volume of air exiting the air conditioning portion is mechanically diverted into the air conditioning portion.
6. The system of claim 1, further comprising an exhaust damper proximate the exhaust portion configured to control a flow of the portion of the volume of air entering the exhaust portion.
7. The system of claim 1, further comprising:
an inlet vent proximate the air conditioning portion; and
an inlet damper proximate the inlet vent;
wherein the inlet damper is configured to control a flow of external air entering the air conditioning portion.
8. The system of claim 7, further comprising:
an exit vent proximate the air conditioning portion; and
an exit damper proximate the exit vent;
wherein the exit vent is configured to control a flow of conditioned air exiting the system.

9. The system of claim 7, wherein circulated conditioned air and external air is mixed within the air conditioning portion.

10. The system of claim 1, further comprising at least one fan arranged within the air conditioning portion configured to force air flow through the air conditioning portion.

11. The system of claim 1, further comprising at least one filter arranged within the air conditioning portion configured to capture particulates from air flowing there-through.

12. The system of claim 1, further comprising at least one fan arranged within the exhaust portion configured to force air flow through the exhaust portion.

13. An air conditioning system, comprising:
a housing, wherein the housing defines:
an air conditioning portion configured to condition air entering and flowing there-through,
an exhaust portion configured to exchange heat with the air conditioning portion through a working fluid, and
a diversion channel proximate the air conditioning portion and the exhaust portion;
wherein the diversion channel is arranged to divert a portion of air entering the air conditioning portion to the exhaust portion.

14. The system of claim 13, wherein the housing further defines an inlet port and an exit port proximate the air conditioning portion, wherein the inlet port is configured to allow air external the housing enter the air conditioning portion, and wherein the exit port is configured to allow air internal the air conditioning portion exit the air conditioning portion.

15. The system of claim 14, further comprising an inlet damper proximate the inlet port configured to control a flow of air through the inlet port.

16. The system of claim 14, further comprising an exit damper proximate the exit port configured to control a flow of air through the exit port.

17. The system of claim 14, further comprising an exhaust damper proximate the exhaust portion configured to control a flow of air into the exhaust portion, and an air conditioning damper proximate the air conditioning portion configured to control a flow of air into the air conditioning portion.

18. The system of claim 13, further comprising:
at least one filter arranged within the air conditioning portion;
at least one fan arranged within the air conditioning portion;
an evaporator arranged within the air conditioning portion; and

a condenser arranged within the exhaust portion in fluid communication within the evaporator through the working fluid.

19. The system of claim 14, further comprising a compressor in fluid communication with the condenser and the evaporator through the working fluid.

20. The system of claim 19, further comprising an expansion valve in fluid communication with the condenser and the evaporator through the working fluid.

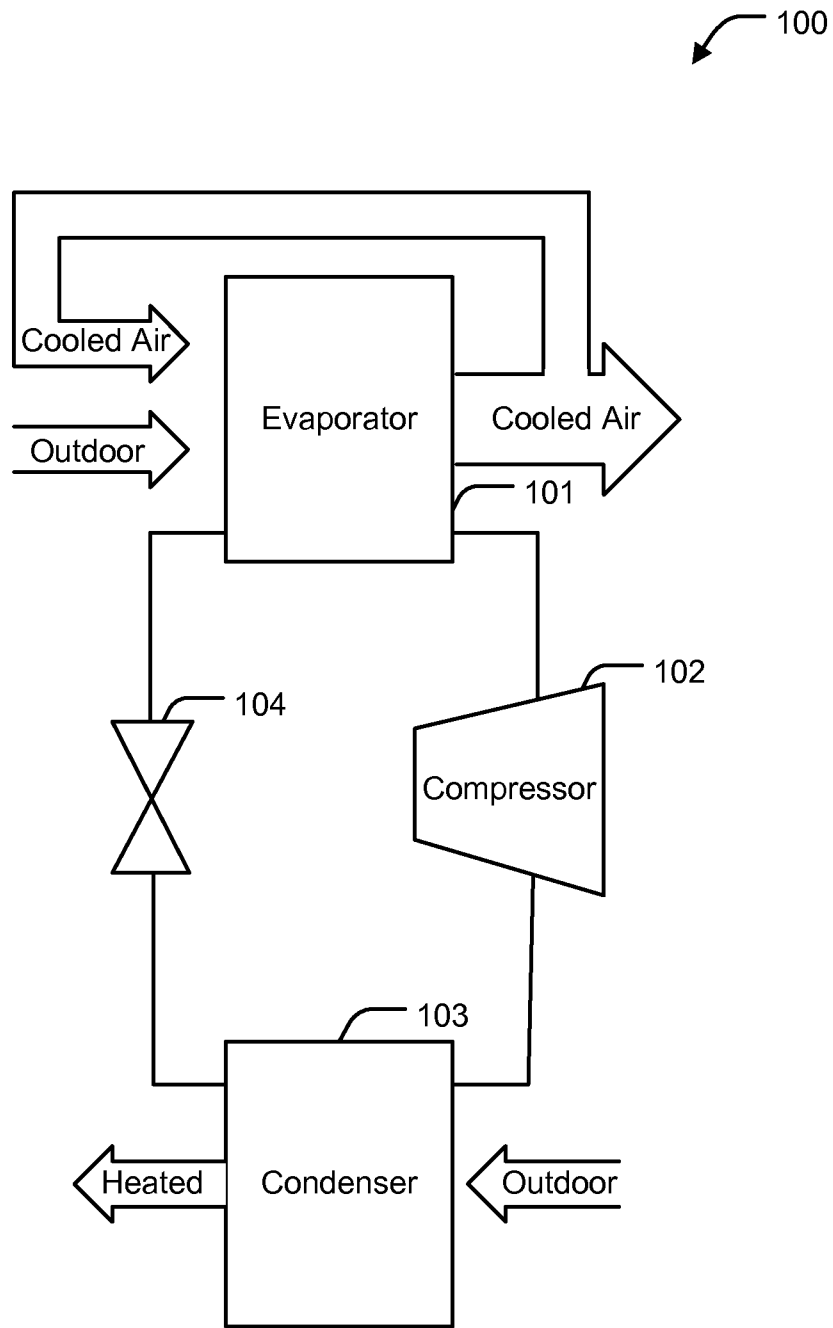


FIG. 1

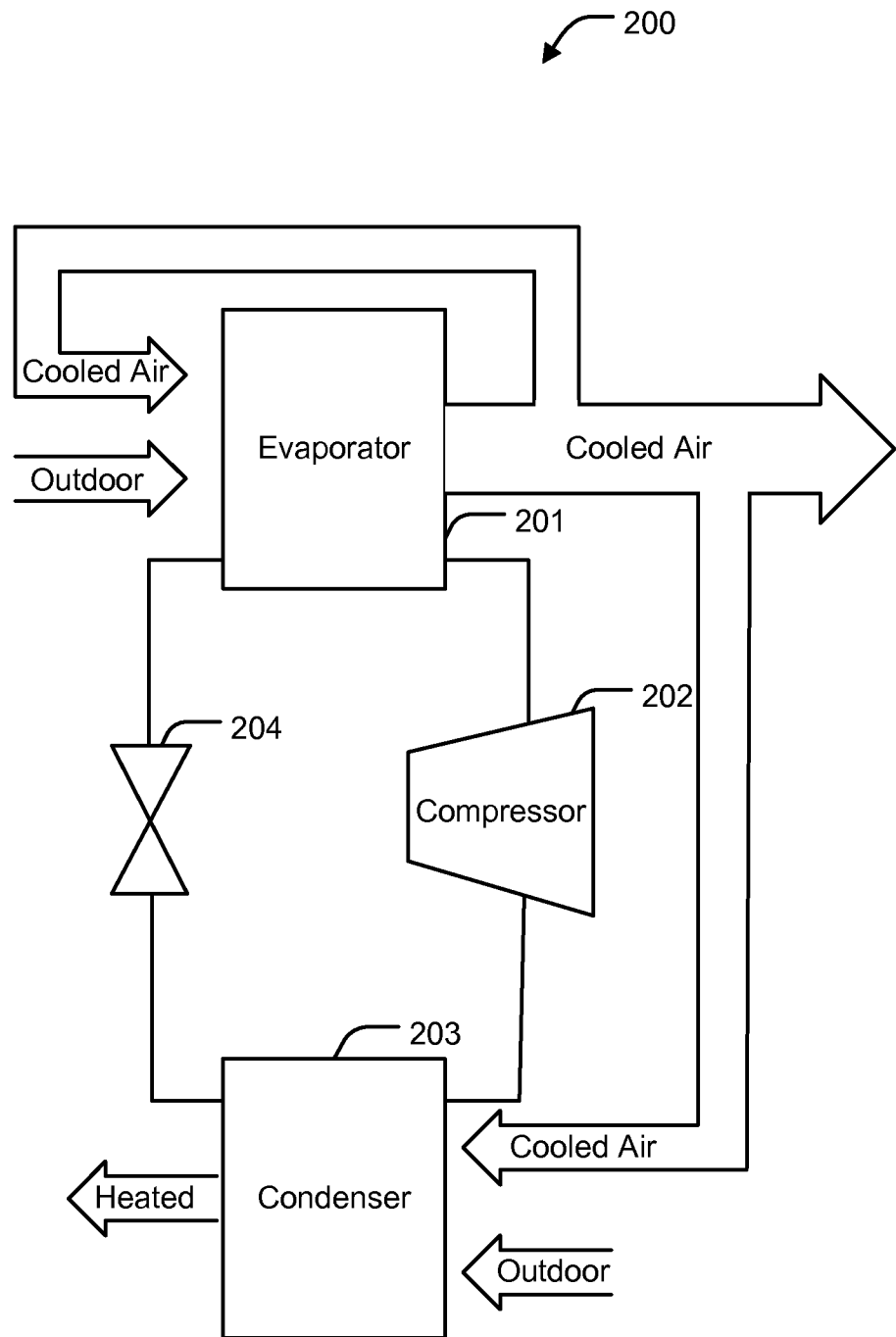


FIG. 2

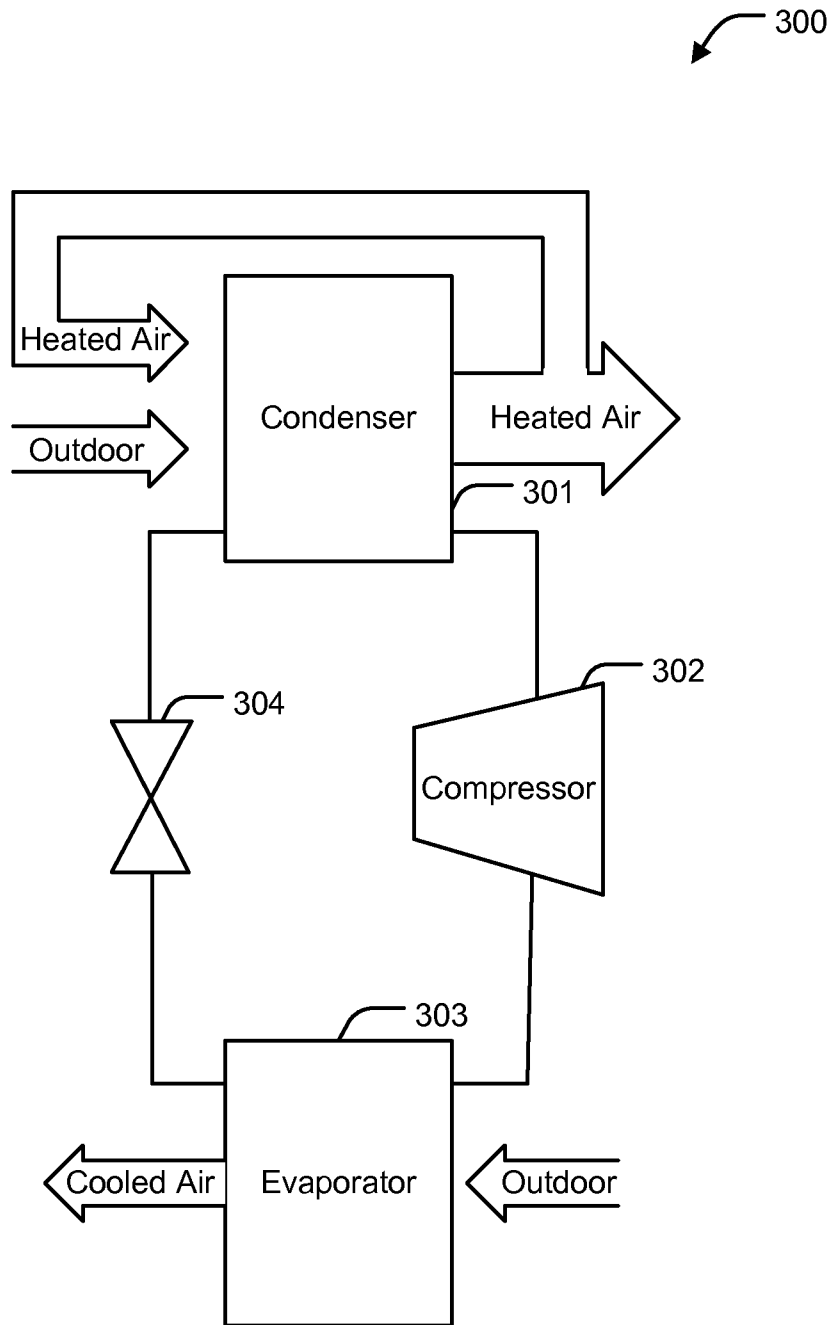


FIG. 3

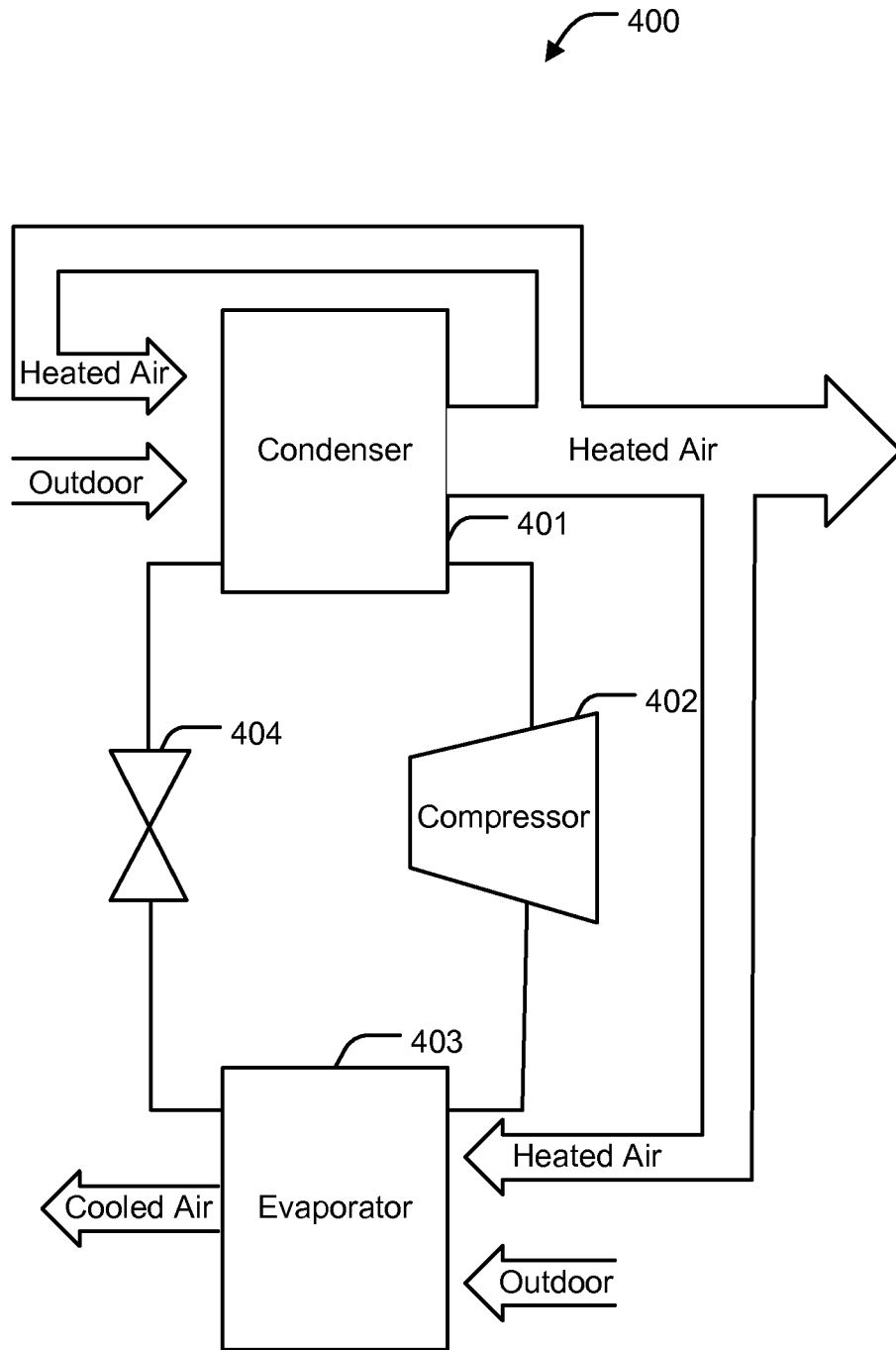


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/035127

A. CLASSIFICATION OF SUBJECT MATTER
INV. F24F3/044 F25B25/00 F25B29/00
ADD.
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)
F24F 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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 25 36 124 A1 (LINDE AG) 17 February 1977 (1977-02-17) the whole document	1-20
X	US 4 176 525 A (DOUGAN ROGER W [US] ET AL) 4 December 1979 (1979-12-04) column 2, line 58 - column 8, line 34 figures	1,13
A	US 6 751 972 B1 (JUNGWIRTH CURTIS A [US]) 22 June 2004 (2004-06-22) abstract; figures	1
A	US 2 100 834 A (CHAPMAN ROBERT L) 30 November 1937 (1937-11-30) abstract; figures	1
	----- -/--	

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search 8 June 2012	Date of mailing of the international search report 19/06/2012
--	--

Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Mattias Grenbäck
--	--

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/035127

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 913 283 A1 (CALSONIC CORP [JP] CALSONIC KANSEI CORP [JP]) 6 May 1999 (1999-05-06) abstract; figures -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2012/035127

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 2536124	A1	17-02-1977	NONE

US 4176525	A	04-12-1979	NONE

US 6751972	B1	22-06-2004	NONE

US 2100834	A	30-11-1937	NONE

EP 0913283	A1	06-05-1999	EP 0913283 A1 06-05-1999
		JP 10100662 A	21-04-1998
		US 5975191 A	02-11-1999
