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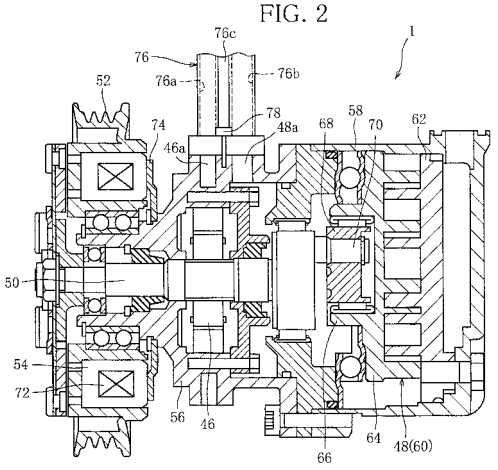
(54) FLUID MACHINE

(57) A fluid machine which can be compact and produced at reduced costs and which can increase the amount of heat added to a refrigerant circulating in a Rankine cycle and thus greatly increase the efficiency of the Rankine cycle. A fluid machine (1) comprising a pump mechanism (46) incorporated in a Rankine cycle to force a working fluid to circulate in the Rankin cycle to recover waste heat from a heat source, and an expansion mechanism (48) rotationally driven by expansion of the working fluid having been forced out by the pump mechanism (46) and then superheated, the pump mechanism and the expansion mechanism being linked by a shared drive shaft (50), wherein a pump mechanism exit section (76a) through which the refrigerant flows out of the pump mechanism (46) and an expansion mechanism exit section (76b) through which the refrigerant flows out of the expansion mechanism (48) are open outward in the same direction.

FIG. 2



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Description

Technical Field

[0001] This invention relates to a fluid machine, specifically a fluid machine suited to be incorporated in a Rankin cycle which recovers and utilizes waste heat from a vehicle engine.

Background Art

[0002] As a fluid machine of this type, there is known a pump-linked expansion machine comprising a pump mechanism incorporated in a Rankin cycle to force a refrigerant as a working fluid to circulate in the Rankin cycle to recover waste heat from a vehicle engine, for example, and an expansion mechanism for producing rotary drive power by expansion of the refrigerant having been forced out by the pump mechanism and then superheated, the pump mechanism and the expansion mechanism being linked by a shared drive shaft to form a unit (see patent document 1, for example).

[0003] In this prior art, an expansion mechanism exit passage and a pump mechanism exit passage are arranged such that a part of the former extends close to a part of the latter to allow transfer of heat from the refrigerant flowing in the expansion mechanism exit passage to the refrigerant flowing in the pump mechanism exit passage, thereby increasing the amount of heat added to the refrigerant in the Rankine cycle, and thus, increasing the efficiency of the Rankine cycle.

[0004] Patent document 1: Japanese patent application preliminary publication No. 2006-266238

Disclosure of the Invention

Problem to be Solved by the Invention

[0005] The above prior art however gives no special consideration to make the fluid machine compact and reduce the production costs. Further, there is room for further increase in the amount of heat added to the refrigerant. The present invention has been made in consideration of such problems. An object of the present invention is to provide a fluid machine which can be compact and produced at reduced costs and which can further increase the amount of heat added to the refrigerant circulating in the Rankine cycle, and thus, greatly increase the efficiency of the Rankine cycle in which the fluid machine is incorporated.

Means for Solving the Invention

[0006] In order to achieve the above object, the present invention provides a fluid machine comprising a pump mechanism incorporated in a Rankine cycle to force a working fluid to circulate in the Rankin cycle to recover waste heat from a heat source, and an expansion machine for producing rotary drive power by expansion of the working fluid having been forced out by the pump mechanism and then superheated, the pump mechanism and the expansion mechanism being linked by a shared drive shaft, wherein a pump mechanism exit section through which the refrigerant flows out of the pump mechanism and an expansion mechanism exit section through which the refrigerant flows out of the expansion mechanism are open outward in the same direction.

[0007] In order to achieve the above object, the present invention may further comprise an exit port member connected to both the pump mechanism exit section and the expansion mechanism exit section.

[0008] In order to achieve the above object, the present invention may be arranged such that the exit port member has a pump mechanism exit passage and an expansion mechanism exit passage extending close to each other with a partition with a specified thermal conductivity interposed between, the pump mechanism exit passage and the expansion mechanism exit passage being connected to the pump mechanism exist section and the expansion mechanism exit section, respectively.

[0009] In order to achieve the above object, the present invention may be arranged such that the pump mechanism exit passage and the expansion mechanism exit passage of the exit port member form a double pipe configuration functioning as an internal heat exchanger.

Effect of the Invention

[0010] As stated above, in the fluid machine according to the present invention, a pump mechanism exit section through which the refrigerant flows out of the pump mechanism and an expansion mechanism exit section through which the refrigerant flows out of the expansion mechanism are open outward in the same direction. This facilitates connection of the pump mechanism exit section and the expansion mechanism exit section to the Rankine cycle circulation path and allows the fluid machine to have a compact configuration as compared with the case where these exit sections are at different locations. Further, this allows the fluid machine to be composed of a reduced number of components, and thus produced at reduced costs.

[0011] Further, the present invention may comprise an exit port member connected to both the pump mechanism exit section and the expansion mechanism exit section. Such exit port member allows the fluid machine to have an integrated configuration of the pump mechanism exit section and the expansion mechanism exit section, which enables a further compact configuration of the fluid machine, and thus, a further reduction in the production costs.

[0012] Further, the present invention may be arranged such that the exit port member has a pump mechanism exit passage and an expansion mechanism exit passage extending close to each other with a partition with a specified thermal conductivity interposed between, the pump

mechanism exit passage and the expansion mechanism exit passage being connected to the pump mechanism exist section and the expansion mechanism exit section, respectively. In this case, the exit port member allows transfer of heat from the refrigerant flowing in the expansion mechanism exit passage to the refrigerant flowing in the pump mechanism exist passage, and thus, can function as an internal heat exchanger in the Rankine cycle. This can increase the amount of heat added to the refrigerant circulating in the Rankine cycle, and thus, greatly increase the efficiency of the Rankine cycle in which the fluid machine is incorporated.

[0013] Further, the pump mechanism exit passage and the expansion mechanism exit passage of the exit port member may form a double pipe configuration functioning as an internal heat exchanger. This allows further efficient transfer of heat from the refrigerant flowing in the expansion mechanism exit passage to the refrigerant flowing in the pump mechanism exit passage, and thus, further increase of the efficiency of the Rankine cycle in which the fluid machine is incorporated.

Brief Description of the Drawings

[0014]

FIG. 1 is a schematic diagram showing a waste heat utilization device to which an embodiment of the present invention is applied,
FIG. 2 is a vertical cross-sectional view of a fluid machine shown in FIG. 1, and
FIG. 3 is a diagram showing a variant of an exit port member shown in FIG. 2.

Explanation of the Reference Characters

[0015]

1	Fluid machine
40	Rankine circuit (Rankine cycle)
46	Pump mechanism
46a	Pump mechanism exit section
48	Expansion mechanism
48a	Expansion mechanism exit section
50	Drive shaft
76	Exit port member
76a	Pump mechanism exist passage
76b	Expansion mechanism exist passage
76c	Partition

Best Mode of Carrying out the Invention

[0016] Referring to the drawings, the mode of carrying out the present invention will be described below in detail.

Embodiment 1

[0017] An embodiment of the present invention will be described on the basis of the drawings. FIG. 1 schematically shows a waste heat utilization device 2 in which a fluid machine 1, an embodiment of the present invention, is incorporated. The waste heat utilization device 2 is mounted on a vehicle, for example, and comprises an electric power extraction circuit 4, an air conditioning circuit 20, a cooling water circuit 30, and a Rankine circuit (Rankine cycle) 40. The electric power extraction circuit 4 is an electric circuit for converting rotary drive power, produced by the vehicle engine 6, to electric power and extracting the electric power. The rotary drive power produced by the engine 6 is transmitted from an engine 6 side pulley 8 to a belt 12, then to an electric power recovery circuit 4 side pulley 10, and thus, to an alternator 14. The alternator 14 converts the rotary drive power to electric power, and the electric power extraction circuit 4 extracts the electric power. The electric power extracted by the electric power extraction circuit 4 is used as electric drive power for a variety of electrical devices mounted on the vehicle, for example.

[0018] The air conditioning circuit 20 forms a closed loop with a compressor 24, an air-conditioning condenser, a gas-liquid separator, an expansion valve, an air-conditioning evaporator, etc. disposed serially in a refrigerant circulation path 22, in the direction of circulation of a refrigerant as a working fluid. The devices disposed in the refrigerant circulation path, except for the compressor, are omitted in the diagram. The air conditioning circuit air-conditions, for example a vehicle interior by supplying the vehicle interior with air having passed through the air-conditioning evaporator. The compressor 24 is driven by the rotary drive power produced by the engine 6 and transmitted to a pulley 26 by the belt 12, and compresses the refrigerant having evaporated in the air-conditioning evaporator, and thus, converts it into superheated vapor. The refrigerant discharged from the compressor 24 is condensed into a liquid in the air-conditioning condenser, and after passing through the gas-liquid separator, the liquid refrigerant is routed to the expansion valve. The refrigerant is expanded by passing through the expansion valve, and then flows to the air conditioning evaporator.

[0019] The cooling water circuit 30 forms a closed loop with a Rankine evaporator 34, a radiator, a thermostat, a water pump, etc. disposed serially in a cooling water circulation path 32 extending from the engine 6, in the direction of circulation of cooling water. The devices disposed in the cooling water circulation path, except for the Rankine evaporator, are omitted in the diagram. The cooling water circuit cools the engine 6.

[0020] The Rankine circuit 40 forms a closed loop with the aforementioned Rankine evaporator 34, a fluid machine 1, a Rankine condenser 44, etc. disposed serially in a refrigerant circulation path 42, in the direction of circulation of a refrigerant as a working fluid. The Rankinge circuit recovers waste heat from the engine 6 by means of the cooling water circulating in the cooling water circuit 30.

[0021] Here, the fluid machine 1 is a pump-linked expansion machine comprising a pump mechanism 46 for forcing the refrigerant to circulate and an expansion mechanism 48 for producing rotary drive power by expansion of the refrigerant having been forced out by the pump mechanism 46 and then superheated in the Rankine evaporator 34, the pump mechanism and the expansion mechanism being linked by a shared drive shaft 50. The fluid machine assists rotary drive of the engine 6 by means of a pulley 52 of the fluid machine 1 and the aforementioned belt 12.

[0022] The refrigerant having passed through the expansion mechanism 48 and left the fluid machine 1 is condensed to a liquid in the Rankine condenser 44, and the liquid refrigerant is again drawn in and forced out by the pump mechanism 46 of the fluid machine 1, thus leaving the fluid machine 1 toward the Rankine evaporator 34.

[0023] FIG. 2 is a vertical cross-sectional view of the fluid machine 1 as an embodiment of the present invention. To the drive shaft 50 side of the pulley 52, the fluid machine 1 has a clutch mechanism 54 for appropriately transmitting the rotary drive power produced by the expansion mechanism 48 from the drive shaft 50 to the pulley 52, and thus, to the engine 6. The pump mechanism 46 is driven together by the rotary drive power produced by the expansion mechanism 48. The pump mechanism 46 is a rotary pump driven by the drive shaft 50 to rotate, and arranged in a front casing 56, between the expansion mechanism 48 and the clutch mechanism 54.

[0024] The expansion mechanism 48 is a scroll unit 60 arranged in a rear casing 58. The scroll unit 60 comprises a fixed scroll 62 and a movable scroll 64 orbiting relative to the fixed scroll 62. The movable scroll 64 has a boss portion 66 on the rear side, or side remote from the fixed scroll 62, and an eccentric bush 68 is inserted in the bush portion 66. A crank pin 70 is inserted in the eccentric bush 68. The crank pin 70 is joined to the scroll unit 60 side end of the drive shaft 50 at an eccentric position, so that the movable scroll 64 can orbit without rotating.

[0025] The clutch mechanism 54 has a clutch coil 72 arranged inside the pulley 52. When a current is supplied to the clutch coil 72, a clutch plate 74 contacts the pulley 52, so that the rotary drive power can be appropriately transmitted from the drive shaft 50 to the engine 6.

[0026] In the present embodiment, the refrigerant having passed through the pump mechanism 46 leaves the fluid machine 1 through a pump mechanism exit section 46a, while the refrigerant having passed through the expansion mechanism 48 leaves the fluid machine 1 through an expansion mechanism exit section 46a.

[0027] The exit sections 46a, 48a are provided in the outer circumference of the pump mechanism 46. They are open to outside the fluid machine 1, in the same direction, and connected to one exit port member 76. The exit port member 76 is fixed to the front casing by a bolt 78. The exit port member has a pump mechanism exit passage 76a and an expansion mechanism exit passage 76b extending parallel and close to each other, which are connected to the pump mechanism exit portion 46a and the expansion mechanism exit portion 48a, respectively. The exit passages 76a, 76b are separated from each other by a partition 76c which is made of a material higher in thermal conductivity than at least the materials of the other parts of the exit port member 76.

[0028] As stated above, in the present embodiment, the pump mechanism exit section 46a and the expansion mechanism exit section 48a are open to outside the fluid machine 1, in the same direction, which facilitates connection of the exit sections 46a, 48a to the circulation path 42 of the Rankine circuit 40, and allows the fluid machine 1 to have a compact configuration as compared with the case where the exit sections 46a, 48a are at different locations. Further, this allows the fluid machine 1 to be composed of a reduced number of components, and thus produced at reduced costs.

[0029] Further, the use of the exit port member 76 allows the fluid machine 1 to have an integrated configuration of the exit sections 46a, 48a, which enables a further compact configuration of the fluid machine 1, and thus, a further reduction in the production costs.

[0030] Furthermore, the exit port member 76 having the pump mechanism exit passage 67a and the expansion mechanism exit passage 76b separated from each other by the partition 76c of a material with a high thermal conductivity and extending parallel and close to each other can function as an internal heat exchanger in the Rankine circuit 40. Specifically, the exit port member 76 can preheat the refrigerant before its entering the Rankine evaporator 34, by transfer of heat from the refrigerant flowing in the expansion mechanism exit passage 76b to the refrigerant flowing in the pump mechanism exit passage 76a. This increases the amount of heat added to the refrigerant circulating in the Rankin circuit 40, and thus, greatly increases the efficiency of the Rankine circuit 40 in which the fluid machine 1 is incorporated.

[0031] In the above, one embodiment of the present invention has been described. The present invention is however not limited to the described embodiment, but can be modified in various ways without departing from the scope and spirit thereof.

[0032] For example, the exit port member 76 may be modified like a variant shown in FIG. 3, in which the exit passages 76a, 76b form a double pipe configuration providing inner and outer passages, not shown, to form an internal heat exchanger 80. This configuration allows more efficient heat transfer from the refrigerant flowing in the expansion mechanism exit passage 76b to the refrigerant flowing in the pump mechanism exit passage 76a, and thus, further increase of the efficiency of the Rankine circuit 40 in which the fluid machine 1 is incorporated.

Industrial Applicability

[0033] The present invention allows a fluid machine to have a compact configuration and be produced at re-

duced costs, and can further increase the amount of heat added to the refrigerant circulating in the Rankine cycle and thus increase the efficiency of the Rankine cycle in which the fluid machine is incorporated. Thus, the present invention is applicable to fluid machines suited to be incorporated in the Rankine cycle which recovers and utilizes waste heat from a vehicle engine.

Claims

1. A fluid machine comprising a pump mechanism incorporated in a Rankine cycle to force a working fluid to circulate in the Rankin cycle to recover waste heat from a heat source, and an expansion machine for producing rotary drive power by expansion of the working fluid having been forced out by the pump mechanism and then superheated, the pump mechanism and the expansion mechanism being linked by a shared drive shaft, wherein a pump mechanism exit section through which the refrigerant flows out of the pump mechanism and an expansion mechanism exit section through which the refrigerant flows out of the expansion mechanism are open outward in the same direction.

2. The fluid machine according to claim 2, further comprising an exit port member connected to both the pump mechanism exit section and the expansion mechanism exit section.

3. The fluid machine according to claim 2, wherein the exit port member has a pump mechanism exit passage and an expansion mechanism exit passage extending close to each other with a partition with a specified thermal conductivity interposed between, the pump mechanism exit passage and the expansion mechanism exit passage being connected to the pump mechanism exist section and the expansion mechanism exit section, respectively.

4. The fluid machine according to claim 3, wherein the pump mechanism exit passage and the expansion mechanism exit passage of the exit port member form a double pipe configuration functioning as an internal heat exchanger.

FIG. 1

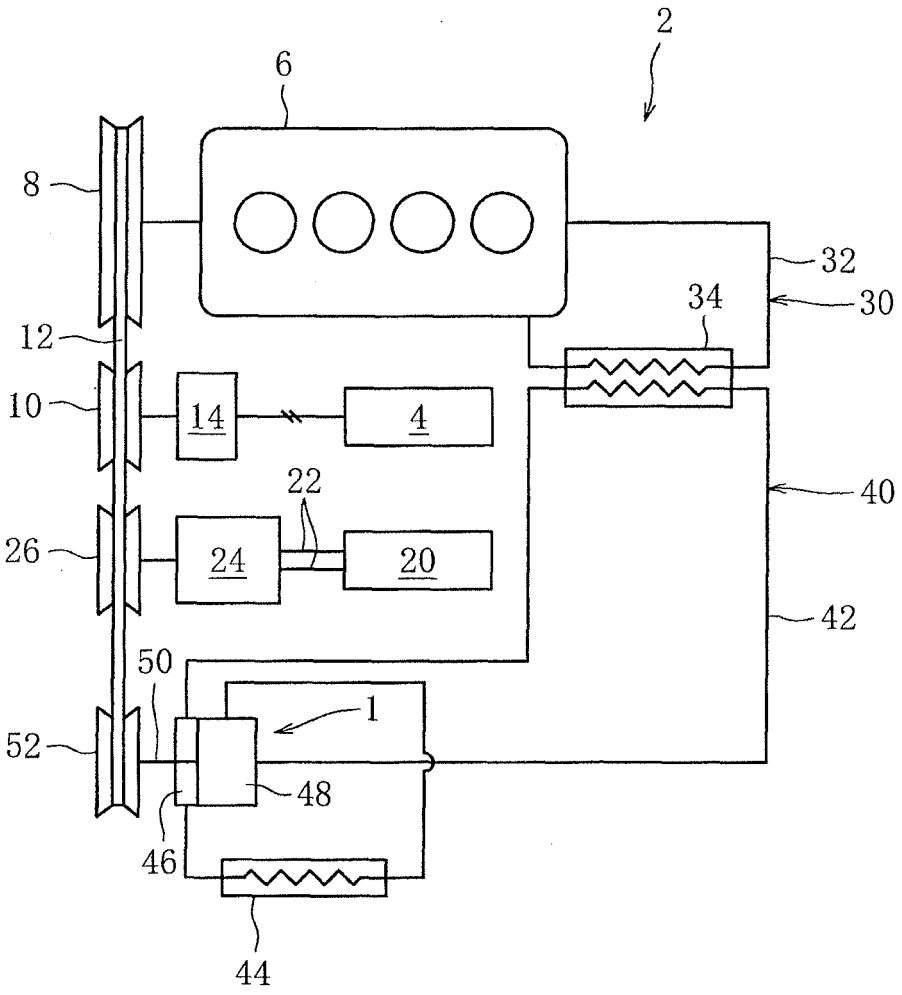
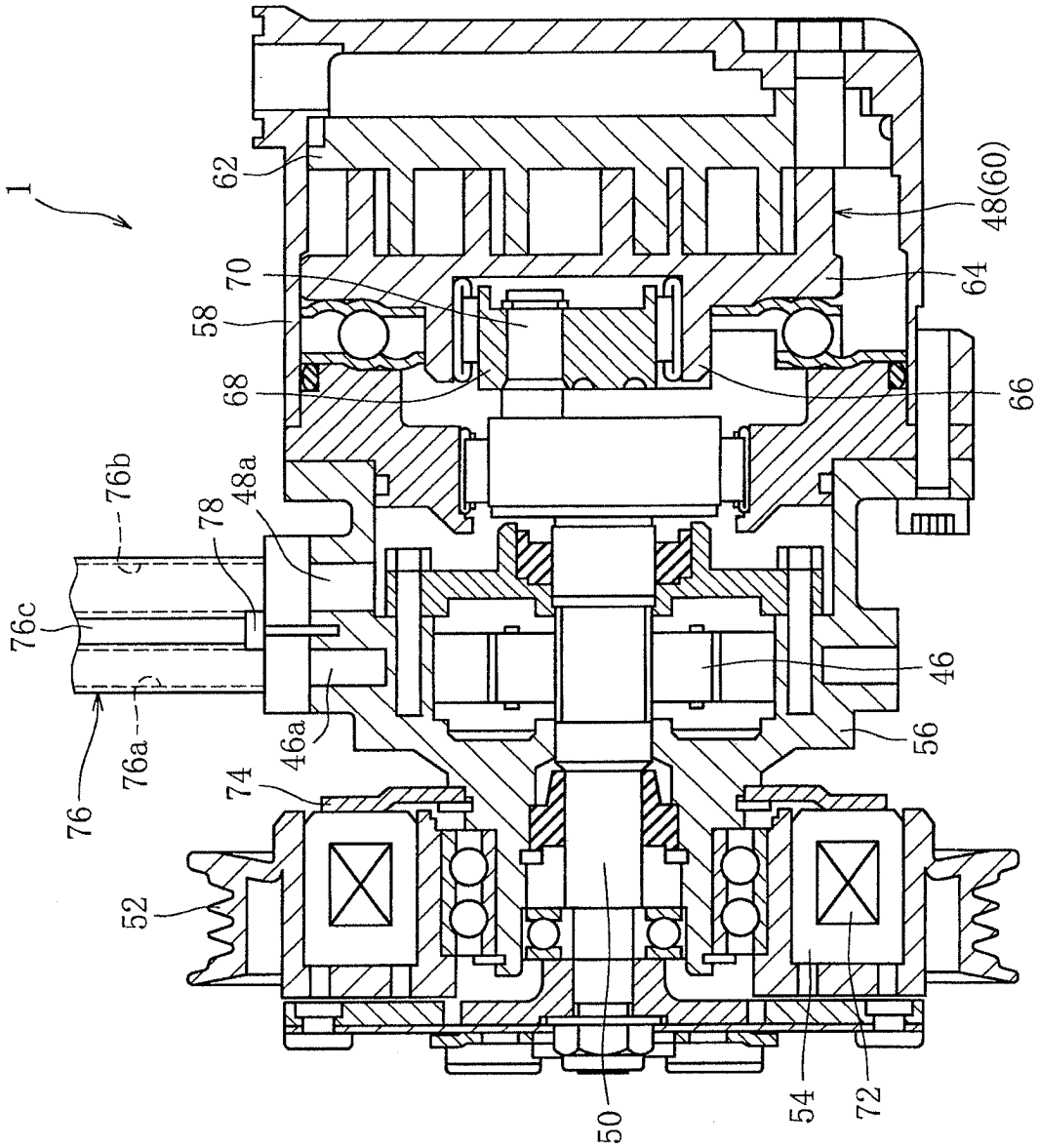


FIG. 2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76b
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76c
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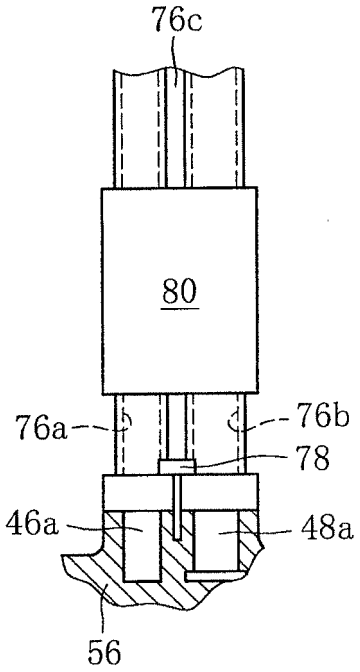
FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/067133

A. CLASSIFICATION OF SUBJECT MATTER
F01C21/18(2006.01)i, *F01C1/02*(2006.01)i, *F01C13/04*(2006.01)i, *F04C23/02*(2006.01)i, *F04C29/12*(2006.01)i

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)
F01C21/18, F01C1/02, F01C13/04, F04C23/02, F04C29/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2009
Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	JP 2003-139059 A (Daikin Industries, Ltd.), 14 May 2003 (14.05.2003), paragraph [0062]; fig. 4 (Family: none)	1-4
Y	JP 2008-163931 A (Kabushiki Kaisha Teratekku), 17 July 2008 (17.07.2008), paragraphs [0007], [0012]; fig. 1, 2 (Family: none)	3,4

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 December, 2009 (15.12.09)	28 December, 2009 (28.12.09)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/067133

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2008/0264062 A1 (Melvin L. PRUEITT), 30 October 2008 (30.10.2008), paragraph [0040]; fig. 1 & WO 2008/134283 A2	3,4
E,Y	JP 2009-270559 A (Kabushiki Kaisha Teratekku), 19 November 2009 (19.11.2009), claim 8; paragraph [0013]; fig. 1, 2 (Family: none)	1-4
A	JP 2008-508463 A (Agam Energy Systems Ltd.), 21 March 2008 (21.03.2008), abstract; fig. 1 & US 2008/0314041 A1 & EP 1778950 A & WO 2006/011150 A1 & CN 101018928 A	3,4

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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