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

(11) EP 2 413 067 A1

(12) EUROPEAN PATENT APPLICATION

published in accordance with Art. 153(4) EPC

(43) Date of publication:
01.02.2012 Bulletin 2012/05

(21) Application number: **10761443.0**

(22) Date of filing: **08.04.2010**

(51) Int Cl.:
F25B 43/02 *(2006.01)* ***B04C 5/103*** *(2006.01)*
F25B 1/00 *(2006.01)*

(86) International application number:
PCT/JP2010/002560

(87) International publication number:
WO 2010/116739 (14.10.2010 Gazette 2010/41)

(84) Designated Contracting States:
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 SE SI SK SM TR

(30) Priority: **08.04.2009 JP 2009093930**

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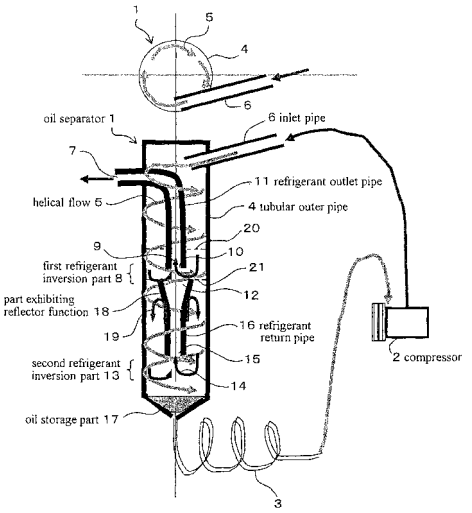
(54) OIL SEPARATOR

(57) Provided is an oil separator which can separate refrigerant and refrigeration machine oil with high efficiency, which can effectively prevent the outflow of separated oil towards the refrigerant discharge path side, which can reduce pressure loss in the flow of refrigerant, and which can be made compact especially in the radial direction. The oil separator is provided with: a tubular outer pipe which is disposed on the compressor outlet side; an inlet pipe for introducing refrigerant containing refrigeration machine oil into the tubular outer pipe in such a manner as to produce a downward helical flow of refrigerant containing refrigeration machine oil along the inner surface of the tubular outer pipe; a refrigerant outlet pipe which has an external outflow port for the outflow of refrigerant to outside the tubular outer pipe, has a section extending in the axial direction of the tubular outer pipe at the central position of the tubular outer pipe, and allows the inflow, from the lower end of the above-mentioned section, of refrigerant separated from the refrigerant containing refrigeration machine oil having flowed down in the helical flow, and wherein the flow direction has been inverted in relation to the vertical direction at a first refrigerant inversion part; a refrigerant return pipe which extends in the axial direction of the tubular outer pipe at the central position of the tubular outer pipe, below the refrigerant outlet pipe, and which allows the inflow, from the lower end thereof, of refrigerant separated from the refrigerant containing refrigeration machine oil having flowed down in the helical flow, and wherein the flow direction has been inverted in relation to the vertical direction at a second refrigerant inversion part; and an oil storage part which is formed at the bottom of the tubular outer pipe. Furthermore, a part exhibiting a reflector function for preventing refrigeration machine oil stored in the oil storage part from flowing out into the refrigerant outlet pipe is provided between the refrigerant return pipe and the inner surface of the tubular outer pipe.

FIG. 1



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Description

Technical Field of the Invention

[0001] The present invention relates to an oil separator which separates refrigeration machine oil mixed in refrigerant discharged from a compressor, and specifically, to an oil separator suitable to be disposed in a refrigeration circuit of an air conditioning system for a vehicle.

Background Art of the Invention

[0002] For example, in a refrigeration circuit of an air conditioning system for a vehicle, there may be a case where provided is an oil separator having a function for separating refrigeration machine oil mixed in refrigerant discharged from a compressor and returning the separated refrigeration machine oil to the compressor. In a conventional oil separator, because the outer shape and the length dimension are large, the mounting position to an automobile has been limited, and further, because the structure is relatively complicated and the cost is high, it has not been so common to separate oil in refrigerant discharged from a compressor by an oil separator disposed outside the compressor and to return the separated refrigeration machine oil to the compressor. Therefore, an oil separating mechanism incorporated integrally into a compressor itself has been common, but in such a case, the function for oil separation has been limited.

[0003] Further, for example, in refrigerant HFO1234yf, etc. planned to be used from the viewpoint of preventing global warmth, because its temperature for separation into two layers of refrigerant and refrigeration machine oil in a high temperature region is relatively low as compared with a conventional refrigerant HFC134a, oil return to a compressor in a refrigeration circuit may deteriorate, and further, because performance of refrigeration system may be considered to deteriorate from its refrigerant property, it is considered to be necessary to decrease the amount of oil to be circulated in the refrigeration circuit itself, improve the efficiency of the air conditioning system and realize a performance level nearly equal to that of HFC134a.

[0004] For example, as a prior art, as disclosed in Patent document 1, a compressor built-in type oil separator aiming its compact structure has been considered. Where, in the example disclosed in this Patent document 1, in a conventional type oil separator which has an outer tube for generating a whirl flow of refrigerant containing refrigeration machine oil introduced thereinto and an inner tube for leading refrigerant, separated from oil at a whirl flow inversion part, to outside, a structure is employed wherein the outer tube is divided into a whirl flow separation part relatively small in cross section of flow path and a whirl flow inversion chamber relatively large in cross section of flow path, as the refrigerant and the oil are flowing from the whirl flow separation part varying the cross-sectional area of flow path to the whirl flow inversion chamber, its flow speed is reduced, and it is aimed that the oil dropped down to the bottom of the outer tube can be stably accumulated.

Prior art documents

Patent documents

[0005] Patent document 1: JP-A-2005-180808

Summary of the Invention

Problems to be solved by the Invention

[0006] However, in the above-described oil separator structure disclosed in Patent document 1, outflow of the oil stored in the lower part into the outlet pipe (inner tube) due to splashing up cannot be avoided, and consequently, it is difficult to realize an excellent oil separation performance. Further, because a structure is employed wherein the diameter of the outer tube is enlarged partially, large-sized form in the radial direction as the whole of the oil separator cannot be avoided, and therefore, it is a disadvantageous structure less in freedom on space for disposition in refrigeration circuit or space for being mounted. Furthermore, although in the above-described Patent document 1 there is a description of a structural example which employs an improvement for enlarging the pipe diameter of the entrance of the outlet pipe provided as a return pipe in order to reduce the pressure loss in return flow to the outlet pipe of the separator, this causes the oil to be liable to enter into the outlet pipe further easily, and the amount of oil flowing out from the outlet pipe toward outside (for example, toward a condenser in the refrigeration circuit) may increase.

[0007] Accordingly, an object of the present invention is to provide an oil separator which can separate refrigerant and refrigeration machine oil with extremely high efficiency, which can effectively prevent the outflow of separated oil towards the refrigerant discharge path side, and which can reduce pressure loss in the flow of refrigerant.

[0008] Further, another object of the present invention is to provide an oil separator which can realize a compact structure without making it large-sized especially in the radial direction while achieving an excellent separation performance, which can spatially improve mounting property in case of being mounted as a sole body, and which can be easily designed to be integrated with another device.

Means for solving the Problems

[0009] To achieve the above objects, an oil separator according to the present invention comprises:

a tubular outer pipe which is disposed on a compressor outlet side so as to extend in a vertical direction;

an inlet pipe provided at an upper part of the tubular outer pipe for introducing refrigerant containing refrigeration machine oil, discharged from a compressor, into the tubular outer pipe in such a manner as to produce a downward helical flow of refrigerant containing refrigeration machine oil along an inner surface of the tubular outer pipe;

a refrigerant outlet pipe which has an external outflow port at an upper end for flowing out refrigerant to outside the tubular outer pipe, has a section extending in an axial direction of the tubular outer pipe at a central position of the tubular outer pipe, and has a first refrigerant inflow port at a lower end of the section for flowing in refrigerant therein, which has been separated from refrigerant containing refrigeration machine oil having flowed down in the helical flow and the flow direction of which has been inverted in relation to vertical direction at a first refrigerant inversion part;

a refrigerant return pipe which extends in an axial direction of the tubular outer pipe at a central position of the tubular outer pipe, below the refrigerant outlet pipe, has a refrigerant communication port at an upper end for being confronted with or connected to a lower end of the refrigerant outlet pipe, and has a second refrigerant inflow port at a lower end for flowing in refrigerant therein, which has been separated from refrigerant containing refrigeration machine oil having flowed down in the helical flow and the flow direction of which has been inverted in relation to vertical direction at a second refrigerant inversion part; and

an oil storage part, which is formed at a bottom of the tubular outer pipe, capable of temporarily storing refrigeration machine oil separated from refrigerant,

wherein a part exhibiting a reflector function for preventing refrigeration machine oil stored in the oil storage part from flowing out into the refrigerant outlet pipe is provided between the refrigerant return pipe and the inner surface of the tubular outer pipe.

[0010] In such an oil separator according to the present invention, although the refrigeration machine oil having a greater mass is separated from the refrigerant by centrifugal separation in the helical flow of the refrigerant containing refrigeration machine oil in the tubular outer pipe, in the downflow direction of this helical flow two refrigerant inversion parts of the first refrigerant inversion part and the second refrigerant inversion part are provided, and by inverting the flow direction of refrigerant in relation to vertical direction at each refrigerant inversion part, the refrigerant is separated from the refrigerant containing refrigeration machine oil (as viewed from the oil side, the refrigeration machine oil is separated from the refrigerant containing refrigeration machine oil). The refrigerant separated at the first refrigerant inversion part enters into the refrigerant outlet pipe from the first refrigerant inflow port, and is flowed out from the external outflow port to outside of the oil separator through the refrigerant outlet pipe, and the refrigerant separated at the second refrigerant inversion part enters into the refrigerant return pipe from the second refrigerant inflow port, and is flowed out from the external outflow port to outside of the oil separator through the refrigerant return pipe, the refrigerant communication port and successively the refrigerant outlet pipe. Therefore, the separation of refrigeration machine oil and refrigerant is carried out at two steps in the axial direction of the tubular outer pipe, and as compared with a conventional single-step separation, the efficiency of separation can be improved. Then, the part exhibiting a reflector function is provided between the refrigerant return pipe and the inner surface of the tubular outer pipe, namely, between the first refrigerant inversion part and the second refrigerant inversion part, and it can be prevented by the reflector effect due to the part exhibiting a reflector function that the refrigeration machine oil stored in the oil storage part at the bottom of the tubular outer pipe flows out into the refrigerant outlet pipe through the first refrigerant inflow port by splashing up, etc. Since return of oil into the separated refrigerant due to splashing up, etc. can be prevented, also from this point of view, the efficiency of separation can be improved. Further, because this part exhibiting a reflector function also exhibits a function for temporarily contracting the cross-sectional area of flow path with respect to the downflow of the helical flow of the refrigerant containing refrigeration machine oil, can also be expected improvement of the inversion and separation performance of refrigerant at the first refrigerant inversion part positioned at an upstream side of the part exhibiting a reflector function, improvement of separation performance due to the helical flow at a downstream side of the part exhibiting a reflector function by temporarily increasing the flow speed by temporarily contracting the cross-sectional area of flow path, and further, improvement of the inversion and separation performance of refrigerant at the second refrigerant inversion part due to enlargement of the cross-sectional area of flow path after the temporary contraction of the cross-sectional area of flow path. As a result, the efficiency for separation as the whole of the oil separator can be greatly improved. Further, because the separation due to the above-described two-step refrigerant inversion and the inflow operation of the separated refrigerant from both refrigerant inversion parts into the discharge path are performed, as compared with a conventional single-step case, reduction of resistance at the refrigerant inversion parts can be expected, and whereby reduction of resistance of flow path and pressure loss as the whole of the oil separator becomes possible. Furthermore, because, by the discharge operation of the refrigerant separated at the first refrigerant inversion part through the refrigerant outlet pipe, inducing effect from the second refrigerant inflow port of the refrigerant return pipe, of the refrigerant separated at the second refrigerant inversion part, can also be expected, an efficient discharge of separated refrigerant becomes

possible, and as the whole of the oil separator, further reduction of resistance in refrigerant flow path and pressure loss becomes possible.

[0011] Further, in the oil separator according to the present invention, the diameter of the tubular outer pipe may be a constant diameter, and because in this tubular outer pipe two refrigerant inversion parts of the first refrigerant inversion part and the second refrigerant inversion part and the part exhibiting a reflector function therebetween can be formed, there is no portion enlarged in outer diameter of oil separator and it is not necessary to make it partially large-sized in the radial direction as in the aforementioned Patent document 1, and therefore, a compact structure can be realized particularly in the radial direction. Therefore, spatially, the mounting property in case of being mounted as a sole body, in particular, the space efficiency, can be improved. Further, a tubular outer pipe having a constant diameter may be employed, it also becomes possible to facilitate integration with another device, for example, a condenser disposed at a downstream position of a compressor in a refrigeration circuit.

[0012] In the oil separator according to the present invention exhibiting such an excellent performance, as more concrete structures of the above-described refrigerant return pipe and the above-described part exhibiting a reflector function, various structures can be employed. For example, a structure can be employed wherein the refrigerant return pipe comprises a tubular pipe having a constant diameter which extends upwardly from the second refrigerant inversion part, and the part exhibiting a reflector function comprises a bevel part which extends from an upper end of this tubular pipe toward an obliquely downward direction and which is enlarged in diameter as located at a lower position.

[0013] Alternatively, a structure may be employed wherein the refrigerant return pipe comprises a bell mouth type pipe which extends upwardly from the second refrigerant inversion part and which is enlarged in diameter as located at an upper position, and the part exhibiting a reflector function is formed from the bell mouth type pipe.

[0014] Alternatively, a structure may be employed wherein the refrigerant return pipe comprises a tubular pipe part having a constant diameter which extends upwardly from the second refrigerant inversion part and a bell mouth type pipe part which extends upwardly from an upper end of the tubular pipe part and which is enlarged in diameter as located at an upper position, and the part exhibiting a reflector function is formed from the bell mouth type pipe part.

[0015] Alternatively, a structure may be employed wherein the refrigerant outlet pipe and the refrigerant return pipe are formed as an integrated tubular pipe having a connection part therebetween, an opening as the first refrigerant inflow port is formed on a pipe wall of the refrigerant outlet pipe positioned above the connection part, and the part exhibiting a reflector function comprises a bevel part which extends from the connection part or the vicinity thereof toward an obliquely downward direction and which is enlarged in diameter as located at a lower position.

[0016] Alternatively, a structure may be employed wherein the refrigerant return pipe comprises a first bell mouth type pipe part which extends upwardly from the second refrigerant inversion part and which is enlarged in diameter as located at an upper position, and a second bell mouth type pipe part which is connected to an upper end of the first bell mouth type pipe part and which is contracted in diameter as located at an upper position, a lower end of the refrigerant outlet pipe is connected to an upper end of the refrigerant return pipe at a connection part to form an integrated pipe structure, an opening as the first refrigerant inflow port is formed on a pipe wall of the refrigerant outlet pipe positioned above the connection part, and the part exhibiting a reflector function is formed from the first bell mouth type pipe part.

[0017] Alternatively, a structure may be employed wherein the refrigerant return pipe comprises a tubular pipe part having a constant diameter which extends upwardly from the second refrigerant inversion part, a first bell mouth type pipe part which extends upwardly from an upper end of the tubular pipe part and which is enlarged in diameter as located at an upper position, and a second bell mouth type pipe part which is connected to an upper end of the first bell mouth type pipe part and which is contracted in diameter as located at an upper position, a lower end of the refrigerant outlet pipe is connected to an upper end of the refrigerant return pipe at a connection part to form an integrated pipe structure, an opening as the first refrigerant inflow port is formed on a pipe wall of the refrigerant outlet pipe positioned above the connection part, and the part exhibiting a reflector function is formed from the first bell mouth type pipe part.

[0018] The above-described refrigerant outlet pipe or refrigerant return pipe may be fixed relative to the tubular outer pipe at a predetermined figure and at a predetermined position by a certain manner. For example, a structure may be employed wherein at least the refrigerant return pipe is supported relative to the inner surface of the tubular outer pipe via a bracket at a condition where a path for refrigerant containing refrigeration machine oil is ensured.

[0019] It is preferred that the refrigeration machine oil separated by the oil separator and temporarily stored in the oil storage part according to the present invention is returned to a portion needing lubrication in the system, in particular, returned to a compressor, for example, a crank chamber in the compressor. For this, it is preferred that an oil return tube for returning refrigeration machine oil stored in the oil storage part to a compressor is connected to the oil separator.

[0020] Further, the position for disposing the oil separator according to the present invention is not particularly restricted as long as it is an exit side of a compressor,

and for example, an embodiment can be employed wherein the oil separator is disposed between a compressor and a condenser in a refrigeration circuit having the compressor, the condenser, an expansion mechanism and an evaporator in this order. In this case, a structure may be employed wherein the oil separator is built in a header pipe of the condenser, and the external outflow port of the refrigerant outlet pipe is opened toward inside of the header pipe.

[0021] Further, the oil separator according to the present invention, in particular, its tubular outer pipe, can also be formed integrally with another device or a part of another device. For example, in case where the oil separator is built in a header pipe of the above-described condenser, a structure may be employed wherein the header pipe and the tubular outer pipe are formed integrally by extrusion molding.

[0022] Furthermore, although use, etc. of according to the present invention also is not particularly restricted, from the viewpoint that the oil separator is excellent in mounting property and space efficiency for disposition as well as in performance, it is particularly suitable to be provided in a refrigeration circuit of an air conditioning system for a vehicle. For example, even in case being mounted in an engine room, it can be mounted efficiently without causing a waste dead space.

Effect according to the Invention

[0023] Thus, according to the oil separator of the present invention, in the oil separator separating refrigeration machine oil and refrigerant basically by centrifugal separation, since the refrigerant inversion parts for inverting the flow direction of separated refrigerant in relation to the vertical direction are provided at two steps, the separated refrigerant can be discharged from both refrigerant inversion parts through the refrigerant outlet pipe and it can be effectively prevented by the part exhibiting a reflector function that the oil temporarily stored in the oil storage part at the bottom portion is returned into the separated refrigerant by splashing up and the like, an excellent separation performance capable of separating refrigeration machine oil and refrigerant with an extremely high efficiency can be exhibited. By the excellent separation performance, refrigeration machine oil can be efficiently circulated only to places necessary to be lubricated, and the rate of oil circulation can be effectively reduced as viewed from the whole of a refrigeration system connecting respective heat exchangers, etc. Therefore, the amount of oil enclosed in the system can be reduced, and the amount of oil circulation to a part, which basically does not require circulation of refrigeration machine oil, can be greatly reduced, thereby realizing improvement of performance of heat transfer and at respective heat exchangers and reduction of resistance of refrigerant flow in the refrigeration circuit, and further improving COP (coefficient of performance) as a whole. Further, since staying of oil at a portion, which basically does not need refrigeration machine oil, can also be reduced, improvement of the quality and reliability for durability of each portion can be expected. By improvement of these performances, in case where the oil separator according to the present invention is applied to an air conditioning system for a vehicle, it can contribute also to saving of fuel consumption of the vehicle.

[0024] Further, in the oil separator according to the present invention, because it is not necessary to provide a part enlarged in pipe diameter to the tubular outer pipe, a compact structure can be realized particularly by avoiding a large-sized configuration in the radial direction, and in case where the oil separator is mounted as a sole body, it can be mounted without causing a waste dead space, for example, along a part of another device, and therefore, it can be mounted at a good space efficiency. Further, because there is no part enlarged in pipe diameter in the tubular outer pipe, it becomes possible to incorporate it into a part of another device, for example, into a header pipe of a condenser with an integral structure, the mounting property can be further improved, and it may also become possible to make the whole of the system compact, facilitate the manufacture thereof, and reduce the cost. Such an excellent space efficiency of the oil separator according to the present invention, in case of applying it to an air conditioning system for a vehicle, may contribute to increase of design freedom of the vehicle, and further, to reduction of amount of material for a vehicle body, lightening in weight thereof, etc.

Brief explanation of the drawings

[0025]

[Fig. 1] Fig. 1 is a schematic diagram of an oil separator according to an embodiment of the present invention.

[Fig. 2] Fig. 2 is a schematic diagram of an oil separator according to another embodiment of the present invention.

[Fig. 3] Fig. 3 is a schematic diagram of an oil separator according to a further embodiment of the present invention.

[Fig. 4] Fig. 4 is a schematic diagram of an oil separator according to a still further embodiment of the present invention.

[Fig. 5] Fig. 5 is a schematic diagram of an oil separator according to a still further embodiment of the present invention.

[Fig. 6] Fig. 6 is a schematic diagram of an oil separator according to a still further embodiment of the present invention.

[Fig. 7] Fig. 7 is a systematic diagram of equipment of a refrigeration circuit showing an example of a position disposed with an oil separator according to the present invention.

[Fig. 8] Fig. 8 is a schematic partial diagram of a structure of an example wherein an oil separator ac-

cording to the present invention is incorporated integrally into a header pipe of a condenser.

Embodiments for carrying out the Invention

[0026] Hereinafter, embodiments of the present invention will be explained referring to figures.
Fig. 1 shows schematic structure and operation of an oil separator according to an embodiment of the present invention. In the figure, symbol 1 indicates an oil separator, the oil separator 1 separates discharged refrigerant from a compressor 2 (high-temperature and high-pressure gas refrigerant), which contains refrigeration machine oil, into refrigeration machine oil and refrigerant, and returns the separated refrigerant to, for example, a condenser disposed at a downstream side in a refrigeration circuit, and returns the separated refrigeration machine oil into, for example, a crank case of compressor 2 through an oil return tube 3. Oil separator 1 has a tubular outer pipe 4 which is disposed on a outlet side of compressor 2 so as to extend in a vertical direction substantially at a constant diameter and at a configuration of a straight pipe, and an inlet pipe 6 provided at an upper part of the tubular outer pipe 4 for introducing refrigerant containing refrigeration machine oil, discharged from compressor 2, into the tubular outer pipe 4 in such a manner as to produce a downward helical flow 5 of the refrigerant containing refrigeration machine oil along an inner surface of the tubular outer pipe 4. The refrigerant introduction angle of this inlet pipe 6 relative to tubular outer pipe 4 is set at an angle that does not decrease the speed of the refrigerant, which has been introduced into tubular outer pipe 4, in the circumferential direction of the tubular outer pipe so much, for example, set at an angle close to the tangential direction of the inner circumferential surface of tubular outer pipe 4. The refrigerant containing refrigeration machine oil introduced into tubular outer pipe 4 flows down along the inner surface of tubular outer pipe 4 while depicting helical flow 5, and at that time, a part of refrigeration machine oil greater in mass is centrifugally separated from refrigerant, and the separated refrigeration machine oil flows downward moving on and along the inner surface of tubular outer pipe 4 by its self-weight.

[0027] This oil separator 1 further has a refrigerant outlet pipe 11 which has an external outflow port 7 at an upper end side for flowing out the separated refrigerant to outside of tubular outer pipe 4, has a section extending in the axial direction of tubular outer pipe 4 at a central position of tubular outer pipe 4, and has a first refrigerant inflow port 10 at a lower end side of the section for flowing in refrigerant therein, which has been separated from refrigerant containing refrigeration machine oil having flowed down in the helical flow 5 and the flow direction of which has been inverted in relation to vertical direction at a first refrigerant inversion part 8, and has a refrigerant return pipe 16 which extends in an axial direction of tubular outer pipe 4 at a central position of tubular outer pipe 4, below this refrigerant outlet pipe 11, has a refrigerant communication port 12 at an upper end side for being confronted with or connected to a lower end of refrigerant outlet pipe 11 (in this depicted example, being confronted at a gap), and has a second refrigerant inflow port 15 at a lower end side for flowing in refrigerant therein, which has been separated from refrigerant containing refrigeration machine oil having flowed down in the helical flow 5 and the flow direction of which has been inverted in relation to vertical direction at a second refrigerant inversion part 13. The above-described external outflow port 7 of refrigerant outlet pipe 11 is formed at an end of the upper portion of refrigerant outlet pipe 11 which is formed in a curved pipe. Further, oil separator 1 has an oil storage part 17, which is formed at a bottom portion of tubular outer pipe 4, capable of temporarily storing refrigeration machine oil separated from refrigerant.

[0028] Then, in this oil separator 1, a part exhibiting a reflector function 18 for preventing refrigeration machine oil stored in oil storage part 17 from flowing out into refrigerant outlet pipe 11 is provided between refrigerant return pipe 16 and the inner surface of tubular outer pipe 4. In this embodiment, part exhibiting a reflector function 18 is formed at an upper portion side of refrigerant return pipe 16 and formed as a bell mouth type pipe which is enlarged in diameter as located at an upper position. Where, in Fig. 1, symbol 20 indicates a support bracket for fixing refrigerant outlet pipe 11 at a predetermined position relative to the inner surface of tubular outer pipe 4, and symbol 21 indicates a support bracket for fixing refrigerant return pipe 16 at a predetermined position relative to the inner surface of tubular outer pipe 4.

[0029] In oil separator 1 according to this embodiment constituted as described above, since two refrigerant inversion parts of first refrigerant inversion part 8 and second refrigerant inversion part 13 are provided in the downflow direction of helical flow 5 of refrigerant containing refrigeration machine oil and refrigerant separated and inverted in order at the two-step refrigerant inversion is introduced in the external discharge direction through refrigerant outlet pipe 11, the efficiency of separation can be greatly improved as compared with a conventional single-step separation. Further, by the structure wherein part exhibiting a reflector function 18 is provided between first refrigerant inversion part 8 and second refrigerant inversion part 13, it can be prevented by the reflector effect due to the part exhibiting a reflector function 13 that the refrigeration machine oil temporarily stored in oil storage part 17 flows out into refrigerant outlet pipe 11 through first refrigerant inflow port 10 by splashing up, etc. of refrigerant in the upward direction due to the disturbance, etc. of refrigerant at second refrigerant inversion part 13. The return flow of the oil returned again to oil storage part 17 by this reflector effect is indicated by symbol 19 in Fig. 1. Further, because the oil splashed up into refrigerant return pipe 16 is also weakened in refrigerant flow speed in the upper diameter-enlarged pipe portion forming this part exhibiting a reflector function 13,

refrigeration machine oil great in mass is liable to be returned again toward oil storage part 17 at the bottom portion through the inside of refrigerant return pipe 16. Thus, since oil return into the separated refrigerant due to oil splashing up, etc. can be prevented, the efficiency of separation can be further improved.

[0030] Further, because this part exhibiting a reflector function 18 also functions for temporarily contracting the cross-sectional area of flow path with respect to the downflow of helical flow 5 of the refrigerant containing refrigeration machine oil as shown in the figure, it can be achieved to improve the inversion and separation performance of refrigerant at first refrigerant inversion part 8 positioned at an upstream side of part exhibiting a reflector function 18, and because the flow speed is temporarily increased by the temporary contraction of the cross-sectional area of flow path, the centrifugal separation performance due to the helical flow at a downstream side of part exhibiting a reflector function 18 is improved, and further, the flow speed is rapidly changed by the enlargement in cross-sectional area of flow path after the temporary contraction of the cross-sectional area of flow path, and therefore, it may be also expected to improve the inversion and separation performance of refrigerant at second refrigerant inversion part 13. Therefore, the efficiency for separation as the whole of oil separator 1 can be greatly improved, as compared with a conventional structure at a single step without a part exhibiting a reflector function.

[0031] Further, because of the separation due to the two-step refrigerant inversion at first refrigerant inversion part 8 and second refrigerant inversion part 13, since the resistance with respect to refrigerant inflow into the discharge path at the time of inversion separation at each refrigerant inversion part is suppressed small, as compared with a conventional one-step case, the resistance in flow path at this part at the time of discharge can be reduced, and consequently, reduction of the resistance in flow path and the pressure loss as the whole of the oil separator becomes possible. Further, as aforementioned, by the discharge operation of the refrigerant separated at first refrigerant inversion part 8 through refrigerant outlet pipe 11, suction operation from refrigerant return pipe 16 disposed therebelow at a confronting state is induced, and inducing effect from second refrigerant inflow port 15 of refrigerant return pipe 16, of the refrigerant 14 separated at second refrigerant inversion part 13, can also be expected. As a result, as the whole of oil separator 1, an efficient discharge of separated refrigerant becomes possible, and further reduction of resistance in refrigerant flow path and pressure loss becomes possible.

[0032] Further, because tubular outer pipe 4 is formed as a straight pipe shape with a substantially constant diameter and first refrigerant inversion part 8, second refrigerant inversion part 13 and part exhibiting a reflector function 18 are formed in the straight pipe-shape tubular outer pipe 4, it is not necessary to provide a diameter-enlarged pipe portion to tubular outer pipe 4 defining the outline of the oil separator, in particular, a structure compact in the radial direction and good in space efficiency can be realized, and the mounting property into a place limited in space (for example, into an engine room of a vehicle) can be improved.

[0033] In the oil separator according to the present invention, various structures can be employed for the refrigerant return pipe, the part exhibiting a reflector function, and the connection structure between the refrigerant outlet pipe and the refrigerant return pipe. Hereinafter, some structural examples thereof will be shown.

[0034] In oil separator 31 shown in Fig. 2, although inlet pipe 33, refrigerant outlet pipe 34 and refrigerant return pipe 35 are provided relatively to tubular outer pipe 32 similarly in the above-described embodiment, the refrigerant return pipe 35 is formed as constant-diameter tubular pipe extending upwardly from second refrigerant inversion part 36, and a part exhibiting a reflector function 37 is formed as a bevel part which extends from an upper end of this tubular pipe toward an obliquely downward direction and which is enlarged in diameter as located at a lower position. In such a part exhibiting a reflector function 37 formed as a bevel part, the inflow of the oil splashed up from a lower position to a portion around refrigerant return pipe 35 can be prevented efficiently.

[0035] In oil separator 41 shown in Fig. 3, although inlet pipe 43, refrigerant outlet pipe 44 and refrigerant return pipe 45 are provided relatively to tubular outer pipe 42 similarly in the aforementioned embodiment, substantially the entire length of the refrigerant return pipe 45 comprises a bell mouth type pipe which extends upwardly from a second refrigerant inversion part 46 and which is enlarged in diameter as located at an upper position, and the part exhibiting a reflector function is formed from the bell mouth type pipe. Namely, the refrigerant return pipe 45 and the part exhibiting a reflector function are formed as an identical pipe. In the structure of such a part exhibiting a reflector function, the reflector effect can be exhibited over a relatively long zone in the vertical direction.

[0036] In oil separator 51 shown in Fig. 4, although an inlet pipe (omitted in the figure), refrigerant outlet pipe 53 and refrigerant return pipe 54 are provided relatively to tubular outer pipe 52 similarly in the aforementioned embodiment, refrigerant outlet pipe 53 and refrigerant return pipe 54 are formed as an integrated tubular pipe having a connection part 55 therebetween, and an opening 56 as the first refrigerant inflow port is formed on a pipe wall of refrigerant outlet pipe 53 positioned above this connection part 55. Then, a part exhibiting a reflector function 57 is formed as a structure comprising a bevel part which extends from the connection part 55 or the vicinity thereof toward an obliquely downward direction and which is enlarged in diameter as located at a lower position. Symbol 58 indicates a support bracket for fixing the above-described integrated tubular pipe at a predetermined position relatively to the inner surface of tubular outer pipe

52. Because refrigerant outlet pipe 53 and refrigerant return pipe 54 are formed as an integrated tubular pipe, supporting by support bracket 58 becomes easy, and the number of support bracket s 58 may be small.

[0037] In oil separator 61 shown in Fig. 5, although an inlet pipe (omitted in the figure), refrigerant outlet pipe 63 and refrigerant return pipe 64 are provided relatively to tubular outer pipe 62 similarly in the aforementioned embodiment, refrigerant return pipe 64 comprises a first bell mouth type pipe part 66 which extends upwardly from second refrigerant inversion part 65 and which is enlarged in diameter as located at an upper position, and a second bell mouth type pipe part 67 which is connected to an upper end of the first bell mouth type pipe part 66 and which is contracted in diameter as located at an upper position, and a lower end of refrigerant outlet pipe 63 is connected to an upper end of refrigerant return pipe 64 at a connection part 68 to form an integrated pipe structure. An opening 69 as the first refrigerant inflow port is formed on a pipe wall of refrigerant outlet pipe 63 positioned above this connection part 68. Then, the part exhibiting a reflector function is formed from the above-described first bell mouth type pipe part 66. Refrigerant outlet pipe 63 and refrigerant return pipe 64 formed as an integrated tubular pipe are fixed at predetermined positions relatively to the inner surface of tubular outer pipe 62 by support brackets 70. In such a structure, the part exhibiting a reflector function can be formed by first bell mouth type pipe part 66 over a relatively long zone, and by second bell mouth type pipe part 67, it becomes possible to perform the refrigerant inversion at the first refrigerant inversion part more smoothly and to promote the flow path contraction effect relative to the downward helical flow, and therefore, a more smooth as a whole can be expected.

[0038] Fig. 6 depicts an oil separator 71 according to a modification of the structure shown in Fig. 5, as compared with the structure shown in Fig. 5, refrigerant return pipe 72 comprises a tubular pipe part 74 having a constant diameter which extends upwardly from second refrigerant inversion part 73, a first bell mouth type pipe part 75 which extends upwardly from an upper end of the tubular pipe part 74 and which is enlarged in diameter as located at an upper position, and a second bell mouth type pipe part 76 which is connected to an upper end of the first bell mouth type pipe part 75 and which is contracted in diameter as located at an upper position. Tubular outer pipe 77, an inlet pipe (omitted in the figure), refrigerant outlet pipe 78, opening 79 and support brackets 80 are substantially the same in structure as those shown in Fig. 5.

[0039] As aforementioned, the position for disposing the oil separator according to the present invention is not particularly restricted as long as it is an exit side of a compressor, and for example, as shown in Fig. 7, an oil separator 86 can be disposed between a compressor 81 and a condenser 82 in a refrigeration circuit 85 having the compressor 81, the condenser 82, an expansion mechanism 83 and an evaporator 84 in this order.

[0040] In this case, in particular, a structure can be employed wherein oil separator 86 is built in a header pipe of condenser 82, and the external outflow port of the refrigerant outlet pipe is opened toward the inside of the header pipe. Further in this case, for example, as shown in Fig. 8, it is possible to incorporate an oil separator 91 into a header pipe 93 of a condenser 92 and to form the header pipe 93 and a tubular outer pipe 94 of the oil separator 91 integrally, in particular, to integrally form by extrusion molding. In Fig. 8, symbol 95 indicates heat exchange tubes of condenser 92 connected to header pipe 93, symbol 96 indicates a lid portion of header pipe 93, symbol 97 indicates an inlet pipe of oil separator 91, and symbol 98 indicates a refrigerant outlet pipe of oil separator 91, respectively, and a part of the integrally formed tubular outer pipe 94 forms a partition wall 99 between oil separator 91 and the tube-side inside of header pipe 93. In such a structure, a desired oil separator 91 can be disposed compactly in a refrigeration circuit without making the whole of the refrigeration circuit particularly large-sized.

Industrial Applications of the Invention

[0041] The oil separator according to the present invention can be applied to any use for separating refrigeration machine oil from refrigerant discharged from a compressor, and in particular, it is suitable to be disposed in a refrigeration circuit, especially, between a compressor and a condenser in a refrigeration circuit of an air conditioning system for a vehicle.

Explanation of symbols

[0042]

1, 31, 41, 51, 61, 71, 86, 91: oil separator
2, 81: compressor
3: oil return tube
4, 32, 42, 52, 62, 77, 94: tubular outer pipe
5: helical flow
6, 33, 43, 97: inlet pipe
7: external outflow port
8: first refrigerant inversion part
9: inverted refrigerant
10: first refrigerant inflow port
11, 34, 44, 53, 63, 78, 98: refrigerant outlet pipe
12: refrigerant communication port
13, 36, 46, 65, 73: second refrigerant inversion part
14: inverted refrigerant
15: second refrigerant inflow port
16, 35, 45, 54, 64, 72: refrigerant return pipe
17: oil storage part
18, 37, 57: part exhibiting a reflector function
19: return flow of oil
20, 21, 58, 70, 80: support bracket
55, 68: connection part

56, 69, 79: opening
66, 75: first bell mouth type pipe part
67, 76: second bell mouth type pipe part
74: tubular pipe part having a constant diameter
82, 92: condenser
83: expansion mechanism
84: evaporator
85: refrigeration circuit
93: header pipe
95: heat exchange tube
96: lid portion of header pipe
99: partition wall

Claims

1. An oil separator comprising:

a tubular outer pipe which is disposed on a compressor outlet side so as to extend in a vertical direction;
an inlet pipe provided at an upper part of said tubular outer pipe for introducing refrigerant containing refrigeration machine oil, discharged from a compressor, into said tubular outer pipe in such a manner as to produce a downward helical flow of refrigerant containing refrigeration machine oil along an inner surface of said tubular outer pipe;
a refrigerant outlet pipe which has an external outflow port at an upper end for flowing out refrigerant to outside said tubular outer pipe, has a section extending in an axial direction of said tubular outer pipe at a central position of said tubular outer pipe, and has a first refrigerant inflow port at a lower end of said section for flowing in refrigerant therein, which has been separated from refrigerant containing refrigeration machine oil having flowed down in said helical flow and the flow direction of which has been inverted in relation to vertical direction at a first refrigerant inversion part;
a refrigerant return pipe which extends in an axial direction of said tubular outer pipe at a central position of said tubular outer pipe, below said refrigerant outlet pipe, has a refrigerant communication port at an upper end for being confronted with or connected to a lower end of said refrigerant outlet pipe, and has a second refrigerant inflow port at a lower end for flowing in refrigerant therein, which has been separated from refrigerant containing refrigeration machine oil having flowed down in said helical flow and the flow direction of which has been inverted in relation to vertical direction at a second refrigerant inversion part; and
an oil storage part, which is formed at a bottom of said tubular outer pipe, capable of temporarily storing refrigeration machine oil separated from refrigerant,
wherein a part exhibiting a reflector function for preventing refrigeration machine oil stored in said oil storage part from flowing out into said refrigerant outlet pipe is provided between said refrigerant return pipe and said inner surface of said tubular outer pipe.

2. The oil separator according to claim 1, wherein said refrigerant return pipe comprises a tubular pipe having a constant diameter which extends upwardly from said second refrigerant inversion part, and said part exhibiting a reflector function comprises a bevel part which extends from an upper end of said tubular pipe toward an obliquely downward direction and which is enlarged in diameter as located at a lower position.

3. The oil separator according to claim 1, wherein said refrigerant return pipe comprises a bell mouth type pipe which extends upwardly from said second refrigerant inversion part and which is enlarged in diameter as located at an upper position, and said part exhibiting a reflector function is formed from said bell mouth type pipe.

4. The oil separator according to claim 1, wherein said refrigerant return pipe comprises a tubular pipe part having a constant diameter which extends upwardly from said second refrigerant inversion part and a bell mouth type pipe part which extends upwardly from an upper end of said tubular pipe part and which is enlarged in diameter as located at an upper position, and said part exhibiting a reflector function is formed from said bell mouth type pipe part.

5. The oil separator according to claim 1, wherein said refrigerant outlet pipe and said refrigerant return pipe are formed as an integrated tubular pipe having a connection part therebetween, an opening as said first refrigerant inflow port is formed on a pipe wall of said refrigerant outlet pipe positioned above said connection part, and said part exhibiting a reflector function comprises a bevel part which extends from said connection part or the vicinity thereof toward an obliquely downward direction and which is enlarged in diameter as located at a lower position.

6. The oil separator according to claim 1, wherein said refrigerant return pipe comprises a first bell mouth type pipe part which extends upwardly from said second refrigerant inversion part and which is enlarged in diameter as located at an upper position, and a second bell mouth type pipe part which is connected to an upper end of said first bell mouth type pipe part and which is contracted in diameter as located at an upper position, a lower end of said refrigerant outlet

pipe is connected to an upper end of said refrigerant return pipe at a connection part to form an integrated pipe structure, an opening as said first refrigerant inflow port is formed on a pipe wall of said refrigerant outlet pipe positioned above said connection part, and said part exhibiting a reflector function is formed from said first bell mouth type pipe part.

7. The oil separator according to claim 1, wherein said refrigerant return pipe comprises a tubular pipe part having a constant diameter which extends upwardly from said second refrigerant inversion part, a first bell mouth type pipe part which extends upwardly from an upper end of said tubular pipe part and which is enlarged in diameter as located at an upper position, and a second bell mouth type pipe part which is connected to an upper end of said first bell mouth type pipe part and which is contracted in diameter as located at an upper position, a lower end of said refrigerant outlet pipe is connected to an upper end of said refrigerant return pipe at a connection part to form an integrated pipe structure, an opening as said first refrigerant inflow port is formed on a pipe wall of said refrigerant outlet pipe positioned above said connection part, and said part exhibiting a reflector function is formed from said first bell mouth type pipe part.

8. The oil separator according to any of claims 1 to 7, wherein at least said refrigerant return pipe is supported relative to said inner surface of said tubular outer pipe via a bracket at a condition where a path for refrigerant containing refrigeration machine oil is ensured.

9. The oil separator according to any of claims 1 to 8, wherein an oil return tube for returning refrigeration machine oil stored in said oil storage part to a compressor is connected to said oil separator.

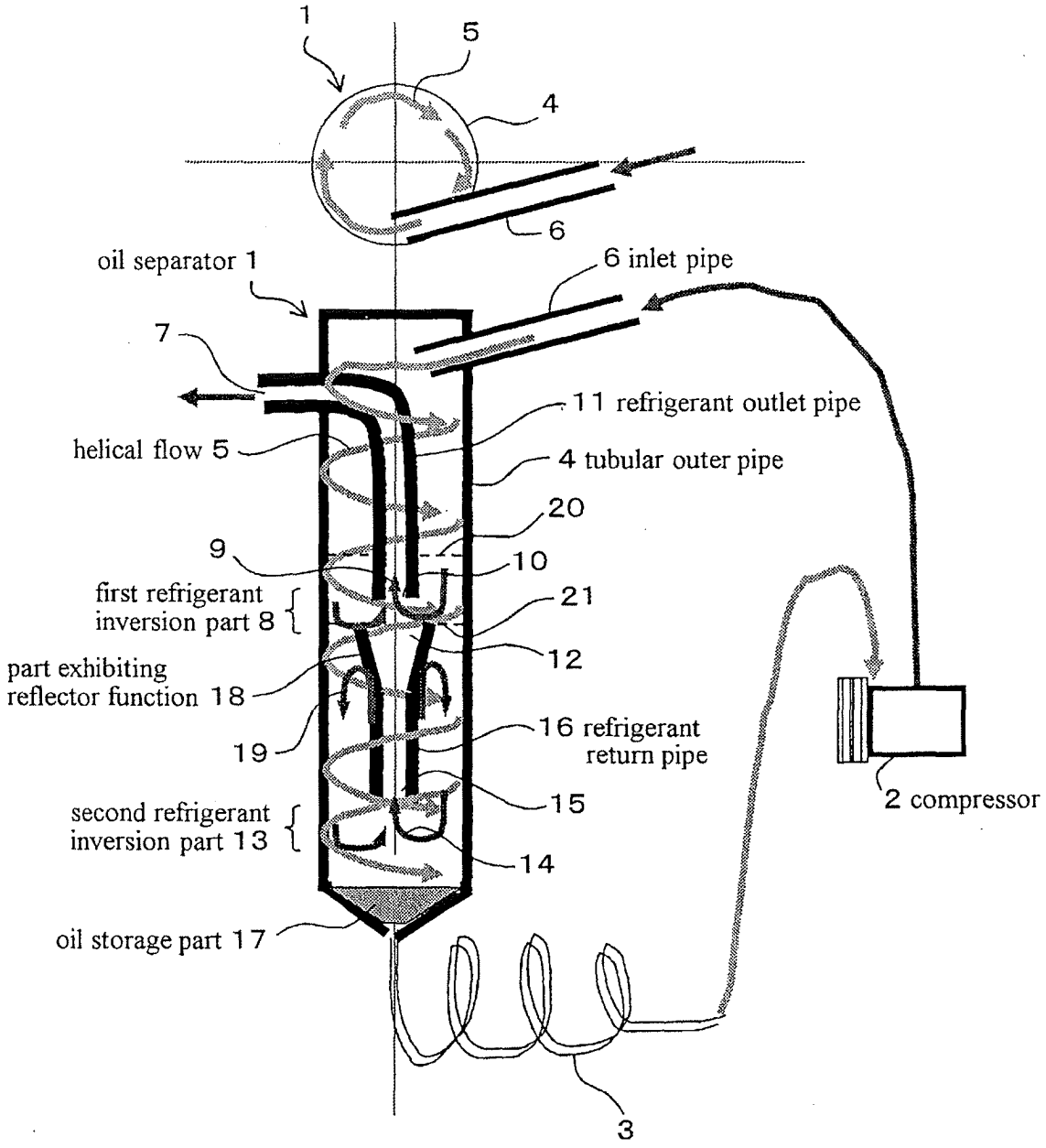
10. The oil separator according to any of claims 1 to 9, wherein said oil separator is disposed between a compressor and a condenser in a refrigeration circuit having said compressor, said condenser, an expansion mechanism and an evaporator in this order.

11. The oil separator according to claim 10, wherein said oil separator is built in a header pipe of said condenser, and said external outflow port of said refrigerant outlet pipe is opened toward inside of said header pipe.

12. The oil separator according to claim 11, wherein said header pipe and said tubular outer pipe are formed integrally by extrusion molding.

13. The oil separator according to any of claims 1 to 12, wherein said oil separator is provided in a refrigeration circuit of an air conditioning system for a vehicle.

FIG. 1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5
4
6
oil separator 1
6 inlet pipe
7
11 refrigerant outlet pipe
helical flow 5
4 tubular outer pipe
20
9
10
first refrigerant inversion part 8
21
12
part exhibiting reflector function 18
19
16 refrigerant return pipe
15
second refrigerant inversion part 13
14
oil storage part 17
2 compressor
3

FIG. 2

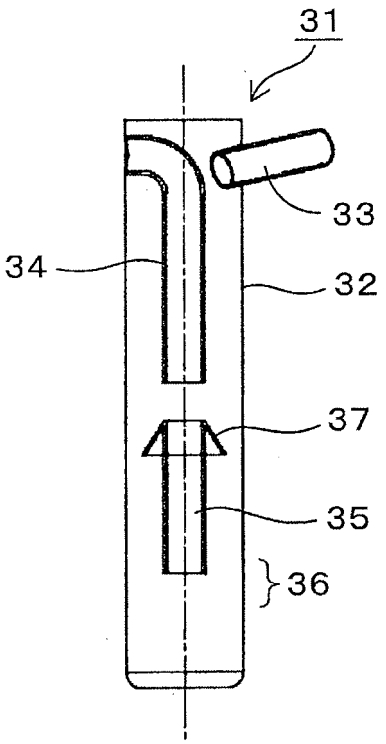

FIG. 3

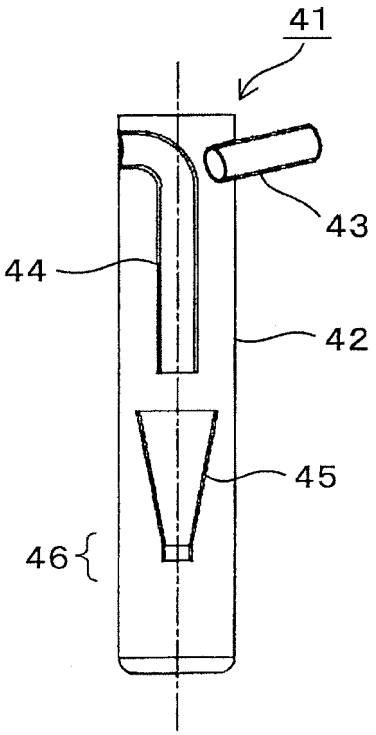

FIG. 4

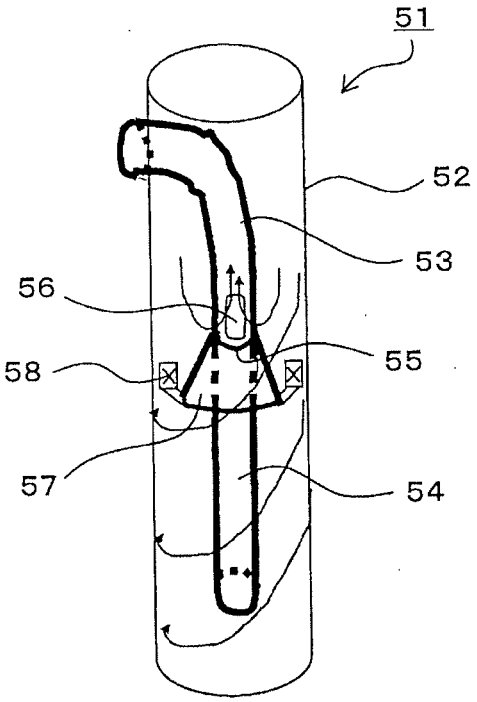

FIG. 5

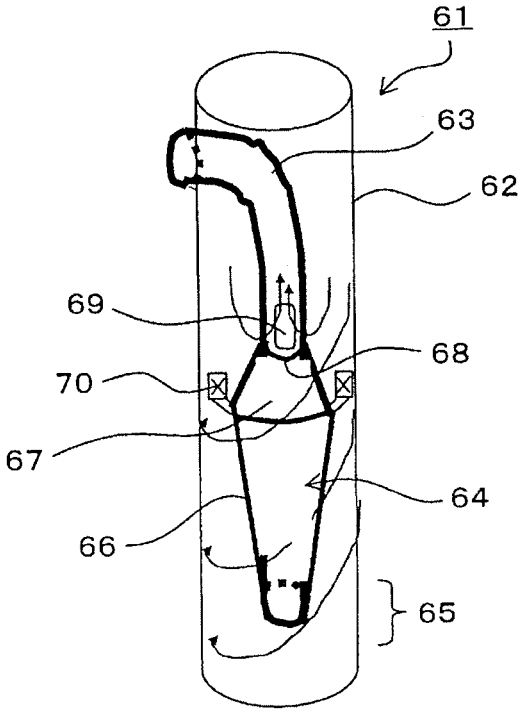

FIG. 6

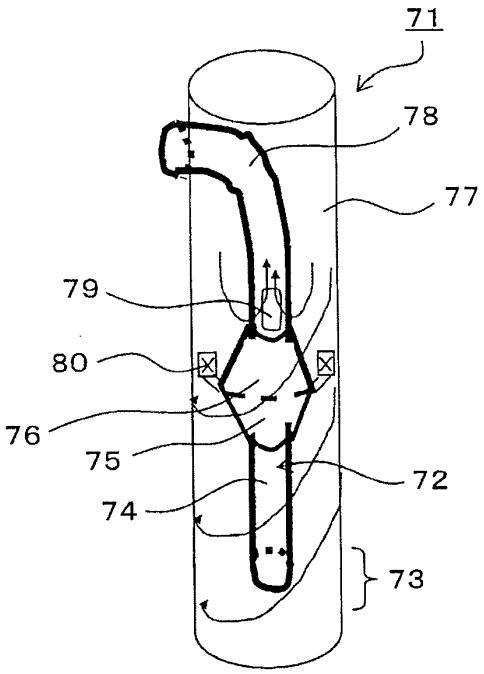
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FIG. 7

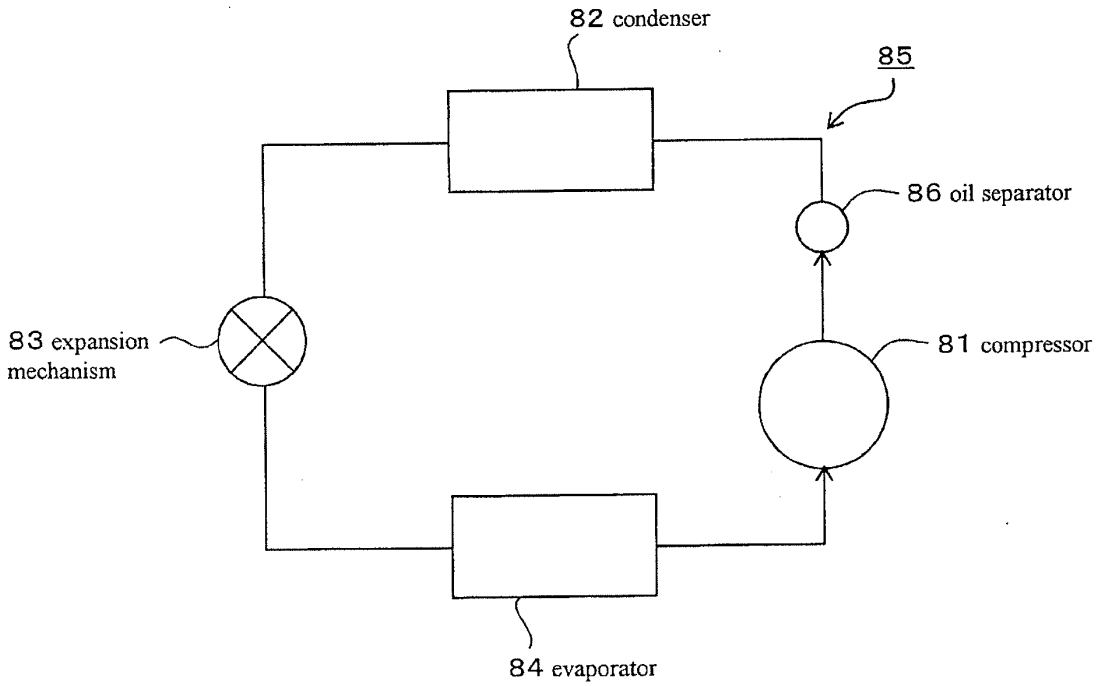
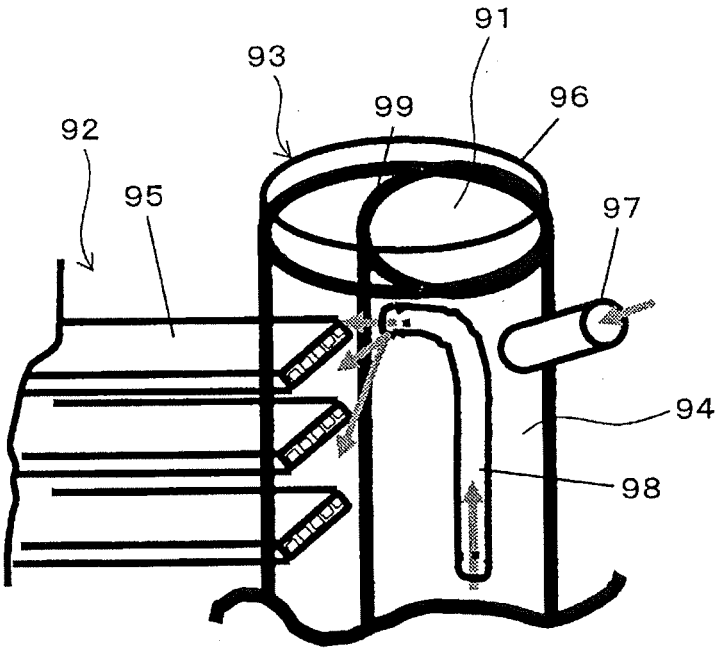

82 condenser
85
86 oil separator
83 expansion mechanism
81 compressor
84 evaporator

FIG. 8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/002560

A. CLASSIFICATION OF SUBJECT MATTER
F25B43/02(2006.01)i, *B04C5/103*(2006.01)i, *F25B1/00*(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)
F25B43/02, B04C5/103, F25B1/00

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 1996-2010
Kokai Jitsuyo Shinan Koho 1971-2010 Toroku Jitsuyo Shinan Koho 1994-2010

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.
Y	JP 5-296611 A (Daikin Industries, Ltd.), 09 November 1993 (09.11.1993), fig. 7; paragraphs [0069] to [0073]	1,3,8-13
Y	JP 59-97475 A (Hussmann Corp.), 05 June 1984 (05.06.1984), fig. 1, 2; page 6, lower left column, line 15 to page 7, lower left column, line 11	1,3,8-13
Y	JP 2002-333221 A (Mitsubishi Heavy Industries, Ltd.), 22 November 2002 (22.11.2002), fig. 1 to 3; paragraphs [0038] to [0041]	11-13

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

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"P" document published prior to the international filing date but later than the priority date claimed
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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
24 June, 2010 (24.06.10)	06 July, 2010 (06.07.10)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/002560

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2000-304378 A (Mitsubishi Heavy Industries, Ltd.), 02 November 2000 (02.11.2000), fig. 1 to 3; paragraphs [0026] to [0032]	11-13
A	JP 5-329401 A (Daikin Industries, Ltd.), 14 December 1993 (14.12.1993), fig. 1; paragraphs [0018] to [0026]	1-13
A	US 2006/0196220 A1 (Gary W. WESTERMEYER), 07 September 2006 (07.09.2006), entire text; all drawings	1-13

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

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PCT/JP2010/002560

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JP 5-329401 A	1993.12.14	(Family: none)
US 2006/0196220 A1	2006.09.07	US 2006/0196221 A1

Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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