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(54) **REFRIGERATING APPARATUS**

(57) A buffer container (71) is connected to an out-flow port (33) of an expansion mechanism (60). The buffer container (71) is shaped like a cylinder extending in the direction of refrigerant flow and has a greater transverse cross sectional area than that of the outflow port (33). The buffer container (71) contains therein a flow

stabilizing plate (75) having a mesh part (75a) shaped like a circular plate. The variation in pressure is reduced by pressure supply and pressure absorption by the buffer container (71) and, in addition, refrigerant droplets are made fine in size during passage through the flow stabilizing plate (75).

FIG. 3A

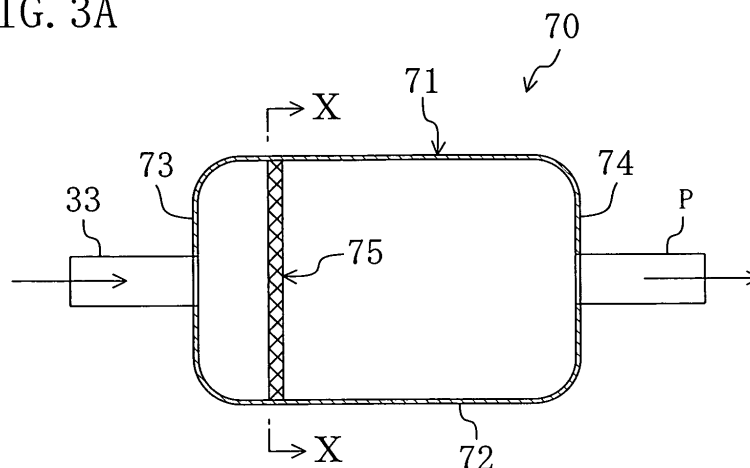
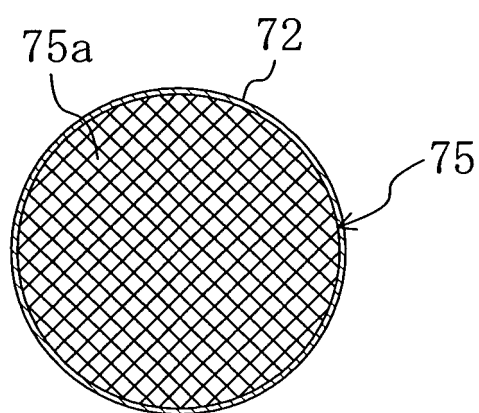


FIG. 3B



Description

TECHNICAL FIELD

[0001] This invention relates in general to a refrigeration apparatus and in particular to a strategy for reducing pressure pulsation.

BACKGROUND ART

[0002] In the past, vapor compression refrigeration cycle-based refrigeration apparatuses using carbon dioxide as a refrigerant have been known. This type of refrigeration apparatus has a refrigerant circuit in which a compressor, a cooler, an expander, and an evaporator are connected in the order given (see, for example, JP-A-2000-234814).

[0003] In the refrigerant circuit of the aforesaid patent document, the refrigerant is compressed to supercritical state by the compressor and then cooled in the cooler. This cooled refrigerant is expanded by the expander to lower pressure, evaporated in the evaporator, and returned back to the compressor, which cycle is repeated. For example, this refrigeration apparatus is used as a heating apparatus, in which case the cooler is installed in the room.

PROBLEMS THAT THE INVENTION SEEKS TO OVERCOME

[0004] However, the problem with the above-described conventional refrigeration apparatus is that there is generated considerable vibration, especially at the outlet side of the expander. More specifically, the use of a positive displacement expander causes pressure pulsations at the inlet and outlet sides thereof due to the fact that the suction flow rate of the suction process and the discharge flow rate of the discharge process are not constant. This pressure pulsation causes vibration. Furthermore, refrigerant in a gas/liquid two-phase state flows out of the expander and refrigerant droplets impinge on the pipe wall or the like, thereby producing the problem of generating more considerable vibrations at the outlet side of the expander. This therefore gives rise to increasing the possibility that at the outlet side of the expander the equipment is subjected to damage by vibration, and its reliability may be reduced considerably.

[0005] With these problems with the prior art in mind, the present invention was devised. Accordingly, an object of the present invention is to reduce at least pressure pulsation at the outlet side of the expander for the purpose of vibration reduction.

DISCLOSURE OF THE INVENTION

[0006] The present invention provides the following solutions to the above-described drawbacks.

[0007] The present invention provides, as a first as-

pect, a refrigeration apparatus comprising a refrigerant circuit (20), to which a positive displacement expander (60) is connected by piping, for performing a vapor compression refrigeration cycle. The refrigerant circuit (20) is provided, along a piping line on the outlet side of the positive displacement expander (60), with a flow path enlarged part (71) whose refrigerant flow path for flow of refrigerant has a greater transverse cross sectional area than that of the outlet side piping line so that the variation in pressure of the refrigerant flowing out of the positive displacement expander (60) is reduced.

[0008] In the first aspect of the present invention, the flow path enlarged part (71) constitutes a pressure buffer space for reducing the variation in pressure of the refrigerant flowing out of the positive displacement expander (60). Accordingly, the variation in pressure (pressure pulsation) occurring at the outlet side of the positive displacement expander (60) is reduced. This therefore controls the vibration of the entire equipment resulting from the variation in pressure.

[0009] The present invention provides, as a second aspect, a refrigeration apparatus comprising a refrigerant circuit (20), to which a positive displacement expander (60) is connected by piping, for performing a vapor compression refrigeration cycle. The refrigerant circuit (20) is provided, along an outlet side piping line of the positive displacement expander (60), with a tubular flow path enlarged part (71) whose refrigerant flow path for flow of refrigerant has a greater transverse cross sectional area than that of the outlet side piping line, the tubular flow path enlarged part (71) extending along the direction of flow of the refrigerant.

[0010] In the second aspect of the present invention, for example, as shown in Figure 3, the flow path enlarged part (71) is shaped like a tubular container extending in the direction of flow of the refrigerant, and the inside of this container constitutes a pressure buffer space. More specifically, if the amount of outflow of the refrigerant from the positive displacement expander (60) increases to cause a rise in pressure, this increased amount of refrigerant is stored in the flow path enlarged part (71) for pressure absorption. On the other hand, if the amount of outflow of the refrigerant from the positive displacement expander (60) decreases to cause a drop in pressure, this decreased amount of refrigerant flows out to the outlet side piping line from the flow path enlarged part (71) for pressure supply. In other words, in response to the variation in pressure at the outlet side of the positive displacement expander (60), the rate of flow of the refrigerant at the outlet side thereof is regulated to lessen the variation in pressure. This therefore controls the variation in pressure at the outlet side of the positive displacement expander (60), thereby controlling the vibration of the entire equipment.

[0011] The present invention provides, as a third aspect according to the aforesaid second aspect, a refrigeration apparatus in which the flow path enlarged part (71) is oriented to extend in an up and down direction

and connected to the outlet side piping line of the positive displacement expander (60) so that the refrigerant entering from the upper side flows vertically downwardly and is let out from the bottom side.

[0012] In the third aspect of the present invention, as shown in Figure 10, the flow path enlarged part (71) is shaped like a tubular container extending in an up and down direction, i.e., in a vertical direction. And the refrigerant exiting the positive displacement expander (60) flows in from the upper side of the flow path enlarged part (71), travels vertically downwardly, and flows out to the outlet side piping line from the bottom side, thereby making it possible to prevent accumulation of liquid refrigerant on the bottom side. In other words, although the refrigerant exiting the positive displacement expander (60) is in a gas/liquid two-phase state, the liquid refrigerant will not accumulate in the flow path enlarged part (71), but be let out therefrom without fail.

[0013] The present invention provides, as a fourth aspect according to either the aforesaid first aspect or the aforesaid second aspect, a refrigeration apparatus in which the flow path enlarged part (71) contains therein a refrigerant flow stabilizing means (75, 76).

[0014] In the fourth aspect of the present invention, the flow of the refrigerant which has entered the flow path enlarged part (71) is stabilized by the flow stabilizing means (75, 76). That is to say, the flow of the liquid refrigerant of the refrigerant which has flowed into the flow path enlarged part (71) becomes stable, thereby making it possible to prevent the liquid refrigerant from violently impinging upon the internal wall of the piping line or the like. Accordingly, the flow stabilizing means (75, 76) controls vibration caused by impingement of the liquid refrigerant upon the pipe wall or the like. As a result, in addition to the effect of control of the pressure pulsation, the vibration of the entire equipment is controlled to a further extent.

[0015] The present invention provides, as a fifth aspect according to the aforesaid fourth aspect, a refrigeration apparatus in which the flow stabilizing means (76) is a flow stabilizing plate which is formed into a plate-like shape having a plurality of through holes and which is oriented to face towards the direction of flow of the refrigerant.

[0016] In the fifth aspect of the present invention, as shown in Figure 6, the refrigerant which has entered the flow path enlarged part (71) passes and flows through the through holes of the flow stabilizing plate, whereby the refrigerant flow is made stable. Furthermore, when the refrigerant is passing through the through holes, the refrigerant flow velocity increases. As a result, the refrigerant droplets are made fine in size by force resulting from the increased flow velocity. Because of this, even when the liquid refrigerant collides against the pipe wall or the like, the resulting impact is small. Therefore, the vibration of the equipment is further controlled.

[0017] The present invention provides, as a sixth aspect according to the aforesaid fourth aspect, a refrigeration

apparatus in which the flow stabilizing means (75) is a flow stabilizing plate which is formed by a plate-like mesh member and which is oriented to face towards the direction of flow of the refrigerant.

[0018] In the sixth aspect of the present invention, as shown in Figure 3, the refrigerant which has entered the flow path enlarged part (71) passes and flows through the mesh member, whereby the refrigerant flow is made stable. Furthermore, when the refrigerant is passing through the mesh member, the refrigerant droplets contained in the refrigerant are made fine in size by the mesh member. Because of this, even when the liquid refrigerant collides against the pipe wall or the like, the resulting impact is small. Therefore, the vibration of the equipment is further controlled.

[0019] The present invention provides, as a seventh aspect according to either the aforesaid second aspect or the aforesaid third aspect, a refrigeration apparatus in which the flow path enlarged part (71) contains therein a partition plate (77) which has a through hole and which divides the inside of the flow path enlarged part (71) in the direction of flow of the refrigerant.

[0020] In the seventh aspect of the present invention, for example, as shown in Figure 7, the inside of the flow path enlarged part (71) is divided by the partition plate (77) into an upstream side space and a downstream side space. In other words, the flow path enlarged part (71) has, for example, two pressure buffer spaces. The through hole is formed through the partition plate (77) and the upstream side space and the downstream side space are in fluid communication with each other via the through hole. Accordingly, in the flow path enlarged part (71), the variation in pressure of the refrigerant at the outlet side of the positive displacement expander (60) is reduced in two stages. In addition, if two or more partition plates (77) are employed to define three or more pressure buffer spaces, this lessens the variation in pressure in multiple stages. This therefore controls impact associated with an abrupt variation in pressure. The vibration of the entire equipment is further controlled.

[0021] The present invention provides, as an eighth aspect according to the aforesaid first aspect or the aforesaid second aspect, a refrigeration apparatus in which the refrigerant is carbon dioxide.

[0022] In the eighth aspect of the present invention, carbon dioxide is used as the refrigerant which is circulated through the refrigerant circuit (20). This makes it possible to provide earth-conscious types of equipment and apparatus. Especially, for the case of use of carbon dioxide, it is compressed up to critical state, thereby allowing the variation in pressure at the outlet side of the positive displacement expander (60) to increase correspondingly. Nevertheless, this variation in pressure is assuredly and effectively controlled.

ADVANTAGEOUS EFFECTS

[0023] Therefore, in accordance with the first aspect

of the present invention, the flow path enlarged part (71) is arranged along the outlet side piping line of the positive displacement expander (60). The flow path enlarged part (71) is formed such that its refrigerant flow path has a greater transverse cross sectional area than that of the outlet side piping line so that the variation in pressure of the refrigerant flowing out of the positive displacement expander (60) is reduced. This therefore makes it possible to control the vibration of the equipment caused by the variation in pressure. As a result, it becomes possible to prevent the equipment from being damaged.

[0024] In addition, in accordance with the second aspect of the present invention, the flow path enlarged part (71) is arranged along the outlet side piping line of the positive displacement expander (60). The flow path enlarged part (71) is formed such that its refrigerant flow path has a greater transverse cross sectional area than that of the outside piping line, and that it is shaped like a tube extending along the direction of flow of the refrigerant, thereby making it possible to ensure pressure supply and pressure absorption for the outlet side piping line from the flow path enlarged part (71). This therefore makes it possible to control the variation in pressure, whereby the vibration of the entire equipment is controlled.

[0025] In addition, in accordance with the third aspect of the present invention, it is arranged such that in the flow path enlarged part (71) the refrigerant flows vertically downwardly and is let out from the bottom side, which arrangement makes it possible to prevent liquid refrigerant from accumulating within the flow path enlarged part (71).

[0026] In addition, in accordance with the fourth to sixth aspects of the present invention, it is arranged such that the refrigerant flow stabilizing means (75, 76) is disposed within the flow path enlarged part (71), which arrangement makes it possible to ensure stabilization of the refrigerant flow. This therefore makes it possible to control impingement of the liquid refrigerant upon the pipe wall. Therefore, it becomes possible to control vibrations resulting from such a liquid refrigerant collision.

[0027] In addition, in accordance with the seventh aspect of the present invention, it is arranged such that the partition plate (77) is disposed within the flow path enlarged part (71) to define a plurality of pressure buffer spaces therein, which arrangement makes it possible to lessen the variation in pressure in multiple stages. This therefore makes it possible to reduce impact caused by an abrupt variation in pressure. Therefore, the vibration of the entire equipment is further controlled, thereby making it possible to further prevent the equipment from being damaged.

[0028] In addition, in accordance with the eighth aspect of the present invention, carbon dioxide is used as a refrigerant which is circulated through the refrigerant circuit (20). This makes it possible to provide earth-conscious types of equipment and apparatus. Especially, for the case of use of carbon dioxide, it is compressed up to

critical state, thereby allowing the variation in refrigerant pressure to increase correspondingly. Nevertheless, this variation in pressure is assuredly and effectively controlled.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] In the drawings:

Figure 1 is a piping arrangement schematic showing an air conditioner according to an embodiment of the present invention;

Figure 2, comprised of Figure 2(A) which is a transverse cross sectional view and Figure 2(B) which is a longitudinal cross sectional view, is an illustration representative of the principal part of an expander according to an embodiment of the present invention;

Figure 3, comprised of Figure 3(A) which is a longitudinal cross sectional view and Figure 3(B) which is a transverse cross sectional view, is an illustration representative of a buffer container according to a first embodiment of the present invention;

Figure 4 shows transverse cross sectional views illustrating operating states of an expansion mechanism according to an embodiment of the present invention;

Figure 5 is comprised of Figure 5(A) which is a graphical characteristic diagram representing the flow velocity and pressure of the discharge refrigerant of the expander, and Figure 5(B) which is a graphical characteristic diagram representing the magnitude of vibration generated at the outlet side of the expander;

Figure 6, comprised of Figure 6(A) which is a longitudinal cross sectional view and Figure 6(B) which is a transverse cross sectional view, is a diagram showing a buffer container according to a variation of the first embodiment;

Figure 7, comprised of Figure 7(A) which is a longitudinal cross sectional view and Figure 7(B) which is a transverse cross sectional view, is a diagram showing a buffer container according to a second embodiment of the present invention;

Figure 8 is a longitudinal cross sectional view showing a buffer container according to a variation of the second embodiment;

Figure 9 is a longitudinal cross sectional view showing a buffer container according to a third embodiment of the present invention;

Figure 10 is a longitudinal cross sectional view showing a buffer container according to a variation of the third embodiment; and

Figure 11 is comprised of Figure 11(A) which is a graphical characteristic diagram representing the flow velocity and pressure of the discharge refrigerant of a conventional expander, and Figure 11(B) which is a graphical characteristic diagram representing the magnitude of vibration generated at the outlet side of the conventional expander.

REFERENCE NUMERALS IN THE DRAWINGS

[0030]

10: air conditioner (refrigeration apparatus)

20: refrigerant circuit

60: expansion mechanism (positive displacement expander)

71: buffer container (flow path enlarged part)

75, 76: flow stabilizing plate (flow stabilizing means)

77: partition plate

BEST EMBODIMENT MODE FOR CARRYING OUT THE INVENTION

[0031] In the following, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

FIRST EMBODIMENT OF THE INVENTION

[0032] Referring to Figure 1, there is shown an air conditioner (10) of a first embodiment of the present invention. The air conditioner (10) constitutes a refrigeration apparatus of the present invention. The air conditioner (10) is provided with a refrigerant circuit (20) which is a closed circuit including an outdoor heat exchanger (23), an indoor heat exchanger (24), two four-way switching valves (21, 22), and a compression and expansion unit (30) which are connected by piping. The refrigerant circuit (20) is charged with carbon dioxide (CO₂) as a refrigerant. The refrigerant circuit (20) is configured such that a vapor compression refrigeration cycle is performed as this refrigerant of CO₂ is circulated therethrough.

[0033] The outdoor heat exchanger (23) constitutes a heat exchanger on the heat source side. The indoor heat exchanger (24) constitutes a heat exchanger on the utilization side. Both the outdoor heat exchanger (23) and the indoor heat exchanger (24) are fin and tube heat exchangers of the cross fin type. And, the outdoor heat exchanger (23) is configured such that the refrigerant

circulating through the refrigerant circuit (20) exchanges heat with outdoor air. On the other hand, the indoor heat exchanger (24) is configured such that the refrigerant circulating through the refrigerant circuit (20) exchanges heat with indoor air.

[0034] The casing of the compression and expansion unit (30) houses therein a compression mechanism (50), an electric motor (40), and an expansion mechanism (60). The compression mechanism (50), the electric motor (40), and the expansion mechanism (60) are coupled together in that order by a shaft (45) serving as a rotation shaft. The compression mechanism (50) constitutes a rotary compressor of the swinging piston type. The expansion mechanism (60) is a rotary expander of the swinging piston type, and constitutes a positive displacement expander (60) of the present invention.

[0035] The compression and expansion unit (30) has a suction port (34) through which the refrigerant in the refrigerant circuit (20) is drawn into the compression mechanism (50) and a discharge port (31) through which the refrigerant compressed in the compression mechanism (50) is discharged to the refrigerant circuit (20). In addition, the compression and expansion unit (30) has an inflow port (32) through which the refrigerant in the refrigerant circuit (20) is guided to the expansion mechanism (60) and an outflow port (33) through which the refrigerant expanded in the expansion mechanism (60) is guided to the refrigerant circuit (20). Details of the expansion mechanism (60) are described later.

[0036] The first four-way switching valve (21) has four ports. The first port is connected to the discharge port (31) of the compression and expansion unit (30). The second port is connected to a gas side end which is one end of the indoor heat exchanger (24). The third port is connected to a gas side end which is one end of the outdoor heat exchanger (23). The fourth port is connected to the suction port (34) of the compression and expansion unit (30). The first four-way switching valve (21) is configured such that it can be selectively switched between the two states. The first state (indicated by solid line in Figure 1) provides fluid communications between the first and second ports, and between the third and fourth ports. The second state (indicated by broken line in Figure 1) provides fluid communications between the first and third ports, and between the second and fourth ports.

[0037] The second four-way switching valve (22) has four ports. The first port is connected to the outflow port (33) of the compression and expansion unit (30). The second port is connected to a liquid side end which is the other end of the outdoor heat exchanger (23). The third port is connected to a liquid side end which is the other end of the indoor heat exchanger (24). The fourth port is connected to the inflow port (32) of the compression and expansion unit (30). The second four-way switching valve (22) is configured such that it can be selectively switched between the two state. The first state (indicated by solid line in Figure 1) provides fluid communications

between the first and second ports, and between the third and fourth ports. The second state (indicated by broken line in Figure 1) provides fluid communications between the first and third ports, and between the second and fourth ports.

[0038] The expansion mechanism (60) is described with reference to Figure 2. Figure 2(A) depicts a cross section taken transversely relative to the central axis of the shaft (45). On the other hand, Figure 2(B) depicts a cross section taken longitudinally along the central axis of the shaft (45).

[0039] The expansion mechanism (60) has a front head (61), a rear head (62), a cylinder (63), and a rotary piston (67).

[0040] One end surface of the cylinder (63) is closed by the front head (61) while the other end surface thereof is closed by the rear head (62).

The rotary piston (67) is shaped like a circular ring or circular cylinder. The rotary piston (67) is housed in the inside of the cylinder (63). In addition, the rotary piston (67) is, at its outer peripheral surface, in sliding contact with the inner peripheral surface of the cylinder (63). Further, the end surfaces of the rotary piston (67) are in sliding contact with the front and rear heads (61, 62), respectively. Defined within the cylinder (63) between its inner peripheral surface and the outer peripheral surface of the rotary piston (67) is an expansion chamber (65).

[0041] The shaft (45) runs completely through the rotary piston (67). The shaft (45) has a main shaft part (46). Formed at one end of the main shaft part (46) is an eccentric part (47) whose diameter is greater than the outside diameter of the main shaft part (46). The eccentric part (47) is off-centered from the axial center of the main shaft part (46) by a given amount. And the eccentric part (47) is rotatably engaged with the rotary piston (67).

[0042] In addition, a blade (68) shaped like a plate is mounted in an integral manner with the rotary piston (67). The blade (68) is configured such that it projects outwardly from the outer peripheral surface of the rotary piston (67), and divides the expansion chamber (65) within the cylinder (63) into a high pressure side (suction/expansion side) and a low pressure side (discharge side).

[0043] The cylinder (63) is provided with a pair of bushes (69). The blade (68) is tucked between the bushes (69). The bushes (69) rotatably retractably support the blade (68).

[0044] The inflow port (32) extends completely through the rear head (62). The terminal end of the inflow port (32) opens at an inside surface area of the rear head (62) that comes into sliding contact with the eccentric part (47). In other words, the inflow port (32) is opened at a position where its terminal end does not fluidly communicate with the expansion chamber (65). On the other hand, the outflow port (33) extends through the cylinder (63) in radial direction. The outflow port (33) opens, facing towards the low pressure side of the expansion chamber (65). Both the inflow port (32) and the outflow port (33) are extended to outside the casing of the compression

and expansion unit (30) by piping lines.

[0045] The rear head (62) is provided with a groove-like passageway (9a) shaped like a concave groove. As shown in Figure 2(A), one end of the groove-like passageway (9a) is located slightly inside from the inner peripheral surface of the cylinder (63) while the other end thereof is located at the portion where the rear head (62) and the eccentric part (47) come into sliding contact with each other. And the groove-like passageway (9a) is configured such that it can fluidly communicate with the expansion chamber (65).

[0046] The eccentric part (47) of the shaft (45) is provided with an interconnecting passageway (9b) shaped like a concave groove. As shown in Figure 2(A), the interconnecting passageway (9b) is shaped like a circular arc extending along the outer periphery of the eccentric part (47). The interconnecting passageway (9b) is configured such that it moves with the rotation of the shaft (45) so that the inflow port (32) and the groove-like passageway (9a) are intermittently brought into fluid communication with each other.

[0047] In addition, the refrigerant circuit (20) is provided with a pressure buffer means (70) for controlling the variation in pressure (pressure pulsation) at the outlet side piping line of the expansion mechanism (60), which is a feature of the present invention. The pressure buffer means (70) is provided with a buffer container (71). The buffer container (71) is connected along the outlet side piping line of the expansion mechanism (60).

[0048] As shown in Figure 3, the entire buffer container (71) is shaped like a container of substantially cylindrical shape. The buffer container (71) has a body part (72), an inlet side end part (73), and an outlet side end part (74). The body part (72) is shaped like a tube of circular shape when viewed in cross section. The inlet side end part (73) and the outlet side end part (74) are in continuous formation to the both ends of the body part (72), and close these ends. The volume of the buffer container (71) is greater than the volume of the expansion chamber (65). Preferably the buffer container (71) has a volume ten or more times that of the expansion chamber (65).

[0049] Connected to the center of the inlet side end part (73) is the outflow port (33) of the expansion mechanism (60). Connected to the center of the outlet side end part (74) is a connection pipe (P) which is a part of the refrigeration circuit and which is linked to the first port of the second four-way switching valve (22). Together with the outflow port (33), the connection pipe (P) constitutes the outlet side piping line of the expansion mechanism (60). The buffer container (71) is coaxially connected to the outflow port (33) and to the connection pipe (P), whereby the refrigerant flowing in from the outflow port (33) horizontally moves and flows out to the connection pipe (P). In other words, the buffer container (71) is shaped like a tube extending along the direction of flow of the refrigerant. Since, as just described, the buffer container (71) is shaped like a circular cylinder, the resistance of flow of the refrigerant becomes less in compar-

ison with the case where the buffer container (71) is shaped like a tube of rectangular shape when viewed in cross section.

[0050] The transverse cross sectional area of the body part (72) is taken considerably larger than that of each of the outflow port (33) and the connection pipe (P). The buffer container (71) is configured as follows. That is, when the refrigerant pressure in the outflow port (33) increases, the buffer container (71) takes in refrigerant from the outflow port (33) and stores it. On the hand, when the refrigerant pressure in the outflow port (33) decreases, the buffer container (71) discharges refrigerant to the outflow port (33). In other words, the buffer container (71) constitutes a flow path enlarged part in the outlet side piping line of the expansion mechanism (60) and its inside serves as a pressure buffer space.

[0051] The buffer container (71) contains therein a flow stabilizing plate (75). The flow stabilizing plate (75) constitutes a refrigerant flow stabilizing means configured to stabilize the refrigerant flow.

[0052] The entire flow stabilizing plate (75) is shaped like a circular plate. The flow stabilizing plate (75) has an outside diameter substantially equal to the inside diameter of the body part (72) of the buffer container (71), and is mounted to the buffer container (71), with its outer periphery in contact with the entire inner periphery of the body part (72). Stated another way, the flow stabilizing plate (75) is located so as to face towards the direction of flow of the refrigerant. And, as shown in Figure 3(B), the flow stabilizing plate (75) has a mesh part (75a) which has a net-like structure inside the outer circumference thereof. The flow stabilizing plate (75) is configured such that refrigerant droplets are made fine in size during their passage through the mesh part (75a). The refrigerant which has flowed into the buffer container (71) passes through the mesh part (71 a) of the flow stabilizing plate (75) and flows towards the downstream side. In addition, the flow stabilizing plate (75) is mounted on the side of the inlet side end part (73) in the buffer container (71). Figure 3(B) is a cross sectional view taken along line X-X of Figure 3(A).

RUNNING OPERATION

[0053] Next, description will be made regarding the running operation of the air conditioner (10). The cooling and heating operations of the air conditioner (10) are first described. Then, the operation of the expansion mechanism (60) is described.

COOLING OPERATION

[0054] In the cooling operation, the electric motor (40) of the compression and expansion unit (30) is energized, with the first and second four-way switching valves (21, 22) changed to their respective broken-line states as shown in Figure 1. The refrigerant is circulated through the refrigerant circuit (20), whereby the vapor compression

refrigeration cycle is performed.

[0055] The refrigerant compressed to high pressure in the compression mechanism (50) is discharged from the compression and expansion unit (30) by way of the discharge port (31). In this state, the pressure of the high pressure refrigerant is being higher than its critical pressure. This high pressure refrigerant is fed to the outdoor heat exchanger (23) by way of the first four-way switching valve (21). In the outdoor heat exchanger (23), the inflow high pressure refrigerant gives up heat to outdoor air.

[0056] The high pressure refrigerant after its heat loss in the outdoor heat exchanger (23) passes through the second four-way switching valve (22) and flows into the expansion chamber (65) of the expansion mechanism (60) from the inflow port (32). In the expansion chamber (65), the high pressure refrigerant expands and its internal energy is converted into rotational power of the shaft (45). And the refrigerant now at low pressure after expansion exits the compression and expansion unit (30) by way of the outflow port (33) and is fed to the indoor heat exchanger (24) by way of the second four-way switching valve (22).

[0057] In the indoor heat exchanger (24), the inflow low pressure refrigerant absorbs heat from indoor air and is evaporated, and the indoor air is cooled. The low pressure gas refrigerant exits the indoor heat exchanger (24), passes through the first four-way switching valve (21), and is drawn into the compression mechanism (50) of the compression and expansion unit (30) from the suction port (34). And the compression mechanism (50) again compresses the drawn refrigerant and discharges it.

HEATING OPERATION

[0058] In the heating operation, the electric motor (40) of the compression and expansion unit (30) is energized, with the first and second four-way switching valves (21, 22) changed to their respective solid-line states as shown in Figure 1. The refrigerant is circulated through the refrigerant circuit (20), whereby the vapor compression refrigeration cycle is performed.

[0059] The refrigerant compressed to high pressure in the compression mechanism (50) is discharged from the compression and expansion unit (30) by way of the discharge port (31). In this state, the pressure of the high pressure refrigerant is being higher than its critical pressure. This high pressure refrigerant is fed to the indoor heat exchanger (24) by way of the first four-way switching valve (21). In the indoor heat exchanger (24), the inflow high pressure refrigerant gives up heat to indoor air to heat it.

[0060] The high pressure refrigerant after its heat loss in the indoor heat exchanger (24) passes through the second four-way switching valve (22) and flows into the expansion chamber (65) of the expansion mechanism (60) from the inflow port (32). In the expansion chamber (65), the high pressure refrigerant expands and its internal energy is converted into rotational power of the shaft

(45). And the refrigerant now at low pressure after expansion exits the compression and expansion unit (30) by way of the outflow port (33) and is fed to the outdoor heat exchanger (23) by way of the second four-way switching valve (22).

[0061] In the outdoor heat exchanger (23), the inflow low pressure refrigerant absorbs heat from outdoor air and is evaporated. The low pressure gas refrigerant exits the outdoor heat exchanger (23), passes through the first four-way switching valve (21), and is drawn into the compression mechanism (50) of the compression and expansion unit (30) from the suction port (34). And the compression mechanism (50) again compresses the drawn refrigerant and discharges it.

OPERATION OF EXPANSION MECHANISM

[0062] Referring to Figure 4, the operation of the expansion mechanism (60) is described. When high pressure refrigerant in a supercritical state flows into the expansion chamber (65) of the expansion mechanism (60), the shaft (45) rotates counterclockwise in Figure 4. Figure 4 illustrates operating states of the expansion mechanism (60) for every 45-degree rotational angle of the shaft (45).

[0063] When the angle of rotation of the shaft (45) is 0 degrees, the terminal end of the inflow port (32) is closed by the end surface of the eccentric part (47). At this time, the expansion chamber (65) is blocked off from fluidly communicating with the inflow port (32), and, as a result, no high pressure refrigerant will flow into the expansion chamber (65).

[0064] When the angle of rotation of the shaft (45) is 45 degrees, the inflow port (32) is placed in the state of fluid communication with the interconnecting passageway (9b). In addition, the interconnecting passageway (9b) is also in fluid communication with the groove-like passageway (9a). The upper end of the groove-like passageway (9a) in Figure 4 is placed in the state of deviation from the end surface of the rotary piston (67), and comes into fluid communication with the high pressure side of the expansion chamber (65). At this time, the expansion chamber (65) is placed in the state of fluid communication, through the groove-like passageway (9a) and the interconnecting passageway (9b), with the inflow port (32), and high pressure refrigerant flows into the high pressure side of the expansion chamber (65). That is, the inflow of high pressure refrigerant into the expansion chamber (65) is commenced during the time period from 0 degrees to 45 degrees of the angle of rotation of the shaft (45).

[0065] When the angle of rotation of the shaft (45) is 90 degrees, the expansion chamber (65) still remains in the state of fluid communication, through the groove-like passageway (9a) and the interconnecting passageway (9b), with the inflow port (32). Therefore, high pressure refrigerant keeps flowing into the high pressure side of the expansion chamber (65) during the time period from

45 degrees to 90 degrees of the angle of rotation of the shaft (45).

[0066] When the angle of rotation of the shaft (45) is 135 degrees, the interconnecting passageway (9b) is placed in the state of deviation from both the groove-like passageway (9a) and the inflow port (32). At this time, the expansion chamber (65) is placed in the state of being blocked off from the inflow port (32) and, as a result, no high pressure refrigerant will flow into the expansion chamber (65). In other words, the inflow of high pressure refrigerant into the expansion chamber (65) is terminated during the time period from 90 degrees to 135 degrees of the angle of rotation of the shaft (45).

[0067] Upon such termination of the inflow of high pressure refrigerant into the expansion chamber (65), the high pressure side of the expansion chamber (65) becomes a closed space and the refrigerant therein expands. Stated another way, the shaft (45) rotates and the volume of the high pressure side of the expansion chamber (65) increases, as shown in Figure 4. During that time period, low pressure refrigerant after expansion is continuously discharged through the outflow port (33) from the low pressure side of the expansion chamber (65) in fluid communication with the outflow port (33).

[0068] The refrigerant in the expansion chamber (65) keeps expanding until the contact part between the rotary piston (67) and the cylinder (63) reaches the outflow port (33) during the time period from 135 degrees to 360 degrees of the angle of rotation of the shaft (45). And, when the contact part between the rotary piston (67) and the cylinder (63) is passing transversely across the outflow port (33), the expansion chamber (65) comes into fluid communication with the outflow port (33) and the discharge of expanded refrigerant starts. Thereafter, when the contact part between the rotary piston (67) and the cylinder (63) has passed through the outflow port (33), the expansion chamber (65) is blocked off from the outflow port (33) and the discharge of expanded refrigerant stops.

[0069] As described above, the suction and the discharge of the refrigerant in the positive displacement expansion mechanism (60) are determined by the angle of rotation of the shaft (45). Therefore, the suction flow rate and the discharge flow rate of the refrigerant in the expansion mechanism (60) become intermittent through the cycle. Accordingly, in the inflow and outflow ports (32, 33) of the expansion mechanism (60), both the suction refrigerant and the discharge refrigerant undergo variations in pressure, i.e., pressure pulsation. These variations in pressure cause the entire equipment to vibrate. Furthermore, since in the outflow port (33) of the expansion mechanism (60) the liquid after expansion is in a gas/liquid two-phase state, this also causes vibrations when refrigerant droplets impinge upon the internal wall of the piping line. In this way, the magnitude of vibration generated at the outlet side of the expansion mechanism (60) is greater than the magnitude of vibration generated at the inlet side.

[0070] The function of the pressure buffer means (70) will be therefore described. When the variation in pressure of the discharge refrigerant occurs, the buffer container (71) performs pressure supply and absorption.

[0071] For example, if the flow rate of the discharge refrigerant in the outflow port (33) decreases to cause a drop in refrigerant pressure, a larger amount of refrigerant than usual flows out to the connection pipe (P) from the buffer container (71). This controls the drop in pressure of the refrigerant in the connection pipe (P). In addition, if the flow rate of the discharge refrigerant in the outflow port (33) increases to cause a rise in refrigerant pressure, this increased amount of refrigerant of the refrigerant which has flowed into the buffer container (71) is stored "as is" in the buffer container (71) while the rest of the refrigerant flows out to the connection pipe (P). This controls the rise in pressure of the refrigerant in the connection pipe (P). In other words, the buffer container (71) is configured to perform refrigerant discharge and absorption in response to the variation in pressure in the outflow port (33) so that the refrigerant flow rate in the connection pipe (P) is always kept constant.

[0072] In addition, the refrigerant which has flowed into the buffer container (71) from the outflow port (33) passes through the mesh part (75a) of the flow stabilizing plate (75), and the flow of the refrigerant is stabilized. Accordingly, refrigerant droplets will not violently impinge upon the wall of the piping line. Furthermore, refrigerant droplets are made fine in size when passing through the mesh part (75a), and even when refrigerant droplets impinge upon the wall of the piping line, its impact is small.

[0073] The above shows that, as shown in Figure 5 (A), the variation in pressure of the refrigerant in the outlet side piping line of the expansion mechanism (60) becomes more reduced when compared to the conventional technology without provision of the buffer container (71) (see Figure 11(A)). Furthermore, Figure 5(B) shows that the vibration in the outlet side piping line of the expansion mechanism (60) totally becomes more reduced when compared to the conventional case (see Figure 11 (B)) because it has no portion of high vibration amplitude.

ADVANTAGEOUS EFFECTS OF FIRST EMBODIMENT

[0074] As described above, in accordance with the first embodiment, it is arranged such that the buffer container (71), whose flow path for refrigerant flow has a greater transverse cross sectional area than that of the outflow port (33) of the expansion mechanism (60), is disposed along the outlet side piping line of the expansion mechanism (60). As a result of such arrangement, it becomes possible to ensure control of the variation in pressure of the discharge refrigerant of the expansion mechanism (60), thereby making it possible to control the vibration of the entire equipment resulting from such pressure variation.

[0075] Furthermore, it is arranged such that the buffer

container (71) is provided with the mesh-like flow stabilizing plate (75). As a result of such arrangement, it becomes possible to not only stabilize the flow of the refrigerant which has flowed into the buffer container (71), but also to miniaturize the refrigerant droplets contained in the refrigerant. This makes it possible to control violent impingement of the refrigerant droplets upon the wall of the piping line. Even when the refrigerant droplets impinge upon the wall of the piping line, its impact can be reduced because they are small in size. Accordingly, it becomes possible to control vibration caused by impingement of liquid refrigerant upon the wall of the piping line or the like and, in cooperation with the aforesaid effects, the vibration of the entire equipment can be controlled to a further extent. This therefore eliminates the possibility of damage to the equipment.

[0076] In addition, the variation in pressure of the discharge refrigerant in the expansion mechanism (60) is controlled. Therefore, the discharge pressure loss is controlled; the drop in efficiency of the positive displacement expansion mechanism (60) is prevented; and noise resulting from an abrupt variation in pressure is prevented.

[0077] Additionally, it is arranged such that the buffer container (71) is shaped like a tube extending along the refrigerant flow. This arrangement makes it possible to reduce the resistance of flow of the refrigerant to a further extent, for example, when compared to the case where the buffer container (71) is formed into a shape extending in a direction perpendicular to the refrigerant flow. This therefore makes it possible to control the drop in operating efficiency caused by provision of the buffer container (71).

[0078] In addition, the refrigerant circuit (20) uses carbon dioxide as a refrigerant, thereby making it possible to provide earth-conscious types of apparatus. Especially, for the case of use of carbon dioxide, it is compressed up to critical state, thereby allowing the variation in refrigerant pressure to increase correspondingly. Nevertheless, this variation in pressure is assuredly and effectively reduced.

VARIATION OF FIRST EMBODIMENT

[0079] With reference to Figure 6, a variation of the first embodiment is described. This variation differs in configuration of the flow stabilizing plate (75) of the buffer container (71) from the first embodiment. In other words, instead of employing the flow stabilizing plate (75) of the first embodiment which is a mesh plate, the flow stabilizing plate (75) of the present variation is formed such that it is provided, all over its surface, with small apertures (76a) which are through holes (see Figure 6(B)). Figure 6(B) depicts a cross section taken along line X-X of Figure 6(A).

[0080] In this case, the refrigerant which has flowed into the buffer container (71) passes and flows through the small apertures (76a), whereby the refrigerant flow is stabilized. Furthermore, when the refrigerant passes

through the small apertures (76a), its flow velocity becomes increased and refrigerant droplets are made fine in size by force resulting from the increased flow velocity. Therefore, as in the first embodiment, it becomes possible to control vibration caused by impingement of refrigerant droplets upon the wall of the piping line. Other configurations, operations, and working effects are the same as the first embodiment.

SECOND EMBODIMENT OF THE INVENTION

[0081] Next, a second embodiment of the present invention will be described by making reference to Figure 7.

[0082] Unlike the first embodiment in which the buffer container (71) contains therein the flow stabilizing plate (75), the buffer container (71) of the second embodiment contains therein a partition plate (77). More specifically, the partition plate (77) is shaped like a circular plate and its outside diameter is approximately equal to the inside diameter of the body part (72) of the buffer container (71). A single circular through hole (77a) serving as a refrigerant flow hole is formed centrally in the partition plate (77). The through hole (77a) is formed such that its inside diameter is approximately equal to the inside diameter of the outflow port (33). And, the partition plate (77) is arranged centrally in the inside of the buffer container (71). The inside of the buffer container (71) is divided by the partition plate (77) into an upstream side space on the side of the outflow port (33) and a downstream side space on the side of the connection pipe (P). In other words, the inside of the buffer container (71) is made up of these two pressure buffer spaces.

[0083] In this case, for example, when there is a drop in pressure of the discharge refrigerant of the expansion mechanism (60), the refrigerant flows towards the downstream side space from the upstream side space and flows out into the connection pipe (P) together with the refrigerant in the downstream side space. On the other hand, when there is a rise in pressure of the discharge refrigerant of the expansion mechanism (60), this increased amount of refrigerant flows towards the upstream side space from the outflow port (33) and a part thereof flows towards the downstream side space. To sum up, in the buffer container (71), the variation in pressure of the discharge refrigerant is reduced in two stages. This buffers impact associated with an abrupt variation in pressure. Therefore, it becomes possible to control the vibration of the entire equipment. Other configurations, operations, and working effects are the same as the first embodiment.

[0084] The number of partition plates (77) to be provided is not limited to the above value. For example, a plurality of partition plates (77) may be provided to define a plurality of pressure buffer spaces. For example, as shown in Figure 8, it may be arranged such that three partition plates (77) are provided to define four pressure buffer spaces. In this case, the variation in pressure of the discharge refrigerant of the expansion mechanism

(60) is reduced in four stages. Therefore, the occurrence of vibration can be further controlled.

THIRD EMBODIMENT OF THE INVENTION

[0085] Next, with reference to Figure 9, a third embodiment of the present invention will be described below.

[0086] The buffer container (71) of the third embodiment contains therein a single flow stabilizing plate (75) of the same type as shown in the first embodiment and a single partition plate (77) of the same type as shown in the second embodiment. More specifically, the partition plate (77) and the flow stabilizing plate (75) are arranged in that order from the side of the outflow port (33). In other words, in the buffer container (71), its inside is divided into two pressure buffer spaces of which the downstream one accommodates the flow stabilizing plate (75). This makes it possible to control vibration caused by pressure variation, vibration caused by impingement of refrigerant droplets upon the pipe wall or the like, and vibration caused by impact resulting from an abrupt variation in pressure. The partition plate (77) and the flow stabilizing plate (75) may switch their position with each other. Alternatively, of course, the flow stabilizing plate (76) used in the variation of the first embodiment may be employed as a substitute for the mesh-like flow stabilizing plate (75). Other configurations, operations, and working effects are the same as the first embodiment.

VARIATION OF THIRD EMBODIMENT

[0087] With reference to Figure 10, a variation of the third embodiment is described. Unlike the third embodiment in which the buffer container (71) is used in a horizontally "collapsed" state, the buffer container (71) of the present variation is used in a vertically "raised" state. In other words, unlike the third embodiment in which the refrigerant which has flowed into the buffer container (71) flows in a horizontal direction, the refrigerant flows in an up and down direction in the present variation.

[0088] More specifically, the buffer container (71) is arranged such that its body part (72) extends in an up and down direction. The upper end surface of the body part (72) is closed by the inlet side end part (73) while the lower end surface thereof is closed by the outlet side end part (74). In other words, the buffer container (71) is shaped like a cylindrical container extending in a vertical direction. And the outflow port (33) is connected to the upper side of the body part (72) which is the upper side surface of the buffer container (71). The connection pipe (P) is connected to the center of the outlet side end part (74) which is the bottom side of the buffer container (71).

[0089] In the buffer container (71), the refrigerant which has flowed in from the outflow port (33) flows vertically downwardly. Stated another way, the inflow gas refrigerant, as well as the liquid refrigerant, flows from above to below and is discharged to the connection pipe

(P). This prevents the liquid refrigerant from accumulating in the buffer container (71). The outflow port (35) may be connected to the inlet side end part (73) which is the top surface of the buffer container (71).

OTHER EMBODIMENTS

[0090] For example, the shape of each of the flow stabilizing plates (75, 76) of the foregoing embodiments is not limited to the above shapes. That is to say, the cross sectional shape of each of the flow stabilizing plates (75, 76) may be formed into a circular or polygonal shape having some area that substantially occupies the transverse cross section of the buffer container (71).

[0091] In addition, the number of flow stabilizing plates (75) is not limited to one. Two or more flow stabilizing plates (75) may be arranged adjacently in parallel.

[0092] The shape of the buffer container (71) is not limited to cylindrical shape. In other words, the buffer container (71) may be shaped either like a tube having a rectangular shape (when viewed in cross section) extending along the refrigerant flow direction or like a gradually widening pipe whose refrigerant flow path transverse cross sectional area gradually expands from the inlet to the outlet side.

[0093] It should be noted that the above-described embodiments are essentially preferable exemplifications which are not intended in any sense to limit the scope of the present invention, its application, or its application range.

INDUSTRIAL APPLICABILITY

[0094] As has been described above, the present invention finds its utility in the field of refrigeration apparatuses provided with a refrigerant circuit having a positive displacement expander.

Claims

1. A refrigeration apparatus comprising:

a refrigerant circuit (20), to which a positive displacement expander (60) is connected by piping, for performing a vapor compression refrigeration cycle,

wherein the refrigerant circuit (20) is provided, along an outlet side piping line of the positive displacement expander (60), with a flow path enlarged part (71) whose refrigerant flow path for flow of refrigerant has a greater transverse cross sectional area than that of the outlet side piping line so that the variation in pressure of the refrigerant flowing out of the positive displacement expander (60) is reduced.

2. A refrigeration apparatus comprising:

a refrigerant circuit (20), to which a positive displacement expander (60) is connected by piping, for performing a vapor compression refrigeration cycle,

wherein the refrigerant circuit (20) is provided, along an outlet side piping line of the positive displacement expander (60), with a tubular flow path enlarged part (71) whose refrigerant flow path for flow of refrigerant has a greater transverse cross sectional area than that of the outlet side piping line, the tubular flow path enlarged part (71) extending along the direction of flow of the refrigerant.

3. The refrigeration apparatus of claim 2, wherein the flow path enlarged part (71) is oriented to extend in an up and down direction and connected to the outlet side piping line of the positive displacement expander (60) so that the refrigerant entering from the upper side flows vertically downwardly and is let out from the bottom side.

4. The refrigeration apparatus of either claim 1 or claim 2, wherein the flow path enlarged part (71) contains therein refrigerant flow stabilizing means (75, 76).

5. The refrigeration apparatus of claim 4, wherein the flow stabilizing means (76) is a flow stabilizing plate which is formed into a plate-like shape having a plurality of through holes and which is oriented to face towards the direction of flow of the refrigerant.

6. The refrigeration apparatus of claim 4, wherein the flow stabilizing means (75) is a flow stabilizing plate which is formed by a plate-like mesh member and which is oriented to face towards the direction of flow of the refrigerant.

7. The refrigeration apparatus of either claim 2 or claim 3, wherein the flow path enlarged part (71) contains therein a partition plate (77) which has a through hole and which divides the inside of the flow path enlarged part (71) in the direction of flow of the refrigerant.

8. The refrigeration apparatus of either claim 1 or claim 2, wherein the refrigerant is carbon dioxide.

FIG. 1

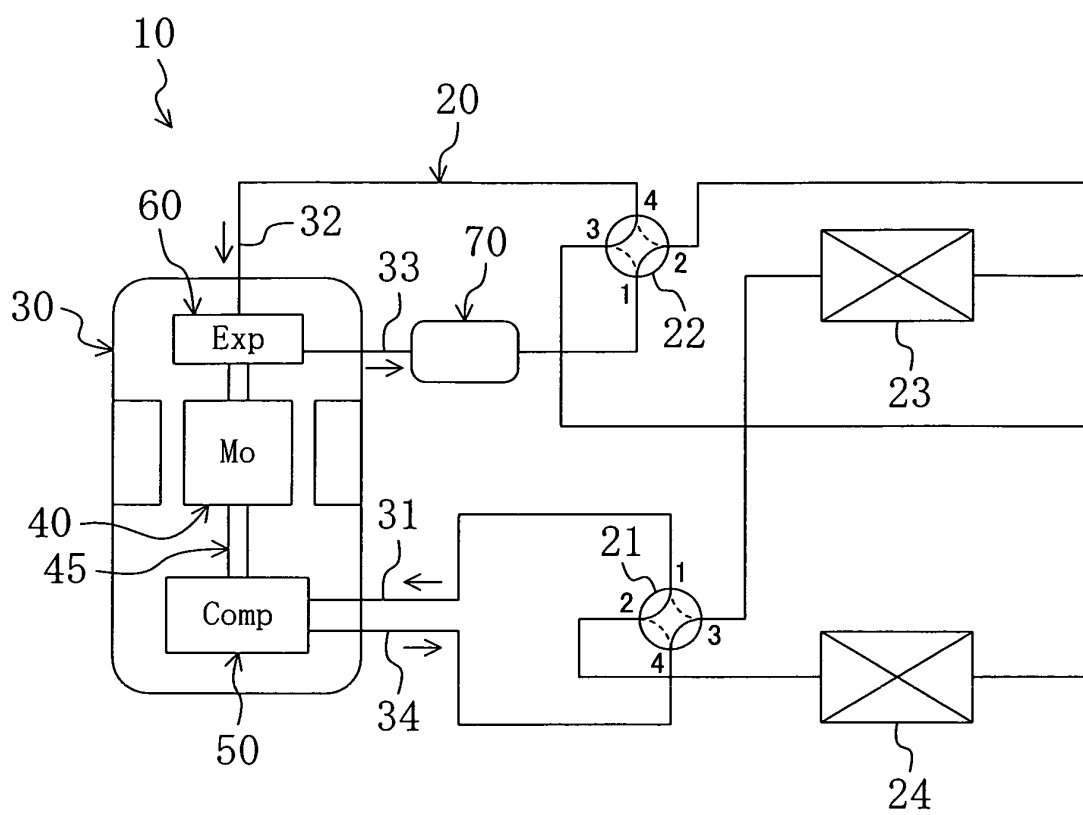


FIG. 2B

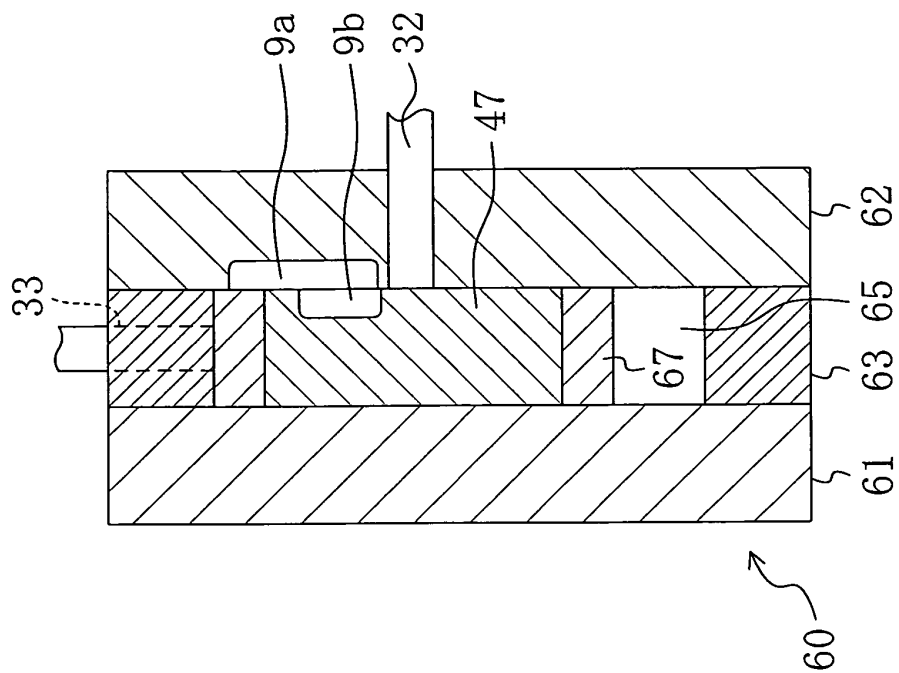


FIG. 2A

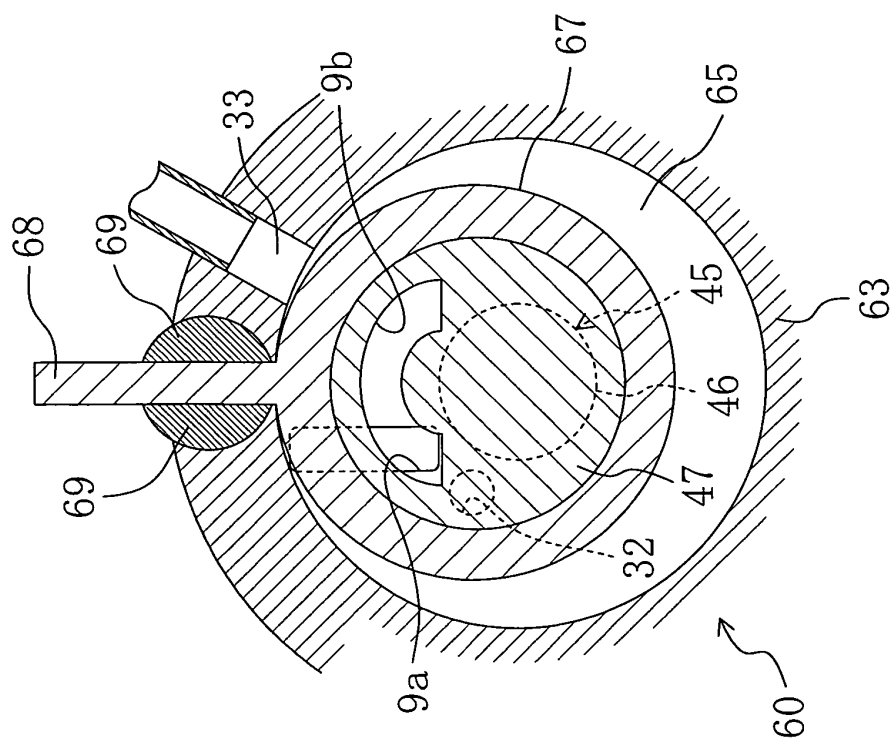


FIG. 3A

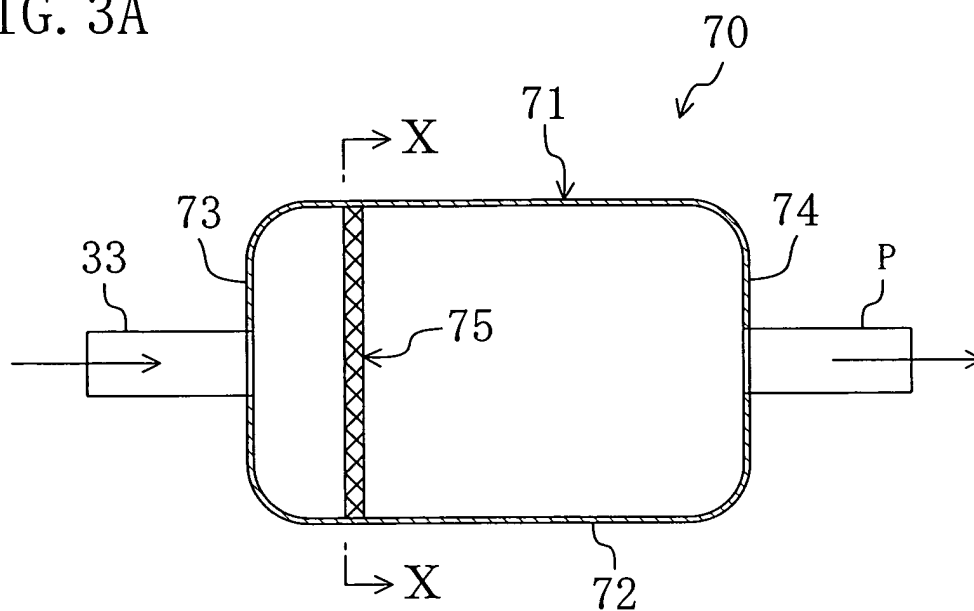


FIG. 3B

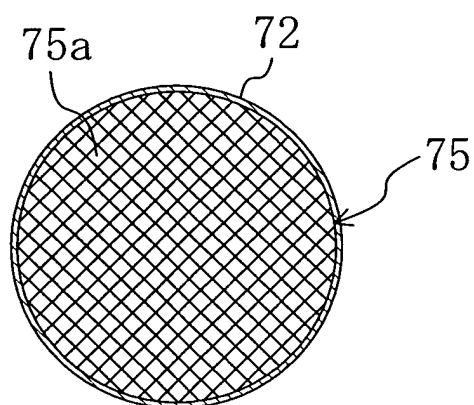


FIG. 4

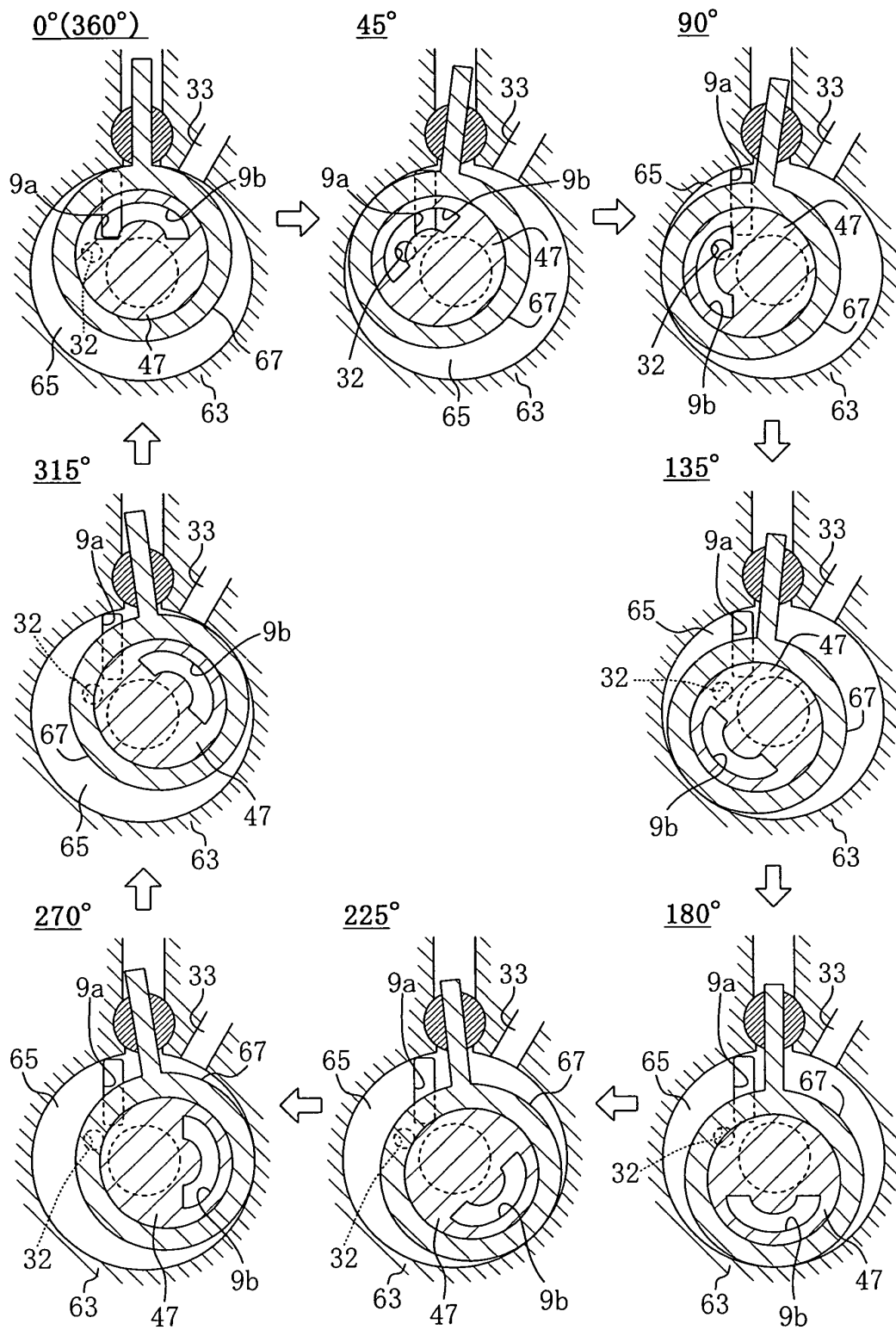


FIG. 5A

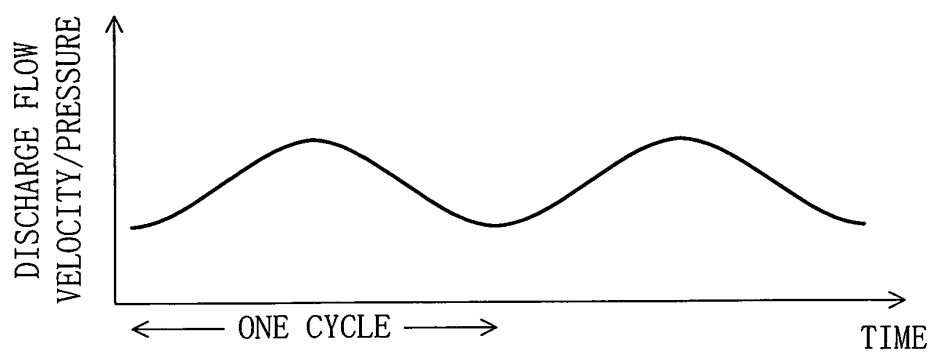


FIG. 5B

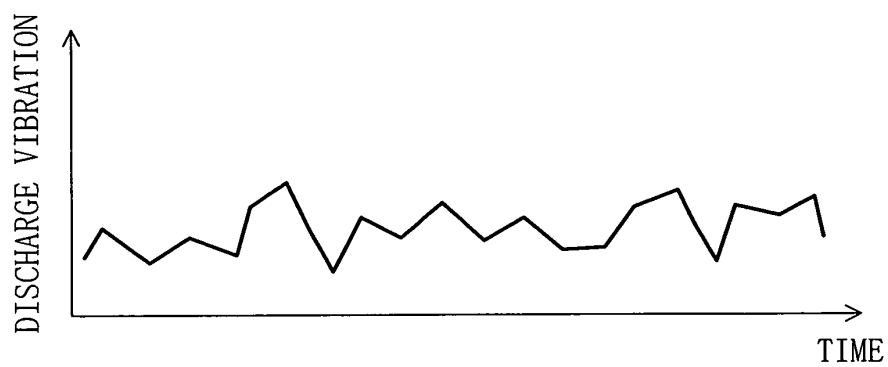


FIG. 6A

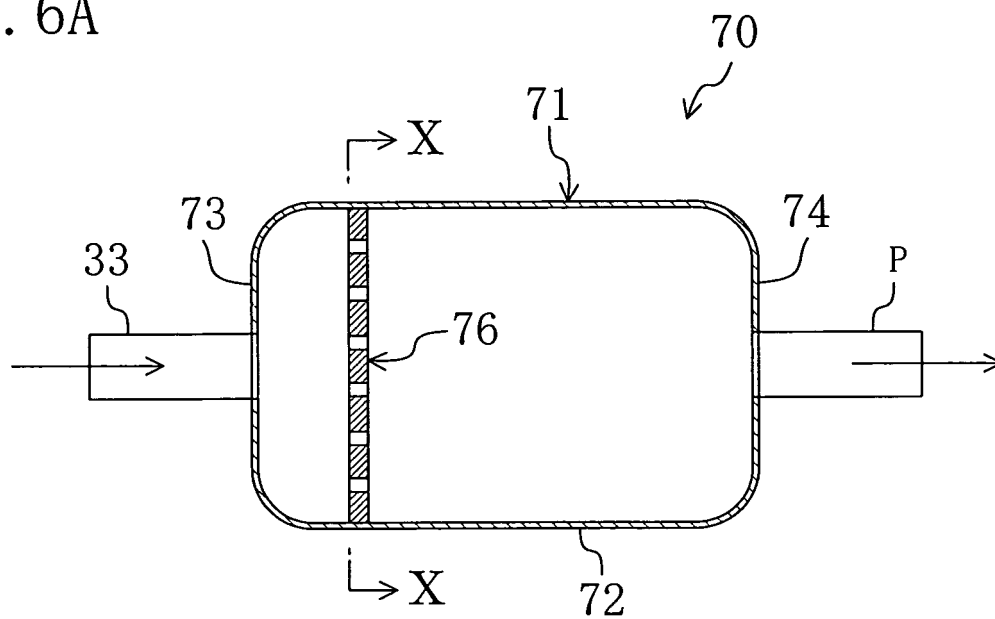


FIG. 6B

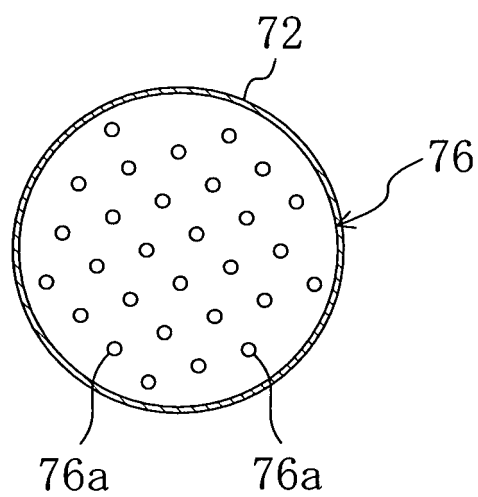


FIG. 7A

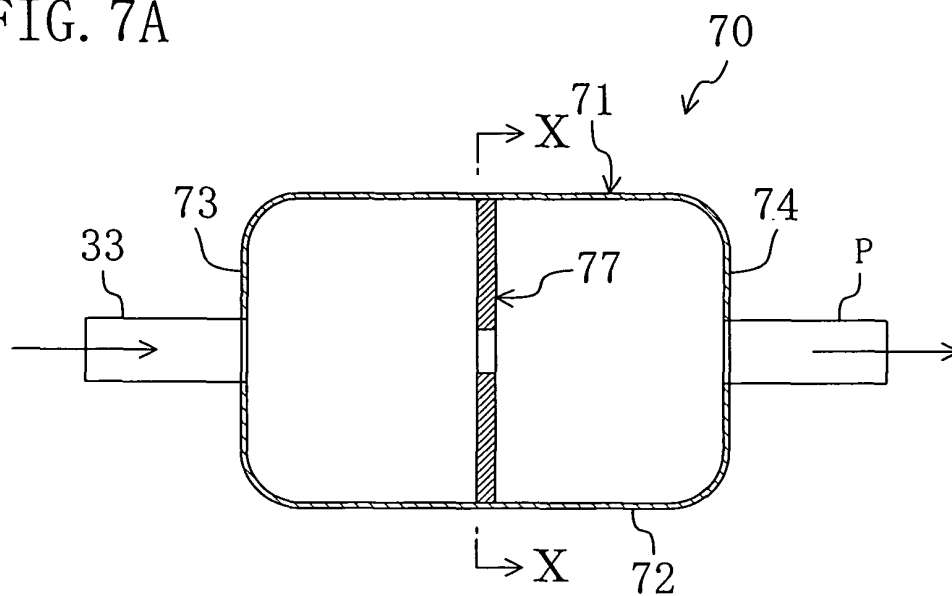


FIG. 7B

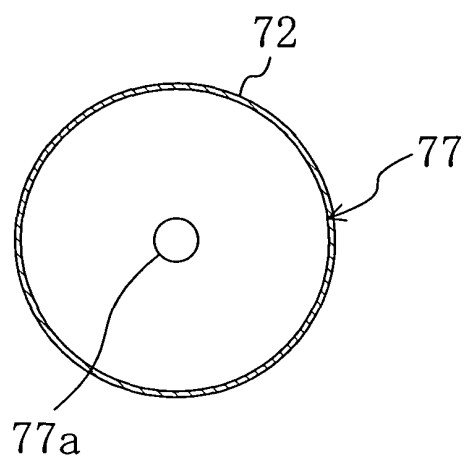


FIG. 8

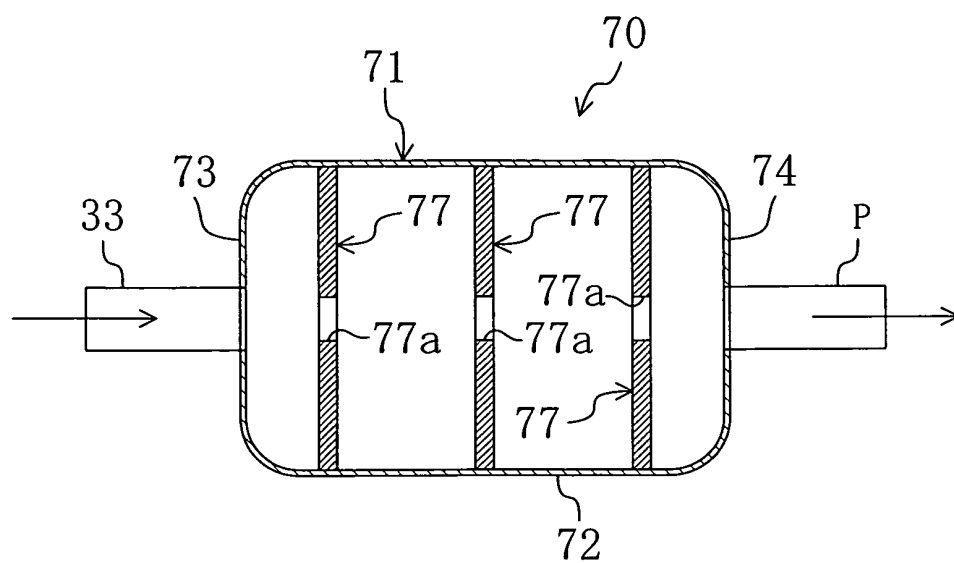


FIG. 9

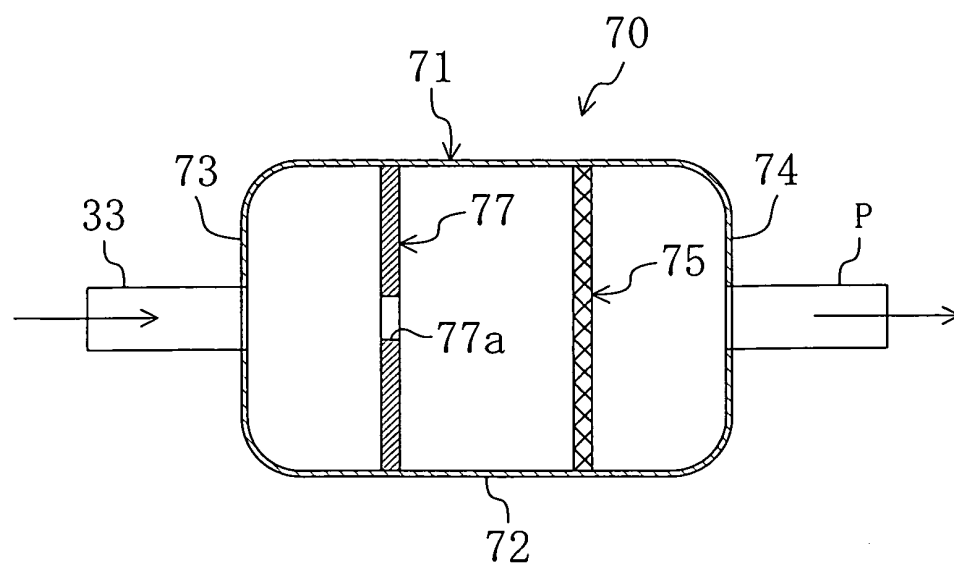


FIG. 10

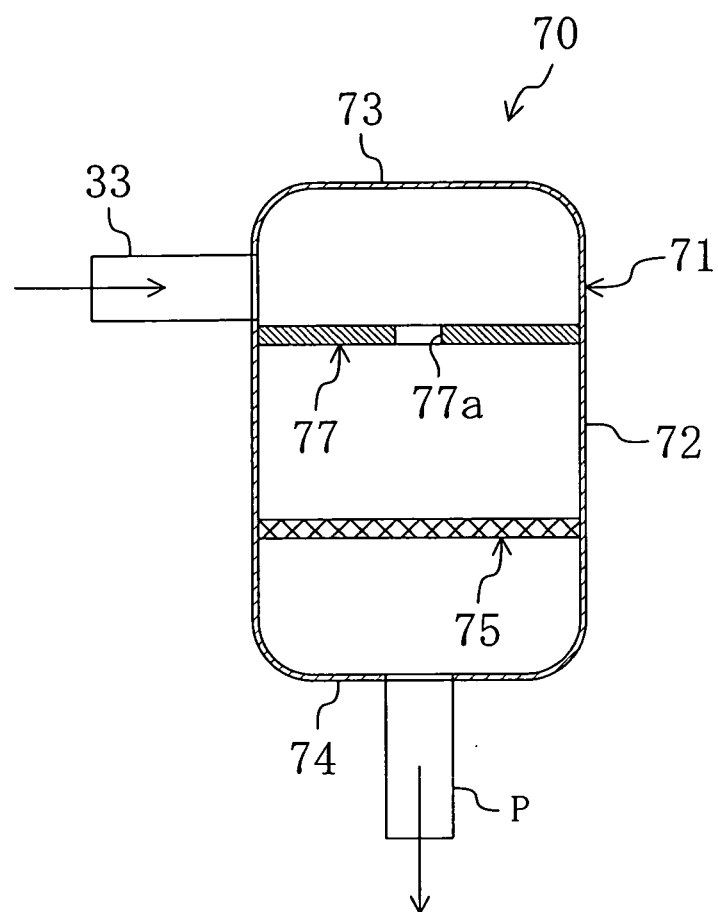


FIG. 11A
PRIOR ART

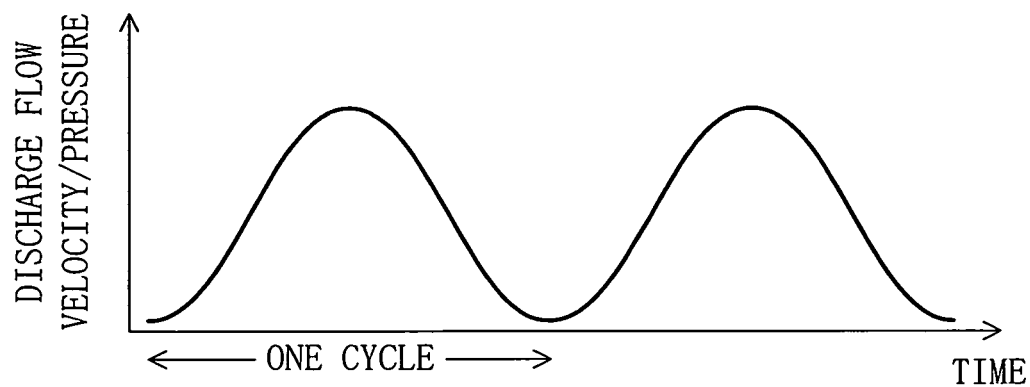
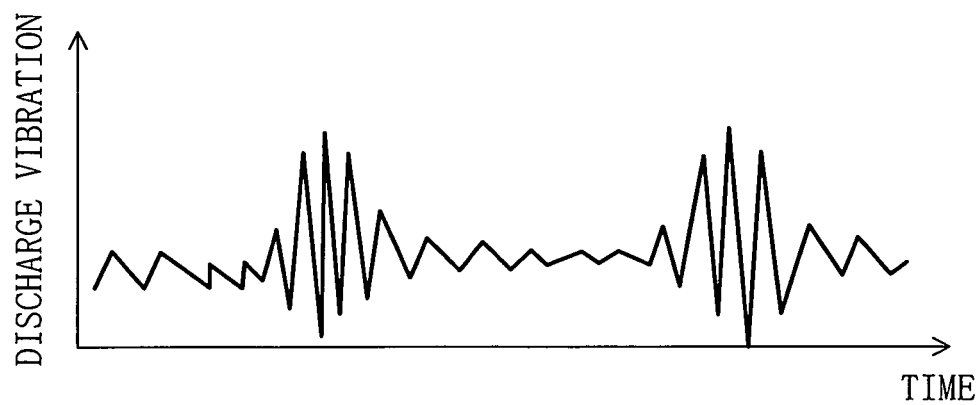


FIG. 11B
PRIOR ART



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/304366

A. CLASSIFICATION OF SUBJECT MATTER		
F25B41/06(2006.01), F25B1/00(2006.01), F25B11/02(2006.01)		
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)		
F25B41/06(2006.01), F25B1/00(2006.01), F25B11/02(2006.01)		
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 1996-2006
Kokai Jitsuyo Shinan Koho	1971-2006	Toroku Jitsuyo Shinan Koho 1994-2006
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 2004-190938 A (Daikin Industries, Ltd.), 08 July, 2004 (08.07.04), Full text; Figs. 1 to 7 (Family: none)	1-8
Y	JP 5-322379 A (Hitachi, Ltd.), 07 December, 1993 (07.12.93), Par. No. [0012]; Fig. 1 (Family: none)	1-8
☒ 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 02 June, 2006 (02.06.06)		Date of mailing of the international search report 13 June, 2006 (13.06.06)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/304366

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 34860/1983 (Laid-open No. 139875/1984) (Matsushita Seiko Co., Ltd.), 18 September, 1984 (18.09.84), Page 3, line 1 to page 6, line 2; Figs. 2 to 4 (Family: none)	3, 6
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 174747/1981 (Laid-open No. 82484/1983) (General Corp.), 03 June, 1983 (03.06.83), Page 2, lines 4 to 17; Fig. 3 (Family: none)	3
Y	JP 9-250844 A (Fujitsu General Ltd.), 22 September, 1997 (22.09.97), Par. Nos. [0019] to [0021]; Fig. 2 (Family: none)	6

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000234814 A [0002]