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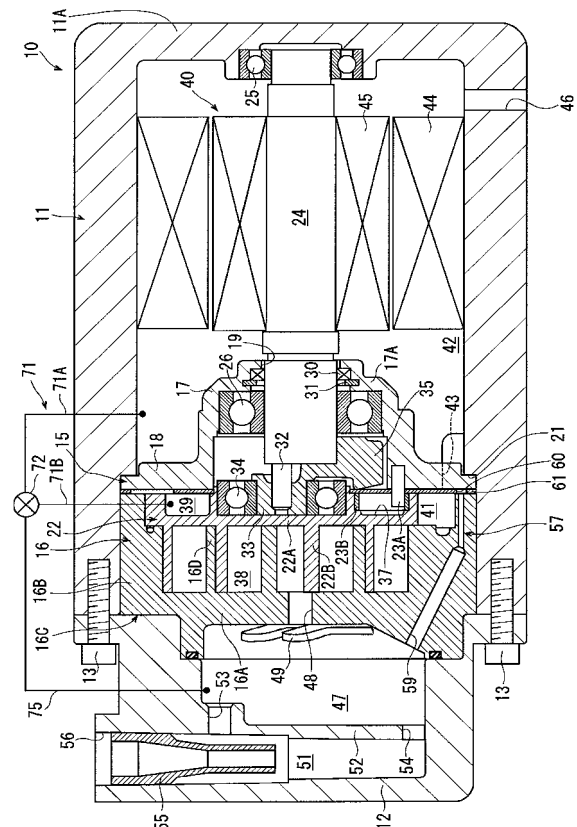
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(54) **Scroll compressor**

(57) A compressor includes a housing (10), a fixed scroll (16), a movable scroll (22) and a control valve (72). The housing (10) has a suction chamber (42), a discharge chamber (47) and a backpressure chamber (39) formed therein. The scrolls are pressed against each other by backpressure in the backpressure chamber (39). The control valve (72) for controlling the backpressure has first (74A), second (74B) and third chambers (74C) arranged in this order. The first, second and third chambers are connected to the discharge chamber (47), the backpressure chamber (39) and the suction chamber (42), respectively. The control valve (72) has a valve member (76). The valve member (76) has a first pressure-receiving surface (S1) located in the first chamber (74A), a second pressure-receiving surface (S2) located in the second chamber (74B) and a third pressure-receiving surface (S3) located in the third chamber (74C). The area of the third pressure-receiving surface (S3) is larger than the area of the first pressure-receiving surface (S1) and larger than the area of the second pressure-receiving surface (S2).

FIG. 1



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a scroll compressor.

[0002] A conventional scroll compressor is disclosed in Japanese Unexamined Patent Application Publication No. 57-76291. The compressor has a housing, a fixed scroll and a movable scroll that cooperate to form a suction chamber, a compression chamber, a discharge chamber and a backpressure chamber. In the compressor, the movable scroll is pressed against the fixed scroll by backpressure in the backpressure chamber.

[0003] More specifically, high pressure such as discharge pressure in the discharge chamber is introduced into the backpressure chamber through a fixed throttle, and an adjusting valve is provided between the backpressure chamber and the suction chamber. The adjusting valve has a valve chamber connected to the backpressure chamber through a backpressure passage and connected to the suction chamber through a low-pressure passage. The adjusting valve has a ball-shaped valve member provided in the valve chamber and urged so as to close the backpressure passage.

[0004] In such adjusting valve, the valve member is operated by pressure difference between the backpressure in the backpressure chamber and the suction pressure in the suction chamber so as to adjust the backpressure. The movable scroll is pressed against the fixed scroll by load that is based on the backpressure. The backpressure needs to be controlled appropriately by the adjusting valve in order to reduce power loss and prevent poor compression.

[0005] In the above compressor, however, the suction pressure and the backpressure applied to the valve member of the adjusting valve are relatively low, which makes it difficult to control the backpressure appropriately.

[0006] In scroll compressors, generally, it is preferable that backpressure P_b (load) is increased as discharge pressure P_d is increased, in order to reduce power loss and prevent poor compression, as shown in Fig. 8. However, if the fixed throttle and the adjusting valve are adjusted in the above compressor so as to prevent poor compression in a condition where the discharge pressure is high, the backpressure (load) becomes too high in a condition where the discharge pressure is low, which results in power loss as indicated by hatching in Fig. 8. Thus, in the above compressor, it is difficult to control the backpressure appropriately in various operating conditions of the compressor, which may cause power loss and poor compression.

[0007] Further, in the above compressor, the discharge pressure is introduced through the fixed throttle into the backpressure chamber. In this case, if the inner diameter of the fixed throttle is large, compression efficiency of the compressor may be reduced. On the other hand, if the inner diameter of the fixed scroll is small, it

may be difficult to design the arrangement of the fixed throttle.

[0008] Japanese Unexamined Patent Application Publication No. 11-132165 discloses a control valve for controlling the backpressure. The control valve has a valve member to which not only the backpressure and the suction pressure but also the discharge pressure are applied. In this case, the backpressure is appropriately controlled, as compared to the above compressor using the fixed throttle and the adjusting valve. Further, the backpressure P_b (load) is appropriately controlled depending on the discharge pressure P_d , which allows reduction of power loss and prevents poor compression in various operating conditions of the compressor.

[0009] In the case where the backpressure, the suction pressure and the discharge pressure are applied to the valve member, however, when the amount of backpressure applied to the valve member is large, the backpressure, which is to be controlled, greatly affects the control of the backpressure itself, so that the movement of the valve member may become unstable. For example, if the valve member is moved by high backpressure so that the backpressure chamber is connected to the suction chamber, the backpressure is decreased quickly, so that the valve member in turn is moved in opposite direction. Thus, the movement of the valve member becomes unstable, which makes it difficult to control the control valve appropriately.

[0010] Further, if the amount of discharge pressure applied to the valve member is large, the valve member becomes difficult to move easily as the suction pressure is decreased. In this case, power loss is increased in a condition where the suction pressure is low and the discharge pressure is high.

[0011] The present invention is directed to providing a scroll compressor that allows a backpressure control valve to be controlled appropriately thereby to reduce power loss and prevent poor compression in various operating conditions of the compressor.

SUMMARY OF THE INVENTION

[0012] In accordance with an aspect of the present invention, a scroll compressor includes a housing, a fixed scroll, a movable scroll and a control valve. The housing has a suction chamber, a discharge chamber and a backpressure chamber formed therein. The fixed scroll is accommodated in the housing. The movable scroll is accommodated in the housing. The movable scroll cooperates with the fixed scroll to form therebetween a compression chamber. The movable scroll and the fixed scroll are pressed against each other by backpressure in the backpressure chamber. The control valve is provided for controlling the backpressure in the backpressure chamber by communication with the suction chamber, the discharge chamber or the compression chamber. The control valve has a first chamber, a second chamber and a third chamber arranged in this order. The first chamber

is connected to the discharge chamber or the compression chamber, the second chamber is connected to the backpressure chamber, and the third chamber is connected to the suction chamber. The control valve has a valve member. The valve member has a first pressure-receiving surface located in the first chamber, a second pressure-receiving surface located in the second chamber and a third pressure-receiving surface located in the third chamber. The area of the third pressure-receiving surface is larger than the area of the first pressure-receiving surface and larger than the area of the second pressure-receiving surface.

[0013] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is a longitudinal sectional view of a scroll compressor according to a first embodiment of the present invention;

Fig. 2 is a schematic block diagram of the compressor of Fig. 1;

Fig. 3 is a sectional view of a control valve of the compressor of Fig. 1;

Fig. 4 is a schematic view showing pressure-receiving surfaces of a valve member of the control valve of Fig. 3;

Fig. 5 is a schematic block diagram of a scroll compressor according to a second embodiment of the present invention;

Fig. 6 is a sectional view of the second embodiment of the control valve;

Fig. 7 is a schematic view showing pressure-receiving surfaces of a valve member of the control valve of Fig. 6;

Fig. 8 is a graph showing a characteristic of a conventional compressor and a calculated ideal value; and

Fig. 9 is a graph showing a characteristic of the compressor according to the embodiments of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] The following will describe the embodiments of

the present invention with reference to the accompanying drawings.

[0016] Fig. 1 shows a scroll compressor according to the first embodiment of the present invention. It is noted that the right-hand side and the left-hand side as viewed in Fig. 1 are the front side and the rear side of the scroll compressor, respectively, and that the upper and lower sides as viewed in Fig. 1 are the upper and lower sides of the scroll compressor when installed in place, respectively. The scroll compressor (hereinafter referred to as compressor) is used, for example, in a vehicle air conditioner. The compressor has a cylindrical front housing 11 the opening of which is covered by a rear housing 12. The front housing 11 and the rear housing 12 form a housing assembly 10 (housing) of the compressor. The housing assembly 10 accommodates therein a shaft support 15, a fixed scroll 16 and a movable scroll 22. The fixed scroll 16 is located behind the shaft support 15. The front housing 11 and the rear housing 12 are connected to each other by using bolts 13 while keeping the shaft support 15 in contact with the fixed scroll 16. The compressor has a suction chamber 42 formed between the front housing 11 and the shaft support 15 and a discharge chamber 47 formed between the fixed scroll 16 and the rear housing 12.

[0017] The shaft support 15 has a cylindrical base 17 and a flange 18 that projecting radially outward from the rear end of the base 17. The base 17 has an end wall 17A through which a shaft hole 19 is formed. The flange 18 is engaged with a step 21 that is formed in the inner peripheral surface of the front housing 11. The shaft support 15 has a pin 23A fixed to the rear end thereof for preventing the rotation of the movable scroll 22 on its own axis.

[0018] The compressor has a rotary shaft 24 extending in the front housing 11 in longitudinal direction of the compressor. The front end of the rotary shaft 24 is rotatably supported by a bearing 25 that is mounted on the middle of the end wall 11A of the front housing 11. The rear end of the rotary shaft 24 is rotatably supported by a bearing 26 that is mounted in the base 17 of the shaft support 15. The gap between the shaft support 15 and the rotary shaft 24 is sealed by a seal member 30 that is retained on the shaft support 15 by a circlip 31.

[0019] The rotary shaft 24 has at the rear end thereof an eccentric pin 32 that is eccentric to the axis of the rotary shaft 24. The eccentric pin 32 is fitted into a cylindrical bush 33. The bush 33 has a sector-shaped balance weight 35 formed in the half of the circumference thereof. The balance weight 35 serves to cancel the centrifugal force caused by the rotation of the movable scroll 22.

[0020] The fixed scroll 16 has a cylindrical base 16C and a scroll wall 16D. The base 16C is formed by an end wall 16A and a side wall 16B. The scroll wall 16D is located radially inward of the side wall 16B and projects forward from the end wall 16A.

[0021] The movable scroll 22 is located between the fixed scroll 16 and the shaft support 15 and coupled to

the bush 33 through a bearing 34. The movable scroll 22 has a circular base plate 22A and a scroll wall 22B that projects rearward from the base plate 22A.

[0022] The fixed scroll 16 and the movable scroll 22 are engaged with each other so that the end of the scroll wall 16D slides on the base plate 22A and the end of the scroll wall 22B slides on the end wall 16A of the base 16C. The base plate 22A of the movable scroll 22 is formed with a recess 37 into which a ring 23B is loosely fitted for receiving the pin 23A on the shaft support 15. The pin 23A slides and rolls on the inner peripheral surface of the ring 23B.

[0023] The fixed scroll 16 cooperates with the movable scroll 22 to form therebetween a compression chamber 38 that is defined by the scroll walls 16D and 22B. The base plate 22A of the movable scroll 22 cooperates with the shaft support 15 to form therebetween a backpressure chamber 39 that faces the rear end of the rotary shaft 24. Further, the compressor has a suction region 41 that is defined by the shaft support 15, the side wall 16B of the fixed scroll 16 and the radially outermost portion of the movable scroll 22.

[0024] The suction chamber 42 communicates with the suction region 41 through a suction passage 43 that is formed in the lower portion of the front housing 11. In the suction chamber 42, a stator 44 is fixedly mounted on the inner peripheral surface of the front housing 11, and a rotor 45 is fixed to the rotary shaft 24 at a position radially inward of the stator 44. The rotor 45, the stator 44 and the rotary shaft 24 constitute a motor mechanism 40 that allows the rotary shaft 24 to rotate integrally with the rotor 45 when the stator 44 is energized.

[0025] The side wall of the front housing 11 has an inlet port 46 formed therethrough. Although not shown, the inlet port 46 is connected via a pipe to an evaporator that is connected to an expansion valve and a condenser via a pipe. The compressor, the evaporator, the expansion valve and the condenser constitute a refrigeration circuit of a vehicle air conditioner. Low-pressure and low-temperature refrigerant gas in the refrigeration circuit is introduced from the inlet port 46 through the suction chamber 42 and the suction passage 43 into the suction region 41.

[0026] The discharge chamber 47 is formed between the base 16C of the fixed scroll 16 and the rear housing 12. The base 16C has a discharge port 48 through which the compression chamber 38 communicates with the discharge chamber 47. The discharge port 48 is normally closed by a discharge valve (not shown) the opening of which is restricted by a retainer 49 mounted to the rear end of the base 16C.

[0027] The rear housing 12 is formed with an oil separation chamber 51 that extends vertically behind the discharge chamber 47. The oil separation chamber 51 is separated from the discharge chamber 47 by a partition wall 52. The partition wall 52 is formed therethrough with a discharge hole 53 through which the oil separation chamber 51 communicates with the discharge chamber

47. In the oil separation chamber 51, an oil separator 55 is provided for separating lubricating oil contained in refrigerant gas. The oil separator 55 is of a generally cylindrical shape and fitted into the upper portion of the oil separation chamber 51. When refrigerant gas is introduced from the discharge chamber 47 through the discharge hole 53 into the oil separation chamber 51, lubricating oil contained in the refrigerant gas is separated by centrifugal force by the oil separator 55. The separated oil is dropped into the bottom of the oil separation chamber 51 and stored therein. The part of the oil separation chamber 51 located above the oil separator 55 forms an outlet port 56 that is connected through a pipe to the condenser of the refrigeration circuit.

[0028] The lower portions of the oil separation chamber 51 and the discharge chamber 47 are connected through an oil hole 54. The lower portion of the discharge chamber 47 is also connected to the backpressure chamber 39 through a supply passage 57. The supply passage 57 is formed by a communication hole 59 and a circular slit 60. The communication hole 59 extends through the side wall 16B of the fixed scroll 16. The slit 60 is formed in a plate 61 that is interposed between the shaft support 15 and the movable scroll 22, so as to extend to the backpressure chamber 39. The slit 60 serves as a fixed throttle for throttling the supply passage 57 at a position upstream of the backpressure chamber 39 as viewed in flowing direction of refrigerant gas. The communication hole 59 is located upstream of the slit 60. High-pressure refrigerant gas in the discharge chamber 47, which contains lubricating oil, is delivered through the supply passage 57 into the backpressure chamber 39 (see Fig. 2).

[0029] Referring to Figs. 1 and 2, the backpressure chamber 39 is connected to the suction chamber 42 through a bleed passage 71 that is provided with a backpressure control valve 72 (hereinafter referred to as control valve). The bleed passage 71 is formed by a low-pressure passage 71A and a backpressure passage 71B. The low-pressure passage 71A connects the suction chamber 42 to the control valve 72. The backpressure passage 71 B connects the control valve 72 to the backpressure chamber 39.

[0030] Referring to Fig. 3, the control valve 72 has a case 73 that cooperates with the front housing 11 to form a valve chamber 74. The valve chamber 74 includes a first chamber 74A connected to the discharge chamber 47 through a high-pressure passage 75, a second chamber 74B connected to the backpressure chamber 39 through the backpressure passage 71 B, and a third chamber 74C connected to the suction chamber 42 through the low-pressure passage 71A. The first, second and third chambers 74A, 74B and 74C are arranged in this order as viewed from the bottom of Fig. 3. The valve chamber 74 may be formed by any suitable member other than the front housing 11 and the case 73. The control valve 72 has O-rings 78A and 78B provided between the front housing 11 and the case 73.

[0031] The control valve 72 has a valve member 76

accommodated in the valve chamber 74 so as to move up and down. The valve member 76 includes a tapered portion 76A tapered downward and a cylindrical portion 76B arranged coaxially with the tapered portion 76A. The cylindrical portion 76B is formed integrally with the tapered portion 76A and extends downward from the lower end of the tapered portion 76A. The tapered portion 76A is tapered to the second chamber 74B. The tapered portion 76A has a spring seat 76C formed in the upper surface thereof for retaining a spring 77.

[0032] The valve member 76 has a first pressure-receiving surface S1 located in the first chamber 74A, a second pressure-receiving surface S2 located in the second chamber 74B and a third pressure-receiving surface S3 located in the third chamber 74C. The area of the first pressure-receiving surface S1 corresponds to the area of the lower surface of the cylindrical portion 76B. In a condition that almost all tapered portion 76A is located in the second chamber 74B, the area of the third pressure-receiving surface S3 corresponds to the cross-sectional area of the large end of the tapered portion 76A. The area of the second pressure-receiving surface S2 corresponds to the difference between the cross-sectional area of the large end of the tapered portion 76A and the cross-sectional area of the cylindrical portion 76B, that is, the difference between the areas of the first and third pressure-receiving surfaces S1 and S3. This relation could be slightly changed depending on the relative position of the tapered portion 76A and the second and third chambers 74B and 74C. As shown in Fig. 4, the area of the third pressure-receiving surface S3 is larger than the area of the first pressure-receiving surface S1 and also larger than the area of the second pressure-receiving surface S2. The area of the third pressure-receiving surface S3 is the sum of the areas of the first and second pressure-receiving surfaces S1 and S2. In the valve member 76, the lower surface of the cylindrical portion 76B located in the first chamber 74A forms the first pressure-receiving surface S1, the upper surface of the tapered portion 76A located in the third chamber 74C forms the third pressure-receiving surface S3, and the tapered surface of the tapered portion 76A located in the second chamber 74B forms the second pressure-receiving surface S2. The area of the second pressure-receiving surface S2 corresponds to the area of the tapered portion 76A located in the second chamber 74B in axial direction of the valve member 76.

[0033] Referring to Fig. 3, the tapered portion 76A of the valve member 76 is located across the third chamber 74C and the second chamber 74B. The cylindrical portion 76B of the valve member 76 is slidably fitted in the first chamber 74A so that the first chamber 74A is hermetically sealed from the second chamber 74B. The control valve 72 has a valve seat 74D provided between the third chamber 74C and the second chamber 74B. The valve seat 74D is associated with the tapered portion 76A of the valve member 76.

[0034] The third chamber 74C is connected to the suc-

tion chamber 42 through the low-pressure passage 71A. The lower portion of the second chamber 74B is connected to the backpressure chamber 39 through the backpressure passage 71 B. The valve seat 74D faces the tapered portion 76A of the valve member 76. The valve seat 74D has an inner diameter that is slightly larger than the diameter of the large end of the tapered portion 76A. The tapered portion 76A is slidable in the second chamber 74B so that the second chamber 74B is hermetically sealed from the third chamber 74C. The O-ring 78A is provided between the low-pressure passage 71A and the backpressure passage 71 B.

[0035] The lower portion of the first chamber 74A is connected to the discharge chamber 47 through the high-pressure passage 75. The O-ring 78B is provided between the high-pressure passage 75 and the backpressure passage 71 B. The spring 77 is interposed between the valve seat 76C of the valve member 76 and the inner surface of the case 73 so as to urge the tapered portion 76A toward the valve seat 74D.

[0036] In the above-described compressor, when the rotary shaft 24 of the motor mechanism 40 is rotated, the eccentric pin 32 of the rotary shaft 24 is rotated around the axis of the rotary shaft 24. The movable scroll 22 coupled to the eccentric pin 32 is rotated around the axis of the rotary shaft 24 with the rotation on its own axis restricted by sliding and rolling movement of the pin 23A on the inner peripheral surface of the ring 23B. The volume of the compression chamber 38 between the scroll walls 16D and 22B of the fixed and movable scrolls 16 and 22 is varied with the rotation of the movable scroll 22, and refrigerant gas is introduced from the evaporator through the inlet port 46, the suction chamber 42 and the suction passage 43 into the suction region 41. The refrigerant gas is then introduced into the compression chamber 38 and compressed therein. When the pressure of the refrigerant gas is increased to a predetermined discharge pressure, the refrigerant gas is discharged through the discharge port 48 into the discharge chamber 47. The refrigerant gas is delivered through the discharge hole 53 into the oil separation chamber 51 where lubricating oil contained in the refrigerant gas is separated. The refrigerant gas from which the lubricating oil has been separated is delivered through the oil separator 55 and the outlet port 56 into the condenser. The vehicle air conditioner is thus operated.

[0037] Lubricating oil separated from the refrigerant gas is dropped from the oil separator 55 into the bottom of the oil separation chamber 51 and stored therein. The lubricating oil stored in the oil separation chamber 51 is delivered through the slit 60 of the supply passage 57 to the backpressure chamber 39, along with a small amount of refrigerant gas (see Fig. 2).

[0038] Referring to Fig. 3, in the control valve 72, the discharge pressure P_d in the discharge chamber 47 is applied through the high-pressure passage 75 to the first pressure-receiving surface S1 of the valve member 76 so as to move the valve member 76 upward. When the

valve member 76 is moved upward, the tapered portion 76A is moved apart from the valve seat 74D. In this case, the amount of refrigerant gas flowing from the backpressure chamber 39 through the backpressure passage 71 B, the second chamber 74B, the valve seat 74D, the third chamber 74C and the low-pressure passage 71A into the suction chamber 42 is increased, so that the backpressure P_b in the backpressure chamber 39 is decreased.

[0039] In the control valve 72, on the other hand, the suction pressure P_s in the suction chamber 42 is applied through the low-pressure passage 71A to the third pressure-receiving surface S3 of the valve member 76 so as to move the valve member 76 downward. When the valve member 76 is moved downward, the tapered portion 76A is moved toward the valve seat 74D. In this case, the amount of refrigerant gas flowing from the backpressure chamber 39 into the suction chamber 42 is decreased, so that the backpressure P_b is increased.

[0040] In the control valve 72, the valve member 76 receives not only the backpressure P_b and the suction pressure P_s but also the discharge pressure P_d . Therefore, the backpressure P_b is appropriately controlled, as compared to the conventional compressor using the fixed throttle and adjusting valve as described in the background section. Also, the backpressure P_b (load) is appropriately controlled depending on the discharge pressure P_d , which allows reduction of power loss and prevents poor compression in various operating conditions of the compressor.

[0041] Further, since the area of the third pressure-receiving surface S3 is larger than the area of the second pressure-receiving surface S2, the amount of backpressure P_b applied to the valve member 76 becomes smaller. Thus, the backpressure, which is to be controlled, less affects the control of the backpressure itself, so that the movement of the valve member 76 becomes stable. This results in highly-responsive control valve 72.

[0042] Furthermore, since the area of the third pressure-receiving surface S3 is larger than the area of the first pressure-receiving surface S1, the amount of discharge pressure P_d applied to the valve member 76 also becomes smaller. In this case, the valve member 76 is moved easily as the suction pressure P_s is decreased.

[0043] Fig. 9 is a graph showing a characteristic of the compressor according to the embodiments of the present invention. As is obvious from the graph, the first embodiment of the compressor allows reduction of power loss not only in a condition where the suction pressure P_s is high and the discharge pressure P_d is high, but also in a condition where the suction pressure P_s is low and the discharge pressure P_d is high. It is noted that the compressor as a comparative example in Fig. 9 is composed in such a way that the backpressure P_b , the suction pressure P_s and the discharge pressure P_d are applied to the valve member of the control valve, and the area of the surface of the valve member receiving the suction pressure P_s is the same as the area of the surface of the

valve member receiving the discharge pressure P_d . The compressor according to the first embodiment has good performance in the condition where the suction pressure P_s is low, as compared to the comparative example. In the compressor in which the pressure in the space around the movable scroll 22 corresponds to the suction pressure P_s , the operation of the compressor is affected by the suction pressure P_s . Therefore, the first embodiment of the compressor achieving good performance regardless of the change in the suction pressure P_s is very practical.

[0044] As described above, the first embodiment of the compressor allows not only the appropriate control of the highly-responsive control valve 72 but also reduction of power loss and prevention of poor compression in various operating conditions of the compressor.

[0045] Particularly in the first embodiment of the compressor, the discharge chamber 47 is connected to the backpressure chamber 39 through the supply passage 57, and the amount of refrigerant gas flowing from the backpressure chamber 39 into the suction chamber 42 is limited to the minimum by the control valve 72. Therefore, the discharge pressure P_d relieved to the suction chamber 42 is minimum, which results in high compression efficiency of the compressor.

[0046] Further, since the tapered portion 76A of the valve member 76 is tapered toward the second chamber 74B, the opening of the valve member 76 is gradually varied as the valve member 76 is moved. This offers more flexibility in designing and selecting specifications for the spring 77.

[0047] Furthermore, the compressor requires neither sensors for detecting pressures such as the discharge pressure P_d and the suction pressure P_s nor controllers for calculating load condition for operating the valve member 76, which allows manufacturing cost reduction.

[0048] Figs. 5, 6 and 7 show the second embodiment of the present invention. In Figs. 5, 6 and 7, same reference numerals are used for the common elements or components in the first and second embodiment, and the description of such elements or components for the second embodiment will be omitted.

[0049] Referring to Fig. 5, the backpressure chamber 39 is connected to the discharge chamber 47 through the supply passage 57 that is provided with a backpressure control valve 82 (hereinafter referred to as control valve). The supply passage 57 is formed by high-pressure passages 81A and 81 B and a backpressure passage 81C. The high-pressure passages 81A and 81B connect the discharge chamber 47 to the control valve 82. The backpressure passage 81C connects the control valve 82 to the backpressure chamber 39. The backpressure chamber 39 and the suction chamber 42 are connected through the bleed passage 71 that is provided with a fixed throttle 80.

[0050] Referring to Fig. 6, the control valve 82 has a case 83 that cooperates with the front housing 11 to form a valve chamber 84. The valve chamber 84 includes

chambers 84A and 84B (first chamber) connected to the discharge chamber 47 through the high-pressure passages 81A and 81 B, a chamber 84C (second chamber) connected to the backpressure chamber 39 through the backpressure passage 81C, and a chamber 84D (third chamber) connected to the suction chamber 42 through a low-pressure passage 85. The chambers 84A, 84B, 84C and 84D are arranged in this order as viewed from the bottom of Fig. 6. The valve chamber 84 may be formed by any suitable member other than the front housing 11 and the case 83. The control valve 82 has O-rings 88A and 88B provided between the front housing 11 and the case 83.

[0051] The control valve 82 has a valve member 86 accommodated in the valve chamber 84 so as to move up and down. The valve member 86 includes a cylindrical head portion 86A, a cylindrical neck portion 86B arranged coaxially with the head portion 86A, a tapered portion 86C tapered upward and a cylindrical portion 86D arranged coaxially with the tapered portion 86C. The neck portion 86B is formed integrally with the head portion 86A and extends downward from the lower end of the head portion 86A. The tapered portion 86C is formed integral with the neck portion 86B and tapered to the chamber 84C. The cylindrical portion 86D is formed integrally with the tapered portion 86C and extends downward from the lower end of the tapered portion 86C.

[0052] The valve member 86 has a first pressure-receiving surface S1 located in the chamber 84A, a second pressure-receiving surface S2 located in the chamber 84C and a third pressure-receiving surface S3 located in the chamber 84D. The area of the first pressure-receiving surface S1 corresponds to the area of the lower surface of the cylindrical portion 86D. The area of the third pressure-receiving surface S3 corresponds to the area of the upper surface of the head portion 86A. In a condition that almost all tapered portion 86C is located in the chamber 84C, the area of the second pressure-receiving surface S2 corresponds to the difference between the lower surface of the head portion 86A and the cross-sectional area of the cylindrical portion 86D, that is, the difference between the areas of the first and third pressure-receiving surfaces S1 and S3. This relation could be slightly changed depending on the relative position of the tapered portion 86C and the chambers 84B and 84C. As shown in Fig. 7, the area of the third pressure-receiving surface S3 is larger than the area of the first pressure-receiving surface S1 and also larger than the area of the second pressure-receiving surface S2. The area of the third pressure-receiving surface S3 is the sum of the areas of the first and second pressure-receiving surfaces S1 and S2.

[0053] Referring to Fig. 6, the cylindrical portion 86D of the valve member 86 is slidably fitted in the chamber 84A so that the chamber 84A is hermetically sealed from the chamber 84B. The tapered portion 86C of the valve member 86 is located across the chamber 84B and the chamber 84C. The control valve 82 has a valve seat 84E provided between the chamber 84B and the chamber

84C. The valve seat 84E is associated with the tapered portion 86C of the valve member 86.

[0054] The chamber 84D is connected to the suction chamber 42 through the low-pressure passage 85. The upper portion of the chamber 84C is connected to the backpressure chamber 39 through the backpressure passage 81C. The valve seat 84E faces the tapered portion 86C of the valve member 86. The valve seat 84E has an inner diameter that is slightly larger than the diameter of the large end of the tapered portion 86C. The tapered portion 86C is slidable in the chamber 84C so that the chamber 84C is hermetically sealed from the chamber 84B. The O-ring 88A is provided between the low-pressure passage 85 and the backpressure passage 81C.

[0055] The chambers 84A and 84B are connected to the discharge chamber 47 through the high-pressure passages 81A and 81 B. The O-ring 88B is provided between the high-pressure passages 81A and 81 B and the backpressure passage 81C. The control valve 82 has a spring 87 that is interposed between the upper surface of the head portion 86A of the valve member 86 and the inner surface of the case 83 so as to urge the tapered portion 86C away from the valve seat 84E.

[0056] In the control valve 82, the discharge pressure Pd in the discharge chamber 47 is applied through the high-pressure passages 81A and 81 B to the first pressure-receiving surface S1 of the valve member 86 so as to move the valve member 86 upward. When the valve member 86 is moved upward, the tapered portion 86C is moved toward the valve seat 84E. In this case, the amount of refrigerant gas flowing from the discharge chamber 47 through the high-pressure passage 81 B, the chamber 84B, the valve seat 84E, the chamber 84C and the backpressure passage 81C into the backpressure chamber 39 is decreased. Refrigerant gas in the backpressure chamber 39 is delivered through the bleed passage 71 to the suction chamber 42, and the backpressure Pb in the backpressure chamber 39 is decreased, accordingly.

[0057] In the control valve 82, on the other hand, the suction pressure Ps in the suction chamber 42 is applied through the low-pressure passage 85 to the third pressure-receiving surface S3 of the valve member 86 so as to move the valve member 86 downward. When the valve member 86 is moved downward, the tapered portion 86C moved apart from the valve seat 84E. In this case, the amount of refrigerant gas flowing from the discharge chamber 47 into the backpressure chamber 39 is increased, so that the backpressure Pb is increased.

[0058] The second embodiment offers the advantages similar to those of the first embodiment.

[0059] The above embodiments may be modified in various ways as exemplified below.

[0060] In the previous embodiments, the present invention is applied to the scroll compressor with the motor mechanism 40, that is, a motor-driven compressor. Alternatively, the present invention may be applied to a

scroll compressor with no electric motor.

[0061] In the previous embodiments, the supply passage 57 and the high-pressure passage 75 connect the discharge chamber 47 to the backpressure chamber 39. Alternatively, the supply passage 57 and the high-pressure passage 75 may connect the compression chamber 38 to the backpressure chamber 39.

[0062] In the previous embodiments, the movable scroll 22 is pressed against the fixed scroll 16 by backpressure. Alternatively, the fixed scroll 16 may be pressed against the movable scroll 22 by backpressure.

[0063] In the previous embodiments, the first chamber 74A (84A, 84B) is connected to the discharge chamber 47. Alternatively, the first chamber 74A (84A, 84B) may be connected to the compression chamber 38. In this case, since it is necessary that the pressure in the compression chamber 38 should be maintained at a pressure that is large enough to control the backpressure, the first chamber 74A (84A, 84B) may be connected to the radially innermost portion of the compression chamber 38 between the fixed and movable scrolls 16 and 22, for example.

[0064] A compressor includes a housing, a fixed scroll, a movable scroll and a control valve. The housing has a suction chamber, a discharge chamber and a backpressure chamber formed therein. The scrolls are pressed against each other by backpressure in the backpressure chamber. The control valve for controlling the backpressure has first, second and third chambers arranged in this order. The first, second and third chambers are connected to the discharge chamber, the backpressure chamber and the suction chamber, respectively. The control valve has a valve member. The valve member has a first pressure-receiving surface located in the first chamber, a second pressure-receiving surface located in the second chamber and a third pressure-receiving surface located in the third chamber. The area of the third pressure-receiving surface is larger than the area of the first pressure-receiving surface and larger than the area of the second pressure-receiving surface.

Claims

1. A scroll compressor, comprising:

a housing (10) having a suction chamber (42), a discharge chamber (47) and a backpressure chamber (39) formed therein;
a fixed scroll (16) accommodated in the housing (10);
a movable scroll (22) accommodated in the housing (10), the movable scroll (22) cooperating with the fixed scroll (16) to form therebetween a compression chamber (38), the movable scroll (22) and the fixed scroll (16) being pressed against each other by backpressure in the backpressure chamber (39); and

a control valve (72) for controlling the backpressure in the backpressure chamber (39) by communication with the suction chamber (42), the discharge chamber (47) or the compression chamber (38),

characterized in that the control valve (72) has a first chamber (74A), a second chamber (74B) and a third chamber (74C) arranged in this order, the first chamber (74A) being connected to the discharge chamber (47) or the compression chamber (38), the second chamber (74B) being connected to the backpressure chamber (39), the third chamber (74C) being connected to the suction chamber (42),

wherein the control valve (72) has a valve member (76), the valve member (76) having a first pressure-receiving surface (S1) located in the first chamber (74A), a second pressure-receiving surface (S2) located in the second chamber (74B) and a third pressure-receiving surface (S3) located in the third chamber (74C), wherein the area of the third pressure-receiving surface (S3) is larger than the area of the first pressure-receiving surface (S1) and larger than the area of the second pressure-receiving surface (S2).

2. The scroll compressor according to claim 1, wherein the control valve (72) has a valve seat (74D) associated with the valve member (76) and provided between the second chamber (74B) and the third chamber (74C), and the control valve (72) is controllable to the communication between the backpressure chamber (39) and the suction chamber (42).

3. The scroll compressor according to claim 2, wherein the backpressure chamber (39) is connected to the discharge chamber (47) through a throttle (60).

4. The scroll compressor according to claim 2, wherein the valve member (76) includes a tapered portion (76A) facing the valve seat (74D) and tapered to the second chamber (74B).

5. The scroll compressor according to claim 4, wherein the tapered portion (76A) is located across the second chamber (74B) and the third chamber (74C).

6. The scroll compressor according to claim 4, wherein the valve member (76) has cylindrical shape with the tapered portion (76A), the valve member (76) has an end surface located in the first chamber (74A) to form the first pressure-receiving surface (S1), the valve member (76) has an end surface located in the third chamber (74C) to form the third pressure-receiving surface (S3), and the tapered portion (76A) is located in the second chamber (74B) to form the second pressure-receiving surface (S2).

7. The scroll compressor according to claim 5, wherein the area of the second pressure-receiving surface (S2) corresponds to the area of the tapered portion (76A) located in the second chamber (74B) in axial direction of the valve member (76). 5
8. The scroll compressor according to claim 1, wherein the control valve (82) has a valve seat (84E) associated with the valve member (86) and provided between the first chamber (84B) and the second chamber (84C), and the control valve (82) is controllable to the communication between the discharge chamber (47) and the backpressure chamber (39). 10
9. The scroll compressor according to claim 8, wherein the backpressure chamber (39) is connected to the suction chamber (42) through a throttle (80). 15
10. The scroll compressor according to claim 8, wherein the valve member (86) includes a tapered portion (86C) facing the valve seat (84E) and tapered to the second chamber (84C), and the tapered portion (86C) is located across the first chamber (84B) and the second chamber (84C). 20

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FIG. 1

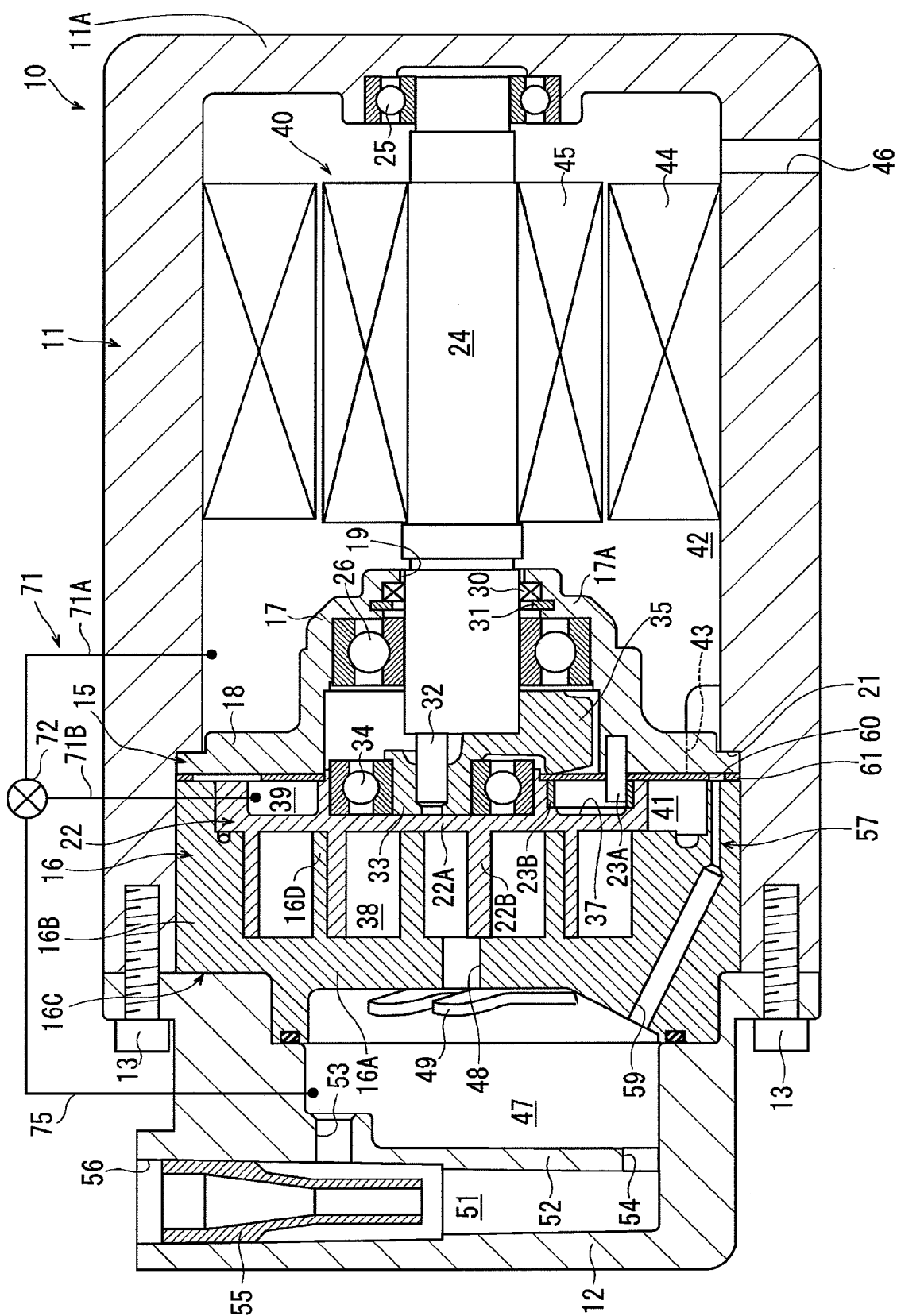


FIG. 2

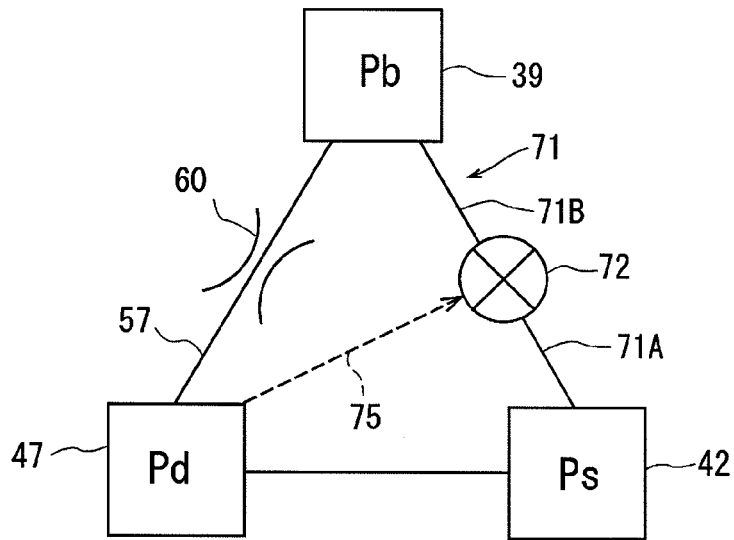


FIG. 3

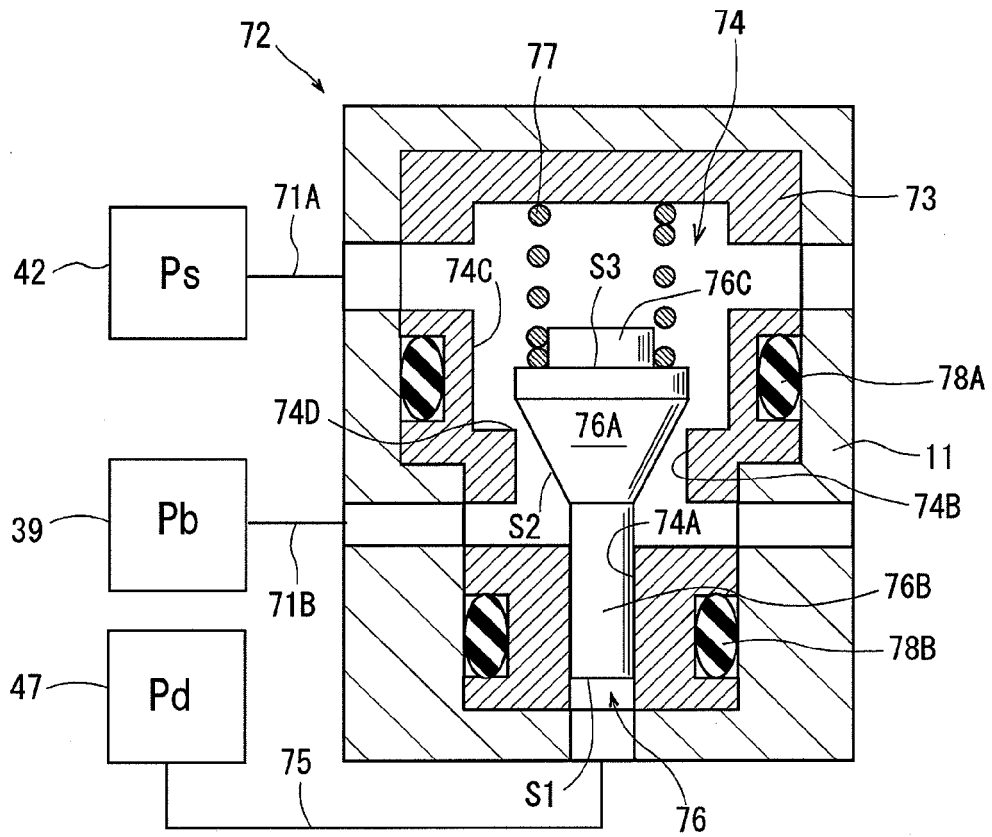


FIG. 4

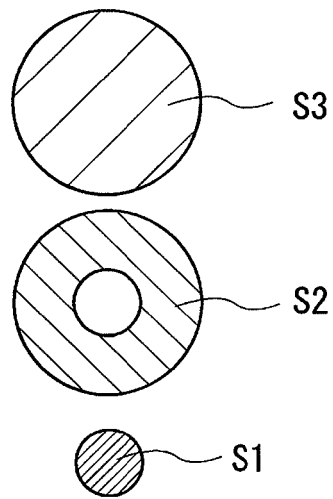


FIG. 5

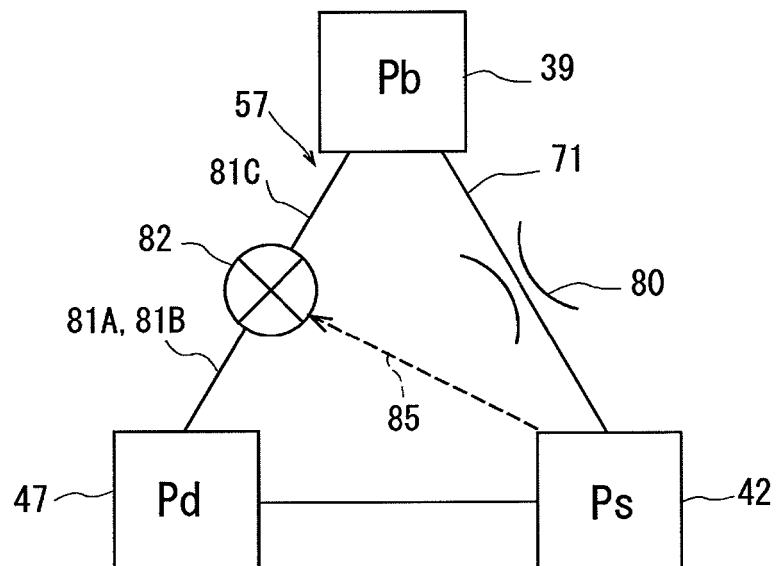


FIG. 6

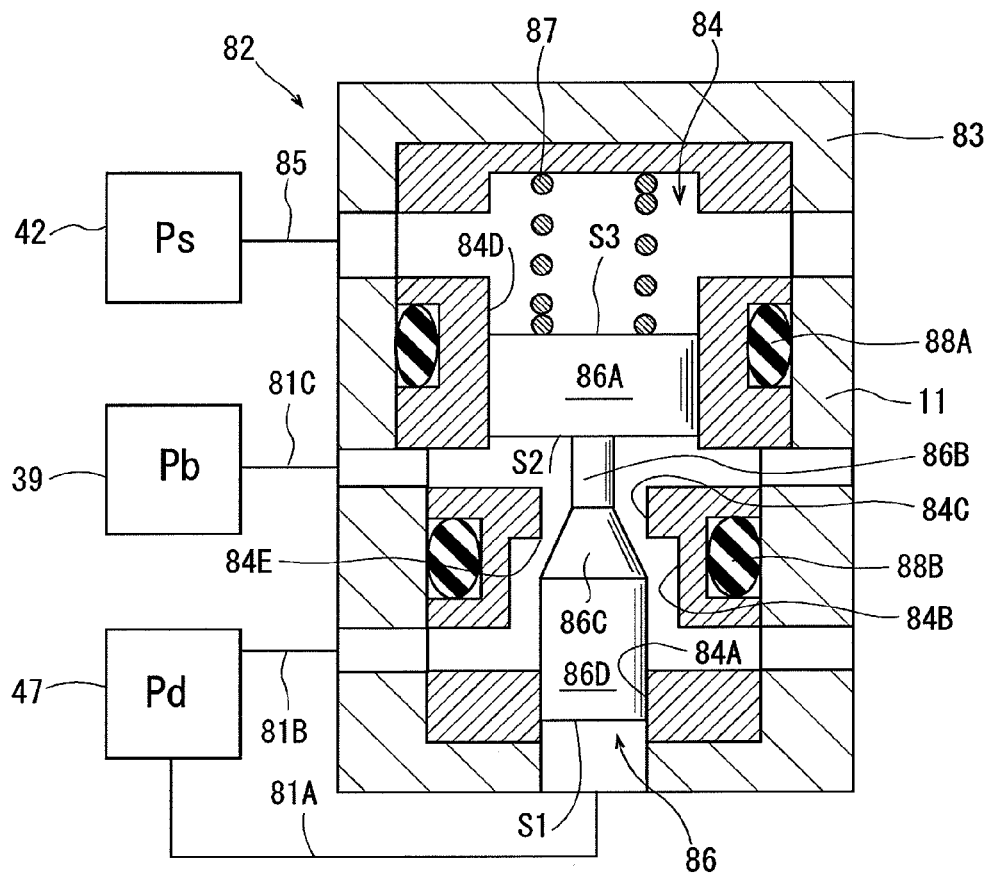


FIG. 7

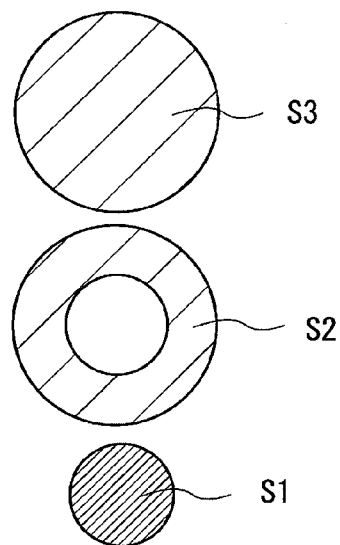


FIG. 8

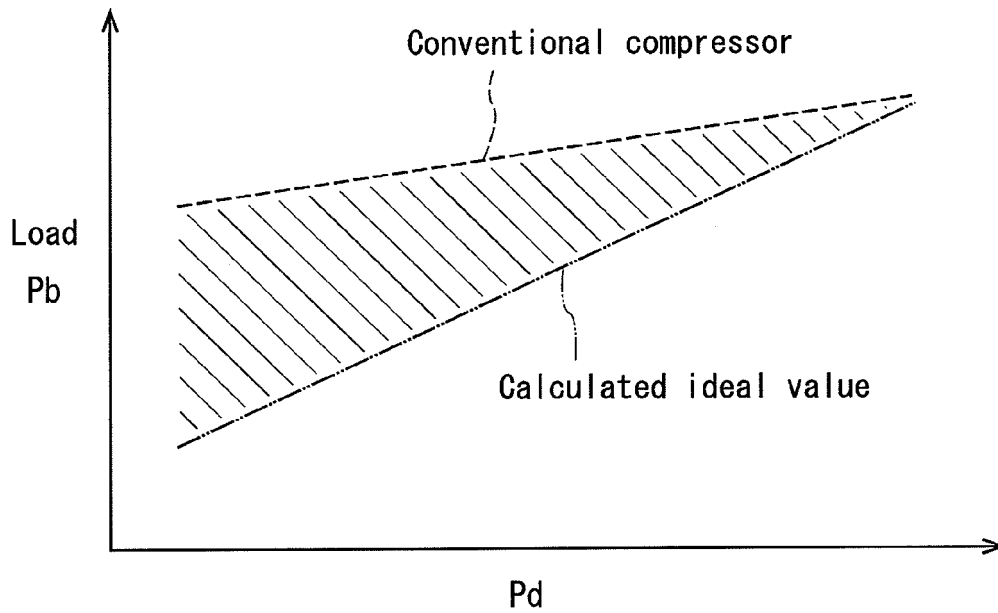
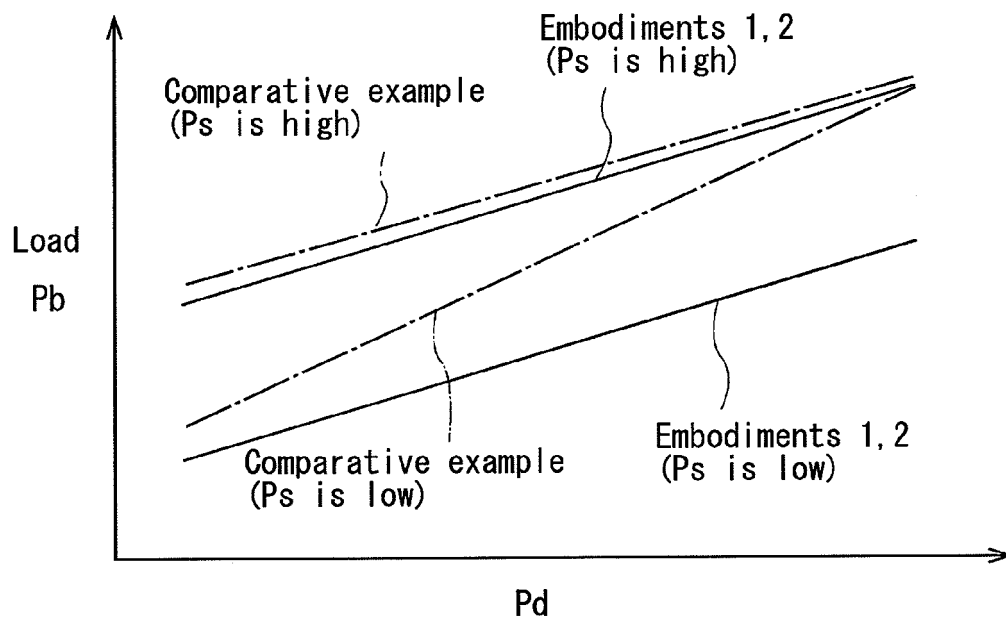


FIG. 9



REFERENCES CITED IN THE DESCRIPTION

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