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(54) **SCROLL COMPRESSOR**

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(57) **ABSTRACT**

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.

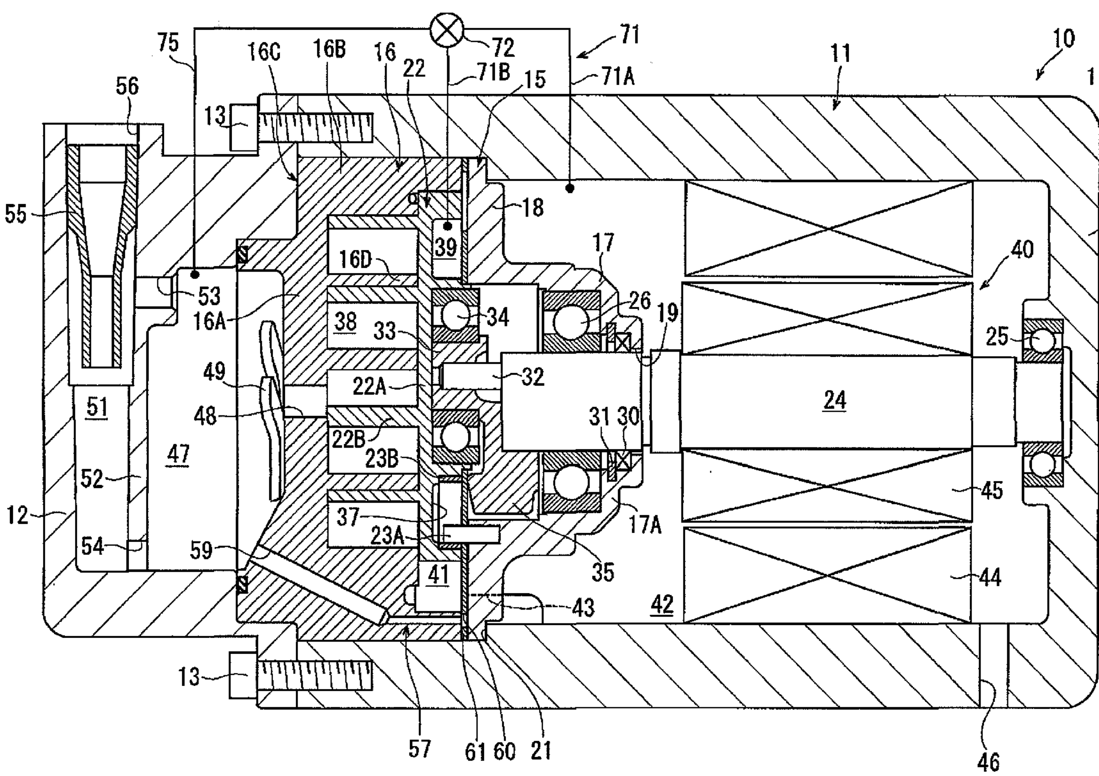
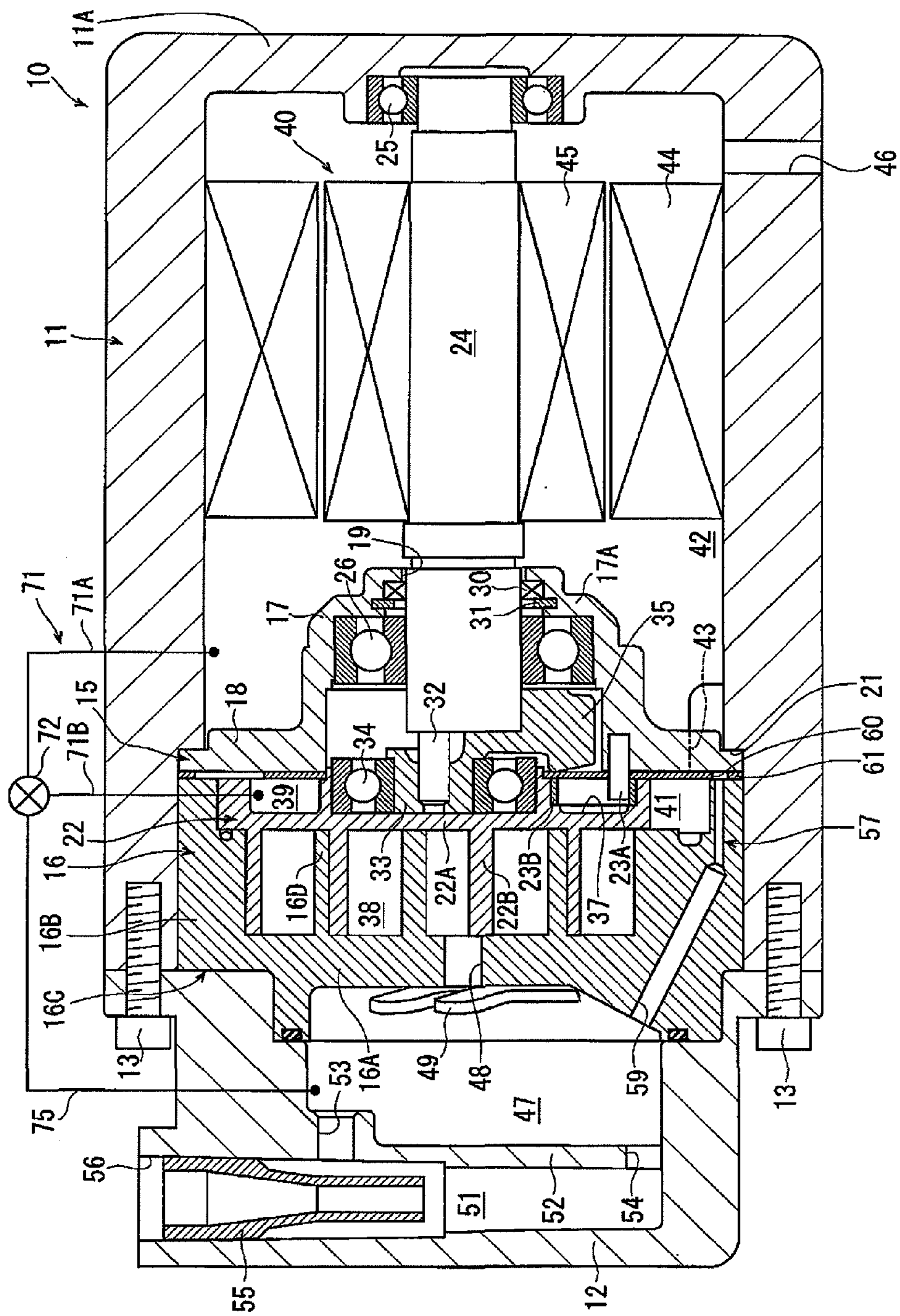


FIG. 1


10
11
11A
12
13
15
16
16A
16B
16C
16D
17
17A
18
19
21
22
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22B
23A
23B
24
25
26
30
31
32
33
34
35
37
38
39
40
41
42
43
44
45
46
47
48
49
51
52
53
54
55
56
57
59
60
61
71
71A
71B
72
75

FIG. 2

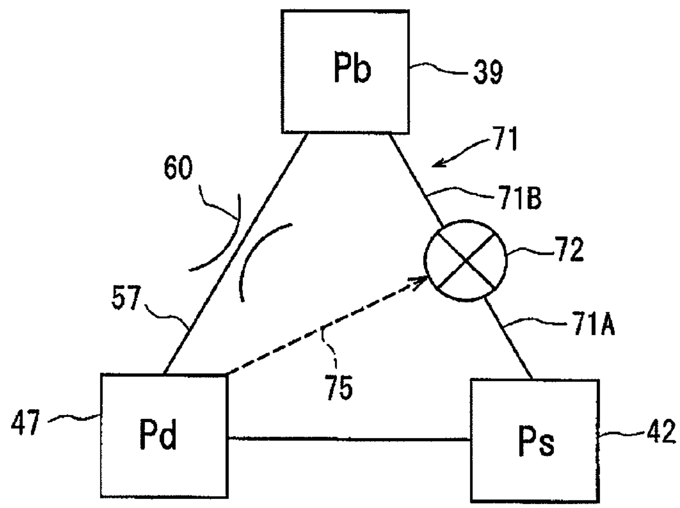

Pb
39
71
60
71B
72
57
71A
75
47
Pd
Ps
42

FIG. 3

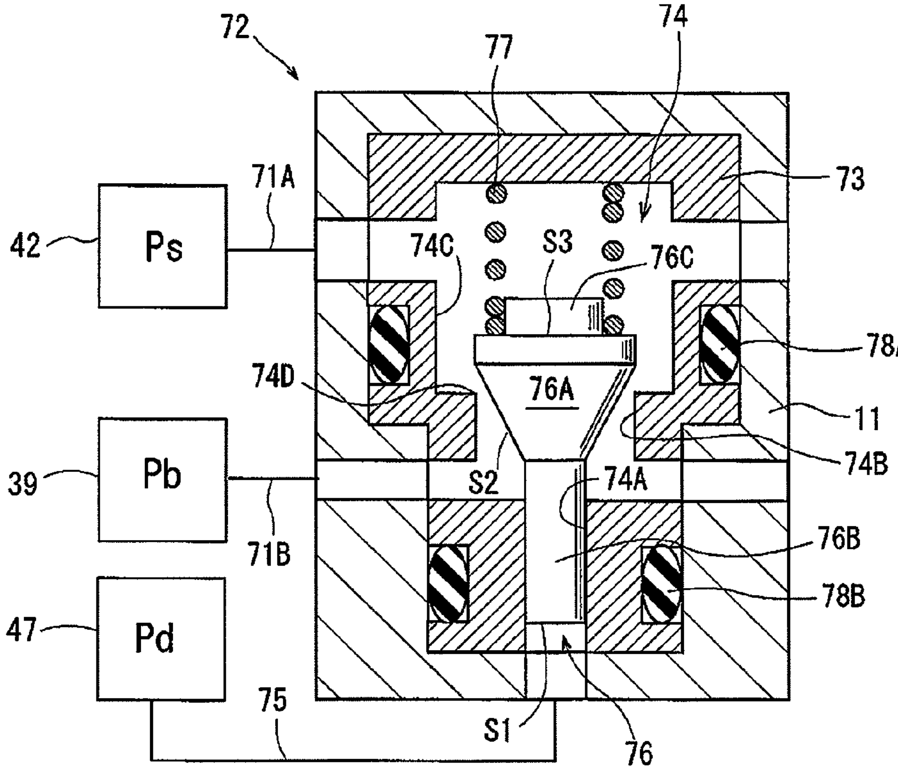

72
77
74
73
71A
42
Ps
74C
S3
76C
78A
74D
76A
11
74B
39
Pb
S2
74A
71B
76B
78B
47
Pd
75
S1
76

FIG. 4

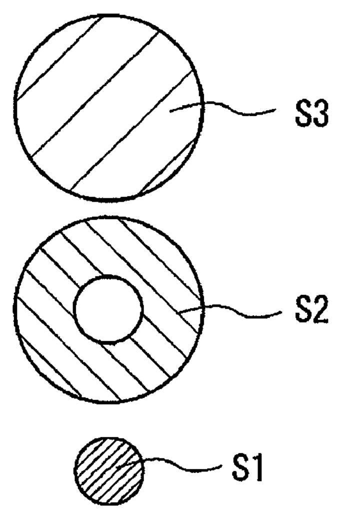


FIG. 5

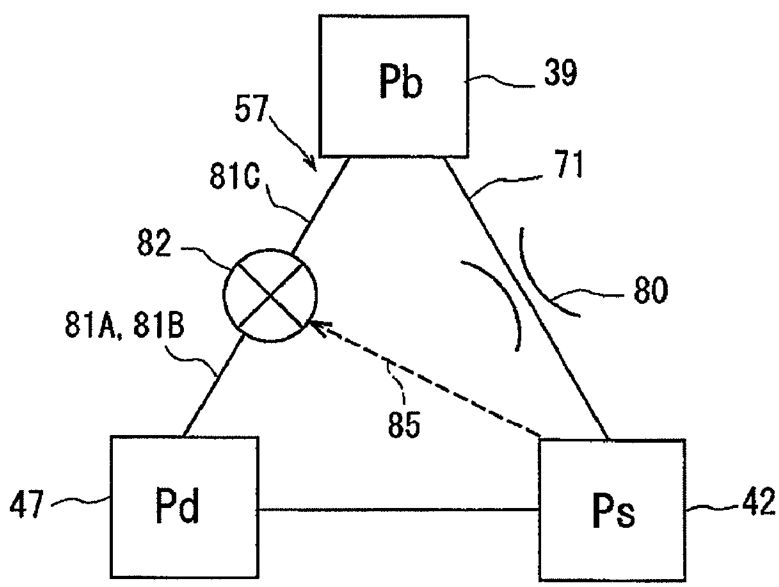


FIG. 6

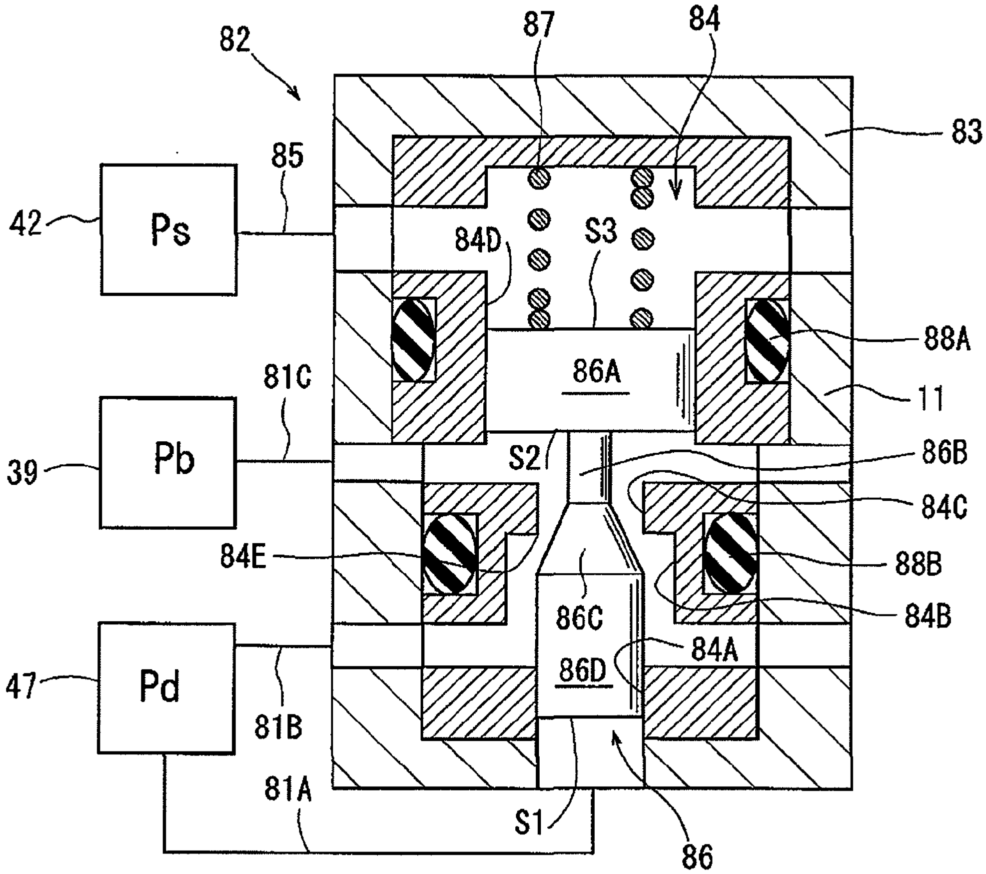

82
87
84
83
85
42
Ps
84D
S3
88A
86A
81C
11
Pb
39
S2
86B
84C
84E
88B
86C
84B
Pd
84A
47
86D
81B
81A
S1
86

FIG. 7

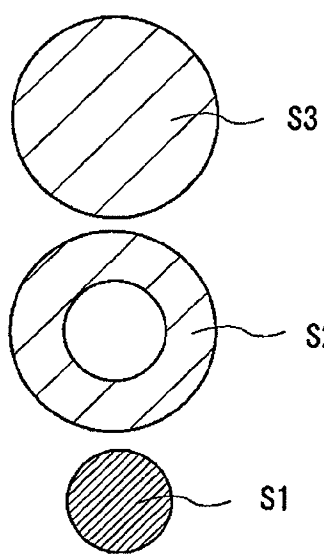

S3
S2
S1

FIG. 8

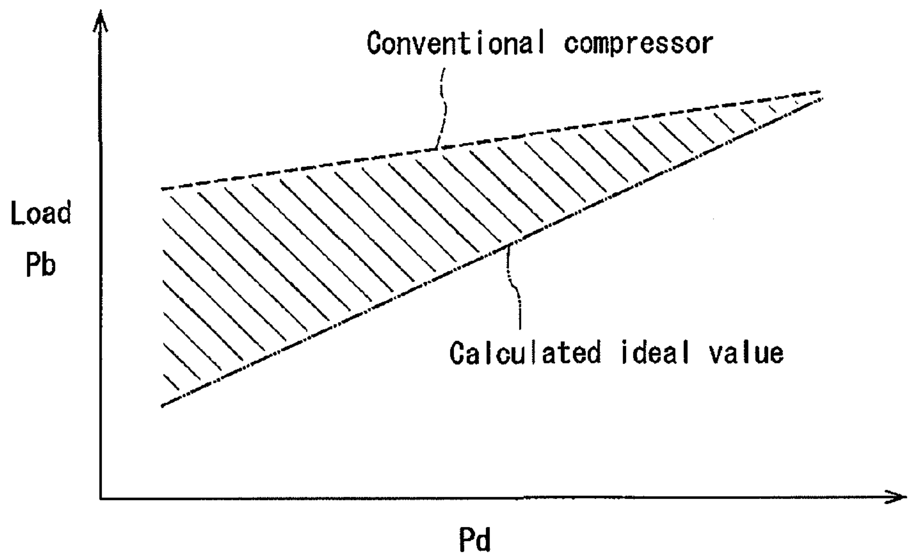
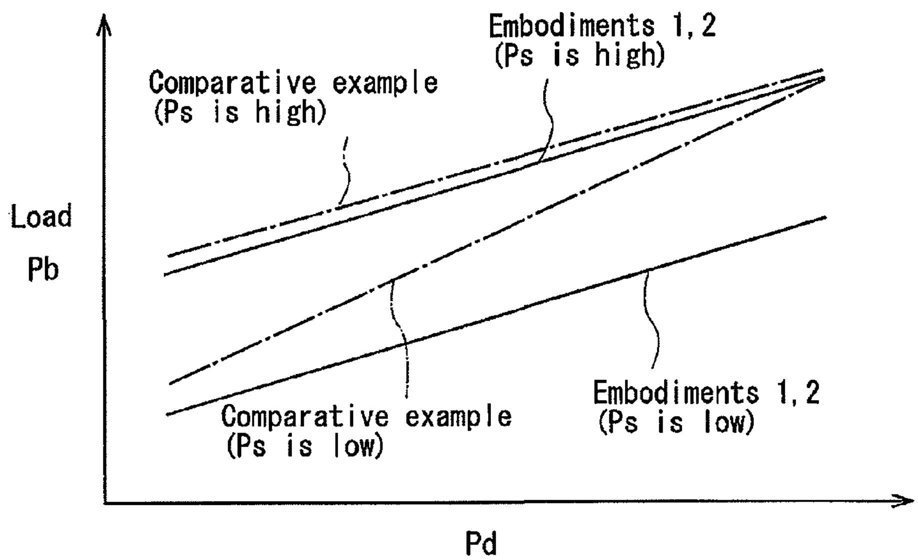

Conventional compressor
Load
Pb
Calculated ideal value
Pd

FIG. 9


Embodiments 1, 2
(Ps is high)
Comparative example
(Ps is high)
Load
Pb
Comparative example
(Ps is low)
Embodiments 1, 2
(Ps is low)
Pd

SCROLL COMPRESSOR

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 thorough 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 Pb (load) is increased as discharge pressure Pd 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 Pb (load) is appropriately controlled depending on the discharge pressure Pd, 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;

[0015] FIG. **2** is a schematic block diagram of the compressor of FIG. **1**;

[0016] FIG. **3** is a sectional view of a control valve of the compressor of FIG. **1**;

[0017] FIG. **4** is a schematic view showing pressure-receiving surfaces of a valve member of the control valve of FIG. **3**;

[0018] FIG. **5** is a schematic block diagram of a scroll compressor according to a second embodiment of the present invention;

[0019] FIG. **6** is a sectional view of the second embodiment of the control valve;

[0020] FIG. **7** is a schematic view showing pressure-receiving surfaces of a valve member of the control valve of FIG. **6**;

[0021] FIG. **8** is a graph showing a characteristic of a conventional compressor and a calculated ideal value; and

[0022] 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

[0023] The following will describe the embodiments of the present invention with reference to the accompanying drawings.

[0024] 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**.

[0025] 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 **17**A 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 **23**A fixed to the rear end thereof for preventing the rotation of the movable scroll **22** on its own axis.

[0026] 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 **11**A 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**.

[0027] 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**.

[0028] The fixed scroll **16** has a cylindrical base **16**C and a scroll wall **16**D. The base **16**C is formed by an end wall **16**A and a side wall **16**B. The scroll wall **16**D is located radially inward of the side wall **16**B and projects forward from the end wall **16**A.

[0029] 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 **22**A and a scroll wall **22**B that projects rearward from the base plate **22**A.

[0030] The fixed scroll **16** and the movable scroll **22** are engaged with each other so that the end of the scroll wall **16**D slides on the base plate **22**A and the end of the scroll wall **22**B slides on the end wall **16**A of the base **16**C. The base plate **22**A of the movable scroll **22** is formed with a recess **37** into which a ring **23**B is loosely fitted for receiving the pin **23**A on the shaft support **15**. The pin **23**A slides and rolls on the inner peripheral surface of the ring **23**B.

[0031] The fixed scroll **16** cooperates with the movable scroll **22** to form therebetween a compression chamber **38** that is defined by the scroll walls **16**D and **22**B. The base plate **22**A 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 **16**B of the fixed scroll **16** and the radially outermost portion of the movable scroll **22**.

[0032] 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.

[0033] 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**.

[0034] The discharge chamber **47** is formed between the base **16**C of the fixed scroll **16** and the rear housing **12**. The base **16**C 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 **16**C.

[0035] 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.

[0036] 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).

[0037] 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 71B connects the control valve 72 to the backpressure chamber 39.

[0038] 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 71B, 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.

[0039] 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.

[0040] 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.

[0041] 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.

[0042] The third chamber 74C is connected to the suction 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 71B. 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 71B.

[0043] 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 71B. 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.

[0044] 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 **23**A on the inner peripheral surface of the ring **23**B. The volume of the compression chamber **38** between the scroll walls **16**D and **22**B 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.

[0045] 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**).

[0046] Referring to FIG. **3**, in the control valve **72**, the discharge pressure Pd in the discharge chamber **47** is applied through the high-pressure passage **75** to the first pressure-receiving surface S**1** 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 **76**A is moved apart from the valve seat **74**D. In this case, the amount of refrigerant gas flowing from the backpressure chamber **39** through the backpressure passage **71**B, the second chamber **74**B, the valve seat **74**D, the third chamber **74**C and the low-pressure passage **71**A into the suction chamber **42** is increased, so that the backpressure Pb in the backpressure chamber **39** is decreased.

[0047] In the control valve **72**, on the other hand, the suction pressure Ps in the suction chamber **42** is applied through the low-pressure passage **71**A to the third pressure-receiving surface S**3** 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 **76**A is moved toward the valve seat **74**D. 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 Pb is increased.

[0048] In the control valve **72**, the valve member **76** receives not only the backpressure Pb and the suction pressure Ps but also the discharge pressure Pd. Therefore, the backpressure Pb 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 Pb (load) is appropriately controlled depending on the discharge pressure Pd, which allows reduction of power loss and prevents poor compression in various operating conditions of the compressor.

[0049] Further, since the area of the third pressure-receiving surface S**3** is larger than the area of the second pressure-receiving surface S**2**, the amount of backpressure Pb 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**.

[0050] Furthermore, since the area of the third pressure-receiving surface S**3** is larger than the area of the first pressure-receiving surface S**1**, the amount of discharge pressure Pd applied to the valve member **76** also becomes smaller. In this case, the valve member **76** is moved easily as the suction pressure Ps is decreased.

[0051] 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 Ps is high and the discharge pressure Pd is high, but also in a condition where the suction pressure Ps is low and the discharge pressure Pd is high. It is noted that the compressor as a comparative example in FIG. **9** is composed in such a way that the backpressure Pb, the suction pressure Ps and the discharge pressure Pd are applied to the valve member of the control valve, and the area of the surface of the valve member receiving the suction pressure Ps is the same as the area of the surface of the valve member receiving the discharge pressure Pd. The compressor according to the first embodiment has good performance in the condition where the suction pressure Ps 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 Ps, the operation of the compressor is affected by the suction pressure Ps. Therefore, the first embodiment of the compressor achieving good performance regardless of the change in the suction pressure Ps is very practical.

[0052] 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.

[0053] 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 Pd relieved to the suction chamber **42** is minimum, which results in high compression efficiency of the compressor.

[0054] Further, since the tapered portion **76**A of the valve member **76** is tapered toward the second chamber **74**B, 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**.

[0055] Furthermore, the compressor requires neither sensors for detecting pressures such as the discharge pressure Pd and the suction pressure Ps nor controllers for calculating load condition for operating the valve member **76**, which allows manufacturing cost reduction.

[0056] 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.

[0057] 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 **81**A and **81**B and a backpressure passage **81**C. The high-pressure passages **81**A and **81**B connect the discharge chamber **47** to the control valve **82**. The backpressure passage **81**C 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**.

[0058] 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 **84**A and **84**B (first chamber) connected to the discharge chamber **47** through the high-pressure passages **81**A and **81**B, a chamber **84**C (second chamber) connected to the backpressure chamber **39** through the backpressure passage **81**C, and a chamber **84**D (third chamber) connected to the suction chamber **42** through a low-pressure passage **85**. The chambers **84**A, **84**B, **84**C and **84**D 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 **88**A and **88**B provided between the front housing **11** and the case **83**.

[0059] 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 **86**A, a cylindrical neck portion **86**B arranged coaxially with the head portion **86**A, a tapered portion **86**C tapered upward and a cylindrical portion **86**D arranged coaxially with the tapered portion **86**C. The neck portion **86**B is formed integrally with the head portion **86**A and extends downward from the lower end of the head portion **86**A. The tapered portion **86**C is formed integral with the neck portion **86**B and tapered to the chamber **84**C. The cylindrical portion **86**D is formed integrally with the tapered portion **86**C and extends downward from the lower end of the tapered portion **86**C.

[0060] The valve member **86** has a first pressure-receiving surface S**1** located in the chamber **84**A, a second pressure-receiving surface S**2** located in the chamber **84**C and a third pressure-receiving surface S**3** located in the chamber **84**D. The area of the first pressure-receiving surface S**1** corresponds to the area of the lower surface of the cylindrical portion **86**D. The area of the third pressure-receiving surface S**3** corresponds to the area of the upper surface of the head portion **86**A. In a condition that almost all tapered portion **86**C is located in the chamber **84**C, the area of the second pressure-receiving surface S**2** corresponds to the difference between the lower surface of the head portion **86**A and the cross-sectional area of the cylindrical portion **86**D, that is, the difference between the areas of the first and third pressure-receiving surfaces S**1** and S**3**. This relation could be slightly changed depending on the relative position of the tapered portion **86**C and the chambers **84**B and **84**C. As shown in FIG. **7**, the area of the third pressure-receiving surface S**3** is larger than the area of the first pressure-receiving surface S**1** and also larger than the area of the second pressure-receiving surface S**2**. The area of the third pressure-receiving surface S**3** is the sum of the areas of the first and second pressure-receiving surfaces S**1** and S**2**.

[0061] Referring to FIG. **6**, the cylindrical portion **86**D of the valve member **86** is slidably fitted in the chamber **84**A so that the chamber **84**A is hermetically sealed from the chamber **84**B. The tapered portion **86**C of the valve member **86** is located across the chamber **84**B and the chamber **84**C. The control valve **82** has a valve seat **84**E provided between the chamber **84**B and the chamber **84**C. The valve seat **84**E is associated with the tapered portion **86**C of the valve member **86**.

[0062] The chamber **84**D is connected to the suction chamber **42** through the low-pressure passage **85**. The upper portion of the chamber **84**C is connected to the backpressure chamber **39** through the backpressure passage **81**C. The valve seat **84**E faces the tapered portion **86**C of the valve member **86**. The valve seat **84**E has an inner diameter that is slightly larger than the diameter of the large end of the tapered portion **86**C. The tapered portion **86**C is slidable in the chamber **84**C so that the chamber **84**C is hermetically sealed from the chamber **84**B. The O-ring **88**A is provided between the low-pressure passage **85** and the backpressure passage **81**C.

[0063] The chambers **84**A and **84**B are connected to the discharge chamber **47** through the high-pressure passages **81**A and **81**B. The O-ring **88**B is provided between the high-pressure passages **81**A and **81**B and the backpressure passage **81**C. The control valve **82** has a spring **87** that is interposed between the upper surface of the head portion **86**A of the valve member **86** and the inner surface of the case **83** so as to urge the tapered portion **86**C away from the valve seat **84**E.

[0064] In the control valve **82**, the discharge pressure Pd in the discharge chamber **47** is applied through the high-pressure passages **81**A and **81**B to the first pressure-receiving surface S**1** 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 **86**C is moved toward the valve seat **84**E. In this case, the amount of refrigerant gas flowing from the discharge chamber **47** through the high-pressure passage **81**B, the chamber **84**B, the valve seat **84**E, the chamber **84**C and the backpressure passage **81**C 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.

[0065] 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 S**3** 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 **86**C moved apart from the valve seat **84**E. 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.

[0066] The second embodiment offers the advantages similar to those of the first embodiment.

[0067] The above embodiments may be modified in various ways as exemplified below.

[0068] 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.

[0069] 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**.

[0070] 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.

[0071] In the previous embodiments, the first chamber **74**A (**84**A, **84**B) is connected to the discharge chamber **47**. Alternatively, the first chamber **74**A (**84**A, **84**B) 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 **74**A (**84**A, **84**B) may be connected to the radially innermost portion of the compression chamber **38** between the fixed and movable scrolls **16** and **22**, for example.

What is claimed is:

1. A scroll compressor, comprising:

a housing having a suction chamber, a discharge chamber and a backpressure chamber formed therein;

a fixed scroll accommodated in the housing;

a movable scroll accommodated in the housing, the movable scroll cooperating with the fixed scroll to form therebetween a compression chamber, the movable scroll and the fixed scroll being pressed against each other by backpressure in the backpressure chamber; and

a control valve for controlling the backpressure in the backpressure chamber by communication with the suction chamber, the discharge chamber or the compression chamber,

wherein the control valve has a first chamber, a second chamber and a third chamber arranged in this order, the first chamber being connected to the discharge chamber or the compression chamber, the second chamber being connected to the backpressure chamber, the third chamber being connected to the suction chamber,

wherein the control valve has a valve member, the valve member having 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,

wherein 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.

2. The scroll compressor according to claim **1**, wherein the control valve has a valve seat associated with the valve member and provided between the second chamber and the third chamber, and the control valve is controllable to the communication between the backpressure chamber and the suction chamber.

3. The scroll compressor according to claim **2**, wherein the backpressure chamber is connected to the discharge chamber through a throttle.

4. The scroll compressor according to claim **2**, wherein the valve member includes a tapered portion facing the valve seat and tapered to the second chamber.

5. The scroll compressor according to claim **4**, wherein the tapered portion is located across the second chamber and the third chamber.

6. The scroll compressor according to claim **4**, wherein the valve member has cylindrical shape with the tapered portion, the valve member has an end surface located in the first chamber to form the first pressure-receiving surface, the valve member has an end surface located in the third chamber to form the third pressure-receiving surface, and the tapered portion is located in the second chamber to form the second pressure-receiving surface.

7. The scroll compressor according to claim **5**, wherein the area of the second pressure-receiving surface corresponds to the area of the tapered portion located in the second chamber in axial direction of the valve member.

8. The scroll compressor according to claim **1**, wherein the control valve has a valve seat associated with the valve member and provided between the first chamber and the second chamber, and the control valve is controllable to the communication between the discharge chamber and the backpressure chamber.

9. The scroll compressor according to claim **8**, wherein the backpressure chamber is connected to the suction chamber through a throttle.

10. The scroll compressor according to claim **8**, wherein the valve member includes a tapered portion facing the valve seat and tapered to the second chamber, and the tapered portion is located across the first chamber and the second chamber.

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