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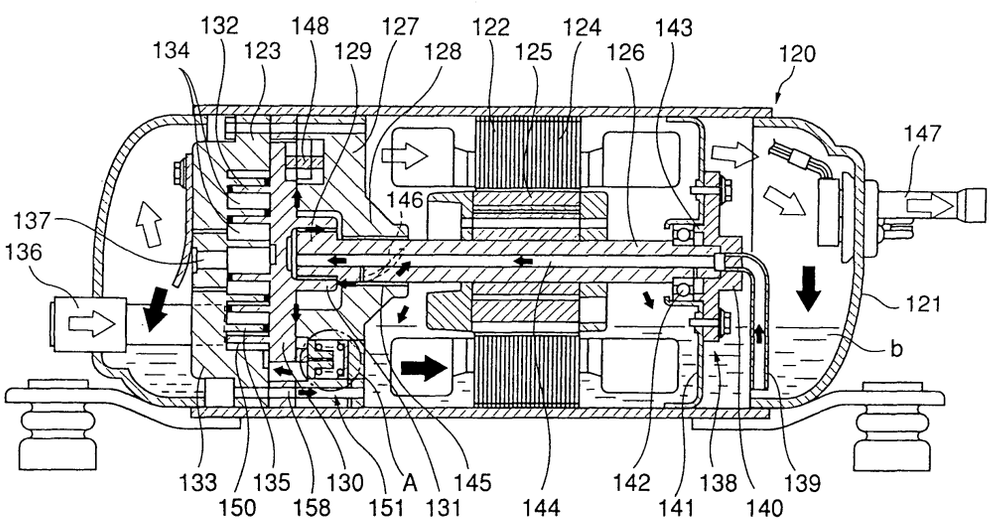
(54) Scroll compressor

(57) A highly reliable scroll compressor with an improved oil injection mechanism having a particular composition in a particular position in a scroll compression element is disclosed. The oil injection mechanism for injecting and supplying a lubricant is provided in the vicinity of an intake position where a refrigerant gas is introduced from outside an hermetic housing into the scroll compression element via an intake pipe. The oil injection mechanism is fixed to a support frame being composed of an oil nozzle for injecting the lubricant through an oil feed passage and a valve that opens/closes an oil feed passage inlet of the oil nozzle by utilizing the elasticity of a spring. The oil injection mechanism may be fixed at other location than the support frame; it may be secured, for example, to an stationary scroll.

Fig. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a scroll compressor mounted on an air conditioner, a refrigerating machine, etc. and, more particularly, to a scroll compressor adapted to discharge compressed gas, which has been compressed in a plurality of compression chambers formed by the engagement between a stationary scroll and a swivel scroll, out of a hermetic housing.

2. Description of Related Art

[0002] A scroll compressor employed for a refrigerating cycle of an air conditioner or the like is constructed as shown in Fig. 4 as disclosed, for example, in Japanese Examined Patent Publication No. 7-99150.

[0003] A cylindrical hermetic housing 101 with its both ends closed includes an electric element 102 and a scroll compression element 103 therein. The electric element 102 is composed of a stator 104 secured to the inner wall surface of the hermetic housing 101 and a rotor 105 rotatably supported in the stator 104, a rotating shaft 106 being connected to the rotor 105 in a penetrating fashion. One end of the rotating shaft 106 is rotatably supported on a support frame 107 partly constituting the scroll compression element 103. The other end of the rotating shaft 106 juts out of the rotor 105, a displacement pump 108 such as a trochoid pump, rotary pump, or reciprocating pump being connected to the distal end thereof. An oil inlet pipe 109 is connected to an end of the displacement pump 108. The end of the intake side of the oil inlet pipe 109 is extended downward so that it is submerged in a lubricant "b" contained in the hermetic housing 101.

[0004] An oil feed passage for taking in the lubricant "b" by the displacement pump 108 is bored in the rotating shaft 106 in the axial direction, so that the lubricant is recirculated after it is supplied to sliding parts such as the support frame 107.

[0005] The central part of one end of the rotating shaft 106 supported by the support frame 107 in the penetrating manner is formed as a pin or crank 110 provided eccentrically in relation to the axial center of the rotating shaft 106. A swivel scroll 111 is connected to the pin 110. The swivel scroll 111 is formed into a discoid shape, a boss hole 112 for connection with the pin 110 being formed at the center of one side surface thereof, while a spiral lap 113 is integrally formed on the other side surface of the swivel scroll 111.

[0006] Joined to the support frame 107 is a stationary scroll 114. The stationary scroll 114 has a spiral lap 115 formed on a portion thereof opposed to the swivel scroll 111, and also a plurality of compression chambers 116 formed between itself and the lap 113. These compression chambers 116 such in a refrigerant gas through the outer peripheral portion thereof and reduces the volumes as they move toward the center so as to compress the refrigerant gas.

[0007] A discharge port 117 is formed at the center of the stationary scroll 114. The stationary scroll 114 is provided with a muffler 118 that surrounds the outer side of the discharge port 117.

[0008] There has also been proposed a horizontal type scroll compressor under Japanese Examined Patent Publication No. 3-175186. This type does not employ the pump for supplying a lubricant, and it discharges compressed gas into a hermetic housing; it has a through hole in the swivel scroll to communicate an appropriate compression chamber among the scroll compression elements, the rear surface of the swivel scroll, and the support frame so as to set the pressure among them to an appropriate medium pressure, e.g. 8 to 9 kg/cm^2 that is lower than the pressure, e.g. 15 to 25 kg/cm^2, in a hermetic housing. By utilizing the pressure differential, a lubricant is sucked up and passed through the oil feed passage provided in the rotating shaft to be supplied to respective sliding parts including a support frame. The swivel scroll is pressed against a stationary scroll by the foregoing pressure to bring them into contact so as to provide gas seal thereby to compress the refrigerant gas.

[0009] However, regardless of whether the lubrication is conducted using a pump or pressure differential, there has been the problem described below. The amount of a lubricant supplied varies according to the number of revolutions of the rotating shaft; therefore, a sufficient amount of the lubricant is supplied as long as the number of revolutions is sufficiently large, but if the number of revolutions decreases, then the amount of the lubricant supplied decreases. As a result, the an insufficient amount of the lubricant is supplied, for example, to a plurality of the compression chambers 116 formed between the lap 115 and the lap 113, and the lubricating and sealing performance deteriorates with resultant deterioration of the whole performance, meaning deteriorated reliability.

SUMMARY OF THE INVENTION

[0010] The inventors have enthusiastically studied to solve the problem and found a solution thereto, which has led to the accomplishment of the present invention. According to the solution, a separate oil injection mechanism having a particular composition is installed in a particular position in the scroll compression element. Accordingly, it is an object of the present invention to provide a highly reliable scroll compressor with an improved oil injection mechanism. To solve the problem, there is provided a highly reliable scroll compressor equipped with an oil injection mechanism having a simple constitution in accordance with another aspect of the

present invention. This scroll compressor makes it possible to easily avoid insufficient supply of the lubricant to the compression chambers even when the number of revolutions of the rotary shaft decreases.

[0011] A scroll compressor described in Claim 1 of the present invention is equipped with an electric element and a scroll compression element driven by a rotating shaft of the electric element that are placed in a hermetic housing, a lubricant contained in the hermetic housing, and a lubricating portion provided on an end of the rotating shaft to supply the lubricant from the lubricating portion to respective sliding portions via an oil feed passage provided in the rotating shaft and circulate it for reuse, wherein: an oil injection mechanism composed of an oil nozzle for injecting oil and a valve for opening/closing an oil feed passage inlet of the oil nozzle by the elasticity of a spring is provided in the vicinity of a communication passage extending between a first suction inlet for taking in a refrigerant gas into the scroll compression element from outside the hermetic housing and a second suction inlet located in a position opposed to the first suction inlet and in communication with the first suction inlet through the communication passage, so that the valve opens the oil feed passage inlet to inject the lubricant held in the hermetic housing into the communication passage if the difference between the pressure in the hermetic housing that acts on the rear surface of the valve and the pressure in the communication passage that acts on the outlet of the oil nozzle is small, whereas the valve closes the oil feed passage inlet to stop the injection of the lubricant if the pressure differential is large.

[0012] According to another aspect of the invention described in Claim 2 of the present invention, the injection amount of the lubricant is 0.1 to 3% for the elimination volume per unit time in the scroll compressor described in Claim 1.

[0013] According to yet another aspect of the invention described in Claim 3 of the present invention, the valve opens the oil feed passage inlet to inject the lubricant if the pressure differential is less than the range of $4x10^5$ to $8x10^5$ N/m^2 (4 to 8 kgf/cm^2) in the scroll compressor described in Claims 1 or 2.

[0014] According to a further aspect of the invention described in Claim 4 of the invention, the lubrication system in the lubricating portion in the scroll compressor described in Claims 1 to 3 utilizes pressure differential or an oil pump.

[0015] According to a further aspect of the invention described in Claim 5 of the invention, in the scroll compressor described in Claims 1 to 4, the oil injection mechanism is provided in the vicinity of the communication passage extending from a line connecting the center of the rotating shaft and the center of the first suction inlet to a line drawn 90 degrees away from the center of the rotating shaft toward the second suction inlet, using the foregoing line as the baseline.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a sectional view showing the entire composition of an embodiment of the scroll compressor in accordance with an aspect of the present invention.

Fig. 2 is an enlarged schematic representation of portion A of Fig. 1.

Fig. 3 is a schematic representation showing the position where a lubricant is injected to a scroll compression element of another scroll compressor in accordance with the present invention.

Fig. 4 is a sectional view showing the entire composition of another conventional scroll compressor.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] One aspect of the present invention related to Claims 1 to 5 of the present application will now be described in conjunction with Fig. 1 through Fig. 4.

[0018] Figure 1 is a sectional view showing the entire composition of an embodiment of the scroll compressor in accordance with the aspect of the invention. Figure 2 is an enlarged schematic representation of portion A of Fig. 1. Figure 3 is a schematic representation illustrative of the position of the oil injection of another scroll compressor in accordance with the invention.

[0019] The compressor shown in Fig. 1 is a scroll compressor 120 equipped with a cylindrical hermetic housing 121 having its both ends closed. Housed in the hermetic housing 121 are an electric element 122 and a scroll compression element 123 driven by the electric element 122.

[0020] The electric element 122 has a stator 124 fixed in the hermetic housing 121 and a rotor 125 positioned at the center of the stator 124. A rotating shaft 126 oriented in the direction of the axial center of the hermetic housing 121 is connected to the center of the rotor 125 in a penetrating fashion, and one end thereof penetrates the center of a support frame 127 supporting the scroll compression element 123 so that it is rotatably supported. In this case, the support frame 127 is connected and secured to the inner wall surface of the hermetic housing 121. The middle portion near one end of the rotating shaft 126 is rotatably supported by a bearing 128 of the support frame 127, and the rotor 125 is supported on the inner wall surface of the hermetic housing 121 via the rotating shaft 126 and the support frame 127.

[0021] The central part of one end of the rotating shaft 126 penetrating the support frame 127 is formed as a pin or crank 129 provided eccentrically in relation to the axial center of the rotating shaft 126. A swivel scroll 130 is joined to the pin 129. The swivel scroll 130 is provided with a boss hole 131 in which the pin 129 is inserted for connection to the center of one side surface of a discoid

panel board, and a spiral lap 132 formed on the other side surface of the panel board.

[0022] A stationary scroll 133 is joined to the support frame 127. The stationary scroll 133 has a spiral lap 135 positioned in a zigzag fashion with respect to the lap 132 of the swivel scroll 130 so as to form a plurality of compression chambers 134.

[0023] Connected to the side wall surface of the stationary scroll 133 is an intake pipe 136 for refrigerant gas that penetrates the hermetic housing 121. Provided at the center of the stationary scroll 133 is a discharge port 137 for discharging a compressed refrigerant gas into the hermetic housing 121.

[0024] The intake side of the scroll compression element 123 of the refrigerant gas introduced through the intake pipe 136, the rear surface of the swivel scroll 130, i.e. the surface of the side where the boss hole 131 of the panel board is located, and the support frame 127 are in communication at the peripheral portion of the panel board of the swivel scroll 130. Hence, the pressure among those places is nearly as low as that at the foregoing refrigerant gas intake side and it is lower than the pressure in the hermetic housing 121.

[0025] A differential lubricating portion 138 is provided on the other end of the rotating shaft 126. The lubricating portion 138 is installed in the hermetic housing 121 to rotatably support the rotating shaft 126 and it is equipped with an auxiliary support frame 141 having an auxiliary bearing 140 with an oil introducing pipe 139 attached thereto. A bearing 142 is installed between the auxiliary support frame 141 and the rotating shaft 126, a receiving portion 143 of the bearing 142 being provided on the auxiliary bearing 140.

[0026] The rotating shaft 126 has an oil feed passage 144 extending from one end to the other end thereof. A small hole 145 communicating the oil feed passage 144 with the sliding surface of the bearing 128 is provided in the middle of the portion where the rotating shaft 126 is rotatably supported by the bearing 128. A spiral groove 146 in communication with the small hole 145 is provided in the surface of the rotating shaft 126, beginning from the outlet of the small hole 145 and extending toward the electric element 122 until the portion where the rotating shaft 126 is rotatably supported by the bearing 128. The lubricant that has left one end of the rotating shaft 126 gas-seals the boss hole 131 and the sliding surface of the pin 129, and the lubricant that has passed through the small hole 145 flows through the groove 146 to lubricate the sliding surface and also to gas-seal the sliding surface on the side of the scroll compression element 123 from the small hole 145.

[0027] The hermetic housing 121 is filled with the lubricant "b" up to a predetermined level. The lubricant "b" is sucked up from the lubricating portion 138 by the pressure differential mentioned above and it passes through the oil feed passage 144 provided in the rotating shaft 126 to be fed to respective sliding portions including the bearing 128. The lubricant is circulated for repeated use.

[0028] According to the invention, an oil injection mechanism 151 for injecting and supplying the lubricant is provided in the vicinity of an intake position 150 where the refrigerant gas is introduced from outside the hermetic housing 121 into the scroll compression element 123 via the intake pipe 136.

[0029] As shown in Fig. 2, the oil injection mechanism 151 is fixed to the support frame 127; it is composed of an oil nozzle 153 for injecting a lubricant through an oil feed passage 152 and a valve 156 that opens/closes an oil feed passage inlet 155 of the oil nozzle 153 by utilizing the elasticity of a spring 154. Reference numeral 157 denotes a fixing plug for fixing the oil injection mechanism 151, reference numeral 158 denotes a lubricant return passage, and reference numeral 159 denotes a lubricant branch passage. The oil injection mechanism 151 may be fixed at other location than the support frame 127; it may be secured, for example, to the stationary scroll 133.

[0030] The valve 156 shown in Fig. 1 and Fig. 2 is shaped like a cap that is capable of housing a part of the spring 154; it may, however, be shaped like a plate. In other words, there is no particular restriction on the shape of the valve. The clearance between the valve 156 and the support frame 127 fixing the valve 156, the diameter and the length of the oil feed passage 152 are to be determined properly.

[0031] When the operation of the horizontal type scroll compressor 120 having the constitution described above is begun, the refrigerant gas is sucked in through the intake pipe 136 to the intake position 150 of the outer peripheral portion of the scroll compression element 123, and compressed as it gradually moves toward the center of the scroll compressor. The refrigerant gas is discharged into the hermetic housing 121 through the discharge port 137 provided at the center of the stationary scroll 133 and the accompanying lubricant is separated in this space, thus suppressing pulsation.

[0032] The discharged gas flows through passages (not shown) provided in the stationary scroll 133 and the support frame 127 as indicated by the white arrows and reaches the electric element 122 side. And the lubricant in the refrigerant gas is further separated primarily by the centrifugal force generated by the rotation of the rotor 125 and by the baffle plate effect due to the stator 124, the auxiliary support frame 141, etc., then the refrigerant gas from which the lubricant has been separated is discharged out of the hermetic housing 121 through a discharge pipe 147. The separated lubricant flows as indicated by the black arrows and accumulates at the bottom of the hermetic housing 121 and it is circulated for repeated use.

[0033] Although it is not illustrated, the refrigerant gas intake side, the rear surface of the swivel scroll 130, and the support frame 127 are in communication; hence, the pressure among those places is substantially as low as that at the refrigerant gas intake side and it is lower than the pressure in the hermetic housing 121. This pressure

differential causes the lubricant "b" to be sucked up through the oil introducing pipe 139 of the lubricating portion 138 and supplied under high pressure via the oil feed passage 144 provided in the rotating shaft 126, as indicated by the black arrows. A part of the supplied high-pressure lubricant passes through the small hole 145 as indicated by the black arrows and flows through the groove 146 toward the electric element 122 to lubricate sliding surfaces before it reaches the bottom of the hermetic housing 121. The clearance between the rotating shaft 126 and the bearing 128 is extremely small. The clearance is set, for example, to approximately 10 to 30 (m; hence, the sliding portions of the rotating shaft 126 and the bearing 128 on the side of the scroll compression element 123 from the small hole 145 is well gas-sealed.

[0034] The high-pressure lubricant leaving one end of the rotating shaft 126 gas-seals the boss hole 131 and the sliding surface of the pin 129. After that, these lubricants flow between the swivel scroll 130 and the support frame 127 as indicated by the black arrows to lubricate the groove of an Oldham ring 148, then flows along the outer periphery of the panel board of the swivel scroll 130 to be supplied to the refrigerant gas intake side in the scroll compression element 123 to lubricate sliding surfaces. The lubricant is then discharged together with the compressed gas through the discharge port 137 into the hermetic housing 121, and separated from the compressed gas before reaching the bottom of the hermetic housing 121.

[0035] The Oldham ring 148 is installed between the support frame 127 and the swivel scroll 130; it is revolved on a circular orbit by being driven by the electric element 122 so that the swivel scroll 130 does not rotate with respect to the stationary scroll 133.

[0036] As long as the rotational speed of the rotating shaft 126 is high, this lubricating system is good enough to sufficiently lubricate the sliding surfaces of the scroll compression element 123. If the rotational speed of the rotating shaft 126 is low, then this lubricating system is not good enough; therefore, the oil injection mechanism 151 is actuated to inject and supply the lubricant if the rotational speed of the rotating shaft 126 is low.

[0037] The pressure in the hermetic housing 121 acts, via the lubricant, on the rear surface on the side of the fixing plug 157 of the valve 156 of the oil injection mechanism 151. When the difference between the pressure in the hermetic housing 121 and the pressure in the vicinity of the refrigerant gas intake position 150 acting on the outlet side of the oil nozzle 153 is small, the high elasticity of the spring 154 causes the valve 156 to push toward the fixing plug 157 to keep the oil feed passage inlet 155 open. Therefore, the lubricant held in the hermetic housing 121 flows in the direction indicated by the arrows via the lubricant return passage 158 and the lubricant branch passage 159, passes through the intake position 150 before it is injected to the scroll compression element 123.

[0038] When the pressure differential is high, the pressure differential causes the valve 156 to overcome the elasticity of the spring 154 and moves toward the oil nozzle 153, and the inner surface of the valve 156 comes in contact with the oil feed passage inlet 155 to close it, thus stopping the injection of the lubricant.

[0039] As set forth above, it is important to adjust the elasticity of the spring 154 so that, if the rotational speed of the rotating shaft 126 is high and the pressure in the hermetic housing 121 becomes higher than a predetermined level, then the injection of the lubricant by the oil injection mechanism is stopped, and if the rotational speed of the rotating shaft 126 is low and the pressure in the hermetic housing 121 becomes lower than the predetermined level, then the lubricant is injected by the oil injection mechanism 151.

[0040] The amount of injected lubricant is preferably about 3 % at the maximum for the elimination volume per unit time. The absence of the oil injection deteriorates the sealing performance; however, if the injection amount exceeds 3 %, then the volume effect deteriorates. Hence, the amount of the lubricant to be injected should be determined to obtain the best possible balance of the two factors.

[0041] The pressure differential for actuating the oil injection mechanism 151 is not particularly restricted. It is preferable, however, to normally set the pressure differential so that the valve 156 opens the oil feed passage inlet 155 to inject the lubricant when the pressure differential is lower than the range from about $4x10^5$ to about $8x10^5$ N/m^2 (about 4 to about 8 kgf/cm^2).

[0042] Figure 3 shows the position where the lubricant is injected to the scroll compression element of another scroll compressor in accordance with the present invention. The oil injection mechanism 151 (not shown) is provided at a location in the vicinity of a communication passage 161 located between a first suction inlet 160 provided on the stationary scroll 133 for taking the refrigerant gas into the scroll compression element 123 from outside the hermetic housing 121 and a second suction inlet 162 that is provided on the stationary scroll 133 at the position opposed to the first suction inlet 160 and that is in communication with the communication passage 161. In addition, the oil injection mechanism 151 is provided at the location in the vicinity of the communication passage 161 between a line "a" connecting a center 163 of the rotating shaft 126 and a center 164 of the first suction inlet 160 and a line "c" drawn 90 degrees away from the center 163 of the rotating shaft 126 toward the second suction inlet 162, using the line "a" as the baseline. The lubricant is injected from the oil injection mechanism 151 to the communication passage 161 located between the line "a" and the line "c" (an example of the injecting position is indicated by the black arrow). Except this part of constitution, this scroll compressor in accordance with the invention shares the same constitution as that of the scroll compressor 120 shown in Fig. 1 and Fig. 2.

[0043] The refrigerant gas is introduced through the two places, namely, the first suction inlet 160 and the second suction inlet 162, so that the intake efficiency of the refrigerant gas is improved. Moreover, the lubricant that has been injected at the particular position of the communication passage 161 is uniformly supplied to the scroll compression element 123 by the refrigerant gas that has been taken in; therefore, the sealing performance and lubricating performance are further improved.

[0044] Specific examples of the refrigerant employed in the present invention are HFC-based refrigerants such as 1, 1, 1, 2-tetrafluoroethane (R134a) simple substance, a mixed refrigerant (R407C) of R134a, difluoromethane (R-32), and pentafluoroethane (R-125), and the mixed refrigerant (R410A) of R-32 and R-125, or HCFC-based refrigerants such as a simple substance or a mixed refrigerant of hydrochloro-difluoromethane (R22).

[0045] Specific examples of the lubricant employed in the present invention are ester-based oils or ether-based oils compatible with the refrigerants mentioned above, or alkylbenzene-based oils incompatible with the refrigerants, or mixtures of these.

[0046] The above description of the scroll compressor in accordance with the present invention refers to a horizontal type scroll compressor. The scroll compressor in accordance with the invention, however, is not limited to the horizontal type; the invention is applicable also to a vertical scroll compressor or other types of scroll compressors.

[0047] The scroll compressor in accordance with the invention is equipped with the oil injection mechanism of the simple construction that makes it easy to avoid insufficient lubricant supplied to the scroll compression element when the number of revolutions of the rotating shaft decreases thereby to permit stable operation with good sealing and lubricating performance, high reliability, and high compression efficiency over an extended period of time.

Claims

1. A scroll compressor (120) comprising: an electric element (122) and a scroll compression element (123) driven by a rotating shaft (126) of said electric element (122) that are housed in a hermetic housing (121), a lubricant (b) contained in said hermetic housing (121), and a lubricating portion provided on an end of said rotating shaft (126), the lubricant (b) being supplied from said lubricating portion to respective sliding portions via an oil feed passage (144) provided in said rotating shaft (126) and circulated for reuse, wherein: an oil injection mechanism (151) composed of an oil nozzle (153) for injecting oil and a valve (156) for opening/closing an oil feed passage inlet (155) of said oil nozzle (153) by the elasticity of a spring (154) is provided in the vicinity of a communication passage (161) between a first suction inlet (160) for taking in a refrigerant gas into said scroll compression element (123) from outside said hermetic housing (121) and a second suction inlet (162) that is located in a position opposed to said first suction inlet (160) and placed in communication with said first suction inlet (160) through said communication passage (161), so that said valve (156) opens said oil feed passage inlet (155) to inject the lubricant (b) held in said hermetic housing (121) into said communication passage (161) if the difference between the pressure in said hermetic housing (121) that acts on the rear surface of said valve (156) and the pressure in said communication passage that acts on an outlet of said oil nozzle (153) is small, whereas said valve closes said oil feed passage inlet to stop the injection of the lubricant if said pressure differential is large.

2. A scroll compressor (120) according to claim 1, wherein the injection amount of the lubricant (b) is set to 0.1 to 3% for the elimination volume per unit time.

3. A scroll compressor (120) according to claim 1 or 2, wherein said valve (156) opens said oil feed passage inlet (155) to inject the lubricant (b) if said pressure differential is less than a range of $4 \cdot 10^5$ to $8 \cdot 10^5$ N/m^2 (4 to 8 kgf/cm^2).

4. A scroll compressor (120) according to claims 1 to 3, wherein a lubrication system in said lubricating portion utilizes pressure differential or an oil pump.

5. A scroll compressor (120) according to claims 1 to 4, wherein said oil injection mechanism (151) is provided in the vicinity of said communication passage extending from a line connecting the center of said rotating shaft (126) and the center of said first suction inlet to a line drawn 90 degrees away from the center of said rotating shaft (126) toward said second suction inlet, using said line as a baseline.

Fig. 1

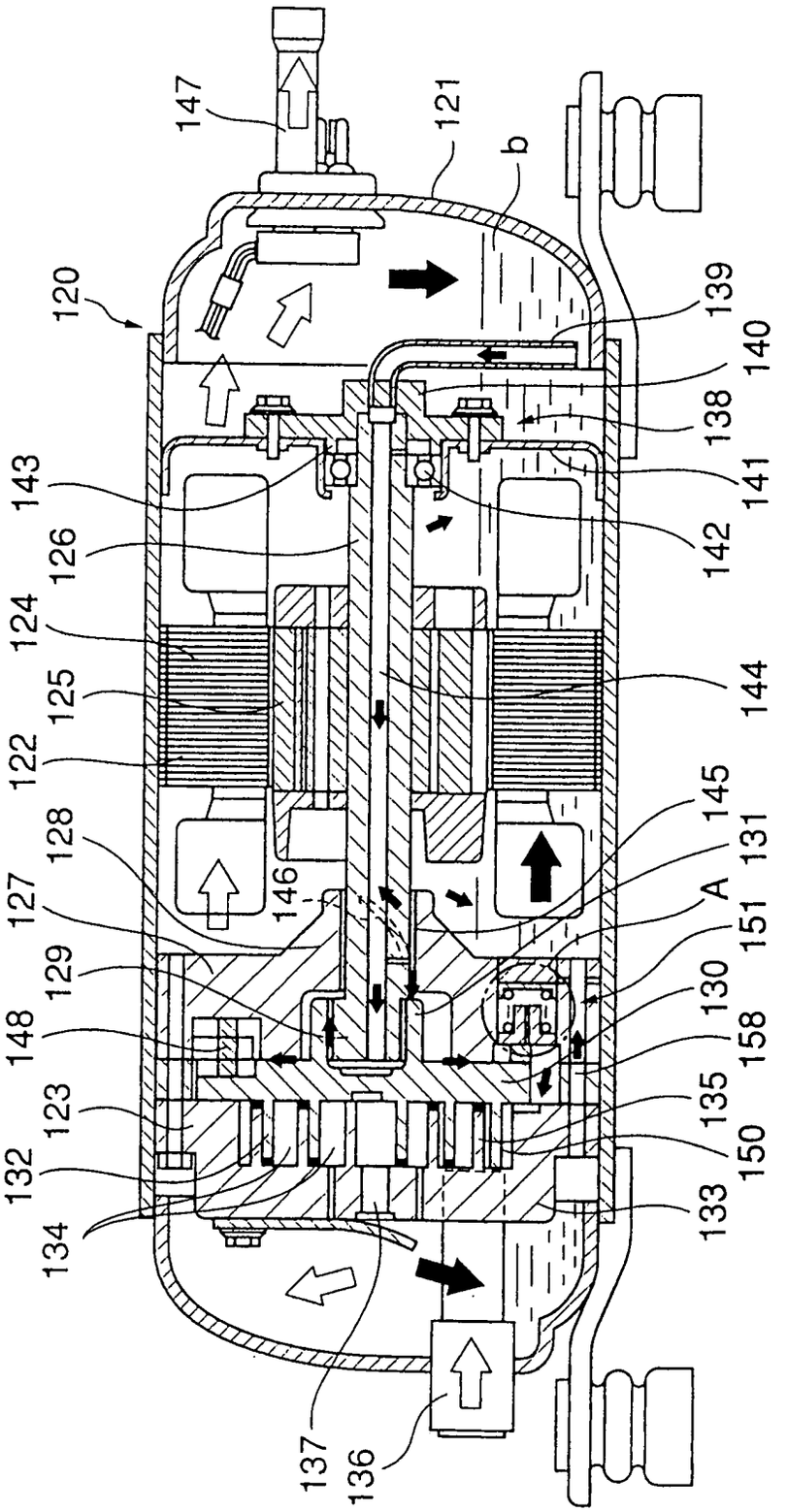
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Fig. 2

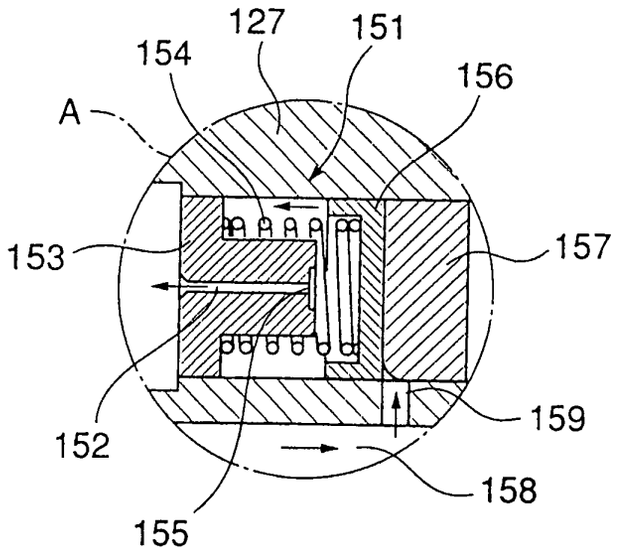
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Fig. 3

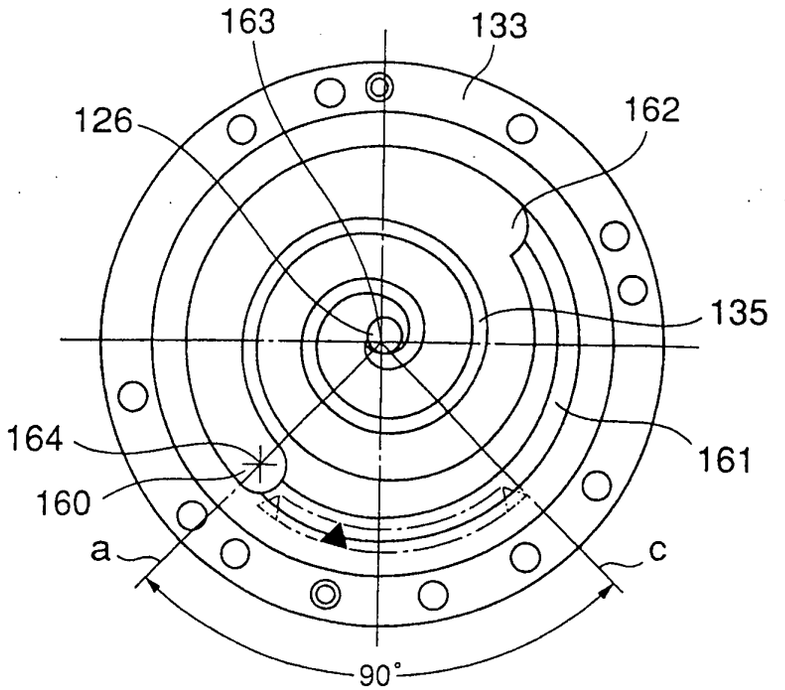
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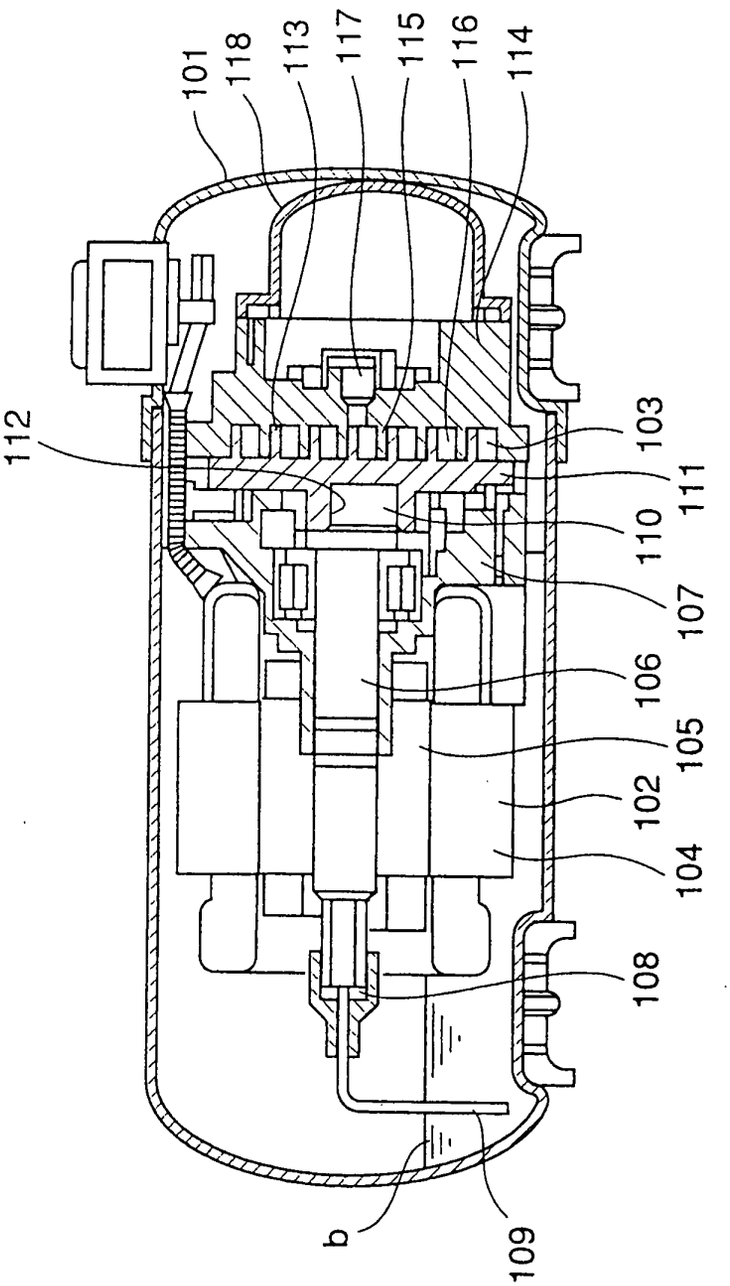
Fig. 4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EUROPEAN SEARCH REPORT

Application Number
EP 03 00 6365

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	PATENT ABSTRACTS OF JAPAN vol. 18, no. 297 (M-1617), 7 June 1994 (1994-06-07) -& JP 06 058273 A (DAIKIN IND LTD), 1 March 1994 (1994-03-01) * abstract *	1,4	F04C18/02 F04C29/08 F04C29/02
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 297 (M-1617), 7 June 1994 (1994-06-07) -& JP 06 058270 A (DAIKIN IND LTD), 1 March 1994 (1994-03-01) * abstract *	1,4	
A	PATENT ABSTRACTS OF JAPAN vol. 015, no. 069 (M-1083), 19 February 1991 (1991-02-19) & JP 02 294580 A (DAIKIN IND LTD), 5 December 1990 (1990-12-05) * abstract *	1,4	
A	US 4 494 914 A (SHIIBAYASHI) 22 January 1985 (1985-01-22) * column 10, line 6 - line 33; figures 11,12 *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7) F04C F01C
A	EP 0 648 932 A (KABUSHIKI KAISHA TOYODA JIDOSHOKKI SEISAKUSHO) 19 April 1995 (1995-04-19) * claim 1; figure 3 *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 011, no. 025 (M-556), 23 January 1987 (1987-01-23) & JP 61 197786 A (TOSHIBA CORP), 2 September 1986 (1986-09-02) * abstract *	1	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	4 April 2003	Dimitroulas, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EUROPEAN SEARCH REPORT

Application Number
EP 03 00 6365

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 5 110 268 A (SAKURAI ET AL.) 5 May 1992 (1992-05-05) * claim 1; figure 1 * ---	1	
A	PATENT ABSTRACTS OF JAPAN vol. 007, no. 159 (M-228), 13 July 1983 (1983-07-13) & JP 58 067986 A (HITACHI SEISAKUSHO KK), 22 April 1983 (1983-04-22) * abstract * ---	1	
A	PATENT ABSTRACTS OF JAPAN vol. 008, no. 270 (M-344), 11 December 1984 (1984-12-11) & JP 59 141785 A (MITSUBISHI DENKI KK), 14 August 1984 (1984-08-14) * abstract * ---	1	
A	DE 92 10 747 U (INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE) 12 November 1992 (1992-11-12) * claims 1-4; figure 6 * ---	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	PATENT ABSTRACTS OF JAPAN vol. 015, no. 013 (M-1069), 11 January 1991 (1991-01-11) & JP 02 264181 A (HITACHI LTD), 26 October 1990 (1990-10-26) * abstract * ---	1	
A	US 5 013 225 A (RICHARDSON, JR.) 7 May 1991 (1991-05-07) * column 5, line 14 - column 6, line 19; figure 1 * ---	1	
	-/--		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	4 April 2003	Dimitroulas, P

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Application Number
EP 03 00 6365

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 5 660 539 A (MATSUNAGA ET AL.) 26 August 1997 (1997-08-26) * column 7, line 55 - column 8, line 6; figure 1 * * column 8, line 51 - column 9, line 32; figures 1,2 *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 015, no. 427 (M-1174), 30 October 1991 (1991-10-30) & JP 03 179189 A (HITACHI LTD), 5 August 1991 (1991-08-05) * abstract *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 545 (M-1337), 16 November 1992 (1992-11-16) & JP 04 203377 A (HITACHI LTD), 23 July 1992 (1992-07-23) * abstract *	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	4 April 2003	Dimitroulas, P

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04-04-2003

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 06058273 A	01-03-1994	NONE	
JP 06058270 A	01-03-1994	NONE	
JP 02294580 A	05-12-1990	JP 2035590 C JP 7065574 B	28-03-1996 19-07-1995
US 4494914 A	22-01-1985	JP 58172404 A DE 3312280 A1 KR 8800832 B1	11-10-1983 20-10-1983 14-05-1988
EP 648932 A	19-04-1995	JP 3144611 B2 JP 7119653 A DE 69415916 D1 DE 69415916 T2 EP 0648932 A1 US 5501584 A	12-03-2001 09-05-1995 25-02-1999 01-07-1999 19-04-1995 26-03-1996
JP 61197786 A	02-09-1986	NONE	
US 5110268 A	05-05-1992	JP 2816210 B2 JP 3175186 A	27-10-1998 30-07-1991
JP 58067986 A	22-04-1983	NONE	
JP 59141785 A	14-08-1984	NONE	
DE 9210747 U	12-11-1992	DE 9210747 U1	12-11-1992
JP 02264181 A	26-10-1990	JP 2708537 B2	04-02-1998
US 5013225 A	07-05-1991	NONE	
US 5660539 A	26-08-1997	JP 3344843 B2 JP 8121366 A JP 8261177 A CN 1132826 A ,B	18-11-2002 14-05-1996 08-10-1996 09-10-1996
JP 03179189 A	05-08-1991	JP 2607707 B2	07-05-1997
JP 04203377 A	23-07-1992	NONE	

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