



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) **EP 1 464 839 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
06.10.2004 Bulletin 2004/41

(51) Int Cl.7: **F04C 18/02**, F04C 29/02,
F04C 29/00, F04C 27/00

(21) Application number: **04007456.9**

(22) Date of filing: **26.03.2004**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PL PT RO SE SI SK TR**
Designated Extension States:
AL LT LV MK

(30) Priority: **31.03.2003 JP 2003096121**

(71) Applicant: **Kabushiki Kaisha Toyota Jidoshokki
Kariya-shi, Aichi-ken (JP)**

(72) Inventors:
• **Kawaguchi, Masahiro
Kariya-shi Aichi-ken (JP)**
• **Iwasa, Jiro
Kariya-shi Aichi-ken (JP)**

• **Iguchi, Masao
Kariya-shi Aichi-ken (JP)**
• **Sakamoto, Masaya
Kariya-shi Aichi-ken (JP)**
• **Sato, Shinya
Kariya-shi Aichi-ken (JP)**
• **Tashiro, Tomoharu
Kariya-shi Aichi-ken (JP)**
• **Yamanouchi, Akihito
Kariya-shi Aichi-ken (JP)**

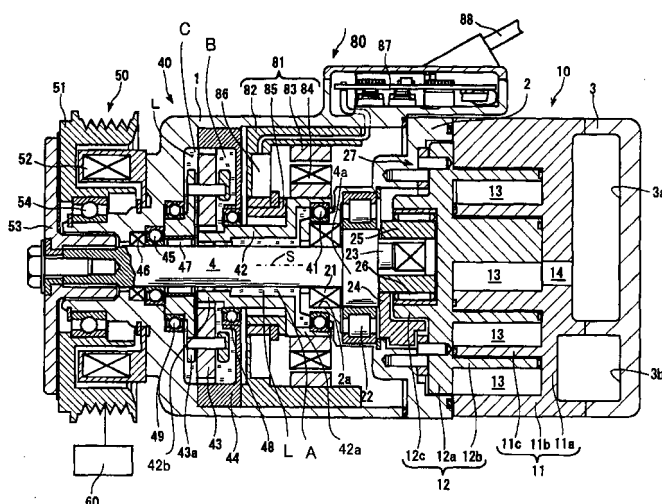
(74) Representative:
**Leson, Thomas Johannes Alois, Dipl.-Ing.
Patentanwälte
Tiedtke-Bühling-Kinne & Partner,
Bavariaring 4
80336 München (DE)**

(54) **Hybrid compressor**

(57) A hybrid compressor includes a housing, a rotary shaft, a compression mechanism and a drive mechanism. The rotary shaft is rotatably supported by the housing. The compression mechanism is located in the housing and connected to the rotary shaft for compressing refrigerant gas. The drive mechanism is located in the housing for driving the compression mechanism. A

speed-changing mechanism is located in the housing for transmitting power from the drive mechanism to the compression mechanism via the rotary shaft. The speed-changing mechanism varies the rotational speed of the drive mechanism. A sealing mechanism is located in the housing for sealing a space partially defined by the speed-changing mechanism.

FIG. 1



EP 1 464 839 A1

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a hybrid compressor preferably used in a vehicle air-conditioning system.

[0002] Japanese Unexamined Patent Publication No. 11-93876 discloses a hybrid compressor that includes a housing, a compression mechanism, a drive mechanism and a transmission mechanism. The compression mechanism and the drive mechanism are provided in the housing, and the transmission mechanism is provided outside the housing. The compression mechanism sucks refrigerant gas, compresses it and discharges it. The drive mechanism includes an electric motor that rotates a rotary shaft through a speed-changing mechanism for driving the compression mechanism. The transmission mechanism transmits power to the drive shaft from an external drive source such as an engine that is located outside the housing. This reference discloses scroll type and vane type compression mechanisms, an induction motor as the electric motor of the drive mechanism and an electromagnetic clutch as the transmission mechanism.

[0003] In the hybrid compressor, when the external drive source is in an operational state, the power is transmitted from the external drive source to the rotary shaft through the transmission mechanism to drive the compression mechanism. On the other hand, when the external drive source is in a stop state, the drive mechanism rotates the rotary shaft through the speed-changing mechanism that reduces the rotational speed of the rotary shaft to drive the compression mechanism. Thus, even if the external drive source is either in the operational state or the stop state, the compressor is operated to work the vehicle air-conditioning system. Therefore, comfort of car interior is maintained.

[0004] Meanwhile, the refrigerant gas and the lubricating oil sent from the compression mechanism respectively cool and lubricate the electric motor and the speed-changing mechanism. However, it has been proven in prior art that the lubricating oil sent only from the compression mechanism is insufficient for lubricating the speed-changing mechanism. Thus, in the conventional hybrid compressor, the function of the speed-changing mechanism deteriorates after a long period of time, and the efficiency and the life of the hybrid compressor also deteriorate.

SUMMARY OF THE INVENTION

[0005] The present invention provides a hybrid compressor that maintains its efficiency and its life even though the hybrid compressor is used for a long period of time.

[0006] According to the present invention, a hybrid compressor includes a housing, a rotary shaft, a com-

pression mechanism and a drive mechanism. The rotary shaft is rotatably supported by the housing. The compression mechanism is located in the housing and connected to the rotary shaft for compressing refrigerant gas. The drive mechanism is located in the housing for driving the compression mechanism. A speed-changing mechanism is located in the housing for transmitting power from the drive mechanism to the compression mechanism via the rotary shaft. The speed-changing mechanism varies the rotational speed of the drive mechanism. A sealing mechanism is located in the housing for sealing a space partially defined by the speed-changing mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The features of the present invention that are believed to be novel are set forth with particularity in the appended claims. The invention together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

FIG. 1 is a longitudinal cross-sectional view of the hybrid compressor according to a first preferred embodiment of the present invention; and

FIG. 2 is a longitudinal cross-sectional view of the hybrid compressor according to a second preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0008] First and second preferred embodiments according to the present invention will be respectively described in reference to FIGs. 1 and 2. Now, the first preferred embodiment will be described. As shown in FIG. 1, a housing of a hybrid compressor includes a front housing 1, a center housing 2, a fixed scroll member 11 and a rear housing 3. The front housing 1 is fixed to the center housing 2. The hybrid compressor includes a compression mechanism 10, a drive mechanism 80, a speed-reducing mechanism 40 and an electromagnetic clutch 50. The compression mechanism 10 is located in the center housing 2, the fixed scroll member 11 and the rear housing 3. The drive mechanism 80 and the speed-reducing mechanism 40 are located in the front housing 1. The electromagnetic clutch 50 as a transmission mechanism is located outside the front housing 1. A first housing includes the center housing 2, the fixed scroll member 11 and the rear housing 3. The fixed scroll member 11 and the rear housing 3 correspond to a first housing main body, and the center housing 2 corresponds to a partition wall. The front housing 1 corresponds to a second housing.

[0009] The compression mechanism 10 includes the fixed scroll member 11 and a movable scroll member 12

that are engaged with each other to define compression chambers 13. The fixed scroll member 11 includes a fixed base plate 11a, a shell portion 11b and a fixed spiral wall 11c. The shell portion 11b is fixed to the center housing 2 and the rear housing 3 and is sandwiched between the center housing 2 and the rear housing 3. The shell portion 11b constitutes the outer periphery of the fixed scroll member 11. The fixed base plate 11a has a disc shape and is formed integrally with the shell portion 11b at the side of the rear housing 3. The fixed spiral wall 11c protrudes from the fixed base plate 11a toward the center housing 2 in an involute curve. The movable scroll member 12 includes a movable base plate 12a, a movable spiral wall 12b and a boss 12c. The movable base plate 12a has a disc shape. The movable spiral wall 12b protrudes from the movable base plate 12a toward the rear housing 3 in an involute curve. The compression chambers 13 are defined by the fixed base plate 11a, the fixed spiral wall 11c, the movable base plate 12a and the movable spiral wall 12b. The boss 12c is formed on the movable base plate 12a in the center housing 2.

[0010] A suction chamber 3b and a discharge chamber 3a are defined by the fixed scroll member 11 and the rear housing 3. Although not shown, a suction port extends through the outer periphery of the fixed base plate 11a to interconnect the suction chamber 3b and the compression chambers 13. The suction chamber 3b is also connected to an evaporator of a refrigeration circuit that is not shown. A discharge port 14 extends through the center of the fixed base plate 11a to interconnect the compression chambers 13 and the discharge chamber 3a. The discharge chamber 3a is connected to a condenser of the refrigeration circuit that is not shown.

[0011] A shaft hole 2a is formed in the center housing 2. A rotary shaft 4 is inserted through the shaft hole 2a. A shaft seal device 21 is arranged between the rotary shaft 4 and the shaft hole 2a. Thus, the center housing 2 is hermetically fixed to the front housing 1. The rotary shaft 4 is rotatably supported by the center housing 2 via the shaft seal device 21 and a radial bearing 22. A slide key 23 is protruded from the inner end of a large diameter portion 4a of the rotary shaft 4 and is offset from a central axis S of the rotary shaft 4. A counter weight 24 is fitted to a drive bush 25 that is inserted to the slide key 23. The boss 12c of the movable scroll member 12 is supported by the drive bush 25 via a radial bearing 26. A self-rotation preventing mechanism 27 is provided between the center housing 2 and the movable base plate 12a for preventing the movable base plate 12a from self-rotating.

[0012] The drive mechanism 80 includes a direct current motor (a DC motor) 81 for rotationally driving the rotary shaft 4 and a printed circuit board 87 that has integrated circuits (IC) for controlling the DC motor 81. The DC motor 81 includes a casing 82, a pair of permanent magnets 83, a rotor 84 and a brush 85. The casing

82 has a cylindrical shape. The outer circumferential surface of the casing 82 is fixed to the front housing 1. The pair of the permanent magnets 83 are fixed to the inner circumferential surface of the casing 82 and face each other. The rotor 84 has a cylindrical shape and is rotatably provided inside the casing 82. A plurality of salient poles has winding wire and is mounted on the outer circumferential surface of the rotor 84. The salient poles are arranged around the central axis S. The brush 85 electrically contacts the rotor 84 through a sun gear 42 for switching the direction of electric current applied to the winding wire. The brush 85 is electrically connected to the printed circuit board 87 via a connector 86. The printed circuit board 87 is connected via a cable 88 to a computer that is not shown.

[0013] The speed-reducing mechanism 40 for reducing the rotational speed of the rotary shaft 4 relative to the rotational speed of the drive mechanism 80 transmits driving power from the drive mechanism 80 to the compression mechanism 10. The speed-reducing mechanism 40 includes a planetary gear mechanism that has the sun gear 42, three planetary gears 43 and an internal gear 44. A part 42a of the sun gear 42 is fitted into the rotor 84 of the DC motor 81 to rotate integrally. External gear teeth are formed on the outer circumferential surface of a part 42b of the sun gear 42. A shield bearing 41 is arranged between the sun gear 42 and the center housing 2. Thus, the sun gear 42 and the rotor 84 are rotatably supported by the center housing 2 via the shield bearing 41. Internal gear teeth are formed on the inner circumferential surface of the internal gear 44. The internal gear 44 is fixed to the front housing 1 and rotatably supports the sun gear 42 via a shield bearing 48. The three planetary gears 43 are rotatably provided between the sun gear 42 and the internal gear 44. External gear teeth are formed on the outer circumferential surface of each of the planetary gears 43 and are engaged with the external gear teeth of the sun gear 42 as well as the internal gear teeth of the internal gear 44. Each of the planetary gears 43 is connected to an arm 43a. The arm 43a is rotatably supported by the front housing 1 via a shield bearing 49, and the rotary shaft 4 is supported by the front housing 1 via a shaft seal device 46 and a shield bearing 45. Thus, the speed-reducing mechanism 40 is sealed by the shaft seal devices 21 and 46, the shield bearings 41, 48, 49 and 45. Namely, a space A is substantially defined by the sun gear 42, the rotary shaft 4 and the center housing 2 and is sealed by the shield bearing 41 and the shaft seal device 21. A space B is substantially defined by the sun gear 42, the planetary gears 43 and the internal gear 44 and is sealed by the shield bearing 48. A space C is substantially defined by the planetary gears 43, the arm 43a, the rotary shaft 4 and the front housing 1 and is sealed by the shield bearings 49 and 45 and the shaft seal device 46. The spaces A, B and C communicate with each other and constitute the internal space of the speed-reducing mechanism 40. Lubricating oil L is

stored inside the spaces A, B and C of the speed-reducing mechanism 40 and does not leak to the outside due to the above sealing mechanism. The shaft seal devices 21 and 46, the shield bearings 41, 48, 49 and 45 correspond to a sealing mechanism.

[0014] A one-way clutch 47 is arranged between the arm 43a of the speed-reducing mechanism 40 and the rotary shaft 4. The one-way clutch 47 is the same type of the one-way clutch as disclosed in Japan Unexamined Patent Publication No. 2002-276775. The one-way clutch 47 transmits power from the speed-reducing mechanism 40 to the rotary shaft 4 and blocks power from the rotary shaft 4 to the speed-reducing mechanism 40.

[0015] The electromagnetic clutch 50 is provided outside the front housing 1. The electromagnetic clutch 50 includes a hub 53, a pulley 51 and a coil 52. The hub 53 has an armature and is fixed to the outer end of the rotary shaft 4. The pulley 51 is rotatably provided at the front housing 1 via a bearing device 54. The pulley 51 is wound to a belt that is not shown, and the belt is connected to an engine 60 as an external drive source. The coil 52 is fixed to the front housing 1 in the pulley 51. When an electric current is applied to the coil 52, the armature of the hub 53 moves and is magnetically connected to the pulley 51, and the rotary shaft 4 is rotated synchronously with the pulley 51. Thus, driving power is transmitted from the engine 60 to the rotary shaft 4. On the other hand, when electric current is not applied to the coil 52, the armature of the hub 53 moves away from the pulley 51, and the rotary shaft 4 is not rotated by the pulley 51. Thus, the driving power is not transmitted from the engine 60 to the rotary shaft 4.

[0016] In the above-constructed hybrid compressor, when electric current is not applied to the electromagnetic clutch 50 but is applied to the DC motor 81, the drive mechanism 80 drives the compression mechanism 10. Namely, when the electric current is not applied to the coil 52 of the electromagnetic clutch 50, the pulley 51 and the hub 53 is separated from each other. Thus, the pulley 51 idles, and the driving power is not transmitted from the engine 60 to the rotary shaft 4. When the electric current is applied to the DC motor 81, the rotor 84 rotates. Since the part 42a of the sun gear 42 of the planetary gear mechanism is fitted into the rotor 84, the sun gear 42 rotates integrally with the rotor 84. In accordance with the rotation of the sun gear 42, the arm 43a is rotated via the planetary gears 43. The rotational speed of the arm 43a is reduced due to the gear ratio among the sun gear 42, the planetary gears 43 and the internal gear 44. Then, the rotary shaft 4 rotates via the one-way clutch 47 at the same rotational speed of the arm 43a. Therefore, the rotation of the rotor 84 is transmitted to the drive shaft 4 via the speed-reducing mechanism 40 that reduces the rotational speed of the rotor 84.

[0017] When the rotary shaft 4 rotates, the slide key 23 orbits around the central axis S. The cooperation of

the drive bush 25 that is fitted to the slide key 23 and the self-rotation preventing mechanism 27 allows the movable scroll member 12 to orbit around the central axis S. As the compression chamber 13 that is defined by the fixed base plate 11a, the fixed spiral wall 11c, the movable base plate 12a and the movable spiral wall 12b moves toward the center of the fixed scroll member 11, the compression chambers 13 sequentially reduce in volume. In this way, the compression mechanism 10 is driven by the rotation of the rotary shaft 4. Refrigerant gas is introduced from the refrigeration circuit via the suction chamber 3b to the compression chambers 13 in a suction process and is compressed due to the movement of the compression chambers 13. Then, the compressed refrigerant gas is discharged from the compression chambers 13 to the refrigeration circuit via the discharge port 14 and the discharge chamber 3a.

[0018] On the other hand, when electric current is not applied to the DC motor 81 but is applied to the coil 52 of the electromagnetic clutch 50, the engine 60 drives the compression mechanism 10 via the electromagnetic clutch 50. Namely, when the electric current is not applied to the DC motor 81, the rotor 84 does not rotate, and the driving power is not transmitted from the drive mechanism 80 to the rotary shaft 4 via the speed-reducing mechanism 40. When the electric current is applied to the coil 52 of the electromagnetic clutch 50, the pulley 51 is magnetically connected to the hub 53, and the driving power is transmitted from the engine 60 to the rotary shaft 4 via the electromagnetic clutch 50. When the rotary shaft 4 rotates, the compression mechanism 10 is driven as described above. In this way, the engine 60 drives the compression mechanism 10 via the electromagnetic clutch 50. Furthermore, when the electric current is not applied to DC motor 81 and the electromagnetic clutch 50, the drive of the compression mechanism 10 is stopped.

[0019] In the hybrid compressor, the speed-reducing mechanism 40 that transmits the power from the drive mechanism 80 to the compression mechanism 10 is sealed by the shaft seal devices 21 and 46, the shield bearings 41, 48, 49 and 45 from the drive mechanism 80 and the compression mechanism 10. Thus, the lubricating oil L is utilized only for the speed-reducing mechanism 40 and sufficiently lubricates the speed-reducing mechanism 40. Furthermore, the lubricating oil L in the speed-reducing mechanism 40 is substantially prevented from leaking to the outside of the speed-reducing mechanism 40 due to the above sealing. Thus, the compression mechanism 10, the drive mechanism 80 and the electromagnetic clutch 50 are protected from the lubricating oil L. The drive mechanism 80 and the electromagnetic clutch 50 perform a long life in comparison to the prior art components due to the block of the damage caused by the lubricating oil. For the above reason, even though the hybrid compressor in the first preferred embodiment is used for a long period, the efficiency of the hybrid compressor is hard to deteriorate.

[0020] In the hybrid compressor, the shaft seal device 21 is arranged between the rotary shaft 4 and the shaft hole 2a so that the center housing 2 is hermetically fixed to the front housing 1. Thus, the drive mechanism 80 is separated from the compression mechanism 10, and the refrigerant gas and lubricating oil in the compression mechanism 10 is prevented from invading the drive mechanism 80. Therefore, the DC motor 81 is utilized as the motor of the drive mechanism 80.

[0021] Furthermore, since the speed-reducing mechanism 40 for reducing the speed of the rotary shaft 4 transmits the power from the drive mechanism 80 to the compression mechanism 10 in the hybrid compressor, the rotational torque of the DC motor 81 can be small. Thus, the DC motor 81 is miniaturized, and the hybrid compressor is miniaturized due to the miniaturized DC motor 81.

[0022] The one-way clutch 47 is arranged between the speed-reducing mechanism 40 and the rotary shaft 4 in the hybrid compressor. The one-way clutch 47 transmits the driving power from the DC motor 81 to the rotary shaft 4 via the speed-reducing mechanism 40 and blocks the power that is applied to the compression mechanism 10 from the rotary shaft 4 to the speed-reducing mechanism 40. Thus, since the speed-reducing mechanism 40 and the drive mechanism 80 are not load for the compression mechanism 10, the compression mechanism 10 is prevented from being locked.

[0023] The compression mechanism 10 is located in the first housing including the center housing 2, the fixed scroll member 11 and the rear housing 3. The speed-reducing mechanism 40 and the drive mechanism 80 are located in the second housing or the front housing 1. The second housing is fixed to the first housing. Thus, the second housing is only modified and the first housing is shared as a common portion, the structure and the combination of the drive mechanism 80 and the speed-reducing mechanism 40 are modified variously.

[0024] Meanwhile, the speed-reducing mechanism 40 and the one-way clutch 47 are alternatively removed from the hybrid compressor, and the rotor 84 of the drive mechanism 80 is directly connected to the rotary shaft 4. When electric current is applied to the electromagnetic clutch 50, the driving power is transmitted from the engine 60 to the rotary shaft 4 via the electromagnetic clutch 50. As the rotary shaft 4 rotates, the rotor 84 of the drive mechanism 80 is rotated in the permanent magnets 83. Thus, the drive mechanism 80 generates electric power and function as a power generation mechanism. In this case, when the compression mechanism 10 does not substantially introduce, compress and discharge the refrigerant gas while the compression mechanism 10 is driven, all of the torque of the rotary shaft 4 is substantially utilized for generating the electric power. Furthermore, in this case, a pulley can be utilized to connect the engine 60 to the rotary shaft 4 instead of the electromagnetic clutch 50.

[0025] Now, the second preferred embodiment will be

described. As shown in FIG. 2, a housing of a hybrid compressor housing includes a front housing 1, a center housing 2, a fixed scroll member 11 and a rear housing 3. The front housing 1 is fixed to the center housing 2. The hybrid compressor also includes a compression mechanism 10, a drive mechanism 70, a speed-reducing mechanism 40 and an electromagnetic clutch 50. The compression mechanism 10 is located in the center housing 2, the fixed scroll member 11 and the rear housing 3. The drive mechanism 70 and the speed-reducing mechanism 40 are located in the front housing 1. The electromagnetic clutch 50 is located outside the front housing 1. A first housing includes the center housing 2, the fixed scroll member 11 and the rear housing 3. The fixed scroll member 11 and the rear housing 3 correspond to a first housing main body, and the center housing 2 corresponds to a partition wall. The front housing 1 corresponds to a second housing.

[0026] The compression mechanism 10 includes the fixed scroll member 11 and a movable scroll member 12 that are engaged with each other to define compression chambers 13. The fixed scroll member 11 includes a fixed base plate 11a, a shell portion 11b and a fixed spiral wall 11c. The shell portion 11b is fixed to the center housing 2 and the rear housing 3 and is sandwiched between the center housing 2 and the rear housing 3. The shell portion 11b constitutes the outer periphery of the fixed scroll member 11. The fixed base plate 11a has a disc shape and is formed integrally with the shell portion 11b at the side of the rear housing 3. The fixed spiral wall 11c protrudes from the fixed base plate 11a toward the center housing 2 in an involute curve. The movable scroll member 12 includes a movable base plate 12a, a movable spiral wall 12b and a boss 12c. The movable base plate 12a has a disc shape. The movable spiral wall 12b protrudes from the movable base plate 12a toward the rear housing 3 in an involute curve. The compression chambers 13 are defined by the fixed base plate 11a, the fixed spiral wall 11c, the movable base plate 12a and the movable spiral wall 12b. The boss 12c is formed on the movable base plate 12a in the center housing 2.

[0027] A suction chamber 3b and a discharge chamber 3a are defined by the fixed scroll member 11 and the rear housing 3. Although not shown, a suction port extends through the outer periphery of the fixed base plate 11a to interconnect the suction chamber 3b and the compression chambers 13. The suction chamber 3b is connected to an evaporator of a refrigeration circuit that is not shown. A discharge port 14 extends through the center of the fixed base plate 11a and interconnects the compression chambers 13 and the discharge chamber 3a. The discharge chamber 3a is connected to a condenser of the refrigeration circuit that is not shown.

[0028] A rotary shaft 4 is rotatably supported in the center housing 2 via a radial bearing 22. A slide key 23 is protruded from the inner end of a large diameter portion 4a of the rotary shaft 4 and is offset from a central

axis S of the rotary shaft 4. A counter weight 24 is fitted to a drive bush 25 that is inserted to the slide key 23. The boss 12c of the movable scroll member 12 is supported by the drive bush 25 via a radial bearing 26. A self-rotation preventing mechanism 27 is provided between the center housing 2 and the movable base plate 12a for preventing the movable base plate 12a from self rotating.

[0029] The drive mechanism 70 includes an induction motor 71 for rotationally driving the rotary shaft 4 and a printed circuit board 77 that has integrated circuits (IC) for controlling the induction motor 71. The induction motor 71 includes a yoke 72, a plurality of coils 73 and a rotor 74. The yoke 72 has a cylindrical shape, and the outer circumferential surface of the yoke 72 is fixed to the front housing 1. A plurality of the coils 73 is provided on the inner circumferential surface of the yoke 72. The rotor 74 has a cylindrical shape and is rotatably provided inside the yoke 72. The coils 73 are electrically connected to the printed circuit board 77 via a wiring and a connector 76. The wiring is partially shown in FIG. 2. The printed circuit board 77 is connected via a cable 78 to a computer that is not shown.

[0030] The speed-reducing mechanism 40 is provided between the drive mechanism 70 and the compression mechanism 10. The speed-reducing mechanism 40 includes a planetary gear mechanism that has a sun gear 42, three planetary gears 43 and an internal gear 44. An O-ring 44a is provided on the outer circumferential surface of the internal gear 44. A part 42a of the sun gear 42 is fitted into the rotor 74 of the induction motor 71 to rotate integrally. External gear teeth are formed on the outer circumferential surface of a part 42b of the sun gear 42. The rotary shaft 4 is rotatably supported by the sun gear 42 via a shaft seal device 46c and a shield bearing 41. Internal gear teeth are formed on the inner circumferential surface of the internal gear 44. The internal gear 44 is fixed to the yoke 72 of the induction motor 71. The sun gear 42 is rotatably supported by the internal gear 44 via a shield bearing 48 and by the yoke 72 via a shaft seal device 46b. The three planetary gears 43 are rotatably provided between the sun gear 42 and the internal gear 44. External gear teeth are formed on the outer circumferential surface of each of the planetary gears 43 and are engaged with the external gear teeth of the sun gear 42 as well as the internal gear teeth of the internal gear 44. Each of the planetary gears 43 is connected to an arm 43a. The arm 43a is rotatably supported by the front housing 1 via a shield bearing 49, and the rotary shaft 4 is supported by the front housing 1 via a shaft seal device 46a and a shield bearing 45. Thus, the speed-reducing mechanism 40 is sealed by the shaft seal devices 46a, 46b and 46c, the shield bearings 41, 48, 49 and 45 and the O-ring 44a. Namely, a space A is substantially defined by the sun gear 42 and the rotary shaft 4 and is sealed by the shield bearing 41 and the shaft seal device 46c. A space B is substantially defined by the sun gear 42, the planetary gears 43 and

the internal gear 44 and is sealed by the shield bearing 48 and the shaft seal device 46b. A space C is substantially defined by the planetary gears 43, the arm 43a, the rotary shaft 4 and the front housing 1 and is sealed by the shield bearings 49, 45 and the shaft seal device 46a. The spaces A, B and C communicate with each other and constitute the internal space of the speed-reducing mechanism 40. Lubricating oil L is stored inside the space A, B and C of the speed-reducing mechanism 40 and does not leak to the outside due to the above sealing mechanism. The shaft seal devices 46a, 46b and 46c, the shield bearings 41, 48, 49 and 45 and the O-ring 44a correspond to a sealing mechanism.

[0031] A one-way clutch 47 is arranged between the arm 43a of the speed-reducing mechanism 40 and the rotary shaft 4. The one-way clutch 47 is the same type of the one-way clutch as disclosed in Japan Unexamined Patent Publication No. 2002-276775. The one-way clutch 47 transmits power from the speed-reducing mechanism 40 to the rotary shaft 4 and blocks power from the rotary shaft 4 to the speed-reducing mechanism 40.

[0032] The electromagnetic clutch 50 is provided outside the front housing 1. The electromagnetic clutch 50 includes a hub 53, a pulley 51 and a coil 52. The hub 53 has an armature and is fixed to the outer end of the rotary shaft 4. The pulley 51 is rotatably provided at the front housing 1 via a bearing device 54. The pulley 51 is wound to a belt that is not shown, and the belt is connected to an engine 60 as an external drive source. The coil 52 is fixed to the front housing 1 in the pulley 51. When electric current is applied to the coil 52, the armature of the hub 53 moves and is magnetically connected to the pulley 51, and the rotary shaft 4 is rotated synchronously with the pulley 51. Thus, driving power is transmitted from the engine 60 to the rotary shaft 4. On the other hand, when the electric current is not applied to the coil 52, the armature of the hub 53 moves away from the pulley 51, and the rotary shaft 4 is not rotated by the pulley 51. Thus, the driving power is not transmitted from the engine 60 to the rotary shaft 4.

[0033] In the above-constructed hybrid compressor, when electric current is not applied to the electromagnetic clutch 51 but is applied to the induction motor 71, the drive mechanism 70 similarly drives the compression mechanism 10 as described in the first preferred embodiment. On the other hand, when the electric current is not applied to the induction motor 71 but is applied to the coil 52 of the electromagnetic clutch 50, the engine 60 drives the compression mechanism 10 via the electromagnetic clutch 50. Furthermore, when the electric current is not applied to the induction motor 71 and the electromagnetic clutch 50, the drive of the compression mechanism 10 is stopped.

[0034] In the hybrid compressor, the speed-reducing mechanism 40 that the speed-reducing mechanism 40 that transmits the power from the drive mechanism 70 to the compression mechanism 10 is sealed by the shaft

seal devices 46a, 46b and 46c, the shield bearings 41, 48, 49 and 45 and the O-ring 44a from the drive mechanism 70 and the compression mechanism 10. Thus, the lubricating oil L is utilized only for the speed-reducing mechanism 40 and sufficiently lubricates the speed-reducing mechanism 40. Furthermore, the lubricating oil L in the speed-reducing mechanism 40 is prevented from leaking to the outside of the speed-reducing mechanism 40. Thus, the compression mechanism 10, the drive mechanism 70 and the electromagnetic clutch 50 are protected from the lubricating oil L. The drive mechanism 70 and the electromagnetic clutch 50 are performed a long life in comparison to the prior art components due to the block of the damage caused by the lubricating oil. For the above reason, even though the hybrid compressor in the second preferred embodiment is used for a long period, the efficiency of the hybrid compressor is hard to deteriorate.

[0035] In the hybrid compressor, the drive mechanism 70 communicates with the compression mechanism 10. Thus, the induction motor 71 is cooled and lubricated by the refrigerant gas and lubricating oil that are sent from the compression mechanism 10.

[0036] Furthermore, since the speed-reducing mechanism 40 for reducing the speed of the rotary shaft 4 transmits the power from the drive mechanism 70 to the compression mechanism 10 in the hybrid compressor, the rotational torque of the induction motor 71 can be small. Thus, the induction motor 71 is miniaturized, and the hybrid compressor is miniaturized due to the miniaturized induction motor 71.

[0037] The one-way clutch 47 is arranged between the speed-reducing mechanism 40 and the rotary shaft 4 in the hybrid compressor. The one-way clutch 47 transmits the driving power from the induction motor 71 to the rotary shaft 4 via the speed-reducing mechanism 40 and blocks the driving power that is applied to the compression mechanism 10 from the rotary shaft 4 to the speed-reducing mechanism 40. Thus, since the speed-reducing mechanism 40 and the drive mechanism 70 are not load for the compression mechanism 10, the compression mechanism 10 is prevented from being locked.

[0038] In the above-described first and second preferred embodiments, the compression mechanism 10 is a scroll type. However, a vane type and a swash plate type are utilized as the compression mechanism.

[0039] The present examples and embodiments are to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein but may be modified within the scope of the appended claims.

[0040] A hybrid compressor includes a housing, a rotary shaft, a compression mechanism and a drive mechanism. The rotary shaft is rotatably supported by the housing. The compression mechanism is located in the housing and connected to the rotary shaft for compressing refrigerant gas. The drive mechanism is located in

the housing for driving the compression mechanism. A speed-changing mechanism is located in the housing for transmitting power from the drive mechanism to the compression mechanism via the rotary shaft. The speed-changing mechanism varies the rotational speed of the drive mechanism. A sealing mechanism is located in the housing for sealing a space partially defined by the speed-changing mechanism.

Claims

1. A hybrid compressor including a housing (1, 2, 3, 11), a rotary shaft (4), a compression mechanism (10) and a drive mechanism (70, 80), the rotary shaft (4) being rotatably supported by the housing (1, 2, 3, 11), the compression mechanism (10) being located in the housing (1, 2, 3, 11) and connected to the rotary shaft (4) for compressing refrigerant gas, the drive mechanism (70, 80) being located in the housing (1, 2, 3, 11) for driving the compression mechanism (10), **characterized in that** a speed-changing mechanism (40) is located in the housing (1, 2, 3, 11) for transmitting power from the drive mechanism (70, 80) to the compression mechanism (10) via the rotary shaft (4), the speed-changing mechanism (40) varying the rotational speed of the drive mechanism (70, 80) to a different rotational speed of the rotary shaft (4), and **in that** a sealing mechanism (21, 46, 46a, 46b, 46c, 41, 45, 48, 49, 44a) is located in the housing (1, 2, 3, 11) for sealing a space (A, B, C) partially defined by the speed-changing mechanism (40).
2. The hybrid compressor according to claim 1, wherein the housing (1, 2, 3, 11) includes a first housing (2, 3, 11) and a second housing (1) that are fixed to each other, the compression mechanism (10) being located in the first housing (2, 3, 11), the drive mechanism (70, 80) and the speed-changing mechanism (40) being located in the second housing (1).
3. The hybrid compressor according to claim 2, wherein the first housing (2, 3, 11) includes a first housing main body (3, 11) and a center housing (2) having a shaft hole (2a) through which the rotary shaft (4) is inserted, the second housing (1) being hermetically fixed to the first housing (2, 3, 11), the sealing mechanism (21) being located between the rotary shaft (4) and the shaft hole (2a).
4. The hybrid compressor according to any one of claims 1 through 3, further including a transmission mechanism (50) provided outside the housing (1, 2, 3, 11) which transmits power from an external drive source (60) to the rotary shaft (4) for driving the compression mechanism (10).

5. The hybrid compressor according to any one of claims 1 through 4, wherein the speed-changing mechanism (40) reduces the rotational speed of the rotary shaft (4) relative to the rotational speed of the drive mechanism (70, 80). 5
6. The hybrid compressor according to any one of claims 1 through 5, wherein the speed-changing mechanism (40) and the housing (1, 2) together define a space (A, B, C) for storing lubricant (L) that lubricates the speed-changing mechanism (40), the space (A, B, C) being sealed by the sealing mechanism (21, 46, 46a, 46b, 46c, 41, 45, 48, 49, 44a). 10
7. The hybrid compressor according to any one of claims 1 through 6, wherein the sealing mechanism (41, 49, 44a) is located between the housing (1, 2) and the speed-changing mechanism (40). 15
8. The hybrid compressor according to any one of claims 6 and 7, wherein the rotary shaft (4) extends through the space (A, B, C), the sealing mechanism (21, 45, 46, 46a) being located between the housing (1, 2) and the rotary shaft (4). 20
9. The hybrid compressor according to any one of claims 6 through 8, wherein the rotary shaft (4) extends through the space, the sealing mechanism (41, 46c) being located between the speed-changing mechanism (40) and the rotary shaft (4). 25
10. The hybrid compressor according to any one of claims 1 through 9, wherein the speed-changing mechanism (40) includes a first gear (42) and a second gear (44). 30
11. The hybrid compressor according to claim 10, wherein the sealing mechanism (48) is located between the first gear (42) and the drive mechanism (70). 35
12. The hybrid compressor according to claim 6, wherein the speed-changing mechanism (40) includes a first gear (42); the rotary shaft (4) extending through the space (A, B, C), the space (A, B, C) including a first space (A) substantially defined by the first gear (42), the rotary shaft (4) and the housing (2); and the sealing mechanism (41, 21) sealing the first space (A). 40
13. The hybrid compressor according to claim 6, wherein the speed-changing mechanism (40) includes a first gear (42); the rotary shaft (4) extending through the space (A, B, C), the space (A, B, C) including a first space (A) substantially defined by the first gear (42) and the rotary shaft (4); and the sealing mechanism (41, 46c) sealing the first space (A). 45
14. The hybrid compressor according to any one of claims 6, 12 and 13, wherein the speed-changing mechanism (40) includes a first gear (42), a second gear (44) and a third gear (43); the space (A, B, C) including a second space (B) substantially defined by the first gear (42), the second gear (44) and the third gear (43); and the sealing mechanism (46b, 48) sealing the second space (B). 50
15. The hybrid compressor according to any one of claims 6 and 12 through 14, wherein the speed-changing mechanism (40) includes a third gear (43) and an arm (43a); the rotary shaft (4) extending through the space (A, B, C), the space (A, B, C) including a third space (C) substantially defined by the third gear (43), the arm (43a), the rotary shaft (4) and the housing (1); and the sealing mechanism (45, 46, 46a, 49) sealing the third space (C). 55
16. The hybrid compressor according to claim 1, wherein the speed-changing mechanism (40) and a portion of the housing (1, 2) for housing the speed-changing mechanism (40) provide the space (A, B, C) to maintain lubricant (L), the portion of the housing (1, 2) and the speed-changing mechanism (40) being sealed by the sealing mechanism (21, 46, 46a, 46b, 46c, 41, 45, 48, 49, 44a) so as to contain the lubricant (L) in the space (A, B, C).

FIG. 1

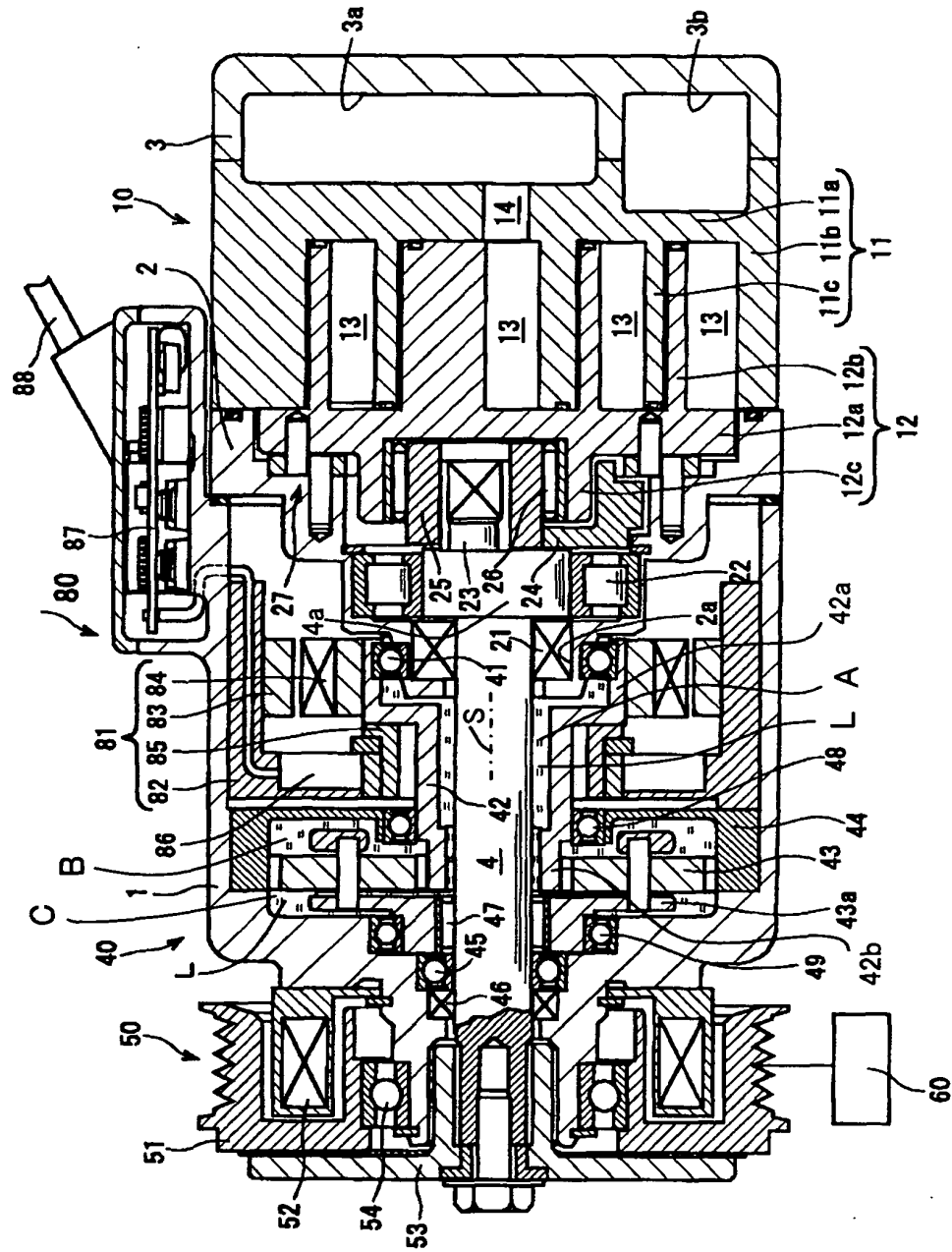
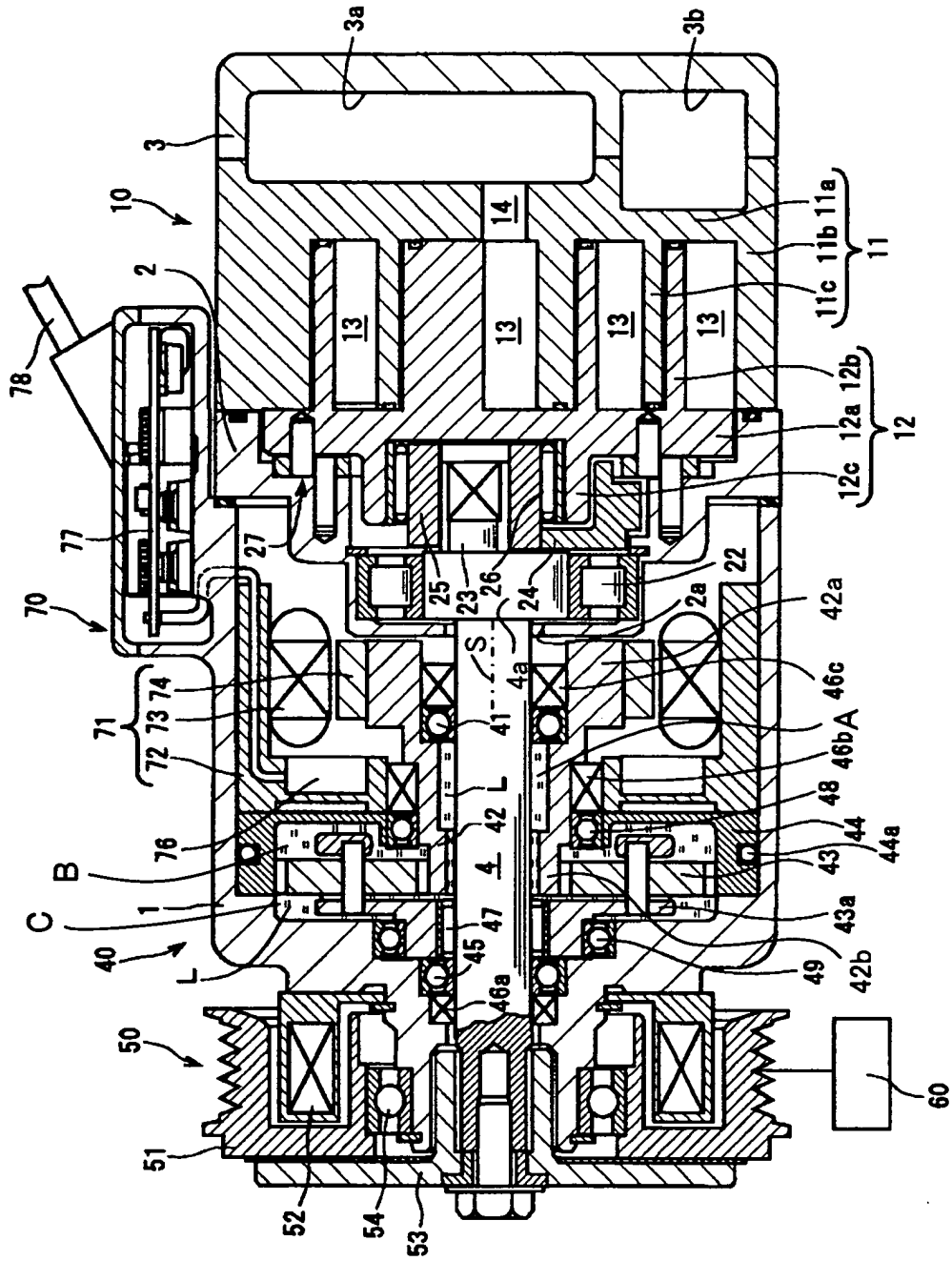


FIG. 2





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 00 7456

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)
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 01, 31 January 2000 (2000-01-31) -& JP 11 287182 A (CALSONIC CORP), 19 October 1999 (1999-10-19) * abstract * * figures 1,5,6 *	1-8, 10-16	F04C18/02 F04C29/02 F04C29/00 F04C27/00
X	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 09, 30 July 1999 (1999-07-30) -& JP 11 093876 A (DENSO CORP; NIPPON SOKEN INC), 6 April 1999 (1999-04-06) * abstract * * figures 1,2,4,5 *	1-8, 10-16	
X	US 6 234 769 B1 (KATO HIROYASU ET AL) 22 May 2001 (2001-05-22) * figures 1,8,9,11,12 * * column 9, line 16 - column 11, line 42 *	1-16	
A	PATENT ABSTRACTS OF JAPAN vol. 017, no. 330 (M-1434), 23 June 1993 (1993-06-23) -& JP 05 039777 A (NIPPONDENSO CO LTD), 19 February 1993 (1993-02-19) * abstract * * figures 1,2 *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7) F04C B60H F04B
A	EP 1 221 391 A (TOYOTA JIDOSHOKKI KK) 10 July 2002 (2002-07-10) * figure 1 * * column 3, line 9 - column 4, line 47 *	2,3	
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 6 July 2004	Examiner Lequeux, F
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

EPO FORM 1503 03 82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 04 00 7456

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

06-07-2004

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 11287182	A	19-10-1999	NONE	
JP 11093876	A	06-04-1999	DE 19830312 A1	04-02-1999
			US 6234769 B1	22-05-2001
			US 2001018025 A1	30-08-2001
US 6234769	B1	22-05-2001	JP 11030182 A	02-02-1999
			JP 11037046 A	09-02-1999
			JP 11093876 A	06-04-1999
			DE 19830312 A1	04-02-1999
			US 2001018025 A1	30-08-2001
JP 05039777	A	19-02-1993	NONE	
EP 1221391	A	10-07-2002	JP 2002205538 A	23-07-2002
			BR 0200032 A	22-10-2002
			CN 1364703 A	21-08-2002
			EP 1221391 A2	10-07-2002
			US 2002104321 A1	08-08-2002