

Description

The present invention relates to a compressor with a variable displacement mechanism, and more particularly, to a slant plate type compressor with a variable displacement mechanism, of which the top dead center position of the piston can be changed in response to the change of the piston stroke.

A conventional slant plate type compressor with a variable displacement mechanism as used in an automotive air conditioning system controls the displacement of the compressor in response to the condition of the air conditioning load and other requirements. However, since the mechanism for detecting the displacement of the compressor is complicated and expensive to construct, such a mechanism is not generally used.

Alternatively, if the displacement of the compressor can be easily detected, the information can be usefully utilized for the control of an engine control system or a monitor of an air conditioning system.

A conventional detecting device for detecting the displacement of the compressor is disclosed in, e.g., JP-A-62218670. The detecting device includes a non-contact type position detecting device, which has a detected object, for utilizing the change of the electrostatic volume or the change of the magnetic flux density. This non-contact type position detecting device can detect only the range of about 1 mm. Accordingly, it is difficult for the detecting device to directly detect the change of the position of the slant plate which varies over a large angle. Likewise, it is difficult for the detecting device to directly detect the change of the position of the piston, i.e., the change of the piston stroke since the piston stroke changes within the range of 1-30 mm. Then, if this type of detecting device is used, it is necessary to use an electrical calculation circuit to convert the pulse signal received from the detecting device, during the rotation of the drive shaft, into a signal corresponding to the displacement of the compressor, which is expensive.

It is an object of this invention to provide a slant plate type compressor with a variable displacement mechanism which includes a detecting device which can directly detect its displacement correctly.

It is another object of this invention to provide a slant plate type compressor with a variable displacement mechanism which includes an inexpensive and simple detecting device.

EP-A-0183295 and EP-A-0264148 disclose a positive displacement pump having the ability of sensing the instant when a piston is occupying one set point in its cycle.

US-A-4822252 discloses a slant plate type compressor with a variable displacement mechanism

which comprises a compressor housing enclosing a crank chamber, the housing including a cylinder block; a plurality of cylinders formed for defining compression space in the cylinder block; a piston slidably fitted with each of the cylinders; a drive mechanism coupled to the pistons to reciprocate the pistons within the cylinders, the drive mechanism including a drive shaft rotatably supported in the housing, and coupling means for drivingly coupling the pistons with the drive shaft and for converting rotary motion of the drive shaft into reciprocating motion of the pistons, the coupling means including a slant plate having a surface disposed at a slant angle relative to a plane perpendicular to the drive shaft, the slant angle changing in response to a change in pressure in the crank chamber, the stroke of the piston changing in response to the change of the slant angle and defining compression volume in the compression space to change the capacity of the compressor, the position of the top dead center of the piston changing within a certain range in response to the change of the stroke of the piston; a suction chamber and a discharge chamber enclosed within the compressor housing; a communication path linking the crank chamber with the suction chamber; control valve means for varying the capacity of the compressor by controlling the link between the crank and the suction chambers through the path; and according to the present invention such a slant plate type compressor is characterised by sensor means disposed adjacent the cylinder for detecting the position of the piston at top dead center within the compression space.

In the accompanying drawings:

Fig. 1 is a cross-sectional view of a slant plate type compressor with a variable displacement mechanism, of which the inclined angle of the slant plate is at the largest, in accordance with the first embodiment of this invention.

Fig. 2 is a cross-sectional view of a slant plate type compressor with a variable displacement mechanism, of which the inclined angle of the slant plate is at the least, in accordance with the first embodiment of this invention.

Fig. 3 is a cross-sectional view of a part of a slant plate type compressor with a variable displacement mechanism in accordance with the second embodiment of this invention.

Fig. 4 is a cross-sectional view of a part of a slant plate type compressor with a variable displacement mechanism in accordance with the third embodiment of this invention.

Fig. 5 is a graph of showing the relationship between a piston stroke and a position of a top dead center of a piston.

Referring to FIG. 1, wobble plate type compressor 1 includes front end plate 2, cylinder cas-

ing 3 having cylinder block 31, valve plate 4, and cylinder head 5. Front end plate 2 is fixed on one end of cylinder casing 3 by securing bolts (not shown). Axial hole 21 which is formed through the center of front end plate 2 receives drive shaft 7. Radial bearing 8 is disposed in axial hole 21 to rotatably support drive shaft 7. Annular sleeve portion 22 projects from front end plate 2 and surrounds drive shaft 7, defining seal cavity 23. Cylinder casing 3 is provided with cylinder block 31 and crank chamber 32. Cylinder block 31 has a plurality of equiangularly spaced cylinders 33 formed therein.

Cam rotor 10 is fixed on drive shaft 7 by pin 103. Thrust needle bearing 11 is disposed between the inner surface of front end plate 2 and the adjacent axial end surface of cam rotor 10. Arm portion 101 of cam rotor 10 extends in the direction of cylinder block 31. Hole 102 is formed on arm portion 101. Cylindrical member 12, provided with flange portion 121 is disposed around drive shaft 7 and is rotatably supported on drive shaft 7 through spherical element 13 slidably fitted on drive shaft 7. Second arm portion 122 is formed on the outer surface of flange portion 121 of cylindrical member 12 and faces arm portion 101 of cam rotor 10. Elongated hole 123, formed in arm portion 122, is aligned with hole 102. Pin 14, inserted through hole 102, is slidably movable within elongated hole 123. Ring-shaped wobble plate 15 is mounted on the outer surface of cylindrical member 12 through radial needle bearing 16. Thrust needle bearing 17 is disposed in a gap between flange portion 121 and wobble plate 15. The other end of drive shaft 7 is rotatably supported through radial bearing 18 in the central bore of cylinder block 31. Sliding shaft 151 is attached on the outer peripheral portion of wobble plate 15 and projects toward the bottom surface of cylinder casing 3. The end of sliding shaft 151 is slidably disposed in groove 321 to prevent the rotation of wobble plate 15.

One end of piston rod 19 is rotatably connected to receiving surface 152 of wobble plate 15. The other end of piston rod 19 is rotatably connected to piston 20 which is slidably disposed in cylinder 33.

A suction port (not shown) and discharge port 42 are formed in valve plate 4. A suction reed valve (not shown) is disposed on valve plate 4. Discharge reed valve (not shown) is disposed on valve plate 4 opposite the suction reed valve. Cylinder head 5 is connected to cylinder casing 3 through a gasket (not shown) and valve plate 4. Partition wall 51 extends axially from the inner surface of cylinder head 5 and divides the interior of cylinder head 5 into suction chamber 52 and discharge chamber 53. Suction chamber 52 is connected to the external fluid circuit through fluid inlet port 60 formed in

cylinder head 5. Discharge chamber 53 is connected to the external fluid circuit through fluid outlet port 61 formed in cylinder head 5.

Bellows 63 is disposed in cylindrical bore 62 formed in cylinder block 31. Bore 62 is communicated with suction chamber 52 through aperture 64 formed through valve plate 4 and is communicated with crank chamber 32 through passage-way 65 formed through cylinder block 31. Aperture 64 is normally closed by needle element 631 disposed on one end of bellows 63. The communication between crank chamber 32 and suction chamber 52 is controlled in accordance with the movement of bellows 63.

Proximity position sensor 70 is a non-contact type position detecting device and has a capacity for detecting the range of about 1 mm. Proximity position sensor 70 is disposed on valve plate 4 at the cylinder side to face to the top surface of piston 20.

In operation, rotational motion is applied to drive shaft 7 through an external driving source (not shown) and is communicated to cam rotor 10. The rotational motion of cam rotor 10 is converted to nutational motion at wobble plate 15 through cylindrical member 12. Sliding shaft 151, connected to wobble plate 15 and disposed in groove 321, prevents wobble plate 15 from rotating. The nutational motion of wobble plate 15 is converted to the reciprocating motion of pistons 20 in cylinders 33 through piston rods 19. Accordingly, refrigeration fluid is sucked through inlet port 60 to suction chamber 52 and flows into cylinder 33 through suction port 41. Refrigeration fluid is compressed in cylinder 33 and is discharged into discharge chamber 53 through discharge port 42. The compressed refrigeration fluid then flows into the external fluid circuit through outlet port 61.

Distance Δx between the inner surface of valve plate 4 and the top surface of piston 20 is 0.3 mm when the inclined angle of flange portion 121 as shown in FIG. 1 is at the largest and is 1.3 mm when the inclined angle of flange portion 121 as shown in FIG. 2 is at the least.

The change of the displacement of the compressor, i.e., the relationship between the change of the inclined angle of slant plate 121 and the position of the top dead center of piston 20 is defined in accordance with the shape of elongated hole 123 formed in arm portion 122. Therefore, even though the detected output from position sensor 70 is non-linear to the value of distance Δx , the detected output proportional to the piston stroke can be outputted by suitably selecting the shape of elongated hole 123.

With reference to FIG. 3, a part of the construction of a compressor in accordance with the second embodiment of this invention is shown.

Detected object 80 which is a permanent magnet is disposed in the top end surface of piston 20. Hall generator 81 is on valve plate 4 at the cylinder side to face to detected object 80. Hall generator 81 can output the output corresponding to distance Δx between itself and detected object 80.

With reference to FIG. 4, a part of the construction of a compressor in accordance with the third embodiment of this invention is shown. Detected object 90 which is a permanent magnet is disposed on the side surface of piston 20. Hall generator 91 is disposed on the side of cylinder casing 3. Hall generator 91 can output the output corresponding to distance Δx between itself and detected object 90.

As shown in FIG. 5, the displacement of the compressor can be directly detected by changing the position of the top dead center of a piston within the range between 0.3 - 1.3 mm and by a non-contact type position sensor which has a capacity for detecting range of about 1 mm.

Claims

1. A slant plate type compressor (1) with a variable displacement mechanism comprising a compressor housing enclosing a crank chamber (32), the housing including a cylinder block (31); a plurality of cylinders (33) formed for defining compression space in the cylinder block (31); a piston (20) slidably fitted with each of the cylinders (33); a drive mechanism coupled to the pistons (20) to reciprocate the pistons (20) within the cylinders (33), the drive mechanism including a drive shaft (7) rotatably supported in the housing, and coupling means for drivingly coupling the pistons (20) with the drive shaft (7) and for converting rotary motion of the drive shaft (7) into reciprocating motion of the pistons (20), the coupling means including a slant plate (15) having a surface disposed at a slant angle relative to a plane perpendicular to the drive shaft (7), the slant angle changing in response to a change in pressure in the crank chamber (32), the stroke of the piston (20) changing in response to the change of the slant angle and defining compression volume in the compression space to change the capacity of the compressor (1), the position of the top dead center of the piston (20) changing within a certain range in response to the change of the stroke of the piston (20); a suction chamber (52) and a discharge chamber (53) enclosed within the compressor housing; a communication path (65) linking the crank chamber (32) with the suction chamber (52); control valve means (63,64) for varying the capacity of the compressor (1) by

controlling the link (65) between the crank (32) and the suction (52) chambers through the path (65); and characterised by sensor means (70) disposed adjacent the cylinder (33) for detecting the position of the piston (20) at top dead center within the compression space.

2. A compressor according to claim 1, wherein the sensor means (81) is disposed on the surface of a valve plate (4) opposite the piston (20) in the direction of reciprocating motion of the piston (20).
3. A compressor according to claim 2, further comprising a detected object (80) made of permanent magnet disposed on the surface of the piston (20) opposite the sensor means (81).
4. A compressor according to claim 1, wherein the sensor means (91) is disposed on the surface for defining the cylinders (33).
5. A compressor according to claim 4, further comprising a detected object (90) made of permanent magnet disposed on the outer circumferential surface of the piston (20).

Patentansprüche

1. Verdichter vom Schrägplattentyp (1) mit veränderlichem Hubmechanismus, welcher umfaßt: ein eine Kurbelkammer (32) enthaltendes Verdichtergehäuse, wobei das Gehäuse einen Zylinderblock (31) enthält; eine Mehrzahl von Zylindern (33), die zum Festlegen eines Verdichtungsraums in dem Zylinderblock (31) gebildet sind; einen Kolben (20), der mit jedem der Zylinder (33) verschiebbar versehen ist; einen Antriebsmechanismus, der mit den Kolben (20) so gekoppelt ist, daß er die Kolben (20) in den Zylindern (33) hin- und herbewegt, wobei der Antriebsmechanismus eine in dem Gehäuse drehbar abgestützt Antriebswelle (7) und ein Koppelmittel zum treibenden Koppeln der Kolben (20) mit der Antriebswelle (7) und zum Umwandeln einer Drehbewegung der Antriebswelle (7) in eine Hin- und Herbewegung der Kolben (20) enthält, wobei das Koppelmittel eine schräge Platte (15) enthält, welche eine Oberfläche aufweist, die in einem Neigungswinkel relativ zu einer zur Antriebswelle (7) senkrechten Ebene angeordnet ist, wobei sich der Neigungswinkel in Reaktion auf eine Änderung des Drucks in der Kurbelkammer (32) ändert, wobei sich der Hub des Kolbens (20) in Reaktion auf die Änderung des Neigungswinkels ändert und ein Verdichtungsverhältnis in



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With reference to FIG. 4, a part of the construction of a compressor in accordance with the third embodiment of this invention is shown. Detected object 90 which is a permanent magnet is disposed on the side surface of piston 20. Hall generator 91 is disposed on the side of cylinder casing 3. Hall generator 91 can output the output corresponding to distance Δx between itself and detected object 90.

As shown in FIG. 5, the displacement of the compressor can be directly detected by changing the position of the top dead center of a piston within the range between 0.3 - 1.3 mm and by a non-contact type position sensor which has a capacity for detecting range of about 1 mm.

Claims

1. A slant plate type compressor (1) with a variable displacement mechanism comprising a compressor housing enclosing a crank chamber (32), the housing including a cylinder block (31); a plurality of cylinders (33) formed for defining compression space in the cylinder block (31); a piston (20) slidably fitted with each of the cylinders (33); a drive mechanism coupled to the pistons (20) to reciprocate the pistons (20) within the cylinders (33), the drive mechanism including a drive shaft (7) rotatably supported in the housing, and coupling means for drivingly coupling the pistons (20) with the drive shaft (7) and for converting rotary motion of the drive shaft (7) into reciprocating motion of the pistons (20), the coupling means including a slant plate (15) having a surface disposed at a slant angle relative to a plane perpendicular to the drive shaft (7), the slant angle changing in response to a change in pressure in the crank chamber (32), the stroke of the piston (20) changing in response to the change of the slant angle and defining compression volume in the compression space to change the capacity of the compressor (1), the position of the top dead center of the piston (20) changing within a certain range in response to the change of the stroke of the piston (20); a suction chamber (52) and a discharge chamber (53) enclosed within the compressor housing; a communication path (65) linking the crank chamber (32) with the suction chamber (52); control valve means (63, 64) for varying the capacity of the compressor (1) by

controlling the link (65) between the crank (32) and the suction (52) chambers through the path (65); and characterised by sensor means (70) disposed adjacent the cylinder (33) for detecting the position of the piston (20) at top dead center within the compression space.

2. A compressor according to claim 1, wherein the sensor means (81) is disposed on the surface of a valve plate (4) opposite the piston (20) in the direction of reciprocating motion of the piston (20).
3. A compressor according to claim 2, further comprising a detected object (80) made of permanent magnet disposed on the surface of the piston (20) opposite the sensor means (81).
4. A compressor according to claim 1, wherein the sensor means (91) is disposed on the surface for defining the cylinders (33).
5. A compressor according to claim 4, further comprising a detected object (90) made of permanent magnet disposed on the outer circumferential surface of the piston (20).

Patentansprüche

1. Verdichter vom Schrägplattentyp (1) mit veränderlichem Hubmechanismus, welcher umfaßt: ein eine Kurbelkammer (32) enthaltendes Verdichtergehäuse, wobei das Gehäuse einen Zylinderblock (31) enthält; eine Mehrzahl von Zylindern (33), die zum Festlegen eines Verdichtungsraums in dem Zylinderblock (31) gebildet sind; einen Kolben (20), der mit jedem der Zylinder (33) verschiebbar versehen ist; einen Antriebsmechanismus, der mit den Kolben (20) so gekoppelt ist, daß er die Kolben (20) in den Zylindern (33) hin- und herbewegt, wobei der Antriebsmechanismus eine in dem Gehäuse drehbar abgestützt Antriebswelle (7) und ein Koppelmittel zum treibenden Koppeln der Kolben (20) mit der Antriebswelle (7) und zum Umwandeln einer Drehbewegung der Antriebswelle (7) in eine Hin- und Herbewegung der Kolben (20) enthält, wobei das Koppelmittel eine schräge Platte (15) enthält, welche eine Oberfläche aufweist, die in einem Neigungswinkel relativ zu einer zur Antriebswelle (7) senkrechten Ebene angeordnet ist, wobei sich der Neigungswinkel in Reaktion auf eine Änderung des Drucks in der Kurbelkammer (32) ändert, wobei sich der Hub des Kolbens (20) in Reaktion auf die Änderung des Neigungswinkels ändert und ein Verdichtungsverhältnis in



dem Verdichtungsraum festlegt, um die Leistung des Verdichters (1) zu ändern, wobei sich die Lage des obersten Totpunktes des Kolbens (20) in einem bestimmten Bereich in Reaktion auf die Änderung des Hubs des Kolbens (20) ändert; eine Ansaugkammer (52) und eine Auslaßkammer (53), welche in dem Verdichtergehäuse enthalten sind; einen Verbindungspfad (65), der die Kurbelkammer (32) mit der Ansaugkammer (52) verbindet; ein Steuer-ventilmittel (631, 64) zum Ändern der Leistung des Verdichters (1) durch Steuern der Verbindung (65) zwischen der Kurbelkammer (32) und der Ansaugkammer (52) mittels des Pfades (65); und welcher gekennzeichnet ist durch ein dem Zylinder (33) benachbart angeordnetes Sensormittel (70) zum Ermitteln der Stellung des Kolbens (20) im obersten Totpunkt in dem Verdichtungsraum.

2. Verdichter nach Anspruch 1, bei welchem das Sensormittel (81) auf der Oberfläche einer Ventilplatte (4) gegenüber dem Zylinder (20) in der Richtung einer Hin- und Herbewegung des Kolbens (20) angeordnet ist.
3. Verdichter nach Anspruch 2, welcher ferner ein ermitteltes Objekt (80) umfaßt, das aus einem auf der Oberfläche des Kolbens (20) gegenüber dem Sensormittel (81) angeordneten Permanentmagneten besteht.
4. Verdichter nach Anspruch 1, bei welchem das Sensormittel (91) auf der Oberfläche zum Festlegen der Zylinder (33) angeordnet ist.
5. Verdichter nach Anspruch 4, welcher ferner ein ermitteltes Objekt (90) umfaßt, das aus einem auf der Außenumfangsoberfläche des Kolbens (20) angeordneten Permanentmagneten besteht.

Revendications

1. Compresseur de type à plateau en biais (1) muni d'un mécanisme à déplacement variable, comprenant un carter de compresseur enfermant une chambre de manivelle (32), le carter comprenant un bloc de cylindres (31); une pluralité de cylindres (33) formés pour définir un espace de compression à l'intérieur du bloc de cylindres (31); un piston (20) monté en glissement à l'intérieur de chacun des cylindres (33); un mécanisme d'entraînement couplé aux pistons (20) pour faire aller et venir ces pistons (20) à l'intérieur des cylindres (33), le mécanisme d'entraînement comprenant un arbre d'entraînement (7) monté en rotation dans

le carter, et des moyens d'accouplement pour coupler en entraînement les pistons (20) à l'arbre d'entraînement (7) et pour transformer le mouvement de rotation de l'arbre d'entraînement (7) en un mouvement alternatif des pistons (20), les moyens d'accouplement comprenant un plateau en biais (15) présentant une surface disposée sous un certain angle d'inclinaison par rapport à un plan perpendiculaire à l'arbre d'entraînement (7), l'angle d'inclinaison changeant en réponse à une variation de pression dans la chambre de manivelle (32), la course du piston (20) changeant en réponse au changement de l'angle d'inclinaison et définissant un volume de compression dans l'espace de compression pour modifier la capacité du compresseur (1), la position du point mort haut du piston (20) changeant à l'intérieur d'une certaine plage en réponse au changement de la course du piston (20); une chambre d'aspiration (52) et une chambre de décharge (53) enfermées dans le carter de compresseur; un chemin de communication (65) reliant la chambre de manivelle (32) à la chambre d'aspiration (52); des moyens de soupapes de commande (631, 64) pour faire varier la capacité du compresseur (1) en commandant la liaison (65) entre la manivelle (32) et la chambre d'aspiration (52) par l'intermédiaire du chemin (65); caractérisé par des moyens de détecteur (70) disposés au voisinage du cylindre (33) pour détecter la position du piston (20) au point mort haut à l'intérieur de l'espace de compression.

2. Compresseur selon la revendication 1, caractérisé en ce que les moyens de détecteur (81) sont disposés sur la surface d'une plaque à soupapes (4) à l'opposé du piston (20) dans la direction du mouvement alternatif du piston (20).
3. Compresseur selon la revendication 2, caractérisé en ce qu'il comprend en outre un objet détecté (80) constitué par un aimant permanent disposé sur la surface du piston (20) à l'opposé des moyens de détecteur (81).
4. Compresseur selon la revendication 1, caractérisé en ce que les moyens de détecteur (91) sont disposés sur la surface pour définir les cylindres (33).
5. Compresseur selon la revendication 4, caractérisé en ce qu'il comprend en outre un objet détecté (90) constitué par un aimant permanent disposé sur la surface circonférentielle extérieure du piston (20).