

Description

The present invention relates to a wobble plate type compressor for a refrigerating system, and more particularly to a variable capacity mechanism utilized on such compressors.

Wobble plate type compressors which reciprocate pistons by changing the rotational movement of a cam rotor into the wobble movement of a wobble plate are well-known. Variable capacity mechanisms in which the compression capacity changed by altering the stroke volume of pistons by changing the angle of the inclined surface of the cam rotor are also well-known, as shown in US-A-3861829.

In the above mentioned variable capacity mechanism, the angle of the inclined surface of the cam rotor is changed by differential pressure between a crank chamber, in which the cam rotor is disposed, and a suction chamber, thus changing the stroke volume of the pistons and in turn changing the compression capacity of the compressor.

However, when the angle of the inclined surface of the cam rotor is determined by controlling the moment produced on the cam rotor, the durability of the joint portion connecting the pistons with rods at the side of the wobble plate is decreased whereby the pistons at the rear surface side, namely, at the crank chamber side, are urged by the pressure.

Also, since the pressure in the crank chamber is controlled, the volume of the crank chamber is larger than that of the suction chamber. For this reason, the response for the angle of the inclined surface of the cam rotor is not sufficient.

Furthermore, when the differential pressure between the crank chamber and the suction chamber is changed, the oil may flow into the crank chamber from the suction chamber.

A variable capacity compressor which does not use the differential pressure between the crank chamber and the suction chamber, so as to resolve the above-mentioned problems, is shown in US-A-4061443. A modulating cylinder for controlling the angle of the inclined surface of the cam rotor is disposed in the crank chamber and connects with a compressor sump area through a rear head return bore, a valve plate slot, a hole, a valve disc hole, a cylinder block axial return bore, a crossover tube, aligned axial bore, radial bore, aperture, shaft radial front bore and shaft front radial exit bore in series. Lubricating oil flowing into the modulating cylinder is compressed by an oil gear pump assembly disposed in the cylinder block. The modulating cylinder is operated by the pressure of lubricating oil and the angle of the inclined surface of the cam rotor is varied in accordance with the operation of the modulating cylinder.

However, since the modulating cylinder in the above mentioned compressor is disposed in the

crank chamber, the crank chamber must be large to accommodate it. Accordingly, the size of such a compressor is larger than that of a conventional compressor.

It is an object of the present invention to provide a compact wobble plate type compressor with a variable capacity mechanism. A further object is to provide a wobble plate type compressor with a variable capacity mechanism which includes an actuator for changing the stroke volume of pistons in the centre of a cylinder block.

These and other objects are achieved in accordance with the present invention by a wobble plate type compressor with a variable capacity mechanism and including a plurality of pistons reciprocating in cylinder bores of a cylinder block, the wobble plate changing rotational movement into wobble movement and reciprocating the pistons through piston rods connecting the pistons with the wobble plate; a cam rotor connected to the drive shaft; by a disc member connected to the cam rotor for rotation with the shaft by means of a link portion formed on the disc member and having a hole receiving a pin slidably disposed in an elongate hole in the cam rotor, the disc member having a slider slidably disposed around the drive shaft; an actuator, for changing the angle of the disc member and the wobble plate by moving the slider, an electromagnetic valve, and thus changing the stroke volume of the pistons, characterised in that the actuator is disposed in the centre of the cylinder block, is operated by the differential pressure between the crank chamber and the discharge chamber, the pressure from the discharge chamber being applied through an electromagnetic valve.

Two examples of compressors according to the invention will now be described with reference to the attached drawings, in which:—

Figure 1 is a vertical cross-sectional view of a first wobble plate type compressor;

Figure 2 is a diagrammatic view showing the variation of angle of the inclined surface of a wobble plate utilized in the compressor of Figure 1;

Figure 3 is a vertical cross-sectional view of a second wobble plate type compressor.

Figure 1 shows a wobble plate type compressor 1 including a front housing 2, cylinder casing 3 having a cylinder block 31, valve plate 4 and cylinder head 5. The front housing 2 is fixed on one end surface of the casing 3 by bolts 6. An axial hole 21 is formed through the front housing 2 at the centre thereof for receiving the drive shaft 7. A radial bearing 8 is disposed in the hole 21 to support drive shaft 7 rotatably. A sleeve portion 22 projects from front housing 2 and surrounds drive shaft 7 to define a seal cavity 23 in which is disposed a mechanical seal 9. The cylinder housing 3 is also provided with a crank chamber 32 at the opposite end from the cylinder block 31.

The cam rotor 10 is fixed to the inner end of

drive shaft 7 and a thrust needle bearing 11 is disposed between the inner wall surface of front housing 2 and the adjacent axial end surface. An ear-shaped portion 101 of cam rotor 10 extends in the direction of cylinder block 31 and a rectangular shaped hole 102 is formed in the ear-shaped portion 101.

A cylinder member 12, provided with a flange portion 121, is disposed so as to surround drive shaft 7. An ear-shaped portion 122 is formed on the outer surface of the flange portion 121 of cylinder member 12 so as to face the ear shaped portion 101 of cam rotor 10. A hole 123 is formed on ear-shaped portion 122 at a position adjacent to that of the rectangular-shaped hole 102 and a pin-shaped member 13 fitted into hole 123 is inserted into rectangular-shaped hole 102 to slidably move along the inner edge of the long hole 102. Ring-shaped wobble plate 14 is mounted on the outer surface of cylinder member 12 through a radial needle bearing 15. A thrust needle bearing 16 is disposed in a gap between the flange portion 121 and ring-shaped wobble plate 14. The other end of drive shaft 7 is rotatably supported by a radial ball bearing 17 disposed in the centre bore of cylinder block 31. A sliding shaft 141 is fixed into wobble plate 14 and projected in the direction of the bottom surface of the cylinder casing 3. An axially extended groove 321 is disposed along the path of motion of the sliding shaft 141, the end of which is disposed in the groove 321 and slides along the inner edge of groove 321, thereby to prevent rotating motion of the wobble plate 14.

One end of piston rods 17' is rotatably connected to receiving surfaces 142 of the wobble plate 14 and the other ends of the piston rods 17 are rotatably connected to pistons 18 slidably disposed in cylinder bores 33.

Suction holes 19 and discharge holes 20 are formed in valve plate 4. A suction reed valve (not shown) is disposed on the valve plate 4 and a discharge reed valve (not shown) is disposed on the valve plate 4 at the opposite side to the suction reed valve.

The cylinder head 5 is connected to cylinder casing 3 through gasket 41 and valve plate 4. An axially extending partition wall 51 is formed in the inner surface of cylinder head 5 and divides the interior of cylinder head 5 into two chambers, such as a suction chamber 52 and discharge chamber 53.

A slider 24 is slidably disposed on the outer surface of the drive shaft 7 and is connected to cylinder member 12 so that the cylinder member 12 is rotatably and slidably disposed on drive shaft 7. Coil spring 25 is disposed between cam rotor 10 and one end of slider 24 surrounding the drive shaft 7.

Actuator 26 which comprises a disc-shaped plunger 261, coil spring 262 and pressure chamber 263, is disposed on an inner terminal end of drive shaft 7. The disc-shaped plunger 261 is slidably disposed on the inner end of drive shaft 7 so that it closes the opening of pressure

chamber 263 which is formed on the outer end portion of central bore of cylinder block 31, and is in sliding contact with cylinder block 31 and normally pushed towards the crank chamber by coil spring 262. The other end of slider 24 is connected to disc-shaped plunger 261 through thrust needle bearing 27 so that the rotational force of slider 24 cannot be communicated to the plunger 261 and the axial force of plunger 261 can be transmitted to the slider 24.

An aperture 311 which connects pressure chamber 262 with discharge chamber 53 is formed through cylinder block 31. The opening and closing of aperture 311 is controlled by an electromagnetic valve 28. Valve seat 29 is disposed on valve plate 4 at the side of discharge chamber 53 to seat a valve portion 281 of electromagnetic valve 28.

In operation when rotational movement is applied to drive shaft 7 through the driving source, the rotational movement is communicated to the cam rotor 10 and the rotational movement of cam rotor 10 is transmitted to wobble plate 14 through cylindrical member 12. However, since sliding shaft 141 connected with wobble plate 14 is disposed in the groove 321, engagement between groove 321 and shaft 141 prevents the wobble plate 14 from rotating. Therefore, the rotational movement transmitted to wobble plate 14 from the cam rotor 10 is changed to wobble movement. When wobble plate 14 starts its wobble movement, pistons 18 are reciprocated in the cylinders through the piston rods 17 connected to the wobble plate 14. Accordingly, refrigerant gas sucked from inlet port 30 through suction chamber 52 flows into cylinder bore 33 through suction portion 19. The refrigerant gas is compressed in cylinder bore 33 and discharged into discharge chamber 53 through discharge port 20. Compressed refrigerant gas in discharge chamber 53 flows into a refrigerant circuit (not shown) through an outlet port (not shown).

Referring to Figure 2, the mechanism of the wobble movement is shown. During compression stroke, if gas pressure given to each of piston 18 is expressed as F_{pi} , the amount of gas pressure given to all of pistons is expressed as ΣF_{pi} . Only two pistons are shown, one with a solid line and one with a dotted line. The other pistons are omitted for clarity. The gas pressure ΣF_{pi} urges pistons 18 to the left as seen and, if the force with which coil spring 125 urges slider 24 to the right is expressed as F_{sp} , the force with which plunger 261 (not shown in Figure 2) urges slider 24 to the left is expressed as F_c , the drag at the supporting portion of pin-shaped member 13 is expressed as F_L , and the coefficient of friction between drive shaft 7 and slider 25 is expressed as μ , the gross gas pressure ΣF_{pi} can be determined from the following equation.

$$\Sigma F_{pi} = F_L \cos \beta - F_c + \mu F_R + F_{sp} + F_p \quad (1)$$

Where β is the angle made by the drag F_L with the

Y axis, and F_p is the gas pressure on the rear of the piston. F_p can be determined from the following equation,

$$F_p = n\pi D^2(P_c)/4,$$

(where n is the number of pistons, D is the diameter of the pistons, and P_c is the pressure in the crank chamber).

If F_R is the force component of the drag F_L which is orthogonal to the drive shaft 7, F_R can be determined from the following equation.

$$F_R = F_L \sin \beta \quad (2).$$

Also, if the distance between the acting point (P) of the force given to the supporting portion of pin-shaped member 13 and the underside of drive shaft 7 is L_1 , the distance between the acting point (P) and ΣF_{pi} is L_2 , the distance between the acting point (P) and the centre axis of drive shaft 7 is L_3 , and the distance between the acting point (P) and the component F_R is L_4 , then, the relationship shown in the following equation is given as to the moment around the acting point (P).

$$(\Sigma F_{pi}) \cdot L_2 = (F_{sp} - F_c) \cdot L_3 + F_R \cdot L_1 - F_R \cdot L_4 + F_p \cdot L_3 \quad (3)$$

Cylinder member 12 and wobble plate 14 are inclined so that the moment can be balanced.

In order to increase refrigerating capacity, pressure chamber 263 is connected to discharge chamber 53 through aperture 311 by opening of electromagnetic valve 28. Since high pressure compressed gas from discharge chamber 53 flows into pressure chamber 263 through aperture 311, the pressure in pressure chamber 263 is increased. Accordingly, plunger 261 is moved to the left as shown against the tensile stress of coil spring 262 and the urging force of coil spring 25, and slider 24 is moved to the left. Since slider 24 and cylindrical member 12 are freely connected, cylindrical member 12 receives the moment of right-handed rotation by movement of slider 24, and cylindrical member 12 is inclined so as to satisfy formula (3). When the angle of the inclined surface of cylindrical member 12, that is, wobble plate 14 is enlarged as mentioned above, the stroke volume of piston 18 connected to wobble plate 14 is enlarged, and the angle of the inclined surface of wobble plate 14 is increased by moving pin-shaped portion member 13 to the upper end of long hole 102, and the compression volume is enlarged. Accordingly, refrigerating capacity is increased.

On the other hand, when pressure chamber 262 is disconnected from discharge chamber 53 through aperture 311 by closing of electromagnetic valve 28, the pressure in pressure chamber 262 is decreased, and plunger 261 is moved to the right by the tensile stress of coil spring 262. Accordingly, slider 24 is moved to the right and slider 24 is moved to the right. Cylindrical member 12 receives the moment of left-handed

rotation, and cylindrical member 12 is inclined so as to satisfy formula (3). When the angle of the inclined surface of cylindrical member 12, that is, wobble plate 14, is made small as mentioned above, the stroke volume of piston 18 connected to wobble plate 14 becomes small and the angle of the inclined surface of wobble plate 14 is made small by moving pin-shaped piston member 13 to the under end of long hole 102, and the compression volume becomes small. Accordingly, refrigerating capacity is decreased.

In order to maintain the angle of the inclined surface of swash plate 14 constant, it is necessary to maintain the pressure in pressure chamber 263 constant. Maintaining the pressure in pressure chamber 263 constant is possible by controlling the ON-OFF duty proportion of the electromagnetic valve 28.

Referring to Figure 3, bellows 34 is disposed instead of actuator 26 in the compressor shown in Figure 1. Bellows 34 is connected to discharge chamber 53 through electromagnetic valve 28. Slider 24 is moved whereby bellows 34 is shrunken or swollen by opening or closing electromagnetic valve 28. Accordingly, the angle of the inclined surface of cylindrical member 12 is varied.

Claims

1. A wobble plate type compressor with a variable capacity mechanism and including a plurality of pistons (18) reciprocating in cylinder bores of a cylinder block (31), the wobble plate (14) changing rotational movement into wobble movement and reciprocating the pistons through piston rods (17') connecting the pistons with the wobble plate; a cam rotor (10) connected to the drive shaft (7); a disc member (121) connected to the cam rotor for rotation with the shaft (7) by means of a link portion (122) formed on the disc member and having a hole (123) receiving a pin (13) slidably disposed in an elongate hole (102) in the cam rotor, the disc member (121) having a slider (24) slidably disposed around the drive shaft; an actuator (26), for changing the angle of the disc member and the wobble plate by moving the slider (24) and thus changing the stroke volume of the pistons, characterised in that the actuator (26) is disposed in the centre of the cylinder block (31), is operated by the differential pressure between the crank chamber (32) and the discharge chamber (53), the pressure from the discharge chamber being applied through an electromagnetic valve (28).

2. A compressor according to claim 1, wherein the actuator includes a pressure chamber (263) connected with the discharge chamber (53) through an aperture; a plunger mechanism (261) connected with the slider through a thrust needle bearing (27); and the electromagnetic valve (28) operating the plunger mechanism for sliding the slider by opening or closing the aperture between the pressure chamber and the discharge chamber.

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3. A compressor according to claim 1, wherein the actuator comprises a bellows (34) connected with the slider through a thrust needle bearing (27), the valve mechanism operating the bellows for sliding the slider according to gas pressure flow into the bellows by opening or closing the aperture between the interior of the bellows and the discharge chamber.

Patentansprüche

1. Taumelscheibenverdichter mit einem Mechanismus für veränderliche Fördermenge mit einer Mehrzahl von sich in Zylinderbohrungen eines Zylinderblockes (31) hin- und herbewegenden Kolben (18), wobei die Taumelscheiben (14) Drehbewegung in Taumelbewegung ändert und die Kolben durch Kolbenstangen (17'), die die Kolben mit der Taumelscheibe verbinden, hin- und herbewegt; einem mit der Antriebswelle (7) verbundenen Nockenrotor (10); einem Scheibenteil (221), das mit dem Nockenrotor zum Drehen mit der Welle (7) mit Hilfe eines Verbindungsabschnittes (122) verbunden ist und ein Loch (123) aufweist, das einen Stift (13) aufnimmt, der verschiebbar in einem länglichen Loch (102) in dem Nockenrotor angeordnet ist, wobei das Scheibenteil (121) einen verschiebbar um die Antriebswelle angebrachten Rutscher (24) aufweist; einem Betätigungselement (26) zum Ändern des Winkels des Scheibenteiles und der Taumelscheibe durch Bewegen des Rutschers (24) und somit Ändern des Hubvolumens der Kolben, dadurch gekennzeichnet, daß das Betätigungselement (26) in dem Zentrum des Zylinderblockes (31) angeordnet ist, durch den differentiellen Druck zwischen der Kurbelkammer (32) und der Entleerungskammer (53) betätigt wird, wobei der Druck in der Entleerungskammer durch ein elektromagnetisches Ventil (28) angelegt ist.

2. Kompressor nach Anspruch 1, indem das Betätigungselement eine mit der Entleerungskammer (53) durch eine Öffnung verbundene Druckkammer (263); einen mit dem Rutscher durch ein Drucknadellager (27) verbundenen Kolbenmechanismus (261) aufweist; und das elektromagnetische Ventil (28) den Kolbenmechanismus zum Verschieben des Rutschers durch Öffnen oder Schließen der Öffnung zwischen der Druckkammer und der Entleerungskammer betätigt.

3. Kompressor nach Anspruch 1, bei dem das Betätigungselement einen mit dem Rutscher durch ein Drucknadellager (27) verbundenen Balgen (34) aufweist, der Ventilmechanismus den Balgen zum Verschieben des Rutschers gemäß des Gasdruckflusses in den Balgen durch Öffnen oder Schließen der Öffnung zwischen dem

Inneren des Balgens und der Entleerungskammer betätigt.

Revendications

1. Compresseur de type à plateau oscillant muni d'un mécanisme à capacité variable et comprenant un certain nombre de pistons (18) effectuant un mouvement de va-et-vient dans les alésages de cylindre d'un bloc de cylindre (31), le plateau oscillant (14) transformant le mouvement de rotation en un mouvement d'oscillation et faisant aller et venir les pistons par l'intermédiaire de tiges de piston (17') reliant les pistons au plateau oscillant; un rotor à came (10) relié à l'arbre d'entraînement (7); un élément de disque (121) relié au rotor à came pour tourner avec l'arbre (7) sous l'action d'une partie de liaison (122) formée sur l'élément de disque et comportant un trou (123) recevant un axe (13) monté en glissement dans un trou allongé (102) du rotor à came, l'élément de disque (121) comportant un curseur (24) monté en glissement sur l'arbre d'entraînement; un organe de manoeuvre (26) destiné à modifier l'angle de l'élément de disque et du plateau oscillant par déplacement du curseur (24), pour modifier ainsi le volume de course des pistons, compresseur caractérisé en ce que l'organe de manoeuvre (26) est placé au centre du bloc de cylindre (31), et en ce que cet organe de manoeuvre est actionné par la différence de pression entre la chambre de manivelle (32) et la chambre d'échappement (3), la pression provenant de la chambre d'échappement étant appliquée par l'intermédiaire d'une soupape électromagnétique (28).

2. Compresseur selon la revendication 1, caractérisé en ce que l'organe de manoeuvre comprend une chambre de pression (263) relié à la chambre d'échappement (53) par l'intermédiaire d'une ouverture; un mécanisme de plongeur (261) relié au curseur par l'intermédiaire d'un palier de butée à aiguilles (27); et la soupape électromagnétique (28) manoeuvrant le mécanisme de plongeur pour faire glisser le curseur par ouverture ou fermeture de l'ouverture comprise entre la chambre de pression et la chambre d'échappement.

3. Compresseur selon la revendication 1, caractérisé en ce que l'organe de manoeuvre est constitué par un soufflet (34) relié au curseur par l'intermédiaire d'un palier de butée à aiguilles (27), le mécanisme de soupape actionnant le soufflet pour faire glisser le curseur suivant le débit de gaz sous pression pénétrant dans le soufflet, par ouverture ou fermeture de l'ouverture comprise entre l'intérieur du soufflet et la chambre d'échappement.

