

"Horizontal Crankshaft Hermetic Compressor"

The present invention relates to a hermetic compressor with horizontal crankshaft, and to an oil pump thereof.

05 Horizontal rotary type compressors are being more often used in refrigeration appliances due to the possibility of additional gain (comparatively to the vertical type ones) in terms of effective volume for the refrigerator.

10 In horizontal crankshaft compressors, oil circulation cannot be carried out according to the techniques usually applied in vertical crankshaft compressors, that is, to provide a centrifugal pump at the lower end of the crankshaft which is immersed in the oil at the lower part of the shell, forcing the oil through the crankshaft up to the parts requiring lubrication. For lubrication of horizontal crankshaft
15 compressors there is a need for lifting the oil from the sump to the crankshaft, wherefrom it is supplied to the bearings and other parts requiring lubrication.

20 One earlier method for lifting and circulating the oil is proposed by the patent specification US 4.449.895. This patent presents a horizontal rotary type hermetic compressor whose lubrication system comprises a curved pipe which extends to the oil sump at the bottom of the shell and a coiled spring which rotates within this curved pipe. The coiled spring has one of its ends connected to the crankshaft, while its other end is immersed in the oil.

25 When the crankshaft is driven, it causes the coiled spring to rotate, lifting the oil through the annular passage formed between the coils of the spring and the inner peripheral surface of the pipe. The oil is led into the pressure chamber at the end of the sub bearing and then supplied to the sub bearing, eccentric and main bearing by means
30 of oil grooves made on the crankshaft surface.

35 Although this system ensures a continuous supply of oil to the bearings and eccentric, it gives place to additional mechanical losses in the compressor. These mechanical losses are caused by the friction between the coils of the spring and the inner surface of the oil pipe.

40 Another problem of this solution is that the shell must necessarily be longer because more interior space is needed for mounting the oil pipe at the end of the sub bearing. In addition to a greater amount of material (steel plate) required for forming the shell this increase of length causes a more intensive superheating of the suction gas, and a consequent decrease of volumetric efficiency of the compressor. This superheating is due to the heat transfer from the compressed gas discharged at high temperature into the shell to the suction gas. The suction gas is taken in through the connection pipe (inside the shell).

The longer this pipe is the greater the amount of heat transferred through its wall, and so the superheating of the suction gas.

05 Still another problem of this solution concerns the high cost involved in manufacturing the coiled spring, since the non-circular cross section wire requires a specific project for its manufacturer.

10 Another method known for lifting and circulating the oil is proposed by the US Patent 4.472.121. This patent discloses a lubrication system for a horizontal rotary type compressor in which the lubricant oil accumulated in the bottom of the shell is forced into a lubrication bore formed centrally and axially in the crankshaft by the effective use of the refrigerant gas pulsation under high pressure discharged from the compression chamber. For this purpose the compressor is provided with: a lubricant oil feed tube, one end of which is in communication with the lubrication bore of the crankshaft and its other end is opened into the lubricant oil in the oil sump; and a refrigerant gas discharge pipe, one end of which is inserted within the end of the lubricant oil feed tube opened into the oil sump and its other end is in communication with the refrigerant gas discharged from the compression chamber.

20 When the refrigerant gas is discharged from the discharge pipe into the end of the oil feed tube (opened into the oil sump), the lubricant oil accumulated in the bottom of the shell and mixed with refrigerant gas is forced into lubricant oil feed tube through a gap formed at the overlapping end portions of the two pipes. The lubricant oil is stored in an oil collector and distributed through a central lubrication bore to the parts requiring lubrication.

25 In spite of its simple construction and low cost, this system has the inconvenience of providing an insufficient lubrication at the moment of starting the compressor, because the refrigerant gas pressure in the discharge pipe is insufficient for forcing the oil accumulated in the oil sump into the oil feed tube and for lifting it up to the crankshaft. This insufficiency of lubrication, besides causing noise due to the contact of the metallic parts, brings about an early wear of the compressor components.

30 Another inconvenience of this device is that it causes the refrigerant to be absorbed by the oil, reducing its viscosity and thus altering the lubrication conditions of the bearings. This absorption of refrigerant by the oil also causes a reduction of refrigerant amount circulating in the refrigeration system, which results in efficiency decrease of this system.

35 Another undesired effect of this system concerns the pressure losses of the refrigerant gas in the discharge. These pressure losses directly affect the electric energy consumption of the compressor and consequently its efficiency.

40 Finally the US Patent 4,568,253 discloses an oil pump for a hermetic rotary compressor with horizontal crankshaft. Its crankcase is provided with a vertical passageway, in communication with the oil sump.

The crankshaft comprises: a reduced diameter portion which forms with the crankcase an annular chamber; and a pair of oppositely angularly disposed helical grooves in communication with the annular chamber.

05 Upon rotation of the crankshaft, a low pressure area is developed in the annular chamber causing lubricant to be drawn upwardly through the crankcase passageway and into the annular chamber. Lubricant is then delivered by the helical grooves along the opposite end portions of the crankshaft lubricating bearings and other moving parts of the compressor.

10 In spite of having simple construction and low cost, this pump has in practice some troubles.

The helical grooves of the crankshaft end portions reduce the effective lift surface of the bearing, already reduced by the intermediate lowered portion of the crankshaft, which causes the contact and thus the wear of the crankshaft and the bearing.

15 Another troublesome aspect that must be mentioned is that the oil flow in this system is seriously affected by the presence of refrigerant gas, what happens mainly when compressor starts up. This refrigerant gas is released from the oil when compressor shuts off, forming gas bubbles which are retained in the bearing and in the crankcase passageway. When
20 compressor starts up, the low pressure created between the crankshaft and the bearing causes the bubbles to expand, which brings about some delay in the suction and in the delivery of the oil to the bearing making its lubrication difficult.

The present specification will describe a horizontal rotary type hermetic compressor having a pump with low energy consumption that delivers a continuous and adequate oil flow for lubricating the compressor without affecting its efficiency.

The pump is self priming and is capable of providing an efficient lubrication when the compressor starts up and supplying the oil into the bearings quickly and independently of the refrigerant gas retained in the lubrication circuit.

The oil pump takes up only a small longitudinal space and transmits a low level of noise. It is of simple construction, high reliability and low cost.

The invention concerns a horizontal crankshaft hermetic compressor of the type that comprises: a compressor unit including a cylinder which houses a piston, this piston being driven by a crankshaft which is supported by a main bearing and a sub bearing; an electric motor which rotatably drives the crankshaft; an oil pump which is defined around a portion of the crankshaft and in fluid

communication with the oil sump and with the parts of the unit requiring lubrication; and a hermetic shell enclosing the compressor unit, the electric motor, the oil pump and the lubricant oil sump.

According to the present invention in such a compressor the oil pump comprises: a cylindric and eccentric portion of the crankshaft which is disposed in such a way as to slip within a cylindric housing, this housing being concentric to the geometric axis of the crankshaft and provided in one of the bearings or in a front cover of the sub bearing, at least one flexible blade element with a width corresponding to the axial length of the cylindric housing, this blade element having at least one of its edges attached to the interior surface of the housing, and passing between and being in contact with the cylindric housing and the eccentric portion at a region of contact so as to define an admission and a pressure chamber, one in each space of the cylindric housing defined between said attached edge of the blade element and the region of contact, the admission chamber and the pressure chamber being in fluid communication respectively with the lubricant oil collected in the oil sump and with the parts of the crankshaft and bearings requiring lubrication.

Still according to the present invention, there is a horizontal crankshaft hermetic compressor having a crankshaft supported by a main bearing and a sub-bearing and driven by an electric motor and a lubricating pump comprising a cylindrical portion of the crankshaft eccentrically disposed in a cylindrical chamber formed in one of the bearings or in a front cover of the sub-bearing, and a flexible blade element fixed by at least one of its edges to the wall of the chamber and extending around the crankshaft portion to divide the space between the chamber and the said portion into a suction chamber communicating with an oil sump and a pressure chamber communicating with the parts to be lubricated.

In accordance with a preferred embodiment of the invention, the blade element consists of a plastic material film that is thermally resistant and compatible with the chemical conditions of the medium.

In accordance with another embodiment of the invention, the blade element is a metal with properties of flexibility, wear and fatigue resistance. Such an oil pump has features of positive displacement since its flow depends only on the volume displaced by the eccentric.

Contrary to some of the systems described before, this device does not use the effect of viscosity or the action of centrifugal force for sucking and lifting the oil which besides imparting self-priming features to it, makes it possible for an efficient lubrication of the bearings when compressor starts up, since the oil is supplied quickly and even with the presence of refrigerant gas in the lubrication circuit.

Another favourable aspect of this device is that it has a low energy consumption and a low noise level, since the friction surfaces are considerably reduced and the clearances required between the parts are reasonably large.

Another particular advantage of this type of pump is that it delivers a continuous oil flow which can easily be adequated to the needs of the compressor unit by varying only the eccentricity, the diameter or the length of the eccentric portion, without affecting in a sensible manner its energy consumption.

These and other features and advantages of the invention will become more apparent by reference to the description of some of its preferred embodiments which is done in conjunction with the accompanying drawings, wherein:

Figures 1A and 1B are partial longitudinal sectional views of a horizontal rotary type hermetic compressor in accordance with two preferred embodiments of the present invention;

05 Figure 2 is a front view of the compressor shown in figure 1B, taken in the direction of the arrow "A";

Figure 3 is a front sectional view of the compressor shown in figures 1A and 1B, taken along section line B-B';

Figures 4, 5 and 6 are front sectional views taken along section line C-C' of figure 1A showing the oil pump in operation;

10 Figure 7 is a front sectional view taken along section line C-C' of figure 1A showing another construction of the oil pump illustrated in figure 1A;

Figures 8 and 9 are front sectional views taken along section line C-C' of figure 1B showing two different constructions of the oil pump illustrated in figure 1B.

Referring to the figures above, the horizontal rotary type hermetic compressor includes essentially a compressor unit 1 and electric motor 2, both mounted within a shell 3.

20 The compressor unit 1 comprises a cylinder block 4, a main bearing 5 and a sub bearing 6. The main bearing 5 and the sub bearing 6 are screwed at the cylinder block 4 and support a crankshaft 7 that drives a rolling piston 8 within a cylinder 9 formed in the cylinder block 4.

25 The compressor unit 1 also includes a slidable vane 10 which is held in a slot 11 of the cylinder block 4. The vane 10 is axially forced against the rolling piston 8 by means of a spring 12 so as to slide through the slot 11 on the piston surface.

30 The vane 10 defines with the rolling piston 8, with the cylinder 9 and with the flanged portions 13 and 14 of the main bearing 5 and sub bearing 6, tight chambers of suction 15 and compression 16 that are connected respectively to the suction inlet tube 17 and discharge tube 18, both welded to the shell 3 of the compressor. The suction inlet tube 17 is connected directly to the suction chamber 15 through its internal projection 19, and the discharge tube 18 communicates with the compression chamber 16 through the interior volume of the shell 3.

35 The compressor unit 1 is driven by the electric motor 2 which comprises a stator 20 with windings 21 and a rotor 22 secured on the crankshaft 7.

Referring more particularly to figure 1A, the crankshaft 7 has a cylindric eccentric portion 23 disposed within the main bearing 5 or sub bearing 6. The cylindric eccentric portion 23 is disposed in such a way as to slip within a cylindrical housing 26. This housing 26 is concentric to the geometric axis of the crankshaft 7 and provided, according to the example illustrated, in the main bearing 5. The housing depth corresponds to the axial length of the eccentric portion 23 of the crankshaft 7.

45 In fig. 1B, the eccentric portion 23 of the crankshaft 7 has the shape of a cylindric axial projection with reduced diameter which extends

from the end front face 24b of the crankshaft 7. As illustrated, the cylindric housing 26 is provided in a front cover 37 of the sub bearing 6 and is mounted on its front end by means of a metallic fastener 27 or another means. A more detailed description of this embodiment has been omitted in the present report since it can be well understood from the description of Fig. 1A

Figs. 4 to 9 illustrate a curved and lengthened flexible blade element 25 which is attached to the cylindric internal surface of the housing 26 by means of one (Figs. 4, 5, 6, 8 and 9) or both edges (Fig. 7) and is inserted through the clearance at an area of contact 28 between the cylindric eccentric portion 23 and the housing 26.

As illustrated, the blade element 25 has the function of separating the admission chamber 29 from the pressure chamber 30, whose volumes are delimited: by the opposite surfaces of the blade element 25 and the interior surface of the housing 26; by the edge of attachment 31 of the blade element 25 at the interior surface of the housing 26 and the area of contact 28; and by the lateral walls of the housing 26, one of which is defined (in the example of Fig. 1A) by the lateral surface 24a of the piston 8 and eccentric portion 36 of the crankshaft 7, and the other by the bottom surface 32 of the housing 26.

Referring to Figs. 1A, 4, 5, 6 and 7, the admission chamber 29 of the oil pump is connected to the oil sump 34 in the bottom of the shell 3 by means of a suction hole 33a which is made through the flange 13 of the main bearing 5. The pressure chamber 30 is connected to a central oil feed hole 39 by means of an oil discharge hole 38 which is radially disposed through the eccentric portion 23 of the crankshaft 7.

The distribution of the oil from the central oil feed hole 39 to the surfaces of the main bearing 5 and the sub bearing 6, and to the internal surface of the rolling piston 8 is carried out by means of one or more radial openings 38a (Fig. 1a). It must be noticed that the peripheral end of the oil discharge hole 38 (Figs. 1A, 4, 5, 6 and 7) is set in a slightly advanced angular position respective to the area of contact 28 between the

eccentric portion 23 and the internal surface of the housing 26, so as to make use of the whole volume of oil displaced by the pump.

Referring to Figs. 1B, 8 and 9, the admission chamber 29 is connected to the oil sump 34 in the bottom of the shell 3 by means of a suction pipe 33b.

The pressure chamber 30 is connected to the sub bearing 6 and main bearing 5 by means of lubrication grooves which can have different shapes.

In Figs. 1B and 8 helical grooves 35 are made in the surface of the crankshaft 7. These helical grooves 35 have the function of supplying the oil along the sub bearing 6, eccentric 36 and main bearing 5 according to the conventional techniques. As shown in Fig. 8 the oil displaced by the pump is discharged through the front end of the helical groove 35 which is set in a slightly advanced angular position respective to the point of contact 28.

As shown in Figure 8, the inlet port of the suction pipe 33b has the point of attachment 31 of the blade element 25 displaced from it in a direction opposite to the direction of rotation of the crankshaft 7.

Fig. 9 shows another constructive example where the oil displaced by the pump is discharged through a groove 40. This groove 40 is made in the cylindric internal surface of the front cover 37 and in the surfaces of the sub bearing 6 and the main bearing 5.

An aspect that must be enhanced is that the free edge of the blade elements 25 illustrated in Figs. 4, 5, 6, 8 and 9 is sufficiently flexible so as to make the oil pressure equal in the whole volume of the pressure chamber 30.

Another aspect to be mentioned regarding Figs. 4, 5, 6, 8 and 9 is that the blade element 25 can have its length reduced depending on its material and thickness. In the case where the blade element 25 consists of a plastic film, its length can be reduced provided that there is sufficient adherence of the film with the surface of the eccentric portion 23. This adherence is

due to the oil film created upon rotation of the eccentric portion 23 and acts in such a way as to slightly strain the film separating the admission and pressure sides of the pump.

In the embodiment illustrated in Fig. 7, the volume of oil enclosed between the blade element 25 and the cylindric surface of the eccentric portion 23 (represented by area 41) is subject to an intermediate pressure between the admission chamber 29 and the pressure chamber 30 since there is oil leakage through the clearance between the blade element 25 and the flanged portions 13, 14 of the bearing 5, 6 which are the lateral surfaces of the housing 26.

CLAIMS:

1. Horizontal crankshaft hermetic compressor, comprising a compressor unit having a cylinder which houses a piston, this piston being driven by a crankshaft which is supported by a main bearing and a sub bearing: an electric motor rotatably driving the crankshaft: an oil pump defined around a portion of the crankshaft and in fluid communication with an oil sump and with the parts of the unit requiring lubrication; and a hermetic shell enclosing the compressor unit, the electric motor, the oil pump and the lubricant oil sump, said oil pump comprising a cylindric and eccentric portion (23) of the crankshaft (7) which is disposed in such a way as to slip within a cylindric housing (26), this housing (26) being concentric to the geometric axis of the crankshaft (7) and provided in one of the bearings (5 or 6) or in a front cover (37) of the sub bearing (6): at least one flexible blade element (25) with a width corresponding to the axial length of the cylindric housing (26), this blade element (25) having at least one of its edges attached to the interior surface of the housing (26), and passing between and being in contact with the cylindric housing (26) and the eccentric portion (23) at a region of contact (28) so as to define an admission (29) and a pressure chamber (30), one in each space of the cylindric housing (26) defined between said attached edge of the blade element (25) and the region of contact (28), the admission chamber (29) and the pressure chamber (30) being in fluid communication respectively with the lubricant oil collected in the oil sump and with the parts of the crankshaft (7) and bearings (5 and 6) requiring lubrication.

2. Horizontal crankshaft hermetic compressor according to claim 1, wherein said blade element (25) consists of a plastic material film that is thermally resistant and compatible with the chemical conditions of the medium.



3. Horizontal crankshaft hermetic compressor according to claim 1, wherein said blade element (25) is a metal with properties of flexibility, wear and fatigue resistance.
4. Horizontal crankshaft hermetic compressor according to claim 1, wherein the admission chamber (29) of the oil pump is connected to the oil sump (34) in the bottom of the shell (3) by means of a suction hole (33a) made through the main (5) or sub bearing (6).
5. Horizontal crankshaft hermetic compressor according to claim 1, wherein the admission chamber (29) of the oil pump is connected to the oil sump (34) in the bottom of the shell (3) by means of a suction pipe (33b).
6. Horizontal crankshaft hermetic compressor according to claim 1, wherein the pressure chamber (30) is connected to a central oil feed hole (39) by means of an oil discharge hole (38) radially disposed through the eccentric portion (23), this central oil feed hole (39) being in fluid communication with the parts of the surface of the crankshaft (7) requiring lubrication by means of radial openings (38a) which are made on the crankshaft (7).



7 - Horizontal Crankshaft Hermetic Compressor according to claim 1, wherein the pressure chamber (30) is connected to the sub bearing (6) and main bearing (5) by means of lubrication grooves.

05 8 - Horizontal Crankshaft Hermetic Compressor according to claim 7, wherein the lubrication grooves are made in the surface of the crankshaft (7) in shape of helical grooves (35).

10 9 - Horizontal Crankshaft Hermetic Compressor according to claim 7, wherein the lubrication grooves (40) are made in the cylindric internal surface of the front cover (37) and in the surface of the sub bearing (6) and main bearing (5).

15 10 - Horizontal Crankshaft Hermetic Compressor according to claim 8, wherein the peripheral end of the oil discharge hole (38) is set in a slightly advanced angular position respective to the point of contact (28) between the eccentric portion (23) and the internal surface of the housing (26).

11 - Horizontal Crankshaft Hermetic Compressor according to claim 1, wherein one of the lateral walls of the cylindric housing (26) is defined by part of the lateral surfaces (24a) of the piston (8) and/or an eccentric portion (36) of the crankshaft (7).

20 12 - Horizontal Crankshaft Hermetic Compressor according to claim 1, wherein said oil pump has features of positive displacement.

13 - A horizontal crankshaft hermetic compressor having a crankshaft supported by a main bearing and a sub-bearing and driven by an electric motor and a lubricating pump comprising a cylindrical portion of the crankshaft eccentrically disposed in a cylindrical chamber formed in one of the bearings or in a front cover of the sub-bearing, and a flexible blade element fixed by at least one of its edges to the wall of the chamber and extending around the crankshaft portion to divide the space between the chamber and the said portion into a suction chamber communicating with an oil sump and a pressure chamber communicating with the parts to be lubricated.

14. - A compressor as claimed in claim 13 in which the inlet to the suction chamber is a fixed port and the point of attachment of the blade is displaced from the inlet port in a direction opposite to the direction of rotation of the crankshaft.

15 - A compressor as claimed in claim 13 or 14 in which the outlet from the pressure chamber is formed in the crankshaft.

