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TUNEO MONDEN ET AL

3,513,476

ROTARY COMPRESSORS

Filed June 19, 1968

2 Sheets-Sheet 1

FIG. 1

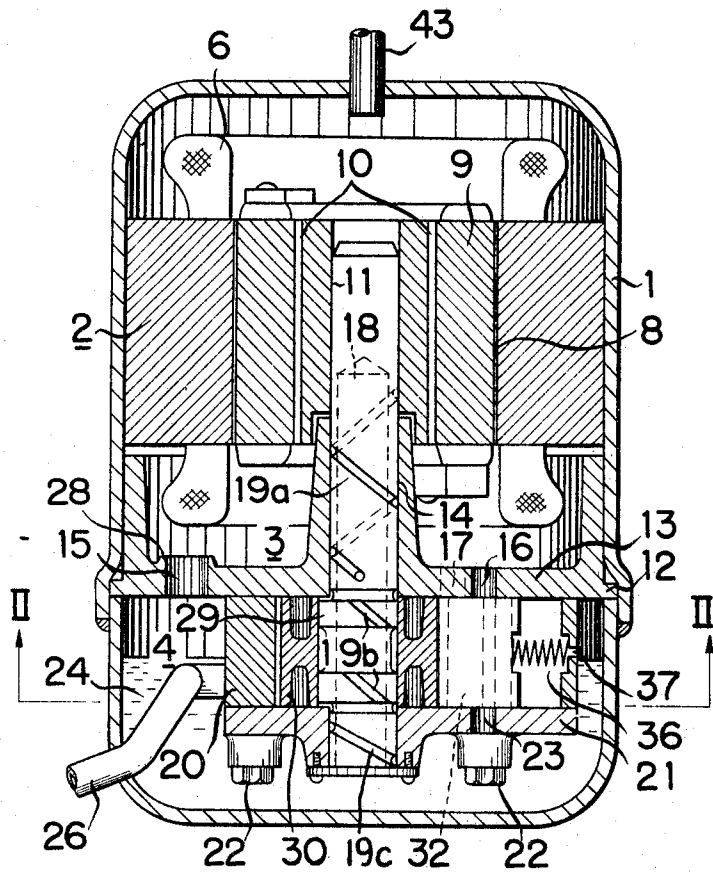
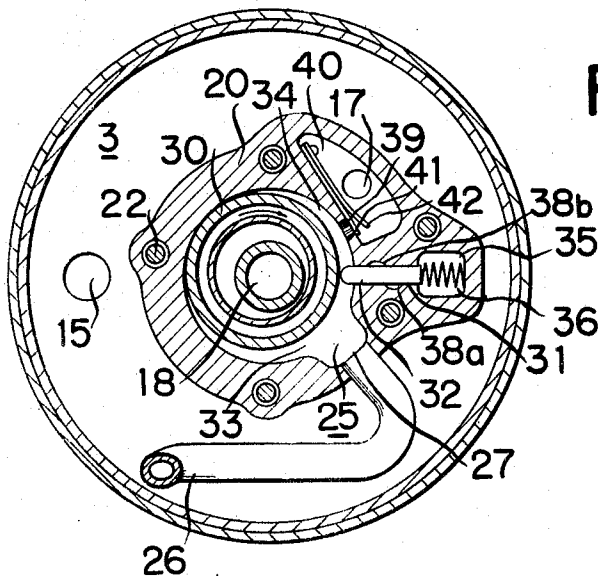


FIG. 2



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FIG. 3

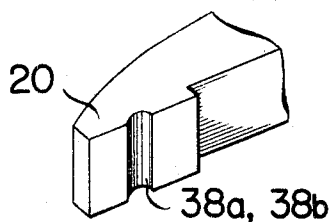


FIG. 6

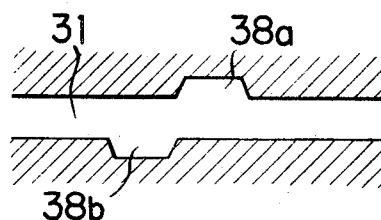


FIG. 4

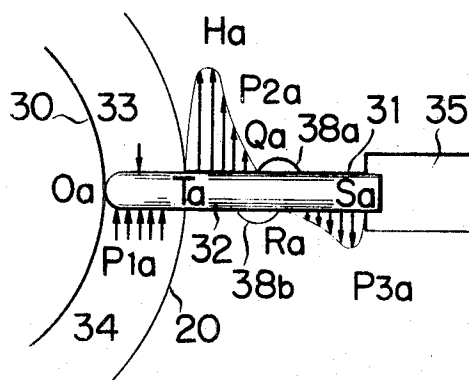


FIG. 7

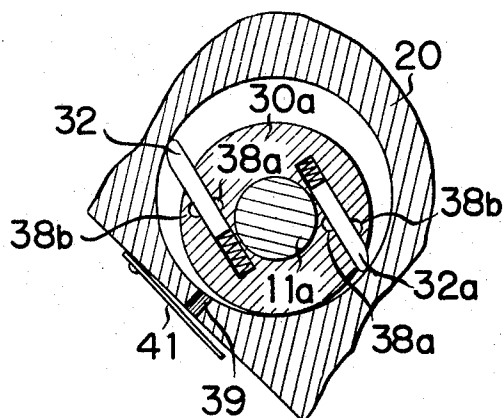
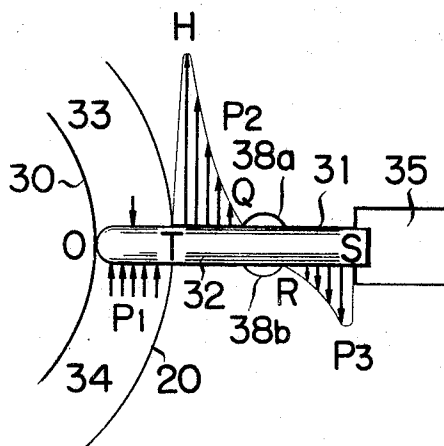


FIG. 5



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ROTARY COMPRESSORS

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4 Claims

ABSTRACT OF THE DISCLOSURE

In a rotary compressor comprising a cylinder, a rotor eccentrically mounted in the cylinder and a blade slidably received in a slot in the cylinder or rotor to divide the interior of the cylinder into high and low pressure chambers, lubricant grooves are formed on the inner wall of the slot on the opposite sides of the blade and at different positions along the length thereof.

BACKGROUND OF THE INVENTION

This invention relates to a rotary compressor especially suitable for use in room air conditioners and the like.

A rotary compressor generally comprises a cylinder containing a rotor which rotates eccentrically therein and a blade arranged to be reciprocated in accordance with the eccentric rotary motion of the rotor, the blade divides the interior of the cylinder into a high pressure chamber and a low pressure chamber so that gas in the low pressure chamber is compressed by the rotary movement of the rotor, and the compressed gas is supplied to a refrigerating circuit from the high pressure chamber. Thus, one side of the blade projecting from the cylinder towards the rotor is in the high pressure chamber whereas the opposite side is in the low pressure chamber, whereby the blade is normally subjected to a transverse or lateral pressure corresponding to the pressure differential between high and low gas pressures. Furthermore, the blade is reciprocated by the rotor rotating at a high speed, and as this reciprocating motion is effected under said transverse pressure due to the difference in gas pressures, some means must be provided to assure smooth reciprocating motion of the blade.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide a novel rotary compressor including an improved lubricating mechanism.

According to this invention, oil grooves are provided on the opposite sides of the blade at different positions along the length of the blade to reduce concentration of transverse pressure created between the slot receiving the blade and the blade reciprocating therein thus assuring smooth reciprocating motion and durability of the blade.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 shows a longitudinal cross-section of one embodiment of the novel rotary compressor;

FIG. 2 is a sectional view taken along a line II—II in FIG. 1;

FIG. 3 is an enlarged perspective view to show an oil groove formed in a blade slot;

FIG. 4 is a diagram to explain the distribution of the transverse pressure acting upon the novel blade;

FIG. 5 is a diagram to explain the distribution of the transverse pressure acting upon a conventional blade;

FIG. 6 shows modified oil groove for the blade; and

FIG. 7 shows a cross-section of a rotary compressor of the other type but embodying this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1 of the accompanying drawings, there is shown a rotary compressor comprising a sealed casing 1 containing an electric motor 2, a frame 3 and a compressor unit 4. Stator 5 of the motor 2 is wound with an energizing coil 6 and supported by the frame 3. A rotor 9 rotating in the stator 5 with an air gap 8 therebetween is formed with axial air ducts 10, the shaft 11 of the motor extending through the frame 3 to the compressor. Frame 3 comprises a cylindrical portion 12 forcibly fitted in the sealed casing 1, a horizontal partition 13 and a bearing member 14 adapted to journal the extension of the shaft 11. Horizontal partition 13 of the frame 3 is provided with perforations 15 and 16 adapted to communicate upper and lower chambers and a perforation 17 (shown by dotted lines) communicated with a muffler chamber of the compressor to be described later. A raised ridge 28 is provided to surround the perforation 15. Further an oil duct 18 is provided to extend through the extension of shaft 11, said oil duct being open at the lower end and communicated with spiral oil grooves 19a, 19b and 19c provided on the periphery of the shaft 11. A cylinder 20 of the compressor unit 4 is securely fixed to the horizontal partition 13 of frame 3 by means of bolts 22 together with a bracket 21 or end plate of the compressor 4 journaling the lower end of shaft 11. Bracket 21 is provided with a perforation 23 aligned with the perforation 16 of said frame 3. The lower half of the compressor unit 4 is normally immersed in a body of oil 24 accumulated in the bottom of the sealed casing 1.

As shown in FIG. 2, inside the cylinder 20 of the compressor unit 4 are formed a gas chamber 25 of circular cross-section and a suction port 27 communicated with a suction pipe 26. A cylindrical rotor 30 is fit around an eccentric 29 of shaft 11 in the gas chamber 25 which is divided into a low pressure gas chamber 33 and a high pressure gas chamber 34 by means of a blade 32 slidably received in a radial slot 31 of the cylinder 20. The blade 32 is normally urged against the periphery of the rotor 30 by means of a spring 36 contained in a chamber 35 which is supplied with oil through an opening 37. As the blade 32 reciprocates very frequently to follow the eccentric rotary motion of the rotor 30, it is clear that the sliding surface between the slot 31 and the blade 32 must be adequately lubricated.

This invention is characterized by providing an improved lubricating means for the blade 32. In the illustrated embodiment, as shown in FIGS. 2 and 4, a pair of semi-circular oil grooves 38a and 38b are formed in the inner wall of the slot 31 on the opposite sides of the blade 32 and axially displaced each other. Accordingly, perforations 16 through the horizontal partition 13 of the frame 3 and perforation 23 through the bracket 21 must be dimensioned to cover oil grooves 38a and 38b. The cylinder 20 is formed with a muffler chamber 40 communicated with the high pressure gas chamber 34 through a discharge port 39 which is normally closed by a discharge valve 41, the extent of the opening thereof being limited by a stop 42. The muffler chamber 40 is communicated with the interior of the motor via a perforation 17 through the horizontal partition 13 of the frame 3.

The rotary compressor operates as follows: When the motor 2 is energized, the eccentric 29 of shaft 11 rotates eccentrically with respect to the axis thereof. Consequently, the rotor 30 is caused to roll along the inner periphery of the gas chamber 25. In FIG. 2, assuming now that the rotor 30 is caused to rotate in the direction indicated by an arrow, gas introduced into the low pressure gas chamber 33 will be compressed by the eccentric rotation of the rotor 30 and the gas in the

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high pressure gas chamber 34 will be discharged into the muffler chamber 40 through the discharge port 39 and the discharge valve 41. High pressure gas in the muffler chamber 40 will then be supplied to the refrigeration system through the perforation 17, air ducts 10 through the rotor of the motor 2 and air gap 8 and through a discharge pipe 43. Oil 24 in the bottom of the sealed casing 1 is pumped upwardly through the oil duct 18 in the shaft 11 by the rotation thereof and is then distributed among spiral oil grooves 19a, 19b and 19c. Although a portion of the pumped up oil is supplied to the sliding surface between the bracket 21 and the rotor 30, most of the oil overflows the upper end of the bearing 14 of the frame 3 and is then collected on the upper surface of the horizontal partition 13. As the perforation 15 therethrough is surrounded by raised ridge 28, oil collected on the upper surface of the horizontal partition 13 preferentially flows through the other perforation 16. Oil overflowed the raised ridge 28 returns to the bottom of the sealed casing 1 through perforation 15. Oil flown into perforation 16 enters into a pair of oil grooves 38a and 39b and then returns back to the bottom of the sealed casing 1 through the sliding surface between the blade 32 and the slot 31 and through the perforation 23 through the bracket 21.

Referring now to FIG. 4, oil grooves 38a and 38b provided for the blade 32 in accordance with this invention provides following lubricating function. The feature of the invention lies in the axial displacement of oil grooves 38a and 38b as shown in FIGS. 2 and 4. Before explaining the operation of this invention, the conventional blade lubricating device, as shown in FIG. 5 will be considered. As shown in this figure, it has been the practice to locate a pair of oil grooves 38a and 38b on the same axial location along the length of the blade 32. As has been pointed out hereinabove, the gas chamber 25 is divided into a high pressure gas chamber 34 and the low pressure gas chamber 33 on the opposite sides of the point of contact between the rotor 30 and the blade 32 so that a transverse or lateral pressure corresponding to the difference between high and low gas pressures acts upon one side of a portion O-T of the blade 32 projecting from the cylinder 20. There is a small clearance between the blade 32 and the slot 31 to form required oil films. However, since small oil grooves 38a and 38b can not form perfect oil films, the distribution of the lateral pressure acting on the portion O-T of the blade 32 projecting into the gas chamber due to the pressure difference can be approximately shown in FIG. 5 wherein P_1 indicates the lateral pressure acting upon the unit area of the projecting portion O-T of the blade 32, P_2 the lateral pressure acting upon the portion T-Q, and P_3 that acting upon the portion R-S of the blade 32. The lateral pressure P_1 has a uniform distribution and the total load created thereby balances with the difference between the distributed loads due to lateral pressures P_2 and P_3 . Approximately, lateral pressures P_2 and P_3 have their maxima at points T and S and their minima at points Q and R, respectively.

Assuming now that the lateral pressure P_1 and the length of the projected portion of blade 32 are constant, load distributions of lateral pressures P_2 and P_3 would be determined by the lengths of portions T-Q and R-S. Thus, when the length is short, the lateral pressure per unit area would increase. Further, as oil grooves 38a and 38b are on the same axial position and are symmetrical with respect to the longitudinal axis of the blade, displacement thereof to the right results in the increase of the lateral pressure P_3 whereas that to the left results in the increase of the lateral pressure P_2 . In any case, with the prior symmetrical arrangement of oil grooves 38a and 38b as shown in FIG. 5, change of their position thereof does not decrease the lateral pressure acting upon the blade 32. As a result, the blade is caused to reciprocate frequently by the eccentric rotary motion of the

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rotor 36 while it is subjected to a considerable lateral pressure thus causing such troubles as excessive wear or seizure at points T and S where the lateral pressures P_2 and P_3 are maximum.

This invention is based on the conception that such trouble as seizure can be prevented by alleviating the local concentration of lateral pressures P_2 and P_3 and according to this invention oil grooves 38a and 38b mutually displaced along the length of the blade as shown in FIGS. 2 and 4. More particularly, the oil groove 38b on the side of high pressure gas chamber 34 is moved towards the center of the cylinder 20 whereas the oil groove 38a on the side of low pressure gas chamber 33 is moved away from the center. The dimensions of perforations 16 and 23 shown in FIG. 1 and are communicating with these oil grooves 38a and 38b should be selected to coincide therewith.

By comparing FIGS. 4 and 5 it will be seen that $Oa-Ta=O-T$, $Ta-Qa>T-Q$, $Ra-Sa>R-S$. Since $P_{1a}=P_1$, $P_{2a}<P_2$ and $P_{3a}<P_3$. In other words, since lengths $Ta-Qa$ and $Ra-Sa$ are longer than T-Q and R-S, respectively, the lateral pressures acting upon the unit area of these sections are small. Further the maximum value H_a of the lateral pressure is smaller than H. This is because that the reactions of lateral pressures P_{1a} and P_1 can be obtained by integrating these lateral pressures in sections $Ta-Qa$ and $T-Q$, respectively. Thus, according to this invention the local concentration of lateral pressures acting between the blade 32 and the slot 31 of the cylinder 20 can be effectively alleviated when compared with the conventional construction shown in FIG. 5 whereby oil films of adequate and uniform thickness are formed between blade 32 and slot 31 thus assuring smooth and frequent reciprocating motion of the blade.

While in the embodiment oil grooves 38a and 38b have been shown as semi-circular they may be trapezoidal as shown in FIG. 6. Further, instead of a combination of ring shaped rotor and an eccentric of a shaft, the rotor of the compressor that rolls eccentrically along the inner surface of the cylinder may be a circular disc eccentrically combined with a shaft. The compressor may also be constructed by a cylinder 20, a shaft 11a eccentric to the center of the cylinder, a rotor in the form of a cylinder concentric to the shaft 11a and one or more of blades 32 and 32a slidably received in the rotor, as shown in FIG. 7. In this modification too, oil grooves 38a and 38b on the opposite sides of each blade are staggered or displaced along the length of the blade.

Thus, it will be seen that according to this invention oil grooves on the opposite sides of a blade are displaced along the length thereof, thus effectively alleviating undesirable concentration of the lateral pressure acting between the blade and a slot slidably receiving it, thereby assuring adequate and uniform oil film.

While the invention has been described in connection with some preferred embodiments thereof, the invention is not limited thereto and includes any modifications and alterations which fall within the scope of the invention as defined in the appended claims.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In a motor driven rotary compressor including a compressor unit and a cylinder wherein an eccentric rotor is housed within a hermetically sealed casing and connected to a shaft of an electric motor, and at least one blade is reciprocable by the eccentric rotary motion of the rotor so as to divide the interior of said cylinder into a high pressure chamber and a low pressure chamber and compress gas in said cylinder, the improvement therein wherein a pair of oil grooves are provided on the inner surfaces of members for receiving the reciprocable blade therein and asymmetrically displaced on a line perpendicular to the longitudinal direction of the blade, the oil groove on the side of the high pressure chamber being

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disposed towards the center of the cylinder whereas the oil groove on the side of the low pressure chamber being away from the center of the cylinder.

2. The rotary compressor according to claim 1 wherein said blade is slidably received in a slot of said cylinder to be urged against the periphery of said rotor and said lubricant grooves are formed on the inner wall of said slot.

3. The rotary compressor according to claim 1 wherein said blade is slidably received in a slot of said rotor to be urged against the inner wall of said cylinder and said lubricant grooves are formed on the inner wall of said slot.

4. The rotary compressor according to claim 1 wherein a compressor unit and its driving motor are contained in a sealed casing.

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U.S. Cl. X.R.

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