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Butts et al.

[11] **3,790,311**

[45] **Feb. 5, 1974**

[54] **FOUR VANE ELLIPTICAL ROTARY AIR CONDITIONING COMPRESSOR**

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[73] Assignee: **General Motors Corporation**, Detroit, Mich.

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[52] **U.S. Cl.** **417/410,** 417/424, 418/182, 418/209, 418/266

[51] **Int. Cl.** **F04b 17/00**

[58] **Field of Search**.... 417/410, 424; 418/209, 182, 418/266, 267

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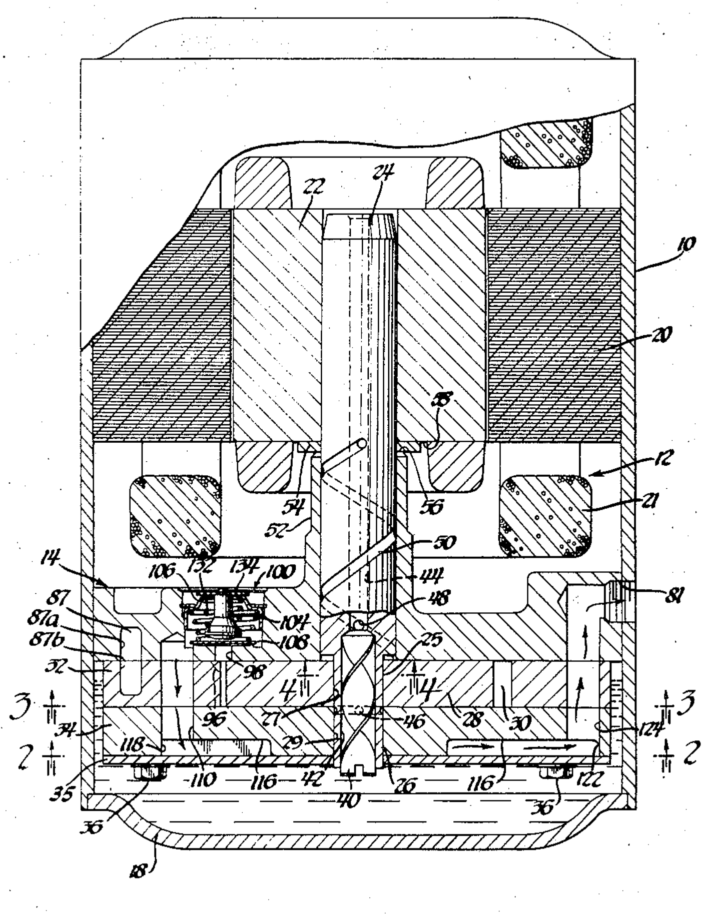
[57] **ABSTRACT**

A rotary hermetically sealed refrigerant electric compressor having an elliptically shaped compression chamber in which a symmetrical rotating rotor, keyed on the drive shaft in an axially slidable manner, includes opposed pairs of sliding vanes providing an inherently balanced bearing loading. The shear forces caused by the compressor rotor revolving against the lower bearing plate are reduced by incorporating a thrust element between the electric motor rotor and stationary hub portion of the upper bearing plate allowing limited movement of the compressor rotor on the shaft in an axial direction to provide for out of squareness dimensional tolerances between the compressor rotor, the shaft and the compression chamber.

3 Claims, 4 Drawing Figures



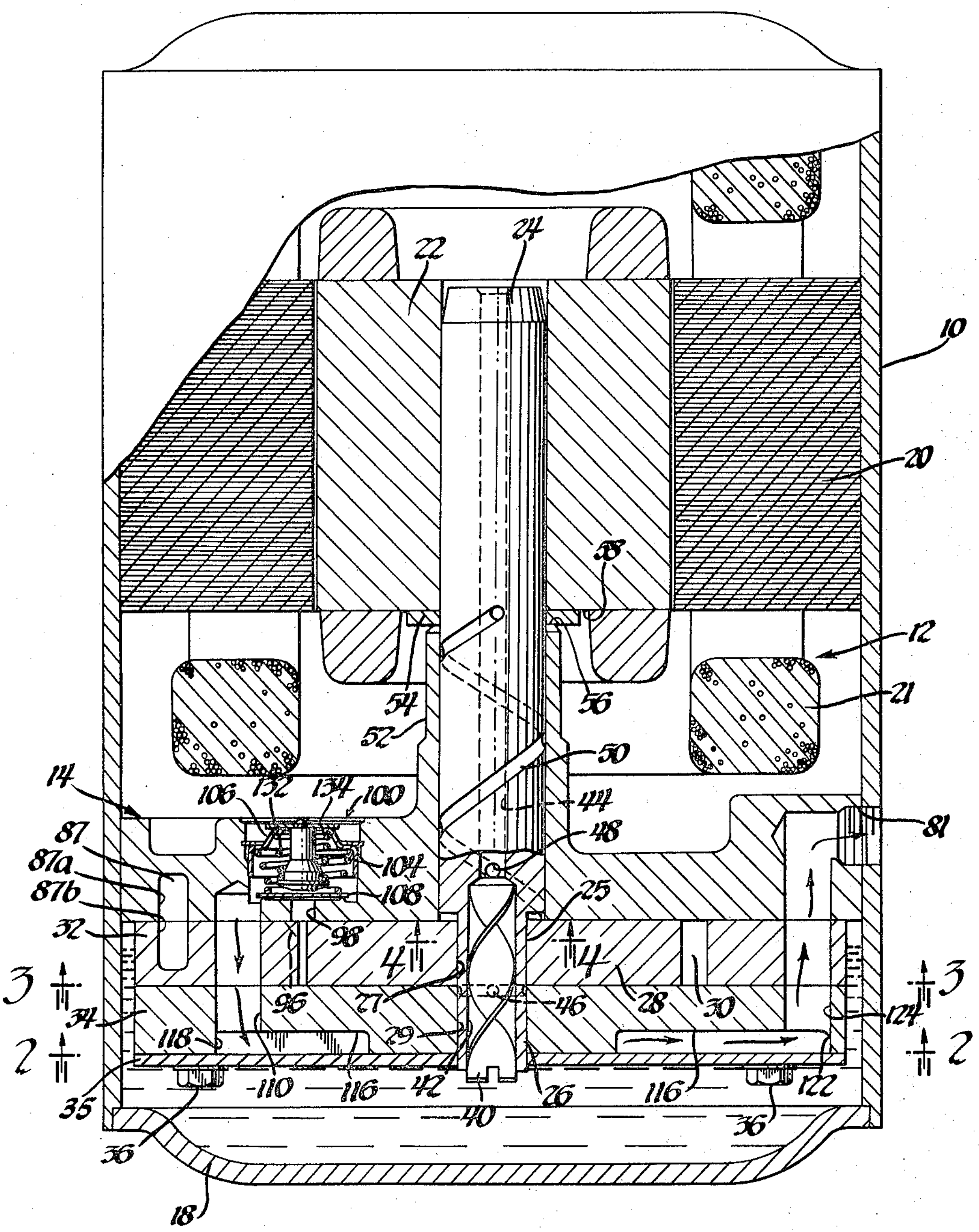

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Fig. 1

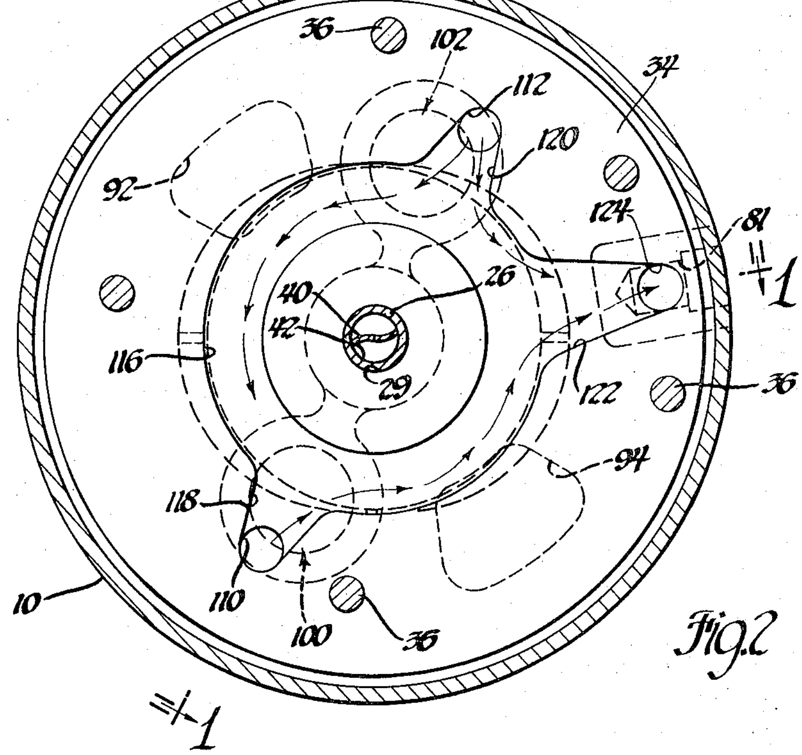

Fig.2

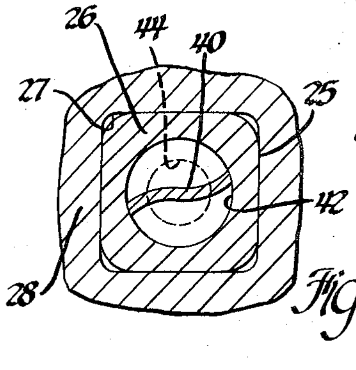

Fig.4

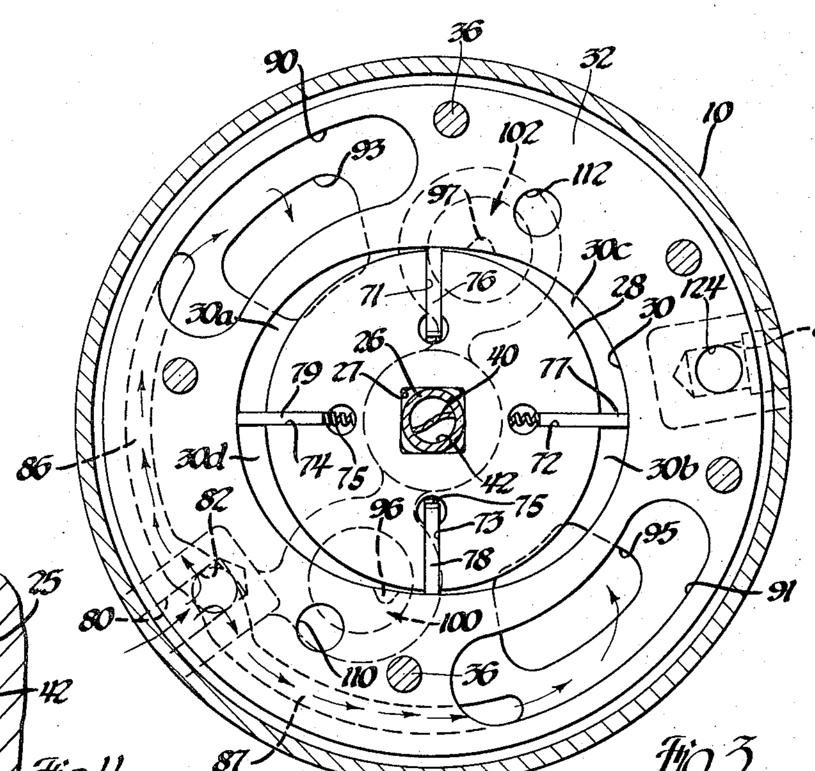

Fig.3

FOUR VANE ELLIPTICAL ROTARY AIR CONDITIONING COMPRESSOR

This invention relates to a rotating vane refrigerant gas compressor and more particularly to a hermetically sealed compressor having an elliptically shaped compression chamber providing inherently balanced bearing loadings.

One problem in designing a rotary compressor for use in a refrigerating system wherein pairs of sliding vanes are provided on a symmetrically positioned rotor is to reduce the shear forces which result from the rotor revolving against the lower bearing plate under an applied thrust load. Another problem results from the squareness requirements between the driving shaft and the rotor.

It is an object of this invention to provide an improved construction for a refrigerant gas compressor having an elliptically shaped cylinder in which a symmetrically positioned rotor incorporating opposed pairs of sliding vanes, is mounted for axial movement on the motor shaft in a manner whereby the rotor is free to float on the motor shaft by providing axial thrust means between the motor rotor and the upwardly extending fixed hub portion of the upper bearing plate.

It is another object of the invention to provide a gas intake manifold arrangement for a refrigerant gas compressor having an elliptically shaped cylinder wherein the refrigerant gas is supplied to the working chamber from both the upper and lower bearing plates.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIG. 1 is a diametric section of a compressor provided with an elliptical chamber taken on line 1—1 of FIG. 2;

FIG. 2 is a horizontal sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a horizontal sectional view taken along line 3—3 of FIG. 1; and,

FIG. 4 is a fragmentary horizontal section taken along the line 4—4 of FIG. 1.

Referring now to the drawings wherein a preferred embodiment of the invention has been shown, reference numeral **10** designates an inverted cup-shaped sheet metal housing element which serves to enclose the motor compressor assembly, generally designated by the reference numeral **12.** The motor compressor assembly includes a cast frame upper bearing plate **14** which is encased in a press fitted manner within the casing **10.** A closure plate **18** is welded or otherwise secured to the housing bottom edge to hermetically seal the open end of the housing **10.** An electric motor stator **20** having windings **21** is fixedly encased in the housing and a complementary motor revolving rotor **22** is supported on the upper end of the main compressor drive shaft **24** in a substantially integrally fitted manner. The drive shaft **24** is provided with an intermediate polygonal shaped portion **25,** preferably having a square cross section (FIG. 4), for reception within a complementary shape aperture **27** in compressor slotted rotor member **28** so as to be keyed thereon such that the slotted circular rotor **28** is symmetrically disposed in elliptical shaped compression chamber **30** for rotation therein. The compressor structure includes the

upper bearing plate or head **14,** a chamber or cylinder forming plate **32** and a lower bearing plate or head **34** including a cover plate **35** maintained in assembled relationship by suitable means such as bolts **36.** A small diameter end portion **26** on the lower end of the shaft is journalled in a bearing **29** in the lower plate **34.**

The lower portion of the housing **10** serves as a lubricant reservoir from whence oil for lubricating the shaft journal bearings is withdrawn by means of an oil pickup helical blade **40** located in the downwardly opening bore **42** communicating with a reduced vertical passage **44** overlying the bore **42.** As the shaft **24** rotates at a high speed the lubricating oil is drawn upwardly through the bore **42** and passageway **44** and thrown out to horizontal passages **46** and **48.** The lubricating oil passes through the radial passageways **46** and **48** into a spiral groove **50** in the periphery of the shaft **24** which extends upwardly in the hub portion **52** of upper bearing plate **14** such that the lubricating oil is urged upwardly in the groove **50** by centrifugal force and spills onto the top of the hub **52** and flows downwardly therefrom.

A thrust washer **54** encircles the shaft **24** between the upper surface **56** of the hub **52** and the lower thrust bearing surface **58** on the rotor **22** operating respectively on the lower and upper opposite faces of the thrust washer for preventing downward axial movement of the motor rotor **22** and drive shaft **24** in a manner whereby the thrust washer **54** receives the main axial thrust loading taken against the lower bearing plate **34.**

As seen in FIG. **3,** the compression chamber **30** is of elliptical configuration in which is located the symmetrical rotating compressor rotor **28** provided with two pair of diametrically opposed radially outwardly opening slots **71, 72, 73** and **74** in which vanes or blades **76, 77, 78** and **79** respectively, are slidably received. In the illustrated embodiment of the invention, the ends of the blades are biased against the elliptical walls of the compression chamber by means of helical compression springs **75** in the rear circular part of the radial slots. In this manner the spring loaded vanes are located such that the vanes **76** and **78** are oriented 180° apart to remain in contact with the elliptical chamber surface while in the same manner the vanes **77** and **79** are also oriented 180° apart. The diametrically opposed pairs of vanes provide four simultaneous compression strokes with resultant opposite and equal forces balanced bearing to theoretically cancel out journalled bearing loads on the shaft **24** due to the compression of the refrigerant gas in the chamber **30.**

As seen in FIG. **3,** the compressor is provided with an inlet **80** in the housing wall in a manner similar to the outlet **81** in accordance with the usual practice. The inlet **80** communicates by means of a common vertical inlet passage **82** with a pair of superimposed composite arcuate channels **86, 87,** as seen in FIG. **1** for channel **87,** formed by groove **87a** in the under surface of the upper bearing plate **14** and the groove **87b** in the upper surface of cylinder **32.** In a manner shown by the arrows in FIG. **3,** the gas is split between the channels **86** and **87,** and moves into duplicate diametrically opposed manifold arcuate openings **90** and **91** formed in cylinder **32** whereby the gas from each opening **90, 91** is fed to duplicate axially aligned compression chamber delivery ports **92, 93** and **94, 95** respectively.

As viewed in FIG. 2, the lower delivery ports 92 and 94 are formed in the top surface of lower bearing plate 34 while the upper delivery ports 93 and 95 are formed in the bottom surface of the upper bearing plate 32 such that the opposed working chambers 30*a* and 30*b* are fed simultaneously from both the top and bottom bearing plates during a portion of a cycle of the rotor 28 from their associated delivery ports while during another portion of the same cycle of the rotor 28 the working chambers 30*c* and 30*d* are fed simultaneously from both sides by their associated delivery ports, thereby providing smooth flow of the refrigerant gas and reduced pressure drop.

As the rotor 28 rotates in a counterclockwise direction, as viewed in FIG. 3, gas is drawn into the suction inlet 80 and down the vertical inlet passageway 82, the arcuate grooves 86 and 87, the openings 90 and 91 and will fill up the low pressure chambers 30*a* and 30*b*. As the rotor 28 rotates the gases within the high pressure sides 30*c* and 30*d* are forced out opposed bevel grooves 96, 97 in the edge of the cylinder 32 into the direction of the discharge ports 98 (FIG. 1) of opposed valve means 100, 102 and are compressed within the decreasing volume bounded by the blades, the rotor and the elliptical wall of the compression chamber. As seen in FIG. 1 the valve means 100, 102 are check valves and include an outer coil spring 104 which is held in place by a stamping 106 whereby spring pressure is applied continuously to the valve discharge disc 108 for biasing it toward the closed position.

The gas which flows past the disc is directed into vertical exit passageways 110, 112 into lobed groove 116 formed on the inner face of the lower bearing plate. As seen in FIG. 2 the compressed gas flows in the direction of the arrows from opposed lobes 118, 120 into the circular groove 116 to enter the common lobe 122 and out the vertical common exit passage 124 to the outlet port 81. It will be noted that valve means 100 may be provided with a second concentric inner coil spring 132 for biasing valve plate 134 to provide a relief valve outlet to prevent excessive pressure within the chamber 30.

A feature of applicant's invention involves the key-like mounting arrangement of slotted rotor 28 on the polygonal section of the shaft 24. As seen in FIG. 4 the intermediate shaft portion 25 is formed with a generally square cross section to allow for sliding reception thereon of the conforming square aperture 27 in the slotted rotor. By virtue of this limited free-floating arrangement, in counter-distinction to an integral rotor and shaft, the rotor 28 is free to float or move axially on the square-sectioned intermediate portion 25 of the shaft with sufficient dimensional allowance so as to accommodate for any out-of-squareness of tolerance build-up between the compressor rotor 28, the shaft 24 and the wall surfaces of the compression chamber 30. The shear or frictional torque forces which normally result from the compressor rotor 28 moving against the compresssion chamber horizontal lower wall surface formed by the bearing plate 34 with an applied thrust load are significantly reduced by incorporating a thrust element in the form of the thrust washer 54 between the motor rotor 22 and upper surface 56 of the hub portion 52. It will be noted that the axial length of the intermediate square sectioned shaft portion 25 has a predetermined axial dimension greater than the thickness of the rotor 28 to insure full keyed alignment between the compression rotor and the shaft.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

We claim:

1. In a refrigerant compressor, the combination of, a hermetically sealed casing; a motor including a motor rotor, stator and vertically disposed shaft having its upper portion fixedly secured to said motor rotor; a compressor located below said motor; said compressor including an upper bearing plate, a cylinder forming plate and a lower bearing plate; said shaft rotatably received within said upper bearing plate; said cylinder forming plate having an elliptical shaped compressor chamber; a circular shaped slotted rotor rotatably symmetrically positioned in said compressor chamber, and having a plurality of paired diametrically opposed vane slots thereon, vanes slidably received in said slots being outwardly biased into engagement with the elliptical wall of said compression chamber; a reduced small diameter bearing portion on the lower end of said shaft rotatably received within said lower bearing plate; an intermediate polygonal sided portion on said shaft extending through said compression chamber slidably received within a complementary polygonal sided aperture in said slotted rotor, whereby said slotted rotor is free to move a predetermined amount in a vertical direction on said shaft intermediate portion so as to provide for any out of squareness tolerances between said slotted rotor and said compression chamber, said upper bearing plate having a hub portion extending upwardly to a point adjacent said motor rotor's bottom surface, a thrust element positioned on said shaft between the upper end surface of said hub and said motor rotor's bottom surface to receive the axial thrust loading of said motor rotor on said upper bearing plate thereby reducing frictional torque forces between said slotted rotor and said lower bearing plate.

2. In a refrigerant compressor, the combination of, a hermetically sealed casing; a motor including a motor rotor, stator and vertically disposed shaft having its upper portion fixedly secured to said motor rotor; a compressor located below said motor; said compressor including an upper bearing plate, a cylinder plate and a lower bearing plate; said shaft rotatably received within said upper bearing plates; said cylinder plate having an elliptical shaped compressor chamber formed therein; a circular shaped slotted rotor rotatably symmetrically positioned in said compressor chamber, and having two pairs of diametrically opposed ninety degree spaced vane slots therein, vanes slidably received in said slots being outwardly biased into engagement with the elliptical wall of said compression chamber; a small diameter bearing portion on the lower end of said shaft rotatably received within said lower bearing plate; an intermediate square cross section portion on said shaft extending through said compression chamber having a square cross section slidably received within a complementary square shaped aperture in said slotted rotor, the axial length of said intermediate portion being a predetermined amount greater than the thickness of said slotted rotor whereby said slotted rotor is free to move a predetermined amount in a vertical direction on said shaft intermediate portion so as to accommodate out of squareness dimensional tolerances between said slotted rotor,

said shaft and said compression chamber lower wall surface, said upper bearing plate having an integral hub portion extending upwardly to a point adjacent said motor rotor's bottom surface, a thrust washer positioned on said shaft between the upper end surface of said hub and said motor rotor's bottom surface dimensional to receive the axial thrust loading of said motor rotor on said upper bearing plate thereby reducing frictional torque forces between said slotted rotor and the top horizontal wall surface of said lower bearing plate.

3. In a refrigerant compressor, the combination of; a hermetically sealed casing, a motor including a motor rotor, stator and a vertically disposed shaft having its upper portion fixedly secured to said motor rotor; a compressor located below said motor; said compressor including an upper bearing plate, a cylinder plate and a lower bearing plate; said shaft rotatably received within said upper bearing plate, said cylinder plate having an elliptical shaped compression chamber formed therein, a circular shaped slotted rotor rotatably symmetrically positioned in said compression chamber, and having two pairs of diametrically opposed ninety degree spaced vane slots therein, vanes slidably received in said slots being outwardly biased into engagement with the elliptical wall of said compression chamber thereby forming opposed working chambers within said elliptical compression chamber, a bearing portion on the lower end of said shaft rotatably received within said lower bearing plate, means for retaining said rotor on an intermediate portion of said shaft so as to be rotatable therewith while allowing limited axial movement thereon between said bearing plates, refrigerant vapor inlet means in said compressor, said inlet means including a common vertical inlet passage in said upper bearing plate, arcuate grooves formed in the under surface of said upper bearing plate and the upper surface of said cylinder plate, said arcuate grooves being superimposed to provide two symmetrical arcuate channels each communicating with said vertical inlet passage, said cylinder plate having diametrically opposed arcuate shaped manifold opening extending therethrough such that each communicates with the distal end of one of said channels, two pairs of axially aligned upper and lower compression chamber delivery ports, said lower delivery ports formed in the top surface of said lower bearing plate and said upper delivery ports formed in the bottom surface of said upper bearing plate, said lower delivery ports and said upper delivery ports respectively being in diametrically opposed relation, each of said delivery ports extending radially so as to partially overlie in symmetrical fashion in associated manifold opening and a portion of said elliptical compression chamber such that the opposed working chambers formed by said elliptical compression chamber and said vanes are fed with refrigerant vapor from both the upper and lower bearing plates.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,790,311 Dated February 5, 1974

Inventor(s) Mervin R. Butts et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 63, "shape" should read -- shaped --. Column 3, line 55, before "tolerance" change "of" to -- or --. Column 4, line 42, before "vertically" insert -- a --; lines 57 and 58, delete "square cross section". Column 6, line 22, after "fashion" change "in" to -- an --.

Signed and sealed this 10th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents