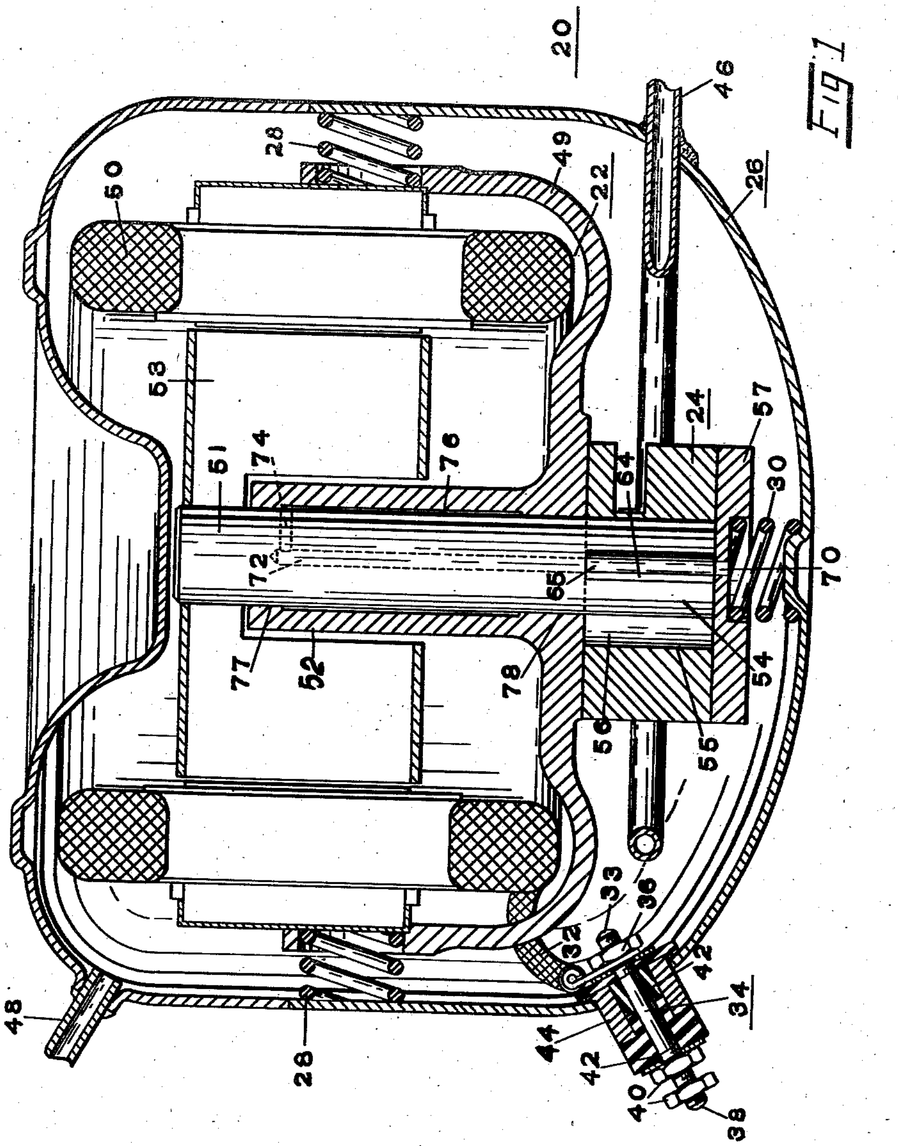
Feb. 25, 1941. A. A. KUCHER 2,233,082

COMPRESSOR FOR REFRIGERATING APPARATUS

Filed Aug. 28, 1936 3 Sheets-Sheet 1



INVENTOR
Andrew A. Kucher
BY
Warren H. F. Schmieding
ATTORNEY

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COMPRESSOR FOR REFRIGERATING APPARATUS

Filed Aug. 28, 1936 3 Sheets-Sheet 2

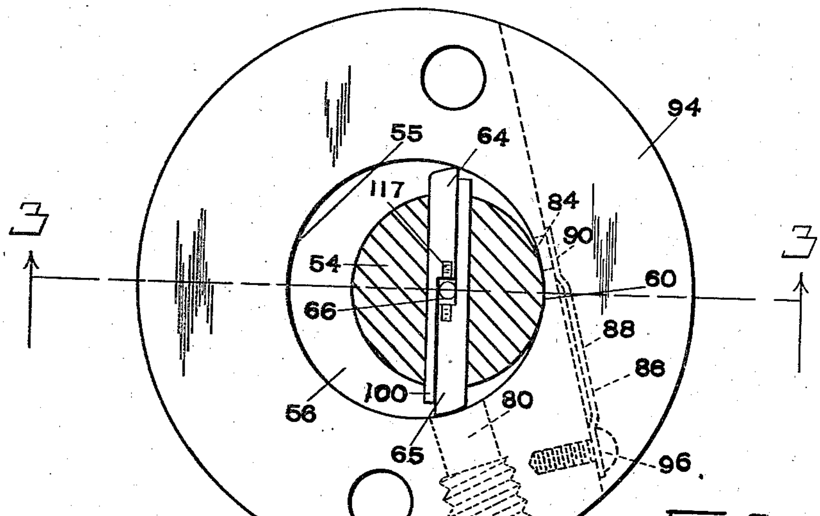

Fig 2

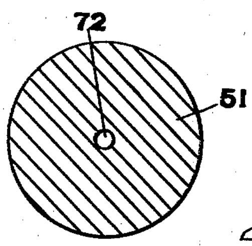

Fig 4

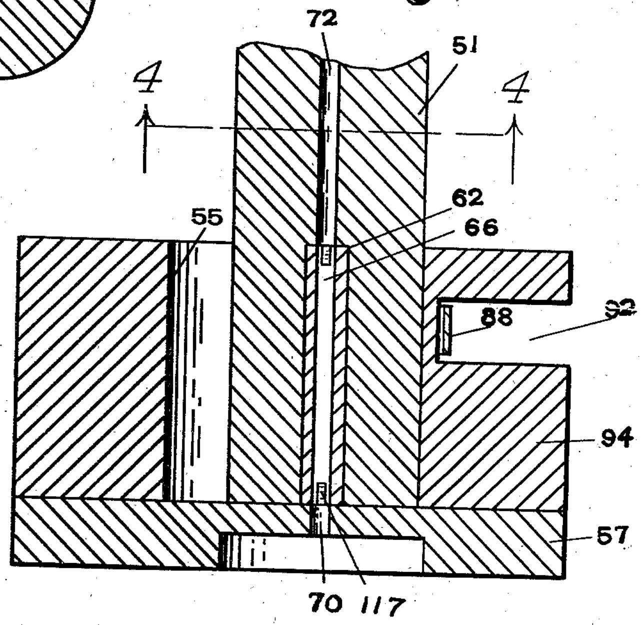

Fig 3

INVENTOR
BY Andrew A. Kucher
Warren H. F. Schmieding
ATTORNEY

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Filed Aug. 28, 1936 3 Sheets-Sheet 3

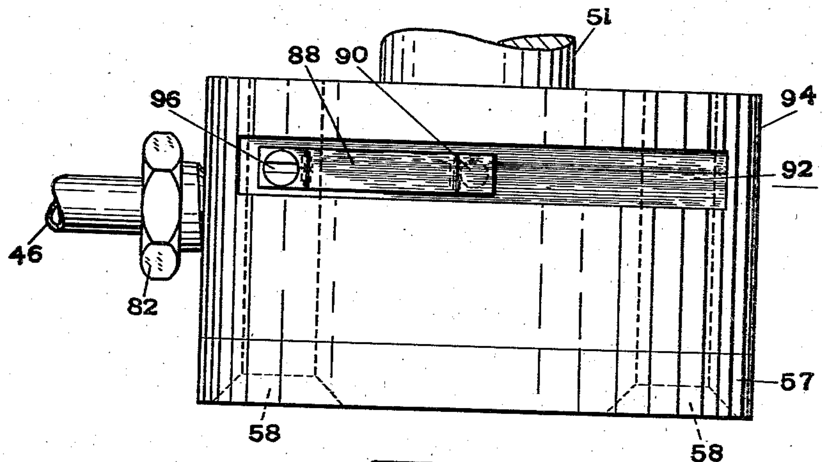

Fig 5

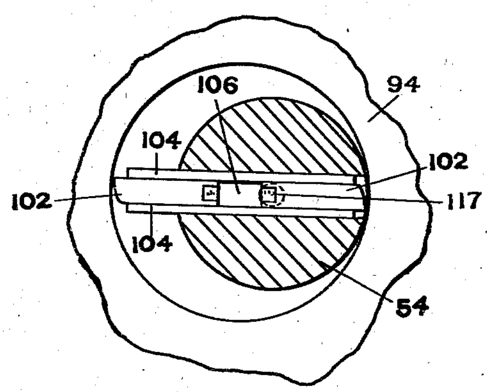

Fig 7

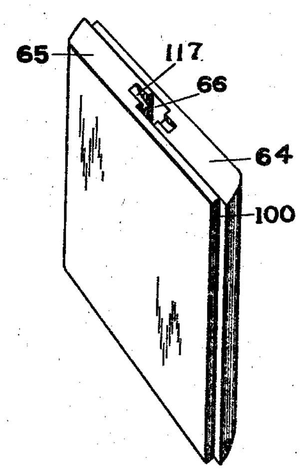

Fig 6

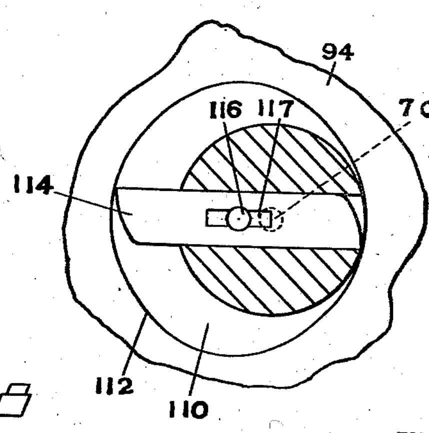

Fig 8

INVENTOR
Andrew A. Kucher
BY
Warren H. F. Schmieding
ATTORNEY

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COMPRESSOR FOR REFRIGERATING APPARATUS

Andrew A. Kucher, Dayton, Ohio

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14 Claims. (Cl. 230—153)

The present invention relates to rotary compressors and the associated driving motors therefor and particularly to compressors of the vane type.

One of the objects of the present invention is to provide a construction in which the vane or vanes of the compressor extend through the shaft or rotor and provides sealing bearing surfaces for a vane or vanes throughout the diameter of the shaft whereby relatively long sealing and bearing surfaces for the vane or vanes may be provided within a small diameter shaft.

Another object is to provide a construction in which the rotor of the compressor and its integral drive shaft can be of the same diameter.

Another object is to utilize the weight of the compressor rotor, and its driving mechanism for maintaining a seal between the rotor and the end of the cylinder.

A further object is to provide apparatus for and a method of maintaining a higher pressure substantially at all times at the sealing surfaces between the vanes and cylinder than is present in the high pressure side of the cylinder, so as to prevent the escape of fluid from the high to the low pressure sides of the vanes.

A still further object is to utilize the fluid compressed as a motive power for causing the vanes to be forced into sealing engagement with the cylinder.

Still another object is to utilize oil under pressure to lubricate the vane bearings, and for causing this oil to be directed adjacent the leading edges of the vanes whereby this oil is utilized as a seal between the vanes and the cylinder.

To carry out the preceding object, it is a further object to provide the rotor of the compressor with a pair of interfitting and overlapping vanes, which when expanded, form a conduit therebetween through which high pressure oil is allowed to pass, the pressure of the oil tending to press the vanes against the cylinder walls, the oil also seeping through the bearing between the interfitting portions of the vanes and leaks into the cylinder adjacent to the leading edge of the rotating vane thus aiding in sealing the vane to the cylinder wall.

Other and further objects and advantages will be apparent from the following description, reference being had to the accompanying drawings wherein preferred forms of embodiments of the present invention are clearly shown.

Fig. 1 is a view of a longitudinal section taken through the center of a motor and compressor unit.

Fig. 2 is a view, on a larger scale, of one form of a rotary compressor detached from the motor;

Fig. 3 is a sectional view of the compressor taken on the line 3—3 of Fig. 2;

Fig. 4 is a sectional view of the motor shaft taken on the line 4—4 of Fig. 3;

Fig. 5 is a side view of the compressor shown in Fig. 2;

Fig. 6 is a perspective view, on a larger scale, of the interfitting vanes used in the compressor shown in Fig. 2;

Fig. 7 is a fragmentary view of a compressor showing the cylinder and another type of vane construction, and,

Fig. 8 is a fragmentary view of a compressor having an elliptical bore and utilizing but a single vane.

A sealed motor compressor unit **20** is shown in cross section in Fig. 1 wherein a motor **22** and a depended compressor **24** are resiliently mounted within a casing **26** by a plurality of springs **28** and **30**. The springs **28** are preferably evenly disposed around the outer periphery of the motor **22** and between the motor **22** and the casing **26**. A single, centrally located spring **30** supports the motor compressor and spaces it from the casing **26** at the bottom thereof. A detailed description of this type of mounting construction may be obtained by referring to my copending application S. N. 95,091.

Electrical connections for the motor **22** are preferably made by a suitable conduit **32** which is connected to the threaded inner end **33** of a binding post **34** by a locknut **36**. The outer end **38** of the binding post **34** is threaded, and is provided with two nuts **40** for the external electrical connections. The post **34** passes through an insulating bushing **42**, made in several parts for ease of assembly, which is held within a metallic bushing **44** that passes through, and is attached to the casing **26**.

An inlet connection or low pressure tube **46** passes through the casing **26** at the lower end thereof and is connected to the compressor **24**. For example, the tube carries low pressure refrigerant and forms a return line for the refrigerating system (not shown) to the low pressure side of the rotary compressor **24**. The tube **46** is welded to the casing **26** to assure a hermetic connection between the two members. The compressor, during operation, discharges the compressed refrigerant directly into the closed casing **26** and high pressure refrigerant leaves the casing by a discharge or high pressure tube **48**.

This tube 48 passes through the casing 26 at the upper end thereof and is welded or otherwise suitably secured to the casing 26. Thus the entire system, including the rotary compressor and its driving motor, is self contained into hermetically sealed casing 26.

The motor-compressor unitary assembly includes a motor frame 49 which carries a motor stator 50. A shaft 51 is journalled in a bearing 52 and carries the motor rotor 53 on its upper end. The shaft 51 extends through the bottom wall of the motor frame 49 and is utilized as a compressor rotor 54. A cylinder 55 having a bore 56 is disposed eccentrically with respect to the compressor rotor 54 and is secured in position by clamping the same between the bottom of the frame 49 and a plate 57 by bolts 58. The shaft 51, including the rotor 54, is preferably the same diameter as the rotor, thus reducing the cost of manufacture. The bottom of the shaft 51 rests upon the plate 57 and, due to the weight of the shaft and motor rotor, it is in sealing engagement therewith.

The rotor 54 and cylinder 55 are disposed so that the periphery of the rotor 54 is tangent to the larger diameter of the cylinder throughout the length of the cylinder as indicated at 60, thereby forming a sealing surface between the rotor and the cylinder.

The rotor 54 is provided with a longitudinal slot 62 cut through it, which slot 62 extends from the bottom of the rotor 54 to a height equal the height of the cylinder 55. In one form, a pair of identical, interfitting and overlapping vanes 64 and 65 fit sufficiently snug within the slot 62 to form a seal therebetween and also to form a seal between the two vanes. The length of either vane 64 or 65 is such that at no time during rotation do both ends of the vane simultaneously touch the wall of the cylinder 55. Thus during rotation of the rotor 54, the vanes 64 and 65 are centrifugally expanded to form a hole between them at 66. This hole 66 is utilized as a conduit of an oiling system that is provided for the assembly.

An oil level is normally maintained within the casing 26, preferably to some point above the bottom of the compressor 24. Since high pressure refrigerant is within the casing 26 the oil, which is in the lower part of the casing 26, is under the same pressure as the high pressure refrigerant. This fact is utilized to provide high pressure lubrication for the system. To accomplish the desired result, a small hole 70 is drilled in the bottom plate 57 of the compressor 24. The hole 70 is drilled so that it registers with the hole 66 formed by the extension of the vanes 64 and 65. To carry the oil further, a longitudinal hole 72 is bored in the motor shaft 51. The hole 72 is drilled coaxially with the shaft 51 and therefore registers with the other two holes 70 and 66. The upper end of hole 72 communicates with a transverse hole 74. The transverse hole 74 carries oil from the longitudinal hole 72 to the periphery of the shaft 51, whence the oil seeps between the shaft 51 and the elongated bearing 52. To increase the oil seepage, and to improve the lubrication of the bearing, an undercut 76 is provided intermediate the two ends of the bearing 52 and extends to about one half inch from either end of the bearing, thus forming two extreme bearing surfaces 77 and 78. The oil hole 74 is disposed to deliver oil directly to the upper bearing 77 and to the undercut 76. The undercut 76, preferably does not exceed five one thousandths of an inch. The oil under pressure within the undercut 76 seeps in both directions to lubricate the bearings 77 and 78 as well as form an oil reservoir to assure adequate lubrication at all times.

An advantage of this type of lubricating system is that the oil under pressure within the bearing 52 tends to seep through the lower bearing portion 78 and tends to pass into the cylinder 55 of the compressor. Thus oil under high pressure, except for very brief periods when the vane ends near an outlet or discharge port 84, is constantly tending to seep into the cylinder to prevent leakage of the fluid being compressed and thereby effectively seals the vanes with the compressor walls. This same tendency toward oil seepage is occuring at the other end of the rotor, since oil is passing through the hole 70 in the bottom plate 57 and, being at a higher pressure, except for very brief periods when the vane ends near an outlet or discharge port 84, than the pressure within the cylinder, tends to seep into the cylinder and aids in sealing and lubricating the vanes at the lower ends thereof. From the foregoing it will be noted that all of the sealing surfaces of the vanes have high pressure fluid on one side thereof substantially at all times, the fluid being at a pressure nearly equal to the discharge pressure of the compressor. This film of oil at the sealing surfaces under high pressure increases the efficiency of the compressor since it aids in preventing the loss of gas at the sealing surfaces.

The compressor 24 is provided with an inlet port or low pressure intake 80 which enters the cylinder 55 through a wall thereof and which may be connected by a threaded fitting 82 to the low pressure line 46. An outlet or discharge port 84 also disposed in the wall of the cylinder 55, allows the compressed refrigerant to escape from the cylinder 55. The discharge port 84 is normally closed by a flapper valve 86 which consists of a leaf spring 88 suitably depressed at 90 to close the port 84. The spring 88 is set within a milled slot 92, in the compressor body 94, which slot lessens the length of the port 84 and provides a flat surface for attaching the spring 88 to the body 94. A machine screw 96, threaded into the body 94, holds the spring 88 in position at its fixed end, opposite the port 84.

The vanes 64 and 65, due to their slidable fit in the rotor 54, move reciprocally through the rotor slot 62 to accommodate the portion of the cylinder 55 through which they are passing, for example, when the vanes are substantially vertical, with reference to Fig. 2, they protrude equal distances on either side of the rotor, but when they have moved 90 degrees, they protrude from one side only.

In operation, as the vanes 64 and 65 rotate with the rotor 54, they draw low pressure refrigerant into the cylinder 55 through the inlet port 80. As a vane passes the port 80 it causes a reduced pressure to be created behind the vane which draws the refrigerant into the cylinder 55. The other vane picks up this refrigerant, and due to the crescent shape of the effective cylinder, which decreases in volume as the vanes rotate, compresses the refrigerant, which compressed refrigerant is then exhausted or discharged through port 84 and by the valve 86. Thus the vanes 64 effectively divide the cylinder 55 into two progressively moving compartments, namely, a low pressure compartment and a high pressure compartment.

Since the casing 26 is under high pressure and due to the fact that oil is forced under high pressure through the lower part of the compressor at 70 and that oil is forced under high pressure through the undercut 76 and lower bearing 78, the top and bottom of the vanes are subjected to pressure from the exterior of the cylinder and thereby prevents leakage of fluid from the high to the low pressure sides of vanes and out of the top and bottom of the cylinder through the sealing surfaces of the vanes.

The entire side of one wall of the slot 62 forms a bearing surface for one side of the vane 64. This also is true of the other side of the slot 62 and the other vane 65. The faces of each vane 64 and 65 bear upon the adjacent faces of the other vane. Thus in effect, by this construction both sides of each vane 64 and 65 are provided with substantially full length bearing surfaces throughout the diameter of the rotor 54. It will also be noted that the vanes are disposed so that, during normal clockwise rotation, the interfitting leg 100 of one vane 64 is in front of the leading edge of the other vane. Since oil under pressure is passing through the hole 66, oil seeping through the slight clearance between the vanes 64 and 65 leaks out into the cylinder between the interfitting leg 100 of the vanes 64 and 65. This may be explained by the fact that the oil in the hole 66 is under greater pressure, practically at all times, than the internal pressure of the cylinder, because the oil is under the pressure of the discharge from the cylinder. The oil that leaks out from between the vanes is held in a pocket in front of the rotating, leading edge of the vanes 64 and 65. This aids materially in sealing the vane to the cylinder. The oil pressure between the vanes 64 and 65, which aids the seal between the vanes as it tends to constantly urge the vanes toward the walls of the slot 62 as well as urge the vanes 64 and 65 and tends to constantly maintain this oil seal in front of the leading edge of the rotating vanes, is one of the distinct features of my invention.

Another embodiment of my invention is shown in Fig. 7, where the only change is in the vane construction. A pair of identical vanes 102 is provided which is held in the slot 62 by two identical shims 104 disposed on either side of the vanes. These shims 104 and vanes 102 are substituted for the interfitting vanes 64 and 65 of the compressor shown in Fig. 2. These shims are sufficiently rigid, so as to maintain the vanes longitudinally aligned with the slot 62. Due to the sliding movement of the shims 104, during rotation of the rotor 54, long bearing surfaces are maintained at all times between the vanes and the shims and between the shims and the rotor. The shims 104 also provide for a constant length of seal between the vanes and the rotor slot 62. The vanes 102 are maintained in the expanded position by centrifugal force and by the pressure of the oil passing through the space 106 between the vanes 102. Here again oil seepage between the shims 104 and the vanes 102 provides an oil film at the leading edge of the rotating vanes to aid in sealing the vanes to the cylinder wall.

In the embodiment in Fig. 8, the bore 110 is made elliptical, so that a cross plane through the cylinder 112 is an ellipse with its major axis, the vertical axis, with reference to Fig. 8. A single vane 114 is provided, the overall length of which is equal to the length of the minor axis of the elliptical cross plane of the cylinder. The ellipse is so calculated that the vane 114 contacts the side walls of the cylinder 112 at all times and at both ends of the vane during rotation of the vane. The vane 114 thus divides the cylinder into two compartments. Here again the bearing surfaces for the vane are approximately equal to the diameter of the rotor and the sealing surfaces are therefore also approximately equal to the diameter of the rotor. A hole 116 is drilled through the vane 114 to allow oil to flow therethrough, the oil coming from the casing 26 through the hole 70 in the bottom plate of the compressor 24 and passing through the hole 116 into the communicating hole 72 in the motor shaft.

In all of the embodiments described the rotor 54 with its slot 62 is placed in the same relative position within the cylinder. In all embodiments, the oil conduits 70 in the plate 57, the conduits in the vanes and the oil hole 72 always register regardless of the position of the rotor. Undercuts 117 may be provided in the opposite ends of the vanes 64, 65, 102 and 114 for this purpose.

Among the advantages of my present invention is the reduction in size of the compressor with an attendant reduction in loss due to friction whereby an efficient and low cost compressor is provided. By extending the vane or vanes completely through the slot in the rotor, substantial size bearing surfaces are maintained whereby the turning torque on the vane, during rotation, has substantially no detrimental effect, the long bearing surfaces for the vanes, maintaining the vanes in strict alignment with the slot at all times. By providing long bearing surfaces in this manner, the rotor has been reduced in size. Likewise the cylinder and other parts of the compressor can be made smaller. Since a small rotor can be employed, the friction losses between the end of the rotor and between the ends of vanes and the cylinder end walls are materially reduced. Although the rotor has been reduced in size, nevertheless, a long sealing surface is maintained between the compartments of the cylinder, that is, by extending the bearing surfaces completely through the rotor and by having the vane or vanes in contact with the bearing surface throughout the length thereof, an effective seal is maintained at these sliding joints.

While the forms of embodiments of the present invention as herein disclosed constitute preferred forms, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow:

I claim:

1. In a rotary compressor, in combination, a cylinder, a bearing, a shaft journalled in the bearing, said shafts being less in diameter than the diameter of the cylinder, and extending into the cylinder, said shaft having uniform diameter within the bearing and cylinder and bearing tangentially against and in sealing engagement with a wall of the cylinder.

2. In a rotary compressor, in combination, a cylinder, end walls for said cylinder, a rotor of less diameter than that of the cylinder, said rotor having a driving extension uniform in diameter with the rotor in the cylinder and extending through one of the end walls, said rotor bearing tangentially against and in sealing engagement with a side wall of the cylinder, the end of the rotor within the cylinder sealingly engaging the other end wall of the cylinder.

3. In a rotary compressor, in combination, a cylinder, a bearing, a shaft journalled in the

bearing and extending into the cylinder, said shaft being less in diameter than the diameter of the cylinder, said shaft having uniform diameter within the bearing and cylinder and bearing tangentially against and in sealing engagement with a wall of the cylinder, and vane means within the cylinder extending through the shaft.

4. In combination, a casing containing lubricant; a compressor including a cylinder having an end face, said end face having an oil passage extending therethrough for conducting lubricant from the casing, a rotor disposed eccentrically within the cylinder and having a longitudinal slot, vane means within the slot and forming the entire inside wall of a conduit, said conduit being in constant communication with the oil passage in the end face; a shaft bearing; a shaft for the rotor journalled in the bearing and disposed exteriorly of the cylinder and having an extending oil hole in constant communication with the conduit for conducting lubricant to the bearing.

5. In combination, a casing containing lubricant; a compressor including a cylinder having an end face, a rotor disposed eccentrically within the cylinder and having a longitudinal slot, vane means within the slot and forming the entire inside wall of a conduit; a shaft bearing; a driving shaft for the rotor extending exteriorly of the cylinder, said shaft having an oil hole leading to the bearing and said end face having an oil hole, said oil holes being constantly aligned with said conduit for conducting lubricant from the casing to the bearing.

6. In combination, a casing containing lubricant; a compressor including a vertically extending cylinder having a bottom end face, said end face having a vertically extending passage therethrough for conducting lubricant from the casing, a rotor disposed eccentrically within the cylinder and having a longitudinal slot, vane means within the slot and forming a conduit in constant communication with the oil passage in the end face; an upwardly extending bearing member; a shaft member for the rotor journalled in the bearing member, one of said members being undercut to provide a plurality of spaced bearing surfaces for the shaft member, said shaft member having an extending oil hole in continuous communication with the conduit for conducting lubricant to the upper bearing surface.

7. In combination, a casing containing a lubricant; a compressor including a vertically extending cylinder having a bottom end face, a rotor disposed eccentrically within the cylinder and having a longitudinal slot, vane means within the slot and forming a conduit; an upwardly extending bearing member; a shaft member for the rotor journalled in the bearing member, one of said members being undercut to provide a plurality of spaced bearing surfaces for the shaft member, said shaft member having an oil hole leading to the upper bearing surface and said end face having an oil hole, said oil holes being constantly aligned with said conduit for conducting lubricant from the casing to the bearing surfaces.

8. Compressing mechanism comprising in combination, means forming a cylinder, a rotor within the cylinder and having a longitudinal slot extending through the rotor substantially throughout the length of the cylinder, a plurality of overlapping vanes slidable within the slot, inner portions of said vanes being spaced from one another at all times to form the entire inside wall of an oil conduit, said means having an opening leading from the high pressure side of the compressing mechanism and registering with the conduit for conducting oil to the conduit.

9. Compressing mechanism comprising in combination, a cylinder having an end face, a rotor within the cylinder and having a longitudinal slot extending through the rotor substantially throughout the length of the cylinder, a plurality of overlapping vanes slidable within the slot, inner portions of said vanes being spaced from one another at all times to form the entire inside wall of an oil conduit, said end plate having an opening leading from the high pressure side of the compressing mechanism and registering with the conduit.

10. Compressing mechanism comprising in combination, means forming a cylinder, a rotor within the cylinder and having a longitudinal slot extending through the rotor substantially throughout the length of the cylinder, a plurality of overlapping vanes slidable within the slot, inner portions of said vanes being spaced from one another at all times to form the entire inside wall of an oil conduit, said means having an opening leading from the high pressure side of the compressing mechanism and registering with the conduit for conducting oil to the conduit, a shaft for driving the rotor, a bearing for the shaft, said shaft having an oil hole registering with the conduit and extending to the bearing.

11. In combination, a casing containing lubricant; a compressor including a cylinder having an end face, said end face having an oil passage therethrough for conducting lubricant from the casing, a rotor disposed eccentrically within the cylinder and having a longitudinal slot, overlapping vanes within the slot, said vanes being undercut longitudinally and cooperating with one another to form the entire inside wall of a conduit, said conduit being in communication with the oil passage in the end face; a shaft bearing exterior of the cylinder; a shaft for the rotor journalled in the bearing and having an oil hole in communication with the conduit for conducting lubricant to the bearing.

12. In combination, a casing containing lubricant; a compressor including a cylinder having an end face, said end face having an oil passage therethrough for conducting lubricant from the casing, a rotor disposed eccentrically within the cylinder and having a longitudinal slot, overlapping vanes within the slot, one end of each vane engaging the cylindrical wall of the cylinder and one end of each vane being spaced from the cylinder wall, the cylinder engaging end of each vane trailing the adjacent end of the other vane, said vanes being undercut longitudinally and cooperating with one another to form the entire inside wall of a conduit, said conduit being in communication with the oil passage in the end face; a shaft bearing exterior of the cylinder; a shaft for the rotor journalled in the bearing and having an oil hole in communication with the conduit for conducting lubricant to the bearing.

13. In combination, a closed casing containing oil under high pressure; a rotary compressor including a cylinder having an end face, said end face having an oil passage therethrough for conducting lubricant from the casing, a member within the cylinder and bearing tangentially against the cylindrical wall of the cylinder, said

member having a longitudinal slot therethrough, a pair of overlapping vanes within the slot, a side face of one of the vanes sealingly engaging substantially the entire surface of one side of the slot and a side face of the other vane sealingly engaging substantially the entire surface of the other side of the slot, the opposite faces of the vanes being spaced throughout from the surfaces of the slot, said vanes being undercut longitudinally and cooperating with one another to form the entire inside wall of a conduit, said conduit registering with the oil passage in the end face.

14. In combination, a closed casing containing oil under high pressure; a rotary compressor including a cylinder having an end face, said end face having an oil passage therethrough for conducting lubricant from the casing, a member within the cylinder and bearing tangentially against the cylindrical wall of the cylinder, said member having a longitudinal slot therethrough, a pair of overlapping vanes within the slot, a side face of one of the vanes sealingly engaging substantially the entire surface of one side of the slot and a side face of the other vane sealingly engaging substantially the entire surface of the other side of the slot, the opposite faces of the vanes engaging one another and each having surfaces in different planes extending in opposite directions and to the extreme opposite edges of the vane, the step portions in different planes of the vanes being spaced from one another to form a conduit, said conduit registering with the oil passage in the end face.

ANDREW A. KUCHER.