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HERMETIC REFRIGERANT COMPRESSOR

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FIG. 2

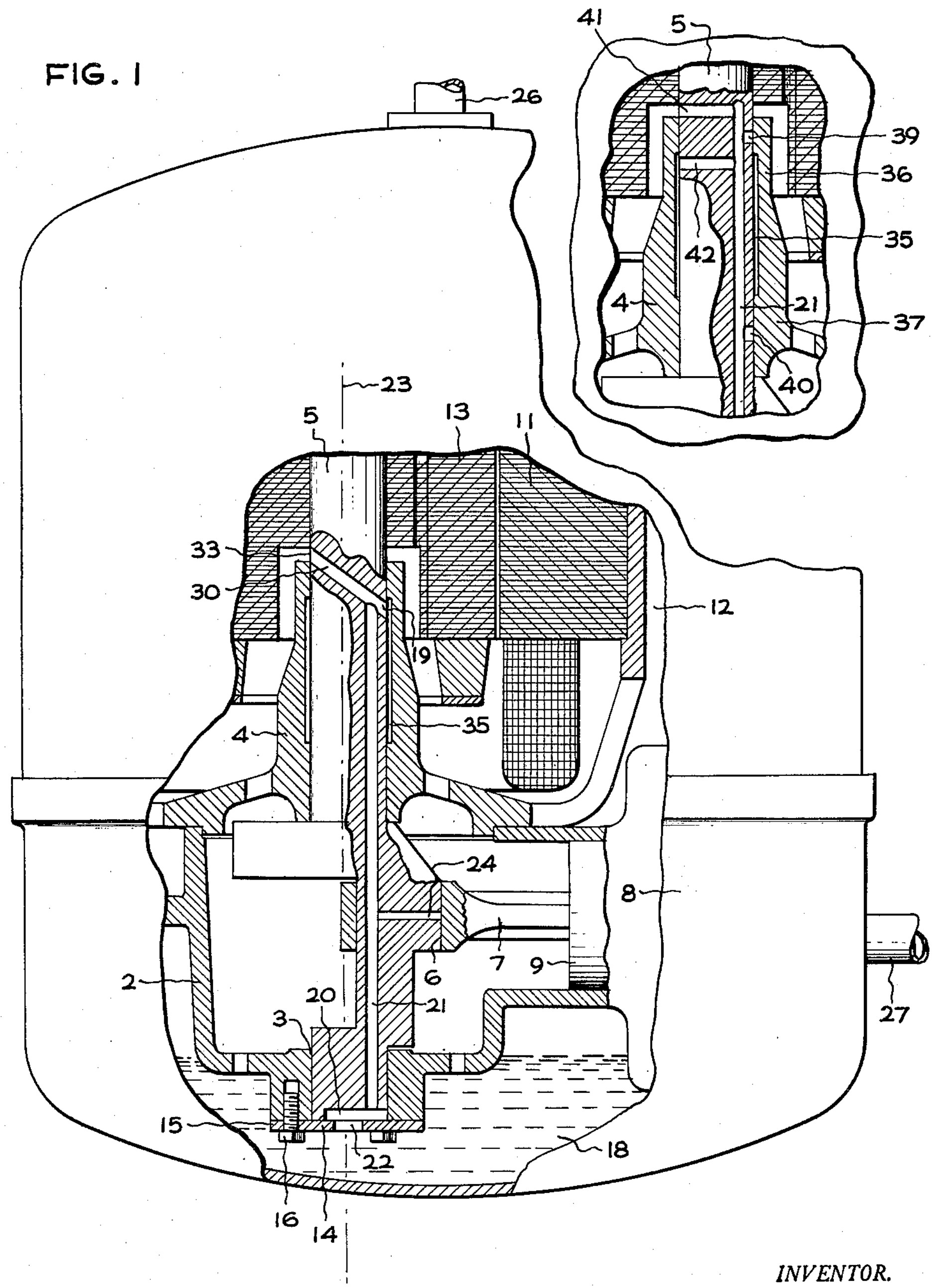

FIG. 1

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HERMETIC REFRIGERANT COMPRESSOR

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The present invention relates to hermetically sealed refrigerant compressors and is more particularly concerned with an improved lubricating arrangement for such compressors.

Hermetic refrigerant compressors comprise a motor compressor unit including a compressor for compressing the refrigerant and a motor for driving the compressor sealed within a gas-tight casing. The lower portion of the casing contains a body of lubricating oil which is employed to lubricate the various bearing surfaces of the compressor unit. The remaining space with the hermetic casing is filled with refrigerant vapor which may be at either low (suction) pressure or high (discharge) pressure depending upon the manner in which the hermetic compressor is connected into the refrigerating system. In one form of hermetic compressor of the type with which the present invention is concerned the compressor and the motor for driving the compressor are mounted one above the other on a common vertical shaft. The shaft in turn is mounted in axially aligned bearings suitably supported by a supporting frame and to provide sufficient rigidity to the construction at least one of these bearings is normally positioned adjacent the upper portion of the shaft above the normal oil level in the casing. In order to provide the proper lubrication for any bearing surfaces above the normal oil level, it is of course necessary to provide some means for conveying lubricating oil from the oil reservoir to such surfaces.

A proposed simple and low cost means for providing lubrication for the unimmersed bearing surfaces comprises a lubricant passage having an inlet end at the center of rotation of the lower or immersed end of the vertical shaft communicating with the body of lubricating oil and an outlet port terminating on a circumferential surface of the shaft adjacent the bearing surface. During rotation of the shaft, centrifugal forces on the oil entering the inlet end of the passage causes the oil to flow upwardly through the passage to the surface to be lubricated.

While this proposed arrangement for lubricating unimmersed bearing surfaces possesses a number of advantages including a freedom from any moving parts other than those required for the motor compressor unit, in actual practice it has been found that the arrangement is not completely satisfactory for use in connection with hermetic compressor employed to compress a refrigerant which is oil-soluble to any substantial extent. Examples of such refrigerants are the chlorinated fluorinated hydrocarbon compounds such as those sold under the trade name "Freon." With such oil soluble refrigerants and under certain conditions of use, the unimmersed bearing surfaces received inadequate lubrication resulting in bearing failure. It has now been discovered that these bearing failures result primarily from the fact that the small quantity of refrigerant dissolved in the oil tends to separate or centrifuge therefrom in the lubricant passageway formed in the shaft so that the lighter free refrigerant vapor and foam formed as a result of the separation prevents any substantial quantity of lubricant from reaching the uppermost bearing surfaces.

It is an object of the present invention to provide an oil pump arrangement of the above described type including means for assuring positive lubrication of unimmersed bearing surfaces.

Another object of the present invention is to provide a centrifugal oil pump for a hermetic refrigerant compressor comprising a lubricant passage formed within the compressor shaft for centrifugally pumping lubricating oil to unimmersed bearing surfaces and refrigerant venting means in communication with the lubricant passage for venting from the passage any refrigerant vapor and foam which would otherwise interfere with the supply of lubricating oil to unimmersed bearing surfaces.

Further objects of the invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In carrying out the objects of this invention, there is provided a hermetic compressor including a vertical shaft supported by bearing surfaces at least one of which is arranged above the level of the oil reservoir contained in the hermetic casing. Means for supplying oil from the oil reservoir to the unimmersed bearing surfaces comprises a lubricant passage having an inlet end at the lower or immersed end of the shaft and at approximately the center of rotation or axis thereof and one or more outlets on the circumferential surfaces of the shaft at unimmersed bearing surfaces or areas. In order to vent the refrigerant vapor and foam formed in the lubricant passage during rotation of the shaft and thereby provide for a continuous supply of refrigerant-free oil to the unimmersed bearing surfaces, there is provided in communication with the lubricant passage adjacent the upper end thereof, a refrigerant vent which extends from the lubricant passage through the axis of rotation of the shaft and has its outlet on the opposite side of the shaft in communication with the interior of the hermetic casing above the body of lubricating oil.

For a better understanding of the invention, reference may be had to the accompanying drawing in which the

FIG. 1 is a side elevational view, partially in section, of a hermetic refrigerant compressor incorporating an embodiment of the invention; and

FIG. 2 is a partial sectional view illustrating another modification of the invention.

Referring to the drawing, there is shown a hermetic compressor including a hermetic casing housing **1** in which is suitably supported a refrigerant compressor unit. The unit includes a frame **2** comprising two axially aligned bearings **3** and **4** in which is mounted a vertically extending shaft **5** having an eccentric portion **6** intermediate its upper and lower ends on which is mounted the connecting rod **7** of a compressor **8** including piston **9**. Means for driving the compressor comprises an electric motor **11** positioned in the upper portion **12** of the hermetic casing and having a rotor **13** keyed to the shaft **5**. A thrust or cover plate **14** secured by bolts **16** to the portion of the frame **2** overlying the lower end of bearing **3** serves as a thrust bearing surface for the shaft within the frame **2**.

In order to provide a source of lubricating oil for the various bearing surfaces of the compressor unit there is employed a reservoir or body of oil **18** in the lower portion of the hermetic casing. This body of lubricant is of sufficient depth that the lower end of the shaft including at least a portion of bearing **3** is substantially immersed in the reservoir and is lubricated by the oil contained therein. For the purpose of providing lubrication for the upper main bearing **4** and crank bearing **6** which in the modification shown are disposed above the body of oil and below the motor **11**, there is provided a centrifugal pumping arrangement including a lubricant passage or duct in the shaft **5** having its lower or inlet end at the center of rotation of the shaft below the oil level in the reservoir **18** and an upper outlet on the peripheral surface of the shaft encompassed by and in frictional engagement with the upper bearing 4. In the modification shown this lubricant passage comprises a horizontal, radially extending groove 20 which with thrust plate 15 forms a radial passage and a vertical portion or passage 21 parallel to but offset from the vertical axis or center of rotation 23 of the shaft. The lower end of the passage 21 communicates with the radially extending groove 20 and the upper end terminates within or slightly above the portion of the shaft journalled in the upper unimmersed bearing 4. To assure lubrication of the lower bearing under varying oil level conditions, this bearing can be force fed by extending groove 20 to the periphery of the shaft. Adjacent the upper end of the vertical passage 21 there is provided an oil port 19 extending from the passage to the peripheral surface of the shaft within the bearing 4. By this arrangement oil entering the lower passage 20 through the opening 22 in the thrust plate 15 is subjected to centrifugal forces set up by rotation of the shaft and flows upwardly along the passageway 21 and outwardly through the oil port 19 to lubricate the bearing surfaces of the upper bearing 4. Intermediate the ends of the shaft 5 and in line with the connecting rod 7 there may also be provided one or more additional ports such as port 24 which is adapted to furnish lubricating oil to the bearing crank 6 formed between the eccentric portions of the shaft and the connecting rod 7.

A compressor of this type is adapted to be connected into a refrigerant system to receive suction gas from an evaporator through the inlet conduti 26 and to discharge compressed refrigerant through the outlet conduit 27 to the condenser. The suction gas is introduced directly into the interior of the hermetic casing and completely fills the space within the casing while the compressed refrigerant from the compressor 8 is discharged directly from the compressor through the outlet conduit 27. As a result of this arrangement the refrigerant vapor drawn into the hermetic casing through the inlet 26 is always in contact with the body oil 18 provided in the lower part of the casing 1 and in the case of oil-soluble refrigerants becomes absorbed or dissolved in that body of oil. As a net result the oil eventually becomes saturated with refrigerant vapor at the conditions of temperature and pressure existing within the hermetic casing 1. When this lubricating oil saturated with the dissolved refrigerant is subjected to an increase in temperature, a reduction of refrigerant vapor pressure, or to the centrifugal forces set up in the horizontal portions of the oil passage formed within the shaft 5 and particularly in the radially extending passageway 20, there is a reduction in pressure which causes some or all of the dissolved or absorbed refrigerant to boil out and separate in either a vapor phase or in the form of an oil foam. This separation takes place not only in the radial passage 20 but also in the vertical passage 21. In this passage 21, the refrigerant vapor tends to flow along the side of the passage nearest the center of rotation of the shaft while the oil, which is the heavier of the two, takes the opposite side. Also, since the refrigerant vapor is somewhat lighter than the oil it tends to collect along with the refrigerant oil foam at the upper end of the passage 21 and depress the static head of pure lubricating oil within the passage 21 to a point where it is no longer able to effectively lubricate the upper bearing surfaces forming part of the upper bearing 4.

In accordance with the present invention, this vapor or foam locking tendency of the refrigerant liberated within the lubricant passage is eliminated by providing a refrigerant vent or passage 30 at the upper end of the vertical passage 21. In the modification shown in FIG. 1, this vent is a continuation of the oil port 19 and extends from the upper portion of the vertical passage 21 through the center of rotation or center line 23 of the shaft and terminates in an outlet end 33 on the opposite side of the shaft in direct communication with the upper refrigerant vapor-filled portion of the hermetic casing.

The operation of the pump including the refrigerant vent 30 is quite simple and effective. Upon rotation of the shaft 5, oil from the reservoir 18 enters through the opening or port 22 in the thrust plate 14 which is submerged in the oil reservoir. Due to the centrifugal or radial forces to which the oil is subjected during its flow radially outwardly through the passage 20, the oil is forced upwardly through the vertical passage 21. At the same time, refrigerant absorbed by the oil boils out and forms a separate phase or phases. As the centrifugal pressure forces both the oil and the refrigerant vapor or foam to travel up the vertical passage 21, the refrigerant tends to flow along the side nearest the center of rotation or axis 23 of the shaft at a faster rate than the heavier oil which follows a path along the outer side of the passage 21. At the upper end of the passage 21, both the oil and refrigerant vapor and foam reach the cross-port arrangement comprising the refrigerant vent 33 and the oil port 19. The heavier oil flows outwardly through port 19 away from the center of rotation of the shaft and into the main bearing oil groove 35. At the same time, the lighter refrigerant is forced inwardly to the center of the shaft by the continuously rising column or head of oil and refrigerant in the vertical passage 21 and after passing the axis of the shaft is thrown outwardly through the opposite end portion 33 of the refrigerant vent 30 which opens into the upper refrigerant vapor-filled portion 12 of the hermetic casing above the bearing 4.

Preferably the radius from the center of rotation of the shaft 5 to the outer end of the refrigerant vent 30 is at least twice and preferably about 2.5 times as great as the radius to the near side of the vertical passage 21. A difference of about this magnitude in the two radii provides a positive scavenging pump which effectively removes separated refrigerant from the oil pump and passages. On the other hand the static and centrifugal head of the oil in vertical passage 21 is such that it cannot be drawn inwardly across the center of rotation, consequently no oil spills out of the refrigerant vent 30.

While the oil port 19 and the refrigerant vent 30 are shown in FIGURE 1 as having been formed by one drilling operation at such angle as to include an outlet for the oil port 19 into the upper main bearing 4 and a refrigerant vent outlet 33 above the bearing 4, any suitable configuration of these two ports or vents is equally effective as long as the refrigerant vent 30 is level with or higher than the uppermost oil port 19 and so long as the refrigerant vent crosses the center of rotation 23 of the shaft.

In FIG. 2 there is shown a modification of the present invention which includes both means for venting refrigerant from the vertical oil passage and also for ventilating the groove within the upper bearing 4. In this modification, oil vents are provided for both the upper and lower portions, that is the upper portion 36 and the lower portion 37 which are separated by the groove 35. The upper portion 36 is lubricated by the oil vent 39 and the lower portion by the oil vent 40 while refrigerant is removed from the top of the vertical passage 21 through a horizontally extending refrigerant vent 41. To relieve any refrigerant vapor pressure which may be set up within the groove 35, there is provided an additional vent 42 connecting this groove with the vertical passage 21. This additional passage 42 is parallel to vent 40 and extends from passage 21 through the axis of the shaft to the groove 35.

The motor compressor unit may be of any type that includes a vertical drive shaft one end of which is immersed in an oil reservoir and the other end of which extends vertically upwardly and is supported in such position by one or more unimmersed bearing surfaces. For example, a rotary compressor or scotch-yoke type of compressor can be substituted for the one illustrated, the only requirement being that the shaft be such that there can be drilled or otherwise formed in the shaft a lubricant passage extending approximately from the lower end of the shaft at center of rotation thereof upwardly to the unimmersed bearing surfaces and that this passageway have a radial component such that the oil entering the lubricating passage will be subjected to a centrifugal force or pumping action sufficient to provide an oil head sufficient to reach all of the unimmersed surfaces requiring lubrication.

By the present invention there has been provided a low cost lubricating arrangement which provides positive lubrication of the unimmersed bearing surfaces with substantially refrigerant-free oil. The lubricating arrangement builds up an oil pressure or head very rapidly when the compressor is first started with resultant low starting wear. It also maintains a constant oil pressure at all bearing surfaces under all conditions of temperatures, pressures and foaming existing within the oil reservoir. Unlike many lubricating systems for hermetic compressors, the system of the present invention requires no flow or by-passing of oil through the bearings to flush refrigerant from the oil passages and bearing surfaces and with the resultant lower over-all pumping rates for the oil, there is less agitation of the oil in the oil reservoir so that any dirt which may be present in this oil can settle to the bottom of the reservoir where it will remain indefinitely. In addition, the quantity of oil pumped by the lubricating system of the present invention is limited to that amount actually required to make up the leakage from the bearings and this is held to a minimum since the bearings require no venting of refrigerant directly to the casing.

While there has been shown and described specific embodiments of this invention it is to be understood that the invention is not limited to the particular forms shown and described and it is intended by the appended claims to cover all modifications within the spirit and scope of the invention.

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

1. In a refrigerating compressor, the combination of a housing having therein a refrigerant space and a lubricant storage space; a shaft rotatably mounted within said housing and having therein a lubricant receiving passage communicating with said lubricant space and a connecting inclined vent passage communicating with said refrigerant space, the inclination of said vent passage being in a direction toward the center line of said shaft to thereby prevent the passage of lubricant through said vent passage.

2. In a refrigerant compressor of the type including a vertically-disposed rotary drive shaft and a bearing surface engaging an upper portion of said shaft, the lower end of the shaft being formed with a horizontal duct extending from the axis of the shaft and with a vertical duct intercepting the horizontal duct at a point remote from the axis, said upper portion of said shaft being formed with a lateral duct extending from said vertical duct to a point on the periphery of said shaft engaged by said bearing surface, and means forming an oil reservoir around the lower end of the shaft communicating with said horizontal duct therein and extending upwardly above the horizontal duct therein to a level below said lateral duct, whereby upon rotation of the shaft oil may be forced centrifugally through said horizontal duct and upwardly to said lateral duct, that improvement which comprises a vent provided in said shaft extending from said lateral duct to the periphery of the shaft at an uncovered portion thereof above said lateral duct, whereby refrigerant vapor in said vertical and lateral ducts may escape freely therefrom, said vent being disposed between the lateral duct and shaft periphery to pass through the axis of rotation of the shaft, thereby to establish a centrifugal force when the shaft is rotated opposing the flow of oil therethrough.

3. In a refrigerant compressor of the type having a cylinder and a piston reciprocably mounted in the cylinder, a drive shaft angularly disposed to the cylinder and having upper and lower concentric portions and an intermediate eccentric portion aligned with the piston, a connecting rod between the piston and eccentric portion and a wrist pin between the piston and adjacent end of the connecting rod, the lower end of the shaft being formed with a horizontal duct extending from the axis of the shaft and with a vertical duct intercepting the horizontal duct at a point remote from the axis, said eccentric portion being formed with a lateral duct extending from said vertical duct to the periphery of the eccentric portion, and means forming an oil reservoir around the lower end of the shaft communicating with said horizontal duct therein and extending upwardly above the horizontal duct therein to a level below said lateral duct, whereby upon rotation of the shaft oil may be forced centrifugally through said horizontal duct and upwardly to the eccentric portion, that improvement which comprises forming the eccentric portion with a vent extending from said lateral duct to the periphery of the shaft at an uncovered portion thereof above the connecting rod, whereby refrigerant vapor in said vertical and lateral ducts may escape freely therefrom and disposing said vent between the lateral duct and shaft periphery to pass through the axis of rotation of the shaft, thereby to establish a centrifugal force when the shaft is rotated, opposing the flow of oil therethrough.

4. A hermetic refrigerant compressor comprising a hermetic casing including a lower portion containing a body of lubricating oil and an upper portion containing refrigerant vapor, a refrigerant compressor unit positioned within said casing and including a vertically-disposed shaft having its lower end submerged in said body of lubricating oil, a bearing supporting said shaft and positioned in the upper portion of said casing above said body of oil, said bearing including upper and lower portions and a groove therebetween, and means for lubricating said bearing comprising a radially extending passageway in the submerged lower portion of said shaft having its inner end in open communication with said body of oil, a vertical passage in said shaft parallel to and offset from the center line of said shaft and extending from said radially extending passage upwardly to a point within said shaft above the upper portion of said bearing, oil outlet ports in said shaft extending from the upper portion of said vertical passage to the surfaces of said shaft encompassed by the upper and lower portions of said bearing in a direction away from the axis of said shaft, a horizontal refrigerant vent in said shaft having an inlet end communicating with said vertical passage at a point at least as high as the uppermost of said oil outlet ports, said vent passing through the axis of said shaft and terminating on the opposite side of said shaft at a point exposed to the refrigerant vapor in the upper portion of said casing, and an additional passage in said shaft parallel to said refrigerant vent, said additional passage extending from said vertical passage through the axis of said shaft and opening into said groove on the opposite side of said shaft.

5. In a refrigerating compressor, the combination of a housing having therein a refrigerant space and a lubricant storage space, a shaft rotatably mounted within said housing, and a bearing surface engaging said shaft above said lubricant space, said shaft having therein a vertical lubricant receiving passage having an inlet communicating with said lubricant space and an outlet communicating with said bearing surface, that improvement which comprises a refrigerant vapor vent in said shaft having an inlet end communicating with said vertical passage at a point at least as high as said outlet and its outlet end communicating with the refrigerant space in the upper portion of said casing whereby refrigerant vapor in said vertical passage may escape freely from said vertical passage, said vent passing through the axis of said shaft thereby establishing a centrifugal force in said vapor vent when the shaft is rotated opposing the flow of oil therethrough.

6. In a hermetic refrigerant compressor comprising a

hermetic casing including a lower portion containing a body of lubricating oil and an upper portion containing refrigerant vapor, a refrigerant compressor unit positioned within said casing and including a vertically-disposed rotary drive shaft having its lower end submerged in said body of lubricating oil, a bearing surface supporting said shaft and positioned in said casing above said body of oil, and means for lubricating said bearing surface comprising a radially extending passageway in the submerged lower portion of said shaft having its inner end in open communication with said body of oil, a vertical passage in said shaft parallel to and offset from the center line of said shaft and extending from said radially extending passage upwardly to a point within said shaft adjacent said bearing surface, an oil outlet port in said shaft extending from the upper portion of said vertical passage to the surface of said shaft encompassed by said bearing surface in a direction away from the axis of said shaft, that improvement which comprises a refrigerant vapor vent in said shaft having an inlet end communicating with said vertical passage at a point at least as high as said oil outlet port and its outlet end communicating with the refrigerant vapor in the upper portion of said casing whereby refrigerant vapor in said vertical passage and port may escape freely therefrom, said vent passing through the axis of said shaft thereby establishing a centrifugal force in said vapor vent when the shaft is rotated opposing the flow of oil therethrough.

7. In a hermetic refrigerant compressor of the type including a hermetic casing and a compressor unit in said casing comprising a vertically-disposed rotary drive shaft and a bearing surface engaging an upper portion of said

shaft, the lower end of the shaft being formed with a horizontal duct extending from the axis of the shaft and with a vertical duct intercepting the horizontal duct at a point remote from said shaft axis, said upper portion of said shaft being formed with a lateral duct extending from said vertical duct to a point on the periphery of said shaft engaged by said bearing surface, and means forming an oil reservoir in said casing around the lower end of the shaft communicating with said horizontal duct therein and extending upwardly above the horizontal duct to a level below said lateral duct whereby upon rotation of the shaft oil may be forced centrifugally through said horizontal duct and upwardly through said vertical duct to said lateral duct, that improvement which comprises a vent provided in said shaft extending from said vertical duct at a point at least as high as said lateral duct to the periphery of the shaft at a portion thereof communicating with said casing above said oil reservoir, whereby refrigerant vapor in said vertical and lateral ducts may escape freely therefrom, said vent being disposed between the vertical duct and shaft periphery to pass through the axis of rotation of the shaft, thereby to establish a centrifugal force when the shaft is rotated opposing the flow of oil therethrough.

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