Oct. 27, 1964 J. TOUBORG 3,154,244

LUBRICATION OF REFRIGERATION COMPRESSORS

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Fig. 1.

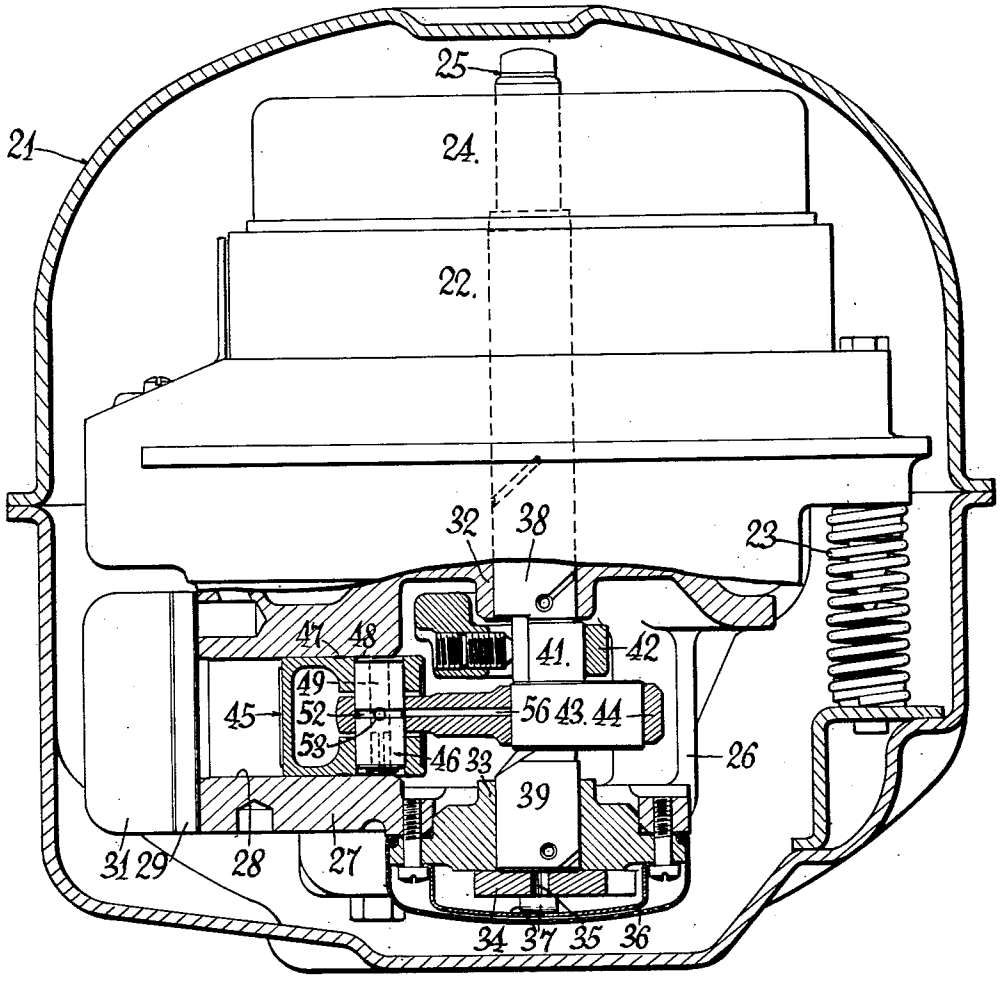
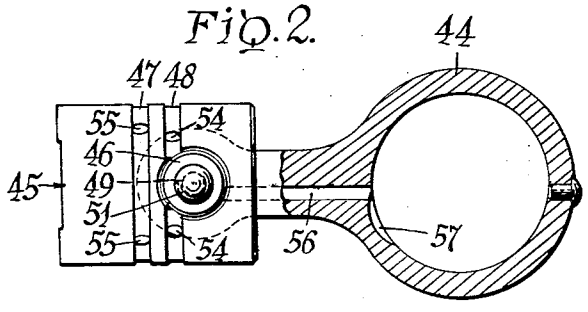


Fig. 2.



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Fig. 4.

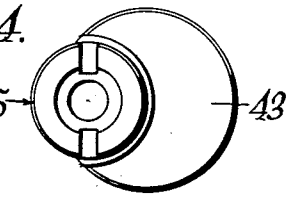


Fig. 8.

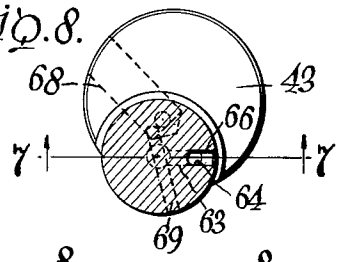


Fig. 7.

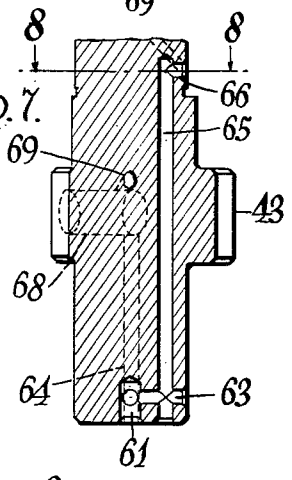


Fig. 3.

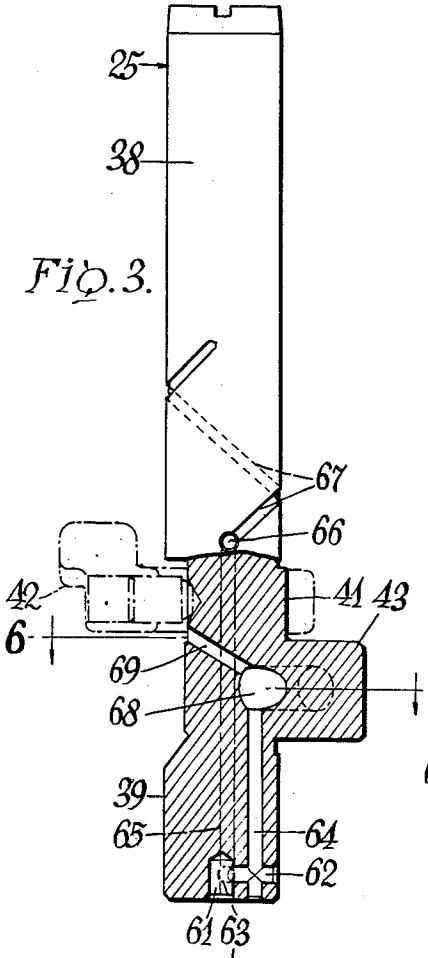


Fig. 6.

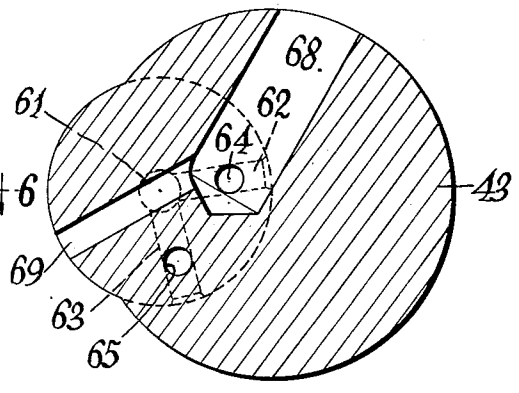
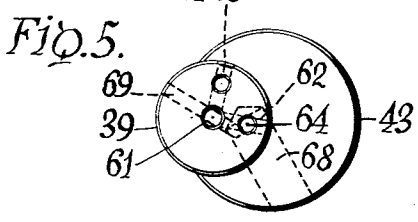


Fig. 5.



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LUBRICATION OF REFRIGERATION COMPRESSORS

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2 Claims. (Cl. 230—206)

This invention relates to the lubrication of refrigeration compressors, and particularly of the type wherein lubricant is supplied by centrifugally acting pumping means to the main bearings and pistons through ducts which are in communication with the oil pool in the crankcase of the compressor.

A compressor incorporating a lubrication system of this type is described and claimed in my prior Patent No. 2,274,943 of March 3, 1942, for "Refrigeration Compressor." Briefly, as set forth in my prior patent, a hermetic compressor includes a vertical shaft, mounted in spaced radial bearings, and the lower end of the shaft extends into the pool of oil contained in the crankcase. The shaft, in the preferred form of the invention therein described, is formed with two ducts or risers extending axially from the lower end, each of which is offset from the shaft axis. One riser extends to the upper radial bearing, while the other extends to an eccentric portion of the shaft, on which the big end of the connecting rod is mounted. The lower end of the shaft is formed with radial ducts communicating with the risers, and these ducts are in communication with the oil reservoir. As the shaft rotates, the radial ducts function as impellers of a centrifugal pump, to force oil into the risers, and thence to the upper bearing, and also to the piston through a duct formed in the connecting rod.

A great number of compressors, lubricated by the patented arrangement, have been placed in service during the ensuing years, and have functioned effectively and satisfactorily. It was noted, however, that occasionally there would be an unsatisfactory noise condition, particularly when the compressor was started after a long idle period. Tests also revealed that a high current consumption frequently accompanied this starting noise condition. I have now discovered that these defects are not caused so much by the centrifugal pump itself, or manufacturing imperfections, but by the service conditions under which the compressor may operate. Under some conditions, the risers and ducts become filled with refrigerant vapor, which creeps into them by volatilization from the oil bath during a long shut-down period. The vapor retards the flow of oil when the compressor is again started, and thus the parts to be lubricated, particularly the wrist pin and piston, are starved for oil, thus leading to the stated noise condition and excessive power consumption.

I have now discovered that if provision is made to enable the vapor to escape readily to the crankcase, it no longer retards the flow of oil to the bearings, and therefore the deleterious effects of the vapor are eliminated. This may be accomplished by providing vent ports communicating with both the oil ducts and the crankcase, so organized that, while the vapor or gas may flow therethrough, the rotation of the compressor shaft prevents the leakage of oil to the crankcase, and aids in forcing the oil to the parts to be lubricated. In this respect, the present invention differs from that of my above-mentioned prior patent, wherein it was pointed out that ends of certain ducts should be constantly covered.

The invention will be fully understood from the following detailed description of the best embodiment of its

principles now known to me, reference being had to the accompanying drawing, wherein:

FIG. 1 is a section, with parts in elevation, of a hermetic compressor in which the invention is incorporated;

FIG. 2 is a view partly in elevation and partly in section, of the piston and connecting rod shown in FIG. 1, rotated through an angle of ninety degrees and drawn on an enlarged scale;

FIG. 3 is a view, partly in elevation and partly in section, of the compressor shaft;

FIGS. 4 and 5 are respectively plans of the upper and lower ends of the shaft of FIG. 3;

FIG. 6 is an enlarged section on line 6—6 of FIG. 3;

FIG. 7 is a fragmentary section of the lower end of the shaft, rotated from the FIG. 3 position to reveal more clearly one of the risers, and taken substantially on the line 7—7 of FIG. 8; and

FIG. 8 is a section on the line 8—8 of FIG. 7.

The compressor shown in FIG. 1 is generally of the type shown in my aforesaid prior patent and in others which have been granted to me, and, as its construction is well known to those skilled in the art, no attempt will be made to present a detailed description of a number of features not relevant to the present invention. Briefly, the compressor comprises a sheet metal casing 21, within which is a main casting 22, supported in the casing by a plurality of spring mountings 23. The upper part of the casting 22 has fitted therein an electric motor 24, whose rotor carries a main shaft 25, the lower end of which depends into an open or crankcase portion 26 of the casting 22. One lower portion 27 of the casting 22 constitutes a cylinder block, formed with a cylinder bore 28, the head end of which is capped by a valve plate 29 and a cylinder head 31.

The shaft 25 is rotatably mounted in an upper radial bearing 32 formed in the casting 22, and a removable lower radial bearing 33 connected to the bottom of the casting. A foot or thrust bearing 34 is detachably secured to the bearing 33, to cover the lower end of the shaft 25, and it is formed with an axially aligned aperture 35 to admit oil to the shaft 25, as will be noted again hereinafter. A filter screen 36 is placed over the ends of the bearings 33 and 34, and the flexible screen is spaced from the aperture 35 by a leaf spring 37, so that, during operation, the screen cannot be drawn by suction or pressure to block the aperture 35. The upper and lower portions 38 and 39 of the shaft 25 are concentric, and between them is an offset portion 41 on which is mounted a counterweight 42, and another offset portion 43 constituting an eccentric. The big end of a connecting rod 44 encircles the eccentric, and the small end is retained within a piston 45—mounted in the cylinder 28—by a wrist pin 46. It will be obvious that the piston will reciprocate in the cylinder as the shaft 25 is rotated, to compress refrigerant vapor inducted through the head 31, in the well known manner.

As is further shown in FIG. 2, the piston 45 is formed with two circumferential oil grooves 47 and 48, the latter of which intercepts the bearing bore for the wrist pin 46. The pin itself is formed with a longitudinal bore 49, the lower end of which is closed by a plug 51, while the upper end, as viewed in FIG. 1, is in fluid communication with the groove 48. The pin 46 is also formed with a circumferential groove 52, containing an aperture 53 which communicates with the bore 49. The lower portion of the groove 48 is formed with two holes 54, while the groove 47 is formed with six equally spaced holes 55, and both sets of holes communicate with the hollow interior of the piston. There is sufficient clearance around the small end of the connecting rod 44 to

enable any gas finding its way into the interior of the piston to flow freely to the crankcase portion of the compressor. The connecting rod **44** is formed with an axial duct **56** extending between its ends which communicates with the groove **52**, and with an arcuate oil pocket **57** formed in the strap or big end. Oil is supplied from the crankcase to these various grooves and passageways to lubricate the eccentric, wrist pin, and cylinder wall, as will now be explained.

Referring also to FIGS. 3 to 8, the lower concentric shaft section **39** is axially drilled to provide a bore **61** of limited length, and which is aligned with the opening **35** of the thrust bearing **34**. A pair of angularly spaced radial ducts **62** and **63** extend from the bore **61** to the periphery of the section **39**, and these are intercepted by vertical riser ducts **64** and **65**, spaced from the axis of rotation, and respectively terminating in the eccentric portion **43** and at the lower end of the upper shaft section **38**. Inasmuch as the lower end of the shaft **25**, together with the bearing **34** and at least a substantial portion of the bearing **33**, are submerged in the oil bath in the crankcase, these various passages constitute centrifugal pumps. The bore **61** is an inlet or eye, the ducts **62** and **63** are impellers or vanes, and the vertical ducts **64** and **65** are discharge lines or risers as has been fully explained in my prior patent. In common with my earlier invention, the riser **65** communicates with a lateral duct **66**, located adjacent the lower portion of the upper bearing **32**, which in turn communicates with a spiral groove **67** in the upper shaft section **38**, thereby to provide lubrication for the upper bearing.

The riser **64** terminates in a lateral duct **68** extending to the periphery of the eccentric **43**, and it will be noted that the duct **68** is of substantially greater diameter than either the impeller **62** or riser **64**. This increase in diameter has been found beneficial in solving the problem to which the present invention is directed. It will now be seen that, as the shaft **25** rotates, oil will be forced from the impeller **62** into the riser **64** and into the duct **68** to provide lubrication for the strap end of the connecting rod **44**. When the end of the duct **68** overlaps the connecting rod duct **56**, oil is discharged into the duct **56**, and thence into the groove **52**, hole **53** and bore **49** to supply lubricant to the wrist pin and cylinder wall.

It was previously noted that a temporary condition of noise and unnecessarily high power consumption was sometimes heretofore encountered, and it appears consistent with available evidence to attribute such condition to the presence of refrigerant vapor in portions of the lubrication passageways leading to the piston. Such vapor as is entrained in the oil may separate, expand, and thereby displace the residual lubricant around the piston, causing a dry condition. While the pump impellers **62** and **63** are constantly submerged, and are therefore self-priming, the vapor pressure in the overlying passageways creates a head or resistance against which the impellers must work, and, as the centrifugal pumps endeavor to overcome this resistance, any trapped vapor has its back pressure increased, thus adding to the difficulty. Until such trapped vapor is forced out in some manner or other, the dry condition continues, and is not alleviated until adequate lubricant is finally forced to the dry areas.

Provision is now made to eliminate this vapor pressure resistance. The eccentric portion **43** of the shaft **25** is drilled with a vent passage **69**, extending angularly upward from the duct **68** to the lower portion of the counterweight section **41**. The outlet end of the vent **69** is just below the counterweight **42**, and therefore it is in constant free communication with the crankcase portion of the compressor, which is under low pressure as compared to the pressure which can be developed by the oil pump. Accordingly, refrigerant vapor escaping

from oil contained in the riser **64** and duct **68** may pass freely to the crankcase, and thus eliminate itself as a cause of additional resistance to the oil pump, when the compressor is started. The upper end of the vent **69** is also above the level of the connecting rod duct **56** and the wrist pin aperture **53**, and therefore oil which may be contained therein is no longer subjected to gas pressure which might tend to displace it. Similarly, should there be a gas formation in the oil ring grooves **47** and **48**, such gas may escape through the various holes **54** and **55** to the interior of the piston **45** which, as previously noted, is vented to the crankcase. Residual oil in the grooves **47** and **48** may remain there, at least in part, by adhesion and capillary attraction.

Accordingly, when the compressor is again started, there is no head resistance from the vapor, and the relatively large volume of the duct **68** provides a reservoir for oil which is then free to flow to the piston **45**. It is of particular interest to note that the vent **69** extends from the duct **68** directly across the axis of rotation of the shaft **25**, and above the inlet eye **61**. Hence, that portion of the vent **69** between the axis and duct **68** is, in effect, an additional centrifugal impeller which repels oil attempting to enter it, and forces such oil back into the duct **68**. Thus, while the duct **68** is always vented to the crankcase, the location of the vent **69** is such as to preclude loss of oil therethrough to short circuit or bypass the piston.

It will accordingly be seen that the invention provides a simple and effective means to eliminate vapor-lock in the lubricating system of the compressor, and make available an adequate supply of lubricant at all times and under all conditions of operation. In addition to elimination of a source of noise, and improvement in power consumption, it has been found that bronze bushings for the piston and wrist pin, heretofore considered necessary in certain sizes of compressors, may safely be eliminated. While the invention has been described with respect to a single embodiment, it will be understood that it is not limited thereto, but should be deemd to encompass all variations and modifications which are within the scope of the following claims.

I claim:

1. In a refrigerant compressor of the type having a generally horizontally disposed cylinder and a piston reciprocably mounted in the cylinder, a generally vertically extending drive shaft having upper and lower concentric portions and an intermediate eccentric portion aligned with the piston, a connecting rod connected to said eccentric portion at one end, a wrist pin connecting the other end of the connecting rod with the piston, the lower end of said shaft being formed with a vertical duct offset from the axis of rotation of the shaft, means responsive to the centrifugal action of the rotating shaft and forming a pump for conducting oil upwardly through said vertical duct, said vertical duct terminating at said eccentric portion, said eccentric portion being formed with a lateral duct extending from said vertical duct to the periphery of said eccentric portion, an oil passageway in said connecting rod extending from said eccentric portion to the wrist pin and means forming an oil reservoir around the lower end of said shaft and below said lateral duct whereby upon rotation of the shaft, the oil flowing into said lateral duct is forced centrifugally into the oil passageway in the connecting rod, the improvement which comprises a vent passageway in said eccentric portion extending from said lateral duct upwardly to the periphery of the shaft at an uncovered portion above the connecting rod whereby refrigerant vapor in said vertical duct and lateral duct may escape freely at all times therefrom, said wrist pin being provided with openings communicating with the oil passageway in the connecting rod, said wrist pin openings extending to the outer surface of the piston to distribute oil thereto, said piston being provided with apertures communicating with said wrist pin openings and

extending from said surface of the piston to the interior of the piston and communicating with the space above said oil reservoir whereby refrigerant vapor formed adjacent the wrist pin may readily escape therefrom.

2. The combination set forth in claim 1 wherein the ends of said oil passageway in said connecting rod and said lateral duct adjacent the periphery of said eccentric portion are adapted to register with one another to establish communication therebetween once during each revolution of said drive shaft and for a relatively small increment of rotation of said drive shaft, and wherein said piston has a bore for reciving said wrist pin, said bore being open at one end at the circumferential surface of the piston and communicating with said wrist pin openings, said piston further having an annular oil distributing and collecting groove in the circumferential surface thereof intersecting said one end of said wrist pin bore, said piston apertures connecting said groove with the interior of said piston to thereby provide constant communication,

via said wrist pin openings and said groove, between said connecting rod passage and the space above said oil reservoir.

References Cited in the file of this patent

UNITED STATES PATENTS

1,649,584	Greenwald	Nov. 15, 1927
1,713,231	Jack	May 14, 1929
1,965,198	Maccabee	July 3, 1934
2,073,547	Berry	Mar. 9, 1937
2,274,942	Touborg	Mar. 3, 1942
2,274,943	Touborg	Mar. 3, 1942
2,280,296	Mantle	Apr. 21, 1942
2,423,719	Muffly	July 8, 1947
2,500,751	Halfvarson	Mar. 14, 1950
2,809,872	Warner	Oct. 15, 1957

FOREIGN PATENTS

709,159	Germany	Aug. 7, 1941