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Ayling

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[54] COMPRESSOR LUBRICATION SYSTEM

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[73] Assignee: **Cardinal Compressor Corporation,** Bristol, Va.

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[52] **U.S. Cl.** **417/372**

[51] **Int. Cl.** **F04b 39/02**

[58] **Field of Search** 417/902, 368, 372, 417/424

[56] **References Cited**

UNITED STATES PATENTS

3,049,285	8/1962	Doeg	417/372
3,098,604	7/1963	Dubberley	417/372
3,182,901	5/1965	Solomon	417/372
3,285,504	11/1966	Smith	417/372
3,692,435	9/1972	Iida et al.	417/372

Primary Examiner—Carlton R. Croyle
Assistant Examiner—Richard J. Sher
Attorney—Robert T. Palmer

[57] **ABSTRACT**

A refrigerant compressor has a vertically extending crankshaft with its lower end in an oil sump. An off-center bore extends vertically within the crankshaft, and is connected through radial bores to the bearings. The bottom of the off-center bore is connected to the outlet of an oil pump formed in the bottom of the crankshaft. The inlet of the oil pump is connected to the oil in the sump. A gas pump is formed in the lower portion of the crankshaft above the oil pump. The gas pump has its inlet connected to the inlet of the oil pump, and has its outlet connected through a radial bore in the crankshaft to the space above the sump. Another gas pump is formed in the upper portion of the crankshaft and has its inlet connected to the top of the off-center bore, and its outlet within the interior of a motor compartment above the off-center bore.

14 Claims, 2 Drawing Figures

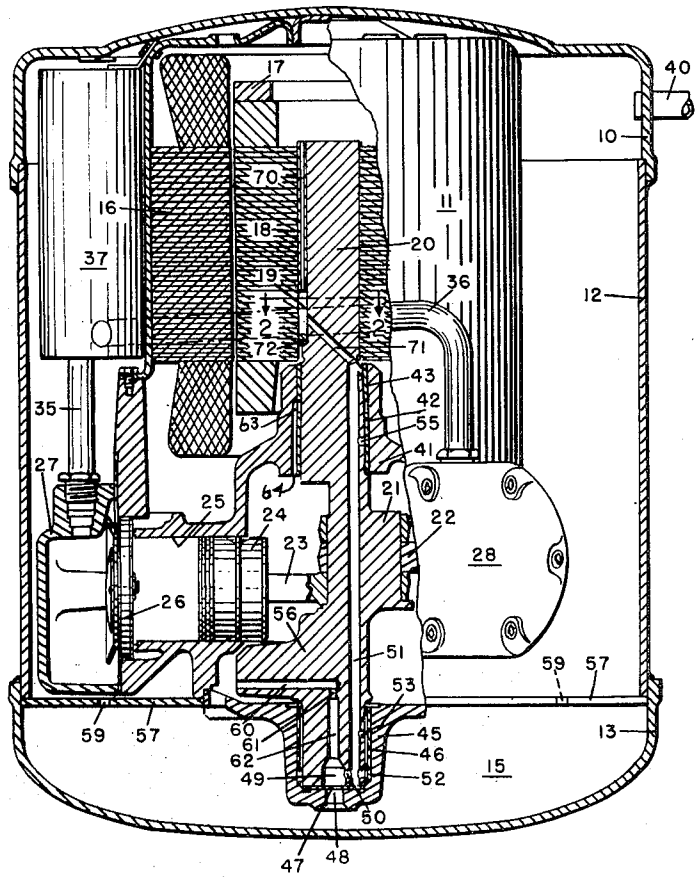


FIG. 1.

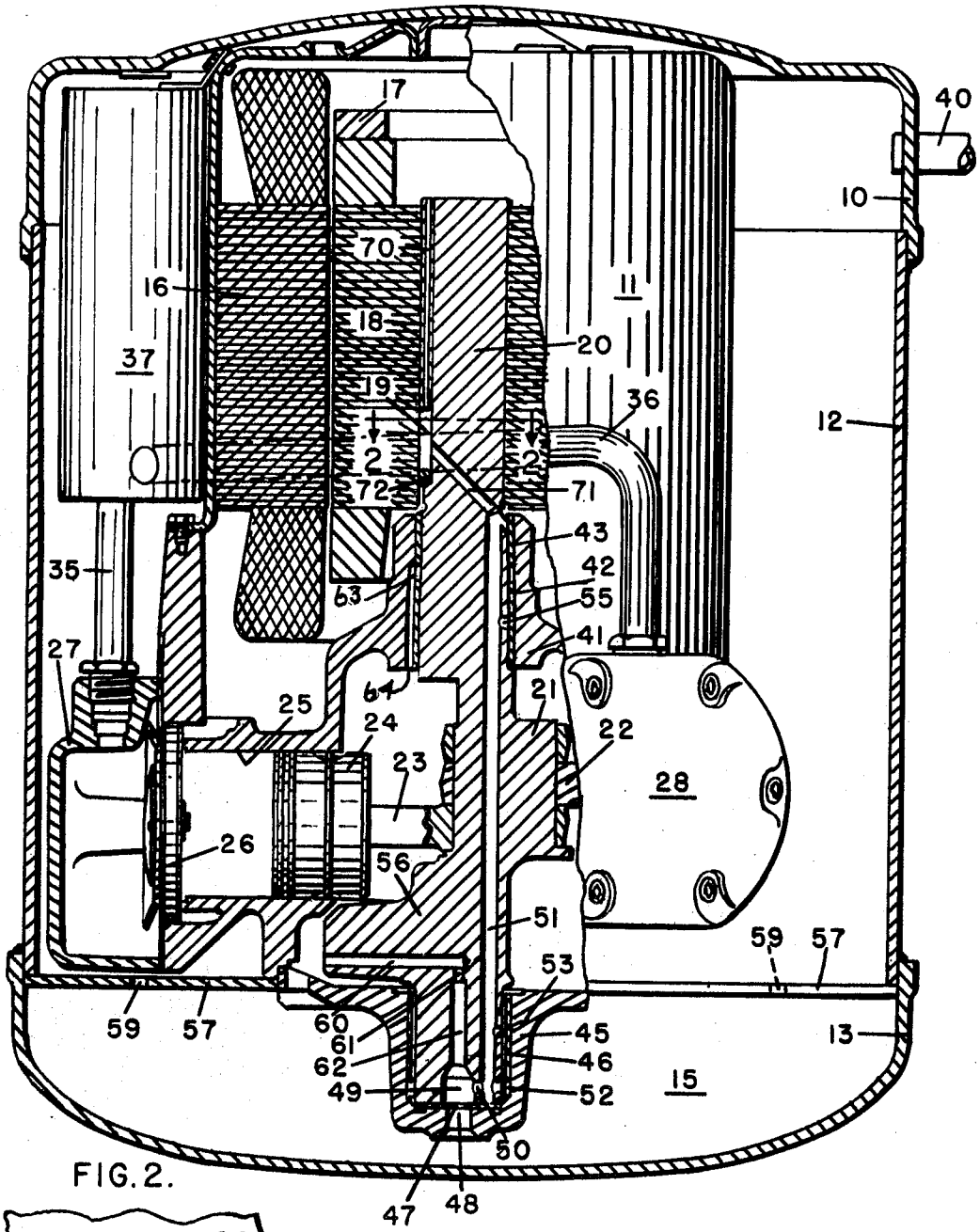
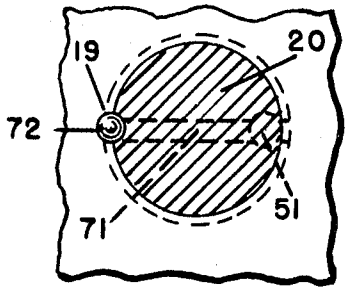

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FIG. 2.


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COMPRESSOR LUBRICATION SYSTEM

BACKGROUND OF THE INVENTION

Many piston type refrigerant compressors have vertically extending crankshafts with off-center bores connecting through radial bores with bearings, and having their bottoms within oil sumps. Centrifugal pumps formed in the bottom portions of the crankshafts have their outlets connected to the bottoms of the off-center bores, and their inlets connected to the oil within the oil sumps. The lubricating oil for such compressors is in contact with the refrigerant so that the oil draining into their oil sumps contains absorbed refrigerant, and hence is volatile. Gas within the oil flowinging through such oil pumps may interfere with the flow of oil, and result in the starving of the bearings. This problem is well known, and there have been many efforts to solve it. My U. S. Pat. No. 3,259,307 discloses the formation of a centrifugal gas pump within the upper portion of a crankshaft for removing gas from the oil within an off-center oil supply bore. My and Paul G. Thaver's joint U. S. Pat. No. 3,388,855 disloses the formation of a centrifugal gas pump within the lower portion of a crankshaft for removing gas from the oil entering an oil pump. The present invention is an improvement of the inventions of both of such patents as will be described later in connection with the explanation of the operation of this invention.

SUMMARY OF THE INVENTION

A piston-type refrigerant compressor has a vertically extending crankshaft with the rotor of an electric driving motor keyed to its upper portion. The bottom of the crankshaft is within an oil sump. An off-center bore is connected through radial bores with the bearings, and is connected at its bottom to the outlet of a radial oil pumping bore within the crankshaft near the bottom of the latter. The inlet of the oil pumping bore is connected through a central bore in the bottom portion of the crankshaft to the oil within the sump.

For removing gas from the oil at the inlet of the oil pumping bore, the top of the central bore is connected through another central bore smaller in diameter than the first mentioned central bore, and an orifice between the latter and a radial bore extending through the crankshaft from its axis and through a counterweight formed on the crankshaft to the space above the oil sump. The other central bore, the orifice, and the radial bore through the crankshaft and the counterweight form a centrifugal gas pump for removing gas from the inlet end of the oil pumping bore. Centrifugal force and the orifice oppose the flow of oil through the gas pump.

For removing gas from the oil within the upper portion of the off-center bore, the top of the latter is connected through a transverse bore crossing the axis of the crankshaft to a keyway formed in adjacent surfaces of the crankshaft and the rotor of the motor. A hollow key extends within the keyway above the transverse bore. The keyway below the key connects with the bottom of the opening within the key. The top of the opening within the key is at the top of the crankshaft, and discharges gas into the upper portion of the motor compartment. The transverse bore forms a centrifugal gas pump for removing gas from the upper portion of the off-center bore, the gas so removed flowing through the keyway below the key, and through the opening within the key into the upper portion of the motor compartment. Centrifugal force opposes the flow of oil through the transverse bore.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 of the drawings is a side elevation, partially in section, of a refrigerant compressor embodying this invention, and

FIG. 2 is an enlarged section through the crankshaft and the keyway of the compressor, the section being taken along the lines 2—2 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

An upper shell **10** around the upper portion of a motor compartment **11** is attached to an intermediate shell **12** which is attached to a lower shell **13** extending around the lower portion of the assembly. The lower shell **13** forms an oil sump **15.** An electric motor **16** has a rotor **17** attached to a vertically extending crankshaft **20** by a hollow cylindrical key **18** within a cylindrical keyway **19** formed within adjacent surface portions of the rotor **17** and the crankshaft **20.** The latter has a crankpin **21** on which eccentric straps **22** and **23** are journalled. The strap **23** is connected to piston **24** operating within cylinder **25.** Valve plate **26** at the top of the cylinder **25** is held in place by a cylinder head **27.** The strap **22** is connected to a piston (not shown) operating within a cylinder having a head **28.** The cylinder heads **27** and **28** are connected by discharge gas tubes **35** and **36** respectively, to a conventional muffler **37** which is connected by conventional tubing (not shown) to the outlet of the motor-compressor unit. A suction gas tube **40** connects through the shell **10** with the motor compartment **11** as is conventional.

Formed to the cylinders is an upper bearing housing **41** around upper bearings **42** and **43** which are around the crankshaft **20** near the bottom of the motor **16.** Attached to the cylinders is a lower bearing housing **45** for a lower bearing **46** around the lower portion of the crankshaft **20.** The housing **45** extends into the oil sump **15** under the bottom of the crankshaft **20.** There is a thrust bearing **47** between the bottom of the crankshaft **20** and the upper surface of the housing **45** opposite thereto. The housing **45** has an opening **48** below the axial center of the crankshaft **20,** connecting the oil sump **15** with a lower central bore **49** within the crankshaft **20.** The bore **49** is connected by a radial bore **50** within the crankshaft **20** to a vertically extending, off-center bore **51** within the crankshaft **20,** and by radial bore **53** within the crankshaft **20** to the lower bearing **46.** The radial bore **50** connects with annular space **52** in the lower bearing housing **45.** The off-center bore **51** is connected by radial bore **55** within the crankshaft **20** to the upper bearing **42.**

A counterweight **56** is formed on the lower portion of the crankshaft **20.** A plate **57** is clamped at the junction of the shells **12** and **13,** and supports the motor-compressor assembly. The plate **57** has openings **59** for the drainage of oil and refrigerant from the motor compartment **11** into the sump **15.**

The bores **49** and **50** form a centrifugal oil pump for forcing oil from the sump **15** through the off-center bore **51** and the radial bore **53** to the bearing **46,** and through the off-center bore **51** and the radial bore **55** to the upper bearing **42.**

The construction described so far with reference to the drawings, except for the plate **57** which forms no part of the present invention, is not novel. The present invention adds, for venting accumulated gas separated from the oil in the central bore **49**, a radial bore **60** within the crankshaft **20** and the counterweight **56**, the outer end of which connects with the space within the compressor just above the plate **57**. The inner end of the radial bore **60** extends inwardly just beyond the axis of the crankshaft **20**, and connects through an orifice **61** on that axis with the upper end of a central bore **62** within the crankshaft **20**. The lower end of the bore **62** connects with the top of the central bore **49**. The bore **62** has a smaller diameter than that of the bore **49**. The resistance to flow through the bore **62**, the orifice **61**, and the bore **60** is substantially greater than that through the bores **49** and **50**.

The radial bore **60**, the orifice **61**, and the axial bore **62** form a centrifugal gas pump, drawing gas from the inlet of the oil pump bore **49**, and discharging the gas into the compressor interior above the oil sump **15** and above the plate **57**. The constriction provided by the orifice **61**, and centrifugal force, greatly restrain the flow of the heavier oil through the gas pump. Increased centrifugal force and therefore a larger pumping head is provided by the relatively long radial gas pump bore **60**.

The previously mentioned Ayling-Thayer U.S. Pat. No. 3,388,855 discloses an orifice between the inlet of an oil pump and the inlet of a gas vent passage but that orifice is not on the axis of the crankshaft, the gas vent bore is relatively short, and the latter discharges gas into an oil sump below the level of the oil therein. The U. S. Pats. Nos. 3,182,901 of B. E. Solomon, and 3,279,683 of E. W. Kleinlein disclose radial gas pumping passages connected through axial passages to the inlets of oil pumps, but their gas pumping passages are not constricted, do not contain orifices, and do not extend through counterweights. The advantages of the orifice on the axis of the crankshaft are that the constriction not only greatly opposes oil flow, but the orifice vents at the center of rotation where the gas exists. The advantage of extending the radial gas pump bore through both the crankshaft and the counterweight rather than just through a crankshaft, is that the gas pump bore is much longer, providing a much larger centrifugal head. This head is needed to prevent backflow from a pressurized crankcase when the compressor is operating, and it aids in priming the oil pump at start-up, especially when there is a very low oil level within the oil sump. The orifice also aids in priming the oil pump by backing up the oil drawn into the axial bores by the rotation of the gas pump bore.

The present invention also adds for venting accumulated gas from the off-center bore **51** at the upper bearings **42** and **43**, a central gas passage **70** within the key **18**, the top of which connects with the upper portion of the motor compartment **11** at the top of the crankshaft **20**, and the bottom of which connects with the keyway **19** below the key **18**, and adds a transverse bore **71** within the crankshaft **20** which connects with and crosses the top of the off-center bore **51**. One end of the transverse bore **71** connects with the upper bearing **43**, and its other end connects with the keyway **19** below the hollow key **18**. The transverse bore slopes upwardly from where it connects with the bearing **43**, and crosses the axis of the crankshaft **20**. A ball **72** acting as a plug is forced into the bottom of the keyway **19**. The lower end of the transverse bore **71** supplies oil from the off-center bore **51** to the upper bearing **43**. The usual annular space **63** between the bearings **42** and **43** connects with the usual oil return passage **64**.

The transverse bore **71** acts as a centrifugal gas pump, removing gas from the top of the off-center bore **51**, and forcing the gas through the lower portion of the keyway **19** and the hollow key **18** in the upper portion of the motor compartment **11** at the top of the crankshaft **20**. Centrifugal force opposes the flow of the heavier oil through the transverse bore **71**.

My previously mentioned U.S. Pat. No. 3,259,307 discloses a transverse gas pump bore connecting the top of an off-center bore to a central bore which extends to the top of a crankshaft. The present invention has the advantage that the transverse bore is longer, providing a greater pumping head, and the cost of deep drilling a center bore is avoided by using an existing keyway and a hollow key within the latter.

The U. S. Pats. Nos. 3,098,604 of C. A. Dubberley, and 3,162,360 of G. T. Privon et al disclose transverse gas pump bores connected to the tops of off-center bores, and connected through downwardly extending counter-bores within the rotors of electric motors with motor compartments below the rotors. The present invention has the advantage over those of the Dubberley and Privon et al. patents in that through discharging the vented gas into the top of a motor compartment instead of into the bottom of the latter, the effect of suction gas pressure drop across the motor which might draw oil through the gas vent passages, is avoided.

I claim:

1. In a refrigerant compressor having a shell with an oil sump in its bottom, having a crankshaft extending upwardly above said sump with its bottom within said sump, said crankshaft having a central bore in its lower portion connecting with said sump, having a longitudinal off-center bore, having a radial bore extending from said off-center bore to said central bore, and having a second radial bore above said first mentioned radial bore with its outer end connecting with the interior of said shell above said sump and with its inner end adjacent to the axis of said crankshaft, the improvement comprising:

the provision of passage means including constriction means providing substantially more resistance to flow therethrough than through said central and said first mentioned radial bores connecting said inner end of said second radial bore to the top of said central bore.

2. The invention claimed in claim **1** in which:

said constriction means comprises an orifice on the axis of said crankshaft below said inner end of said second radial bore.

3. The invention claimed in claim **2** in which said crankshaft has a counterweight thereon, and in which:

said second radial bore extends through said counterweight.

4. The invention claimed in claim **1** in which said crankshaft has a counterweight thereon, and in which:

said second radial bore extends through said counterweight.

5. The invention claimed in claim **4** in which: there is provided a transverse bore extending through said crankshaft, connected to the top of said off-center bore, and crossing said axis, and

there is provided a longitudinal passage at the surface of said crankshaft connected to said transverse bore, and having an open end at the top of said crankshaft.

6. The invention claimed in claim **3** in which:

there is provided a transverse bore extending through said crankshaft, connected to the top of said off-center bore, and crossing said axis, and

there is provided a longitudinal passage at the surface of said crankshaft connected to said trans-verse bore, and having an open end at the top of said crankshaft.

7. The invention claimed in claim **2** in which:

there is provided a transverse bore extending through said crankshaft, connected to the top of said off-center bore, and crossing said axis, and

there is provided a longitudinal passage at the surface of said crankshaft connected to said transverse bore, and having an open end at the top of said crankshaft.

8. The invention claimed in claim **1** in which:

there is provided a transverse bore extending through said crankshaft, connected to the top of said off-center bore, and crossing said axis, and

there is provided a longitudinal passage at the surface of said crankshaft connected to said transverse bore, and having an open end at the top of said crankshaft.

9. The invention claimed in claim **8** in which said compressor has the rotor of an electric motor on the upper portion of said crankshaft, and in which:

there is provided a keyway in said crankshaft and said rotor opposite said off-center bore,

there is provided a hollow key in said keyway, and in which:

said longitudinal passage comprises a portion of said keyway below said key and the opening within said key.

10. The invention claimed in claim **7** in which said compressor has the rotor of an electric motor on the upper portion of said crankshaft, and in which:

there is provided a keyway in said crankshaft and said rotor opposite said off-center bore,

there is provided a hollow key in said keyway, and in which:

said longitudinal passage comprises a portion of said keyway below said key and the opening within said key.

11. The invention claimed in claim **6** in which said compressor has the rotor of an electric motor on the upper portion of said crankshaft, and in which:

there is provided a keyway in said crankshaft and said rotor opposite said off-center bore,

there is provided a hollow key in said keyway, and in which:

said longitudinal passage comprises a portion of said keyway below said key and the opening within said key.

12. The invention claimed in claim **5** in which said compressor has the rotor of an electric motor on the upper portion of said crankshaft, and in which:

there is provided a keyway in said crankshaft and said rotor opposite said off-center bore,

there is provided a hollow key in said keyway, and in which:

said longitudinal passage comprises a portion of said keyway below said key, and the opening within said key.

13. In a refrigerant compressor having a shell with an oil sump in its bottom, having a crankshaft extending upwardly above said sump with its bottom within said sump, having an off-center bore, and having oil pumping means connected to said sump and to said bore, the improvement comprising:

the provision of a transverse bore within said crankshaft connected to the top of said bore and crossing the axis of said crankshaft, and

the provision of means forming a longitudinal passage at the surface of said crankshaft opposite said off-center bore, connected to said transverse bore, and having an open end at the top of said crankshaft.

14. The invention claimed in claim **13** in which said compressor has the rotor of an electric motor on the upper portion of said crankshaft, and in which:

said longitudinal passage comprises a keyway in said crankshaft and said rotor, and a hollow key within said keyway.

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