Feb. 22, 1966 J. C. ROACH 3,236,062

REFRIGERANT COMPRESSOR WITH LUBRICANT COOLING

Filed July 31, 1964

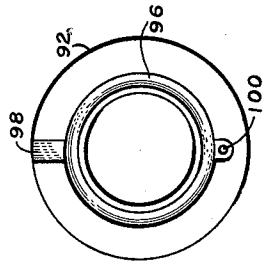


FIG. 3

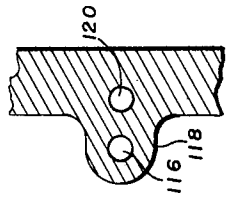


FIG. 2

FIG. 1

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United States Patent Office 3,236,062 Patented Feb. 22, 1966

3,236,062

REFRIGERANT COMPRESSOR WITH LUBRICANT COOLING

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Filed July 31, 1964, Ser. No. 386,717
15 Claims. (Cl. 62—468)

This invention relates to refrigeration apparatus and more particularly this invention relates to refrigeration systems employing a refrigerant compressor, a refrigerant condenser, a refrigerant throttling means and a refrigerant evaporator respectively serially connected in a closed refrigerant circuit wherein said compressor is of the open or non-hermetic type.

In refrigeration systems employing an open or non-hermetic compressor, a seal is required at the power input shaft of the compressor to prevent leakage of the lubricating oil and refrigerant to the atmosphere and to prevent air leakage into the refrigerant system. Since the power input shaft rotates, the seal necessarily includes a pair of sliding surfaces. Such surfaces are accurately machined and generally include a highly polished finish whereby leakage of liquid and gaseous fluids is mitigated. Notwithstanding the polished condition of the sliding surfaces of the seal, considerable heat is generated by friction. This is especially true of compressors operated at speeds of about 3600 r.p.m. The heat generated by sliding friction at the seal surface is deleterious to the flexible elements of the seal generally constructed of neoprene or other organic material which ages or prematurely hardens at elevated temperatures. The resulting lack of resilience in these seal elements results in premature failure of the seal. It is therefore common practice to cool the seal elements to enhance seal life.

The instant invention involves a specific system of refrigerating a refrigerant compressor seal by the refrigerant system.

It is therefore a prime object to provide a specific means for refrigerating the shaft seal of a refrigerant compressor by the refrigerant system in which the compressor is incorporated.

Another object of my invention is to provide means for refrigerating a refrigerant compressor shaft seal by circulating compressor lubricating oil in heat exchange relation therewith which has previously been refrigerated by the refrigeration system.

Another object of the instant invention is to provide in a refrigerant system employing a compressor, means for refrigerating both the compression cylinder and the shaft seal thereof by the suction chamber.

A further object of the invention is to provide in a refrigeration system, an open reciprocal compressor employing a shaft seal and means for refrigerating said seal and the crankshaft thereof by sequentially passing lubricating oil through the crankshaft, refrigerating a portion of that oil by heat exchange with the suction chamber, and heat exchanging the refrigerated oil with the shaft seal.

Still another object of this invention is to provide a refrigeration system employing an open compressor with a more compact, more efficient and lower cost cooling means for the shaft seal thereof.

Other objects and advantages will become apparent as this specification proceeds to describe the invention with reference to the accomapnying drawing in which:

FIGURE 1 is a semischematic view of my novel refrigeration system with the compressor thereof shown in cross section;

FIGURE 2 is an enlarged detailed section taken at 2—2 of FIGURE 1; and

FIGURE 3 is an enlarged detailed view of the seal seat taken at 3—3 of FIGURE 1.

Now referring to the drawings, refrigeration system 10 includes a refrigerant compressor 12, a refrigerant condenser 14, a refrigerant throttling means such as a variable orifice expansion valve 16 and a refrigerant condenser 18 respectively serially connected in a closed refrigerant circuit 20 by connecting conduit means.

Refrigerant compressor 12 includes a housing 22 and a partition 24 dividing the housing into a crankcase chamber 26 and a suction chamber 28. A refrigerant gas compression cylinder 30 disposed within housing 22 extends through the suction chamber. Cylinder 30 may be constructed integrally with housing 22, however it is preferably constructed as a separate sleeve insert as shown. The number of cylinders employed is not material to the invention and for that reason only one cylinder of a multicylinder compressor is illustrated.

A fluid passage 32 communicates between suction chamber 28 and the interior of cylinder 30. Interposed in passage 32 is an annular suction valve 34 biased to the closed position by a plurality of coil springs 36 circumferentially spaced about cylinder 30. Another fluid passage 38 communicates between the interior of cylinder 30 and the compressor discharge outlet 40 to condenser 14. Disposed in passage 38 is annular discharge valve 42 biased to the closed position by a plurality of circumferentially spaced coil springs 44. Evaporator 18 communicates with the suction chamber at compressor suction inlet 46. Disposed within cylinder 30 is piston 48 arranged for reciprocal movement.

An elongated crankshaft 50 in crankcase chamber 26 is mounted for rotation about a horizontal axis by bearings 52 and 54. A crank portion of crankshaft 50 intermediate bearings 52 and 54 is journaled to connecting rod 56 pivotally connected to piston 48. One end 58 of crankshaft 50 extends outward through an annular boss 60 extending outward of housing 22 and radially spaced from crankshaft end portion 58 defining an annular space 62 or seal chamber therebetween. Crankshaft end portion 58 is drivingly coupled at 64 to a suitable drive motor 66. The other end of crankshaft 50 is drivingly coupled at 68 to an oil pump 70. Oil pump 70 is provided with an oil passage 72 for receiving oil from oil sump 74 disposed within the reservoir of oil in the lower portion of crankcase chamber 26. A crankshaft seal means 76 is provided at crankshaft end 58 to prevent oil and refrigerant from passing through annular space 62 to the atmosphere and to exclude air from the refrigerant system.

Sealing means 76 is comprised of an annular seal seat 78 fixed to annular boss 60 and a resilient annular seal 80 mounted for rotation with crankshaft end portion 58 for sliding engagement with seal seat 78.

Annular seal 80 is comprised of an annular friction ring 82 preferably composed of carbon and arranged to abut seat 78, a flexible annular connector 84 composed of neoprene or like material for sealingly connecting carbon friction ring 82 to crankshaft end portion 58, a coil spring 86 circumscribing crankshaft portion 58 arranged to bias carbon friction ring 82 in slidable sealing relation with seal seat 78 and appropriate spring retainer members 88 and 90 for spring 86.

Seal seat 78 is comprised of a grooved annular plate 92 and an annular closure plate 94 which is sealingly connected to boss 60. One side of plate 92 presents the surface upon which slides carbon ring 82. The opposite side of plate 92 is provided with an annular groove 96 disposed radially co-extensive with carbon ring 82 for conducting cooling oil. With this arrangement most of the heat which is generated at the sliding surface of the seal is conducted to the cooling oil in groove 96 and very lit-

tle is transmitted through the carbon ring 82 to resilient neoprene member 84. Cooling oil enters groove 96 via inlet 98 and exits at aperture 100 into the annular space 62 from whence it is discharged into crankcase chamber 26 via passage 102. The open face of groove 96 is closed by furnace brazing or otherwise bonding the grooved side of annular plate 92 to closure plate 94.

Lubricating oil discharged from oil pump 70 is conducted via passage 104 to bearing 52 and annular oil groove 106 adjacent thereto in crankshaft 50. Oil which is collected in groove 106 is transmitted to a second annular groove 108 in crankshaft 50 adjacent bearing 54 via a pair of communicating bores 110 which may be approximately closed by plugs at 112. An oil pressure relief valve 114 permits a large portion of the oil reaching groove 108 to return directly to the oil reservoir in the lower portion of crankcase chamber 26. A portion of the oil delivered to groove 108 is conducted through a first bore 116 within an elongated boss 118 of the wall of the suction chamber 28, through a second bore 120 also within and in parallel relation to the wall of the suction chamber, and through a passage 122 in annular boss 60 to inlet 98 of seal seat 78. It will be seen that bores 116 and 120 may comprise two small parallel drill holes joined by a larger bore which may be provided with a plug 124 at one end. Oil passing through the passage formed by bores 116 and 120 is refrigerated by heat exchange with suction chamber 28. The refrigerated oil is then conducted sequentially through the seal seat and the annular space encompassing seal 80 as aforedescribed.

In operating the refrigeration system herein disclosed, motor 66 drives crankshaft 50 causing piston 48 to draw refrigerant gas from the suction chamber 28 and deliver it at a higher pressure to condenser 14 where heat of vaporization is removed. The resulting liquid refrigerant is throttled to a lower pressure by throttling means 16 whence it passes to the evaporator 18 and suction chamber 28 where it is vaporized by absorbing heat.

Heat is absorbed by the suction chamber from cylinder 48 and from the oil passing through bores 118 and 120. The refrigerated oil cools the crankshaft seal 98 as aforementioned. The cooling effect remaining in this oil is utilized by admixture of the oil from seal 76 with the oil in the crankcase which in turn is circulated by pump 70 through the crankshaft to cool the same. It will be noted that this scheme of cooling the compressor shaft seal by the refrigeration system does not require external oil lines or that the suction chamber extend to the oil seal which necessarily requires added space at or about the seal chamber.

Although I have shown and described a specific embodiment of this invention, it is to be understood that various modifications may be made without departing from the spirit and scope of the invention and therefore I desire to be limited only by the claims.

I claim:

1. A refrigeration system comprising: a refrigerant compressor; a refrigerant condenser; a refrigerant throttling means and a refrigerant evaporator respectively serially connected in a closed refrigerant circuit; said compressor including a housing; a refrigerant gas compression cylinder disposed within said housing; a piston mounted for reciprocal movement within said cylinder; a partition dividing said housing into a suction chamber and a crankcase chamber; said suction chamber being in fluid communication with said evaporator for receiving cool refrigerant gas therefrom; means for providing fluid communication between said suction chamber and the interior of said compression cylinder and between the interior of said compression cylinder and said condenser; an elongated crankshaft disposed in said crankcase having one end thereof extending outward of said housing and adapted to be rotatably driven; crankshaft sealing means disposed adjacent said extending end of said crankshaft; a connecting rod connected to said piston and said crankshaft; means for pumping oil from the lower portion of said crankcase for lubricating said compressor; and means forming a conduit in fluid communication with said pumping means for sequentially conducting oil first in heat exchange relation with a wall of said suction chamber and secondly in heat exchange relation with said sealing means whereby said sealing means is cooled by said refrigeration system.

2. The apparatus as defined in claim 1 wherein the last mentioned means includes a passage extending within and generally parallel to a wall of said suction chamber.

3. A refrigeration system comprising: a refrigerant compressor; a refrigerant condenser; a refrigerant throttling means and a refrigerant evaporator respectively serially connected in a closed refrigerant circuit; said compressor including a housing; a refrigerant gas compression cylinder disposed within said housing; a piston mounted reciprocal movement within said cylinder; a partition dividing said housing into a suction chamber and a crankcase chamber; said suction chamber being in fluid communication with said evaporator for receiving cool refrigerant gas therefrom; means for providing fluid communication between said suction chamber and the interior of said compression cylinder and between the interior of said compression cylinder and said condenser; an elongated crankshaft disposed in said crankcase having one end thereof extending outward of said housing and adapted to be rotatably driven; crankshaft sealing means disposed adjacent said extending end of said crankshaft; an oil pump drivingly connected to said crankshaft at the end remote from said extending end; a connecting rod connected to said piston and journaled on said crankshaft intermediate the pump driving end and said extending end; an oil passage extending in said crankshaft from said pump through the connecting rod journal to a zone adjacent said extending end whereby said connecting rod journal is cooled by oil passing therethrough; means for conducting at least a portion of the oil delivered to said zone through a conduit extending in heat exchange relation with a portion of said closed refrigerant circuit between said refrigerant throttling means and said compression cylinder whereby the oil is cooled by the refrigerant system; and means for conducting the cooled oil from said conduit in heat exchange relation with said sealing means whereby said sealing means is cooled.

4. A refrigeration system comprising: a refrigerant compressor; a refrigerant condenser; a refrigerant throttling means and a refrigerant evaporator respectively serially connected in a closed refrigerant circuit; said compressor including a housing; a refrigerant gas compression cylinder disposed within said housing; a piston mounted for reciprocal movement within said cylinder; a partition dividing said housing into a suction chamber and a crankcase chamber; said suction chamber being in fluid communication with said evaporator for receiving cool refrigerant gas therefrom; means for providing fluid communication between said suction chamber and the interior of said compression cylinder and between the interior of said compression cylinder and said condenser; an elongated crankshaft disposed in said crankcase having one end thereof extending outward of said housing and adapted to be rotatably driven; crankshaft sealing means disposed adjacent said extending end of said crankshaft; an oil pump drivingly connected to said crankshaft at the end remote from said extending end; a connecting rod connected to said piston and journaled on said crankshaft intermediate the pump driving end and said extending end; an oil passage extending in said crankshaft from said pump through the connecting rod journal to a zone adjacent said extending end whereby said connecting rod journal is cooled by oil passing therethrough; means for conducting at least a portion of the oil delivered to said zone through a conduit extending in heat exchange relation with said suction chamber whereby the oil is cooled by the refrigerant system; and means for conducting the

cooled oil from said conduit in heat exchange relation with said sealing means whereby said sealing means is cooled.

5. A refrigeration system comprising: a refrigerant compressor; a refrigerant condenser; a refrigerant throttling means and a refrigerant evaporator respectively serially connected in a closed refrigerant circuit; said compressor including a housing; a partition dividing said housing into a suction chamber and a crankcase chamber; said suction chamber being in fluid communication with said evaporator for receiving cool refrigerant gas therefrom; a refrigerant gas compression cylinder disposed within said housing and extending into said suction chamber for cooling thereby; a piston mounted for reciprocal movement within said cylinder; means for providing fluid communication between said suction chamber and the interior of said compression cylinder and between the interior of said compression cylinder and said condenser; an elongated crankshaft disposed in said crankcase chamber having one end thereof extending outward of said housing and adapted to be rotatably driven; crankshaft sealing means disposed adjacent said extending end of said crankshaft; a connecting rod connected to said piston and said crankshaft; means for pumping oil from the lower portion of said crankcase for lubricating said compressor; a fluid passage disposed entirely within said housing extending from said pumping means to a zone in heat exchange relation with said suction chamber and thence to a zone in heat exchange relation with said sealing means whereby the suction gas in said suction chamber cools both said compression cylinder and said crankshaft sealing means.

6. A refrigeration system comprising: a refrigerant compressor; a refrigerant condenser; a refrigerant throttling means and a refrigerant evaporator respectively serially connected in a closed refrigerant circuit; said compressor including a housing; a refrigerant gas compression cylinder disposed within said housing; a piston mounted for reciprocal movement within said cylinder; a partition dividing said housing into a suction chamber and a crankcase chamber; said suction chamber being in fluid communication with said evaporator for receiving cool refrigerant gas therefrom; means for providing fluid communication between said suction chamber and the interior of said compression cylinder and between the interior of said compression cylinder and said condenser; means forming a seal chamber associated with said crankcase chamber; an elongated crankshaft disposed in said crankcase chamber having one end thereof extending outward of said housing through said seal chamber and adapted to be rotatably driven; crankshaft sealing means disposed in said seal chamber adjacent said extending end of said crankshaft; a connecting rod connected to said piston and said crankshaft; means for pumping oil from the lower portion of said crankcase chamber for lubricating said compressor; a first fluid passage disposed entirely within said housing extending from said pumping means in heat exchange relation with said suction chamber whereby oil passing therein is cooled; and a second fluid passage extending from said first fluid passage through said means forming said seal chamber to said seal chamber whereby said seal is lubricated and cooled.

7. A refrigeration system comprising: a refrigerant compressor; a refrigerant condenser; a refrigerant throttling means and a refrigerant evaporator respectively serially connected in a closed refrigerant circuit; said compressor including a housing having a partition dividing the interior thereof into a suction chamber and a crankcase chamber, means connecting the outlet of said evaporator in fluid communication with said suction chamber, a compression cylinder disposed within said housing, piston means in said cylinder, means connecting the interior of said compression cylinder in fluid communication with said suction chamber and said condenser, a crankshaft rotatably mounted in said crankcase chamber having an end thereof extending outward of said housing adapted to be rotatably driven, connecting rod means for connecting said piston means to said crankshaft, oil pump means for lubricating said compressor, said housing including an annular portion extending outward of said crankcase chamber in radially spaced circumscribing relation with said one end of said crankshaft defining an annular space between said annular portion and said crankshaft, an annular seal seat circumscribing said crankshaft rigidly mounted at the end of said annular space remote from said crankcase chamber and having a sealing surface on the side adjacent said crankcase chamber, an annular seal disposed within said annular space on the crank case chamber side of said seal seat and mounted for rotation with said crankshaft and resiliently biased toward said seal seat for sliding engagement therewith, and seal seat cooling means comprising a first fluid passage within said oil seal seat circumferentially arranged about said shaft and having an inlet and an outlet, said outlet communicating with said annular space, a second fluid passage connecting said oil pump means to said inlet, and a third fluid passage connecting said annular space to said crankcase chamber, said second fluid passage extending within and in substantially parallel relation to a wall of said suction chamber whereby oil which is precooled by said suction chamber cools said seal seat prior to entry into said annular chamber.

8. A refrigeration system comprising: a refrigerant compressor, a refrigerant condenser, a refrigerant throttling means and a refrigerant evaporator respectively connected in a closed refrigerant circuit, said compressor including a housing defining a suction chamber, a shaft disposed in said housing having one end extending outwardly of said housing and adapted to be rotatably driven, bearing means for rotatably mounting said shaft, seal means for said shaft disposed where said shaft emerges from said housing, an oil reservoir in said housing, an oil pump means in said housing drivingly connected to said shaft for pumping oil from said oil reservoir, fluid passage means connecting said pump means with said seal means, said fluid passage means including a heat exchange portion disposed in heat exchange relation with said suction chamber, an oil pressure relief valve connected to said passage between said pump means and said heat exchange portion, and means for connecting said bearing means to said fluid passage between said pump means and said relief valve.

9. In a refrigeration system, a refrigerant compressor including a housing; a refrigerant gas compression cylinder disposed within said housing; a piston mounted for reciprocal movement within said cylinder; a partition dividing said housing into a suction chamber and a crankcase chamber; said suction chamber being adapted to receive cool refrigerant gas from a refrigerant evaporator; means for providing fluid communication between said suction chamber and the interior of said compression case having one end thereof extending outward of said cylinder; an elongated crankshaft disposed in said crankhousing and adapted to be rotatably driven; crankshaft sealing means disposed adjacent said extending end of said crankshaft; a connecting rod connected to said piston and said crankshaft; means for pumping oil from the lower portion of said crankcase for lubricating said compressor; and means forming a conduit in fluid communication with said pumping means for sequentially conducting oil first in heat exchange relation with a wall of said suction chamber and secondly in heat exchange relation with said sealing means whereby said sealing means is cooled by said refrigeration system.

10. The apparatus as defined by claim 1 wherein the last mentioned means includes a passage extending within and generally parallel to a wall of said suction chamber.

11. In a refrigeration system, a refrigerant compressor including a housing; a refrigerant gas compression

cylinder disposed within said housing; a piston mounted for reciprocal movement within said cylinder; a partition dividing said housing into a suction chamber and a crankcase chamber; said suction chamber being adapted to receive cool refrigerant gas from a refrigerant evaporator; means for providing fluid communication between said suction chamber and the interior of said compression cylinder; an elongated crankshaft disposed in said crankcase having one end thereof extending outward of said housing and adapted to be rotatably driven; crankshaft sealing means disposed adjacent said extending end of said crankshaft; an oil pump drivingly connected to said crankshaft at the end remote from said extending end; a connecting rod connected to said piston and journaled on said crankshaft intermediate the pump driving end and said extending end; an oil passage extending in said crankshaft from said pump through the connecting rod journal to a zone adjacent said extending end whereby said connecting rod journal is cooled by oil passing therethrough; means for conducting at least a portion of the oil delivered to said zone through a conduit extending in heat exchange relation with said suction chamber whereby the oil is cooled by the cool refrigerant within said suction chamber and means for conducting the cooled oil from said conduit in heat exchange relation with said sealing means whereby said sealing means is cooled.

12. In a refrigeration system, a refrigerant compressor including a housing; a partition dividing said housing into a suction chamber and a crankcase chamber; said suction chamber being adapted to receive cool refrigerant gas from a refrigerant evaporator; a refrigerant gas compression cylinder disposed within said housing and extending into said suction chamber for cooling thereby; a piston mounted for reciprocal movement within said cylinder; means for providing fluid communication between said suction chamber and the interior of said compression cylinder; an elongated crankshaft disposed in said crankcase chamber having one end thereof extending outward of said housing and adapted to be rotatably driven; crankshaft sealing means disposed adjacent said extending end of said crankshaft; a connecting rod connected to said piston and said crankshaft; means for pumping oil from the lower portion of said crankcase for lubricating said compressor; a fluid passage disposed entirely within said housing extending from said pumping means to a zone in heat exchange relation with said suction chamber and thence to a zone in heat exchange relation with said sealing means whereby the suction gas in said suction chamber cools both said compression cylinder and said crankshaft sealing means.

13. In a refrigeration system, a refrigerant compressor including a housing; a refrigerant gas compression cylinder disposed within said housing; a piston mounted for reciprocal movement within said cylinder; a partition dividing said housing into a suction chamber and a crankcase chamber; said suction chamber being adapted to receive cool refrigerant gas from a refrigerant evaporator; means for providing fluid communication between said suction chamber and the interior of said compression cylinder; means forming a seal chamber associated with said crankcase chamber; an elongated crankshaft disposed in said crankcase chamber having one end thereof extending outward of said housing through said seal chamber and adapted to be rotatably driven; crankshaft sealing means disposed in said seal chamber adjacent said extending end of said crankshaft; a connecting rod connected to said piston and said crankshaft; means for pumping oil from the lower portion of said crankcase chamber for lubricating said compressor; a first fluid passage disposed entirely within said housing extending from said pumping means in heat exchange relation with said suction chamber whereby oil passing therein is cooled; and a second fluid passage extending from said first fluid passage through said means forming said seal chamber to said seal chamber whereby said seal is lubricated and cooled.

14. In a refrigeration system, a refrigerant compressor including a housing having a partition dividing the interior thereof into a suction chamber and a crankcase chamber, said suction chamber being adapted to receive cool refrigerant gas from a refrigerant evaporator, a compression cylinder disposed within said housing, piston means in said cylinder, means connecting the interior of said compression cylinder in fluid communication with said suction chamber, a crankshaft rotatably mounted in said crankcase chamber having an end thereof extending outward of said housing adapted to be rotatably driven, connecting rod means for connecting said piston means to said crankshaft, oil pump means for lubricating said compressor, said housing including an annular portion extending outward of said crankcase chamber in radially spaced circumscribing relation with said one end of said crankshaft defining an annular space between said annular portion and said crankshaft, an annular seal seat circumscribing said crankshaft rigidly mounted at the end of said annular space remote from said crankcase chamber and having a sealing surface on the side adjacent said crankcase chamber, an annular seal disposed within said annular space on the crankcase chamber side of said seal seat mounted for rotation with said crankshaft and resiliently biased toward said seal seat for sliding engagement therewith, and seal seat cooling means comprising a first fluid passage within said seal seat circumferentially arranged about said shaft and having an inlet and an outlet, said outlet communicating with said annular space, a second fluid passage connecting said oil pump means to said inlet, and a third fluid passage connecting said annular space to said crankcase chamber, said second fluid passage extending within and in substantially parallel relation to a wall of said suction chamber whereby oil which is precooled by said suction chamber cools said seal seat prior to entry into said annular chamber.

15. In a refrigeration system, a refrigerant compressor including a housing defining a suction chamber, a shaft disposed in said housing having one end extending outwardly of said housing and adapted to be rotatably driven, bearing means for rotatably mounting said shaft, seal means for said shaft where it emerges from said housing, an oil reservoir in said housing, an oil pump means in said housing drivingly connected to said shaft for pumping oil from said oil reservoir, fluid passage means connecting said pump means with said seal means, said fluid passage means including a heat exchange portion disposed in heat exchange relation with said suction chamber, an oil pressure relief valve connected to said passage between said pump means and said heat exchange portion, and means for connecting said bearing means to said fluid passage between said pump means and said relief valve.

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