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CENTRIFUGAL COMPRESSOR LUBRICATING AND MOTOR COOLING SYSTEMS

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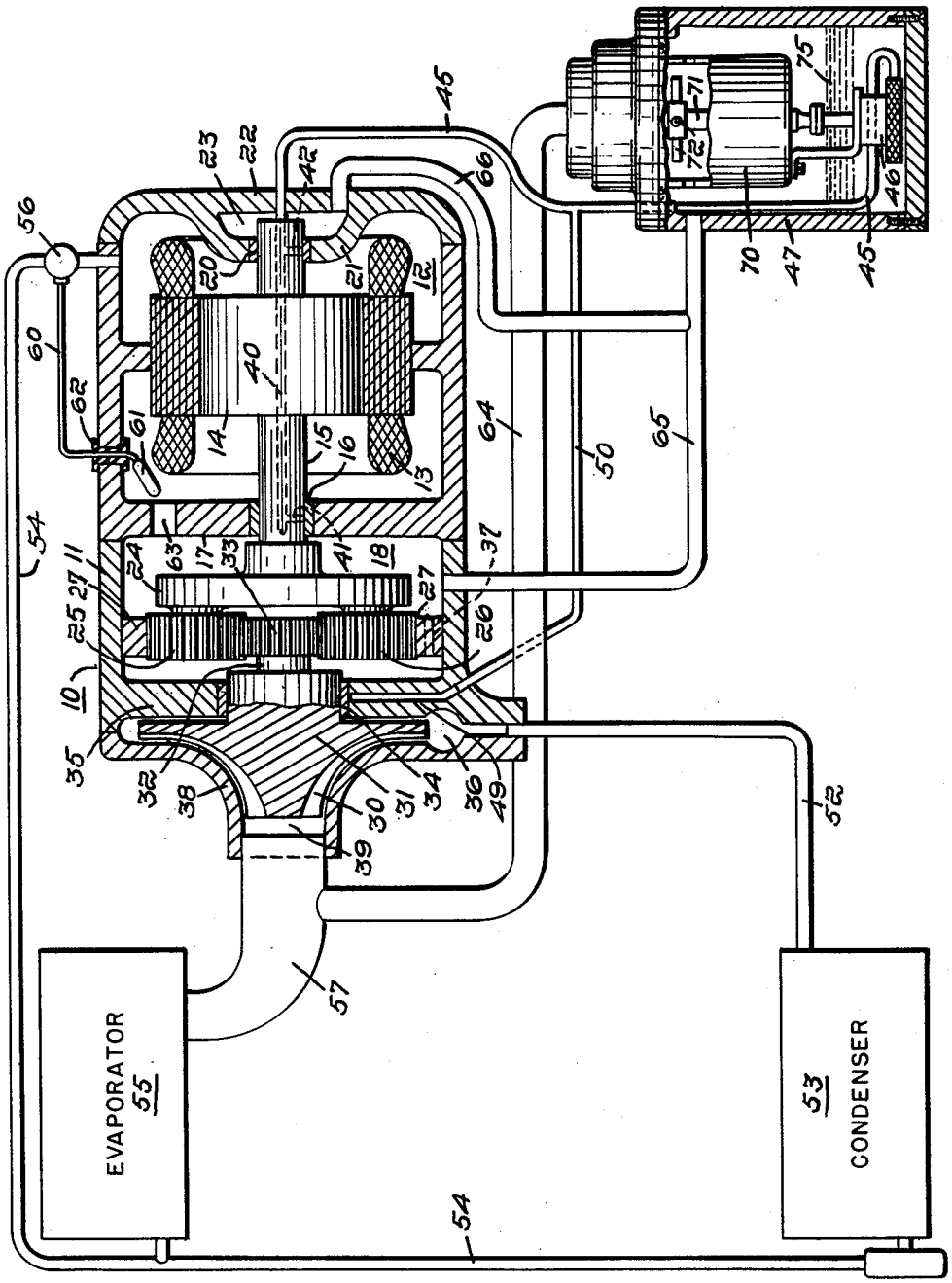

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CENTRIFUGAL COMPRESSOR LUBRICATING AND MOTOR COOLING SYSTEMS

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This invention relates to lubricating and motor cooling systems for centrifufial refrigerant compressors, and relates particularly to such systems for hermetically sealed, centrifugal refrigerant compressors.

In refrigerant compressors, the refrigerants and the lubricating oils are mixed as they pass through the compressors, and need to be separated before the refrigerants pass into the associated systems. In piston-type compressors having crankcases, such separation can take place within the compressors. Such separation cannot take place in large centrifugal compressors because of their shapes, the lack of internal space, and the large quantities of refrigerant handled. The rotors of centrifugal compressors usually have their speeds stepped up by gear boxes, and the refrigerant leaking into such a gear box needs to be separated from the oil therein.

A feature of this invention is that it removes mixed oil and refrigerant from a hermetic centrifugal refrigerant compressor driven by an enclosed electric motor, separates the oil from the refrigerant in an external separator, pumps the oil separated from the refrigerant with an external pump to the bearings of the motor and compressor, and supplies the separated refrigerant into the inlet of the compressor.

Another feature of this invention is that it cools the motor of the compressor with refrigerant which is expanded over the motor and then is supplied into the gear box for cooling the gears in the latter.

Another feature of this invention is that it cools the motor shaft by providing a passage therein through which the oil for the bearings of the shaft passes.

An object of this invention is to improve oil-refrigerant separation systems of centrifugal refrigerant compressors.

Another object of this invention is to improve the cooling of the drives, including gears, of centrifugal refrigerant compressors.

This invention will now be described with reference to the annexed drawing which shows a hermetic, centrifugal refrigerant compressor embodying this invention in section; shows diagrammatically the refrigeration circuit in which the compressor is connected, and shows the oil and refrigerant separation system embodying this invention.

A hermetic refrigerant compressor 10 has a casing 11 having at one end a motor compartment 12 containing an electric motor 13 having a rotor 14 on a rotary shaft 15. The shaft 15 is supported in a bearing 16 in a partition 17 which separates the motor compartment 12 from a gear compartment 18, and in a bearing 20 in an inner casing wall 21 spaced from an outer end casing wall 22. A chamber 23 is formed between the walls 21 and 22. The outer end of the shaft 15 terminates short of the wall 22.

The inner end of the shaft 15 is attached to a planetary gear rotor 24 which has spaced-apart gears 25 and 26 rotatably attached thereto, and which mesh with a ring

gear 27 which extends around the gears 25 and 26 and is secured to the inner surface of the casing 11. A centrifugal compressor rotor 30 has a hub 31 attached to shaft 32 of gear 33 which is between and meshed with the gears 25 and 26. The hub 31 is supported in a bearing 34 in a partition 35 which separates scroll-shaped outlet passage 36 of the rotor 30 from the gear compartment 18. End wall 38 of the casing 11 is opposite the end wall 22, and is shaped to form an axial passage 39 to the rotor 30 and to form with the partition 35 the casing walls of the compressor.

The shaft 15 has a central passage 40 which connects through radial passages 41 and 42 with the bearings 16 and 20 respectively. The passage 40 is connected at the outer end of the shaft 15 by tube 45 to the outlet of oil pump 46 in sump 75 of external refrigerant-oil separator 47. The partition 35 has a passage 49 therein which connects with the bearing 34 at its inner end, and which extends through the casing 11 and is connected at its outer end by a tube 50 to the tube 45.

The outlet of the passage 36 is connected by a tube 52 to the inlet of condenser 53, the outlet of which is connected by tube 54 to the inlet of evaporator 55, and through an expansion valve 56 to the interior of the motor compartment 12 near its outer end. The outlet of the evaporator 55 is connected by a tube 57 to the inlet passage 39 of the compressor rotor 30. The evaporator 55 would contain the usual expansion means which is not shown. The expansion valve 56 is connected by a tube 60 which extends through a seal 62 in an opening in the upper wall of the casing 11, to a thermostatic bulb 61 within the motor compartment 12 near its inner end.

The separated gas outlet of the separator 47 is connected by a tube 64 to the tube 57. The interior of the separator 47 is connected by a tube 65 to the interior the the gear compartment 18 through an opening in the lower wall of the casing 11 at the bottom of the compartment 18. The bottom of the chamber 23 is connected by a tube 66 to the tube 65. The partition has a passage 37 in its lower portion for facilitating the flow of oil from the left side of the compartment 18 into the tube 65.

The partition 17 has an opening 63 in its upper portion for passing expanded refrigerant from the motor compartment 12 into the gear compartment 18 for cooling the latter. The pressure within the compartment 12 is higher than in the compartment 18 so that oil cannot flow through the opening 63 from the compartment 18 into the compartment 12.

The refrigerant-oil separator 47 is disclosed in detail in the copending application of John L. Ditzler, Serial No. 196,820, filed May 22, 1962. It consists generally of an electric motor 70 which has a shaft 71, the lower end of which drives the pump 46, and which has on its upper end, radially extending tubes 72 connected to a central passage which is not shown, in the shaft 71, and which opens into a chamber which is not shown, connecting with the gas outlet tube 64. During the rotation of the tubes 72 by the motor shaft 31, refrigerant gas is drawn into them by the difference in pressure within the separator 47 and at the compressor inlet passage 39 to which the tube 64 is connected. The oil due to its mass and centrifugal force is prevented from entering the tubes 72, and falls by gravity into the sump in which the pump 46 is located.

Operation

In operation, the motor 13 rotates through the gears in the gear compartment 18, the rotor 30 of the compressor at a speed higher than that of the rotor 14 of the motor 13. The compressor rotor 30 compresses refrigerant gas drawn from the evaporator 55, and supplies the compressed gas to the condenser 53 from which liquid refrigerant is supplied to the evaporator 55, and through the expansion valve 56 into the motor compartment 12. The thermostatic bulb 61 adjusts the valve 56 to maintain the desired temperature within the motor compartment. The expanded refrigerant passes from the motor compartment 12 through the opening 63 in the partition 17 into the gear compartment 18 for cooling the gears in the latter.

The pump 46 pumps oil from the sump 75 in the separator 47 through the tube 45 and the passages 40, 41 and 42 in the shaft 15 to the bearings 16 and 20, and pumps oil through the tube 50 and the passage 49 to the bearing 34. The oil pumped through the passages in the shaft 15 cool it and its bearings, and thus aid in cooling the motor 13.

Oil mixed with refrigerant leaks through the bearing 20 into the chamber 23 and drains by gravity through the tube 66 to the separator 47. Oil flows through the bearings 16 and 34 into the gear compartment 18, and such oil mixed with the refrigerant supplied into the gear compartment from the motor compartment, drains by gravity through the tube 65 into the separator 47. The refrigerant that is separated from the oil in the separator 47 passes through the tube 64 into the inlet passage 39 of the compressor.

What we claim is:

1. A hermetic, centrifugal, refrigerant compressor comprising a casing, a motor compartment in one end of said casing, an electric motor having a rotor in said compartment, a compressor compartment in the opposite end of said casing, said compressor compartment having a gas inlet and a gas outlet, a centrifugal rotor in said compressor compartment, a gear compartment in said casing between said motor and compressor compartments, meshed gears in said gear compartment, said casing having a first partition between said compressor and gear compartments and having a second partition between said gear and motor compartments, bearings in said partitions, drive means extending from said centrifugal rotor through said bearing in said first partition and connected to one of said gears, said motor rotor having a shaft extending through said bearing in said second partition and connected to another one of said gears, said casing having a connection for supplying refrigerant from an external condenser into said motor compartment, said second partition having an opening for passing refrigerant from said motor compartment into said gear compartment, said casing having oil inlet means for receiving oil from external said casing, and means forming passages connecting said oil inlet means to said bearings, said casing having an outlet at the bottom of said gear compartment for draining mixed oil and refrigerant from said gear compartment.

2. A hermetic, centrifugal, refrigerant compressor comprising a casing, a motor compartment in one end of said casing, said casing having inner and outer walls at said end forming therebetween a chamber, an electric motor having a rotor in said compartment, a compressor compartment in the opposite end of said casing, said compressor compartment having a gas inlet and a gas outlet, a centrifugal rotor in said compressor compartment, a gear compartment in said casing between said motor and compressor compartments, meshed gears in said gear compartment, said casing having a first partition between said compressor and gear compartments and having a second partition between said gear and motor compartments, bearings in said partitions and said inner wall, drive means extending from said centrifugal rotor through said bearing in said first partition and connected to one of said gears, said motor rotor having a shaft extending through said bearings in said second partition and said inner wall and connected to another one of said gears, said casing having a connection for supplying refrigerant from an external condenser into said motor compartment, said second partition having an opening for passing refrigerant from said motor compartment into said gear compartment, said casing having oil inlet means for receiving oil from external said casing, and means forming passages connecting said oil inlet means to said bearings, said casing having outlets at the bottoms of said gear compartments and said chamber for draining mixed oil and refrigerant therefrom.

3. A hermetic, centrifugal, refrigerant compressor comprising a casing, a motor compartment in one end of said casing, an electric motor having a rotor in said compartment, a compressor compartment in the opposite end of said casing, said compressor compartment having a gas inlet and a gas outlet, a centrifugal rotor in said compressor compartment, a gear compartment in said casing between said compressor and motor compartments, meshed gears in said gear compartment, said casing having a first partition between said compressor and gear compartments and having a second partition between said gear and motor compartments, bearings in said partitions, drive means extending from said rotor in said compressor compartment through said bearing in said first partition and connected to one of said gears, said motor rotor having a shaft extending through said bearing in said second partition and connected to another one of said gears, said casing having a connection for supplying refrigerant from an external condenser into said motor compartment, said second partition having an opening for supplying refrigerant from said motor compartment into said gear compartment, said casing having oil inlet means for receiving oil from external said casing, means forming a passage connecting said oil inlet means to said bearing in said first partition, and means including a passage within said shaft connecting said oil inlet means to said bearing in said second partition, said casing having an outlet at the bottom of said gear compartment for draining mixed oil and refrigerant from said gear compartment.

4. A hermetic, centrifugal, refrigerant compressor comprising a casing, a motor compartment in one end of said casing, said casing having inner and outer walls at said end forming therebetween a chamber, an electric motor having a rotor in said compartment, a compressor compartment in the opposite end of said casing, said compressor compartment having a gas inlet and a gas outlet, a centrifugal rotor in said compressor compartment, a gear compartment in said casing between said compressor and motor compartments, meshed gears in said gear compartment, said casing having a first partition between said compressor and gear compartments and having a second partition between said gear and motor compartments, bearings in said partitions and said inner wall, drive means extending from said centrifugal rotor through said bearing in said first partition and connected to one of said gears, said motor rotor having a shaft extending through said bearings in said second partition and said inner wall and connected to another one of said gears, said casing having a connection for supplying refrigerant from an external condenser into said motor compartment, said second partition having an opening for passing refrigerant from said motor compartment into said gear compartment, said casing having oil inlet means for receiving oil from external said casing, means forming a passage connecting said oil inlet means to said bearing in said first partition, and means including a passage within said shaft connecting said oil inlet means to said bearings in said second partition and said inner wall, said casing having outlets at the bottoms of said gear compart-

ment and said chamber for draining mixed oil and refrigerant therefrom.

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