Centrifugal Refrigeration Compressor

In a centrifugal compressor a sealed annular space is established between the backside of the impeller and the housing wall. Pump means is provided to maintain a minimum pressure in the annular space at a level above the pressure in the bearing structure mounted in the housing wall. The arrangement prevents the passage of oil from the bearing structure to the area behind the impeller when the discharge pressure falls to an abnormally low level.

3 Claims, 1 Drawing Figure
The difficulties and problems encountered when the head against which the compressor is working, as the condenser pressure in a refrigeration system drops to an abnormally low level, are well understood. In the centrifugal type compressor, the impeller shaft bearing structure, located in proximity to the impeller, is supplied with oil under pressure. A seal is provided between the bearing structure and the impeller to restrain the passage of oil discharged from the bearing to the backside of the impeller. In addition to this seal, the passage of oil in that direction from the bearing structure is restrained by the refrigerant vapor pressure existing behind the impeller during normal operation of the system. However, if the condenser pressure in a refrigeration system or the back pressure against which the compressor is operating falls to an abnormally low level, the pressure in the area immediately behind the impeller may drop to a level below the pressure in the bearing structure and oil could pass through the seal, and will be discharged through the diffuser by the impeller and accordingly enter the system to which the compressor is connected.

An example of an installation wherein the condensing pressure may drop abnormally low, is where some air conditioning load still exists in winter, when the condenser water is near freezing, such as lake or river water. Another example is during start up of equipment which has reached a high ambient temperature, while shutdown, with cold condenser water.

This invention has as an object a centrifugal refrigeration compressor embodying an arrangement to restrain the passage of oil from the area of the impeller shaft bearing structure, to the area contiguous to the rear side of the impeller regardless of the low level to which the condenser pressure may drop.

SUMMARY OF THE INVENTION

The centrifugal compressor is constructed with an annular area between the rear side of the impeller and the compressor housing wall. This area is sealed by sealing means engaging the impeller and the impeller shaft. Pump means is provided for maintaining the sealed area at a pressure slightly above the pressure in the bearing structure. The pump means is disclosed as a passage extending axially from the rear end of the impeller shaft toward the impeller end and terminating at radially extending passages communicating with sealed area. The open end of the axial passage has communication with the low-pressure side of the refrigeration system, or with the atmosphere if the compressor is used, for example, as an air compressor. Upon high speed rotation of the impeller shaft, this arrangement acts as a centrifugal pump to pressurize the sealed off annular area behind the impeller.

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a sectional view of that portion of a centrifugal compressor disclosing the impeller shaft and motion transmitting mechanism for rotating it.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The compressor structure shown in the drawing is in general of conventional arrangement. The housing is formed with spaced apart wall structures 11, 12. The wall 11 is formed with an opening of substantial diameter in which a cylindrical bearing support 13 is mounted. A bearing cap 15 is mounted in the support 13 and forms a journal bearing for the impeller shaft 17. The support 13 is formed with an inwardly extending flange 18 in which there is arranged a slip ring 19 having close running clearance with impeller shaft 17. The shaft 17 is formed with an enlargement or collar 21. Thrust bearing structure 23 is mounted in the space between the collar 21 and the flange 18. This area in which the thrust bearing 23 is mounted is supplied with oil under pressure through a passage 24. After passing through the bearing 23 it is drained through the passage 25 provided with a flow regulating orifice 26.

The impeller shaft 17 extends through the bearing structure in the wall 11 into an impeller compartment. The impeller 27 is fixedly mounted on the extending portion of the impeller shaft by means including a key 30. The rear wall of the impeller is formed with a rearwardly extending cylindrical flange 31 arranged in concentric spaced relation to the shaft 17. A seal member 32 is mounted against the bearing support 13 as by screws 33 which extend through the bearing support and are threaded into the housing 10.

The seal member 32 is formed with a labyrinth seal portion 34 engaging the impeller flange 31, and labyrinth seal portion 35 engaging the shaft 17. The sealing structure in conjunction with the shaft and rear wall of the impeller forms an annular space 36.

The opposite end of the impeller shaft 17 is journaled in a bearing 37 mounted in the wall structure 12. As shown in the drawing, the compressor housing includes an extension 38 forming a motor compartment in which an impeller driving motor is mounted. The stator windings of the motor are indicated at 39. The motor has an output shaft 40 extending through the housing wall 12 into the transmission area intermediate the walls 11, 12. A hub 41 is fixed to the motor shaft 40, as by a key 42. The hub is formed with a cylindrical portion serving as a journal for rotation in a bearing 45 mounted in the wall 12. An annular gear 46 is mounted on the outer flange portion of the hub 41 and fixed thereto as by a shrink fit. The gear 46 is arranged in mesh with a pinion gear 47 fixed to the impeller shaft 17. The gears 46, 47 serve as motion transmitting means connecting the motor shaft 40 to the impeller shaft 17 to effect rotation thereof at a speed of several thousand r.p.m. The bearings 37, 45 are supplied with oil from a pipe 48.

The motor compartment is sealed from the transmission compartment by a seal plate 49 attached to the wall 12 as by screws 50. A seal 52 is provided between the periphery of the plate 49 and the bore of an annular member 51 attached to the housing 10. The plate 49 also includes a seal 53 engaging the motor shaft 40. These seals serve to restrain the passage of oil, or oil vapor, from the transmission compartment into the motor compartment. Oil is supplied for cooling to the gears 46, 47 from a conduit 55.

To further restrain passage of oil from the transmission compartment to the motor compartment, the transmission compartment is maintained at a pressure slightly below the pressure in the motor compartment. A collar 57 is threaded upon the end of the motor shaft 40 and is formed with radially extending passages 58. The inner ends of these passages communicate with the axially extending passage 60, the opposite end of which terminates with the passages 61 extending radially from the motor shaft. These passages 61 are of greater radial length than the passages 58, and accordingly act as a centrifugal pump to effect a flow of vapor from the transmission compartment into the motor compartment, and create a pressure therein slightly above that in the transmission compartment. Accordingly oil mist entering the passage 58 with the vapor is separated by centrifugal action and prevented from entering the axial passages 61.

It will be understood that the volute 70 of the compressor is connected to the pressurized side of the system as the condenser of a refrigeration system.

In normal operation the pressure against which the compressor is operating effects pressurization of the annular space 36 to a sufficient level to prevent oil flow from the bearing area through the seal means 35 to the space 36. A drain passage 62 extends from the area between the slipring 19 and the seal 35 and communicates with the transmission compartment. Normally, the drain passage will direct any oil seeping under the slipring into the transmission compartment rather than passing through the area 36 due to the fact the area 36 is normally pressurized by the impeller at a level substantially above the pressure level in the transmission compartment. However, the pressure in the diffuser 63 can drop to that of the transmission compartment or even go below it. In that case, oil may pass through the seal 35 into the area 36 and
through the seal 34 into the diffuser 63 and be discharged into the system. This invention includes pump means operable to maintain pressure in the annular space 36 sufficiently high enough to prevent oil flow from the bearing area through the seal means 35. In the embodiment of the invention disclosed in the drawing, the pump means is incorporated in the impeller shaft 17. The shaft is formed with a passage 75 extending axially from the outboard end of the shaft journaled in bearing 37, and terminating in radially disposed passages 77 communicating with the space 36. The outer end of the shaft 17 terminates between a labyrinth seal 78 and the wall 49. The housing part 51 is formed with a passage 80 connected by a conduit 81 to the evaporator of the refrigeration system or to atmosphere in the case of an air compressor.

As previously stated, the impeller shaft is driven at several thousand r.p.m. and the passages 75, 77 act as a centrifugal pump to pressurize the space 36 with refrigerant vapor drawn from the evaporator when the condenser pressure approaches or becomes less than the pressure in the evaporator. The pressure established by the shaft pump is sufficient to prevent passage of oil from the bearing area through the seal means 35 to the space 36.

Accordingly, under normal operation when the condenser pressure is high, discharge refrigerant at high pressure passes through the seal 34 into the chamber 36 where the pressure is maintained slightly above evaporator pressure by the centrifugal pumping action of the radial passages 77 in the shaft 17, and the pressure drop through the passages 75, 80, 81. This reduces pressure between the seals 34 and 35 acting on the back of the impeller in the chamber 36 reducing the thrust loading in the bearing 23.

Occasionally in refrigeration systems operating in normal manner, oil vapor finds its way into the system and is returned by the suction gas into the compressor suction. This oil liquid, because its density is greater than that of the refrigerant vapor, passes up the hub walls of the impeller passages, and at the tips of the impeller blades some of the oil passes downwardly over the rear wall of the impeller, and finds its way past labyrinth seal 34 into the area 36. The centrifugal pumping action of the passages 77 separates the oil from refrigerant vapor and prevents oil from passing through the passages 75, 80, and 81 into the evaporator. To provide for the drainage of such oil accumulation, the sealing member 32 is provided with a small orifice 85. This orifice is dimensioned to permit the escape of such small quantities of oil from the space 36 for drainage into the transmission compartment of the housing. Accordingly, our invention prevents any substantial oil flow into the area 36 behind the impeller and therefore maintains a very low level of oil accumulation in the compression system.

We claim:
1. A hermetic centrifugal gas compressor comprising a housing having spaced apart first and second walls defining an impeller compartment and a transmission compartment, said first wall separating said impeller compartment from said transmission compartment and including a bearing structure, an impeller shaft having an end portion journaled in said bearing structure and extending into said impeller compartment, an impeller mounted on said extending portion of said shaft in said impeller compartment and being spaced axially from said first wall, the opposite end of said shaft being journaled in said second wall, sealing means carried by said first wall and having running sealing engagement with said impeller and said shaft and forming in conjunction therewith an annular space intermedate the impeller and said first wall, means for supplying lubricant under pressure to said bearing structure, pumping means operable to maintain a pressure in said annular space above the pressure in said bearing structure, and an impeller driver operatively connected to said shaft to effect rotation thereof.
2. A centrifugal gas compressor as set forth in claim 1 wherein said pump means is formed in said impeller shaft.
3. A hermetic centrifugal compressor as set forth in claim 1 wherein said pump means consists of a passage extending axially of said impeller shaft, one end of said passage having communication with the low pressure side of the system, the opposite end of said passage terminating in radially disposed passages in said shaft, said radially disposed passages communicating with said annular space.