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[54] **CENTRIFUGAL REFRIGERATION COMPRESSOR**

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[58] **Field of Search** ....415/122, 170 A; 415/109, 111, 415/112, 175; 84/176, 16; 277/15, 59, 72; 308/36.3

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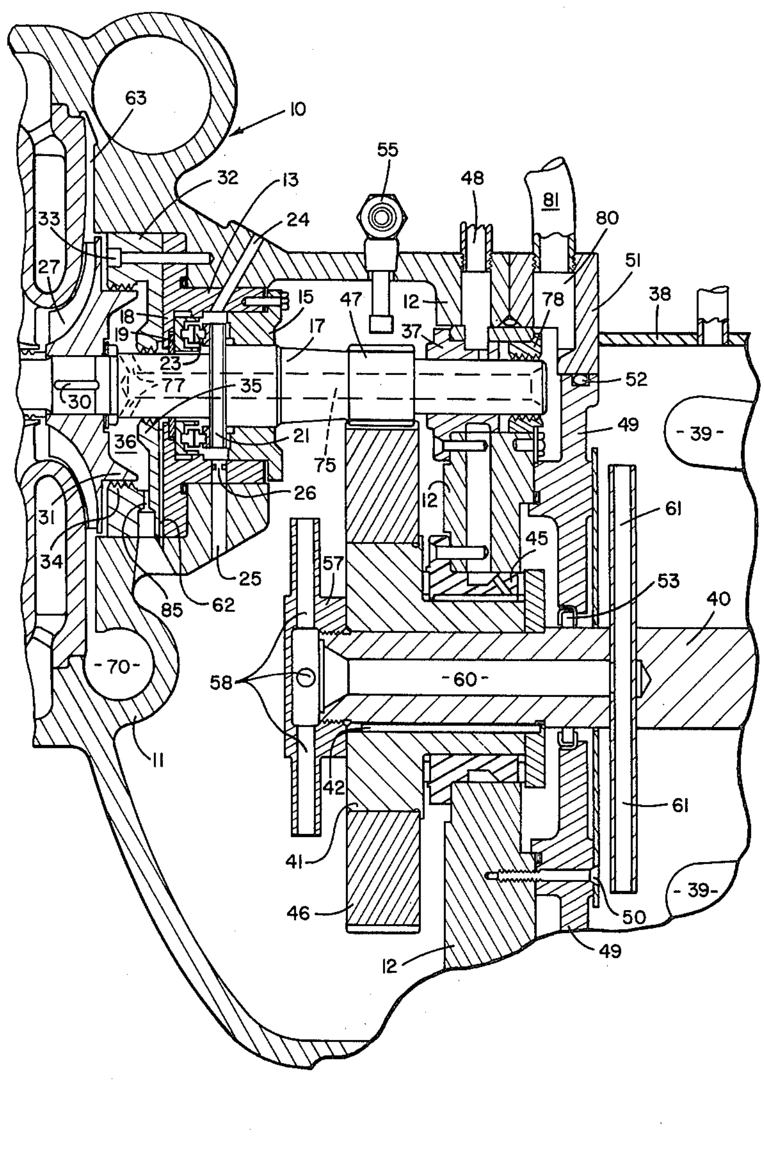
[57] **ABSTRACT**

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



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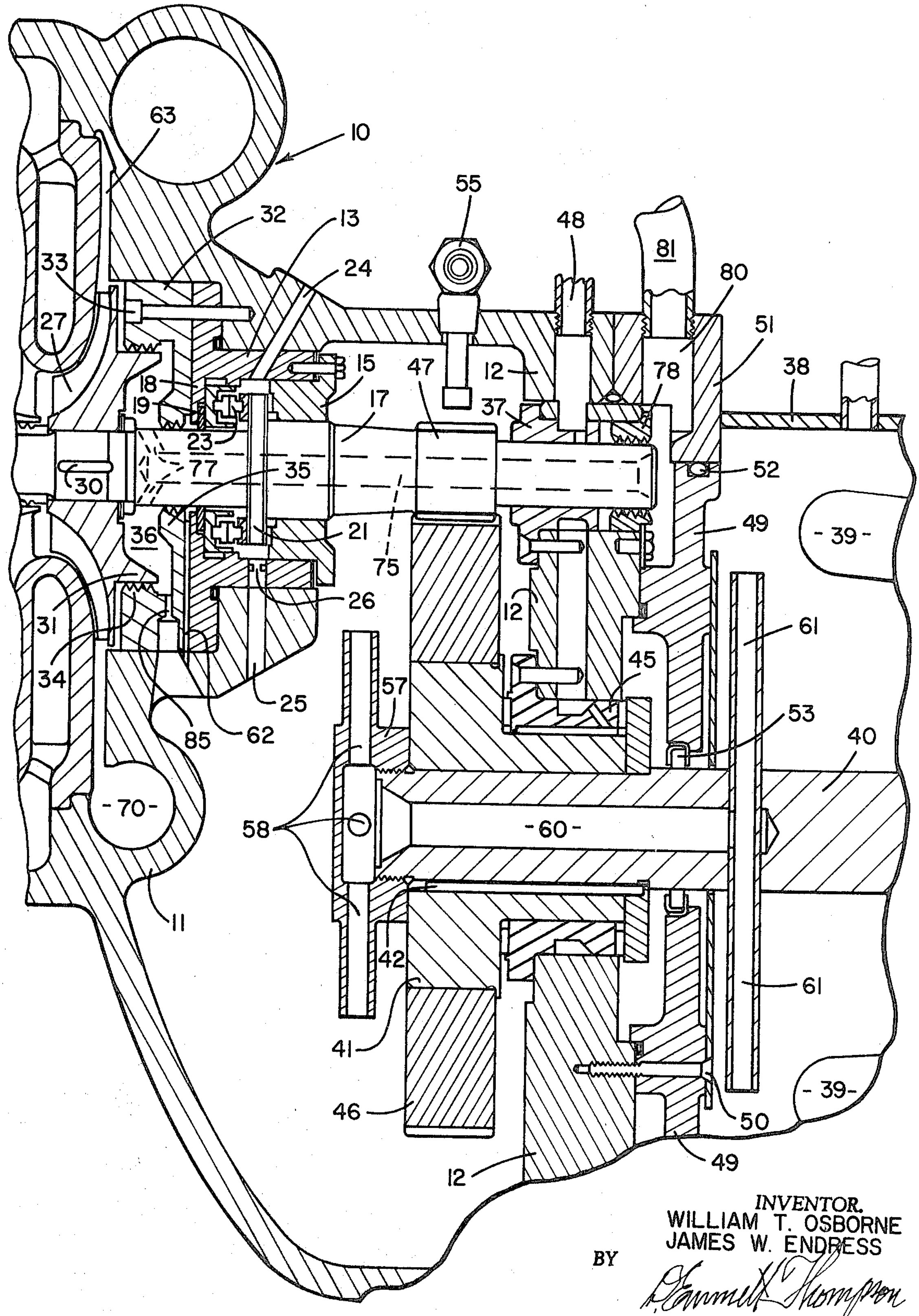

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CENTRIFUGAL REFRIGERATION COMPRESSOR

BACKGROUND OF THE INVENTION

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 slipring **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 an 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 passage **60**.

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 seal **35** 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 intermediate 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.

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