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REFRIGERATING APPARATUS WITH MOTOR DRIVEN CENTRIFUGAL COMPRESSOR

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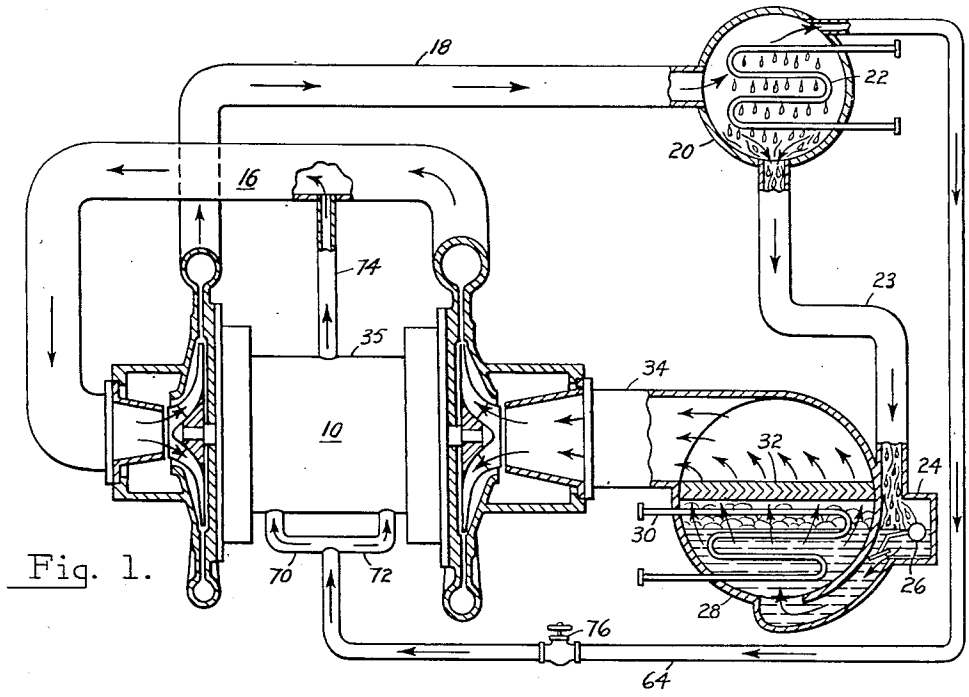


Fig. 1.

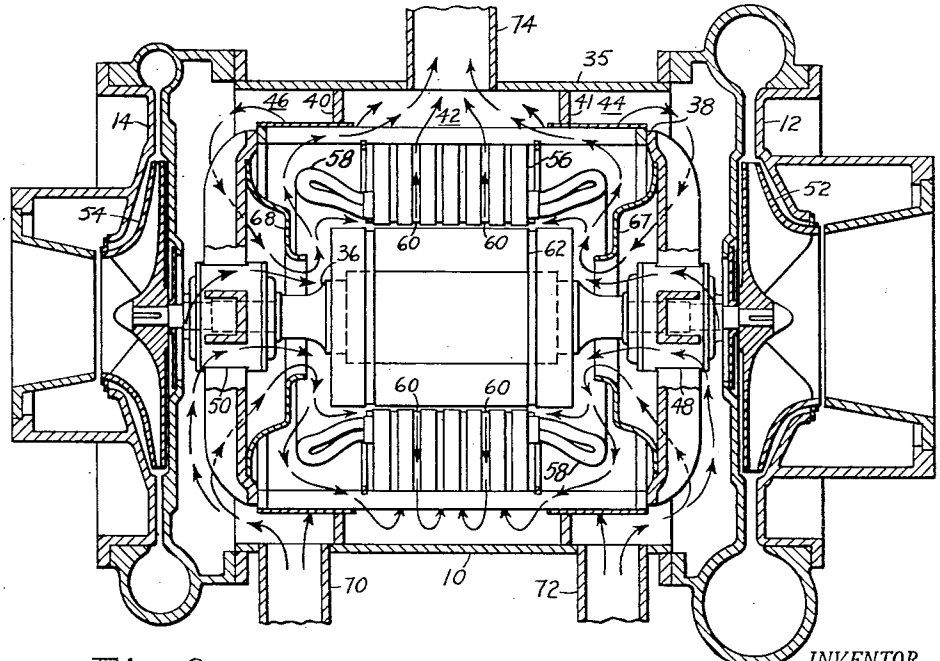


Fig. 2.

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REFRIGERATING APPARATUS WITH MOTOR DRIVEN CENTRIFUGAL COMPRESSOR

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4 Claims. (Cl. 62—117.6)

This invention relates to refrigerating apparatus of the type including a motor-compressor assembly, and particularly to apparatus in which a motor and a multi-stage compressor are housed in a sealed unit.

It is an object of this invention to provide means for cooling the motor using the refrigerant of the apparatus as a heat exchange medium.

It is another object of the invention to provide circulation of refrigerant gas from the condenser to the motor casing, thence over the rotor and stator of the motor, and thence to the cross-over pipe between the first and second stage of the compressor.

It is another object of the invention to provide passageways in the motor casing to conduct refrigerant gas in two streams to the ends of the motor to flow first over the bearings and with each stream then separating into two streams one of which flows over the stator winding and the other of which flows through the gap and outwardly through passageways in the stator.

Other objects and advantages of the invention will appear as the specification proceeds to describe the invention with reference to the accompanying drawings; in which—

Figure 1 is a partly diagrammatic view of the refrigeration apparatus of my invention.

Figure 2 is a cross-sectional view of the motor-compressor assembly taken on an axial plane.

Referring now to Figure 1, an electric motor **10** has at one end a first compressor stage **12** and at the other end a second compressor stage **14**. A cross-over pipe **16** conducts gas from the discharge of the first stage to the inlet of the second stage **14**. The gas discharged from the second stage **14** flows through a pipe **18** to a condenser **20**. The condenser **20** may be of the shell-and-tube type in which cooling water flows through the tubing **22** and the refrigerant is in the shell outside the tubes. Refrigerant liquid condensed in condenser **20** flows by gravity through pipe **23** to a float chamber **24**. Float **26** in float chamber **24** opens and closes to control the flow of refrigerant liquid to an evaporator **28** which is also of the shell-and-tube type in which the secondary refrigerant liquid such as water or brine flows through the tubing **30** and the refrigerant is in the shell outside the tubing **30**. The secondary refrigerant liquid circulates between the evaporator **28** and the cooling load served by the refrigeration apparatus to transfer heat from the load to the evaporator **28**. In removing heat from the secondary refrigerant, the refrigerant in the evaporator **28** boils forming gas which passes through the liquid eliminator **32** and thence into the suction pipe **34** to the inlet of the first stage compressor **12**.

The motor **10** has a fluid tight casing **35** secured in fluid tight relationship to compressor housings **12** and **14**. A motor frame **38** is supported in said fluid tight casing **35** by a pair of rings **40** and **41** which divide the annular space between motor frame **38** and said fluid tight casing **35** into a central chamber **42** and end chambers **44** and **46**. Motor frame **38** has bearings **48** and **50** which rotatably support a shaft **36**. Shaft **36** extends

at one end into compressor housing **12** and has impeller **52** secured thereto. The other end of shaft **36** extends into housing **14** and has impeller **54** secured thereto. A stator **56** is secured to the motor frame **36**. Stator **56** has the usual windings **58**. A plurality of radial passageways **60** extend through the stator **56**. A rotor **62** is mounted on shaft **36** to rotate therewith. Rotor **62** rotates within stator **56** and has an outside diameter slightly less than the inside diameter of the stator **56** to provide a gap between the rotor **62** and stator **56**. Refrigerant gas flows from the condenser **20** through a pipe **64** into branch pipes **70** and **72** which in turn conduct the gas to the end chambers **44** and **46** respectively.

After the gas has traversed its path through the motor **10**, as will be described in detail below, it flows from the motor **10** through pipe **74** which conducts the gas to the cross-over pipe **16**. After entering the pipe **16**, this gas flows with the gas discharged from the first stage **12** and enters the second stage **14**.

The flow of gas through pipe **64** may be manually controlled by valve **76**. If desired valve **76** may be of the thermostatic type in which a temperature sensing bulb is mounted in the gas stream leaving the motor **10**.

The gas, having entered the motor **10** through pipes **70** and **72**, flows to end chambers **44** and **46** from which it is conducted by shrouds **67** and **68** into an annular stream surrounding the shaft **36**. On leaving the shrouds **67** and **68** part of each stream flows over the winding **58** and into the central chamber **42** and part of each stream flows into the gap between the rotor **62** and stator **56** and then outwardly through the radial passageways **60** in the stator **56** and into the central chamber **42**. Central chamber **42** thus collects the gas flowing over the windings **58** and the gas flowing from the radial passageways **60** and conducts the gas to the pipe **74**.

It is thus seen that the gas space above the tubes in the condenser provides a dependable source of gas for motor cooling. Since the condenser is at a pressure substantially equal to the discharge pressure of the second stage **14** and since the pressure in the cross-over pipe **16** is substantially equal to the discharge pressure of the first stage **12**, there is sufficient pressure difference to cause a considerable flow of cooling gas through the motor.

The gas entering the cross-over pipe **16** from the motor **10** through pipe **74** is superheated because it has removed heat from the motor. This superheated gas mixes with the gas in the cross-over pipe **16** and minimizes the danger of condensation of liquid in the second stage of the compressor.

The additional gas passing through the second stage **14** permits a more efficient second stage design by reason of the fact that the passageways in the impeller can be made slightly wider.

While the apparatus disclosed and described herein constitutes a preferred form of the invention, yet it will be understood that the apparatus is capable of alteration without departing from the scope or spirit of the invention, and that all modifications that fall within the scope of the appended claims are intended to be included herein.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a refrigerating apparatus, the combination of an evaporator for vaporizing refrigerant, a condenser for liquefying refrigerant, a two stage compressor for circulating refrigerant through said evaporator and condenser, a cross-over conduit for conducting refrigerant from the first stage of the compressor to the second stage of the compressor, a motor for driving said compressor, a fluid tight casing enclosing said motor, said fluid tight casing being in fluid tight engagement with said compressor, a first conduit connected to said condenser and to said fluid tight casing for conducting refrigerant gas from said

condenser to said fluid tight casing, a second conduit, connected to said fluid tight casing and to said cross-over conduit for conducting refrigerant gas from said fluid tight casing to said cross-over conduit whereby refrigerant gas flows through said fluid tight casing to remove heat from the motor.

2. In refrigerating apparatus, the combination of an evaporator for vaporizing refrigerant, a condenser for liquefying refrigerant, a pipe for conducting refrigerant from said condenser to said evaporator, a centrifugal compressor having a first compressor stage and a second compressor stage, said first compressor stage being connected to receive refrigerant from said evaporator, a cross-over conduit for conducting refrigerant from said first compressor stage to the inlet of said second compressor stage, a pipe for conducting refrigerant from said second compressor stage to said condenser, a motor casing in fluid tight engagement with said centrifugal compressor, a motor frame in said motor casing, annular rings between said motor frame and said motor casing to support said motor frame in said motor casing, said annular rings being arranged to divide the annular space between said motor frame and said motor casing into a central chamber and two end chambers, a stator mounted in said motor frame opposite said central portion, said stator having radial passageways extending therethrough, passageways in said motor frame from said end chambers to the inner ends of said radial passageways, bearings in each end of the motor frame, a shaft and rotor assembly rotatably mounted in said bearings, said shaft and rotor assembly extending into said centrifugal compressor, an impeller in each compressor stage, said impellers being secured to said shaft and rotor assembly, conduit means connected to said condenser and said end chambers for conducting refrigerant from said condenser to said end chambers, conduit means connected to said central chamber and said cross-over conduit for conducting refrigerant from said central chamber to said cross-over conduit whereby refrigerant is caused to flow from said end chambers through the passageways in said motor frame and then through the radial passageways in the stator to remove heat from the motor.

3. In refrigerating apparatus, the combination of an evaporator for vaporizing refrigerant, a condenser for liquefying refrigerant, a pipe for conducting refrigerant from said condenser to said evaporator, a first stage centrifugal compressor having an inlet connected to receive refrigerant from said evaporator, a second stage centrifugal compressor, a cross-over conduit for conducting refrigerant from said first stage centrifugal compressor to the inlet of said second stage centrifugal compressor, a pipe for conducting refrigerant from said second stage centrifugal compressor to said condenser, a motor casing in fluid tight engagement at one end with said first stage centrifugal compressor and at its other end with said second stage centrifugal compressor, a motor frame in said annular motor casing, annular rings between said motor frame and said motor casing to support said motor frame in said motor casing, said annular rings being arranged to divide the annular space between said motor frame and said motor casing into a central chamber and two end chambers, a stator mounted in said motor frame opposite said central portion, said stator having radial passageways extending therethrough, passageways in said motor frame from said end chambers to the inner ends of said radial passageways, bearings in each end of the motor frame, a shaft and rotor assembly rotatably mounted in said bearings, said shaft and rotor assembly having one end extending into said first stage centrifugal compressor, an impeller secured to said one end of said shaft and rotor assembly, said shaft and rotor assembly having its other end extending into said second stage centrifugal compressor, an impeller secured to said other end of said shaft and rotor assembly, conduit means connected to said condenser and said end chambers for conducting refrigerant from said condenser to said end chambers, conduit means connected to said central chamber and said cross-over conduit for conducting refrigerant from said central chamber to said cross-over conduit whereby refrigerant is caused to flow from said end chambers through the passageways in said motor frame and then through the radial passageways in the stator to remove heat from the motor.

4. In refrigerating apparatus, the combination of an evaporator for vaporizing refrigerant, a condenser for liquefying refrigerant, a pipe for conducting refrigerant from said condenser to said evaporator, a first compressor stage, a second compressor stage, said first compressor stage being connected to receive refrigerant from said evaporator, a cross-over conduit for conducting refrigerant from said first compressor stage to the inlet of said second compressor stage, a discharge pipe for conducting refrigerant from said second compressor stage to said condenser, a motor casing in fluid sealing relationship with said compressor stages, a motor frame in said motor casing, bearings in each end of the motor frame, a shaft and rotor assembly rotatably mounted in said bearings, said shaft and rotor assembly extending into said compressor stages, an impeller in each of said compressor stages, said impellers being secured to said shaft and rotor assembly, a first conduit connected to said condenser and to said motor casing for conducting refrigerant from said condenser to said motor casing, a second conduit connected to said motor casing and to said cross-over conduit for conducting refrigerant from said motor casing to said cross-over conduit whereby refrigerant is caused to flow from said condenser to said motor casing and thence to said cross-over conduit to remove heat from the motor casing.

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