Nov. 15, 1966 R. SMITH 3,285,504

REFRIGERANT APPARATUS

Filed Dec. 10, 1964 2 Sheets-Sheet 1

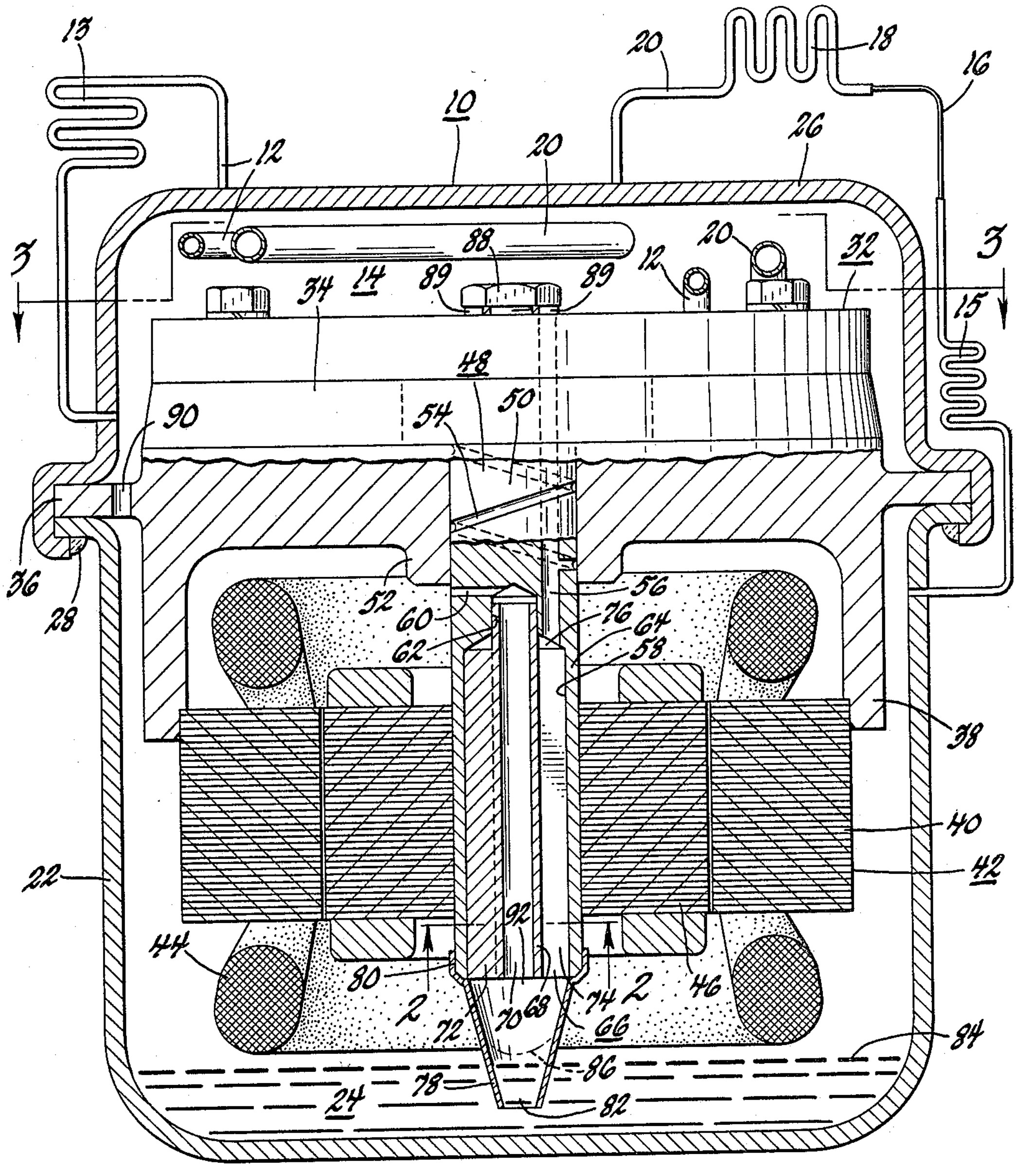

Fig. 1

INVENTOR.
Robert Smith
BY J.C. Evans
HIS ATTORNEY

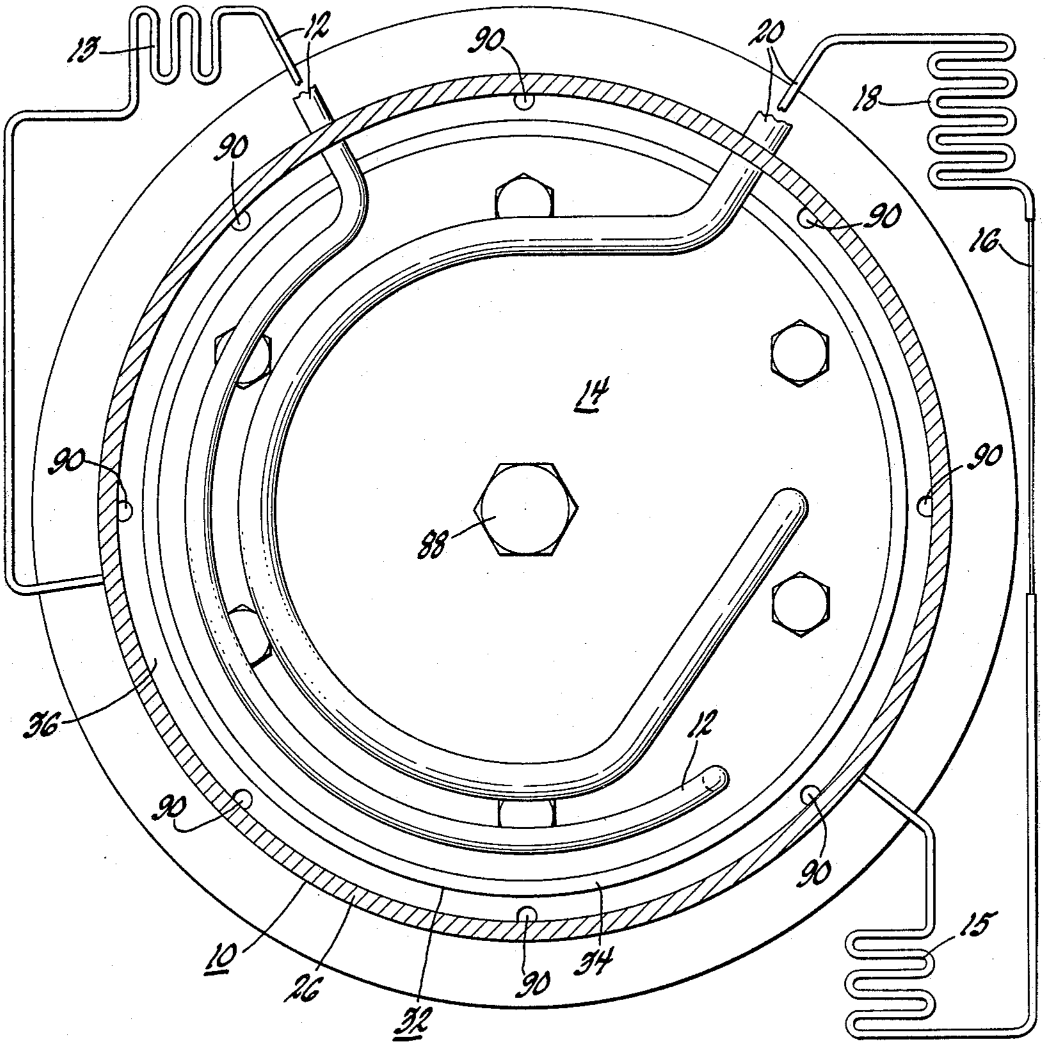

Fig. 3

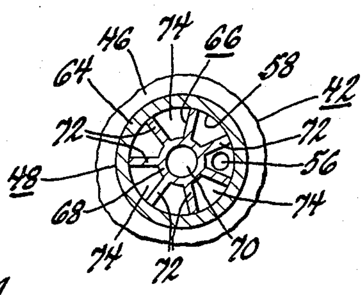

Fig. 2

INVENTOR.
Robert Smith
BY J. C. Evans
HIS ATTORNEY

United States Patent Office

3,285,504
Patented Nov. 15, 1966

3,285,504
REFRIGERANT APPARATUS

Robert Smith, Dayton, Ohio, assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Filed Dec. 10, 1964, Ser. No. 417,267
10 Claims. (Cl. 230—207)

This invention relates to refrigerant apparatus and more particularly to hermetically sealed motor compressor units.

One major problem in hermtically sealed motor compressors is that of noise transmission from the internally located operative components thereof. It has been determined that noise transmission is, in part, related to the location of the operative components in the liquid lubricant present within a sump region in the compressor. Consequently, an attempt has been made to remove the compressor and motor drive units from the sump region of such compressors by locating them within the enclosed space formed by the outer shell of the compressor at a point spaced above the liquid level in the sump region. One particularly desirable arrangement is where the compressor is located in the uppermost part of the shell and the drive motor is located between the compressor and the liquid level in the sump region.

While the above-described structure is unusually well suited for solving noise problems, it tends to create lubrication problems by locating the main bearing points in the apparatus remotely of the lubricant in the sump region. Furthermore, the compressors in such units are typically of a construction wherein the refrigerant circulation pattern through the unit flows directly into and out of the compressor without flowing directly across the electric drive motor armature or rotor. Hence, drive components tend to have an undesirable heat buildup therein.

It is an object of the present invention, therefore, to improve hermetically sealed motor compressor units of the type having an inverted compressor and motor arrangement by the provision of a hollow drive shaft connection between an electric drive motor and compressor for forming a large area cooling surface in close heat transfer relationship with a motor armature or rotor which is cooled by means of a conical pickup that distributes liquid lubricant from the sump region across the large area cooling surface and thence to a bearing surface for lubrication thereof.

A further object of the present invention is to prevent undesirable foaming of liquid lubricant and cooling fluid within a hermetically sealed compressor of the type having an inverted motor driven compressor by the provision of a hollow drive shaft having an insert element therein forming a plurality of circumferentially spaced radially, outwardly located liquid flow passageways and a centrally located separate gas flow passageway selectively and separately supplied by a conical pickup member on the end of the shaft that serves to centrifugally draw liquid from the sump region into the liquid flow passages while separating gas therefrom that flows into the central opening and wherein the shaft and insert element cooperate to separately return gas from the central opening into a space above the sump region and the lubricant into a bearing region prior to passage into the upper space.

A still further object of the invention is to improve cooling and lubrication in a hermetically sealed compressor of the type having an inverted compressor unit driven by an electric motor located between the compressor unit and a sump region of the compressor by the provision of an elongated shaft for operatively connecting the rotor of the motor to the compressor including a first portion having a large diameter opening directed axially therethrough for forming a substantial cooling surface area in close heat transfer relationship with the rotor and including a first passageway from the opening for directing a first fluid therefrom and a second passageway from the opening for directing a second fluid therefrom and wherein a magnetic flux return insert is located within the large diameter opening forming a first plurality of radially, outwardly directed liquid passageways therethrough and a separate centrally located gas passageway therethrough to feed the first and second passageways respectively.

Futher objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a view in vertical section of the refrigerant apparatus of the present invention;

FIGURE 2 is a view in horizontal section taken along the line 2—2 of FIGURE 1 looking in the direction of the arrows; and

FIGURE 3 is a view in horizontal section taken along the line 3—3 of FIGURE 1 looking in the direction of the arrows.

Referring to FIGURE 1, a refrigerant apparatus is illustrated including a hermetically sealed compressor shell **10** having a discharge line **12** therefrom fluidly communicating with a superheat removing coil **13** from whence refrigerant is returned interiorly of the shell **10** into an upper space **14** therein. The refrigerant passes from space **14** into a condenser **15** that is connected through a capillary tube or restricter **16** to an evaporator unit **18** serially connected to a suction line **20** from the compressor shell **10**. In the illustrated arrangement the compressor shell **10** includes a first shell bottom portion **22** for forming a lower liquid containing sump region **24**. The shell portion **22** is joined to an upper shell portion **26** and connected thereto by suitable means such as by welding **28** to hermetically seal the space **14** located above the lower sump region **24**.

Within the upper space **14** is located an inverted rotary compressor **32** with an inlet and outlet connected respectively to lines **20** and **12**. In the illustrated embodiment the compressor **32** is supported on the shell **10** by means representatively shown as including an outer housing portion **34** with a radially outwardly directed flange **36** thereon secured between the shell portions **22, 26** in supported relationship therewith. By virtue of this arrangement noises from the compressor **32** are substantially muffled by surrounding space **14**. The housing portion **34** also includes a depending tubular portion **38** that supportingly receives the stator **40** of an electric drive motor **42** which is representatively shown as an A.C. induction motor. The stator **40** includes a coil **44** that, upon energization, is effective to produce a toroidally-shaped, magnetic flux field that interacts with a rotor **46** to cause relative rotation thereof with respect to stator **40**.

The rotor **46** is secured to a shaft **48** having an upper portion **50** thereof rotatably supported within a bearing support or hub **52** on the housing portion **34**. The upper portion **50** includes a helical groove **54** in the outer surface thereof serving as a lubrication passageway which communicates with a first passageway **56** in the shaft **48** that, in turn, is in communication with a large diameter opening **58** that extends through the shaft **48** from a point above the rotor **46** to the end of the shaft located immediately above the sump region **24**. The shaft also includes a second shaft opening **60** that communicates with a smaller diameter axial opening **62** in the shaft concentrically arranged with opening **58** immediately thereabove.

In accordance with certain of the principles of the present invention the large diameter opening **58** serves to form a substantial cooling surface area that is separated from the rotor **46** only by a thin-sectioned wall **64** of the shaft **48** which is fixedly secured to the radially innermost part of the rotor **46** in direct heat transfer relationship therewith.

Within the opening **58** is a magnetic flux return insert **66** including an elongated tubular, central portion **68** forming a central opening **70**. The tubular portion **68** has an extension thereon that extends into the opening **62** in the shaft **48**. Additionally, the insert **66** includes a plurality of circumferentially located spaced ribs or dividers **72** throughout substantially the whole length of the tubular centrally located part **68**. Each of the ribs **72** in cooperation with its adjacent rib forms a plurality of separate radially, outwardly located passageways **74** that are separated from the opening **70**. The passageways **74** are all in communication with a common collection chamber or space **76** formed conjointly by the extension of the tubular extension **68** and the inner surface of the shaft **48** above opening **58**. The space **76**, as best shown in FIGURE 1, is in fluid communication with the first shaft passageway **56**.

On the lower opened end of the shaft **48** a conically-shaped pickup member **78** is located so that a large diameter opened end **80** thereon is fit thereover in supported relationship thereon and a lower, smaller diameter opened end **82** is disposed beneath a liquid level **84** in the sump region **24**.

In operation, upon energization of the motor **42**, the element **78** spins with respect to the liquid in the sump region **24** to centrifugally draw it upwardly therein as shown at **86** in FIGURE 1 so that the liquid component of the fluid is directed through the radially, outwardly located passageways **74** into the collection space **76**. The liquid component, for example a lubricating oil, is then pressured through passageway **56** through the spiral or helical groove **54** to lubricate the shaft bearing support formed by hub **52**. In the illustrated arrangement, the liquid from the helical groove **54** is directed to a slinger **88** secured to the upper end of the shaft **48**. Vanes **89** or the like on the underside of slinger **88** throw oil radially, outwardly thereof against the inner surface of the shell **10** which serves as a heat exchange surface for removing heat from the oil. The oil, as it circulates across the relatively large surface defined by the inside wall of the shell **10**, serves as a means for removing heat generated within the rotor **46** which is subsequently removed through the shell exteriorly of the unit. Openings **90** in flange **36** return the oil back to the sump region **24**.

Another feature of the invention is that during the circulation of oil across the inner surface of wall **64**, the conical member **78** separates gases therefrom into a region shown at **92** in FIGURE 1 from whence the gas component of the fluid in the sump region passes upwardly through opening **70** thence through the side opening **60** into the space **14**. By so separating gas from liquid, any tendency for undesirable foaming of lubricant within the space **14** is substantially eliminated.

In addition to serving as a gas and liquid separator, the insert **66**, by virtue of the ribs **72** thereon, affords a flux return path for the toroidally-shaped flux pattern from the stator winding **44** to thereby prevent undesirable flux concentrations in the pattern that would otherwise be produced by the high reluctance of a completely open shaft region at the passageway **58** therein.

In addition to the oil cooling and gas separating action described above, the illustrated hermetically sealed motor compressor unit separates refrigerant circulating therethrough from lubricating fluid therein. Accordingly, there is no problem of undesirable condensation of oil particles within the compressor of the type that might undesirably affect its valving action.

In view of the above-described embodiment of the present invention, it will be appreciated by those skilled

in the art that a low-cost, easily assembled lubricating and cooling arrangement is disclosed in an inverted compressor structure that is unusually well suited for conjointly separating gas and liquid components in a compressor sump region to prevent undesirable foaming effects within the compressor shell while producing an unusually effective cooling interchange between the liquid component of the fluid and heat generated within a rotor. Simultaneously, lubrication of rotating bearing surfaces is obtained while retaining a structure that has desired electrical flux characteristics such as found in solid drive shaft connections between motor and compressor in such hermetically sealed units.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In refrigerant apparatus, the combination of, a hermetically sealed shell including a lower liquid sump region and an upper gas space, a compressor including an outer housing located within said gas space for muffling noises, motor means for driving said compressor including a stator and a rotor, a shaft having a portion thereon rotatably supported by said compressor housing and a portion thereof secured to said rotor for driving the compressor upon energization of said motor means, means forming an internal cooling surface in said shaft portion adjacent said rotor located in direct heat transfer relationship therewith, pumping means for drawing liquid from said sump region and passing it across said internal cooling surface for removing heat from said rotor, said pumping means including means for separating gas from the liquid means including an elongated insert element in said shaft having a tubular portion arranged concentrically of said cooling surface in spaced relationship therewith for separately directing said gas through said shaft to a point interiorly of the gas space above said motor means, and means for collecting and directing a portion of the liquid across the portion of said shaft rotatably supported by said compressor housing for preventing frictional wear therebetween.

2. In refrigerant apparatus, the combination of, a hermetically sealed shell including a lower liquid sump region and an upper gas space, a compressor including an outer housing located within said gas space for muffling noises, motor means for driving said compressor including a stator and a rotor, a shaft having a portion thereon rotatably supported by said compressor housing and a portion thereof secured to said rotor for driving the compressor upon energization of said motor means, means forming an internal cooling surface in said shaft portion adjacent said rotor located in direct heat transfer relationship therewith, pumping means for drawing liquid from said sump region and passing it across said internal cooling surface for removing heat from said rotor, said pumping means including means for separating gas from the liquid, means including an elongated insert element in said shaft having a tubular portion arranged concentrically of said cooling surface in spaced relationship therewith for separately directing gas through said shaft to a point interiorly of the gas space above said motor means, and a plurality of ribs directed radially outwardly from said tubular portion into engagement with said cooling surface to form a magnetic flux return path.

3. In refrigerant apparatus, the combination of, a hermetically sealed outer shell having a lower liquid sump region and an upper gas region, a compressor supported within said upper gas region including an outer housing portion, a motor supported between said outer housing and said sump region including a rotor and a stator, a shaft for driving said compressor having a first portion thereof rotatably supported by said housing portion and a second portion thereof secured for rotation with said rotor, said second portion having a large diameter axial opening therethrough for forming a substantial cooling surface in close heat transfer relationship with said rotor, pumping means carried by said second shaft portion for centrifugally directing liquid from said sump region across said cooling surface, an insert within said large diameter opening including a tubular portion concentrically of and in spaced relationship with said surface having one end thereof in communication with said pumping means for directing gas upwardly through the shaft and outwardly thereof through a side opening therein into the gas region separately from the centrifuged liquid, and passageway means for collecting and directing the centrifuged liquid from the large diameter opening into the interface between said first shaft portion and said housing portion for lubrication therebetween.

4. In the combination of claim 3, said passageway means including a plurality of ribs directed radially outwardly from said tubular portion into engagement with said cooling surface to form a magnetic flux return path.

5. A hermetically sealed motor compressor unit comprising, an outer shell having means forming a liquid sump region and a gas space therein, a compressor unit supported above said sump region in said gas space, an electric drive motor supported between said compressor and said sump including a stator and a rotor, a shaft connecting said rotor to said compressor for driving said compressor upon energization of said electric motor, said shaft having an enlarged diameter opening therethrough at its interconnection with said rotor, a conically-shaped oil pickup tube supported on said shaft having an open end thereof within said sump region for communicating said sump region with said large diameter shaft opening, an insert element located within said shaft opening including a central opening therethrough located concentrically with the interior space of said conical pickup element, means forming a passageway in said shaft above said rotor for communicating the central opening of said insert with the space above said sump region, said insert element spaced from said shaft to form passageways directed longitudinally thereof for receiving liquid centrifugally displaced by said conical pickup for passage across substantially the full inside surface of said shaft in the vicinity of said rotor for removing heat therefrom, and means for directing liquid passing through said longitudinal passageways from said rotor for distribution into the space above said sump region separately of the gas.

6. A hermetically sealed motor compressor unit comprising, an outer shell having means forming a liquid sump region and a gas space therein, a compressor unit supported above said sump region in said gas space, an electric drive motor supported between said compressor and said sump including a stator and a rotor, a shaft connecting said rotor to said compressor for driving said compressor upon energization of said electric motor, said shaft having an enlarged diameter opening therethrough at its interconnection with said rotor, a conically-shaped oil pickup tube supported on said shaft having an open end thereof within said sump region for communicating said sump region with said large diameter shaft opening, an insert element located within said shaft opening including a central opening therethrough located concentrically with the interior space of said conical pickup element, means forming a passageway in said shaft above said rotor for communicating the central opening of said insert with the space above said sump region, said insert including a plurality of circumferentially spaced radially outwardly directed ribs for forming a plurality of radially outwardly located passageways directed longitudinally of said large diameter opening for receiving liquid centrifugally displaced by said conical pickup for passage across substantially the full inside surface of said shaft in the vicinity of said rotor for removing heat therefrom, said ribs serving as a flux return path for preventing undesirable flux concentrations in the flux pattern surrounding said stator and means for directing liquid passing through said radially outwardly located passageways from said

shaft for distribution into the space above said sump region, said central opening in said insert being isolated from said radially outwardly directed oil passageways whereby gas released in said conical pickup element is fluidly separated from the circulated liquid as it passes through said shaft.

7. A hermetically sealed motor compressor unit comprising, an outer shell having means forming a liquid sump region and a gas space therein, a compressor unit supported above said shell, an inlet to said compressor and an outlet from said compressor, conduit means for communicating said inlet and outlet exteriorly of said outer shell, an electric drive motor supported between said compressor and said sump including a stator and a rotor, a shaft connecting said rotor to said compressor for driving said compressor upon energization of said electric motor, said shaft having an enlarged diameter opening therethrough at its interconnection with said rotor, a conically-shaped oil pickup tube supported on said shaft having an open end thereof within said sump region for communicating said sump region with said large diameter shaft opening, an insert element located within said shaft opening including a central opening therethrough located concentrically with the interior space of said conical pickup element, means forming a passageway in said shaft above said rotor for communicating the central opening of said insert with the space above said sump region, said insert element spaced from said shaft to form passageways directed longitudinally for receiving liquid centrifugally displaced by said conical pickup for passage across substantially the full inside of said shaft in the vicinity of said rotor for removing heat therefrom, and means for directing liquid passing through said longitudinal passageways from said rotor for distribution into the space above said sump region separately of the gas.

8. A hermetically sealed motor compressor unit comprising, an outer shell having means forming a liquid sump region and a gas space therein, a compressor unit supported above said shell, an inlet to said compressor and an outlet from said compressor, conduit means for communicating said inlet and outlet exteriorly of said outer shell, an electric drive motor supported between said compressor and said sump including a stator and a rotor, a shaft connecting said rotor to said compressor for driving said compressor upon energization of said electric motor, said shaft having an enlarged diameter opening therethrough at its interconnection with said rotor, a conically-shaped oil pickup tube supported on said shaft having an open end thereof within said sump region for communicating said sump region with said large diameter shaft opening, an insert element located within said shaft opening including a central opening therethrough located concentrically with the interior space of said conical pickup element, means forming a passageway in said shaft above said rotor for communicating the central opening of said insert with the space above said sump region, said insert including a plurality of circumferentially spaced radially outwardly directed ribs for forming a plurality of radially outwardly located passageways directed longitudinally of said large diameter opening for receiving liquid centrifugally displaced by said conical pickup for passage across substantially the full inside surface of said shaft in the vicinity of said rotor for removing heat therefrom, said ribs serving as a flux return path for preventing undesirable flux concentrations in the flux pattern surrounding said stator, and means for directing liquid passing through said radially outwardly located passageways from said shaft for distribution into the space above said sump region, said central opening in said insert being isolated from said radially outwardly directed oil passageways whereby gas released in said conical pickup element is fluidly separated from the circulated liquid as its passes through said shaft.

9. In a refrigeration compressor, the combination of, a hermetically sealed outer shell including a lower liquid sump region therein and a gas space located above the sump region, a compressor unit supported in said space above said sump region for noise muffling, an electric drive motor located between said compressor and said sump region including a stator and a rotor, a drive shaft having a tubular open ended portion secured for rotation with said rotor and an exteriorly grooved portion rotatably supported by said compressor and including an upper end connected for rotation to said compressor, an open ended conical element having its large diameter end connected to the open end of said tubular shaft portion and its small diameter end in communication with the sump region for centrifugally lifting liquid from the sump region for passage interiorly of the tubular shaft portion, an elongated insert element having a centrally located tubular portion arranged concentrically of said conical pickup element for directing gas released interiorly thereof through passageway means in said shaft above said rotor, said tubular insert portion and said tubular shaft portion conjointly forming a liquid collection space at one end of said insert, means communicating said liquid collection space with the space above said sump region for returning liquid thereto, said insert having a portion thereon spaced from said shaft to form a cooling passageway for directing liquid picked up by said conical element from said sump region across substantially the full inner surface of said tubular shaft portion for removing heat from the rotor prior to distribution of the liquid into the space above the sump region, said tubular insert portion separately directing gas from the central region of said conical pickup element through said shaft passageway into the space above said sump region to prevent undue foaming the liquid during the circulation thereof from the sump region into the space thereabove and its return back to said sump region.

10. In a refrigeration compressor, the combination of, a hermetically sealed outer shell including a lower liquid sump region therein and a gas space located above the sump region, a compressor unit supported in said space above said sump region for noise muffling, an electric drive motor located between said compressor and said sump region including a stator and a rotor, a drive shaft having a tubular open ended extension secured for rotation with said rotor and an exteriorly grooved portion rotatably supported by said compressor and including an upper end connected for rotation to said compressor, an open ended conical element having its large diameter end connected to the open end of said tubular shaft portion and its small diameter end in communication with the sump region for centrifugally lifting liquid from the sump region for passage interiorly of the tubular shaft portion, an elongated insert element having a centrally located tubular portion arranged concentrically of said conical pickup element for directing gas released interiorly thereof through passageway means in said shaft above said rotor, a plurality of circumferentially located radially outwardly directed ribs on said tubular insert portion slidably received within said drive shaft extension for locating the tubular insert portion concentrically therewith and to form a magnetic flux return path for said motor, said tubular insert portion and said tubular drive shaft extension conjointly forming a liquid collection space at one end of said insert element, means communicating said liquid collection space with the space above said sump region for returning oil thereto, said ribs forming a plurality of cooling passageways for directing liquid picked up by said conical element from said sump region across substantially the full inner surface of said tubular drive shaft extension for removing heat from the rotor prior to distribution of the liquid into the space above the sump region, said tubular insert portion separately directing gas from the central region of said conical pick-up element through said shaft passageway into the space above said sump region to prevent undue foaming of the liquid during the circulation thereof from the sump region into the space thereabove and its return back to said sump region.

References Cited by the Examiner

UNITED STATES PATENTS

2,040,641	5/1936	Bingham	230—207 X
2,888,193	5/1959	Greenwald	230—207 X
3,049,285	8/1962	Doeg	230—206
3,098,604	7/1963	Dubberley	230—206
3,182,901	5/1965	Solomon	230—206

ROBERT M. WALKER, *Primary Examiner.*