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Co-rotational scroll apparatus with positive lubricant flow

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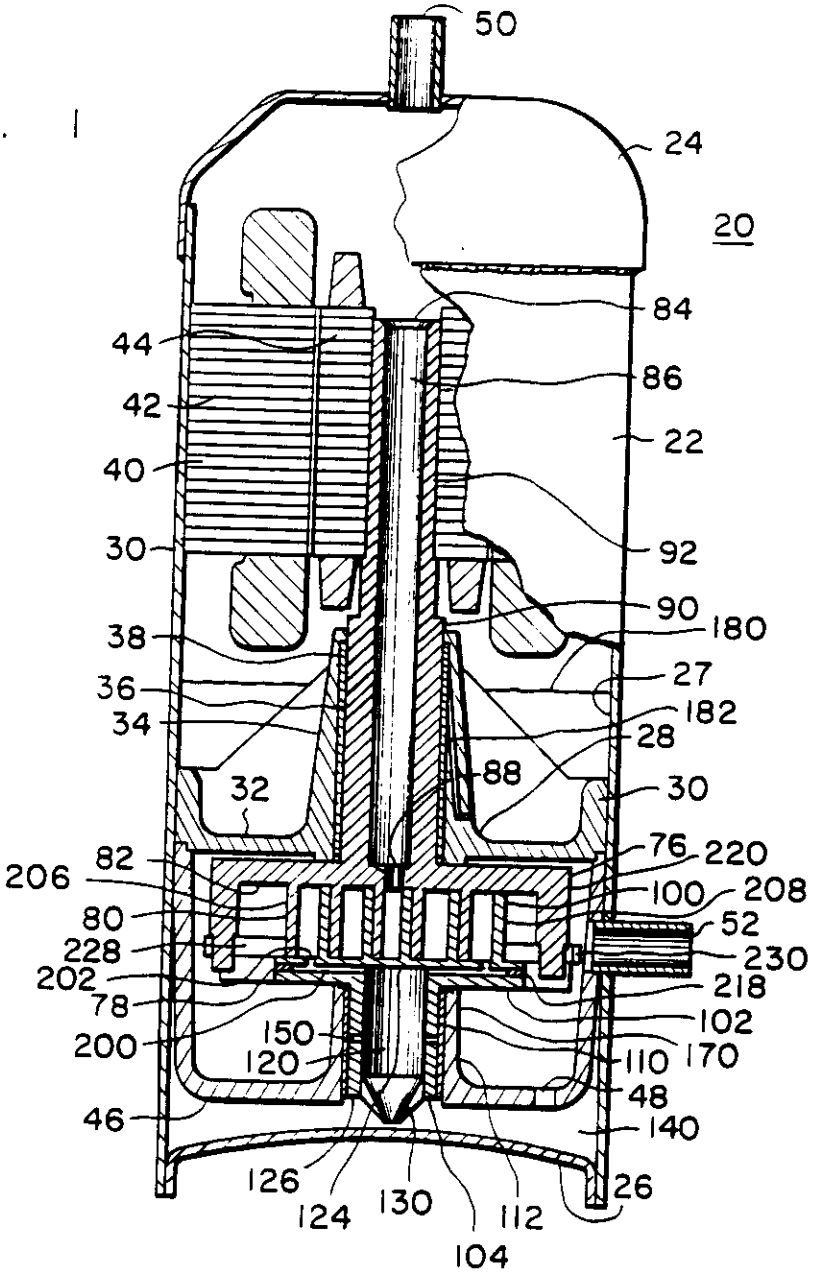
FIG. 1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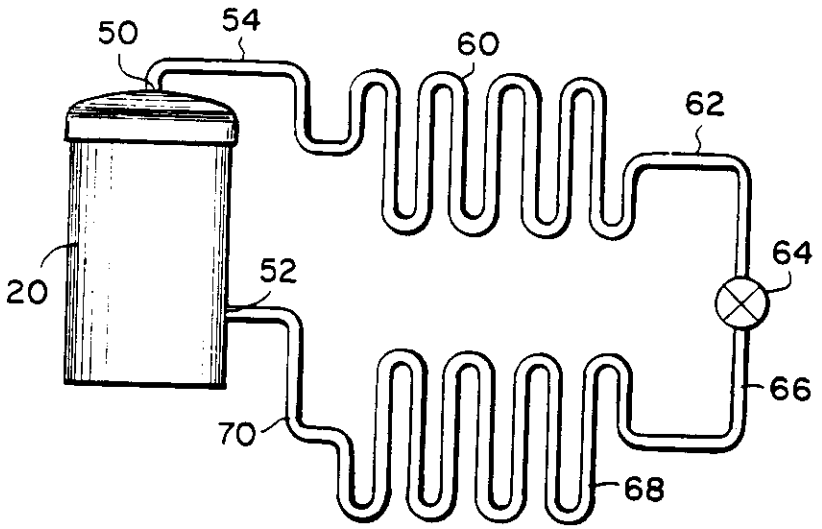
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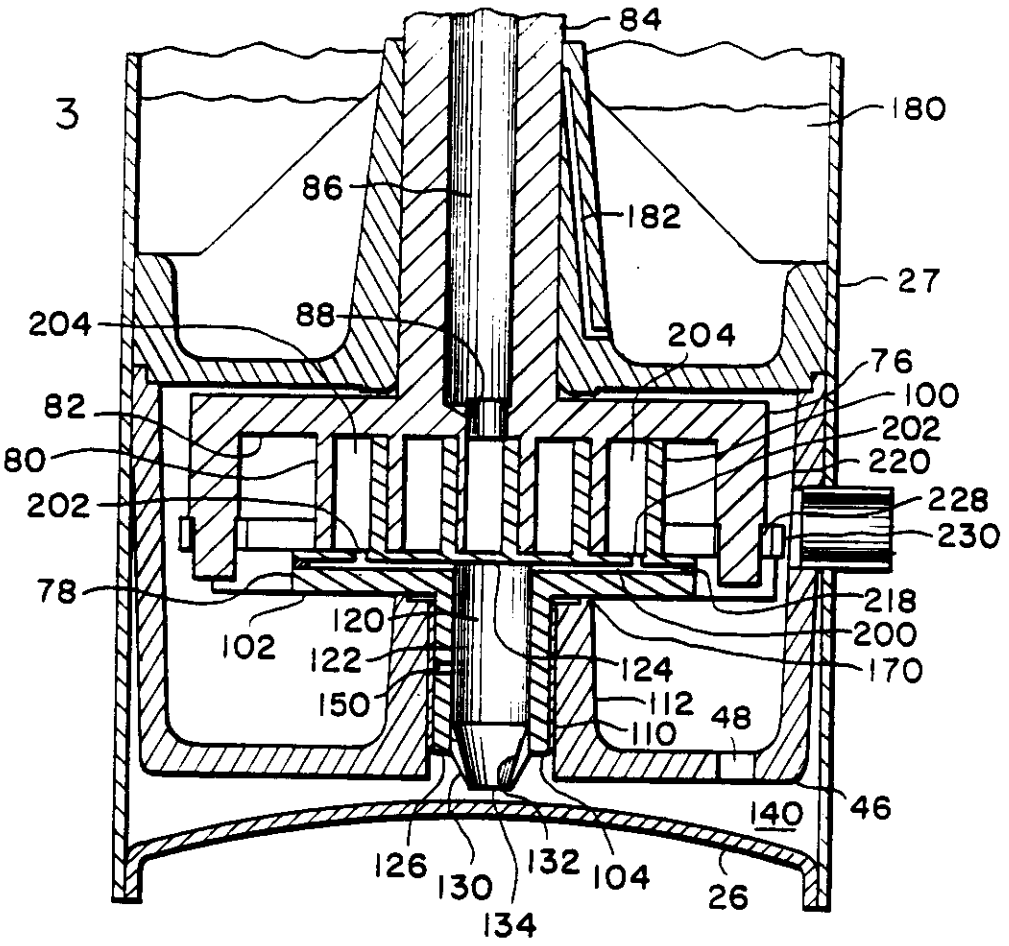
FIG. 2

FIG. 3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26
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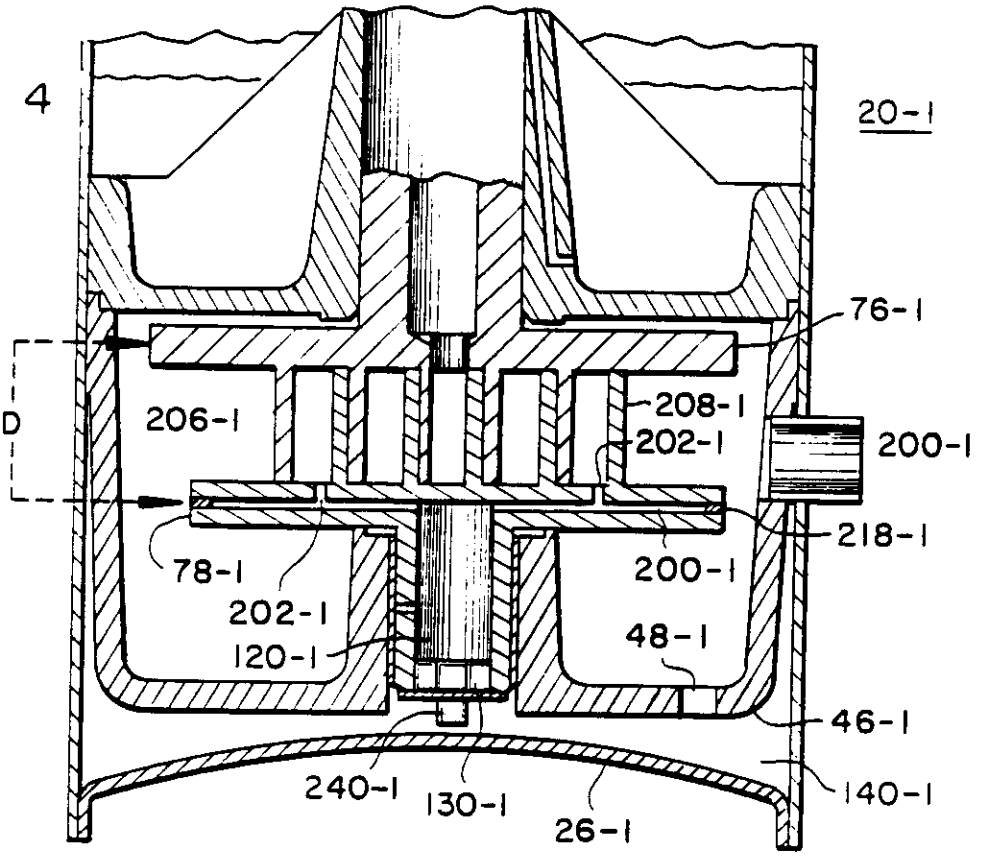
FIG. 4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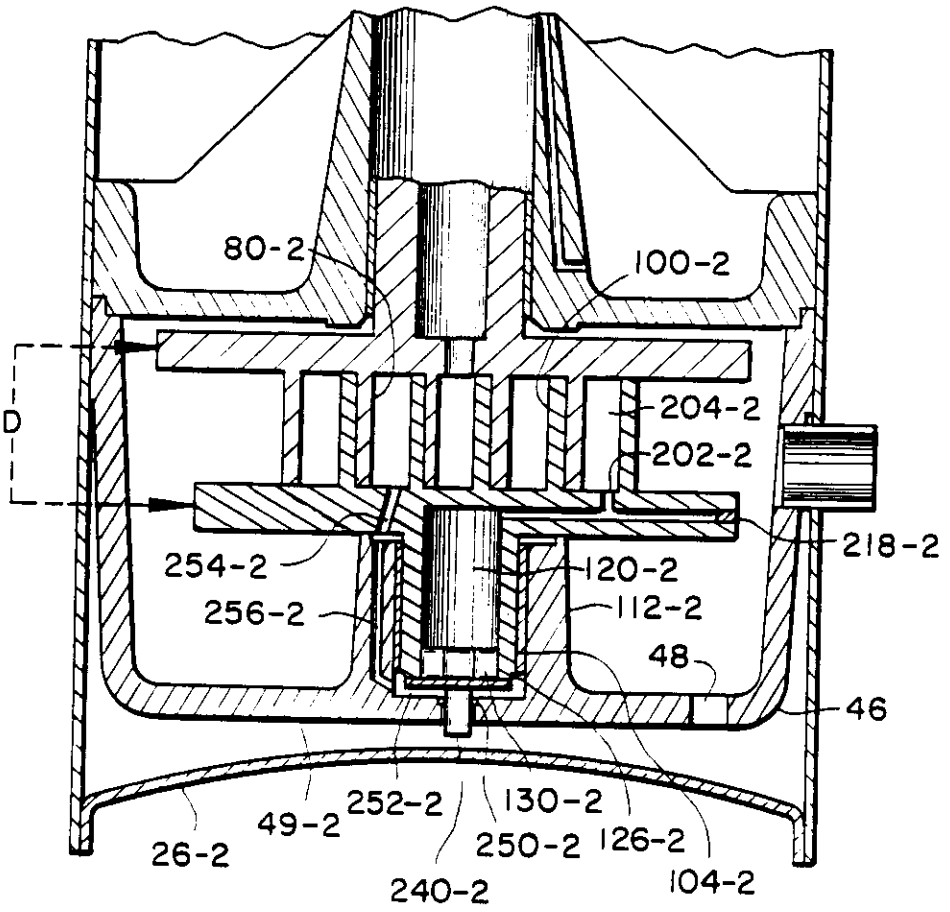
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126-2
240-2
104-2

FIG. 5

CO-ROTATIONAL SCROLL APPARATUS WITH POSITIVE LUBRICANT FLOW

The invention relates to the lubrication of co-rotational scroll-type fluid transfer apparatus and particularly, but not exclusively, to the lubrication of the scroll wraps of such apparatus.

Scroll apparatus for fluid compression or expansion are typically comprised of two upstanding interfitting involute spirodal wraps which are generated about respective axes. Each respective involute wrap is mounted upon an end plate and has a tip disposed in contact or near-contact with the end plate of the other respective scroll wrap. Each scroll wrap further has flank surfaces which adjoin in moving line contact, or near contact, the flank surfaces of the other respective scroll wrap to form a plurality of moving chambers. Depending upon the relative orbital motion of the scroll wraps, the chambers move from the radially exterior end of the scroll wraps to the radially interior ends of the scroll wraps for fluid compression, or from the radially interior end of the

respective scroll wraps for fluid expansion. The scroll wraps, to accomplish the formation of the chambers, are put in relative orbital motion by a drive mechanism which constrains the scrolls to non-rotational relative motion. The general principles of scroll wrap generation and operation are discussed in numerous patents, such as U.S. Patent Number 801,182.

Numerous attempts have been made to develop co-rotational scroll apparatus. Such apparatus provides for concurrent rotary motion of both scroll wraps on parallel, offset axis to generate the requisite orbital motion between the respective scroll wrap elements. However, most commercially successful scroll apparatus to date have been of the fixed scroll-orbiting scroll type due to various difficulties in achieving success with co-rotating scroll apparatus.

In addition to the energy consumed by the additional bearing surfaces typically found, other energy losses can occur. As the scrolls rotate, fluid around and in the vicinity of the scrolls is "fanned" by the scroll members. After the scrolls have been rotating for a period of time, the fluid adjacent the scrolls develops a swirling or centrifugal flow field around the periphery of the scrolls due to the motion of the scroll members. This presents a substantial difficulty when the scroll members are contained in a shell or enclosure. The flow field thus developed increases the total energy requirement for the scroll apparatus, since both the scrolls and the fluid are rotated, and the overall efficiency of the scroll apparatus is reduced.

It has also been difficult to obtain and control adequate lubricant flow through the scroll wraps of a co-rotational scroll apparatus. In many applications such as refrigeration and air conditioning, the scroll apparatus is employed as a gas compressor in a closed circuit system. Lubrication of the compressor in such systems is typically accomplished by providing a lubricant which is miscible in the gas to be compressed, and circulating all or a portion of this lubricant in the closed system. The effect of the centrifugal flow field is to precipitate this miscible lubricant out of the gas, leaving effectively no lubricant available to flow through the scroll wraps of the scroll apparatus and filling the container in which the scrolls rotate with lubricant. This lubricant accumulating in the container also tends to be swirled by the scrolls, requiring additional energy input to the scrolls.

In certain co-rotational scroll apparatus, lubricant is also provided to the bearings supporting the scroll elements. This lubricant also contributes to the lubricant accumulation in the container as it flows from the bearings after having lubricated them.

An object of the invention is to at least partially overcome the above-described problems in the lubrication of co-rotational scroll apparatus.

Accordingly, the invention provides a scroll apparatus comprising:

a shell defining a suction pressure portion and a sump, said sump being disposed in said suction pressure portion;

a first scroll member disposed in said suction pressure portion, said first scroll member having a first scroll end plate having a first scroll shaft and an oppositely directed first scroll wrap disposed

thereon;

a second scroll member disposed in said suction pressure portion, said second scroll member having a second scroll end plate having a second scroll shaft and an oppositely directed second scroll wrap disposed thereon, said scroll wraps being in interleaving engagement and cooperating, in use of the apparatus, to form an alternately open and closed first chamber, said second scroll end plate defining a lubricant passage and said second scroll shaft defining a lubricant gallery, said lubricant passage being in flow communication with said lubricant gallery and said first chamber;

pumping means for pumping lubricant from said sump to said lubricant gallery, said pumping means being disposed in said second scroll shaft; and

means for concurrently rotating said first and second scroll members.

The invention also includes a scroll compressor apparatus comprising:

a hermetic shell which defines a suction pressure portion, a discharge pressure portion and a sump, said sump being disposed in said suction pressure portion;

a first scroll member disposed in said suction pressure portion, said first scroll member having a first scroll end plate having a first scroll shaft and an oppositely directed first scroll wrap disposed thereon;

a second scroll member disposed in said suction pressure portion, said second scroll member having a second scroll end plate having a second scroll shaft and an oppositely directed second scroll wrap disposed thereon, said scroll wraps being in interleaving and cooperating, in use of the apparatus, to form an alternately open and closed first compression chamber,

said second scroll shaft defining a lubricant gallery and said second scroll end plate defining a lubricant passage which is in flow communication with said first compression chamber and said lubricant gallery;

pumping means for pumping lubricant from said sump to said lubricant gallery, said pumping means being disposed in said second scroll shaft;

a bearing support member disposed in said suction pressure portion;

bearing means disposed in said bearing support member for rotatably supporting said second scroll member;

a motor driveably connected to said first scroll shaft for rotating said first scroll member; and

means for concurrently rotating said second scroll member with said first scroll member.

The invention further includes a refrigeration system for circulating refrigerant in closed loop connection comprising:

a condenser for condensing refrigerant to liquid form;

an expansion device for receiving liquid refrigerant from said condenser and expanding said refrigerant;

an evaporator for receiving said refrigerant from said expansion device and evaporating said refrigerant to vapour form; and

a compressor for receiving said refrigerant from the evaporator, compressing said refrigerant and sending said refrigerant to the condenser, said compressor comprising:

a hermetic shell defining a suction pressure portion, a discharge pressure portion and a sump;

a first scroll member disposed in said suction pressure portion, said first scroll member having a

first scroll end plate having a first scroll shaft and an oppositely directed first scroll wrap disposed thereon;

a second scroll member disposed in said suction pressure portion, said second scroll member having a second scroll end plate having a second scroll shaft and an oppositely directed second scroll wrap disposed thereon, said scroll wraps being in interleaving engagement and cooperating, in operation of the compressor, to form an alternately open and closed first compression chamber, said second scroll shaft defining a lubricant gallery and said second scroll member defining a lubricant passage which is in flow communication with said first compression chamber and said lubricant gallery;

pumping means for pumping lubricant from said sump to said lubricant gallery, said pumping means being disposed in said second scroll shaft;

a bearing support member in said suction portion for supporting said second scroll member;

bearing means disposed in said bearing support member for rotatably supporting said second scroll member;

a motor driveably connected to said first scroll shaft for rotating said first scroll member; and

means for concurrently rotating said second scroll member with said first scroll member.

The invention also includes a scroll apparatus comprising:

a first scroll member having an end plate and a scroll wrap disposed on said end plate;

a second scroll member having an end plate and a scroll wrap disposed on said end plate, said scroll wraps cooperating, in operation of the apparatus, to form an alternately open and closed first chamber,

said second scroll member end plate defining a lubricant passage having an outlet disposed for flow communication with said first chamber;

pumping means for pumping lubricant to said lubricant passage; and

means for rotating said first and second scroll members.

The invention also includes a co-rotational scroll-type fluid-transfer apparatus wherein provision is made for lubricant flow through the length of the scroll wraps by virtue of there being provided at least one lubricant outlet arranged for introducing a lubricant into the region where the scroll wraps in operation of the apparatus cooperate to define an initial fluid-transfer chamber and pumping means for pumping said lubricant to the or each said outlet.

In order that the invention may be well understood, some embodiments thereof, which are given by way of example only, will now be described with reference to the following drawings, in which:

Figure 1 is a cross-sectional view of a co-rotational scroll apparatus;

Figure 2 is a schematic representation of a closed circuit system such as a refrigeration or air conditioning system in which the co-rotational scroll apparatus can be used;

Figure 3 is an enlarged partial cross-sectional view of the scroll apparatus of Figure 1;

Figure 4 is an enlarged partial cross-sectional view of a first alternative embodiment of the co-rotational scroll apparatus; and

Figure 5 is an enlarged partial cross-sectional view of a second alternative embodiment of the co-rotational scroll apparatus.

A co-rotational scroll-type fluid transfer

apparatus generally shown in Figure 1 as a hermetic scroll compressor assembly will be interchangeably referred to as a scroll apparatus or as a compressor assembly 20. It will be readily apparent to those skilled in the art that the described features of the scroll apparatus 20 may equally be used in scroll-type fluid pumps or expanders, and that the scroll apparatus need not necessarily be of the hermetic type.

The compressor assembly 20 includes a hermetic shell 22 having an upper portion 24, a lower, or base, portion 26, and a central exterior shell 27, in which is affixed an intermediate, central frame portion 28. The central frame portion 28 is defined by a generally cylindrical or annular exterior portion 30 and a central portion 32 disposed across one end thereof. The annular exterior portion 30 of the central frame portion 28 is sized to sealingly fit within the central exterior shell 27 so that it may be mated thereto by a press fit, by welding, or by other suitable means.

It will be appreciated that the central frame portion 28 defines within the hermetic shell 22 a suction pressure portion (that portion of the shell volume below the central frame portion in Figure 1) and a discharge pressure portion (that portion of the shell volume above the central frame portion in Figure 1).

Integral with the central frame portion 28 is a generally cylindrical upper bearing housing 34, which is substantially coaxial with the axis of the annular exterior portion 30. A drive shaft aperture 36 extends axially through the center of the upper bearing housing 34, and an upper main bearing 38 is disposed radially within the drive shaft receiving

aperture 36. Preferably, the upper main bearing 38 is a rotation bearing, or journal, and may be made, for example, of sintered bronze or a similar material. The upper main bearing 38 may also be of the roller or ball bearing type.

A motor 40 is disposed within the upper portion 24 and central exterior shell 27 of the hermetic shell 22. The motor 40 is preferably a single phase or three phase electric motor comprised of a stator 42 which is circumferentially disposed about a rotor 44, with an annular space therebetween permitting free rotation of the rotor 44 within the stator 42 as well as the flow of lubricant or refrigerant fluid. The stator 42 may be affixed within the central exterior shell 27 by press fit therebetween, by a plurality of bolts or screws (not shown), by weldments between appropriate mounting surfaces on the stator 42 and the central exterior shell 27 (not shown), or by other means. It will be readily apparent to those skilled in the art that alternative types of motors 40 and means of mounting the motor 40, and alternative types of drive means, would be equally suitable for application in the scroll apparatus 20.

A discharge aperture 50 is shown in the upper shell portion 24 for discharging high pressure fluid from the scroll apparatus 20, and a shell suction aperture 52 is shown disposed in the central exterior shell 27 for receiving low pressure fluid into the scroll apparatus 20. This permits connection of the scroll apparatus 20 to a suitable fluid system. Preferably, the scroll compressor apparatus 20 would be connected to a refrigeration or air conditioning system. Such a system is shown generally in schematic representation in Figure 2. The representative system includes a discharge line 54 connected between the shell discharge aperture 50 and a condenser 60 for expelling heat from the refrigeration system and condensing the refrigerant. A line 62 connects the condenser to an expansion device 64. The expansion device may be a thermally actuated or an electrically actuated valve controlled by a suitable controller (not shown), or may be one or more capillary tubes. Another line 66 connects the expansion device 64 to an evaporator 68 for transferring expanded refrigerant from the expansion device 64 to the evaporator 68 for acceptance of heat. Finally, a refrigeration system suction line 70 transfers the evaporated refrigerant from the evaporator 68 to the compressor assembly 20, wherein the refrigerant is compressed and returned to the refrigeration system.

It is believed that the general principles of refrigeration systems capable of using such a compressor system 20 are well understood in the art, and that detailed explanation of the devices and mechanisms suitable for constructing such a refrigeration system need not be discussed

herein. It is also believed that it will also be apparent to those skilled in the art that such a refrigeration or air conditioning system may include multiple units of the compressor assembly 20 in parallel or series connections, as well as multiple condensers or evaporators and other components, hence such embodiments of refrigeration systems need not be discussed here in detail.

Referring again to Figure 1, and more particularly to Figure 3, the scroll apparatus 20 comprises a drive scroll member, arbitrarily designated the first scroll member 76, and an idler scroll member, arbitrarily designated the second scroll member 78. The first scroll member 76 includes an upstanding first involute scroll wrap 80 which is integral with a generally planar first scroll end plate 82 and a generally centrally disposed first scroll, or drive, shaft 84 extending from the first scroll end plate oppositely of the first scroll wrap 80. A discharge gallery 86 is defined by a bore extending through the axis of the drive shaft 84. The discharge gallery 86 is in flow communication with a discharge aperture 88 defined by a generally central bore through the drive scroll end plate 82. The drive shaft 84 includes a first, relatively larger diameter bearing portion 90 extending axially through the upper main bearing 38 for a free rotational fit therein, and a second relatively smaller diameter rotor portion 92 which extends axially through the rotor 44 and is affixed thereto. The rotor 44 may be affixed to the rotor portion 92 by such means as a power transmitting key in juxtaposed keyways, a press fit therebetween, or other suitable means.

The second, or idler scroll member 78 includes a second, or idler, scroll wrap 100 which is disposed in

interfitting and interleaving engagement with the first scroll wrap 80. The second scroll member 78 also includes a substantially planar second, or idler, end plate 102. The idler scroll wrap 100 is an upstanding involute extending from the idler end plate 102. A second scroll, or idler, shaft 104 extends from the idler end plate 102 oppositely of the idler scroll wrap 100.

A main bearing support member 46 is provided in the central shell 27 between the central frame 28 and the base portion 26 for supporting the second scroll member 78. An annular bearing 110 for rotationally supporting the second scroll member 78 is disposed within an annular wall defining a second shaft or idler bearing housing 112. The bearing housing 112 is integral with the bearing support member 46. The bearing may be a sleeve bearing made of sintered bronze material, for example, or may be of the roller or ball type. Apertures 48 are provided in the lower bearing support member 46 to permit flow communication through the lower bearing support 46.

The idler shaft 104 is annular, having a hollow interior defining a lubricant gallery 120 which is cylindrical. The gallery 120 is defined by a cylindrical outer wall 122, a planar upper surface 124 and the lower end 126 of the shaft 104. While the preferred shape of the lubricant gallery 120 is cylindrical, it would be possible to provide grooves (not shown) or other alterations to enhance control of the lubricant within gallery 120.

Pumping means in the form of a lubricant pump 130 is disposed at or adjacent the lower end 126 of the idler scroll shaft 104. The pump 130 is a centrifugal pump having an angled inner wall 132 for imparting centrifugal energy to lubricant entering through an

intake aperture 134 which thereby functions as a pumping means for ensuring a positive flow of lubricant into the lubricant gallery 120 during operation of the scroll apparatus 20.

A sump 140 for containing a reservoir of accumulated lubricant is disposed in the suction pressure portion of the hermetic shell 22 and is defined by the lower part of the central exterior shell 27 and the base portion 26 of the hermetic shell. The base portion is dome-shaped, to provide both additional strength to resist pressure contained within the hermetic shell 22 and also to permit the settling of any debris contained in fluids in the sump 140 around the perimeter of the sump 140 rather than near the center thereof, and therefore away from the pump 130. This minimizes the chances that any such debris would be brought into the gallery 120 by the action of the pump 130.

A means for baffling the lubricant contained in the sump 140 ensures that in operation of the scroll apparatus, the lubricant is quiescent, so that foaming of the lubricant is minimized and the settling of debris in the sump 140 is enhanced. The bearing support member 46 also serves as means for baffling the lubricant contained in the sump 140. However, those skilled in the art will recognize that a separate baffle may be provided which would be equally suitable, and that the bearing support member 46 need not therefore also perform as the means to baffle the lubricant.

A bearing feed passage 150 is defined in and extends through the idler scroll shaft 104 to allow lubricant flow from the lubricant gallery 120 to the bearing 110. The bearing feed passage 150 is sized to control the volume of lubricant flow to the bearing

110 to ensure proper lubrication according to the size and material used in the bearing 110 of the particular scroll apparatus 20. As shown, the bearing feed passage 150 is located approximately midway between the upper surface 124 and the lower end 126 of the gallery 120 for an evenly proportioned flow of lubricant along the idler scroll bearing 110.

The upper shoulder 170 of the bearing housing 112 serves as an annular thrust bearing for accepting the weight of the first and second scroll members 76 and 78 as well as the rotor 44. It will be appreciated by those skilled in the art that it is desirable for the scroll apparatus to be disposed in a vertical or near vertical position (for example, within 46 degrees of vertical) so that the mass of the rotor 44 and the scroll members 76 and 78 will bias the second scroll member 78 against the thrust bearing 170.

A reservoir 180 for containing lubricant is provided in the central portion 32 of the frame portion 28. The lubricant therein is provided to the upper main bearing 38 through an upper bearing lubricant bore 182 in the upper bearing housing 34. The upper main bearing 38 is sized with respect to the drive shaft 84 so that the flow of lubricant discharged into the sump 140 is controlled in quantity.

The second scroll end plate 102 defines passage means in the form of a lubricant passage 200 which extends radially outwardly through the end plate 102. The lubricant passage 200 is in flow communication with the lubricant gallery 120 adjacent the upper surface 124 thereof. A lubricant passage outlet 202 permits fluid flow from the lubricant passage 200 to the first chamber 204 formed by the outer ends 206 and 208 of the scroll wraps 76 and 78, respectively. It

will be noted that while the first chamber 204 in a compression device is a compression chamber, the first chamber 204 is in fact also a suction chamber since it is open to suction pressure during at least a portion of the rotation of the scroll apparatus, so that the term is used interchangeably herein.

A plug 218 is provided in the outer radial end of the lubricant passage 200. This plug 218 is necessitated by the fact that the lubricant passage 200 as shown is drilled into the second scroll end plate 102. Alternative means of constructing the second scroll end plate 102 might render the plug 218 unnecessary, as the passage 200 would be fully contained within the second scroll end plate 102. Those skilled in the art will recognise that alternative means of forming the passage 200 or of replacing the plug 218 are available.

It will also be appreciated by those skilled in the art that while two radially opposed lubricant passages 200 are shown in the second scroll end plate 102, it would be possible to provide one, three, four or more lubricant passages 200, and such passages 200 need not be either radially opposed or equally radially or angularly spaced. Therefore, the provision of two lubricant passages are shown in this and each of the other embodiments for descriptive purposes only.

The scroll apparatus 20 is shown in Figures 1 and 3 having an interconnecting drive means between the first scroll member 76 and the second scroll member 78 for ensuring concurrent rotation of the scroll members. The drive means includes two radially opposed drive keys 220 which extend from the second scroll end plate 82 and two radially opposed idler keys (not shown). The drive keys 220 and the idler

keys are disposed at 90 degree intervals about the axis of the scroll members for sliding engagement with drive slots 228 of a drive coupling 230, whereby concurrent rotation of the scroll members 76 and 78 is ensured. Those skilled in the art will recognize that there are several alternative means of ensuring concurrent rotation between the first scroll member 76 and second scroll member 78 which are readily available. These include the use of flexible members affixed to the respective scroll end plates or the provision of gears and shaft in engagement with each scroll member. As there are various equally suitable alternative drive means for rendering operational the scroll apparatus 20, no further discussion of any particular drive means is believed to be necessary herein and the inclusion of a drive means in the alternative embodiments of scroll apparatus 20 shown in Figures 4 and 5 is indicated by linked arrows D.

When the same item or feature appears in a figure illustrating an alternative embodiment of the scroll apparatus, it is labelled with the same reference numeral, followed by a numeric suffix to correspond with the designation of that alternative embodiment in the specification. The numeric designation of the alternative embodiment does not correspond to its preference but rather is intended simply to distinguish the embodiments.

Turning now to Figure 4, a first alternative embodiment of the scroll apparatus 20-1 comprises pumping means in the form of a positive displacement pump 130-1 rather than the centrifugal pump 130 of the above-described embodiment. A positive displacement pump 130-1 provides the advantage of positive lubricant flow in a scroll apparatus operating at a relatively low rotational speed, or where the scroll

apparatus operates over a wide range of speeds. The positive displacement pump 130-1 is provided with a lubricant inlet tube 240-1 which extends therefrom into the sump 140-1 to ensure a flow of lubricant into the pump 130-1. While the preferred type of positive displacement pump 130-1 would be an internal gear pump, there are several types of positive displacement pumps 130-1 which are suitable for shaft end application. Internal gear pumps and other such suitable pumps 130-1 are believed to be well known in the art and no extensive discussion is believed to be necessary herein.

In Figure 5, a second alternative embodiment of the scroll apparatus 20-2 comprises, in the same way as scroll apparatus 20-1, a positive displacement pump 130-2. In this alternative embodiment, the bearing support member 45-2 has a floor portion 49-2 so as to enclose, or substantially enclose, the lower end 126-2 of the idler scroll shaft 104-2.

The lower end 126-2 of the second scroll shaft, the floor portion 49-2 and a pressure seal 250-2 which is disposed between the lubricant inlet tube 240-2 and the floor portion define a pressure balance chamber 252-2 between the idler scroll shaft lower end 126-2 and the lower bearing housing 112-2. The pressure seal 250-2 seals an aperture in the floor portion 49-2 which permits the lubricant inlet tube 240-2 to extend into the sump 140-2 to withdraw lubricant therefrom. A pressure bleed passage 254-2 defined in the second scroll end plate 102-2 permits the flow of pressurized fluid from one of the chambers formed by the scroll wraps 80-2 and 100-2 into the pressure balance chamber 252-2 by way of a passage 256-2 in the lower bearing housing 112-2. The pressurized fluid in the pressure balance chamber 252-2 acts upon the idler scroll shaft

104-2 to provide a pressure biasing force biasing the second scroll member toward the first scroll member 76-2.

The operation of either of the above described alternative embodiments of the scroll apparatus 20-1, 20-2 is substantially similar to that of the preferred embodiment (scroll apparatus 20) which operation is described below. Therefore no separate description of the operation of the alternative embodiments is believed necessary.

Returning again to Figures 1 and 3 for reference, the operation of the scroll apparatus 20 will now be described. In operation, the motor 40 of the compressor assembly 20 is connected to an appropriate electrical supply (not shown) and actuated to cause rotation of the rotor 44. The rotor 44 in turn rotates the drive shaft 84, driving the first scroll end plate 82. The drive means D causes the concurrent rotation of the lower, or second, scroll member 78. Because the axis of the first scroll member 76 is not aligned with the axis of the second scroll member 78, a relative orbital motion is set up between the driven scroll wrap 80 and the idler scroll wrap 100. This orbital motion causes a plurality of chambers to be formed. A first chamber, as defined by the outer scroll portions 206 and 208, is open to and closed from the suction space. The first chambers thus formed decrease in volume as they move toward the radially inner ends of the respective scroll wraps 80 and 100 whereby fluid drawn into the first chamber is compressed.

The compressed fluid is discharged from the scroll wraps 80 and 100 through the discharge aperture 88 into the discharge gallery 86 and thereafter into the discharge pressure portion of the hermetic shell

22 defined in the upper shell portion 24.

Lubricant separated from inlet suction fluid flows into the sump 140 and accumulates therein with that discharged from the upper main bearing 38. Lubricant accumulating within the sump 140 is forced into the lubricant gallery 120 by the centrifugal pump 130. The pump 130 maintains a positive flow of lubricant into the gallery 120 as long as the scroll apparatus 20 is in operation.

Lubrication of the idler bearing 110 occurs after operation of the scroll apparatus 20 has started and the lubricant level in the lubricant gallery 120 has reached the bearing feed passage 150, with lubricant flowing therethrough to the idler bearing 110.

Those skilled in the art will appreciate that the lubricant pump 130 will maintain the level of lubricant in the sump 140 at a desired level, preventing an undesirable accumulation of fluid, whether the fluid is lubricant alone or condensed from the gases to be compressed or other unpumped fluid. The various lubricant passages 200 provide the desired effect of maintaining adequate lubrication of the scroll wraps 80 and 100 without undue consumption of power in the pumping of lubricant. A positive, adequate flow of lubricant also improves the sealing of the chambers of the scroll apparatus, providing an additional performance benefit.

In the embodiments, a co-rotational scroll-type fluid transfer apparatus comprises two scroll members acting as a compressor, each scroll member having a scroll wrap which is in interleaving engagement with the other respective scroll wrap. The scroll members operate in a container, or shell,which is provided with an inlet for fluid, and are oriented so that the axes of the scroll members are generally vertical.

One of the scroll members is provided with passage means which communicate through the scroll member to discharge lubricant between the scroll end plates. The lubricant is discharged through outlets, or openings, adjacent the respective outer end of each of the scroll wraps adjacent the point where the scroll wraps form the first compression chamber so as to provide lubricant to the entire scroll wrap length. The outlets can be disposed in the scroll end plate at any location adjacent the outer ends of the scroll wraps which will permit lubricant flow into the first compression chamber as it is formed.

Lubricant is provided to the passage means through a lubricant gallery in the shaft of the scroll member. A pumping means in the end of the shaft is exposed to a low-pressure sump adjacent the end of the scroll member shaft. The sump is generally at the lowest point in the scroll apparatus so that lubricant in the space containing the scroll members tends to collect in the sump. The pumping means provides a positive flow of lubricant from the sump into the lubricant gallery and hence into the lubricant passages. This positive flow ensures a flow of lubricant to the scroll wraps via the outlets and also limits the amount of lubricant accumulation in the sump.

A flow of lubricant is also provided to the bearing which rotatably supports the scroll member in which the lubricant gallery is disposed. This is accomplished by providing lubricant feed passages in the shaft of that scroll member, thereby permitting a metered flow of lubricant through the shaft to the bearing.

It will be appreciated that the scroll apparatus of the embodiments is suitable for use in closed

circuit systems such as refrigeration systems and is simple, inexpensive and suitable for mass production.

It will be appreciated that the scroll apparatus 20, 20-1, 20-2 can be readily implemented without substantial modification of conventional scroll apparatus. The provision of constant, positive lubrication prevents unnecessary wear in the scroll wraps and assures a controlled, effective and adequate flow of lubricant therethrough, reducing unnecessary wear and potential requirements for maintenance in the compressor assembly. It will be appreciated, therefore, that the compressor assembly has both improved reliability and efficiency.

Modifications to the preferred and alternative embodiments of the subject invention will be apparent to those skilled in the art within the scope of the claims that follow hereinbelow.

CLAIMS:

1. A scroll apparatus comprising:

a shell defining a suction pressure portion and a sump, said sump being disposed in said suction pressure portion;

a first scroll member disposed in said suction pressure portion, said first scroll member having a first scroll end plate having a first scroll shaft and an oppositely directed first scroll wrap disposed thereon;

a second scroll member disposed in said suction pressure portion, said second scroll member having a second scroll end plate having a second scroll shaft and an oppositely directed second scroll wrap disposed thereon, said scroll wraps being in interleaving engagement and cooperating, in use of the apparatus, to form an alternately open and closed first chamber, said second scroll end plate defining a lubricant passage and said second scroll shaft defining a lubricant gallery, said lubricant passage being in flow communication with said lubricant gallery and said first chamber;

pumping means for pumping lubricant from said sump to said lubricant gallery, said pumping means being disposed in said second scroll shaft; and

means for concurrently rotating said first and second scroll members.

2. A scroll apparatus as claimed in claim 1, wherein said shell comprises a bearing support member for supporting said second scroll member shaft and baffling said sump such that, in use of the apparatus, lubricant in said sump is quiescent.

3. A scroll apparatus as claimed in claim 2, further comprising a bearing disposed in said bearing support member for providing rotational support to said second scroll member.

4. A scroll apparatus as claimed in claim 3, wherein said second scroll shaft comprises a bearing feed passage in flow communication with said lubricant gallery and said bearing for permitting flow of lubricant to said bearing.

5. A scroll apparatus as claimed in any one of claims 1 to 4, wherein said shell further comprises a portion in said sump adapted for permitting the settling of debris from the lubricant away from said pumping means.

6. A scroll apparatus as claimed in any one of the preceding claims, wherein said pumping means is a centrifugal pump.

7. A scroll apparatus as claimed in any one of claims 1 to 5, wherein said pumping means is a positive displacement pump.

8. A scroll compressor apparatus comprising:

a hermetic shell which defines a suction pressure portion, a discharge pressure portion and a sump, said sump being disposed in said suction pressure portion;

a first scroll member disposed in said suction pressure portion, said first scroll member having a first scroll end plate having a first scroll shaft and an oppositely directed first scroll wrap disposed thereon;

a second scroll member disposed in said suction

pressure portion, said second scroll member having a second scroll end plate having a second scroll shaft and an oppositely directed second scroll wrap disposed thereon, said scroll wraps being in interleaving and cooperating, in use of the apparatus, to form an alternately open and closed first compression chamber, said second scroll shaft defining a lubricant gallery and said second scroll end plate defining a lubricant passage which is in flow communication with said first compression chamber and said lubricant gallery;

pumping means for pumping lubricant from said sump to said lubricant gallery, said pumping means being disposed in said second scroll shaft;

a bearing support member disposed in said suction pressure portion;

bearing means disposed in said bearing support member for rotatably supporting said second scroll member;

a motor driveably connected to said first scroll shaft for rotating said first scroll member; and

means for concurrently rotating said second scroll member with said first scroll member.

9. A scroll apparatus as claimed in claim 8, further comprising a bearing feed passage defined in said second scroll shaft, said bearing feed passage being in flow communication with said lubricant gallery and said bearing for permitting flow of the lubricant to said bearing.

10. A scroll apparatus as claimed in claim 8 or 9, wherein said shell comprises a base portion having a perimeter region adapted to permit settling of debris from fluid in said sump.

11. A scroll apparatus as claimed in claim 8, 9 or 10, further comprising baffle means for baffling lubricant in said sump.

12. A scroll apparatus as claimed in any one of claims 8 to 11, wherein said pumping means is a positive displacement.

13. A scroll apparatus as claimed in any one of claims 8 to 12, wherein said pumping means comprises a lubricant inlet tube extending into said sump.

14. A scroll apparatus as claimed in claim 13, further comprising a pressure balance chamber, said pressure balance chamber being defined by (i) a lower end of said second scroll shaft, (ii) said bearing support member, which is provided with a floor portion so as to substantially enclose said lower end, and (iii) a pressure seal disposed between said floor portion and said lubricant tube.

15. A scroll apparatus as claimed in claim 14, wherein said second scroll end plate comprises a pressure bleed passage for communicating said pressurized fluid to said pressure balance chamber.

16. A scroll apparatus as claimed in any one of claims 8 to 11, wherein said pumping means is a centrifugal pump.

17. A refrigeration system for circulating refrigerant in closed loop connection comprising:

a condenser for condensing refrigerant to liquid form;

an expansion device for receiving liquid

refrigerant from said condenser and expanding said refrigerant;

an evaporator for receiving said refrigerant from said expansion device and evaporating said refrigerant to vapour form; and

a compressor for receiving said refrigerant from the evaporator, compressing said refrigerant and sending said refrigerant to the condenser, said compressor comprising:

a hermetic shell defining a suction pressure portion, a discharge pressure portion and a sump;

a first scroll member disposed in said suction pressure portion, said first scroll member having a first scroll end plate having a first scroll shaft and an oppositely directed first scroll wrap disposed thereon;

a second scroll member disposed in said suction pressure portion, said second scroll member having a second scroll end plate having a second scroll shaft and an oppositely directed second scroll wrap disposed thereon, said scroll wraps being in interleaving engagement and cooperating, in operation of the compressor, to form an alternately open and closed first compression chamber, said second scroll shaft defining a lubricant gallery and said second scroll member defining a lubricant passage which is in flow communication with said first compression chamber and said lubricant gallery;

pumping means for pumping lubricant from said sump to said lubricant gallery, said pumping means being disposed in said second scroll shaft;

a bearing support member in said suction portion for supporting said second scroll member;

bearing means disposed in said bearing support member for rotatably supporting said second scroll

member;

a motor driveably connected to said first scroll shaft for rotating said first scroll member; and

means for concurrently rotating said second scroll member with said first scroll member.

18. A refrigeration system as claimed in claim 17, further comprising a bearing feed passage defined in said second scroll shaft for permitting flow of lubricant from said lubricant gallery to said bearing means.

19. A refrigeration system as claimed in claim 17 or 18, wherein said suction pressure portion comprises a base portion having a perimeter region adapted to permit settling of debris from fluid in said sump.

20. A refrigeration system as claimed in claim 17, 18 or 19, further comprising baffle means for reducing foaming of lubricant in said sump in operation of the compressor.

21. A refrigeration system as claimed in any one of claims 17 to 20, wherein said pumping means is a positive displacement pump.

22. A refrigeration system as claimed in any one of claims 17 to 21, wherein said pumping means comprises a lubricant inlet tube extending therefrom into said sump.

23. A refrigeration system as claimed in claim 22, wherein said bearing support member is adapted to substantially enclose a lower end of said second scroll shaft and a pressure seal is disposed between

a floor portion of said bearing support member and said lubricant inlet tube, whereby said bearing support member, second scroll shaft and pressure seal define a pressure balance chamber.

24. A refrigeration system as claimed in claim 23, wherein said second scroll end plate comprises a pressure bleed passage for communicating pressurized fluid to said pressure balance chamber.

25. A refrigeration system as claimed in any one of claims 17 to 20, wherein said pumping means is a centrifugal pump.

26. A scroll apparatus comprising:

a first scroll member having an end plate and a scroll wrap disposed on said end plate;

a second scroll member having an end plate and a scroll wrap disposed on said end plate, said scroll wraps cooperating, in operation of the apparatus, to form an alternately open and closed first chamber, said second scroll member end plate defining a lubricant passage having an outlet disposed for flow communication with said first chamber;

pumping means for pumping lubricant to said lubricant passage; and

means for rotating said first and second scroll members.

27. A co-rotational scroll-type fluid-transfer apparatus wherein provision is made for lubricant flow through the length of the scroll wraps by virtue of there being provided at least one lubricant outlet arranged for introducing a lubricant into the region where the scroll wraps in operation of the apparatus

cooperate to define an initial fluid-transfer chamber and pumping means for pumping said lubricant to the or each said outlet.

28. An apparatus as claimed in claim 27, wherein one scroll member of said apparatus comprises passage means in an end plate thereof, said passage means being in flow communication with the or each outlet and said pumping means via passage means defined in a rotatable shaft extending from said end plate.

29. A co-rotational scroll-type fluid-transfer apparatus substantially as herein described with reference to Figures 1 and 3, Figure 4 or Figure 5 of the accompanying drawings.

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