(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 348 601 A2**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: 89105199.7

(51) Int. Cl.4: **F04C 18/02**

(22) Date of filing: 23.03.89

(30) Priority: 01.07.88 US 214446

(43) Date of publication of application: 03.01.90 Bulletin 90/01

(84) Designated Contracting States: DE FR GB IT

(71) Applicant: TECUMSEH PRODUCTS COMPANY
100 East Patterson Street
Tecumseh Michigan 49286(US)

(72) Inventor: Barito, Thomas R.
200 Wellington Road
Dewitt New York 13214(US)
Inventor: Richardson, Hubert, Jr.
10121 North Hawkins Highway
Brooklyn Michigan 49230(US)
Inventor: Johnson, William C.
221 Pentecost Highway
Onsted Michigan 49265(US)

(74) Representative: Weitzel, Wolfgang, Dr.-Ing.
St. Pöltener Strasse 43
D-7920 Heidenheim(DE)

(54) **Scroll compressor.**

(57) A scroll-type hermetic compressor is disclosed including a hermetically sealed housing (12), fixed and orbiting scroll members (48, 50), a stationary frame member (52) including a thrust surface (55) adjacent the orbiting scroll member bottom surface (51), and a crankshaft (32) drivingly coupled to the orbiting scroll member. A seal (158) extends from a fixed location on the orbiting scroll member bottom surface toward the thrust surface and slidingly seals thereagainst, whereby fixed radially inner and outer portions (154, 156) of the scroll member are defined which are exposed to discharge and suction pressures (110, 98) for axial compliance. The seal consists of an annular groove (152) on the orbiting scroll member bottom surface in which an annular seal element (158) is unattachedly retained. The groove may be supplied with pressurized oil to aid in sealing with the seal element or, alternatively, to provide a hydrostatic seal without a seal element.

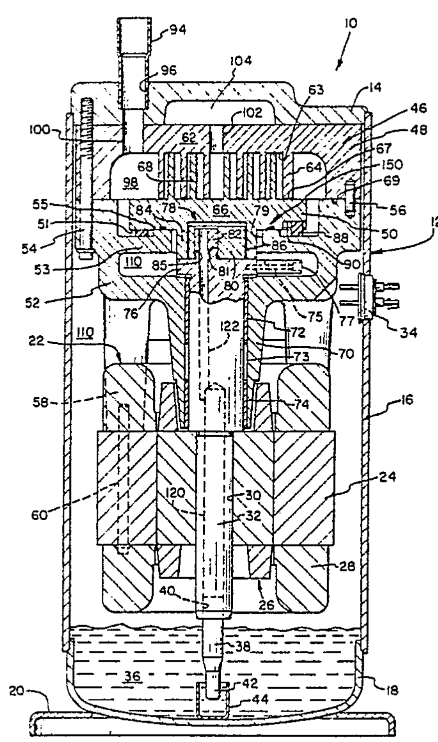


FIG. 1

EP 0 348 601 A2

SCROLL COMPRESSOR

The present invention relates generally to a hermetic scroll-type compressor and, more particularly, to such a compressor having intermeshing fixed and orbiting scroll members, wherein it is necessary to provide an axial force on the orbiting scroll member to bias it toward the fixed scroll member for proper sealing therebetween.

A typical scroll compressor comprises two facing scroll members, each having an involute wrap, wherein the respective wraps interfit to define a plurality of closed pockets. When one of the scroll members is orbited relative to the other, the pockets travel between a radially outer suction port and a radially inner discharge port to convey and compress the refrigerant fluid.

It is generally believed that the scroll-type compressor could potentially offer quiet, efficient, and low-maintenance operation in a variety of refrigeration system applications. However, several design problems persist that have prevented the scroll compressor from achieving wide market acceptance and commercial success. For instance, during compressor operation, the pressure of compressed refrigerant at the interface between the scroll members tends to force the scroll members axially apart. Axial separation of the scroll members causes the closed pockets to leak at the interface between the wrap tips of one scroll member and the face surface of the opposite scroll member. Such leakage causes reduced compressor operating efficiency and, in extreme cases, can result in an inability of the compressor to operate.

Attempts in prior art scroll-type compressors to resist the separating force applied to the scroll members during operation of the compressor, in order to prevent the aforementioned leakage, have not proven to be entirely satisfactory. One approach is to axially preload the scroll members toward each other with a force sufficient to resist the dynamic separating force. However, this approach results in high initial frictional forces between the scroll members and/or bearings when the compressor is at rest, thereby causing difficulty during compressor startup. Another prior art approach involves assuring close manufacturing tolerances for component parts and having the separating force borne by a thrust bearing. This approach not only requires an expensive thrust bearing, but also involves high manufacturing costs in maintaining close machining tolerances.

Another prior art scroll-type compressor design, disclosed in many prior art patents, involves the provision of an intermediate pressure chamber behind the orbiting scroll member, whereby the intermediate pressure creates an upward force to oppose the separating force. Such a design recognizes the fact that suction pressure behind the orbiting scroll member is insufficient to oppose the separating force, while discharge pressure behind the orbiting scroll member results in too great an upward force causing rapid wear of the scroll wraps and faces. However, establishing an intermediate pressure between suction pressure and discharge pressure requires that an intentional leak be introduced between an intermediate pressure pocket and a discharge pressure region. Such a leak results in less efficient operating conditions for the compressor.

Several other prior art scroll compressor designs, directed to controlling the upward force on the orbiting scroll member to oppose the separating force, have utilized a combination of gaseous refrigerant at suction pressure and gaseous refrigerant at discharge pressure for exposure to respective areas on the backside of the orbiting scroll member. In such compressor designs, various seal means have been utilized to separate the respective gas pressure regions. For instance, it is known to attach an annular seal element to a fixed frame member adjacent the bottom surface of the orbiting scroll member, whereby the seal element extends toward and slidingly seals against the bottom surface. A problem with such a seal arrangement is that the relative orbiting motion of the scroll member with respect to the seal element changes the axial force distribution on the scroll member, thereby generating an unwanted moment.

Another axial compliance mechanism for a scroll compressor involves respective regions of the orbiting scroll member bottom surface exposed to oil at discharge pressure and refrigerant fluid at suction pressure. The regions are sealingly separated by a flexible annular seal element that is disposed between the orbiting scroll member bottom surface and a rotating thrust surface comprising a radially extending plate portion of a driven crankshaft.

The present invention is directed to overcoming the aforementioned problems associated with scroll-type compressors, wherein it is desired to provide an axial force on the orbiting scroll member to facilitate sealing and prevent leakage between the interfitting scroll members.

The present invention overcomes the disadvantages of the above-described prior art scroll-type compressors by providing an improved axial compliance mechanism, capable of applying a net axial force on the bottom surface of an orbiting scroll member toward a cooperating fixed scroll member, to resist the tendency of the scroll members to axially separate during compressor operation.

Generally, the present invention provides an axial compliance mechanism for a scroll-type compressor wherein a seal extends from a fixed location on the back surface of the orbiting scroll member toward an adjacent stationary thrust surface and slidingly seals thereagainst, whereby the seal separates between fixed portions of the bottom surface which are exposed to discharge and suction pressure, respectively, despite the orbiting motion of the orbiting scroll member relative to the stationary thrust plate.

More specifically, the invention provides, in one form thereof, a hermetically sealed scroll-type compressor comprising a housing including a discharge pressure chamber and a suction pressure chamber therein. Fixed and orbiting scroll members include respective wrap elements that are operatively intermeshed to compress refrigerant fluid when the orbiting scroll member is caused to orbit relative to the fixed scroll member. The orbiting scroll member includes a plate portion having a back surface adjacent a stationary thrust surface. A seal is provided intermediate the back surface and the stationary thrust surface to sealingly separate between respective portions of the plate portion back surface exposed to the discharge and suction pressure chambers. The seal is fixed with respect to the orbiting scroll member and slidingly engages the thrust surface, whereby the respective exposed portions of the back surface are fixed despite the orbiting motion of the orbiting scroll member.

In one aspect of the invention, the seal intermediate the orbiting scroll member and the stationary thrust surface is an annular seal element unattachedly retained within an annular seal groove on the plate portion bottom surface. In another aspect of the invention, oil at substantially discharge pressure is provided within the annular seal groove to help urge the annular seal element into sealing relationship with the thrust surface. In yet another aspect of the invention, the seal comprises a hydrostatic seal wherein oil at discharge pressure is supplied to the annular seal groove and exits therefrom toward the thrust surface to provide a seal without the use of an annular seal element. In each of the aforementioned seal arrangements, the seal orbits with the orbiting scroll member such that the portion of the bottom surface exposed to discharge and suction pressure are fixed.

An advantage of the scroll compressor of the present invention is that axial forces applied to the orbiting scroll member bottom surface, for the purpose of axial compliance of the orbiting scroll member toward the fixed scroll member, are substantially identical throughout orbiting motion of the scroll member, thereby reducing undesirable moments with respect to the orbiting scroll member central axis.

Another advantage of the scroll compressor of the present invention is that sealing between respective portions of the orbiting scroll member bottom surface exposed to discharge and suction pressure is accomplished while allowing for a fixed location of the respective portions during orbiting motion of the scroll member.

A further advantage of the scroll compressor of the present invention is that sealing between respective portions of the orbiting scroll member bottom surface exposed to discharge and suction pressure is accomplished with a simple seal that does not require that a seal element be fixedly attached to other compressor components, thereby avoiding potential seal leakage problems.

Another advantage of the scroll compressor of the present invention, in accordance with one form thereof, is that sealing between respective portions of the orbiting scroll member bottom surface exposed to discharge and suction pressure is enhanced by the discharge pressure present at the interface between pressure regions rather than requiring an additional source of discharge pressure.

A still further advantage of the scroll compressor of the present invention is that axial compliance of the orbiting scroll member toward the fixed scroll member is accomplished effectively without excessive leakage between the discharge pressure region and suction pressure region of the compressor.

Yet another advantage of the scroll compressor of the present invention is the provision of a simple, reliable, inexpensive, and easily manufactured axial compliance mechanism for producing a substantially fixed axial force on the orbiting scroll member toward the fixed scroll member.

The scroll compressor of the present invention, in one form thereof, provides a hermetically sealed housing including therein a discharge pressure chamber at discharge pressure and a suction pressure chamber at suction pressure. A fixed scroll member is provided having an involute fixed wrap element. Likewise, an orbiting scroll member is provided including a plate portion having a face surface and a back surface. The face surface has an involute orbiting wrap element thereon, whereby the fixed and orbiting wrap elements are intermeshed to define at least one pocket of refrigerant fluid compressed by orbiting motion of the orbiting scroll member with respect to the fixed scroll member. A stationary thrust surface is adjacent the plate portion back surface. A seal intermediate the orbiting scroll member and the stationary thrust surface sealingly separates between respective portions of the plate portion back surface exposed to the discharge pressure chamber and the suction pressure chamber. The seal establishes the respective portions of the plate portion back surface at fixed locations thereon, despite the orbiting motion of the orbiting scroll member. The seal may comprise an annular seal element partially disposed within a seal groove included on the plate portion bottom surface. In such an arrangement, the annular seal element may be unattachedly retained within the annular seal groove.

The present invention further provides, in one form thereof, a scroll-type compressor including a hermetically sealed housing having discharge and suction pressure chambers therein. An oil sump is provided within the discharge pressure chamber. Fixed and orbiting scroll members operatively intermesh to define at least one pocket of refrigerant fluid compressed by orbiting motion of the orbiting scroll member with respect to the fixed scroll member. The bottom surface of the orbiting scroll member has an annular seal groove formed therein. A stationary thrust surface is provided adjacent the orbiting scroll member bottom surface. A seal mechanism, cooperating between the orbiting scroll member and the stationary thrust surface, sealingly separates between respective portions of the orbiting scroll member bottom surface exposed to discharge pressure and suction pressure. The seal mechanism establishes the respective portions on the orbiting scroll member bottom surface at fixed locations thereon despite the orbiting motion of the orbiting scroll member. According to this form of the invention, the seal mechanism operates by supplying oil flow from the oil sump into the annular seal groove. For example, oil may be supplied to the groove through an axial passageway in the crankshaft and radial passageways in the orbiting scroll member. According to one aspect of the invention, the seal mechanism comprises a hydrostatic seal provided by flow of oil from the annular seal groove toward the thrust surface. In accordance with another aspect of the present invention, the seal mechanism comprises an annular seal element partially disposed within the annular seal groove. The seal element extends from the groove toward the thrust surface to sealingly contact thereagainst. Oil in the annular seal groove provides an urging force to the annular seal element toward the thrust surface.

Fig. 1 is a longitudinal sectional view of a compressor of the type to which the present invention pertains, taken along the line 1-1 in Fig. 3 and viewed in the direction of the arrows;

Fig. 2 is a longitudinal sectional view of the compressor of Fig. 1, taken along the line 2-2 in Fig. 3 and viewed in the direction of the arrows;

Fig. 3 is a top view of the compressor of Fig. 1;

Fig. 4 is an enlarged fragmentary sectional view of the compressor of Fig. 1, according to one embodiment of the present invention;

Fig. 5 is an enlarged bottom view of the orbiting scroll member of the compressor of Fig. 1;

Fig. 6 is an enlarged fragmentary sectional view of the compressor of Fig. 1, particularly showing the annular seal element in a non-actuated state;

Fig. 7 is an enlarged fragmentary sectional view of the compressor of Fig. 1, particularly showing the annular seal element in an actuated state;

Fig. 8 is an enlarged fragmentary sectional view of a scroll-type compressor similar to the compressor of Fig. 1, according to an alternative embodiment of the present invention wherein the seal groove is supplied with oil through radially extending passages in the orbiting scroll member, the reference numerals used in Figs. 8-12 being identical to those used in Figs. 1-7 in the case of identical components, and being primed in those instances where a component has been modified in accordance with the alternative embodiment;

Fig. 9 is a bottom view of the orbiting scroll member of the compressor of Fig. 8;

Fig. 10 is an enlarged fragmentary sectional view of the compressor of Fig. 8, particularly showing a hydrostatic seal not utilizing an annular seal element;

Fig. 11 is an enlarged fragmentary sectional view of the compressor of Fig. 8, wherein an annular seal element is utilized, particularly showing the annular seal element in a non-actuated state;

Fig. 12 is an enlarged fragmentary sectional view of the compressor of Fig. 8, particularly showing the annular seal element of Fig. 11 in an actuated state;

Fig. 13 is an enlarged bottom view of the orbiting scroll member of the compressor of Fig. 1, according to an alternative embodiment of the present invention wherein radial grooves are provided to enhance seal actuation; and

Fig. 14 is an enlarged fragmentary sectional view of the compressor of Fig. 1 incorporating the orbiting scroll member of Fig. 13, particularly showing the annular seal element in a non-actuated state.

In an exemplary embodiment of the invention as shown in the drawings, and in particular by referring to Figs. 1-3, a compressor 10 is shown having a housing generally designated at 12. The housing has a top cover plate 14, a central portion 16, and a bottom portion 18, wherein central portion 16 and bottom portion 18 may alternatively comprise a unitary shell member. The three housing portions are hermetically secured together as by welding or brazing. A mounting flange 20 is welded to bottom portion 18 for mounting the compressor in a vertically upright position. Located within hermetically sealed housing 12 is an electric motor generally designated at 22, having a stator 24 and a rotor 26. Stator 24 is provided with windings 28. Rotor 26 has a central aperture 30 provided therein into which is secured a crankshaft 32 by an interference fit. A terminal cluster 34 is provided in central portion 16 of housing 12 for connecting motor 22 to a source of electric power.

Compressor 10 also includes an oil sump 36 generally located in bottom portion 18. A centrifugal oil pickup tube 38 is press fit into a counterbore 40 in the lower end of crankshaft 32. Oil pickup tube 38 is of conventional construction and includes a vertical paddle (not shown) enclosed therein. An oil inlet end 42 of pickup tube 38 extends downwardly into the open end of a cylindrical oil cup 44, which provides a quiet zone from which high quality, non-agitated oil is drawn.

Compressor 10 includes a scroll compressor mechanism 46 enclosed within housing 12. Compressor mechanism 46 generally comprises a fixed scroll member 48, an orbiting scroll member 50, and a main bearing frame member 52. As shown in Fig. 1, fixed scroll member 48 and frame member 52 are secured together and are attached to top cover plate 14 by means of a plurality of mounting bolts 54. Precise alignment between fixed scroll member 48 and frame member 52 is accomplished by a pair of locating pins 56. Frame member 52 includes a plurality of mounting pads 58 to which motor stator 24 is attached by means of a plurality of mounting bolts 60, such that there is an annular gap between stator 24 and rotor 26.

Fixed scroll member 48 comprises a generally flat face plate 62 having a face surface 63, and an involute fixed wrap 64 extending axially from surface 63. Likewise, orbiting scroll member 50 comprises a generally flat face plate 66 having a back surface 51, top face surface 67, and an involute orbiting wrap 68 extending axially from surface 67. Fixed scroll member 48 and orbiting scroll member 50 are assembled together so that fixed wrap 64 and orbiting wrap 68 operatively interfit with each other. Furthermore, face surfaces 63, 67 and wraps 64, 68 are manufactured or machined such that, during compressor operation when the fixed and orbiting scroll members are forced axially toward one another, the tips of wraps 64, 68 sealingly engage with respective opposite face surfaces 67, 63. Alternatively, the radially outermost portion of face surface 67 could slidably bear against a bottom surface 69 of fixed scroll member 48, in which case surface 69 would extend further radially inwardly than shown in the drawings.

Main bearing frame member 52 includes an annular, radially inwardly projecting portion 53, including an axially facing stationary thrust surface 55 adjacent back surface 51 and in opposing relationship thereto. Back surface 51 and thrust surface 55 lie in substantially parallel planes and are axially spaced according to machining tolerances and the amount of permitted axial compliance movement of orbiting scroll member 50 toward fixed scroll member 48.

Main bearing frame member 52, as shown in Figs. 1 and 2, further comprises a downwardly extending bearing portion 70. Retained within bearing portion 70, as by press fitting, is a conventional sleeve bearing assembly comprising an upper bearing 72 and a lower bearing 74. Two sleeve bearings are preferred rather than a single longer sleeve bearing to facilitate easy assembly into bearing portion 70 and to provide an annular space 73 between the two bearings 72, 74. Accordingly, crankshaft 32 is rotatably journalled within bearings 72, 74.

Crankshaft 32 includes a concentric thrust plate 76 extending radially outwardly from the sidewall of crankshaft 32. A balance weight 77 is attached to thrust plate 76, as by bolts 75. In the preferred embodiment disclosed herein, the diameter of thrust plate 76 is less than the diameter of a round opening 79 defined by inwardly projecting portion 53 of frame 52, whereby crankshaft 32 may be inserted downwardly through opening 79. Once crankshaft 32 is in place, balance weight 77 is attached thereto through a mounting hole (not shown) extending through frame member 52. This mounting hole also insures that the space surrounding thrust plate 76 is part of housing chamber 110 at discharge pressure.

Situated on the top of crankshaft 32 is an eccentric crank mechanism 78. According to a preferred embodiment, crank mechanism 78 comprises a cylindrical roller 80 having an axial bore 81 extending therethrough at an off-center location. An eccentric crankpin 82, constituting the upper, offset portion of crankshaft 32, is received within bore 81, whereby roller 80 is eccentrically journalled about eccentric crankpin 82. Orbiting scroll member 50 includes a lower hub portion 84 that defines a cylindrical well 85 into which roller 80 is received. Roller 80 is journalled for rotation within well 85 by means of a sleeve bearing 86, which is press fit into well 85. Each of sleeve bearings 72, 74, and 86 is preferably a steel-backed bronze bushing.

When crankshaft 32 is rotated by motor 22, the operation of eccentric crankpin 82 and roller 80 within well 85 causes orbiting scroll member 50 to orbit with respect to fixed scroll member 48. Roller 80 pivots slightly about crankpin 82 so that crank mechanism 78 functions as a conventional swing-link radial compliance mechanism to promote sealing engagement between fixed wrap 64 and orbiting wrap 68. Orbiting scroll member 50 is prevented from rotating about its own axis by means of a conventional Oldham ring assembly, comprising an Oldham ring 88, and Oldham key pairs 90, 92 associated with orbiting scroll member 50 and frame member 52, respectively.

In operation of compressor 10 of the preferred embodiment, refrigerant fluid at suction pressure is introduced through a suction pipe 94, which is received within a counterbore 96 in top cover plate 14 and is attached thereto as by silver soldering or brazing. A suction pressure chamber 98 is generally defined by fixed scroll member 48 and frame member 52. Refrigerant is introduced into chamber 98 from suction tube 94 through a suction passageway 100 defined by aligned holes in top cover plate 14 and fixed scroll member 48. As orbiting scroll member 50 is caused to orbit, refrigerant fluid within suction pressure chamber 98 is compressed radially inwardly by moving closed pockets defined by fixed wrap 64 and orbiting wrap 68.

Refrigerant fluid at discharge pressure in the innermost pocket between the wraps is discharged upwardly through a discharge port 102 communicating through face plate 62 of fixed scroll member 48. Compressed refrigerant discharged through port 102 enters a discharge plenum chamber 104 defined by the underside of top cover plate 14. A radially extending duct 106 formed in top cover plate 14 and an axially extending duct 108 extending along the side of fixed scroll member 48 and frame member 52 allow the compressed refrigerant in discharge plenum chamber 104 to be introduced into housing chamber 110 defined within housing 12. As shown in Fig. 2, a discharge tube 112 extends through central portion 16 of housing 12 and is sealed thereat as by silver solder 114. Discharge tube 112 allows pressurized refrigerant within housing chamber 110 to be delivered to the refrigeration system (not shown) in which compressor 10 is incorporated.

Compressor 10 also includes a lubrication system for lubricating the moving parts of the compressor, including the scroll members, crankshaft, and crank mechanism. An axial oil passageway 120 is provided in crankshaft 32, which communicates with tube 38 and extends upwardly along the central axis of crankshaft 32. At a central location along the length of crankshaft 32, an offset, radially divergent oil passageway 122 intersects passageway 120 and extends to an opening 124 on the top of eccentric crankpin 82 at the top of crankshaft 32. As crankshaft 32 rotates, oil pickup tube 38 draws lubricating oil from oil sump 36 and causes oil to move upwardly through oil passageways 120 and 122. Lubrication of upper bearing 72 and lower bearing 74 is accomplished by means of flats (not shown) formed in crankshaft 32, located in the general vicinity of bearings 72 and 74, and communicating with oil passageways 120 and 122 by means of radial passages (not shown).

Referring now to Fig. 4, lubricating oil pumped upwardly through offset oil passageway 122 exits crankshaft 32 through opening 124 located on the top of eccentric crankpin 82. Lubricating oil delivered from hole 124 fills a chamber 138 within well 85, defined by bottom surface 140 of well 85 and the top surface of crank mechanism 78, including roller 80 and crankpin 82. Oil within chamber 138 tends to flow downwardly along the interface between roller 80 and sleeve bearing 86, and the interface between bore 81 and crankpin 82, for lubrication thereof. A flat (not shown) may be provided in the outer cylindrical surfaces of roller 80 and crankpin 82 to enhance lubrication.

Referring now to Fig. 4, lubricating oil at discharge pressure is provided by the aforementioned lubrication system to the central portion of the underside of orbiting scroll member 50 within well 85. Accordingly, when the lubricating oil fills chamber 138, an upward force acts upon orbiting scroll member 50 toward fixed scroll member 48. The magnitude of this upward force, determined by the surface area of bottom surface 140, is insufficient to provide the necessary axial compliance force. Therefore, in order to increase the upward force on orbiting scroll member 50, an annular portion of back surface 51 immediately adjacent, i.e., circumjacent, hub portion 84 is exposed to refrigerant fluid at discharge pressure, as will now be further described.

The axial compliance mechanism of compressor 10, in accordance with several embodiments of the present invention, will now be further described with reference to Figs. 4-12. Generally, respective fixed portions of back surface 51 are exposed to discharge and suction pressure, thereby providing a substantially constant force distribution acting upwardly upon orbiting scroll member 50 toward fixed scroll member 48. Consequently, moments about the central axis of orbiting scroll member 50 are minimized. More specifically, an annular seal mechanism 150, cooperating between back surface 51 and adjacent stationary thrust surface 55, sealingly separates between a radially inner portion 154 and a radially outer portion 156 of back surface 51, which are exposed to discharge pressure and suction pressure, respectively. As will be further explained herein, seal mechanism 150 includes an annular seal groove 152 formed in back surface 51.

In accordance with the embodiment of Figs. 4-7, seal mechanism 150 comprises an annular elastomeric seal element 158 unattachedly received within seal groove 152. In the preferred embodiment, the radial thickness of seal element 158 is less than the radial width of seal groove 152, as best shown in Figs. 6 and 7. Referring to Fig. 6, wherein seal element 158 is shown in an unactuated state when the compressor is off, the axial thickness of seal element 158 is greater than the axial depth of seal groove 152 so as to slightly space back surface 51 from thrust surface 55.

Referring again to Fig. 6, annular seal groove 152 includes a radially inner wall 160, a radially outer wall 162, and a bottom wall 164 extending therebetween. Likewise, annular seal element 158 is generally rectangular and includes a radially inner surface 166, a radially outer surface 168, a top surface 170 and a bottom surface 172. In its unactuated condition shown in Fig. 6, seal element 158 has a diameter less than the diameter of outer wall 162, whereby outer surface 168 is slightly spaced from outer wall 162.

In operation of compressor 10, axial compliance of orbiting scroll member 50 toward fixed scroll member 48 occurs as the compressor compresses refrigerant fluid for discharge into housing chamber 110. As housing chamber 110 becomes pressurized, discharge pressure occupies the volume shown radially inwardly from inner wall 166 in Fig. 6, thereby causing seal element 158 to expand radially outwardly and scroll member 50 to move axially upwardly away from thrust surface 55, as shown in Fig. 7. As a result of the axial movement of scroll member 50, increased space is created between back surface 51 and thrust surface 55. Seal element 158 moves downwardly toward thrust surface 55 under the influence of gravity and/or a venturi effect created by the initial fluid flow between bottom surface 172 and thrust surface 55. Consequently, discharge pressure occupies the space between bottom wall 164 and top surface 170. From the foregoing, it will be appreciated that discharge pressure acting on top surface 170 and inner surface 166 of seal element 158 creates a force distribution on the seal element that urges it axially downwardly toward thrust surface 55 and radially outwardly toward outer wall 168 to seal thereagainst.

As previously described, seal element 158 moves downwardly toward thrust surface 55 when orbiting scroll member 50 moves axially upwardly, thereby creating a space between back surface 51 and thrust surface 55. To enhance this initial seal actuation, a plurality of radial grooves 57 may be provided in back surface 51, as shown in Figs. 13 and 14. Specifically, grooves 57 are formed axially deeper than bottom wall 164 and extend radially inwardly so as to expose top surface 170 to discharge pressure within housing chamber 110 prior to seal actuation, as shown in Fig. 14. Accordingly, seal element 158 is encouraged to move downwardly upon compressor start-up.

Several alternative embodiments of seal mechanism 150 are shown in Figs. 8-12, and will now be described. All relate to a modification to the orbiting scroll member of the preferred embodiment, whereby fluid communication means are provided within modified orbiting scroll member 50′, for supplying lubricating oil at discharge pressure from chamber 138 to annular seal groove 152. More specifically, as illustrated in Figs. 8 and 9, scroll member 50′ includes an oil passageway 174 extending from an opening in bottom surface 140 of well 85 to an opening in bottom wall 164 of seal groove 152. Oil passageway 174 comprises a central axial passage 176, four passages 178 extending radially from passage 176, and four axial passages 180 extending from respective passages 178 to bottom wall 164 of seal groove 152.

The provision of oil passageway 174 not only enhances seal mechanism 150 wherein an annular elastomeric seal element is utilized, but also permits a hydrostatic sealing arrangement, as illustrated in Fig. 10. In such an arrangement, the manufacturing tolerances for compressor 10 are more exacting to provide less space between back surface 51 and thrust surface 55. In this manner, oil delivered to seal groove 152 through oil passageway 174 flows from the groove and acts against thrust surface 55 to provide a seal between the primarily gaseous regions of housing chamber 110 and suction pressure chamber 98. The oil creating the hydrostatic seal has a tendency to leak into suction pressure chamber and, therefore, minimum spacing between back surface 51 and thrust surface 55 should be maintained to prevent oil rates in the refrigeration system from becoming too high for efficient operation. However, some leakage of oil is desirable for lubrication of scroll wraps and the like.

Figs. 11 and 12 illustrate a further embodiment of seal mechanism 150 wherein annular seal element 158 is combined with oil passageway 174. The operation of this sealing arrangement is substantially as previously described with respect to the embodiment of Figs. 6 and 7, with the added feature that oil passage 174 provides a means for insuring that seal element 158 is quickly and properly actuated. More specifically, oil flows from passage 180 to housing chamber 110 through the space between seal element 158 and seal groove 152, i.e., the space between top surface 170 and bottom surface 164, and between inner surface 166 and inner wall 160.

It will be appreciated that seal mechanism 150, in accordance with the various embodiments described herein, provides a seal between respective fixed portions of back surface 51 that orbits with orbiting scroll member 50, whereby the upward force distribution on back surface 51 remains substantially constant throughout its orbiting motion. This is possible, in part, due to the ability of the various seal configurations to slidingly seal against stationary thrust surface 55.

The provision of a stationary thrust surface against which the seal configurations slidingly seal exhibits several noteworthy advantages. For instance, relative movement between the seal element and sealing surfaces is minimized, thereby reducing frictional forces and increasing seal life. Additionally, leakage past the seal is more effectively controlled. It should also be noted that in the seal configuration described herein, leakage is minimized by the absence of seal mounting apparatus and complex multi-piece seal configurations.

The annular seal element disclosed herein is preferably composed of a Teflon material. More specifically, a glass-filled Teflon, or a mixture of Teflon, Carbon, and Ryton is preferred in order to provide the seal element with the necessary rigidity to resist extruding into clearances due to pressure differentials. Furthermore, the surfaces against which the Teflon seal contacts are preferably cast iron.

Claims

1. A scroll-type compressor for compressing refrigerant fluid, comprising: a hermetically sealed housing (12) including therein a discharge pressure chamber (110) at discharge pressure and a suction pressure chamber (98) at suction pressure; a fixed scroll member (48) including an involute fixed wrap element (64); and an orbiting scroll member (50) including a plate portion (66) having a face surface (67) and a back surface (51), said face surface having an involute orbiting wrap element (68) thereon, said fixed and orbiting wrap elements being intermeshed to define at least one pocket of refrigerant fluid compressed by orbiting motion of said orbiting scroll member with respect to said fixed scroll member; characterized by a stationary thrust surface (55) adjacent said plate portion back surface; and orbiting seal means (150), intermediate said orbiting scroll member and said stationary thrust surface, for sealingly separating between respective portions (154, 156) of said plate portion back surface exposed to said discharge pressure chamber and said suction pressure chamber, said seal means establishing said respective portions at fixed locations on said plate portion back surface despite the orbiting motion of said orbiting scroll member.

2. The scroll-type compressor of Claim 1 characterized in that said plate portion back surface (51) includes an annular seal groove (152) and said seal means (150) comprises an annular seal element (158) partially disposed within said seal groove.

3. The scroll-type compressor of Claim 2 characterized in that said annular seal element (158) is unattachedly retained within said annular seal groove (152).

4. The scroll-type compressor of Claim 2 characterized in that said seal element (158) extends from said seal groove (152) toward said thrust surface (55) and slidingly seals thereagainst.

5. The scroll-type compressor of Claim 1, and further characterized by a frame member (52) attached to said fixed scroll member (48), said stationary thrust surface (55) consisting of a portion of said frame member.

6. The scroll-type compressor of Claim 1 characterized in that said respective portions (154, 156) of said plate portion back surface (51) comprise a radially inner portion (154) exposed to said discharge pressure chamber (110) and a radially outer portion (156) exposed to said suction pressure chamber (98).

7. The scroll type compressor of Claim 2 characterized in that said annular seal groove (152) has radially inner and outer walls (160, 162) and a bottom wall (164) therebetween; and said seal element (158) sealingly contacts said radially outer wall and is spaced from said radially inner wall and said bottom wall to permit compressed refrigerant fluid from said discharge pressure chamber (110) therebetween, whereby said seal element (158) is urged against said radially outer wall and toward said thrust surface (55).

8. The scroll-type compressor of Claim 7 characterized in that said orbiting scroll member back surface (51) includes at least one radial groove (57) formed therein which extends from said seal groove bottom wall (164) radially inwardly to communicate with said discharge pressure chamber (110), whereby discharge pressure is initially provided in said radial groove at the interface between said seal element (158) and said seal groove bottom wall to enhance actuation of said seal element.

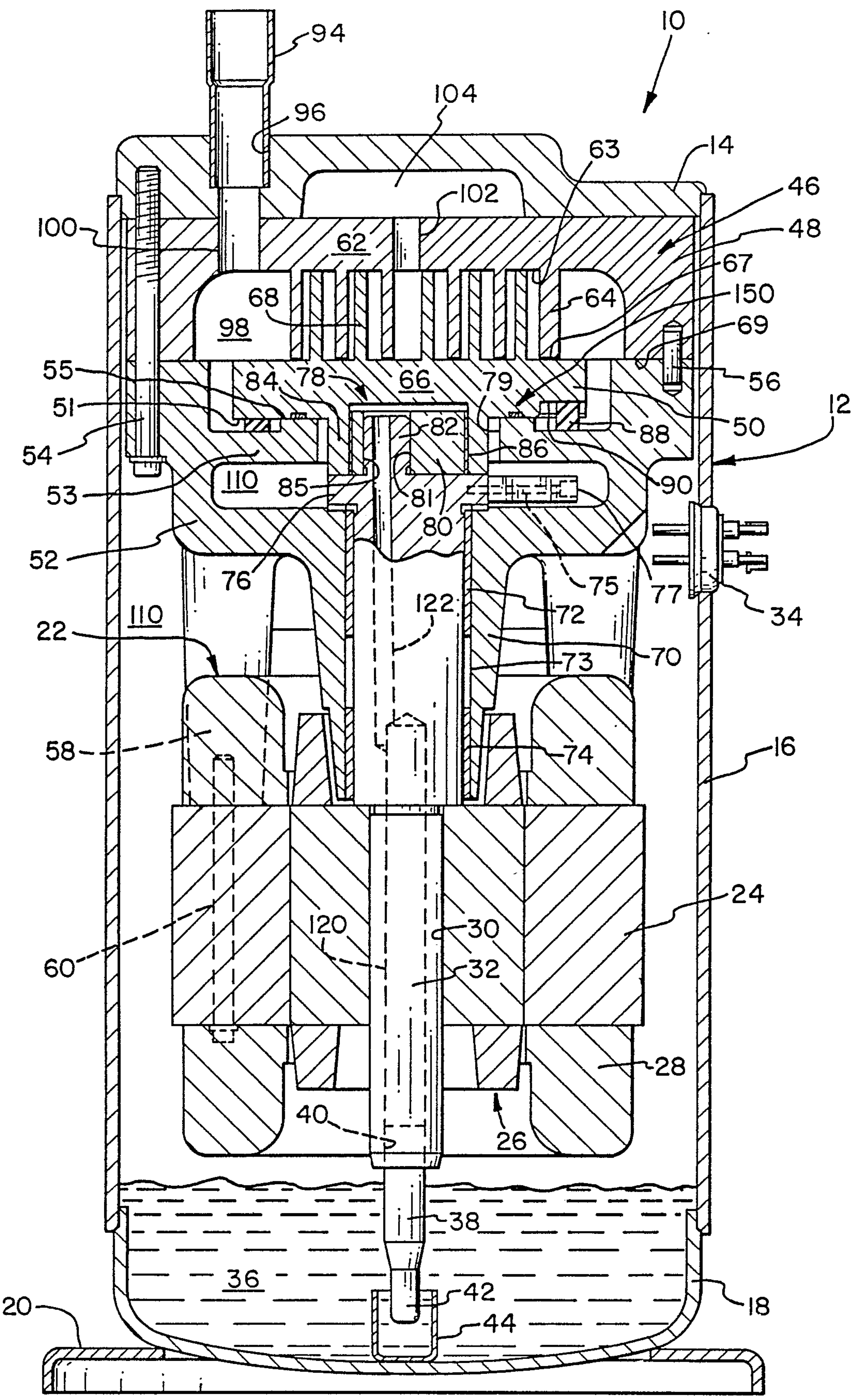
9. A scroll-type compressor for compressing refrigerant fluid, comprising: a hermetically sealed housing (12) including therein a discharge pressure chamber (110) at discharge pressure and a suction pressure chamber (98) at suction pressure; an oil sump (36) within said discharge pressure chamber; a fixed scroll member (48) including an involute fixed wrap element (64); and an orbiting scroll member (50) having a top surface (67) and a bottom surface (51), said orbiting scroll member including an involute orbiting wrap element (68) on said top surface, said fixed and orbiting wrap elements being intermeshed to define at least one pocket of refrigerant fluid compressed by orbiting motion of said orbiting scroll member with respect to said fixed scroll member, characterized by said orbiting scroll member bottom surface having an annular seal groove (152) formed therein; a stationary thrust surface (55) adjacent said orbiting scroll

member bottom surface; and seal means (150), cooperating between said orbiting scroll member and said stationary thrust surface, for sealingly separating between respective portions (154, 156) of said orbiting scroll member bottom surface exposed to said discharge pressure chamber and said suction pressure chamber, said seal means establishing said respective portions at fixed locations on said plate portion back surface despite the orbiting motion of said orbiting scroll member, said seal means comprising means (174) for supplying oil flow from said oil sump into said annular seal groove.

10. The scroll-type compressor of Claim 9 characterized in that said seal means (150) comprises a hydrostatic seal provided by flow of oil from said annular seal groove (152) toward said thrust surface (55).

11. The scroll-type compressor of Claim 9 characterized in that said seal means (150) comprises an annular seal element (158) partially disposed within said annular seal groove (152) and extending therefrom toward said thrust surface (55) to sealingly contacting thereagainst, said oil in said annular seal groove providing an urging force to said annular seal element toward said thrust surface.

12. The scroll-type compressor of Claim 11 characterized in that said annular seal groove (152) includes a radially inner wall (160), a radially outer wall (162), and a bottom wall (164) therebetween; and said annular seal element (158) sealingly contacts said radially outer wall and is spaced from said radially inner wall and said bottom wall to permit the oil in said annular seal groove (152) to flow therebetween, whereby said seal element is urged against said radially outer wall and toward said thrust surface (55).



10
94
96
104
63
14
46
102
48
100
62
67
64
150
68
69
98
56
55
84
78
66
79
12
51
82
50
54
86
88
53
110
85
81
90
80
52
76
75
77
34
122
72
22
110
70
73
58
74
16
24
60
120
30
32
28
40
26
38
36
42
20
18
44

FIG. 1

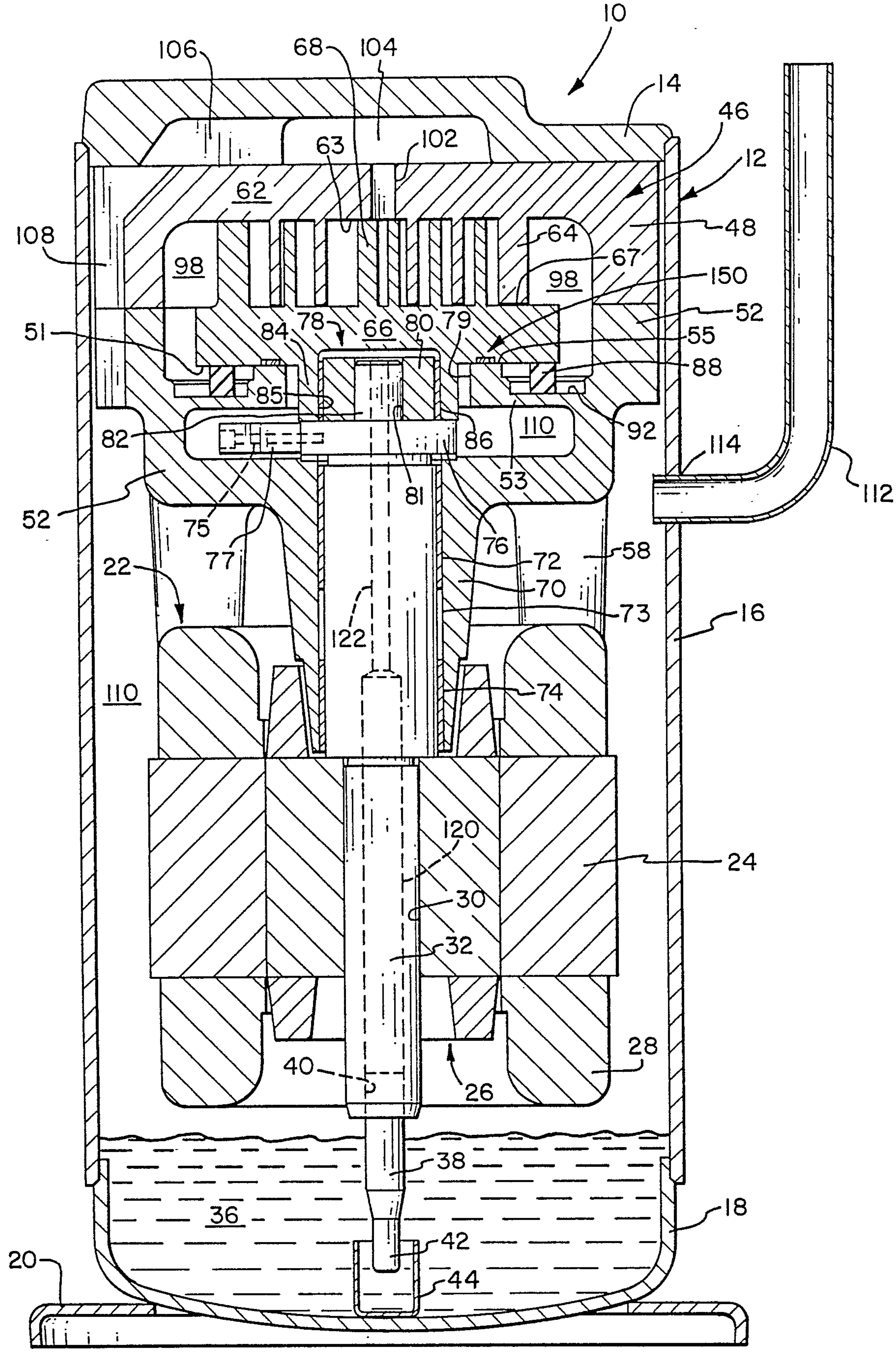

10
106
68
104
14
46
12
102
63
62
48
108
98
64
67
98
150
52
51
84
78
66
80
79
55
88
85
82
110
86
92
114
112
52
53
75
81
76
72
58
22
77
70
73
16
122
110
74
120
24
30
32
28
40
26
38
36
18
42
20
44

FIG. 2

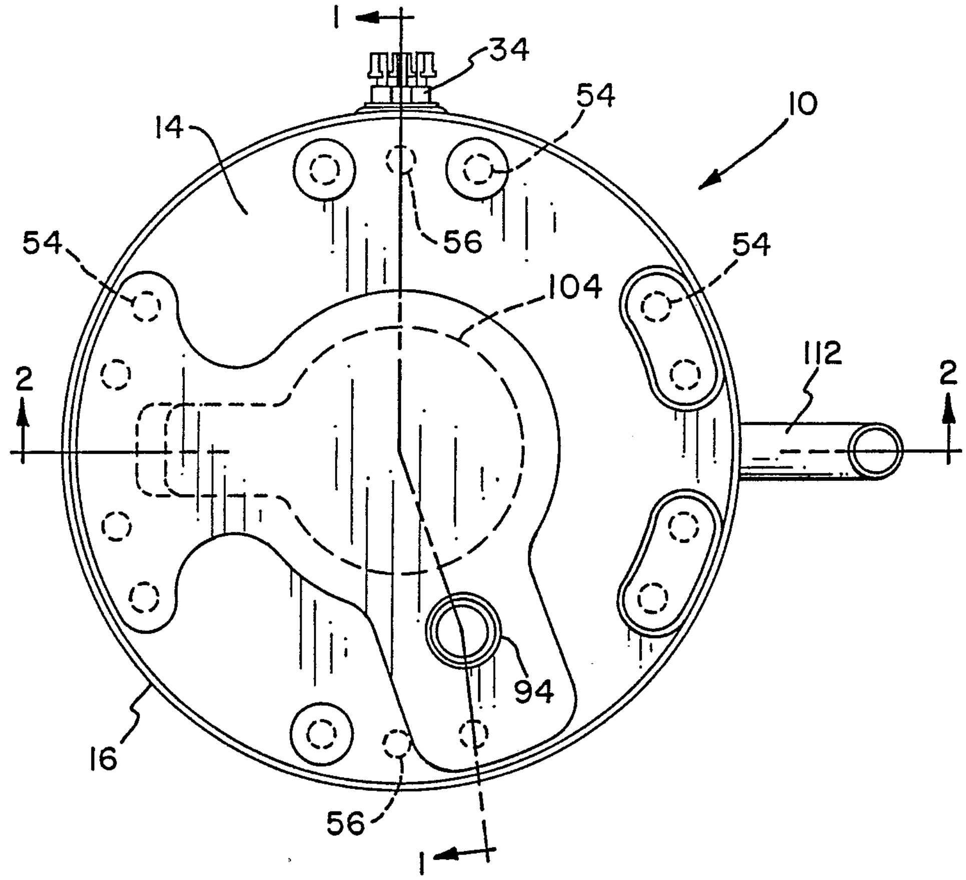

1
34
54
10
14
56
54
54
104
112
2
2
94
16
56
1

FIG. 3

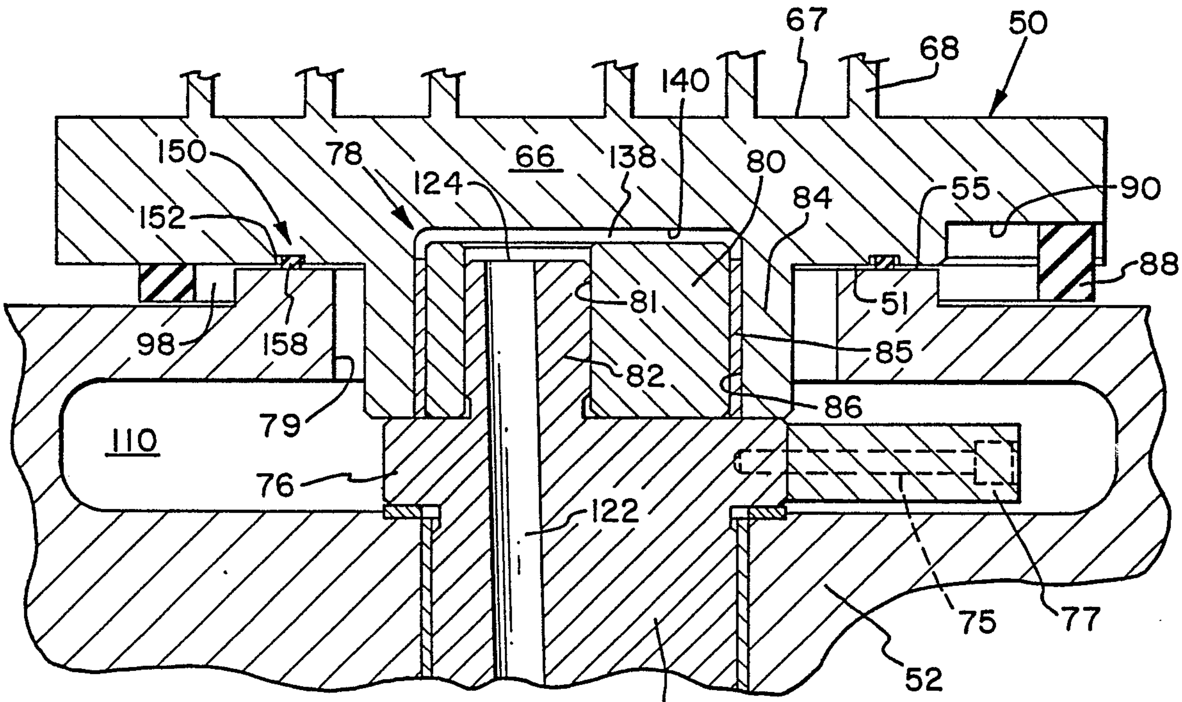

67
50
68
140
150
78
124
66
138
80
84
55
90
152
88
51
98
158
81
85
82
86
79
110
76
122
75
77
52
32

FIG. 4

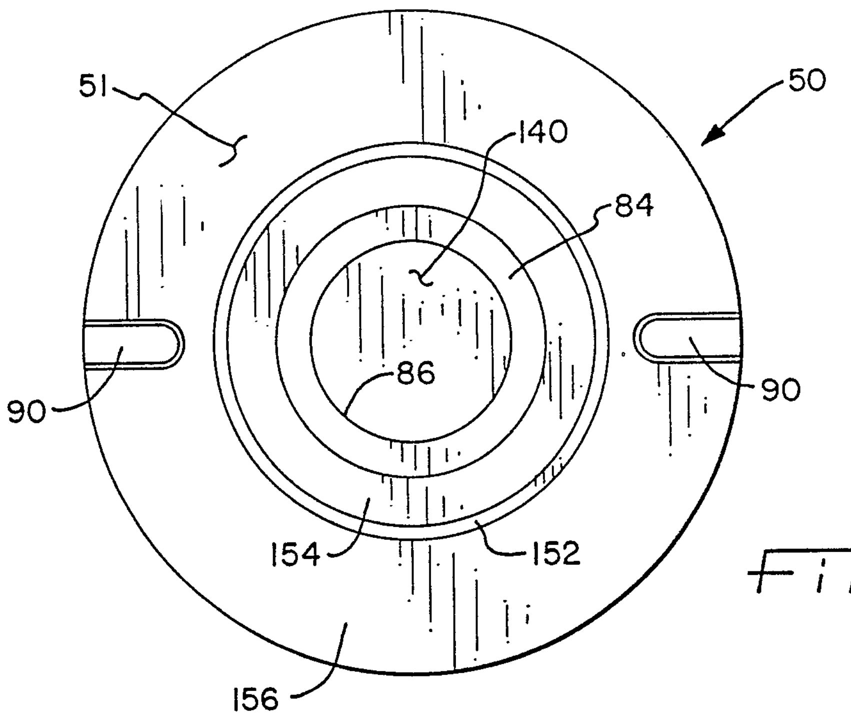


FIG. 5

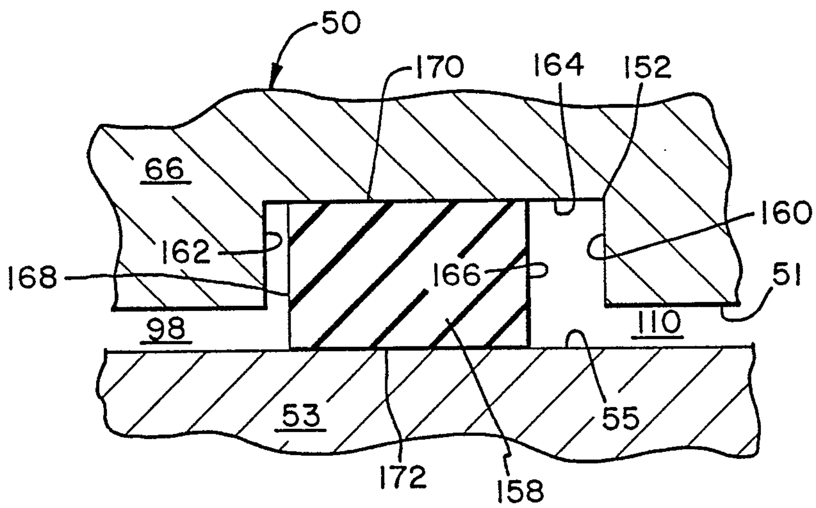


FIG. 6

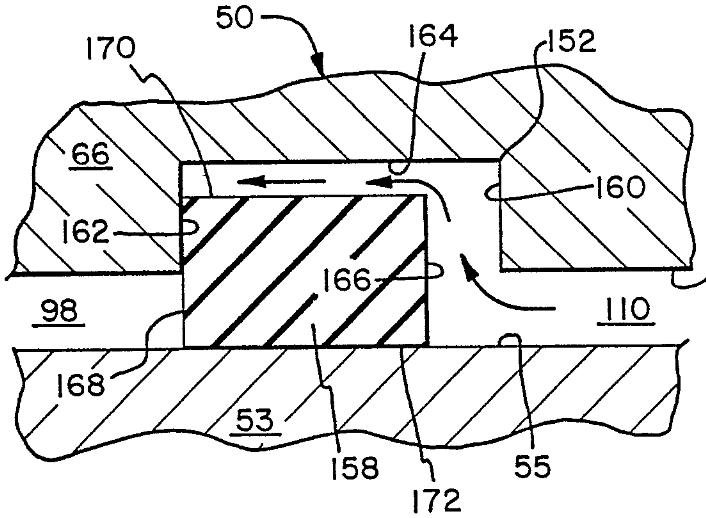
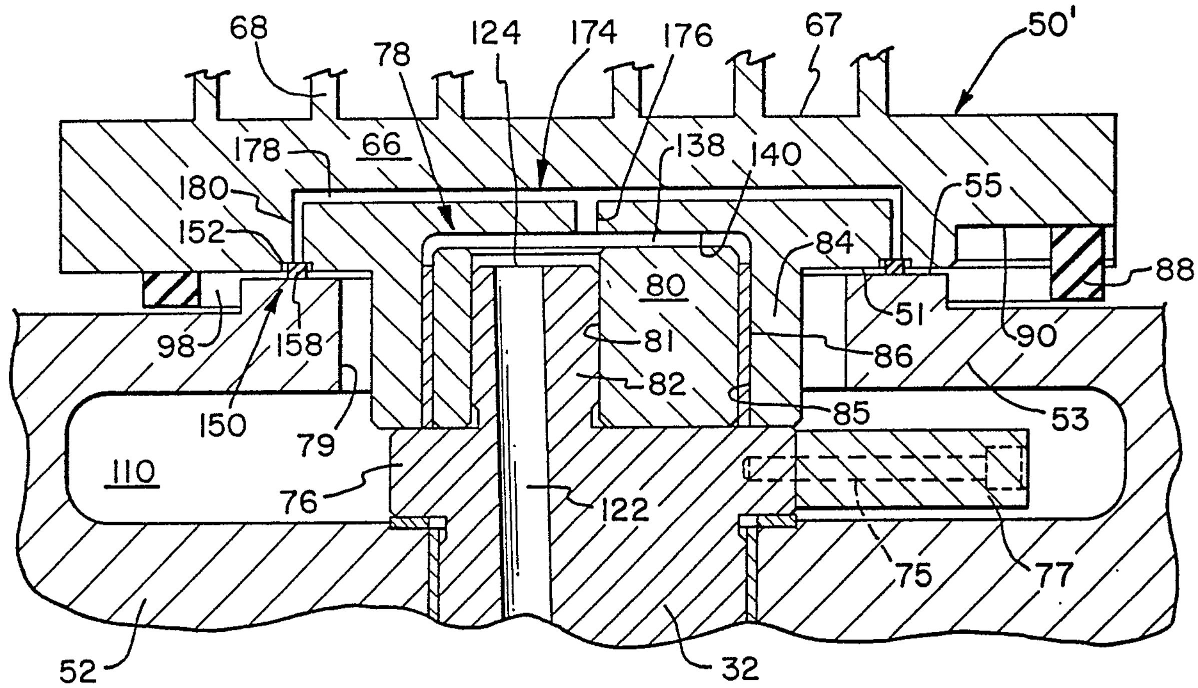
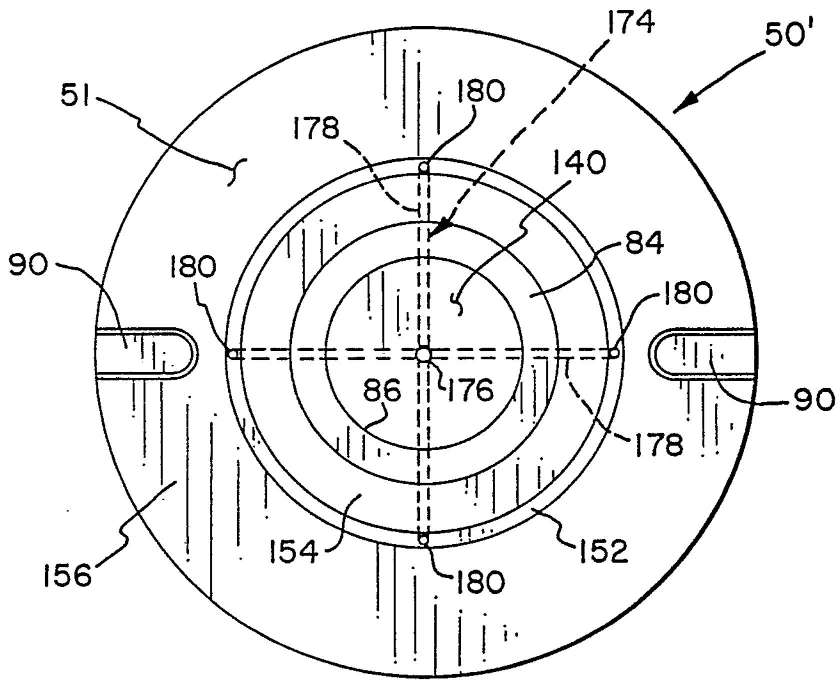


FIG. 7



68
78
124
174
176
67
50'
178
66
138
140
180
55
152
84
80
88
51
98
158
81
86
90
82
150
85
53
79
110
76
122
75
77
52
32

FIG. 8



174
50'
51
180
178
140
90
84
180
180
86
176
90
178
154
152
156
180

FIG. 9

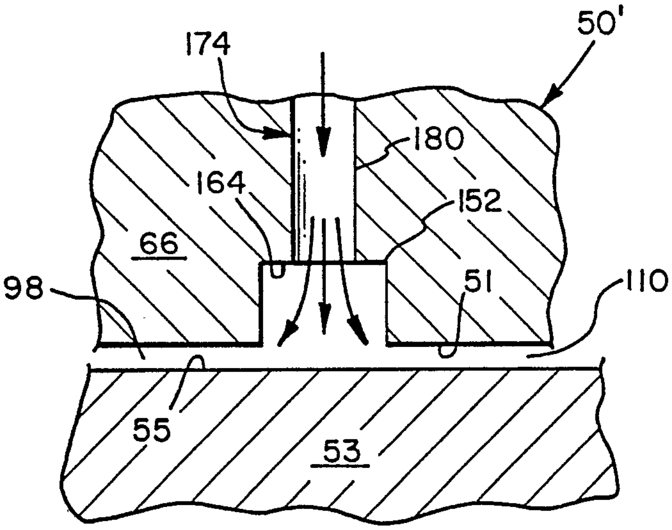


FIG. 10

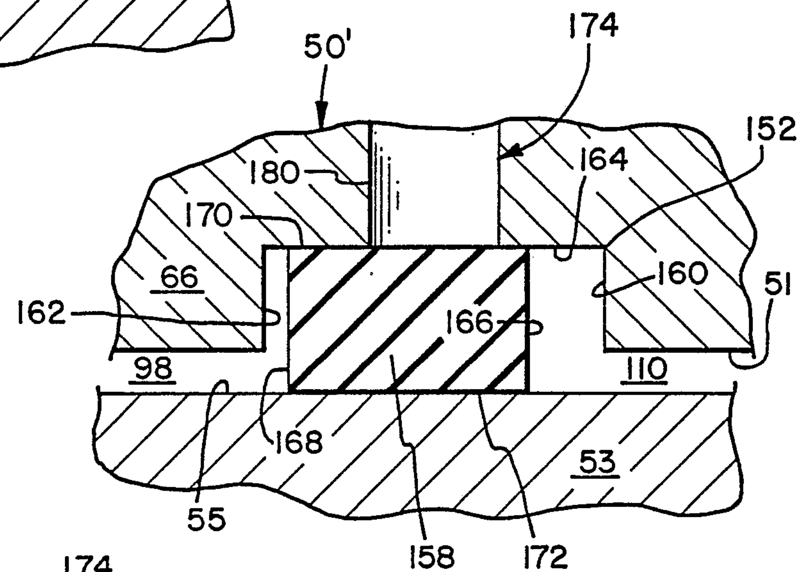


FIG. 11

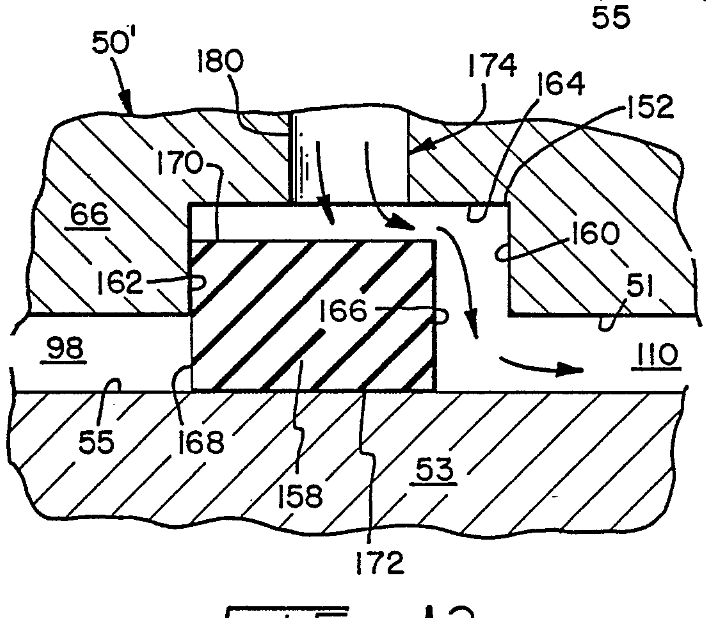


FIG. 12

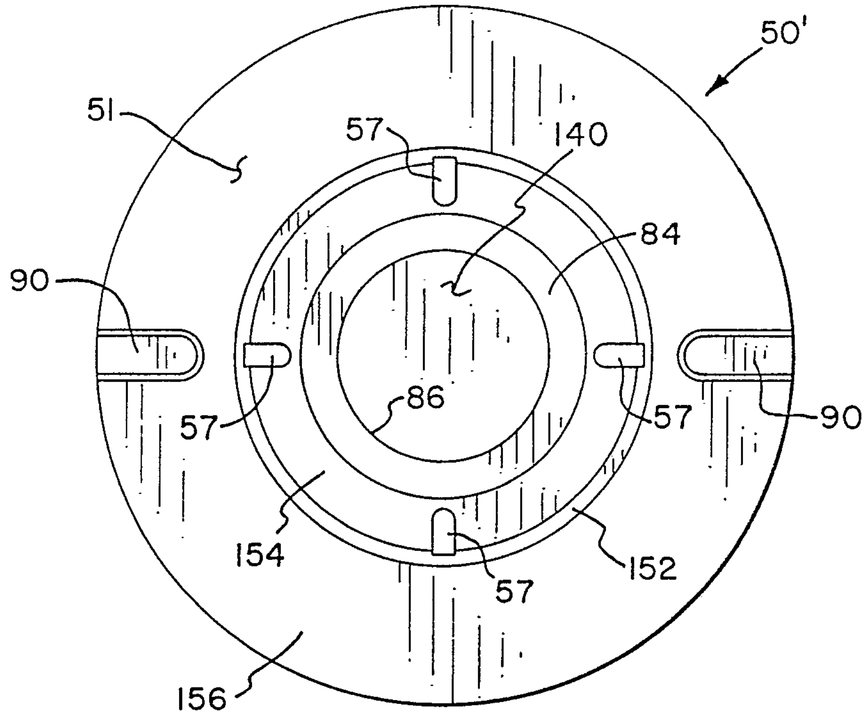

50'
51
57
140
84
90
57
86
57
90
154
152
57
156

FIG. 13

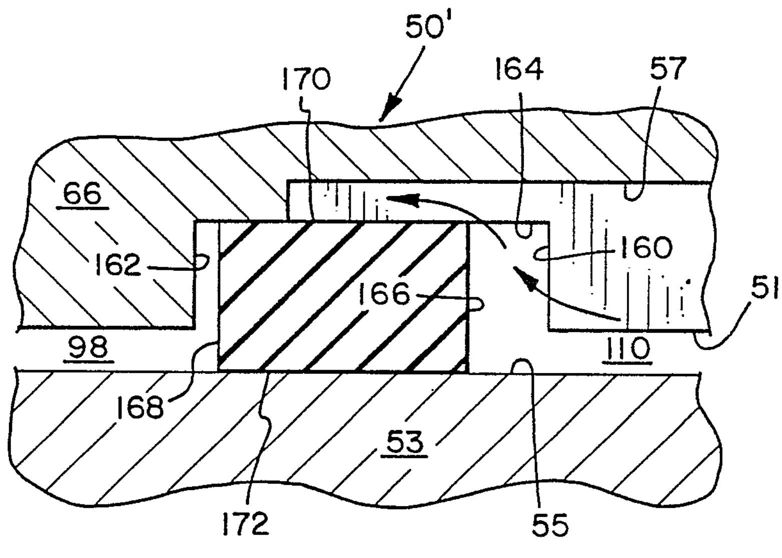

50'
170
164
57
66
162
160
166
51
98
110
168
53
172
55

FIG. 14