US 20060285981A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2006/0285981 A1

Theodore, JR. (43) Pub. Date: Dec. 21, 2006

(54) SWASH RING COMPRESSOR WITH SPHERICAL BEARING

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(21) Appl. No.: 11/157,740

(22) Filed: Jun. 21, 2005

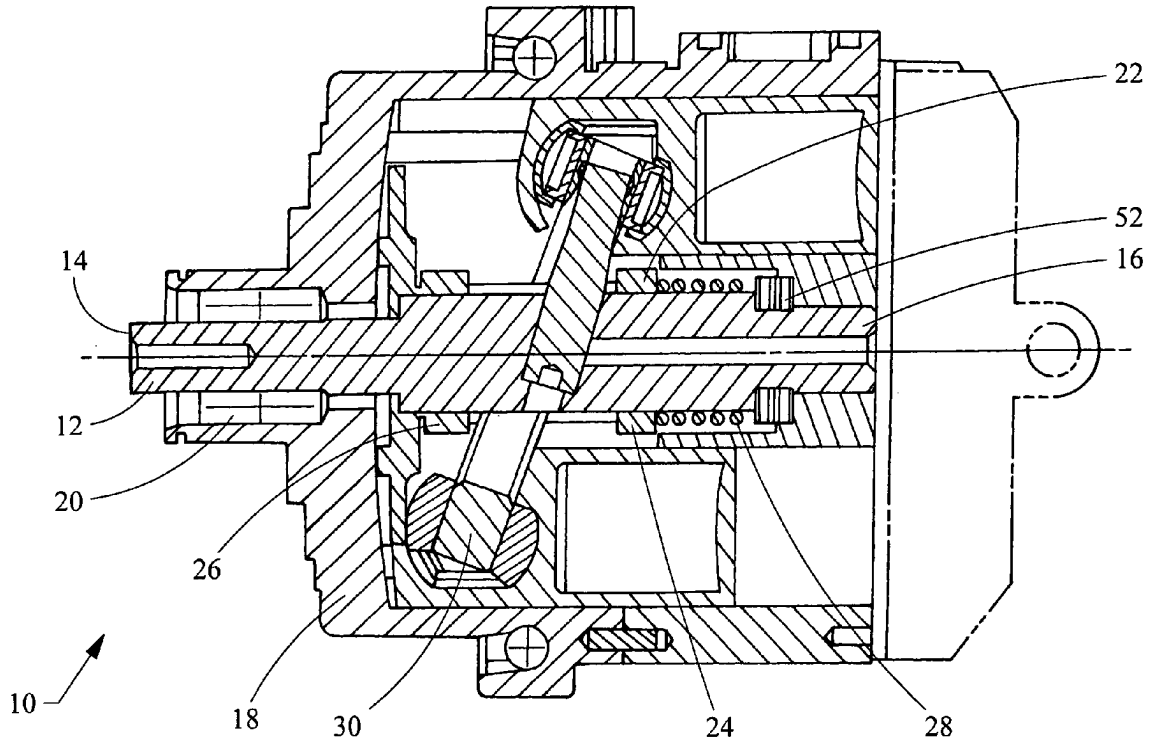
Publication Classification

(51) Int. Cl.
F04B 27/08 (2006.01)

(52) U.S. Cl. 417/269

(57) ABSTRACT

A variable displacement compressor includes a housing and a rotatable shaft supported within the housing. A pin extends generally outward from the shaft and includes a generally cylindrical distal end. A sleeve is slidably mounted about the shaft and rotates with the shaft. A swash ring is pivotally supported on the sleeve by a pair of bearing pins that extend radially outward from opposite sides of the sleeve and pivotally engage the swash ring. The swash ring is rotatable with the shaft and includes a radially inwardly open spherical pocket. A spherical bearing insert is positioned within the pocket and the cylindrical distal end of the pin slidably engages the spherical bearing insert. The swash ring defines an adjustable angle with respect to the longitudinal axis of the shaft. A biasing member engages the sleeve and biases the sleeve along the shaft.



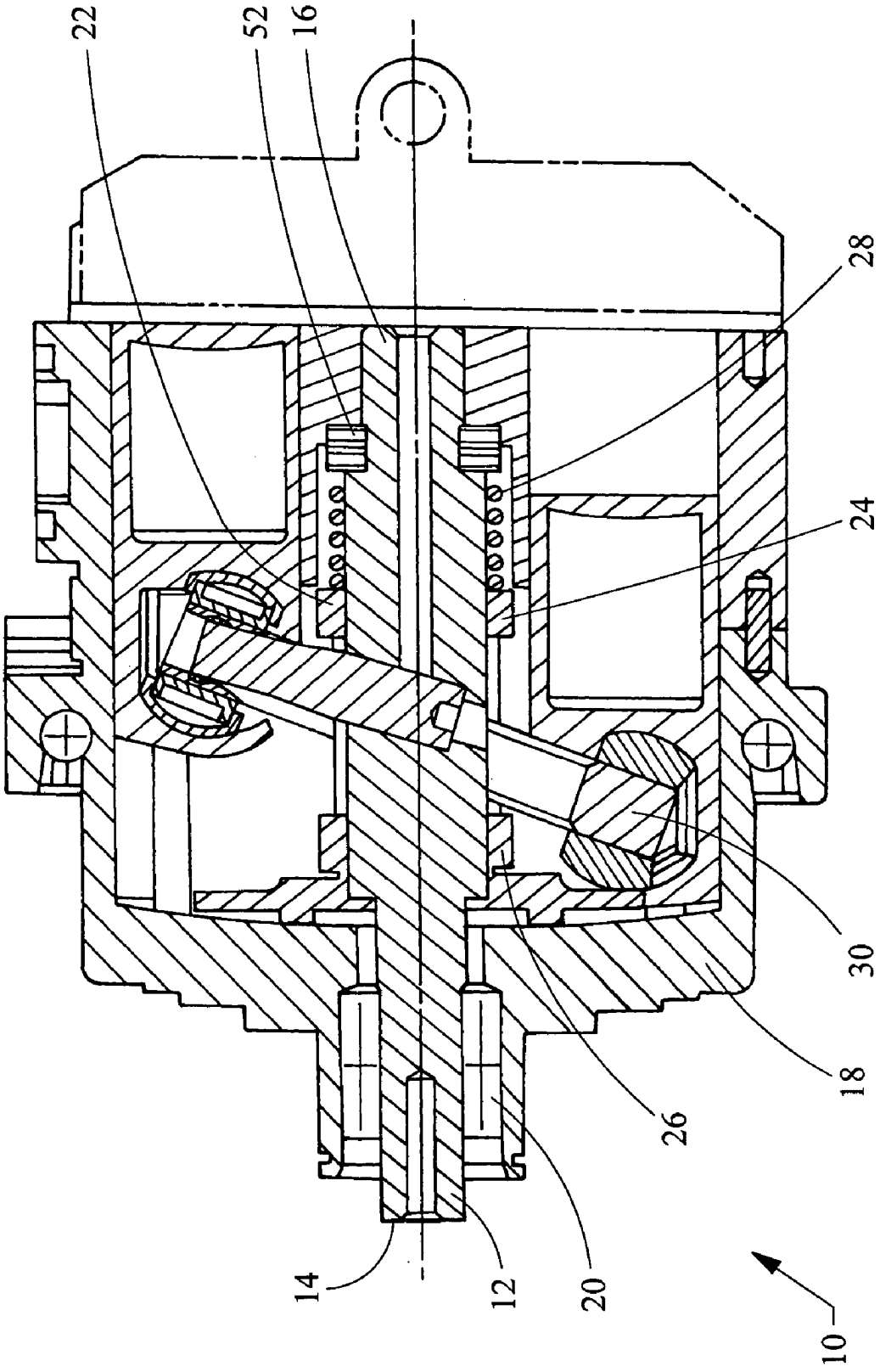


Fig. 1

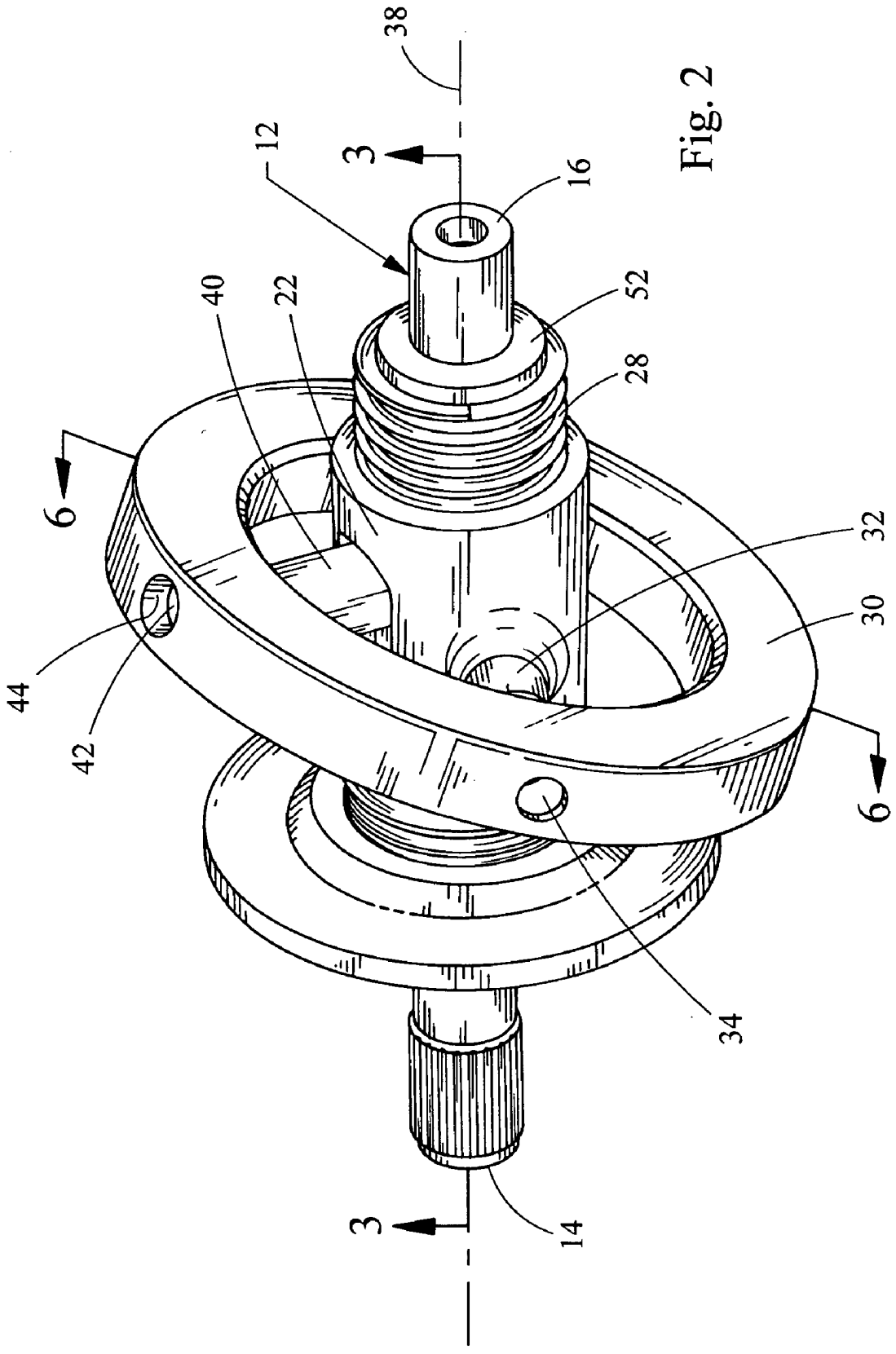


Fig. 2

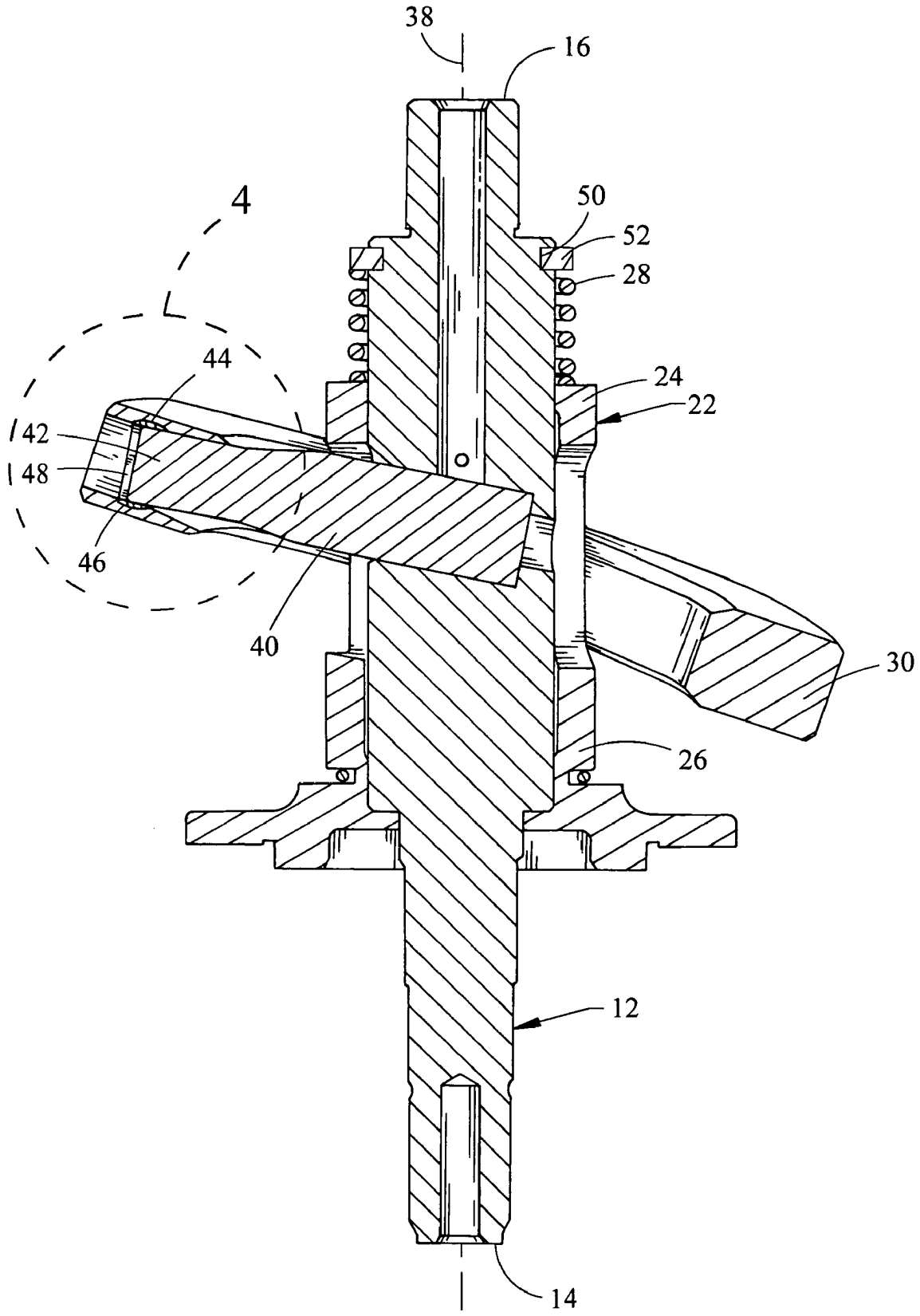


Fig. 3

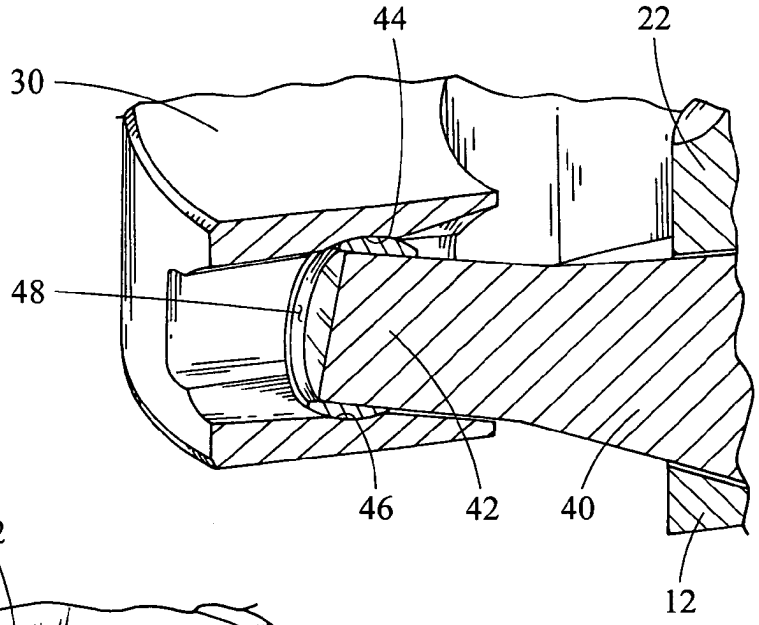


Fig. 4

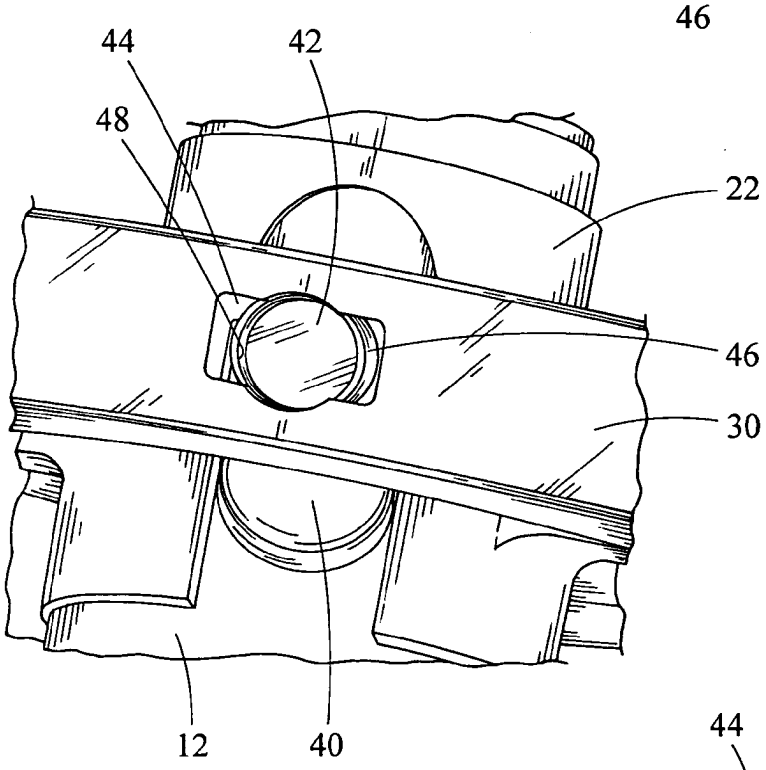


Fig. 5

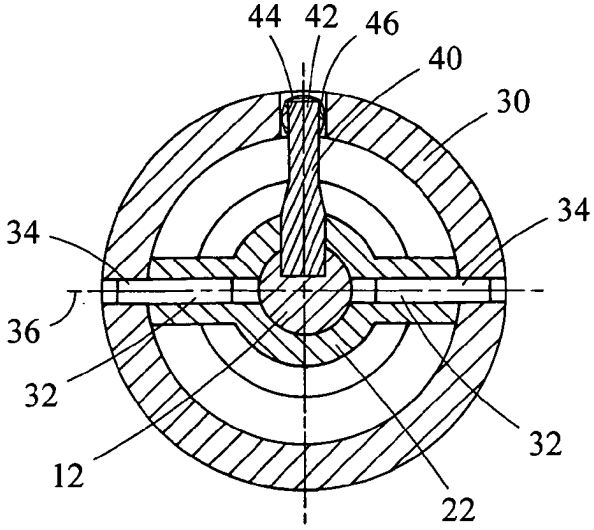


Fig. 6

SWASH RING COMPRESSOR WITH SPHERICAL BEARING

BACKGROUND OF INVENTION

[0001] 1. Technical Field of the Invention

[0002] The present invention generally relates to a variable displacement compressor having a swash ring construction. More specifically, the present invention relates to a variable displacement swash-ring compressor having spherical bearing.

[0003] 2. Description of the Prior Art

[0004] In an automotive vehicle equipped with air conditioning, a compressor is used to pump coolant through the air conditioning system to cool the vehicle. Most often, the compressor is driven by a serpentine belt of the vehicle and, hence, the speed of the compressor is controlled by the speed of the vehicle. In order to provide consistent operation of the air conditioning system, variable displacement compressors have been developed to allow the compressor to provide constant performance at all vehicle speeds. In a variable displacement compressor, higher displacement is necessary when the vehicle is idling or running at low speeds. When the vehicle is running at high speeds, the compressor is cycling much more rapidly, and therefore can provide equivalent performance at a lower displacement.

[0005] The typical automotive air conditioning compressor uses multiple pistons to pump the coolant through the system. The pistons are driven back and forth within the compressor by a plate or ring that is attached to a rotating shaft. The plate or ring is mounted at an angle relative to the shaft and engages each of the pistons. Due to the angle of the ring, radial positions around a periphery of the ring have varying axial positions within the compressor. The pistons are fixed radially within the compressor housing, so that as the shaft and ring rotate the pistons slide along the periphery of the ring and are thereby moved axially back and forth with rotations of the shaft and ring. Variable displacement is achieved by limiting the stroke of the pistons. Variable displacement compressors are available in three basic types: 1) wobble plate compressors, 2) swash-plate compressors, or 3) swash ring compressors. The present invention is related to a swash ring compressor.

[0006] In a swash ring compressor, the pistons within the compressor are driven by a swash ring. Variable displacement, by limiting the stroke of the pistons, is achieved by varying the angle of the swash ring relative to the rotating shaft. U.S. Pat. No. 6,164,252 describes the construction of a variable displacement swash ring compressor and is hereby incorporated by reference into the present application.

[0007] In the '252 patent, a sleeve is slidably mounted for limited axial movement along the compressor's shaft and a swash ring is pivotally mounted onto the sleeve. A pin, rigidly mounted within and extending from the shaft, engages the swash ring at an axial distance from the pivotal connection between the swash ring and the sleeve. As the sleeve slides along the shaft, the swash ring moves axially with the sleeve at the pivotal connection, but cannot move axially at the point where the pin engages the swashring. This causes the swash ring to pivot about the point where the pin engages the swash ring, thereby changing the angle of the swash ring relative to the shaft.

[0008] As a result of the pin transferring rotation to the swash ring, the pin undergoes very high stresses and is therefore made from very hard materials. The contact between the pin and a pocket formed within the swash ring is generally a point contact, causing very high stress at that point, leading to accelerated wear.

[0009] As seen from the above, there is a need to improve the design of the pin/swash ring interface for a compressor so that the compressor can be made more robust.

SUMMARY OF THE INVENTION

[0010] The disadvantages of the prior art are overcome by providing a variable displacement swash ring compressor with a spherical bearing insert that couples the pin to the swash ring. Use of the spherical bearing insert spreads the loads out over a larger area of the pocket within the swash ring, thereby reducing the point loads and stresses.

[0011] In one aspect, the present invention is a compressor that includes a shaft rotatably mounted within the compressor. A sleeve is slidably supported on the shaft. A swash ring is pivotally mounted onto the sleeve such that the swash ring is angularly adjustable with respect to the shaft. A pin is fixedly mounted to and extends from the shaft and has a cylindrical distal end. The swash ring includes a radially inwardly open spherical pocket. A spherical bearing insert is positioned within the pocket and the cylindrical distal end of the pin slidably engages the spherical bearing insert such that the distal end of the pin is pivotally coupled to the swash ring. The connection between the swash ring and the pin forces the swash ring to rotate with the shaft, while allowing the swash ring to be angularly adjusted relative to the shaft. The sleeve is further biased along the shaft by a spring whose position may be varied.

[0012] In another aspect of the present invention, the spherical bearing insert includes a cylindrical orifice extending therethrough, the cylindrical distal end of the pin being received within the cylindrical orifice of the spherical bearing insert.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The above, as well as other advantages of the present invention, will become readily apparent to those skilled in the art from the following detailed description of a preferred embodiment when considered in the light of the accompanying drawings in which:

[0014] **FIG. 1** is a sectional view of a swash-ring compressor of the present invention;

[0015] **FIG. 2** is a perspective view of the shaft, swash-ring and sleeve of the compressor of **FIG. 1**;

[0016] **FIG. 3** is a sectional view taken along lines **3-3** of **FIG. 2**;

[0017] **FIG. 4** is an enlarged portion of **FIG. 3** as indicated by the circle labeled "**FIG. 4**" in **FIG. 3**;

[0018] **FIG. 5** is a side view of the swash ring and sleeve showing the engagement of the pin with the spherical bearing insert and swash ring; and

[0019] **FIG. 6** is a sectional view taken along line **6-6** of **FIG. 2**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] A complete description of a variable displacement swash-ring compressor is found in U.S. Pat. No. 6,164,252 which has been incorporated by reference into the present application.

[0021] Referring now to **FIG. 1**, a variable displacement piston compressor of the present invention is shown generally at **10**. The compressor **10** includes a driven shaft **12** having a first end **14** and a second end **16**. The first and second ends **14**, **16** of the shaft **12** are supported within a compressor housing **18** by bearing elements **20**. The shaft **12** is adapted for rotational movement within the compressor housing **18**. Typically, the shaft **12** will have a pulley (not shown) mounted to one of the ends **14**, **16**. The pulley engages a serpentine belt of an automotive vehicle, although, the concepts of the present invention would work on a compressor where the shaft **12** is driven by other means.

[0022] Referring now also to **FIGS. 2 and 3**, a sleeve **22** is slidably supported on the shaft **12** and includes a first collar portion **24** and a second collar portion **26** at opposing ends thereof. The first and second collar portions **24**, **26** slidably support the sleeve **22** on the shaft **12**. A spring **28** is mounted on the shaft **12** to bias the sleeve **22** along the shaft **12** for adjustment purposes of a swash ring **30** further discussed below.

[0023] The spring **28** can be positioned between one of the collar portions **24**, **26** of the sleeve **22** and a structural portion of the compressor **10**. As shown in **FIG. 3**, the shaft **12** includes a snap ring groove formed therein. A snap ring **52** is positioned within the snap ring groove **50** to provide a stop to support the spring **28**.

[0024] Referring to **FIG. 6**, the swash ring **30** is pivotally mounted onto the sleeve **22**. The sleeve **22** includes a pair of axially aligned bearing pins **32**. The bearing pins **32** extend radially outward from diametrically opposite sides of the sleeve **22**. The swash ring **30** is pivotally supported on distal ends **34** of the bearing pins **32** such that the swash ring **30** is pivotal about an axis **36** running longitudinally through the bearing pins **32** and perpendicular to and through a central axis **38** of the shaft **12**. The pivotal connection between the swash ring **30** and the sleeve **22** allows the angle of the swash ring **30** relative to the shaft **12** to be adjusted.

[0025] Referring again to **FIGS. 2 and 3**, a pin **40** is mounted within and extends from the shaft **12**. A distal end **42** of the pin **40** is generally cylindrical. The swash ring **30** includes a radially inwardly open pocket **44**. Referring to **FIGS. 4 and 5**, the pocket **44** is generally spherical in shape and is sized to receive and retain a spherical bearing insert **46** therein. The spherical bearing insert **46** includes a cylindrical orifice **48** extending therethrough.

[0026] The distal end **40** of the pin **42** slidingly engages the orifice **48** within the spherical bearing insert **46**. The spherical bearing insert **46** allows pivotal movement of the pin relative to the swash ring such that the swash ring **30** is allowed to pivot about the distal end **42** of the pin **40**. However, the connection between the distal end **42** of the pin **40** and the swash ring **30** forces the swash ring **30** to rotate with the shaft **12**.

[0027] Because the shape of the pocket **44** and the spherical bearing insert **46** are both generally spherical, the engagement between the pocket **44** and the spherical bearing insert **46** is over a large portion of the surface area of the pocket. This larger area of engagement spreads the loads transferred between the pin **40** and the swash ring **30** over the contact area, thereby reducing the point loads that are experienced by the pin **40**, the bearing insert **46**, and the swash ring **30**. Because the loads experienced are low, the spherical bearing insert **46** can be formed of a softer alloy, such as copper alloys. The use of the spherical bearing insert **46** will reduce the overall wear and tear experienced by the swash ring **30** and the pin **40**, thereby increasing the life of the compressor **10**.

[0028] The foregoing discussion discloses and describes the preferred embodiment, and variations thereof, of the present invention. One skilled in the art will readily recognize from such discussion, and from the accompanying drawings and claims, that changes and modifications can be made to the invention without departing from the true spirit and fair scope of the invention as defined in the following claims. The invention has been described in an illustrative manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation.

What is claimed is:

1. A variable displacement compressor comprising;

a housing;

a shaft supported within the housing for rotational movement about an axis running longitudinally therethrough;

a pin extending generally outward from the shaft and including a generally cylindrical distal end;

a sleeve mounted about the shaft, being slidable along the shaft and rotatable with the shaft;

a swash ring pivotally supported on the sleeve by a pair of bearing pins, the bearing pins being axially aligned with one another and extending radially outward from diametrically opposed sides of the sleeve and pivotally engaging the swash ring wherein the swash ring is pivotable about an axis running longitudinally through the bearing pins and perpendicularly through the axis of the shaft, the swash ring being rotatable with the shaft and further including a radially inwardly open spherical pocket;

a spherical bearing insert being positioned within the pocket, the cylindrical distal end of the pin slidably engaging the spherical bearing insert thereby pivotally coupling the swash ring to the distal end of the pin, the swash ring further defining an angle with respect to the longitudinal axis of the shaft, the angle being adjustable with respect to the axis;

a piston supported within the housing, the piston coupled to the swash ring whereby rotation of the swash ring causes reciprocating axial movement of the piston; and

a biasing member engaging the sleeve and biasing the sleeve along the shaft.

2. The variable displacement compressor of claim 1 wherein the biasing member is positioned between the sleeve and a structural portion of the compressor.

3. The variable displacement compressor of claim 1 wherein the shaft includes a snap ring groove having a snap ring positioned therein and the biasing member is positioned between the sleeve and the snap ring.

4. The variable displacement compressor of claim 1 wherein the biasing member is a spring.

5. The variable displacement compressor of claim 1 wherein the spherical bearing insert includes a cylindrical orifice extending therethrough, the cylindrical distal end of the pin being received within the cylindrical orifice of the spherical bearing insert.

6. The variable displacement compressor of claim 1 wherein the spherical bearing insert is formed of a copper alloy.

7. The variable displacement compressor of claim 1 wherein the swash ring is made from a non-ferrous alloy and the spherical bearing is made from a ferrous alloy.

8. A variable displacement compressor comprising;

a housing;

a shaft supported within the housing for rotational movement about an axis running longitudinally therethorugh;

a pin extending generally outward from the shaft and including a generally cylindrical distal end;

a sleeve mounted about the shaft, being slidable along the shaft and rotatable with the shaft;

a swash ring pivotally supported on said sleeve by a pair of bearing pins, the bearing pins being axially aligned with one another and extending radially outward from diametrically opposed sides of the sleeve and pivotally engaging the swash ring wherein the swash ring is pivotable about an axis running longitudinally through the bearing pins and perpendicularly through the axis of the shaft, the swash ring being rotatable with the shaft and further including a radially inwardly open spherical pocket;

a copper alloy spherical bearing insert being positioned within the pocket, the spherical bearing insert including a cylindrical orifice extending therethrough, the cylindrical distal end of the pin being slidably received within the cylindrical orifice, thereby pivotally coupling the swash ring to the distal end of the pin, the swash ring further defining an angle with respect to the longitudinal axis of the shaft, the angle being adjustable with respect to the axis;

a piston supported within the housing, the piston coupled to the swash ring whereby rotation of the swash ring causes reciprocating axial movement of the piston; and

a biasing member engaging the sleeve and biasing the sleeve along the shaft.

9. The variable displacement compressor of claim 8 wherein the biasing member is positioned between the sleeve and a structural portion of the compressor.

10. The variable displacement compressor of claim 8 wherein the shaft includes a snap ring groove having a snap ring positioned therein and the biasing member is positioned between the sleeve and the snap ring.

11. The variable displacement compressor of claim 8 wherein the biasing member is a spring.

* * * * *