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(54) **PISTON HAVING ANTI-ROTATION FOR SWASHPLATE COMPRESSOR**

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(52) **U.S. Cl.** ..... **417/269**; 92/71; 92/165 PR

(58) **Field of Search** ..... 417/269; 91/499; 92/71, 172, 165 PR

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,622,567		12/1952	Myard	121/101
3,938,397		2/1976	Rasmussen	74/60
3,939,717		2/1976	Teisen	74/60
4,379,425	*	4/1983	Ishizuka	92/71
4,963,074		10/1990	Sanuki et al.	417/222
5,228,841	*	7/1993	Kimura et al.	417/222.2
5,382,139		1/1995	Kawaguchi et al.	417/269
5,461,967		10/1995	Burkett et al.	92/71
5,490,767	*	2/1996	Kanou et al.	417/222.1
5,615,599	*	4/1997	Terauchi	92/165 R
5,706,716		1/1998	Umemura	92/165 PR
5,720,215	*	2/1998	Asplund et al.	92/71
5,738,000		4/1998	Forster	92/165 R
5,771,775		6/1998	Ota et al.	92/165 PR
5,868,556		2/1999	Umemura	417/269
5,934,172	*	8/1999	Terauchi	92/465 PR

FOREIGN PATENT DOCUMENTS

258916 of 1928 (IT) .

* cited by examiner

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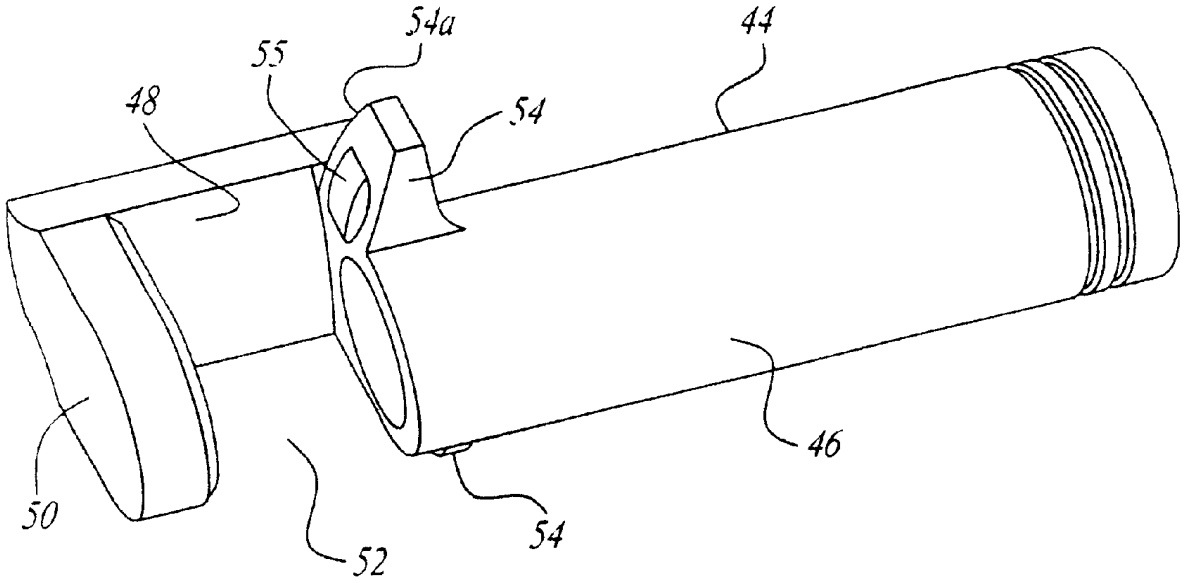
(57) **ABSTRACT**

A piston having anti-rotation for a swashplate compressor includes a body portion extending axially and a connecting portion spaced radially from a longitudinal axis of the body portion and extending axially. The piston also includes a pair of opposed anti-rotation wings extending radially from one end of the body portion between the connecting portion and the longitudinal axis of the body portion.

27 Claims, 4 Drawing Sheets



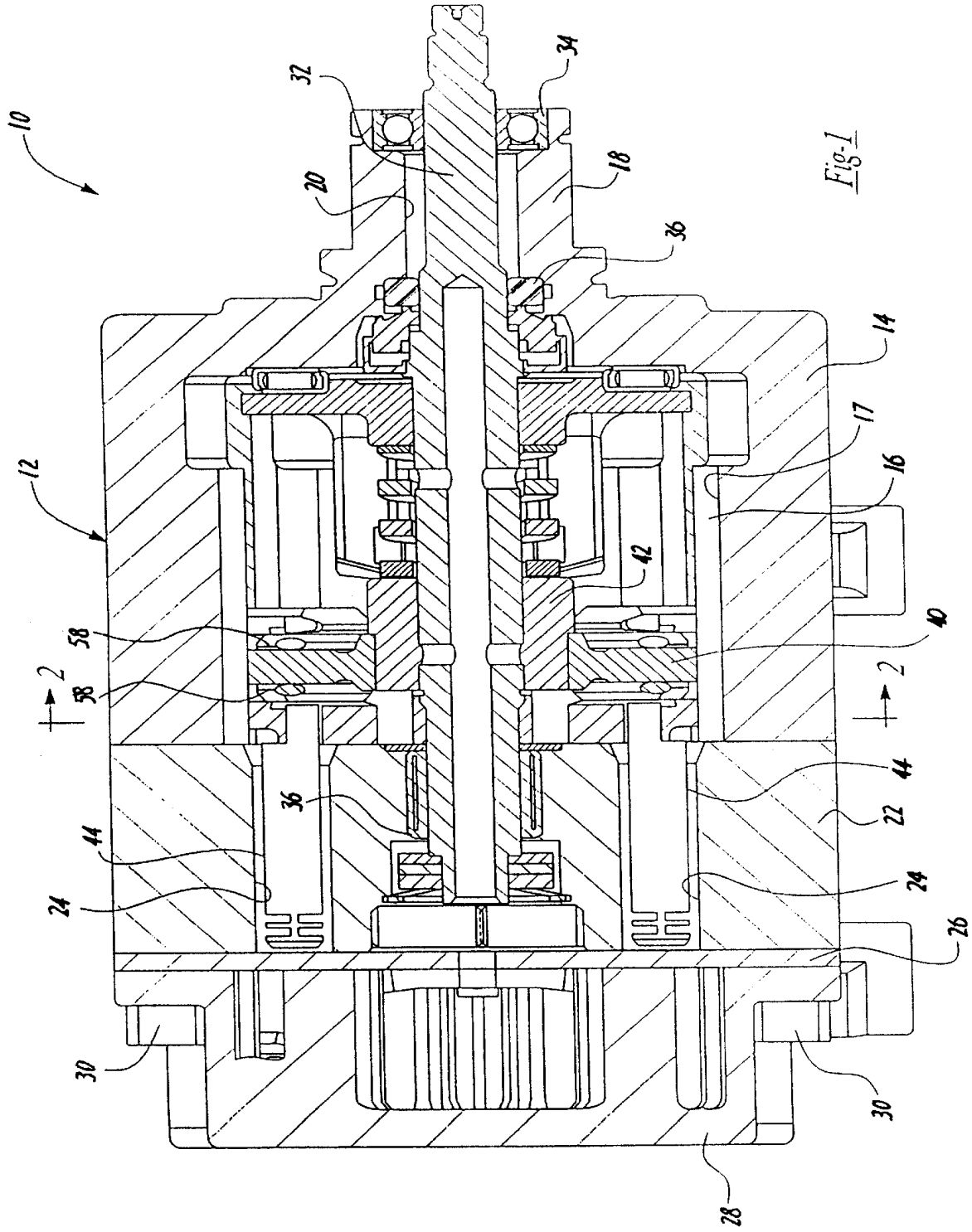


Fig-1

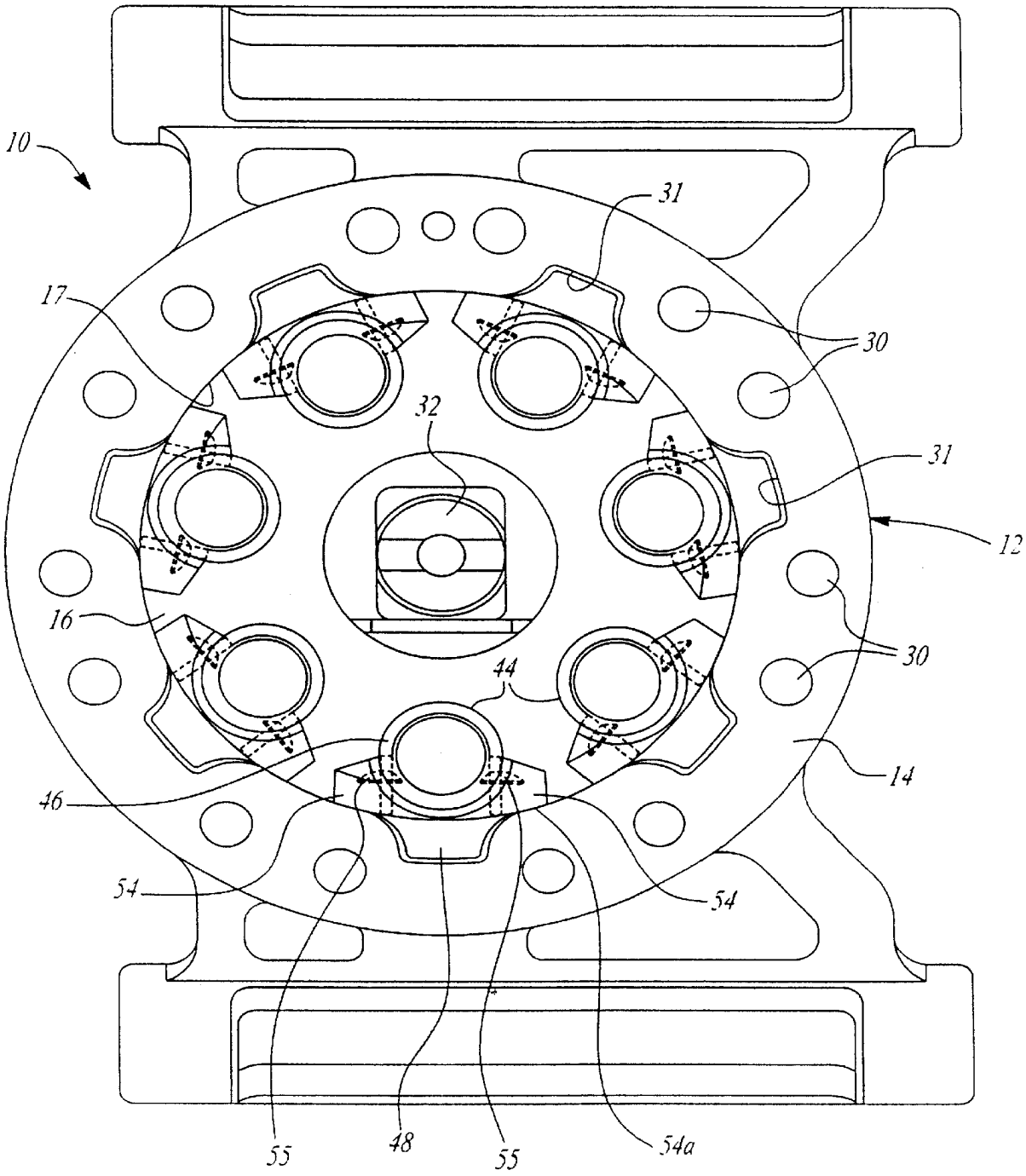


Fig-2

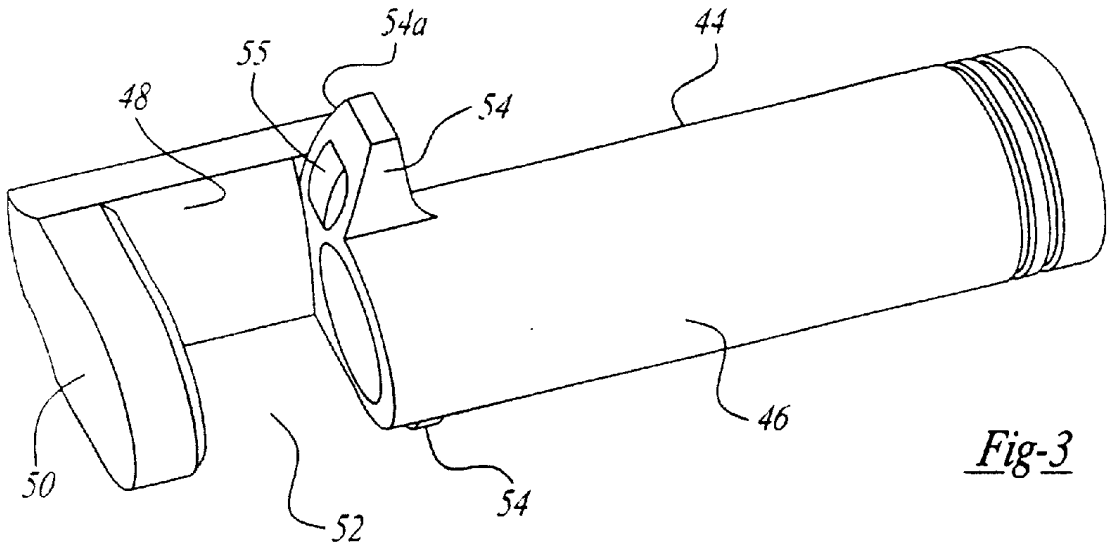


Fig-3

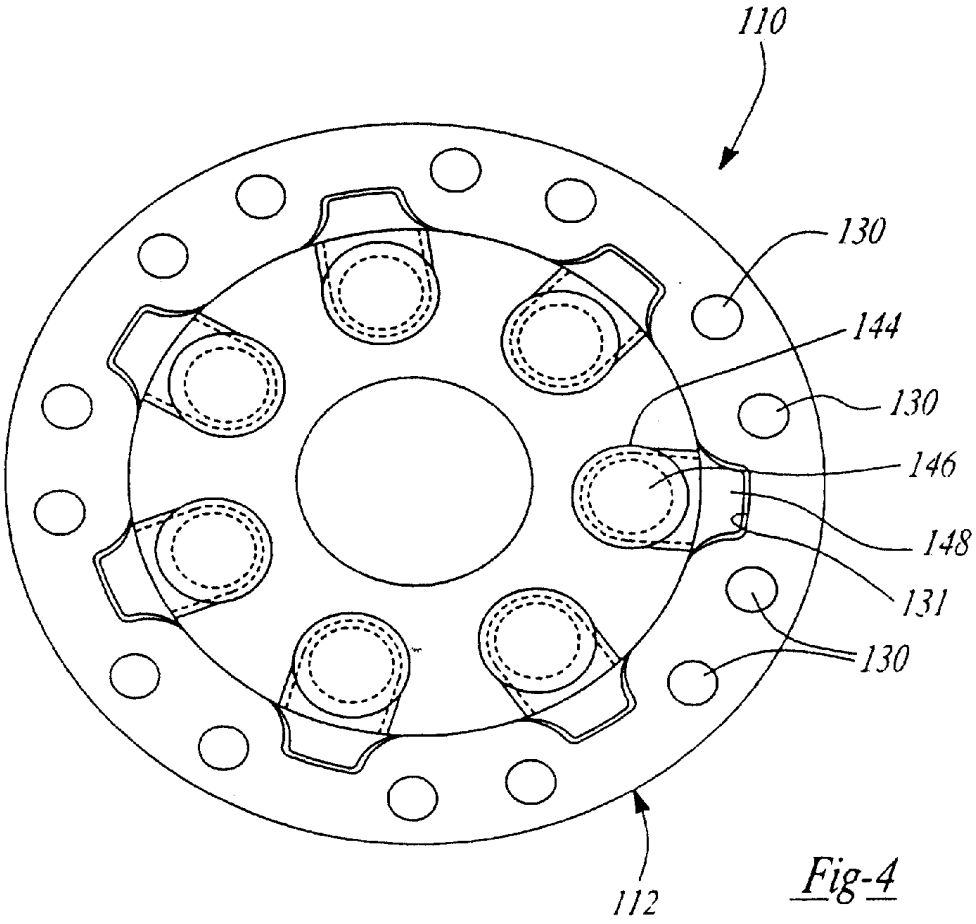


Fig-4

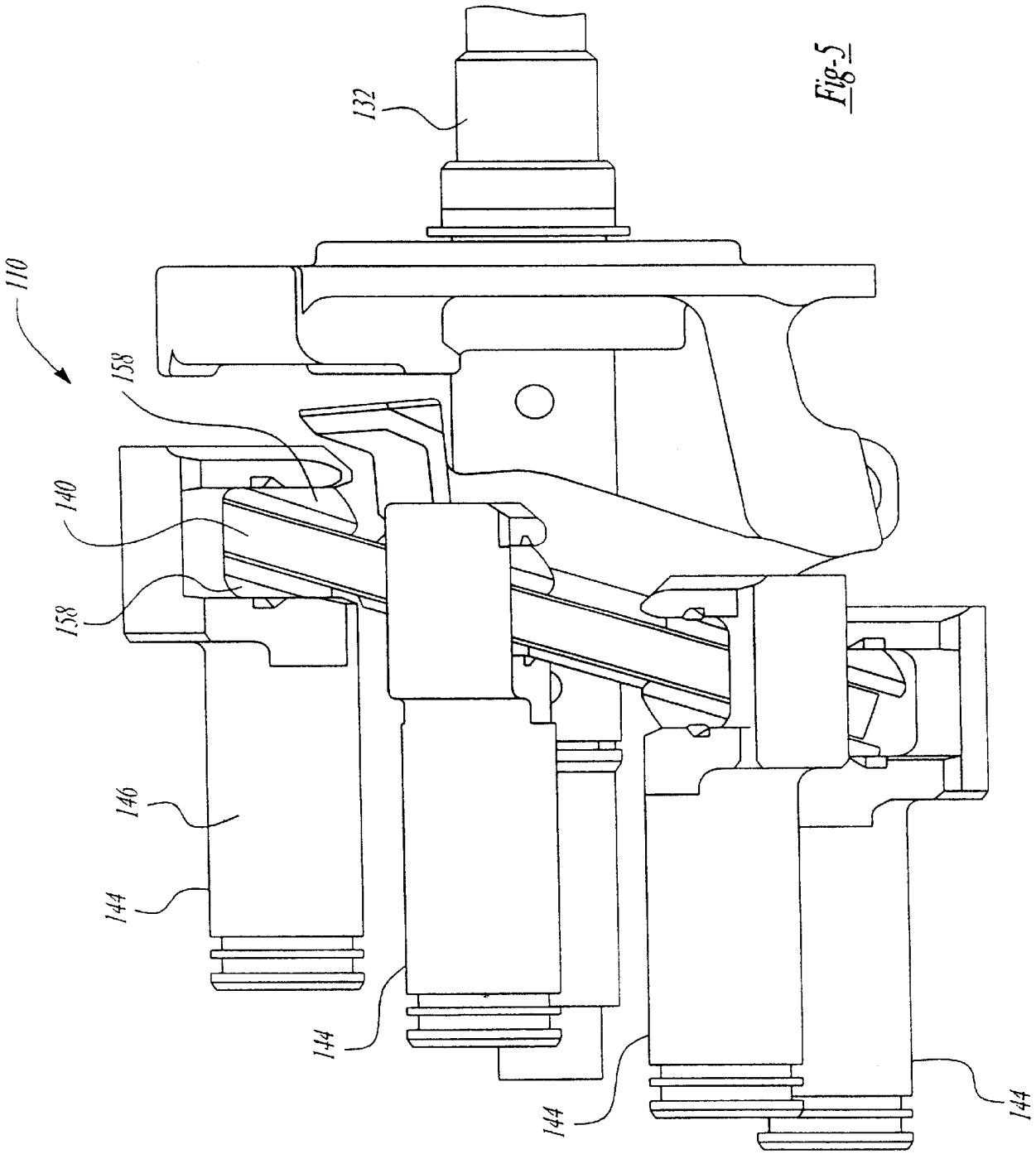


Fig-5

PISTON HAVING ANTI-ROTATION FOR SWASHPLATE COMPRESSOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to air conditioning systems for vehicles and, more specifically, to a piston having anti-rotation for a swashplate compressor of an air conditioning system in a motor vehicle.

2. Description of the Related Art

It is known to provide an air conditioning system for a motor vehicle. The air conditioning system typically carries a fluid medium such as a refrigerant to cool air for an occupant compartment of the motor vehicle. It is also known to provide a compressor for the air conditioning system to compress the refrigerant circulating therethrough. One type of compressor for an air conditioning system is known as a swashplate compressor. An example of such a compressor for an air conditioning system is disclosed in U.S. Pat. No. 5,720,215. In this patent, the compressor has a housing with a cylindrical inner surface surrounding a cylinder block having a series of cylinder bores. A central drive shaft rotates a slanted swashplate that moves axially in a reciprocating manner to drive corresponding pistons connected thereto in their cylinder bores. Unlike wobble plate driven pistons, there is a need to limit the rotation of the pistons in a swashplate compressor. The swashplate compressor has anti-rotation wings that prevent the piston from rubbing with the swashplate. However, the limiting housing dimension is dependent on the swashplate mechanism in the crankcase.

It is desirable to provide a piston for a swashplate compressor of an air conditioning system with an anti-rotation feature. It is also desirable to provide a piston for a swashplate compressor of an air conditioning system that allows for much tighter packaging of the compressor. It is further desirable to provide anti-rotation wings for the pistons in a swashplate compressor to limit rotation of the pistons. Therefore, there is a need in the art to provide a piston having anti-rotation for a swashplate compressor of an air conditioning system that accomplishes these desires.

SUMMARY OF THE INVENTION

Accordingly, the present invention is a piston having anti-rotation for a swashplate compressor including a body portion extending axially and a connecting portion spaced radially from a longitudinal axis of the body portion and extending axially. The piston also includes a pair of opposed anti-rotation wings extending radially from one end of the body portion between the connecting portion and the longitudinal axis of the body portion.

One advantage of the present invention is that a piston having anti-rotation is provided for a swashplate compressor of an air conditioning system of a vehicle. Another advantage of the present invention is that the piston has anti-rotation wings moved closer to a centerline of the piston, enabling the anti-rotation feature of the swashplate compressor to be maintained within a tighter packaging space.

Other features and advantages of the present invention will be readily appreciated, as the same becomes better understood after reading the subsequent description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a fragmentary elevational view of a piston having anti-rotation, according to the present invention, illustrated in operational relationship with a swashplate compressor for use with an air conditioning system.

FIG. **2** is a sectional view taken along line **2**—**2** of FIG. **1**.

FIG. **3** is a perspective view of the piston having anti-rotation of FIGS. **1** and **2**.

FIG. **4** is a side elevational view of another embodiment, according to the present invention, of the piston having anti-rotation and swashplate of FIG. **1**.

FIG. **5** is an elevational view of the swashplate compressor of FIG. **1** illustrating the housing removed.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Referring to the drawings and in particular FIGS. **1** and **2**, one embodiment of a swashplate compressor **10**, according to the present invention, is shown for a refrigerant system such as an air conditioning system (not shown) of a vehicle such as a motor vehicle (not shown). The swashplate compressor **10** relates to fixed or variable swashplate compressors. As illustrated in FIGS. **1** and **2**, the swashplate compressor **10** is of the variable type. It should be appreciated that the swashplate compressor **10** could be of the fixed type.

The swashplate compressor **10** includes a housing, generally indicated at **12**, having a first or shaft housing **14** with a cavity **16** formed by an inner surface **17**. The first housing **14** is generally cylindrical in shape with a generally circular cross-section. The first housing **14** has a projection **18** extending axially at one end with a passage **20** extending axially therethrough and communicating with the cavity **16**.

The housing **12** also includes a second or cylinder housing **22** disposed adjacent the first housing **14**. The second housing **22** is generally cylindrical in shape with a generally circular cross-section. The second housing **22** has at least one, preferably a plurality of cylinder bores **24** extending axially therethrough and spaced circumferentially thereabout. The cylinder bores **24** extend axially and are generally circular in shape.

The housing **12** includes an end plate **26** disposed adjacent the second housing **22**. The end plate **26** is generally circular in shape. The housing **12** also includes an end or third housing **28** disposed adjacent the end plate **26**. The third housing **28** is generally cylindrical in shape with a generally circular cross-section. The housing **12** further includes at least one, preferably a plurality of fasteners **30** such as bolts to secure the third housing **28**, end plate **26**, second housing **22** and first housing **14** together. The housing **12** includes at least one, preferably a plurality of slots **31** extending axially in the second housing **22** and spaced circumferentially thereabout for a function to be described. The slots **31** are generally trapezoidal in shape and spaced circumferentially between a pair of adjacent fasteners **30**. The housing **12** is made of a metal material such as steel. It should be appreciated that the swashplate compressor **10** could be used for air conditioning systems in other applications besides motor vehicles. It should further be appreciated that the swashplate compressor **10** may be used with refrigerant systems other than an air conditioning system.

Referring to FIGS. **1** through **3**, the swashplate compressor **10** includes a rotatable shaft **32** extending axially through the first housing **14** and second housing **22**. The shaft **32** has a generally circular cross-sectional shape and is made of a rigid material such as steel. The swashplate compressor **10** includes a plurality of bearings **34** and bushings **36** to support the shaft **32** in the housing **12**. It

should be appreciated that the shaft **32** extends through the passageway **20** and out of the first housing **14** for connection to a device (not shown) to rotate the shaft **32**.

The swashplate compressor **10** includes a swashplate **40** disposed in the cavity **16** of the first housing **14** and about the shaft **32** by a support member **42**. The swashplate **40** is generally circular in shape and disposed about the support member **42**. The support member **42** is generally cylindrical in shape and disposed about the shaft **32**. The swashplate **40** and support member **42** are made of a metal material such as steel. It should be appreciated that the shaft **32**, support member **42** and swashplate **40** rotate as a unit.

Referring to FIGS. **1** through **3**, the swashplate compressor **10** includes at least one, preferably a plurality of pistons **44**, according to the present invention, connected to and driven by the swashplate **40**. The pistons **44** have a body portion **46** that is generally cylindrical in shape with a generally circular cross-section. The pistons **44** have a connecting portion **48** extending axially from one end of the body portion **46** at a periphery thereof. The connection portion **48** has a generally trapezoidal cross-sectional shape and is disposed in the slots **31** of the housing **12**. The piston **44** also have a flange portion **50** extending radially from one end of the connecting portion **48** to form an axial space **52** between the end of the body portion **46** and the flange portion **50**. The space **52** allows the piston **44** to fit over the edge of the swashplate **40**. The pistons **44** further have a pair of opposed anti-rotation wings **54** extending radially from one end of the body portion **46** adjacent the connection portion **48**. The anti-rotation wings **54** are spaced radially from a longitudinal axis of the body portion **46**. The anti-rotation wings **54** have a contact surface **54***a* which is rounded or complementary to and abuts the inner surface **17** of the cavity **16** to prevent the pistons **44** from rotating due to the sliding and twisting of the pistons **44** when in a reciprocating manner. The anti-rotation wings **54** may include an aperture or groove **55** extending axially therethrough. The groove **55** is generally oval shaped. The groove **55** allows the swashplate **40** to turn in both directions to its fullest angle without interference to move to a full capacity position. The body portion **46**, connecting portion **48**, flange portion **50** and anti-rotation wings **54** are integral, unitary and one-piece. It should be appreciated that each piston **44** is a monolithic structure.

The swashplate compressor **10** includes a pair of half plate shoes **58** disposed in the space **52** of the piston **44** with one shoe **58** between the swashplate **40** and the flange portion **50** and another shoe **58** between the swashplate **40** and the body portion **46**. The half plate shoes **58** allow the swashplate **40** edge to both slide freely and twist through the space **52** as the piston **40** is driven in a reciprocating manner. It should be appreciated that the sliding and twisting action can impose a twisting force on the piston **44**, causing it to turn about its own axis within the bore **24**.

In operation of the swashplate compressor **10**, the shaft **32** is rotated by an external drive (not shown). The rotation of the shaft **32** causes the swashplate **40** to rotate. As the swashplate **40** rotates, the pistons **44** slide in the cylinder bores **24** to compress the refrigerant. The connecting portion **48** slides in the slot **31** and the anti-rotation wings **54** slide along the inner surface **17** and prevent the piston **44** from twisting and rotating. It should be appreciated that the swashplate **40** is slanted to vary the amount of compression for the pistons **44** to compress the refrigerant.

Referring to FIGS. **4** and **5**, another embodiment **110**, according to the present invention, of the swashplate compressor **10** is shown. Like parts of the swashplate compressor **10** have like reference numerals increased by one hundred (100). In this embodiment, the swashplate compressor **110** eliminates the anti-rotation wings on the pistons **144**. The slots **131** in cooperation with the connecting portion **148** of the pistons **144** act as an anti-rotation feature. The swashplate compressor **110** operates similar to the swashplate compressor **10**.

The present invention has been described in an illustrative manner. 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.

Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the present invention may be practiced other than as specifically described.

What is claimed is:

1. A piston having anti-rotation for a swashplate compressor comprising:

a head portion slidably engageable in an axial direction within a piston bore;

a body portion extending axially from said head portion;

a flange portion cooperating with said body portion to form an axial space between said flange portion and said body portion;

a connecting portion spaced radially from a longitudinal axis of said body portion adapted to support said flange portion and extending axially; and

a pair of opposed anti-rotation wings extending radially from said body portion.

2. A piston having anti-rotation as set forth in claim **1** wherein said anti-rotation wings have an aperture extending axially therethrough.

3. A piston having anti-rotation as set forth in claim **1** including a flange portion extending radially from one end of said connecting portion to form an axial space between said flange portion and said body portion.

4. A piston having anti-rotation as set forth in claim **3** wherein said body portion, said connecting portion, said flange portion and said anti-rotation wings are integral with each other, unitary and one piece.

5. A piston having anti-rotation as set forth in claim **1** wherein said body portion is generally cylindrical in shape.

6. A piston having anti-rotation as set forth in claim **1** wherein said connecting portion has a generally trapezoidal shape.

7. A piston having anti-rotation as set forth in claim **1** wherein said body portion is centered along the longitudinal axis of said head portion.

8. A piston having anti-rotation as set forth in claim **1** wherein said connecting portion is spaced radially from said body portion.

9. A piston having anti-rotation as set forth in claim **1** wherein said anti-rotation wings have a contacting portion in contact with a housing inner surface.

10. A piston having anti-rotation as set forth in claim **9** wherein said contacting portion has generally the same radius of curvature as the cylinder wall.

11. A piston having anti-rotation as set forth in claim **1** wherein said connecting portion is spaced radially from a longitudinal axis of said piston body portion and extending axially, wherein said longitudinal axis is generally along the peripheral of said piston body portion and the piston head portion.

12. A piston having anti-rotation as set forth in claim **1** wherein said axial space is adapted to support a pair of shoes coupling a swashplate.

13. A swashplate compressor comprising:

a housing having an inner surface forming a cavity and at least one slot extending axially along said inner surface, said housing including at least one cylinder bore;

a shaft extending through said housing and into said cavity and rotatable relative to said housing;

a swashplate operatively connected to said shaft for rotation therewith; and

at least one piston disposed in said at least one cylinder bore and operatively connected to said swashplate for reciprocating movement as said swashplate rotates, said at least one piston having a head portion slidably engageable in an axial direction within a piston bore, a body portion extending axially from said head portion, a flange portion cooperating with said body portion to form an axial space between said flange portion and said body portion, a protruding portion spaced radially from a longitudinal axis of said body portion adapted to support said flange portion wherein said protruding portion is extending axially and disposed in said at least one slot, and a pair of opposed anti-rotation wings extending radially from said body portion.

14. A swashplate compressor as set forth in claim 13 wherein each of said anti-rotation wings have an aperture extending axially therethrough.

15. A swashplate compressor as set forth in claim 13 including a flange portion extending radially from one end of said protruding portion to form an axial space between said flange portion and said body portion.

16. A swashplate compressor as set forth in claim 15 wherein said body portion, said protruding portion, said flange portion and said anti-rotation wings are integral with each other, unitary and one piece.

17. A swashplate compressor as set forth in claim 13 wherein said body portion is generally cylindrical in shape.

18. A swashplate compressor as set forth in claim 13 wherein said protruding portion has a generally trapezoidal shape.

19. A swashplate compressor as set forth in claim 13 wherein said body portion of said at least one piston is centered along the longitudinal axis of said head portion.

20. A swashplate compressor as set forth in claim 13 wherein said protruding portion of said at least one piston is spaced radially from said body portion.

21. A swashplate compressor as set forth in claim 13 wherein said anti-rotation wings have a contacting portion in contact with said inner surface.

22. A swashplate compressor as set forth in claim 21 wherein said contacting portion has generally the same radius of curvature as the cylinder wall.

23. A swashplate compressor as set forth in claim 13 wherein said protruding portion is spaced radially from a longitudinal axis of said piston body portion and extending axially wherein said longitudinal axis is along the peripheral of said piston body portion and the piston head portion.

24. A swashplate compressor as set forth in claim 13 wherein said slot is shaped to generally decrease in width as the distance from said shaft increases.

25. A swashplate compressor as set forth in claim 13 wherein said slot has a generally rounded edge along the axial direction of said housing inner surface.

26. A swashplate compressor as set forth in claim 13 wherein said anti-rotation wings prevent rotation of at least one said piston as said swashplate rotates.

27. A swashplate compressor as set forth in claim 13 wherein said axial space is adapted to support a pair of shoes coupling said swashplate.

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