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Nagulpelli et al.

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(54) **COMPRESSOR HAVING OLDHAM KEYS**

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F04C 18/02 (2006.01)

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CPC ***F04C 18/0215*** (2013.01); *F04C 18/0207* (2013.01); *F04C 18/0246* (2013.01); *F04C 2240/50* (2013.01)

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(56) **References Cited**

U.S. PATENT DOCUMENTS

4,121,438	A	10/1978	McCullough
4,877,382	A	10/1989	Caillat et al.
4,992,033	A	2/1991	Caillat et al.
5,080,566	A	1/1992	Sakata et al.
5,099,658	A	3/1992	Utter et al.
5,141,417	A	8/1992	Bush
5,141,421	A	8/1992	Bush et al.

(Continued)

FOREIGN PATENT DOCUMENTS

AU	780605-82	4/2005
CN	1219647 A	6/1999

(Continued)

OTHER PUBLICATIONS

U.S. Appl. No. 15/252,579, filed Aug. 31, 2016, Paul L. Fullenkamp et al.

(Continued)

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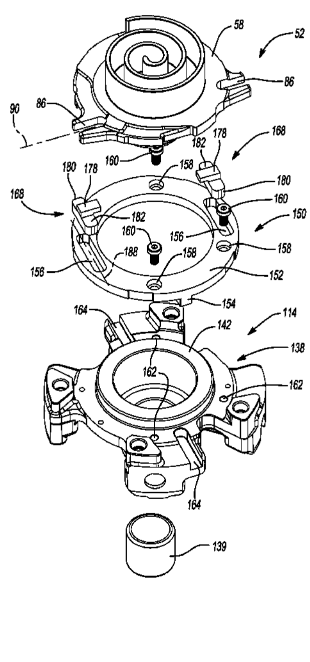
(57) **ABSTRACT**

A compressor may include a non-orbiting scroll, an orbiting scroll, a bearing housing and first and second discrete keys. The non-orbiting scroll may include a first end plate having a first spiral wrap extending therefrom. The orbiting scroll may include a second end plate having a second spiral wrap extending therefrom and meshingly engaged with the first spiral wrap of the non-orbiting scroll. The bearing housing may support the orbiting scroll. Each of the first and second keys may be slidably engaged in first slots formed in the second end plate of the orbiting scroll and slidably engaged in second slots formed in the first end plate of the non-orbiting scroll or third slots formed in the bearing housing.

24 Claims, 9 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

5,178,526 A 1/1993 Galante et al.
5,219,281 A 6/1993 Caillat et al.
5,275,543 A 1/1994 Tanaka et al.
5,320,506 A 6/1994 Fogt
5,330,334 A 7/1994 Bush et al.
5,382,144 A 1/1995 Tanaka et al.
5,403,172 A 4/1995 Blass et al.
5,407,335 A 4/1995 Caillat et al.
5,538,408 A 7/1996 Blass et al.
5,582,512 A 12/1996 Bush
5,704,773 A 1/1998 Higashiyama
5,842,845 A 12/1998 Kawano et al.
5,897,306 A 4/1999 Beck
6,106,252 A 8/2000 Yamanaka et al.
6,139,295 A 10/2000 Utter et al.
6,146,118 A 11/2000 Haller et al.
6,231,324 B1 5/2001 Clendenin et al.
6,261,072 B1 7/2001 Abe et al.
6,439,867 B1 8/2002 Clendenin
6,546,816 B2 4/2003 Schlabach
6,752,606 B2 6/2004 Koo
6,776,593 B1 * 8/2004 Cho F04C 18/0215 418/55.3
7,014,438 B2 3/2006 Fukuda et al.
7,182,586 B2 2/2007 Kim et al.
7,661,938 B2 2/2010 Ginies et al.
7,717,687 B2 5/2010 Reinhart
7,736,137 B2 6/2010 Ueno et al.
7,918,658 B2 4/2011 Bush et al.
8,057,202 B2 11/2011 Haller
8,096,792 B2 1/2012 Suefuji et al.
8,157,550 B2 4/2012 Kudo
8,177,534 B2 5/2012 Ni
8,186,980 B2 5/2012 Komai et al.
8,241,022 B2 8/2012 Nakajima
8,262,377 B2 9/2012 Caillat et al.
8,287,257 B2 10/2012 Dunaevsky
8,303,280 B2 11/2012 Kiyokawa et al.
8,356,987 B2 1/2013 Guo et al.
8,393,882 B2 3/2013 Ignatiev et al.
8,651,842 B2 2/2014 Yamamoto et al.
8,864,479 B2 10/2014 Watts et al.
8,931,759 B2 1/2015 Bonanno et al.
8,967,986 B2 3/2015 Harashima et al.
9,017,050 B2 4/2015 Ginies et al.
9,169,841 B2 10/2015 Bonnefoi et al.
9,181,949 B2 11/2015 Duppert et al.
9,316,223 B2 4/2016 Unami et al.
9,322,404 B2 4/2016 Roof et al.
9,347,441 B2 5/2016 Rice et al.
9,534,599 B2 1/2017 Rosson et al.
10,400,770 B2 9/2019 Fullenkamp et al.
11,002,275 B2 5/2021 Fullenkamp et al.
2008/0085204 A1 4/2008 Lifson
2008/0119294 A1 5/2008 Erikson et al.
2009/0317276 A1 12/2009 Lee et al.
2011/0044833 A1 2/2011 Dunaevsky
2011/0081264 A1 * 4/2011 Ishizono F04C 23/02 417/410.5
2014/0178228 A1 6/2014 Rosson et al.
2014/0369819 A1 12/2014 Yamashita et al.
2015/0037190 A1 2/2015 Smerud et al.
2015/0260189 A1 9/2015 Kato
2016/0115954 A1 4/2016 Doepker et al.
2016/0123326 A1 * 5/2016 Fogt F01C 1/0215 418/55.3
2016/0230764 A1 8/2016 Tatsuwaki et al.
2016/0238006 A1 8/2016 Rosson et al.
2017/0067466 A1 3/2017 Oh et al.
2017/0234313 A1 8/2017 Fullenkamp et al.
2019/0383289 A1 12/2019 Fullenkamp et al.

FOREIGN PATENT DOCUMENTS

CN 1515799 A 7/2004
CN 206668549 U 11/2017
JP S6388288 A 4/1988
JP H02227581 A 9/1990
JP H04330392 A 11/1992
JP H0587063 A 4/1993
JP H05223068 A 8/1993
JP H0610853 A 1/1994
JP H06088579 A 3/1994
JP 2000337272 A 12/2000
KR 20170029313 A 3/2017

OTHER PUBLICATIONS

Office Action regarding U.S. Appl. No. 16/555,413, dated Sep. 24, 2020.

Offfice Action regarding Chinese Patent Application No. 201710083894.9, dated Aug. 27, 2019. Translation provided by Unitalen Attorneys at Law.

Office Action regarding European Patent Application No. 17156102.0, dated Feb. 26, 2020.

Office Action regarding Indian Patent Application No. 201821049934, dated Aug. 10, 2020.

Search Report regarding European Patent Application No. 17156102.0, dated Jul. 24, 2017.

Office Action regarding Chinese Patent Application No. 201710083894.9, dated Jun. 4, 2018. Translation provided by Unitalen Attorneys at Law.

Office Action regarding U.S. Appl. No. 15/252,579, dated Jun. 26, 2018.

Office Action regarding U.S. Appl. No. 15/252,579, dated Dec. 20, 2018.

Office Action regarding Chinese Patent Application No. 201710083894.9, dated Feb. 27, 2019. Translation provided by Unitalen Attorneys at Law.

Notice of Allowance regarding U.S. Appl. No. 15/252,579, dated Jun. 20, 2019.

Notice of Allowance regarding U.S. Appl. No. 16/555,413, dated Feb. 3, 2021.

* cited by examiner

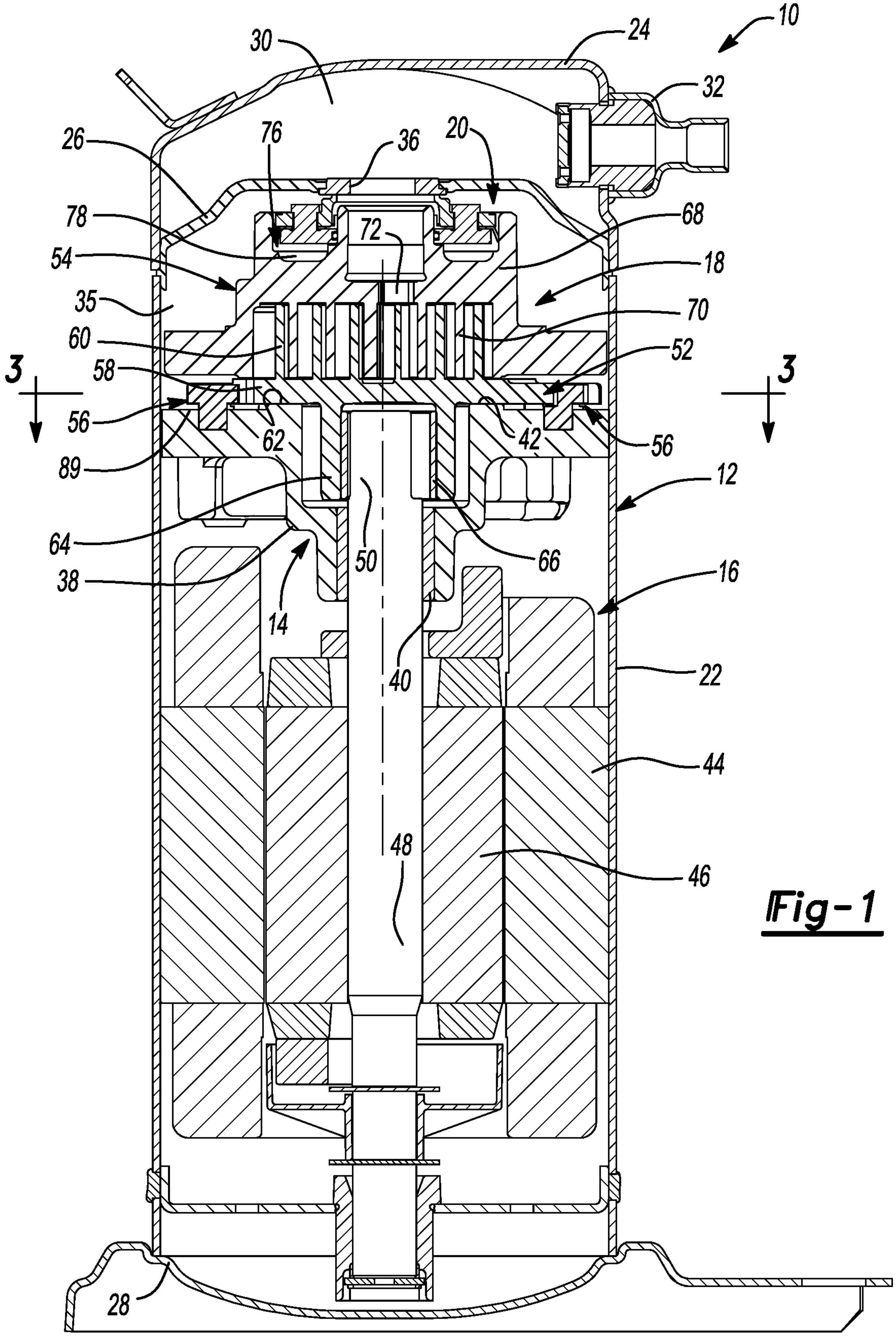

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Fig-1

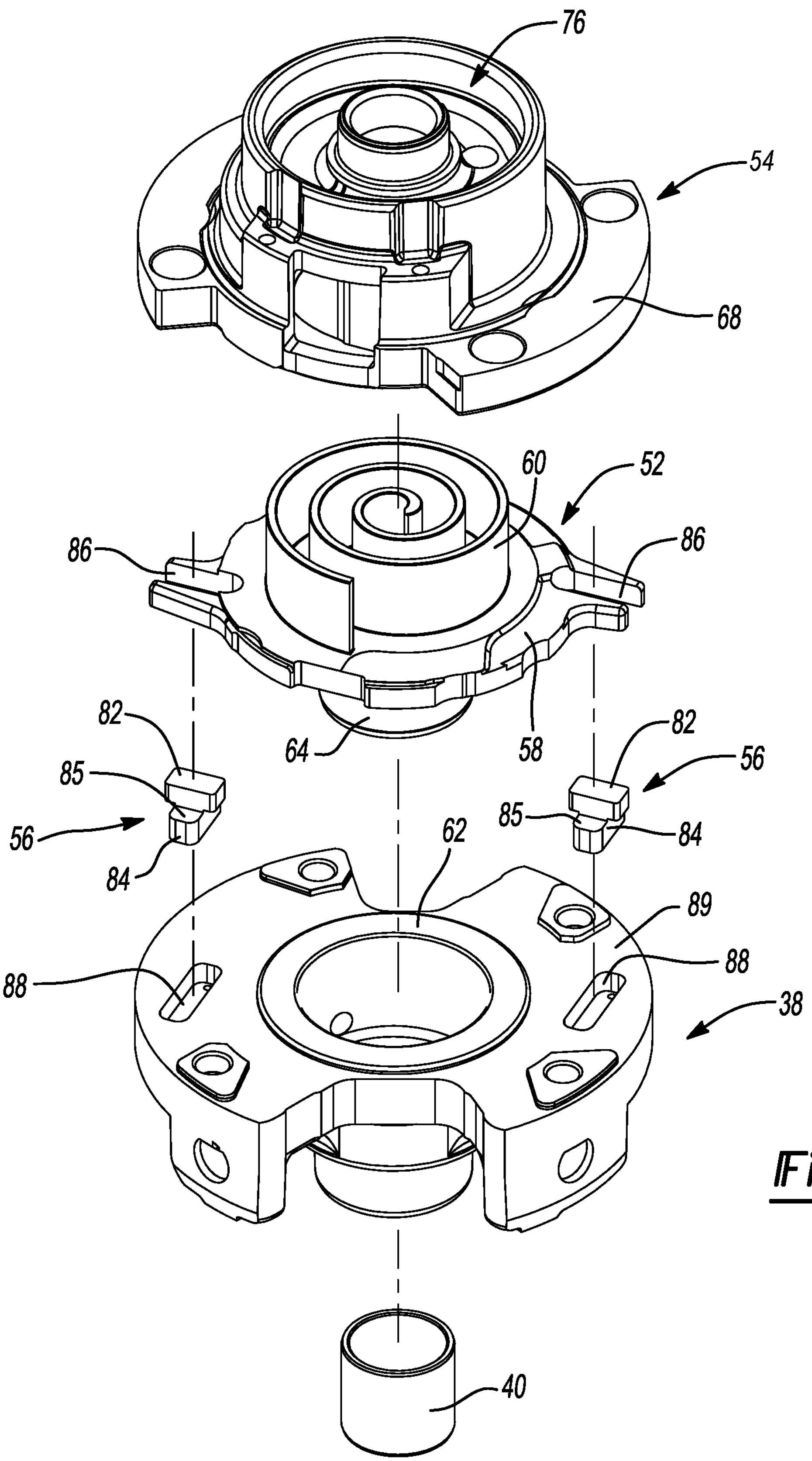

Fig-2

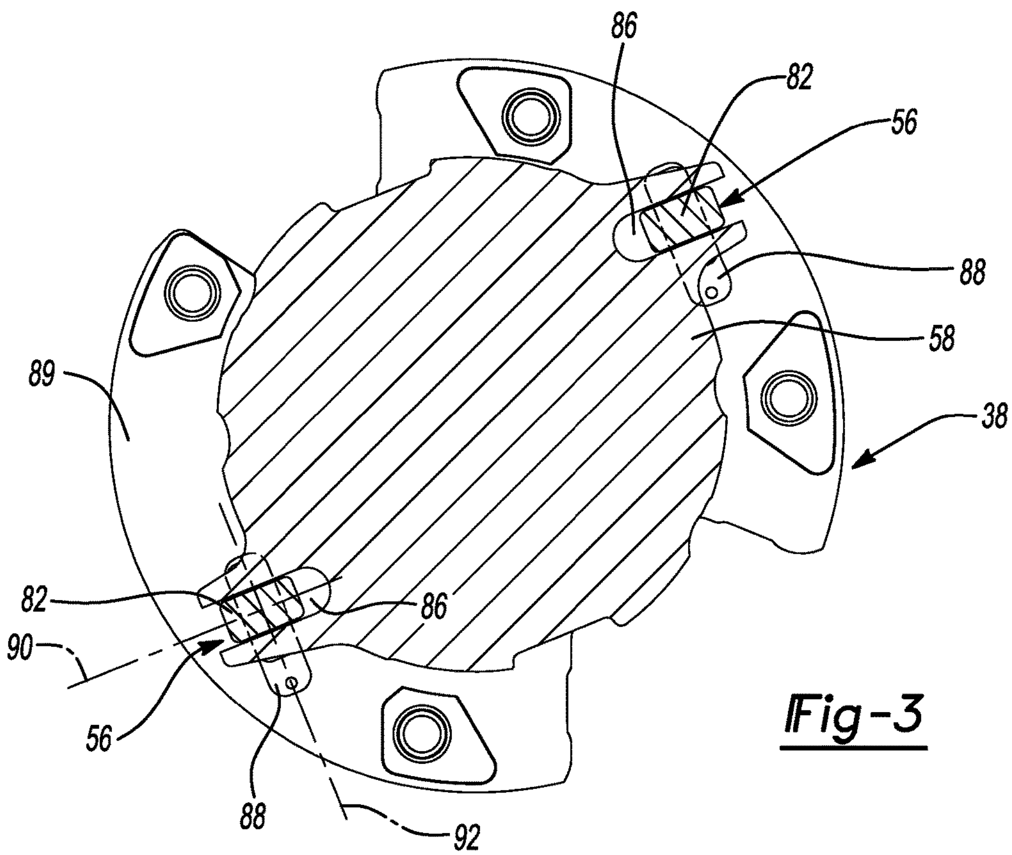
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Fig-3

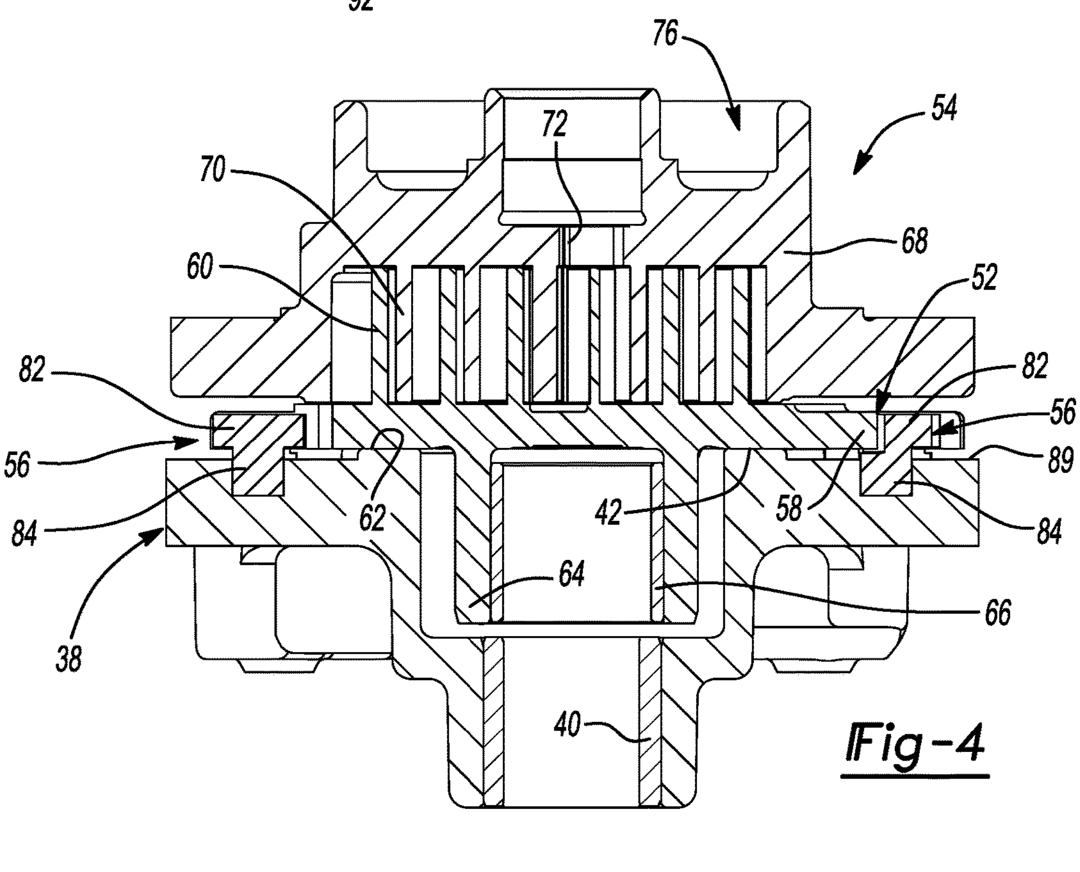
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Fig-4

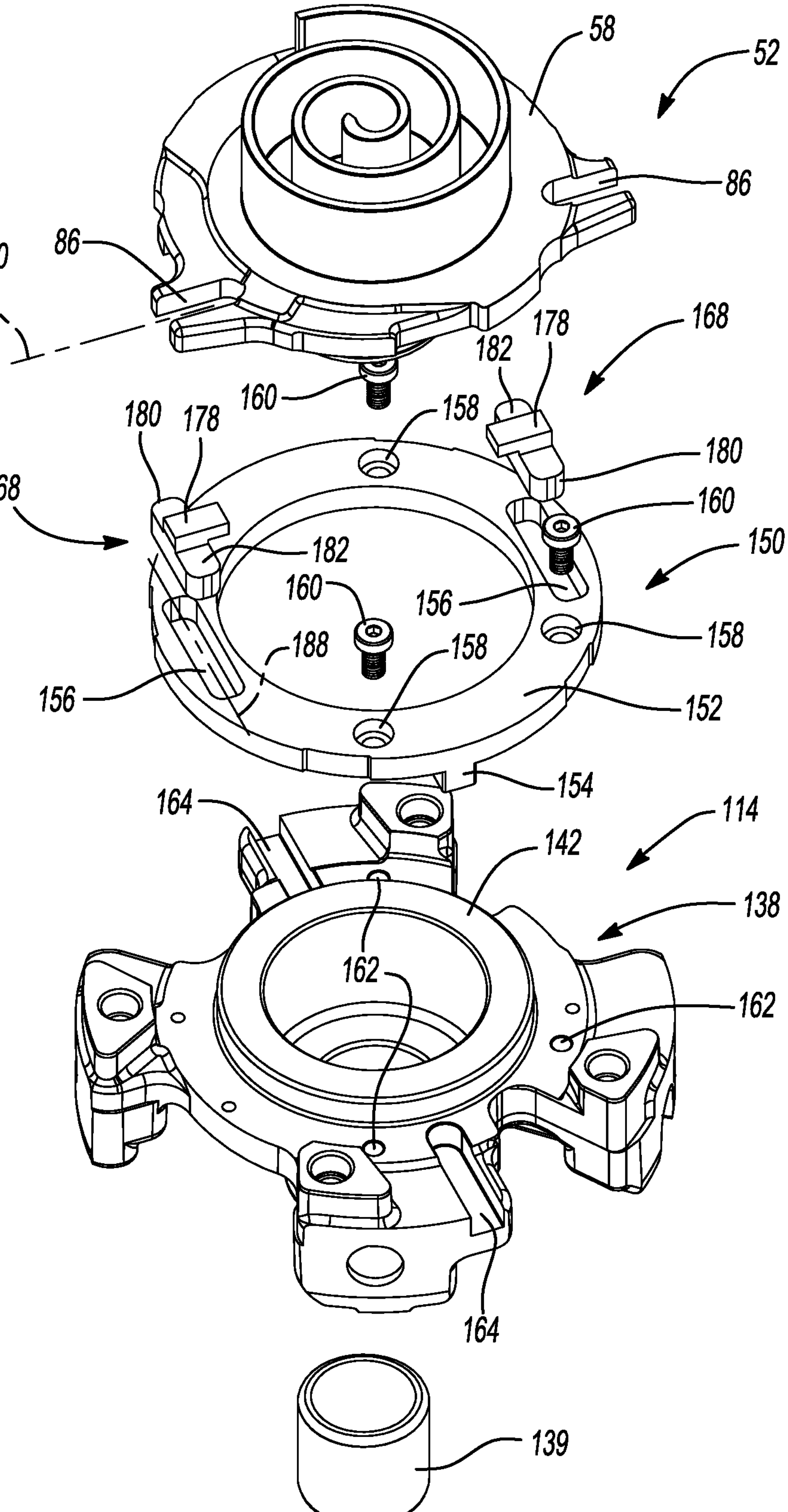
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Fig-5

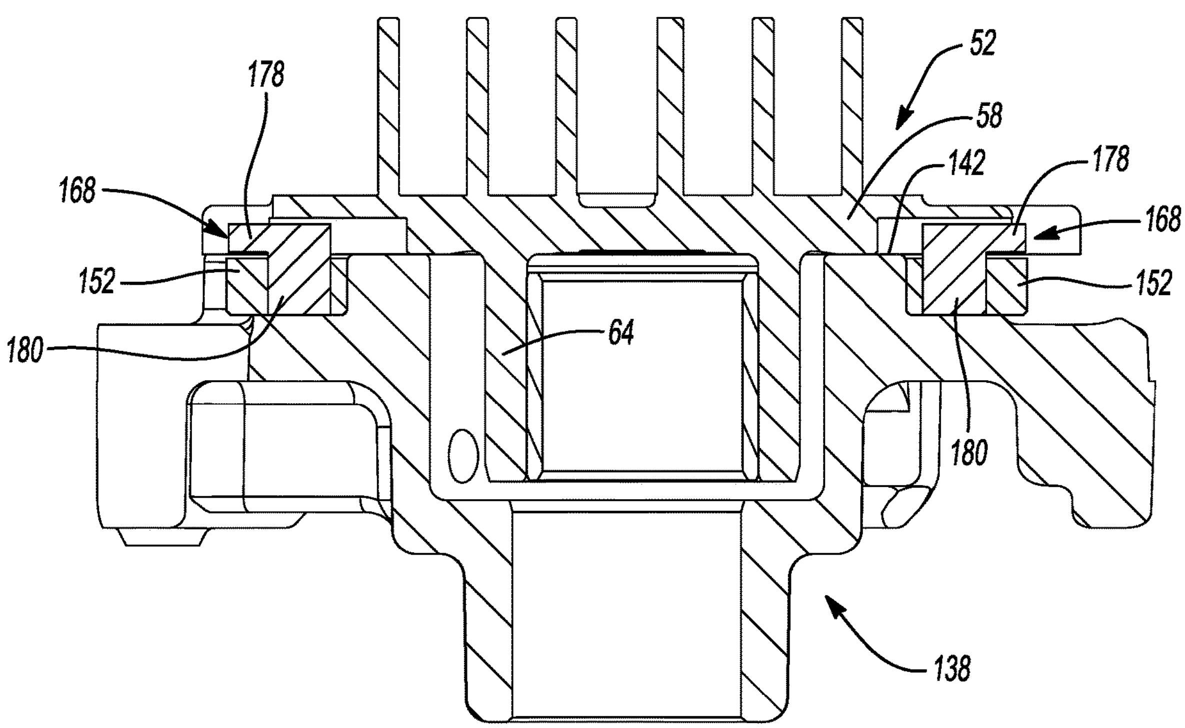

Fig-6

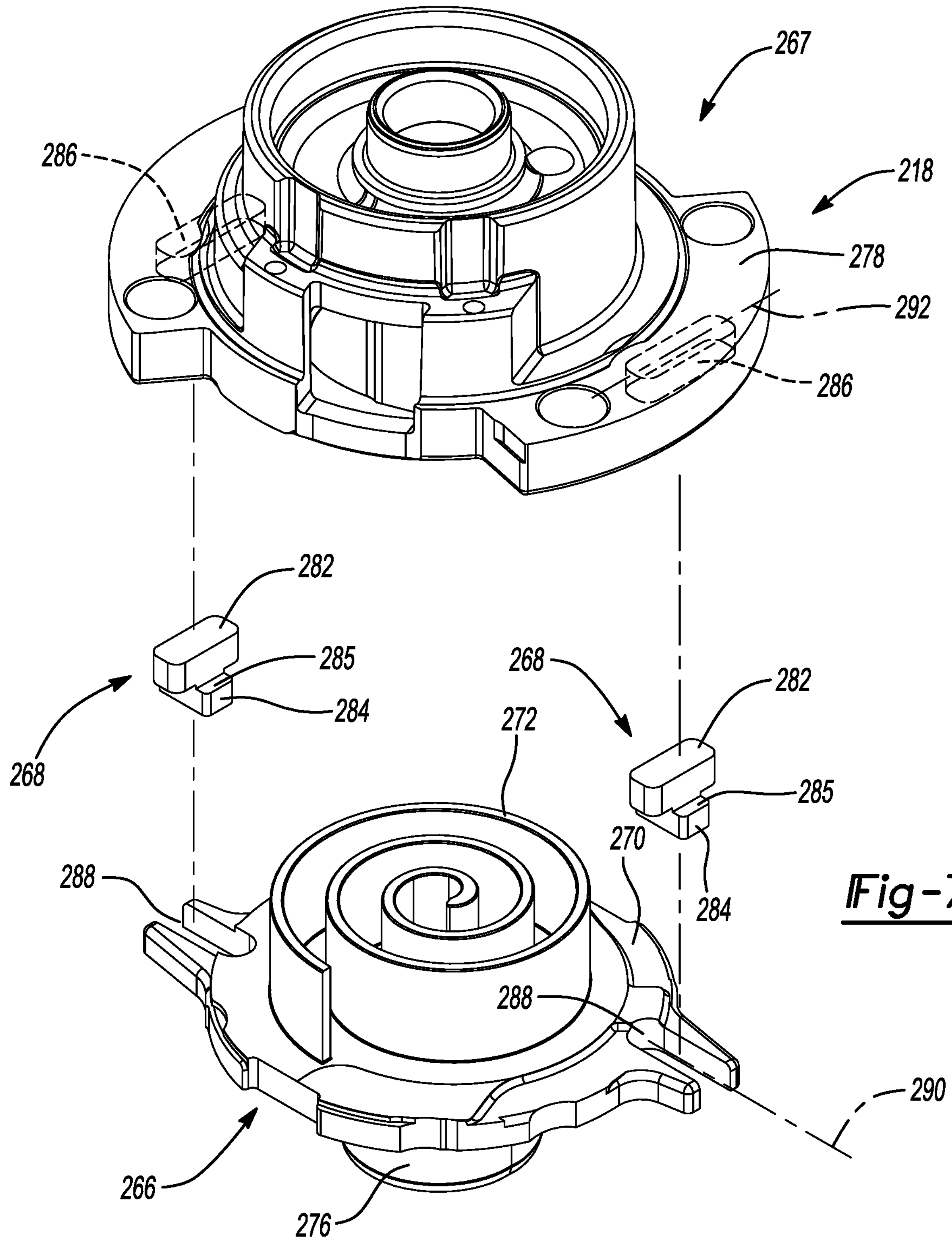
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Fig-7

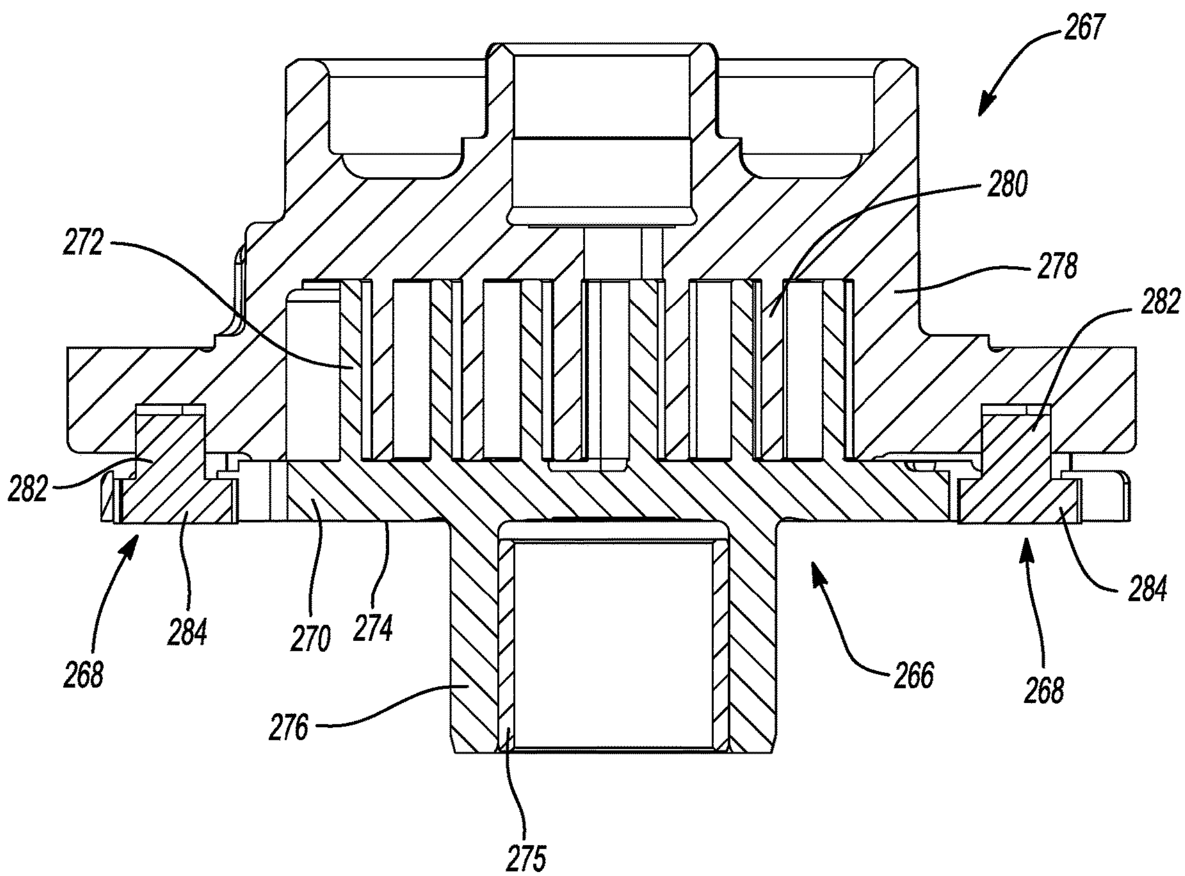

Fig-8

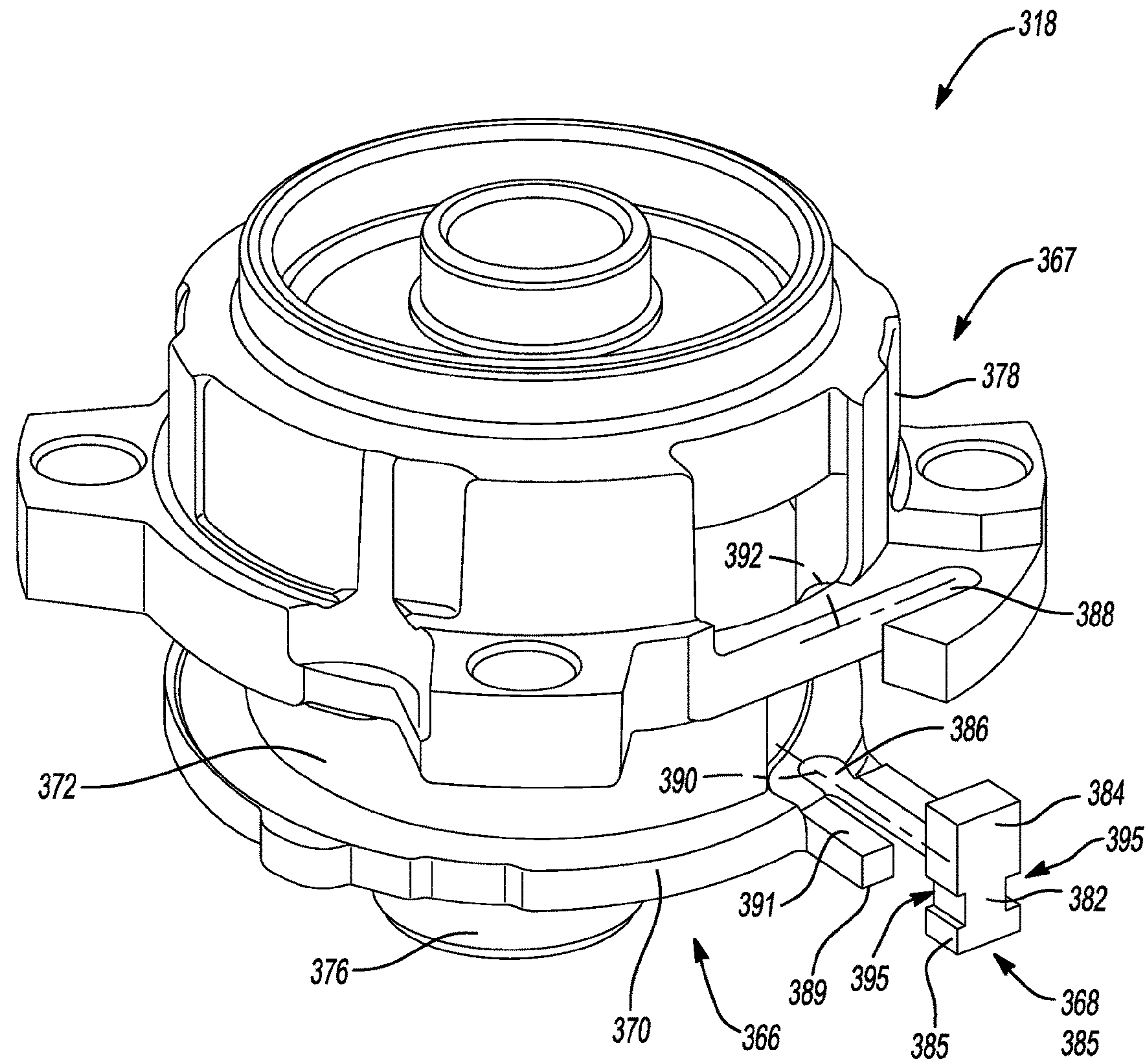
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Fig-9

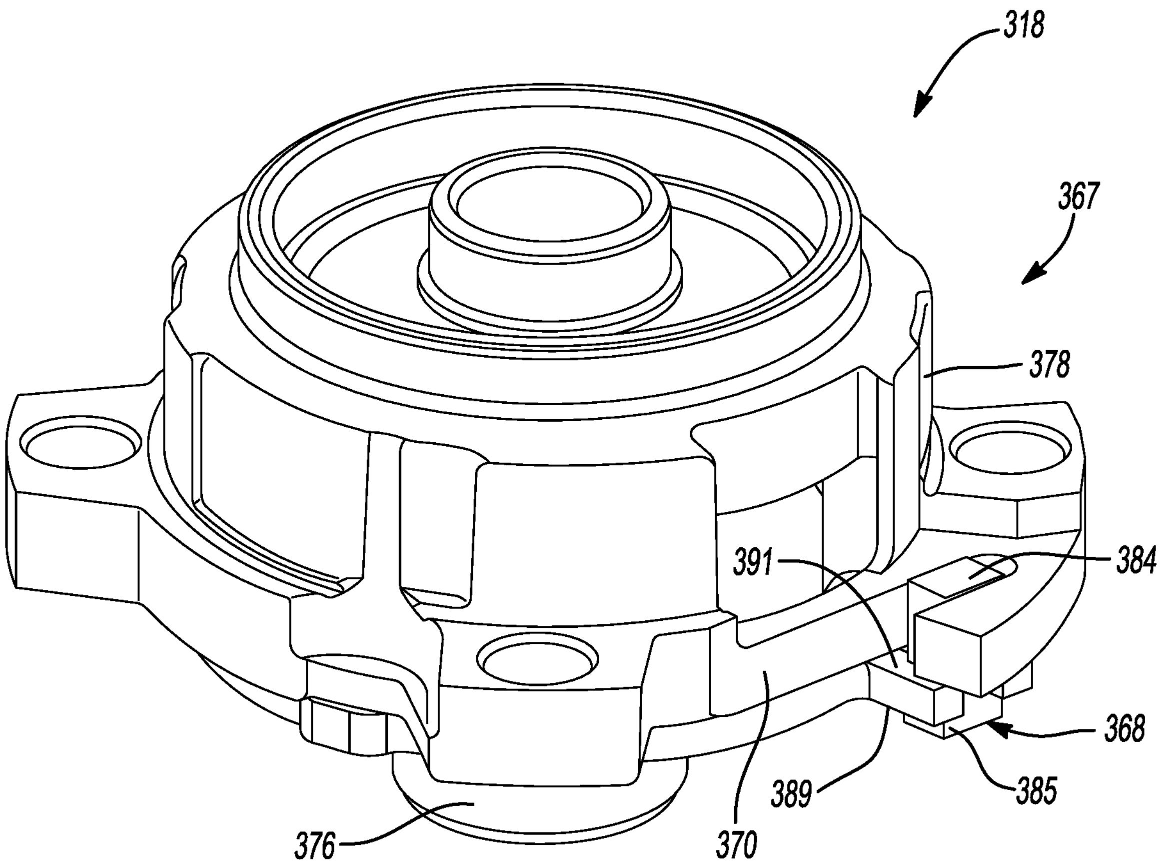

Fig-10

COMPRESSOR HAVING OLDHAM KEYS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit and priority of Indian Patent Application No. 201821049934, filed Dec. 31, 2018. The entire disclosure of the above application is incorporated herein by reference.

FIELD

The present disclosure relates to a compressor having Oldham keys.

BACKGROUND

This section provides background information related to the present disclosure and is not necessarily prior art.

A climate-control system such as, for example, a heat-pump system, a refrigeration system, or an air conditioning system, may include a fluid circuit having an outdoor heat exchanger, an indoor heat exchanger, an expansion device disposed between the indoor and outdoor heat exchangers, and one or more compressors circulating a working fluid (e.g., refrigerant or carbon dioxide) between the indoor and outdoor heat exchangers. Efficient and reliable operation of the one or more compressors is desirable to ensure that the climate-control system in which the one or more compressors are installed is capable of effectively and efficiently providing a cooling and/or heating effect on demand.

SUMMARY

This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

In one form, the present disclosure provides a compressor that may include a non-orbiting scroll, an orbiting scroll, a bearing housing and first and second discrete keys. The non-orbiting scroll may include a first end plate having a first spiral wrap extending therefrom. The orbiting scroll may include a second end plate having a second spiral wrap extending therefrom and meshingly engaged with the first spiral wrap of the non-orbiting scroll. The bearing housing may support the orbiting scroll. Each of the first and second keys may be slidably engaged in first slots formed in the second end plate of the orbiting scroll and slidably engaged in second slots formed in the first end plate of the non-orbiting scroll or third slots formed in the bearing housing.

In some configurations of the above paragraph, each of the first and second keys are slidably engaged in the first slots formed in the second end plate of the orbiting scroll and slidably engaged in the second slots formed in the first end plate of the non-orbiting scroll.

In some configurations of any one or more of the above paragraphs, the first and second keys extend through the first slots and the second slots.

In some configurations of any one or more of the above paragraphs, longitudinal axes of the first slots and longitudinal axes of the second slots are 90 degrees apart.

In some configurations of any one or more of the above paragraphs, a driveshaft engages the orbiting scroll and drives the orbiting scroll in an orbital path relative to the non-orbiting scroll.

In some configurations of any one or more of the above paragraphs, the first and second keys translate in the second

slots formed in the first end plate of the non-orbiting scroll as the orbiting scroll is driven in the orbital path.

In some configurations of any one or more of the above paragraphs, the first slots are positioned below the second slots.

In some configurations of any one or more of the above paragraphs, each of the first and second keys includes a first member and a second member. The first member is slidably engaged in a respective first slot formed in the second end plate of the orbiting scroll and the second member is slidably engaged in a respective second slot formed in the first end plate of the non-orbiting scroll.

In some configurations of any one or more of the above paragraphs, the first member and the second member are coated with a material having a high lubricity.

In some configurations of any one or more of the above paragraphs, at least one of the first member and the second member is coated with a material having a high lubricity.

In some configurations of any one or more of the above paragraphs, each of the first and second keys are slidably engaged in the first slots formed in the second end plate of the orbiting scroll and slidably engaged in the third slots formed in a surface of the bearing housing.

In some configurations of any one or more of the above paragraphs, longitudinal axes of the first slots and longitudinal axes of the third slots are 90 degrees apart.

In some configurations of any one or more of the above paragraphs, a driveshaft engages the orbiting scroll and drives the orbiting scroll in an orbital path relative to the non-orbiting scroll.

In some configurations of any one or more of the above paragraphs, the first and second keys translate in the third slots formed in the surface of the bearing housing as the orbiting scroll is driven in the orbital path.

In some configurations of any one or more of the above paragraphs, the first slots are positioned above the third slots.

In some configurations of any one or more of the above paragraphs, each of the first and second keys includes a first member and a second member. The first member is slidably engaged in a respective first slot formed in the second end plate of the orbiting scroll and the second member is slidably engaged in a respective third slot formed in the surface of the bearing housing.

In some configurations of any one or more of the above paragraphs, the second member has a thickness that is thicker than a thickness of the first member.

In some configurations of any one or more of the above paragraphs, at least one of the first member and the second member is coated with a material having a high lubricity.

In another form, the present disclosure provides a compressor that may include a non-orbiting scroll, an orbiting scroll, a driveshaft, a bearing housing and first and second discrete keys. The non-orbiting scroll includes a first end plate having a first spiral wrap extending therefrom. The orbiting scroll includes a second end plate having a second spiral wrap extending therefrom and meshingly engaged with the first spiral wrap of the non-orbiting scroll. The driveshaft engages the orbiting scroll and drives the orbiting scroll in an orbital path relative to the non-orbiting scroll. The bearing housing supports the orbiting scroll and defines a thrust bearing surface. Each of the first and second keys are slidably engaged in first slots formed in the second end plate of the orbiting scroll and are slidably engaged in second slots formed in a surface of the bearing housing. The first and second keys are permitted to translate in the second slots as the driveshaft drives the orbiting scroll in the orbital path.

In some configurations of the above paragraph, the first and second key are X-shaped.

In some configurations of any one or more of the above paragraphs, longitudinal axes of the first slots and longitudinal axes of the second slots are 90 degrees apart.

In some configurations of any one or more of the above paragraphs, the first slots are positioned above the second slots.

In some configurations of any one or more of the above paragraphs, the each of the first and second keys includes a first member and a second member. The first member is slidably engaged in a respective first slot formed in the second end plate of the orbiting scroll and the second member is slidably engaged in a respective second slot formed in the surface of the bearing housing.

In some configurations of any one or more of the above paragraphs, the first member may extend radially inwardly from a middle portion of a surface of the second member.

In some configurations of any one or more of the above paragraphs, at least one of the first member and the second member is coated with a material having a high lubricity.

In some configurations of any one or more of the above paragraphs, the second member has a thickness that is thicker than a thickness of the first member.

In yet another form, the present disclosure provides a compressor that includes a non-orbiting scroll, an orbiting scroll, a bearing housing, a bracket plate and first and second discrete keys. The non-orbiting scroll includes a first end plate having a first spiral wrap extending therefrom. The orbiting scroll includes a second end plate having a second spiral wrap extending therefrom and meshingly engaged with the first spiral wrap of the non-orbiting scroll. The bearing housing supports the orbiting scroll. The bracket plate is fixed to the bearing housing. Each of the first and second keys are slidably received in first slots formed in the second end plate of the orbiting scroll and are slidably engaged in second slots formed in the bracket plate.

In some configurations of the above paragraph, the longitudinal axes of the first slots and the longitudinal axes of the second slots are 90 degrees apart.

In some configurations of any one or more of the above paragraphs, the first slots are positioned above the second slots.

In some configurations of any one or more of the above paragraphs, each of the first and second keys includes a first member and a second member. The first member is slidably engaged in a respective first slot formed in the second end plate of the orbiting scroll and the second member is slidably engaged in a respective second slot formed in the bracket plate.

In some configurations of any one or more of the above paragraphs, the first member extends radially inwardly from a middle portion of a surface of the second member.

In some configurations of any one or more of the above paragraphs, the second member has a thickness that is thicker than a thickness of the first member.

In some configurations of any one or more of the above paragraphs, at least one of the first member and the second member is coated with a material having a high lubricity.

Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

FIG. **1** is a cross-sectional view of a compressor having Oldham keys according to the principles of the present disclosure;

FIG. **2** is an exploded view of a compression mechanism and a main bearing housing of the compressor of FIG. **1**;

FIG. **3** is a cross-sectional view of the compressor taken along line **3-3** of FIG. **1**;

FIG. **4** is a cross-sectional view of the main bearing housing, the compression mechanism and the Oldham keys of the compressor of FIG. **1**;

FIG. **5** is an exploded view of an orbiting scroll of the compression mechanism and the Oldham keys of FIG. **2** with an alternate main bearing housing;

FIG. **6** is a cross-sectional view of the orbiting scroll, the Oldham keys and the alternate main bearing housing of FIG. **5**;

FIG. **7** is an exploded view of another alternate compression mechanism;

FIG. **8** is a cross-sectional view of the compression mechanism of FIG. **7**;

FIG. **9** is an exploded view of another alternate compression mechanism and Oldham key; and

FIG. **10** is a perspective view of the compression mechanism and Oldham key of FIG. **9**.

Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

Example embodiments will now be described more fully with reference to the accompanying drawings.

Example embodiments are provided so that this disclosure will be thorough, and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well-known processes, well-known device structures, and well-known technologies are not described in detail.

The terminology used herein is for the purpose of describing particular example embodiments only and is not intended to be limiting. As used herein, the singular forms "a," "an," and "the" may be intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms "comprises," "comprising," "including," and "having," are inclusive and therefore specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. The method steps, processes, and operations described herein are not to be construed as necessarily requiring their performance in the particular order discussed or illustrated, unless specifically identified as an order of performance. It is also to be understood that additional or alternative steps may be employed.

When an element or layer is referred to as being “on,” “engaged to,” “connected to,” or “coupled to” another element or layer, it may be directly on, engaged, connected or coupled to the other element or layer, or intervening elements or layers may be present. In contrast, when an element is referred to as being “directly on,” “directly engaged to,” “directly connected to,” or “directly coupled to” another element or layer, there may be no intervening elements or layers present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., “between” versus “directly between,” “adjacent” versus “directly adjacent,” etc.). As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

Although the terms first, second, third, etc. may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms may be only used to distinguish one element, component, region, layer or section from another region, layer or section. Terms such as “first,” “second,” and other numerical terms when used herein do not imply a sequence or order unless clearly indicated by the context. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the example embodiments.

Spatially relative terms, such as “inner,” “outer,” “beneath,” “below,” “lower,” “above,” “upper,” and the like, may be used herein for ease of description to describe one element or feature’s relationship to another element(s) or feature(s) as illustrated in the figures. Spatially relative terms may be intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as “below” or “beneath” other elements or features would then be oriented “above” the other elements or features. Thus, the example term “below” can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

With reference to FIG. **1**, a compressor **10** is provided that may include a hermetic shell assembly **12**, a bearing housing assembly **14**, a motor assembly **16**, a compression mechanism **18**, and a seal assembly **20**. The shell assembly **12** may generally form a compressor housing and may include a cylindrical shell **22**, an end cap **24** at the upper end thereof, a transversely extending partition **26**, and a base **28** at a lower end thereof. The end cap **24** and partition **26** may generally define a discharge chamber **30**. A discharge fitting **32** may be attached to the shell assembly **12** at an opening in the end cap **24**. A suction gas inlet fitting (not shown) may be attached to the shell assembly **12** at another opening and may communicate with a suction chamber **35** defined by the shell **22** and the partition **26**. The partition **26** may include a discharge passage **36** therethrough providing communication between the compression mechanism **18** and the discharge chamber **30**.

The bearing housing assembly **14** may be affixed to the shell **22** and may include a main bearing housing **38** and a bearing **40**. The main bearing housing **38** may house the bearing **40** therein and may define an annular flat thrust bearing surface **42** on an axial end surface thereof.

The motor assembly **16** may include a motor stator **44**, a rotor **46**, and a driveshaft **48**. The motor stator **44** may be press fit into the shell **22**. The driveshaft **48** may be rotatably driven by the rotor **46** and may be rotatably supported within the bearing **40**. The rotor **46** may be press fit on the driveshaft **48**. The driveshaft **48** may include an eccentric crankpin **50**.

The compression mechanism **18** may generally include an orbiting scroll **52**, a non-orbiting scroll **54** and Oldham keys **56**. The orbiting scroll **52** may include an end plate **58** having a spiral wrap **60** on the upper surface thereof and an annular flat thrust surface **62** on the lower surface. The thrust surface **62** may interface with the annular flat thrust bearing surface **42** on the main bearing housing **38**. A cylindrical hub **64** may project downwardly from the thrust surface **62** and may have a drive bushing **66** rotatably disposed therein. The drive bushing **66** may include an inner bore in which the crank pin **50** is drivingly disposed. A flat surface of the crankpin **50** may drivingly engage a flat surface in a portion of the inner bore of the drive bushing **66** to provide a radially compliant driving arrangement.

The non-orbiting scroll **54** may include an end plate **68** and a spiral wrap **70** projecting downwardly from the end plate **68**. The spiral wrap **70** may meshingly engage the spiral wrap **60** of the orbiting scroll **52**, thereby creating a series of moving fluid pockets. The fluid pockets defined by the spiral wraps **60**, **70** may decrease in volume as they move from a radially outer position (at a suction pressure) to a radially intermediate position (at an intermediate pressure) to a radially inner position (at a discharge pressure) throughout a compression cycle of the compression mechanism **18**.

The end plate **68** may include a discharge passage **72** and an annular recess **76**. The discharge passage **72** is in communication with one of the fluid pockets at the radially inner position and allows compressed working fluid (e.g., at the discharge pressure) to flow into the discharge chamber **30**. The annular recess **76** may receive the seal assembly **20** and cooperate with the seal assembly **20** to define an axial biasing chamber **78** therebetween. The biasing chamber **78** receives fluid from the fluid pocket in the intermediate position through an intermediate passage (not shown). A pressure differential between the intermediate-pressure fluid in the biasing chamber **78** and fluid in the suction chamber **35** exerts an axial biasing force on the non-orbiting scroll **54** urging the non-orbiting scroll **54** toward the orbiting scroll **52** to sealingly engage the scrolls **52**, **54** with each other.

As shown in FIG. **2**, the Oldham keys **56** may be generally X-shaped and may include a first member **82** and a second member **84** extending perpendicular to the first member **82**. The keys **56** are separate and discrete components (i.e., the keys **56** are not integrally formed with or fixedly attached to a ring, unlike conventional Oldham rings). The first member **82** may extend in a direction perpendicular to a rotational axis of the driveshaft **48** from a middle portion of a surface **85** of the second member **84**. The first member **82** may slidably engage slots (keyways) **86** formed in the end plate **58** of the orbiting scroll **52**, and the second member **84** may slidably engage slots (keyways) **88** formed in a surface **89** (i.e., positioned below the thrust surface **62** of the main bearing housing **38**) of the main bearing housing **38**. In this way, the keys **56** prevent rotation of the orbiting scroll **52** relative to the non-orbiting scroll **54** while allowing orbital movement of the orbiting scroll **52** relative to the non-orbiting scroll **54**. Stated another way, the second member **84** of the keys **56** slides (or translates) within the slots **88** of the main bearing housing **38** as the orbiting scroll **52** orbits, thereby restricting the orbiting scroll **52** from rotating. The thickness of the second member **84** may be thicker than the thickness of the first member **82**. In some configurations, the thickness of the first member **82** may be thicker than the thickness of the second member **84**.

As shown in FIG. **3**, longitudinal axes **90** of the slots **86** formed in the end plate **58** of the orbiting scroll **52** are angled (e.g., 90 degrees) from longitudinal axes **92** of the slots **88** formed in the surface **89** of the main bearing housing **38**. The slots **86** of the orbiting scroll **52** are positioned above the slots **88** of the main bearing housing **38**.

In some configurations, the first and/or second members **82**, **84** may be coated or made entirely from a material or materials that have a high lubricity and/or are less prone to wear. Such materials may include Vespel® (i.e., polymide containing graphite; manufactured by DuPont), bronze (e.g., bismuth bronze, bronze with graphite, bronze with silicone, etc.), aluminum bronze, cast iron, ceramic, polyarletherketone (PAEK) group materials (e.g., resins including polyetheretherketone (PEEK), polyetherketone (PEK), polyetheretheretherketone (PEEEK), polyetherketoneketone (PEKK), polyetheretherketoneketone (PEEKK), polyetherketoneetheretherketone (PEKEEK), polyetheretherketoneetheretherketone (PEEKEEK), or combinations thereof), polyamideimide (PAI) (e.g., Torlon®, manufactured by Solvay), polyphenylene sulfide (PPS), or polyphthalamide (PPA), for example, or other materials with high lubricity.

One of the benefits of the keys **56** of the present disclosure is the reduced friction (i.e., due to the elimination of the Oldham coupling) during operation of the compressor relative to compressors having conventional Oldham couplings with a ring integrally formed with keys. This reduction of frictions improves the efficiency of the compressor. Also, the keys **56** provide cost advantages to manufacture as compared to manufacturing the Oldham coupling, for example.

With reference to FIGS. **5** and **6**, another bearing housing assembly **114** and Oldham keys **168** are provided that may be incorporated into the compressor **10** instead of the bearing housing assembly **14** and Oldham keys **56**, respectively, described above. The structure and function of the bearing housing assembly **114** and the Oldham keys **168** may be similar or identical to that of the bearing housing assembly **14** and Oldham keys **56**, respectively, described above, apart from any exceptions noted below.

The bearing housing assembly **114** may be affixed to the shell **22** and may include a main bearing housing **138** and a bearing **139**. The main bearing housing **138** may house the bearing **139** therein and may define an annular flat thrust bearing surface **142** on an axial end surface thereof.

A bracket plate **150** may be attached to the bearing housing **138** and may include an annular body **152** and protrusions **154** (only one shown in FIG. **5**). The body **152** may include slots **156** and apertures **158** formed therein. Fasteners **160** may extend through the apertures **158** in the body **152** and apertures **162** in the bearing housing **138**, thereby attaching the bracket plate **150** to the bearing housing **138**. The protrusions **154** may extend from the body **152** in an axial direction (i.e., in a direction parallel to a rotational axis of the driveshaft **48**). The protrusions **154** may be received in slots **164** formed in the bearing housing **138**, thereby rotationally fixing the bracket plate **150** to the bearing housing **138** and properly positioning the bracket plate **150** to the bearing housing **138**. It is understood that the bracket plate **150** allows an operator (not shown) to retrofit traditional bearing housings so as to include the Oldham keys as described herein. Longitudinal axes of the slots **156** are parallel to longitudinal axes of the slots **164**.

The Oldham keys **168** may be generally T-shaped and may include a first member **178** and a second member **180**. The first member **178** may extend radially inwardly (i.e., in a direction perpendicular to a rotational axis of the driveshaft **48**) from a middle portion of a surface **182** of the second member **180**. The first member **178** may slidably engage the slots (keyways) **86** formed in the end plate **58** of the orbiting scroll **52**, and the second member **180** may slidably engage the slots **156** formed in the body **152** of the bracket plate **150**. In this way, the keys **168** prevent rotation of the orbiting scroll **52** relative to the main bearing housing **138** while allowing orbital movement of the orbiting scroll **52** relative to the main bearing housing **138**. Stated another way, the second member **180** of the keys **168** slides (or translates) within the slots **156** of the bracket plate **150** as the orbiting scroll **52** orbits, thereby restricting the orbiting scroll **52** from rotating. The thickness of the second member **180** is thicker than the thickness of the first member **178**. In some configurations, the thickness of the first member **178** may be thicker than the thickness of the second member **180**.

Longitudinal axes **90** of the slots **86** formed in the end plate **58** of the orbiting scroll **52** are angled (e.g., 90 degrees) from longitudinal axes **188** of the slots **156** formed in the body **152** of the bracket plate **150**. The slots **86** of the orbiting scroll **52** are above the slots **156** of the bracket plate **150**.

In some configurations, the first and/or second members **178**, **180** may be coated or made entirely from a material or materials that have a high lubricity and/or are less prone to wear. Such materials may include Vespel® (i.e., polymide containing graphite; manufactured by DuPont), bronze (e.g., bismuth bronze, bronze with graphite, bronze, with silicone, etc.), aluminum bronze, cast iron, ceramic, polyarletherketone (PAEK) group materials (e.g., resins including polyetheretherketone (PEEK), polyetherketone (PEK), polyetheretheretherketone (PEEEK), polyetherketoneketone (PEKK), polyetheretherketoneketone (PEEKK), polyetherketoneetheretherketone (PEKEEK), polyetheretherketoneetheretherketone (PEEKEEK), or combinations thereof), polyamideimide (PAI) (e.g., Torlon®, manufactured by Solvay), polyphenylene sulfide (PPS), or polyphthalamide (PPA), for example, or other materials with high lubricity.

With reference to FIGS. **7** and **8**, another compression mechanism **218** is provided. The compression mechanism **218** may be incorporated into the compressor **10** instead of the compression mechanism **18** described above. The structure and function of the compression mechanism **218** may be similar or identical to that of the compression mechanism **18** described above, apart from any exceptions noted below.

The compression mechanism **218** may generally include an orbiting scroll **266**, a non-orbiting scroll **267** and Oldham keys **268**. The orbiting scroll **266** may include an end plate **270** having a spiral wrap **272** on the upper surface thereof and an annular flat thrust surface **274** on the lower surface. The thrust surface **274** may interface with the annular flat thrust bearing surface **42** on the main bearing housing **38**. A cylindrical hub **276** may project downwardly from the thrust surface **274** and may have a drive bushing **275** rotatably disposed therein. The drive bushing **275** may include an inner bore in which the crank pin **50** is drivingly disposed. The flat surface of the crankpin **50** may drivingly engage a flat surface in a portion of the inner bore of the drive bushing to provide a radially compliant driving arrangement. The non-orbiting scroll **267** may include an end plate **278** and a spiral wrap **280** projecting downwardly from the end plate **278**. The spiral wrap **280** may meshingly engage the spiral wrap **272** of the orbiting scroll **266**, thereby creating a series of moving fluid pockets.

The Oldham keys **268** may be generally X-shaped and may include a first member **282** and a second member **284** extending perpendicular to the first member **282**. The first member **282** may extend in a direction perpendicular to a rotational axis of the driveshaft **48** from a middle portion of a surface **285** of the second member **284**. The first member **282** may slidably engage slots (keyways) **286** formed in the end plate **278** of the non-orbiting scroll **276**, and the second member **284** may slidably engage slots (keyways) **288** formed in the end plate **270** of the orbiting scroll **266**. In this way, the keys **268** prevent rotation of the orbiting scroll **266** relative to the non-orbiting scroll **267** while allowing orbital movement of the orbiting scroll **266** relative to the non-orbiting scroll **267**. Stated another way, the first member **282** of the keys **268** slides (or translates) within the slots **286** of the non-orbiting scroll **267** as the orbiting scroll **266** orbits, thereby restricting the orbiting scroll **266** from rotating. The thickness of the first member **282** is thicker than the thickness of the second member **284**. In some configurations, the thickness of the second member **284** may be thicker than the thickness of the first member **282**.

Longitudinal axes **290** of the slots **288** formed in the end plate **270** of the orbiting scroll **266** are angled (e.g., 90 degrees) from longitudinal axes **292** of the slots **286** formed in the end plate **278** of the non-orbiting scroll **267**. The slots **288** of the orbiting scroll **266** are positioned below the slots **286** of the non-orbiting scroll **267**.

In some configurations, the first and/or second members **282**, **284** may be coated or made entirely from a material or materials that have a high lubricity and/or less are prone to wear. Such materials may include Vespel® (i.e., polymide containing graphite; manufactured by DuPont), bronze (e.g., bismuth bronze, bronze with graphite, bronze with silicone, etc.), aluminum bronze, cast iron, ceramic, polyarletherketone (PAEK) group materials (e.g., resins including polyetheretherketone (PEEK), polyetherketone (PEK), polyetheretheretherketone (PEEEK), polyetherketoneketone (PEKK), polyetheretherketoneketone (PEEKK), polyetherketoneetheretherketone (PEKEEK), polyetheretherketoneetheretherketone (PEEKEEK), or combinations thereof), polyamideimide (PAI) (e.g., Torlon®, manufactured by Solvay), polyphenylene sulfide (PPS), or polyphthalamide (PPA), for example, or other materials with high lubricity.

With reference to FIGS. **9** and **10**, another compression mechanism **318** is provided. The compression mechanism **318** may be incorporated into the compressor **10** instead of the compression mechanisms **18**, **218** described above. The structure and function of the compression mechanism **318** may be similar or identical to that of the compression mechanisms **18**, **218** described above, apart from any exceptions noted below.

The compression mechanism **318** may generally include an orbiting scroll **366**, a non-orbiting scroll **367** and Oldham keys **368** (only one shown in FIGS. **9** and **10**). The orbiting scroll **366** may include an end plate **370** having a spiral wrap **372** on the upper surface thereof and an annular flat thrust surface (not shown) on the lower surface. The thrust surface (not shown) may interface with the annular flat thrust bearing surface **42** on the main bearing housing **38**. A cylindrical hub **376** may project downwardly from the thrust surface and may have a drive bushing (not shown) rotatably disposed therein. The drive bushing may include an inner bore in which the crank pin **50** is drivingly disposed. The flat surface of the crankpin **50** may drivingly engage a flat surface in a portion of the inner bore of the drive bushing to provide a radially compliant driving arrangement. The non-orbiting scroll **367** may include an end plate **378** and a spiral wrap (not shown) projecting downwardly from the end plate **378**. The spiral wrap may meshingly engage the spiral wrap **372** of the orbiting scroll **366**, thereby creating a series of moving fluid pockets.

Each key **368** (only one shown in FIGS. **9** and **10**) may include a first portion or member **382**, a second portion or member **384** and an end portion **385**. The first portion **382** may have a width that is narrower than a width of the second portion **384** and the end portion **385**. The first portion **382** may include slots **395** formed in opposing lateral sides thereof. The slots **395** slidably receive the end plate **370** of the orbiting scroll **366** when the first portion **382** slidably engage slots **386** (keyways; only one shown in FIG. **9**) formed in the end plate **370** of the orbiting scroll **366**. The second portion **384** may slidably engage slots **388** (keyways; only one shown in FIG. **9**) formed in the end plate **378** of the non-orbiting scroll **367**. In this way, the keys **368** prevent rotation of the orbiting scroll **366** relative to the non-orbiting scroll **367** while allowing orbital movement of the orbiting scroll **366** relative to the non-orbiting scroll **367**. Stated another way, the second portion **384** of the keys **368** slides (or translates) within the slots **388** of the non-orbiting scroll **367** as the orbiting scroll **366** orbits, thereby restricting the orbiting scroll **366** from rotating. The end portion **385** may abut against a bottom surface **389** of the end plate **370** of the orbiting scroll **366** and the second portion **384** may abut against a top surface **391** of the end plate **370** of the orbiting scroll **366**. In this way, the keys **368** are prevented from moving in the axial direction (i.e., direction parallel to a rotational axis of the driveshaft **48**).

Longitudinal axes **390** of the slots **386** formed in the end plate **370** of the orbiting scroll **366** are angled (e.g., 90 degrees) from longitudinal axes **392** of the slots **388** formed in the end plate **378** of the non-orbiting scroll **367**. The slots **386** of the orbiting scroll **366** are positioned below the slots **388** of the non-orbiting scroll **367**.

In some configurations, the keys **368** may be coated or made entirely from a material or materials that have a high lubricity and/or are less prone to wear. Such materials may include Vespel® (i.e., polymide containing graphite; manufactured by DuPont), bronze (e.g., bismuth bronze, bronze with graphite, bronze with silicone, etc.), aluminum bronze, cast iron, ceramic, polyarletherketone (PAEK) group materials (e.g., resins including polyetheretherketone (PEEK), polyetherketone (PEK), polyetheretheretherketone (PEEEK), polyetherketoneketone (PEKK), polyetheretherketoneketone (PEEKK), polyetherketoneetheretherketone (PEKEEK), polyetheretherketoneetheretherketone (PEEKEEK), or combinations thereof), polyamideimide (PAI) (e.g., Torlon®, manufactured by Solvay), polyphenylene sulfide (PPS), or polyphthalamide (PPA), for example, or other materials with high lubricity.

The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

What is claimed is:

1. A compressor comprising:

a non-orbiting scroll including a first end plate having a first spiral wrap extending therefrom;

an orbiting scroll including a second end plate having a second spiral wrap extending therefrom and meshingly engaged with the first spiral wrap of the non-orbiting scroll, the second end plate having a first slot and a second slot;

a bearing housing assembly supporting the orbiting scroll; and

first and second discrete keys that are unattached from each other and are not integrally formed with each other,

wherein the first key is slidably engaged in the first slot and slidably engaged in a third slot formed in: the first end plate of the non-orbiting scroll or the bearing housing assembly, and

wherein the second key is slidably engaged in the second slot and slidably engaged in a fourth slot formed in: the first end plate of the non-orbiting scroll or the bearing housing assembly.

2. The compressor of claim **1**, wherein the third and fourth slots are formed in the first end plate of the non-orbiting scroll.

3. The compressor of claim **2**, wherein the first key extends at least partially into the first and third slots and the second key extends at least partially into the second and fourth slots.

4. The compressor of claim **3**, wherein longitudinal axes of the first and second slots are angled at 90 degrees relative to longitudinal axes of the third and fourth slots.

5. The compressor of claim **3**, further comprising a driveshaft engaging the orbiting scroll and driving the orbiting scroll in an orbital path relative to the non-orbiting scroll.

6. The compressor of claim **5**, wherein the first key translates in the third slot formed in the first end plate of the non-orbiting scroll as the orbiting scroll is driven in the orbital path, and wherein the second key translates in the fourth slot formed in the first end plate of the non-orbiting scroll as the orbiting scroll is driven in the orbital path.

7. The compressor of claim **2**, wherein the first and second slots are positioned below the third and fourth slots.

8. The compressor of claim **2**, wherein each of the first and second keys includes a first member and a second member,

wherein the first member of the first key is slidably engaged in the first slot formed in the second end plate of the orbiting scroll and the second member of the first key is slidably engaged in the third slot formed in the first end plate of the non-orbiting scroll, and

wherein the first member of the second key is slidably engaged in the second slot formed in the second end plate of the orbiting scroll and the second member of the second key is slidably engaged in the fourth slot formed in the first end plate of the non-orbiting scroll.

9. The compressor of claim **8**, wherein at least one of the first member and the second member of each of the first and second keys is coated.

10. The compressor of claim **1**, wherein the third and fourth slots are formed in the bearing housing assembly.

11. The compressor of claim **10**, wherein the bearing housing assembly includes a bracket, and wherein the third and fourth slots are formed in the bracket.

12. The compressor of claim **10**, wherein longitudinal axes of the first and second slots are angled at 90 degrees relative to longitudinal axes of the third and fourth slots.

13. The compressor of claim **10**, further comprising a driveshaft engaging the orbiting scroll and driving the orbiting scroll in an orbital path relative to the non-orbiting scroll.

14. The compressor of claim **13**, wherein the first key translates in the third slot formed in the surface of the bearing housing assembly as the orbiting scroll is driven in the orbital path, and wherein the second key translates in the fourth slot formed in the surface of the bearing housing assembly as the orbiting scroll is driven in the orbital path.

15. The compressor of claim **10**, wherein the first and second slots are positioned above the third and fourth slots.

16. The compressor of claim **10**, wherein each of the first and second keys includes a first member and a second member,

wherein the first member of the first key is slidably engaged in the first slot formed in the second end plate of the orbiting scroll and the second member of the first key is slidably engaged in the third slot formed in the surface of the bearing housing assembly, and

wherein the first member of the second key is slidably engaged in the second slot formed in the second end plate of the orbiting scroll and the second member of the second key is slidably engaged in the fourth slot formed in the surface of the bearing housing assembly.

17. The compressor of claim **16**, wherein at least one of the first member and the second member of each of the first and second keys is coated.

18. A compressor comprising:

a non-orbiting scroll including a first end plate having a first spiral wrap extending therefrom;

an orbiting scroll including a second end plate having a second spiral wrap extending therefrom and meshingly engaged with the first spiral wrap of the non-orbiting scroll, the second end plate having a first slot and a second slot;

a driveshaft engaging the orbiting scroll and driving the orbiting scroll in an orbital path relative to the non-orbiting scroll;

a bearing housing supporting the orbiting scroll, the bearing housing having a third slot and a fourth slot; and

first and second discrete keys that are unattached from each other and are not integrally formed with each other,

wherein the first key is slidably engaged in the first slot and slidably engaged in the third slot,

wherein the first key is configured to translate in the third slot as the driveshaft drives the orbiting scroll in the orbital path,

wherein the second key is slidably engaged in the second slot and slidably engaged in the fourth slot, and

wherein the second key is configured to translate in the fourth slot as the driveshaft drives the orbiting scroll in the orbital path.

19. The compressor of claim **18**, wherein the first and second keys are X-shaped.

20. The compressor of claim **18**, wherein longitudinal axes of the first and second slots are angled at 90 degrees relative to longitudinal axes of the third and fourth slots.

21. The compressor of claim **20**, wherein the first and second slots are positioned above the third and fourth slots.

22. The compressor of claim **18**, wherein each of the first and second keys includes a first member and a second member,

wherein the first member of the first key is slidably engaged in the first slot formed in the second end plate of the orbiting scroll and the second member of the first key is slidably engaged in the third slot formed in the bearing housing, and

wherein the first member of the second key is slidably engaged in the second slot formed in the second end plate of the orbiting scroll and the second member of the second key is slidably engaged in the fourth slot formed in the bearing housing.

23. The compressor of claim **22**, wherein the first member of the first key extends radially inwardly from a middle portion of a surface of the second member of the first key, and

wherein the first member of the second key extends radially inwardly from a middle portion of a surface of the second member of the second key.

24. The compressor of claim **23**, wherein at least one of the first member and the second member of each of the first and second keys is coated.

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