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

(11) **EP 3 502 477 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
26.06.2019 Bulletin 2019/26

(51) Int Cl.:
F04C 27/00 *(2006.01)* ***F04C 18/12*** *(2006.01)*

(21) Application number: **18215096.1**

(22) Date of filing: **21.12.2018**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **22.12.2017 US 201715852570**

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(54) **ROTARY BLOWER**

(57) A rotary blower includes a housing and a pair of meshed rotors. The meshed rotors are disposed in the housing. Each rotor has a plurality of lobes. Each lobe includes a lobe tip seal insert mounted thereon. The lobe tip seal insert is disposed at a tip of the each lobe. Each lobe tip seal insert is constructed to seal against the housing and to prevent or reduce leakage between each lobe and the housing.

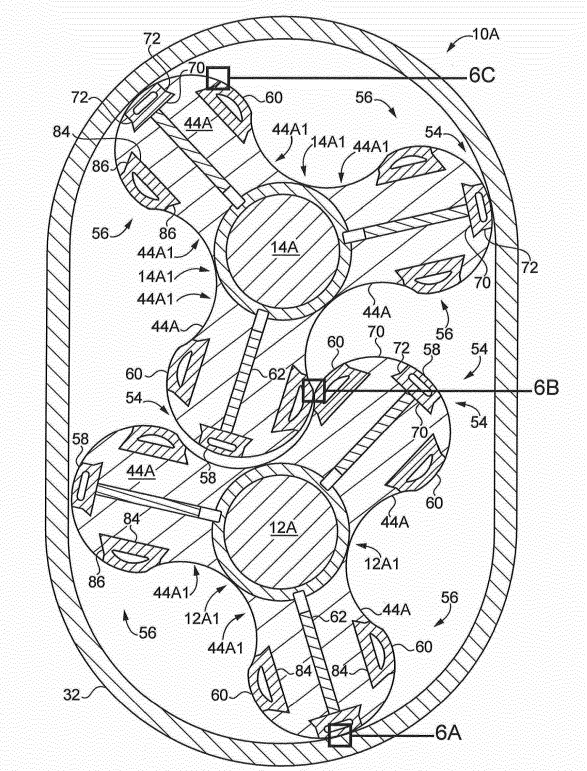

FIG. 5

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Description

TECHNICAL FIELD

[0001] The present application generally relates to blowers and more particularly, but not exclusively, to rotary blowers.

BACKGROUND

[0002] Rotary blowers of various types, e.g., Roots blowers, remain an area of interest. Some existing systems have various shortcomings, drawbacks and disadvantages relative to certain applications. For example, in some rotary blowers, undesirable amounts of leakage between the rotors and/or between the housing and the rotors may occur. Accordingly, there remains a need for further contributions in this area of technology.

SUMMARY

[0003] A rotary blower includes a housing and a pair of meshed rotors. The meshed rotors are disposed in the housing. Each rotor has a plurality of lobes. Each lobe includes a lobe tip seal insert mounted thereon. The lobe tip seal insert is disposed at a tip of each lobe. Each lobe tip seal insert is constructed to seal against the housing and to prevent or reduce leakage between each lobe and the housing.

BRIEF DESCRIPTION OF THE FIGURES

[0004] The description herein makes reference to the accompanying drawings wherein like reference numerals refer to like parts throughout the several views, and wherein:

FIG. 1 schematically illustrates a cross-sectional view depicting some aspects of a non-limiting example of a rotary blower in accordance with an embodiment of the present invention.

FIG. 2 schematically illustrates a cross-sectional view depicting some aspects of a non-limiting example of the rotary blower of FIG. 1 with the rotors at a first rotational position, which is the rotational position illustrated in FIG. 1.

FIG. 3 schematically illustrates a cross-sectional view depicting some aspects of a non-limiting example of the rotary blower of FIG. 1, from the perspective of FIG. 2 but with the rotors at a second rotational position.

FIG. 4 schematically illustrates a cross-sectional view depicting some aspects of a non-limiting example of the rotary blower of FIG. 1, from the perspective of FIG. 2 but with the rotors at a third rotational position.

FIG. 5 schematically illustrates a cross-sectional view depicting some aspects of a non-limiting example of a 3-lobed rotary blower in accordance with an embodiment of the present invention.

FIGS. 6A-6C illustrate cross-sectional views depicting some aspects of non-limiting examples of lobe side seal inserts and a lobe tip seal insert in accordance with an embodiment of the present invention.

FIG. 7 depicts a cross-section illustrating some aspects of a non-limiting example of a lobe side seal insert in accordance with an embodiment of the present invention.

FIG. 8 depicts a cross-section illustrating some aspects of a non-limiting example of a lobe tip seal insert in accordance with an embodiment of the present invention.

FIG. 9 depicts a cross-section illustrating some aspects of a non-limiting example of a pusher weight in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENTS

[0005] For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended. Any alterations and further modifications in the described embodiments, and any further applications of the principles of the invention as described herein are contemplated as would normally occur to one skilled in the art to which the invention relates.

[0006] Referring to FIG. 1, some aspects of a non-limiting example of a rotary blower 10 are illustrated in accordance with an embodiment of the present invention. In one form, rotary blower 10 is a Roots blower. In other embodiments, rotary blower 10 may take other forms. In one form, rotary blower 10 includes a pair of rotors, i.e., a driving rotor 12 in mesh with a driven rotor 14. In one form, each of driving rotor 12 and driven rotor 14 are 2-lobed rotors. In other embodiments, driving rotor 12 and driven rotor 14 may be 3-lobed rotors, 4-lobed rotors, or rotors having any number of lobes. Driving rotor 12 and driven rotor 14 are supported by respective shafts 16, 18 and 20, 22. Shafts 16, 18, 20 and 22 may be integral with rotors 12, 14, or may be separate components affixed or mounted onto or into rotors 12, 14. Shafts 16, 18, 20 and 22 are supported by respective bearings 24, 26, 28 and 30.

[0007] Driving rotor 12 and driven rotor 14 are disposed radially within a housing 32, which cooperates with driving rotor 12 and driven rotor 14 to pump or compress a fluid, such as air. Driving rotor 12 and driven rotor 14 are disposed axially between head plates 34 and 36. Housing 32 is coupled, e.g., bolted, to head plates 34 and 36. Bearings 24, 26, 28 and 30 are mounted in and supported by head plates 34 and 36. Bearings 24, 26, 28 and 30 transmit radial and thrust loads from rotors 12 and 14 to head plates 34 and 36. In one form, bearings 24, 26, 28 and 30 are rolling element bearings. For example, in the depicted embodiment of FIG. 1, bearings 26 and 30 are ball thrust bearings, whereas bearings 24 and 28 are roller bearings. In other embodiments, one or more of bearings 24, 26, 28 and 30 may be one or more other types of bearings.

[0008] Driving rotor 12 is supplied with shaft power via a shaft power source, such as an electric motor (not shown). Driving rotor 12 is operative to supply mechanical power to driven rotor 14 via gears 38 and 40. Gears 38 and 40 are mounted on respective shafts 16 and 20 of respective driving and driven rotors 12 and 14, and are in mesh with each other. Gears 38 and 40 are operative to maintain a desired angular relationship between driving rotor 12 and driven rotor 14, and to transmit rotational motion and power from driving rotor 12 to driven rotor 14. In various embodiments, a plurality of seals (not shown) may be employed to prevent the leakage of oil and/or compressed gas/fluids into undesired portions of rotary blower 10. End plate covers (not shown) may be employed to cover the bearings 24, 26, 28, 30 and gears 38, 40.

[0009] Referring to FIGS. 2-4, in conjunction with FIG. 1, during operation of rotary blower 10, an inlet gas stream to be pumped or compressed enters rotary blower 10 through an inlet 42, and the inlet gas is trapped in chambers formed between lobes 44 and the blower body or housing 32, and is forced out of rotary blower 10 at an outlet 46. In conventional rotary blowers, three types of clearances are typically used in order to allow rotation of the rotors relative to the housing and relative to each other. Examples of such clearances that occur in conventional blowers are illustrated in FIGS. 2-4, which are exaggerated for purposes of illustration. In the depictions of FIG. 1-4, some aspects of the present invention, such as the lobe seal inserts 58, 60 illustrated in and described with respect to FIG. 5-9 are not shown in order to illustrate the clearances. One such clearance is lateral clearance 48, which is the clearance between the rotors 12, 14 (including lobes 44) and the head plates, e.g., such as head plates 34 and 36. Another such clearance is diameter or diametral clearance 50, which is the radial clearance between the rotor lobes and the housing, e.g., housing 32. A third such clearance is the clearance between rotors, or between lobes, e.g., parallel lobes, such as 30° clearance 52. These clearances are typically calculated in consideration of thermal effects, such as dilation or thermal expansion. In conventional rotary blowers, the blower may crash or seize or otherwise be damaged if the clearances are too small. The size of the clearances or amount of clearance impacts blower efficiency. For example, efficiency decreases with increasing clearance, e.g., due to leakage through the clearances. Embodiments of the present invention reduce or eliminate the diameter clearance and the clearance between rotors (lobes), e.g., the 30° clearance, via the use of lobe seal inserts (not shown in FIG. 1-4).

[0010] Referring to FIGS. 5-9, some aspects of a non-limiting example of a 3-lobed rotary blower 10A in accordance with an embodiment of the present invention is illustrated. Rotary blower 10A includes meshed driving rotor 12A and driven rotor 14A. Each of driving rotor 12A and driven rotor 14A have three lobes 44A. Each lobe 44A has a tip 54 and two sides 56. Each lobe 44A includes a lobe tip seal insert 58 mounted thereon. Some aspects of a non-limiting example of lobe tip seal insert 58 are illustrated in FIG. 5, FIG. 6A and FIG. 8. Each lobe 44A also includes two lobe side seal inserts 60 mounted thereon, one lobe side seal insert 60 on each side 56. Some aspects of a non-limiting example of lobe side seal insert 60 are illustrated in FIG. 5, FIG. 6B, FIG. 6C and FIG. 7. In other embodiments, a greater amount of lobe tip seal inserts 58 and lobe side seal inserts 60 may be employed. Some embodiments may include only lobe tip seal insert(s) 58 or only lobe side seal insert(s) 60. In one form, lobe tip seal inserts 58 and lobe side seal inserts 60 are flexible and compliant. In other embodiments, portions of lobe tip seal inserts 58 and lobe side seal inserts 60 may be rigid.

[0011] In one form, the material used to form lobe tip seal inserts 58 and lobe side seal inserts 60 is different than the material used to form the balance of rotors 12A and 14A. For example, the material used to form lobe tip seal inserts 58 and lobe side seal inserts 60 may be non-metallic, whereas the material used to form the balance of rotors 12A and 14A may be metallic in some embodiments. For instance, in some embodiments, lobe tip seal inserts 58 and lobe side seal inserts 60 may be formed from, for example, a polymeric or composite or other non-metallic material. In some embodiments, preferable materials used to make lobe tip seal inserts 58 and lobe side seal inserts 60 are capable of continuous use at temperatures up to 180°C; supports sliding speeds up to 40 m/s, and have a relatively low coefficient of friction. The materials used to make lobe tip seal inserts 58 and lobe side seal inserts 60, and the corresponding coefficients of friction, may vary with the needs of the particular application.

[0012] Each lobe tip seal insert 58 is disposed at tip 54 of each lobe 44A. In one form, each lobe tip seal insert 58 is constructed and operative to seal against housing 32 and to prevent or reduce leakage between each lobe 44A and housing 32. In some embodiments, each lobe tip seal insert 58 is also constructed and operative to seal against portions of the opposite rotor, e.g., at a location 12A1, 14A1 between the lobes 44A, and also at the base or bottom or radially inward portion 44A1 of the lobes

44A, to prevent or reduce leakage between each lobe 44A of one rotor and location 12A1, 14A1 of the other rotor, and between each lobe 44A of one rotor and the base portions 44A1 of lobes 44A on the other rotor. In some embodiments, each lobe tip seal insert 58 is constructed to contact housing 32 during the operation of blower 10. In some embodiments, each lobe tip seal insert 58 is constructed to engage in sliding contact with housing 32 during rotation of the rotors, i.e., during operation of rotary blower 10.

[0013] In a particular embodiment, each lobe tip seal insert 58 is constructed to have an interference fit 64 with housing 32, e.g., as illustrated in FIG. 6A, wherein a free surface boundary 66 of a free lobe tip seal insert 58 (e.g., the sealing surface boundary of a lobe tip seal insert 58 not compressed by housing 32 or an adjacent rotor) extends beyond the compressed surface boundary 68 of a lobe tip seal insert 58 in the interference condition. The interference condition occurs when lobe tip seal 58 on one lobe 44A is compressed by interference with housing 32 or with an adjacent rotor at a location 12A1, 14A1 between lobes or at the base or bottom portion 44A1 of the meshing lobe 44A. The compressed boundary 68 is the boundary of the installed lobe tip seal insert 58 after being compressed due to the interference fit with housing 32 or with an adjacent rotor, e.g., as depicted in FIG. 6A, which illustrates the interference with housing 32. In other embodiments, lobe tip seal inserts 58 may be constructed to reduce diameter clearance 50 (FIG. 2) without contacting housing 32 under some or all operating conditions, or may be constructed to reduce diameter clearance 50 by contacting housing 32 with little or no interference, e.g., under some or all operating conditions.

[0014] In one form, each lobe 44A includes a pusher weight 62, e.g., a rod. In the depiction of FIG. 5 and FIG. 9, pusher weight 62 is a rod having a circular cross section. In other embodiments, pusher weight 62 may have any suitable geometric configuration. Each pusher weight 62 is constructed and operative to impart a radially outward, centrifugal load on a corresponding lobe tip seal insert 58, e.g., to aid in loading lobe tip seal insert 58 in a direction toward housing 32 and toward the lobe and rotor that the lobe 44A is meshing with. The pusher weight 62 may be slidably mounted within a guide slot. The guide slot may be radially oriented. Accordingly, rotation of the rotor may cause the pusher weight 62 to translate along the guide slot and apply the centrifugal load on the lobe tip seal insert 58. The radially outward loading may, for example, aid in maintaining desired contact loading between lobe tip seal insert 58 and housing 32, and between the lobe tip seal insert 58 and the lobe and rotor it is meshing with. Other embodiments may not employ a pusher weight.

[0015] In one form, each lobe 44A includes a tip recess 70 disposed at the tip 54 of the lobe. Lobe tip seal insert 58 is mounted in tip recess 70. Other embodiments may not include a tip recess. In one form, tip recess 70 includes a dovetail 72 for mating with a corresponding dovetail 74 on lobe tip seal insert 58 for retaining lobe tip seal insert 58 on lobe 44A. In other embodiments, other geometric configurations and/or fasteners may be employed to retain lobe tip seal insert 58 onto lobe 44A.

[0016] Each lobe side seal insert 60 is disposed at side 56 of the each lobe 44A. In one form, each lobe side seal insert 60 of one rotor is constructed to seal against an adjacent lobe 44A in mesh therewith of the other rotor, including against an adjacent lobe side seal insert 60. Each lobe side seal insert 60 is constructed and operative to prevent or reduce leakage between adjacent lobes 44A in mesh with each other, e.g., while the lobes are meshing. In some embodiments, each lobe side seal insert 60 is constructed to contact and seal against the adjacent lobe in mesh therewith (including contacting and sealing against the lobe side seal insert 60 on the adjacent lobe) during operation of blower 10. In some embodiments, each lobe side seal insert 60 is constructed to engage in sliding contact with the adjacent lobe 44A in mesh therewith (including sliding contact with an adjacent lobe side seal insert 60) during rotation of the rotors, i.e., during operation of rotary blower 10.

[0017] In a particular embodiment, each lobe side seal insert 60 is constructed to have an interference fit 76 with the adjacent meshing lobe 44A, e.g., as illustrated in FIG. 6B, wherein a free surface boundary 78 of a free lobe side seal insert 60 (e.g., the sealing surface boundary of a lobe side seal insert 60 not compressed by an adjacent lobe 44A, including the adjacent lobe side seal 60) extends beyond the compressed surface boundary 80 of a lobe side seal insert 60 in the interference condition. The interference condition occurs when lobe side seal insert 60 is compressed by interference with the adjacent meshing lobe 44A, including the adjacent lobe side seal insert 60, e.g., as depicted in FIG. 6B. In other embodiments, lobe side seal inserts 60 may be constructed to reduce 30° clearance 52 (FIGS. 3 and 4) without contacting the adjacent lobe 44A in mesh therewith under some or all operating conditions, or may be constructed to reduce 30° clearance 52 by contacting the adjacent lobe 44A in mesh therewith with little or no interference, e.g., under some or all operating conditions. The interference may be generated, for example, by constructing the sealing surface of lobe side seal inserts 60 to protrude beyond the surface of the balance of lobe 44A by a desired distance 82.

[0018] In one form, each lobe 44A includes a side recess 84 disposed on each side 56 of the lobe. Lobe side seal insert 60 is mounted in side recess 84. Other embodiments may not include a side recess. In one form, side recess 84 includes a dovetail 86 for mating with a corresponding dovetail 88 on lobe side seal insert 60 for retaining lobe side seal insert 60 on lobe 44A. In other embodiments, other geometric configurations and/or fasteners may be employed to retain lobe side seal insert 60 onto lobe 44A.

[0019] Embodiments of the present invention include a rotary blower, comprising: a housing; a pair of meshed

rotors disposed in the housing, each rotor having a plurality of lobes; and each lobe including a lobe tip seal insert mounted thereon and disposed at a tip of the each lobe, each lobe tip seal insert being constructed to seal against the housing and to prevent or reduce leakage between each lobe and the housing.

[0020] In a refinement, each lobe tip seal insert is constructed to engage in sliding contact with the housing during rotation of the rotors.

[0021] In another refinement, the rotary blower further comprises a plurality of pusher weights, each pusher weight being constructed to impart a radially outward load on a corresponding lobe tip seal insert.

[0022] In yet another refinement, each lobe includes a tip recess formed at the tip of the lobe; wherein the lobe tip seal insert is mounted in the tip recess.

[0023] In still another refinement, each lobe tip seal insert on one rotor is constructed to contact and seal against the other rotor at a location between the lobes and at a base of the lobes.

[0024] In yet still another refinement, each lobe further includes a lobe side seal insert mounted thereon and disposed on a side of the each lobe, each lobe side seal insert on each lobe on one rotor being constructed to contact and seal against an adjacent lobe in mesh therewith of the other rotor and to prevent or reduce leakage between adjacent lobes in mesh with each other.

[0025] In a further refinement, each lobe side seal insert is constructed to engage in sliding contact with the adjacent lobe during rotation of the rotors.

[0026] In a yet further refinement, each lobe includes a side recess formed at the side of the lobe; and wherein the lobe side seal insert is mounted in the side recess.

[0027] In a still further refinement, each lobe side seal insert and each lobe tip seal insert is non-metallic.

[0028] Embodiments of the present invention include a rotary blower, comprising: a pair of meshed rotors, each rotor having a plurality of lobes; and each lobe including a lobe side seal insert mounted thereon and disposed on a side of the each lobe, each lobe side seal insert on each lobe on one rotor being constructed to seal against an adjacent lobe in mesh therewith of the other rotor and to prevent or reduce leakage between adjacent lobes in mesh with each other.

[0029] In a refinement, each lobe side seal insert is constructed to engage in sliding contact with the adjacent lobe during rotation of the rotors.

[0030] In another refinement, each lobe includes a side recess formed at the side of the lobe; and wherein the lobe side seal insert is mounted in the side recess.

[0031] In yet another refinement, the rotary blower further comprises a housing, wherein the pair of meshed rotors is disposed in the housing; and wherein each lobe further includes a lobe tip seal insert mounted thereon and disposed at a tip of the each lobe, each lobe tip seal insert being constructed to contact and seal against the housing and to prevent or reduce leakage between each lobe and the housing.

[0032] In still another refinement, each lobe tip seal insert is constructed to engage in sliding contact with the housing during rotation of the rotors.

[0033] In yet still another refinement, each lobe tip seal insert and each lobe side seal insert is non-metallic.

[0034] In a further refinement, each lobe includes a tip recess formed at the tip of the lobe; and wherein the lobe tip seal insert is mounted in the tip recess.

[0035] In a yet further refinement, each lobe tip seal insert on one rotor is constructed to contact and seal against the other rotor at a location between the lobes and at a base of the lobes.

[0036] In a still further refinement, the rotary blower further comprises a plurality of pusher weights, each pusher weight being constructed to impart a radially outward load on a corresponding lobe tip seal insert.

[0037] Embodiments of the present invention include a rotary blower, comprising: a housing; a pair of meshed rotors disposed in the housing, each rotor having a plurality of lobes; and means for contacting and sealing against the housing and to prevent or reduce leakage between each lobe and the housing.

[0038] In a refinement, the rotary blower further comprises means on each lobe for contacting and sealing against an adjacent lobe in mesh therewith and to prevent or reduce leakage between adjacent lobes in mesh with each other.

[0039] While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiments have been shown and described and that all changes and modifications that come within the spirit of the inventions are desired to be protected. It should be understood that while the use of words such as preferable, preferably, preferred or more preferred utilized in the description above indicate that the feature so described may be more desirable, it nonetheless may not be necessary and embodiments lacking the same may be contemplated as within the scope of the invention, the scope being defined by the claims that follow. In reading the claims, it is intended that when words such as "a," "an," "at least one," or "at least one portion" are used there is no intention to limit the claim to only one item unless specifically stated to the contrary in the claim. When the language "at least a portion" and/or "a portion" is used the item can include a portion and/or the entire item unless specifically stated to the contrary.

[0040] Unless specified or limited otherwise, the terms "mounted," "connected," "supported," and "coupled" and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings. Further, "connected" and "coupled" are not restricted to physical or mechanical connections or couplings.

Claims

1. A rotary blower, comprising:

   a housing;
   a pair of meshed rotors disposed in the housing, each rotor having a plurality of lobes; and
   each lobe including:

   a lobe tip seal insert mounted thereon and disposed at a tip of the each lobe, each lobe tip seal insert being constructed to seal against the housing and to prevent or reduce leakage between each lobe and the housing; and/or
   a lobe side seal insert mounted thereon and disposed on a side of the each lobe, each lobe side seal insert on each lobe on one rotor being constructed to seal against an adjacent lobe in mesh therewith of the other rotor and to prevent or reduce leakage between adjacent lobes in mesh with each other.

2. The rotary blower of claim 1, wherein each lobe tip seal insert is constructed to engage in sliding contact with the housing during rotation of the rotors.

3. The rotary blower of claim 1 or 2, further comprising a plurality of pusher weights, each pusher weight being constructed to impart a radially outward load on a corresponding lobe tip seal insert.

4. The rotary blower of claim 3, wherein each pusher weight is slidably mounted within a guide slot.

5. The rotary blower of claim 4, wherein the guide slot is radially oriented.

6. The rotary blower of any preceding claim, wherein each lobe includes a tip recess formed at the tip of the lobe; and wherein the lobe tip seal insert is mounted in the tip recess.

7. The rotary blower of any preceding claim, wherein each lobe tip seal insert on one rotor is constructed to contact and seal against the other rotor at a location between the lobes and at a base of the lobes.

8. The rotary blower of any preceding claim, wherein each lobe side seal insert is constructed to engage in sliding contact with the adjacent lobe during rotation of the rotors.

9. The rotary blower of any preceding claim, wherein each lobe includes a side recess formed at the side of the lobe; and wherein the lobe side seal insert is mounted in the side recess.

10. The rotary blower of any preceding claim, wherein each lobe side seal insert and/or each lobe tip seal insert is non-metallic.

11. The rotary blower of any preceding claim, wherein each lobe includes a first lobe side seal insert located on a first side of the lobe and a second lobe side seal insert located on a second side of the lobe.

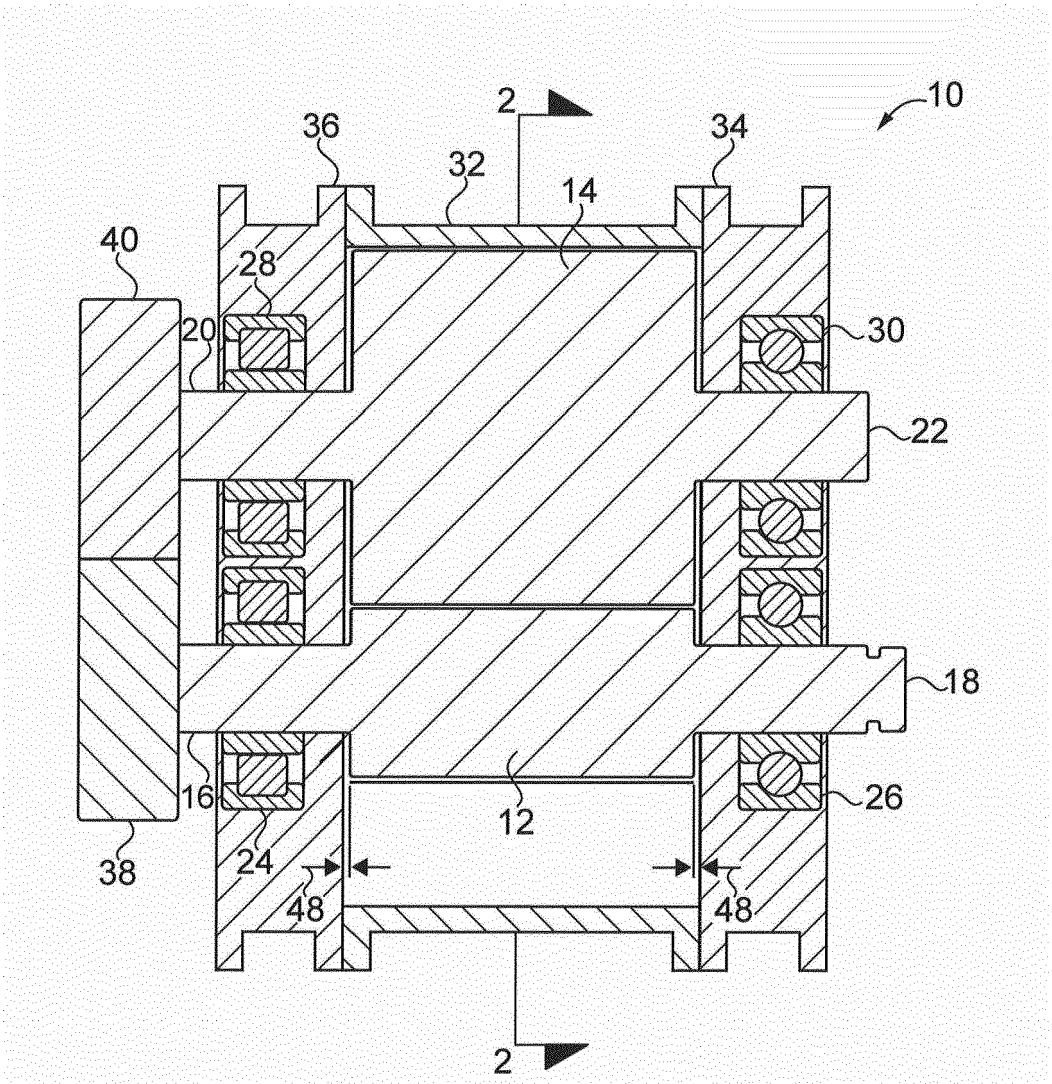


FIG. 1

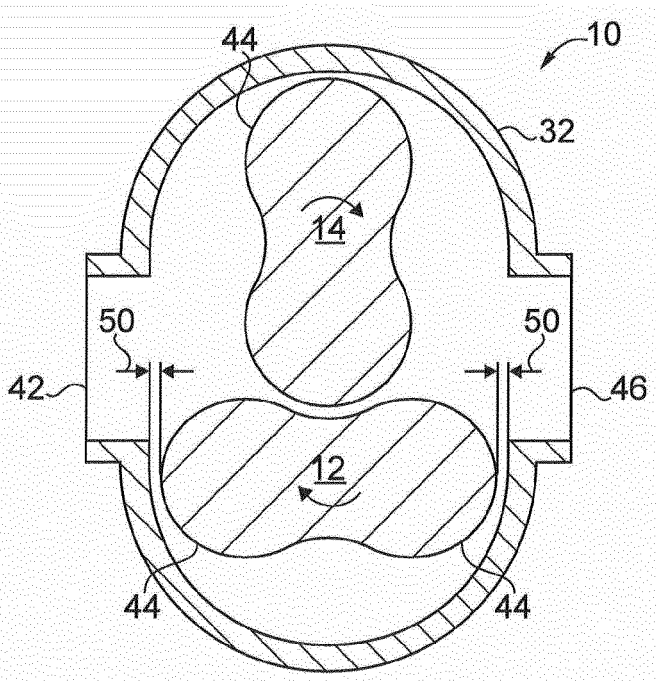


FIG. 2

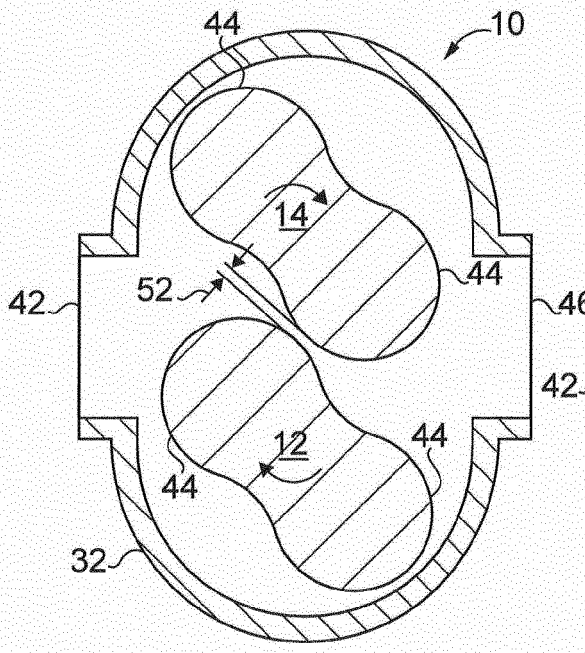


FIG. 3

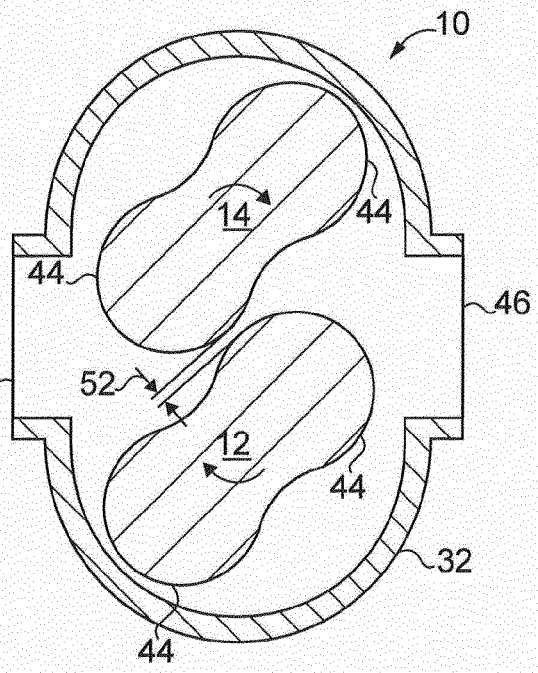
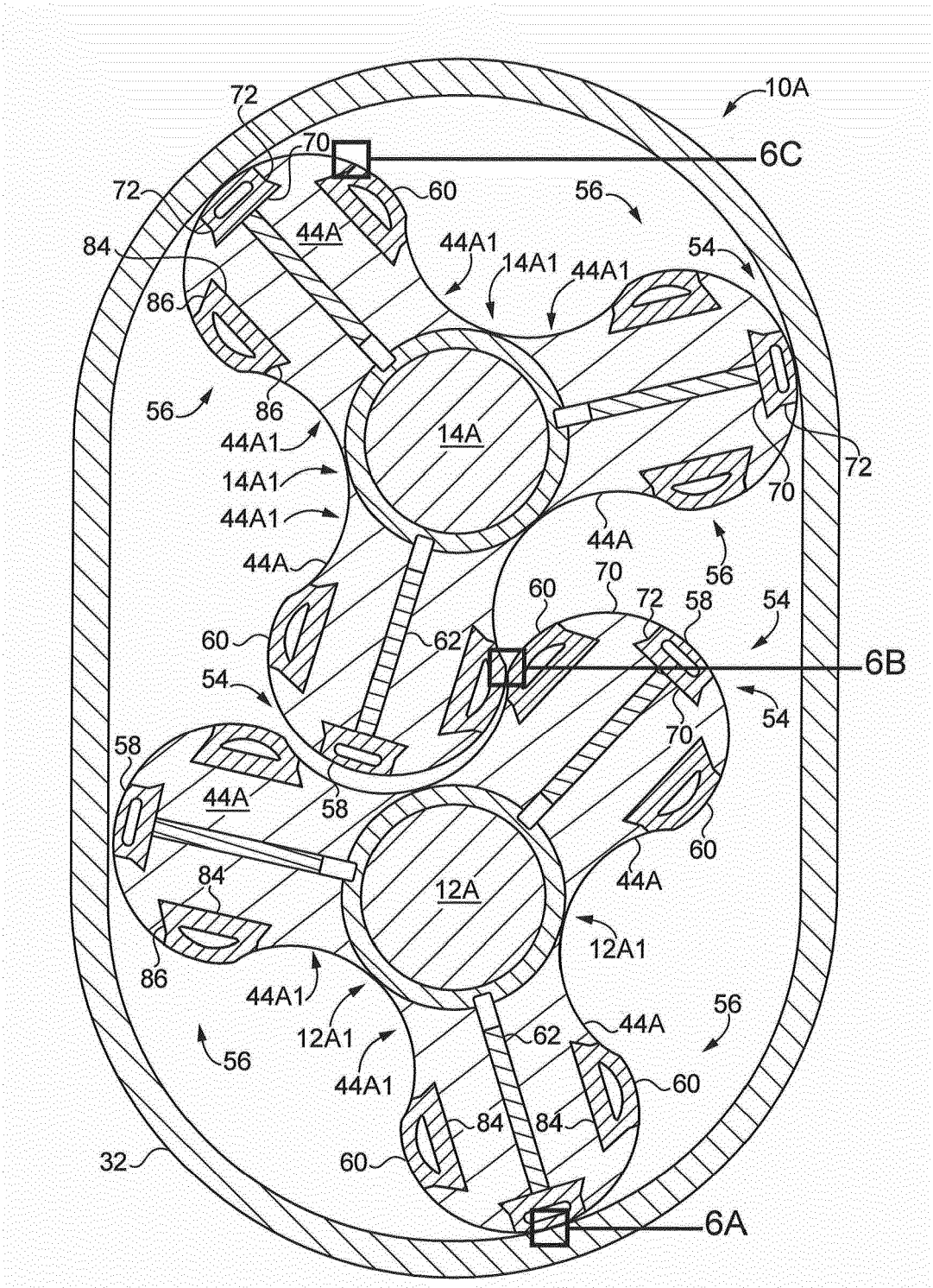


FIG. 4


10A
72
70
6C
72
60
56
84
44A
44A1
14A1
44A1
54
86
56
86
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14A1
44A1
44A
72
70
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56
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54
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44A
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84
12A
44A
12A1
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56
44A1
60
84
84
32
60
6A

FIG. 5

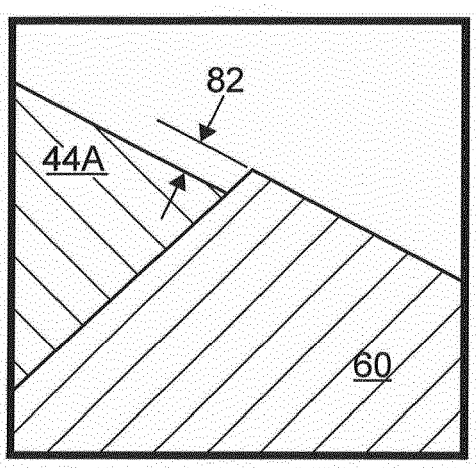

FIG. 6C

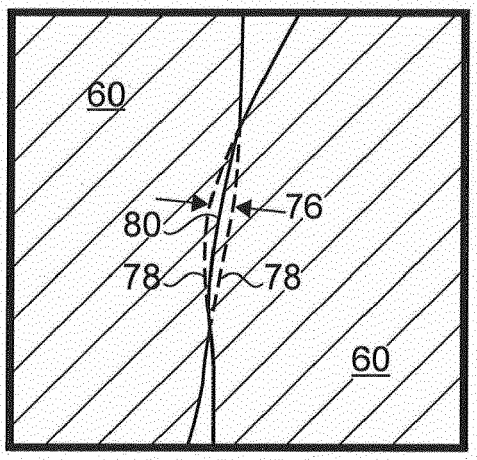

FIG. 6B

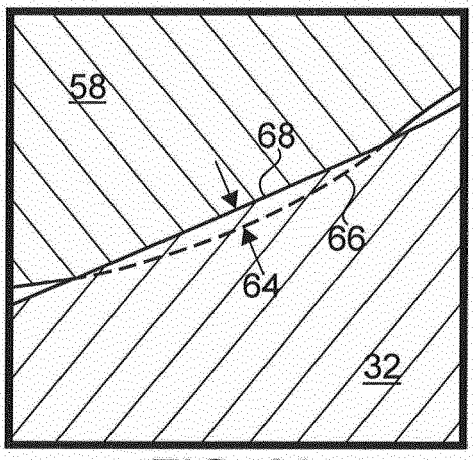

FIG. 6A

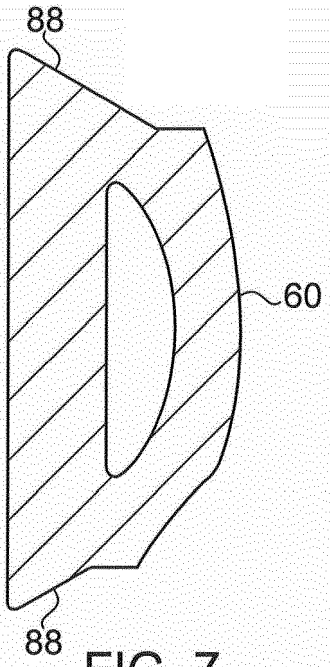

FIG. 7

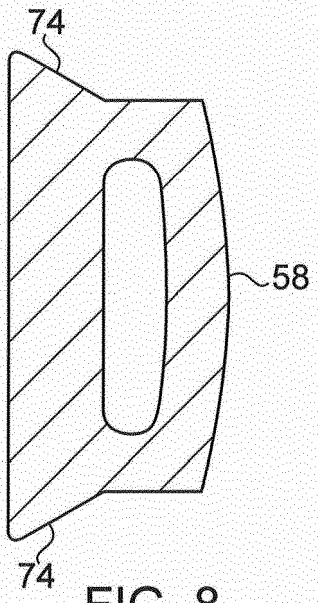

FIG. 8

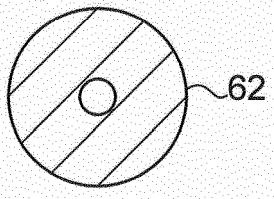

FIG. 9

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 21 5096

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	WO 2016/209868 A1 (DIXON PUMPS [US]; DIXON RANDY [US]) 29 December 2016 (2016-12-29) * page 6, line 30 - page 7, line 6; figure 1 *	1,2,6-11 3-5	INV. F04C27/00 F04C18/12
X	US 5 335 640 A (FEULING JAMES J [US]) 9 August 1994 (1994-08-09) * column 3, line 9 - column 4, line 24; figure 3 *	1	
Y	US 3 707 340 A (BRILLE MAURICE GEORGES) 26 December 1972 (1972-12-26) * column 2, line 62 - column 3, line 14; figure 1 *	3-5	

TECHNICAL FIELDS SEARCHED (IPC)
F04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	27 February 2019	Grilli, Muzio

CATEGORY OF CITED DOCUMENTS

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