(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
24 October 2013 (24.10.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/158554 A2

(51) International Patent Classification:
F04C 18/107 (2006.01)

(21) International Application Number:
PCT/US2013/036611

(22) International Filing Date:
15 April 2013 (15.04.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/625,148 17 April 2012 (17.04.2012) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

WO 2013/158554 A2

(54) Title: SUPERCHARGER ROTOR WITH UNEVEN TIP SURFACE AND METHOD OF MANUFACTURING SAME

(57) Abstract: A supercharger assembly includes a rotor housing having an inner surface. A first and a second rotor are configured to rotate within the housing. The first and the second rotors each have multiple lobes. The lobes of the first rotor mesh with the lobes of the second rotor and the lobes of both rotors have tips that define at least a predetermined clearance with the inner surface of the rotor housing. At least a portion of one of the tips has an uneven surface to increase turbulence of air flow through the predetermined clearance. The increased turbulence of the air flow slows the air flow, thereby reducing leakage and increasing the efficiency of the supercharger assembly. A method of manufacturing a rotor for a supercharger assembly includes creating at least one recess in a tip of a lobe of the rotor to provide an uneven surface at the tip.

SUPERCHARGER ROTOR WITH UNEVEN TIP SURFACE AND METHOD OF MANUFACTURING SAME

This application is being filed on 15 April 2013, as a PCT International Patent application and claims priority to U.S. Patent Application Serial No. 61/625,148 filed on 17 April 2012, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0001] The present teachings generally include a supercharger assembly having rotors with multiple lobes.

BACKGROUND

[0002] Energy efficient engines of reduced size are desirable for fuel economy and cost reduction. Smaller engines provide less torque than larger engines. A supercharger is sometimes used to increase the torque available from an engine. At low engine speeds, when higher torque is often requested by a vehicle operator by depressing the accelerator pedal, the supercharger provides additional air to the engine intake manifold, boosting air pressure and thereby allowing the engine to generate greater torque at lower engine speeds. Leakage of air past the rotors, especially at low rotational speeds, can significantly reduce the ability of the rotor to provide engine boost.

SUMMARY

[0001] A supercharger assembly includes a rotor housing having an inner surface. A first and a second rotor are configured to rotate within the housing. The first and the second rotors each have multiple lobes. The lobes of the first rotor mesh with the lobes of the second rotor and the lobes of both rotors have tips that define at least a predetermined clearance with the inner surface of the rotor housing. At least a portion of one the tips has an uneven surface to increase turbulence of air flow through the predetermined clearance. The increased turbulence should slow the air flow, thereby reducing leakage and increasing the efficiency of the supercharger assembly.

[0002] A method of manufacturing a rotor for a supercharger assembly includes creating at least one recess in a tip of a lobe of the rotor to provide an uneven surface at the tip. The recess may be created by milling or by molding the recess in the lobe.

[0003] The above features and advantages and other features and advantages of the present teachings are readily apparent from the following detailed description of the best modes for carrying out the present teachings when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIGURE 1 is a schematic illustration in fragmentary perspective view of a rotor having rotor tips with uneven surfaces.

[0005] FIGURE 2 is a schematic fragmentary cross-sectional illustration of a rotor tip having an uneven surface in accordance with an alternative aspect of the present teachings.

[0006] FIGURE 3 is a schematic fragmentary cross-sectional illustration of the rotor tip of Figure 1 within a rotor housing.

[0007] FIGURE 4 is a schematic illustration in partial cross-sectional view of a supercharger with a pair of rotors with rotor tips as in Figures 1 and 3 within a rotor housing.

[0008] FIGURE 5 is a schematic illustration in partial cross-sectional view taken at lines 5-5 in Figure 4 showing end faces of the rotors in the rotor cavity.

[0009] FIGURE 6 is a schematic illustration in cross-sectional view taken lengthwise in rotor housing through a mesh of a pair of rotors with the rotor tips illustrated in Figure 2.

DETAILED DESCRIPTION

[0010] Referring to the drawings, wherein like reference numbers refer to like components throughout the several views, Figure 1 shows a rotor 10A mounted on and rotatable with a rotor shaft 12A. The rotor 10A meshes with a second rotor 10B that is mounted on a rotor shaft 12B, as shown in Figure 4. Both rotors 10A and 10B are part of a supercharger assembly 13 and are supported within a rotor housing 14 of a multi-piece housing assembly 15 to rotate within a rotor cavity 16 defined by the rotor housing 14.

[0011] Each of the rotors 10A, 10B has multiple lobes. As shown in Figure 1, rotor 10A has multiple lobes 18A. Specifically, there are four lobes 18A, although a different number of lobes such as three or five lobes can instead be used. Each of the lobes 18A is helically twisted in a counterclockwise direction along the length of the rotor 10A from a first rotor face 20A (i.e., a first axial rotor face) to a second rotor face 22A (i.e., a second axial rotor face) at opposite axial ends 23A, 25A of the rotor 10A, as shown in Figure 4. Similarly, rotor 10B has multiple lobes 18B, but lobes 18B are helically twisted in a clockwise direction to mesh with the lobes 18A. Lobes 18B extend from a first rotor face 20B to a second rotor face 22B at opposite axial ends 23B, 25B of the rotor 10B. Figure 5 shows the rotors 10A, 10B within the housing 14 in an end view.

[0012] An input shaft 24 that can be powered by an engine crankshaft directly or through other gears is connected through a flexible coupling 25 to a first gear 26B mounted to the input shaft 24, as shown in Figure 4. The first gear 26B meshes with a second gear 26A mounted to rotate with the first shaft 12A, moving air between the rotors 10A, 10B from an inlet to an outlet (not shown) to boost air pressure delivered to an engine. Bearings 27 and seals 28 support the rotor shafts 12A, 12B and help enclose the rotors 10A, 10B. The rotors 10A, 10B are supported near an opposite end by additional bearings 29.

[0013] Air leakage within the supercharger assembly 13 decreases the efficiency of the supercharger assembly 13. Specifically, air that can leak past the rotors 10A, 10B and move along an inner surface 30 of the cavity 16 without passing between the rotors 10A, 10B does not contribute to boosting of air pressure in the engine. Accordingly, a clearance 32 between tips 33 of the rotors 10A, 10B and the inner surface 30 of the rotor housing 14 is controlled in size to reduce leakage. The clearance 32 is the minimal clearance between the outermost extremity 45 of the rotor tips 33, also referred to as an outermost surface, and the inner surface 30 of the housing 14 as shown in Figure 3. Because a surface 34 of the rotor tip 33 is uneven, the clearance 32 varies across the surface 34; however, the clearance 32 referred to herein is the clearance between the inner surface 30 and that portion of the surface 34 closest to the inner surface 30 (i.e., the outermost extremity 45). As used herein, an "uneven" rotor tip surface includes recesses or grooves that extend inward, away from the inner surface 30 of the housing 14. By providing an uneven surface 34 on

the tips 33, turbulence in any air flowing past the tips 33 is increased, thus slowing down the air flow and reducing the fraction of air passing through the clearance for each rotation of the rotor.

[0014] Figure 3 shows one example of an uneven surface 34 that can be provided at the tip 33 of lobes 18A and 18B (shown on lobe 18B) to reduce air leakage. The uneven surface 34 has a first outer edge 40 and a second outer edge 42. The uneven surface 34 includes recesses 44, also called grooves, that extend generally perpendicularly from the outer extremity 45 of the surface 34. The recesses 44 define distinct additional edges 46 between and generally parallel with the outer edges 40, 42. The edges 46 and recesses 44 create turbulence in air flowing past the edges 46 and recesses 44, as indicated by the unevenness of the arrow 48 representing air flow. In Figure 3, the outer surface 34 defines only two recesses 44 that extend the entire length of the tip 33 of the rotor 10B from the first axial face 20B to the second axial face 22B in Figure 4. Alternatively, the outer surface 34 could define only one recess, or more than two recesses, or only a portion of the axial length of at least one of the rotor tips 33 could have the uneven surface 34.

[0015] Figure 2 shows an alternative rotor tip 133 that can be used in place of rotor tip 33 on either or both of the lobes 18A, 18B in Figure 1 and is shown in an alternative supercharger assembly 113 in Figure 6. The rotor tip 133 has an uneven surface 134 that has a first outer edge 140 and a second outer edge 142. The uneven surface 134 includes recesses 144, also called grooves, that extend generally nonperpendicularly from an outer extremity or outermost portion 145 of the surface 134. That is, the recesses 144 are angled toward a direction of air flow past the tip 133, with air flow coming from the direction indicated by arrow 148. The recesses 144 define distinct additional edges 146 between and generally parallel with the outer edges 140, 142. The edges 146 and recesses 144 create turbulence in air flowing through the clearance 32 past the edges 146 and recesses 144, as indicated by the unevenness of the arrow 148 representing air flow. The clearance 32 is between the inner surface 30 and the outermost extremity 145 of the tip 133. In Figure 2, the outer surface 134 defines only two recesses 144 that extend the entire length of the tip 133 of the rotor 10A or 10B from the first axial face 20A or 20B to the second axial face 22A or 22B in Figure 6. Alternatively, the outer surface 134

could define only one recess, or more than two recesses, or only a portion of the axial length of at least one of the rotor tips 133 could have the uneven surface 134.

[0016] In certain examples, the recesses 44 can each have a depth greater than the distance of the clearance 32. In certain examples, the rotor tips 39 have lengths that extend along a helical path from the first rotor face 20A to the second rotor face 22A. Similarly, the recesses 44 and edges 40 have lengths that extend along the helical paths defined by the tips 33.

[0017] The rotor tips 33 and 133 can be manufactured according to a method that includes forming a rotor 10A or 10B with multiple helically twisted lobes 18A, 18B that extend between end faces 20A, 22A or 20B, 22B of the rotor 10A or 10B. The method can include creating at least one recess 44 or 144 within a tip 33 or 133 of at least one of the lobes 18 to provide an uneven surface 34 or 134 at the tip 33 or 133. The uneven surface 34 or 134 can be created by milling a recess 44 or 144 along an entire outer surface of the tip 33 or 133 between end faces 20A, 22A or 20B, 22B of the rotor 10A or 10B. Alternatively, the lobe 18 can be molded with the recess 44 or 144. The method can also include forming the rotor housing 14 with a cavity 16 that has an inner surface 30 configured to maintain a predetermined clearance 32 from an outer extremity 45 or 145 of the tip 33 or 133 when the rotor 10A or 10B is positioned within the cavity 16.

[0018] The reference numbers used in the drawings and the specification along with the corresponding components are as follows:

10A	rotor
10B	rotor
12A	rotor shaft
12B	rotor shaft
13	supercharger assembly
14	rotor housing
15	housing assembly
16	rotor cavity
18A	lobe
18B	lobe
20A	first rotor surface
20B	first rotor surface
22A	second rotor surface
22B	second rotor surface
23A	opposite axial end
23B	opposite axial end
24	input shaft
25A	opposite axial end

25B	opposite axial end
26A	second gear
26B	first gear
27	bearings
28	seals
29	bearings
30	inner surface
32	clearance
33	tip
34	surface
40	first outer edge
42	second outer edge
44	recess/groove
45	outermost extremity
46	edge
48	air flow
113	supercharger assembly
133	tip
134	surface
140	first outer edge
142	second outer edge
144	recess/groove
145	outermost extremity
146	edge
148	air flow

[0019] While the best modes for carrying out the many aspects of the present teachings have been described in detail, those familiar with the art to which these teachings relate will recognize various alternative aspects for practicing the present teachings that are within the scope of the appended claims.

CLAIMS

1. A supercharger assembly comprising:

a rotor housing having an inner surface;

a first and a second rotor configured to rotate within the housing; wherein the first and the second rotors each have multiple lobes; wherein the lobes of the first rotor mesh with the lobes of the second rotor; wherein the lobes of the first and second rotors have tips that define at least a predetermined clearance with the inner surface of the rotor housing;

wherein at least a portion of at least one of the tips has an uneven surface to increase turbulence of air flow through the predetermined clearance.

2. The supercharger assembly of claim 1, wherein said one of the tips has a first outer edge and a second outer edge; and wherein the uneven surface forms additional edges between the first and second outer edges.

3. The supercharger assembly of claim 2, wherein the additional edges extend generally parallel with the first outer edge and the second outer edge.

4. The supercharger assembly of claim 2, wherein the uneven surface has an outer extremity and has recesses extending angularly from the outer extremity between the additional edges.

5. The supercharger assembly of claim 4, wherein the recesses are angled toward a direction of air flow past said one of the tips.

6. The supercharger assembly of claim 5, wherein said one of the rotors includes a first rotor face and a second rotor face at axial ends of said one of the rotors; wherein the recesses include only two recesses; and wherein the recesses extend from said first rotor face to said second rotor face.

7. The supercharger assembly of claim 6, wherein the multiple lobes of the first and second rotors are helically twisted between the rotor faces.

8. The supercharger assembly of claim 2, wherein the uneven surface has an outermost portion and has recesses extending generally perpendicularly from the outermost portion between the additional edges.

9. The supercharger assembly of claim 8, wherein said one of the rotors includes a first rotor face and a second rotor face at axial ends of said one of the rotors; wherein the recesses include only two recesses; and wherein the recesses extend from said first rotor face to said second rotor face.

10. The supercharger assembly of claim 9, wherein the multiple lobes of the first and second rotors are helically twisted between the rotor faces.

11. A supercharger assembly comprising:

a rotor housing having an inner surface;

a first and a second rotor configured to rotate within the housing; wherein the first and the second rotors each have a first rotor face and a second rotor face with multiple lobes extending from the first rotor face to the second rotor face; wherein the lobes of the first rotor mesh with the lobes of the second rotor; wherein each of the lobes of the first and the second rotors has a tip that defines at least a predetermined clearance with the inner surface of the rotor housing; and

wherein each of the tips has at least one groove extending from the first rotor face to the second rotor face of the respective first and second rotors to increase turbulence of air flow through the predetermined clearance.

12. The supercharger assembly of claim 11, wherein each of the grooves are angled toward a direction of air flow past the tips.

13. The supercharger assembly of claim 12, wherein said at least one groove includes only two grooves.

14. The supercharger assembly of claim 11, wherein the multiple lobes of the first and second rotors are helically twisted between the rotor faces, wherein the tips oppose the inner surface of the rotor housing and extend along helical paths, and wherein the grooves extend along the helical paths.

15. The supercharger assembly of claim 11, wherein each of the grooves extends generally perpendicularly from an outermost extremity of the tip.

16. A method of manufacturing a rotor for a supercharger assembly comprising:

creating at least one recess in a tip of a lobe of the rotor to provide an uneven surface at the tip.

17. The method of claim 16, wherein said creating includes milling a recess along an entire outer surface of the tip between end faces of the rotor.

18. The method of claim 16, wherein said creating includes molding the lobe with said at least one recess.

19. The method of claim 16, wherein said method further comprises:

forming multiple lobes on the rotor such that the multiple lobes extend helically between end faces of the rotor.

20. The method of claim 16, further comprising:

forming a rotor housing with a cavity that has an inner surface configured to establish a predetermined clearance from an outer extremity of said tip when the rotor is positioned within the cavity.

21. A method for inhibiting leakage past rotor lobe tips of intermeshed rotors of a supercharger, the method comprising:

generating turbulence at locations between the rotor lobe tips and an inner surface of a rotor housing of the supercharger as the rotors are rotated within the rotor housing, the turbulence being generated by discontinuities at the rotor lobe tips.

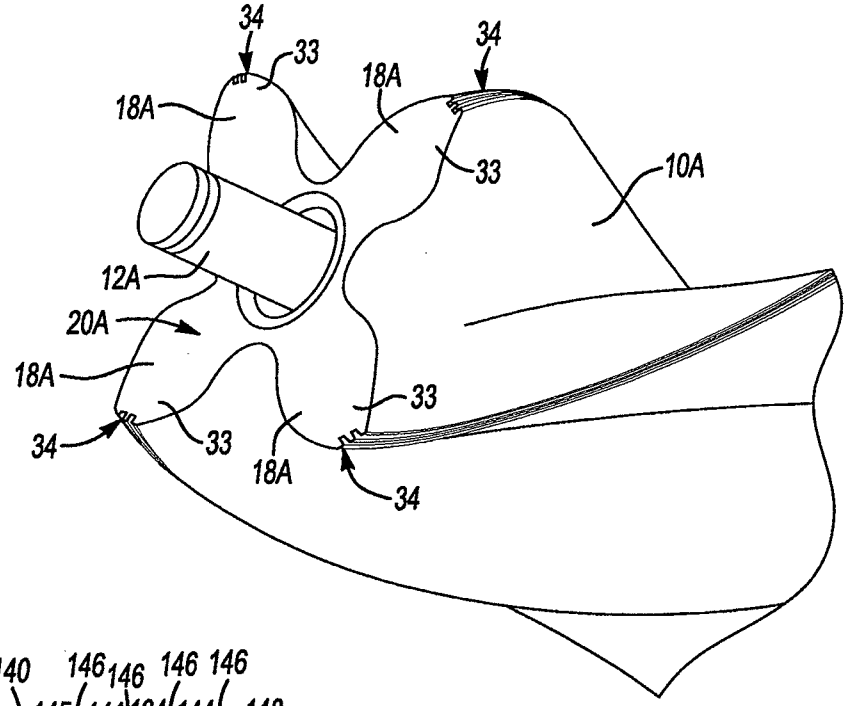

Fig-1

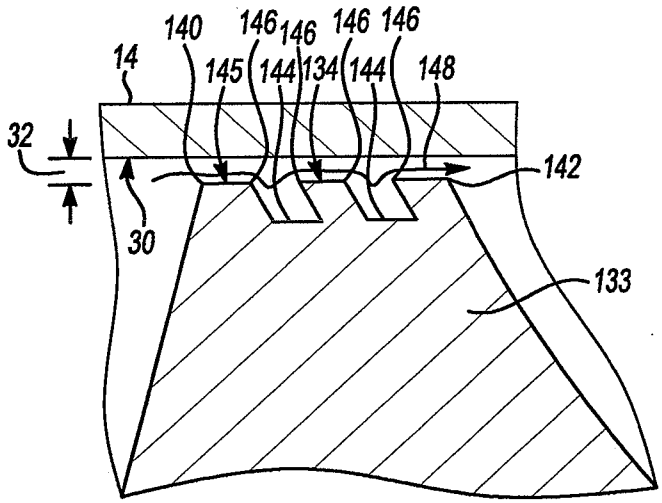

Fig-2

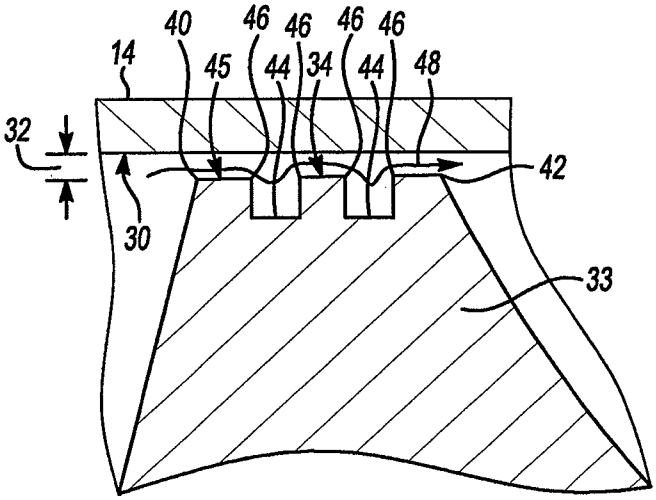

Fig-3

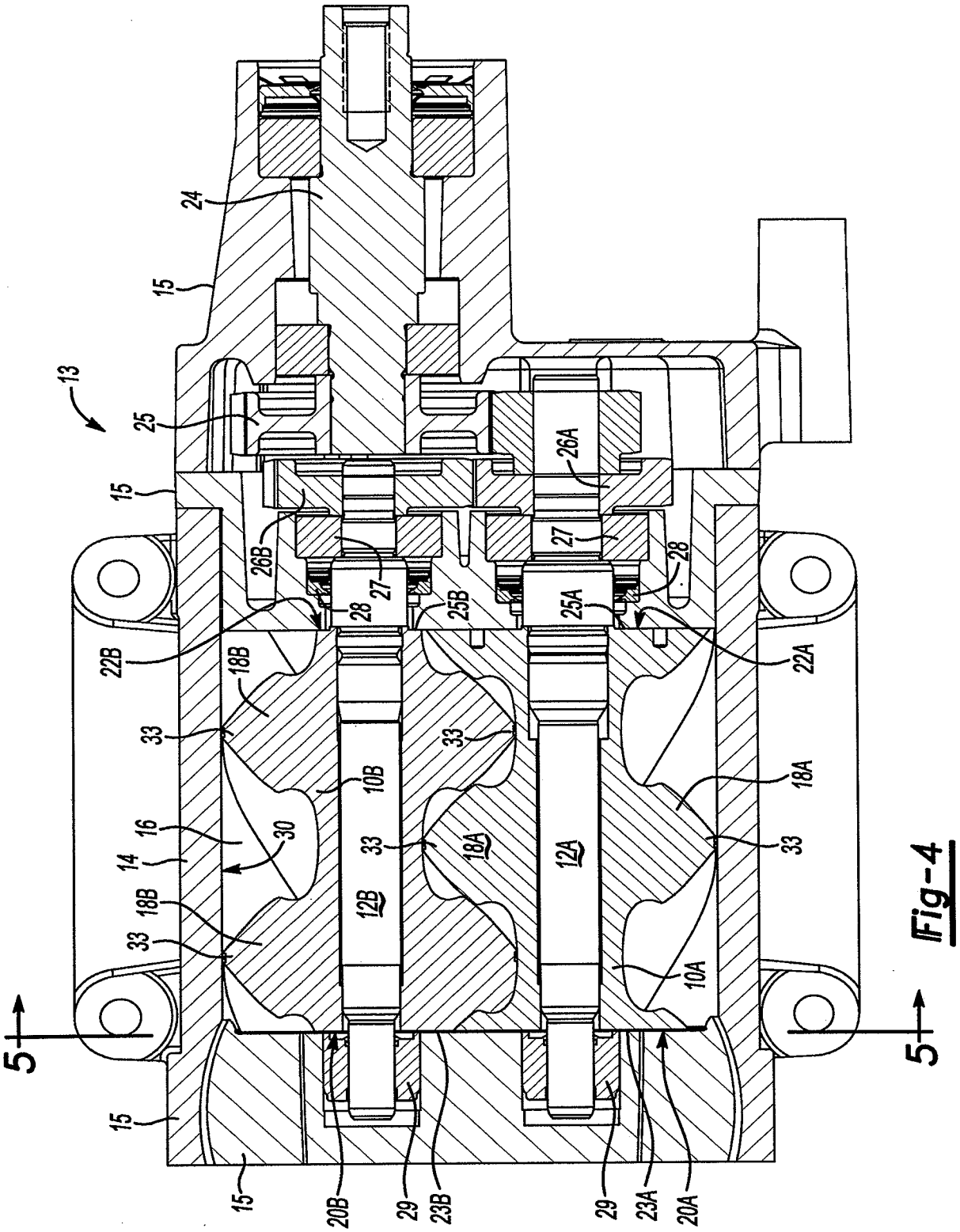
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Fig-4

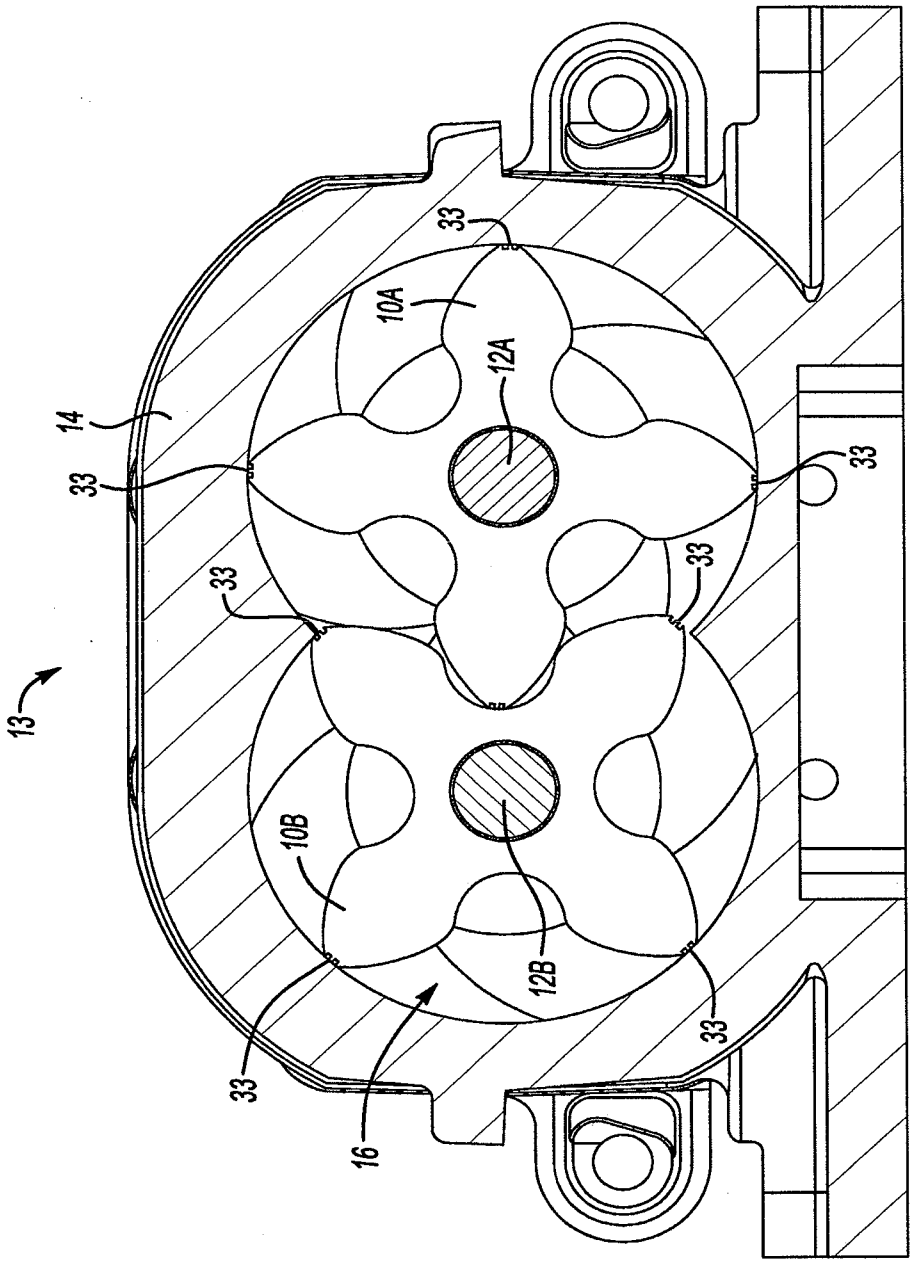

Fig-5

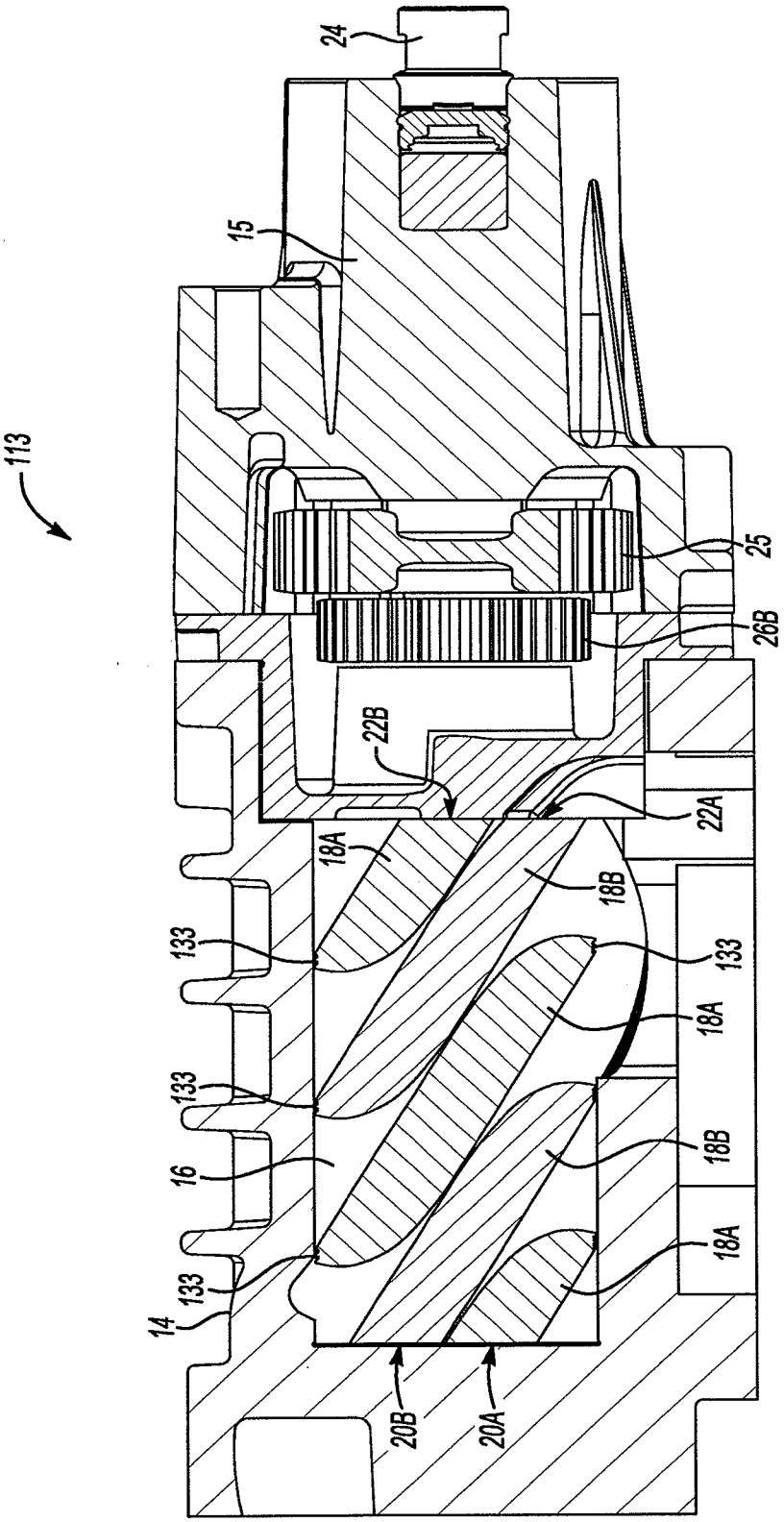
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Fig-6