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

(11) **EP 4 083 374 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.11.2022 Bulletin 2022/44

(21) Application number: **22169724.6**

(22) Date of filing: **25.04.2022**

(51) International Patent Classification (IPC):
F01C 17/06 *(2006.01)* ***F01C 21/10*** *(2006.01)*
F04C 18/02 *(2006.01)* ***F04C 23/00*** *(2006.01)*
F04C 27/00 *(2006.01)* ***F04C 29/00*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F01C 17/06; F01C 21/102; F04C 18/0215; F04C 23/008; F04C 27/005; F04C 29/0057

(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: **28.04.2021 US 202163181039 P**

(71) Applicant: **Dabir Surfaces, Inc.**
Chicago, Illinois 60706 (US)

(72) Inventors:
- **NITSA, Anatoliy**
  Buffalo Grove, 60089 (US)
- **CHUNG, Terry**
  Kildeer, 60047 (US)
- **DZIOBA, David**
  Frankenmuth, 48764 (US)

(74) Representative: **Specht, Peter et al**
Loesenbeck - Specht - Dantz
Patent- und Rechtsanwälte
Am Zwinger 2
33602 Bielefeld (DE)

(54) SCROLL PUMP WITH FLOATING MOTOR COUPLER

(57) A scroll pump includes first and second scroll members connected together by a plurality of idler assemblies configured to allow the second scroll member to move in an orbital path with respect to the first scroll member. A rotary bearing is connected to an end plate of the orbiting scroll member. A motor and motor coupler are coupled to the rotary bearing to move the bearing in an orbital path corresponding to the orbital path followed by the second scroll member. The rotary bearing may roll freely within the coupler.

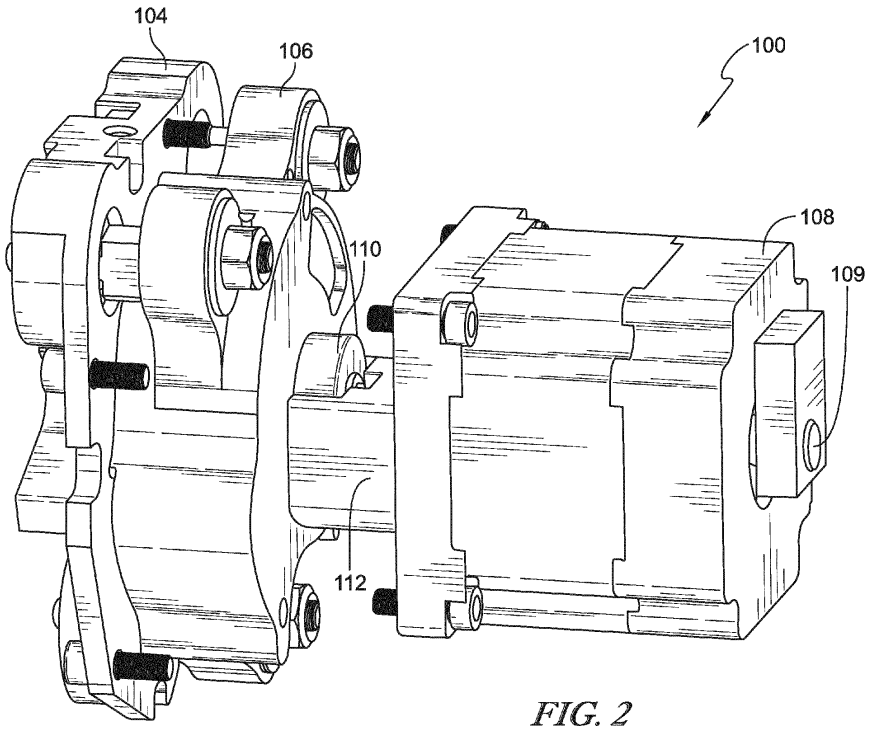

FIG. 2

EP 4 083 374 A2

Description

BACKGROUND AND SUMMARY OF THE DISCLOSURE

[0001] A known scroll pump includes a fixed scroll member having a fixed involute and an orbiting scroll member having an orbiting involute. The orbiting involute is connected to the fixed scroll member by three idler assemblies. The idler assemblies are configured to enable the orbiting scroll member to travel in an orbital path with respect the fixed scroll. Each idler assembly includes a camshaft having a first shaft portion and a second shaft portion parallel to and radially offset from the first shaft portion. The first shaft portion is rotatingly received within a corresponding bore defined by the fixed scroll member proximate a peripheral area of the fixed scroll member, that is, outboard of the fixed involute, and the second shaft portion is rotatingly received within a corresponding bore defined by the orbiting scroll member proximate a peripheral area of the orbiting scroll member, that is, outboard of the orbiting involute. When the first shaft portion rotates within the corresponding bore of the fixed scroll member, the second shaft portion rotates within the corresponding bore of the orbiting scroll member. Consequently, the second shaft of the idler crank orbits about the first shaft of the idler crank in a path corresponding to the orbital path through which the orbiting scroll member travels with respect the fixed scroll.

[0002] The scroll pump is coupled to a motor shaft of a motor through an intervening coupler. The motor is fixed with respect to the fixed scroll member. The coupler includes an output shaft parallel to and radially offset from the motor shaft. The output shaft is rotatingly received within a corresponding bore defined by the orbiting scroll member proximate a center of the orbiting scroll member. When the motor shaft rotates with respect to the motor, the output shaft of the coupler rotates within the corresponding bore defined by the orbiting scroll member, and the output shaft of the coupler orbits about the motor shaft in a path corresponding to the orbital path through which the orbiting scroll member travels with respect the fixed scroll. This motion of the output shaft causes the orbiting scroll member to orbit with respect to the fixed scroll member as discussed above.

[0003] One skilled in the art would recognize that the foregoing arrangement of idler assemblies and coupler constrains the orbiting scroll member to the fixed scroll member and to the motor at four locations. More specifically, the orbiting scroll member is constrained to the fixed scroll member by the three idler assemblies, and the orbiting scroll member is constrained to the motor by the coupler. This high degree of constraint requires that extreme dimensional control and tight tolerances be observed in the manufacture and assembly of the foregoing components to avoid premature wear of the components and excessive binding of the scroll pump assembly.

[0004] Also, in order for the scroll pump to operate reliably and efficiently, the fixed and orbiting scroll members must remain very close to each other without touching each other (except though intervening seals). Typically, this goal is achieved by installing shims of appropriate thickness on the idler assembly camshafts. Selection of the appropriate shim can involve substantial trial and error. For example, a common way of selecting appropriate shims involves estimating a first appropriate shim thickness, test fitting the orbiting scroll to the moving scroll using a first shim of corresponding thickness, determining whether the first shim is too thick or too thin, and iteratively test fitting the orbiting scroll to the fixed scroll using further shims of greater or lesser thickness until a desired fit is achieved. This process can be time consuming and can subject the scroll pump to damage due to repeated assembly and disassembly.

[0005] The present disclosure is directed to a scroll pump wherein the degree of constraint between the fixed scroll member and the orbiting scroll member is lessened. It also is directed to a process for simplifying the foregoing assembly process.

[0006] In a preferred embodiment, a scroll pump includes a pump housing, a fixed scroll member fixedly connected to the pump housing, an orbiting scroll member floatingly contained within the pump housing and in orbiting engagement with the fixed scroll member, a rotary bearing rotatingly connected to the orbiting scroll member, the rotary bearing having a radius and diameter and an axis of rotation, a motor fixedly connected to the housing, the motor comprising a motor shaft, the motor shaft having an axis of rotation parallel to and radially offset from the axis of rotation of the rotary bearing, and a coupler fixedly connected to the motor shaft and operably engaged with the rotary bearing. In this embodiment, the coupler includes a sidewall having an inner surface, which is engaged with a corresponding bearing surface of the rotary bearing. Also, the rotary bearing is unconstrained by the coupler in at least one direction perpendicular to the axis of rotation of the motor shaft. Further, rotation of the coupler causes the rotary bearing and the orbiting scroll member to orbit with respect to the fixed scroll member.

[0007] In an embodiment, the inner surface of the coupler includes a first bearing surface and a second bearing surface spaced from the first bearing surface.

[0008] In an embodiment, the inner surface of the coupler includes a third bearing surface extending in a direction from the first bearing surface to the second bearing surface.

[0009] In an embodiment, the inner surface of the coupler further comprises a third bearing surface extending between the first bearing surface and the second bearing surface and connecting the first bearing surface to the second bearing surface.

[0010] In an embodiment, the first bearing surface, the second bearing surface, and the third bearing surface are connected together by at least one curvilinear connecting surface.

[0011] In an embodiment, the at least one curvilinear connecting surface has a radius nominally equal to the diameter of the rotary bearing.

[0012] In an embodiment, the first bearing surface is parallel to a tangent of the rotary bearing, and wherein the second bearing surface is parallel to the first bearing surface.

[0013] In an embodiment, the third bearing surface is perpendicular to at least one of the first bearing surface and the second bearing surface.

[0014] In an embodiment, the third bearing surface is perpendicular to the first bearing surface and the second bearing surface.

[0015] In an embodiment, the third bearing surface is oriented with respect to the first bearing surface at a first included angle of greater than 90 degrees and the second bearing surface is oriented with respect to the first bearing surface at a second included angle of less than 90 degrees.

[0016] In an embodiment, a perpendicular distance between the first bearing surface of the coupler and the second bearing surface of the coupler is nominally greater than the diameter of the rotary bearing so that the rotary bearing is free to roll on the first bearing surface and the second bearing surface.

[0017] In an embodiment, the coupler is weighted to counteract unbalanced centrifugal forces imparted thereto by the orbiting scroll during operation of the scroll pump.

[0018] In a preferred embodiment, a scroll pump may be assembled by providing a first scroll member having a first end plate and a first involute extending from the first involute, providing a second scroll member having a second end plate and a second involute extending from the second involute, providing a plurality of idler camshafts, each having a first shaft portion and a second shaft portion, fitting the first shaft portions of the idler camshafts to the first scroll member, axially fixing the first shaft portions of the idler camshafts to the first scroll member, providing a shim having a thickness corresponding to a predetermined clearance between the first end plate and the second involute, fitting the second scroll member to the first scroll member with the first end plate adjacent the second involute and the second end plate adjacent the first involute, fitting the shim between the first scroll member and the second scroll member to set the predetermined clearance between the first end plate and the second involute, fitting the second shaft portions of the idler camshafts to the second scroll member; and axially fixing the second shaft portions of the idler camshafts to the second scroll member by expanding an end of the idler camshaft against a bearing connected and axially fixed to the second scroll member.

[0019] In an embodiment, the method may further include removing the shims.

[0020] In an embodiment, the step of fixing the idler assembly axially to the second scroll member may include removably fixing the idler assembly axially to the second scroll member.

[0021] In an embodiment, the step of fixing the idler assembly axially to the second scroll member may include permanently fixing the idler assembly axially to the second scroll member.

[0022] In a preferred embodiment, a scroll pump may be assembled by providing a first scroll member having a first end plate and a first involute extending from the first involute, providing a second scroll member having a second end plate and a second involute extending from the second involute, providing a plurality of idler camshafts, each having a first shaft portion and a second shaft portion, fitting the first shaft portions of the idler camshafts to the first scroll member, axially fixing the first shaft portions of the idler camshafts to the first scroll member, fitting the second scroll member to the first scroll member with the first end plate adjacent the second involute and the second end plate adjacent the first involute with a predetermined clearance between the first end plate and the second involute, fitting the second shaft portions of the idler camshafts to the second scroll member, and axially fixing the second shaft portions of the idler camshafts to the second scroll member by expanding an end of the idler camshaft against a bearing connected and axially fixed to the second scroll member.

[0023] In an embodiment, the method may further include providing a fixture configured to hold the first scroll member and the second scroll member with the predetermined clearance between the first end plate and the second involute, fitting the first scroll member in the fixture, and fitting the second scroll member in the fixture with the predetermined clearance between the first end plate and the second involute.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024]

Fig. 1 is a perspective view of an illustrative scroll pump having a fixed scroll member, an orbiting scroll member, a pump housing, and a motor, according to the present disclosure;

Fig. 2 is a perspective view of the scroll pump of Fig. 1 with the pump housing removed to show coupling of the motor of the scroll pump with the orbiting scroll member of the scroll pump by a coupler;

Fig. 3 is a perspective view of the scroll pump of Fig. 1 with the fixed scroll member and orbiting scroll member removed;

Fig. 4 is a perspective view of the orbiting scroll member;

Fig. 5 is an exploded perspective view of the scroll pump of Fig. 1;

Fig. 6 is a cross-sectional side elevation view of the scroll pump of Fig. 1;

Fig. 7A is an end elevation view of an illustrative coupler according to the present disclosure;

Fig. 7B is a perspective view of the coupler of Fig. 7A;

Fig. 8A is an end elevation view of another illustrative coupler according to the present disclosure;
Fig. 8B is a perspective view of the coupler of Fig. 8A;
Fig. 9 is a cross-sectional elevation view of a portion of the scroll pump of Fig. 1;
Fig. 10A - 10C are perspective views showing components of an idler assembly of the scroll pump of Fig. 1; and
Fig. 11 is a top plan view of an orbiting scroll member of the scroll pump of Fig. 1.

DETAILED DESCRIPTION OF THE DRAWINGS

[0025] The drawings show illustrative embodiments of a scroll pump 100 according to the present disclosure.

[0026] The scroll pump 100 includes a pump housing 102, a first or fixed scroll member 104 fixedly attached to the pump housing 102, a second or orbiting scroll member 106 in orbiting engagement with the fixed scroll member 104, and a motor 108 fixedly connected to the pump housing 102 and operably engaged with the orbiting scroll member 106. A rotary bearing 110 having a desired radius and diameter is rotatingly connected to the orbiting scroll member 106 proximate a central portion thereof. A coupler 112 is fixedly connected to a motor shaft 109 of the motor 108 and operably engaged with the rotary bearing 110, as will be discussed further below.

[0027] The pump housing 102 includes a sidewall 114 and an end wall 116 covering a first end of the sidewall 114. The sidewall 114 defines a plurality of registration tabs 115 extending axially in a direction away from the end wall 116. The end wall 116 defines an opening 118 receiving the coupler 112 therethrough. The motor 108 is fixedly connected to a first end of the housing 102, and the fixed scroll member 104 is fixedly connected to a second end of the housing 102 opposite the first end of the housing. As shown, the motor 108 is fixedly connected to a first side of the end wall 116 opposite the sidewall 114, and the fixed scroll member 104 is fixedly connected to a second end of the sidewall 114 opposite the first end of the sidewall 114. Alternatively, the motor 108 and the fixed scroll member 104 could be fixedly connected to the respective ends of the housing 102 in other ways.

[0028] The fixed scroll member 104 includes a first or fixed scroll or involute 120 extending axially from a central portion of a first or fixed end plate 122. A first or fixed seal 120S is disposed at the free end of the fixed involute 120 opposite the fixed end plate 122. The free end of the fixed involute 120 may define a groove configured to receive the fixed seal 120S. The fixed end plate 122 defines three openings 124 configured to receive corresponding rotary bearings 136 of corresponding idler assemblies 132, as will be discussed further below.

[0029] The orbiting scroll member 106 includes a second or orbiting scroll or involute 126 extending axially from a central portion of a second or orbiting end plate 128. A second or orbiting seal 126S is disposed at the free end of the orbiting involute 126 opposite the orbiting end plate 128. The free end of the orbiting involute 126 may define a groove configured to receive the orbiting seal 126S. The orbiting involute 126 is configured to receive the fixed involute 120 in interleaved, orbiting engagement therewith. The orbiting end plate 128 defines three openings 130 configured to receive corresponding rotary bearings 138 of corresponding idler assemblies 132, as will be discussed further below. The orbiting end plate 128 also defines a plurality of registration slots 133 configured to receive the registration tabs 115 in axially sliding engagement.

[0030] As suggested above, the fixed scroll member 104 is operably connected to the orbiting scroll member 106 by three idler assemblies 132. Each of the idler assemblies 132 includes a idler camshaft 134, a first rotary bearing assembly 136, and a second rotary bearing assembly 138.

[0031] Each of the idler camshafts 134 includes a first shaft portion 140 and a second shaft portion 142 parallel to and radially spaced from the first shaft portion 140. The first shaft portion 140 is received within a corresponding opening defined by the first rotary bearing assembly 136, and the first shaft portion 140 is axially fixed to the first rotary bearing assembly 136. The second shaft portion 142 is received within an opening defined by the second rotary bearing assembly 138. The second shaft portion 142 is axially captured to the second rotary bearing assembly by suitable fasteners 146, which may be, for example without limitation, threaded fasteners.

[0032] The first rotary bearing assembly 136 includes first and second rotary bearings 136A, 136B. Each of the first and second rotary bearings 136A, 136B includes an annular outer bearing race that is received within the corresponding opening 124 in the fixed scroll member 104 in press fit engagement. The annular outer bearing race of the second bearing 136B further includes a flange 137 extending radially outwardly from a body thereof. The flange 137 limits the extent to which the annular outer bearing race of the second bearing may be inserted into the corresponding opening 124.

[0033] Similarly, the second rotary bearing assembly 138 includes first and second rotary bearings 138A, 138B. Each of the first and second rotary bearings 138A, 138B includes an annular outer bearing race that is received within the corresponding opening 130 in the orbiting scroll member 106 in press fit engagement. The annular outer bearing race of the second bearing 138B further includes a flange 139 extending radially outwardly from a body thereof. The flange 139 limits the extent to which the annular outer bearing race of the second bearing may be inserted into the corresponding opening 130.

[0034] The first shaft portion 140 of the idler camshaft 134 is configured to rotate within the rotary bearings of the fixed scroll member 104 about a first axis of rotation. The second shaft portion 142 of the idler camshaft is configured to rotate within the rotary bearings of the orbiting scroll member 106 about a second axis of rotation parallel to and radially offset from the first axis of rotation.

The radial offset of the second shaft portion 142 of the idler camshaft 134 with respect to the first shaft portion 140 of the idler camshaft 130 causes the orbiting scroll member 106 to travel in an orbital path with respect to the fixed scroll member 104 when the idler camshafts rotate.

[0035] As mentioned above, the rotary bearing 110 is rotatably connected to the orbiting scroll member 106 proximate a central portion thereof. More specifically, the rotary bearing 110 is rotatably connected to an axle 146 extending perpendicularly from a central portion of the plate 128 of the orbiting scroll member 106, opposite the orbiting scroll 126. The rotary bearing 110 has an axis of rotation parallel to compression surfaces of the orbiting scroll 120 and perpendicular to the plate 122 of the fixed scroll member 104. As mentioned above, the rotary bearing 110 engages with the coupler 112.

[0036] As best shown in Figs. 7A-8B, the coupler 112 includes a base 148 and a sidewall 150 extending from a first side of the base 148. As shown, the sidewall 150 is U-shaped. In other embodiments, the sidewall 150 could have other shapes, for example, curvilinear or rectangular shapes. The base 148 of the coupler 112 defines an opening 152 configured to receive a motor shaft 109 of the motor 108. The base 148 of the coupler 112 is keyed or otherwise fixed to the motor shaft 109 for rotation therewith.

[0037] The sidewall 150 defines an open end 154 and an interior surface 156. In embodiments, the open end 154 could be a closed end. The interior surface 156 includes a first bearing surface 156A and a second bearing surface 156B spaced from and opposite the first bearing surface 156A. As shown, the first bearing surface 156A is flat. As shown, the second bearing surface 156B is flat, parallel to, and spaced from the first bearing surface 156A. As shown, each of the first and second bearing surfaces 156A, 156B is parallel to a tangent to an outer surface of the rotary bearing 110. The interior surface 156 also includes a third bearing surface 156C connecting the first and second bearing surfaces 156A, 156B. As shown, the third bearing surface 156C is flat.

[0038] As shown in Figs. 7A and 7B, the third bearing surfaces 156C may be perpendicular to the first and second bearing surfaces 156A, 156B. Alternatively, as shown in Figs. 8A and 8B, a first included angle α between the first bearing surfaces 156A and the third bearing surface 156C may be 90 degrees or greater or lesser than 90 degrees. Similarly, a second included angle β between the second bearing surface 156B and the third surface region 156C may be 90 degrees or lesser or greater than 90 degrees. The first and second angles α and β may be selected to better direct force imparted by the first, second, and third bearing surfaces 156A, 156B, 156C against the rotary bearing 110 in a direction normal to the rotary bearing 110 as the coupler 112 revolves around the rotary bearing 110.

[0039] Although the first, second, and third bearing surfaces 156A, 156B, 156C are shown as flat, any or all of them could be curvilinear. Also, any or all of the first, second, and third bearing surfaces 156A, 156B, 156C could be connected to an adjacent one of the first, second, and third bearing surfaces 156A, 156B, 156C by a curvilinear connecting surface, as shown, or by a flat connecting surface. The curvilinear connecting surface connecting the first, second, and third bearing surfaces 156A, 156B, 156C may have a radius of curvature nominally equal to the radius of the rotary bearing 110 to enable the rotary bearing to roll freely with respect to and among the first, second, and third bearing surfaces 156A, 156B, 156C and/or to avoid or mitigate impact loads placed on the coupler by the bearing and vice versa. As suggested above, the shapes and relative orientations of the first, second, third bearing surfaces 156A, 156B, 156C may be selected to better direct force imparted by the first, second, and third bearing surfaces 156A, 156B, 156C against the rotary bearing 110 in a direction normal to the rotary bearing 110 as the coupler 112 revolves around the rotary bearing 110.

[0040] In any event, the first and second bearing surfaces 156A, 156B are separated from each other by a distance sufficiently greater than the outer diameter of the rotary bearing 110 to enable the rotary bearing 110 to freely roll on the bearing surfaces 156A, 156B, 156C as the coupler 112 rotates with the motor shaft 109, and to mitigate or preclude binding between the rotary bearing 110 and the bearing surfaces 156A, 156B, 156C.

[0041] As mentioned above, the base 148 defines an opening 152 configured to receive the motor shaft 109. The opening 152 is proximate the open end 154 of the sidewall 150 and distant from the third bearing surface 156C of the sidewall 150. Because the opening 152 is proximate the open end 154 of the sidewall 150 and distant from the third bearing surface 156C of the sidewall 150, the coupler 112 is offset eccentrically from the motor shaft 109. This configuration allows the coupler 112 to counterbalance reaction forces resulting from movement of the orbiting scroll member 106. In embodiments (not shown), additional counterbalance members (not shown) may be provided at the opposite end of the motor 108 but such additional counterbalance members may be substantially smaller than otherwise might be required, thereby allowing the scroll pump 100 to be smaller and lighter weight than it otherwise might be.

[0042] In operation, the motor 108 is energized to rotate the motor shaft 109. The motor shaft 109 in turn rotates the coupler 112. The bearing surfaces 156A, 156B, 156C of the coupler 112 engage the outer surface of the rotary bearing 110, and the rotary bearing 110 rolls upon and follows the bearing surfaces 156A, 156B, 156C as the coupler 112 rotates. This interaction causes the rotary bearing 110 to travel in an orbital path with respect to the fixed scroll member 104, and thereby causes the orbiting scroll member 106 to travel in an orbital path with respect to the fixed scroll member 104.

[0043] The shapes and relative orientations of the first, second, third bearing surfaces 156A, 156B, 156C, as dis-

cussed above, may be selected to better direct force imparted by the first, second, and third bearing surfaces 156A, 156B, 156C against the rotary bearing 110 in a direction normal to the rotary bearing 110 as the coupler 112 revolves around the rotary bearing 110 in the first rotation direction or the second rotation direction.

[0044] Figs. 9-11 best show certain features of embodiments of the scroll pump 100 that may facilitate assembly of the scroll pump 100 and setting of clearances between the fixed scroll member 104 and the orbiting scroll member 106. More specifically, Fig. 9 shows a portion of the fixed scroll member 104, the orbiting scroll member 106, and one of the idler assemblies 132, including the idler camshaft 134, the first bearing assembly 136, and the second bearing assembly 138. The first bearing assembly 136 is received within the corresponding opening 124 of the fixed scroll member 104 and the first shaft portion 140 of the idler camshaft 134 is received within the first bearing assembly 136. Similarly, the second bearing assembly 138 is received within the corresponding opening 130 of the orbiting scroll member 106 and the second shaft portion 142 of the idler camshaft 134 is received within the second bearing assembly 138.

[0045] The flange 137 of the first bearing assembly 136 precludes the first bearing assembly 136 from being drawn through the opening 124 toward the orbiting scroll member 106.

[0046] A fastener (and optional washer) 158 secured to the first end 140 of the idler camshaft 134 preclude the idler camshaft 134 from being drawn through the first bearing assembly 136. As shown, the fastener 158 is a threaded fastener engaged with a complementary threaded bore 160 in the first end 140 of the idler camshaft 134.

[0047] Similarly, the flange 139 of the second bearing assembly 138 precludes the second bearing assembly 138 from being drawn through the opening 130 toward the fixed scroll member 104.

[0048] As best shown in Figs. 9 and 10A - 10C, the second shaft portion 142 of the idler camshaft 134 defines a bore 162. A portion of the bore 162 opposite the free end of the second shaft portion 142 is threaded. The second shaft portion 142 defines a pair of diametrically opposed slits 164 extending from the free end thereof toward the first shaft portion 140. The slits 164 split the second shaft portion 142 axially into a first section 142A and a second section 142B proximate the free end thereof. In embodiments, more or fewer slits 164 could be provided to thereby define more or fewer sections 142x of the second shaft portion 142.

[0049] A locking wedge 166 having a tapered, for example, conically tapered, exterior radial surface 168 is configured to have its tapered end inserted into the bore 162 defined by the second shaft portion 142. A threaded fastener 170 having a shoulder 172 is configured to be inserted through an aperture 174 extending axially through the locking wedge 166 so that that the shoulder 172 of the fastener 170 may abut an end surface 176 in bearing engagement. The threaded fastener 170 may then be loosely screwed into the threaded portion of the bore 162.

[0050] With reference to Fig. 11, the orbiting scroll member 106 may be assembled to the fixed scroll member 104 with removable shims S setting the desired clearance between the fixed and orbiting scroll members 104, 106. For example, three or more shims S, of appropriate thickness may be disposed between adjacent surfaces of the fixed and orbiting scroll members 104, 106, for example, between the fixed end plate 122 and the free end of the orbiting scroll 126 adjacent the orbiting seal 126S. With the fixed and orbiting scroll members 104, 106 and the shims S so assembled, the threaded fastener 170 may be further screwed into the bore 162 so that the shoulder 162 of the fastener 170 drives the locking wedge 166 into the bore 162, thereby radially expanding the first and second sections 142A, 142B of the second shaft portion 142 radially outwardly into locking engagement with the inner race of one or both of the bearings 138A, 138B of the second bearing assembly 138. With the locking wedge 166 so engaged with the second bearing assembly 138, the fixed and orbiting scroll members 104, 106 are fixed at the desired clearance therebetween. The shims S may then be removed from the assembled fixed and orbiting scroll members 104, 106, for example, by withdrawing them radially from between the fixed and orbiting scroll members 104, 106.

[0051] Alternatively, the desired clearance between the fixed and orbiting scroll members 104, 106 may be set using an assembly fixturing device, as would be understood by one skilled in the art, and the threaded fastener 170 may be screwed into the bore 162 to drive the locking wedge 166 into the bore 162 as discussed above.

[0052] The foregoing expansion of the first and second sections 142A, 142B of the second shaft portion 142 radially outwardly into locking engagement with the inner race of one or both of the bearings 138A, 138B of the second bearing assembly 138 may be permanent. That is, the foregoing expansion may be plastic expansion whereby the first and second sections 142A, 142B of the second shaft portion 142 remain lockingly engaged with the second bearing assembly 138 even if the threaded fastener 170 is removed from the bore 162. In such embodiments, the fixed and orbiting scroll members 104, 106, once assembled together may not be readily disassembled.

[0053] Alternatively, the foregoing expansion may be plastic expansion, so that the first and second sections 142A, 142B of the second shaft portion 142 do not remain lockingly engaged with the second bearing assembly 138 if the threaded fastener 170 is removed from the bore. In such embodiments, the fixed and orbiting scroll members 104, 106, once assembled together may be more easily disassembled.

[0054] The foregoing description and corresponding drawings refer to one or more illustrative embodiments of a scroll pump according to the present disclosure.

These embodiments are illustrative, and not limiting. One skilled in the art would recognize that the disclosed embodiments could be modified in numerous ways without departing from the scope of the invention as defined by the appended claims.

Claims

1. A scroll pump comprising:

a pump housing;
a fixed scroll member fixedly connected to the pump housing;
an orbiting scroll member floatingly contained within the pump housing and in orbiting engagement with the fixed scroll member;
a rotary bearing rotatingly connected to the orbiting scroll member, the rotary bearing having a radius and diameter and an axis of rotation;
a motor fixedly connected to the housing, the motor comprising a motor shaft, the motor shaft having an axis of rotation parallel to and radially offset from the axis of rotation of the rotary bearing; and
a coupler fixedly connected to the motor shaft and operably engaged with the rotary bearing;
wherein the coupler comprises a sidewall having an inner surface, the inner surface of the coupler engaged with a corresponding bearing surface of the rotary bearing;
wherein the rotary bearing is unconstrained by the coupler in at least one direction perpendicular to the axis of rotation of the motor shaft;
wherein rotation of the coupler causes the rotary bearing and the orbiting scroll member to orbit with respect to the fixed scroll member.

2. The scroll pump of claim 1 wherein the inner surface of the coupler includes a first bearing surface and a second bearing surface spaced from the first bearing surface.

3. The scroll pump of claim 1 wherein the inner surface of the coupler includes a third bearing surface extending in a direction from the first bearing surface to the second bearing surface.

4. The scroll pump of claim 3 wherein the inner surface of the coupler further comprises a third bearing surface extending between the first bearing surface and the second bearing surface and connecting the first bearing surface to the second bearing surface.

5. The scroll pump of claim 4 wherein the first bearing surface, the second bearing surface, and the third bearing surface are connected together by at least one curvilinear connecting surface.

6. The scroll pump of claim 4 wherein the at least one curvilinear connecting surface has a radius nominally equal to the diameter of the rotary bearing.

7. The scroll pump of claim 4 wherein the first bearing surface is parallel to a tangent of the rotary bearing, and wherein the second bearing surface is parallel to the first bearing surface.

8. The scroll pump of claim 7 wherein the third bearing surface is perpendicular to at least one of the first bearing surface and the second bearing surface.

9. The scroll pump of claim 7 wherein the third bearing surface is perpendicular to the first bearing surface and the second bearing surface.

10. The scroll pump of claim 7 wherein the third bearing surface is oriented with respect to the first bearing surface at a first included angle of greater than 90 degrees and the second bearing surface is oriented with respect to the first bearing surface at a second included angle of less than 90 degrees.

11. The scroll pump of claim 7 wherein a perpendicular distance between the first bearing surface of the coupler and the second bearing surface of the coupler is nominally greater than the diameter of the rotary bearing so that the rotary bearing is free to roll on the first bearing surface and the second bearing surface.

12. The scroll pump of claim 1 wherein the coupler is weighted to counteract unbalanced centrifugal forces imparted thereto by the orbiting scroll during operation of the scroll pump.

13. A method of assembling a scroll pump, comprising:

providing a first scroll member having a first end plate and a first involute extending from the first involute;
providing a second scroll member having a second end plate and a second involute extending from the second involute;
providing a plurality of idler camshafts, each having a first shaft portion and a second shaft portion;
fitting the first shaft portions of the idler camshafts to the first scroll member;
axially fixing the first shaft portions of the idler camshafts to the first scroll member;
providing a shim having a thickness corresponding to a predetermined clearance between the first end plate and the second involute;
fitting the second scroll member to the first scroll member with the first end plate adjacent the second involute and the second end plate adjacent

the first involute;
fitting the shim between the first scroll member and the second scroll member to set the predetermined clearance between the first end plate and the second involute;
fitting the second shaft portions of the idler camshafts to the second scroll member; and
axially fixing the second shaft portions of the idler camshafts to the second scroll member by expanding an end of the idler camshaft against a bearing connected and axially fixed to the second scroll member.

14. The method of claim 13 further comprising removing the shims.

15. The method of claim 14 wherein the step of fixing the idler assembly axially to the second scroll member comprises removably fixing the idler assembly axially to the second scroll member.

16. The method of claim 14 wherein the step of fixing the idler assembly axially to the second scroll member comprises permanently fixing the idler assembly axially to the second scroll member.

17. A method of assembling a scroll pump, comprising:

providing a first scroll member having a first end plate and a first involute extending from the first involute;
providing a second scroll member having a second end plate and a second involute extending from the second involute;
providing a plurality of idler camshafts, each having a first shaft portion and a second shaft portion;
fitting the first shaft portions of the idler camshafts to the first scroll member;
axially fixing the first shaft portions of the idler camshafts to the first scroll member;
fitting the second scroll member to the first scroll member with the first end plate adjacent the second involute and the second end plate adjacent the first involute with a predetermined clearance between the first end plate and the second involute;
fitting the second shaft portions of the idler camshafts to the second scroll member;
axially fixing the second shaft portions of the idler camshafts to the second scroll member by expanding an end of the idler camshaft against a bearing connected and axially fixed to the second scroll member.

18. The method of claim 17 further comprising:

providing a fixture configured to hold the first scroll member and the second scroll member with the predetermined clearance between the first end plate and the second involute;
fitting the first scroll member in the fixture; and
fitting the second scroll member in the fixture with the predetermined clearance between the first end plate and the second involute.

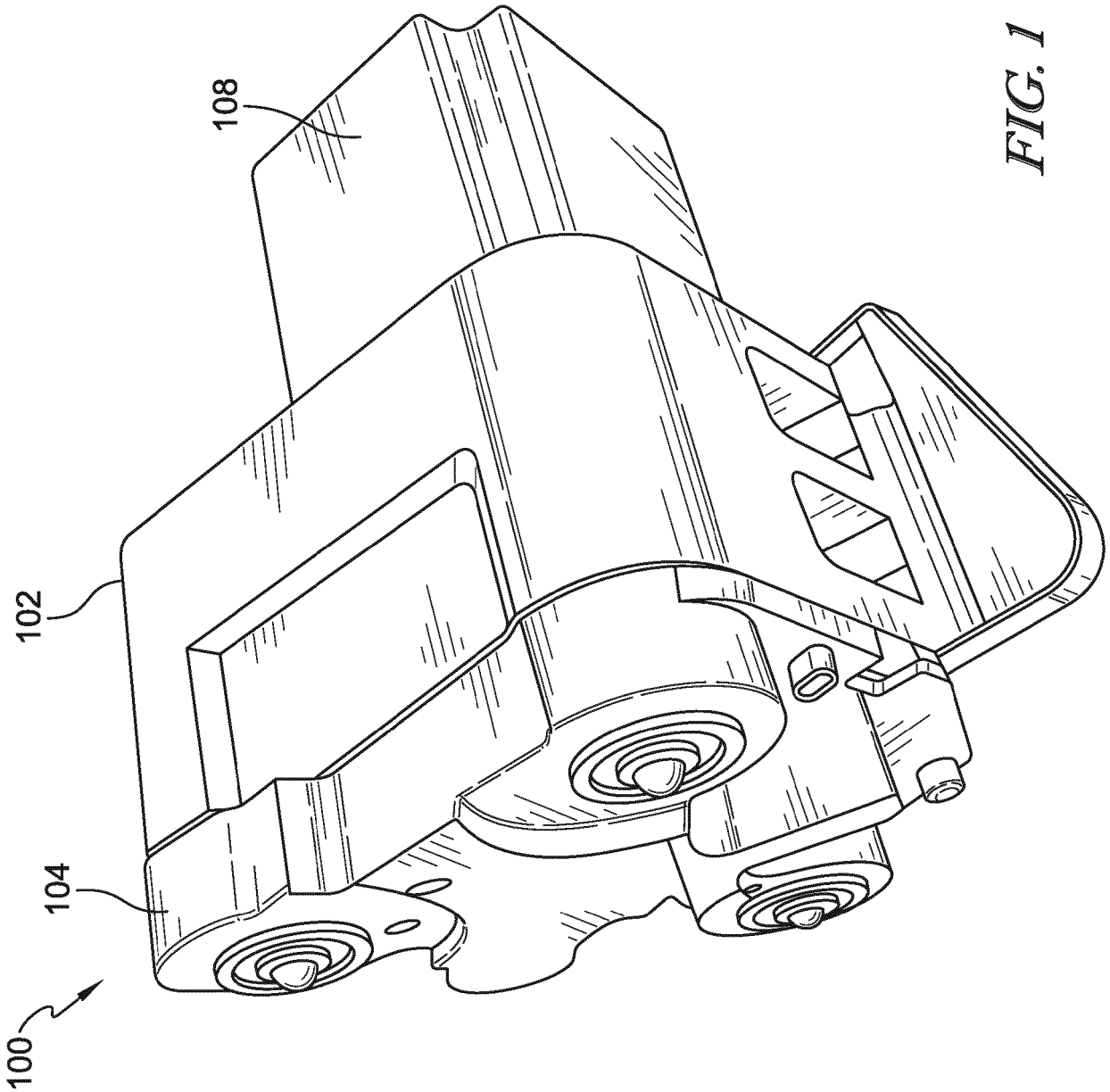

FIG. 1

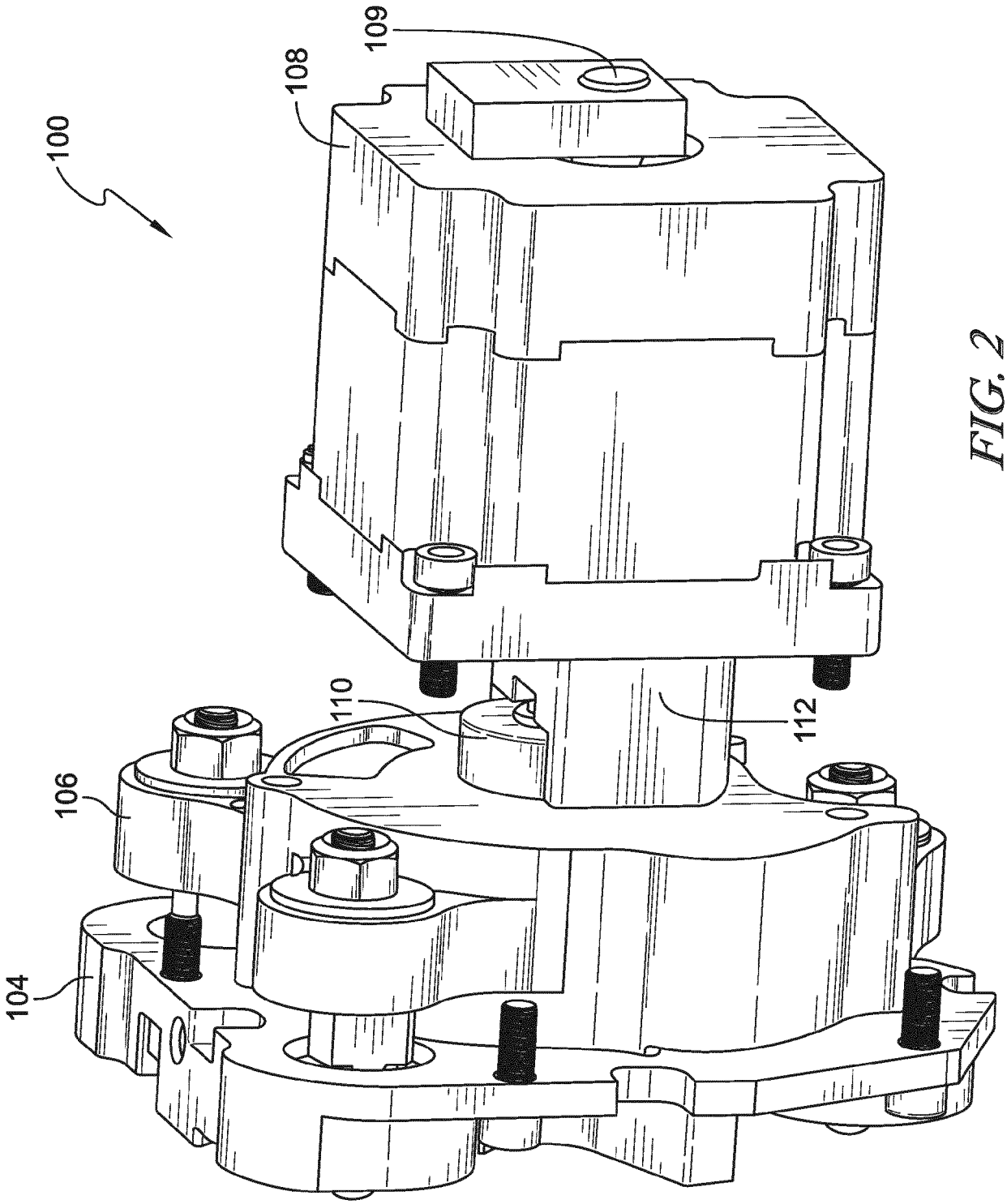

FIG. 2

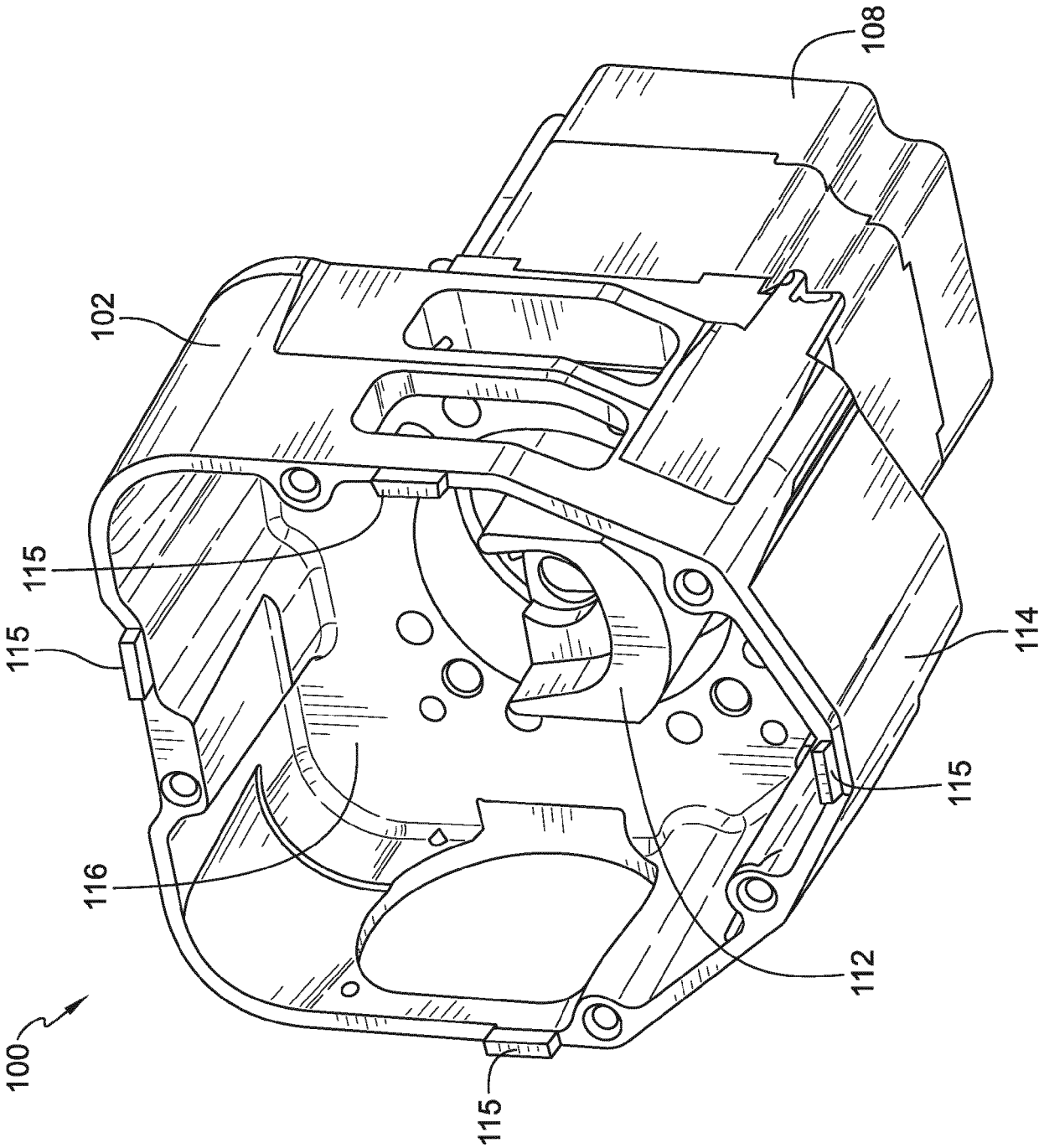

FIG. 3

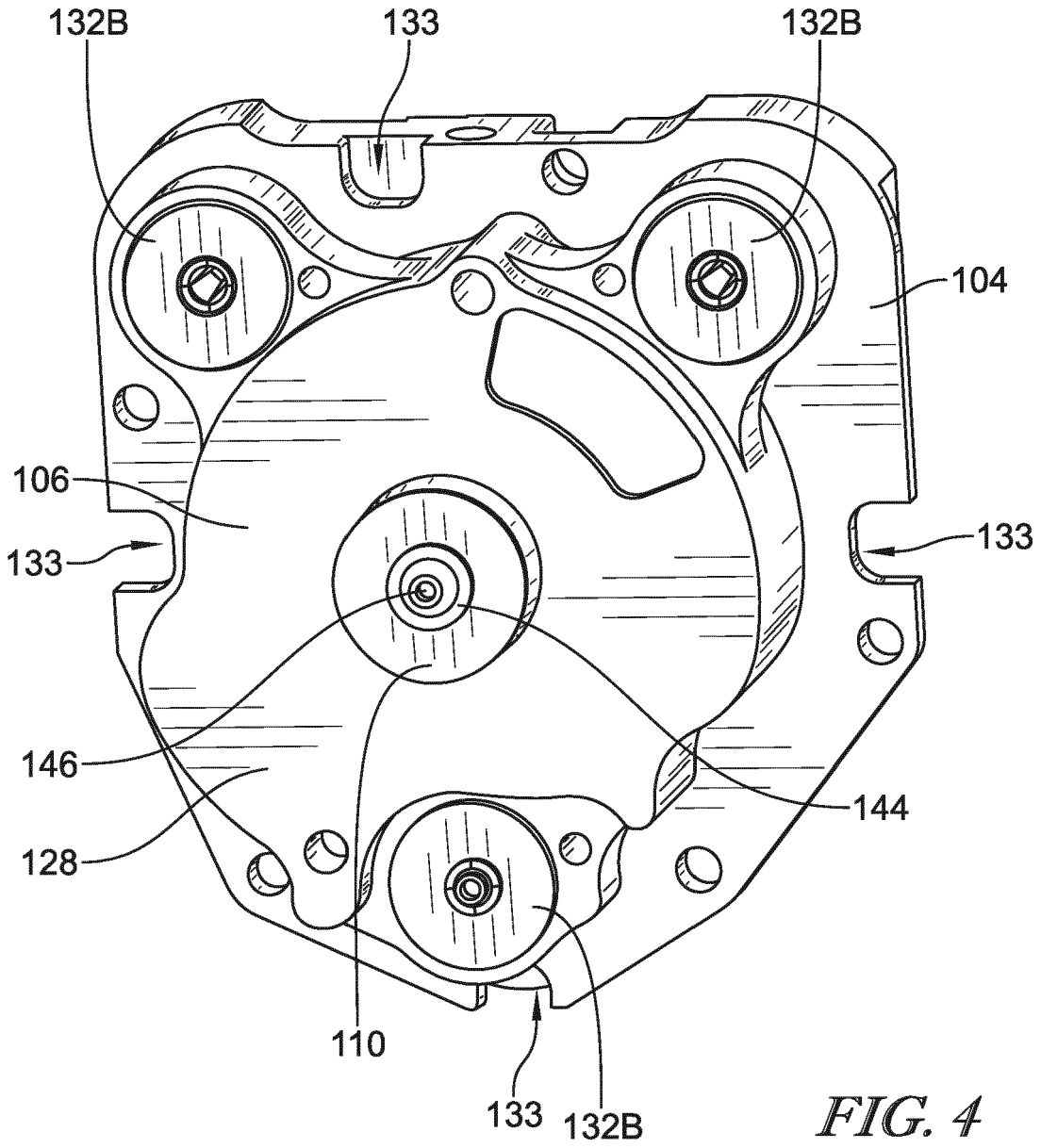

FIG. 4

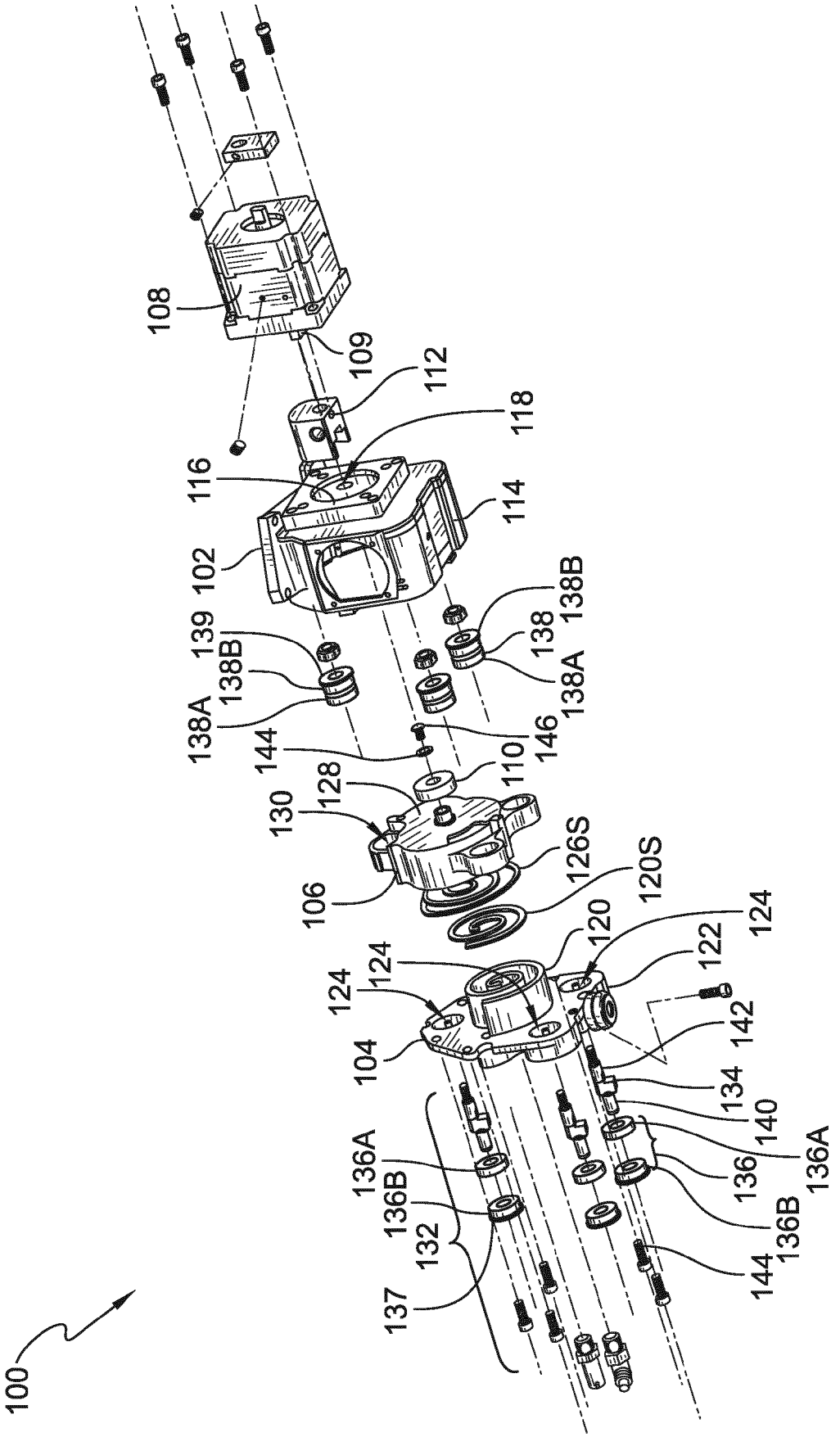
100
102
104
106
108
109
110
112
114
116
118
120
120S
122
124
126S
128
130
132
134
136
136A
136B
137
138
138A
138B
139
140
142
144
146

FIG. 5

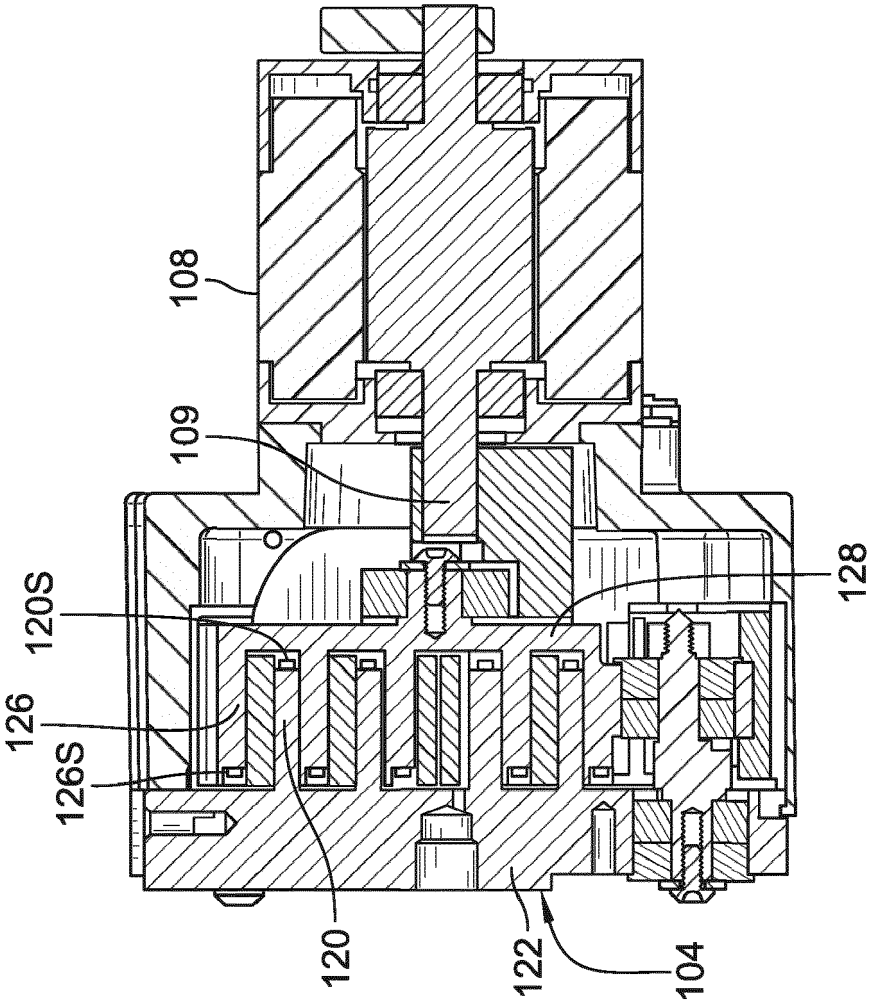

FIG. 6

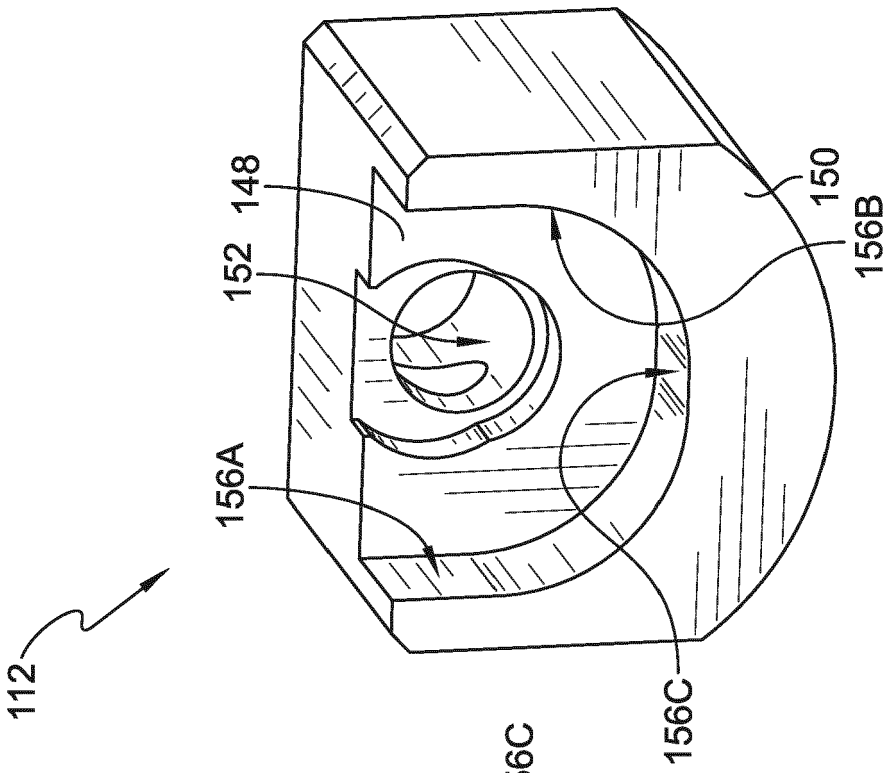
112
148
152
156A
150
156B
156C

FIG. 7B

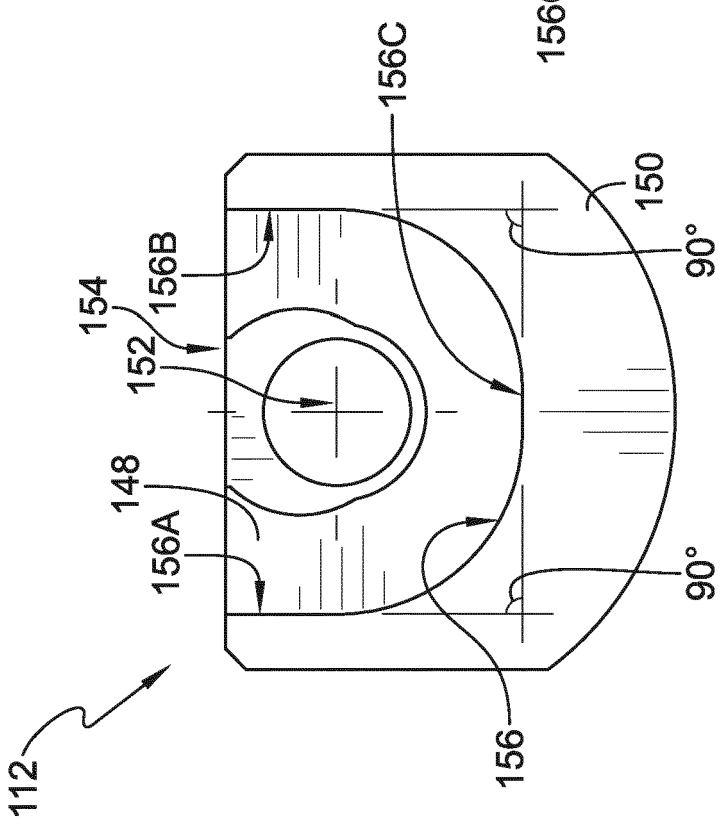
112
156C
150
90°
154
156B
152
148
156A
90°
156

FIG. 7A

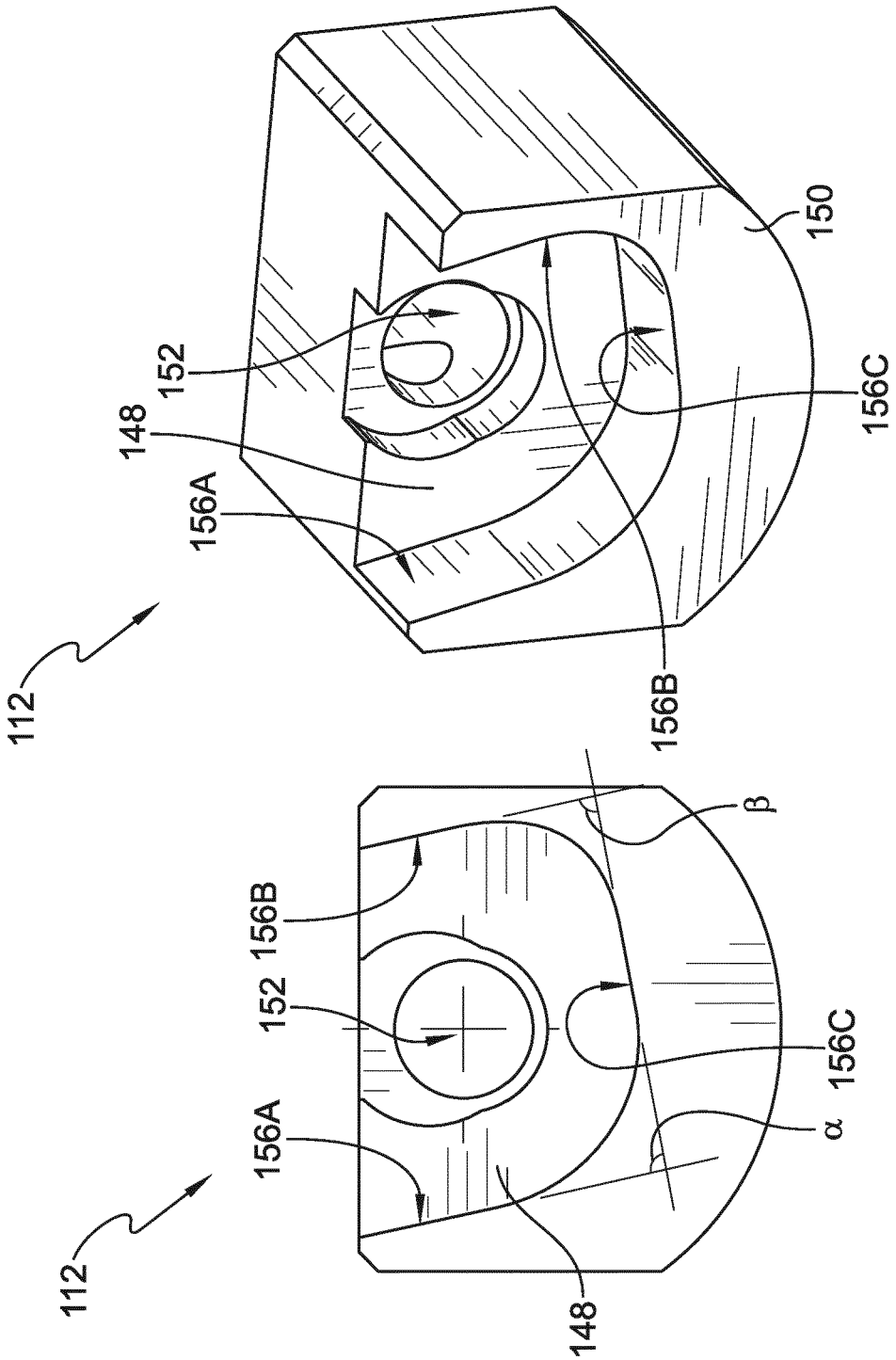

FIG.8B

FIG. 8A

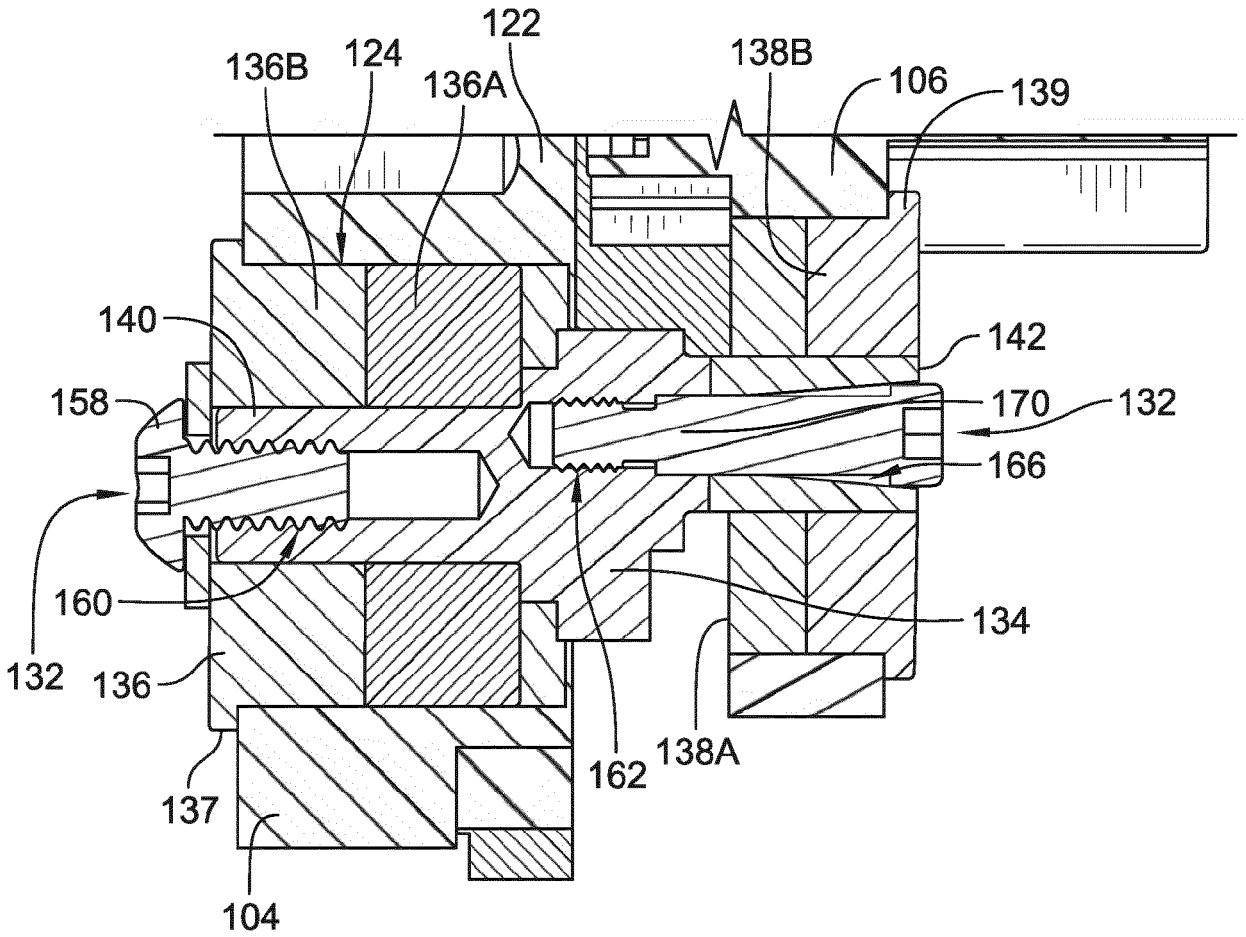
122
136B
124
136A
138B
106
139
140
142
158
170
132
166
160
134
132
136
138A
162
137
104

FIG. 9

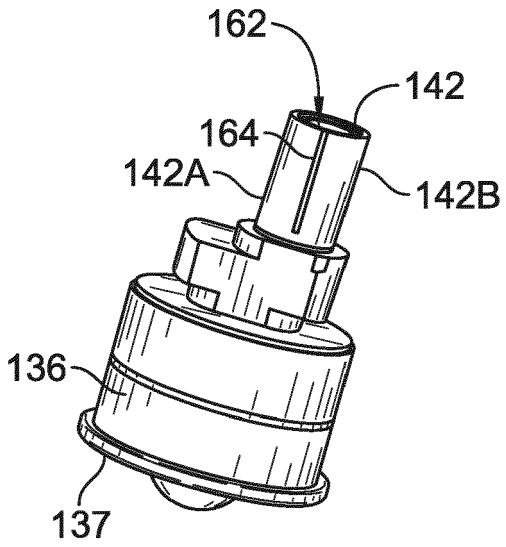

FIG. 10A

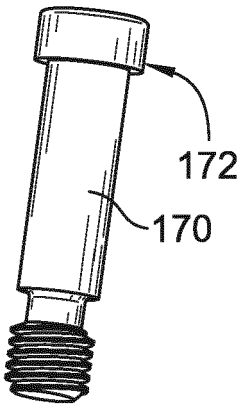

FIG. 10B

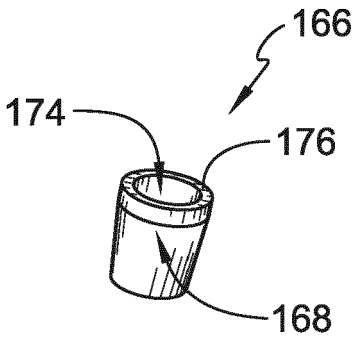

FIG. 10C

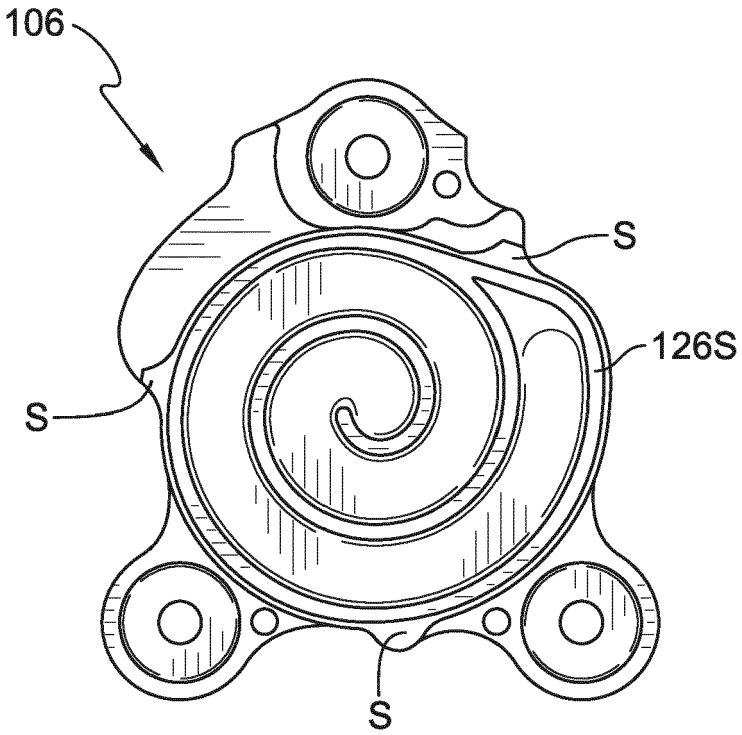

FIG. 11