

- [54] ROTOR AND GEAR ASSEMBLY FOR
-
- ROTARY MECHANISMS

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- [51] Int. Cl. F01c 17/02, F16h 51/08

- [58] **Field of Search**74/432, 433; 418/61, 91, 92

References Cited

UNITED STATES PATENTS

- | | | | |
|-----------|---------|----------------------|----------|
| 3,176,915 | 4/1965 | Bentele et al. | 418/91 X |
| 3,400,604 | 9/1968 | Jones..... | 74/433 |
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[57] ABSTRACT

An improved rotor and gear assembly for rotary mechanisms, such as combustion engines or the like, in which the gear is seated in one face of the rotor and secured to the rotor by a plurality of circumferentially spaced fastening means extending from the face of the rotor opposite from the gear, through the rotor, into the gear to thereby flexibly secure the gear against radial movement due to thermal distortion resulting from cyclically varying stress loads and thermal induced stresses.

2 Claims, 6 Drawing Figures

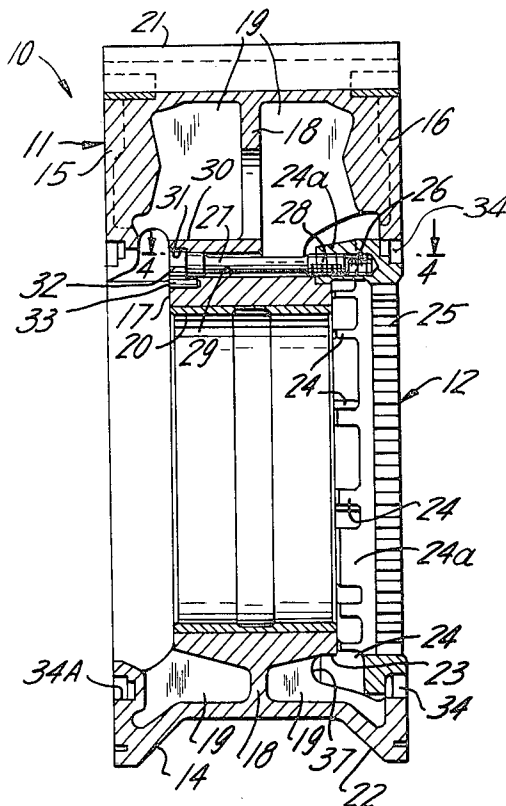


FIG. 1

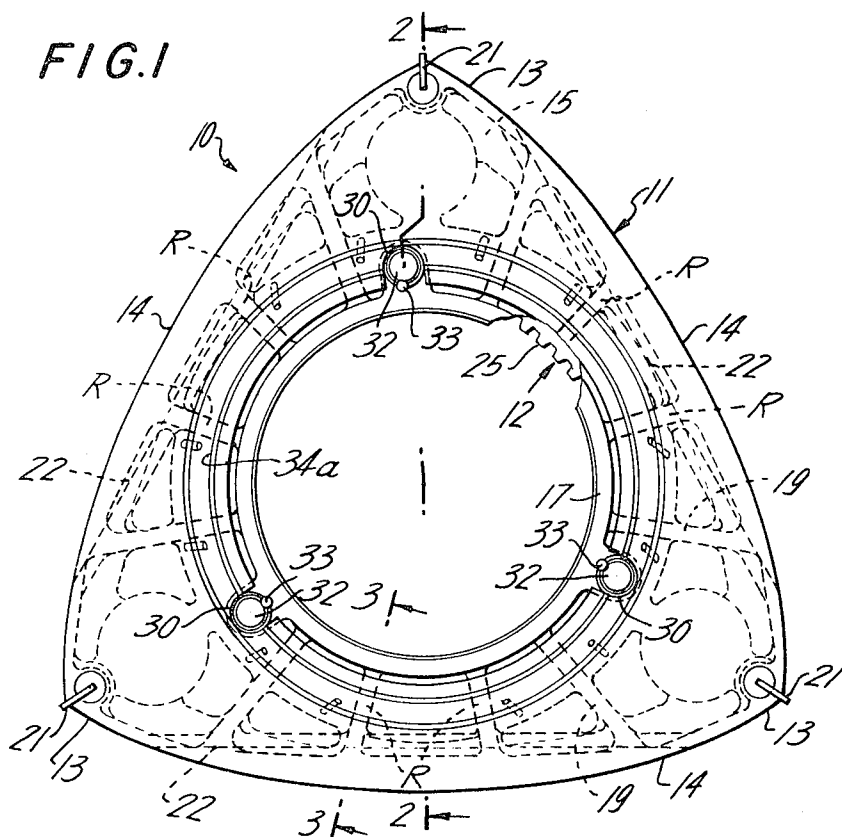
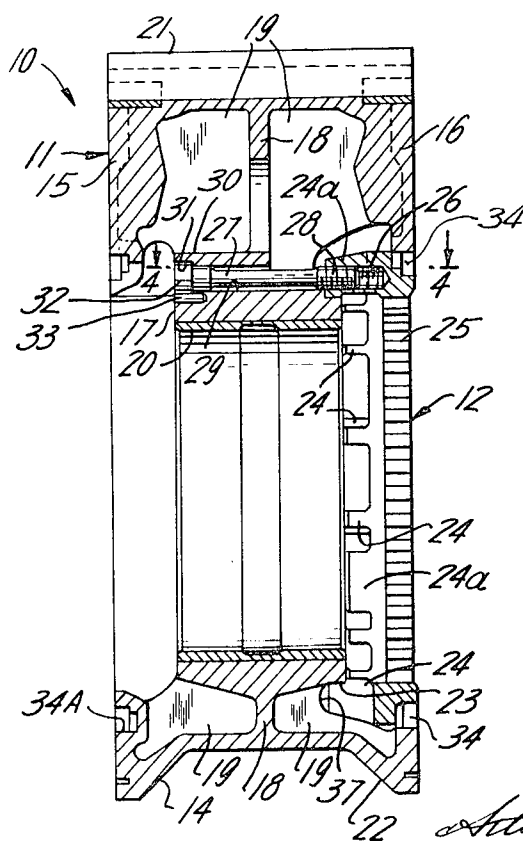


FIG. 2



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FIG. 4

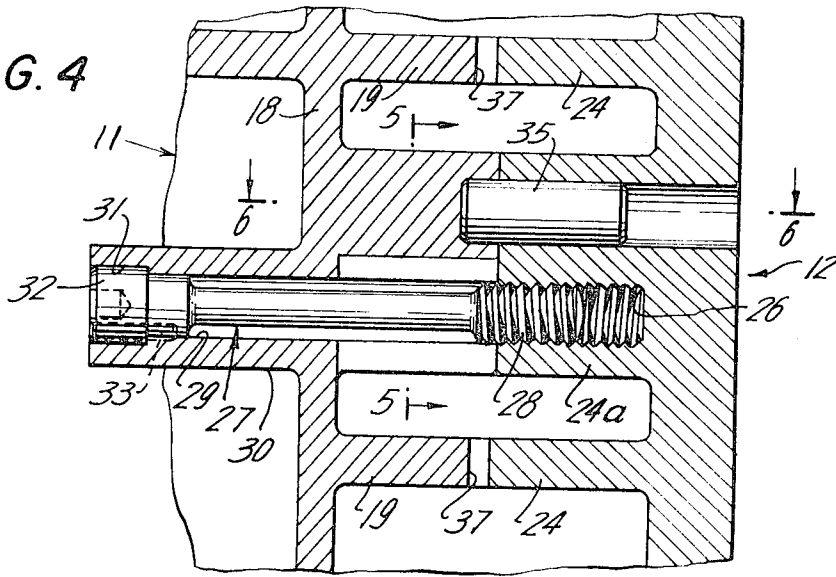


FIG. 3

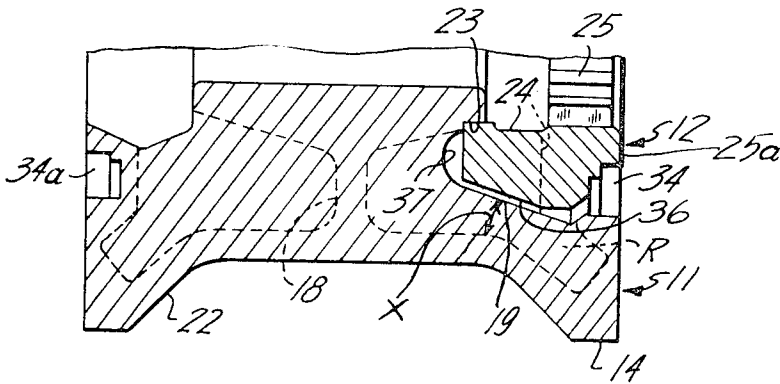


FIG. 5

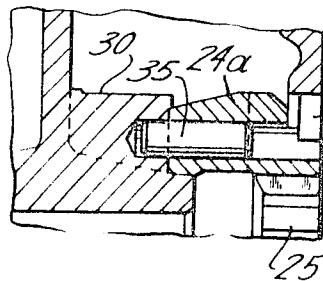
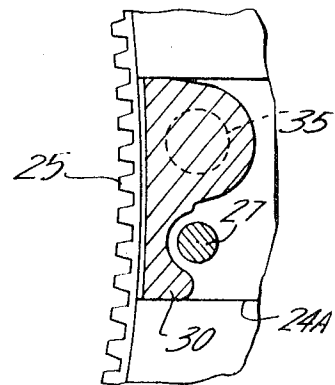


FIG. 6

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ROTOR AND GEAR ASSEMBLY FOR ROTARY MECHANISMS

This invention relates to rotary mechanisms for fluid pumps, fluid motors, compressors, combustion engines or the like. More specifically, the invention relates to a rotor and gear assembly for such rotary mechanisms.

BACKGROUND OF THE INVENTION

Heretofore, rotor and gear assemblies of the type exemplified in the U.S. Pat. 17 to Jones, No. 3,400,604, while constituting an improvement over then known assemblies, were still subject to failures resulting from cyclically varying loads and thermally induced stresses imposed upon the rotor and gear assemblies. At least some of the failures were attributable to excessive expansion of the rotor hub portion relative to the timing gear and the concentration of stress in a sharp shoulder partly defining the seat for the gear in one face of the rotor. Other failures, in the heretofore known rotor and gear assemblies, were the loosening of gear holding bolts which can be attributed to excessive differential expansion and contraction between the holding bolts and the rotor. Accordingly, the present invention contemplates an improved rotor and gear construction wherein thermal distortion and resultant stresses in the gear and rotor, which caused the aforementioned failures, are substantially minimized.

It is, therefore, an object of the present invention to provide an improved rotor and gear assembly having a longer operative life than heretofore known rotor and gear assemblies.

It is another object of this invention to provide an improved rotor and gear assembly of relatively simple construction and yet having a high degree of reliability as compared with heretofore known rotor and gear assemblies.

It is a further object of this invention to provide an improved rotor and gear assembly capable of operating at high loads and speeds with failures resulting therefrom substantially minimized.

It is yet another object of this invention to provide an improved rotor and gear assembly wherein each component is of improved construction to cooperatively function to produce an assembly highly resistant to cyclically varying loads and thermal stresses.

A feature of this invention is the attachment of the gear to the rotor by holding means, such as bolts, extending through the rotor, from one face thereof to engage the pilot bosses of the gear seated in the opposite face of the rotor. The construction provides pilot bosses and ribs and holding means, such as bolts, of relatively long dimension in a direction parallel to the axis of the rotor so that a substantial amount of the rotational force imposed by the radial thermal expansion of the rotor hub, relative to the gear is absorbed by the flexure and extension of the holding means, and thus torsional bending stresses on the gear are substantially less than in heretofore known rotor and gear assemblies. This feature also permits the fabrication of the gear so that toothed body portion has a relatively small radial dimension in cross-section for flexibility to absorb the torsional bending displacement imposed by thermal expansion loads and a relatively large cross-sectional dimension in an axial direction for structural strength and reduced stress and for providing an annular projection to limit axial movement of the rotor relative to the housing.

Another feature of the present invention is the provision of positioning and arranging the reinforcing ribs of the rotor in circumferentially spaced relation to each other and spaced from thinnest cross-sectional portion of the rotor in a radial direction adjacent the combustion recess area of the rotor so that each of the ribs has a large depth in a radial direction and a relatively large curved fillet at the rib root. This feature provides ribs of increased strength as well as obviating points of stress concentration and potential failure in the ribs.

SUMMARY OF THE INVENTION

The present invention contemplates an improved rotor and gear assembly for a rotary mechanism, such as pumps, com-

pressors, combustion engines, or the like, comprising a rotor having a plurality of apex portions interconnected by a plurality of peripheral wall portions and opposite, substantially parallel, end faces. One end face is provided with a recess to form a seat for a ring shaped gear, such as a timing gear for a rotor of a rotary internal combustion engine of the type disclosed in the U.S. Pat. No. 3,176,915 to Bentele et al. The gear has a plurality of circumferentially spaced piloting bosses and ribs which extend parallel to the gear axis and are adapted to contact the rotor seat. The piloting bosses are disposed equiangularly from each other and are constructed and arranged to receive a fastening means, such as a bolt or the like. Each of the fastening means extends from the rotor end face, opposite from the gear, through the rotor, to engage the associated piloting boss of the gear and hold the gear to the rotor. Each fastening means and the piloting bosses and ribs are of relatively long length to coact to provide a firm, yet flexible connection to minimize radial movement of the gear due to thermal distortion resulting from cyclically varying loads and thermal induced stresses.

The gear peripherally is adapted to coact with the rotor to provide a seat for an end seal, thus eliminating the need for a conventional oil seal adapter ring and thereby simplifying the rotor-gear assembly while retaining the annular axial projection for limiting the axial movement of the rotor relative to the housing which feature is disclosed in U.S. Pat. No. 3,261,542.

The rotor is provided with a plurality of reinforcing ribs which are arranged in circumferentially spaced relation to each other and spaced from the thinnest cross-sectional portion of the rotor, in a radial direction, adjacent the combustion recess area of the rotor so that each of the ribs has a large depth in a radial direction and a relatively large curved fillet portion at the rib root. This construction provides ribs of increased structural strength, as well as obviating points of stress concentration and potential failure in the ribs. The outer peripheral surfaces of the pilot bosses and ribs of the ring gear are each chamfered toward the rotor axis to further provide rotor reinforcing ribs, particularly those rotor ribs adjacent the aforementioned thinnest cross-sectional portion of the rotor, of relatively large depth.

Also to obviate a loosening or failure of the fastening means, the bosses of the rotor for receiving the fastening means are offset from the rotor reinforcing ribs so that the thermal loads to which the peripheral surface of the rotor is exposed is not as readily transmitted to the rotor bosses, through the ribs, as in heretofore known rotor-gear assemblies, so that the torsional bending stress in the gear and the thermal load on the fastening means which tends to radially shift the position of the rotor and gear bosses relative to the fastening means is substantially minimized.

BRIEF DESCRIPTION OF DRAWING

The invention will be more fully understood from the following description when considered in connection with the accompanying drawings in which:

FIG. 1 is an elevational view of the end face of the rotor and gear assembly, opposite from the end face to which the gear is secured;

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

FIG. 3 is a fragmentary view in cross-section taken along line 3—3 of FIG. 1;

FIG. 4 is a fragmentary cross-sectional view taken substantially along line 4—4 in FIG. 2, with parts broken away for illustration purposes and on a somewhat enlarged scale;

FIG. 5 is a cross-sectional view taken along line 5—5 of FIG. 4; and

FIG. 6 is a fragmentary view in cross-section taken along line 6—6 of FIG. 4 and shown on a somewhat reduced scale.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Now referring to the drawing, the reference number 10 generally designates the rotor and gear assembly, according to this invention, which assembly is suitable for a rotary mechanism, such as fluid pumps, compressors, fluid motors, and particularly applicable to rotary, internal combustion engines. The rotor and gear assembly 10 comprises a rotor 11 and a gear 12. In an internal combustion engine application of rotor and gear assembly 10, gear 12 is a timing gear which meshes with a pinion gear (not shown) mounted on an eccentric shaft (not shown).

The rotor 11 may be, as shown in FIG. 1, a unitary, cast body of relatively soft metal having a substantially triangular profile formed by three spaced apex portions 13 interconnected by arcuate shaped peripheral wall portions 14. As shown in FIG. 2, the rotor body has two opposite end faces 15 and 16 and an integral recessed hub portion 17. Hub portion 17 is joined to the peripheral wall portions 14 by a circumferential web 18 lying in a plane substantially normal to the rotor axis and juxtaposed, circumferentially spaced ribs 19 extending from opposite sides of web 18 to end faces 15 and 16 in planes substantially normal to the web. The hub portion 17 has a bore lined by suitable bearing material 20 through which the eccentric of the shaft (not shown) extends to support the rotor for rotation in a substantially epitrochoidal shaped chamber (not shown). An apex seal 21 is mounted in each apex portion 13 to engage the walls (not shown) of the chamber (not shown) in which the rotor rotates to define a plurality of volumetrically variable working chambers (not shown). To provide an adequate volume for combustion in the working chambers in the case of an internal combustion engine, each of the surfaces of peripheral edge portions 14 are recessed at 22 to form combustion pockets. The hub portion 17 in end face 16 is recessed to receive gear 12 and is provided with an internal annular notch 23 against which gear 12 abuts or seats. Due to the cyclically varying loads imposed on the rotor due, for example, in the case of a rotary internal combustion engine, by the compression and combustion occurring in the working chamber adjacent each combustion pocket recess 22 of the rotor, as well as the thermal distortion imposed on the rotor and gear due to thermal gradients and differential expansion and contraction between rotor 11 and gear 12, the rotor and gear assembly 10 must be constructed and interconnected to provide a tight or firm, yet flexible, attachment of the gear to the rotor. To this end, an improved fastening means, rotor and gear construction, according to this invention, is provided.

Gear 12 is provided with a plurality of circumferentially spaced bosses 24a and rib portions 24 projecting from internal toothed portion 25 in parallelism to the axis of the gear. The bosses 24a, preferably three bosses equiangularly arranged as shown in FIG. 1, are each arcuate shaped enlargements and have a tapped hole 26 therein to engage a fastening means, such as a bolt 27 (see FIGS. 2, 4 and 5) having a threaded shank portion 28 which is receivable in the tapped hole 26. Each of the bolts 27 extends through a bore 29 in a rotor boss 30 formed in hub portion 17 of side face 15, which bore 29 is in alignment with tapped hole 26 in pilot boss portions 24a. Boss 30 may include, as shown in FIGS. 2 and 4, a partial boss on the gear side of web 18. Since the tapped holes 26 are formed in gear 12 of hardened metal, rather than as heretofore in the relatively soft rotor body, the strength of the connection between the gear and the rotor is considerably improved. Each of the bores 29 is counterbored at 31 to provide an annular shoulder against which the head portion 32 of bolt 27 abuts. The shank of each bolt 27 is of reduced diameter in relation to the diameter of bore 29 to provide a relatively elastic shank and one which can undergo flexure relative to hub portion 17 of the rotor. A pin type key 33 is employed to lock each of the bolts against rotation relative to the rotor.

Since each of the bolts 27 is dimensioned to extend from the hub portion 17 of face 15 substantially the entire width of the

hub portion, the bolt has a relatively long shank of substantially greater flexibility than heretofore known gear holding bolts. The gear bosses 24a and ribs 24 are also relatively long, the bosses, ribs and bolts 27 coacting to minimize the transmittal of rotative force or rotational deformation, of the gear about its centroidal axis, from the rotor hub portion 17 to gear 12 due to differential expansion and contraction between the hub portion 17 and gear 12. Thus, the stresses on gear 12 and the potential failure of the gear are substantially less than in conventional rotor-gear assemblies.

The peripheral toothed portion 25 of gear 12 is of relatively large dimension in an axial direction since it need not be recessed to provide room for a conventional end seal adapter (not shown). Thus, the gear is provided with added structural strength and such added body also permits fabrication of an annular stepped notch 34 which defines with the adjacent peripheral rotor surface a grooved retaining seat for an end ring seal (not shown). In addition, the toothed portion 25 has an annular, axially projecting surface 25a which lies in a plane outwardly of the rotor surface 16 to limit axial movement of rotor 11 in the rotor housing (not shown). Thus, the rotor and gear assembly 10 obviates the need for an end seal adapter ring and thereby provides the assembly with greater reliability while simultaneously retaining the annular, axially projecting surface for limiting axial movement of the rotor relative to its housing. A similar annular stepped notch 34a is provided in the opposite end face 15 of rotor 11 to also receive another end seal ring (not shown).

The gear 12, as in conventional rotor-gear assemblies, is dimensioned in relation to the recess in end face 16 to be spaced along its outer peripheral surface from the ribs 19 of the rotor so that the necessity for accurate machining of the distal ribs surfaces is obviated. Also, the inner surface of the gear is dimensioned to loosely seat within notch 23 so that, upon heating and the differential expansion between the rotor and gear, the gear and the surfaces of notch 23 only then come into tight abutment. This latter mentioned cool-loose fit, minimizes the stresses imposed on the gear and rotor due to the thermal loads to which the assembly is subjected.

Also, as is conventional and as shown in FIGS. 4, 5 and 6, a pilot pin 35 is disposed in aligned bores in each gear boss 24a and a "blind" hole in boss 30 of the rotor. The pins 35 function to restrain relative movement of rotor 11 and gear 12 in planes perpendicular to the rotor and gear axes.

Another improved feature of rotor and gear assembly 10 is, as best shown in FIG. 3, forming of the gear bosses 24a and ribs 24 so that the distal surfaces 36 of bosses 24a and ribs 24 have a relatively steeply inclined chamfer which permits the adjacent ribs 19 to have a relatively large dimension depth, X and, hence, sufficient structural strength to minimize fracture thereof. To provide sufficient rib body for requisite structural strength is of particular importance to the ribs 19, next adjacent to the thinnest cross-sectional part of rotor 11 between hub portion 17 and peripheral walls 14. These ribs 19, hereinafter designated by the letter R, are offset from the thinnest cross-sectional part of the rotor, which offset location permits the ribs to have a greater depth than if located at the thinnest cross-sectional part of the rotor as is the case of heretofore known rotor-gear assemblies as exemplified in U.S. Pat. No. 3,400,604. Thus, the offset location of ribs R and the relatively steep chamfered surfaces 36 of the gear coact to permit ribs R to have a depth X and, thus, the desired strength to minimize fracture thereof.

A further improved feature according to this invention relating to ribs 19 is that the ribs 19 are provided at their roots with a relatively large radii curvature 37 (see FIG. 3) forming a fillet which is free of points of stress concentration which formally existed in heretofore known rotor-gear assemblies wherein a sharp corner was proved in the ribs to accommodate the bosses and ribs of the gear.

A still further feature of the rotor and gear assembly 10 is that the bosses 24a of the gear and the rotor bosses 30 are offset from ribs 19 so that the thermal loads to which the

peripheral walls 14 of rotor 11 are exposed during compression and combustion of gaseous fluids in the working chambers (not shown) is not directly transmitted to the bosses 24a and 30 through the ribs from the peripheral walls 14 and thereby minimizes misalignment of the bosses and the resultant load and stresses imposed on bolts 27 and pins 35. 5

It is believed now readily apparent that the improved rotor and gear assembly 10 according to this invention has increased resistance to cyclically variable loads and thermal detorsional stresses and, therefore, longer operative life. It is an assembly which is of simplified construction wherein a need for seal ring adapter has been eliminated to thus provide an assembly of increased reliability. 10

What is claimed is:

1. A rotor and gear assembly for rotary mechanisms comprising: 15

- a. a rotor having opposite end faces, contiguous peripheral walls and a hub portion formed in a recess in each of the end faces;
- b. said hub portion, said peripheral walls and end faces 20 being interconnected by circumferentially spaced ribs;
- c. each of said ribs being joined to the end faces, hub portion, and peripheral walls and having an inner distal edge portion inclined to extend from said end faces inwardly in a direction toward the hub portion of the rotor;
- d. a ring gear having an internal toothed portion and a plurality of circumferentially spaced elongated boss portions projecting axially from the plane of the toothed portion; 25

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- e. each of which has an inner surface extending substantially parallel to the gear axis and a chamfered outer surface extending inwardly toward the gear axis;
 - f. said ring gear being disposed to abut said hub portion adjacent said inner surfaces of said boss portions and with the chamfered outer surfaces of said boss portions closely spaced from the distal inclined edge portions of the circumferentially spaced ribs of the rotor; and
 - g. fastening means including an elongated, relatively flexible body portion for each of said boss portions;
 - h. a bore in said hub portion for each boss portion coaxially aligned with the associated boss portion and of a dimension to receive the body portion of the fastening means therethrough in spaced relation to the walls of the bore to permit flexure of the body portion;
 - i. each of said fastening means extending, from the hub portion surface opposite from the ring gear, through the hub portion to a connection at the end of the body portion to said boss portion of the gear whereby said fastening means and said associated boss portion coact to flexibly secure said gear against radial movement due to cyclically varying loads and circumferential distortion from thermally induced stresses.
2. The assembly of claim 1 wherein said fastening means is a bolt having an elongated flexible shank having a threaded end portion receivable in a threaded hole in each boss portion.

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