used provided they are equally distributed around the circumference of the insert to preclude imbalance.

The coupling system of the present invention also includes ring gear coupling **54**. Bolts **140** secure the forward end of the ring gear coupling to a nonrotating bearing support **56**. Bolts **142** secure the aft end of the coupling to support **148** which extends longitudinally from and is part of the ring gear housing **50**. The ring gear coupling has an inflexible hub **150** and at least one undulant flexible portion **152**. The flexible portion has an arch **154** radially outward of the hub. The junctures **156** between the hub and arch are curved in cross section to improve flexibility of the coupling and minimize stress concentrations thereon. A single flexible portion is adequate for accommodating angular misalignment between the ring gear **48** and the central axis **28**. Two or more longitudinally spaced apart flexible sections are used for accommodation of parallel misalignment or a combination of angular and parallel misalignment. The torsional rigidity of the arch **154** and hub **150** make the coupling rigid with respect to torsion about the longitudinal axis. The undulant character of the flexible portion makes the coupling compliant with respect to torsion about vertical and lateral axes and with respect to translation about all three axes. Accordingly, the coupling resists rotation of the ring gear housing while isolating the gear train from forces and moments arising from misalignments between the ring gear housing and the central longitudinal axis **28**.

Because the planetary gear train is flexibly coupled to its neighboring components in the engine, it can be radially displaced from its ideally centered position. While such behavior is consistent with and necessary for reducing wear on the gear train components, excessive displacement is undesirable. For example, high amplitude displacements of the gear train (resulting, for example from an unexpected rotary imbalance in an external device to which the gear train is coupled) can break the sun gear coupling, leaving the fan unpowered, or can break the ring gear coupling, leaving the gear train unsupported in the engine.

To limit excessive radial displacement of the gear train, the coupling system, and in particular the ring gear coupling, may include a deflection limiter **158**. The deflection limiter includes longitudinally extending first support **148** and a second support **162**, at least partially longitudinally coextensive with the first support. The second support is secured by bolts **164** to the wall **168** forming the inner flow path boundary of the engine and thus serves as a mechanical ground. The first and second supports are radially spaced apart by a small gap **172** so that excessive radial displacement of the ring gear housing is precluded by contact between the supports. The energy associated with such excessive displacements is transferred through the second support and to the flow path wall which absorbs the energy of contact without sustaining damage.

It is also desirable to dissipate the energy associated with normal vibrations of the gear train. Accordingly, the second support of the preferred embodiment includes a pair of grooves **176** and **178** with fluid seals **180**, **182** disposed therein. The second support also has a conduit **184** for supplying a viscous vibration damping fluid, not shown, from a source, also not shown, to the annulus of height **172** bounded by the seals and the first and second supports. The first and second supports thus cooperate to define a squeeze film damper Whose principals of operation are well known and therefore are not further described herein.

The first and second supports of the preferred embodiment also include cooperating anti-torque splines **190**. As illustrated in FIG. **3**, the spline teeth **192**, **194** are not normally in contact, but instead are separated radially and circumferentially by clearances **196**, **198** which are larger than the gap **172** (FIG. **2**) in the deflection limiter **158**. Therefore, the deflection limiter, rather than the spline, regulates the maximum radial displacement of the ring gear housing. However if the ring gear coupling deforms or twists excessively about the longitudinal axis, (for example because of the application of unexpectedly high torque) the splines engage to provide an alternate torque path for resisting rotation of the ring gear housing and to prevent further deformation of the coupling. Likewise, if the ring gear coupling is broken, the splines engage to resist rotation of the ring gear housing while the first and second supports assure vertical and lateral support of the housing.

The undulant sun gear and ring gear couplings of the present invention are of continuous construction, that is, there are no readily separable joints such as bolted flanges along the longitudinal length of the couplings. The ring gear coupling is made from a continuous sheet of metal which is cold formed in a mold into the desired undulant shape and subsequently bent to bring its lateral edges into abutting contact. The abutting lateral edges are then welded together. The sun gear coupling is made of three forged, machined pieces **202**, **204**, **206** which are electron beam welded at weld joints **208** and **210** (not readily discernible in the finished part) to form a continuous coupling. The region of each ring **64** immediately adjacent the weld joint is thicker than the rest of the ring to reduce stresses by maximizing the surface area over which forces acting on the joint are distributed. The continuous character of the couplings provides greater flexibility than could be obtained with a bolted flange in an equivalent radial space.

The coupling system provides unique operational advantages not available with prior art couplings. The sun gear and ring gear couplings are rigid with respect to torsion about the longitudinal axis and consequently transmit or resist high torque about the longitudinal axis. Within the elastic limits of the materials used for their construction, the couplings are flexible with respect to torsion about lateral and vertical axes and with respect to translation along all three axes. If, for example, the drive shaft **24** becomes misaligned with the longitudinal axis **28**, the sun gear coupling flexes to ensure that the sun gear axis remains at or near its ideal orientation thereby maintaining optimum contact between the sun gear and planet gear teeth. If the flexible coupling were not present, the misalignment of the shaft would reorient the sun gear and impose additional stress on the meshing sun gear and planet gear teeth. The coupling system of the present invention achieves such flexibility without the mechanical complexity of multiple constituent parts characteristic of some prior art couplings. Moreover, the couplings of the present system require no lubrication and are radially compact.

The best mode for carrying out the invention was presented in the context of a speed reducing planetary gear train whose sun gear accepts an input from an external source of rotary motion and whose planet carrier drives an external rotary device. However the invention is equally applicable to a speed amplifying gear