A rotary internal combustion engine of trochoidal type having phasing gearing between the housing and the rotor, wherein the large gear borne by the rotor and the smaller gear borne by a side wall and through which the shaft passes, are in engagement by means of teeth extending axially from their end faces. This arrangement permits the use of gears of smaller outer diameter, hence allowing more space on the rotor side face for seals, a larger and stronger shaft passing through the small gear, and stronger gear teeth.
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ROTARY ENGINE OF TROCHOIDAL DESIGN

BACKGROUND OF THE INVENTION

This invention relates to a rotary piston engine of trochoidal design as shown generally in U. S. Pat. Nos. 2,988,008 and 2,988,065, wherein a rotor is disposed within the engine cavity of a multiloled trochoidal peripheral housing, the rotor being rotatably mounted on an eccentric portion of a shaft transciering the side walls of the housing. The rotor bears on one side face a gear coaxial with the rotor's axis of rotation on the eccentric, and in engagement with a smaller gear borne by a housing side wall. The smaller gear is coaxial with the shaft axis, and the shaft passes through the smaller gear. These gears assist in maintaining the selected rotational phasing between the rotor and the shaft.

In such engines of the prior art the phasing gears have been spur gears with radially extending teeth, the smaller gear being of pinion type with an annular web portion from which the teeth extend radially outwardly, and the large gear being a ring gear having an annular web with the teeth extending radially inwardly therefrom. Such gears are exemplified in U. S. Pat. Nos. 3,091,386 and 3,323,497. The annular web members of both gears have been used to provide attachment to their respective supporting means. The necessary radial width of the annular web is caused by the ring gear and the amount of space available on the rotor side face for positioning the annular oil seals surrounding the gear, as shown in U. S. Pat. Nos. 3,171,590 and 3,400,939.

The radial width of the web of the pinion gear limits the diameter of the shaft passing therethrough, this gear being required to be in suitable ratio to the ring gear. In order to keep the shaft diameter as large as possible, use has been made of gear teeth having a relatively small module, usually about 1.5, the module being defined as the pitch diameter of the gear in millimeters divided by the number of teeth. A small module necessitates a relatively large number of relatively weak teeth. The restricted space on the rotor face results in structural limitations in the possible ratio of $e$ to $R$ of the engine, where $e$ is the spacing between the parallel axes of rotation of the rotor and of the shaft, and $R$ is the radius from the rotational axis of the rotor to a rotor apex.

SUMMARY

The present invention provides a rotary engine of the trochoidal type having phasing gearing which, with the same module as in the prior art type requires substantially less space, or else, with the same space requirement makes possible substantially stronger teeth, which can also be produced more economically than previously. This is accomplished by the use of gears having meshing teeth on their end faces, and having no radial extent greater than the tooth height, either inside or outside the teeth.

It is an object of this invention to provide a trochoidal rotary engine with phasing gearing which enables the use of a larger diameter shaft.

It is another object to provide such an engine with phasing gearing leaving a larger clear area of the rotor side face available for seal installation.

It is another object to provide a rotary engine with such gearing having stronger teeth which can be more economically produced.

Still another object is to provide gears on parallel shafts having meshing end-face teeth.

A further object is to provide a rotary engine having phasing gearing with a larger module than was possible in the prior art.

These objects and advantages and others ancillary thereto will be readily understood on reading the following specification in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an axial cross-section in elevation of a trochoidal rotary engine embodying the phasing gearing of the invention;

FIG. 2 is an exploded perspective view showing schematically the phasing gears of FIG. 1 in their relation to the rotor; and

FIG. 3 is a fragmentary view of portions of the rotor and a side wall, showing a modified embodiment of the phasing gearing.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention will be described in connection with a rotary engine having a basically epitrochoidal peripheral housing of two lobes and an accurately triangular rotor having three apexes. However, it is to be understood that the invention is also applicable to such trochoidal engines of other design, such as one with a three-lobed housing and a four-apexed rotor, or a one-lobed housing and a two-apexed rotor, or to any mechanism in which phasing gearing is provided between a rotor and a housing.

In FIG. 1 there is shown a rotary engine having a housing comprising a peripheral shell 1 with a two-lobed trochoidal inner surface 2, and two side parts 3 and 4, defining an engine cavity. A rotatable shaft 5 extends through the side parts 3 and 4, being appropriately mounted in bearings borne by the side parts, and having an eccentric portion 6 disposed within the engine cavity. A generally triangular rotor 7 is rotatably mounted on the eccentric 6, the rotor bearing at its apexes seal members 8 which during rotation of the rotor continuously sweep the inner peripheral surface 2 in sealing relation therewith. The axis 11 of rotation of the rotor on the eccentric portion is displaced from, but parallel to, the rotational axis 12 of the shaft.

The shaft rotates at times three times the speed of the rotation of the rotor within the housing. This speed ratio is maintained by synchronized phasing gearing comprising a ring gear 9 mounted on a side face of the rotor and in mesh with a pinion gear 10 borne by the adjacent side part of the housing. Although the gears are referred to as ring and pinion gears, it is to be understood that they are not the known examples of gears bearing those designations, wherein a ring gear would have teeth projecting in the radially inward direction and the pinion gear would have teeth projecting in the radially outward direction. The configuration of the present ring and pinion gears will be described below.

The ring gear 9 is coaxial with the rotor axis 11, and the pinion 10 is coaxial with the shaft axis 12, the shaft passing through the pinion gear. In accordance with the invention, the teeth 13 and 14 of the two gears 9 and 10 respectively extend axially from the gear bases 15 and 16 respectively of the two gears. Gear base 15 of
ring gear 9 has the same outer and inner diameters as the outer and inner diameters of the teeth 13 extending therefrom, and gear base 16 of the pinion gear 10 has the same outer and inner diameters as the outer and inner diameters of its axially extending teeth, with the pitch diameters of the two gears being tangent at the point of complete meshing.

In the embodiment shown in FIGS. 1 and 2 the teeth 13 and 14 of the two gears are attached at one end exclusively to the gear bases 15 and 16 respectively, the opposite ends of the teeth being free-standing, as best shown in FIG. 2. The individual teeth are thus self-supporting, and it is possible to produce or machine their form and engaging surfaces by a rotating end mill or a rotating pot-shaped grinding wheel. The tooth flanks may advantageously be designed on an involute approximating a circular arc, for the purpose of making it possible to produce them by means of a rotating tool with the greatest possible accuracy. However, it is also possible to produce the gears by a sintering process. Also, the teeth can of course be cut by any of the known gear-cutting means. Although the tooth form is shown only schematically in FIG. 2, it is to be understood that the teeth may have any form which would be suitable for radial teeth of the prior art.

Because the radial breadth of the gears 9 and 10 is determined solely by the radial height of the teeth 13 and 14, this produces substantial advantages in comparison with the gears of the prior art, the radial extent of which was the sum of the tooth height plus the radial width of the flange or web. With the same radial extent as in a prior art gear, the gears of the invention can have a module two or three times that of the ordinary teeth, and thus teeth that are two or three stronger.

On the other hand, if there is used with the invention the module of ordinary teeth, 1.5 for example, then the radial extent of the gears is substantially reduced. With the pinion this reduction in radial breadth is taken from the inner diameter, so that it is feasible to have a larger aperture therethrough for the passage of a shaft of greater diameter and higher strength. In the case of the ring gear the reduction of radial breadth results in a smaller outer diameter, so that in engines having a great angle of traverse, that is, a small e:R ratio, there remains sufficient room on the side face of the rotor for installation of the side seals.

In the embodiment shown in FIG. 1 the gear base 16 of the pinion 10 serves also as a sleeve for the shaft bearing 17, the base 16 being mounted on the housing side part 3 by an external flange or other convenient means. The gear base 15 of ring gear 9 may be fastened to the rotor 7 by screws 18 passing through the rotor from the opposite side. Moreover, gear base 15 can be set into a recess 19 in the rotor with a light press-fit to insure centering.

In the example already described the gear teeth are connected to their respective gear bases only at one end. The embodiment shown in FIG. 3 differs in that each gear base 15' and 16' is provided with an annular extension 20 and 21 respectively, which in addition to the end connection of the teeth also connect what would be the roots of the teeth in ordinary spur type gears. That is, the axial extension 20 of the ring gear is a thin barrel disposed on the radially outward or root side of the teeth 13' and connected thereto, and the extension 21 of the pinion is a thin barrel disposed on the radially inward or root side of the teeth 14' and connected thereto. These extensions 20 and 21 give very substantial strength to the teeth 13' and 14', even when the barrels are very thin, since the teeth are now unitary on two sides with the gear bases. The total radial breadth of the gears 9' and 10' is only immaterially increased by these extensions.

In this embodiment, although the gears may be mounted in the manner previously described, they may also be advantageously mounted by heavy dowels 22 between the ring gear 9' and rotor 7, and by similar dowels 23 between the pinion 10' and the side wall 3, the dowels being pressed into corresponding holes in the gears and their respective mounting members. Gears 9' and 10' are preferably fabricated by a sintering process.

What is claimed is:

1. In a rotary engine of trochoidal type having a housing comprising side walls and a peripheral wall defining an engine cavity, a shaft trans piercing the side walls and having an eccentric portion disposed within the cavity, a rotor rotatably mounted on the eccentric and bearing on one side face a gear in engagement with a gear borne by the adjacent side wall, the improvement comprising: each of the gears having a gear base portion with gear teeth extending axially therefrom.

2. The combination recited in claim 1, wherein the roots of the teeth of each gear are connected to one another by annular extensions of their respective gear bases.

3. The combination recited in claim 1, wherein the flanks of the profile of the teeth of each gear are on circular arcs approximating involute toothings.

4. The combination recited in claim 1, wherein the teeth of each gear are connected respectively at one end of the gear teeth to their respective gear bases.

5. The combination recited in claim 1, wherein the inner and outer diameters of the teeth of each gear are substantially equal to the respective inner and outer diameters of their respective gear bases.

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