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ROTOR GUIDE ARRANGEMENT FOR A ROTARY INTERNAL COMBUSTION ENGINE

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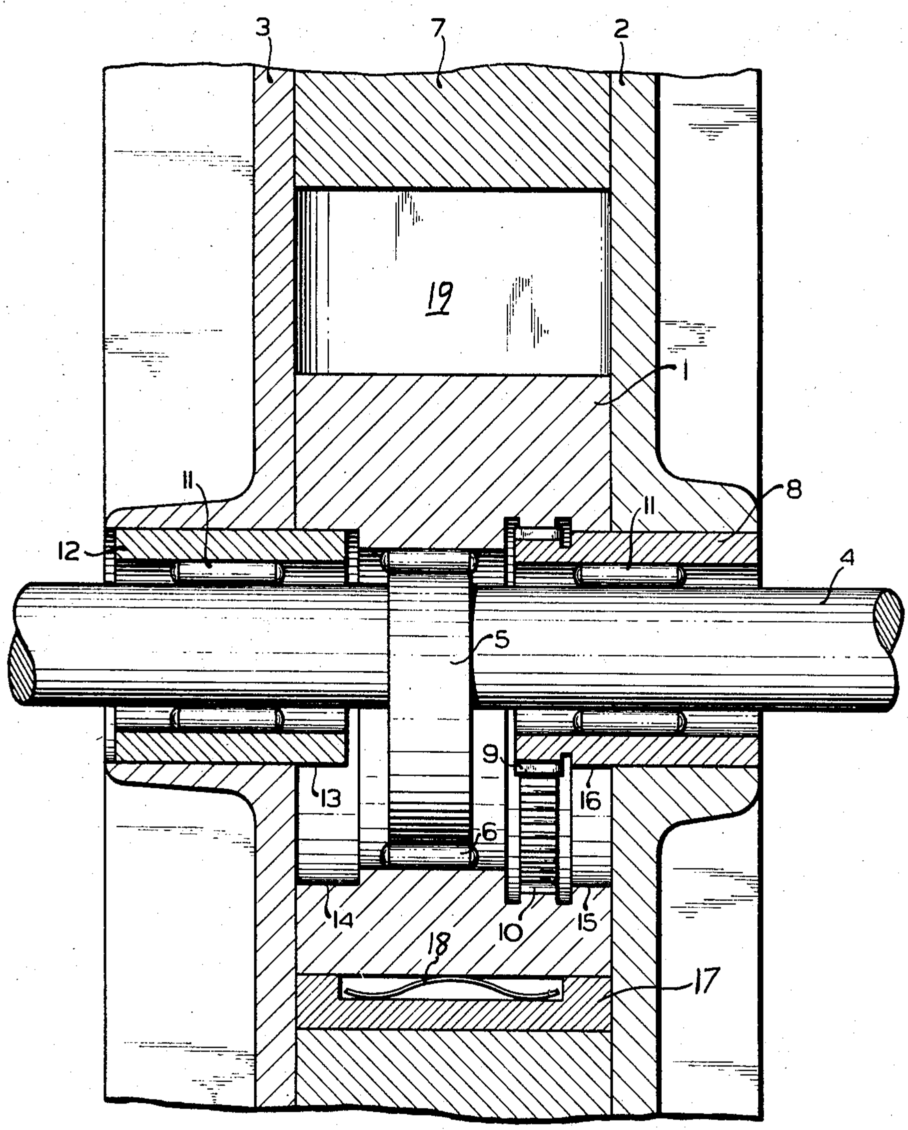

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ROTOR GUIDE ARRANGEMENT FOR A ROTARY INTERNAL COMBUSTION ENGINE

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This invention relates to rotary internal combustion engines, and particularly to an improved guide arrangement for the rotor of such an engine.

The engine with the improvement of which this invention is more specifically concerned is of the well-known type developed mainly by Felix Wankel and his co-workers and is equipped with a casing, usually of epitrochoidal shape, and a rotor of triangular cross section which is rotatably mounted on an eccentric in the casing cavity and defines three sealed, circumferential chambers with the inner face of the casing. The eccentric is fixedly mounted on the output shaft or crank shaft of the engine, and the rotor is connected with the casing by meshed gears which cause the rotor to rotate on the eccentric during rotation of the shaft. An explosive fuel mixture is admitted to the engine chamber, compressed, ignited, and exhausted after transmitting its energy to the shaft by expanding.

During the sequential explosion of the fuel mixtures in the engine chambers, tangential forces are exerted on the meshed gears because of non-uniform distribution of pressures. The gears necessarily have some flank clearance and resulting backlash, and the afore-mentioned forces cause high-frequency vibrations which account for much of the noisiness of the known engines of the type described. The vibrations also cause or contribute materially to the formation of axially elongated wear marks or grooves spacedly distributed about the inner circumferential wall of the casing and increasing in depth from the median radial plane of the engine toward the axially terminal end walls.

Another factor contributing to the formation of the afore-described wear marks is the tendency of the rotor to tilt relative to its normal axis of rotation, but the effects of wear due to such tilting are mostly found in the end walls.

The object of the invention is a reduction in the wear of the engine parts due to the factors described above, and a reduction in the engine noise.

It has been found that an engine of the type described operates with less vibration, and therefore at a lower noise level when the rotor is more securely guided than has been done heretofore. It has also been found that a guiding arrangement which eliminates or materially reduces the possibility of rotor tilting sharply reduces wear marks on the engine casing.

An engine according to the instant invention has a rotor equipped with an annular contact face of circular cross section about the axis of rotation of the rotor on the eccentric. It further has a supporting collar secured to the engine casing and having another annular contact face abuttingly engaging the face of the rotor during rotation of the engine shaft with the eccentric and of the rotor on the eccentric. The abuttingly cooperating contact faces and the meshing gears, which are axially spaced from the contact faces provided a two-point guide or support arrangement for the rotor which virtually eliminates the possibility of tilting movement and sharply reduces wear of the end walls. Friction between the engaged contact faces counteracts the forces which tend to generate circumferential vibrations in the engine. The characteristic

wear marks on the circumferential casing wall are not observed in the engines of the invention.

Other features and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood from the following detailed description of a preferred embodiment when considered with the appended drawing whose sole figure shows as much of a Wankel-type engine as is necessary for an understanding of this invention. As far as not illustrated, the engine may be identical with that disclosed in U.S. Patent No. 3,081,753 to Roy T. Hurley et al. The sole figure of the drawing shows the engine in section on the crankshaft axis substantially in the manner of FIG. 8 of the aforementioned patent.

Referring now to the instant drawing in detail, there is seen a rotor **1** of approximately triangular shape when viewed in radial section (not illustrated). It is arranged in the cavity of a casing mainly consisting of axially terminal end walls **2**, **3** and of a circumferential wall **7** which is epitrochoidal in radial section as is conventional, but not shown in the drawing.

The output shaft or crankshaft **4** of the engine is journaled in the end walls **2**, **3** in a manner presently to be described in more detail, and carries a fixedly fastened eccentric **5**. A roller bearing **6** on the cylindrical face of the eccentric **5** rotatably supports the rotor **1** for rotation about an axis which is parallel to, but spaced from the axis of the shaft **4**.

The teeth of a pinion **9** fixedly fastened to the end wall **2** meshingly engage teeth of an internally toothed gear rim **10** on the piston **1**. The pitch circle of the pinion **9** is centered in the axis of the shaft **4**, and the pitch circle of the gear rim **10** is centered in the axis of rotation of the rotor **1** on the eccentric **5**. The structure described so far is common to this invention and the known engines.

The shaft **4** is supported in the end walls **2**, **3** by anti-friction bearings whose inner races are provided by the shaft surface. Sleeves **8**, **12** fixedly mounted in the walls **2**, **3** provide the outer races and retain anti-friction elements **11**, such as rollers or balls. The afore-mentioned pinion **9** is an integral part of the sleeve **8**. A portion of the sleeve **12** projects inward from the wall **3** into the casing cavity to form a supporting collar on the wall. A cylindrical outer face **13** on the projecting collar portion has a diameter equal to the pitch diameter of the pinion **9**, and is centered on the axis of the shaft **4**.

The face **13** makes abutting contact with an internal cylindrical face **14** on the rotor **1** whose diameter is equal to the pitch diameter of the gear rim **10**, and which is centered in the axis of rotation of the rotor **1** on the eccentric **5**.

The sleeve **8** projects axially inward from the wall **2** a distance sufficient to provide an annular supporting face **16**, similar to the face **13**, between the wall **2** and the pinion **9**. The face **16** abuttingly engages a cooperating inner annular face **15** on the rotor **1**, the face **15** being coaxial with the face **14** and of equal diameter.

The drawing also shows one of the three apex seals **17**, conventional in themselves, which are mounted on the rotor **1** and are held in sealing engagement with the surface of the circumferential casing wall **7** by associated springs **18** during operation of the engine. The seals **17** circumferentially divide three chambers **19** from each other, only one chamber being visible in the drawing. The devices which cause fuel mixture to enter the engine, which ignite the compressed mixture, and which permit discharge of the spent mixture have not been illustrated and will not be described since they are evident from the aforementioned patent, and not directly relevant to this invention.

When the engine of the invention is operated, the rotor **1** is guided by the engaged contact faces **13**, **14**, **15**, 16, and only partly by the meshed gears **9, 10**. The gears are relieved of tangential forces by the friction between the contact faces which damp circumferential vibration. Absence of vibrations is characteristic of this engine even when flank clearance in the gears **9, 10** has been increased substantially by normal wear. Tilting movement of the rotor in the plane of the drawing is practically eliminated even when the bearing **6** of the eccentric becomes somewhat loose because of wear.

While the provision of two pairs of cooperating contact faces on the rotor and casing is preferred, many of the advantages of this invention are achieved when only one pair of cooperating contact faces is provided, and the meshed gears **9, 10** are relied upon for provding a second guide or support for the rotor on the casing. The axial spacing of the two rotor guides or supports should be as great as is practical, and the gears and one pair of contact faces should be arranged on opposite sides of the eccentric in an engine of the type described.

The reduction in the wear of the casing walls is substantial even with a single pair of contact faces, but best results are obtained with the illustrated arrangement in which the gears **9, 10** are relieved of much of their load.

While it is preferred that the contact faces have diameters equal to the pitch circles of the associated gear elements, this relationship is not necessary for operativeness of the engine, and contact faces of different diameters may be selected if relative circumferential movement of engaged faces is acceptable.

The basic features of this invention are applicable to rotary internal combustion engines of other types than that shown in the drawing, and those skilled in the art will readily adapt the above teachings to specific circumstances.

It should be understood, therefore, that the foregoing disclosure relates only to a preferred embodiment of the invention, and that it is intended to cover all changes and modifications of the example of the invention herein chosen for the purpose of the disclosure which do not constitute departures from the spirit and scope of the invention set forth in the appended claims.

What is claimed is:

1. In a rotary combustion engine, in combination:

(a) a casing having a first axis and including two end walls transverse of said axis and a circumferential wall connecting said end walls to define a cavity in said casing;

(b) a shaft journaled in said end walls for rotation about said axis;

(c) an eccentric fixedly fastened to said shaft for rotation therewith in said cavity;

(d) rotor means mounted on said eccentric for rotation about a second axis spaced from said first axis and extending in a common direction therewith, said rotor means defining a first annular contact face of circular cross section about said second axis;

(e) first gear means fixed on said casing and having a pitch circle centered on said first axis;

(f) second gear means fixed on said rotor and meshing with said first gear means, said second gear means having a pitch circle centered in said second axis;

(g) collar means secured to said casing and defining a second annular contact face of circular cross section about said first axis, said contact faces being axially spaced from said gear means and abuttingly engaging each other during rotation of said shaft and of said rotor means about said first and second axes respectively; and

(h) sealing means sealingly connecting said casing and said rotor means for defining a plurality of circumferentially spaced chambers between the casing and the rotor means during rotation of the latter.

2. In an engine as set forth in claim **1**, said first gear means being fixedly fastened to one of said end walls in said cavity and said collar means being fastened to the other end wall in said cavity.

3. In an engine as set forth in claim **2**, said collar means being fixedly fastened to said other end wall.

4. In an engine as set forth in claim **3**, said first contact face being an inner face directed toward said second axis, and said second face being an outer face directed away from said first axis, said first gear means having external gear teeth, and said second gear means including an internally toothed gear rim.

5. In an engine as set forth in claim **4**, the diameters of said first and second contact faces being substantially equal to the diameters of the pitch circles of said second and first gear means respectively.

6. In an engine as set forth in claim **5**, a bearing sleeve coaxially interposed between said other end wall and said shaft, said collar means being integral with said bearing sleeve.

7. In an engine as set forth in claim **4**, supporting means fixedly fastened to said other end wall and defining a third annular contact face of circular cross section about said first section, said rotor means further defining a fourth annular contact face of circular cross section about said second axis abuttingly engaging said third contact face during rotation of said shaft and of said rotor means about said first and second axes respectively, said third and fourth contact faces being spaced in the direction of said axes from said first and second contact faces.

References Cited

UNITED STATES PATENTS

1,419,930	6/1922	Joynt et al.	230—145
1,686,569	10/1928	McMillan	230—145
2,993,482	7/1961	Froede	123—8
3,081,753	3/1963	Hurley et al.	123—8
3,091,386	5/1963	Paschke	230—145
3,102,519	9/1963	Froede	230—145
3,111,884	11/1963	Peras	91—56
3,260,247	7/1966	Gassmann et al.	123—8

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