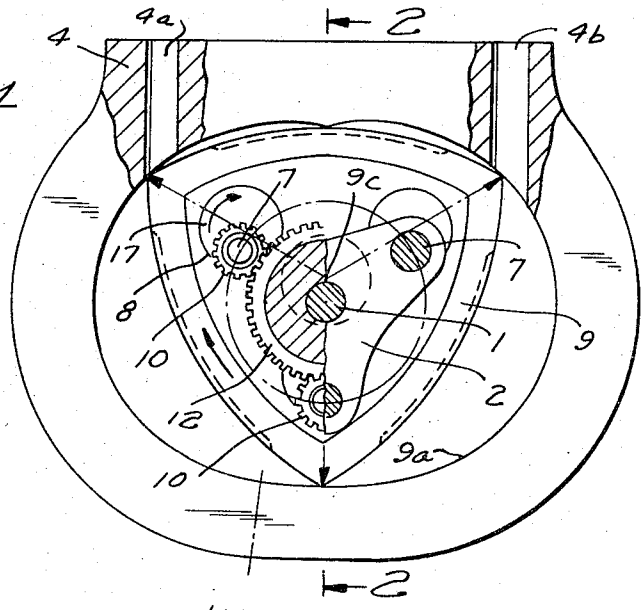
Oct. 24, 1967 J. ASSUM 3,348,529

ROTARY PISTON MACHINE

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FIG. 1



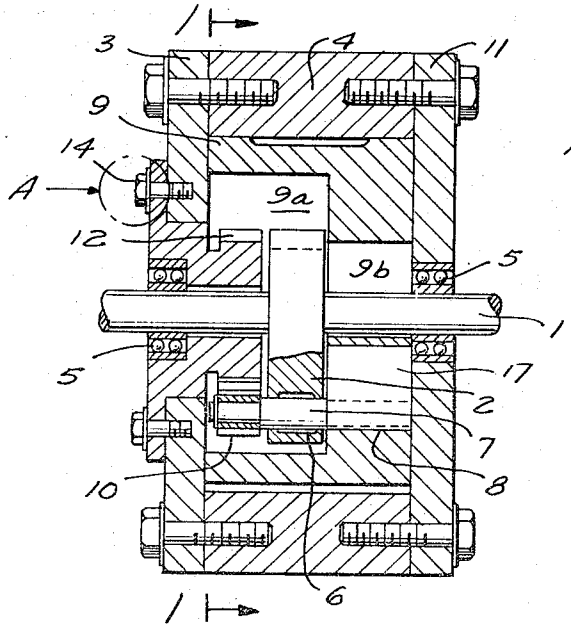


FIG. 2

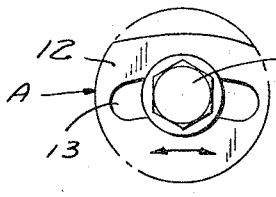


FIG. 3

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ROTARY PISTON MACHINE

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FIG. 4

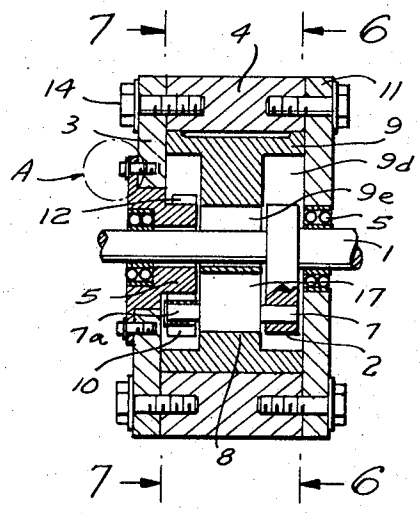
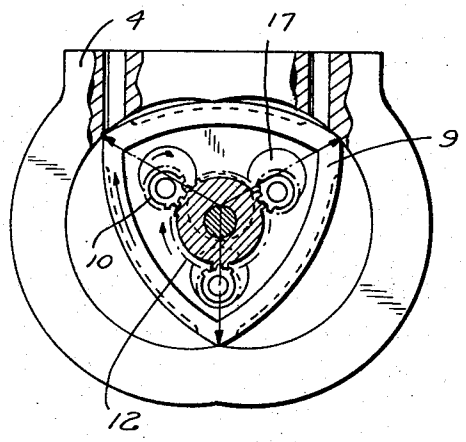


FIG. 7



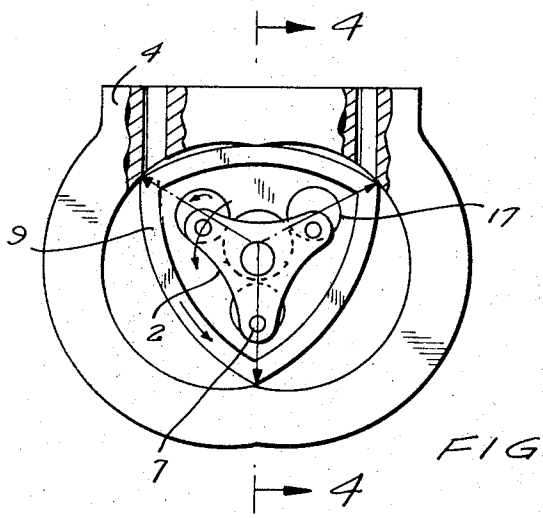


FIG. 6

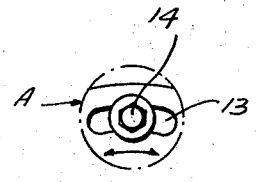


FIG. 5

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FIG. 8

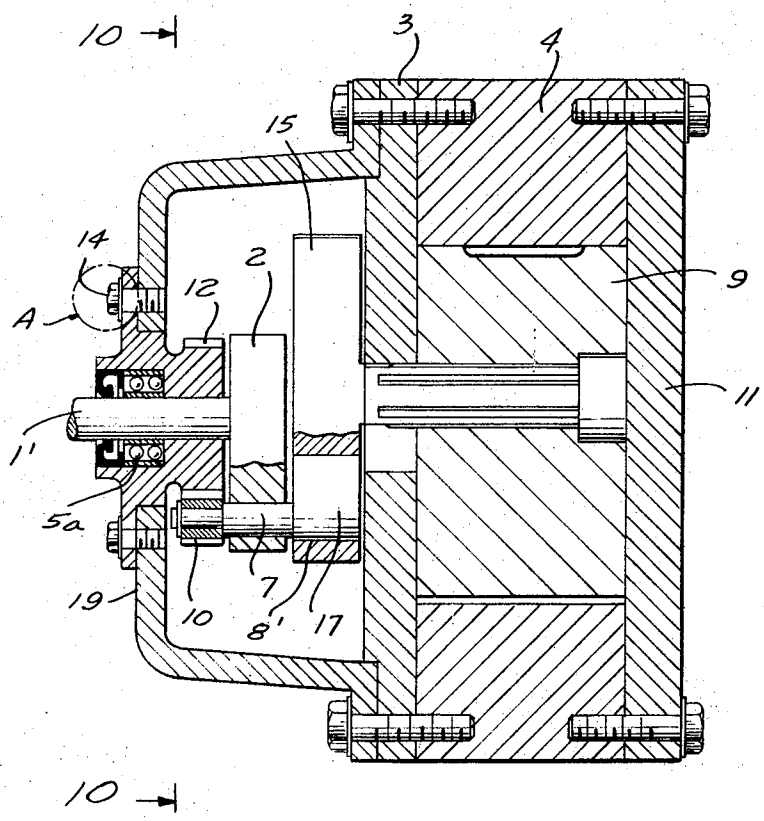
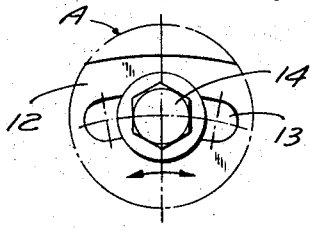


FIG. 9



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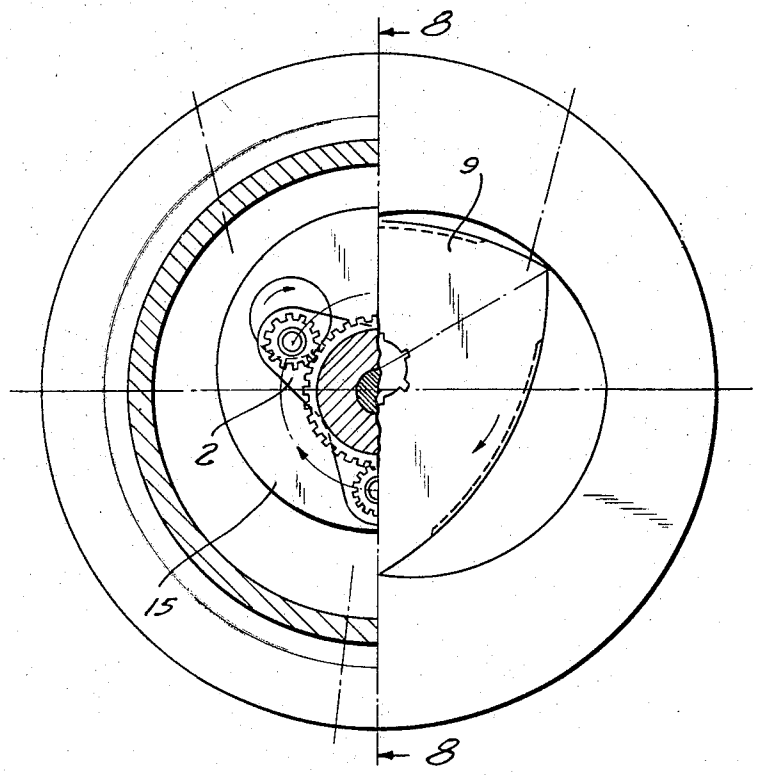
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FIG. 10



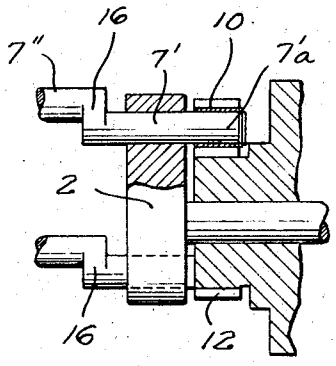


FIG. 11

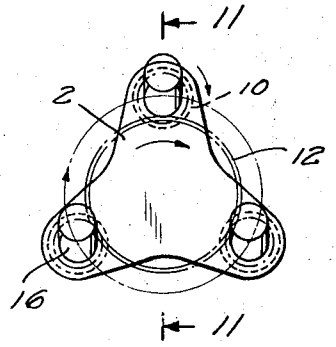


FIG. 12

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United States Patent Office 3,348,529 Patented Oct. 24, 1967

3,348,529

ROTARY PISTON MACHINE

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Filed Aug. 10, 1965, Ser. No. 478,654
14 Claims. (Cl. 123—8)

ABSTRACT OF THE DISCLOSURE

A rotary piston machine for transmitting torque between a piston performing a composite rotary motion and a shaft consisting of a casing; a rotor in this casing and rotary means which are mounted in the casing for rotation about an axis and which include a shaft and a flange of this shaft. The rotary machine also includes a plurality of crank shafts mounted on said flange and on the rotor, respectively, for turning movement so as to transmit a torque between the rotor and the rotary means.

The present invention relates to a rotary piston machine, and more particularly to apparatus for transmitting a torque between a piston performing a composite rotary motion and a shaft.

Rotary piston machines are known, for example combustion engines, in which a rotary piston having three peripheral corners is guided along an inner annular guide face of a casing. Since the guide face is a non-circular, and preferably of epitrochoid configuration, the piston performs a composite motion which has to be transferred to an output shaft rotating about its axis. In accordance with the prior art, the transmission of the torque of the rotary piston to the output shaft is effected by an inner gear of the rotary piston meshing with a spur gear secured to the output shaft. In a known machine of this type, the ratio of the teeth of the two gears is 3:2.

It is a disadvantage of this known construction that only a few teeth of the gears are in positive meshing engagement. Furthermore, it is difficult to control the relative motion between the gears. In the event that play develops, the rotary piston flutters or vibrates, which causes impacts of the guide portions of the rotary piston on the guide face of the casing, resulting in damage to the guide face, and great wear, causing increased vibrations and more play. The rotary speed of the shaft is three times the rotary speed of the rotary piston. Since rotary piston engines operate at a substantially higher rotary speed than the crank shaft of conventional engines with reciprocating pistons, the resulting high rotary speed of the output shaft is undesired. In order to reduce the high rotary speed of the shaft to a practical rotary speed, a reduction gearing is required by which the efficiency and the output torque of the machine is produced. Another disadvantage of the known construction is that the gradually developing play between the meshing gear teeth cannot be compensated by adjustment of the gears.

It is one object of the invention to overcome the disadvantages of known rotary piston machines, and to provide means for supporting the rotary piston on a plurality of movable means so that the forces produced by combustion gases and by the mass of the rotary piston, are more uniformly distributed, and a precise and uniform composite motion of the rotary piston is assured.

Another object of the invention is to provide a transmission between the rotary piston and a shaft which permits substantially the same rotary speed of the shaft and of the rotary piston.

Another object of the invention is to connect the rotary piston with a shaft by a transmission including gears

permitted an adjustment to compensate for play between the gear teeth.

Another object of the invention is to support the rotary piston on a flange of a drive shaft or driven shaft in such a manner that relative motions between the piston and the shaft caused by the composite motion of the piston are possible.

With these objects in view, the present invention is concerned with an improvement of a rotary piston machine, particularly of the type in which a multi-cornered piston performs a composite motion along a non-circular annular guide face of a casing.

One embodiment of the invention comprises a rotor including a rotary piston means performing a composite rotary motion in a casing means; rotary means preferably including a shaft and a flange mounted in the casing means for rotation about an axis; and a plurality of eccentric means angularly spaced about said axis and being respectively mounted in the flange of the rotary means and in the rotor for turning movement about parallel axes. In this manner, a torque is transmitted between the rotor and the shaft.

Each eccentric means includes a pinion which meshes with a gear mounted on the casing means coaxial with the axis of the shaft.

In one embodiment of the invention, each eccentric means includes a circular plate turnably mounted in the rotor, either directly on the rotary piston means or on a member fixedly connected with the same, a shaft portion mounted in the flange of the shaft, and a support portion to which the pinion is secured.

In another embodiment, a crank shaft has a first journal portion mounted in the rotor, and a second journal portion mounted in the flange of the shaft.

It is possible to mount the flange of the shaft and the stationary gear in recesses of the rotary piston, and to provide central openings in the rotary piston and in the stationary gear through which the shaft passes. In another embodiment of the invention, the rotor includes in addition to the rotary piston which is mounted in a separate casing, a rotary member in which angularly spaced bores receiving the circular members of the eccentric means are provided. In this embodiment, a separate casing houses the output shaft and its flange, the stationary gear, and the above-mentioned member which forms part of the rotor. In one embodiment of the invention, the stationary gear and the flange are located in the recess of the rotary piston, and the shaft passes through central openings in the piston and in the stationary gear.

In all embodiments of the invention, it is preferred to mount the stationary gear on the casing means adjustable in relation to the pinions so that play may be taken up by adjustments.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is an elevation with a cover plate removed, and partially in section along line 1—1 in FIG. 2;

FIG. 2 is an axial sectional view taken on line 2—2 in FIG. 1;

FIG. 3 is an enlarged view of a detail as viewed in the direction of the arrow A in FIG. 2;

FIG. 4 is an axial sectional view taken on line 4—4 in FIG. 6;

FIG. 5 is a fragmentary view on an enlarged scale taken in the direction of the arrow A in FIG. 4 and illustrating a detail;

FIG. 6 is an elevation with one cover plate of the casing removed, and partially in section along line C—D in FIG. 4;

FIG. 7 is an elevation with another cover plate removed, and partially in section on line A—B in FIG. 4, FIG. 5 to 7 illustrating a second embodiment of the invention;

FIG. 8 is an axial sectional view taken on line **8**—**8** in FIG. 10;

FIG. 9 is a fragmentary view on an enlarged scale taken in the direction of the arrow A in FIG. 8, and illustrating a detail;

FIG. 10 is a side elevation, partially in section along line **10**—**10** in FIG. 8, FIGS. 8 to 10 illustrating a third embodiment of the invention;

FIG. 11 is a fragmentary sectional view taken on line **11**—**11** in FIG. 12; and

FIG. 12 is a side elevation of the structure shown in FIG. 11, FIGS. 11 and 12 illustrating a modification of the embodiments of FIGS. 1, 4, and 8.

Referring now to the drawings, corresponding parts are designated by like reference numerals. In the embodiment of FIG. 1, casing means are provided which include an annular body **4** provided with inlet and outlet means *4a*, *4b* and having an inner annular guide face of epitrochoid configuration. The sides of the annular casing portion **4** are closed by cover plates **3** and **11** which are secured by screws to the central casing portion **4**. Cover plate **11** has a central bore in which a ball bearing **5** is mounted.

Cover plate **3** has a larger central bore in which a hub portion of a spur gear **12** is turnably mounted. The hub portion of gear **12** has a larger flange provided with part-circular slots **13** through which screws **14** pass into threaded bores of cover plate **3**, as best seen in FIG. 3. Gear **12** has a central opening at the end of which a bearing *5a* is provided for supporting shaft **1** which is also supported in bearing **5**. Shaft **1** has a star-shaped flange **2** located adjacent gear **12** in a recess *9a* of a rotary piston **9** which has three corners, and arcuate surfaces between the corners. Guide portions at the corners of rotary piston **9** slide along the inner epitrochoid face of the central casing portion **4** and form with the same expanding and contracting chambers comuunicating with inlet and outlet means *4a*, *4b*, and also bounded by the inner faces of cover plates **3** and **4**. The machine is preferably used as a combustion engine, suitable ignition means, not shown, being provided, but it is also possible to use the machine as a hydraulic motor or as a pump.

Piston **9** has a central opening *9b* through which a portion of shaft **1** passes without touching the walls of the opening. Three circular bores **8** are formed in piston **9**, spaced the same distance from the geometrical center *9c* of piston **9**, and from each other. The center *9c* is located eccentric to the axis of shaft **1**.

A circular member **17** is located in each bore **8**, and forms part of eccentric means which further include a shaft portion **7** whose axis is parallel to the axis of the respective circular member **17**, and a support portion *7a* to which a pinion **10** is secured. The three pinions **10** are in meshing engagement with the stationary gear **12**. The lines connecting the axes of each member **17** with the axis of the corresponding shaft portion **7**, are parallel to each other when the pinions **10** mesh with spur gear **12**. The transmission ratio between pinions **10** and gear **12** is one to three.

The eccentric means **7**, **17** support the rotary piston **9** on the flange of shaft **1** in such a manner that the corners of piston **9** move along an epitrochoid line exactly corresponding to the shape of the inner annular guide face *4a* of the casing portion **4**. The composite motion of piston **9** is transmitted by the eccentric means **7**, **17** to the star-shaped flange **2** and to shaft **1** which serves as output shaft if the machine is operated as a motor. Piston **9** is also supported by the three pinions **10** at three peripheral points of gear **12**.

Due to the fact that the rotary piston is supported by three angularly spaced elements, binding, jamming, or fluttering of piston **9** is prevented.

If play develops between the teeth of pinions **10** and gear **12**, it is eliminated by turning gear **12** a corresponding small angle after loosening screws **14**, whereupon the gear is again secured to the casing. By similar adjustment, the position of the rotary piston **9** can be found in which the sealing elements, not shown, provided at the corners of the piston, are disposed so that no pressure is exerted on the same during rotation of the piston.

The embodiment of FIGS. 4 to 7 corresponds to the embodiment of FIGS. 1 to 3 as far as the general construction of the machine is concerned. As best seen in FIG. 4, piston **9** has at the ends thereof a pair of recesses *9d* connected by a central opening *9e*. Gear **12** and flange **2** are respectively located in the two recesses *9d*, and a portion of shaft **1** passes through the central opening *9e*. The eccentric circular members **17** are located in bores **8** of the central wall of piston **9** between shaft portions **7** and supporting portions *7a* for pinions **10**. As in the embodiment of FIGS. 1 to 3, flange **2** and gear **12** are located within piston **9**, but in contrast to the embodiment of FIGS. 1 to 3, gear **12** and flange **2** are not located adjacent each other so that the piston is supported by pinions **10** and shaft portions **7** on gear **12** and flange **2** symmetrically in relation to the central wall of piston **9**.

The embodiment illustrated in FIGS. 8 to 10 provides piston **9** in the chamber formed by central casing portion **4**, and cover plates **3** and **11**, but the other parts of the machine are located in a second casing **19** which is secured to the first casing housing the rotary piston **9**. Piston **9** has a central fluted bore into which a corresponding shaft portion of a member **15** projects, so that piston **9** and member **15** together form a rotor performing a composite rotary motion as the corners of piston **9** move along the epitrochoid guide face of casing portion **4**. Since the shaft portion of member **15** revolves about a small circle, cover wall **3** has a corresponding opening *3a*. Shaft **1'** is mounted for turning movement in a bearing *5a* in gear **12** which is mounted on casing **19** by means of screws **14** passing through slots **13**, see FIG. 9, in order to permit adjustment of gear **12**. Shaft **1'** terminates in flange **2** which has three bearing bores turnably supporting shaft portions **7** of eccentric means which include circular eccentric members **17** mounted in corresponding bores **8'** of member **15**, and support portions *7a* on which pinions **10** are mounted in positions meshing with spur gear **12**. Due to the fact that cover plate **3** separates the combustion chamber formed between the inner guide face of casing portion **4** and rotary piston **9** from the torque transmitting and supporting means located in casing **19**, the same are shielded from the heat developed in the casing **3**, **4**, **11**.

The eccentric means described with reference to the embodiments of FIGS. 1 to 10, may be modified as shown in FIGS. 11 and 12. Instead of providing circular eccentric members **17** of greater diameter than shaft portions **7**, crank shafts **16** may be used, each of which includes a shaft portion **7'** mounted in the flange **2**, a support portion *7'a* to which a pinion **10** is secured, and a crank portion **7''** located in a bore of rotary piston **9** as described with reference to FIGS. 1 to 7, or in member **15** as described with reference to FIGS. 8 to 10.

In all embodiments of the invention, the shaft rotates at the same rotary speed as the rotary piston **9**, as compared with prior art constructions in which the shaft is driven at three times the rotary speed of the piston, unless a reduction gearing is provided. The meshing engagement between the stationary gear **12** and the three pinions **10** is particularly smooth, and advantageous as far as the

exact guidance of the rotary piston **9** is concerned. Due to the precise control by pinions **10** rolling on gear **12**, and by the eccentric means **7**, **17**, fluttering of piston **9**, and intermittent shocks on the corner portions of piston **9**, and the corresponding sealing means are avoided. The transmission ratio between the pinions and the stationary gear may be selected as desired, and more than three eccentric means may be used for connecting the rotor with the flange of the shaft. The rotor of the machine may consist of the rotary piston **9**, as described with reference to the first two embodiments, or may include member **15** and the rotary piston, as described with reference to the embodiment of FIG. 8.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of rotary piston machines differing from the types described above.

While the invention has been illustrated and described as embodied in a rotary piston combustion engine including a plurality of eccentric means for connecting the rotor of the machine with the output shaft, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A rotary piston machine comprising, in combination, casing means having an inner non-circular annular guide face; a rotor including a rotary piston means in said casing means having portions guided on said guide face so that said rotor makes a composite rotary motion; rotary means mounted in said casing means for rotation about an axis and including a shaft and a flange on said shaft; and a plurality of eccentric means angularly spaced about said axis, each of said eccentric means being mounted in said flange and in said rotor, respectively, for turning movement about parallel axes so as to transmit a torque between said rotor and said rotary means.

2. A rotary piston machine comprising, in combination, casing means having an inner non-circular annular guide face; a rotor including a rotary piston means in said casing means having portions guided on said guide face so that said rotor makes a composite rotary motion; rotary means mounted in said casing means for rotation about an axis and including a shaft and a star-shaped flange on said shaft; and a plurality of eccentric means angularly spaced about said axis, each of said eccentric means being mounted in said flange and in said rotor, respectively, for turning movement about parallel axes so as to transmit a torque between said rotor and said rotary means.

3. A rotary piston machine comprising, in combination, casing means having an inner non-circular annular guide face; a rotor including a rotary piston means in said casing means having portions guided on said guide face so that said rotor makes a composite rotary motion; rotary means mounted in said casing means for rotation about an axis and including a shaft and a flange on said shaft; and a plurality of eccentric means angularly spaced about said axis, each of said eccentric means including a shaft portion mounted in said flange and a circular member mounted in said rotor, respectively, for turning movement about parallel axes so as to transmit a torque between said rotor and said rotary means.

4. A rotary piston machine comprising, in combination, casing means having an inner non-circular annular guide face; a rotor including a rotary piston means in said casing means having portions guided on said guide face so that said rotor makes a composite rotary motion; rotary means mounted in said casing means for rotation about an axis and including a shaft and a flange on said shaft; and a plurality of crank shafts angularly spaced about said axis and having journal portions mounted in said flange and in said rotor, respectively, for turning movement about parallel axes so as to transmit a torque between said rotor and said rotary means.

5. A rotary piston machine comprising, in combination, casing means having an inner non-circular annular guide face; a rotor including a rotary piston means in said casing means having portions guided on said guide face so that said rotor makes a composite rotary motion; rotary means mounted in said casing means for rotation about an axis and including a shaft and a flange on said shaft; a plurality of eccentric means angularly spaced about said axis, each of said eccentric means being mounted in said flange and in said rotor, respectively, for turning movement about parallel axes so as to transmit a torque between said rotor and said rotary means; a piston secured to each of said eccentric means for turning movement therewith; and a stationary gear mounted on said casing means coaxial with said axis and meshing with said pinions whereby said rotor is supported.

6. A rotary piston machine comprising, in combination, casing means having an inner non-circular annular guide face; a rotary piston means in said casing means having portions guided on said guide face so that said rotary piston means makes a composite rotary motion, said rotary piston means having a recess and a central opening; a shaft mounted in said casing means for rotation about an axis, passing through said central opening, and having a flange located in said recess; a stationary gear located in said recess secured to said casing means and having an opening into which said shaft projects, and a bearing for supporting said shaft, said gear being located adjacent said flange; a plurality of eccentric means angularly spaced about said axis, each of said eccentric means including a circular member mounted for turning movement in said rotary piston means, a shaft portion mounted in said flange for turning movement about an axis eccentric to the center of said circular member, and a support portion; and a plurality of pinions respectively secured to said support portions and meshing with said gear whereby said rotary piston means is supported and a torque is transmitted between said rotary piston means and said shaft.

7. A rotary piston machine comprising, in combination, casing means having an inner non-circular annular guide face; a rotary piston means in said casing means having portions guided on said guide face so that said rotary piston means makes a composite rotary motion, said rotary piston means having recesses at the ends thereof and a central opening connecting said recesses; a shaft mounted in said casing means for rotation about an axis, passing through said recesses and said central opening, said shaft having a flange located in one of said recesses; a stationary gear secured to said casing means and located in the other recess, said gear having an opening into which said shaft projects, and a bearing for supporting said shaft; a plurality of eccentric means angularly spaced about said axis, each of said eccentric means including a circular member mounted for turning movement in said rotary piston means between said recesses, a shaft portion mounted in said flange for turning movement about an axis eccentric to the center of said circular member, and a support portion located in said other recess; and a plurality of pinions respectively secured to said support portions and meshing with said gear whereby said rotary piston means is supported and a torque is transmitted between said rotary piston means and said shaft.

8. A rotary piston machine comprising, in combination, casing means including a first casing having an inner non-circular annular guide face, and a second casing secured to said first casing; a rotary piston means in said first casing having portions guided on said guide face so that said rotary piston means makes a composite rotary motion; a rotary member located in said second casing; means connecting said rotary member with said piston means so that said rotary member participates in said composite motion; a stationary gear secured to said second casing and having a central opening and a bearing surrounding said central opening; a shaft partly located in said center opening and supported on said bearing, said shaft having a flange located between said gear and said member in said second casing; a plurality of eccentric means angularly spaced about said shaft, each of said eccentric means including a circular member mounted for turning movement in said member, a shaft portion mounted in said flange for turning movement about an axis eccentric to the center of said circular member, and a support portion; and a plurality of pinions respectively secured to said support portions and meshing with said gear whereby said rotary piston means is supported and a torque is transmitted between said rotary piston means and said shaft.

9. A rotary piston machine comprising, in combination, casing means having an inner non-circular annular guide face; a rotary piston means in said casing means having portions guided on said guide face so that said rotary piston means makes a composite rotary motion, said rotary piston means having a recess and a central opening; a shaft mounted in said casing means for rotation about an axis, passing through said central opening, and having a flange located in said recess; a stationary gear located in said recess and having an opening into which said shaft projects, and a bearing for supporting said shaft, said gear being located adjacent said flange; adjustable means for mounting said stationary gear on said casing means; a plurality of eccentric means angularly spaced about said axis, each of said eccentric means including a circular member mounted for turning movement in said rotary piston means, a shaft portion mounted in said flange for turning movement about an axis eccentric to the center of said circular member, and a support portion; and a plurality of pinions respectively secured to said support portions and meshing with said gear whereby said rotary piston means is supported and a torque is transmitted between said rotary piston means and said shaft.

10. A rotary piston machine comprising, in combination, casing means having an inner non-circular annular guide face; a rotary piston means in said casing means having portions guided on said guide face so that said rotary piston means makes a composite rotary motion, said rotary piston means having recesses at the ends thereof and a central opening connecting said recesses; a shaft mounted in said casing means for rotation about an axis, passing through said recesses and said central opening, said shaft having a flange located in one of said recesses; a stationary gear located in the other recess, said gear having an opening into which said shaft projects, and a bearing for supporting said shaft; adjustment means for mounting said stationary gear on said casing means; a plurality of eccentric means angularly spaced about said axis, each of said eccentric means including a circular member mounted for turning movement in said rotary piston means between said recesses, a shaft portion mounted in said flange for turning movement about an axis eccentric to the center of said circular member, and a support portion located in said other recess; and a plurality of pinions respectively secured to said support portions and meshing with said gear whereby said rotary piston means is supported and a torque is transmitted between said rotary piston means and said shaft.

11. A rotary piston machine comprising, in combination, casing means including a first casing having an inner non-circular annular guide face, and a second casing secured to said first casing; a rotary piston means in said first casing having portions guided on said guide face so that said rotary piston means makes a composite rotary motion; a rotary member located in said second casing; means connecting said rotary member with said piston means so that said rotary member participates in said composite motion; a stationary gear having a central opening and a bearing surrounding said central opening; adjustable means for mounting said stationary gear on said casing means; a shaft partly located in said center opening and supported on said bearing, said shaft having a flange located between said gear and said member in said second casing; a plurality of eccentric means angularly spaced about said shaft, each of said eccentric means including a circular member mounted for turning movement in said member, a shaft portion mounted in said flange for turning movement about an axis eccentric to the center of said circular member, and a support portion; and a plurality of pinions respectively secured to said support portions and meshing with said gear whereby said rotary piston means is supported and a torque is transmitted between said rotary piston means and said shaft.

12. A rotary piston machine comprising, in combination, casing means having an inner non-circular annular guide face; a rotor including a rotary piston means in said casing means having portions guided on said guide face so that said rotor makes a composite rotary motion; rotary means mounted in said casing means for rotation about an axis and including a shaft and a flange on said shaft; a plurality of eccentric means angularly spaced about said axis, each of said eccentric means being mounted in said flange and in said motor, respectively, for turning movement about parallel axes so as to transmit a torque between said rotor and said rotary means; a pinion secured to each of said eccentric means for turning movement therewith; a stationary gear coaxial with said axis and meshing with said pinion; and adjustable mounting means for mounting said stationary gear on said casing means whereby said motor is supported.

13. A rotary piston machine comprising, in combination, casing means having an inner non-circular annular guide face; a rotor including a rotary piston means in said casing means having portions guided on said guide face so that said rotor makes a composite rotary motion; rotary means mounted in said casing means for rotation about an axis and including a shaft and a flange on said shaft; a plurality of eccentric means angularly spaced about said axis, each of said eccentric means being mounted in said flange and in said rotor, respectively, for turning movement about parallel axes so as to transmit a torque between said rotor and said rotary means; a pinion secured to each of said eccentric means for turning movement therewith; a stationary gear coaxial with said axis and meshing with said pinion; and adjustable mounting means for mounting said stationary gear on said casing means whereby said rotor is supported, said adjustable mounting means including threaded means for securing said gear to said casing means in adjusted positions.

14. A machine as set forth in claim 13 wherein said gear has a flange with a curved slot, and said threaded means include a screw passing through said slot and threaded into said casing means.

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