Dec. 1, 1964 HANNS-DIETER PASCHKE 3,159,336

NON-JAMMING APEX SEAL

Filed April 26, 1962

PRIOR ART

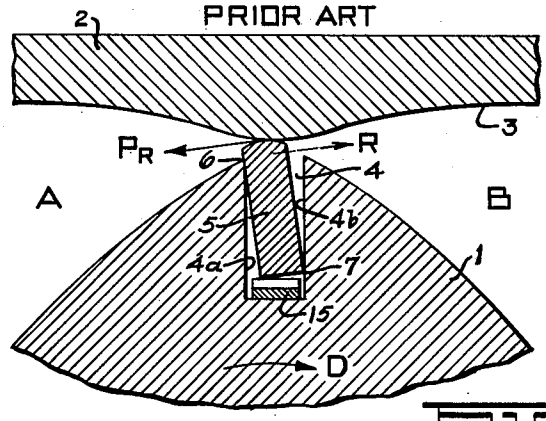


FIG. 1

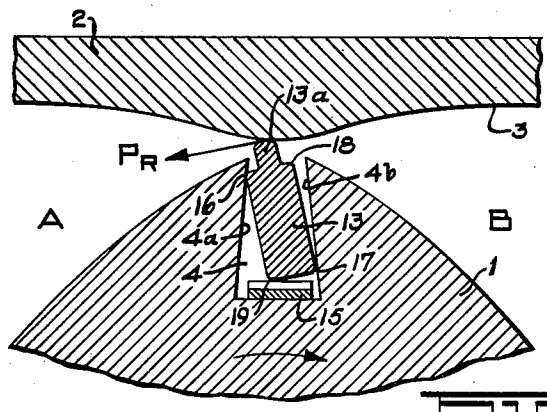


FIG. 3

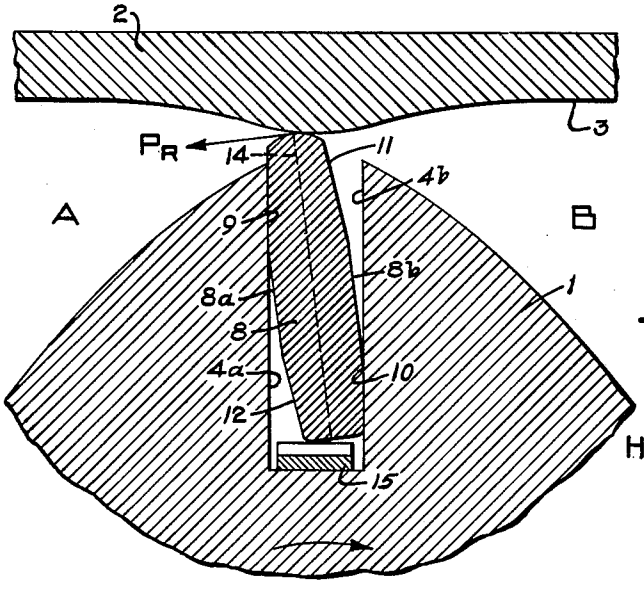


FIG. 2

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NON-JAMMING APEX SEAL

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7 Claims. (Cl. 230—145)

This invention relates to rotary mechanisms such as fluid pumps, compressors, motors and the like. For example, the invention may be embodied in a rotary combustion engine of the type disclosed in United States Patent No. 2,988,065 issued to Felix Wankel et al. on June 13, 1961. In particular, the invention is directed to a seal construction for such mechanisms.

As disclosed in said above-mentioned patent, such mechanisms normally comprise an outer body having axially-spaced end walls interconnected by a peripheral wall forming a cavity. As viewed in a plane transverse to the axis of said end walls, the inner surface of the peripheral wall defines a multi-lobed shape which is basically an epitrochoid. An inner rotor having axially-spaced end faces is mounted within said cavity on an axis which is spaced from but parallel to the axis of said outer body end walls and has a plurality of circumferentially-spaced apex portions. As the inner rotor rotates, the apex portions continuously engage the inner surface of said peripheral wall to form a plurality of working chambers which vary in volume due to the relative rotation of the inner rotor and outer body. There is also provided an intake port for admitting a fuel-air mixture to the chambers, an exhaust port for allowing exhaust gases to be expelled from said chambers and an ignition means such that during engine operation each working chamber defined by the inner rotor and outer body passes through the stages of intake, compression, expansion and exhaust. This is due to the fact, as stated in the above-mentioned patent, that the inner rotor and outer body may rotate relative to one another or preferably the cycle may be performed by rotating the inner rotor while the outer body remains stationary.

In order to maintain efficient operation of the engine, seal means are provided within a groove at each apex portion of the inner rotor so that an effective seal is provided between the inner surface of the peripheral wall of the outer body and each apex portion of the inner rotor. Due to factors such as manufacturing tolerances and thermal distortions of the epitrochoidal shape of the inner surface of the peripheral wall the apex seals generally move slightly in a radial direction during engine operation in order that constant contact is made between the inner peripheral surface and each apex portion of the inner rotor. Also, due to the varying pressures arising in adjacent working chambers, the apex seal members are at times caused to tilt with respect to the side walls of their grooves.

One of the problems which sometimes arises is that, when the seal is in a tilted position, further inward movement of the seal causes a pivoting action or tilting movement counter to the force producing the original tilting thereby resulting in a jamming or gouging of the edges of the seal members into the sides of the groove and into the inner surface of the peripheral wall. This jamming may result in injury of the seal member and the inner surface of the peripheral wall. Also, if this jamming friction is suddenly overcome, the apex seal member may move inwardly out of contact with the peripheral wall. In the next instant, however, the seal member may be suddenly flung outward and cause damage to the inner surface of the peripheral wall by leaving chatter marks or small grooves in said wall surface.

The invention overcomes this problem in that the strip is slidingly guided against the groove walls while in its tilted state so that the seal member can move radially inwardly into the groove without any accompanying tilting movement of the seal member back toward a position in which it is parallel to the side walls of the groove. This ensures that the spacing of the points of contact of the seal strip in its groove does not vary, so that with groove walls that are parallel to one another perfect parallel guidance is obtained. Because of this, the seal strip in moving radially does not need to make a pivoting movement.

In another embodiment of the invention, the seal groove is designed so that its walls diverge from one another in a radially-inward direction, which produces during radial movement of the seal strip a pivoting movement, but in a direction corresponding to that of the force producing the tilting, so that the seal strip can shift and make its radial movement without hindrance.

The bearing portions of the seal strip against the groove walls can be flat or linear. For reasons of maintaining lower specific pressure per unit of area, the flat bearing portion is preferred.

Accordingly, it is one object of the invention to provide a novel and effective sealing arrangement for the working chambers of an engine of the type described.

It is further an object of this invention to provide a sealing arrangement wherein the seal strip is slidingly guided in the seal strip mounting groove.

Another object of this invention resides in the provision of a seal strip mounting groove which is constructed so as to slidingly guide the seal member during movement of said member with respect to said groove.

Other objects of the invention will become apparent upon reading the following detailed description in connection with the drawing in which:

FIGURE 1 is a cross-sectional view taken through a rotor apex and peripheral wall of the outer body, of the prior art,

FIGURE 2 is a view similar to that of FIGURE 1 showing one embodiment of the invention, and

FIGURE 3 is a view similar to FIGURE 1 showing another embodiment of the invention.

With reference to FIGURE 1 of the drawing, there is shown a portion of the outer body peripheral wall 2 having an inner surface 3 which, as stated above, is basically an epitrochoid. Disposed within a housing formed in part by the wall 2 is a rotor 1, having a plurality of apex portions, only one of which is shown, which rotates on an axis eccentric to the housing axis in a direction shown by arrow D. The rotor 1 is provided at each of its apex portions with a groove 4 in which there is disposed a radically-movable seal strip 5. A spring 15 is positioned beneath the seal strip 5 and urges the seal strip outwardly from the groove so that the seal strip will continuously engage the inner surface 3 in order to seal off the adjacent working chambers A and B from one another. Assuming that a higher gas pressure prevails in chamber B than in chamber A, the gas pressure will enter the groove 4 from chamber B and in combination with the frictional force P_R acting between the crest of the strip 5 and the inner surface 3 will cause the strip 5 to tilt into the position illustrated. In this tilted position the seal strip rests at one portion against the groove corner 6 and at its lower corner portion 7 against groove wall 4b. If, when in this tilted position, the seal strip is forced to move raially inward, for example, because of irregularities or heat-distortion of the inner surface, the spacing of the contact portions 6 and 7 increases causing the seal strip to make a slight

pivoting movement in the direction R against the direction of frictional force P_R and the pressure in the chamber B. This pivoting movement can result in the digging of the seal strip into the inner surface **3** and thereby deforming said surface.

In accordance with the invention, these drawbacks are avoided in that when the seal strip is in its tilted position it is slidingly guided against both groove walls. In the embodiment of the present invention illustrated in FIGURE 2 the seal strip **8** is provided with a narrow and generally polygon-like cross-section with its diagonally opposed sides parallel such that it has pairs of diagonal faces **9, 10**, and **11, 12**, respectively, which are opposite and parallel. There are also provided opposed faces **8***a* and **8***b* which are parallel to each other and the groove walls **4***a* and **4***b*. The portion of the seal strip which engages the inner surface of the peripheral wall may be rounded as illustrated but not necessarily so. During normal operation the seal member **8** assumes its normal position wherein at least one of the faces **8***a*, **8***b* engages one of the groove walls **4***a*, **4***b* in a substantially parallel surface contact. As shown, the seal strip in its tilted position bears against the groove wall **4***a* with its face **9** and against groove wall **4***b* with its face **10**. If the seal strip should be forced to move inward with respect to the groove while in the illustrated position, it can be seen that no pivoting movement will take place because the groove walls **4***a* and **4***b* give perfect parallel guidance to the seal strip **8**. When the gas pressure is higher in chamber A than in chamber B, the seal strip is tilted to another position in which face **11** bears against groove wall **4***b* and face **12** bears against groove wall **4***a*. Again, as in the opposite position, no pivoting action will occur during inward motion of the seal strip.

In FIGURE 3 there is shown an embodiment of the invention wherein the groove **4** is widened in a radially-inward direction, that is, the side walls of groove **4** diverge gradually from its outer-most to its inner-most portion. Also in FIGURE 3 each face of the portion **13***a* of the seal strip **13** projecting beyond the groove **4** is substantially cut back to reduce the width of the projecting portion **13***a* so that this portion does not interfere with inward motion of the seal. Whereas in the embodiment of FIGURE 2 the seal strip **8** made surface contact with the groove walls, the seal strip **13** of FIGURE 3 make lineal contact with the groove walls along its rounded corners **16, 17, 18**, and **19** depending upon the direction of tilt. In this form of the invention, when the strip **13** is forced inward, the strip makes a pivoting movement but this time in the same direction as the frictional force P_R which is contrary to the pivotal movement of the strip **5** illustrated in FIGURE 1. Thus the seal strip will be able to yield and move inwardly without any danger of jamming. Obviously, the seal strip **8** of FIGURE 2 may be used with the form of groove used in FIGURE 3 and likewise the seal strip **13** of FIGURE 3 may be used with grooves having parallel walls.

While the invention has been set forth in detail, it will be obvious to one skilled in the art that the invention is not limited to seal strips of one-part construction but may also be applied to seal strips of multi-part construction, for example, one divided lengthwise, as shown in dot-dash line **14** of FIGURE 2. Also, the invention is not limited to application in internal combustion engines, but may be utilized in other rotary mechanisms such as fluid pumps, fluid motors, etc. where sealing is required. It will be further obvious to one skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the invention described herein.

What I claim as my invention is:

1. A sealing arrangement for the working chambers of a rotary mechanism having an outer body with axially-spaced end walls interconnected with a peripheral wall forming a cavity with said cavity having a multi-lobed profile; an inner rotor having axially-spaced end faces mounted within said cavity, said rotor having a plurality of circumferentially spaced portions for engagement with the inner surface of said peripheral wall whereupon, during relative rotation of said outer body and inner rotor, working chambers of variable volume are formed; said sealing arrangement comprising a seal member mounted in a groove in at least one of said circumferentially spaced portions for radial movement with respect to said groove and having a single apex portion for sealing engagement with the inner surface of said outer body peripheral wall and the width of said groove inwardly of its outer edge being at least as great as that at the groove outer edge, said seal member having diagonally opposed portions at its radially inward and outward regions for engagement with the side walls of said groove when said seal member is in a maximum tilted position relative to said groove side walls and the configuration of said seal member and said groove being related to one another for permitting sliding engagement of said seal member with said groove side walls and for preventing the corners of said seal member from digging into said groove side walls and the corners of said groove from digging into the seal member side walls when said seal member is in a maximum tilted position such that said seal member can slide radially inwardly into the groove without accompanying substantial tilting movement of said seal member toward a positon parallel to said groove side walls.

2. A sealing arrangement as recited in claim 1 wherein said groove has opposite and parallel side faces and said seal member has a narrow and generally polygon-like cross section with diagonally opposed parallel faces for engagement with the groove side walls.

3. A sealing arrangement as recited in claim 1 wherein the side faces of said groove diverge in a radially inward direction and said seal member has parallel side faces.

4. A sealing arrangement for the working chambers of a rotary combustion engine having an outer body with axially-spaced end walls interconnected with a peripheral wall forming a cavity which is basically an epitrochoid, an inner rotor having axially-spaced end faces mounted within said outer body on an axis spaced from but parallel to the axis of the outer body end walls, said rotor having a plurality of circumferentially spaced apex portions for engagement with the inner surface of said peripheral wall to form working chambers of variable volume upon relative rotation of said outer body and inner rotor; said sealing arrangement comprising a seal member mounted in a groove in each of said apex portions for radial movement with respect to said groove and having a single apex portion intermediate of its side walls projecting beyond said groove for sealing engagement with the inner surface of said outer body peripheral wall and the width of said groove inwardly of its outer edge being at least as great as that at the groove outer edge, said seal member having opposed portions at the diagonals of the seal member body at its radially inward and outward regions for engagement with the side walls of said groove when said seal member is in a maximum tilted position relative to said groove side walls and the configuration and spacing of said opposed portions of said seal member and the configuration and width of said groove being related relative to one another for permitting sliding engagement of said seal member with said groove side walls when said seal member is in a maximum tilted position such that the portion of said seal member projecting beyond said groove does not prevent said seal member from moving further radially inwardly within said groove.

5. A sealing arrangement as recited in claim 4 wherein said seal member is formed with diagonal faces which are opposite and parallel.

6. A sealing arrangement as recited in claim 4 wherein said seal member is of narrow polygon-like cross section having one set of opposed parallel faces for engagement with said groove walls when said seal member is in a normal position and a second set of diagonal faces which are opposed and parallel for engagement with said groove walls when said seal member is in said maximum tilted position.

7. A sealing arrangement as recited in claim 4 wherein said seal member has parallel side walls and the portion of said seal member projecting beyond said groove is cut back from said seal member side walls.

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