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SEALING STRUCTURE

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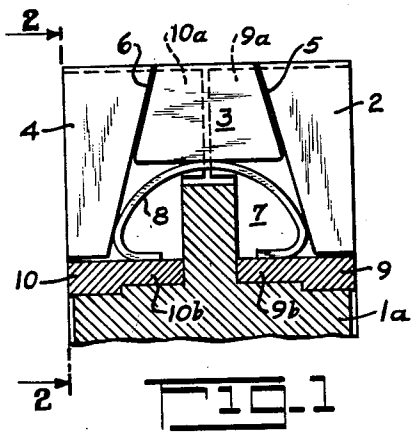


FIG. 1

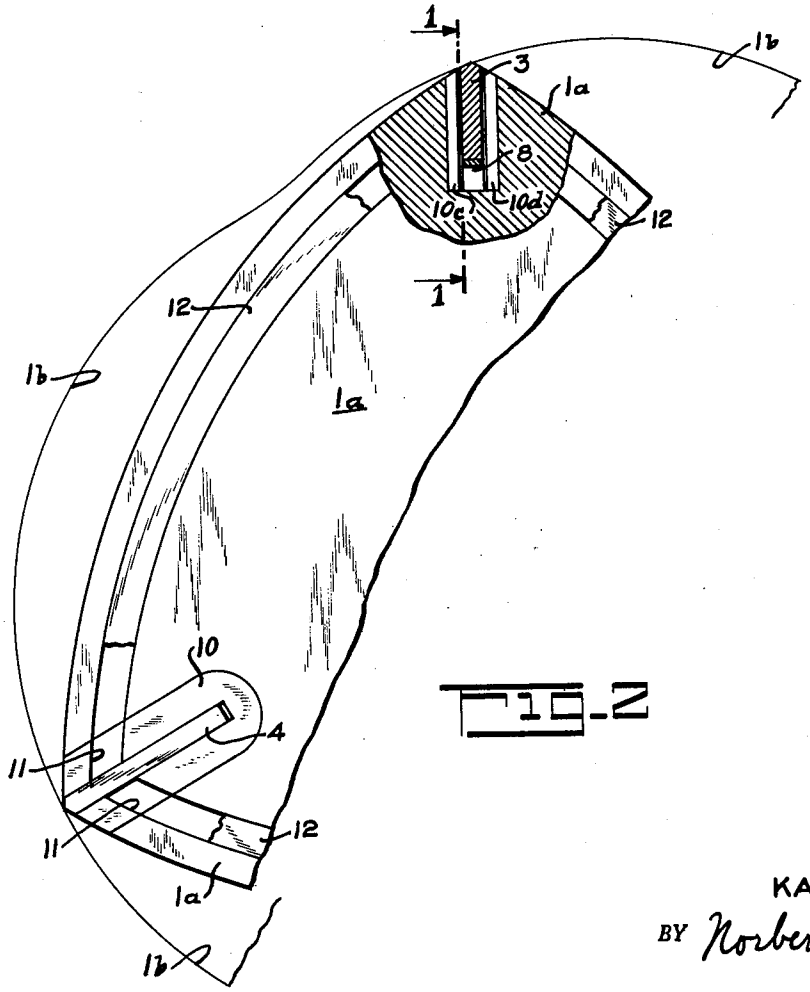


FIG. 2

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SEALING STRUCTURE

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This invention relates to sealing structures of the kind used in conjunction with rotary mechanisms, such as combustion engines, compressors, pumps, or expansion engines.

The invention is particularly useful in connection with rotary combustion engines similar to that disclosed in U.S. Patent No. 2,988,065.

Such a rotary combustion engine comprises an outer body having a cavity therein and an inner body relatively rotatable within said cavity, about an axis laterally spaced from but parallel to the axis of said cavity. The outer body has axially-spaced end walls and a peripheral wall interconnecting the end walls to form said cavity, the inner surface of the cavity peripheral wall having a multi-lobe profile which preferably is basically an epitrochoid. The inner body has end faces disposed adjacent to said outer body end walls for sealing cooperation therewith and has a peripheral surface with a plurality of circumferentially-spaced apex portions, each carrying a radially-movable seal for sealing engagement with the multi-lobe inner surface of the outer body peripheral wall to form a plurality of working chambers between the two bodies which vary in volume upon relative rotation of the two bodies. Each such apex seal of the inner body runs axially from one end face to the other of the inner body. The number of apices will usually exceed the number of lobes of the epitrochoid by one.

In the subsequent discussion it will be assumed that the inner body is rotary whereas the outer body is stationary. Accordingly, the inner body will be identified as the rotor and the outer body as housing. It will be appreciated, however, that the considerations applicable to the prior art as well as to the described invention apply equally in the situations where the relations of inner and outer body are inverted, or where both inner and outer body may be rotating as described in the mentioned Patent 2,988,065.

Each apex seal is seated in a slot or groove that is provided at the corresponding apex of the inner body, with play in both the radial and also the peripheral or lateral directions. One or the other of the side surfaces of the seal engages its confronting slot side wall with surface contact, depending upon the relative pressures prevailing in the adjacent chambers.

Let the working chambers, sealed off from one another by a given apex seal, be designated by A and B. Let the given pressures prevailing in chambers A and B also be designated as A and B respectively. The seal has "exposed" parts, namely the part which projects radially outwardly of the rotor body and the two end parts which project axially outwardly of the rotor body. These exposed parts are subject to the pressures A and B at respective side walls of the seal. If pressure A exceeds pressure B, the seal assumes one position in which the seal side wall adjacent chamber B engages its confronting slot side wall with surface contact. If pressure B exceeds pressure A, the seal assumes an alternate position wherein the seal side wall adjacent chamber A engages its confronting slot side wall with surface contact. In the operation of the engine the relation of pressures A and B changes, pressure A exceeding pressure B for some portions of the engine cycle and pressure B exceeding pressure A for other portions of the engine cycle. Accordingly the seal repeatedly shifts from one position to the other to follow the relative magnitudes of pressures A and B.

One problem with such apex seal structure is to assure sealing at operating engine temperatures. It has been found with prior art apex sealing structures that due to differential expansion of housing, rotor and seal, sealing engagement is not maintained by the seal at all the sealing surfaces, namely the housing peripheral wall and also the two housing end walls. Another problem is maintaining the seal in one or the other above-described desired positions in which seal side wall engages slot side wall with surface contact. It has been observed that apex seals tend to tilt within the slot in the course of engine operation, so that the seal-to-slot contact is reduced from surface contact to line contact, thereby further reducing sealing efficiency.

The present invention is directed to the solution of these problems and contemplates a novel seal structure meeting this objective. In accordance with the invention, the seal has a laterally (peripherally) extending through-opening at its underside, a pair of jaw-like, end leg parts which are of symmetrical construction and location, and a middle part wedged between the end leg parts, the interior surfaces of these parts defining the through-opening. The end leg parts are split from the middle part along a pair of splitting planes which are symmetrical with respect to the transverse (latterally extending) median plane of the seal and which converge to common intersection with such median plane and with each other, radially outwardly and axially inwardly. The very same splitting planes also define the mentioned interior surfaces of the end legs. This construction assures freedom of the parts to move relative to one another both axially and radially to assure engagement by the seal of the housing peripheral wall as well as its end walls under conditions of thermal expansion of seal, rotor, and housing at operating temperature of the engine. Moreover, since the splits between seal parts extend to the contact line between seal and housing peripheral wall, the seal parts are also free to move in the lateral (peripheral) direction relative to each other, even at such contact line. Hence merely one seal part need be subject to tilting effects, which are due to localized frictional binding at the contact line and therefore temporary, the other seal parts assuming or retaining their correct dispositions for surface contact with slot side walls.

Within the mentioned through-opening of the seal there is preferably disposed a resilient member which engages the mentioned interior surface of each of the three seal parts so as to urge these seal parts to positive sealing engagement with the respective interior housing walls. More particularly, the middle part of the seal experiences urging in the radial direction, whereas the end parts have urging force components in both the axial and radial directions. In a preferred embodiment of the invention the resilient member is arcuate in shape, the arc being tangent to the inter engaged, seal-part surfaces.

For a better understanding of the invention, reference is made to the following more detailed specification of which the appended claims form a part, when considered together with the accompanying drawing, in which:

FIG. 1 is a fragmentary, axial sectional view, taken along line 1—1 of FIG. 2, of an apex portion of an engine rotor carrying apex seal structure in accordance with a preferred embodiment of the invention; and

FIG. 2 is an end view of the engine rotor of FIG. 1, being partly in section, taken along line 2—2 of FIG. 1.

Referring to FIGS. 1 and 2, there is shown the apex portion of a rotor 1*a*, whose plural apices (FIG. 2) en-

gage the interior peripheral housing wall 1*b* of the engine in sealing relation by means of plural apex seals 1*c*, carried by rotor 1*a* at the apices. The profile of housing 1*b* is preferably basically a multi-lobed epitrochoid, and the number of apices of rotor 1*a* will exceed the number of lobes by one. The rotor 1*a* rotates eccentrically within housing 1*b* in the manner described in the introductory part of the specification. The apex seals project axially from the rotor end walls and engage the epitrochoidally-shaped interior end walls (not shown) of housing 1*b* in sealing relation.

As may best be seen in FIG. 1, the apex seal is composed of a pair of jaw-like, end leg parts 2, 4, and a middle part 3 which is wedged between the end leg parts 2, 4. The parts 2, 4 are symmetrically located and constructed with respect to the transverse (laterally extending) median plane defined by section line 2—2. The interior surfaces of parts 2, 3, 4 define a laterally (peripherally) extending through-opening at the seal underside. End leg parts 2, 4 are split from middle part 3 along a pair of splitting planes 5, 6 which are symmetrical with respect to transverse median plane 2—2 and which converge to common intersection with such median plane and with each other, radially outwardly and axially inwardly. Moreover, splitting planes 5, 6 also define the mentioned interior surfaces of end legs 2, 4.

Seated within opening 7 is a leaf spring member 8 of arcuate or bowed shape, which engages the interior surfaces of seal parts 2, 3, 4 tangentially so as to urge part 3 radially outwardly, and parts 2, 4 in both the radial and axial directions to sealing engagement with the housing peripheral and end walls. Opening 7 is in pressure communication with one or the other adjacent working chambers, whichever has the greater pressure. Communication with the working chamber at lower pressure is sealed off by the seal in response to the higher of the two pressures. The pressure admitted to opening 7 impinges on the interior surfaces of parts 2, 3, 4 and serves to urge them to sealing engagement with the peripheral and end walls of housing 1*b* in the same manner as spring 8.

The seal parts 2, 3, 4, as well as the spring 8, are disposed inside two spaced and substantially U-shaped guide parts or retainers 9 and 10 (see also FIG. 2) with the ends of the spring 8 bearing against the members 9, 10 at approximately the valleys of the U as shown in FIG. 1. The members 9, 10 are shaped to form a plurality of steps 9*a*, 9*b*, and 10*a*, 10*b* (FIG. 1), and 10*c*, 10*d* (FIG. 2) to assure stability of seating within the rotor; corresponding steps 9*c*, 9*d* are not visible in FIG. 2. The members 9, 10 are symmetrical in construction and location. As shown in FIG. 2, the guide parts 9, 10 are provided with grooves 11 to receive the usual side or end seals 12 of the rotor, which with the apex seals, serve to seal off adjacent working chambers from one another. The guide parts 9, 10 are axially movable and in sealing engagement with the adjacent end walls of the outer body.

While the invention has been described by one specific embodiment, it should be understood that this invention is not limited to specific details of construction and arrangement thereof herein illustrated, and that changes and modifications may occur to one skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. In a rotary mechanism of the kind comprising an outer body having a cavity therein and an inner body relatively rotatable within said cavity about an axis laterally spaced from but parallel to the axis of said cavity, said outer body having axially-spaced end walls and a peripheral wall interconnecting the end walls to form said cavity, the inner surface of the cavity peripheral wall having multi-lobe profile which is basically an epitrochoid, said inner body having end faces disposed adjacent to said outer body end walls for sealing cooperation therewith and having a peripheral surface with a plurality of circumferentially-spaced apex portions, said inner body being provided at each apex with a through-slot that extends axially from one of its end faces to the other, each such slot being defined by a pair of side walls, an apex seal member seated in each said slot with play in both the radial and circumferential directions and engaging the multi-lobe inner surface of the outer body peripheral wall and also its axially-spaced end walls in sealing relation to form a plurality of working chambers between the two bodies which vary in volume upon relative rotation of the two bodies, normally different respective gas pressures prevailing in said working chambers during operation of said rotary mechanism, each said sealing member having: a pair of axially extending side walls which confront the side walls of the respective slot, a laterally extending through-opening at the seal underside, a pair of jaw-like, end leg parts, and a middle part wedged between the end leg parts, the interior surfaces of these parts defining the through-opening, said end leg parts being split from the middle part along a pair of splitting planes which converge to intersection with reference to the inner body center radially outwardly and axially inwardly, said splitting planes also defining the mentioned interior surfaces of the end legs, whereby said parts are freely movable relative to each other in the lateral direction, even at the contact line between seal and the interior peripheral wall of said outer body, and are also free to move relative to one another in the axial and radial directions.

2. The invention according to claim 1, further provided with a resilient member seated within each through-opening, each such resilient member being of arcuate shape and engaging the aforesaid interior surfaces of the parts of a given seal tangentially so as to urge the seal to engage with the interior peripheral wall and also the end walls of the outer body for sealing engagement therewith.

3. The invention according to claim 2, further provided with a means for retaining each seal member and its resilient member, being seated in the inner body, at least in part radially inwardly of the respective resilient member with reference to the inner body center and bearing against the free ends of such resilient member.

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