United States Patent [19]

Huf

[11] **3,797,974**

[45] **Mar. 19, 1974**

[54] **PACKING STRIP ARRANGEMENT FOR ROTARY PISTON ENGINES**

[75] Inventor: **Franz Huf,** Konstanz, Germany

[73] Assignee: **Dornier System GmbH,** Friedrichshafen, Germany

[22] Filed: **June 20, 1972**

[21] Appl. No.: **264,486**

[30] **Foreign Application Priority Data**

June 30, 1971 Germany 2132521

[52] **U.S. Cl.** **418/129,** 418/144

[51] **Int. Cl.** ... **F01c 19/02,** F04c 15/00, F04c 27/00

[58] **Field of Search** 418/125, 129, 144

[56] **References Cited**

UNITED STATES PATENTS

3,514,236	5/1970	Rashev	418/144
3,193,186	7/1965	Peras	418/129
732,280	6/1903	Draper et al	418/144
638,173	11/1899	Casaday	418/129
3,369,739	2/1968	Abermeth	418/129

Primary Examiner—Carlton R. Croyle
Assistant Examiner—John J. Vrablik
Attorney, Agent, or Firm—James E. Bryan, Esq.

[57] **ABSTRACT**

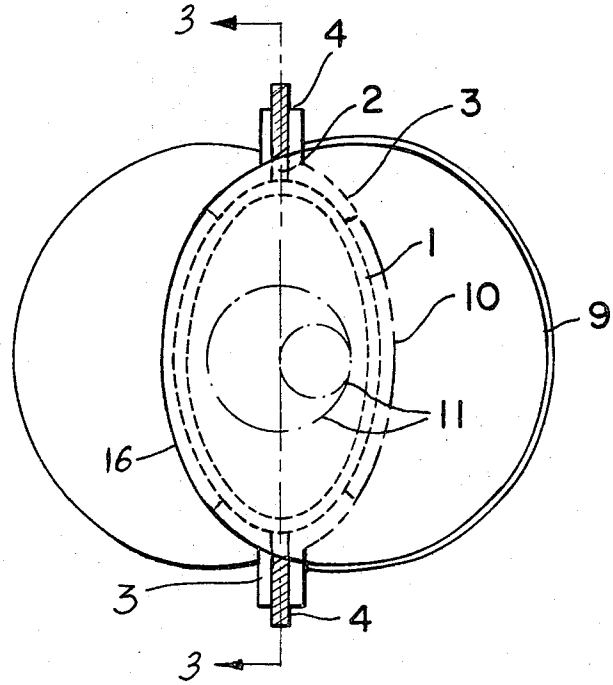
This invention relates to a packing strip arrangement for sealing the working chambers of rotary piston engines of trochoidal construction having a trochoidal piston rotor, a housing boundary shaped according to the coordinated outer envelope curve, and contracted portions with radial packing strips at said contracted portions, which comprises

sealing ring means in each of the lateral housing walls within the inner envelope curve described by the edge of the piston rotor, said sealing ring means being closed within themselves,

sealing element means starting from said sealing ring means, extending radially in the direction to the contracted points, and directly adjoining the radial packing strips at the outer ends thereof,

and curved transition element means which rest against said sealing ring means and guide said sealing element means in the radial direction.

11 Claims, 11 Drawing Figures



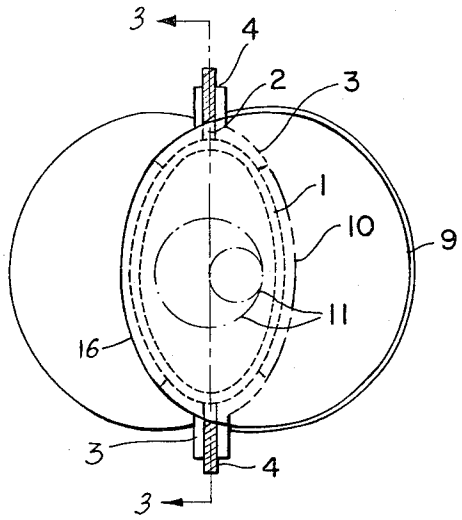


FIG. 1

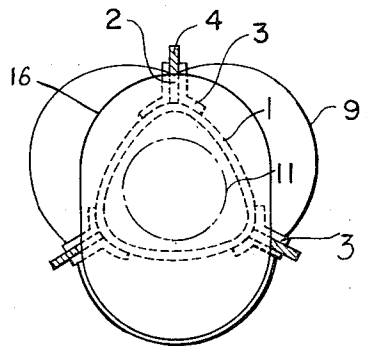


FIG. 2

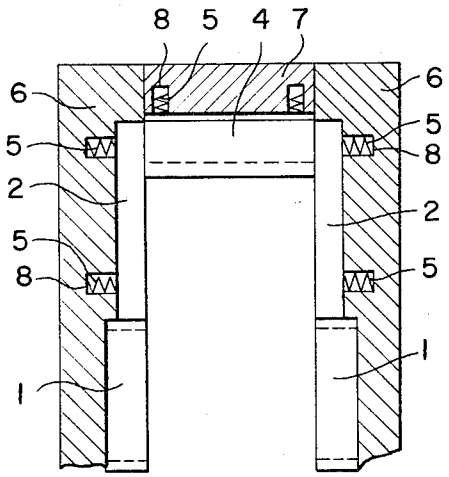
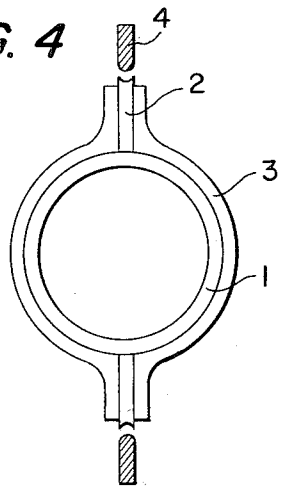


FIG. 3

FIG. 4



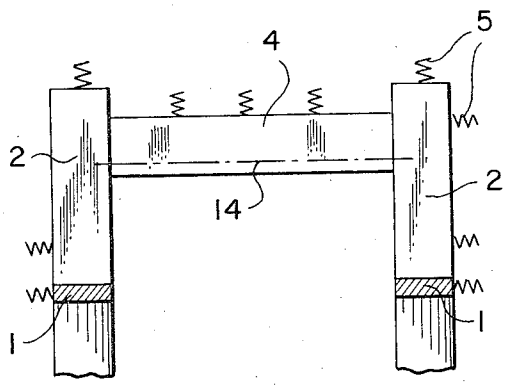


FIG. 5

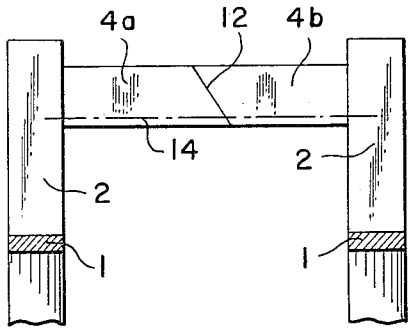


FIG. 6

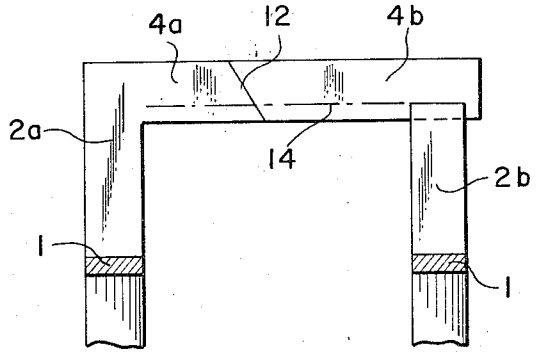


FIG. 7

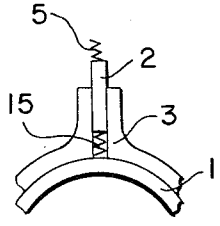


FIG. 8

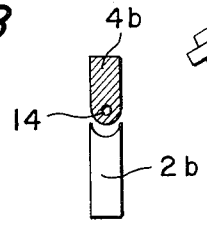


FIG. 9

FIG. 10

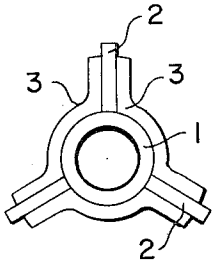
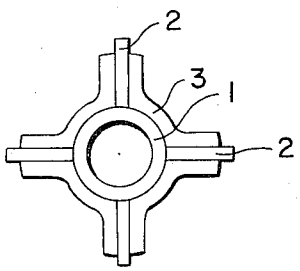


FIG. 11



PACKING STRIP ARRANGEMENT FOR ROTARY PISTON ENGINES

The present invention relates to an arrangement of packing strips for rotary piston engines having trochoidal piston rotors and a housing shaped according to the outer envelope curve and, respectively, the equidistant curve path thereof.

It is known in the art to provide, on rotary piston engines with trochoidal piston rotors and a housing which is shaped after the outer envelope curve of the trochoid, packing strips which effectively seal the working chambers. A system of axial packing strips is disposed for this purpose at the side walls of the piston rotor, and arranged in addition thereto are radial packing strips at the contracted points of the outer envelope curve, i.e., at the housing. These packing strips which are disposed partly at the rotating piston rotor and partly at the stationary housing have the disadvantage that, during the transition from the axial packing strip system to the radial packing strip system a gap, a so-called packing strip fault, will occur. Even when using additional sealing means at the transition points between the rotating and the stationary packing strips it is possible only with great difficulty to achieve a usable sealing effect at these points. Such additional intermediate elements between the radial packing strip are known, for example, from French Pat. No. 1,277,311. In that patent they are arranged at the contracted or waisted points in the housing wall and will come to be positioned laterally both against the radial packing strip and against the portion of the lateral piston wall which is positioned between the piston edge or border and the axial packing strip. They are subjected to an increasing extent to wear and tear by the piston edge and therefore do not assure a sufficient sealing effect. Furthermore, the axial packing strips which are disposed equidistantly with respect to the trochoid in grooves of the lateral piston rotor wall along the piston edge or border are very difficult to make. When a multi-curved trochoid is considered, for example a configuration which resembles the cloverleaf shape, as shown in the afore-mentioned French Pat. No. 1,277,311, it is apparent that the manufacture and processing of the packing strip bed involves considerable problems. In addition thereto, it is sought that the packing strip be inserted relatively movably within the packing strip bed thereof so that it be possible to compensate for states of stress which are produced by the varying temperatures and gas pressures. Moreover, such packing strips with multiple curvatures being complicated also because of the trochoidal shape are very difficult to make from a material that is particularly suitable for packing strips, such as a cast iron alloy and the like. The packing strips being disposed at the rotating piston rotor assume, due to the centrifugal force, inadmissible states of stress and can, as a result, be clamped-in in the packing strip bed during the operation of the piston and be damaged, thus rendering the packing strip bed unusable after a short running time.

It is also known in the art to provide elastic elements in the packing strip bed, for the purpose of obtaining a sufficient and uniform contact pressure, whereby the packing strips themselves, or also the intermediate pieces, are pressed uniformly against the gliding surface disposed opposite thereto, for example the housing wall. It has further already been proposed in the art

to utilize the arising gas pressure itself for the purpose of pressing packing strips against a housing wall. While it is true that by virtue of this arrangement of known packing strip systems the problem of sealing the working chambers has been solved to a certain extent, no usable solution could be found at the above-mentioned critical transition points between the radial packing strip and the axial packing strip. The leakage loss and the resultant decrease in efficiency of such machines were accepted as unavoidable.

The present invention is based on the concept of providing a packing strip arrangement for rotary piston engines with a trochoidal piston rotor and the coordianted housing corresponding to the outer envelope curve with respect to the trochoid, which eliminates leaky transition points from the radial to the axial part of the packing strips. It is a further object of the present invention that an influencing of the packing strips because of the centrifugal force is largely prevented, and an automatic re-adjustment of the packing strips should be possible. This object is obtained in that, in the two lateral housing walls within the inner envelope curve described by the piston edge, there is provided in each case a sealing ring closed within itself, and starting therefrom sealing elements extending radially in the direction to the contracted points, which sealing elements adjoin at the outer ends thereof directly to the radial packing strips being disposed at the contracted point, and that at the abutment area of the sealing ring and the sealing element outside of the sealing ring transition members are provided for which, on the one hand, come to rest against and make contact with this sealing ring in an arched or curved manner and, on the other hand, guide the sealing element in a radial direction. In order to make it possible that the sealing ring be made as large as possible, it is proposed, according to another embodiment of the present invention, that the sealing ring be disposed so as to extend equidistantly with respect to the inner envelope curve. The sealing ring also, however, may be advantageously provided in a circular shape. By virtue of this packing strip arrangement it is effectively achieved that all of the individual parts both in the lateral housing wall and at the adjacent trochoid envelope curve wall may be firmly arranged in a packing strip bed. As a result thereof, neither the radial nor the axial packing strips are subject to the centrifugal force, and no relative movement of the individual sealing elements will arise with regard to the piston rotor. It is essential and advantageous that the packing strip arrangement is combined to a closed system.

This packing strip arrangement is usable for any type of construction of rotary piston engines with a trochoidal piston rotor. According to a further embodiment of the present invention, the intermediate pieces or elements with the curved portions thereof enclose the sealing ring in its entirety. In this case, the various transition members extend respectively between two successive sealing elements leading to the contracted portions of the housing. This packing strip arrangement assures primarily that the packing strip fault is eliminated and that a completely closed sealing border is present in the axial and the radial direction. The sealing or packing strips are all accommodated in the static part, i.e., in the lateral housing walls and in the housing limiting wall. An effective connection may be obtained from both sides of the packing strips without difficult transi-

tion points being created thereby. It is apparent that, by virtue of using the inventive packing strip arrangement, the output of the machine may be further increased. The manufacture of a preferably circular sealing ring with a corresponding groove in the lateral housing wall as a sealing or packing strip bed produces no difficulties. In the case of cardioid piston rotors with two mutually oppositely-positioned radial packing strips, the transition pieces may be provided in a sleeve jointed manner.

The present invention will now be further described herein on the basis of one embodiment thereof and with reference to the accompanying drawings, wherein

FIG. 1 illustrates a packing strip arrangement in the lateral housing wall of a rotary piston engine being provided with a two-curved outer envelope curve;

FIG. 2 illustrates a packing strip arrangement in the lateral housing wall of a rotary piston engine being provided with a three-curved outer envelope curve;

FIG. 3 is a longitudinal cross-sectional view of FIG. 1;

FIG. 4 illustrates a sealing ring with adjacent sealing elements;

FIG. 5 is a side view of FIG. 4;

FIGS. 6 and 7 illustrate modified embodiments of FIG. 5;

FIG. 8 illustrates the provision of the transition from the sealing ring to the sealing element;

FIG. 9 illustrates the provision of the contact point of the sealing element with respect to the radial packing strip, and

FIGS. 10 and 11 illustrate provisions of the transition pieces with the use of a three-curved and, respectively, four-curved outer envelope curve.

FIG. 1 illustrates a packing strip arrangement in the direction of view toward a lateral housing wall of a rotary piston engine formed with a two arched outer envelope curve. The outer envelope curve 9 representing the stator, and a trochoidal form 16, representing the rotor, are drawn in with thin lines. In the extension of this curve path, the inner envelope curve 10 is indicated in phantom. At the contracted or waisted points of the envelope curve 9, the radial packing strips 4 are mounted in a manner known per se. A sealing ring 1 is inserted in the lateral housing wall within the inner envelope curve 10, which has been designated in phantom, but outside of the indicated geartooth system 11. It extends here, for example, equidistantly with respect to the inner envelope curve 10. In a radial direction from the sealing ring 1 to the contracted points of the envelope curve 9, sealing elements 2 are continued in the same plane, i.e., in the lateral housing wall. Disposed adjacent thereto are the radial packing strips 4, shown in this figure, which constitute the transition to the oppositely-positioned housing wall. Also provided between the sealing ring 1 and the sealing elements 2 and, respectively, the radial packing strips 4 are pairs of transition pieces or elements 3 which come to be positioned, on the one hand, along the sealing elements 2 in the direction toward the radial packing strips 4 and, on the other hand, rest on or against the sealing ring 1 in a curved or arched manner in a certain area. These transition elements 3 serve for guiding the sealing elements 2 and for bridging the sealing to the sealing ring 1.

FIG. 2 illustrates in a similar manner the arrangement of packing strips at a machine with a three-arched or curved outer envelope curve 9, representing the stator, and a trochoidal form 16, representing the rotor. In this case it is possible to make the sealing ring 1 in the form of the known constant-diameter lobed cylinder. It is essential that the sealing ring 1 is positioned outside of the geartooth system 11 and within and at least approximately equidistantly with respect to the inner envelope curve (which has not been shown in this figure). The sealing ring, however, also could be provided circular, and disposed concentrically with respect to the gear tooth part 11. Here again, the sealing elements 2 adjoin or extend in the same plane of the sealing ring 1, and further adjacent thereto, the radial sealing or packing strip 4 establish the transverse connection to the sealing element in the opposite lateral housing wall. The approximately angular transition pieces or elements 3 serve for eliminating any possible leakage points.

FIG. 3 is a cross-sectional view through a rotary piston engine according to the type shown in FIGS. 1 and 2. The line of intersection is indicated in FIG. 1 with reference symbols A—A. Starting or extending from the center line of the rotary piston engine, which may be designated as the center of the eccentric shaft, recesses are milled into the lateral wall 6 in such a manner that sealing rings 1 may be inserted thereinto. Provided adjacent thereto in the radial direction from the sealing rings 1 toward the contracted points of the type of rotary piston engine having been chosen are the sealing elements 2. These latter are equally placed into a specifically provided bed within the housing wall 6 and, in this particular instance, are seated on the sealing ring 1. In order to render possible the pressing of the sealing ring 1 and of the sealing elements 2 against the piston rotor (not shown), recesses 8 are disposed in the housing in which compression springs 5 are positioned. These compression springs 5 press the various parts of the packings against the piston rotor (not shown). The same holds true for the housing 7 disposed at the end face, which establishes the connection between the two lateral housing walls 6. Disposed in the housing 7 are in the same fashion recesses 8 with compressed springs 5 placed thereinto, which springs press the radial packing strips 4 disposed at the contracted points against the circumference of the piston rotor (not shown). The transition pieces or elements 3 have been omitted from FIG. 3 so that the position of the sealing elements 2 with respect to the sealing ring 1 could be illustrated more clearly.

FIG. 4 illustrates a modified embodiment of FIG. 1 with a circular sealing ring 1. Disposed around this sealing ring 1 are the transition pieces or elements 3 in a pipe-clamped or sleeve-jointed manner. The transition elements 3 enclose, on the one hand, completely with respectively one half thereof the sealing ring and, on the other hand, constitute with the straight, projecting legs thereof, a guide for the sealing elements 2.

FIG. 5 is a side view of FIG. 4. The sealing rings 1 which are joined in the radial direction by the sealing elements 2 are shown in a cross-sectional view. The transition between the sealing ring 1 and the sealing element 2 is so provided that the point of contact of the sealing elements 2 at the sealing ring 1 has the same radius as the sealing ring in such a manner that a sealing contact surface is produced. The radial packing strip 4 connects the two sealing elements 2 with each other. The radial sealing or packing strip 4 is so adapted in the length thereof by means of a selected fit that the sealing

elements 2 can rest against the piston rotor (not shown) laterally in a precisely sealing manner. Here again, springs 5 have been shown which indicate that from the outside, i.e., from the housing walls, a uniform spring pressure acts upon the packing strips. Also indicated at the radial packing strip 4 is a dash-dotted line 14 whose function it is to indicate the center line of the radial packing strip which is provided with a semicircular cross-section at the sealing surface thereof.

FIGS. 6 and 7 illustrate modified embodiments of the radial packing strip 4 of FIG. 5. In FIG. 6, the radial packing strip 4 is divided into two parts, namely into the radial packing strips 4*a* and 4*b*. by means of a separating section 12 extending diagonally with respect to the longitudinal axis thereof. The separating line or section 12 is disposed approximately in the center of the radial packing strip. The sealing elements 2 adjoin the radial packing strips 4*a* and 4*b*, respectively. A different type of provision is shown in FIG. 7 as far as the radial packing strip portions 4*a* and 4*b*, respectively, are concerned. The radial packing strip portion 4*a* and the sealing element 2*a* are combined to a single piece or element in an angular fashion. Disposed adjacent thereto at the lower side is the sealing ring 1 in the manner described above. On the other hand, the second radial packing strip portion 4*b* rests against the separating line or section 12. The radial packing strip portion 4*b* rests upon the end of the sealing element 2*b*. The two radial packing strip portions 4*a* and 4*b* equally have a semicircular configuration viewed in cross-section on the side thereof facing the piston rotor. It extends from the inside of the sealing element 2*a* and beyond the further sealing element 2*b*. This provision has the advantage that the packing strips can automatically become readjusted, i.e., that the natural wear and tear may be compensated for in a simple manner. In this connection, on one of the two sides of the piston rotor, a loose contact point of the sealing elements 2 with a radial packing strip portion 4*a* and/or 4*b* is avoided and replaced by a firm connection.

FIG. 8 is a section from FIG. 4 in which a sealing element 2 does not immediately and directly adjoin the sealing ring 1 but is held in a central position by means of springs 15 and/or 5. It is for bridging this point which is produced by the provision of a spring 15 between the sealing ring 1 and the sealing element 2 that the transition pieces 3 are provided for.

FIG. 9 illustrates the contact point between the sealing element 2*b*, shown in FIG. 7, and the adjacent radial packing strip portion 4*b*. Since, as mentioned hereinabove, the radial packing strip portion 4*b* is provided in a semi-cylindrical shape with the center line 14 at the contact point of the piston rotor, the adjoining sealing element 2*b* has the same radius of the semicylinder, but is concave in shape.

FIGS. 10 and 11 show a provision of the transition elements with a three-curved and, respectively, four-curved or arched outer envelope curve. The transition elements enclose the round portion of the sealing ring 1 in its entirety and furthermore rest against the sealing elements 2 at least over a certain length thereof. The transition pieces or elements 3 extend here respectively between two successive sealing elements 2.

It is essential for this packing strip arrangement that all of the individual parts thereof are accommodated in the lateral housing wall 6 and, respectively, in the end face housing part 7 and therefore are not exposed to any centrifugal forces. No packing strips are necessary any longer within the piston rotor itself. The sealing ring 1 is positioned outside of the gear-tooth system relative to the eccentric shaft gearing, but is installed within the inner envelope curve in the lateral housing wall 6. The sealing ring 1 may be positioned equidistantly with respect to the inner envelope curve. For reasons of manufacturing techniques, however, a sealing ring 1 will expediently be chosen which can be traced back to simple, basic geometric figures, for example the circular shape. Also suitable in this connection is an elliptical configuration of the sealing ring and, respectively, one which corresponds to the lobed cylinder wherein all diameters have equal length.

It will be obvious to those skilled in the art that many modifications may be made within the scope of the present invention without departing from the spirit thereof, and the invention includes all such modifications. What is claimed is:

1. In a rotary piston engine of trochoidal construction having a trochoidal rotor, a stator having a periphery in the form of an outer envelope curve formed by said rotor during its rotation with a plurality of contracted portions separating said periphery into chambers and end walls, a radially-disposed packing strip in each of said contracted portions of said stator, a sealing ring mounted in each of said end walls, and sealing element means equal in number to the number of packing strips, extending radially from each of said sealing rings and whose outer ends are adapted to contact the inner ends of said packing strips during the rotation of said rotor, the improvement comprising transitional seal means on each side of each of said sealing elements where said sealing element joins said sealing ring having a curved portion which conforms to at least a portion of the outer periphery of said sealing ring and a radial portion which contacts and extends along the entire radial dimension of said sealing element and at least a portion of said packing strip, whereby a facing pair of said transition seals guide said sealing element along the entire radial extension thereof and at least a portion of said packing strip between said pair of transition seals.

2. An engine in accordance with claim 1, in which the sealing ring is within and equidistant from the inner envelope curve formed by the rotor during its rotation.

3. An engine in accordance with claim 1, in which the sealing ring has a circular configuration.

4. An engine in accordance with claim 1, in which the curved portions of back-to-back transitional seals are joined to conform to and enclose the portion of the sealing ring between them.

5. An engine in accordance with claim 1, in which the sealing elements rest against the sides of the packing strips.

6. An engine in accordance with claim 1, in which compression spring means are disposed in the stator against the outward edges of the packing strips to urge said packing strips radially inward.

7. An engine in accordance with claim 1, in which spring means are disposed between the sealing ring and the sealing elements to urge said sealing elements radially outward.

8. An engine in accordance with claim 1, in which the sealing elements rest against the edges of the packing strips.

9. An engine in accordance with claim 8, in which the edges of the packing strips are semi-cylindrical and the

ends of the sealing elements have recesses conforming to the shape of said edges of said packing strips.

10. An engine in accordance with claim 1, in which the packing strips are split along a line diagonal with respect to the longitudinal axes of said packing strips.

11. An engine in accordance with claim 10, in which one portion of the split packing strips is rigidly connected to the sealing element in contact with its end.

* * * * *