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Seidl

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[54] **SEALING MEANS FOR ROTARY PISTON MACHINES**

[75] Inventor: **Jiri Seidl**, Uppsala, Sweden

[73] Assignee: **Monark–Crescent A B Kyrkogatan**, Varberg, Sweden

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **418/121**, 418/142

[51] **Int. Cl.** **F01c 19/04**

[58] **Field of Search** ..... 418/120, 121, 142, 418/122, 123; 277/81 P

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Primary Examiner—Carlton R. Croyle
Assistant Examiner—Michael Koczo, Jr.
Attorney—Irvin S. Thompson et al.

[57] **ABSTRACT**

Sealing means for rotary piston machines of the apex piston type comprise three types of basic sealing elements: apex seals for sealing engagement between the apexes of the piston and the centre wall of the housing; side sealing strips for sealing engagement between the ends of the piston and the end walls of the housing; coupling members for bridging the gap between the ends of the apex seals and the side sealing strips. This coupling member is located in the same groove as is the apex seal and below the end of the latter one.

13 Claims, 12 Drawing Figures

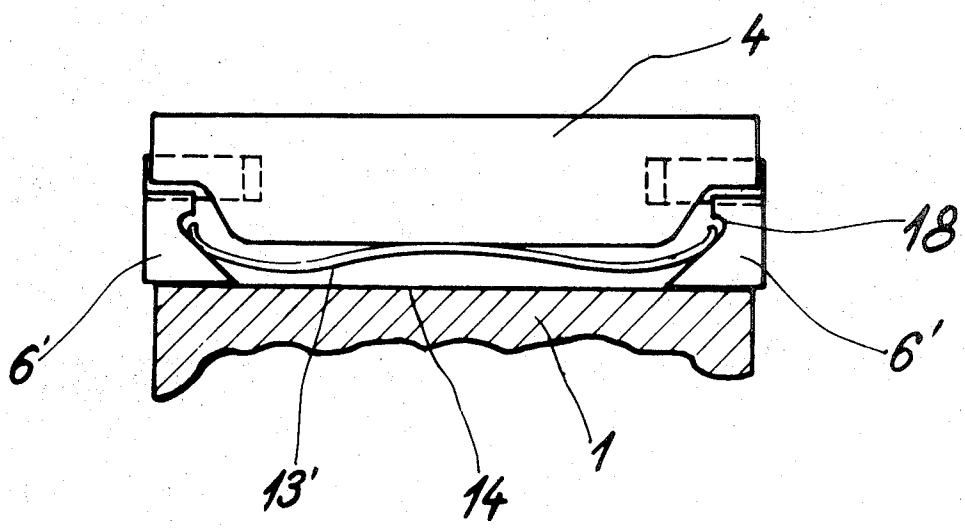


Fig. 1

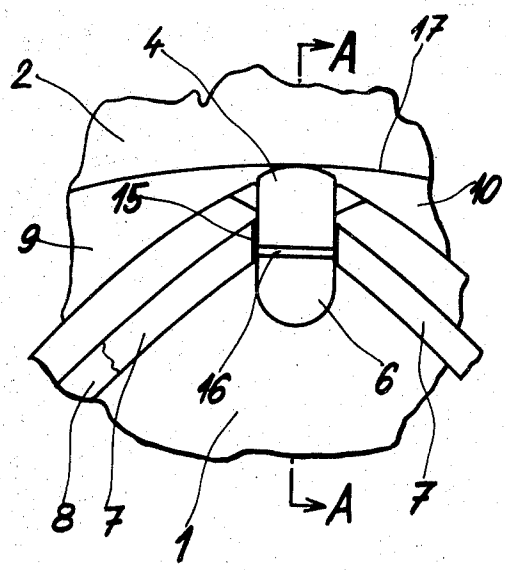


Fig. 2

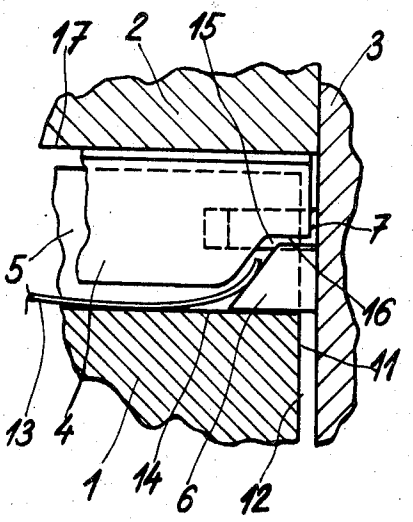


Fig. 3

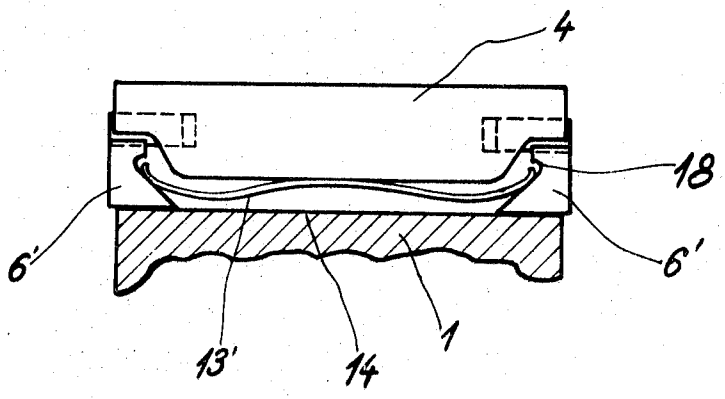


Fig. 4

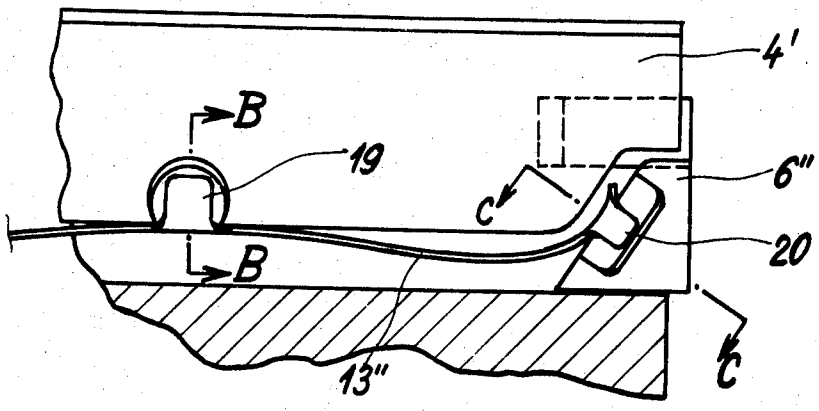


Fig. 5

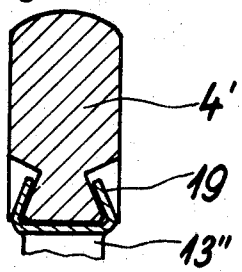


Fig. 6

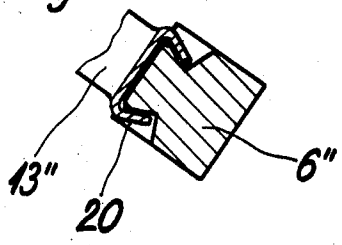


Fig. 7

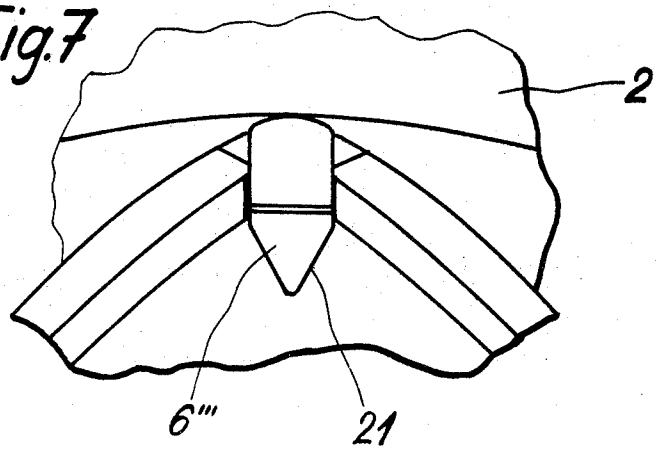


Fig. 8

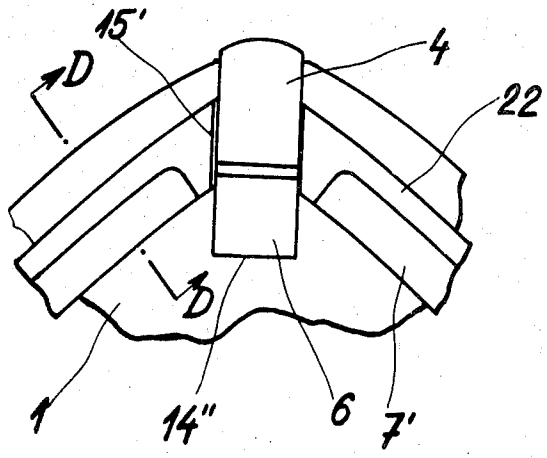


Fig. 9

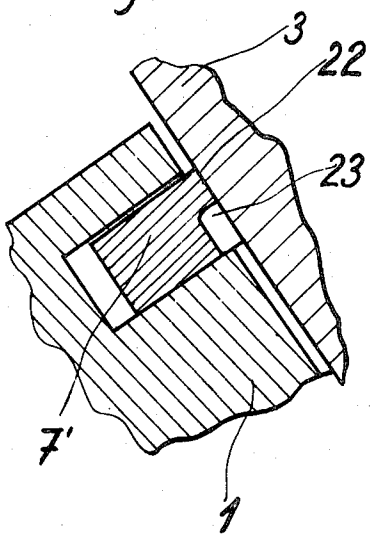


Fig. 10

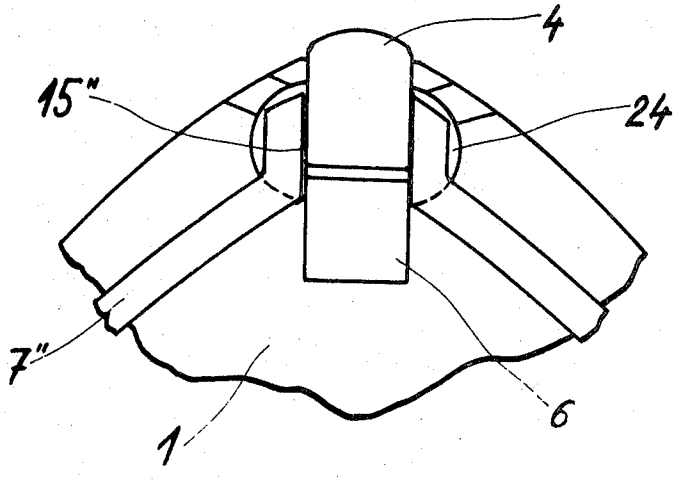


Fig. 11

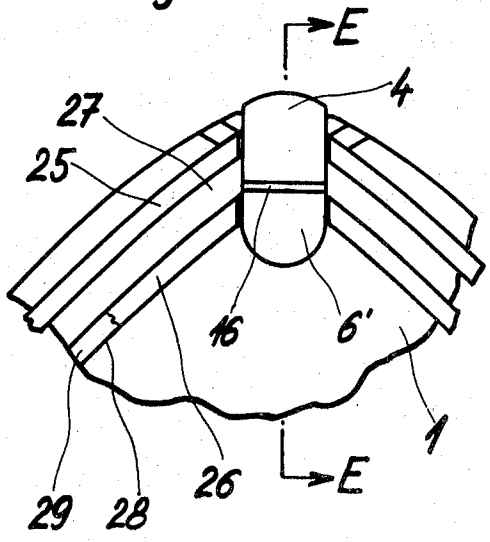
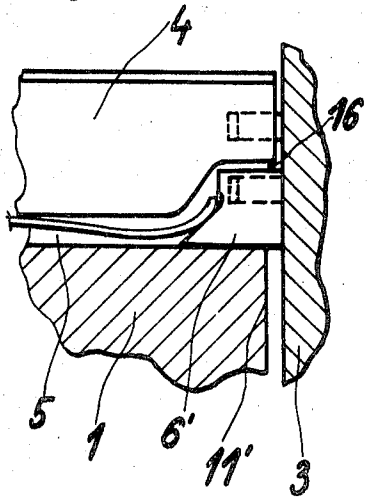


Fig. 12



SEALING MEANS FOR ROTARY PISTON MACHINES

The present invention relates to sealing means for rotary piston machines, especially for rotary piston combustion engines, comprising a housing composed of spaced end walls and a centre wall interconnecting the end walls to define an enclosed cavity, and a rotary piston rotatably mounted within said housing, said piston being provided with a plurality of apex portions.

In a known rotary engine of the above type the sealing means consist of three basic elements: apex seals, side sealing strips and coupling members. Usually the piston has special grooves or recesses for each of these three elements, i.e., special grooves in the apex portions for the apex seals, special grooves in the ends for the side sealing strips and special recesses for the coupling members.

The object of the coupling member is to connect the apex seal with the side sealing strips, thus closing the sealing system for the rotor and during different working conditions of the machine separating each working chamber from the other ones, and this even if the apex seals are radially worn off. Therefore the coupling member is provided with a groove which is in alignment with the apex groove in order to maintain a proper sealing engagement between the apex seal on the one hand and its groove and the groove of the coupling member on the other hand.

It is very difficult and expensive in production to maintain the alignment of the apex groove with the groove of the coupling member. It is necessary to keep the mutual positions of the apex groove, the recess in the piston end surface for the coupling member and its groove to enable the interchangeability of parts.

It is an object of the present invention to simplify this coupling between the apex seals and the side sealing strips.

Other objects and advantages of the present invention will become apparent from a consideration of the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a fragmentary view of the piston with the sealing elements;

FIG. 2 is a fragmentary section taken along the line A—A of FIG. 1;

FIG. 3 is a fragmentary section of another embodiment of the sealing means, taken along the line A—A of FIG. 1;

FIG. 4 is a fragmentary section of still another embodiment of the sealing means, taken along the line A—A of FIG. 1;

FIG. 5 is a cross-section of the apex seal and a spring for it, taken along the line B—B of FIG. 4;

FIG. 6 is a cross section of the coupling member and the spring, taken along the line C—C of FIG. 4;

FIG. 7 is a fragmentary view of the piston with a modified shape of the bottom of the apex groove;

FIG. 8 is a fragmentary view with a modified shape of the side sealing strips;

FIG. 9 is a cross-section of the side sealing strips, taken along the line D—D of FIG. 8;

FIG. 10 is a fragmentary view of the piston with a modified shape of the side sealing strips;

FIG. 11 is a fragmentary view of the piston with double side sealing strips; and

FIG. 12 is a fragmentary cross-section along the line E—E of FIG. 11.

The sealing means illustrated in FIGS. 1–2 are arranged on a piston 1, having three apexes, which piston moves in a housing 2 composed of spaced end walls 3 and a centre wall 17 interconnecting the end walls to define an enclosed cavity. For sealing against the centre wall 17 there is inserted in a groove 5 in each apex a seal 4. This groove and seal extend axially in the length direction of the apex. In this groove 5 there are also two coupling members 6, one in each end of the apex. The two ends 11 of the piston 1 are provided with side sealing strips 7 inserted in grooves 8 for engagement with the end walls 3 of the housing 2.

The object of the sealing means is to seal the variable volume working chambers 9 and 10. It means to prevent the penetration of the working medium (the gas) from the working chambers along the piston end faces 11, radially inwardly to the space 12, and to prevent the working medium in one chamber from penetrating into another chamber.

The sealing of the piston ends 11 is ensured by the sealing strips 7 and the coupling members 6. By the pressure of the working medium and eventually by means of a special spring the strips 7 are pressed against the radially inner walls of the groove 8 and at the same time against the adjacent end wall 3, while by the same medium and eventually by a plate spring 13, located in the groove 5, the coupling member 6 is pressed against the bottom 14 of said groove and simultaneously against the adjacent end wall 3 of the housing 2. The bottom 14 of the apex groove 5, in the whole length of the apex or at least in the part of sealing engagement with the coupling member 6, is rounded by a radius which is larger or equal to the half-width of the apex groove 5. The rounded shape of the bottom 14 of the apex groove 5 and a corresponding rounded shape of the coupling member 6 ensures a good mutual sealing engagement and is easy to make. A flat bottom in the centre part of the apex groove gives more space for the spring 13.

By their end faces 15 the side sealing strips 7 are in sealing engagement with the coupling members 6. It is in fact very difficult to ensure the contact sealing engagement between both end faces 15 of the side sealing strip 7 and both coupling members 6. Under influence of a tangential component of the friction force during the rotation of the piston 1 the one end face 15 of the strip 7 will be pressed against the one coupling member 6 and the one apex seal 4, while the other end face 15 of the strip 7 will have a less perfect sealing engagement with the adjacent coupling member 6 and apex seal 4. It will be a small play between them.

The separation of the working chambers 9 and 10 from each other is enabled through arrangement of the three types of sealing elements 4, 6 and 7 in a special way. The apex seal 4 and the two coupling members 6 are placed in the common groove 5 of the piston 1. The gap 16 between the apex seal 4 and the coupling member 6 interconnects the neighbouring working chambers 9 and 10. However, this gap is necessary to ensure the radial movement of the apex seal 4 in the groove 5. Moreover the gap 16 is enlarged during operation of the machine due to the fact that the apex seal 4 is radially worn off.

Beside its main function described above the side sealing strip 7 also acts as a connecting member, which

bridges and seals the gap **16**, as it by its end face **15** is in sealing engagement simultaneously with an adjacent coupling member **6** and an adjacent apex seal **4** as above mentioned. A good sealing is ensured even if the apex seal **4** is worn off as long as the gap **16** is bridged. Therefore the end face **15** is made large enough to bridge this gap during the whole life of the machine or at least between the intervals of prescribed service actions.

The present sealing means have the advantage of making it unnecessary to have special recesses for the couplind members. Therefore the production costs will be lower and the parts of the sealing system can without complication be substituted by the normal spare parts.

In all operating conditions of the machine the spring **13** ensures good sealing engagement between the apex seal **4** and the centre wall **17** of the housing **2**, between the coupling members **6** and the adjacent end walls of the housing and between the coupling members **6** and the bottom **14** of the groove **5**.

Preferably a single spring **13'** for the apex seal **4** and the two coupling members **6'** is used, as is shown in FIG. **3**. It is also advantageous if the spring has a minimum of supports in order to be as soft as possible. Therefore the spring **13'** in FIG. **3** is loaded only in three points, i.e., in its centre by the apex seal **4** and in its ends by the coupling members **6'** and is not supported by the bottom **14** of the groove **5**. The coupling members **6'** are provided with inwardly directed protrusions **18** in order to limit the movement of the spring **13'** and thereby to prevent eventual damage of the end walls **3** of the housing **2**.

Preferably, in order to simplify mounting and service the apex seal **4'**, the spring **13''** and the two coupling members **6''** are made as a single unit as is shown in FIGS. **4, 5** and **6**.

The spring **13''** there is provided with a centre clamp **19** for connection with the apex seal **4'** and with end clamps **20** for sliding connection with the coupling members **6''**. The sliding connection is necessary to enable a relative movement between the spring **13''** and the coupling members **6''**. These clamps **19** and **20** are made integral with the spring **13''** as is shown in FIGS. **4, 5** and **6**, but can of course be made as separate parts.

According to another embodiment of the invention the bottom **21** of the apex groove is V-shaped as is shown in FIG. **7**, the coupling members **6''41** having corresponding shape. The V-shaped bottom of said groove is especially advantageous from a production point of view, and enables a good sealing contact with the coupling members **6'''**, as the V-shaped coupling member is pressed down into the V-shaped groove by means of the spring **13** and the gas pressure.

The embodiments according to FIGS. **8, 9** and **10** enable a good sealing even if the apex seal is extremely weared off.

FIGS. **8** and **9** show an essentially wider sealing strip **7'**, which in its full width is in sealing engagement with the adjacent end wall of the housing only at the ends **15'**, where it at the same time is in sealing engagement with the apex seal **4** and the coupling members **6**. The radially inner side of the sealing strip **7'** is provided with a recess **23** (see FIG. **9**) extending between the ends **15'**, which means that the sliding surface **22** against the end wall **3** of the housing **2** is smaller, thereby decreasing the friction losses and ensuring a sufficient specific pressure between the sliding surface **22** and the end wall **3** of the housing.

FIG. **10** shows a sealing strip **7''** which at its both ends is radially bent out to enlarge the end face **15''** against the apex seal **4** and the coupling members **6**. The piston **1** is provided with a recess **24** corresponding to this enlarged end face **15''**.

FIGS. **11** and **12** show another embodiment of the sealing means according to the invention. The piston end face **11'** is provided with at least two radially spaced sealing strips between two adjacent apexes. The radially outer sealing strips **25** are in sealing engagement with the apex seals **4**, while the radially inner sealing strips **26** are in sealing engagement with the coupling members **6'**. The high pressure working medium penetrates partially from the working chamber into the apex groove **5** under the apex seal **4** and then through the gap **16** between the apex seal **4** and the coupling member **6'** into the intermediate space **27** between the radially outer side sealing strip **25** and the radially inner side sealing strip **26**. The function of the sealing system is improved, as the pressure of the working medium ensures a permanent contact between the radially inner side sealing strip **26** and the radially inner walls **28** of the radially inner side grooves **29** even under influence of friction forces and under influence of vacuum in one of the working chambers during the suction stroke.

Having described my invention, I claim:

1. Sealing means for rotary piston machines, especially for rotary piston combustion engines composed of spaced end walls and a centre wall interconnecting said end walls to define an enclosed cavity, and a rotary piston rotatably mounted within said housing, said piston being provided with a plurality of apex portions, each extending axially and having a groove, an apex seal in said groove in engagement with the centre wall of said housing and extending substantially between the end walls of said housing, a coupling member in each end of said piston for sealing engagement with the end walls of said housing, and sealing strips in both ends of said piston for sealing between these ends and the end walls of said housing, said coupling member being placed in the same groove as is the apex seal and radially below the ends of the latter, and said sealing strips being arranged with their ends in simultaneous sealing engagement with said coupling member and said apex seal.

2. Sealing means according to claim **1**, characterized by the fact, that each apex groove contains a single spring for pressing the apex seal against the centre wall of said housing and at the same time for pressing the coupling members apart and against the end walls of said housing and against the bottom of said groove.

3. Sealing means according to claim **2**, characterized by the fact, that said spring is in contact with only the apex seal and the coupling members.

4. Sealing means according to claim **3**, characterized by the fact, that the contact points of the spring are in the middle of said apex seal and in the ends of said coupling members.

5. Sealing means according to claim **2**, characterized by the fact, that the coupling members are provided with inwardly directed protrusions to limit the movement of the spring, thereby preventing any damage on the end walls of said housing which otherwise may be caused by said spring.

6. Sealing means according to claim 2, characterized by the fact, that the spring is connected by means of a central clamp to the apex seal and by means of end clamps is connected to the coupling members.

7. Sealing means according to claim 6, characterized by the fact, that the clamps are integral with the spring.

8. Sealing means according to claim 1, characterized by the fact, that the bottom of the apex groove at least in its ends, where the coupling members are located, is rounded by a radius which is at least equal to the half-width of the apex groove and that the coupling members are correspondingly rounded.

9. Sealing means according to claim 1, characterized by the fact, that the bottom of the apex groove at least in its ends, where the coupling members are located, is V-shaped and that the coupling members are correspondingly shaped.

10. Sealing means according to claim 1, characterized by the fact, that the sliding surface of the sealing strips in sealing engagement with the end walls of said housing is largest in the neighbourhood of the apex seal and the coupling member.

11. Sealing means according to claim 10, characterized by the fact, that the sealing strips are in sealing engagement with the end walls of said housing in their full width in the neighbourhood of the apex seals and the coupling members only, whereas the remaining part of the sliding surface of the sealing strips has been made narrower through a recess made on the radially inward side of said sliding surface.

12. Sealing means according to claim 10, characterized by the fact, that both ends of the sealing strips are provided with an outwardly directed extension for sealing engagement with the apex seal and the coupling member.

13. Sealing means according to claim 1, characterized by the fact, that the piston end is supplied with at least two radially spaced sealing strips extending between the apexes, the radially outer one being in sealing engagement with the apex seal and the radially inner one being in sealing engagement with the coupling member.

* * * * *