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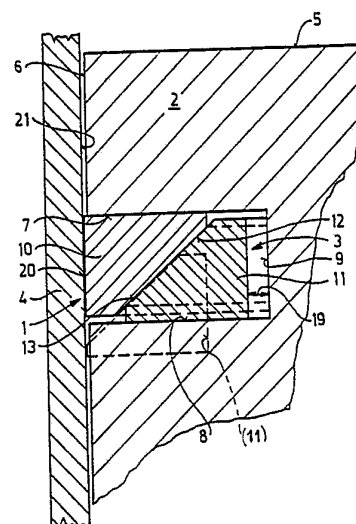
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(54) Title: PISTON RING DEVICE FOR PISTON RECIPROCATING MACHINES, MAINLY FOR INTERNAL COMBUSTION ENGINES

(57) Abstract

The invention relates to a piston ring device for piston reciprocating machines, mainly for internal combustion engines, comprising split ring elements arranged by way of self-tensioning in a ring groove of the piston in built-in state and with a cylindrical surface which tightly fits in the cylinder wall. The essence of the invention lies in that the said piston ring device (1) associated with the single ring groove (3) of the piston (2) is divided and consists of at least two separate split ring elements (10, 11, 23), which are in built-in state in locked connection and loaded by force directly by their tapered surfaces (12, 13, 24, 25) or in given case indirectly by an additional prestressed packing piece (shim), mainly elastic element (28), and fill out axially and tightly the ring groove (3).



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**PISTON RING DEVICE FOR PISTON RECIPROCATING MACHINES,
MAINLY FOR INTERNAL COMBUSTION ENGINES**

BACKGROUND OF THE INVENTION

The invention relates to a piston ring device applicable in piston reciprocating machines, mainly in internal combustion engines.

It is well-known that the role of the piston ring device in piston reciprocating machines, e.g. piston pumps, compressors, working hydraulic or pneumatic cylinders or internal combustion engines is to seal the gap between the piston making reciprocating motion (stroke) in the cylinder and the cylinder wall. The better is the sealing, the lower is the loss of medium in the cylinder space.

PRIOR ART

The piston rings used in internal combustion engines fit into ring grooves machined in the outer mantle of the piston. According to their role, they are compression rings or oil retaining rings (scraper rings).

The presently used piston ring devices are made - without exception - as a single split circular ring, mostly of grey cast iron, or alloyed casting. The cross sectional profile of this self-tensioning compression ring is generally flat quadrangle, its outer cylindrical mantle tightly rests on the cylinder wall but its inner cylinder mantle is arranged at a radial gap from the cylindrical wall of the ring groove. The known compression ring generally has 0.02 - 0.03 mm axial gap in the ring groove.

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The known oil retaining piston rings are made similarly as a single, split rectangular circular ring provided with oil retaining holes or ducts in their middle part [see e.g. Pattantyus: Gépész és Villamos Mérnökök Kézikönyve (Manual for electrical and mechanical engineers), Műszaki Könyvkiadó, Budapest, Hungary, 1962 vol.4., p.304-307)].

According to the experiences acquired in the practice, the main problem of the traditional and presently still widely used piston ring devices is the dimensional changes due to thermal expansion, causing jamming, consequently stuck pistons mainly at higher temperatures. Further problem is that owing to the reciprocating motion of the piston, the piston rings become "knockout", thus their sealing will be more and more inefficient. This involves partly increased gas loss and partly the lubricating oil flowing into the combustion chamber. The latter one causes excessive oil consumption and increases the environment polluting exhaust gas emission. In the wake of their joint effect, the engine's efficiency deteriorates, while its fuel consumption and the environment pollution considerably increase, hence it will shortly be in need of complete renewal of the engine at a high cost.

ESSENCE OF THE INVENTION

The present invention is aimed at elimination of above shortcomings, i.e. at the realization of an improved piston ring device ensuring better sealing between the piston and cylinder for a much longer life than the known solutions.

To solve the problem, the piston ring device described in the introductory part was used as starting point, machined as a split circular ring which when built in, sits by way of self-tensioning in the piston's ring groove and tightly fits the cylinder wall.

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The piston ring device according to the invention was further developed by dividing the piston ring device (engaged with the same piston's ring groove), i.e. it consists of at least two separate, self-tensioning split ring elements. When built in, they are in connection locked and loaded by force directly through their tapered surfaces, or in given case indirectly with the insertion of additional split ring or other packing piece (shim), where each of the tapered surfaces of the ring elements in radial section has an inclined straight or curved constituent, and the ring elements axially form a tight fit with the ring groove.

In a preferred embodiment of the invention the piston ring device consists of two split ring elements only built in by turning their tapered polished surfaces of the same size opposite each other, and where the gap - created by splitting the ring elements arranged preferably on the top in the ring groove - is smaller in dismounted state than the one arranged underneath in the ring groove. This further simplifies the manufacture and building in.

According to the invention such embodiment is also feasible, where the piston ring device consists of two V-shaped split ring elements, and a third central split ring element loading these elements outwardly with the surfaces tapered on both sides, where the outer cylindrical mantle of the two external ring elements tightly fit the cylinder wall, and their end-faces rest on the front walls of the ring groove. This way, the self-tensioning mantle pressure of the piston ring device can be adjusted even more safely to the value at discretion.

But a further embodiment is also feasible according to the invention, where the piston ring device has a triangular central split ring element the outer cylinder mantle of which tightly fits the cylinder wall, while its upper and lower tapered surfaces coact with the tapered surfaces of

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the second and third ring elements by forcing the external ring element radially outward, furthermore, the end-faces of the second and third ring elements rest on the upper and lower front walls of the ring groove.

In case of oil retaining piston ring device, such embodiment is preferred, where the two split ring elements are identically shaped and turned opposite each other in built in state, and a prestressed elastic element e.g. an endless annular coil spring is built between the opposite tapered surfaces of the ring elements. The two ring elements are axially spaced from each other, or in given case provided with ducts to clear away the oil. This simplifies the manufacture and building in.

BRIEF DESCRIPTION OF THE DRAWINGS:

The invention is described in detail with the aid of enclosed drawings presenting some embodiments of the solution according to the invention given by way of example, in which:

Fig.1: Longitudinal section of the piston ring device according to the invention in built in state;

Fig.2: Top view of the lower ring element of the piston ring device according to Fig.1 drawn to a smaller scale;

Fig.3: Bottom view of the upper ring element of the piston ring device according to Fig.1 drawn to a smaller scale;

Fig.4: Enlarged section along line IV-IV marked in Fig.2;

Fig.5: Enlarged section along line V-V marked in

Fig.3;

Fig.6: Partial section of the second embodiment of the piston ring device according to the invention given by way of example, in built in state;

Fig.7: Sectional view of a further version of the solution according to Fig.6;

Fig.8: Sectional view of another embodiment according to the invention given by way of example;

Fig.9: View of the solution according to Fig.8 in dismounted state, cut out in part.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in Fig.1, a piston ring device 1 according to the invention is arranged in a ring groove 3 of a piston 2 (illustrated only in part and schematically). The piston 2 makes reciprocating motion in a cylinder 4 of an internal combustion engine, where role of the piston ring device 1 is to seal the piston 2 in the cylinder 4. End-face of the piston 2 towards a combustion chamber is marked with 5, its mantle with 6, furthermore, upper and lower end plates of the ring groove 3 with 7 and 8 respectively, and its internal cylindrical wall with 9.

The piston ring device 1 according to the invention associated with the ring groove 3 of the piston 2 is divided, i.e. it consists of at least two separate but coacting split ring elements. In the embodiment according to Fig.1, the piston ring device 1 consists of two, an upper and a lower ring elements 10 and 11, in this case being in direct contact with each other and in connection locked and loaded by force

in built in state. The ring elements 10 and 11 are made as split self-tensioning circular rings provided with tapered surfaces 12 and 13, respectively, at their engaging parts.

The view and section of the ring elements 10 and 11 are shown better in Fig.2-5. Fig.2 and 4 present the lower ring element 11, while Fig.3 and 5 the upper ring element 10. Comparison of Fig.2 and 3 reveals, that a gap 15 formed when splitting the lower ring element 11 was selected much bigger than a gap 14 of the upper ring element 10 in order to facilitate the building in. (Position of the lower ring element 11 before building in is shown with dashed line in Fig.1). It is evident that the ring elements 10 and 11 are elastically deformable in the process of building in.

Comparison of Fig.4 and 5 reveals that the ring elements 10 and 11 in this case have the tapered surfaces 12 and 13 of identical cone angle 16, where the constituent in radial section is straight. However, Fig.4 and 5 present a version (marked with dashed line), where the constituent is curved. But in given case, this constituent may be even other, convex or concave as well. The tapered surfaces 12 and 13 are polished.

The end-face of the lower ring element 11 is at a radial spacing 19 from the wall 9 of the ring groove 3 in built in state (Fig.1). As shown in Fig.1, only thermal expansion gap exists between the upper end-face of the lower ring element 11 and the upper end-plate 7 of the ring groove 3, the size of which can be about 1/100 mm.

Thus, the piston ring device 1 according to Fig.1 can be used as compression ring in the internal combustion engines, the production technology and material may be the same as those used at the present time. The cone angle 19 (shown in Fig.4 and 5) may be between 10 grade to 84 grade as required by the existing utilization.

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Fig.3 and 5 show that dimensions of the upper ring element 10 can be essentially the same as that of the ring element 11 discussed above. A mantle surface 20 of the ring element 10 tightly fits an inner wall 21 of the cylinder 4 (Fig.1). Furthermore, an upper end-face 22 of the ring element 10 rests on the upper end plate 7 of the ring groove 3. (The same thermal expansion gap exists between a lower end-face of the ring element 10 and the lower end plate 8 of the ring groove 3 as mentioned in connection with the ring element 11).

From Fig.1 it is clearly evident, that building in the piston ring device 1 according to the invention takes place with elastic deformation of the split ring elements 10 and 11. In built in state, the self-tensioning ring elements 10 and 11 remain in direct connection locked and loaded by force through the tapered surfaces 12 and 13. As a result, the inner and lower ring element 11 tries to drive the outer and upper ring element 10 radially outward, whereby always safe ring pressure is achieved. This way, the ring element 10 will rest in sealed condition on the wall 21 of the cylinder 4 even if the piston ring device 1 has been used for a long time, because the unavoidable wear during use is automatically compensated by the piston ring device 1 according to the invention through the relative movement of the self-tensioning ring elements 10 and 11 along their tapered surfaces 12 and 13.

The present invention is essentially different from the prior art in the respect too, that the ring elements 10 and 11 of the piston ring device 1 with their end-faces 22 and 17 tightly fit the end plates 7 and 8 of the ring groove 3, moreover they are pressed to it (without any gap as used to be in the prior art). This implies the advantage that the piston ring device 1 does not "float" axially in the ring groove 3, thereby its risk of "knockout" is completely eliminated. Additional advantage of the invention is that in case of cooling problems of the engine, the piston 2 does

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not "get stuck", - as it may occur in the traditional piston rings - since the connection locked and loaded by force and the relative movement possibility of the ring elements 10 and 11 along their tapered surfaces prevent this phenomenon.

Fig.6 presents a further embodiment of the piston ring device 1 according to the invention, where the upper ring element 10 and lower ring element 11 in the ring groove 3 are in indirect, i.e. coacting and connection locked and loaded by force through a centrally arranged third split ring element 23. Tapered surfaces 24 and 25 of the ring element 23 are in coaction with the tapered surfaces 12 and 13 of the ring elements 10 and 11, respectively. Thus, the ring element 23 presses the ring elements 10 and 11 radially outward and axially apart, so their mantle surfaces 18 and 20 tightly fit the wall 21 of the cylinder 4. The ring element 23 is made similarly as split ring of the same material as that of the other ring elements 10, 11.

Fig.7 shows the inverse embodiment of the piston ring device 1 according to Fig.6. Here, the outer end-face 26 of the central ring element 23 tightly fits the wall 21 of the cylinder 4, while its tapered surfaces 24 and 25 coact with tapered surfaces 12 and 13 of internally arranged split ring elements 10 and 11. Evidently, the ring elements 10 and 11 transmit their self-tensioning pressure additionally loading the ring element 23 radially outward, and the ring elements 10, 11 and 23 fill out axially tightly the ring groove 3.

Finally, a further embodiment of the piston ring device 1 according to the invention given by way of example is shown in Fig.8 and 9, that can be used as oil retaining ring device. This piston ring device 1 is illustrated in Fig.8 in sectional view and in built in state, while its view (partly cut out) is shown in Fig.9 in dismounted state. This oil retaining piston ring device 1 consists of two ring elements

(marked also with 10 and 11 for the sake of better perspicuity). The ring elements 10 and 11 are made as split circular rings, their tapered surfaces 12 and 13 of the same size turned opposite each other. Their splitting gaps are marked also with 14 and 15 (Fig.9).

In this case, the ring elements 10 and 11 are at axial spacing 27 from each other forming oil outlet gap at the same time. An elastic element 28 is built in between the tapered surfaces 12 and 13 of ring elements 10 and 11, forcing them axially and radially apart. This elastic element 28 in this case is made as an endless annular pre-stressed coil spring.

Fig.8 clearly shows that external mantle surfaces 20, 18 the ring elements 10 and 11 tightly fit the wall 21 of the cylinder 4, and their pressing on is further improved by the elastic element 28. An annular oil space 29 is formed on the middle mantle surface of ring elements 10 and 11 by way of recessing in communication with the gap formed by the spacing 27.

As evident from the foregoing, the piston ring device 1 according to the invention is originally different from the traditional solutions in respect of its construction and way of functioning. Its main advantage is that at relatively low expenditure, with guaranteed long life it offers reliable sealing between the piston 2 and the cylinder 4. Further essential advantage is that it prevents "knockout" of the piston ring device 1 and the piston 2 becoming "stuck", thus saving substantial expenses for the users of the engine.

In the above description and claims under the term "connection locked and loaded by force" -- a force-locking coupling or connection -- is to be understood.

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List of reference numbers

- 1 - piston ring device
- 2 - piston
- 3 - ring groove
- 4 - cylinder
- 5 - end-face
- 6 - mantle
- 7 - upper end plate
- 8 - lower end plate
- 9 - wall
- 10 - upper ring element
- 11 - lower ring element
- 12 - tapered surface
- 13 - tapered surface
- 14 - gap
- 15 - gap
- 16 - cone engle
- 17 - end-face
- 18 - cylindrical mantle surface
- 19 - radial spacing
- 20 - sealed mantle surface
- 21 - wall
- 22 - end-face
- 23 - central ring element
- 24 - tapered surface
- 25 - tapered surface
- 26 - end-face
- 27 - axial spacing
- 28 - elastic element
- 29 - oil space

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C L A I M S

1. Piston ring device for piston reciprocating machine, mainly for internal combustion engines, comprising split ring element arranged by way of self-tensioning in a ring groove of the piston in built in state, and its cylindrical mantle surface tightly fits the cylinder wall, **characterized** in that said piston ring device (1) associated with the single ring groove (3) of the piston (2) being divided and it consists of at least two separate split ring elements (10, 11, 23), in built in state they are in connection locked and loaded by force directly by their tapered surfaces (12, 13, 24, 25), or in given case indirectly through additional prestressed packing piece (shim), mainly elastic element (28), and they fill out axially tightly the ring groove (3).
2. Piston ring device according to claim 1, **characterized** by consisting of two ring elements (10, 11) directly co-acting with each other by way of their tapered surfaces (12, 13), where an external mantle surface (20 or 18) one of the ring elements (10 or 11) tightly fits the internal wall (21) of the cylinder (4).
3. Piston ring device according to claim 1, **characterized** by a central third ring element (23) built in between the upper and lower ring elements (10, 11), wherein tapered surfaces (24, 25) of the central ring element (23) in built in state are in connection locked and loaded by force with the tapered surfaces (12, 13) of the upper and lower ring elements (10, 11), thereby loading the ring elements (10, 11) radially outwardly, and the cylindrical mantle surfaces (20, 18) of the upper and lower ring elements (10, 11) tightly fits the cylinder's (4) wall (21).
4. Piston ring device according to claim 1, **characterized**

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by a central ring element (23) built in between the upper and lower ring elements (10, 11) wherein an external end-face (26) of said central ring element (23) tightly fits the cylinder's (4) wall (21), and tapered surfaces (24, 25) of the central ring element (23) are in connection with the tapered surfaces (12 and 13) of the upper and lower ring elements (10, 11), thereby loading the central ring element (23) radially outwardly.

5. Piston ring device according to claim 1, **characterized** by consisting of two ring elements (10, 11) of preferably the same size and shape built in by way of turning their tapered surfaces (12, 13) opposite each other, and a prestressed elastic element (28) e.g. an endless annular coil spring is built in between the tapered surfaces (12, 13), furthermore in the case of an oil retaining ring device (1) the ring elements (10, 11) are provided with oil outlets.

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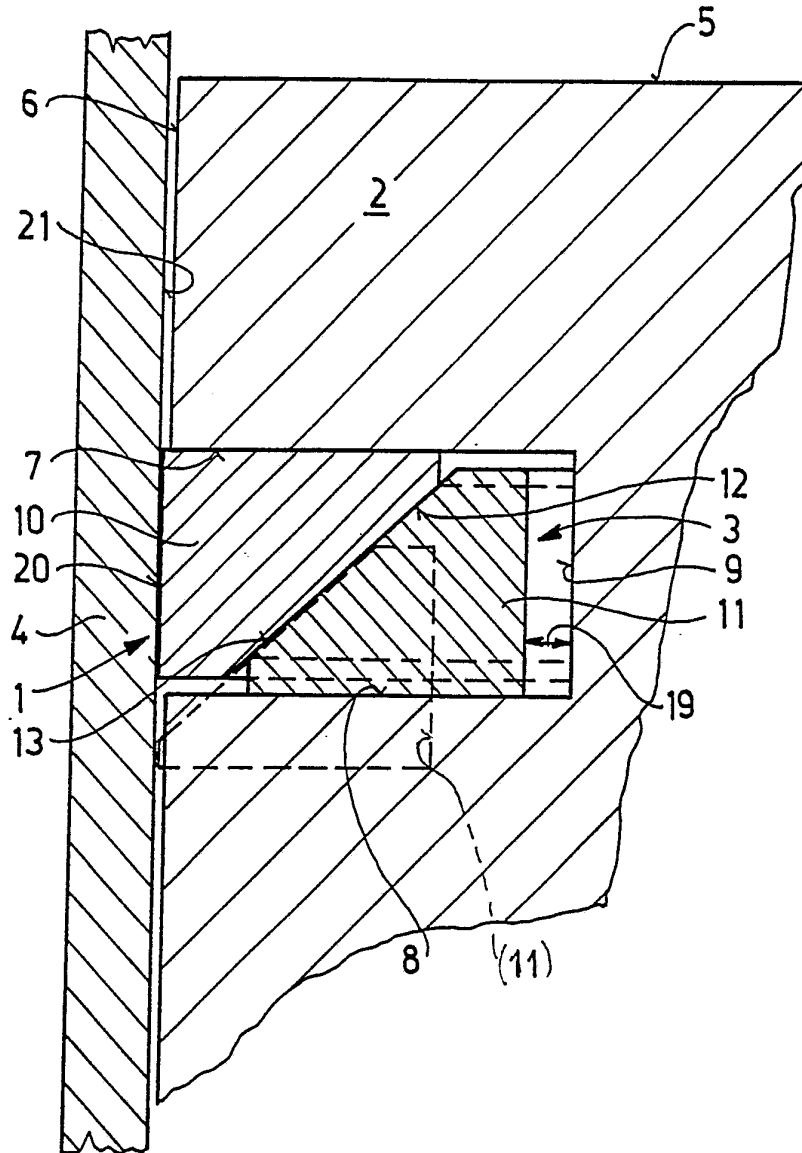


Fig. 1

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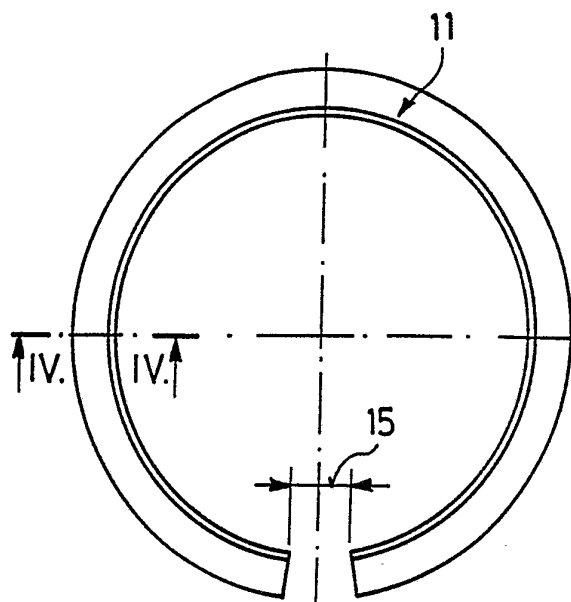


Fig. 2

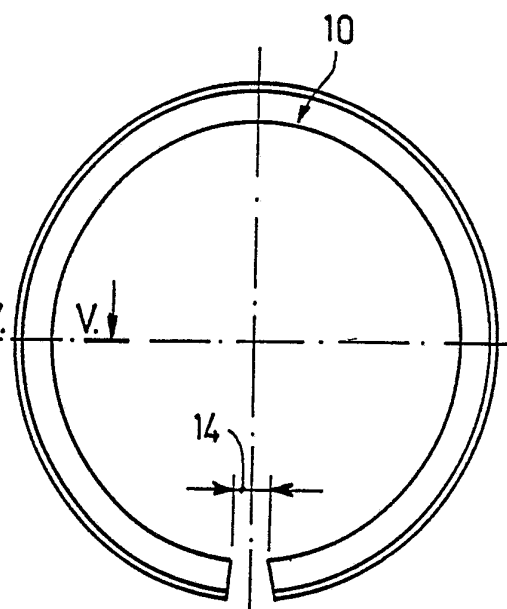


Fig. 3

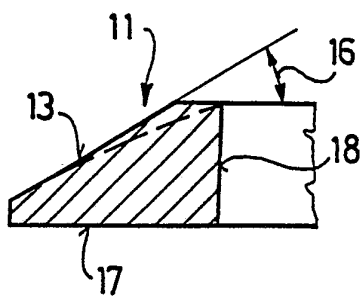


Fig. 4

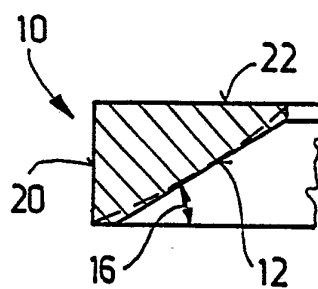


Fig. 5

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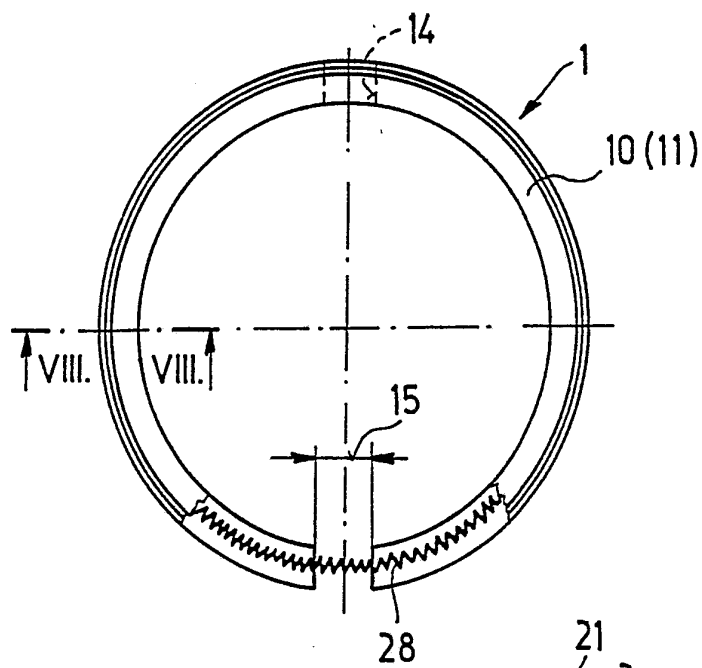


Fig. 9

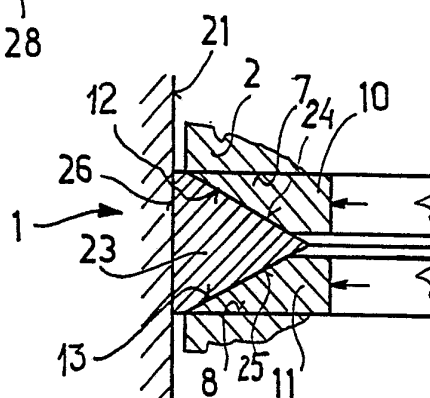


Fig. 7

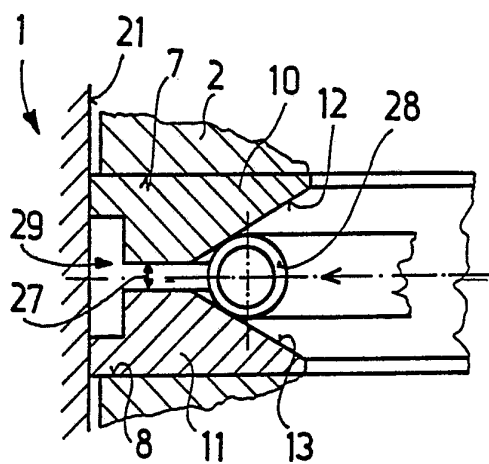


Fig. 8.

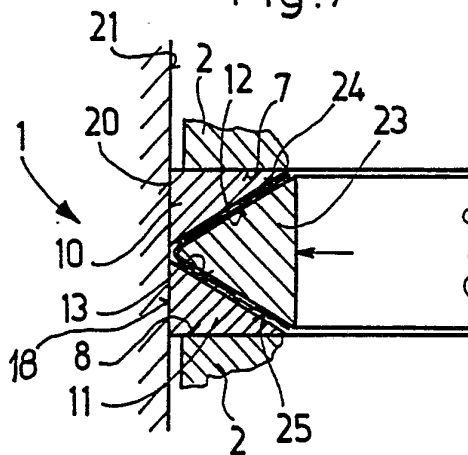
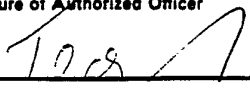


Fig. 6

INTERNATIONAL SEARCH REPORT

International Application No PCT/HU 91/00002

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
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Int. Cl. ⁵ : F 02 F 5/00; F 16 J 9/00		
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Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category [*]	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
Y	DE, C, 835 815 (SCHNÜRLE), 03 April 1952 (03.04.52), see totality.	(1,2,5)
Y	US, A, 3 066 943 (BRENNEKE) 04 December 1962 (04.12.62), see fig. 5.	(1,2,5)
A	US, A, 4 032 159 (ZITTING) 28 June 1977 (28.06.77), see fig. 1-3.	(3,4)
A	FR, A1, 2 561 713 (PONS) 27 September 1985 (27.09.85), see fig. 5,6.	(3,4)
A	US, A, 2 918 340 (KNOEBEL) 22 December 1959 (22.12.59), see totality.	(1,2,5)
A	DE, B, 1 101 070 (GOETZWERKE FRIEDRICH GOETZE AG) 02 March 1961 (02.03.61), see totality.	(1,2,5)

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25 March 1991 (25.03.91)		12 April 1991 (12.04.91)
International Searching Authority		Signature of Authorized Officer
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Annex to the International Search Report on International Patent Application No. PCT/HU 91/00002

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Annexe au rapport de recherche internationale relatif à la demande de brevet international n°.

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DE-C - 835815		None	
US-A - 3066943		None	
US-A - 4032159	28-06-77	None	
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US-A - 2918340		None	
DE-B - 1101070		None	