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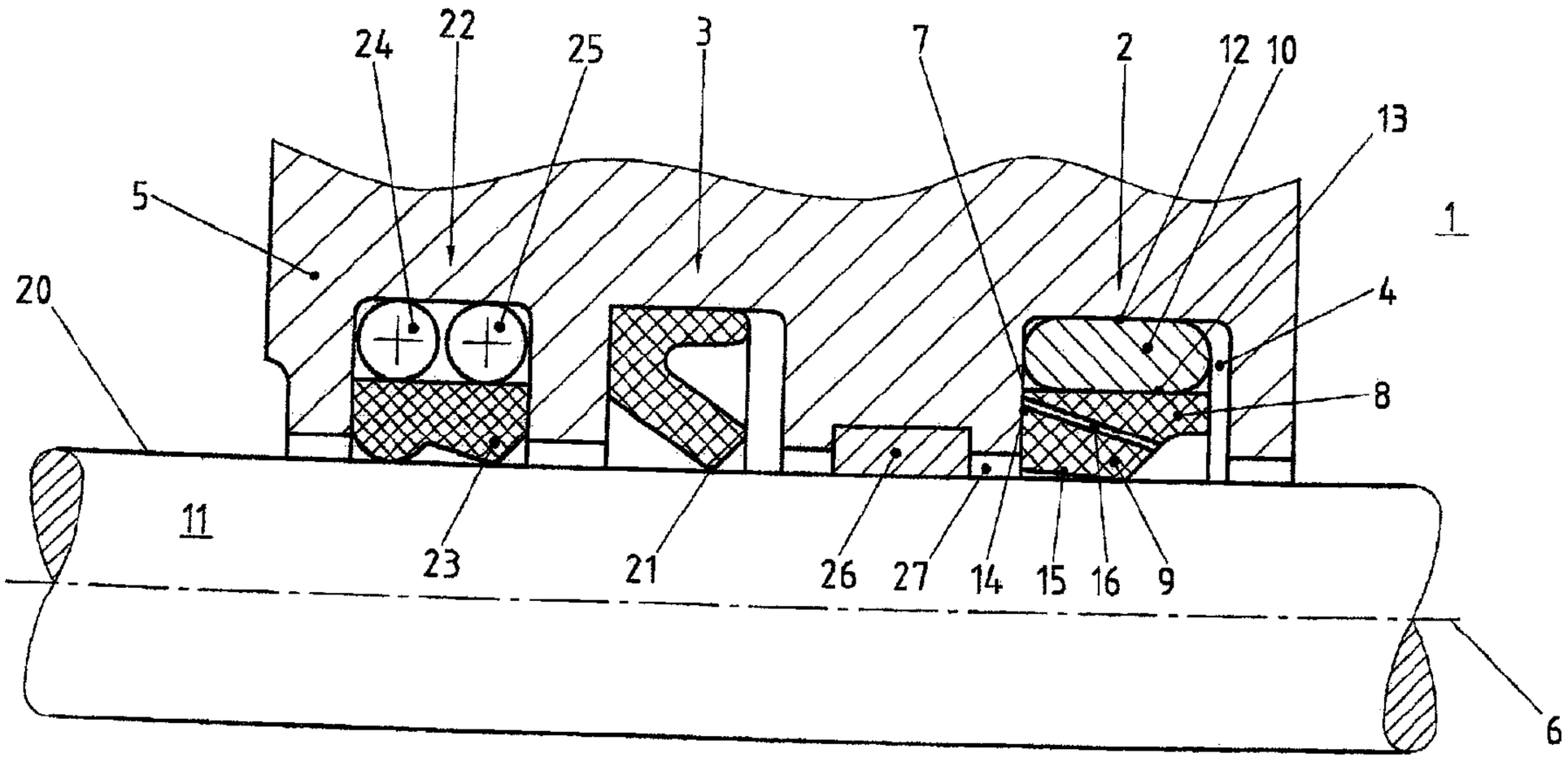


(57) Abrégé/Abstract:
A rod or primary piston seal with a primary seal facing the space to be sealed and a secondary seal directed away therefrom has the primary seal fitted into a groove of a mounting element, which groove is open towards the relatively movable machine part and is defined at a side distal from the space to be sealed by a first lateral surface extending substantially perpendicularly to the seal axis, and the primary seal includes a sealing lip ring of tenacious plastic having a sealing lip engaging the machine part and being forced against the machine part by a profiled ring of elastomeric material, which profiled ring is supported on the base of the groove and engages the sealing lip ring with its inner surface, whereby the sealing lip ring has an essentially rectangular profile between the sealing lip and the end surface facing the distal side surface, the surface defining the sealing lip on the side facing away from the pressure encloses a maximum angle of 8° with the sealing axis in the relaxed condition of the seal, and the sealing lip ring is penetrated by at least one relief opening which is positioned between the high pressure side sealing lip and the outer surface of the sealing lip ring and opens in the low pressure side end surface. Such a seal has a wide field of use, can be used independent of the construction of the secondary seal, can be easily manufactured and is effective at the lowest pressure differentials. If a reversal of the pressure condition occurs, the mouth of the relief opening is uncovered and the liquid can flow back in opposite direction for equalization of the pressure.

Abstract

A rod or primary piston seal with a primary seal facing the space to be sealed and a secondary seal directed away therefrom has the primary seal fitted into a groove of a mounting element, which groove is open towards the relatively movable machine part and is defined at a side distal from the space to be sealed by a first lateral surface extending substantially perpendicularly to the seal axis, and the primary seal includes a sealing lip ring of tenacious plastic having a sealing lip engaging the machine part and being forced against the machine part by a profiled ring of elastomeric material, which profiled ring is supported on the base of the groove and engages the sealing lip ring with its inner surface, whereby the sealing lip ring has an essentially rectangular profile between the sealing lip and the end surface facing the distal side surface, the surface defining the sealing lip on the side facing away from the pressure encloses a maximum angle of 8° with the sealing axis in the relaxed condition of the seal, and the sealing lip ring is penetrated by at least one relief opening which is positioned between the high pressure side sealing lip and the outer surface of the sealing lip ring and opens in the low pressure side end surface. Such a seal has a wide field of use, can be used independent of the construction of the secondary seal, can be easily manufactured and is effective at the lowest pressure differentials. If a reversal of the pressure condition occurs, the mouth of the relief opening is uncovered and the liquid can flow back in opposite direction for equalization of the pressure.

PRIMARY ROD AND PISTON SEAL

Field of the Invention

The invention relates to seals and especially seals for axially movable rods and pistons.

Background Art

Seal arrangements are generally used for the sealing of axially movable rods or pistons in order to seal a high pressure side from a low pressure side. Seals of this type often include sealing lip rings made of a viscoelastic plastic on PTFE (poly tetra fluoroethylene) basis or a harder thermoplastic, which rings include one or more circumferential sealing lips. On their exterior surface, the sealing lip rings are generally radially compressed by a profiled ring of a softer elastomeric material for improved sealing.

The sealing lip ring and the profiled ring are installed in a housing grove. When multiple sequentially arranged seals are present on a rod, an inverted pressure situation can be generated upon translational movement of the two machine parts relative to one another. In that situation, the initially present pressure gradient from the sealed high pressure space to the low pressure space is reversed, which means the low pressure side becomes the high pressure side and the high pressure side becomes the low pressure side. This can result in unacceptable deformations of the sealing lip ring, which in turn can lead to leakage or premature seal failure. A pressure inversion is generated especially upon a pressure drop on the high pressure side, the sealed space and simultaneously a pressure buildup occurs in the sealing space between the primary and secondary seals and then remains at an elevated pressure level or only with great time delay once again decreases to the level of pressure on the high pressure side. The pressure in the sealed space can thereby mount to a level significantly above the maximum operating pressure. Apart from the associated increased friction within the sealing system as a whole, the sealing lip ring of the primary seal can also become rotated under these conditions. The initial contact pressure of the sealing lip is destroyed by plastic deformation and wear such that a sufficient sealing function is no longer present. Thus, the undesired pressure buildup on the low pressure side and the potential for a

pressure inversion possibly damaging the sealing lip is a significant problem with prior seals.

A sealing arrangement is known from DE 196 54 357 A1 wherein at least one connecting channel is provided in the contact surface of the sealing ring through which the high and low pressure sides can be connected. A tension ring and the sealing ring with the connecting channel are mutually oriented such that the high pressure side of the channel is closed by the tension ring during a normal pressure situation, while upon a pressure gradient inversion the connecting channel is opened. The tension ring thereby functions as a one way valve. This construction relies on the additional tension ring and is potentially subject to malfunction upon fatigue of the tension ring material.

Another attempted solution of the problem is apparent from DE 36 20 539 A1. Again, a sealing ring of elastic plastic and a tension ring are used. The sealing ring, on its side facing the rod has two axially spaced apart annular sealing lips and has a least one channel originating in an interior surface between the sealing lips and connecting with and opening into an exterior surface of the sealing ring. The opening of the channel is normally covered by the tension ring. A type of pressure release valve is created in this manner and as soon as the intermediate pressure between the sealing lips exceeds the value of the surface pressure with which the tension ring rests against the opening of the channel, the tension ring is lifted off the opening and the liquid can flow back through the channel into the space to be sealed. The intermediate space defined by the two sealing lips of the seal is thereby ventilated. Again, the additional tension ring and its tension force are required for proper operation of the pressure equalization aspect.

Summary of the Invention

It is therefore an object of the invention to provide a sealing arrangement which includes a simpler construction for counteracting a pressure buildup in an intermediate seal space between individual axially spaced seals.

It is another object to ensure that upon a pressure drop on the high pressure side, a pressure buildup in the sealed space should not remain at the higher pressure level or follow the pressure drop on the high pressure side only with a large time delay. At the same time, only a small or no pressure increase should occur in the intermediate seal space upon a renewed pressure increase on the high pressure side.

This object is achieved in a rod or primary piston seal in accordance with the invention in that the sealing lip ring has an essentially rectangular profile between the sealing lip and an end surface, that the surface defining the sealing lip on the side facing away from the pressure encloses a maximum angle of 8° with the sealing axis in the relaxed condition of the seal, and that the sealing lip ring is penetrated by at least one relief passage which extends between the high pressure side of the sealing lip, with an opening in the low pressure side end surface. Such a seal has a wide field of use, since it can be used independent of the construction of the secondary seal. It can be easily manufactured and is effective at the lowest pressure differentials. It operates reliably and is of simplified construction, since it does not require any separate parts or rings functioning as a one way valve. As soon as a reversal of the pressure condition occurs, the mouth of the relief opening is uncovered and the liquid can flow back in opposite direction.

A preferred rod and primary piston seal in accordance with the invention includes a primary seal adjacent the space to be sealed and a secondary seal spaced therefrom, whereby the primary seal is inserted in a groove of a supporting element, the groove being open towards the relatively movable machine part and defined on a side remote from the space to be sealed by a first side wall extending substantially perpendicularly to the seal axis. The primary seal includes a sealing lip ring of tenacious plastics material having first and second end surfaces respectively adjacent and remote the space to be sealed and a sealing lip for engaging the machine part and for being forced against the machine part by a profiled ring of elastomeric material. The profiled ring is supported on the base of the groove and with an interior surface engages the sealing lip ring. The sealing lip ring has an essentially rectangular profile between the sealing lip and the second end surface facing the side surface of the groove, and a surface defining the sealing lip on the side facing away from the sealed space enclosing a maximum angle of 8° with the sealing axis in the relaxed condition of the seal. The sealing lip ring is penetrated by at least one relief opening which is extends between the high pressure side of the sealing lip in the outer surface of the sealing lip ring and the low pressure side in the second end surface.

In order to achieve a high functional reliability it is possible to provide the sealing lip ring on the first side with a circumferential supporting ridge and to ventilate the space between the sealing lip and the supporting ridge by at least one axial groove in the supporting

ridge. During its manufacture, the supporting ridge is then preferably structured such that its nominal diameter essentially corresponds with that of the sealing lip.

In order to achieve an axial alignment between the sealing lip ring and the profiled ring, the sealing lip ring can undercut the profiled ring on the second side directed away from the space to be sealed. Furthermore, the pressure ring can be supported with a lateral bulge on the side wall of the groove closer to the space to be sealed.

Brief Description of the Drawings

The invention will now be described in more detail by way of example only and with reference to the attached drawings, wherein

Fig. 1 is a half axial cross-section through a rod seal with multiple sealing elements;

Fig. 2 is an enlarged representation of the primary seal according to Fig. 1; and

Fig. 3 is another embodiment of the primary seal in cross-section.

Detailed Description of the Preferred Embodiment

Fig. 1 illustrates in cross-section a mounting element 5, for example a housing wall, which is penetrated by a machine part 11. On the right side of the holding element 5 is the space to be sealed 1. The seal arrangement includes various parts. A primary seal 2 is provided which is placed adjacent the space to be sealed 1 and a secondary seal 3 which is positioned on the other side of the primary seal from the space to be sealed. The secondary seal 3 is in the present exemplary embodiment a lip seal with a sealing lip 21. The seal arrangement preferably also includes a double acting wiper 22. The latter consists of a sealing ring 23 which is held by two clamping rings 24 and 25 and pressed against the machine part 11. A guide ring 26 of appropriate material is preferably provided for the machine element 11.

The primary seal 2 is fitted into a groove 4 in the mounting element 5. The groove has a pair of side walls respectively proximal and distal to the sealed space. The distal groove side wall 7 preferably extends perpendicularly to the seal axis 6. The primary seal 2 includes a sealing lip ring 8 manufactured of a tenacious plastic, preferably PTFE, and has a sealing lip 9 engaging the machine part 11. The sealing lip ring 8 is forced against the machine part 11

by a profiled ring 10 made of elastomeric material. The profiled ring 10 is supported on the base 12 of the groove 4. The profiled ring 10 rests with its radially inner surface 13 against the sealing lip ring 8. The sealing lip ring 8 has a pair of first and second axial end surfaces respectively adjacent to and remote from the space to be sealed. The second end surface 14 of the sealing lip ring 8 rests against the distal side wall 7 of the groove 4 and has an essentially rectangular profile. The radially inward surface 15 of the sealing lip ring 8 extending between the sealing lip 9 and the end surface 14 is slightly oblique and in the relaxed condition of the seal 2 encloses an angle β with the sealing surface 20 or the seal axis 6 which is a maximum of 8°. The sealing lip ring 8 has one or several circumferentially distributed relief passages 16 which extend between the end surface 14 and the opposite axial end surface at a point between the sealing lip 9 and the outer surface 13 of the sealing lip ring 8.

When an over pressure is present in the space to be sealed 1, the sealing lip ring 8 rests with its sealing lip 9 against the machine part 11 and with its second end surface 14 against the distal side wall 7 of the groove 4. As soon as a liquid pressure has built up in the intermediate space 27 between the primary seal 2 and the secondary seal 3 which pressure is higher than the one in sealed space 1, the pressurized liquid in the intermediate space can enter between the distal side wall 7 of the groove 4 and the second end surface 14 of the sealing lip ring 8, from where it is then guided through the relief passage 16 into the sealed space 1.

The primary seal is shown in enlarged scale in Fig. 2. The sealing lip ring 8 and the profiled ring 10 are inserted into groove 4. The sealing lip ring 8 is provided with the sealing lip 9 which rests against the machine part 11. The sealing lip ring 8 rests against the distal side wall 7 of the groove 4 remote from the sealed space 1 with the annular surface portion 29 of the second end surface 14 extending towards the central axis. The relief passages 16 are positioned so that they can provide a connection between the sealed space 1 and the intermediate space 27 between the primary and secondary seals. The shape and location of the relief passages 16 within the sealing lip ring 8 can thereby be arbitrary. It is important for operation of the sealing ring that upon a positive pressure gradient from the sealed space 1 to the intermediate space 27 the second end surface 14 with the opening 30 of the relief passage 16 engages the distal side wall 7 of the groove 4 in such a way that the opening is closed. The sealing lip ring 8 is therefor forced against the distal side surface 7. As soon as the pressure in

the intermediate space 27 exceeds the pressure in the sealed space 1, for whatever reason, the sealing lip ring 8 is slightly axially moved by that pressure in direction towards the sealed space 1 so that liquid can escape from the intermediate space 27 into the resulting gap between annular surface portion 29 and the distal side wall 7. From that gap, the liquid can then flow to the openings 30 of the relief passages 16 and through the relief passages 16 into the sealed space 1 until the pressure is again equalized.

The cross-section of the relief passages 16 is preferably dimensioned such that already at a relatively minor pressurization of the sealed space 1 the sealing lip ring 8 is axially forced towards the distal side wall 7 to rest with its second end surface 14 against the side wall 7 of the groove 4. The angle δ between the second end surface 14 and the radially inward surface 15 of the sealing lip ring 8 is preferably 90°. The two angles β respectively between the second end surface 14 and the distal side wall 7 and the radially inward surface 15 of the sealing lip ring 8 and the outer surface 20 of the machine part 11 can be between 0° and 8°. The angle α enclosed by the sealed space exposed side of the sealing lip 9 and the surface of the machine element 11 can be adapted to the requirements of the respective construction and application.

Another preferred embodiment of the primary seal 2 is shown in Fig. 3, wherein the sealing lip ring 8 is further provided with a circumferential supporting ridge 31. The sealing lip ring is additionally supported on the machine part 11 by this supporting ridge 31. The enclosed space 32 between the sealing lip 9 and the supporting ridge 31 is connected with sealed space 1 by several axial grooves 33. In this manner, the space 32 is ventilated. The relief passages 16 are positioned with their entry openings 34 in the region of the axial grooves 33. The nominal diameter of the supporting ridge 31 is during manufacture essentially the same as the nominal diameter of the sealing lip 9.

Furthermore, in this preferred embodiment, the sealing lip ring 8 on the side facing away from sealed space 1 has a projection 35 with which it undercuts the profiled ring 10. Additionally, the profiled ring 10 is provided with a lateral bulge 36 by which it is supported on the first side wall 37 of the groove.

CLAIMS:

1. Rod or piston primary seal, comprising

a mounting element having a groove open towards the relatively movable rod or piston and being defined by a base, a side wall proximal to a space to be sealed and a side wall distal to the space to be sealed, the distal side wall extending substantially perpendicular to an axis of the seal;

a primary seal adjacent the space to be sealed and a secondary seal remote therefrom;

the primary seal including a sealing lip ring having a sealing lip for engaging the rod or piston and for being forced against the rod or piston by a profiled ring of elastomeric material, the profiled ring being supported on the base of the groove and with a radially inner surface engaging the sealing lip ring, the sealing lip ring having first and second axial end surfaces respectively adjacent to and remote from the space to be sealed and an essentially rectangular profile between the sealing lip and the second end surface facing the distal side wall, a radially inward surface of the sealing lip ring defining the sealing lip on the side facing away from the sealed space enclosing a maximum angle of 8° with the seal axis in the relaxed condition of the seal, and the sealing lip ring being penetrated by at least one relief opening extending between the sealing lip and the outer surface of the sealing lip ring and opening in the end surface, the sealing lip ring being axially movable in the groove between a sealed position wherein the opening of the relief passage in the end surface is sealed by the distal side wall of the groove and a second position wherein the sealing lip ring is moved away from the distal side wall of the groove to allow communication of the relief passage with an intermediate space between the primary and secondary seals.

2. Rod or piston primary seal according to claim 1, wherein the relief opening has a cross-sectional surface of 0.19 to 3.1 mm^2.

3. Rod or piston primary seal according to claim 1 or 2, wherein the sealing lip ring on the side of the sealing lip facing the sealed space has a circumferential supporting ridge and the space between the sealing lip and the supporting ridge is ventilated by at least one axial groove in the supporting ridge.

4. Rod or piston primary seal according to any one of claims 1 to 3, wherein the supporting ridge during manufacture has a nominal diameter which is essentially the same as the nominal diameter of the sealing lip.

5. Rod or piston primary seal according to any one of claims 1 to 4, wherein the sealing lip ring undercuts the profiled ring with a radial projection at the second end facing away from the sealed space.

6. Rod or piston primary seal according to any one of claims 1 to 5, wherein the profiled ring has a lateral bulge for supporting the profiled ring on the proximal side wall of the groove.

Fig. 1

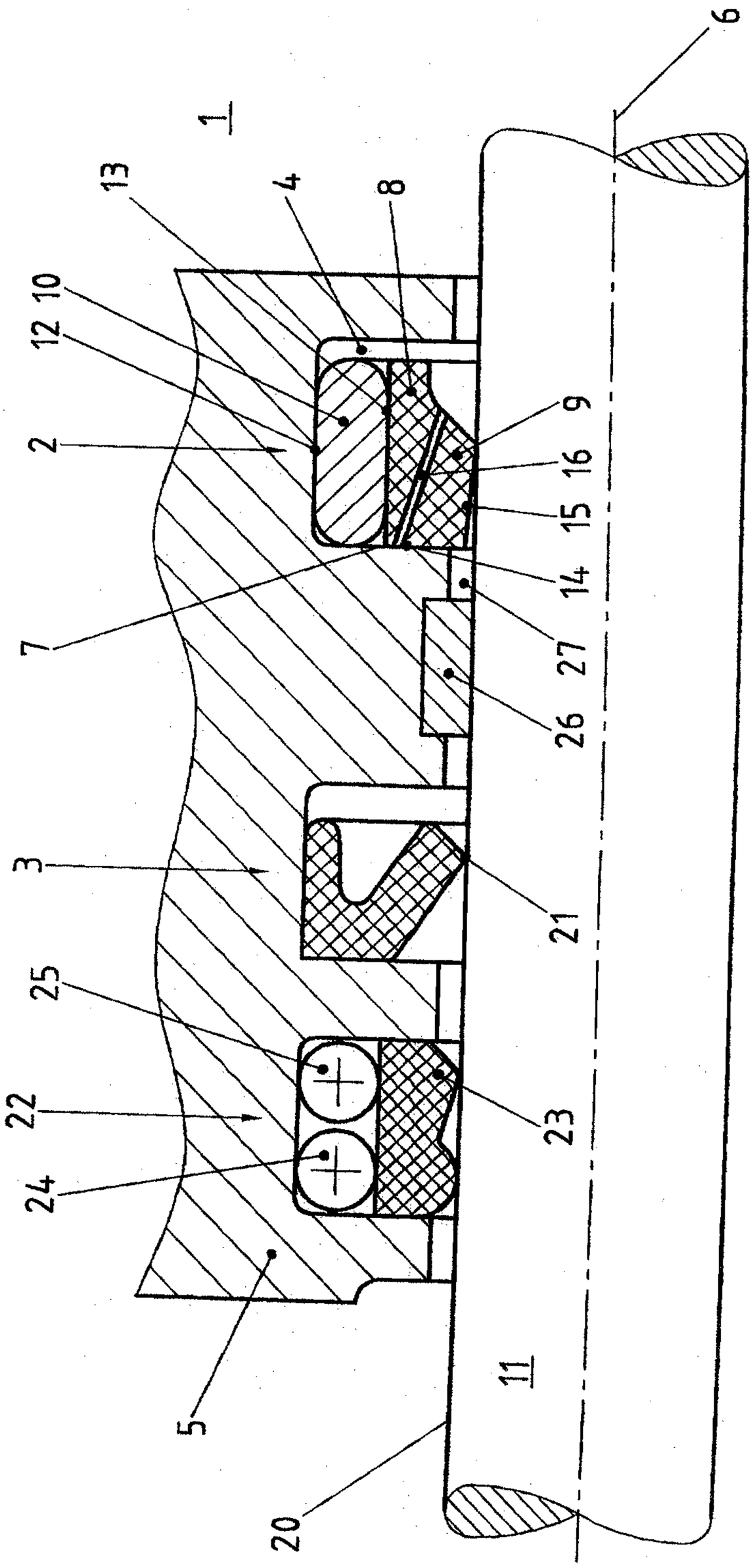


Fig.2

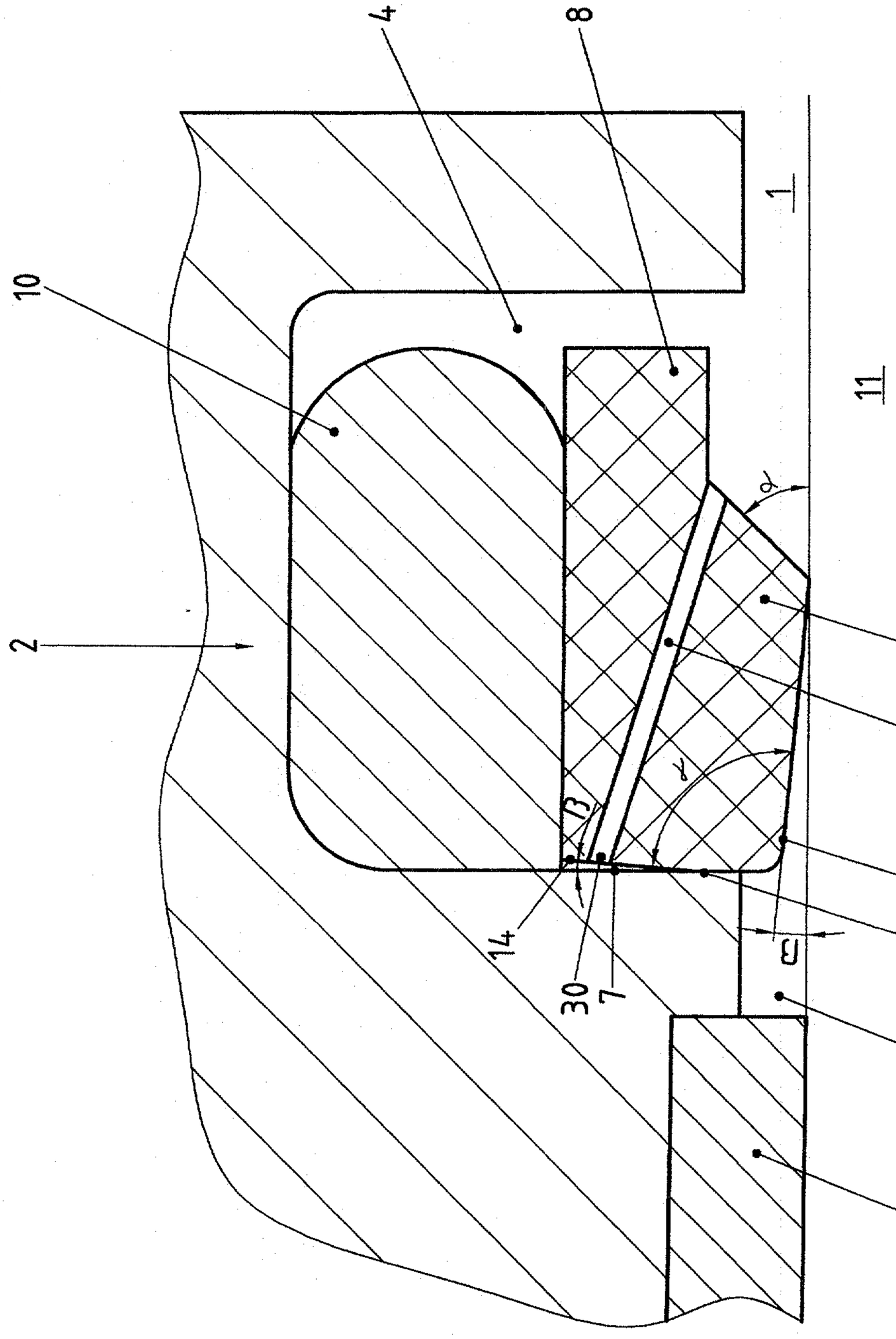
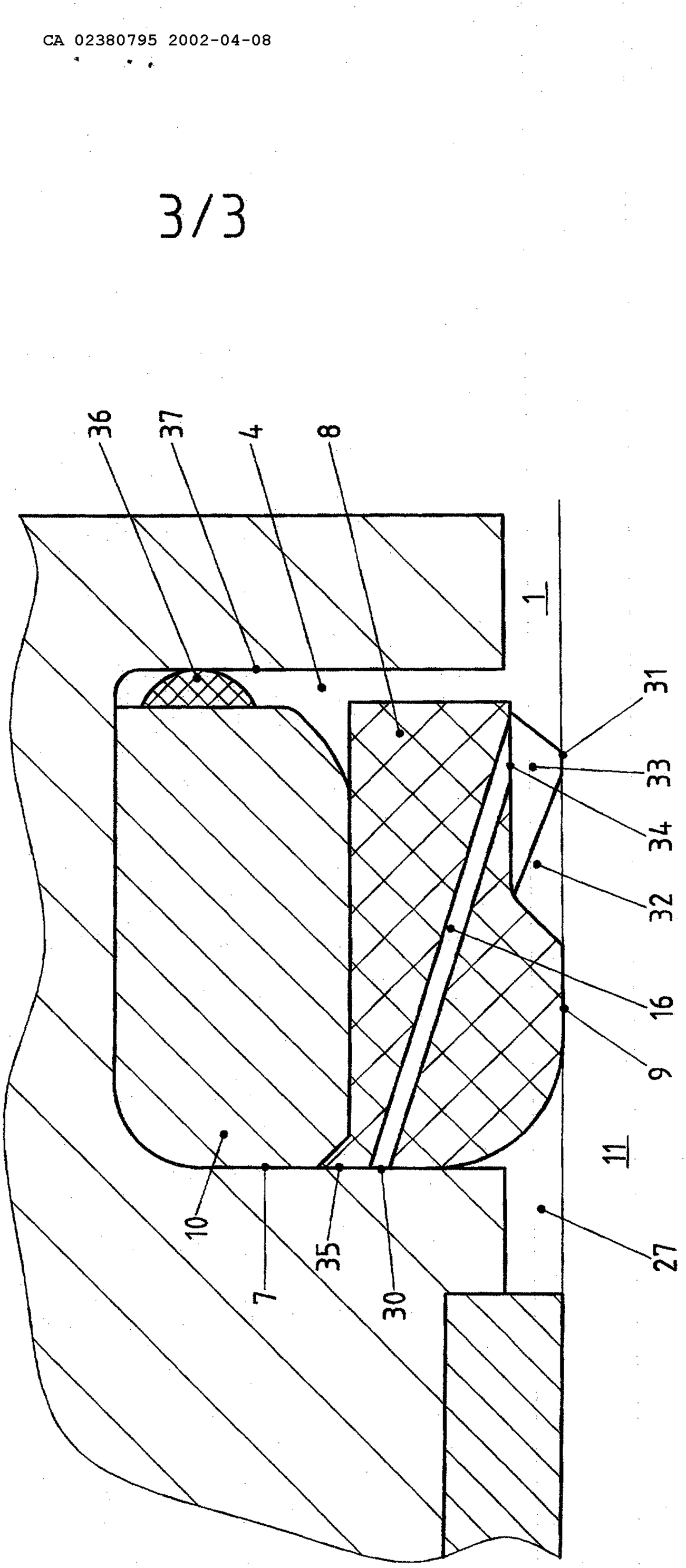
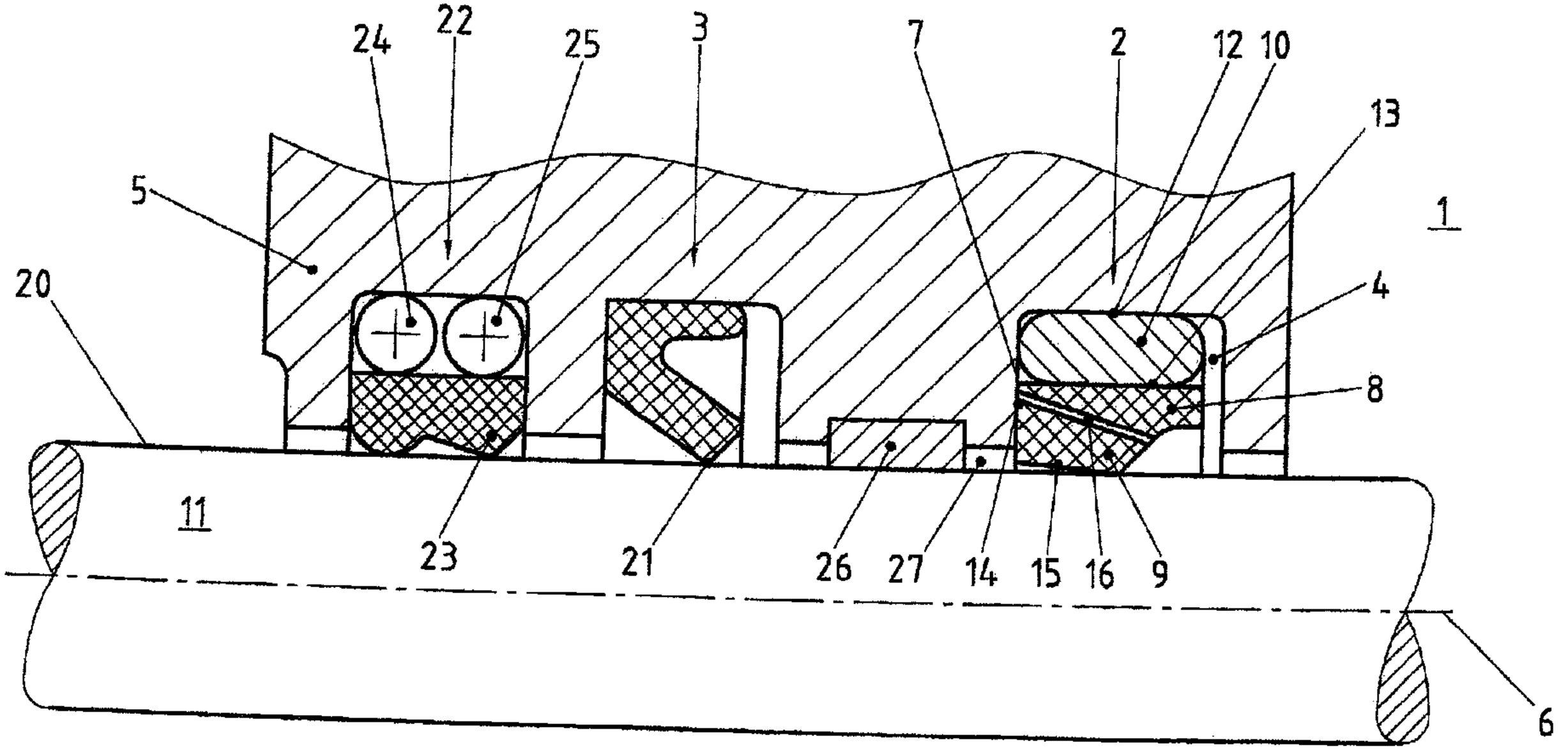


Fig. 3

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