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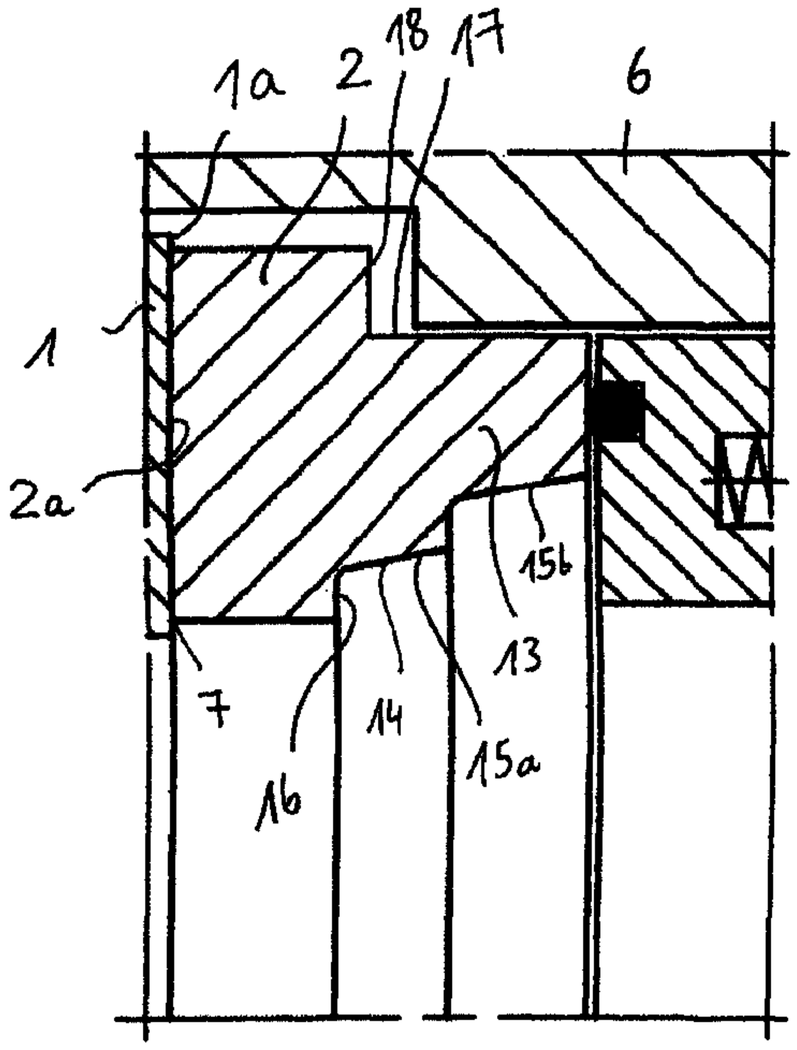
(54) **Title: SLIDE RING SEAL**



(57) **Abrégé/Abstract:**
A slide ring seal, comprising a rotating counter ring (1) and a stationary slide ring (2), wherein the counter ring (1) and the slide ring (2) have in each case sealing surfaces (1a, 2a) which bear against one another and wherein the sealing surface (1a) of the counter ring (1) faces the sealing surface (2a) of the slide ring (2), solves the problem of developing and refining a slide ring seal such that it ensures a reliable function even at varying and different sliding speeds, pressures and temperatures.

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(54) Title: SLIDE RING SEAL

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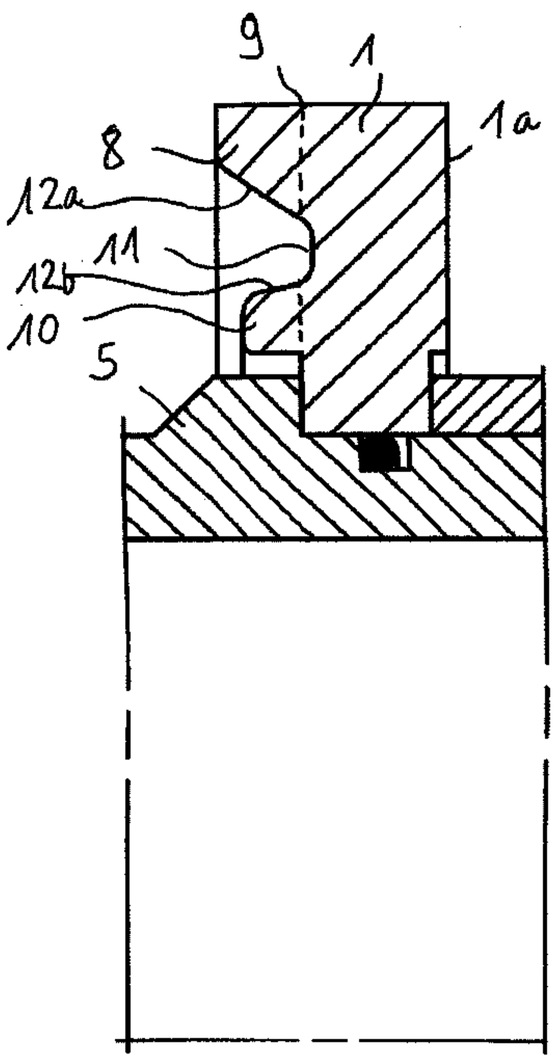

Fig. 3

(57) Abstract: A slide ring seal, comprising a rotating counter ring (1) and a stationary slide ring (2), wherein the counter ring (1) and the slide ring (2) have in each case sealing surfaces (1a, 2a) which bear against one another and wherein the sealing surface (1a) of the counter ring (1) faces the sealing surface (2a) of the slide ring (2), solves the problem of developing and refining a slide ring seal such that it ensures a reliable function even at varying and different sliding speeds, pressures and temperatures.

(57) Zusammenfassung: Eine Gleitringdichtung, umfassend einen rotierenden Gegenring (1) und einen stationären Gleitring (2), wobei der Gegenring (1) und der Gleitring (2) jeweils aneinander liegende Dichtflächen (1a, 2a) aufweisen und wobei die Dichtfläche (1a) des Gegenrings (1) der Dichtfläche (2a) des Gleitrings (2) gegenüberliegt, löst die Aufgabe, eine Gleitringdichtung derart auszugestalten und weiterzubilden, dass diese auch bei variierenden und unterschiedlichen Gleitgeschwindigkeiten, Drücken und Temperaturen eine zuverlässige Funktion gewährleistet.

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SLIDE RING SEAL

Description

Technical Field

The invention relates to a slide ring seal including a rotating counter ring and a stationary slide ring, whereby the counter ring and the slide ring have sealing surfaces which bear against one another and whereby the sealing surface of the counter ring is opposite the sealing surface of the slide ring.

Background Art

Slide ring seals of the above-mentioned type are known from EP 1 209 386 A1.

A counter ring can rotate relative to the stationary slide ring at slide speeds relative to the average slide surface diameter of up to 200 m/s. As a result of viscous friction in the sealing gap, a significant heat input into the slide and counter s occurs at high sliding speeds. Axial temperature gradients in the slide and counter rings can lead to large deformations of the rings. The geometry of the sealing gap can thereby change in an undesired manner or in an unacceptable manner with respect to the height of the sealing gap as well as its V-shaped widening.

It is known from EP 1 209 386 A1 to provide a rotating counter ring with an axial protuberance in order to compensate thermally based warping of the rotating counter ring.

It is a disadvantage of the known slide ring seals that the warping behaviour of the rotating counter ring despite the known measures does not always and in all possible operating conditions allow for a reliable functioning when high temperatures develop.

The demands on the function and operating reliability of the slide ring seals are very high, especially when the slide ring seals are used in turbo machinery, for example compressors or gas turbines with highly variable operating conditions with respect to pressure, revolution speeds and temperature.

Description of the Invention

It is therefore an object of the invention to design and further develop a slide ring seal of the above mentioned type in such a way that it guarantees a reliable function and

high operational safety, even at variable and different sliding speeds, rotational speeds, pressures and temperatures.

This object is achieved in accordance with the slide ring seal of the present invention. In an aspect, the present invention seeks to provide a slide ring seal comprising: a rotating counter ring and a stationary slide ring, whereby the counter ring and the slide ring have respective sealing surfaces, which bear against one another, and whereby the sealing surface of the counter ring is opposite the sealing surface of the slide ring; wherein the counter ring comprises: a first axial protrusion that protrudes from a radial plane of the counter ring; and a second axial protrusion that protrudes from the radial plane and is disposed at a distance from the first protrusion

In another aspect, the radial plane is directed away from the sealing surface of the counter ring. In another aspect, the first protrusion is disposed at a radially outer end of the counter ring and the second protrusion faces a radially inner end of the counter ring. In another aspect, the first protrusion has a trapezoid cross-section. In another aspect, the second protrusion has a trapezoid cross-section. In another aspect, the first and second axial protrusions each have round edges. In another aspect, the first axial projection is larger in size than the second axial protrusion. In another aspect, the slide ring includes an axial bulge having a radially inward shoulder with recesses. In another aspect, the radially inward shoulder has a stepped configuration. In another aspect, the radially inward shoulder opens into a first radial plane of the slide ring and a radially outward shoulder of the slide ring opens into a second radial plane of the slide ring, and the first and second radial planes being disposed at different distances from the sealing surface of the slide ring. In another aspect, the slide ring is pressed by a pressure ring against the counter ring, the pressure ring being supported via a spring element against a first housing wall, a seal arrangement being disposed between the pressure ring and a second housing wall and between the pressure ring and the slide ring, the seal arrangement having a first and a second sealing element that are uncoupled and separate from one another. In another aspect, a first sealing element bears exclusively against the slide ring and against the pressure ring. In another aspect, a second sealing element bears exclusively against the pressure ring and against the second housing wall. In another aspect, the first sealing element is made of an elastomer. In another aspect, the second sealing element is made of polytetrafluorethylene (PTFE). In another aspect, the second sealing element has a U-shaped cross-section. In another aspect, the slide ring

is pressed by a pressure ring against the counter ring, the pressure ring being supported via a spring element against a first housing wall, a sealing arrangement disposed between the pressure ring and a second housing wall and between the pressure ring and the slide ring, the pressure ring, together with the first and second housing walls, defining a space that is shielded against infiltrating contamination. In another aspect, the pressure ring has an axially projecting annular wall with a radially outer surface disposed opposite a radially inner end of the first housing wall. In another aspect, the annular wall projects in an axial direction beyond the first housing wall. In another aspect, the sealing ring seal includes a passage disposed in at least one of the first and the second housing walls configured to allow dirt to exit from the space. In another aspect, the counter ring has two radial planes, each being associated with a clamping cam. In another aspect, the clamping cams project in an axial direction from their respective radial planes. In another aspect, the clamping cams are annular and concentric with respect to the counter ring. In another aspect, the clamping cams have a same height on both sides of the counter ring in the radial direction.

In still another aspect, the present invention seeks to provide an arrangement, comprising: a slide ring seal as defined above; a shaft, the counter ring of the slide ring being non-rotatably joined to the shaft via a clamping element and a bushing, a first clamping cam bears against the bushing and the second clamping cam bears against the clamping element

The counter ring could have a first axial protuberance, which protrudes from a radial plane of the counter ring, whereby the counter ring has second axial protuberance which protrudes from the radial plane and is spaced apart from the first protuberance.

A second protuberance, which together with the first protuberance forms a valley, can compensate for the tilting moments which occur because of axial temperature gradients. Although the person skilled in the art would expect that a further protuberance would lead to a relatively complex, hard to control deformation behaviour of the counter ring, this path could be taken. The first protuberance then stands in sensible interplay with the second protuberance when the counter ring is rotating. The counter ring hereby surprisingly exhibits in equal measures both flexibility as well as stability with respect to its deformation behaviour, even under highly variable loads with respect to pressure, rotational speed and temperature. An optimal geometry of the sealing ring gap is thereby maintained even under highly variable operating conditions.

The radial plane could be directed away from the sealing surface of the counter ring. It is advantageous that the sealing surfaces which bear against one another are not affected hereby.

The first protuberance could be formed on the radially outer end of the counter ring, whereby the second protuberance is facing the radially inner end of the counter ring. The rotational plane of the counter ring is hereby stabilized against tilting.

The first protuberance could be of trapezoid shape in cross-section. This specific construction has proven especially advantageous, since it results in a positive mass distribution and center of mass shift within the counter ring.

Against this background, the second protuberance could be of trapezoid shape in cross-section. Planes which are oriented parallel to the rotational axes are hereby avoided on which fluids, especially liquid lubricants could deposit.

The protuberances can have rounded edges. Secondary vortex tears on the protuberances can thereby be minimized.

The first protuberance could have a larger extent than the second protuberance. This surprisingly results in an equally flexible and stable deformation behaviour of the rotating counter ring at different operating conditions.

It is known from EP 1 209 386 A1 to provide a rotating counter ring with an axial protuberance in order to compensate thermally based warping of the rotating counter ring.

It is a disadvantage of the known slide ring seals that the deformation behaviour of the rotating counter ring, despite the known measures, not always allows in all possible operating conditions for a reliable function at high temperature development.

Especially when slide ring seals are used in turbo machinery, especially compressors or gas turbines with highly variable operating conditions with respect to pressure, rotational speed and temperature, very high demands are made on the function and operating safety of the slide ring seals.

Before this background, the sliding ring could have an axial protuberance, the radially inner face of which has cut outs.

This surprisingly results in a virtually constant gap width. The stationary slide ring then follows in its movement and deformation behaviour the rotating counter ring in such a way that the sealing gap between the sealing surfaces does not widen or decrease in an unacceptable manner. The cut outs are in sensible interplay with the counter ring during its rotation, whereby the counter ring rotates surprisingly stably and quietly and the slide ring follows it axially. The stable and quiet rotation leads to a very high leak tightness and an optimized gap width between the sealing surfaces.

Whenever reference is made to the gap width in this description, this designates the spacing of the sealing surfaces. The person skilled in the art calls this axial distance also gap height. The cut outs are not provided with seals or seal elements. The cut outs are also free of centering elements which axially or radially rest on the radially inward flank.

The radially inward flank can be stepped. Steps can be provided without problem in the body of the sliding ring.

The radially inward flank could end in a first radial plane of the sliding ring, whereby a radially outward flank of the sliding ring ends on a second radial plane of the sliding ring and whereby the first and second radial planes are differently spaced from the sealing surface of the sliding ring. A very advantageous shape of the sliding ring results

from this specific design so that the sealing gap between the sealing surfaces is virtually constant.

It is known from EP 1 209 386 A1 to seal a space facing the sealing surface of the sliding ring against a space on the housing side in which the pressure ring is positioned. The seal is achieved with a sealing arrangement which includes a single sealing element. The sealing element simultaneously contacts the pressure ring, the sliding ring and the second housing wall.

It is a disadvantage of the known slide ring seal that the sealing element limits the freedom of movement of the slide ring. This can result in particular in a stick-slip-behaviour.

Very high demands on the function and operational safety of the slide ring seals are however, placed on slide ring seals in turbo machinery especially compressors and gas turbines, with high variable operating conditions with respect to pressure, rotational speed and temperature.

It is hereby desirable to construct and further develop a slide ring seal of the above mentioned type in such a way that it guarantees a reliable function and operating safety even at variable and differing rotational speeds, pressures and temperatures.

Against this background, the sliding ring can be pressed by a pressure ring against the counter ring, whereby the pressure ring is supported by way of a spring element on a first housing wall, whereby a sealing arrangement is provided between the pressure ring and a second housing wall as well as between the pressure ring and the slide ring and whereby the sealing arrangement includes two separate sealing elements which are decoupled from one another.

Two separate sealing elements which are decoupled from one another can fulfill different sealing tasks in an optimal manner by selection of different materials. It has thereby been found especially that the sealing elements with respect to their elasticity properties and morphological properties can be adapted to their respective installation situation independently from one another. The slide ring hereby exhibits, even upon strongly varying demands with respect to pressure, rotational speed and temperature in equal measures both flexibility as well as stability with respect to its movement behaviour. An optimal geometry of the sealing gap is thereby maintained even upon strongly varying operating conditions.

Against this background, a first sealing element could rest exclusively against the slide ring and the pressure ring. A reliable seal between the axially opposing end surfaces of the slide ring and the pressure ring can hereby be achieved.

A second sealing element could exclusively rest against the pressure ring and the second housing wall. A reliable seal between the radially opposing end surfaces of the pressure ring and the housing can thereby be achieved.

The first sealing element could be made of an elastomer. An elastomer is usually sufficiently soft and can therefore seal very reliably between the axially opposing end surfaces of the slide ring and the pressure ring.

The second sealing element could be made of polytetrafluorethylene (PTFE). This material preferably does not adhere to the second housing wall and provides the pressure ring with a certain mobility relative to the housing.

The second sealing element could be at least in regions formed with a U-shaped cross-section. The second sealing element can thereby create a spreading effect. A U-shape involves a pair of protruding legs which can respectively rest against the pressure ring at the second housing wall under contact pressure.

It is known from EP 1 209 386 A1 to seal a space facing the sealing surface of the slide ring against a housing side space in which the pressure ring is positioned. The seal is achieved with a sealing arrangement which includes a single sealing element. The sealing element rests simultaneously on the pressure ring, on the slide ring and on the second housing wall.

It is a disadvantage of the known slide ring seal that contamination can enter into the housing side space. The contamination can enter from the side facing away from the slide ring.

This can lead to friction damage because of infiltrated dirt particles, especially because of infiltrated dust. This can lead to undesirable changes in the surface condition between the sealing element and the housing. This can be accompanied with a worsening of the shifting behaviour of the pressure ring relative to the housing. Undesirable changes in the geometry of the sealing gap can occur as a result.

Very high demands on the function and operational safety of the slide ring seals are however, placed on slide ring seals in turbo machinery especially compressors and gas

turbines, with high variable operating conditions with respect to pressure, rotational speed and temperature.

It is hereby desirable to construct and further develop a slide ring seal of the mentioned type in such a way that it guarantees a reliable function and operational safety even at variable and different rotational speeds, pressures and temperatures.

Against this background, the slide ring can be pressed by a pressure ring against the counter ring, whereby the pressure ring is supported on a first housing wall by way of a spring element, whereby a sealing arrangement is provided between the pressure ring and a second housing wall as well as between the pressure ring and the slide ring and whereby the pressure ring together with the housing walls defines a space which is shielded against infiltrating contamination.

A shielding prevents the entry of contamination. The surface condition between the sealing element and the housing is hereby almost not negatively influenced. A worsening of the shifting behaviour of the pressure ring relative to the housing can therefore be positively counteracted. As a result, disadvantageous changes of the geometry of the sealing gap can be avoided. An optimal geometry of the sealing gap can thereby be maintained even during strongly varying operating conditions.

The pressure ring may have an axially protruding annular wall, the radially outer surface of which is positioned opposite the radially inner end of the first housing wall. This realizes a chambering of the pressure ring and the spring element in a housing side annular space. Advantageously, no fragments can be transported outward upon failure of the spring element.

The annular wall can surpass the first housing wall in axial direction. An overhang reliably prevents the infiltration of dust into the space in which the spring element is housed.

A passage can be provided in the first and/or second housing wall through which contamination already present can exit from the space. The passage is preferably formed behind the pressure ring on the side facing away from the slide ring. In that the passage is provided in a lower region of the housing, already infiltrated contamination can exit the space by way of gravity.

Against this background, it is known from EP 1209386 A1 to clamp a rotating counter ring torque-proof by way of a bushing and a clamping element.

It is a disadvantage of known slide ring seals that the rotating counter ring during rotation can carry out undesired tilting motions. This can lead to undesired changes of the geometry of the sealing gap between the sealing surfaces. The slide ring seal can then no longer ensure a reliable function during all occurring operating conditions.

Especially upon use of slide ring seals in turbo machinery, for example compressors or gas turbines with strongly varying operating conditions regarding pressure, rotational speed and temperature, however, very high demands are placed on the function and operational reliability of the slide ring seals.

It is thereby desired to design and further develop a slide ring seal of the above-mentioned type so that it ensures a reliable function and operational reliability even at varying and differing rotational speeds, pressures and temperatures.

Against this background, the counter ring may include two radial planes respectively associated with a clamping cam.

A defined clamping of the counter ring can be assured with axially protruding clamping cams. Tilting moments which occur can be surprisingly easily compensated and prevented. It was thereby initially found that a counter ring clamped between clamping elements can be in frictional contact therewith. Friction forces occur thereby which can cause tilting moments. It has further been found that clamping cams can be positioned in such a way that the attacking tilting moments can compensate each other. It has hereby been concretely found that the clamping cams define a plane on which the tilting moments can attack in a defined and compensatable manner. The counter ring therefore surprisingly displays a high degree of stability with respect to tilting behaviour even at strongly varying loads with respect to pressure, rotational speed and temperature. An optimal geometry of the sealing gap is thereby maintained even under strongly varying operating conditions.

The term association of the clamping cams with the radial planes means either a forming of the clamping cams on the counter ring directly or on the clamping elements of the shaft.

The counter ring may have two radial planes from which respectively one clamping cam protrudes. Preferably, the clamping cams are formed on the counter ring and not on the bushing and the clamping element. This is because the material used for the

counter ring is softer than the materials for the bushing or the clamping element. Furthermore, an even wear of the clamping cams is desired.

The clamping cams can be of annular shape and concentric to the counter ring. The counter ring can thereby be anchored on the shaft by linear pressure.

The clamping cams can be formed out of and made in piece with the counter ring.

The clamping cams can be formed on both sides of the counter ring and in radial direction at the same height. This ensures that tilting moments which occur attack on the same plane and preferentially compensate one another.

As soon as the counter ring and the shaft move radially relative to one another tilting moments occur. These tilting moments are compensated in that the clamping cams are positioned at the same radial height.

One embodiment can include a slide ring seal of the type described herein and a shaft, whereby the counter ring is connected torque-proof with the shaft by way of a clamping element and a bushing and whereby a first clamping cam engages the bushing and the second clamping cam the clamping element. The counter ring can be clamped on the shaft in a defined manner by the bushing and the clamping element.

The slide ring seal described herein is especially suited for use in turbo machinery, for example compressors or gas turbines, since it guarantees a reliable function even under varying and differing sliding speeds, pressures and temperatures.

The slide ring seal described herein seals a gas or a mixture of a gas and a fluid, whereby the sealing surfaces are gas lubricated.

Several possibilities exist to preferably embody and to further develop the teaching of the present invention. Reference is made herefor to the claims below on the one hand and on the other hand to the following description of a preferred embodiment of the slide ring seal in accordance with the invention by way of reference to the drawing.

Generally preferred embodiments and further embodiments of the teaching are described in connection with the description of the preferred embodiment and with reference to the drawing.

Brief Description of the Drawing

In the drawing:

Figure 1 shows a cross-section of a slide ring seal of the prior art;

Figure 2 shows a cross-section of a the housing side portion of the slide ring seal according to Figure 1;

Figure 3 shows a cross-section of a shaft side portion of a slide ring seal in which the rotating counter ring has two protuberances in axial direction;

Figure 4 shows a cross-section of a housing side portion of a slide ring seal in which the stationary slide ring has an axial bulge in which a stepped shoulder is formed;

Figure 5 shows a cross-section of a slide ring seal of the prior art in which a single sealing element is associated with the pressure ring;

Figure 6 shows a cross-section of a slide ring seal in which two separate, mutually decoupled sealing elements are associated with the pressure ring;

Figure 7 shows a cross-section of a slide ring seal of the prior art in which a single sealing element is associated with the pressure ring;

Figure 8 shows a cross-section of a slide ring seal in which an axially protruding annular wall is associated with the pressure ring;

Figure 9 shows a cross-section of a slide ring seal of the prior art in which the rotating counter ring does not include any clamping cams in axial direction; and

Figure 10 shows a cross-section of a shaft side portion of a slide ring seal in which the counter ring has clamping cams protruding on both sides.

Description of the Invention

Figure 1 shows a slide ring seal of the prior art.

The slide ring seal shown in Figure 1 includes a rotating counter ring 1 and a stationary slide ring 2, whereby the counter ring 1 and the slide ring 2 have mutually contacting sealing surfaces 1a, 2a, whereby the sealing surface 1a of the counter ring 1 is opposite the sealing surface 2a of the slide ring 2.

The rotating counter ring 1 is fastened on a rotating shaft 5 and rotates with the latter. This stationary slide ring 2 is positioned loosely centered in a housing.

Figure 2 shows a housing side portion of the slide ring seal according to Figure 1.

Figure 3 shows a shaft side portion of a slide ring seal and Figure 4 shows a housing side portion of a slide ring seal. The housing side portion according to Figure 4 can thereby be combined with the shaft side portion according to Figure 3 or the shaft side portion according to Figure 1.

The slide ring seal shown in Figure 3 and Figure 4 includes a rotating counter ring and a stationary slide ring 2, whereby the counter ring 1 and the slide ring 2 include sealing surfaces 1a, 2a which bear against one another, whereby the sealing surface 1a of the counter ring 1 is opposite the sealing surface 2a of the slide ring 2. A sealing gap 7 is thereby formed between the sealing ring surfaces 1a, 2a. The rotating counter ring 1 is fixed on a rotating shaft 5 and rotates with the latter. The stationary slide ring 2 is loosely centered in a housing 6.

The counter ring 1 has a first axial protuberance 8, which protrudes from a radial plane 9 of the counter ring 1 which is shown in broken lines. The counter ring 1 has a second axial protuberance 10 which protrudes from the radial plane 9 and is radially spaced apart from the first protuberance 8.

The first protuberance 8 and the second protuberance 10 concretely define a valley 11 which is located somewhat deeper than the radial plane 9. The valley 11 may however also be somewhat higher than the radial plane 9. The counter ring 9 is made of metal and has a diameter (inside measure) of 300 mm. The radial plane 9 is axially directed away from the sealing surface 1a of the counter ring 1. The first protuberance 8 is formed on the radially outer end of the counter ring 1, whereby the second protuberance 10 is directed towards the radially inner end of the counter ring 1.

The first protuberance 8 and the second protuberance 10 are trapezoid in cross-section. The protuberances 8, 10 have rounded edges 12a, 12b.

The first protuberance 8 shows a larger dimension than the second protuberance 10.

Figure 4 shows that the slide ring 2 has an axial bulge 13, the radially inner shoulder 14 of which has recesses 15a, 15b. The radially inner shoulder is constructed with steps.

The radially inner shoulder 14 ends in a first radial plane 16 of the slide ring 2, whereby a radially outer shoulder 17 of the slide ring 2 ends in a second radial plane 18 of the slide ring 2 and whereby the first and second radial planes 16, 18 are spaced at different distances from the sealing surface 2a of the slide ring 2.

The slide ring 2 is made of carbon material.

Figures 2 shows a slide ring seal of the prior art.

The slide ring seal illustrated in Figure 5 includes a rotating counter ring 1 and a stationary slide ring 2, whereby the counter ring 1 and the slide ring 2 have sealing surfaces 1a, 2a which bear against one another, whereby the sealing surface 1a of the counter ring 1 is opposite the sealing surface 2a of the slide ring 2, whereby the slide ring 2 is pressed by a pressure ring 2b against the counter ring 1, whereby the pressure ring 2b is supported by way of a spring element 2c against a first housing wall 6a and whereby a sealing arrangement 2d is provided between the pressure ring 2b and a second housing wall 6b as well as between the pressure ring 2b and the slide ring 2.

The rotating counter ring 1 is torque-proof mounted on a rotating shaft 5 and rotates therewith. The stationary slide ring 2 is positioned loosely centered in a housing 6. This results in a sealing gap 7 between the sealing surfaces 1a, 2a.

Figure 6 shows a slide ring seal which includes a rotating counter ring 1 and a stationary slide ring 2, whereby the counter ring 1 and the slide ring 2 have sealing surfaces 1a, 2a which bear against one another, whereby the sealing surface 1a of the counter ring 1 is axially opposite the sealing surface 2a, of the slide ring 2, whereby the slide ring 2 is axially pressed by a pressure ring 2b against the counter ring 1, whereby the pressure ring 2b is supported by way of a spring element 2c axially against a first housing wall 6a and whereby between the pressure ring 2b and a second housing wall 6b as well as between the pressure ring 2b and the slide ring 2a a sealing arrangement 2d, 2e is provided, whereby the sealing arrangement 2d, 2e includes 2 mutually decoupled and separate sealing elements 2d, 2e.

A first sealing element 2e bears exclusively against the slide ring 2 and the pressure ring 2b. A second sealing element 2d bears exclusively against the pressure ring 2b and the first housing wall 6b.

The first sealing element 2e is made of an elastomer. The first sealing element 2e is located in a grove 2f of the pressure ring 2b, which is directed axially toward the slide ring 2. The first sealing element 2e is designed as an O-ring.

The second sealing element 2d is made of polytetraflorethylene (PTFE). The second sealing element 2d is designed, at least in portions, with a U-shaped cross-section. A V-shaped design is hereby also conceivable. It circumferentially surrounds the pressure ring 2b and lies in a peripherally extending annular grove 2g.

The counter ring 1 is made of metal and has a diameter (inside measure) of 300 mm. The slide ring 2 is made of carbon material.

The rotating counter ring 1 is torque-proof mounted on a rotating shaft 5 and rotates therewith. A stationary slide ring 2 is positioned loosely centered in a housing 6. A sealing gap 7 is thereby formed between the sealing surfaces 1a, 2a.

Figure 7 shows a slide ring seal of the prior art.

The slide ring seal illustrated in Figure 7 includes a rotating counter ring 1 and a stationary slide ring 2, whereby the counter ring 1 and the slide ring 2 have sealing surfaces 1a, 2a which bear against one another, whereby the sealing surface 1a of the counter ring 1 is opposite the sealing surface 2a of the slide ring 2, whereby the slide ring 2 is pressed by a pressure ring 2b against the counter ring 1, whereby the pressure ring 2b is supported by way of a spring element 2c against a first housing wall 6a and whereby a sealing arrangement 2d is provided between the pressure ring 2b and a second housing wall 6b as well as between the pressure ring 2b and the slide ring 2.

The rotating counter ring 1 is torque-proof mounted on a rotating shaft 5 and rotates therewith. The stationary slide ring 2 is positioned loosely centered in a housing 6. This results in a sealing gap 7 between the sealing surfaces 1a, 2a.

The slide ring seal illustrated in Figure 8 includes a rotating counter ring 1 and a stationary slide ring 2, whereby the counter ring 1 and the slide ring 2 have sealing surfaces 1a, 2a which bear against one another, whereby the sealing surface 1a of the counter ring 1 is opposite the sealing surface 2a of the slide ring 2, whereby the slide ring 2 is pressed by a pressure ring 2b against the counter ring 1, whereby the pressure ring 2b is supported by way of a spring element 2c against a first housing wall 6a and whereby a sealing arrangement 2d is provided between the pressure ring 2b and a second housing wall 6b as well as between the pressure ring 2b and the slide ring 2.

Together with the housing walls 6a, 6b, the pressure ring 2b defines a space which is shielded against infiltrating contamination. The space is formed on the side of the pressure ring 2b which is directed away from the slide ring 2. The space, namely the housing side space, is designed as an annular space in which the spring element 2c is received.

The pressure ring 2b has an axially protruding annular wall 2h, the radially outer surface of which is positioned opposite the first housing wall 6a. The annular wall 2h

thereby protrudes in the same direction in which the spring element 2c protrudes from the pressure ring 2b. The spring element 2c is received in a blind hole in the pressure ring 2b and designed as a cylindrical compression spring.

The annular wall 2h surpasses the first housing wall 6a in axially direction. The annular wall 2h on the back side of the first housing wall 6a which is directed away from the pressure ring 2b, protrudes with an annular overhang from the first housing wall 6a.

A passage 6c is formed in the first and second housing wall 6a, 6b through which contamination can exit from the space. The passage 6c is preferably positioned on the side directed axially away from the slide ring 2 behind the pressure ring 2b. By placement of the passage 6c in a lower region of the housing 6, already infiltrated contamination can exit the space under the influence of gravity.

The counter ring 1 is made of metal and has a diameter (inside measure) of 300 mm. The slide ring 2 is made of carbon material.

The rotating counter ring 1 is mounted torque-proof on a rotating shaft 5 and rotates therewith. The stationary slide ring 2 is mounted loosely centered in a housing 6. This results in a sealing gap 7 between the sealing surfaces 1a, 2a.

Figure 9 shows a slide ring seal of the prior art.

The slide ring seal shown in Figure 9 includes a rotating counter ring 1 and a stationary slide ring 2, whereby the counter ring 1 and the slide ring 2 have sealing surfaces 1a, 2a which bear against one another, whereby the sealing surface 1 of the counter ring is opposite the sealing surface 2a of the slide ring 2.

The rotating counter ring 1 is torque-proof mounted on a rotating shaft 5 and rotates therewith. The stationary slide ring 2 is mounted loosely centered in a housing 6.

Figure 10 shows the shaft side portion of the slide ring seal with a construction analogous to the one of the slide ring seal according to Figure 9, comprising a rotating counter ring 1 and a stationary slide ring 2, whereby the counter ring 1 and the slide ring 2 have sealing surfaces 1a, 2a which respectively bear against one another, whereby the sealing surface 1a of the counter ring 1 is opposite the sealing surface 2a of the slide ring 2. The counter ring has to axially opposite radial planes 1b, 1c from which respectively one clamping cam 1d, 1e protrudes in axial direction. The clamping cams 1d, 1e protrude from both sides of the counter ring 1.

The clamping cams 1d, 1e are annular and concentric with the counter ring 1. They can also be constructed only partially on the radial planes 1b, 1c.

The radial planes 1b, 1c are shifted axially inward relative to the sealing surface 1a and the radial plane opposite the sealing surface 1a. The clamping cams 1d, 1e are formed on both sides of the counter ring 1 and in radial direction at the same height relative to the axis rotation of the shaft 5.

Figure 10 concretely shows the shaft side portion of an arrangement, including a slide ring seal of the above described type and a rotating shaft 5, whereby the counter ring 1 is connected torque-proof with a shaft 5 by way of a clamping element 5a and a bushing 5b and whereby a first clamping cam 1d engages the bushing 5b and the second clamping cam 1c engages a clamping element 5a.

Preferably, the clamping cams 1d, 1e are formed on the counter ring 1 and not on the bushing 5b and the clamping element 5a. This is because the material of the counter ring 1 is softer than the materials of the bushing 5b or the clamping element 5a. Furthermore, even wear of the clamping cams 1d, 1e is desired.

The counter ring is made of metal and has a diameter (inside measure) of 300 mm.

The slide ring 2 is made of carbon material.

With respect to further preferred embodiments and further developments of the teaching in accordance with the invention, reference is made to the general part of the description on the one hand and to the appended patent claims on the other hand.

In closing, it is expressly emphasized that all embodiments and combinations of slide ring seals and slide ring seal arrangements disclosed in the description and/or the patent claims are fully disclosed, independent of their specific illustration in the Figures.

CLAIMS:

1. A mechanical face seal, comprising:

a rotating counter ring having a sealing surface, the counter ring including:

a first axial projection that protrudes from a radial plane of the counter ring and is disposed at a radially outer end of the counter ring; and

a second axial projection that protrudes from the radial plane and is spaced from and facing a radially inner end of the counter ring, wherein the second axial projection is disposed at a distance from the first axial projection and the first projection protrudes further from the radial plane than the second projection; and

a stationary face seal ring having a sealing surface, the sealing surface of the counter ring being disposed opposite from the sealing surface of the face seal ring, the sealing surfaces of the counter ring and the face seal ring bearing against each other;

wherein the first axial projection and the second axial projection protrude away from the stationary face seal.

2. The mechanical face seal according to claim 1, wherein the radial plane faces away from the sealing surface of the counter ring.

3. The mechanical face seal according to claim 1, wherein the first projection has a trapezoidal cross section.

4. The mechanical face seal according to claim 1, wherein the second projection has a trapezoidal cross section.

5. The mechanical face seal according to claim 1, wherein the projections have rounded-off edges.

6. The mechanical face seal according to claim 1, wherein the face seal ring includes an axial projection having a radially inner flank with recesses.

7. The mechanical face seal according to claim 6, wherein the radially inner flank has a stepped configuration.

8. The mechanical face seal according to claim 6, wherein the radially inner flank opens up into a first radial plane of the face seal ring and a radially outer flank of the face seal ring opens up into a second radial plane of the face seal ring, and the first and the second radial planes being disposed at different distances from the sealing surface of the face seal ring.

9. The mechanical face seal according to claim 1, wherein the face seal ring is pressed by a pressure ring against the counter ring, the pressure ring being supported via a spring element against a first housing wall, a sealing unit being disposed between the pressure ring and a second housing wall and between the pressure ring and the face seal ring, the sealing unit having a first and a second sealing element that are uncoupled and separate from each other.

10. The mechanical face seal according to claim 9, wherein the first sealing element bears exclusively against the face seal ring and against the pressure ring.

11. The mechanical face seal according to claim 9, wherein the second sealing element bears exclusively against the pressure ring and against the second housing wall.

12. The mechanical face seal according to claim 9, wherein the first sealing element is made of an elastomer.

13. The mechanical face seal according to claim 9, wherein the second sealing element is made of polytetrafluorethylene.

14. The mechanical face seal according to claim 9, wherein the second sealing element has a U-shaped cross section.

15. The mechanical face seal according to claim 1, wherein the face seal ring is pressed by a pressure ring against the counter ring, the pressure ring being supported via a spring element against a first housing wall, a sealing unit being disposed between the pressure ring and a second housing wall and between the pressure ring and the face seal ring, the pressure ring, together with the housing walls, delimiting a space that is shielded against ingress of dirt.

16. The mechanical face seal according to claim 15, wherein the pressure ring has an axially projecting annular wall with a radially outer surface disposed opposite from a radially inner end of the first housing wall.

17. The mechanical face seal according to claim 16, wherein the annular wall projects in an axial direction beyond the first housing wall.

18. The mechanical face seal according to claim 15, further comprising a passage disposed in at least one of the first and second housing walls configured to allow dirt to exit the space.

19. The mechanical face seal according to claim 1, wherein the counter ring has two radial planes each being associated with a clamping cam.

20. The mechanical face seal according to claim 19, wherein the clamping cams project in an axial direction from their respective radial planes.

21. The mechanical face seal according to claim 19, wherein the clamping cams are annular and coaxial with respect to the sealing surface of the counter ring.

22. The mechanical face seal according to claim 19, wherein the clamping cams have a same height on both sides of the counter ring in the radial direction.

23. An arrangement, comprising:

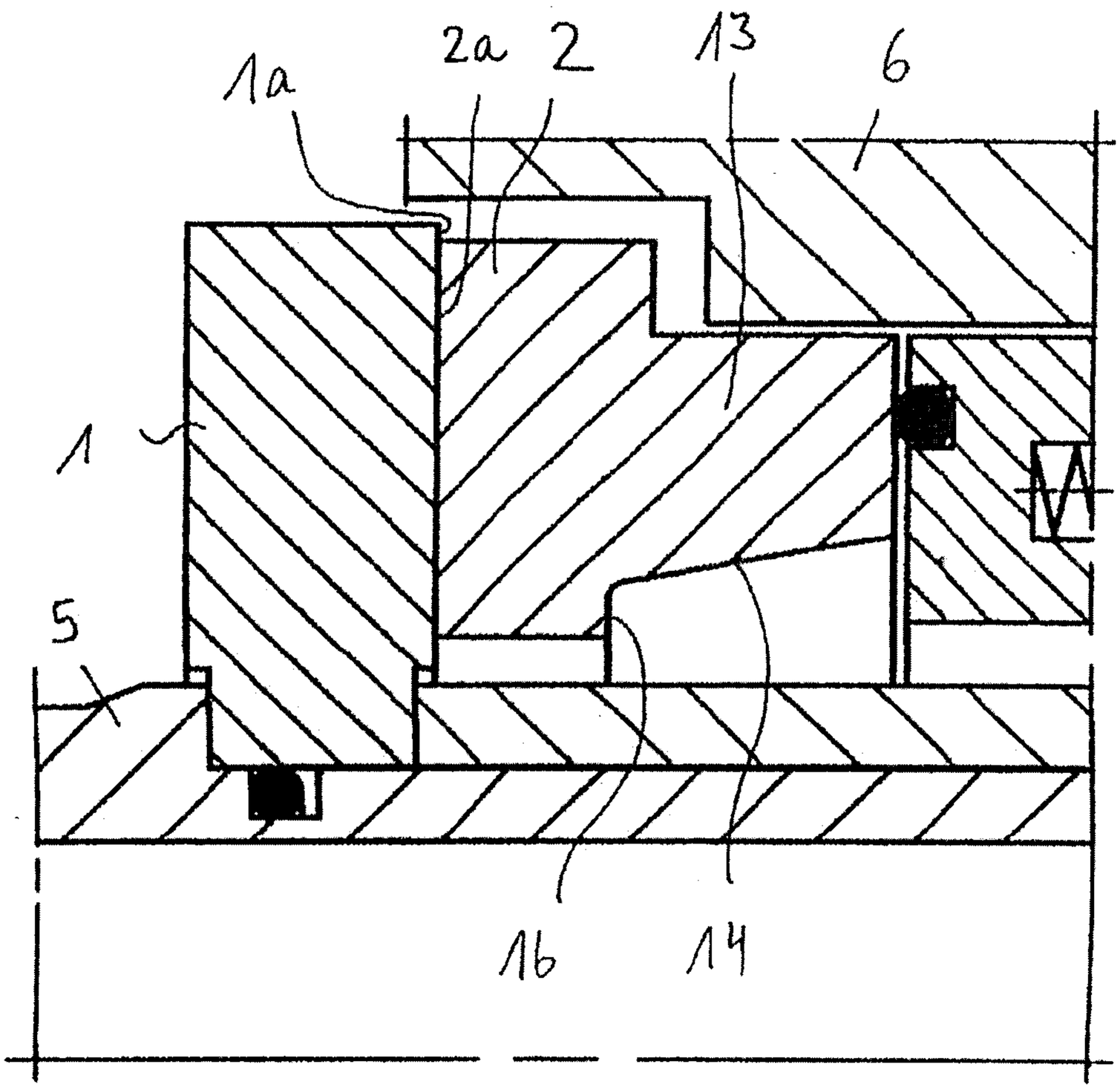
a mechanical face seal, comprising:

a rotating counter ring having a sealing surface, the counter ring including a first axial projection that protrudes from a radial plane of the counter ring and is disposed at a radially outer end of the counter ring and a second axial projection that protrudes from the radial plane and is spaced from and facing a radially inner end of the counter ring, wherein the second axial projection is disposed at a distance from the first axial projection and the first projection protrudes further from the radial plane than the second projection;

a stationary face seal ring having a sealing surface, the sealing surface of the counter ring being disposed opposite from the sealing surface of the face seal ring, the sealing surfaces of the counter ring and the face seal ring bearing against each other; and

first and second clamping cams, and

a shaft, the counter ring being non-rotatably joined to the shaft via a clamping element and a bushing, the first clamping cam bearing against the bushing and the second clamping cam bearing against the clamping element.



PRIOR ART

Fig. 1

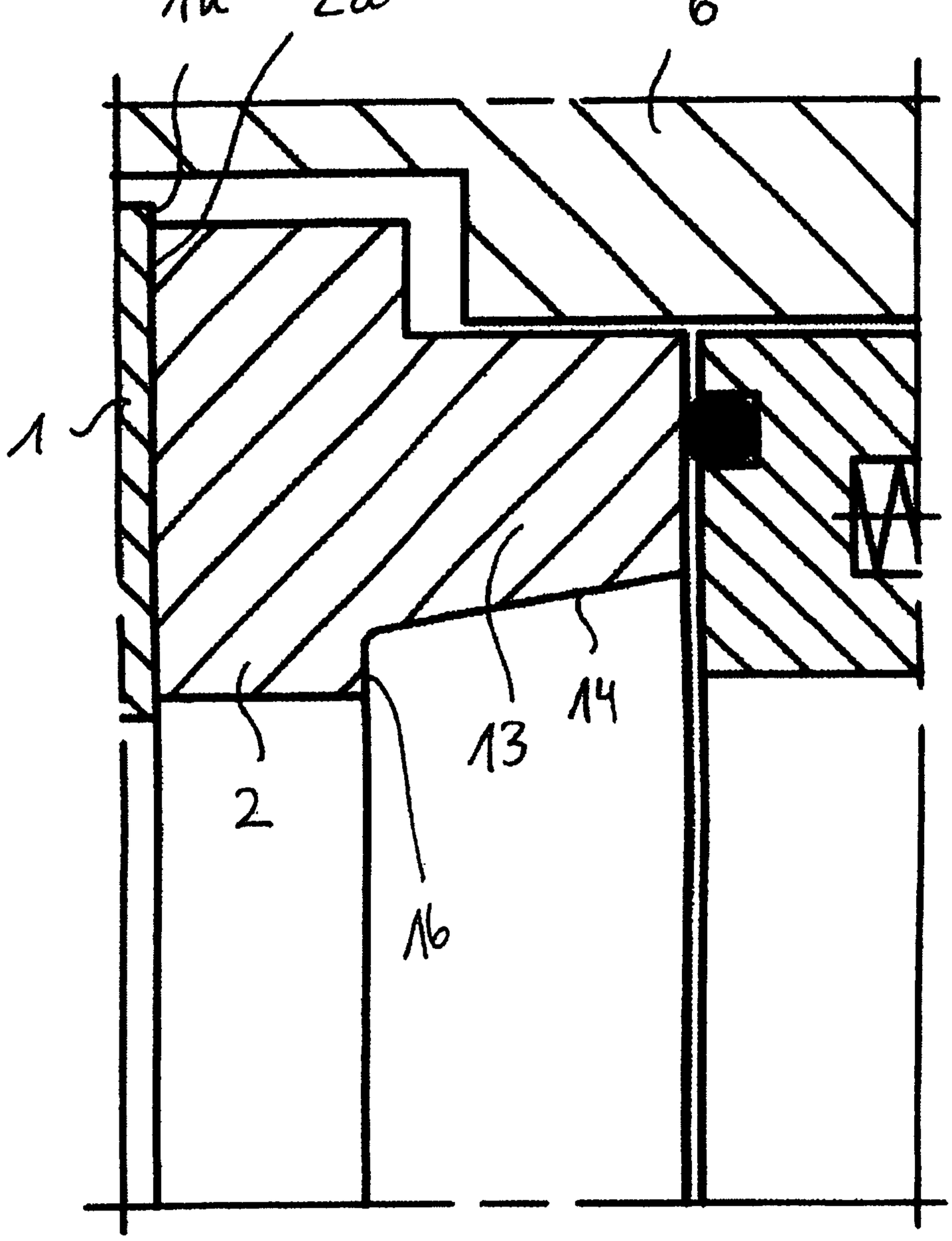
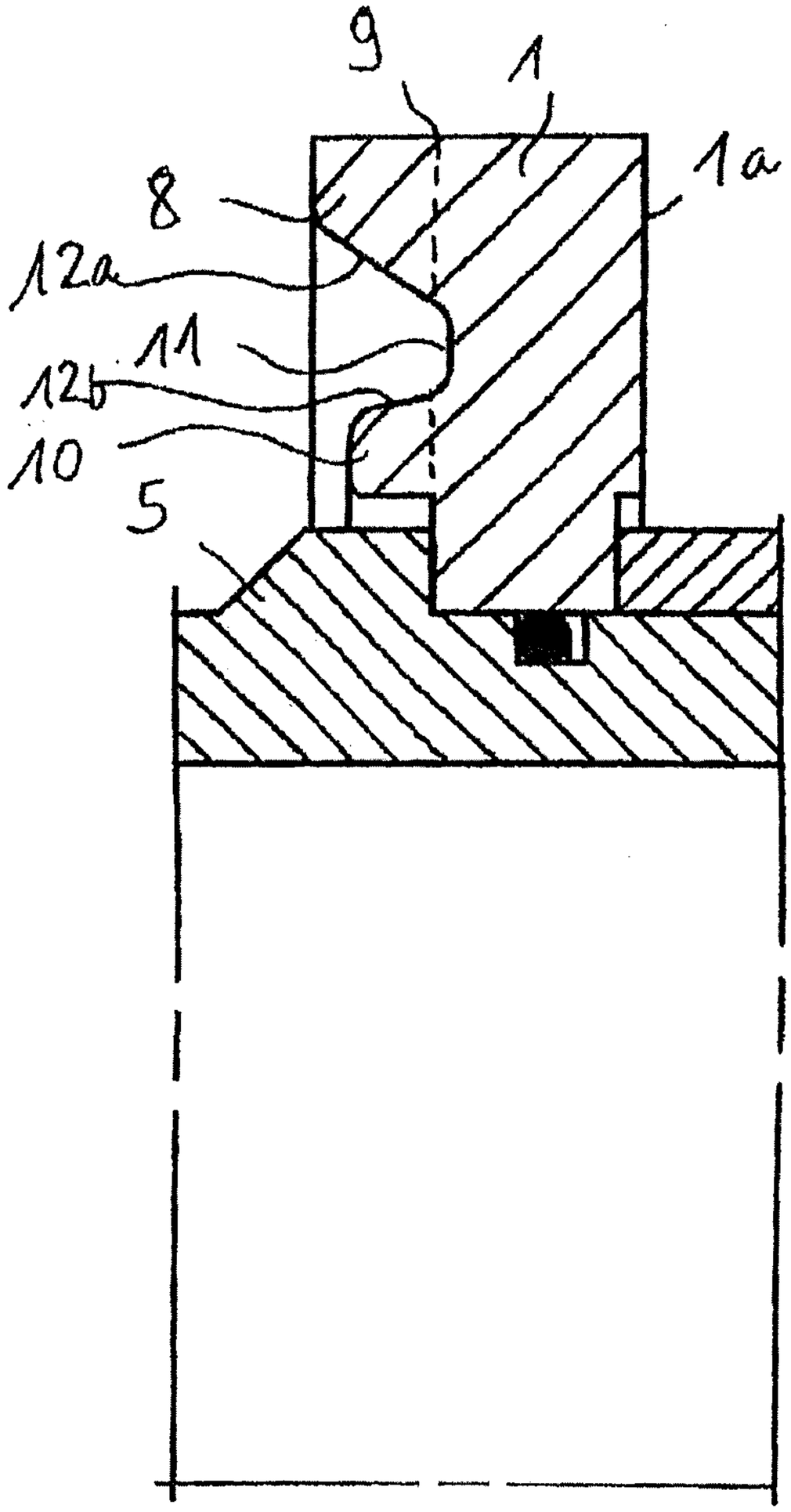


Fig. 2



PRIOR ART

Fig. 3

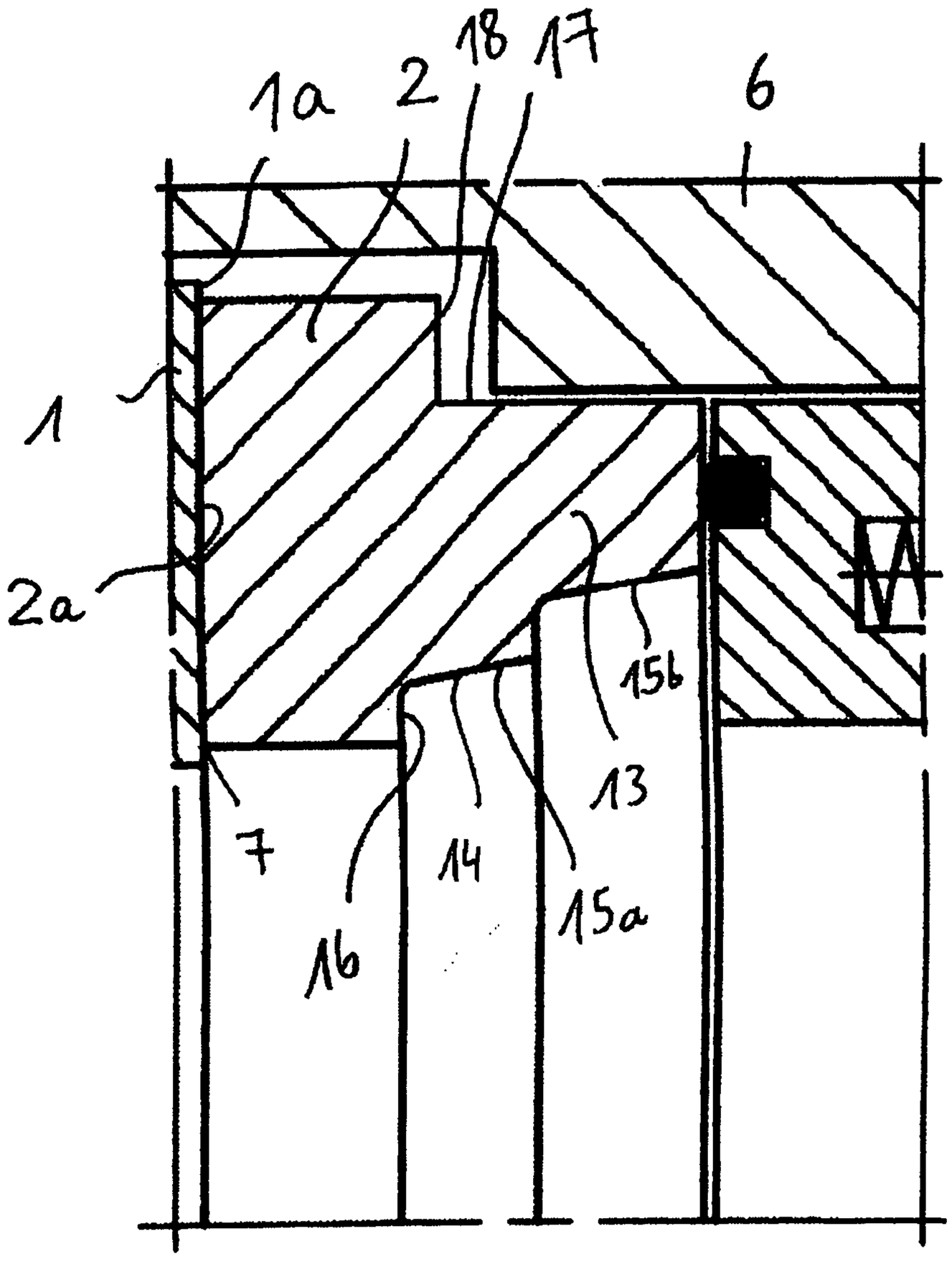
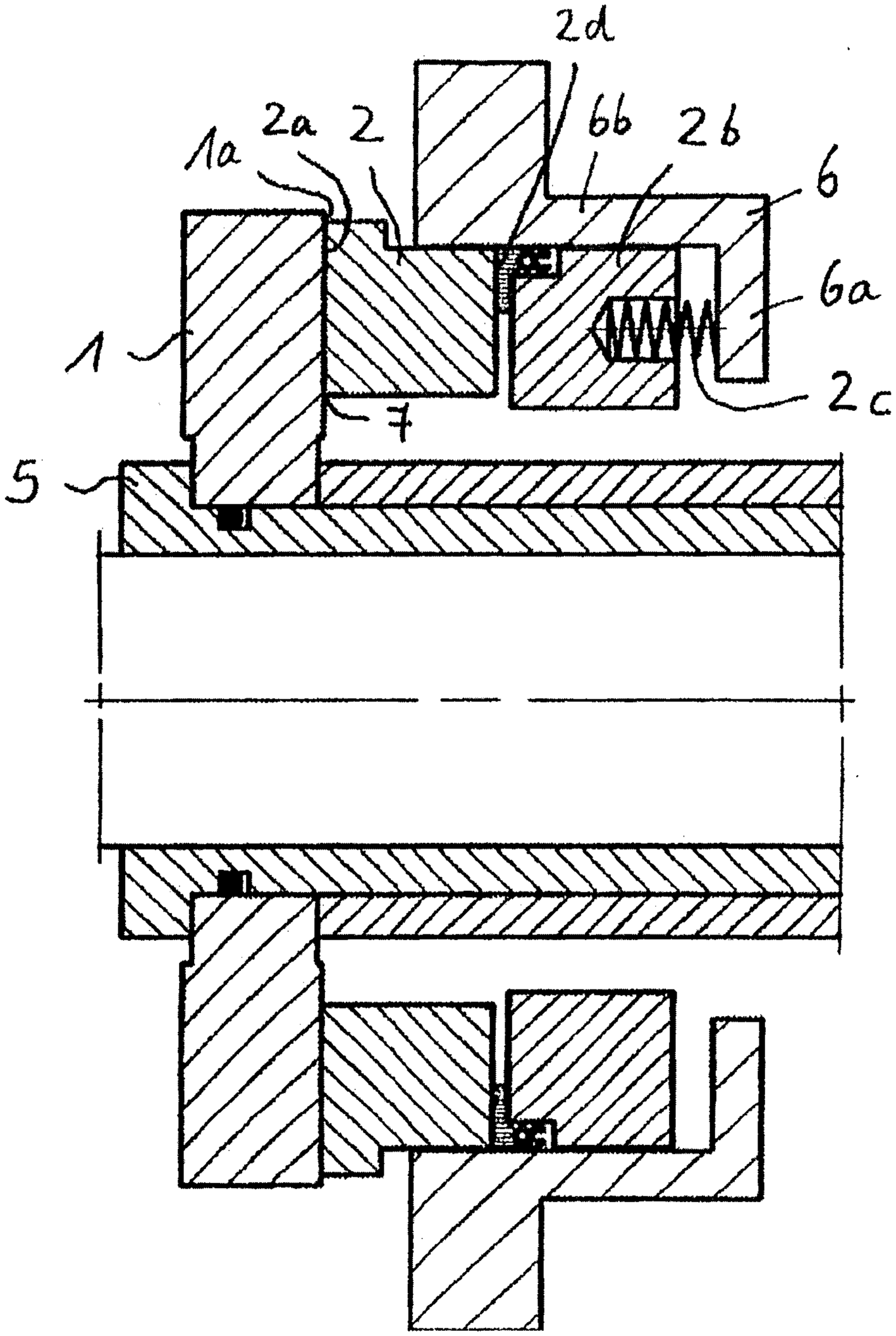


Fig. 4



PRIOR ART

Fig. 5

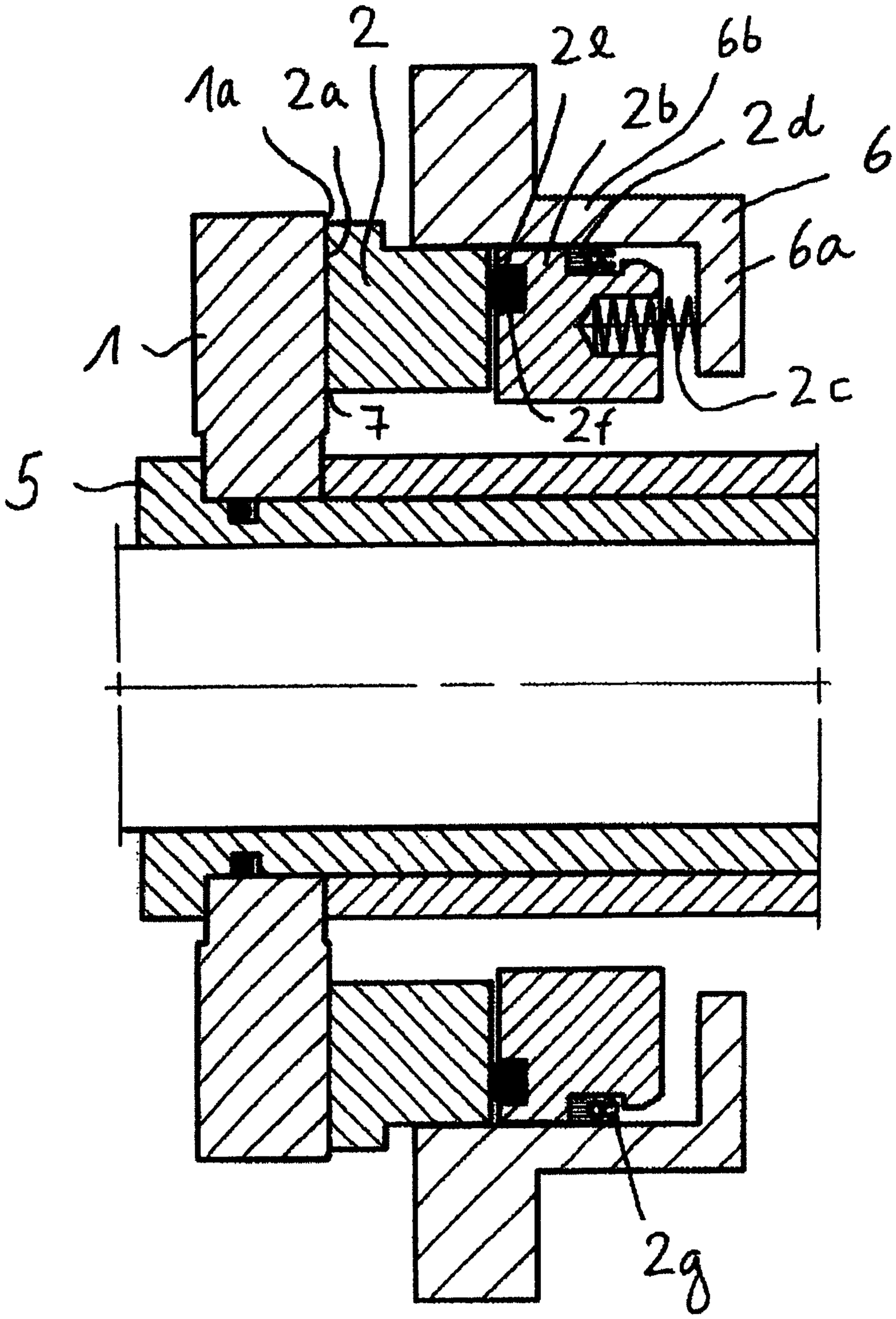
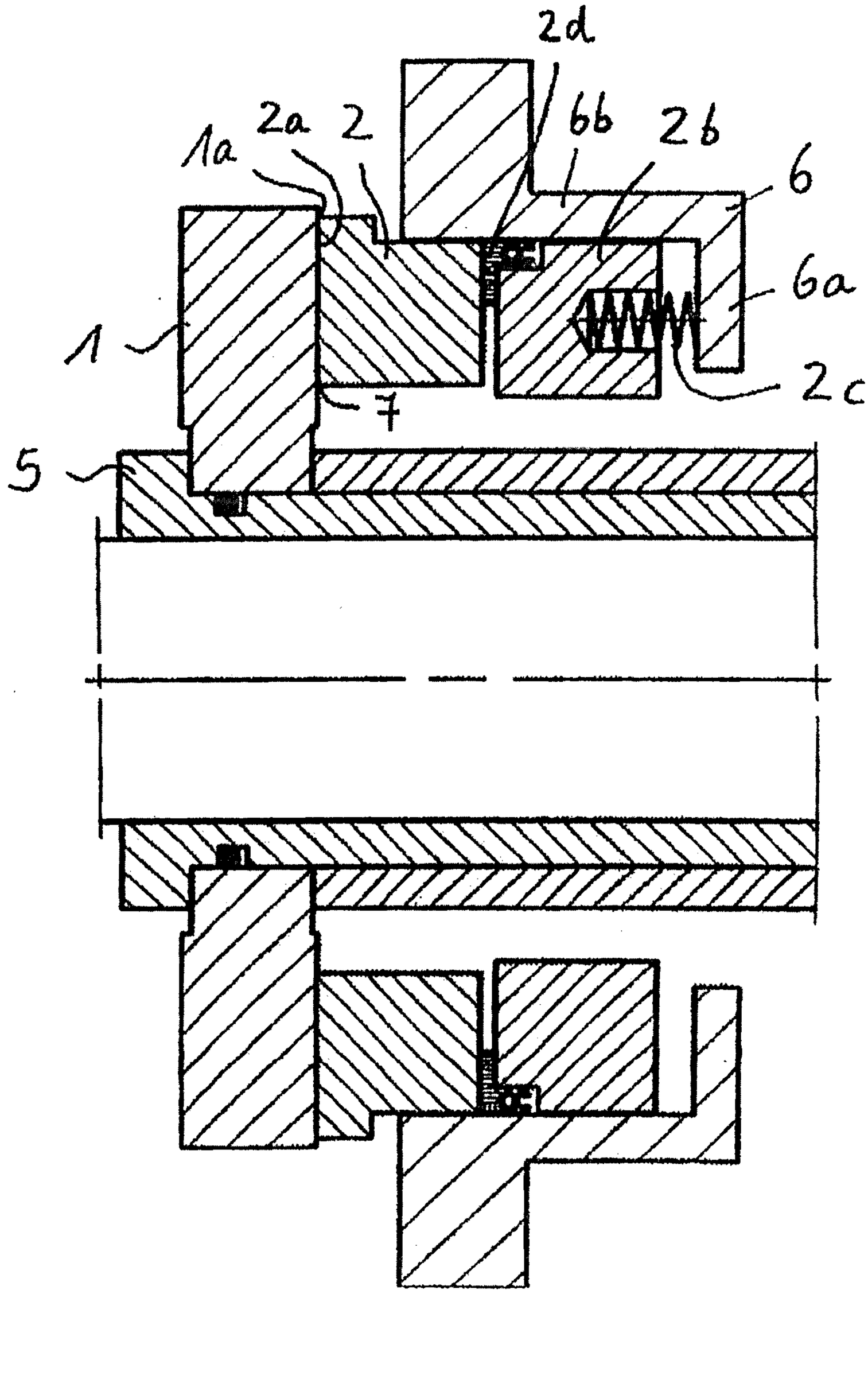


Fig. 6



PRIOR ART

Fig. 7

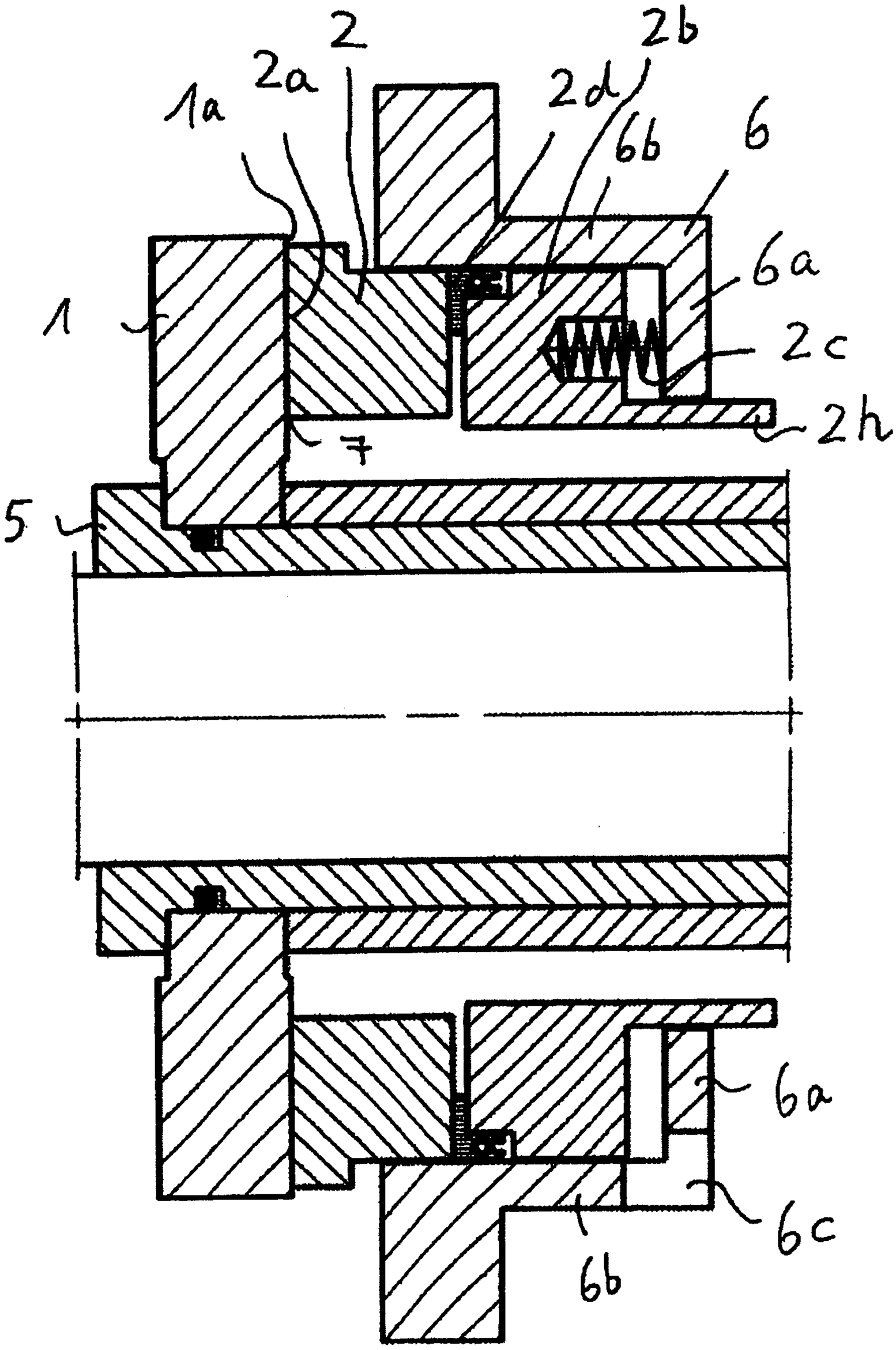
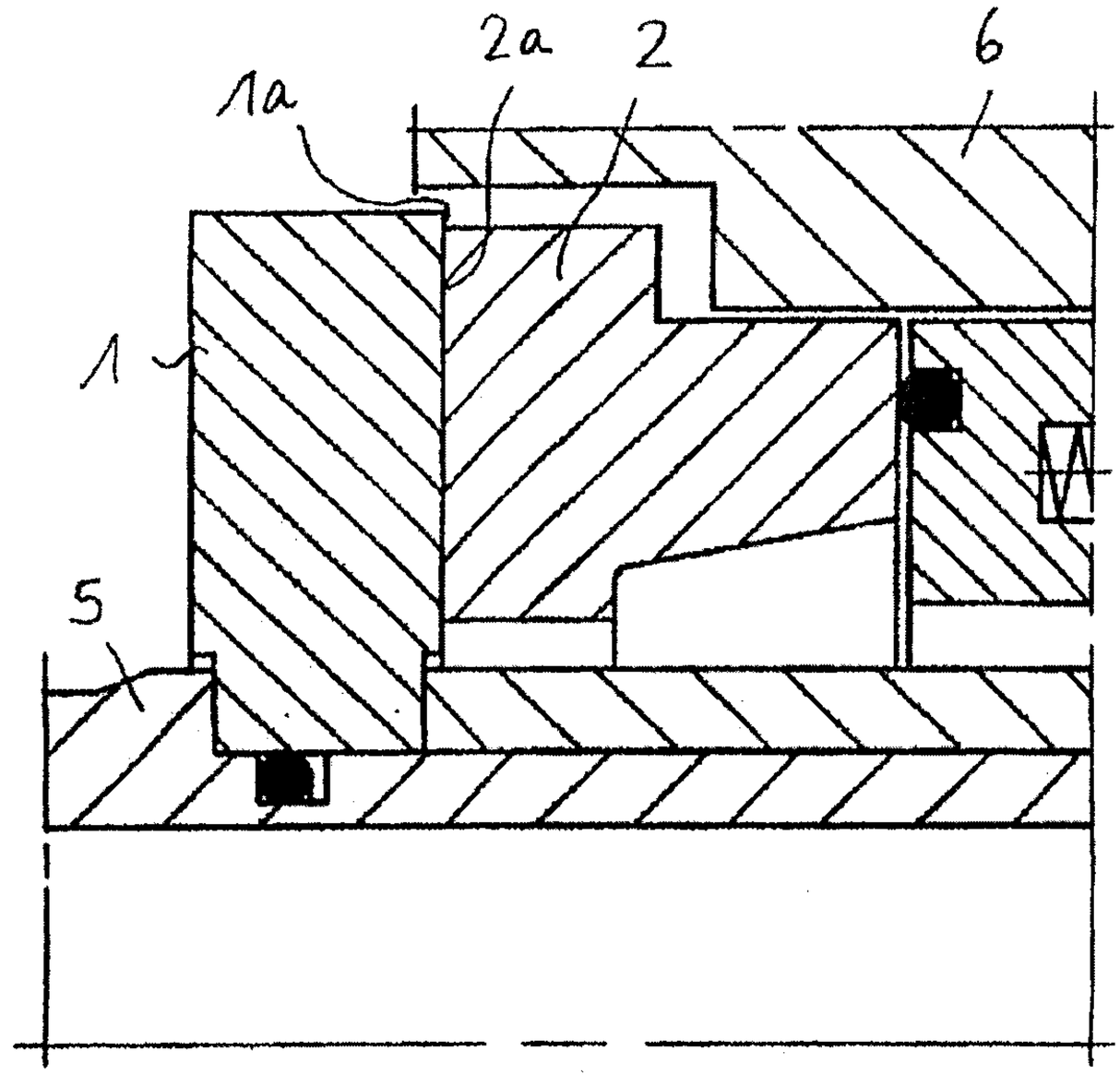


Fig. 8



PRIOR ART

Fig. 9

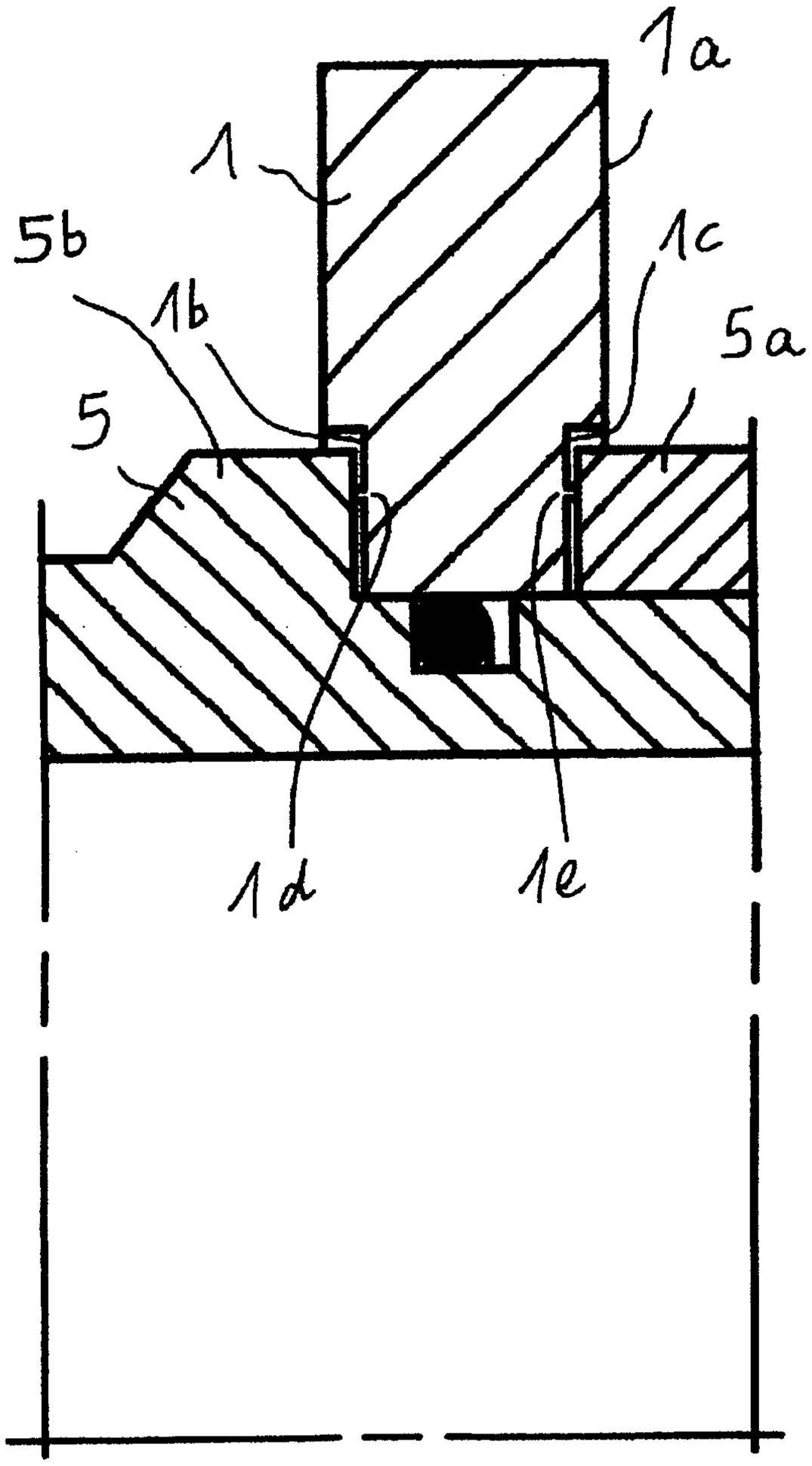
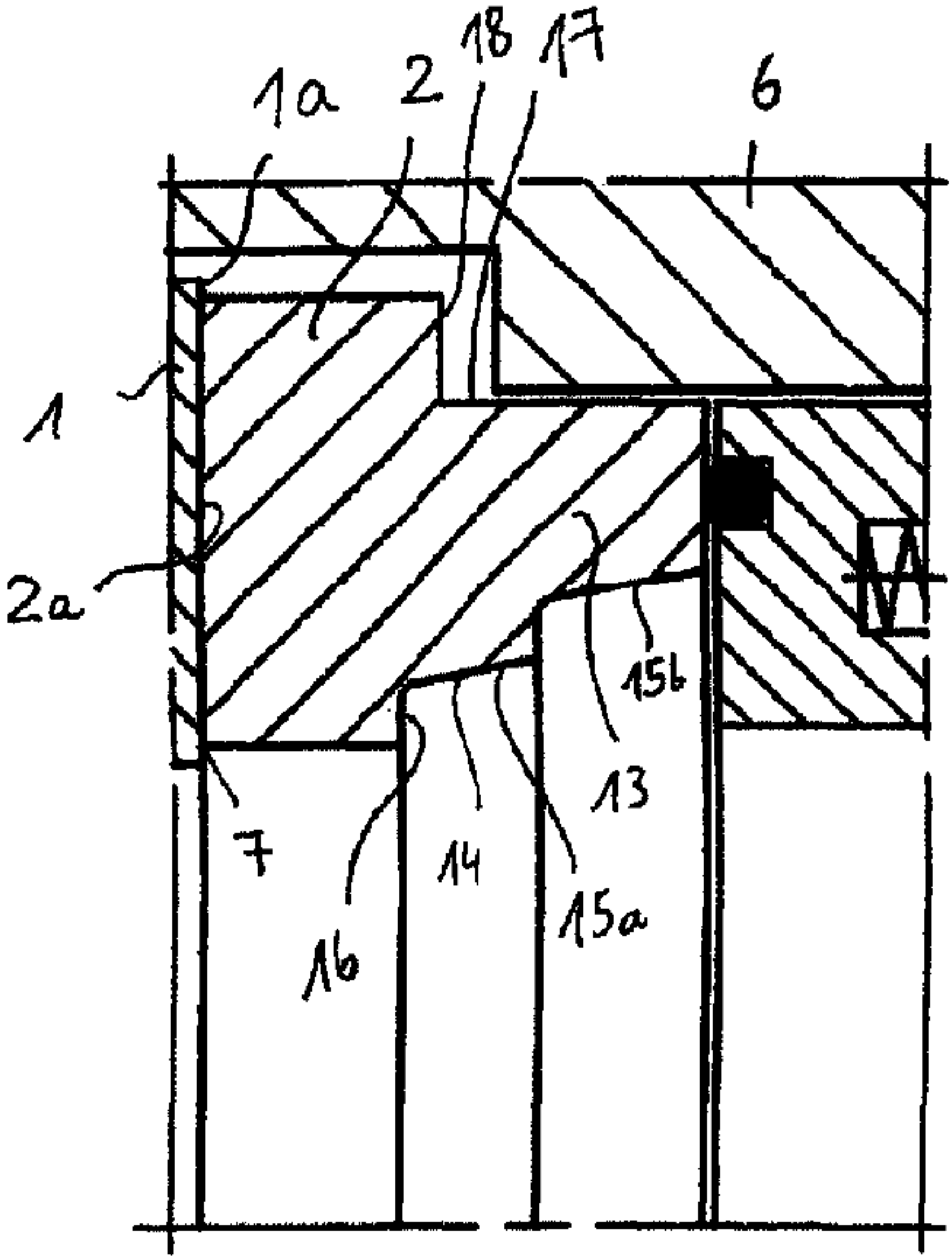


Fig. 10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